Appendix A: Data Forms (Manufacturing and EOL)

DESIGN FOR THE ENVIRONMENT
TOXICS USE REDUCTION INSTITUTE
WIRE & CABLE PROJECT
Life-Cycle Inventory (LCI) Data

Introduction

In March 2004, the Design for the Environment (DfE) Program in the U.S. Environmental Protection Agency's (EPA) Office of Pollution Prevention and Toxics (OPPT) and the Toxics Use Reduction Institute (TURI) at the University of Massachusetts Lowell formed a partnership to help the Wire and Cable industry assess the life-cycle environmental impacts of standard and alternative wire and cable formulations. The DfE Program conducts comparative analyses of alternative products or processes to provide businesses with data to make environmentally informed choices about product or Program has no regulatory or enforcement agenda and was established to act as a partner with industry to promote pollution prevention. TURI helps industries, institutions, and communities implement toxics use reduction as a means of achieving both a cleaner environment and a healthy economy. This environmental life-cycle assessment will address human and environmental impacts (e.g., energy, natural resource use, global warming, chronic toxicity) of various wire and cable formulations. Abt Associates Inc. is conducting the life-cycle inventory (LCI), which is the data collection phase of a life-cycle assessment, with technical assistance from the industry partners.

Boundaries

A *life-cycle* assessment considers impacts from materials acquisition, material manufacturing, product manufacturing, use, and final disposition of a product. The LCI data are intended to be used to evaluate relative environmental impacts over the entire life cycle of a product. In this project, the product is a cable. Therefore, data associated with the materials and processes used directly in the manufacturing, use, and disposition of the product are relevant to the LCI and requested in the following tables. You will not need to include materials or energy *not directly* used in the production of the cable (e.g., general building heating and air conditioning).

Product focus

This project will evaluate standard and alternative formulations for three product types:

1. Category 6, riser-rated communication wire (CMR)
2. Category 6, plenum-rated communication wire (CMP)
3. Non-metallic sheathed cable as used in building wire (NM-B)

Most recent (or projected) production data are desired.

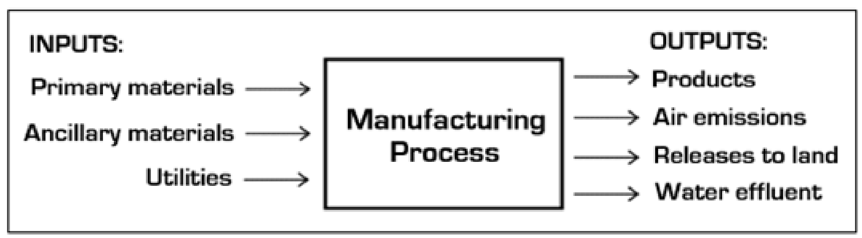

Fig. 1. Manufacturing process inventory conceptual template

Inventory data

We are asking for data on one or multiple "product(s) of interest," or the components of the product(s), that you manufacture, which may be one as defined above under Product Focus. The inputs and outputs data (Fig. 1) that you provide will be aggregated in the LCI to quantify the overall inputs and outputs of a wire and cable formulation over its life cycle. A separate set of forms should be completed for each cable of interest.

Data sources

Much of the requested information can be drawn from existing sources, including, but not limited to the following:

1. Purchase and production records
2. Bills and invoices
3. Material Safety Data Sheets (MSDS)
4. Toxic Release Inventory (TRI) forms
5. Audit and analysis results (e.g., wastewater discharge analyses)
6. Local, state, and federal reporting forms (e.g., hazardous waste manifests)
7. Local, state, and federal permits
8. Monthly utility billing records

How the data will be used

Abt Associates will collect inventory data and tally the inputs and outputs for the different wire and cable formulations. Information gathered in these forms will be used to develop environmental profiles based on inputs and outputs for the manufacturin

Results of project

The results are intended to provide industry with an analysis of the life-cycle environmental impacts of standard and alternative wire and cable formulations. Results will help identify areas for product and process improvement as related to risk and env

For any questions, please contact ***Maria Leet Socolof at 301.347.5344*** *, <maria_socolof@abtassoc.com> or* ***David Cooper at 865.591.8966*** *, <david_cooper@abtassoc.com> at Abt Associates Inc., 4800 Montgomery Lane, Suite #600, Bethesda, MD 20814. Fax: 301.652.753*

For more project details, see < http://www.epa.gov/dfe > and/or the Draft Final Goal Definition and Scoping Document.

INSTRUCTIONS

1. Please be sure to read the introductory text on each page before filling out the tables.
2. The data you supply in the tables should represent inputs and outputs associated only with the **"product of interest" (i.e., a wire and cable product or component as defined in the introduction under Product Focus, and what you specify in Table 2a, #1)**. If quantities provided are not specific to the "product of interest," please explain how they differ in the comments section at the bottom of the appropriate table. The ultimate goal is to quantify the amount of inputs and outputs per unit (e.g., ft) of cable manufactured.
3. Where supporting information is available as independent documents, reports, or calculations, please provide them as attachments with reference to the associated table(s).
4. If you have more than one product of interest to this project, please duplicate the forms and fill out one set of forms for each product.
5. If there is not adequate room on a page to supply your data (including comments), please copy the appropriate page and attach it to this packet.
6. The ensuing pages refer to the following indices to detail specifics about the data. Additional information is provided below as required.
   Data Quality Indicators Index: These indicators will be used to assess the level of data quality provided in the tables. Please report a DQI for the numerical value requested in each table on the following pages. The first category, **Measured**, pertains to a value that is a directly measured quantity. The second category, **Calculated**, refers to a value that required one or more calculation(s) to obtain. The third category, **Estimated**, refers to a value that required a knowledgable employee's professional judgement to estimate. Lastly, the fourth category, **Assumed**, should be used only when a number had to be speculatively estimated.
   Hazardous and Nonhazardous Waste Management Methods Index: These methods are applicable to both hazardous and nonhazardous wastes (Tables 7a and 7b). Please give the appropriate abbreviation in the Management Method column on p. 7 where requested. Depending on whether the management method is on or offsite, please indicate by specifying "on" or "off" in the appropriate column on p. 7.

For Tables 3 - 6:

Data Quality Indicators Index	
M	- Measured
C	- Calculated
E	- Estimated
A	- Assumed

For Tables 6a and 6b:

Wastewater Treatment/Disposal Methods Index	
A	- Direct discharge to surface water
B	- Discharge to offsite wastewater treatment facility
C	- Underground injection
D	- Surface impoundment (e.g., settling pond)
E	- Direct discharge to land
F	- Other (please specify in comments section)

For Tables 7a and 7b (also provided on page 10):

Waste Management Methods Index	
RU	- Reused
R	- Recycled
L	- Landfilled
S	- Solidified/stabilized
Iv	- Incinerated - volume reduction
Ie	- Incinerated - energy conversion
D	- Deep well injected
O	- Other (please specify in comments section)

IF YOU HAVE QUESTIONS, PLEASE CONTACT EITHER:

Maria L. Socolof: Phone: 301.347.5344
Email: maria_socolof@abtassoc.com

OR

David Cooper: Phone: 865.591.8966
Email: david_cooper@abtassoc.com

1. FACILITY & CONTACT INFORMATION

Table 1.

Facility Information		Contact Information	
1. Company name:		4a. Prepared by:	Date:
2. Facility name:		4b. Title:	
3. Facility address (location):		4c. Phone number:	Ext.:
		4d. Fax number:	
		4e. Email address:	

5. Major products manufactured onsite and their % of your total production (by weight or volume--and please specify):

2. PRODUCT OF INTEREST INFORMATION

NOTE: The *product of interest* is the product that you manufacture that is of interest to this project (e.g., cable, compounded pellets, heat stabilizer) for which the following forms should be completed

Table 2a.

1. **Wire and cable product** (please check the cable type that you manufacture, compound, or supply a component for).

☐ CMR (Cat 6) ☐ CMP (Cat 6) ☐ NM-B

2. Which **product alternatives** do you manufacture or supply to? (See Tables 2b, 2c, and 2d for descriptions of these alternatives.)

CMR	CMP	NM-B	
☐ Lead-stabilized cable (baseline)	☐ Lead-stabilized cable (baseline)	☐ Lead-stablized cable (baseline)	☐ Other (specify): ________
☐ Lead-free cable	☐ Lead-free cable	☐ Alternate lead-stabilized cable (alt plasticizer)	
☐ Other (specify): ________	☐ Other (specify): *e.g., deca-BDE-free*	☐ Lead-free cable	
________	________	☐ Halogen-free cable	

Note, for each alternative, please complete a separate set of forms (Tables 2-7) and specify at the top of each table which alternative the data represent.

3. Resin and additive **suppliers**: Please check the type of component and list the specific material you manufacture (see Tables 2b, 2c, and 2d for examples of the materials we are interested in receiving data for).

☐ Resin ________	☐ Flame retardant ________	☐ Plasticizer ________	☐ Processing Aid ________
☐ Filler ________	☐ Heat stabilizer ________	☐ Other ________	☐ N/A

4. Resin and additive **suppliers**: Please check the component for which you supply materials or products.

☐ Conductor insulation ☐ Cable jacketing

☐ Conductor jacketing ☐ Other (specify): ________

5. Please specify the product of interest for which the remainder of the forms will be completed (e.g., compounded pellets of PVC with additives used for CMP cable jacketing; lead-stabilized, baseline alternative):

____

6. Please provide a brief description of the main operations/subprocesses (e.g., compounding, extrusion) required to manufacture the product of interest: ________

____

____

7. Annual production (past, current, or projected) of product of interest (e.g., units of linear cable, kg of dibasic lead phthlate): ________

8. Year (or period of time) for which data are supplied (past, current, or projected): ________

9. Facility's percent global market share for product of interest (optional): ________

10. What % of the product of interest is recycled from your manufacturing process? ________ If recycled, (please check): ☐ **ON-SITE** ☐ **OFF-SITE**

a. If recycled on-site, how? ________

b. If recycled off-site, where? (please provide facility name and location if possible): ________

____

11. Do you have any information about post-consumer recycling of the product of interest? (We will collect more detailed information in Phase II of the study.): ☐ **YES** ☐ **NO**

THE FOLLOWING DATA ARE APPLICABLE TO THE ITEM SPECIFIED IN TABLE 2a, #5

3. PRIMARY & ANCILLARY INPUTS

1. Primary & Ancillary Materials: Primary materials are defined as those materials that become part of the final product. Ancillary materials are those material inputs that assist production, yet do not become part of the final product (e.g., cleaning materials). Please include the trade name and the generic name of each material where applicable.
2. CAS # or MSDS: Please include either the CAS (Chemical Abstract Service) number of each material (fill in the blank with the number) or state "MSDS" and append a copy to this document.
3. Annual quantity/units & Density/units: Please specify the annual amount of material consumed in the year of interest (as specified in Table 2a). Please use the units of mass-per-year (e.g., kg/yr, lb/yr). If you specify units of volume in lieu of mass, please provide the density. If *annual* quantities are not available, provide applicable units (e.g., kg/1000 kg of product).
4. Data quality indicators: See the Data Quality Indicators Index on p. iii for abbreviations. Please supply the DQI for the *annual quantity* value given.
5. Recycled content: Please specify the recycled content of each material identified. For example, 60/40/0 would represent a material that has 60% virgin material, 40% pre-consumer recycled and 0% post-consumer recycled content. Enter N/A (not applicable) for all components that are assemblies.

Table 3a. **Primary Materials**[1]	**CAS # or MSDS**[2]	**Annual Quantity**[3]	**Units**	**Density**[3]	**Units**	**DQI**[4]	**Recycled Content**[5]	**Country of origin of material (if known)**
EXAMPLE: GRTX resin (polypropylene resin)	*MSDS*	*450,000*	*kg/yr*	-----	---	*M*	*60/40/0*	USA
1.								
2.								
3.								
4.								
5.								
6.								
7.								
Primary material comments:								

Table 3b. **Ancillary Materials**[1]	**CAS # or MSDS**[2]	**Annual Quantity**[3]	**Units**	**Density**[3]	**Units**	**DQI**[4]	**Recycled Content**[5]	**Country of origin of material (if known)**
EXAMPLE: Petroleum naphtha (cleaning solvent)	*8032-32-4*	*920*	*liters/yr*	*0.96*	*kg/liter*	*C*	*100/0/0*	USA
1.								
2.								
3.								
4.								
5.								
6.								
7.								
Ancillary material comments:								

4. UTILITY INPUTS

1. Annual quantity/units: Please specify the amount of the utility consumed in year of interest (as sepcified in Table 2a). If possible, please exclude nonprocess-related consump If this is not possible, please include a comment that nonprocess-related consumption is included. If *annual* quantities are not available, provide applicable units (e.g., kg/1000 kg of product).
2. Data quality indicators: See the Data Quality Indicators Index on p. iii for abbreviations. Please supply the DQI for the *annual quantity* value given.
3. Individual Utility Notes:

Electricity:
The quantity of electricity should reflect only that used toward manufacturing the product of interest (identified on p. 2). One approach would be to start with your facility's to electrical energy consumption, remove nonprocess-related consumption, then estimate what portion of the remaining consumption is related to the specific operations of intere Please include consumption in all systems that use electricity for process-related purposes. Some examples include compressed air, chilled water, water deionization, and HV consumption where clean or controlled environments are utilized.

Natural gas and LNG:
Please exclude all use for space heating or other nonprocess-related uses. If you choose to use units other than MCF (thousand cubic feet), please utilize only units of energy content or volume (e.g., mmBTU, therm, CCF).

Fuel oils:
Please use units of either volume or energy content (e.g., liters, mmBTU, MJ). Additionally, if the fuel oil is not delivered by underground pipeline, please include the associa transportation information.

All waters (e.g., DI, city):
Please include all waters received onsite. Please indicate consumption in units of mass or volume.

Table 4.	**Utilities[3]**	**Annual Quantity[1]**	**Units**	**DQI[2]**
1.	Electricity		e.g., MJ	
2.	Natural gas		e.g., MCF	
3.	Liquified natural gas (LNG)		e.g., MCF	
4.	Fuel oil - type #2 (includes distillate and diesel)		e.g., liters	
5.	Fuel oil - type #4		e.g., liters	
6.	Fuel oil - type #6 (includes residual)		e.g., liters	
7.	Other petroleum-based fuel		e.g., liters	
8.	Water		e.g., liters	
9.				
10.				
11.				
12.				
13.				
Utility comments:				

5. AIR EMISSIONS

1. Air emissions: The emissions listed in the table below are some of the more common ones found in air release inventories; if you have information on other specific emissions, please provide them in the space provided. If you have any reporting forms or other air emission records for applicable year, please attach copies to this questionnaire. Also, if you have information on stack as well as fugitive emissions, please copy this page and place each set of emissions on a different page. The energy consumed in any equipment used onsite to treat air emissions should be included in the utilities values on p. 7.
2. Annual quantity/units: Please specify the amount of air emissions generated and released to the environment in the year of interest (as specified in Table 2a). If the emissions data are for a different year, please specify the year in the comments section below. Please use units of mass-per-year (e.g., kg/yr, lb/yr). If *annual* quantities are not available, provide applicable units (e.g., kg/1000 kg of product).
3. Data quality indicators: See the Data Quality Indicators Index on p. iii for abbreviations. Please supply the DQI for the *annual quantity* value given.

Table 5. **Air Emissions**[1]	**CAS number**	**Annual Quantity**[2]	**Units**	**DQI**[3]
Total particulates	-----			
Particulates < 10 microns (PM-10)	-----			
Sulfur oxides (SOx)	-----			
Nitrogen oxides (NOx)	-----			
Carbon monoxide	630-08-0			
Carbon dioxide	124-38-9			
Methane	74-82-8			
Benzene	71-43-2			
Toluene	108-88-3			
Xylenes	1330-20-7			
Naphthalene	91-20-3			
Total nonmethane VOCs	-----			
Other speciated hydrocarbon emissions:				
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				

Table 5 (continued). **Air Emissions**[1]	**CAS number**	**Annual Quantity**[2]	**Units**	**DQI**[3]
Ammonia	7664-41-7			
Arsenic	7440-38-2			
Chromium	7440-47-3			
Copper	7440-50-8			
Lead	7439-92-1			
Manganese	7439-96-5			
Mercury	7439-98-7			
Nickel	7440-02-0			
Other emissions:				
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				

Air emission comments:

6. WASTEWATER RELEASES & CONSTITUENTS

1. Annual quantity/units: Please specify the amount of wastewater(s) generated in the year of interest (as specified in Table 2a). Please use units of mass-per-year (e.g., kg/yr, lb/yr). If multiple streams exist, please copy this page and fill it out for each stream. If *annual* quantities are not available, provide applicable units (e.g., kg/1000 kg of product).
2. Wastewater treatment/disposal method: See the Wastewater Treatment/Disposal Methods Index on p. iii for method abbreviations.
3. Data quality indicators: See the Data Quality Indicators Index on p. iii for abbreviations. Please include one DQI for the annual wastewater stream quantity value supplied, and one DQI for the wastewater constituents information supplied. If more than one DQI is applicable to the wastewater constituents data, please clarify this in the comment section.
4. Wastewater constituents: Please let us know what type of values you are supplying (e.g., daily maximums, monthly averages, annual averages). Additionally, if you have any reporting forms of other wastewater constituent records for the year of interest, please attach them to this questionnaire. The energy consumed in any equipment used onsite to treat wastewater releases should be included in the utilities values on p. 7.
5. Concentration/units: Please specify the concentration of wastewater constituents generated in the year of interest. Please use units of mass-per-volume (e.g., mg/liter, lb/gal).

Table 6a. **Wastewater Stream**	**Annual Quantity**[1]	**Units**	**Treatment/Disposal Method**[2]	**DQI for Annual Quantity**[3]	**DQI for Constituents below**[3]

Table 6b. **Wastewater Constituents**[4]	**CAS number**	**Concentration**[5]	**Units**
Dissolved solids	-----		
Suspended solids	-----		
Carbonaceous Oxygen Demand (COD)	-----		
Biological Oxygen Demand (BOD)	-----		
Oil & grease	-----		
Hydrochloric acid	7647-01-0		
Sulfuric acid	7664-93-9		
Other acids (please specify):			
1.			
2.			
Phosphorus			
Phosphates			
Sulfates			
Fluorides			
Cyanide			
Chloride			
Chromium			
Aluminum			
Nickel			

Table 6b (continued). **Wastewater Constituents**[4]	**CAS number**	**Concentration**[5]	**Units**
Mercury	7439-98-7		
Lead	7439-92-1		
Nitrogen			
Zinc			
Tin			
Ferrous sulfate			
Ammonia	7664-41-7		
Nitrates			
Pesticides			
Other speciated constituents:			
1.			
2.			
3.			
4.			
5.			
6.			

Wastewater comments:

7. HAZARDOUS & NONHAZARDOUS WASTES

1. Hazardous wastes and EPA hazardous waste numbers: Please list your waste streams that are considered hazardous by the U.S. EPA. Include the hazardous waste codes for any hazardous waste you include. Nonhazardous wastes can include by-products and co-products that are reused, reintroduced, or recycled back into the product.
2. Annual quantity/units & Density/units: Please specify the amount of waste generated in the year of interest (as specified in Table 2a). Use units of mass-per-year (e.g., kg/yr, lb/yr). Please also provide the density for each waste. If *annual* quantities are not available, provide applicable units (e.g., kg/1000 kg of product).
3. Data quality indicators: See the Data Quality Indicators Index on p. iii for abbreviations. Please supply the DQI for the *annual quantity* value given.
4. Management method: See key to right of tables for Management Methods Index. If none are applicable, please indicate other and use the comments section to expound.

Table 7a. **Hazardous Wastes**[1]	**EPA Haz. Waste #**[1]	**Annual Quantity**[2]	**Units**	**Density**[2]	**Units**	**DQI**[3]	**Mgmt. method**[4]	**On or offsite?**
EXAMPLE: Spent solvent (toluene)	*F005*	*20,000*	*kg/yr*	*0.9*	*kg/liter*	*M*	*Ie*	*off*
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								

Hazardous waste comments:

Table 7b. **Nonhazardous Wastes**[1]	**Annual Quantity**[2]	**Units**	**Density**[2]	**Units**	**DQI**[3]	**Mgmt. method**[4]	**On or offsite?**
EXAMPLE: Waste metal chips	*22,000*	*kg/yr*	*1,000*	*kg/m3*	*C*	*R*	*off*
1.							
2.							
3.							
4.							
5.							
6.							
7.							

Nonhazardous waste comments:

Management Methods Index	
RU	Reused
R	Recycled
L	Landfilled
S	Solidified/stabilized
Iv	Incinerated-volume reduction
Ie	Incinerated-energy conversion
D	Deep well injected
O	Other (specify in comments)

INSTRUCTIONS

1. **We are looking to identify inputs and outputs associated with the recycling of cables at your facility.**

2. Please be sure to read all the notes on each page when filling out the questionnaire.

3. Where supporting information is available as independent documents, reports, or calculations, please provide them as attachments with reference to the associated table(s) in this questionnaire.

4. The following indices refer to information requested in the ensuing pages:

For Tables 2 - 5:

Data Quality Indicators Index	
M	- Measured
C	- Calculated
E	- Estimated
A	- Assumed

Data Quality Indicators Index: These indicators will be used to assess the level of data quality provided in the tables. Please report a DQI for the numerical value requested in each table on the following pages. The first category, **Measured**, pertains to a value that is a directly measured quantity. The second category, **Calculated**, refers to a value that required one or more calculation(s) to obtain. The third category, **Estimated**, refers to a value that required a knowledgeable employee's professional judgment to estimate. Lastly, the fourth category, **Assumed**, should be used only when a number had to be speculatively estimated.

For Tables 4a and 4b:

Wastewater Treatment/Disposal Methods Index	
A	- Direct discharge to surface water
B	- Discharge to offsite wastewater treatment facility
C	- Underground injection
D	- Surface impoundment (e.g., settling pond)
E	- Direct discharge to land
F	- Other (please specify in comments section)

For Table 5:

Waste Management Methods Index	
RU	- Reused
R	- Recycled
L	- Landfilled
S	- Solidified/stabilized
Iv	- Incinerated - volume reduction
Ie	- Incinerated - energy conversion
D	- Deep well injected
O	- Other (please specify in comments section)

Hazardous and Nonhazardous Waste Management Methods Index: These methods are applicable to both hazardous and nonhazardous wastes (Table 5). Please give the appropriate abbreviation in the Management Method column on p. 5 where requested. Depending on whether the management method is on or offsite, please indicate by specifying "on" or "off" in the appropriate column on p. 5.

Your cooperation and assistance are greatly appreciated.

*For any questions, please contact **Maria Leet Socolof at 301.347.5344** , <maria_socolof@abtassoc.com> or **David Cooper at 865.824.3362** , <david_cooper@abtassoc.com> at Abt Associates Inc., 4800 Montgomery Lane, Suite #600, Bethesda, MD 20814. Fax: 301.652.7530.*

1. FACILITY & PROCESS INFORMATION

Table 1a. **Facility Information** | **Contact Information**

Facility Information		Contact Information	
1. Company/Facility name:	___	3a. Prepared by:	___ Date: ___
2. Facility address (location):	___	3b. Title:	___
	___	3c. Phone number:	___ Ext.: ___
	___	3d. Fax number:	___
	___	3e. Email address:	___

Table 1b. Process Information

1. Briefly describe the main operations you use to recycle cable scrap ___

2a How much cable scrap does your facility recycle annually? ___ (mass/y)

2b Can you estimate the % of total worldwide or U.S. scrap cables that you recycle: ___ (% of worldwide scrap) ___ (% of U.S. scrap)

2c How much scrap cable do you expect to recycle

5 years?	___	(mass/y or % of all worldwide cables)	(mass/yr or % of U.S. scrap)
10 years?	___	(mass/y or % of all worldwide cables)	(mass/yr or % of U.S. scrap)
25 years?	___	(mass/y or % of all worldwide cables)	(mass/yr or % of U.S. scrap)
40 years?	___	(mass/y or % of all worldwide cables)	(mass/yr or % of U.S. scrap)

3. What % of the cable scrap you recycle is telecom cable? ___ %

4. What % of the cable scrap you recycle is building cable? ___ %

5. What % of your cable recycling operations are from:
   - post industrial waste (e.g., out-of-spec cables): ___ %
   - post consumer waste (e.g., end-of-life cables): ___ %

6. Do you generate air emissions from recycling cables? ___ If so, complete Table 3.

7. Does your cable recycling involve any wet processes that generate wastewater effluents? ___ If so, complete Tables 4a and 4b.

8. What do you do with the recovered plastic fraction? ___

9. What do you do with the recovered conductor? ___

10. What is the year (or period of time) of the data you are supplying (in the following tables)? ___

11. Facility's percent global market share for recycling cables (optional): ___

2. MATERIAL AND UTILITY INPUTS

Please provide the inputs associated with cable recycling

Table 2a. Input Streams & Materials[1]		Primary or ancillary[2]	CAS # or MSDS[3]	Annual Quantity[4]	Units	Density[4] (needed only if volume given)	Units	DQI[5]
EXAMPLE: Cable scrap		*P*	*NA*	*450,000*	*kg/yr*	-----	---	*M*
1.								
2.								
3.								
4.								
5.								

Material input comments:

Table 2b. Utility Inputs[1]		Annual Quantity[4]	Units	DQI[5]
EXAMPLE: Fuel oil #6 (includes residual)		*100*	*MJ*	*C*
1.	Electricity			
2.	Fuel (specify type):			
3.	Water			
4.	other fuels:			
5.				
6.				
7.				

Utility input comments:

NOTES:
1. Input Streams & Materials and Utility Inputs: Enter material inputs to the cable recycling operations (e.g., cable scrap) in Table 2a and utility inputs (e.g., electricity, fuel, water) in Table 2b.
2. Primary or Ancillary: Primary materials are defined as those materials that become part of the final product output. Ancillary materials are those material inputs that assist operations (e.g., lubricants).
3. CAS # or MSDS: For chemical compounds, please include either the CAS (Chemical Abstract Service) number of the material, or enter "MSDS" and append a copy of the MSDS.
4. Annual quantity/units & Density/units: Please specify the annual amount of material consumed (preferably in mass for Table 2a and either mass or energy for Table 2b). If you specify units of volume, please provide the density. If *annual* quantities are not available, provide applicable units (e.g., kg/1000 kg of product).
5. Data quality indicators: See the Data Quality Indicators Index on p. i for abbreviations. Please supply the DQI for the *annual quantity* value given.

3. AIR EMISSIONS

If you generate air emissions from your processes associated with cable recycling, please complete the following table.

Table 3. **Air Emissions**[1]	**CAS number**	**Annual Quantity**[2]	**Units**	**DQI**[3]
Total particulates	-----			
Particulates < 10 microns (PM-10)	-----			
Sulfur oxides (SOx)	-----			
Nitrogen oxides (NOx)	-----			
Carbon monoxide	630-08-0			
Carbon dioxide	124-38-9			
Methane	74-82-8			
Benzene	71-43-2			
Toluene	108-88-3			
Xylenes	1330-20-7			
Naphthalene	91-20-3			
Total nonmethane VOCs	-----			
Other speciated hydrocarbon emissions:				
1.				
2.				
3.				
4.				
5.				

Table 3 (continued). **Air Emissions**[1]	**CAS number**	**Annual Quantity**[2]	**Units**	**DQI**[3]
Ammonia	7664-41-7			
Arsenic	7440-38-2			
Chromium	7440-47-3			
Copper	7440-50-8			
Lead	7439-92-1			
Manganese	7439-96-5			
Mercury	7439-98-7			
Nickel	7440-02-0			
Other emissions:				
1.				
2.				
3.				
4.				
5.				

Air emission comments:

NOTES:

1. Air emissions: The emissions listed in the table above are some of the more common ones found in air release inventories; if you have information on other specific emissions, pl provide them in the space provided. If you have any reporting forms or other air emission records for the applicable year, please attach copies to this questionnaire. Also, if you h information on stack as well as fugitive emissions, please copy this page and place each set of emissions on a different page. The energy consumed in any equipment used onsite t air emissions should be included in the utilities values in Table 2b.
2. Annual quantity/units: Please specify the amount of air emissions generated and released to the environment in the year of interest (as specified in Table 1b). If the emissions dat are for a different year, please specify the year in the comments section below. Please use units of mass-per-year (e.g., kg/yr, lb/yr). If *annual* quantities are not available, provic units (e.g., kg/1000 kg of product).
3. Data quality indicators: See the Data Quality Indicators Index on p. i for abbreviations. Please supply the DQI for the *annual quantity* value given.

4. WASTEWATER RELEASES & CONSTITUENTS

If you generate wastewater releases and constituents from your processes associated with cable recycling, please complete these tables.

Table 4a. **Wastewater Stream**	**Annual Quantity[1]**	**Units**	**Treatment/Disposal Method[2]**	**DQI for Annual Quantity[3]**	**DQI for Constituents below[3]**

Table 4b. **Wastewater Constituents[4]**	**CAS number**	**Concentration[5]**	**Units**
Dissolved solids	-----		
Suspended solids	-----		
Carbonaceous Oxygen Demand (COD)	-----		
Biological Oxygen Demand (BOD)	-----		
Oil & grease	-----		
Hydrochloric acid	7647-01-0		
Sulfuric acid	7664-93-9		
Other acids (please specify):			
1.			
2.			
Phosphorus			
Phosphates			
Sulfates			
Fluorides			
Cyanide			
Chloride			
Chromium			
Aluminum			
Nickel			

Table 4b (continued). **Wastewater Constituents[4]**	**CAS number**	**Concentration[5]**	**Units**
Mercury	7439-98-7		
Lead	7439-92-1		
Nitrogen			
Zinc			
Tin			
Ferrous sulfate			
Ammonia	7664-41-7		
Nitrates			
Pesticides			
Other speciated constituents:			
1.			
2.			
3.			
4.			
5.			
6.			

Wastewater comments:

NOTES:

1. Annual quantity/units: Please specify the amount of wastewater(s) generated in the year of interest (as specified in Table 1b). Please use units of mass-per-year (e.g., kg/yr, lb/yr). If multiple streams exist, please copy this page and fill it out for each stream. If *annual* quantities are not available, provide applicable units (e.g., kg/1000 kg of product).
2. Wastewater treatment/disposal method: See the Wastewater Treatment/Disposal Methods Index on p. i for method abbreviations.
3. Data quality indicators: See the Data Quality Indicators Index on p. i for abbreviations. Please include one DQI for the annual wastewater stream quantity value supplied, and one DQI for the wastewater constituents information supplied. If more than one DQI is applicable to the wastewater constituents data, please clarify this in the comment section.
4. Wastewater constituents: Please let us know what type of values you are supplying (e.g., daily maximums, monthly averages, annual averages). Additionally, if you have any reporting forms of other wastewater constituent records for the year of interest, please attach them to this questionnaire. The energy consumed in any equipment used onsite to treat wastewater releases should be included in the utilities values in Table 2b.
5. Concentration/units: Please specify the concentration of wastewater constituents generated in the year of interest. Please use units of mass-per-volume (e.g., mg/liter, lb/gal).

5. OUTPUTS -- PRODUCTS AND SOLID WASTE

Please list the product and solid waste streams generated by your processes associated with cable recycling.

Table 5. Output Streams[1]	Annual Production[2]	Units	DQI[3]	Density[4] (needed only if landfilled)	Units	Management Method[5]	On or Offsite?	Hazardous Waste?[6]
EXAMPLE 1: Copper conductor	*100*	*kg/y*	*C*	----	----	*Sm**	*off*	*N*
EXAMPLE 2: Lubricant	*1,000*	*kg/yr*	*M*	*0.9*	*kg/liter*	*L*	*off*	*N*
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								
Waste comments:								

NOTES:

1. Output Streams: This includes "product outputs that are sent for further processing or recycling as well as solid wastes (nonhazardous or EPA hazardous waste) that are treated or disposed of.
2. Annual Production & units: Please specify the amount of the output stream generated in the year of interest. Use units of mass-per-year (e.g., kg/yr, lb/yr).
3. Data Quality Indicator: See the Data Quality Indicators Index on p. i for abbreviations. Please supply the DQI for the *annual quantity* value given.
4. Density: Please provide the approximate bulk density for any waste that is landfilled (this will be used to calculate volume of landspace used).
5. Management Method: Please supply the follow-up processing method or the treatment/disposal method for each output stream . See the Waste Management Methods Index on abbreviations. If none are applicable, please indicate "other" and explain in the comments section.
6. Hazardous Waste?: If the output is a solid waste stream, is it an EPA Subtitle C hazardous waste? Indicate Yes or No.

Appendix B: Fire Scenario: Estimation of Frequency of Structure Fires in Buildings Containing CMR / CMP Cables and NM-B Cables

The EOL distribution of pathways for wire and cable characterizes a portion of wire and cable as prematurely reaching the end of its life due to building fires. The annual quantity of wire and cable reaching it end-of-life state in this way may be calculated given data on the total amount of wire and cable installed in buildings, the annual frequency of fires in buildings containing cable, and the average damage caused by those fires.

Only data regarding the existing amount of wire and cable were readily available. This appendix describes a calculation made to estimate the annual frequency of structure fire containing CMR, CMP, and NM-B cables (calculated to be 1.1 percent of buildings containing CMR / CMP cables and 0.5 percent of cables containing NM-B cables). The third factor, the average cable loss per building fire is discussed in Section 2.4.5.1 of this report.

Methodology

The annual frequency of fires in buildings containing CMR / CMP / NM-B cables is estimated using the following formulas:

- Annual frequency of fires in buildings with CMR = # of fires each year in buildings containing CMR / # of buildings containing CMR
- Annual frequency of fires in buildings with CMP = # of fires each year in buildings containing CMP / # of buildings containing CMP
- Annual frequency of fires in buildings with NM-B = # of fires each year in buildings containing NM-B / # of buildings containing NM-B

Universe of Buildings

The universes of buildings used in the denominators of these equations were compiled from various sources of data and are listed in Tables B-1 through B-4 below. CMR and CMP cables were assumed to be found in only certain commercial buildings. Table B-5 displays a summary of the total universe of buildings and the number of buildings estimated to have CMR, CMP, and NM-B cables.

Table B-1 Universe of Residential Buildings

Type of Housing Unit	Estimated Number of Housing Units[1]	Assumed Number of Housing Units per Building	Calculated Number of Buildings
Single, detached	76,112,065	1	76,112,065
Single, attached	7,063,608	1	7,063,608
2	5,029,858	2	2,514,929
3 or 4	5,723,743	3.5	1,635,355
5 to 9	6,179,145	7	882,735
10 to 19	5,594,120	15	372,941
20 to 49	4,252,727	30	141,758
50 or more	5,734,117	100	57,341
Mobile Home	8,737,428	1	8,737,428
Boat, RV, van, etc.	95,075	1	95,075
Total	**124,521,886**		**97,613,235**

[1]Data taken from 2005 American Community Survey, http://factfinder.census.gov/servlet/DTTable?_bm=y&-geo_id=01000US&-ds_name=ACS_2005_EST_G00_&-SubjectID=14573966&-redoLog=true&-mt_name=ACS_2005_EST_G2000_B25024&-format=&-CONTEXT=dt

Table B-2 Universe of Commercial Buildings[1]

Principal Building Use	Number of Buildings	Number of Buildings with CMR / CMP
Education	386,000	386,000
Food Sales	226,000	226,000
Food Service	297,000	297,000
Health Care – Inpatient	8000	8000
Health Care – Outpatient	121000	121000
Lodging	142,000	142,000
Mercantile – Retail (Other than Mall)	443000	443000
Mercantile – Enclosed and Strip Malls	213000	213000
Office	824,000	824,000
Public Assembly	277,000	
Public Order and Safety	71,000	71,000
Religious Worship	370,000	
Service	622,000	622,000
Warehouse and Storage	597,000	
Other	79,000	79,000
Vacant	182,000	182,000
Total	**4,859,000**	**3,615,000**

[1]Data taken from 2003 Commercial Buildings Energy Consumption Survey (CBECS), http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set1/2003pdf/a1.pdf.

Table B-3 Universe of Industrial Buildings[1]

	Number of Establishments	Assumed Number of Buildings per Establishment	Calculated Number of Buildings
US Manufacturing Establishments	350,728	1	350,728
Total	350,728		350,728

[1]Data are from "Table 1: Statistics for all Manufacturing Establishments: 2005 and Earlier Years", from "Statistics for Industry Groups and Industries: 2005"; Annual Survey of Manufactures, and are for the year 2002. http://www.census.gov/prod/2006pubs/am0531gs1.pdf.

Table B-4 Universe of Agricultural Buildings[1]

	Number of Establishments	Assumed Number of Buildings per Establishment	Calculated Number of Buildings
Total Farms	2,128,982	1	2,128,982
Total	2,128,982		2,128,982

[1]Data are from Agriculture Census of the United States, 2002, NASS, Table 50 - Selected Characteristics of Farms by North American Industry Classification System: 2002.
http://www.nass.usda.gov/census/census02/volume1/us/st99_1_050_050.pdf

Table B-5 Universe of Buildings with CMR, CMP, and NM-B

Building Type	Number of Buildings in Universe	CMR	CMP	NM-B
Residential	97,613,235	0	0	97,613,235
Commercial	4,859,000	3,615,000	3,615,000	4,859,000
Industrial	350,728	0	0	350,728
Agricultural	2,128,982	0	0	2,128,982
Total	**104,951,945**	**3,615,000**	**3,615,000**	**104,951,945**

Universe of Structure Fires

Structure fires

Table B-6 Universe of Structure Fires and Number involving Buildings with CMR, CMP, and NM-B

Building Type	% of Structure Fires			Number of Structure Fires		
	Residential[1]	Non-Residential[2]	Total[1]	Total	CMR / CMP	NM-B
Residential - 1-/2-Family	72%		53.9%	275,575		275,575
Residential - Multifamily	25%		18.6%	94,920		94,920
Residential - Other	4%		2.9%	14,799		14,799
Non-Residential - Storage		30.9%	7.6%	38,843		38,843
Non-Residential - Business		19.8%	4.9%	24,890	24,890	24,890
Non-Residential - Assembly		14.1%	3.5%	17,725		17,725
Non-Residential - Manufacturing		9.9%	2.4%	12,445		12,445
Non-Residential - Special Property		9.0%	2.2%	11,314		11,314
Non-Residential - Health Care, Detention		6.6%	1.6%	8,297	8,297	8,297
Non-Residential - Educational		6.6%	1.6%	8,297	8,297	8,297
Non-Residential - Industrial		2.9%	0.7%	3,645		3,645
Total	**100%**	**99.8%**	**100.0 %**	**511,000**[3]	**41,483**	**511,000**

[1]Data are from U.S. Fire Administration/National Fire Data Center, "All Structure Fires in 2000," Figure 2. http://ww.usfa.dhs.gov/downloads/pdf/tfrs/v3i8.pdf.

[2]Data are from U.S. Fire Administration/National Fire Data Center, "Non-Residential Structure Fires in 2000," Figure 2. http://ww.usfa.dhs.gov/downloads/pdf/tfrs/v3i10.pdf.

[3]Data are from U.S. Fire Administration, "Structure Fires," 2005 value. http://www.usfa.dhs.gov/statistics/national/all_structures.shtm.

Table B-7 Calculation of Annual Frequency of Fires in Buildings Containing CMR, CMP, and NM-B Cables

Cable Type	Number of Buildings Containing Cable	Number of Structure Fires in Buildings Containing Cable	Annual Frequency of Fires
CMR	3,615,000	41,483	1.1%
CMP	3,615,000	41,483	1.1%
NM-B	104,951,945	511,000	0.5%

Note, the WCP assumes 10% of the cables in a fire are burned (see Section 2.4.5.1 of main report).

Appendix C: Waste Densities

Table C-1. Waste Densities for Landfill Space Use Impact Category

Flow	Density (D) (kg/m^3)	Reference	Note
Consumer Waste			
Industrial waste for municipal disposal	800	(7)	N/A
Inert chemical waste	445	(4)	N/A
Liquid waste	1000	N/A	Assumed the same density as water
Mineral waste	2560	(7)	Average of miscellaneous materials densities
Municipal waste	445	(4)	N/A
Packaging waste (metal)	267	(1)	Combined values for steel and aluminum packaging waste, weighted by the percentage each contributed to the packaging waste total.
Packaging waste (plastic)	192	(1)	Used value for total plastics packaging
Paper (unspecified)	472	(1)	Used landfill density of paper and paperboard packaging
PVC Waste	601	(2)	Average of PVC chips and resin
Unspecified industrial waste	800	(7)	Used value for Industrial waste for municipal disposal
Waste (unspecified)	445	(4)	N/A
Hazardous Waste			
Hazardous waste (unspec.)	445	(4)	N/A
Hazardous waste incineration products (25% water)	584	(4)	Assumed the value was equal to 75% of that for hazardous waste density, plus 25% of that for water
Inert chemical waste	445	(4)	N/A
Liquid hazardous waste	1000	N/A	Assumed the same density as water
Regulated chemicals	445	(4)	Used value for inert chemical waste
Slag	3000	(9)	N/A
Slags and ash	1900	(7) and (9)	Used average of values for slag and ash
Sludge	1000	(7)	N/A
Radioactive Waste			
CaF2 (low radioactivity)	3180	(3)	N/A
Highly radioactive waste	449	(4)	N/A
Highly-active fission product solution	1000	N/A	Assumed the same density as water

Table C-1. Waste Densities for Landfill Space Use Impact Category

Flow	Density (D) (kg/m^3)	Reference	Note
Jacket and body material	449	(4)	N/A
Low to mid level radioactive waste	449	(4)	Used value of medium and low radioactive wastes
Medium and low radioactive liquid waste	1000	N/A	Used density of water
Medium and low radioactive wastes	449	(4)	N/A
Plutonium as residual product	19800	(5)	Assumed elemental density
Radioactive tailings	449	(4)	Used "mining waste" value
Uranium depleted	19300	(6)	N/A
Uranium spent as residue	19000	(5)	Assumed elemental density
Volatile fission products (inert gases;iodine;C14)	11300	(5)	Used the density of iodine gas
Waste radioactive	449	(4)	Used "mining waste" value
Stockpile Goods			
Ash	800	(7)	N/A
Demolition waste	1900	(7) and (9)	Used average of values for slag and ash
Overburden	449	(4)	Used "mining waste" value
Tailings	449	(4)	Used "mining waste" value
Treatment residue (mineral)	449	(4)	Used "mining waste" value
Hazardous waste for disposal			
Hazardous waste to landfill	445	(4)	Used value for Hazardous waste (unspec.)
Hazardous waste (misc.)	445	(4)	Used value for Hazardous waste (unspec.)
Toxic chemicals (unspecified)	445	(4)	Used value for inert chemical waste
Waste for disposal			
IWP Sludge to landfill	1000	(7)	Used value for Sludge
Misc trash to landfill	800	(7)	Used value for Industrial waste for municipal disposal
Nylon waste to landfill	465	(2)	Average of values for nylon fibers, flakes, pellets and powder
Other waste to landfill	800	(7)	Used value for Industrial waste for municipal disposal
Polyvinyl chloride (PVC) waste to landfill (PVC)	601	(2)	Average of PVC chips and resin
Scrap plastic to landfill	220	(1)	Used landfill density of plastics
Scrap polymer pellets and packaging to landfill (FEP)	849	(8)	Found FEP waste density through reference to the ratio of nylon waste

Table C-1. Waste Densities for Landfill Space Use Impact Category

Flow	Density (D) (kg/m^3)	Reference	Note
			density to nylon density, noted above, compared to FEP density.
WWTP sludge	1000	(7)	Used value for Sludge

Sources:

(1) U.S. Environmental Protection Agency (EPA), 1999. "Characterization of Municipal Solid Waste in the United States: 1998 Update." Office of Solid Waste, Municipal Waste Division, Report No. EPA530-R-98-007. Prepared by Franklin Associates. July 1999. Tables B-9 and B-10.

(2) Machine and Process Design, Inc. Material Bulk Density Reference Chart. http://www.mpd-inc.com/material.htm. (accessed Feb 2008).

(3) Chemfinder.com. Calcium Fluoride [7789-75-5]. http://chemfinder.cambridgesoft.com. (accessed Feb 2008).

(4) U.S. Environmental Protection Agency (EPA), 1998. "Characterization of Municipal Solid Waste in the United States: 1997 Update." Office of Solid Waste, Municipal Waste Division, Report No. EPA530-R-98-007. Prepared by Franklin Associates. May 1998.

(5) Lide, D; Ed. *CRC Handbook of Chemistry and Physics*. 74th Ed. CRC Press, Boca Raton, FL, 1993.

(6) Australian Uranium Association. Nuclear Issues Briefing Paper #53: Uranium and Depleted Uranium. http://www.uic.com.au/nip53.htm. August 2007. (accessed Feb 2008).

(7) *Perry's Chemical Engineers' Handbook*, Perry, R.; Green, D., Eds.; 6th Edition; McGraw-Hill, New York, NY, 1984.

(8) Tech Brief: Fluorinated Ethylene-Propylene – FEP. http://www.azom.com/details.asp?ArticleID=414. (accessed Feb, 2008).

(9) Marewski, U. and Abraham, P.C. NCB Seminar 96-Part 1: Operating Experience of Vertical Roller Mill for Slag Grinding. http://www.loescheindia.com/ncb96_1.html. (accessed Feb 25, 2008).

Appendix D: Equivalency Factors

Tables D-1 through D-5 present equivalency factors for impact categories used in the impact assessment. These are comprehensive lists that exceed the number of chemicals found in the Wire and Cable Partnership life-cycle inventory.

Table D-1. Global Warming Potentials

Flow	Global warming potential (CO_2 equivalents)
1,1,1-Trichloroethane [Halogenated organic emissions to air]	140
Carbon dioxide [Renewable resources]	1
Carbon dioxide [Inorganic emissions to air]	1
Carbon dioxide (biotic) [Air]	1
Carbon tetrachloride (tetrachloromethane) [Halogenated organic emissions to air]	1800
Chlorodifluoromethane (R22) [Halogenated organic emissions to air]	1700
Chloromethane (methyl chloride) [Halogenated organic emissions to air]	16
Dichloromethane (methylene chloride) [Halogenated organic emissions to air]	10
Dichloromonofluoromethane [Halogenated organic emissions to air]	210
Halon (1211) [Halogenated organic emissions to air]	1300
Halon (1301) [Halogenated organic emissions to air]	6900
Methane [Organic emissions to air (group VOC)]	23
Methane (biotic) [Air]	23
Methyl bromide [Halogenated organic emissions to air]	5
Nitrous oxide (laughing gas) [Inorganic emissions to air]	296
Perfluorobutane [Halogenated organic emissions to air]	8600
Perfluorocyclobutane [Halogenated organic emissions to air]	8700
Perfluorohexane [Organic intermediate products]	9000
Perfluorohexane [Halogenated organic emissions to air]	9000
Perfluoropentane [Halogenated organic emissions to air]	8900
Perfluoropropane [Halogenated organic emissions to air]	8600
R 11 (trichlorofluoromethane) [Halogenated organic emissions to air]	4600
R 113 (trichlorofluoroethane) [Halogenated organic emissions to air]	6000
R 114 (dichlorotetrafluoroethane) [Halogenated organic emissions to air]	9800
R 115 (chloropentafluoroethane) [Halogenated organic emissions to air]	7200
R 116 (hexafluoroethane) [Halogenated organic emissions to air]	11905
R 12 (dichlorodifluoromethane) [Halogenated organic emissions to fresh water]	10604
R 12 (dichlorodifluoromethane) [Halogenated organic emissions to sea water]	10604
R 12 (dichlorodifluoromethane) [Halogenated organic emissions to air]	10604
R 123 (dichlorotrifluoroethane) [Halogenated organic emissions to air]	120
R 124 (chlorotetrafluoroethane) [Halogenated organic emissions to air]	620
R 125 (pentafluoroethane) [Halogenated organic emissions to air]	3400
R 13 (chlorotrifluoromethane) [Halogenated organic emissions to air]	14006
R 134 [Halogenated organic emissions to air]	1100

Flow	Global warming potential (CO_2 equivalents)
R 134a (tetrafluoroethane) [Halogenated organic emissions to air]	1300
R 141b (dichloro-1-fluoroethane) [Halogenated organic emissions to air]	700
R 142b (chlorodifluoroethane) [Halogenated organic emissions to air]	2400
R 143 (trifluoroethane) [Halogenated organic emissions to air]	330
R 143a (trifluoroethane) [Halogenated organic emissions to air]	4300
R 152a (difluoroethane) [Halogenated organic emissions to air]	120
R 22 (chlorodifluoromethane) [Halogenated organic emissions to air]	1700
R 225ca (dichloropentafluoropropane) [Halogenated organic emissions to air]	180
R 225cb (dichloropentafluoropentane) [Halogenated organic emissions to air]	620
R 227ea (septifluoropropane) [Halogenated organic emissions to air]	3500
R 23 (trifluoromethane) [Halogenated organic emissions to air]	12005
R 236fa (hexafluoropropane) [Halogenated organic emissions to air]	9400
R 245ca (pentafluoropropane) [Halogenated organic emissions to air]	640
R 32 (trifluoroethane) [Halogenated organic emissions to air]	550
R 41 [Halogenated organic emissions to air]	97
R 43-10 (decafluoropentane) [Halogenated organic emissions to air]	1500
Sulphur hexafluoride [Inorganic emissions to air]	22200
Tetrafluoromethane [Halogenated organic emissions to air]	5700
Trichloromethane (chloroform) [Halogenated organic emissions to air]	30
VOC [Organic emissions to sea water]	16.1
VOC [Organic emissions to fresh water]	16.1
VOC (unspecified) [Organic emissions to air (group VOC)]	16.1

Sources:

- Albritton, D.L. and Meira Filho, L.G. Technical Summary of the Working Group I Report. In: *Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change;* Houghton, J.T; Ding, Y; Griggs, D.J.; Noguer, M; van der Linden, P; Dai, X; Maskell, K; and Johnson, C.A., Eds.; Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2002. http://www.ipcc.ch/pdf/climate-changes-2001/scientific-basis/scientific-ts-en.pdf. (accessed Feb 2008).
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Table D-2. Stratospheric Ozone Depletion Equivalency Factors

Flow	Ozone depletion potential (CFC-11 equivalents)
1,1,1-Trichloroethane [Halogenated organic emissions to air]	0.11
Carbon tetrachloride (tetrachloromethane) [Halogenated organic emissions to air]	1.10
Chloromethane (methyl chloride) [Halogenated organic emissions to air]	0.02
Halon (1211) [Halogenated organic emissions to air]	3
Halon (1301) [Halogenated organic emissions to air]	10
Halon (2404) [Halogenated organic emissions to air]	6
HBFC-1201 (Halon-1201) [Halogenated organic emissions to air]	1.40
HBFC-1202 (Halon-1202) [Halogenated organic emissions to air]	1.25
HBFC-2311 (Halon-2311) [Halogenated organic emissions to air]	0.14
HBFC-2401 (Halon-2401) [Halogenated organic emissions to air]	0.25
HBFC-2402 (Halon-2402) [Halogenated organic emissions to air]	7
Methyl bromide [Halogenated organic emissions to air]	0.60
R 11 (trichlorofluoromethane) [Halogenated organic emissions to air]	1
R 113 (trichlorofluoroethane) [Halogenated organic emissions to air]	0.90
R 114 (dichlorotetrafluoroethane) [Halogenated organic emissions to air]	0.85
R 115 (chloropentafluoroethane) [Halogenated organic emissions to air]	0.40
R 12 (dichlorodifluoromethane) [Halogenated organic emissions to fresh water]	0.82
R 12 (dichlorodifluoromethane) [Halogenated organic emissions to sea water]	0.82
R 12 (dichlorodifluoromethane) [Halogenated organic emissions to air]	0.82
R 123 (dichlorotrifluoroethane) [Halogenated organic emissions to air]	0.01
R 124 (chlorotetrafluoroethane) [Halogenated organic emissions to air]	0.03
R 141b (dichloro-1-fluoroethane) [Halogenated organic emissions to air]	0.09
R 142b (chlorodifluoroethane) [Halogenated organic emissions to air]	0.04
R 22 (chlorodifluoromethane) [Halogenated organic emissions to air]	0.03
R 225ca (dichloropentafluoropropane) [Halogenated organic emissions to air]	0.02
R 225cb (dichloropentafluoropentane) [Halogenated organic emissions to air]	0.02

Sources:

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Table D-3. Photochemical Oxidant Creation Potentials (Photochemical Smog)

Flow	Photochemical oxidant potential (ethene equivalents)
1,1,1-Trichloroethane [Halogenated organic emissions to air]	0.01
1,2-Dichloroethylene [Halogenated organic emissions to air]	0.42
1-Butoxypropanol [Group NMVOC to air]	0.46
1-Butylene (Vinylacetylene) [Group NMVOC to air]	1.08
1-Methoxy-2-propanol [Group NMVOC to air]	0.36
1-Propanol [Group NMVOC to air]	0.56
1-Propylbenzene [Group NMVOC to air]	0.64
2,2-Dimethylbutane [Group NMVOC to air]	0.24
2-Butoxy-ethanol [Group NMVOC to air]	0.48
2-Ethoxy-ethanol [Group NMVOC to air]	0.39
2-Methoxy-ethanol [Group NMVOC to air]	0.31
2-Methylbutan-1-ol [Group NMVOC to air]	0.41
2-Methylbutan-2-ol [Group NMVOC to air]	0.14
2-Methylhexane [Group NMVOC to air]	0.41
2-Methylnonane [Group NMVOC to air]	0.40
3,5-Diethyltoluene [Group NMVOC to air]	1.30
3-Methylbutan-1-ol [Group NMVOC to air]	0.41
3-Methylbutan-2-ol [Group NMVOC to air]	0.37
3-Methylhexane [Group NMVOC to air]	0.36
Acetic acid [Group NMVOC to air]	0.10
Acetone (dimethylcetone) [Group NMVOC to air]	0.18
Alcohols (unspec.) [Group NMVOC to air]	0.20
Alkane (unspecified) [Group NMVOC to air]	0.40
Benzaldehyde [Group NMVOC to air]	-0.09
Benzene [Group NMVOC to air]	0.19
Butane [Group NMVOC to air]	0.35
Butane (n-butane) [Group NMVOC to air]	0.41
Butanol (n-Butanol) [Organic intermediate products]	0.40
Butanol (tertiary butanol) [Organic intermediate products]	0.11
Butanone (methyl ethyl ketone) [Group NMVOC to air]	0.37
Butylene glycol (butane diol) [Group NMVOC to air]	0.20
Butyraldehyde [Group NMVOC to air]	0.80
Carbon monoxide [Inorganic emissions to air]	0.04

Flow	Photochemical oxidant potential (ethene equivalents)
Carbon monoxide (biotic) [Air]	0.03
Carbon tetrachloride (tetrachloromethane) [Halogenated organic emissions to air]	0.02
Chlorobenzene [Halogenated organic emissions to air]	0.02
Chloromethane (methyl chloride) [Halogenated organic emissions to air]	0.01
cis-Dichloroethene [Halogenated organic emissions to air]	0.45
Crude oil [Crude oil (resource)]	0.40
Cyclohexanone [Group NMVOC to air]	0.30
Decane [Group NMVOC to air]	0.38
Diacetone alcohol [Group NMVOC to air]	0.31
Dichlorobenzene (o-DCB; 1,2-dichlorobenzene) [Halogenated organic emissions to air]	0.02
Dichlorobenzene (p-DCB; 1,4-dichlorobenzene) [Halogenated organic emissions to fresh water]	0.02
Dichloroethane (ethylene dichloride) [Halogenated organic emissions to air]	0.02
Dichloroethane (isomers) [Halogenated organic emissions to air]	0.02
Dichloromethane (methylene chloride) [Halogenated organic emissions to air]	0.07
Diisopropylether [Group NMVOC to air]	0.40
Dimethoxy methane [Group NMVOC to air]	0.16
Dimethyl carbonate [Group NMVOC to air]	0.03
Dimethyl ether [Group NMVOC to air]	0.19
Dodecane [Group NMVOC to air]	0.36
Ethane [Group NMVOC to air]	0.12
Ethanol [Group NMVOC to air]	0.40
Ethene (ethylene) [Group NMVOC to air]	0.09
Ethylene acetate (ethyl acetate) [Group NMVOC to air]	0.21
Ethylene glycol [Group NMVOC to air]	0.37
Ethylene oxide [Group NMVOC to air]	0.38
Ethyl-trans-butyl ether [Group NMVOC to air]	0.24
Formic acid (methane acid) [Group NMVOC to air]	0.03
Furfuryl alcohol [Group NMVOC to air]	0.20
Gasoline (regular) [Crude oil products]	0.40
iso-Butyl acetate [Group NMVOC to air]	0.40
iso-Butyraldehyde [Group NMVOC to air]	0.51
iso-Pentane [Group NMVOC to air]	0.41
meta-Ethyltoluene [Group NMVOC to air]	1.02

Flow	Photochemical oxidant potential (ethene equivalents)
Methane [Organic emissions to air (group VOC)]	0.01
Methane (biotic) [Air]	0.01
Methanol [Group NMVOC to air]	0.14
Methyl acetate [Group NMVOC to air]	0.06
Methyl ethyl ketone (MEK, 78-93-3) [Emissions to air]	0.37
Methyl formate [Group NMVOC to air]	0.03
Methyl isopropylketone [Group NMVOC to air]	0.36
Methyl tert-butylether [Group NMVOC to air]	0.18
Methyl tert-butylketone [Group NMVOC to air]	0.32
Methylpentanone [Group NMVOC to air]	0.49
n-Butyl acetate [Group NMVOC to air]	0.27
Neopentane [Group NMVOC to air]	0.17
Nitrogen dioxide [Inorganic emissions to air]	0.03
Nitrogen oxides [Inorganic emissions to air]	0.03
Pentanaldehyde [Group NMVOC to air]	0.77
Pentane (n-pentane) [Group NMVOC to air]	0.40
Polychlorinated biphenyls (PCB unspecified) [Halogenated organic emissions to air]	0.02
Polychlorinated dibenzo-p-dioxins (2,3,7,8 - TCDD) [Halogenated organic emissions to air]	0.02
Polychlorinated dibenzo-p-furans (2,3,7,8 - TCDD) [Halogenated organic emissions to air]	0.02
Propane [Group NMVOC to air]	0.18
Propanol (iso-propanol; isopropanol) [Group NMVOC to air]	0.19
Propionaldehyde [Group NMVOC to air]	0.80
Propionic acid (propane acid) [Group NMVOC to air]	0.15
Propyl acetate [Group NMVOC to air]	0.22
sec-Butyl acetate [Group NMVOC to air]	0.28
Styrene [Group NMVOC to air]	0.14
Sulphur dioxide [Inorganic emissions to air]	0.05
tertiary-Butyl acetate [Group NMVOC to air]	0.05
Tetrachloroethene (perchloroethylene) [Halogenated organic emissions to air]	0.03
Tetrafluoromethane [Halogenated organic emissions to air]	0.02
trans-2-Butene [Group NMVOC to air]	1.13
trans-2-Pentene [Group NMVOC to air]	1.12

Flow	Photochemical oxidant potential (ethene equivalents)
trans-Dichloroethene [Halogenated organic emissions to air]	0.39
Trichloroethene (isomers) [Halogenated organic emissions to air]	0.33
Trichloromethane (chloroform) [Halogenated organic emissions to air]	0.02
Trimethylbenzene [Group NMVOC to air]	1.38
Vinyl acetate (108-05-4) [Emissions to air]	0.22
Vinyl chloride (VCM; chloroethene) [Halogenated organic emissions to air]	0.02
VOC (unspecified) [Organic emissions to air (group VOC)]	0.34
Xylene (para-Xylene; 1,4-Dimethylbenzene) [Group NMVOC to air]	1.01

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(b) Jenkin, M.E. & G.D. Hayman, 1999. Photochemical Ozone Creation Potentials for Oxygenated Volatile Organic Compounds: Sensitivity to Variations in Kinetic and Mechanistic Parameters. Atmos. Environ. 33 (8): 1275-1293.

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(d) Goedkoop, M.J., Spriensma, R.S.; *The Eco-indicator 99, Methodology report. A damage oriented LCIA Method*; VROM, The Hague, The Netherlands, 1999.

(e) Goedkoop M.J. PRé Consultants. The Eco-Indicator 95 – Final Report. 1995. The National Reuse of Waste Programme (NOH), the Netherlands. http://www.pre.nl/download/EI95FinalReport.pdf. (accessed Feb 2008).

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Table D-4. Acidification Potentials

Flow	Acidification potential (SO_2 equivalents)
Ammonia [Inorganic emissions to air]	1.88
Ammonium [Inorganic emissions to air]	3.76
Ammonium nitrate [Inorganic emissions to air]	0.85
Carbon tetrachloride (tetrachloromethane) [Halogenated organic emissions to air]	0.83
Chloromethane (methyl chloride) [Halogenated organic emissions to air]	0.63
Dichloromethane (methylene chloride) [Halogenated organic emissions to air]	0.74
Hydrochloric acid (100%) [Inorganic emissions to air]	0.88
Hydrogen bromine (hydrobromic acid) [Inorganic emissions to air]	0.40
Hydrogen chloride [Inorganic emissions to agricultural soil]	0.88
Hydrogen chloride [Inorganic emissions to air]	0.88
Hydrogen chloride [Inorganic emissions to fresh water]	0.88
Hydrogen chloride [Inorganic emissions to sea water]	0.88
Hydrogen chloride [Inorganic emissions to industrial soil]	0.88
Hydrogen cyanide (prussic acid) [Inorganic emissions to air]	1.60
Hydrogen fluoride [Inorganic emissions to air]	1.60
Hydrogen fluoride (hydrofluoric acid) [Inorganic emissions to sea water]	1.60
Hydrogen fluoride (hydrofluoric acid) [Inorganic emissions to agricultural soil]	1.60
Hydrogen fluoride (hydrofluoric acid) [Inorganic emissions to industrial soil]	1.60
Hydrogen sulphide [Inorganic emissions to agricultural soil]	1.88
Hydrogen sulphide [Inorganic emissions to air]	1.88
Hydrogen sulphide [Inorganic emissions to industrial soil]	1.88
Hydrogen sulphide [Inorganic emissions to sea water]	1.88
Hydrogen sulphide [Inorganic emissions to fresh water]	1.88
Nitric acid [Inorganic emissions to air]	0.51
Nitric acid [Inorganic emissions to sea water]	0.51
Nitric acid [Inorganic emissions to fresh water]	0.51
Nitric acid [Inorganic emissions to industrial soil]	0.51
Nitric acid [Inorganic emissions to agricultural soil]	0.51
Nitrogen dioxide [Inorganic emissions to air]	0.70
Nitrogen monoxide [Inorganic emissions to air]	1.07
Nitrogen oxides [Inorganic emissions to air]	0.70
Phosphoric acid [Inorganic emissions to agricultural soil]	0.98
Phosphoric acid [Inorganic emissions to sea water]	0.98
Phosphoric acid [Inorganic emissions to air]	0.98

Flow	Acidification potential (SO_2 equivalents)
Phosphoric acid [Inorganic emissions to fresh water]	0.98
Phosphoric acid [Inorganic emissions to industrial soil]	0.98
Sulphur dioxide [Inorganic emissions to air]	1
Sulphur trioxid [Inorganic emissions to air]	0.80
Sulphuric acid [Inorganic emissions to air]	0.65
Sulphuric acid [Inorganic emissions to agricultural soil]	0.65
Sulphuric acid [Inorganic emissions to fresh water]	0.65
Sulphuric acid [Inorganic emissions to industrial soil]	0.65
Sulphuric acid [Inorganic emissions to sea water]	0.65
Sulphuric acid aerosol [Inorganic emissions to air]	0.65
Tetrachloroethene (perchloroethylene) [Halogenated organic emissions to air]	0.19
Trichloroethene (isomers) [Halogenated organic emissions to air]	0.72
Trichloromethane (chloroform) [Halogenated organic emissions to air]	0.80
Vinyl chloride (VCM; chloroethene) [Halogenated organic emissions to air]	0.63

Sources:

(a) Heijungs, R., J.B. Guinee, G. Huppes, R.M. Lankreijer, H.A. Udo de Haes, A. Wegener Sleeswijk, A.M.M. Ansems, P.G. Eggels, R. van Duin, and H.P. de Goede. Environmental Life-Cycle Assessment of Products. Vol. I: Guide, and Vol II: Backgrounds. Leiden: CML Center for Environmental Studies, Leiden University. 1992.

(b) Hauschilld, M.Z. and Wenzel, H. Acidification as Assessment Criterion in the Environmental Assessment of Products. In *Scientific Background for Environmental Assessment of Products*; M. Hauschild and H. Wenzel, Eds.; Chapman & Hall, London, 1997.

(c) Goedkoop M.J. PRé Consultants. The Eco-Indicator 95 – Final Report. 1995. The National Reuse of Waste Programme (NOH), the Netherlands. http://www.pre.nl/download/EI95FinalReport.pdf. (accessed Feb 2008).

Table D-5. Eutrophication Potentials[a]

Flow	Eutrophication potential (phosphate equivalents)
Acetic acid [Hydrocarbons to fresh water]	0.02
Acetic acid [Hydrocarbons to sea water]	0.02
Ammonia [Waste to POTW]	0.35
Ammonium / ammonia [Inorganic emissions to sea water]	0.33
Ammonium / ammonia [Inorganic emissions to fresh water]	0.33
Biological oxygen demand (BOD) [Analytical measures to sea water]	0.02
Biological oxygen demand (BOD) [Analytical measures to fresh water]	0.02
Biological oxygen demand (BOD) [Waste to POTW]	0.02
Calcium nitrate (Ca(NO3)2) [Inorganic emissions to fresh water]	0.08
Calcium nitrate (Ca(NO3)2) [Inorganic emissions to sea water]	0.08
Chemical oxygen demand (COD) [Analytical measures to sea water]	0.02
Chemical oxygen demand (COD) [Analytical measures to fresh water]	0.02
Ethanol [Hydrocarbons to sea water]	0.04
Ethanol [Hydrocarbons to fresh water]	0.04
Heptane [Hydrocarbons to sea water]	0.08
Heptane [Hydrocarbons to fresh water]	0.08
Hexane (isomers) [Hydrocarbons to sea water]	0.08
Hexane (isomers) [Hydrocarbons to fresh water]	0.08
Hydrocarbons (unspecified) [Hydrocarbons to fresh water]	0.08
Hydrocarbons (unspecified) [Hydrocarbons to sea water]	0.08
Methanol [Hydrocarbons to fresh water]	0.03
Methanol [Hydrocarbons to sea water]	0.03
Nitrate [Inorganic emissions to sea water]	0.10
Nitrate [Inorganic emissions to fresh water]	0.10
Nitric acid [Inorganic emissions to sea water]	0.10
Nitric acid [Inorganic emissions to fresh water]	0.10
Nitrite [Inorganic emissions to fresh water]	0.10
Nitrite [Inorganic emissions to sea water]	0.10
Nitrogen [Inorganic emissions to fresh water]	0.42
Nitrogen [Inorganic emissions to sea water]	0.42
Nitrogen monoxide [Inorganic emissions to air]	0.13
Nitrogen organic bounded [Inorganic emissions to sea water]	0.42
Nitrogen organic bounded [Inorganic emissions to fresh water]	0.42
Octane [Hydrocarbons to sea water]	0.08

Flow	Eutrophication potential (phosphate equivalents)
Octane [Hydrocarbons to fresh water]	0.08
Oil (unspecified) [Hydrocarbons to fresh water]	0.08
Oil (unspecified) [Hydrocarbons to sea water]	0.08
Organic compounds (dissolved) [Organic emissions to fresh water]	0.02
Organic compounds (dissolved) [Organic emissions to sea water]	0.03
Organic compounds (unspecified) [Organic emissions to sea water]	0.03
Organic compounds (unspecified) [Organic emissions to fresh water]	0.02
Phosphate [Waste to POTW]	1
Phosphate [Inorganic emissions to sea water]	1
Phosphate [Inorganic emissions to fresh water]	1
Phosphoric acid [Inorganic emissions to sea water]	0.97
Phosphoric acid [Inorganic emissions to fresh water]	0.97
Phosphoruos-pent-oxide [Inorganic emissions to sea water]	1.34
Phosphoruos-pent-oxide [Inorganic emissions to fresh water]	1.34
Phosphorus [Inorganic emissions to sea water]	3.06
Phosphorus [Inorganic emissions to fresh water]	3.06
Sodium nitrate (NaNO3) [Inorganic emissions to sea water]	0.07
Sodium nitrate (NaNO3) [Inorganic emissions to fresh water]	0.07
Total dissolved organic bounded carbon [Analytical measures to fresh water]	0.06
Total dissolved organic bounded carbon [Analytical measures to sea water]	0.06
Total organic bounded carbon [Analytical measures to sea water]	0.06
Total organic bounded carbon [Analytical measures to fresh water]	0.06
Xylene (isomers; dimethyl benzene) [Hydrocarbons to fresh water]	0.07
Xylene (isomers; dimethyl benzene) [Hydrocarbons to sea water]	0.07
Xylene (meta-Xylene; 1,3-Dimethylbenzene) [Hydrocarbons to sea water]	0.07
Xylene (meta-Xylene; 1,3-Dimethylbenzene) [Hydrocarbons to fresh water]	0.07
Xylene (ortho-Xylene; 1,2-Dimethylbenzene) [Hydrocarbons to fresh water]	0.07
Xylene (ortho-Xylene; 1,2-Dimethylbenzene) [Hydrocarbons to sea water]	0.07
Xylene (para-Xylene; 1,4-Dimethylbenzene) [Hydrocarbons to sea water]	0.07
Xylene (para-Xylene; 1,4-Dimethylbenzene) [Hydrocarbons to fresh water]	0.07

[a] Only includes water emissions.

Sources:

(a) *Handbook on life cycle assessment - Operational Guide to the ISO Standards,* Guinée, J.B., Ed.; Kluwer, Dordrecht, 2002, and Heijungs, R., J. Guinée, g. Huppes, R.M. Lankreijer, H.A. Udo de Haes, A. Wegener Sleeswijk, A.M.M. Ansems, P.G. Eggels, R. Van Duin en H.P. de Goede. Environmental life cycle assessment of products. Guide and background (ISBN 90-5191-064-9). Leiden (the Netherlands), Centre of Environmental Science of Leiden Univerisity, 1992.

Appendix E: Supporting Toxicity Data for the Wire and Cable Partnership

Appendix E-1: Toxicity Data Collection

Background:

In the Wire and Cable Partnership (WCP), human and ecological toxicity impacts of chemicals found in the life-cycle inventory of selected cable resins are calculated by using a chemical ranking method. This method was originally developed for a life-cycle assessment (LCA) done with support from the EPA Office of Research and Development (ORD) and Saturn Corporation. It was updated for the EPA's Design for the Environment (DfE) Program Computer Display Project (CDP) in consultation with ORD. The final CDP method was reviewed by ORD as well as EPA's Office of Pollution Prevention and Toxics Risk Assessment Division (RAD) prior to publication (Socolof *et al*., 2001). The methodology was subsequently used for the DfE Lead Free Solder Project (LFSP) (Geibig and Socolof, 2005), when other minor updates were made which included (1) separating chronic heath impacts into cancer impacts and chronic non-cancer impacts (for both public and occupational impacts) and (2) removing the presentation of the terrestrial ecotoxicity impact category.

Separating the chronic human impacts into two separate categories was done because the hazard values (HVs) calculated for each of these two impact categories are calculated based on geometric means for different endpoints. For cancer impacts, the HV is based on the geometric mean of cancer slope factors. The geometric mean for cancer slope factors are largely influenced by the slope factors for dioxins, which are very high. Thus the associated hazard values of most cancer impacts have numerically small HVs (since the HV is calculated by dividing the chemical specific slope factor by the geometric mean). Compared to the non-cancer HVs, the cancer HVs are generally much smaller numbers. Therefore, combining the two impact scores into one impact category causes the non-cancer impacts to overshadow the cancer impacts. Therefore, to observe any real resolution in the cancer impact category, the cancer and non-cancer impact categories were separated for the LFSP, as will also be done for the WCP.

The other change from the CDP was to remove the terrestrial toxicity impact category as being presented independently because the chronic non-cancer impacts presented alone are calculated the same way as the terrestrial ecotoxicity impacts. Thus, the terrestrial ecotoxicity impacts are represented by the non-cancer impacts and thus were not presented separately in the LFSP. The WCP LCA will use the methodology as it was used in the LFSP.

In the LCA, there is no intent to conduct a full risk assessment or even a screening level risk assessment, given that there are no real spatial or temporal boundaries to this global, industry-wide LCA. In order to provide some weighting of the inventory data to represent potential toxicity, basic toxicity data (e.g., a NOAEL for chronic, non-carcinogenic effects) are used. The intent is to modify the inventory data by the inherent toxicity of the material to provide a relative toxicity measure.

Toxicity data are being collected for potentially toxic chemicals in the WCP inventory. To save project resources, toxicity data that have been collected for previous DfE projects will be used in the WCP. Toxicity data used prior to this project were collected by Syracuse Research Corporation (SRC) (under contract with EPA) and EPA's RAD for the CDP, and by the Toxicity and Hazard Assessment Group in the Life Sciences Division at the Oak Ridge National Laboratory (ORNL) for the LFSP. ORNL conducted their search in April, 2003 and the data were subsequently reviewed and/or supplemented by EPA's RAD. The description below presents the method to be used to collect the WCP toxicity data.

Data Collection Approach:

Once inventory data are collected for the project, the inventory flows are checked to determine if they are potentially toxic. The lists of potentially toxic and non-toxic chemicals will be reviewed by EPA. Those excluded from the toxicity list are assumed to be non-toxic. The chemicals then deemed potentially toxic are assembled for toxicity data collection. The data are first checked for correct chemical name and Chemical Abstracts Service (CAS) registry number and the associated inventory disposition (e.g., release to water) is identified to help determine classification into different toxicity impact categories. Classification helps determine what toxicity data need to be collected. For example, if an inventory flow is released to water, it will require aquatic toxicity data.

For chemicals identified in the inventory of the life cycle of the wire and cable alternatives, for which toxicity data were collected for previous projects, data from the previous projects will be used. For new chemicals identified in this LCA, chronic human toxicity endpoints and both acute and chronic aquatic toxicity endpoints are being searched. The following specific endpoints will be used for calculating human toxicity scores:

- inhalation or oral NOAEL (or inhalation or oral LOAEL),
- cancer slope factors, and
- cancer weight of evidence (WOE).

For ecological toxicity, the following endpoints are used for calculating aquatic toxicity:

- fish LC_{50} and
- fish NOEL.

EPA's RAD provided guidance for collecting toxicity data for DfE Cleaner Technology Substitutes Assessments. This served as the basis for data collection for this LCA; however, it was modified as applicable to an LCA. As stated in the RAD guidance, when searching for the toxicity endpoints, the first sources to be reviewed will be:

- EPA's Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/)—reference dose, reference concentration, cancer slope factor, unit risk, and weight-of-evidence classification.
- ATSDR (Agency for Toxic Substances and Disease Registry)—a federal public health agency of the U.S. Department of Health and Human Services, provides trusted health information to prevent harmful exposures and diseases related to toxic substances.

- EPA's High Production Volume (HPV) Challenge robust summaries and supporting documents contain information on physical properties, environmental fate and transport, toxicity, and ecotoxicity data submitted by Industry to the HPV Challenge Program, and
- Organization for Economic Cooperation and Development's (OECD's) Screening Information Data Set (SIDS) robust summaries and supporting documents.

If endpoints from these sources are found, and do not conflict with other sources from this list, those data are chosen. If more than one value is found for an endpoint, decisions of what data to use will be presented to EPA by Abt Associates with any final decisions made by EPA.

If endpoints are not found from the above sources, the following databases would be searched:

- STN (CAS-Online)—provides information on chemical identity and chemical use. TOXLINE "special" database plus BIOSIS was searched in conjunction with MEDLINE.
- TSCATS (Toxic Substances Control Act Test Submissions)–the EPA database that holds data submitted to the Agency under TSCA sections 4 and 8). Although data in TSCATS may be unpublished and, therefore, not subjected to peer review by the editors of a journal, the data may provide useful information on particular chemicals and can be considered for preparation of robust summaries if the TSCATS data meet Agency standards for data quality/data adequacy.
- IUCLID (International Uniform ChemicaL Information Database) – maintained under the responsibility of the European Chemicals Bureau (ECB) within the Institute for Health and Consumer Protection (IHCP) of the Joint Research Centre (JRC) of the European Commission, and is distributed free of charge; includes, for example, chemical substances composition, physical/chemical properties, toxicological properties, and eco-toxicological properties.

Other databases have also served as sources (e.g., Health Effects Assessment Summary Tables [HEAST], Hazardous Substances Data Bank [HSDB], Registry of Toxic Effects of Chemical Substances [RTECS]). In general, priority is given to peer-reviewed databases such as IRIS, HEAST, HDSB, then other databases (e.g., RTECS), then other studies or literature, and finally estimation methods (e.g., structure-activity relationships [SARs] or quantitative structure-activity relationships [QSARs]).

In cases where there is more than one data point, we will select a data point based on the applicability of the study to the endpoint of interest and the robustness of the study (as best could be determined from the available data). If the original sources are not reviewed, information from secondary sources (e.g., EPA's ECOTOXicology Data Base System, version 4 [U.S. EPA, 2007]) on the test type and duration will be considered. The following hierarchy of fish studies, based on Swanson *et al.* 1997, will be employed to choose LC_{50} ecotoxicity data in order of preference:

(1) fathead minnow 96-h flow-through test

(2) 96-h flow-through test for another freshwater fish, excluding trout

(3) fathead minnow 96-h static test

(4) 96-h static test for another freshwater fish, excluding trout

If the only adequate data are for trout, they will also be used. In cases where multiple data points (with equivalent quality, test type, and species type) are available, an average of those data will be taken as the data point of interest. This is preferred over taking the most toxic response as these data are used in relative ranking of chemicals and not to serve as protective exposure limits.

Other aquatic species (e.g., daphnia, algae) were not used in the original methodology used to develop the LCIA toxicity method used in this study (i.e., CHEMS-1, Swanson *et al*., 1997); however, this does not preclude future versions of this methodology from using other species besides fish, which would represent lower trophic levels (e.g., daphnia or algae).

Toxicity Data:

The toxicity data required for the LCIA, and to be collected are as follows:

- Cancer (mammalian toxicity)
  - oral SF
  - inhalation SF
  - WOE
- Noncancer (mammalian toxicity)
  - oral NOAEL (or LOAEL)
  - inhalation NOAEL (or LOAEL)
- Aquatic ecotoxicity
  - LC_{50}
  - NOEL or NOEC

In the cases where chronic ecotoxicity (i.e., NOEL or NOEC) data are not available, the log K_{ow} and the LC_{50} can be used to predict the NOEL (described in Geibig and Socolof, 2005, Volume 1, Section 3.1.2.13). The log K_{ow} values will be determined using a LOGKOW/KOWWIN Program (http://www.syrres.com/esc/est_kowdemo.htm), provided the appropriate Simplified Molecular Input line Entry System (SMILES) notation is determined. When other data related to the toxicity of a chemical are readily available, such data will also be reported as "other" toxicity values. For the WCP, new data were searched for approximately 30 chemicals for which we did not already have existing data.

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GLOSSARY OF TOXICITY COMPARISON TERMS

LD50 (Lethal Dose 50)

A calculated dose of a substance which is expected to cause the death of 50 percent of a defined experimental animal population.

LC50 (Lethal Concentration 50)

A calculated concentration of a substance in air or water, which is expected to cause the death of 50 percent of a defined experimental animal population.

LOAEL (Lowest observable adverse effect level)

Lowest concentration or amount of a substance, found by experiment or observation, which causes an adverse alteration of morphology, functional capacity, growth, development, or life span of a target organism distinguishable from normal (control) organisms of the same species and strain under defined conditions of exposure.

NOAEL (No observable adverse effect level)

No-observed-adverse-effect level. Greatest concentration or amount of a substance, found by experiment or observation, which causes no detectable adverse alteration of morphology, functional capacity, growth, development, or life span of the target organism under defined conditions.

WOE (Weight of evidence)

Classification of relevance and quality of studies used to make a determination of carcinogenicity.

Appendix E-2: Toxicity Data Used in Hazard Value Calculations

The toxicity data presented in the following tables are for the master list of chemicals used to calculate endpoint-specific geometric means, which are then used to develop hazard values (HVs) for the chemicals in the WCP inventory. The HVs are a relative ranking of potentially toxic materials used in the occupational, public, and ecotoxicity impact categories. Details of the methodology are described in Chapter 3. Note that the chemicals listed for oral and inhalation NOAELs only include those with NOAEL values in the literature. Chemicals for which we used LOAELs to estimate NOAELs were not included in the calculation of the NOAEL geometric means. Further, the chemicals in the WCP inventory are a subset of the chemicals used to generate the geometric means presented in the following tables:

Table E-1. Slope Factors

Table E-2. Oral NOAELs

Table E-3. Inhalation NOAELs

Table E-4. Fish LC50s

Table E-5. Fish NOELs

Table E-1. Slope Factors[a]

Chemical	CAS #	Oral Slope Factor (mg/kg-day)-1	Inhalation Slope Factor (mg/kg-day)-1
Acephate	30560-19-1	8.70E-03	
Acetaldehyde	75-07-0		7.70E-03
Acrylamide	79-06-1	4.50E+00	4.50E+00
Acrylonitrile	107-13-1	5.40E-01	2.40E-01
Alachlor	15972-60-8	8E-02	
Aldrin	309-00-2	1.70E+01	1.70E+01
Aniline	62-53-3	5.70E-03	
Aramite	140-57-8	2.50E-02	2.50E-02
Aroclor 1016	12674-11-2	4E-01	4E-01
Aroclor 1016	12674-11-2	2E+00	2E+00
Aroclor 1221	11104-28-2	4E-01	4E-01
Aroclor 1221	11104-28-2	2E+00	2E+00
Aroclor 1232	11141-16-5	4E-01	4E-01
Aroclor 1232	11141-16-5	2E+00	2E+00
Aroclor 1242	53469-21-9	4E-01	4E-01
Aroclor 1242	53469-21-9	2E+00	2E+00
Aroclor 1248	12672-29-6	4E-01	4E-01
Aroclor 1248	12672-29-6	2E+00	2E+00
Aroclor 1254	11097-69-1	4E-01	4E-01
Aroclor 1254	11097-69-1		2E+00
Aroclor 1260	11096-82-5	4E-01	4E-01
Aroclor 1260	11096-82-5	2E+00	2E+00
Arsenic, Inorganic	7440-38-2	1.50E+00	5E+01
Atrazine	1912-24-9	2.22E-01	
Azobenzene	103-33-3	1.10E-01	1.10E-01
Benz[a]anthracene	56-55-3	7.30E-01	3.10E-01
Benzene	71-43-2	5.50E-02	2.90E-02
Benzidine	92-87-5	2.30E+02	2.30E+02
Benzo[a]pyrene	50-32-8	7.30E+00	3.10E+00
Benzo[b]fluoranthene	205-99-2	7.30E-01	3.10E-01
Benzo[k]fluoranthene	207-08-9	7.30E-02	3.10E-02
Benzotrichloride	98-07-7	1.30E+01	
Benzyl Chloride	100-44-7	1.70E-01	
Beryllium and compounds	7440-41-7	4.30E+00	8.40E+00
Bis(2-chloro-1-methylethyl)ether (Technical)	108-60-1	7E-02	3.50E-02
Bis(2-chloroethyl)ether	111-44-4	1.10E+00	1.10E+00
Bis(2-ethylhexyl)phthalate	117-81-7	1.40E-02	
Bis(chloromethyl)ether	542-88-1	2.20E+02	2.20E+02
Bromodichloromethane	75-27-4	6.20E-02	
Bromoform	75-25-2	7.90E-03	3.90E-03
Butadiene, 1,3-	106-99-0		1.80E+00
Cadmium (Diet)	7440-43-9		6.10E+00

Chemical	CAS #	Oral Slope Factor (mg/kg-day)-1	Inhalation Slope Factor (mg/kg-day)-1
Cadmium (Water)	7440-43-9		6.10E+00
Captafol	2425-06-1	8.60E-03	
Captan	133-06-2	3.50E-03	
Carbazole	86-74-8	2E-02	
Carbon Tetrachloride	56-23-5	1.30E-01	5.30E-02
Chloranil	118-75-2	4.03E-01	
Chlordane	057-74-9	3.50E-01	1.30E+00
Chloro-2-methylaniline HCl, 4-	3165-93-3	4.60E-01	
Chloro-2-methylaniline, 4-	95-69-2	5.80E-01	
Chlorobenzilate	510-15-6	2.70E-01	2.70E-01
Chlorodibromoethane	73506-94-2	8.40E-02	
Chloroform	67-66-3	6.10E-03	8.10E-02
Chloromethane	74-87-3	1.30E-02	6.30E-03
Chloronitrobenzene, o-	88-73-3	2.50E-02	
Chloronitrobenzene, p-	121-73-3	1.80E-02	
Chlorothalonil	1897-45-6	1.10E-02	
Chromium VI (chromic acid mists)	18540-29-9		4.10E+01
Chromium VI (particulates)	18540-29-9		4.10E+01
Chrysene	218-01-9	7.30E-03	3.10E-03
Coke Oven Emissions	8007-45-2		2.20E+00
Crotonaldehyde, trans-	123-73-9	1.90E+00	
Cyanazine	21725-46-2	8.40E-01	
Cyclohexane, 1,2,3,4,5-pentabromo-6-chloro-	87-84-3	2.30E-02	
DDD	72-54-8	2.40E-01	
DDE	72-55-9	3.40E-01	
DDT	50-29-3	3.40E-01	3.40E-01
Di(2-ethylhexyl)adipate	103-23-1	1.20E-03	
Diallate	2303-16-4	6.10E-02	
Dibenz[a,h]anthracene	53-70-3	7.30E+00	3.10E+00
Dibromo-3-chloropropane, 1,2-	96-12-8	1.40E+00	2.40E-03
Dibromochloromethane	124-48-1	8.40E-02	
Dibromoethane, 1,2-	106-93-4	8.50E+01	7.60E-01
Dichloro-2-butene, 1,4-	764-41-0		9.30E+00
Dichlorobenzene, 1,4-	106-46-7	2.40E-02	
Dichlorobenzidine, 3,3'-	91-94-1	4.50E-01	
Dichloroethane, 1,2-	107-06-2	9.10E-02	9.10E-02
Dichloroethylene, 1,1-	75-35-4	6E-01	1.20E+00
Dichloropropane, 1,2-	78-87-5	6.80E-02	
Dichloropropene, 1,3-	542-75-6	1E-01	1.40E-02
Dichlorvos	62-73-7	2.90E-01	
Dieldrin	60-57-1	1.60E+01	1.60E+01
Diethylstilbesterol	56-53-1	4.70E+03	4.90E+02
Dimethoxybenzidine, 3,3'-	119-90-4	1.40E-02	
Dimethylaniline HCl, 2,4-	21436-96-4	5.80E-01	

Chemical	CAS #	Oral Slope Factor (mg/kg-day)-1	Inhalation Slope Factor (mg/kg-day)-1
Dimethylaniline, 2,4-	095-68-1	7.50E-01	
Dimethylbenzidine, 3,3'-	119-93-7	9.20E+00	
Dimethylhydrazine, 1,1-	57-14-7	3E+00	1.72E+01
Dinitrotoluene Mixture, 2,4/2,6-	25321-14-6	6.80E-01	
Dinitrotoluene, 2,4-	121-14-2	6.80E-01	
Dinitrotoluene, 2,6-	606-20-2	6.80E-01	
Dioxane, 1,4-	123-91-1	1.10E-02	
Diphenylhydrazine, 1,2-	122-66-7	8E-01	8E-01
Direct Black 38	1937-37-7	8.60E+00	
Direct Blue 6	2602-46-2	8.10E+00	
Direct Brown 95	16071-86-6	9.30E+00	
Epichlorohydrin	106-89-8	9.90E-03	4.20E-03
Ethyl Acrylate	140-88-5	4.80E-02	
Ethylbenzene	100-41-4		3.85E-03
Ethylene Oxide	75-21-8	1.02E+00	3.50E-01
Ethylene Thiourea	96-45-7	1.10E-01	
Folpet	133-07-3	3.50E-03	
Fomesafen	72178-02-0	1.90E-01	
Formaldehyde	50-00-0		4.50E-02
Furazolidone	67-45-8	3.80E+00	
Furium	531-82-8	5E+01	
Furmecyclox	60568-05-0	3E-02	
Heptachlor	76-44-8	4.50E+00	4.50E+00
Heptachlor Epoxide	1024-57-3	9.10E+00	9.10E+00
Hexachlorobenzene	118-74-1	1.60E+00	1.60E+00
Hexachlorobutadiene	87-68-3	7.80E-02	7.80E-02
Hexachlorocyclohexane, Alpha-	319-84-6	6.30E+00	6.30E+00
Hexachlorocyclohexane, Beta-	319-85-7	1.80E+00	1.80E+00
Hexachlorocyclohexane, Gamma-	58-89-9	1.30E+00	
Hexachlorocyclohexane, Technical	608-73-1	1.80E+00	1.80E+00
Hexachlorodibenzo-p-dioxin, Mixture	19408-74-3	6.20E+03	4.55E+03
Hexachloroethane	67-72-1	1.40E-02	1.40E-02
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	1.10E-01	
HpCDD, 2,3,7,8-	37871-00-4	1.50E+03	1.50E+03
HpCDF, 2,3,7,8-	38998-75-3	1.50E+03	1.50E+03
HxCDD, 2,3,7,8-	34465-46-8	1.50E+04	1.50E+04
HxCDF, 2,3,7,8-	55684-94-1	1.50E+04	1.50E+04
Hydrazine	302-01-2	3E+00	1.70E+01
Hydrazine Sulfate	10034-93-2	3E+00	1.70E+01
Indeno[1,2,3-cd]pyrene	193-39-5	7.30E-01	3.10E-01
Isophorone	78-59-1	9.50E-04	
Methoxy-5-nitroaniline, 2-	99-59-2	4.60E-02	
Methyl Hydrazine	60-34-4	3E+00	1.72E+01
Methyl-5-Nitroaniline, 2-	99-55-8	3.30E-02	

Chemical	CAS #	Oral Slope Factor (mg/kg-day)-1	Inhalation Slope Factor (mg/kg-day)-1
Methylaniline Hydrochloride, 2-	636-21-5	1.80E-01	
Methylene Chloride	75-09-2	7.50E-03	1.65E-03
Methylene-bis(2-chloroaniline), 4,4'-	101-14-4	1.30E-01	1.30E-01
Methylene-bis(N,N-dimethyl) Aniline, 4,4'-	101-61-1	4.60E-02	
Methylenebisbenzenamine, 4,4'-	101-77-9	2.50E-01	
Mirex	2385-85-5	1.80E+00	
Nickel Refinery Dust	NA		8.40E-01
Nickel Subsulfide	12035-72-2		1.70E+00
Nitrofurazone	59-87-0	1.50E+00	
Nitropropane, 2-	79-46-9	9.50E+00	9.40E+00
Nitrosodiethanolamine, N-	1116-54-7	2.80E+00	
Nitrosodiethylamine, N-	55-18-5	1.50E+02	1.50E+02
Nitrosodimethylamine, N-	62-75-9	5.10E+01	5.10E+01
Nitroso-di-N-butylamine, N-	924-16-3	5.40E+00	5.40E+00
Nitroso-di-N-propylamine, N-	621-64-7	7E+00	
Nitrosodiphenylamine, N-	86-30-6	4.90E-03	
Nitrosomethylethylamine, N-	10595-95-6	2.20E+01	
Nitroso-N-ethylurea, N-	759-73-9	1.40E+02	
Nitrosopyrrolidine, N-	930-55-2	2.10E+00	2.10E+00
OCDD	3268-87-9	1.50E+02	1.50E+02
OCDF	39001-02-0	1.50E+02	1.50E+02
PeCDD, 2,3,7,8-	36088-22-9	7.50E+04	7.50E+04
PeCDF, 1,2,3,7,8-	57117-41-6	7.50E+04	7.50E+04
PeCDF, 2,3,4,7,8-	57117-31-4	7.50E+03	7.50E+03
Pentachloronitrobenzene	82-68-8	2.60E-01	
Pentachlorophenol	87-86-5	1.20E-01	
Phenylenediamine, o-	95-54-5	4.70E-02	
Phenylphenol, 2-	90-43-7	1.94E-03	
Polybrominated Biphenyls	59536-65-1	8.90E+00	
Polychlorinated Biphenyls (high risk)	1336-36-3	2E+00	2E+00
Polychlorinated Biphenyls (low risk)	1336-36-3	4E-01	4E-01
Polychlorinated Biphenyls (lowest risk)	1336-36-3	7E-02	
Prochloraz	67747-09-5	1.50E-01	
Propylene Oxide	75-56-9	2.40E-01	1.30E-02
Quinoline	91-22-5	1.20E+01	
Simazine	122-34-9	1.20E-01	
Sodium Diethyldithiocarbamate	148-18-5	2.70E-01	
Stirofos (Tetrachlorovinphos)	961-11-5	2.40E-02	
TCDD, 2,3,7,8-	1746-01-6	1.50E+05	1.50E+05
TCDF, 2,3,7,8-	51207-31-9	1.50E+04	1.50E+04
Tetrachloroethane, 1,1,1,2-	630-20-6	2.60E-02	2.60E-02
Tetrachloroethane, 1,1,2,2-	79-34-5	2E-01	2E-01
Tetrachloroethylene	127-18-4	5.20E-02	2E-03
Tetrachlorotoluene, p- alpha, alpha, alpha-	5216-25-1	2E+01	

Chemical	CAS #	Oral Slope Factor (mg/kg-day)-1	Inhalation Slope Factor (mg/kg-day)-1
Toluene-2,4-diamine	95-80-7	3.20E+00	
Toluidine, o- (Methylaniline, 2-)	95-53-4	2.40E-01	
Toluidine, p-	106-49-0	1.90E-01	
Toxaphene	8001-35-2	1.10E+00	1.10E+00
Trichloroaniline HCl, 2,4,6-	33663-50-2	2.90E-02	
Trichloroaniline, 2,4,6-	634-93-5	3.40E-02	
Trichloroethane, 1,1,2-	79-00-5	5.70E-02	5.70E-02
Trichloroethylene	79-01-6	1.10E-02	6E-03
Trichlorophenol, 2,4,6-	88-06-2	1.10E-02	1E-02
Trichloropropane, 1,2,3-	96-18-4	7E+00	
Trifluralin	1582-09-8	7.70E-03	
Trimethyl Phosphate	512-56-1	3.70E-02	
Trinitrotoluene, 2,4,6-	118-96-7	3E-02	
Vinyl Bromide	593-60-2		1.10E-01
Vinyl Chloride	75-01-4	1.40E+00	3.08E-02

[a]The hazard value for each chemical was derived by dividing the toxicity values shown here by the applicable geometric mean presented in Appendix E-3

Table E-2. Oral NOAELs[a]

Chemical	CAS #	Oral NOAEL	unit
1,1,1-Trichloroethane	71-55-6	250	mg/kg-day
1,1,2-Trichloroethane	79-00-5	3.9	mg/kg-day
1,2,4-Benzenetricarboxylic Acid, Tris(2-Ethylhexyl) Ester	3319-31-1	100	mg/kg-day
1,2,4-Trichlorobenzene	120-82-1	7.8	mg/kg-day
1,2-Benzenedicarboxylic Acid, 3,4,5,6-Tetrabromo-, Bis(2-Ethylhexyl) Ester (9ci)	26040-51-7	223.4	mg/kg-day
1,2-Dichlorobenzene	95-50-1	18.8	mg/kg-day
1,2-Dichloroethane	107-06-2	18	mg/kg-day
1,2-Dichloropropane	78-87-5	250	mg/kg-day
1,2-Dichlorotetrafluoroethane	76-14-2	273	mg/kg-day
1,3-Dichloropropene	542-75-6	0.125	mg/kg-day
1.4-Dichlorobenzene	106-46-7	10	mg/kg-day
2-(2-butoxyethoxy)-ethanol acetate	124-17-4	1000	mg/kg-day
2,3,7,8-TCDD	1746-01-6	9E-08	mg/kg-day
2,4-D	94-75-7	15	mg/kg-day
2,4-Dinitrotoluene	121-14-2	0.2	mg/kg-day
2-ethoxyethanol	110-80-5	250	mg/kg-day
2-methoxyethanol	109-86-4	50	mg/kg-day
4,4'-Isopropylidenediphenol	80-05-7	500	mg/kg-day
4,4'-Methylenedianiline	101-77-9	3.2	mg/kg-day
4-Nitrophenol	100-02-7	70	mg/kg-day
Acenaphthene	83-32-9	175	mg/kg-day
Acetaldehyde	75-07-0	125	mg/kg-day
Acetic acid	64-19-7	195	mg/kg-day
Acetone	67-64-1	100	mg/kg-day
Acetonitrile	75-05-8	50	mg/kg-day
Acetophenone	98-86-2	423	mg/kg-day
Acrylamide	79-06-1	0.1	mg/kg-day
Acrylic acid	79-10-7	83	mg/kg-day
Acrylonitrile	107-13-1	1	mg/kg-day
Alachlor	15972-60-8	1	mg/kg-day
Aluminum (elemental)	7429-90-5	60	mg/kg-day
Aluminum hydroxide	21645-51-2	23	mg/kg-day
Ammonia	7664-41-7	34	mg/kg-day
Ammonium bifluoride	1341-49-7	0.05	mg/kg-day
Anthracene	120-12-7	1000	mg/kg-day
Antioxida	2082-79-3	30	mg/kg-day
Arsenic	7440-38-2	008	mg/kg-day
Atrazine	1912-24-9	3.5	mg/kg-day
Barium	7440-39-3	0.21	mg/kg-day
Barium carbonate	513-77-9	0.21	mg/kg-day
Barium cmpds	20-02-0	0.21	mg/kg-day

Chemical	CAS #	Oral NOAEL	unit
Barium sulfate	7727-43-7	0.21	mg/kg-day
Benzaldehyde	100-52-7	143	mg/kg-day
Benzene	71-43-2	1	mg/kg-day
Biphenyl	92-52-4	50	mg/kg-day
Bis (2-ethylhexyl) adipate	103-23-1	610	mg/kg-day
Bismuth	7440-69-9	3243	mg/kg-day
Boric acid	11113-50-1	67	mg/kg-day
Boron	7440-42-8	8.8	mg/kg-day
Bromoform	75-25-2	17.9	mg/kg-day
Bromomethane	74-83-9	0.4	mg/kg-day
Butyl acrylate	141-32-2	84	mg/kg-day
Butyl benzyl phthalate	85-68-7	151	mg/kg-day
Butylate	2008-41-5	5	mg/kg-day
Butyraldehyde	123-72-8	75	mg/kg-day
Cadmium cmpds	20-04-2	05	mg/kg-day
Captan	133-06-2	12.5	mg/kg-day
Carbaryl	63-25-2	9.6	mg/kg-day
Carbon tetrachloride	56-23-5	1	mg/kg-day
Chlorine	7782-50-5	14	mg/kg-day
Chlorobenzene	108-90-7	12.5	mg/kg-day
Chlorophenols [o]	20-05-3	50	mg/kg-day
Chloropyrifos	2921-88-2	0.03	mg/kg-day
Chlorothalonil	1897-45-6	1.5	mg/kg-day
Chromium (III)	16065-83-1	1468	mg/kg-day
Chromium (VI)	18540-29-9	2.5	mg/kg-day
Chromium trioxide	1333-82-0	1468	mg/kg-day
Coolant	not available	71	mg/kg-day
Copper	7440-50-8	0.53	mg/kg-day
Crude oil	8002-05-9	893	mg/kg-day
Cumene	98-82-8	154	mg/kg-day
Cyanazine	21725-46-2	0.625	mg/kg-day
Cyanide (-1)	57-12-5	10.8	mg/kg-day
Decabromodiphenyl oxide	1163-19-5	1	mg/kg-day
Di (2-ethylhexyl) phthalate	117-81-7	50	mg/kg-day
Di propylene glycol butyl ether	29911-28-2	450	mg/kg-day
Dibutyl phthalate	84-74-2	125	mg/kg-day
Dichlorodifluoromethane	75-71-8	15	mg/kg-day
Dichloromethane	75-09-2	155	mg/kg-day
Diethanolamine	111-42-2	75	mg/kg-day
Diethyl ether	60-29-7	500	mg/kg-day
Diethyl phthalate	84-66-2	150	mg/kg-day
Diethylene glycol	111-46-6	1250	mg/kg-day
Diisoundecyl phthalate	85507-79-5	790	mg/kg-day
Dimethyl phthalate	131-11-3	1000	mg/kg-day
Dioctyl sebacate	122-62-3	200	mg/kg-day

Chemical	CAS #	Oral NOAEL	unit
Erucamide	112-84-5	7500	mg/kg-day
Ethanol amine	141-43-5	320	mg/kg-day
Ethyl dipropylthiocarbamate	759-94-4	2.5	mg/kg-day
Ethylbenzene	100-41-4	136	mg/kg-day
Ethylene glycol	107-21-1	71	mg/kg-day
Ethylene oxide	75-21-8	30	mg/kg-day
Fluoranthene	206-44-0	125	mg/kg-day
Fluorene	86-73-7	125	mg/kg-day
Fluorine	7782-41-4	0.06	mg/kg-day
Fluorspar (Fluorite) (Calcium fluoride)	7789-75-5	47.5	mg/kg-day
Formaldehyde	50-00-0	15	mg/kg-day
Freon 113	76-13-1	273	mg/kg-day
Glycol ethers	111-76-2	203	mg/kg-day
Glyphosate	1071-83-6	800	mg/kg-day
Heptane	142-82-5	1000	mg/kg-day
Hexachloro-1,3-butadiene	87-68-3	0.2	mg/kg-day
Hexachlorobenzene	118-74-1	0.5	mg/kg-day
Hexachloroethane	67-72-1	1	mg/kg-day
Hydrogen cyanide	74-90-8	10.8	mg/kg-day
Hydrogen sulfide	7783-06-4	3.1	mg/kg-day
Hydroquinone	123-31-9	5	mg/kg-day
Hydrotalcite/zeolite	12304-65-3; 1318-02-1	5000	mg/kg-day
Antioxidant	32687-78-8	25	mg/kg-day
Isophorone	78-59-1	150	mg/kg-day
Isopropyl alcohol	67-63-0	230	mg/kg-day
m, p-xylene	1330-20-7	179	mg/kg-day
Maleic anhydride	108-31-6	10	mg/kg-day
Maneb	12427-38-2	25	mg/kg-day
Manganese	7439-96-5	0.14	mg/kg-day
Manganese oxide	1313-13-9	05	mg/kg-day
Methanol	67-56-1	500	mg/kg-day
Methyl ethyl ketone	78-93-3	125	mg/kg-day
Methyl isobutyl ketone	108-10-1	50	mg/kg-day
Methyl methacrylate	80-62-6	7.5	mg/kg-day
Methyl parathion	298-00-0	2.5	mg/kg-day
Methyl tert-butyl ether	1634-04-4	100	mg/kg-day
Metolachlor	51218-45-2	300	mg/kg-day
m-xylene	108-38-3	250	mg/kg-day
N,N-dimethylaniline	121-69-7	32	mg/kg-day
Naphthalene	91-20-3	71	mg/kg-day
N-butyl alcohol	71-36-3	125	mg/kg-day
Nickel	7440-02-0	5	mg/kg-day
Nickel chloride	7718-54-9	5	mg/kg-day
Nickel cmpds	20-14-4	100	mg/kg-day

Chemical	CAS #	Oral NOAEL	unit
Nitrate		1.6	mg/kg-day
Nitrates/nitrites	14797-55-8	1.6	mg/kg-day
Nitrites	14797-65-0	1	mg/kg-day
Nitrobenzene	98-95-3	0.46	mg/kg-day
Orthoboric acid	10043-35-3	67	mg/kg-day
o-xylene	95-47-6	179	mg/kg-day
P-cresol	106-44-5	50	mg/kg-day
Pentachlorophenol	87-86-5	3	mg/kg-day
Phenol	108-95-2	60	mg/kg-day
Phosphate ester	57583-54-7	1000	mg/kg-day
Phosphine	7803-51-2	0.026	mg/kg-day
Phosphorus (yellow or white)	7723-14-0	0.015	mg/kg-day
Polychlorinated biphenyls	1336-36-3	07	mg/kg-day
Polyethylene mono (nonylphenyl) ether glycol	9016-45-9	1000	mg/kg-day
Polyvinyl pyrrolidone (PVP)	9003-39-8	550	mg/kg-day
Propylene oxide	75-56-9	200	mg/kg-day
p-xylene	106-42-3	1000	mg/kg-day
Pyrene	129-00-0	75	mg/kg-day
Pyridine	110-86-1	1	mg/kg-day
Santicizer 2148	29761-21-5	235	mg/kg-day
Selenium	7782-49-2	0.015	mg/kg-day
Sodium hypochlorite	7681-52-9	2.1	mg/kg-day
Stabilizer	1843-05-6	41	mg/kg-day
Strontium	7440-24-6	190	mg/kg-day
Strontium carbonate	1633-05-2	190	mg/kg-day
Styrene	100-42-5	100	mg/kg-day
Terbufos	13071-79-9	025	mg/kg-day
Terephthalic acid	100-21-0	500	mg/kg-day
Tert-butyl alcohol	75-65-0	1599	mg/kg-day
Tetrachloroethylene	127-18-4	14	mg/kg-day
Tetrahydrofuran	109-99-9	782	mg/kg-day
Toluene	108-88-3	100	mg/kg-day
Trichloroethylene	79-01-6	24	mg/kg-day
Trifluralin	1582-09-8	0.75	mg/kg-day
Uranium	7440-61-6	0.2	mg/kg-day
Vanadium	7440-62-2	03	mg/kg-day
Vinyl acetate	108-05-4	100	mg/kg-day
Xylene (mixed isomers)	1330-20-7	179	mg/kg-day
Zinc (elemental)	7440-66-6	0.9	mg/kg-day
Zirconium	7440-67-7	3494	mg/kg-day

[a]The hazard value for each chemical was derived by dividing the toxicity values shown here by the applicable geometric mean presented in Appendix E-3.

Table E-3. Inhalation NOAEL Data[a]

Chemical	CAS #	Inhalation NOAEL	unit
1,1,1-Trichloroethane	71-55-6	1214.9	mg/m^3
1,2,4-Benzenetricarboxylic Acid, Tris(2-Ethylhexyl) Ester	3319-31-1	260	mg/m^3
1,2,4-Trichlorobenzene	120-82-1	24.3	mg/m^3
1,2-Dichloroethane	107-06-2	221	mg/m^3
1,2-Dichloropropane	78-87-5	710	mg/m^3
1,3-Butadiene	106-99-0	2800	mg/m^3
1,3-Dichloropropene	542-75-6	49.6	mg/m^3
1,4-Dichlorobenzene	106-46-7	75	mg/m^3
1,4-Dioxane	123-91-1	360	mg/m^3
1-Methoxy-2-propanol	107-98-2	658	mg/m^3
2-Ethoxyethanol	110-80-5	7480	mg/m^3
2-Methoxyethanol	109-86-4	93.3	mg/m^3
4,4'-Isopropylidenediphenol	80-05-7	10	mg/m^3
4-Nitrophenol	100-02-7	30	mg/m^3
Acetaldehyde	75-07-0	300	mg/m^3
Acetonitrile	75-05-8	91.5	mg/m^3
Acrylic acid	79-10-7	74	mg/m^3
Allyl chloride	107-05-1	68.3	mg/m^3
Ammonia	7664-41-7	40	mg/m^3
Ammonium nitrate (solution)	6484-52-2	185	mg/m^3
Aniline	62-53-3	19	mg/m^3
Antimony trioxide	1309-64-4	0.51	mg/m^3
Benzene	71-43-2	1.15	mg/m^3
Bromomethane	74-83-9	4.3	mg/m^3
Butyl acrylate	141-32-2	120	mg/m^3
Butyl benzyl phthalate	85-68-7	144	mg/m^3
Butyraldehyde	123-72-8	3200	mg/m^3
Carbon disulfide	75-15-0	10	mg/m^3
Carbon monoxide	630-08-0	114.5	mg/m^3
Carbon tetrachloride	56-23-5	34.3	mg/m^3
Chlorobenzene	108-90-7	377	mg/m^3
Coolant	not available	10	mg/m^3
Cumene	98-82-8	537	mg/m^3
Cumene hydroperoxide	80-15-9	31	mg/m^3
Cyclohexane	110-82-7	1500	mg/m^3
Di (2-ethylhexyl) phthalate	117-81-7	50	mg/m^3
Dichlorobenzene (mixed isomers)	25321-22-6	610.4	mg/m^3
Dichloromethane	75-09-2	796	mg/m^3
Diethanolamine	111-42-2	0.27	mg/m^3
Diisoundecyl phthalate	85507-79-5	180	mg/m^3
Epichlorohydrin	106-89-8	20.7	mg/m^3
Ethyl chloride	75-00-3	3600	mg/m^3

Chemical	CAS #	Inhalation NOAEL	unit
Ethylbenzene	100-41-4	2370	mg/m^3
Ethylene	74-85-1	11600	mg/m^3
Ethylene glycol	107-21-1	10	mg/m^3
Ethylene oxide	75-21-8	18	mg/m^3
Formaldehyde	50-00-0	0.6	mg/m^3
Glycol ethers	111-76-2	121	mg/m^3
HCFC-22	75-45-6	5260	mg/m^3
Hexachloro-1,3-butadiene	87-68-3	58.2	mg/m^3
Hexafluoropropylene (HFP)	116-15-4	67	mg/m^3
HFC-125	354-33-6	245000	mg/m^3
Hydrochloric acid	7647-01-0	15	mg/m^3
Hydrotalcite/zeolite	12304-65-3; 1318-02-1	20	mg/m^3
Isopropyl alcohol	67-63-0	268.3	mg/m^3
Ligroine	8032-32-4	14560	mg/m^3
Maneb	12427-38-2	10	mg/m^3
Mercury	7439-97-6	06	mg/m^3
Methanol	67-56-1	130	mg/m^3
Methyl chloride	74-87-3	1138.4	mg/m^3
Methyl ethyl ketone	78-93-3	8047	mg/m^3
Methyl isobutyl ketone	108-10-1	224	mg/m^3
Methyl methacrylate	80-62-6	111.7	mg/m^3
Metyl tert-butyl ether	1634-04-4	2880	mg/m^3
N,N-Dimethylaniline	121-69-7	06	mg/m^3
N-butyl alcohol	71-36-3	0.1	mg/m^3
Nitrobenzene	98-95-3	27.5	mg/m^3
p-cresol	106-44-5	10	mg/m^3
Phosphine	7803-51-2	0.25	mg/m^3
Phosphoric acid	7664-38-2	50	mg/m^3
Propionaldehyde	123-38-6	200	mg/m^3
Propylene	115-07-1	9375	mg/m^3
Propylene glycol	57-55-6	170	mg/m^3
Propylene oxide	75-56-9	237	mg/m^3
p-xylene	106-42-3	5812.6	mg/m^3
Sec-butyl alcohol	78-92-2	8270	mg/m^3
Styrene	100-42-5	565	mg/m^3
Sulfur dioxide	7446-09-5	0.104	mg/m^3
Sulfuric acid	7664-93-9	0.1	mg/m^3
Terephthalic acid	100-21-0	3	mg/m^3
Tetrachloroethylene	127-18-4	740.2	mg/m^3
Tetrahydrofuran	109-99-9	0.2	mg/m^3
Titanium	7440-32-6	0.8	mg/m^3
Titanium tetrachloride	7550-45-0	09	mg/m^3
Toluene	108-88-3	411.1	mg/m^3
Toluene-2,4-diisocyanate	584-84-9	0.03	mg/m^3

Chemical	CAS #	Inhalation NOAEL	unit
Trichloroethylene	79-01-6	586.6	mg/m^3
Vinyl acetate	108-05-4	176	mg/m^3
Vinyl chloride	75-01-4	69754.5	mg/m^3
Vinylidene chloride	75-35-4	120	mg/m^3

[a]The hazard value for each chemical was derived by dividing the toxicity values shown here by the applicable geometric mean presented in Appendix E-3.

Table E-4. Fish LC50 Data[a]

Chemical	CAS #	Fish LC50	unit
1,1,1-Trichloroethane	71-55-6	48	mg/L
1,1,2-Trichloroethane	79-00-5	82	mg/L
1,2,3,5-Tetrachlorobenzene	634-90-2	4	mg/L
1,2,4-Trichlorobenzene	120-82-1	3	mg/L
1,2,4-Trimethylbenzene	95-63-6	8	mg/L
1,2-Dichlorobenzene	95-50-1	1	mg/L
1,2-Dichloroethane	107-06-2	136	mg/L
1,2-Dichloropropane	78-87-5	127	mg/L
1,3-Butadiene	106-99-0	4	mg/L
1,3-Dichloropropene	542-75-6	0.24	mg/L
1,4-Dichlorobenzene	106-46-7	34	mg/L
1,4-Dioxane	123-91-1	9850	mg/L
1-Methylphenanthrene	832-69-9	1	mg/L
2,2-Dimethylolpropionic acid	4767-03-7	1000	mg/L
2,4,5-Trichlorotoluene	6639-30-1	1	mg/L
2,4,6-Trichlorophenol	88-06-2	3	mg/L
2,4-D	94-75-7	71	mg/L
2,4-Dinitrophenol	51-28-5	11	mg/L
2,4-Dinitrotoluene	121-14-2	24	mg/L
2-Ethoxyethanol	110-80-5	16305	mg/L
2-Methoxyethanol	109-86-4	22655	mg/L
2-Nitropropane	79-46-9	5	mg/L
3,4-Dinitrotoluene	610-39-9	2	mg/L
4,4'-Isopropylidenediphenol	80-05-7	5	mg/L
4,4'-Methylenedianiline	101-77-9	45	mg/L
4-Nitrophenol	100-02-7	41	mg/L
Acetaldehyde	75-07-0	34	mg/L
Acetone	67-64-1	7200	mg/L
Acetonitrile	75-05-8	1640	mg/L
Acrylamide	79-06-1	109	mg/L
Acrylic acid	79-10-7	186	mg/L
Acrylonitrile	107-13-1	10	mg/L
Alachlor	15972-60-8	5	mg/L
Allyl chloride	107-05-1	72	mg/L
Aluminum	7429-90-5	11	mg/L
Aluminum (+3)		3.6	mg/L
Aluminum Hydroxide	21645-51-2	32	mg/L
Ammonia	7664-41-7	2	mg/L
Ammonium nitrate (solution)	6484-52-2	800	mg/L
Ammonium sulfate (solution)	7783-20-2	4000	mg/L
Aniline	62-53-3	108	mg/L
Anthracene	120-12-7	0.01	mg/L
Antimony	7440-36-0	14.4	mg/L

Chemical	CAS #	Fish LC50	unit
Antimony cmpds	20-00-8	833	mg/L
Antioxidant	32687-78-8	100	mg/L
Arsenic	7440-38-2	14.4	mg/L
Arsenic cmpds	20-01-9	32	mg/L
Atrazine	1912-24-9	16	mg/L
Barium	7440-39-3	580	mg/L
Barium cmpds	20-02-0	200	mg/L
Bentonite	1302-78-9	1000	mg/L
Benzaldehyde	100-52-7	27	mg/L
Benzene	71-43-2	19	mg/L
Benzo(k)fluoranthene	207-08-9	1000	mg/L
Benzoyl chloride	98-88-4	35	mg/L
Beryllium	7440-90-5	2	mg/L
Beta diketone		140	mg/L
Beta terpineol	138-87-4	5.4	mg/L
Biphenyl	92-52-4	2	mg/L
Bis(2-ethylhexyl) adipate	103-23-1	0.35	mg/L
Bismuth	7440-69-9	5	mg/L
Boron	7440-42-8	113	mg/L
Boron (B III)		113	mg/L
Bromomethane	74-83-9	11	mg/L
Butyl benzyl phthalate	85-68-7	43	mg/L
Butylate	2008-41-5	7	mg/L
Butyraldehyde	123-72-8	32	mg/L
Cadmium	7440-43-9	01	mg/L
Cadmium cmpds	20-04-2	0.1	mg/L
Caffeine	58-08-2	151	mg/L
Captan	133-06-2	0.2	mg/L
Carbaryl	63-25-2	8	mg/L
Carbon disulfide	79-15-0	694	mg/L
Carbon tetrachloride	56-23-5	41	mg/L
Carbonyl sulfide	463-58-1	2685	mg/L
Catechol	120-80-9	9	mg/L
Chlorine	7782-50-5	0.34	mg/L
Chlorine dioxide	10049-04-4	0.17	mg/L
Chlorobenzene	108-90-7	17	mg/L
Chloroform	67-66-3	71	mg/L
Chlorophenols [o]	20-05-3	19	mg/L
Chloroprene	126-99-8	2	mg/L
Chlorothalonil	1897-45-6	0.05	mg/L
Chlorpyrifos	2921-88-2	2.4	mg/L
Chromium	7440-47-3	52	mg/L
Chromium (VI)	18540-29-9	22.6	mg/L
Chromium cmpds	20-06-4	33	mg/L

Chemical	CAS #	Fish LC50	unit
Chromium III	16065-83-1	3.3	mg/L
Cobalt cmpds	20-07-5	0.38	mg/L
Coolant		227634	mg/L
Copper	7440-50-8	0.014	mg/L
Copper (+1 & +2)		0.014	mg/L
Copper cmpds	20-08-6	0.33	mg/L
Cresol (mixed isomers)	1319-77-3	13	mg/L
Crude Oil	8002-05-9	7.1	mg/L
Cumene	98-82-8	6	mg/L
Cumene hydroperoxide	80-15-9	62	mg/L
Cyanazine	21725-46-2	18	mg/L
Cyanide (-1)	57-12-5	56	mg/L
Cyclohexane	110-82-7	5	mg/L
Cyclohexanone	108-94-1	630	mg/L
Cyclohexylamine	108-91-8	222	mg/L
Decabromodiphenyl oxide	1163-19-5	0.06	mg/L
Di (2-ethylhexyl)phthalate	117-81-7	1	mg/L
Di propylene glycol butyl ether	29911-28-2	930	mg/L
Diaminotoluene (mixed isomers)	25376-45-8	37	mg/L
Dibutyl phthalate	84-74-2	1	mg/L
Dichlorobenzene (mixed isomers)	25321-22-6	1	mg/L
Dichloromethane	75-09-2	330	mg/L
Diethanolamine	111-42-2	4710	mg/L
Diethyl phthalate	84-66-2	32	mg/L
Dimethyl phthalate	131-11-3	121	mg/L
Di-n-octyl phthalate	117-84-0	1	mg/L
Edetic acid (EDTA)	60-00-4	473	mg/L
Epichlorohydrin	106-89-8	35	mg/L
Ethoduomeen	53127-17-6	0.5	mg/L
Ethyl chloride	75-00-3	16	mg/L
Ethyl dipropylthiocarbamate	759-94-4	27	mg/L
Ethylbenzene	100-41-4	11	mg/L
Ethylene	74-85-1	14	mg/L
Ethylene glycol	107-21-1	227634	mg/L
Ethylene oxide	75-21-8	84	mg/L
Fluorine	7782-49-2	100	mg/L
Fluoroboric acid	16872-11-0	1000	mg/L
Fluorosilicic acid	16961-83-4	100	mg/L
Fluorspar	7789-75-5	100	mg/L
Formaldeyde	50-00-0	24	mg/L
Freon 113	76-13-1	290	mg/L
Glycol ethers	111-76-2	1490	mg/L
Glyphosate	1071-83-6	600	mg/L
Heavy fuel oil	64741-62-4	316	mg/L

Chemical	CAS #	Fish LC50	unit
Hexachloro-1,3-butadiene	87-68-3	0.09	mg/L
Hexachlorobenzene	118-74-1	22	mg/L
Hexachlorocyclopentadiene	77-47-4	07	mg/L
Hexachloroethane	67-72-1	1	mg/L
Hexafluoropropylene	116-15-4	245	mg/L
Hexane	110-54-3	2.5	mg/L
Hydrazine	302-01-2	4.83	mg/L
Hydrochloric acid	7647-01-0	19	mg/L
Hydrofluoric acid	7664-39-3	265	mg/L
Hydrogen cyanide	74-90-8	1385	mg/L
Hydroquinone	123-31-9	141	mg/L
Hydrotalcite/zeolite	12304-65-3	2900	mg/L
Iron pyrite	1309-36-0	1000	mg/L
Isobutyraldehyde	78-84-2	41	mg/L
Isopropyl alcohol	67-63-0	8623	mg/L
Lead	7439-92-1	31.5	mg/L
Lead cmpds	20-11-1	5	mg/L
Lead sulfate cake	7446-14-2	60.8	mg/L
Limestone flour	471-34-1	100	mg/L
Lithium salts		2600	mg/L
M,p-xylene		13	mg/L
Malathion	121-75-5	0.1	mg/L
Maleic anhydride	108-31-6	2963	mg/L
Maneb	12427-38-2	2	mg/L
Manganese cmpds	20-12-2	150	mg/L
Mercury	7439-97-6	0.155	mg/L
Mercury cmpds		0.155	mg/L
Metam sodium	137-42-8	0.39	mg/L
Methanol	67-56-1	29400	mg/L
Methl mercury	115-09-3	0.09	mg/L
Methyl chloride	74-87-3	550	mg/L
Methyl ethyl ketone	78-93-3	3220	mg/L
Methyl isobutyl ketone	108-10-1	572	mg/L
Methyl methacrylate	80-62-6	259	mg/L
Methyl parathion	298-00-0	9	mg/L
Methyl tert-butyl ether	1634-04-4	786	mg/L
Methylenebis (phenylisocyanate)	101-68-8	1	mg/L
Metolachlor	51218-45-2	15	mg/L
Metribuzin	21087-64-9	80	mg/L
Molybdenum	7439-98-7	157	mg/L
Molybdenum (Mo II, Mo III, Mo IV, Mo V, Mo VI)		157	3.09
Molybdenum trioxide	1313-27-5	370	mg/L
Monochlorohexafluoropropane (HCFC-226)	431-87-8	23	mg/L
m-xylene	108-38-3	16	mg/L

Chemical	CAS #	Fish LC50	unit
N, N-Demethylaniline	121-69-7	65	mg/L
Naphthalene	91-20-3	6	mg/L
N-butyl alcohol	71-36-3	1860	mg/L
Nickel	7440-02-0	2.48	mg/L
Nickel cmpds	20-14-4	27	mg/L
Nitrate		2213	mg/L
Nitrates/nitrites	14797-55-8	2213	mg/L
Nitric acid	7697-37-2	26	mg/L
Nitrites	14797-65-0	225	mg/L
Nitrobenzene	98-95-3	119	mg/L
Nitrogen dioxide	10102-44-0	196	mg/L
N-nitrosodiphenylamine	86-30-6		mg/L
o-xylene	95-47-6	16	mg/L
p-cresol	106-44-5	25	mg/L
Perfluorooctanoic acid (PFOA)	335-67-1	455	mg/L
Phenol	108-95-2	34	mg/L
Phosphoric acid	7664-38-2	70	mg/L
Phosphorus (yellow or white)	7723-14-0	0.02	mg/L
Phthalic anhydride	85-44-9	364	mg/L
Picric acid	88-89-1	170	mg/L
Polychlorinated biphenyls	1336-36-3	3	mg/L
Potassium bicarbonate	298-14-6	305	mg/L
Propionaldehyde	123-38-6	44	mg/L
Propylene	115-07-1	5	mg/L
Propylene oxide	75-56-9	306	mg/L
p-xylene	106-42-3	2	mg/L
Pyridine	110-86-1	100	mg/L
Sec-butyl alcohol	78-92-2	3670	mg/L
Selenium	7782-49-2	4.9	mg/L
Silver	7440-22-4	04	mg/L
Silver cmpds		12	mg/L
Silvex	93-72-1	13	mg/L
Sodium Hypochlorite	7681-52-9	0.53	mg/L
Strontium	7440-24-6	210	mg/L
Styrene	100-42-5	4	mg/L
Sulfuric acid	7664-93-9	31	mg/L
Terbufos	13071-79-9	0.01	mg/L
Terephthalic acid	100-21-0	29	mg/L
Tert-butyl alcohol	75-65-0	1954	mg/L
Tetrachloroethylene	127-18-4	17	mg/L
Tin	7440-31-5	626	mg/L
Tin (Sn++, Sn4+)		626	mg/L
Titanium tetrachloride	7550-45-0	25	mg/L
Toluene	108-88-3	34	mg/L

Chemical	CAS #	Fish LC50	unit
Toluene-2,4-diisocyanate	584-84-9	53	mg/L
Trans-1,2-dichloroethylene	156-60-5	45	mg/L
Tri propylene glycol butyl ether	55934-93-5	900	mg/L
Trichloroethylene	79-01-6	44	mg/L
Trichlorofluoromethane	75-69-4	114	mg/L
Triethylene glycol	112-27-6	88100	mg/L
Trifluralin	1582-09-8	0.11	mg/L
Vanadium	7440-62-2	4	mg/L
Vinyl acetate	108-05-4	100	mg/L
Vinyl chloride	75-01-4	143	mg/L
Vinylidene chloride	75-35-4	108	mg/L
Xylene (mixed isomers)	1330-20-7	13	mg/L
Zinc (+2)		0.09	mg/L
Zinc (elemental)	7440-66-6	0.09	mg/L
Zinc borate	1332-07-6	409	mg/L
Zinc cmpds	20-19-9	17	mg/L
Zinc sulfate	7733-02-0	14	mg/L

[a]The hazard value for each chemical was derived by dividing the toxicity values shown here by the applicable geometric mean presented in Appendix E-3.

Table E-5. Fish NOEL Data[a]

Chemical	CAS #	Fish NOEL	unit
1,1,1-Trichloroethane	71-55-6	48	mg/L
1,1,2-Trichloroethane	79-00-5	82	mg/L
1,2,3,5-Tetrachlorobenzene	634-90-2	4	mg/L
1,2,4-Trichlorobenzene	120-82-1	3	mg/L
1,2,4-Trimethylbenzene	95-63-6	8	mg/L
1,2-Dichlorobenzene	95-50-1	1	mg/L
1,2-Dichloroethane	107-06-2	136	mg/L
1,2-Dichloropropane	78-87-5	127	mg/L
1,3-Butadiene	106-99-0	4	mg/L
1,3-Dichloropropene	542-75-6	0.24	mg/L
1,4-Dichlorobenzene	106-46-7	34	mg/L
1,4-Dioxane	123-91-1	9850	mg/L
1-Methylphenanthrene	832-69-9	1	mg/L
2,2-Dimethylolpropionic acid	4767-03-7	1000	mg/L
2,4,5-Trichlorotoluene	6639-30-1	1	mg/L
2,4,6-Trichlorophenol	88-06-2	3	mg/L
2,4-D	94-75-7	71	mg/L
2,4-Dinitrophenol	51-28-5	11	mg/L
2,4-Dinitrotoluene	121-14-2	24	mg/L
2-Ethoxyethanol	110-80-5	16305	mg/L
2-Methoxyethanol	109-86-4	22655	mg/L
2-Nitropropane	79-46-9	5	mg/L
3,4-Dinitrotoluene	610-39-9	2	mg/L
4,4'-Isopropylidenediphenol	80-05-7	5	mg/L
4,4'-Methylenedianiline	101-77-9	45	mg/L
4-Nitrophenol	100-02-7	41	mg/L
Acetaldehyde	75-07-0	34	mg/L
Acetone	67-64-1	7200	mg/L
Acetonitrile	75-05-8	1640	mg/L
Acrylamide	79-06-1	109	mg/L
Acrylic acid	79-10-7	186	mg/L
Acrylonitrile	107-13-1	10	mg/L
Alachlor	15972-60-8	5	mg/L
Allyl chloride	107-05-1	72	mg/L
Aluminum	7429-90-5	11	mg/L
Aluminum (+3)		3.6	mg/L
Aluminum Hydroxide	21645-51-2	32	mg/L
Ammonia	7664-41-7	2	mg/L
Ammonium nitrate (solution)	6484-52-2	800	mg/L
Ammonium sulfate (solution)	7783-20-2	4000	mg/L
Aniline	62-53-3	108	mg/L
Anthracene	120-12-7	0.01	mg/L
Antimony	7440-36-0	14.4	mg/L
Antimony cmpds	20-00-8	833	mg/L
Arsenic	7440-38-2	14.4	mg/L

Chemical	CAS #	Fish NOEL	unit
Arsenic cmpds	20-01-9	32	mg/L
Atrazine	1912-24-9	16	mg/L
Barium	7440-39-3	580	mg/L
Barium cmpds	20-02-0	200	mg/L
Bentonite	1302-78-9	1000	mg/L
Benzaldehyde	100-52-7	27	mg/L
Benzene	71-43-2	19	mg/L
Benzo(k)fluoranthene	207-08-9	1000	mg/L
Benzoyl chloride	98-88-4	35	mg/L
Beryllium	7440-90-5	2	mg/L
Beta diketone		140	mg/L
Beta terpineol	138-87-4	5.4	mg/L
Biphenyl	92-52-4	2	mg/L
Bis(2-ethylhexyl) adipate	103-23-1	0.35	mg/L
Bismuth	7440-69-9	5	mg/L
Boron	7440-42-8	113	mg/L
Boron (B III)		113	mg/L
Bromomethane	74-83-9	11	mg/L
Butyl benzyl phthalate	85-68-7	43	mg/L
Butylate	2008-41-5	7	mg/L
Butyraldehyde	123-72-8	32	mg/L
Cadmium	7440-43-9	01	mg/L
Cadmium cmpds	20-04-2	0.1	mg/L
Caffeine	58-08-2	151	mg/L
Captan	133-06-2	0.2	mg/L
Carbaryl	63-25-2	8	mg/L
Carbon disulfide	79-15-0	694	mg/L
Carbon tetrachloride	56-23-5	41	mg/L
Carbonyl sulfide	463-58-1	2685	mg/L
Catechol	120-80-9	9	mg/L
Chlorine	7782-50-5	0.34	mg/L
Chlorine dioxide	10049-04-4	0.17	mg/L
Chlorobenzene	108-90-7	17	mg/L
Chloroform	67-66-3	71	mg/L
Chlorophenols [o]	20-05-3	19	mg/L
Chloroprene	126-99-8	2	mg/L
Chlorothalonil	1897-45-6	0.05	mg/L
Chlorpyrifos	2921-88-2	2.4	mg/L
Chromium	7440-47-3	52	mg/L
Chromium (VI)	18540-29-9	22.6	mg/L
Chromium cmpds	20-06-4	33	mg/L
Chromium III	16065-83-1	3.3	mg/L
Cobalt cmpds	20-07-5	0.38	mg/L
Coolant		227634	mg/L
Copper	7440-50-8	0.014	mg/L
Copper (+1 & +2)		0.014	mg/L

Chemical	CAS #	Fish NOEL	unit
Copper cmpds	20-08-6	0.33	mg/L
Cresol (mixed isomers)	1319-77-3	13	mg/L
Crude Oil	8002-05-9	7.1	mg/L
Cumene	98-82-8	6	mg/L
Cumene hydroperoxide	80-15-9	62	mg/L
Cyanazine	21725-46-2	18	mg/L
Cyanide (-1)	57-12-5	56	mg/L
Cyclohexane	110-82-7	5	mg/L
Cyclohexanone	108-94-1	630	mg/L
Cyclohexylamine	108-91-8	222	mg/L
Decabromodiphenyl oxide	1163-19-5	0.06	mg/L
Di (2-ethylhexyl)phthalate	117-81-7	1	mg/L
Di propylene glycol butyl ether	29911-28-2	930	mg/L
Diaminotoluene (mixed isomers)	25376-45-8	37	mg/L
Dibutyl phthalate	84-74-2	1	mg/L
Dichlorobenzene (mixed isomers)	25321-22-6	1	mg/L
Dichloromethane	75-09-2	330	mg/L
Diethanolamine	111-42-2	4710	mg/L
Diethyl phthalate	84-66-2	32	mg/L
Dimethyl phthalate	131-11-3	121	mg/L
Di-n-octyl phthalate	117-84-0	1	mg/L
Edetic acid (EDTA)	60-00-4	473	mg/L
Epichlorohydrin	106-89-8	35	mg/L
Ethoduomeen	53127-17-6	0.5	mg/L
Ethyl chloride	75-00-3	16	mg/L
Ethyl dipropylthiocarbamate	759-94-4	27	mg/L
Ethylbenzene	100-41-4	11	mg/L
Ethylene	74-85-1	14	mg/L
Ethylene glycol	107-21-1	227634	mg/L
Ethylene oxide	75-21-8	84	mg/L
Fluorine	7782-49-2	100	mg/L
Fluoroboric acid	16872-11-0	1000	mg/L
Fluorosilicic acid	16961-83-4	100	mg/L
Fluorspar	7789-75-5	100	mg/L
Formaldeyde	50-00-0	24	mg/L
Freon 113	76-13-1	290	mg/L
Glycol ethers	111-76-2	1490	mg/L
Glyphosate	1071-83-6	600	mg/L
Heavy fuel oil	64741-62-4	316	mg/L
Hexachloro-1,3-butadiene	87-68-3	0.09	mg/L
Hexachlorobenzene	118-74-1	22	mg/L
Hexachlorocyclopentadiene	77-47-4	07	mg/L
Hexachloroethane	67-72-1	1	mg/L
Hexafluoropropylene	116-15-4	245	mg/L
Hexane	110-54-3	2.5	mg/L
Hydrazine	302-01-2	4.83	mg/L

Chemical	CAS #	Fish NOEL	unit
Hydrochloric acid	7647-01-0	19	mg/L
Hydrofluoric acid	7664-39-3	265	mg/L
Hydrogen cyanide	74-90-8	1385	mg/L
Hydroquinone	123-31-9	141	mg/L
Hydrotalcite/zeolite	12304-65-3	2900	mg/L
Irganox MD1024	32687-78-8	100	mg/L
Iron pyrite	1309-36-0	1000	mg/L
Isobutyraldehyde	78-84-2	41	mg/L
Isopropyl alcohol	67-63-0	8623	mg/L
Lead	7439-92-1	31.5	mg/L
Lead cmpds	20-11-1	5	mg/L
Lead sulfate cake	7446-14-2	60.8	mg/L
Limestone flour	471-34-1	100	mg/L
Lithium salts		2600	mg/L
M,p-xylene		13	mg/L
Malathion	121-75-5	0.1	mg/L
Maleic anhydride	108-31-6	2963	mg/L
Maneb	12427-38-2	2	mg/L
Manganese cmpds	20-12-2	150	mg/L
Mercury	7439-97-6	0.155	mg/L
Mercury cmpds		0.155	mg/L
Metam sodium	137-42-8	0.39	mg/L
Methanol	67-56-1	29400	mg/L
Methl mercury	115-09-3	0.09	mg/L
Methyl chloride	74-87-3	550	mg/L
Methyl ethyl ketone	78-93-3	3220	mg/L
Methyl isobutyl ketone	108-10-1	572	mg/L
Methyl methacrylate	80-62-6	259	mg/L
Methyl parathion	298-00-0	9	mg/L
Methyl tert-butyl ether	1634-04-4	786	mg/L
Methylenebis (phenylisocyanate)	101-68-8	1	mg/L
Metolachlor	51218-45-2	15	mg/L
Metribuzin	21087-64-9	80	mg/L
Molybdenum	7439-98-7	157	mg/L
Molybdenum (Mo II, Mo III, Mo IV, Mo V, Mo VI)		157	mg/L
Molybdenum trioxide	1313-27-5	370	mg/L
Monochlorohexafluoropropane (HCFC-226)	431-87-8	23	mg/L
m-xylene	108-38-3	16	mg/L
N, N-Demethylaniline	121-69-7	65	mg/L
Naphthalene	91-20-3	6	mg/L
N-butyl alcohol	71-36-3	1860	mg/L
Nickel	7440-02-0	2.48	mg/L
Nickel cmpds	20-14-4	27	mg/L
Nitrate		2213	mg/L
Nitrates/nitrites	14797-55-8	2213	mg/L
Nitric acid	7697-37-2	26	mg/L

Chemical	CAS #	Fish NOEL	unit
Nitrites	14797-65-0	225	mg/L
Nitrobenzene	98-95-3	119	mg/L
Nitrogen dioxide	10102-44-0	196	mg/L
N-nitrosodiphenylamine	86-30-6		mg/L
o-xylene	95-47-6	16	mg/L
p-cresol	106-44-5	25	mg/L
Perfluorooctanoic acid (PFOA)	335-67-1	455	mg/L
Phenol	108-95-2	34	mg/L
Phosphoric acid	7664-38-2	70	mg/L
Phosphorus (yellow or white)	7723-14-0	0.02	mg/L
Phthalic anhydride	85-44-9	364	mg/L
Picric acid	88-89-1	170	mg/L
Polychlorinated biphenyls	1336-36-3	3	mg/L
Potassium bicarbonate	298-14-6	305	mg/L
Propionaldehyde	123-38-6	44	mg/L
Propylene	115-07-1	5	mg/L
Propylene oxide	75-56-9	306	mg/L
p-xylene	106-42-3	2	mg/L
Pyridine	110-86-1	100	mg/L
Sec-butyl alcohol	78-92-2	3670	mg/L
Selenium	7782-49-2	4.9	mg/L
Silver	7440-22-4	04	mg/L
Silver cmpds		12	mg/L
Silvex	93-72-1	13	mg/L
Sodium Hypochlorite	7681-52-9	0.53	mg/L
Strontium	7440-24-6	210	mg/L
Styrene	100-42-5	4	mg/L
Sulfuric acid	7664-93-9	31	mg/L
Terbufos	13071-79-9	0.01	mg/L
Terephthalic acid	100-21-0	29	mg/L
Tert-butyl alcohol	75-65-0	1954	mg/L
Tetrachloroethylene	127-18-4	17	mg/L
Tin	7440-31-5	626	mg/L
Tin (Sn++, Sn4+)		626	mg/L
Titanium tetrachloride	7550-45-0	25	mg/L
Toluene	108-88-3	34	mg/L
Toluene-2,4-diisocyanate	584-84-9	53	mg/L
Trans-1,2-dichloroethylene	156-60-5	45	mg/L
Tri propylene glycol butyl ether	55934-93-5	900	mg/L
Trichloroethylene	79-01-6	44	mg/L
Trichlorofluoromethane	75-69-4	114	mg/L
Triethylene glycol	112-27-6	88100	mg/L
Trifluralin	1582-09-8	0.11	mg/L
Vanadium	7440-62-2	4	mg/L
Vinyl acetate	108-05-4	100	mg/L
Vinyl chloride	75-01-4	143	mg/L

Chemical	CAS #	Fish NOEL	unit
Vinylidene chloride	75-35-4	108	mg/L
Xylene (mixed isomers)	1330-20-7	13	mg/L
Zinc (+2)		0.09	mg/L
Zinc (elemental)	7440-66-6	0.09	mg/L
Zinc borate	1332-07-6	409	mg/L
Zinc cmpds	20-19-9	17	mg/L
Zinc sulfate	7733-02-0	14	mg/L

[a]The hazard value for each chemical was derived by dividing the toxicity values shown here by the applicable geometric mean presented in Appendix E-3.

Appendix E-3: Geometric Means Used in Hazard Value Calculations

Table E-6. Geometric Means Used to Calculate Toxicity Hazard Values

Parameter	n	min	max	Geometric mean
Oral SF	175	0.00095	150000	**0.707**
Inhalation SF	105	0.00165	150000	**1.70**
Oral NOAEL	171	9E-08	7500	**16.8**
Inhalation NOAEL	90	0.006	245000	**69.8**
Fish LC50	235	0.001	227634	**27.4**
Fish NOEL	213	0.001	56909	**4.07**

[a] The chemical data used to generate the geometric means are listed in Appendix E-2.

Appendix E-4: Example Toxicity Calculation

The following example illustrates how toxicity impacts are calculated. Please refer to Section 3.2.11 of the main body of this report for descriptions of the methodologies for calculating these impacts.

If two toxic chemicals (e.g., toluene and benzo(a)pyrene) are included in a waterborne release to surface water from Process A, impact scores would be calculated for the following impact categories (based on the classification shown in Table 3-1 of the main report):

- Chronic public health effects, cancer and non-cancer; and,
- Aquatic ecotoxicity.

Despite the output types being waterborne releases, the water eutrophication and water quality impact categories are not applicable here because the chemical properties criteria in Table 3-1 are not met. That is, these chemicals do not contain nitrogen or phosphorus and are not themselves wastewater streams.

Using chronic public health effects as an example, impact scores are then calculated for each chemical as follows:

Cancer effects:

$$IS_{CHP\text{-}CA:toluene} = HV_{CA:toluene} \times Amt_{TCoutput:toluene}$$

$$IS_{CHP\text{-}CA:benzo(a)pyrene} = HV_{CA:benzo(a)pyrene} \times Amt_{TCoutput:benzo(a)pyrene}$$

Non-cancer effects:

$$IS_{CHP\text{-}NC:toluene} = HV_{NC:toluene} \times Amt_{TCoutput:toluene}$$

$$IS_{CHP\text{-}NC:benzo(a)pyrene} = HV_{NC:benzo(a)pyrene} \times Amt_{TCoutput:benzo(a)pyrene}$$

Table E-7 presents toxicity data for the example chemicals. The hazard values and impact scores are calculated as follows:

Table E-7. Toxicity Data Used in Example Calculations

Chemical	Cancer		Chronic non-cancer effects	
	Weight of evidence	Slope factor (SF) $(mg/kg\text{-}day)^{-1}$	Oral (mg/kg-day)	Inhalation (mg/m^3)
Toluene	D, 3	None	100 (NOAEL)	411.1 (NOAEL)
Benzo(a)pyrene	B2, 2A	7.3 (oral) 3.1 (inhalation)	No data	No data

Cancer effects:

The cancer HV for benzo(a)pyrene is calculated as follows:

$$oral: \qquad (HV_{CA_{oral}})_i = \frac{oral\ SF_i}{oral\ SF_{mean}}$$

$HV_{CAoral:benzo(a)pyrene}$ = 7.3 $(mg/kg\text{-}day)^{-1}$) 0.71 $(mg/kg\text{-}day)^{-1}$
= 10.3

$$inhalation: \qquad (HV_{CA_{inh}})_i = \frac{inhalation\ SF_i}{inhalation\ SF_{mean}}$$

$HV_{CAinhalation:benzo(a)pyrene}$ = 3.1 $(mg/kg\text{-}day)^{-1}$) 1.7 $(mg/kg\text{-}day)^{-1}$
= 1.82

Thus, the cancer HV is 10.3, the greater of the two values. The cancer HV for toluene is zero since it has no slope factor and a WOE classification of D (EPA) and 3 (IARC).

Given a hypothetical waterborne release amount of 0.1 kg of benzo(a)pyrene per functional unit, the impact score for benzo(a)pyrene cancer effects is given by:

$IS_{CHP\text{-}CA,W:benzo(a)pyrene}$ = 10.3 x 0.1
= 1.03 kg cancertox-equivalents of benzo(a)pyrene per functional unit

Toluene=s impact score for cancer is zero since its HV is zero.

Non-cancer effects:

Since no data are available for non-cancer effects of benzo(a)pyrene, a default HV of one is assigned, representative of mean toxicity.

The non-cancer HV for toluene is calculated as follows:

$$oral: \qquad (HV_{NC_{oral}})_i = \frac{1/(oral\ NOAEL_i)}{1/(oral\ NOAEL_{mean})}$$

$= 1/100 \text{ mg/kg-day} \,)\, 1/14.0 \text{ mg/kg-day}$

$= 0.140$

$$inhalation: \qquad (HV_{NC_{inhalation}})_i = \frac{1/(inhal\ \ NOAEL_i)}{1/(inhal\ \ NOAELSUBmean)}$$

$= 1/411.1 \text{ mg/m}^3 \,)\, 1/68.7 \text{ mg/m}^3$

$= 0.167$

Thus, the non-cancer HV for toluene is 0.167, the greater of the two values.

Given the following hypothetical output amounts:

$Amt_{TC\text{-}O:TOLUENE}$ = 1.3 kg of toluene per functional unit

$Amt_{TC\text{-}O:BENZO(A)PYRENE}$ = 0.1 kg of benzo(a)pyrene per functional unit

The resulting non-cancer impact scores are as follows:

$IS_{CHP\text{-}NC,W:TOLUENE}$ = 0.167 x 1.3

= 0.22 kg non-cancer-equivalents of toluene per functional unit

$IS_{CHP\text{-}NC,W:BENZO(A)PYRENE}$ = 1 x 0.1

= 0.1 kg non-cancer-equivalents of benzo(a)pyrene per functional unit

If these were the only outputs from Process A relevant to chronic public health effects, the total non-cancer impact score for this impact category for Process A would be:

$IS_{CHP\text{-}NC:PROCESS\_A}$ = $IS_{CHP\text{-}NC\text{-}W:TOLUENE} + IS_{CHP\text{-}NC\ \text{-}W:BENZO(A)PYRENE}$

= 0.22 + 0.1

= 0.23 nkg non-cancertox-equivalents per functional unit for Process A.

If the product system Y contained three processes altogether (Processes A, B, and C), and the non-cancer impact scores for Process B and C were 0.5 and 1.0, respectively, impact scores would be added together to yield a total impact score for the product system relevant to chronic public non-cancer health effects:

$$IS_{CHP\text{-}NC:PROFILE\_Y} = IS_{CHP\text{-}NC:PROCESS\_A} + IS_{CHP\text{-}NC:PROCESS\_B} + IS_{CHP\text{-}NC:PROCESS\_C}$$

$$= 0.23 + 0.5 + 1.0$$

= 1.73 kg non-cancertox-equivalents per functional unit for Profile Y.

An environmental profile would then be the sum of all the processes within that profile for each impact category.

APPENDIX F: Review Statement

The LCA was extensively reviewed by the Core Group. Over 100 comments were addressed prior to the preparation of the final report. Below are the comments received by the EPA LCA expert and how they were addressed. The reviewer found the responses acceptable.

Comments from EPA LCA expert, MaryAnn Curran, Office of Research and Development:

	COMMENT:	RESPONSE:
1.	Overall the contractors did a very nice job with the study. I did not delve into the data so I can't speak to their accuracy but I did take a look at the LCA methodology that was used. I really don't see much wrong in what they did.	
2.	The goal of the study is clearly stated, they followed ISO methodology, clearly state all assumptions and data sources, and use a multi-media/multi-impact approach. They have obviously done LCAs before. The only weakness I can see is the use of an "energy use" category. Typically, accounting for energy use doesn't allow for identification of impacts such as fossil fuel depletion (that is, not all energy is the same). But if for this industry and product type, the energy is being sourced basically from the same place (such as the national grid), then you can get a way with the energy use comparison. The report touches on this a bit in the conclusion section.	For clarification, our "energy use" category is the quantity of energy (electrical or fuel energy) used throughout the life cycle, measured in megajoules per functional unit. It includes electric energy from the national grid (which accounts for energy produced by various fuel types--coal, natural gas, nuclear, etc.), as well as energy used directly from fuels in industrial processes (e.g., natural gas or fuel oil #2). Our energy use category does not account for fossil fuel depletion directly (as you say), and it is only intended to reflect energy use, knowing that some of that energy is from different sources; however we have an impact category for "non-renewable resource use impacts" where fossil fuel depletion is accounted for, along with any other non-renewables.
3.	Also, the data are obviously not the best. I am glad to see this mentioned in the section on recommended improvements. In many places the data are pretty old. (There should be some indication of how age was handled - can it be assumed that the industry didn't change much in certain so that older data is acceptable?) and in other places only limited sources were used to average data. These are very limiting to the robustness of the study, but I think the authors did a good job of identifying these weaknesses and did the best with what they could get. I would just like to see this addressed a little better (more?) in the executive summary, without being too apologetic.	RESPONSE: We have attached an excerpt from the Executive Summary with a suggested sentence to "beef up" the discussion on the data age issue. Excerpt: Last 2 paragraphs of section 3.2.1 of Executive Summary (suggested addition in ALL CAPS): "A variety of secondary data sources were used, including PlasticsEurope for PVC and HDPE data (Boustead, 2005a; Boustead, 2005b); Ecobilan for phthalate plasticizer data (Ecobilan, 2001); Andersson *et al*. for aluminum trihydrate data (Andersson *et al*., 2005); and GaBi4 database (PE & IKP, 2003) for limestone and calcium fillers, electricity generation, natural gas, light fuel oil, and heavy fuel oil. ALTHOUGH SOME DATA ARE SEVERAL YEARS OLD; THEY REPRESENT MATERIALS WHICH HAVE BEEN PROCESSED FOR MANY YEARS AND THUS WE ASSUME THEY ARE PRODUCED USING MATURE TECHNOLOGIES THAT ARE EXPECTED TO BE REPRESENTATIVE OF CURRENT PROCESSES. Using a high-medium-

	COMMENT:	RESPONSE:
		low scale, the overall inventory for the upstream life-cycle stage was given a subjective data quality measure of "medium to low" due to the extensive use of secondary data and the absence of some of the upstream data."
4.	I only found one typo: Check the last reference for Lovstof/mech_recylce.pdf (I assume this should be recycle)	Typo fixed.