

Sheet1

		1990	1990	Vinyl	Vinyl							
		Annual	Annual	Chloride	Chloride							
Facility	Facility	Capacity	Production	Emission	Emissions						SRI	SRI
Name	Location	(million lb)	(million lb)	Factor	(tons/year)						VC	PVC
Borden Chemicals & Plastics	Geismar, LA	800	831.2	8.92	1853.58	5420985	tons of production				X	X
Dow Chemical Co. Texas Ope	Freeport, TX	900	935.1	8.92	2085.27						X	
Dow Chemical	Plaquemine, LA	1300	1350.7	8.92	3012.06						X	
Formosa Plastics Corp.	Baton Rouge, LA	400	415.6	8.92	926.79						X	
Formosa Plastics Corp.	Point Comfort, TX	900	935.1	8.92	2085.27	0.03410801	emission factor based on actual TRI emissio				X	X
Georgia Gulf Corp.	Plaquemine, LA	1260	1309.14	8.92	2919.38						X	X
Westlake Monomers Corp.	Calvert City, KY	1000	1039	8.92	2316.97						X	
The Geon Comp.	La Porte, TX	1300	1350.7	8.92	3012.06						X	
Occidental Chemical Corp.	Deer Park, TX	1100	1142.9	8.92	2548.67	TOTAL, EPA estimate VCM Producers 24,200 tons/year TOTAL, TRI 1990 air emissions VCM Producers 92 tons/year TOTAL, TRI 1990 air emissions all VC sources 626 tons/year					X	
PPG Chemicals Group	Lake Charles, LA	650	675.35	8.92	1506.03						X	
Vista Chemical Co.	Lake Charles, LA	825	857.18	8.92	1911.5						X	
Actual TRI data, 1990		TRI	TRI		TRI							
		Fugitive	Point		Total Air							
Facility	Facility	Air	Air		Emissions							
Name	Location	(lb/year)	(lb/year)		(ton/year)							
Borden Chemicals & Plastics	Geismar, LA	8,161	45,265		26.713							
Dow Chemical Co. Texas Ope	Freeport, TX	7500	770		4.135							
Dow Chemical	Plaquemine, LA	5,900	1,600		3.75							
Formosa Plastics Corp.	Baton Rouge, LA	7,131	98		3.6145							
Formosa Plastics Corp.	Point Comfort, TX	7,800	5,700		6.75							
Georgia Gulf Corp.	Plaquemine, LA	1,700	7,600		4.65							
Westlake Monomers Corp.	Calvert City, KY	23000	27000		25							
The Geon Comp.	La Porte, TX	1600	3300		2.45							
Occidental Chemical Corp.	Deer Park, TX	72	15		0.0435							
PPG Chemicals Group	Lake Charles, LA	8,042	2,257		5.1495							
Vista Chemical Co.	Lake Charles, LA	16,600	3,788		10.194							

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AIR PRODUCTS & CHEMICAL	CALVERT CITY	250	250	0.25	X							
BF GOODRICH	PEDRICKTOWN	12000	76000	44	X							
BF GOODRICH CO.	PLAQUEMINE	20000	5000	12.5	X							
BF GOODRICH GEON VINYL	DEER PARK	510	530	0.52	X							
BF GOODRICH LOUISVILLE	LOUISVILLE	5000	4100	4.55	X							
BORDEN CHEMICALS & PL	ILLIOPOLIS	14625	60835	37.73	X							
CERTAINTED CORP.	SULPHUR	24000	500	12.25	X							
FORMOSA PLASTICS CORP	DELAWARE CITY	23564	101718	62.641	X							
GEORGIA GULF CORP.	DELAWARE CITY	5019	27790	16.4045	X							
GOODYEAR TIRE & RUBBER	NIAGARA FALLS	19011	52771	35.891	X							
KEYSOR-CENTURY CORP.	SAUGUS	50	770	0.41	X							
OCCIDENTAL CHEMICAL C	ADDIS	2300	17700	10	X							
OCCIDENTAL CHEMICAL C	BURLINGTON	3300	37000	20.15	X							
OCCIDENTAL CHEMICAL C	PASADENA	2400	74000	38.2	X							
OCCIDENTAL CHEMICAL C	POTTSTOWN	21299	116976	69.1375	X							
OCCIDENTAL CHEMICAL C	BURLINGTON	10000	4400	7.2	X							
SHINTECH INC.	FREEPORT	53725	13426	33.5755	X							
UNION CARBIDE CORP. TEX	TEXAS CITY	1573	185	0.879	X							
VISTA CHEMICAL CO. VISTA	OKLAHOMA CITY	1400	64300	32.85	X							
VISTA POLYMERS INC. VIST	ABERDEEN	3017	60976	31.9965	X							
VYGEN CORP.	ASHTABULA	38600	250	19.425	X							
GMC INLAND FISHER GUID	ANDERSON	250	250	0.25								
PACIFIC WESTERN RESIN C	CALVERT CITY	14000	6000	10								
WESTLAKE MONOMERS CO	CALVERT CITY	23000	27000	25								
RIVAL CO.	CLINTON	0	0	0								
GMC DELCCHASSIS DIV. H	DAYTON	295	56	0.1755								
UNION CARBIDE CHEMICAL	GARLAND	110	3	0.0565								
VULCAN MATERIALS CO. C	GEISMAR	150	260	0.205								
OCCIDENTAL CHEMICAL C	GREGORY	0	0	0								
UNION CARBIDE CORP. TAF	HAHNVILLE	14	14	0.014								
MOBAY CORP. AG CHEM. DI	KANSAS CITY	629	684	0.6565								
OCCIDENTAL CHEMICAL C	LA PORTE	5	5	0.005								
WELLINGTON LEISURE PR	MADISON	0	0	0								
DOW CHEMICAL USA MIDLA	MIDLAND	672	251	0.4615								
PACIFIC WESTERN RESIN C	PACE	2000	11000	6.5								
UNION CARBIDE CORP.	TORRANCE	11	20	0.0155								
UNION CARBIDE CHEMICAL	TUCKER	11	1	0.006								
ALBA-WALDENIAN INC.	VALDESE	0	0	0								
VULCAN CHEMICALS	WICHITA	10	1	0.0055								
						5,445,904	0					

APPENDIX A: NATIONAL ESTIMATES Chemical Manufacturing: Vinyl Chloride**Vinyl Chloride**

Group Name: Chemical Manufacturing Category

Baseline Year: 1990

of Facilities: 11

National Estimate: 2.42E+04tons/year

Text Method:

ESTIMATE OF EMISSIONS FROM CHEMICAL MANUFACTURING OF VINYL CHLORIDE USING EMISSION FACTORS FROM FIRE

Approach: Appropriate emission factors from the Factor Information Retrieval (FIRE) System Database were multiplied by an estimate of annual chemical production at each facility reported in the "1990 Directory of Chemicals Producers" to produce vinyl chloride (also called vinyl chloride monomer or VC). The 1990 production of VC at each facility as estimated by first dividing the total annual production by total annual capacity for 1990, as reported in "Chemical Products Synopsis - Vinyl Chloride", February, 1991. This factor was then multiplied by the capacity of each facility identified in the "1990 Directory of Chemical Producers" to estimate the production at each facility.

The emission factors from FIRE have units of "lb VC emitted per ton ethylene dichloride (EDC) - VC produced". Vinyl chloride is made from EDC, so these emission factors were assumed to be for the VC production part of the process, not EDC production. Hence, only VC production data was used to estimate emissions.

The facility estimates for each chemical were summed to produce the 1990 national estimate of emissions from chemical manufacturing of vinyl chloride. Spatial allocation of the estimates for each chemical was based on the location of each facility identified in the "1990 Directory of Chemical Producers".

Data Qualifiers:

The emission factors in FIRE (0.720, 2.4 and 5.8 lb/ton) are representative of uncontrolled operations. These factors were added together to estimate VC emissions. Emission factors were only available for certain emission points, so this estimate may not include the entire amount of emissions from this source category.

Example Calculations:

Annual Production, VC produced:

$10600 \text{ (million lbs VC produced)} / 10200 \text{ (million lbs capacity to produce VC)} = 1.039$

$1.039 \times 800 \text{ (million lbs capacity to produce VC in 1990)} = 831 \text{ million lbs VC produced at one facility}$

VC Emission Factors: Uncontrolled EF = $(0.720 + 2.4 + 5.8 \text{ lb/ton}) = 8.920 \text{ lb VC / ton VC produced}$

Emissions Estimate: $831 \text{ (million lbs VC produced)} \times (1 \text{ ton} / 2000 \text{ lbs}) \times 8.92 \text{ lbs VC / ton VC produced} =$
 $= 3707922 \text{ lbs VC} \times (1 \text{ ton} / 2000 \text{ lbs})$
 $= 1854 \text{ tons vinyl chloride from chemical manufacturing of VC at a facility.}$

References:

U.S. Environmental Protection Agency. Factor Information Retrieval (FIRE) System Database, Version 5.1a. Research Triangle Park, North Carolina. September 1995.

Mannsville Chemical Products Corporation. Chemical Product Synopsis - Vinyl Chloride. February 1991.

Mannsville Chemical Products Corporation. Chemical Product Synopsis - Ethylene Dichloride. February 1991.
1990 Directory of Chemical Producers. SRI International. Menlo Park, CA. 1990. pp. 614, 1064.

APPENDIX A: NATIONAL ESTIMATES Chemical Manufacturing: Vinyl Chloride
Vinyl Chloride

Calculations:

CHEM254		1990	1990	Vinyl	Vinyl				
		Annual	Annual	Chloride	Chloride	State	County		
Facility	Facility	Capacity	Production	Emission	Emissions	FP	FP		
Name	Location	(million lbs)	(million lbs)	Factor	(ton/year)	Code	Code		
Borden Chemicals & Plastics	Geismar, LA	800	831.20	8.92	1853.58	22	005		
Dow Chemical	Oyster Creek, LA	900	935.10	8.92	2085.27	48	039		
Dow Chemical	Flaquemine, LA	1300	1350.70	8.92	3012.06	22	047		
Formosa Plastics Corp	Baton Rouge, LA	400	415.60	8.92	926.79	22	033		
Formosa Plastics Corp	Point Comfort, TX	900	935.10	8.92	2085.27	48	057		
Georgia Gulf Corp	Flaquemine, LA	1260	1309.14	8.92	2919.38	22	047		
BFGoodrich Chemical	Calvert City, KY	1000	1039.00	8.92	2316.97	21	157		
BFGoodrich Chemical	La Porte, TX	1300	1350.70	8.92	3012.06	48	201		
Occidental Chemical Corp	Deer Park, TX	1100	1142.90	8.92	2548.67	48	201		
PPG Chemicals Group	Lake Charles, LA	650	675.35	8.92	1506.03	22	019		
Vista Chemical Co	Lake Charles, LA	825	857.18	8.92	1911.50	22	019		
1990 Annual Emission Estimate =			24177.58	tons Vinyl Chloride / year					
Emission factor units = lb / ton EDC-VC produced									

APPENDIX A: NATIONAL ESTIMATES *Chemical Manufacturing: Methyl Chloroform*
Vinyl Chloride

Group Name: Chemical Manufacturing Category

Baseline Year: 1990

of Facilities: 3

National Estimate: 2.15E+00tons/year

Text Method:

ESTIMATE OF EMISSIONS FROM CHEMICAL MANUFACTURING OF 1,1,1-TRICHLOROETHANE USING EMISSION FACTORS FROM FIRE

Approach: Appropriate emission factors from the Factor Information Retrieval (FIRE) System Database were multiplied by an estimate of annual chemical production at each facility reported in the 1990 Directory of Chemicals Producers to produce 1,1,1-trichloroethane (also called methyl chloroform or TCEA). The 1990 production of TCEA at each facility was estimated by first dividing the total annual production by total annual capacity for 1990, as reported in "Chemical Products Synopsis - 1,1,1-Trichloroethane", November, 1992. This factor was then multiplied by the capacity of each facility identified in the "1990 Directory of Chemical Producers" to estimate the production at each facility.

The facility estimates for each chemical were summed to produce the 1990 national estimate of emissions from chemical manufacturing of 1,1,1-trichloroethane. Spatial allocation of the estimates for each chemical was based on the location of each facility identified in the "1990 Directory of Chemical Producers".

Data Qualifiers:

Vinyl chloride emission factors in FIRE are applicable to distillation column vent emissions. Factors for uncontrolled emissions (0.0140 lb/ton) and controlled by incineration (0.0002 lb/ton) are presented. The factors are based on engineering judgement and are representative of a hypothetical plant with 38 lb/yr production capacity. The average of the uncontrolled and controlled emission factors was used to estimate emissions. Emission factors were only available for certain emission points, so this estimate may not include the entire amount of emissions from this category.

Example Calculations:

Annual Production, TCEA produced -

801 (million lbs TCEA produced) / 1050 (million lbs capacity to produce TCEA) = 0.7629

0.7629 x 500 (million lbs capacity to produce TCEA, 1990) = 381.43 million lbs TCEA produced at one facility

Emissions Estimate:

$0.0140 + 0.0002$ (lb VC / ton TCEA produced) / 2 = 0.0071 lb VC / ton TCEA produced average factor

381.43 (million lbs TCEA produced) x (1 ton / 2000 lbs) x 0.0071 lbs VC / ton TCEA produced =

= 1354 lbs vinyl chloride from chemical manufacturing of TCEA x (1 ton / 2000 lbs) =

= 0.677 tons vinyl chloride from chemical manufacturing of TCEA at one facility.

References:

U.S. Environmental Protection Agency. Factor Information Retrieval (FIRE) System Database, Version 5.1a. Research Triangle Park, North Carolina. September 1995.

Mannsville Chemical Products Corporation. Chemical Product Synopsis - Ethylene Dichloride. February 1991.

Mannsville Chemical Products Corporation. Chemical Product Synopsis - 1,1,1-Trichloroethane. November 1992.

1990 Directory of Chemical Producers. SRI International. Menlo Park, CA. 1990. p 1046.

Vinyl Chloride

CHEM172		1990	1990	Average			
		Annual	Annual	VC	VC	State	County
Facility Name	Facility Location	Capacity (million lbs)	Production (million lbs)	Emission Factor	Emissions (ton/year)	RP Code	RP Code
Dow Chemical	Freeport, TX	500	381.45	0.0071	0.68	48	039
PPG Chemicals Group	Lake Charles, LA	350	267.02	0.014	0.93	22	019
Vulcan Chemicals	Geismar, LA	200	152.58	0.014	0.53	22	005
1990 Annual Emission Estimate =				2.15			
Emission factor units = lb vinyl chloride per ton TCEA produced							

Ethylene Dichloride**Group Name:** Chemical Manufacturing Category**Baseline Year:** 1990**# of Facilities:** 15**National Estimate:** 1.15E+04tons/year**Text Method:**

ESTIMATE OF EMISSIONS FROM CHEMICAL MANUFACTURING OF 1,2-DICHLOROETHYLENE USING EMISSION FACTORS FROM FIRE

Approach: Appropriate emission factors from the Factor Information Retrieval (FIRE) System Database were multiplied by an estimate of annual chemical production at each facility reported in the "1990 Directory of Chemicals Producers" to produce 1,2-dichloroethylene (also called ethylene dichloride or EDC). The 1990 production of EDC at each facility was estimated by first dividing the total annual production by total annual capacity for 1990, as reported in "Chemical Products Synopsis - Ethylene Dichloride", February, 1991. This factor was then multiplied by the capacity of each facility identified in the "1990 Directory of Chemical Producers" to estimate the production at each facility.

The facility estimates for each chemical were summed to produce the 1990 national estimate of emissions from chemical manufacturing of ethylene dichloride. Spatial allocation of the estimates for each chemical was based on the location of each facility identified in the 1990 Directory of Chemical Producers.

Data Qualifiers:

1,2-Dichloroethane emission factors in FIRE are applicable to the production of EDC by the oxychlorination and direct chlorination process. Since facilities often employ both types of process, in what is known as a balanced process, the factors for both types of process were used. Only factors for EDC from uncontrolled sources were used. Emission factors were only available for certain emission points, so this estimate may not include the entire amount of emissions from this source category.

Example Calculations:

Annual Production, EDC produced =

14583 (million lbs EDC produced) / 18500 (million lbs capacity to produce EDC) = 0.78827

0.78827 x 1600 (million lbs capacity to produce EDC in 1990) = 1261 million lbs EDC produced at one facility

EDC Emission Factors:

Average uncontrolled EF = (4.07 lb/ton via oxychlorination + 2.16 lb/ton via direct chlorination) / 2 processes =
= 3.115 lb EDC / ton EDC produced

Emissions Estimate:

653.71 (million lbs EDC produced) x (1 ton / 2000 lbs) x 3.1159 lbs EDC / ton EDC produced =

= 1018447 lbs EDC x (1 ton / 2000 lbs)

= 509.223 tons EDC from chemical manufacturing of EDC at one facility.

References:

U.S. Environmental Protection Agency. Factor Information Retrieval (FIRE) System Database, Version 5.1a. Research Triangle Park, North Carolina. September 1995.

Mannsville Chemical Products Corporation. Chemical Product Synopsis - Ethylene Dichloride. February 1991. 1990 Directory of Chemical Producers. SRI International. Menlo Park, CA. 1990. p 520, 832, 1047.

Ethylen Dichloride

[illegible]

APPENDIX A: NATIONAL ESTIMATES *Chemical Manufacturing: Tetrachloroethylene*
Vinyl Chloride

Group Name: Chemical Manufacturing Category

Baseline Year: 1990

of Facilities: 1

National Estimate: 6.70E+01tons/year

Text Method:

ESTIMATE OF EMISSIONS FROM CHEMICAL MANUFACTURING OF TETRACHLOROETHYLENE USING EMISSION FACTORS FROM FIRE

Approach: Appropriate emission factors from the Factor Information Retrieval (FIRE) System Database were multiplied by an estimate of annual chemical production at each facility reported in the "1990 Directory of Chemicals Producers" to produce tetrachloroethylene (also called perchloroethylene or PERC). The 1990 production of PERC at each facility was estimated by first dividing the total annual production by total annual capacity for 1990, as reported in "Chemical Products Synopsis - Perchloroethylene", August, 1992. This factor was then multiplied by the capacity of each facility identified in the "1990 Directory of Chemical Producers" to estimate the production at each facility. The vinyl chloride emission factors is applicable to facilities that co-produce both PERC and trichloroethylene (TCE). Production for these facilities was estimated by the same procedure described above. Only the capacity of the facilities identified in the 1990 Directory of Chemical Producers as co-producing these chemicals were included when estimating production for these chemicals. Capacity and production data for each chemical produced at a facility were added together when facilities co-produced the chemicals. The national production data used to estimate the production of TCE at each facility was reported in "Chemical Products Synopsis - Trichloroethylene", May 1995. The facility estimates for each chemical were summed to produce the 1990 national estimate of emissions from chemical manufacturing of perchloroethylene. Spatial allocation of the estimates for each chemical was based on the location of each facility identified in the "1990 Directory of Chemical Producers".

Data Qualifiers:

Emission factor in FIRE (1.04 lb VC/ton PERC & TCE produced) is representative of uncontrolled emissions from the oxychlorination process drying column vent. It is based on data from one source test from one producer. Production data for the only facility identified in the "Directory of Chemical Producers" to produce both PERC and TCE were included in this estimate. Emission factors were only available for certain emission points, so this estimate may not include the entire amount of emissions from this source category.

Example Calculations:

Annual Production, PERC and TCE Co-produced:

$371 \text{ (million lbs PERC produced)} + 183 \text{ (million lbs TCE produced)} / (630 + 230) \text{ million lbs capacity to produce PERC and TCE, 1990} = 0.6442$

$0.6442 \times (200 \text{ million lbs capacity to produce PERC} + 200 \text{ million lbs capacity to produce TCE, in 1990}) = 257.67 \text{ million lbs PERC and TCE at one facility}$

Emissions Estimate:

$257.67 \text{ (million lbs PERC \& TCE produced)} \times (1 \text{ ton} / 2000 \text{ lbs}) \times 1.04 \text{ lb vinyl chloride} / \text{ton PERC \& TCE produced} = 133988 \text{ lbs vinyl chloride} \times (1 \text{ ton} / 2000 \text{ lbs})$
 $= 66.9942 \text{ tons vinyl chloride from chemical manufacturing of PERC \& TCE at one facility.}$

References:

U.S. Environmental Protection Agency. Factor Information Retrieval (FIRE) System Database, Version 5.1a. Research Triangle Park, North Carolina. September 1995.
Mannsville Chemical Products Corporation. Chemical Product Synopsis - Perchloroethylene. August 1992.
Mannsville Chemical Products Corporation. Chemical Product Synopsis - Trichloroethylene. May 1995.
1990 Directory of Chemical Producers. SRI International. Menlo Park, CA. 1990. p 520, 832, 1047.

APPENDIX A: NATIONAL ESTIMATES Chemical Manufacturing: Tetrachloroethylene

Vinyl Chloride

Calculations:

CHEM246		1990 Annual Capacity	1990 Annual Capacity	1990 Annual Production	Vinyl Chloride Emissions EF	Vinyl Chloride Emissions (ton/year)	State FIP Code	County FIP Code
Facility Name	Facility Location	PERC (million lbs)	TCE (million lbs)	(million lbs)				
Dow Chemical	Pittsburg, CA	50		0	1.04	0	NA	NA
Dow Chemical	Raquelme, LA	90		0	1.04	0	NA	NA
Occidental Chemical Corp	Deer Park, TX	180		0	1.04	0	NA	NA
PPG Industries Chemicals Group	Lake Charles, LA	200	200	257.68	1.04	66.9968	22	019
Vulcan Chemicals	Geismar, LA	150		0	1.04	0	NA	NA
Vulcan Chemicals	Wichita, KS	50		0	1.04	0	NA	NA
1990 Annual Emission Estimate =				66.9968 tons vinyl chloride / year				

Emission factor units = lb vinyl chloride / ton PERC & TCE produced

APPENDIX A: NATIONAL ESTIMATES *Chemical Manufacturing: Methyl Chloroform*
Ethylene Dichloride

Group Name: Chemical Manufacturing Category

Baseline Year: 1990

of Facilities: 3

National Estimate: 3.69E+01tons/year

Text Method:

ESTIMATE OF EMISSIONS FROM CHEMICAL MANUFACTURING OF 1,1,1-TRICHLOROETHANE USING EMISSION FACTORS FROM FIRE

Approach: Appropriate emission factors from the Factor Information Retrieval (FIRE) System Database were multiplied by an estimate of annual chemical production at each facility reported in the 1990 Directory of Chemicals Producers to produce 1,1,1-trichloroethane (also called methyl chloroform or TCEA). The 1990 production of TCEA was estimated at each facility by first dividing the total annual production by total annual capacity for 1990, as reported in "Chemical Products Synopsis - 1,1,1-Trichloroethane", November, 1992. This factor was then multiplied by the capacity of each facility identified in the "1990 Directory of Chemical Producers" to estimate the production at each facility.

The facility estimates for each chemical were summed to produce the 1990 national estimate of emissions from chemical manufacturing of 1,1,1-trichloroethane. Spatial allocation of the estimates for each chemical was based on the location of each facility identified in the "1990 Directory of Chemical Producers".

Data Qualifiers:

1,2-Dichloroethane emission factors in FIRE are applicable to uncontrolled and controlled emissions from the production of TCEA from ethane (0.138 and 0.00200 lb/ton) and from vinyl chloride (0.360 and 0.00800 lb/ton). The average of the uncontrolled and controlled emission factors was used to estimate emissions. The "Chemical Products Synopsis - 1,1,1-Trichloroethane" reports the dominate process involves the hydrochlorination of vinyl chloride (VC). The "Chemical Product Synopsis - Ethylene Dichloride" identifies Vulcan Chemical as the only producer of TCEA that does not also manufacture vinyl chloride monomer. Based on this information, the factors applicable to production from ethane were used to estimate emissions from Vulcan Chemicals, and the factors applicable to production from vinyl chloride were used to estimate emissions from the other two facilities. Additional emission factors for hydrochlorinator vent (3.40 lb/ton) and hydrochlorinator vent condenser and steam stripper vent condenser (9.00 lb/ton) are also in FIRE. Due to the possibility of double counting emissions from the production of TCEA from VC, and the magnitude and age of these factors, they were not used to estimate emissions. Emission factors were only available for certain emission points, so this estimate may not include the entire amount of emissions from this source category.

Example Calculations:

Annual Production, TCEA produced -

$801 \text{ (million lbs TCEA produced)} / 1050 \text{ (million lbs capacity to produce TCEA)} = 0.7629$

$0.7629 \times 500 \text{ (million lbs capacity to produce TCEA, 1990)} = 381.43 \text{ million lbs TCEA produced at one facility}$

Emissions Estimate:

$0.360 + 0.008 \text{ (lb EDC / ton TCEA produced)} / 2 = 0.184 \text{ lb EDC / ton TCEA produced}$

$381.45 \text{ (million lbs TCEA produced)} \times (1 \text{ ton} / 2000 \text{ lbs}) \times 0.184 \text{ lbs EDC / ton TCEA produced} =$

$= 35093 \text{ lbs EDC from chemical manufacturing of TCEA} \times (1 \text{ ton} / 2000 \text{ lbs}) =$

$= 17.5467 \text{ tons EDC from chemical manufacturing of TCEA at one facility.}$

References:

U.S. Environmental Protection Agency. Factor Information Retrieval (FIRE) System Database, Version 5.1a. Research Triangle Park, North Carolina. September 1995.

Mannsville Chemical Products Corporation. Chemical Product Synopsis - Ethylene Dichloride. February 1991

Mannsville Chemical Products Corporation. Chemical Product Synopsis - 1,1,1-Trichloroethane. November 1992.

1990 Directory of Chemical Producers. SRI International. Menlo Park, CA. 1990. p 1046.

Ethylene Dichloride

Calculations:

CHEM170		1990	1990	Average			
Facility	Facility	Annual	Annual	EDC	EDC	State	County
Name	Location	Capacity	Production	Emission	Emissions	FP	FP
		(million lbs)	(million lbs)	Factor	(ton/year)	Code	Code
Dow Chemical	Freeport, TX	500	381.45	0.184	17.55	48	039
PPG Chemicals Group	Lake Charles, LA	350	267.02	0.184	12.28	22	019
Vulcan Chemicals	Geismar, LA	200	152.58	0.184	7.02	22	005
1990 Annual Emission Estimate =					36.85		
Emission factor units = lb EDC / ton TCEA produced							

Ethylene Dichloride**Group Name:** Chemical Manufacturing Category**Baseline Year:** 1990**# of Facilities:** 4**National Estimate:** 4.00E+00tons/year**Text Method:**ESTIMATE OF EMISSIONS FROM CHEMICAL MANUFACTURING OF TETRACHLOROETHYLENE
USING EMISSION FACTORS FROM FIRE

Approach: Appropriate emission factors from the Factor Information Retrieval (FIRE) System Database were multiplied by an estimate of annual chemical production at each facility reported in the "1990 Directory of Chemicals Producers" to produce tetrachloroethylene (also called perchloroethylene or PERC). The 1990 production of PERC at each facility was estimated by first dividing the total annual production by total annual capacity for 1990, as reported in "Chemical Products Synopsis - Perchloroethylene", August, 1992. This factor was then multiplied by the capacity of each facility identified in the "1990 Directory of Chemical Producers" to estimate the production at each facility. The emission factors for 1,2-dichloroethane (EDC) are applicable to facilities that co-produce both PERC and carbon tetrachloride. Production for these facilities was estimated by the same procedure described above. Only the capacity of the facilities identified in the 1990 Directory of Chemical Producers as co-producing these chemicals were included when estimating production for these chemicals. Capacity and production data for each chemical produced at a facility were added together when facilities co-produced the chemicals. The national production data used to estimate the production of TCE and carbon tetrachloride at each facility was reported in "Chemical Products Synopsis - Carbon Tetrachloride", October 1992. The facility estimates for each chemical were summed to produce the 1990 national estimate of emissions from chemical manufacturing of perchloroethylene. Spatial allocation of the estimates for each chemical was based on the location of each facility identified in the "1990 Directory of Chemical Producers".

Data Qualifiers:

Emission factors in FIRE are representative of the hydrocarbon chlorinolysis process, hex waste handling. Factors for EDC from uncontrolled sources (0.0520 lb EDC/ton PERC & Carbon Tet. produced), and for sources controlled with activated carbon adsorption and miscellaneous control devices (0.00052 lb EDC/ton PERC & Carbon Tet. produced) are listed. Since it is unknown which facilities employ controls, an average of the controlled and non-controlled emission factors was used to estimate emissions. Emission factors were only available for certain emission points, so this estimate may not include the entire amount of emissions from this source category. Production data for only those facilities identified in the "Directory of Chemical Producers" to produce both PERC and carbon tetrachloride were included in this estimate.

Example Calculations:**Annual Production, PERC and Carbon Tetrachloride Co-produced:**

$$\begin{aligned} & 371 \text{ (million lbs PERC produced)} + 409 \text{ (million lbs Carbon Tetrachloride produced)} / (630 \times 2) \text{ million lbs} \\ & \text{capacity to produce PERC and Carbon Tet, 1990} = 0.6190 \\ & 0.6190 \times (50 \text{ million lbs capacity to produce PERC} + 80 \text{ million lbs capacity to produce Carbon Tet, in 1990}) = \\ & = 80470000 \text{ lbs PERC and Carbon Tetrachloride at one facility} \end{aligned}$$

Emissions Estimate:

$$\begin{aligned} & (0.052 \text{ lb EDC/ton} + 0.00052 \text{ lb EDC/ton}) / 2 = 0.0286 \text{ lb EDC / ton emission factor} \\ & 80470000 \text{ (lbs PERC and Carbon Tetrachloride produced)} \times (1 \text{ ton} / 2000 \text{ lbs}) \times 0.0286 \text{ lbs EDC / ton PERC \& Carbon Tet produced} = \\ & = 1150 \text{ lbs EDC} \times (1 \text{ ton} / 2000 \text{ lbs}) = 0.575 \text{ tons EDC from a facility} \end{aligned}$$

References:

- U.S. Environmental Protection Agency. Factor Information Retrieval (FIRE) System Database, Version 5.1a. Research Triangle Park, North Carolina. September 1995.
- Mannsville Chemical Products Corporation. Chemical Product Synopsis - Carbon Tetrachloride. October 1992.
- Mannsville Chemical Products Corporation. Chemical Product Synopsis - Perchloroethylene. August 1992.
- Mannsville Chemical Products Corporation. Chemical Product Synopsis - Trichloroethylene. May 1995.
- 1990 Directory of Chemical Producers. SRI International. Menlo Park, CA. 1990. p 520, 832, 1047.

APPENDIX A: NATIONAL ESTIMATES Chemical Manufacturing: Tetrachloroethylene

Ethylene Dichloride

Calculations:

CHEM244		1990	1990	1990				
		Annual	Annual	Annual	EDC	EDC	State	County
Facility	Facility	Capacity	Capacity	Production	Emission	Emissions	FIP	FIP
Name	Location	PERC	CCL4	(million lbs)	Factor	(tons/year)	Code	Code
Dow Chemical	Pittsburg, CA	50	80	99.52	0.0286	0.71	06	013
Dow Chemical	Raquelmine, LA	90	125	167.375	0.0286	1.20	22	047
Occidental Chemical Corp	Deer Park, TX	180		180	0.0286	0.00	NA	NA
PPG Industries Chemicals Group	Lake Charles, LA	200		200	0.0286	0.00	NA	NA
Vulcan Chemicals	Geismar, LA	150	90	205.71	0.0286	1.47	22	005
Vulcan Chemicals	Wichita, KS	50	60	87.14	0.0286	0.62	20	173

1990 Annual Emission Estimate = 4.00 ton EDC / year

Emission Factor Units = lb EDC / ton PERC & CCL4 produced

APPENDIX A: NATIONAL ESTIMATES *Chemical Manufacturing: Trichloroethylene*
Ethylene Dichloride

Group Name: Chemical Manufacturing Category

Baseline Year: 1990

of Facilities: 2

National Estimate: 6.48E+02tons/year

Text Method:

ESTIMATE OF EMISSIONS FROM CHEMICAL MANUFACTURING OF TRICHLOROETHYLENE USING EMISSION FACTORS FROM FIRE AND THE L & E DOCUMENT

Approach: Appropriate emission factors from the document "Locating and Estimating Air Emissions from Sources of Ethylene Dichloride", were multiplied by an estimate of annual chemical production at each facility reported in the "1990 Directory of Chemicals Producers" to produce trichloroethylene (also called trichloroethene or TCE). The 1990 production of TCE was estimated by dividing the total annual production by total annual capacity for 1990, as reported in "Chemical Products Synopsis - Trichloroethylene", May, 1995. This factor was then multiplied by the capacity of each facility identified in the "1990 Directory of Chemical Producers" to estimate the production at each facility.

The facility estimates for each chemical were summed individually to produce the 1990 national estimate of emissions from chemical manufacturing of trichloroethylene. Spatial allocation of the estimates for each chemical was based on the location of each facility identified in the "1990 Directory of Chemical Producers".

Data Qualifiers:

The ethylene dichloride emission factor from the L & E document, (5.0 kg EDC / Mg TCE produced) is applicable to controlled emissions from the production of TCE. This factor was calculated for the L & E document by dividing the 1977 reported TCE emissions by 90 percent of the total TCE production quantity in 1977.

Emission factors were only available for certain emission points, so this estimate may not include the entire amount of emission from this source category.

Example Calculations:

Annual Production, TCE produced -

183 (million lbs TCE produced) / 230 (million lbs capacity to produce TCE) = 0.79565

0.79565 x 120 (million lbs capacity to produce TCE, 1990) = 95.478 million lbs TCE produced at a facility

Emission Factor:

5.0 (Kg EDC / Mg TCE produced) x 1 Mg/1 metric ton x 1 metric ton/2200 lbs x 2000 lbs/ short ton = 4.545 Kg/ton

4.545 (Kg EDC / ton TCE produced) x 1.102E-3 / 1 Kg = 0.0050091 tons EDC / ton TCE produced

0.0050091 tons EDC / ton TCE produced x 2000 lbs / ton = 10.018 lbs EDC / ton TCE produced

Emissions Estimate:

95.478 (million lbs TCE produced) x (1 ton / 2000 lbs) x 10.018 EDC / ton TCE produced =

= 485993 lbs TCE from chemical manufacturing of TCE x (1 ton / 2000 lbs) =

= 242.99 tons TCE from chemical manufacturing of TCE at one facility.

References:

U.S. Environmental Protection Agency. Factor Information Retrieval (FIRE) System Database, Version 5.1a. Research Triangle Park, North Carolina. September 1995.

Mannsville Chemical Products Corporation. Chemical Product Synopsis - Trichloroethylene. May 1995. 1990 Directory of Chemical Producers. SRI International. Menlo Park, CA. 1990. p 1047.

U.S. Environmental Protection Agency. Locating and Estimating Air Emissions from Sources of Ethylene Dichloride. EPA-450/4-84-007d. Research Triangle Park, North Carolina. Printed from AIR CHIEF.

U.S. Environmental Protection Agency. Locating and Estimating Air Emissions from Sources of Chloroform. EPA-450/4/84-007c. Research Triangle Park, North Carolina. March 1984. Printed from AIR CHIEF.

**APPENDIX A: NATIONAL ESTIMATES Chemical Manufacturing: Trichloroethylene
Ethylene Dichloride**

Calculations:

CHEM249		1990	1990	EDC	Cont		
Facility	Facility	Annual	Annual	Emission	EDC	State	County
Name	Location	Capacity	Production	Factor	Emissions	FP	FP
		(million lbs)	(million lbs)	(lb/ton TCE produced)	(ton/year)	Code	Code
Dow Chemical	Freeport, TX	120	95.48	10.18	242.99	48	039
PPG Chemicals Group	Lake Charles, LA	200	159.13	10.18	404.99	22	019

1990 Annual Emission Estimate = 647.98 tons EDC / year from chemical manufacturing TCE

APPENDIX A: NATIONAL ESTIMATES *Chemical Manufacturing: Ethylene Dichloride*
Vinylidene Chloride

Group Name: Chemical Manufacturing Category

Baseline Year: 1990

of Facilities: 15

National Estimate: 6.60E-01 tons/year

Text Method:

ESTIMATE OF EMISSIONS FROM CHEMICAL MANUFACTURING OF 1,2-DICHLOROETHYLENE USING EMISSION FACTORS FROM FIRE

Approach: Appropriate emission factors from the Factor Information Retrieval (FIRE) System Database were multiplied by an estimate of annual chemical production at each facility reported in the "1990 Directory of Chemicals Producers" to produce 1,2-dichloroethylene (also called ethylene dichloride or EDC). The 1990 production of EDC at each facility was estimated by first dividing the total annual production by total annual capacity for 1990, as reported in "Chemical Products Synopsis - Ethylene Dichloride", February, 1991. This factor was then multiplied by the capacity of each facility identified in the "1990 Directory of Chemical Producers" to estimate the production at each facility.

The facility estimates for each chemical were summed to produce the 1990 national estimate of emissions from chemical manufacturing of ethylene dichloride. Spatial allocation of the estimates for each chemical was based on the location of each facility identified in the 1990 Directory of Chemical Producers.

Data Qualifiers:

The vinylidene chloride emission factor in FIRE (0.00018 lb / ton) is applicable to the production of EDC by the oxychlorination process. Since it is unknown which facilities employ which type of process, the factor was applied to the production estimate for all facilities. Emission factors were only available for certain emission points, so this estimate may not include the entire amount of emissions from this source category.

Example Calculations:

Annual Production, EDC produced =

14583 (million lbs EDC produced) / 18500 (million lbs capacity to produce EDC) = 0.78827

0.78827 x 1600 (million lbs capacity to produce EDC in 1990) = 1261 million lbs EDC produced at one facility

Emissions Estimate:

653.71 (million lbs EDC produced) x (1 ton / 2000 lbs) x 0.00018 lbs vinylidene chloride / ton EDC produced =

= 59 lbs vinylidene chloride x (1 ton / 2000 lbs)

= 0.029 tons vinylidene chloride from chemical manufacturing of EDC at one facility.

References:

U.S. Environmental Protection Agency. Factor Information Retrieval (FIRE) System Database, Version 5.1a.

Research Triangle Park, North Carolina. September 1995.

Mannsville Chemical Products Corporation. Chemical Product Synopsis - Ethylene Dichloride. February 1991.

1990 Directory of Chemical Producers. SRI International. Menlo Park, CA. 1990. p 520, 832, 1047.

Vinylidene Chloride

[illegible]

APPENDIX A: NATIONAL ESTIMATES Chemical Manufacturing: Trichloroethylene**Vinylidene Chloride**

Group Name: Chemical Manufacturing Category

Baseline Year: 1990

of Facilities: 1

National Estimate: 1.00E+02tons/year

Text Method:

ESTIMATE OF EMISSIONS FROM CHEMICAL MANUFACTURING OF TRICHLOROETHYLENE USING EMISSION FACTORS FROM FIRE

Approach: Appropriate emission factors from the Factor Information Retrieval (FIRE) System Database were multiplied by an estimate of annual chemical production at each facility reported in the "1990 Directory of Chemicals Producers" to produce trichloroethylene (also called trichloroethene or TCE). The 1990 production of TCE at each facility was estimated by first dividing the total annual production by total annual capacity for 1990, as reported in "Chemical Products Synopsis - Trichloroethylene", May, 1995. This factor was then multiplied by the capacity of each facility identified in the "1990 Directory of Chemical Producers" to estimate the production at each facility. The emission factors for vinylidene chloride are applicable to facilities that co-produce both PERC and Trichloroethylene (TCE). Production for these facilities was estimated by the same procedure described above. Only the capacity of the facilities identified in the 1990 Directory of Chemical Producers as co-producing these chemicals were included when estimating production for these chemicals. Capacity and production data for each chemical produced at a facility were added together when facilities co-produced the chemicals.

The facility estimates for each chemical were summed to produce the 1990 national estimate of emissions from from chemical manufacturing of trichloroethylene. Spatial allocation of the estimates for each chemical was based on the location of each facility identified in the "1990 Directory of Chemical Producers".

Data Qualifiers:

The available emission factors represent uncontrolled and controlled emissions from a TCE neutralizer and distillation vent refrigerated condenser. Since it is unknown which facilities employ controls, the controlled factors (0.00420 and 1.00 lb/ton PCE & TCE produced) and non-controlled emission factors (0.212 and 5.00 lb/ton PCE & TCE produced) were averaged together for this estimate.

Example Calculations:

Annual Production, PERC and TCE Co-produced:

371 (million lbs PERC produced) + 183 (million lbs TCE produced) / (630 + 230) million lbs capacity to produce PERC and TCE, 1990) = 0.6442

0.6442 x (200 million lbs capacity to produce PERC) + (200 million lbs capacity to produce TCE, in 1990) =
= 128.84 million lbs PERC and 128.84 million lbs TCE at one facility

Emissions Estimate:

$(0.212 + 5.00 + 0.00420 + 1.00) / 4 = 1.55405$ lbs vinylidene chloride / ton PERC & TCE produced

257.67 (million lbs PERC & TCE produced) x (1 ton / 2000 lbs) x 1.55405 lbs vinylidene chloride / ton PERC & TCE produced =

200216 lbs vinylidene chloride x (1 ton / 2000 lbs)

= 100.108 tons vinylidene chloride from chemical manufacturing of TCE where PERC & TCE are co-produced at one facility.

References:

U.S. Environmental Protection Agency. Factor Information Retrieval (FIRE) System Database, Version 5.1a. Research Triangle Park, North Carolina. September 1995.

Mannsville Chemical Products Corporation. Chemical Product Synopsis - Perchloroethylene. August 1992.

Mannsville Chemical Products Corporation. Chemical Product Synopsis - Trichloroethylene. May 1995.

1990 Directory of Chemical Producers. SRI International. Menlo Park, CA. 1990. p 520, 832, 1047.

APPENDIX A: NATIONAL ESTIMATES Chemical Manufacturing: Trichloroethylene

Vinylidene Chloride

Calculations:

CHEMIC2026	PERC	TCE	TCE	Vinylidene	Vinylidene	FP	FP
Facility Name	Capacity (million lbs)	Capacity (million lbs)	Production (million lbs)	Chloride EF	Chloride (ton/year)	Code	Code
Dow Chemical	0	120	0	1.55405	0.00	NA	NA
PPG Industries Chemicals Group	200	200	257.68	1.55405	100.11	22	019
1990 Annual Emission Estimate =				100.1119 tons vinylidene chloride per year			

Emission factor units = lb vinylidene chloride / ton PERC & TCE produced

APPENDIX A: NATIONAL ESTIMATES Chemical Manufacturing: Tetrachloroethylene**Vinylidene Chloride**

Group Name: Chemical Manufacturing Category

Baseline Year: 1990

of Facilities: 1

National Estimate: 7.60E+00tons/year

Text Method:

ESTIMATE OF EMISSIONS FROM CHEMICAL MANUFACTURING OF TETRACHLOROETHYLENE USING EMISSION FACTORS FROM FIRE

Approach: Appropriate emission factors from the Factor Information Retrieval (FIRE) System Database were multiplied by an estimate of annual chemical production at each facility reported in the "1990 Directory of Chemicals Producers" to produce tetrachloroethylene (also called perchloroethylene or PERC). The 1990 production of PERC at each facility was estimated by first dividing the total annual production by total annual capacity for 1990, as reported in "Chemical Products Synopsis - Perchloroethylene", August, 1992. This factor was then multiplied by the capacity of each facility identified in the "1990 Directory of Chemical Producers" to estimate the production at each facility. The emission factors for vinylidene chloride are applicable to facilities that co-produce both PERC and Trichloroethylene (TCE). Production for these facilities was estimated by the same procedure described above. Only the capacity of the facilities identified in the 1990 Directory of Chemical Producers as co-producing these chemicals were included when estimating production for these chemicals. Capacity and production data for each chemical produced at a facility were added together when facilities co-produced the chemicals. The national production data used to estimate the production of TCE at each facility was reported in "Chemical Products Synopsis - Trichloroethylene", May 1995.

The facility estimates for each chemical were summed to produce the 1990 national estimate of emissions from chemical manufacturing of perchloroethylene. Spatial allocation of the estimates for each chemical was based on the location of each facility identified in the "1990 Directory of Chemical Producers".

Data Qualifiers:

The emission factors for vinylidene chloride are applicable to facilities that co-produce PERC and TCE. The available emission factors represent uncontrolled and controlled emissions from a PERC distillation vent spray scrubber. Since it is unknown which facilities employ controls, the controlled (0.04 lb/ton) and non-controlled emission factors (0.196 lb/ton) were averaged together for this estimate.

Example Calculations:

Annual Production, PERC and TCE Co-produced:

$371 \text{ (million lbs PERC produced)} + 183 \text{ (million lbs TCE produced)} / (630 + 230) \text{ million lbs capacity to produce PERC and TCE, 1990} = 0.6442$

$0.6442 \times (200 \text{ million lbs capacity to produce PERC}) + (200 \text{ million lbs capacity to produce TCE}) \text{ in 1990} =$
 $= 128.847 \text{ million lbs PERC and } 128.84 \text{ million lbs TCE at one facility}$

Emissions Estimate:

$257.67 \text{ (million lbs PERC \& TCE produced)} \times (1 \text{ ton} / 2000 \text{ lbs}) \times 0.118 \text{ lbs vinylidene chloride} / \text{ton PERC \& TCE produced} =$

$15203 \text{ lbs vinylidene chloride} \times (1 \text{ ton} / 2000 \text{ lbs}) =$

$= 7.60127 \text{ tons vinylidene chloride from chemical manufacturing of PERC where PERC \& TCE are co-produced at one facility.}$

References:

U.S. Environmental Protection Agency. Factor Information Retrieval (FIRE) System Database, Version 5.1a.

Research Triangle Park, North Carolina. September 1995.

Mannsville Chemical Products Corporation. Chemical Product Synopsis - Perchloroethylene. August 1992.

Mannsville Chemical Products Corporation. Chemical Product Synopsis - Trichloroethylene. May 1995.

1990 Directory of Chemical Producers. SRI International. Menlo Park, CA. 1990. p 520, 832, 1047.

APPENDIX A: NATIONAL ESTIMATES Chemical Manufacturing: Tetrachloroethylene
Vinylidene Chloride

Calculations:

CHEMIC2024	PERC	TCE		Vinylidene	Vinylidene		
Facility	Capacity	Capacity	Production	Chloride	Chloride	FP	FP
Name	(million lbs)	(million lbs)	(million lbs)	EF	(ton/year)	Code	Code
Dow Chemical	50		0	0.118	0.00	NA	NA
Dow Chemical	90		0	0.118	0.00	NA	NA
Occidental Chemical Corp	180		0	0.118	0.00	NA	NA
PPG Industries Chemicals Grc	200	200	257.68	0.118	7.60	22	019
Vulcan Chemicals	150		0	0.118	0.00	NA	NA
Vulcan Chemicals	50		0	0.118	0.00	NA	NA

1990 Annual Emission Estimate = 7.60156 tons vinylidene chloride / year

Emission factor units = lb vinylidene chloride / ton PERC & TCE produced

APPENDIX A: NATIONAL ESTIMATES *Landfills: Chemical Waste Emissions***1,1,2-Trichloroethane**

Group Name: Waste Category

Baseline Year: 1990

of Facilities: 5345

National Estimate: 1.70E+01 tons/yr

Text Method:

National emissions for Municipal Solid Waste (MSW) landfills were estimated using the uncontrolled landfill gas concentrations for individual HAPs listed in the following reference:

U.S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, 5th Edition, AP-42, Volume 1: Stationary Point and Area Sources. Research Triangle Park, North Carolina. 1995.

The HAP concentrations provided in the above reference are based on the EPA's Landfill Air Emissions Estimation model. In order to calculate mass emissions for each HAP, a total estimate of landfill gas has to be calculated. This calculation was done using the total mass of methane emitted on a national level. A national estimate of methane (CH₄) generated (9.25E+9 kg/yr) from MSW landfills in the United States was obtained from the following reference:

U.S. Environmental Protection Agency. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1994. Office of Policy, Planning and Evaluation, Washington, D.C. EPA-230-R-96-006. November 1995.

The methane emissions estimate of 9.25E+9 kg/yr represents the average of the range (7.5 to 11 million metric tonnes) reported for U.S. methane emissions from landfills in 1990, excluding emissions from industrial landfills. Industrial landfills were excluded because the HAP concentrations provided in AP-42 do not represent industrial landfills.

Using the AP-42 guidance, the national volumetric flow rate of CH₄ (m³/yr) was calculated based on the national mass flow rate of CH₄ (kg/yr), assuming that the average landfill gas temperature is 25°C. Next the national volumetric flow rate of landfill gas (m³/yr) was calculated, based on the national volumetric flow rate of CH₄ (m³/yr), assuming the landfill gas consists of 50 percent CH₄ and 50 percent CO₂ by volume. Landfills are generally considered uncontrolled sources so no emission reduction controls were assumed in estimating HAP emissions.

Using equations provided in the AP-42 document to determine benzene (as an example) emissions, the national volumetric emission rate of benzene (m³/yr) was then calculated based on the national volumetric flow rate of landfill gas (m³/yr), assuming the benzene concentration in landfill gas is 2.25 ppmv (i.e., the benzene emission concentration provided in the AP-42 document for a MSW landfill with an "unknown" status with regard to co-disposal with hazardous waste). Similarly, the AP-42 concentrations of other pollutants addressed in this inventory were used to calculate their emissions. Finally, the national mass emission rate of benzene (kg/yr) was calculated, based on the national volumetric emission rate of benzene (m³/yr), assuming the landfill gas temperature is 25°C.

APPENDIX A: NATIONAL ESTIMATES *Landfills: Chemical Waste Emissions*

1,1,2-Trichloroethane

Calculations:

THIS SPREADSHEET CALCULATES POLLUTANT MASS EMISSIONS FROM LANDFILLS
GIVEN THE MASS EMISSIONS OF METHANE FROM THE LANDFILL.

Emissions are estimated using the following calculations:

- A- Calculate volumetric emissions (m3) of landfill gas (LFG) from the mass emissions of methane.
- B- Determine volumetric emissions (m3) of pollutant from the volumetric emissions of LFG and pollutant concentration in LFG.
- C- Convert pollutant volumetric emissions (m3) to mass emissions (Mg).

INPUTS:

Methane emissions (kg):	9.25E+09	Pollutant:	1,1,2-Trichloroethane
Methane % by V. of LFG:	50%	Pollutant MW (g/ g mole)	133.42
CO2 % by V. of LFG:	50%	Pollutant conc. (ppmv)	0.1
LFG temp (C)	25	Methane MW (g/ g mole)	16.0

A- using $PV=nRT$, $n=\text{mass}(\text{kg})/\text{MW}$, $P=1$, & $1\text{kg}=1000\text{g}$, then $V=(\text{mass} \cdot R \cdot T \cdot 1,000)/\text{MW}$

Methane emissions (m3)	1.41E+10
LFG emissions (m3)	2.8271E+10

B-Multiply pollutant concentration (ppmv) by LFG emission (m3)

Pollutant volumetric emission rate (m3)	2,827
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B- using $PV=nRT$, $n=\text{mass}(\text{kg})/\text{MW}$, $P=1$, & $1\text{kg}=1000\text{g}$, then $\text{mass}=(V \cdot \text{MW})/(R \cdot T \cdot 1,000)$

Pollutant mass emission rate (kg):	15,427
Pollutant mass emission rate (Mg):	15.43
Pollutant mass emission rate (ton):	17.00

APPENDIX A: NATIONAL ESTIMATES Landfills: Chemical Waste Emissions**Ethylene Dichloride**

Group Name: Waste Category

Baseline Year: 1990

of Facilities: 5345

National Estimate: 9.96E+01 tons/yr

Text Method:

National emissions for Municipal Solid Waste (MSW) landfills were estimated using the uncontrolled landfill gas concentrations for individual HAPs listed in the following reference:

U.S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, 5th Edition, AP-42, Volume I: Stationary Point and Area Sources. Research Triangle Park, North Carolina. 1995.

The HAP concentrations provided in the above reference are based on the EPA's Landfill Air Emissions Estimation model. In order to calculate mass emissions for each HAP, a total estimate of landfill gas has to be calculated. This calculation was done using the total mass of methane emitted on a national level. A national estimate of methane (CH₄) generated (9.25E+9 kg/yr) from MSW landfills in the United States was obtained from the following reference:

U.S. Environmental Protection Agency. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1994. Office of Policy, Planning and Evaluation, Washington, D.C. EPA-230-R-96-006. November 1995.

The methane emissions estimate of 9.25E+9 kg/yr represents the average of the range (7.5 to 11 million metric tonnes) reported for U.S. methane emissions from landfills in 1990, excluding emissions from industrial landfills. Industrial landfills were excluded because the HAP concentrations provided in AP-42 do not represent industrial landfills.

Using the AP-42 guidance, the national volumetric flow rate of CH₄ (m³/yr) was calculated based on the national mass flow rate of CH₄ (kg/yr), assuming that the average landfill gas temperature is 25°C. Next the national volumetric flow rate of landfill gas (m³/yr) was calculated, based on the national volumetric flow rate of CH₄ (m³/yr), assuming the landfill gas consists of 50 percent CH₄ and 50 percent CO₂ by volume. Landfills are generally considered uncontrolled sources so no emission reduction controls were assumed in estimating HAP emissions.

Using equations provided in the AP-42 document to determine benzene (as an example) emissions, the national volumetric emission rate of benzene (m³/yr) was then calculated based on the national volumetric flow rate of landfill gas (m³/yr), assuming the benzene concentration in landfill gas is 2.25 ppmv (i.e., the benzene emission concentration provided in the AP-42 document for a MSW landfill with an "unknown" status with regard to co-disposal with hazardous waste). Similarly, the AP-42 concentrations of other pollutants addressed in this inventory were used to calculate their emissions. Finally, the national mass emission rate of benzene (kg/yr) was calculated, based on the national volumetric emission rate of benzene (m³/yr), assuming the landfill gas temperature is 25°C.

APPENDIX A: NATIONAL ESTIMATES *Landfills: Chemical Waste Emissions*

Ethylene Dichloride

Calculations:

THIS SPREADSHEET CALCULATES POLLUTANT MASS EMISSIONS FROM LANDFILLS
GIVEN THE MASS EMISSIONS OF METHANE FROM THE LANDFILL.

Emissions are estimated using the following calculations:

- A- Calculate volumetric emissions (m3) of landfill gas (LFG) from the mass emissions of methane.
- B- Determine volumetric emissions (m3) of pollutant from the volumetric emissions of LFG and pollutant concentration in LFG.
- C- Convert pollutant volumetric emissions (m3) to mass emissions (Mg).

INPUTS:

Methane emissions (kg):	9.25E+09	Pollutant:	ethylene dichloride
Methane % by V. of LFG:	50%	Pollutant MW (g/g mole)	98.96
CO2 % by V. of LFG:	50%	Pollutant conc. (ppmv)	0.79
LFG temp (C)	25	Methane MW (g/g mole)	16.0

A- using $PV=nRT$, $n=\text{mass}(\text{kg})/\text{MW}$, $P=1$, & $1\text{kg}=1000\text{g}$, then $V=(\text{mass} \cdot R \cdot T \cdot 1,000)/\text{MW}$

Methane emissions (m3)	1.41E+10
LFG emissions (m3)	2.83E+10

B-Multiply pollutant concentration (ppmv) by LFG emission (m3)

Pollutant volumetric emission rate (m3)	22,334
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B- using $PV=nRT$, $n=\text{mass}(\text{kg})/\text{MW}$, $P=1$, & $1\text{kg}=1000\text{g}$, then $\text{mass}=(V \cdot \text{MW})/(R \cdot T \cdot 1,000)$

Pollutant mass emission rate (kg):	90,394
Pollutant mass emission rate (Mg):	90.39
Pollutant mass emission rate (ton):	99.61

APPENDIX A: NATIONAL ESTIMATES Landfills: Chemical Waste Emissions

Vinyl Chloride

Group Name: Waste Category

Baseline Year: 1990

of Facilities: 5345

National Estimate: 5.87E+02tons/yr

Text Method:

National emissions for Municipal Solid Waste (MSW) landfills were estimated using the uncontrolled landfill gas concentrations for individual HAPs listed in the following reference:

U.S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, 5th Edition, AP-42, Volume I: Stationary Point and Area Sources. Research Triangle Park, North Carolina. 1995.

The HAP concentrations provided in the above reference are based on the EPA's Landfill Air Emissions Estimation model. In order to calculate mass emissions for each HAP, a total estimate of landfill gas has to be calculated. This calculation was done using the total mass of methane emitted on a national level. A national estimate of methane (CH_4) generated ($9.25\text{E}+9$ kg/yr) from MSW landfills in the United States was obtained from the following reference:

U.S. Environmental Protection Agency. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1994. Office of Policy, Planning and Evaluation, Washington, D.C. EPA-230-R-96-006. November 1995.

The methane emissions estimate of $9.25\text{E}+9$ kg/yr represents the average of the range (7.5 to 11 million metric tonnes) reported for U.S. methane emissions from landfills in 1990, excluding emissions from industrial landfills. Industrial landfills were excluded because the HAP concentrations provided in AP-42 do not represent industrial landfills.

Using the AP-42 guidance, the national volumetric flow rate of CH_4 (m^3/yr) was calculated based on the national mass flow rate of CH_4 (kg/yr), assuming that the average landfill gas temperature is 25°C . Next the national volumetric flow rate of landfill gas (m^3/yr) was calculated, based on the national volumetric flow rate of CH_4 (m^3/yr), assuming the landfill gas consists of 50 percent CH_4 and 50 percent CO_2 by volume. Landfills are generally considered uncontrolled sources so no emission reduction controls were assumed in estimating HAP emissions.

Using equations provided in the AP-42 document to determine benzene (as an example) emissions, the national volumetric emission rate of benzene (m^3/yr) was then calculated based on the national volumetric flow rate of landfill gas (m^3/yr), assuming the benzene concentration in landfill gas is 2.25 ppmv (i.e., the benzene emission concentration provided in the AP-42 document for a MSW landfill with an "unknown" status with regard to co-disposal with hazardous waste). Similarly, the AP-42 concentrations of other pollutants addressed in this inventory were used to calculate their emissions. Finally, the national mass emission rate of benzene (kg/yr) was calculated, based on the national volumetric emission rate of benzene (m^3/yr), assuming the landfill gas temperature is 25°C .

APPENDIX A: NATIONAL ESTIMATES Landfills: Chemical Waste Emissions

Vinyl Chloride

Calculations:

THIS SPREADSHEET CALCULATES POLLUTANT MASS EMISSIONS FROM LANDFILLS
GIVEN THE MASS EMISSIONS OF METHANE FROM THE LANDFILL.

Emissions are estimated using the following calculations:

- A- Calculate volumetric emissions (m3) of landfill gas (LFG) from the mass emissions of methane.
- B- Determine volumetric emissions (m3) of pollutant from the volumetric emissions of LFG and pollutant concentration in LFG.
- C- Convert pollutant volumetric emissions (m3) to mass emissions (Mg).

INPUTS:

Methane emissions (kg):	9.25E+09	Pollutant:	vinyl chloride
Methane % by V. of LFG:	50%	Pollutant MW (g/g mole)	62.5
CO2 % by V. of LFG:	50%	Pollutant conc. (ppmv)	7.37
LFG temp (C)	25	Methane MW (g/g mole)	16.0

A- using $PV=nRT$, $n=\text{mass}(\text{kg})/\text{MW}$, $P=1$, & $1\text{kg}=1000\text{g}$, then $V=(\text{mass} \cdot R \cdot T \cdot 1,000)/\text{MW}$

Methane emissions (m3)	1.41E+10
LFG emissions (m3)	2.8271E+10

B-Multiply pollutant concentration (ppmv) by LFG emission (m3)

Pollutant volumetric emission rate (m3)	208,360
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B- using $PV=nRT$, $n=\text{mass}(\text{kg})/\text{MW}$, $P=1$, & $1\text{kg}=1000\text{g}$, then $\text{mass}=(V \cdot \text{MW})/(R \cdot T \cdot 1,000)$

Pollutant mass emission rate (kg):	532,598
Pollutant mass emission rate (Mg):	532.60
Pollutant mass emission rate (ton):	586.92

APPENDIX A: NATIONAL ESTIMATES Landfills: Chemical Waste Emissions**Vinylidene Chloride**

Group Name: Waste Category

Baseline Year: 1990

of Facilities: 5345

National Estimate: 2.72E+01tons/yr

Text Method:

National emissions for Municipal Solid Waste (MSW) landfills were estimated using the uncontrolled landfill gas concentrations for individual HAPs listed in the following reference:

U.S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, 5th Edition, AP-42, Volume I: Stationary Point and Area Sources. Research Triangle Park, North Carolina. 1995.

The HAP concentrations provided in the above reference are based on the EPA's Landfill Air Emissions Estimation model. In order to calculate mass emissions for each HAP, a total estimate of landfill gas has to be calculated. This calculation was done using the total mass of methane emitted on a national level. A national estimate of methane (CH_4) generated ($9.25\text{E}+9$ kg/yr) from MSW landfills in the United States was obtained from the following reference:

U.S. Environmental Protection Agency. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1994. Office of Policy, Planning and Evaluation, Washington, D.C. EPA-230-R-96-006. November 1995.

The methane emissions estimate of $9.25\text{E}+9$ kg/yr represents the average of the range (7.5 to 11 million metric tonnes) reported for U.S. methane emissions from landfills in 1990, excluding emissions from industrial landfills. Industrial landfills were excluded because the HAP concentrations provided in AP-42 do not represent industrial landfills.

Using the AP-42 guidance, the national volumetric flow rate of CH_4 (m^3/yr) was calculated based on the national mass flow rate of CH_4 (kg/yr), assuming that the average landfill gas temperature is 25°C . Next the national volumetric flow rate of landfill gas (m^3/yr) was calculated, based on the national volumetric flow rate of CH_4 (m^3/yr), assuming the landfill gas consists of 50 percent CH_4 and 50 percent CO_2 by volume. Landfills are generally considered uncontrolled sources so no emission reduction controls were assumed in estimating HAP emissions.

Using equations provided in the AP-42 document to determine benzene (as an example) emissions, the national volumetric emission rate of benzene (m^3/yr) was then calculated based on the national volumetric flow rate of landfill gas (m^3/yr), assuming the benzene concentration in landfill gas is 2.25 ppmv (i.e., the benzene emission concentration provided in the AP-42 document for a MSW landfill with an "unknown" status with regard to co-disposal with hazardous waste). Similarly, the AP-42 concentrations of other pollutants addressed in this inventory were used to calculate their emissions. Finally, the national mass emission rate of benzene (kg/yr) was calculated, based on the national volumetric emission rate of benzene (m^3/yr), assuming the landfill gas temperature is 25°C .

APPENDIX A: NATIONAL ESTIMATES *Landfills: Chemical Waste Emissions*

Vinylidene Chloride

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GIVEN THE MASS EMISSIONS OF METHANE FROM THE LANDFILL.

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- A- Calculate volumetric emissions (m3) of landfill gas (LFG) from the mass emissions of methane.
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- C- Convert pollutant volumetric emissions (m3) to mass emissions (Mg).

INPUTS:

Methane emissions (kg):	9.25E+09	Pollutant:	vinylidene chloride
Methane % by V. of LFG:	50%	Pollutant MW (g/g mole)	96.94
CO2 % by V. of LFG:	50%	Pollutant conc. (ppmv)	0.22
LFG temp (C)	25	Methane MW (g/g mole)	16.0

A- using $PV=nRT$, $n=\text{mass}(\text{kg})/\text{MW}$, $P=1$, & $1\text{kg}=1000\text{g}$, then $V=(\text{mass} \cdot R \cdot T \cdot 1,000)/\text{MW}$

Methane emissions (m3)	1.41E+10
LFG emissions (m3)	28271353125

B-Multiply pollutant concentration (ppmv) by LFG emission (m3)

Pollutant volumetric emission rate (m3)	6,220
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B- using $PV=nRT$, $n=\text{mass}(\text{kg})/\text{MW}$, $P=1$, & $1\text{kg}=1000\text{g}$, then $\text{mass}=(V \cdot \text{MW})/(R \cdot T \cdot 1,000)$

Pollutant mass emission rate (kg):	24,659
Pollutant mass emission rate (Mg):	24.66
Pollutant mass emission rate (ton):	27.17