**TABLE D-1**
**GRAND CENTRAL SANITARY LANDFILL - ORIGINAL CLOSED LANDFILL**
**Area A - Projected Gas Generation Rates**

**Measured Historical Landfill Gas (LFG) Flowrates**

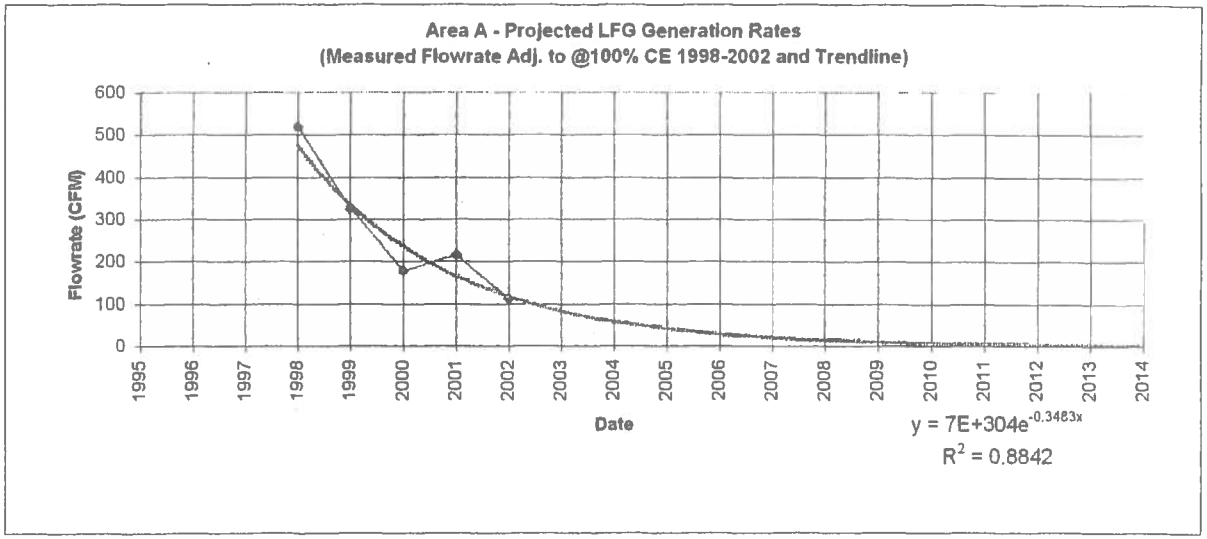
| Date | Measured LFG Flowrate (cfm) | Adjusted Flowrate @ 100% CE 1 (cfm) |
|---|---|---|
| 07/18/98 | 598 | 629 |
| 12/05/98 | 387 | 407 |
| 06/30/99 | 277 | 292 |
| 12/31/99 | 342 | 360 |
| 07/25/00 | 169 | 178 |
| 01/23/01 | 268 | 283 |
| 10/02/01 | 142 | 149 |
| 04/15/02 | 106 | 112 |

**Annual Historical LFG Flowrates**

| Year | Average Measured Flow Rate (cfm) | Adjusted Flowrate @ 100% CE [1] (cfm) |
|---|---|---|
| 1998 | 492 | 518 |
| 1999 | 310 | 326 |
| 2000 | 169 | 178 |
| 2001 | 205 | 216 |
| 2002 | 106 | 112 |

**Projected LFG Flowrates (Calculated from Exponential Trendline)**

| Year | Projected Flowrate @100% CE (cfm) |
|---|---|
| 2003 | 73 |
| 2004 | 51 |
| 2005 | 36 |
| 2006 | 26 |
| 2007 | 18 |
| 2008 | 13 |
| 2009 | 9 |
| 2010 | 6 |
| 2011 | 4 |
| 2012 | 3 |
| 2013 | 2 |
| 2014 | 2 |




Notes:
1. Based on the condition of this landfill area being completely closed and capped since 1993, the collection efficiency (CE) of the gas system installed in Area A was assumed to be 95% when considering historical flow rates. Actual flows were adjusted to 100% CE to calculate total gas generation rate.

**TABLE D-2**
**GRAND CENTRAL SANITARY LANDFILL**
**Areas B & C - Projected Gas Generation Rates**

## USEPA LandGEM Model Output

Model Parameters

| | | |
|---|---|---|
| Lo: 1 | 121 m^3 / Mg | *****User Mode Selection***** |
| k: 1 | 0.068 1/yr | |
| NMOC: 2 | 583 ppmv | |
| Methane: | 50% volume | |
| Carbon Dioxide: | 50% volume | |

Landfill Parameters

Landfill type: No Co-Disposal
Year Opened : 1990 Current Year : 2007 Closure Year : 2007
Capacity: 10207126 Mg
Average Acceptance Rate Required from
Current Year to Closure Year : 0.0 Mg/year

Model Results

| Year | Refuse In Place (Mg) 3 | Methane Generation Rate (Cubic m/yr) | (Cubic ft/min) | Total LFG @ 50% CH4 (Cubic ft/min) |
|---|---|---|---|---|
| 1991 | 416500 | 3427000 | 230 | 461 |
| 1992 | 828400 | 6591000 | 443 | 886 |
| 1993 | 1239000 | 9538000 | 641 | 1282 |
| 1994 | 1651000 | 12300000 | 826 | 1653 |
| 1995 | 2053000 | 14800000 | 994 | 1989 |
| 1996 | 2544000 | 17860000 | 1200 | 2400 |
| 1997 | 3076000 | 21070000 | 1416 | 2831 |
| 1998 | 3781000 | 25480000 | 1712 | 3424 |
| 1999 | 4526000 | 29940000 | 2012 | 4023 |
| 2000 | 5283000 | 34200000 | 2298 | 4596 |
| 2001 | 6032000 | 38110000 | 2561 | 5121 |
| 2002 | 6796000 | 41900000 | 2815 | 5630 |
| 2003 | 7553000 | 45370000 | 3048 | 6097 |
| 2004 | 8309000 | 48610000 | 3266 | 6532 |
| 2005 | 9066000 | 51640000 | 3470 | 6939 |
| 2006 | 9823000 | 54470000 | 3660 | 7320 |
| 2007 | 10210000 | 54050000 | 3632 | 7263 |
| 2008 | 10210000 | 50500000 | 3393 | 6786 |
| 2009 | 10210000 | 47180000 | 3170 | 6340 |

Notes:

1. Values for the landfill gas generation rate constant (k) and generation potential (Lo) used in the model were determined through an iterative process to obtain the best-fit match of the modeled observed rates.
2. NMOC values taken from Air Toxics report dated 12-20-99, for EPA Method 25C analysis of landfill gas samples collected at GCSL on 11-18-99.
3. Refuse in place values (1991-2002) based on information included in PA DEP Landfill Waste Receipt Reports, and Annual Operations Reports. Projected annual waste acceptance values (2003 - closure) are a 3-year average from 2000-2002.

An additional 10 percent was added to the results of the modeled gas generation rates, for both areas described above, as a safety factor to account for seasonal variances. The resulting gas generation rates for each area, and the combined total gas generation rates for the entire landfill are shown in Table D-3.

## SURFACE EMISSIONS

### *Introduction*

The emission of landfill gas from the landfill surface occurs primarily as the result of pressure differentials between gas within the landfill and atmospheric pressure. When the pressure created by the generation of landfill gas exceeds atmospheric pressure near the surface of the landfill, gas can potentially flow to the atmosphere through several pathways including diffusion through landfill cover soils, cracks in the cover soil, along piping systems or through geosynthetic cover layers. To minimize the fugitive emission of landfill gas, GCSL uses an extensive gas collection system to maintain a negative pressure (vacuum) within the landfill. The GCSL gas collection system is comprised of a network of plastic piping connected to perforated vertical and horizontal subsurface pipes (wells) within the waste mass. Centrifugal blowers connected to the end of the pipe network draw gas from the landfill by applying a vacuum to the system. Application of this vacuum causes gas generated in the waste to flow to the wells where it is collected and conveyed by pipes to the flares or the Green Knight Energy Center for combustion.

Although most of the generated gas is collected through this system, variable conditions and discontinuities within the landfill waste mass sometimes result in the development of isolated areas of positive pressure. When these areas develop near the landfill surface, landfill gas can potentially be emitted to the atmosphere. These areas of potential surface emissions are, however, identified and corrected as part of the facility's surface monitoring program. GCSL routinely monitors the surface of the landfill using a handheld instrument called a Flame Ionization Detector (FID), in compliance with the federal New Source Performance Standards (NSPS) for municipal solid waste landfills (USEPA 1998). The FID uses a probe that is held within four inches of the ground surface to collect and analyze air for methane, one of the main components of landfill gas. A technician walks a surveyed route on the ground while analyzing the air at the surface with the FID. Locations that exhibit high methane concentrations are marked on the ground and later located on a map for evaluation and correction.

After evaluating a specific occurrence, several methods are used to reduce or eliminate the fugitive emission. The collection system may be adjusted to apply additional vacuum to gas wells in the vicinity, cover soil may be supplemented or repaired, or in some cases, an additional well or shallow collector may be installed. In all cases, after corrective measures are taken, the location is re-monitored to ensure that the action was effective.

### *Quantification of Landfill Gas Surface Emissions*

As evidenced by historical surface monitoring events and discussed above, landfill gas emissions may occur at various locations and varying rates across the landfill surface. To estimate the total quantity of these emissions, it was assumed that 100 percent of the landfill gas generated within the landfill is either collected by the gas collection system or is emitted from the landfill surface. For this assessment, a landfill gas system collection efficiency of 90 percent was assumed for the entire facility. A collection efficiency of 90 percent is recognized by the USEPA and PA DEP to be reasonably achievable with a properly designed and

TABLE D-3
GRAND CENTRAL SANITARY LANDFILL
LANDFILL GAS GENERATION RATES

| Year | Total Landfill (Areas A, B & C) | | Area A (Closed Original Landfill) | | | Areas B&C (Active Capped and Active Uncapped Landfill Areas) | | Modeled Total Landfill Gas Generation Rate (Sum for Areas A, B and C) (cfm) |
|---|---|---|---|---|---|---|---|---|
| | Measured Gas Collection Rate[1] - 1st Quarter Avg (cfm) | Measured Flow Rate Adjusted to 100% Collection Efficiency[1] (cfm) | Gas Collection Rate[2] (cfm) | Calculated Total Gas Generation Rate [2] (cfm) | Area A Calculated Rate + 10% (cfm) [4] | Areas B&C Modeled Gas Generation Rate[3] (cfm) | Area B&C Modeled Rate + 10%[4] (cfm) | |
| | | | | | | | | |
| 1998 | 3080 | 3422 | 492 | 518 | 570 | 3424 | 3766 | 4336 |
| 1999 | 4395 | 4883 | 310 | 326 | 358 | 4023 | 4426 | 4784 |
| 2000 | 4119 | 4577 | 169 | 178 | 196 | 4596 | 5055 | 5251 |
| 2001 | 4761 | 5290 | 205 | 216 | 238 | 5121 | 5633 | 5871 |
| 2002 | 4214 | 4682 | 106 | 112 | 123 | 5630 | 6194 | 6316 |
| 2003 | 6152 | 6836 | | 73 | 80 | 6097 | 6706 | 6787 |
| 2004 | | | | 51 | 56 | 6532 | 7185 | 7241 |
| 2005 | | | | 36 | 40 | 6939 | 7633 | 7673 |
| 2006 | | | | 26 | 29 | 7320 | 8052 | 8080 |
| 2007 | | | | 18 | 20 | 7263 | 7989 | 8009 |
| 2008 | | | | 13 | 14 | 6786 | 7465 | 7479 |
| 2009 | | | | 9 | 10 | 6340 | 6974 | 6984 |
| 2010 | | | | 6 | 7 | 5923 | 6516 | 6522 |
| 2011 | | | | 4 | 4 | 5534 | 6087 | 6091 |
| 2012 | | | | 3 | 3 | 5170 | 5686 | 5690 |
| 2013 | | | | 2 | 2 | 4830 | 5313 | 5315 |
| 2014 | | | | 2 | 2 | 4512 | 4964 | 4966 |
| 2015 | | | | | | 4215 | 4637 | 4637 |

1. Value represents measured landfill gas flow adjusted to 50% methane basis. Overall system collection efficiency (CE) is estimated at 90%.
2. Measured collection rate for years 1998-2002 (on 50% methane basis). Future years are predicted based on historical data. System collection efficiency for Area A estimated at 95%. See Table D-1.
3. Gas generation rate for Areas B and C modeled fom USEPA LandGEM model. See Table D-2.
4. Plus 10% (adjustment for seasonal variances/safety factor)

maintained gas collection system (Prosser 1998). Therefore, it was assumed that 10 percent of the total gas generated would be emitted from the surface.

It is important to note that GCSL has installed a considerably more extensive gas collection system within the active landfill areas than a typical landfill. Therefore, the assumption of 90 percent collection system efficiency in this analysis is considered conservative, and the calculated gas generation rates shown above (see Table D-3) are thus expected to be overestimated.

Based on observations from past surface methane monitoring events, it is apparent that the frequency and concentrations of methane (landfill gas) emissions from the landfill surface vary according to landfill cover conditions. For instance, methane concentrations are low immediately above the surface of the old closed landfill where there is little gas production and a membrane cap is in place over the entire surface. This indicates that gas emissions are negligible from the old closed landfill. In the uncapped areas of the active landfill, however, higher methane levels are noted on occasion immediately above the landfill surface, indicating that gas emissions are greater from the active uncapped areas than the old closed landfill. To better evaluate and quantify these differences in potential emissions, ERG measured and recorded methane concentrations at more than 3,000 locations during two monitoring events at GCSL conducted in June 2002 and April 2003. A portable flame ionization detector (FID) was used to monitor surface methane concentrations approximately 4 inches above the entire surface of both landfills (closed and active areas) using methods prescribed by the United States Environmental Protection Agency (USEPA). The surface methane concentration and location were recorded for each point, and the data were evaluated and averaged based on location and the type of cover in place (i.e., capped or uncapped/active).

An analysis of the monitoring data and locations showed differences in the average surface methane concentrations between three distinct areas of the landfill surface with different cover conditions, as follows:

- Old landfill capped (Area A): average methane concentration 4 inches above landfill surface = 0.1 parts per million (ppm),
- Active landfill capped (Area B): average methane concentration 4 inches above landfill surface = 2.9 ppm, and
- Active landfill uncapped (Area C): average methane concentration 4 inches above landfill surface = 25.8 ppm.

For Area A, the flow rate of fugitive landfill gas from the surface was assumed to be 10 percent of the total modeled gas generation rate from that area (see Table D-4), although the actual gas collection efficiency for this landfill is expected to be at least 95%. For example, in 2003, the estimated fugitive landfill gas emission rate was calculated to be 8 cfm (10 percent of 80 cfm). For Areas B and C, the flow rate of fugitive landfill gas from the surface was assumed to be 10 percent of the total modeled gas generation rate from each area (see Table D-4). In addition, to calculate fugitive gas flow rates from the active landfill (Areas B and C), the average surface methane concentrations were used to apportion the total landfill gas flow between the two areas. It was assumed that the fugitive landfill gas flow rate from each area was proportional to the average surface methane concentration observed in that area. The percentage of total landfill gas flow from each of these two areas was calculated based on each area's surface area and average surface methane concentration as shown below:

**TABLE D-4**
**GRAND CENTRAL SANITARY LANDFILL**
**LANDFILL GAS FUGITIVE FLOW RATE WORKSHEET**

| (A) | (B) | (C) | (D) | (E) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | Area A | | Areas B & C | | Areas B & C - Percent Distribution of Fugitive Emissions [3] | | Area B | Area C | Landfill Area Sizes (acres) | |
| | Landfill Gas Generation Rate [1] (cfm) | Fugitive Flow Rate [2] (cfm) | Landfill Gas Generation Rate [1] (cfm) | Fugitive Flow Rate [2] (cfm) | Area B | Area C | Fugitive Flow Rate (cfm) | Fugitive Flow Rate (cfm) | Area B | Area C |
| | | =B*0.1 | | =D*0.1 | | | =E*%B | =E*%C | | |
| 2003 | 80 | 8 | 6706 | 671 | 9.4% | 90.6% | 63 | 608 | 39.7 | 43.2 |
| 2004 | 56 | 6 | 7185 | 719 | 14.3% | 85.7% | 103 | 615 | 52.3 | 35.2 |
| 2005 | 40 | 4 | 7633 | 763 | 20.0% | 80.0% | 153 | 611 | 60.3 | 27.2 |
| 2006 | 29 | 3 | 8052 | 805 | 28.6% | 71.4% | 231 | 575 | 68.3 | 19.2 |
| 2007 | 20 | 2 | 7989 | 799 | 43.6% | 56.4% | 348 | 451 | 76.4 | 11.1 |

Notes:

1. See Table D-3.
2. Collection efficiency of 90% used for fugitive emission calculations.
3. Distribution of fugitive emissions between Areas B & C were based on the yearly landfill surface areas for each area, and the NSPS surface methane concentrations (2.9 ppm for Area B and 25.8 ppm for Area C).

   Example Calculation: Area B Percent Distribution = $\frac{\text{(Area B - acres) * (Area B - CH4 ppm) * 100}}{\text{\{ (Area B - acres)*(Area B - CH4 ppm) + (Area C - acres)*(Area C - CH4 ppm) \}}}$

Area B = 39.7 acres x 2.9 ppm = 115.1 acres-ppm
Area C = 43.2 acres x 25.8 ppm = 1114.6 acres-ppm
Total acres-ppm for Areas B and C = 1229.7 acres-ppm

Area B percent of combined fugitive emissions from entire active landfill = 115.1 acres-ppm / 1229.7 acres-ppm * 100 = 9.4%

Area C percent of combined fugitive emissions from entire active landfill = 1114.6 acres-ppm / 1229.7 acres-ppm * 100 = 90.6%

The percentages listed above are based on 2003 capped and uncapped active landfill acreages. The relative contributions of each active landfill area to potential fugitive emissions for future years were calculated based on the estimated capping schedule for the landfill. The resulting percentages were then applied to the total fugitive gas flow rate for Areas B and C to calculate the fugitive gas flow rates from each of the two active landfill areas (Table D-4).

***Quantification of Chemical Emission Rates from the Landfill Surface***

Using available landfill gas analytical data for the site, chemical emission rates were calculated for each of the three areas. The analytical data were based on samples collected in 1999 (for volatile organic compounds) and 2003 (for sulfur compounds) from the inlet gas piping supplying the two enclosed LFG flares at the site. For each of the compounds detected in these datasets, the average concentration was calculated based on the recorded flow rates of landfill gas going to each flare unit during the 1999 or 2003 tests. A concentration of one-half of the compound detection limit was assigned to compounds that were detected in one but not all of the samples (Table D-5).

The resulting average landfill gas compound concentrations were then multiplied by the area-specific fugitive gas flow rates and divided by the landfill surface area to calculate each compound's emission rates (in units of grams compound per square meter surface per second). This calculation was performed for each landfill area for the years 2003 through 2007 (Tables D-6a through D-6e). The 5-year average chemical compound emission rate (based on 2003-2007) was then calculated for use in the air dispersion modeling (Table D-6f).

***Comparison of Measured and Modeled Hydrogen Sulfide Concentrations Above the Landfill Surface***

The modeling described above was likely to overestimate emissions from the landfill surface. The modeled chemical emission rates were based on a combination of modeled landfill gas generation rates and chemical concentrations measured at the enclosed flare inlet piping. The use of inlet piping landfill gas data does not take into account processes that attenuate (i.e., diminish) the release of compounds from the landfill surface, such as oxidation and the effect of cover materials (Bogner et al. 2003, Scheutz et al. 2003, Kjeldsen et al. 2003). Therefore, the actual concentrations of compounds emitted from the landfill surface are likely to be lower than those predicted by the models.

Additionally, modeled landfill gas generation rates were likely to be overestimated due to assumptions about the gas collection system efficiency and uncertainties and assumptions used in the USEPA model (Bogner et al. 1997). Although the USEPA model was adjusted against historical gas generation rates at GCSL, these historical gas generation rates were likely

**Table D-5**
**Landfill Gas Measurements From Grand Central Landfill (Detected Compounds)**

| Compound (a) | Flare #1 Inlet Data (ug/m3) | Flare #2 Inlet Data (ug/m3) | Weighted Average Landfill Gas Concentration from Flare Inlet (ug/m3) (c) |
|---|---|---|---|
| *Volatile Organic Compounds* | | | |
| 1,1,1-Trichloroethane | 2400 | 3500 | 3,152 |
| 1,1-Dichloroethane | 2000 | 4300 | 3,572 |
| 1,2,4-Trimethylbenzene | 11000 | 14000 | 13,051 |
| 1,3,5-Trimethylbenzene | 4100 | 5300 | 4,920 |
| 1,4-Dichlorobenzene | 2200 | 3200 | 2,884 |
| 2-Butanone (Methyl Ethyl Ketone) | 24000 | 120000 | 89,631 |
| 2-Propanol | 7500 | 59000 | 42,708 |
| 4-Ethyltoluene | 9900 | 13000 | 12,019 |
| 4-Methyl-2-pentanone | 2900 | 13000 | 9,805 |
| Acetone | 37000 | 62000 | 54,091 |
| Benzene | 1600 | 2200 | 2,010 |
| Carbon Disulfide | ND (<1000) | 2200 | 1,662 |
| Chlorobenzene | 600 (<380) | ND (<740) | 443 |
| Chloroethane | 780 | 1300 | 1,136 |
| cis-1,2-Dichloroethene | 2600 | ND (<640) | 1,041 |
| Cyclohexane | 5400 | 11000 | 9,228 |
| Ethanol (b) | 32000 | 370000 | 263,076 |
| Ethyl Benzene | 29000 | 34000 | 32,418 |
| Freon 11 | 8800 | 8100 | 8,321 |
| Freon 114 | 940 | 1100 | 1,049 |
| Freon 12 | 10000 | 14000 | 12,735 |
| Heptane | 11000 | 20000 | 17,153 |
| Hexane | 12000 | 24000 | 20,204 |
| m,p-Xylene | 31000 | 50000 | 43,989 |
| Methyl tert-Butyl Ether | 1600 | 3900 | 3,172 |
| Methylene Chloride | 8100 | 23000 | 18,286 |
| o-Xylene | 10000 | 16000 | 14,102 |
| Styrene | 4500 | 10000 | 8,260 |
| Tetrachloroethane | 3800 | 17000 | 12,824 |
| Tetrahydrofuran | 4900 | 9600 | 8,113 |
| Toluene | 39000 | 95000 | 77,285 |
| Trichloroethene | 1900 | 6100 | 4,771 |
| Vinyl Chloride | 2700 | 3800 | 3,452 |

## Table D-5 (Cont.)
## Landfill Gas Measurements From Grand Central Landfill (Detected Compounds)

| Compound (a) | Flare #1 Inlet Data (ug/m3) | Flare #2 Inlet Data (ug/m3) | Weighted Average Landfill Gas Concentration from Flare Inlet (ug/m3) (c) |
|---|---|---|---|
| *Sulfur Compounds* | | | |
| 2-Ethylthiophene | 5130 | ND (<3265) | 3,835 |
| 2,5-Dimethylthiophene | 4664 | ND (<3265) | 3,692 |
| Diethyl disulfide | 7626 | ND (<3560) | 4,802 |
| Hydrogen sulfide | 184178 | 297518 | 262,877 |
| Isopropyl mercaptan | ND (<1900) | 4274 | 3,548 |
| Methyl mercaptan | 2700 | 3800 | 3,464 |

Notes:

ND = not detected. Concentration shown is the sample detection limit.

NC = not calculated because compound was not detected in both landfill gas samples.

(a) Samples were collected by ERG on the flare inlet piping on 11/18/99 and 7/22/03. Samples were analyzed and results reported by Air Toxics Ltd. on 12/07/99 and 7/24/03.
(b) The ethanol result for the Flare #2 sample is estimated because it was measured above the calibrated range.
(c) For compounds with "ND" values for one sample and detectable concentrations for the second sample, 1/2 of the sample detection limit was substituted for the "ND" value to calculate the compound weighted average concentration. The weighted average was calculated to reflect different landfill gas inlet flow rates observed during the 1999 and 2003 sampling programs as follows: weighted average = ((Flare 1 concentration * Flare 1 gas inlet flow) + (Flare 2 concentration * Flare 2 gas inlet flow) / (Flare 1 inlet flow + Flare 2 inlet flow). Flare 1 inlet flows = 1320.49 $ft^3$/min in 1999 and 2301.7 $ft^3$/min in 2003. Flare 2 flows = 2853.74 $ft^3$/min in 1999 and 5229 $ft^3$/min in 2003.

**TABLE D-6a**
**GRAND CENTRAL SANITARY LANDFILL**
**2003 Fugitive Emission Rates for Detected Landfill Gas Constituents**

| Compound | CAS | Landfill Gas Weighted Average Compound Concentrations[2] (ug/m3) | 2003 Emission Rate [1] ($g/m^2$-sec) | | | |
|---|---|---|---|---|---|---|
| | | | Source: | Area A | Area B | Area C |
| | | | Surface Area:[3] | 56.8 acres | 39.7 acres | 43.2 acres |
| | | | Fugitive Flowrate:[3] | 8 cfm | 63 cfm | 608 cfm |
| 1,1,1-Trichloroethane | 71-55-6 | 3152 | | 5.18E-11 | 5.83E-10 | 5.18E-09 |
| 1,1-Dichloroethane | 75-34-3 | 3572 | | 5.87E-11 | 6.61E-10 | 5.87E-09 |
| 1,2,4-Trimethylbenzene | 95-63-6 | 13051 | | 2.14E-10 | 2.42E-09 | 2.14E-08 |
| 1,3,5-Trimethylbenzene | 108-67-8 | 4920 | | 8.08E-11 | 9.11E-10 | 8.08E-09 |
| 1,4-Dichlorobenzene | 106-46-7 | 2884 | | 4.74E-11 | 5.34E-10 | 4.74E-09 |
| 2-Butanone (Methyl Ethyl Ketone) | 78-93-3 | 89631 | | 1.47E-09 | 1.66E-08 | 1.47E-07 |
| 2-Propanol | 67-63-0 | 42708 | | 7.01E-10 | 7.90E-09 | 7.01E-08 |
| 4-Ethyltoluene | 622-96-8 | 12019 | | 1.97E-10 | 2.22E-09 | 1.97E-08 |
| 4-Methyl-2-pentanone | 108-10-1 | 9805 | | 1.61E-10 | 1.81E-09 | 1.61E-08 |
| Acetone | 67-64-1 | 54091 | | 8.88E-10 | 1.00E-08 | 8.88E-08 |
| Benzene | 71-43-2 | 2010 | | 3.30E-11 | 3.72E-10 | 3.30E-09 |
| Carbon Disulfide | 75-15-0 | 1662 | | 2.73E-11 | 3.08E-10 | 2.73E-09 |
| Chlorobenzene | 108-90-7 | 443 | | 7.27E-12 | 8.19E-11 | 7.27E-10 |
| Chloroethane | 75-00-3 | 1136 | | 1.87E-11 | 2.10E-10 | 1.86E-09 |
| cis-1,2-Dichloroethene | 156-59-2 | 1041 | | 1.71E-11 | 1.93E-10 | 1.71E-09 |
| Cyclohexane | 110-82-7 | 9228 | | 1.52E-10 | 1.71E-09 | 1.52E-08 |
| Ethanol | 64-17-5 | 263076 | | 4.32E-09 | 4.87E-08 | 4.32E-07 |
| Ethyl Benzene | 100-41-4 | 32418 | | 5.32E-10 | 6.00E-09 | 5.32E-08 |
| Freon 11 | 75-69-4 | 8321 | | 1.37E-10 | 1.54E-09 | 1.37E-08 |
| Freon 114 | 76-14-2 | 1049 | | 1.72E-11 | 1.94E-10 | 1.72E-09 |
| Freon 12 | 75-71-8 | 12735 | | 2.09E-10 | 2.36E-09 | 2.09E-08 |
| Heptane | 142-82-5 | 17153 | | 2.82E-10 | 3.17E-09 | 2.82E-08 |
| Hexane | 110-54-3 | 20204 | | 3.32E-10 | 3.74E-09 | 3.32E-08 |
| m,p-Xylene | 108-38-3 106-42-3 | 43989 | | 7.23E-10 | 8.14E-09 | 7.22E-08 |
| Methyl tert-Butyl Ether | 1634-04-4 | 3172 | | 5.21E-11 | 5.87E-10 | 5.21E-09 |
| Methylene Chloride | 75-09-2 | 18286 | | 3.00E-10 | 3.38E-09 | 3.00E-08 |
| o-Xylene | 95-47-6 | 14102 | | 2.32E-10 | 2.61E-09 | 2.32E-08 |
| Styrene | 100-42-5 | 8260 | | 1.36E-10 | 1.53E-09 | 1.36E-08 |
| Tetrachloroethene | 127-18-4 | 12824 | | 2.11E-10 | 2.37E-09 | 2.11E-08 |
| Tetrahydrofuran | 109-99-9 | 8113 | | 1.33E-10 | 1.50E-09 | 1.33E-08 |
| Toluene | 108-88-3 | 77285 | | 1.27E-09 | 1.43E-08 | 1.27E-07 |
| Trichloroethene | 79-01-6 | 4771 | | 7.84E-11 | 8.83E-10 | 7.83E-09 |
| Vinyl Chloride | 75-01-4 | 3452 | | 5.67E-11 | 6.39E-10 | 5.67E-09 |
| Hydrogen Sulfide | 7783-06-4 | 262877 | | 4.32E-09 | 4.86E-08 | 4.32E-07 |
| Isopropyl Mercaptan | 75-33-2 | 3548 | | 5.83E-11 | 6.57E-10 | 5.83E-09 |
| Methyl Mercaptan | 74-93-1 | 3464 | | 5.69E-11 | 6.41E-10 | 5.69E-09 |
| 2-Ethylthiophene | 872-55-9 | 3835 | | 6.30E-11 | 7.10E-10 | 6.30E-09 |
| 2,5,-Dimethylthiophene | 638-02-8 | 3692 | | 6.06E-11 | 6.83E-10 | 6.06E-09 |
| Diethyl Disulfide | 110-81-6 | 4802 | | 7.89E-11 | 8.89E-10 | 7.89E-09 |

Notes:
1. Emission rates were calculated using the following equation:

Fugitive Emissions ($g/m^2$ -sec) =
(Area Fugitive Flow rate (ft3/min) * 0.028317 m3/ft3 / 60 sec/min) * (Compound Conc. (ug/m3) / 1,000,000 ug/g) / ( Surface Area (acres) * 4046.9 m2/acre )

Area Fugitive Flowrate (cfm) = Fugitive gas flow rate from each area
Compound Conc. (ug/m3) = Concentration of specific compound in landfill gas
Surface Area (acres) = Area that fugitive emission rate is applied to (Areas A, B or C)
0.028317 = conv. factor from cu. feet to cu. meter (0.028317 m3/ft3)
60 = conv. factor from min to sec (60 sec/min)
1,000,000 = conv. factor from ug to grams (1,000,000 ug/g)
4046.825 = conv. factor from acres to sq. meters (4046.825 m2/acre)

2. See Table D-5.
3. See Table D-4.

**TABLE D-6b**
**GRAND CENTRAL SANITARY LANDFILL**
**2004 Fugitive Emission Rates for Detected Landfill Gas Constituents**

| Compound | CAS | Landfill Gas Weighted Average Compound Concentrations[2] (ug/m3) | 2004 Emission Rate [1] (g/m²-sec) | | | |
|---|---|---|---|---|---|---|
| | | | Source: | Area A | Area B | Area C |
| | | | Surface Area:[3] | 56.8 acres | 52.3 acres | 35.2 acres |
| | | | Fugitive Flowrate:[3] | 6 cfm | 103 cfm | 615 cfm |
| 1,1,1-Trichloroethane | 71-55-6 | 3152 | | 3.88E-11 | 7.24E-10 | 6.43E-09 |
| 1,1-Dichloroethane | 75-34-3 | 3572 | | 4.40E-11 | 8.20E-10 | 7.28E-09 |
| 1,2,4-Trimethylbenzene | 95-63-6 | 13051 | | 1.61E-10 | 3.00E-09 | 2.66E-08 |
| 1,3,5-Trimethylbenzene | 108-67-8 | 4920 | | 6.06E-11 | 1.13E-09 | 1.00E-08 |
| 1,4-Dichlorobenzene | 106-46-7 | 2884 | | 3.55E-11 | 6.62E-10 | 5.88E-09 |
| 2-Butanone (Methyl Ethyl Ketone) | 78-93-3 | 89631 | | 1.10E-09 | 2.06E-08 | 1.83E-07 |
| 2-Propanol | 67-63-0 | 42708 | | 5.26E-10 | 9.81E-09 | 8.71E-08 |
| 4-Ethyltoluene | 622-96-8 | 12019 | | 1.48E-10 | 2.76E-09 | 2.45E-08 |
| 4-Methyl-2-pentanone | 108-10-1 | 9805 | | 1.21E-10 | 2.25E-09 | 2.00E-08 |
| Acetone | 67-64-1 | 54091 | | 6.66E-10 | 1.24E-08 | 1.10E-07 |
| Benzene | 71-43-2 | 2010 | | 2.48E-11 | 4.62E-10 | 4.10E-09 |
| Carbon Disulfide | 75-15-0 | 1662 | | 2.05E-11 | 3.82E-10 | 3.39E-09 |
| Chlorobenzene | 108-90-7 | 443 | | 5.45E-12 | 1.02E-10 | 9.03E-10 |
| Chloroethane | 75-00-3 | 1136 | | 1.40E-11 | 2.61E-10 | 2.31E-09 |
| cis-1,2-Dichloroethene | 156-59-2 | 1041 | | 1.28E-11 | 2.39E-10 | 2.12E-09 |
| Cyclohexane | 110-82-7 | 9228 | | 1.14E-10 | 2.12E-09 | 1.88E-08 |
| Ethanol | 64-17-5 | 263076 | | 3.24E-09 | 6.04E-08 | 5.36E-07 |
| Ethyl Benzene | 100-41-4 | 32418 | | 3.99E-10 | 7.44E-09 | 6.61E-08 |
| Freon 11 | 75-69-4 | 8321 | | 1.03E-10 | 1.91E-09 | 1.70E-08 |
| Freon 114 | 76-14-2 | 1049 | | 1.29E-11 | 2.41E-10 | 2.14E-09 |
| Freon 12 | 75-71-8 | 12735 | | 1.57E-10 | 2.92E-09 | 2.60E-08 |
| Heptane | 142-82-5 | 17153 | | 2.11E-10 | 3.94E-09 | 3.50E-08 |
| Hexane | 110-54-3 | 20204 | | 2.49E-10 | 4.64E-09 | 4.12E-08 |
| m,p-Xylene | 108-38-3 106-42-3 | 43989 | | 5.42E-10 | 1.01E-08 | 8.97E-08 |
| Methyl tert-Butyl Ether | 1634-04-4 | 3172 | | 3.91E-11 | 7.28E-10 | 6.47E-09 |
| Methylene Chloride | 75-09-2 | 18286 | | 2.25E-10 | 4.20E-09 | 3.73E-08 |
| o-Xylene | 95-47-6 | 14102 | | 1.74E-10 | 3.24E-09 | 2.87E-08 |
| Styrene | 100-42-5 | 8260 | | 1.02E-10 | 1.90E-09 | 1.68E-08 |
| Tetrachloroethene | 127-18-4 | 12824 | | 1.58E-10 | 2.94E-09 | 2.61E-08 |
| Tetrahydrofuran | 109-99-9 | 8113 | | 9.99E-11 | 1.86E-09 | 1.65E-08 |
| Toluene | 108-88-3 | 77285 | | 9.52E-10 | 1.77E-08 | 1.58E-07 |
| Trichloroethene | 79-01-6 | 4771 | | 5.88E-11 | 1.10E-09 | 9.73E-09 |
| Vinyl Chloride | 75-01-4 | 3452 | | 4.25E-11 | 7.93E-10 | 7.04E-09 |
| Hydrogen Sulfide | 7783-06-4 | 262877 | | 3.24E-09 | 6.04E-08 | 5.36E-07 |
| Isopropyl Mercaptan | 75-33-2 | 3548 | | 4.37E-11 | 8.15E-10 | 7.23E-09 |
| Methyl Mercaptan | 74-93-1 | 3464 | | 4.27E-11 | 7.95E-10 | 7.06E-09 |
| 2-Ethylthiophene | 872-55-9 | 3835 | | 4.72E-11 | 8.80E-10 | 7.82E-09 |
| 2,5,-Dimethylthiophene | 638-02-8 | 3692 | | 4.55E-11 | 8.48E-10 | 7.53E-09 |
| Diethyl Disulfide | 110-81-6 | 4802 | | 5.92E-11 | 1.10E-09 | 9.79E-09 |

Notes:
1. Emission rates were calculated using the following equation:

Fugitive Emissions (g/m2 -sec) =
(Area Fugitive Flow rate (ft3/min) * 0.028317 m3/ft3 / 60 sec/min) * (Compound Conc. (ug/m3) / 1,000,000 ug/g) / ( Surface Area (acres) * 4046.9 m2/acre )

Area Fugitive Flowrate (cfm) = Fugitive gas flow rate from each area
Compound Conc. (ug/m3) = Concentration of specific compound in landfill gas
Surface Area (acres) = Area that fugitive emission rate is applied to (Areas A, B or C)
0.028317 = conv. factor from cu. feet to cu. meter (0.028317 m3/ft3)
60 = conv. factor from min to sec (60 sec/min)
1,000,000 = conv. factor from ug to grams (1,000,000 ug/g)
4046.825 = conv. factor from acres to sq. meters (4046.825 m2/acre)

2. See Table D-5.
3. See Table D-4.

. ABLE D-6c
**GRAND CENTRAL SANITARY LANDFILL**
**2005 Fugitive Emission Rates for Detected Landfill Gas Constituents**

| Compound | CAS | Landfill Gas Weighted Average Compound Concentrations[2] (ug/m3) | 2005 Emission Rate [1] (g/m²-sec) | | | |
|---|---|---|---|---|---|---|
| | | | Source: | Area A | Area B | Area C |
| | | | Surface Area:[3] | 56.8 acres | 60.3 acres | 27.2 acres |
| | | | Fugitive Flowrate:[3] | 4 cfm | 153 cfm | 611 cfm |
| 1,1,1-Trichloroethane | 71-55-6 | 3152 | | 2.59E-11 | 9.32E-10 | 8.26E-09 |
| 1,1-Dichloroethane | 75-34-3 | 3572 | | 2.93E-11 | 1.06E-09 | 9.37E-09 |
| 1,2,4-Trimethylbenzene | 95-63-6 | 13051 | | 1.07E-10 | 3.86E-09 | 3.42E-08 |
| 1,3,5-Trimethylbenzene | 108-67-8 | 4920 | | 4.04E-11 | 1.46E-09 | 1.29E-08 |
| 1,4-Dichlorobenzene | 106-46-7 | 2884 | | 2.37E-11 | 8.53E-10 | 7.56E-09 |
| 2-Butanone (Methyl Ethyl Ketone) | 78-93-3 | 89631 | | 7.36E-10 | 2.65E-08 | 2.35E-07 |
| 2-Propanol | 67-63-0 | 42708 | | 3.51E-10 | 1.26E-08 | 1.12E-07 |
| 4-Ethyltoluene | 622-96-8 | 12019 | | 9.87E-11 | 3.56E-09 | 3.15E-08 |
| 4-Methyl-2-pentanone | 108-10-1 | 9805 | | 8.05E-11 | 2.90E-09 | 2.57E-08 |
| Acetone | 67-64-1 | 54091 | | 4.44E-10 | 1.60E-08 | 1.42E-07 |
| Benzene | 71-43-2 | 2010 | | 1.65E-11 | 5.95E-10 | 5.27E-09 |
| Carbon Disulfide | 75-15-0 | 1662 | | 1.37E-11 | 4.92E-10 | 4.36E-09 |
| Chlorobenzene | 108-90-7 | 443 | | 3.64E-12 | 1.31E-10 | 1.16E-09 |
| Chloroethane | 75-00-3 | 1136 | | 9.33E-12 | 3.36E-10 | 2.98E-09 |
| cis-1,2-Dichloroethene | 156-59-2 | 1041 | | 8.55E-12 | 3.08E-10 | 2.73E-09 |
| Cyclohexane | 110-82-7 | 9228 | | 7.58E-11 | 2.73E-09 | 2.42E-08 |
| Ethanol | 64-17-5 | 263076 | | 2.16E-09 | 7.78E-08 | 6.90E-07 |
| Ethyl Benzene | 100-41-4 | 32418 | | 2.66E-10 | 9.59E-09 | 8.50E-08 |
| Freon 11 | 75-69-4 | 8321 | | 6.83E-11 | 2.46E-09 | 2.18E-08 |
| Freon 114 | 76-14-2 | 1049 | | 8.62E-12 | 3.10E-10 | 2.75E-09 |
| Freon 12 | 75-71-8 | 12735 | | 1.05E-10 | 3.77E-09 | 3.34E-08 |
| Heptane | 142-82-5 | 17153 | | 1.41E-10 | 5.07E-09 | 4.50E-08 |
| Hexane | 110-54-3 | 20204 | | 1.66E-10 | 5.98E-09 | 5.30E-08 |
| m,p-Xylene | 108-38-3 106-42-3 | 43989 | | 3.61E-10 | 1.30E-08 | 1.15E-07 |
| Methyl tert-Butyl Ether | 1634-04-4 | 3172 | | 2.61E-11 | 9.38E-10 | 8.32E-09 |
| Methylene Chloride | 75-09-2 | 18286 | | 1.50E-10 | 5.41E-09 | 4.79E-08 |
| o-Xylene | 95-47-6 | 14102 | | 1.16E-10 | 4.17E-09 | 3.70E-08 |
| Styrene | 100-42-5 | 8260 | | 6.78E-11 | 2.44E-09 | 2.17E-08 |
| Tetrachloroethene | 127-18-4 | 12824 | | 1.05E-10 | 3.79E-09 | 3.36E-08 |
| Tetrahydrofuran | 109-99-9 | 8113 | | 6.66E-11 | 2.40E-09 | 2.13E-08 |
| Toluene | 108-88-3 | 77285 | | 6.35E-10 | 2.29E-08 | 2.03E-07 |
| Trichloroethene | 79-01-6 | 4771 | | 3.92E-11 | 1.41E-09 | 1.25E-08 |
| Vinyl Chloride | 75-01-4 | 3452 | | 2.84E-11 | 1.02E-09 | 9.05E-09 |
| Hydrogen Sulfide | 7783-06-4 | 262877 | | 2.16E-09 | 7.78E-08 | 6.89E-07 |
| Isopropyl Mercaptan | 75-33-2 | 3548 | | 2.91E-11 | 1.05E-09 | 9.30E-09 |
| Methyl Mercaptan | 74-93-1 | 3464 | | 2.84E-11 | 1.02E-09 | 9.08E-09 |
| 2-Ethylthiophene | 872-55-9 | 3835 | | 3.15E-11 | 1.13E-09 | 1.01E-08 |
| 2,5,-Dimethylthiophene | 638-02-8 | 3692 | | 3.03E-11 | 1.09E-09 | 9.68E-09 |
| Diethyl Disulfide | 110-81-6 | 4802 | | 3.94E-11 | 1.42E-09 | 1.26E-08 |

Notes:

1. Emission rates were calculated using the following equation:

Fugitive Emissions (g/m2 -sec) =
(Area Fugitive Flow rate (ft3/min) * 0.028317 m3/ft3 / 60 sec/min) * (Compound Conc. (ug/m3) / 1,000,000 ug/g) / ( Surface Area (acres) * 4046.9 m2/acre )

Area Fugitive Flowrate (cfm) = Fugitive gas flow rate from each area
Compound Conc. (ug/m3) = Concentration of specific compound in landfill gas
Surface Area (acres) = Area that fugitive emission rate is applied to (Areas A, B or C)
0.028317 = conv. factor from cu. feet to cu. meter (0.028317 m3/ft3)
60 = conv. factor from min to sec (60 sec/min)
1,000,000 = conv. factor from ug to grams (1,000,000 ug/g)
4046.825 = conv. factor from acres to sq. meters (4046.825 m2/acre)

2. See Table D-5.
3. See Table D-4.

**TABLE D-6d**
**GRAND CENTRAL SANITARY LANDFILL**
**2006 Fugitive Emission Rates for Detected Landfill Gas Constituents**

| Compound | CAS | Landfill Gas Weighted Average Compound Concentrations[2] (ug/m3) | 2006 Emission Rate [1] (g/m$^2$-sec) | | | |
|---|---|---|---|---|---|---|
| | | | Source: | Area A | Area B | Area C |
| | | | Surface Area:[3] | 56.8 acres | 68.3 acres | 19.2 acres |
| | | | Fugitive Flowrate:[3] | 3 cfm | 231 cfm | 575 cfm |
| 1,1,1-Trichloroethane | 71-55-6 | 3152 | | 1.94E-11 | 1.24E-09 | 1.10E-08 |
| 1,1-Dichloroethane | 75-34-3 | 3572 | | 2.20E-11 | 1.41E-09 | 1.25E-08 |
| 1,2,4-Trimethylbenzene | 95-63-6 | 13051 | | 8.04E-11 | 5.15E-09 | 4.56E-08 |
| 1,3,5-Trimethylbenzene | 108-67-8 | 4920 | | 3.03E-11 | 1.94E-09 | 1.72E-08 |
| 1,4-Dichlorobenzene | 106-46-7 | 2884 | | 1.78E-11 | 1.14E-09 | 1.01E-08 |
| 2-Butanone (Methyl Ethyl Ketone) | 78-93-3 | 89631 | | 5.52E-10 | 3.53E-08 | 3.13E-07 |
| 2-Propanol | 67-63-0 | 42708 | | 2.63E-10 | 1.68E-08 | 1.49E-07 |
| 4-Ethyltoluene | 622-96-8 | 12019 | | 7.40E-11 | 4.74E-09 | 4.20E-08 |
| 4-Methyl-2-pentanone | 108-10-1 | 9805 | | 6.04E-11 | 3.87E-09 | 3.43E-08 |
| Acetone | 67-64-1 | 54091 | | 3.33E-10 | 2.13E-08 | 1.89E-07 |
| Benzene | 71-43-2 | 2010 | | 1.24E-11 | 7.93E-10 | 7.03E-09 |
| Carbon Disulfide | 75-15-0 | 1662 | | 1.02E-11 | 6.55E-10 | 5.81E-09 |
| Chlorobenzene | 108-90-7 | 443 | | 2.73E-12 | 1.75E-10 | 1.55E-09 |
| Chloroethane | 75-00-3 | 1136 | | 6.99E-12 | 4.48E-10 | 3.97E-09 |
| cis-1,2-Dichloroethene | 156-59-2 | 1041 | | 6.41E-12 | 4.11E-10 | 3.64E-09 |
| Cyclohexane | 110-82-7 | 9228 | | 5.68E-11 | 3.64E-09 | 3.23E-08 |
| Ethanol | 64-17-5 | 263076 | | 1.62E-09 | 1.04E-07 | 9.20E-07 |
| Ethyl Benzene | 100-41-4 | 32418 | | 2.00E-10 | 1.28E-08 | 1.13E-07 |
| Freon 11 | 75-69-4 | 8321 | | 5.13E-11 | 3.28E-09 | 2.91E-08 |
| Freon 114 | 76-14-2 | 1049 | | 6.46E-12 | 4.14E-10 | 3.67E-09 |
| Freon 12 | 75-71-8 | 12735 | | 7.84E-11 | 5.02E-09 | 4.45E-08 |
| Heptane | 142-82-5 | 17153 | | 1.06E-10 | 6.76E-09 | 6.00E-08 |
| Hexane | 110-54-3 | 20204 | | 1.24E-10 | 7.97E-09 | 7.06E-08 |
| m,p-Xylene | 108-38-3 106-42-3 | 43989 | | 2.71E-10 | 1.73E-08 | 1.54E-07 |
| Methyl tert-Butyl Ether | 1634-04-4 | 3172 | | 1.95E-11 | 1.25E-09 | 1.11E-08 |
| Methylene Chloride | 75-09-2 | 18286 | | 1.13E-10 | 7.21E-09 | 6.39E-08 |
| o-Xylene | 95-47-6 | 14102 | | 8.69E-11 | 5.56E-09 | 4.93E-08 |
| Styrene | 100-42-5 | 8260 | | 5.09E-11 | 3.26E-09 | 2.89E-08 |
| Tetrachloroethene | 127-18-4 | 12824 | | 7.90E-11 | 5.06E-09 | 4.48E-08 |
| Tetrahydrofuran | 109-99-9 | 8113 | | 5.00E-11 | 3.20E-09 | 2.84E-08 |
| Toluene | 108-88-3 | 77285 | | 4.76E-10 | 3.05E-08 | 2.70E-07 |
| Trichloroethene | 79-01-6 | 4771 | | 2.94E-11 | 1.88E-09 | 1.67E-08 |
| Vinyl Chloride | 75-01-4 | 3452 | | 2.13E-11 | 1.36E-09 | 1.21E-08 |
| Hydrogen Sulfide | 7783-06-4 | 262877 | | 1.62E-09 | 1.04E-07 | 9.19E-07 |
| Isopropyl Mercaptan | 75-33-2 | 3548 | | 2.19E-11 | 1.40E-09 | 1.24E-08 |
| Methyl Mercaptan | 74-93-1 | 3464 | | 2.13E-11 | 1.37E-09 | 1.21E-08 |
| 2-Ethylthiophene | 872-55-9 | 3835 | | 2.36E-11 | 1.51E-09 | 1.34E-08 |
| 2,5,-Dimethylthiophene | 638-02-8 | 3692 | | 2.27E-11 | 1.46E-09 | 1.29E-08 |
| Diethyl Disulfide | 110-81-6 | 4802 | | 2.96E-11 | 1.89E-09 | 1.68E-08 |

Notes:
1. Emission rates were calculated using the following equation:

Fugitive Emissions (g/m2 -sec) =
(Area Fugitive Flow rate (ft3/min) * 0.028317 m3/ft3 / 60 sec/min) * (Compound Conc. (ug/m3) / 1,000,000 ug/g) / ( Surface Area (acres) * 4046.9 m2/acre )

Area Fugitive Flowrate (cfm) = Fugitive gas flow rate from each area
Compound Conc. (ug/m3) = Concentration of specific compound in landfill gas
Surface Area (acres) = Area that fugitive emission rate is applied to (Areas A, B or C)
0.028317 = conv. factor from cu. feet to cu. meter (0.028317 m3/ft3)
60 = conv. factor from min to sec (60 sec/min)
1,000,000 = conv. factor from ug to grams (1,000,000 ug/g)
4046.825 = conv. factor from acres to sq. meters (4046.825 m2/acre)

2. See Table D-5.
3. See Table D-4.

**TABLE D-6e**
**GRAND CENTRAL SANITARY LANDFILL**
**2007 Fugitive Emission Rates for Detected Landfill Gas Constituents**

| Compound | CAS | Landfill Gas Weighted Average Compound Concentrations[2] (ug/m3) | 2007 Emission Rate [1] (g/m$^2$-sec) | | | |
|---|---|---|---|---|---|---|
| | | | Source: | Area A | Area B | Area C |
| | | | Surface Area:[3] | 56.8 acres | 76.4 acres | 11.1 acres |
| | | | Fugitive Flowrate:[3] | 2 cfm | 348 cfm | 451 cfm |
| 1,1,1-Trichloroethane | 71-55-6 | 3152 | | 1.29E-11 | 1.68E-09 | 1.49E-08 |
| 1,1-Dichloroethane | 75-34-3 | 3572 | | 1.47E-11 | 1.90E-09 | 1.69E-08 |
| 1,2,4-Trimethylbenzene | 95-63-6 | 13051 | | 5.36E-11 | 6.94E-09 | 6.16E-08 |
| 1,3,5-Trimethylbenzene | 108-67-8 | 4920 | | 2.02E-11 | 2.62E-09 | 2.32E-08 |
| 1,4-Dichlorobenzene | 106-46-7 | 2884 | | 1.18E-11 | 1.53E-09 | 1.36E-08 |
| 2-Butanone (Methyl Ethyl Ketone) | 78-93-3 | 89631 | | 3.68E-10 | 4.76E-08 | 4.23E-07 |
| 2-Propanol | 67-63-0 | 42708 | | 1.75E-10 | 2.27E-08 | 2.02E-07 |
| 4-Ethyltoluene | 622-96-8 | 12019 | | 4.94E-11 | 6.39E-09 | 5.67E-08 |
| 4-Methyl-2-pentanone | 108-10-1 | 9805 | | 4.03E-11 | 5.21E-09 | 4.63E-08 |
| Acetone | 67-64-1 | 54091 | | 2.22E-10 | 2.87E-08 | 2.55E-07 |
| Benzene | 71-43-2 | 2010 | | 8.25E-12 | 1.07E-09 | 9.49E-09 |
| Carbon Disulfide | 75-15-0 | 1662 | | 6.83E-12 | 8.83E-10 | 7.85E-09 |
| Chlorobenzene | 108-90-7 | 443 | | 1.82E-12 | 2.35E-10 | 2.09E-09 |
| Chloroethane | 75-00-3 | 1136 | | 4.66E-12 | 6.03E-10 | 5.36E-09 |
| cis-1,2-Dichloroethene | 156-59-2 | 1041 | | 4.28E-12 | 5.53E-10 | 4.92E-09 |
| Cyclohexane | 110-82-7 | 9228 | | 3.79E-11 | 4.90E-09 | 4.36E-08 |
| Ethanol | 64-17-5 | 263076 | | 1.08E-09 | 1.40E-07 | 1.24E-06 |
| Ethyl Benzene | 100-41-4 | 32418 | | 1.33E-10 | 1.72E-08 | 1.53E-07 |
| Freon 11 | 75-69-4 | 8321 | | 3.42E-11 | 4.42E-09 | 3.93E-08 |
| Freon 114 | 76-14-2 | 1049 | | 4.31E-12 | 5.58E-10 | 4.95E-09 |
| Freon 12 | 75-71-8 | 12735 | | 5.23E-11 | 6.77E-09 | 6.01E-08 |
| Heptane | 142-82-5 | 17153 | | 7.04E-11 | 9.12E-09 | 8.10E-08 |
| Hexane | 110-54-3 | 20204 | | 8.30E-11 | 1.07E-08 | 9.54E-08 |
| m,p-Xylene | 108-38-3 106-42-3 | 43989 | | 1.81E-10 | 2.34E-08 | 2.08E-07 |
| Methyl tert-Butyl Ether | 1634-04-4 | 3172 | | 1.30E-11 | 1.69E-09 | 1.50E-08 |
| Methylene Chloride | 75-09-2 | 18286 | | 7.51E-11 | 9.72E-09 | 8.63E-08 |
| o-Xylene | 95-47-6 | 14102 | | 5.79E-11 | 7.49E-09 | 6.66E-08 |
| Styrene | 100-42-5 | 8260 | | 3.39E-11 | 4.39E-09 | 3.90E-08 |
| Tetrachloroethene | 127-18-4 | 12824 | | 5.27E-11 | 6.82E-09 | 6.05E-08 |
| Tetrahydrofuran | 109-99-9 | 8113 | | 3.33E-11 | 4.31E-09 | 3.83E-08 |
| Toluene | 108-88-3 | 77285 | | 3.17E-10 | 4.11E-08 | 3.65E-07 |
| Trichloroethene | 79-01-6 | 4771 | | 1.96E-11 | 2.54E-09 | 2.25E-08 |
| Vinyl Chloride | 75-01-4 | 3452 | | 1.42E-11 | 1.83E-09 | 1.63E-08 |
| Hydrogen Sulfide | 7783-06-4 | 262877 | | 1.08E-09 | 1.40E-07 | 1.24E-06 |
| Isopropyl Mercaptan | 75-33-2 | 3548 | | 1.46E-11 | 1.89E-09 | 1.68E-08 |
| Methyl Mercaptan | 74-93-1 | 3464 | | 1.42E-11 | 1.84E-09 | 1.64E-08 |
| 2-Ethylthiophene | 872-55-9 | 3835 | | 1.57E-11 | 2.04E-09 | 1.81E-08 |
| 2,5,-Dimethylthiophene | 638-02-8 | 3692 | | 1.52E-11 | 1.96E-09 | 1.74E-08 |
| Diethyl Disulfide | 110-81-6 | 4802 | | 1.97E-11 | 2.55E-09 | 2.27E-08 |

Notes:
1. Emission rates were calculated using the following equation:

Fugitive Emissions (g/m2 -sec) =
(Area Fugitive Flow rate (ft3/min) * 0.028317 m3/ft3 / 60 sec/min) * (Compound Conc. (ug/m3) / 1,000,000 ug/g) / ( Surface Area (acres) * 4046.9 m2/acre )

Area Fugitive Flowrate (cfm) = Fugitive gas flow rate from each area
Compound Conc. (ug/m3) = Concentration of specific compound in landfill gas
Surface Area (acres) = Area that fugitive emission rate is applied to (Areas A, B or C)
0.028317 = conv. factor from cu. feet to cu. meter (0.028317 m3/ft3)
60 = conv. factor from min to sec (60 sec/min)
1,000,000 = conv. factor from ug to grams (1,000,000 ug/g)
4046.825 = conv. factor from acres to sq. meters (4046.825 m2/acre)

2. See Table D-5.
3. See Table D-4.

**TABLE D-6f**
**GRAND CENTRAL SANITARY LANDFILL**
**Fugitive Emission Rates for Detected Landfill Gas Constituents**
**Summary 2003-2007 Emission Rates**

| Compound | CAS | Average Emission Rates [1] (g/m2-sec) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Area A | | | | | | Area B | | | | | | Area C | | | | | |
| | | 2003 | 2004 | 2005 | 2006 | 2007 | 5 Year Average | 2003 | 2004 | 2005 | 2006 | 2007 | 5 Year Average | 2003 | 2004 | 2005 | 2006 | 2007 | 5 Year Average |
| 1,1,1-Trichloroethane | 71-55-6 | 5.18E-11 | 3.88E-11 | 2.59E-11 | 1.94E-11 | 1.29E-11 | 2.98E-11 | 5.83E-10 | 7.24E-10 | 9.32E-10 | 1.24E-09 | 1.68E-09 | 1.03E-09 | 5.18E-09 | 6.43E-09 | 8.26E-09 | 1.10E-08 | 1.49E-08 | 9.15E-09 |
| 1,1-Dichloroethane | 75-34-3 | 5.87E-11 | 4.40E-11 | 2.93E-11 | 2.20E-11 | 1.47E-11 | 3.37E-11 | 6.61E-10 | 8.20E-10 | 1.06E-09 | 1.41E-09 | 1.90E-09 | 1.17E-09 | 5.87E-09 | 7.28E-09 | 9.37E-09 | 1.25E-08 | 1.69E-08 | 1.04E-08 |
| 1,2,4-Trimethylbenzene | 95-63-6 | 2.14E-10 | 1.61E-10 | 1.07E-10 | 8.04E-11 | 5.36E-11 | 1.23E-10 | 2.42E-09 | 3.00E-09 | 3.86E-09 | 5.15E-09 | 6.94E-09 | 4.27E-09 | 2.14E-08 | 2.66E-08 | 3.42E-08 | 4.56E-08 | 6.16E-08 | 3.79E-08 |
| 1,3,5-Trimethylbenzene | 108-67-8 | 8.08E-11 | 6.06E-11 | 4.04E-11 | 3.03E-11 | 2.02E-11 | 4.65E-11 | 9.11E-10 | 1.13E-09 | 1.46E-09 | 1.94E-09 | 2.62E-09 | 1.61E-09 | 8.08E-09 | 1.00E-08 | 1.29E-08 | 1.72E-08 | 2.32E-08 | 1.43E-08 |
| 1,4-Dichlorobenzene | 106-46-7 | 4.74E-11 | 3.55E-11 | 2.37E-11 | 1.78E-11 | 1.18E-11 | 2.72E-11 | 5.34E-10 | 6.62E-10 | 8.53E-10 | 1.14E-09 | 1.53E-09 | 9.44E-10 | 4.74E-09 | 5.88E-09 | 7.56E-09 | 1.01E-08 | 1.36E-08 | 8.37E-09 |
| 2-Butanone (Methyl Ethyl Ketone) | 78-93-3 | 1.47E-09 | 1.10E-09 | 7.36E-10 | 5.52E-10 | 3.68E-10 | 8.47E-10 | 1.66E-08 | 2.06E-08 | 2.65E-08 | 3.53E-08 | 4.76E-08 | 2.93E-08 | 1.47E-07 | 1.83E-07 | 2.35E-07 | 3.13E-07 | 4.23E-07 | 2.60E-07 |
| 2-Propanol | 67-63-0 | 7.01E-10 | 5.26E-10 | 3.51E-10 | 2.63E-10 | 1.75E-10 | 4.03E-10 | 7.90E-09 | 9.81E-09 | 1.26E-08 | 1.68E-08 | 2.27E-08 | 1.40E-08 | 7.01E-08 | 8.71E-08 | 1.12E-07 | 1.49E-07 | 2.02E-07 | 1.24E-07 |
| 4-Ethyltoluene | 622-96-8 | 1.97E-10 | 1.48E-10 | 9.87E-11 | 7.40E-11 | 4.94E-11 | 1.14E-10 | 2.22E-09 | 2.76E-09 | 3.56E-09 | 4.74E-09 | 6.39E-09 | 3.93E-09 | 1.97E-08 | 2.45E-08 | 3.15E-08 | 4.20E-08 | 5.67E-08 | 3.49E-08 |
| 4-Methyl-2-pentanone | 108-10-1 | 1.61E-10 | 1.21E-10 | 8.05E-11 | 6.04E-11 | 4.03E-11 | 9.26E-11 | 1.81E-09 | 2.25E-09 | 2.90E-09 | 3.87E-09 | 5.21E-09 | 3.21E-09 | 1.81E-08 | 2.00E-08 | 2.57E-08 | 3.43E-08 | 4.63E-08 | 2.85E-08 |
| Acetone | 67-64-1 | 8.88E-10 | 6.66E-10 | 4.44E-10 | 3.33E-10 | 2.22E-10 | 5.11E-10 | 1.00E-08 | 1.24E-08 | 1.60E-08 | 2.13E-08 | 2.87E-08 | 1.77E-08 | 8.88E-08 | 1.10E-07 | 1.42E-07 | 1.89E-07 | 2.55E-07 | 1.57E-07 |
| Benzene | 71-43-2 | 3.30E-11 | 2.48E-11 | 1.65E-11 | 1.24E-11 | 8.25E-12 | 1.90E-11 | 3.72E-10 | 4.62E-10 | 5.95E-10 | 7.93E-10 | 1.07E-09 | 6.58E-10 | 3.30E-09 | 4.10E-09 | 5.27E-09 | 7.03E-09 | 9.49E-09 | 5.84E-09 |
| Carbon Disulfide | 75-15-0 | 2.73E-11 | 2.05E-11 | 1.37E-11 | 1.02E-11 | 6.83E-12 | 1.57E-11 | 3.08E-10 | 3.82E-10 | 4.92E-10 | 6.55E-10 | 8.83E-10 | 5.44E-10 | 2.73E-09 | 3.39E-09 | 4.36E-09 | 5.81E-09 | 7.85E-09 | 4.83E-09 |
| Chlorobenzene | 108-90-7 | 7.27E-12 | 5.45E-12 | 3.64E-12 | 2.73E-12 | 1.82E-12 | 4.18E-12 | 8.19E-11 | 1.02E-10 | 1.31E-10 | 1.75E-10 | 2.35E-10 | 1.45E-10 | 7.27E-10 | 9.03E-10 | 1.16E-09 | 1.55E-09 | 2.09E-09 | 1.29E-09 |
| Chloroethane | 75-00-3 | 1.87E-11 | 1.40E-11 | 9.33E-12 | 6.99E-12 | 4.66E-12 | 1.07E-11 | 2.10E-10 | 2.61E-10 | 3.36E-10 | 4.48E-10 | 6.03E-10 | 3.72E-10 | 1.86E-09 | 2.31E-09 | 2.98E-09 | 3.97E-09 | 5.36E-09 | 3.30E-09 |
| cis-1,2-Dichloroethene | 156-59-2 | 1.71E-11 | 1.28E-11 | 8.55E-12 | 6.41E-12 | 4.28E-12 | 9.83E-12 | 1.93E-10 | 2.39E-10 | 3.08E-10 | 4.11E-10 | 5.53E-10 | 3.41E-10 | 1.71E-09 | 2.12E-09 | 2.73E-09 | 3.64E-09 | 4.92E-09 | 3.02E-09 |
| Cyclohexane | 110-82-7 | 1.52E-10 | 1.14E-10 | 7.58E-11 | 5.68E-11 | 3.79E-11 | 8.72E-11 | 1.71E-09 | 2.12E-09 | 2.73E-09 | 3.64E-09 | 4.90E-09 | 3.02E-09 | 1.52E-08 | 1.88E-08 | 2.42E-08 | 3.23E-08 | 4.36E-08 | 2.68E-08 |
| Ethanol | 64-17-5 | 4.32E-09 | 3.24E-09 | 2.16E-09 | 1.62E-09 | 1.08E-09 | 2.48E-09 | 4.87E-08 | 6.04E-08 | 7.78E-08 | 1.04E-07 | 1.40E-07 | 8.61E-08 | 4.32E-07 | 5.36E-07 | 6.90E-07 | 9.20E-07 | 1.24E-06 | 7.64E-07 |
| Ethyl Benzene | 100-41-4 | 5.32E-10 | 3.99E-10 | 2.66E-10 | 2.00E-10 | 1.33E-10 | 3.06E-10 | 6.00E-09 | 7.44E-09 | 9.59E-09 | 1.28E-08 | 1.72E-08 | 1.06E-08 | 5.32E-08 | 6.61E-08 | 8.50E-08 | 1.13E-07 | 1.53E-07 | 9.41E-08 |
| Freon 11 | 75-69-4 | 1.37E-10 | 1.03E-10 | 6.83E-11 | 5.13E-11 | 3.42E-11 | 7.86E-11 | 1.54E-09 | 1.91E-09 | 2.46E-09 | 3.28E-09 | 4.42E-09 | 2.72E-09 | 1.37E-08 | 1.70E-08 | 2.18E-08 | 2.91E-08 | 3.93E-08 | 2.42E-08 |
| Freon 114 | 76-14-2 | 1.72E-11 | 1.29E-11 | 8.62E-12 | 6.46E-12 | 4.31E-12 | 9.91E-12 | 1.94E-10 | 2.41E-10 | 3.10E-10 | 4.14E-10 | 5.58E-10 | 3.43E-10 | 1.72E-09 | 2.14E-09 | 2.75E-09 | 3.67E-09 | 4.95E-09 | 3.05E-09 |
| Freon 12 | 75-71-8 | 2.09E-10 | 1.57E-10 | 1.05E-10 | 7.84E-11 | 5.23E-11 | 1.20E-10 | 2.36E-09 | 2.92E-09 | 3.77E-09 | 5.02E-09 | 6.77E-09 | 4.17E-09 | 2.09E-08 | 2.60E-08 | 3.34E-08 | 4.45E-08 | 6.01E-08 | 3.70E-08 |
| Heptane | 142-82-5 | 2.82E-10 | 2.11E-10 | 1.41E-10 | 1.06E-10 | 7.04E-11 | 1.62E-10 | 3.17E-09 | 3.94E-09 | 5.07E-09 | 6.76E-09 | 9.12E-09 | 5.61E-09 | 2.82E-08 | 3.50E-08 | 4.50E-08 | 6.00E-08 | 8.10E-08 | 4.98E-08 |
| Hexane | 110-54-3 | 3.32E-10 | 2.49E-10 | 1.66E-10 | 1.24E-10 | 8.30E-11 | 1.91E-10 | 3.74E-09 | 4.64E-09 | 5.98E-09 | 7.97E-09 | 1.07E-08 | 6.61E-09 | 3.32E-08 | 4.12E-08 | 5.30E-08 | 7.06E-08 | 9.54E-08 | 5.87E-08 |
| m,p-Xylene | 108-38-3 / 106-42-3 | 7.23E-10 | 5.42E-10 | 3.61E-10 | 2.71E-10 | 1.81E-10 | 4.15E-10 | 8.14E-09 | 1.01E-08 | 1.30E-08 | 1.73E-08 | 2.34E-08 | 1.44E-08 | 7.22E-08 | 8.97E-08 | 1.15E-07 | 1.54E-07 | 2.08E-07 | 1.28E-07 |
| Methyl tert-Butyl Ether | 1634-04-4 | 5.21E-11 | 3.91E-11 | 2.61E-11 | 1.95E-11 | 1.30E-11 | 3.00E-11 | 5.87E-10 | 7.28E-10 | 9.38E-10 | 1.25E-09 | 1.69E-09 | 1.04E-09 | 5.21E-09 | 6.47E-09 | 8.32E-09 | 1.11E-08 | 1.50E-08 | 9.21E-09 |
| Methylene Chloride | 75-09-2 | 3.00E-10 | 2.25E-10 | 1.50E-10 | 1.13E-10 | 7.51E-11 | 1.73E-10 | 3.38E-09 | 4.20E-09 | 5.41E-09 | 7.21E-09 | 9.72E-09 | 5.98E-09 | 3.00E-08 | 3.73E-08 | 4.79E-08 | 6.39E-08 | 8.63E-08 | 5.31E-08 |
| o-Xylene | 95-47-6 | 2.32E-10 | 1.74E-10 | 1.16E-10 | 8.69E-11 | 5.79E-11 | 1.33E-10 | 2.61E-09 | 3.24E-09 | 4.17E-09 | 5.56E-09 | 7.49E-09 | 4.61E-09 | 2.32E-08 | 2.87E-08 | 3.70E-08 | 4.93E-08 | 6.66E-08 | 4.10E-08 |
| Styrene | 100-42-5 | 1.36E-10 | 1.02E-10 | 6.78E-11 | 5.09E-11 | 3.39E-11 | 7.80E-11 | 1.53E-09 | 1.90E-09 | 2.44E-09 | 3.26E-09 | 4.39E-09 | 2.70E-09 | 1.36E-08 | 1.68E-08 | 2.17E-08 | 2.89E-08 | 3.90E-08 | 2.40E-08 |
| Tetrachloroethene | 127-18-4 | 2.11E-10 | 1.58E-10 | 1.05E-10 | 7.90E-11 | 5.27E-11 | 1.21E-10 | 2.37E-09 | 2.94E-09 | 3.79E-09 | 5.06E-09 | 6.82E-09 | 4.20E-09 | 2.11E-08 | 2.61E-08 | 3.36E-08 | 4.48E-08 | 6.05E-08 | 3.72E-08 |
| Tetrahydrofuran | 109-99-9 | 1.33E-10 | 9.99E-11 | 6.66E-11 | 5.00E-11 | 3.33E-11 | 7.66E-11 | 1.50E-09 | 1.86E-09 | 2.40E-09 | 3.20E-09 | 4.31E-09 | 2.66E-09 | 1.33E-08 | 1.65E-08 | 2.13E-08 | 2.84E-08 | 3.83E-08 | 2.36E-08 |
| Toluene | 108-88-3 | 1.27E-09 | 9.52E-10 | 6.35E-10 | 4.76E-10 | 3.17E-10 | 7.30E-10 | 1.43E-08 | 1.77E-08 | 2.29E-08 | 3.05E-08 | 4.11E-08 | 2.53E-08 | 1.27E-07 | 1.58E-07 | 2.03E-07 | 2.70E-07 | 3.65E-07 | 2.24E-07 |
| Trichloroethene | 79-01-6 | 7.84E-11 | 5.88E-11 | 3.92E-11 | 2.94E-11 | 1.96E-11 | 4.51E-11 | 8.83E-10 | 1.10E-09 | 1.41E-09 | 1.88E-09 | 2.54E-09 | 1.56E-09 | 7.83E-09 | 9.73E-09 | 1.25E-08 | 1.67E-08 | 2.25E-08 | 1.39E-08 |
| Vinyl Chloride | 75-01-4 | 5.67E-11 | 4.25E-11 | 2.84E-11 | 2.13E-11 | 1.42E-11 | 3.26E-11 | 6.39E-10 | 7.93E-10 | 1.02E-09 | 1.36E-09 | 1.83E-09 | 1.13E-09 | 5.67E-09 | 7.04E-09 | 9.05E-09 | 1.21E-08 | 1.63E-08 | 1.00E-08 |
| Hydrogen Sulfide [2] | 7783-06-4 | 4.32E-09 | 3.24E-09 | 2.16E-09 | 1.62E-09 | 1.08E-09 | 2.48E-09 | 4.86E-08 | 6.04E-08 | 7.78E-08 | 1.04E-07 | 1.40E-07 | 8.60E-08 | 4.32E-07 | 5.36E-07 | 6.89E-07 | 9.19E-07 | 1.24E-06 | 7.63E-07 |
| Isopropyl Mercaptan | 75-33-2 | 5.83E-11 | 4.37E-11 | 2.91E-11 | 2.19E-11 | 1.46E-11 | 3.35E-11 | 6.57E-10 | 8.15E-10 | 1.05E-09 | 1.40E-09 | 1.89E-09 | 1.16E-09 | 5.83E-09 | 7.23E-09 | 9.30E-09 | 1.24E-08 | 1.68E-08 | 1.03E-08 |
| Methyl Mercaptan | 74-93-1 | 5.69E-11 | 4.27E-11 | 2.84E-11 | 2.13E-11 | 1.42E-11 | 3.27E-11 | 6.41E-10 | 7.95E-10 | 1.02E-09 | 1.37E-09 | 1.84E-09 | 1.13E-09 | 5.69E-09 | 7.06E-09 | 9.08E-09 | 1.21E-08 | 1.64E-08 | 1.01E-08 |
| 2-Ethylthiophene | 872-55-9 | 6.30E-11 | 4.72E-11 | 3.15E-11 | 2.36E-11 | 1.57E-11 | 3.62E-11 | 7.10E-10 | 8.80E-10 | 1.13E-09 | 1.51E-09 | 2.04E-09 | 1.25E-09 | 6.30E-09 | 7.82E-09 | 1.01E-08 | 1.34E-08 | 1.81E-08 | 1.11E-08 |
| 2,5,-Dimethylthiophene | 638-02-8 | 6.06E-11 | 4.55E-11 | 3.03E-11 | 2.27E-11 | 1.52E-11 | 3.49E-11 | 6.83E-10 | 8.46E-10 | 1.09E-09 | 1.46E-09 | 1.96E-09 | 1.21E-09 | 6.06E-09 | 7.53E-09 | 9.68E-09 | 1.29E-08 | 1.74E-08 | 1.07E-08 |
| Diethyl Disulfide | 110-81-6 | 7.89E-11 | 5.92E-11 | 3.94E-11 | 2.96E-11 | 1.97E-11 | 4.54E-11 | 8.89E-10 | 1.10E-09 | 1.42E-09 | 1.89E-09 | 2.55E-09 | 1.57E-09 | 7.89E-09 | 9.79E-09 | 1.26E-08 | 1.68E-08 | 2.27E-08 | 1.39E-08 |

Notes.
1 Based on 2003 through 2007 emission rates (See Tables D-6a through D-6e). Gas generation rates are expected to decline after 2007, and thus the average for 2003 through 2007 is a conservative assumption (i.e will overestimate gas generation rates over the long term)
2. The hydrogen sulfide emission rates from the landfill surfaces were adjusted in the risk assessment downward by a factor of 100 based on a comparison of modeled and measured concentrations at 4 inches above the surface of active landfill area (see appendix discussion on calculation of emission rates for more information) The values shown here do not reflect this adjustment.

overestimated by assuming 90% collection efficiency for the entire landfill. GCSL has, however, installed a more extensive gas collection system within active landfill areas than a typical landfill, which means the actual collection efficiency is likely to be greater than 90%, and the modeled gas generation rates are likely to be lower than calculated for this assessment.

The degree of overestimation of the landfill surface emission rates was evaluated by comparing measured and modeled air concentrations of hydrogen sulfide 4 inches above the active landfill surface. Hydrogen sulfide was selected for detailed examination because a readily available monitoring method exists for measuring hydrogen sulfide in the field (Jerome hydrogen sulfide analyzer, Arizona Instrument, Tempe, AZ), this method has been applied at other landfills (Townsend et al. 2000), and hydrogen sulfide is often one of the dominant compounds found in landfill gas, including the landfill gas measured at GCSL.

The measurement effort involved collecting air samples 4 inches above the landfill surface at over 90 locations (one sample for each area of slightly less than one acre) across the roughly 83 acre active landfill area (Landfill Areas B and C, as described in the main report). A total of 94 measurements were collected on August 25 and 26, 2003, using a Jerome 631-X Hydrogen Sulfide Analyzer (Arizona Instrument, Tempe, AZ). The resulting average hydrogen sulfide concentration 4 inches above the surface of the active landfill was 0.004 ppm.

Modeled hydrogen sulfide concentrations were also calculated at 4 inches above the active landfill surface using the modeled chemical emissions rates (see Table D-6f) and a simple area source box model (ASTM 1994), as follows:

$$C_{air} = (ER * Area * CF1 * CF2) / (L * V * H)$$

where

| | | |
|---|---|---|
| $C_{air}$ | = | modeled hydrogen sulfide ambient air concentration 4 inches above the active landfill surface (ppm), |
| ER | = | hydrogen sulfide emission rate (4.39E-7 g/m$^2$-sec), |
| Area | = | active landfill surface area (3.35 E+5 m$^2$), |
| CF1 | = | conversion factor (1,000 mg / g), |
| CF2 | = | conversion factor (1 ppm $H_2S$ / 1.4 mg/m$^3$ $H_2S$), |
| L | = | length of emission source (430 m), |
| V | = | wind speed (3.5 m/sec), and |
| H | = | box height (0.1 m). |

The hydrogen sulfide emission rate was calculated based on the modeled emission rates previously calculated for Areas B and C (8.6E-8 g/m$^2$-sec and 7.63E-7 g/m$^2$-sec, respectively), weighted by the surface areas of landfill Areas B and C (39.7 and 43.2 acres, respectively). The surface area of the active landfill (Areas B and C) was calculated to be 3.35 x $10^5$ m$^2$ (82.9 acres). The length of the emission source was calculated based on the wind direction during the time of sampling. On-site meteorological data collected during the sampling times on August 25 and 26 were compiled to identify the average wind direction, which was from the south. Along this wind vector, the average length of the active landfill area is roughly 430 m (approximately 1,400 feet). The average wind speed during the sampling times was 3.5 m/sec (7.9 miles per hour). The height of the box into which emissions were assumed to be mixed was set at the measurement sampling height of 0.1 m (4 inches). The resulting modeled ambient air concentration of hydrogen sulfide at 4 inches above the active landfill surface was calculated to be 0.7 ppm.

A comparison of the measured and modeled hydrogen sulfide concentrations (0.004 ppm versus 0.7 ppm, respectively) showed that the modeled emission rate from the active landfill surface overestimated actual hydrogen sulfide concentrations by a factor of 175. The modeled emission rates produce an ambient concentration that would be readily detected based on odor (the mean odor threshold for hydrogen sulfide is 0.008 ppm), however, the actual surface measurements show that the average hydrogen sulfide level across the surface of the active landfill was not likely to be readily noticed. Based on this analysis, the modeled hydrogen sulfide emission rates for each landfill area were adjusted downwards by a factor of 100. Since the actual degree of overestimation was calculated to be 175, even the adjusted hydrogen sulfide emission rates were still likely to be overestimated. It is also likely that other compounds present in landfill gas have substantially reduced emission rates compared to those that were modeled. However, no adjustment was made to emission rates for compounds other than hydrogen sulfide in this assessment since the surface measurements used in comparison with modeled data were limited to hydrogen sulfide.

## POINT SOURCE EMISSIONS

The other landfill gas related emission sources at GCSL are the enclosed landfill gas flares and the landfill gas-fueled turbine generators at the Green Knight Energy Center. These sources combust landfill gas and exhaust emissions from a stack or "point source". As discussed in the main report, emission rates from the gas-to-energy plant and the enclosed flares were calculated based on operating data from these facilities and other similar facilities and the concentrations of compounds in the landfill gas.

Compound-specific emission rates for the enclosed flares and landfill gas turbines were calculated by applying the expected destruction efficiency of each device (Table D-7) to the inlet mass flow rate of the compound. A mass flow rate for each compound was calculated by multiplying the landfill gas average compound concentrations by the inlet flow rate of landfill gas to the device. Inlet landfill gas flow rates were based on test reports for each of the point sources and are representative of the maximum modeled landfill gas production rates. The resulting compound emission rates were calculated in units of g/sec for use with the dispersion modeling.

## REFERENCES

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**TABLE D-7**
**GRAND CENTRAL SANITARY LANDFILL**
**2003 Point Source Emissions**

| Compound | CAS | Landfill Gas Weighted Average Compound Concentrations (ug/m³) [1] | Flare #1 | | Flare #2 | | LFGTE Turbine #1 | | LFGTE Turbine #2 | | LFGTE Turbine #3 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | INLET | OUTLET | INLET | OUTLET | INLET | OUTLET | INLET | OUTLET | INLET | OUTLET |
| | | | Mass Flowrate (g/s) [2] | Emission Rate (g/s) [2] | Mass Flowrate (g/s) [2] | Emission Rate (g/s) [2] | Mass Flowrate (g/s) [2] | Emission Rate (g/s) [2] | Mass Flowrate (g/s) [2] | Emission Rate (g/s) [2] | Mass Flowrate (g/s) [2] | Emission Rate (g/s) [2] |
| 1,1,1-Trichloroethane | 71-55-6 | 3152 | 2.15E-03 | 2.15E-04 | 3.01E-03 | 4.18E-04 | 2.08E-03 | 5.35E-05 | 2.17E-03 | 5.65E-05 | 1.99E-03 | 5.17E-05 |
| 1,1-Dichloroethane | 75-34-3 | 3572 | 2.44E-03 | 2.44E-04 | 3.41E-03 | 4.74E-04 | 2.33E-03 | 6.07E-05 | 2.46E-03 | 6.40E-05 | 2.25E-03 | 5.86E-05 |
| 1,2,4-Trimethylbenzene | 95-63-6 | 13051 | 8.91E-03 | 8.91E-04 | 1.25E-02 | 1.73E-03 | 8.52E-03 | 2.22E-04 | 8.99E-03 | 2.34E-04 | 8.23E-03 | 2.14E-04 |
| 1,3,5-Trimethylbenzene | 108-67-8 | 4920 | 3.36E-03 | 3.36E-04 | 4.70E-03 | 6.53E-04 | 3.21E-03 | 8.35E-05 | 3.39E-03 | 8.82E-05 | 3.10E-03 | 8.07E-05 |
| 1,4-Dichlorobenzene | 106-46-7 | 2884 | 1.97E-03 | 1.97E-04 | 2.75E-03 | 3.83E-04 | 1.88E-03 | 4.90E-05 | 1.99E-03 | 5.17E-05 | 1.82E-03 | 4.73E-05 |
| 2-Butanone | 78-93-3 | 89631 | 6.12E-02 | 6.12E-03 | 8.56E-02 | 1.19E-02 | 5.85E-02 | 1.52E-03 | 6.19E-02 | 1.61E-03 | 5.65E-02 | 1.47E-03 |
| 2-Propanol | 67-63-0 | 42708 | 2.91E-02 | 2.91E-03 | 4.08E-02 | 5.67E-03 | 2.79E-02 | 7.25E-04 | 2.94E-02 | 7.65E-04 | 2.69E-02 | 7.00E-04 |
| 4-Ethyltoluene | 622-96-8 | 12019 | 8.20E-03 | 8.20E-04 | 1.15E-02 | 1.59E-03 | 7.85E-03 | 2.04E-04 | 8.28E-03 | 2.15E-04 | 7.58E-03 | 1.97E-04 |
| 4-Methyl-2-pentanone | 108-10-1 | 9805 | 6.69E-03 | 6.69E-04 | 9.36E-03 | 1.30E-03 | 6.40E-03 | 1.66E-04 | 6.76E-03 | 1.76E-04 | 6.18E-03 | 1.61E-04 |
| Acetone | 67-64-1 | 54091 | 3.69E-02 | 3.69E-03 | 5.16E-02 | 7.18E-03 | 3.53E-02 | 9.16E-04 | 3.73E-02 | 9.69E-04 | 3.41E-02 | 8.87E-04 |
| Benzene | 71-43-2 | 2010 | 1.37E-03 | 1.37E-04 | 1.92E-03 | 2.67E-04 | 1.31E-03 | 3.41E-05 | 1.39E-03 | 3.60E-05 | 1.27E-03 | 3.30E-05 |
| Carbon Disulfide | 75-15-0 | 1662 | 1.13E-03 | 1.13E-04 | 1.59E-03 | 2.21E-04 | 1.09E-03 | 2.82E-05 | 1.15E-03 | 2.98E-05 | 1.05E-03 | 2.73E-05 |
| Chlorobenzene | 108-90-7 | 443 | 3.02E-04 | 3.02E-05 | 4.23E-04 | 5.88E-05 | 2.89E-04 | 7.52E-06 | 3.05E-04 | 7.93E-06 | 2.79E-04 | 7.26E-06 |
| Chloroethane | 75-00-3 | 1136 | 7.75E-04 | 7.75E-05 | 1.08E-03 | 1.51E-04 | 7.42E-04 | 1.93E-05 | 7.82E-04 | 2.03E-05 | 7.16E-04 | 1.86E-05 |
| cis-1,2-Dichloroethene | 156-59-2 | 1041 | 7.11E-04 | 7.11E-05 | 9.94E-04 | 1.38E-04 | 6.80E-04 | 1.77E-05 | 7.18E-04 | 1.87E-05 | 6.57E-04 | 1.71E-05 |
| Cyclohexane | 110-82-7 | 9226 | 6.30E-03 | 6.30E-04 | 8.81E-03 | 1.22E-03 | 6.03E-03 | 1.57E-04 | 6.36E-03 | 1.65E-04 | 5.82E-03 | 1.51E-04 |
| Ethanol | 64-17-5 | 263076 | 1.80E-01 | 1.80E-02 | 2.51E-01 | 3.49E-02 | 1.72E-01 | 4.47E-03 | 1.81E-01 | 4.71E-03 | 1.66E-01 | 4.31E-03 |
| Ethyl Benzene | 100-41-4 | 32418 | 2.21E-02 | 2.21E-03 | 3.09E-02 | 4.30E-03 | 2.12E-02 | 5.50E-04 | 2.23E-02 | 5.81E-04 | 2.04E-02 | 5.32E-04 |
| Freon 11 | 75-69-4 | 8321 | 5.68E-03 | 5.68E-04 | 7.94E-03 | 1.10E-03 | 5.43E-03 | 1.41E-04 | 5.73E-03 | 1.49E-04 | 5.25E-03 | 1.36E-04 |
| Freon 114 | 76-14-2 | 1049 | 7.16E-04 | 7.16E-05 | 1.00E-03 | 1.39E-04 | 6.85E-04 | 1.78E-05 | 7.23E-04 | 1.88E-05 | 6.62E-04 | 1.72E-05 |
| Freon 12 | 75-71-8 | 12735 | 8.69E-03 | 8.69E-04 | 1.22E-02 | 1.69E-03 | 8.32E-03 | 2.16E-04 | 8.78E-03 | 2.28E-04 | 8.03E-03 | 2.09E-04 |
| Heptane | 142-82-5 | 17153 | 1.17E-02 | 1.17E-03 | 1.64E-02 | 2.28E-03 | 1.12E-02 | 2.91E-04 | 1.18E-02 | 3.07E-04 | 1.08E-02 | 2.81E-04 |
| Hexane | 110-54-3 | 20204 | 1.38E-02 | 1.38E-03 | 1.93E-02 | 2.68E-03 | 1.32E-02 | 3.43E-04 | 1.39E-02 | 3.62E-04 | 1.27E-02 | 3.31E-04 |
| m,p-Xylene | 108-38-3 106-42-3 | 43989 | 3.00E-02 | 3.00E-03 | 4.20E-02 | 5.84E-03 | 2.87E-02 | 7.47E-04 | 3.03E-02 | 7.88E-04 | 2.77E-02 | 7.21E-04 |
| Methyl tert-Butyl Ether | 1634-04-4 | 3172 | 2.17E-03 | 2.17E-04 | 3.03E-03 | 4.21E-04 | 2.07E-03 | 5.39E-05 | 2.19E-03 | 5.68E-05 | 2.00E-03 | 5.20E-05 |
| Methylene Chloride | 75-09-2 | 18286 | 1.25E-02 | 1.25E-03 | 1.75E-02 | 2.43E-03 | 1.19E-02 | 3.11E-04 | 1.26E-02 | 3.28E-04 | 1.15E-02 | 3.00E-04 |
| o-Xylene | 95-47-6 | 14102 | 9.62E-03 | 9.62E-04 | 1.35E-02 | 1.87E-03 | 9.21E-03 | 2.39E-04 | 9.72E-03 | 2.53E-04 | 8.89E-03 | 2.31E-04 |
| Styrene | 100-42-5 | 8260 | 5.64E-03 | 5.64E-04 | 7.89E-03 | 1.10E-03 | 5.39E-03 | 1.40E-04 | 5.69E-03 | 1.48E-04 | 5.21E-03 | 1.35E-04 |
| Tetrachloroethene | 127-18-4 | 12824 | 8.75E-03 | 8.75E-04 | 1.22E-02 | 1.70E-03 | 8.38E-03 | 2.18E-04 | 8.84E-03 | 2.30E-04 | 8.09E-03 | 2.10E-04 |
| Tetrahydrofuran | 109-99-9 | 8113 | 5.54E-03 | 5.54E-04 | 7.75E-03 | 1.08E-03 | 5.30E-03 | 1.38E-04 | 5.59E-03 | 1.45E-04 | 5.12E-03 | 1.33E-04 |
| Toluene | 108-88-3 | 77285 | 5.27E-02 | 5.27E-03 | 7.36E-02 | 1.03E-02 | 5.05E-02 | 1.31E-03 | 5.33E-02 | 1.38E-03 | 4.87E-02 | 1.27E-03 |
| Trichloroethene | 79-01-6 | 4771 | 3.26E-03 | 3.26E-04 | 4.55E-03 | 6.33E-04 | 3.12E-03 | 8.10E-05 | 3.29E-03 | 8.55E-05 | 3.01E-03 | 7.82E-05 |
| Vinyl Chloride | 75-01-4 | 3452 | 2.36E-03 | 2.36E-04 | 3.30E-03 | 4.58E-04 | 2.25E-03 | 5.86E-05 | 2.38E-03 | 6.18E-05 | 2.18E-03 | 5.66E-05 |

Notes:
1. See Table D-5.
2. The following equations were used to calculate inlet mass flowrates and outlet emission rates for each source:
Inlet Mass Flowrate (g/s) = Compound Conc. (ug/m³) / 1,000,000 ug/g * Inlet landfill gas Flowrate (ACFM) * .028317 (m³/ft³) / 60 (s/min)
Outlet Emission Rate (g/s) = Inlet Mass Flowrate (g/s) * (1-DE)
DE = Compound Destruction Efficiency

| Point Source | Destruction Efficiency (DE) | Destruction Efficiency Source | Inlet Gas Flowrate[3] (DSCFM) | Inlet Flowrate Source |
|---|---|---|---|---|
| Flare #1 | 90.0% | Non-Methane Organic Compound Destruction Efficiency provided in "Flare Emissions Compliance Test Report For The Grand Central Sanitary Landfill", prepared by Air Compliance, Inc., October 1993. | 1,446 | Source Emissions Test Report, Grand Central Sanitary Landfill, prepared by Roy F. Weston, Inc., August 2000 |
| Flare #2 | 86.1% | Non-Methane Organic Compound Destruction Efficiency provided in "Air Emissions Test Report For Earth Resource Engineering Group", prepare by ETS, Inc., January 5, 1998. | 2,023 | |
| Turbine #1 | 97.4% | "Puente Hills Gas To Energy Facility, Solar Turbine - 2002 Annual Source Test Results", prepared by Delta Air Quality Services, Inc., December 2002: Total Gaseous Non-Methane Organic Compounds Destruction Efficiency. Both the Puente Hills and GCSL turbines are manufactured by Solar®, and are the same series (Centaur). The Puente Hills turbines are model GS-4000, and GCSL turbines are model T-4500. The GCSL turbines are used to drive a larger generator set than the Puente Hills installation (3 3 Mw output per turbine vs. 2.8 Mw). | 1,384 | Final Report for Compliance Emission Testing and USEPA Method 20 Testing On Turbines 1,2 & 3 For Green Knight Energy Center", prepared by A & H Emission Testing, January 22, 2002. |
| Turbine #2 | 97.4% | | 1,460 | |
| Turbine #3 | 97.4% | | 1,336 | |

3. Inlet gas flowrates correspond to stack testing dates referenced in this table. The total gas flow rate for the combined events is 7649 dry ft3/min (dscfm), which corresponds to an actual flow rate of 8522 actual ft3/min (acfm). This total gas flow rate value is considered conservative for calculating compound emission rates, as the total projected gas generation rates for 2003 - 2007 range from 6787 acfm - 8080 acfm (see Table D-3).

Kjeldsen, P., Dalager, A. and Broholm, K. 1997. Attenuation of methane and nonmethane organic compounds in landfill gas affected soils. J. Air and Water Management Assoc. 47:1268-1275.

Prosser, R. W., P.E. 1998. Reviewing and Interpreting Landfill Gas Monitoring Data. GC Environmental, Inc. Copyright 1998.

Radian International, LLC and Eastern Research Group et al. 1996. Landfill Gas Emissions Model Version 2.01 (LandGEM). Prepared for USEPA. March 1996.

Scheutz, C., Bogner, J., Morcet, M. and Kjeldsen, P. 2003. Aerobic degradation of non-methane organic compounds in landfill cover soils. Proceedings Sardinia 03 Ninth International Waste Management and Landfill Symposium. S. Margherita di Pula (Cagliari), Sardinia. October 2003.

Townsend, T.G., Chadik, P., Bitton, G., Booth, M., Lee, S. and Yang, K. 2000. Gypsum Drywall Impact on Odor Production at Landfills: Science and Odor Control Strategies. State University of Florida. Florida Center for Solid and Hazardous Waste Management. January 2002.

United States Environmental Protection Agency (USEPA). 1998. 40 CFR 60 Subpart WWW – Standards of Performance for Municipal Solid Waste Landfills. §60.753 Operational Standards for Collection and Control Systems. June 1998.

# Appendix E

# Air Dispersion Modeling Analysis

Trinity Consultants

Offices nationwide ▪ trinityconsultants.com

4 Century Drive, Suite 220, Parsippany, NJ 07054 U.S.A. ▪ (973) 285-9977 ▪ Fax (973) 285-9966

**VIA E-MAIL**

August 29, 2003

Ms. Sarah Foster
CPF Associates
5404 Burling Road
Bethesda, MD 20814

*RE: ISCST3 Dispersion Modeling Results*
*Grand Central Pennsylvania Landfill Project*

Dear Sarah:

At the request of CPF Associates (CPF), Trinity Consultants (Trinity) has performed an air dispersion modeling study for the Grand Central Landfill located in Plainfield Township near Penn Argyl, Pennsylvania. The modeling analysis included point sources and areas sources at the landfill. The modeling calculated ambient air concentrations for 1-hour averaging periods in addition to annual averages.

The objective of the analysis was to determine off-property ambient air concentrations from three area sources at the landfill - Area A (closed, capped), Area B (active, capped), and Area C (active, uncapped). Also, five point sources were modeled: three gas-to-energy turbines and two landfill gas flares. This letter provides a summary of the modeling methodology.

## MODELING INPUT PARAMETERS

The U.S. EPA Industrial Source Complex Short-Term (ISCST3) dispersion model (Version 02035)[1] was used to predict annual average and one-hour average air concentrations at receptors near the landfill. ISCST3 is a steady-state, Gaussian plume model that assesses pollutant concentrations from a wide variety of sources including area sources. Based on maps of the landfill areas provided by EarthRes Group, Inc. (ERG), the boundary of each landfill area was digitized and imported into ISCST3. The shape of each area source was represented in ISCST3 as a polygon area. Due to the model's limitation of 20 points per polygon area, two of the landfill areas needed to be divided into two or four sub-areas to accurately represent the overall shape of the areas.

The model was run using five years (1991-1995) of preprocessed meteorological data. The surface data was taken from the Allentown, Pennsylvania NCDC[2] Station No. 14737. The upper air data was obtained from NCDC Station No. 93734 Sterling, Virginia.[3] Trinity ran the

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[1] http://www.epa.gov/scram001/

[2] National Climatic Data Center

model for each year of meteorological data in order to determine the off-property 1-hour and annual average concentrations. Windrose diagrams for the years of meteorological data used in this modeling analysis are provided in Attachment 1 of this report.

The ISCST3 modeling was performed using regulatory default options for 1-hour and annual averaging periods. Based on an analysis of the site's United States Geological Survey (USGS) Wind Gap Quadrangle Map, the area surrounding the landfill was classified as rural. Therefore, rural dispersion coefficients were used in the modeling. A unit emission rate of 0.001 g/s/m$^2$ was modeled for Landfill Areas A, B, and C, due to a significant figure limitation with the model's output file (that was uncovered during this study). Because the landfill areas were "hill shaped", an average base elevation of each area needed to be determined. The base elevation of each landfill area was determined by averaging the lowest elevation of the landfill area with the highest elevation of the landfill area. In order to determine that the average elevation was conservative, the average landfill elevation was compared to percent of the landfill area above the average elevation. The percent of the landfill area above the average elevation was greater than or equal to 60% for all three landfills. Thus, the following base elevations (above sea level) were used for each landfill area:

- Landfill Area A: 800 ft
- Landfill Area B: 775 ft
- Landfill Area C: 810 ft

Stack parameters were provided by ERG for the five point sources included in the modeling analysis. The point sources were also modeled for 1-hour and annual averaging periods. Each point source was modeled using a unit emission rate of 1 g/s. Table 1 provides the modeled stack parameters for each point source.

**TABLE 1. POINT SOURCE STACK PARAMETERS**

| Emission Point | Point Description | UTM Easting (m) | UTM Northing (m) | Base Elevation (m) | Stack Height (m) | Stack Diameter (m) | Exit Velocity (m/s) | Exit Temperature (K) |
|---|---|---|---|---|---|---|---|---|
| SRC1 | Turbine 1 | 477,800 | 4,522,910 | 215.8 | 10.97 | 1.22 | 34.80 | 669.82 |
| SRC2 | Turbine 2 | 477,808 | 4,522,917 | 215.8 | 10.97 | 1.22 | 34.77 | 696.48 |
| SRC3 | Turbine 3 | 477,816 | 4,522,923 | 215.8 | 10.97 | 1.22 | 33.61 | 724.82 |
| SRC4 | Flare 1 | 477,646 | 4,522,007 | 239.57 | 12.19 | 3.35 | 3.69 | 1177.6 |
| SRC5 | Flare 2 | 477,800 | 4,522,766 | 237.13 | 15.24 | 3.53 | 8.57 | 1200.4 |

* Provided to Trinity by EarthRes Group in an email dated 5/20/03

[3] Some hours in the meteorological data had anomalously low mixing heights. This anomaly is associated with the standard EPA meteorological data preprocessing programs which can occasionally produce unrealistically low mixing heights due to built-in equations used to interpolate the twice-daily mixing height measurements with other hourly meteorological data. In order to correct for this anomaly, Trinity adjusted all hourly mixing heights that were less than 2 m high to 2 m. This methodology was based on personal communication with the following meteorologists: Mr. Dennis Atkinson (EPA), Mr. Dennis Lohman (EPA, Region 3), and Mr. Jon Hill (Trinity).

### MODEL RECEPTORS

A set of receptors spaced 100 m apart was created to represent the boundary of the landfill property. A Cartesian grid with 100 m spacing was created extending 1 km out from the property boundary, while a coarser grid with 500 m spacing was placed 4 km from the property boundary. Attachment 2 contains two plots of the receptor grids showing the landfill areas. Receptor elevations were provided by USGS Digital Elevation Model (DEM) data and verified against elevation contour maps provided by ERG. The model results were post-processed for selected receptor areas as discussed in the following section.

## ISCST3 MODELING RESULTS

The ISCST3 model was run separately for each landfill area and point source. The modeling results were examined in conjunction with land use information, and maps provided by ERG, to identify nearby areas currently used for residential purposes to be evaluated in detail. Areas near to the landfill currently used for residential purposes were identified based on a review of maps of the facility area and a driving survey. The ISCST modeling results within these areas were then examined to identify three specific areas for evaluation. Each specific area was roughly 500 meters by 500 meters in size (approximately 1600 feet by 1600 feet) and included modeled receptor points extending outwards from the property boundary where there are no residential uses of the land. The areas selected for evaluation consisted of the following:

Area 1: An area to the east of the active landfill where modeled concentrations nearest to the active landfill were predicted to be highest,

Area 2: An area to the east of the closed landfill where modeled concentrations nearest to the closed landfill were predicted to be highest, and

Area 3: An area in Pen Argyl to the north of the landfill where modeled concentrations associated with the landfill were predicted to be highest.

These three areas include locations currently used for residential purposes as well as land not used for residential purposes, and include locations where concentrations were predicted by the ISCST model to be highest. These three areas for evaluation are shown in Attachment 2.

The unit emission rate impacts for these three areas will be post-processed by CPF based on calculated emission rates for the risk assessment compounds. The area concentrations (ie Areas 1, 2, and 3) were based on the average of the concentrations calculated at all Cartesian receptors located within each area per year. The maximum modeled results from five years of meteorological data will be post-processed. The chemical-specific concentrations will be calculated by prorating the modeled impact (based on the unit emission rate) by the calculated chemical-specific emission rate divided by the unit emission rate.

***

If you have any questions or comments about any information presented in this letter, please feel free to contact Mike Tsakaloyannis or myself at (973) 285-9977.

Sincerely,

TRINITY CONSULTANTS

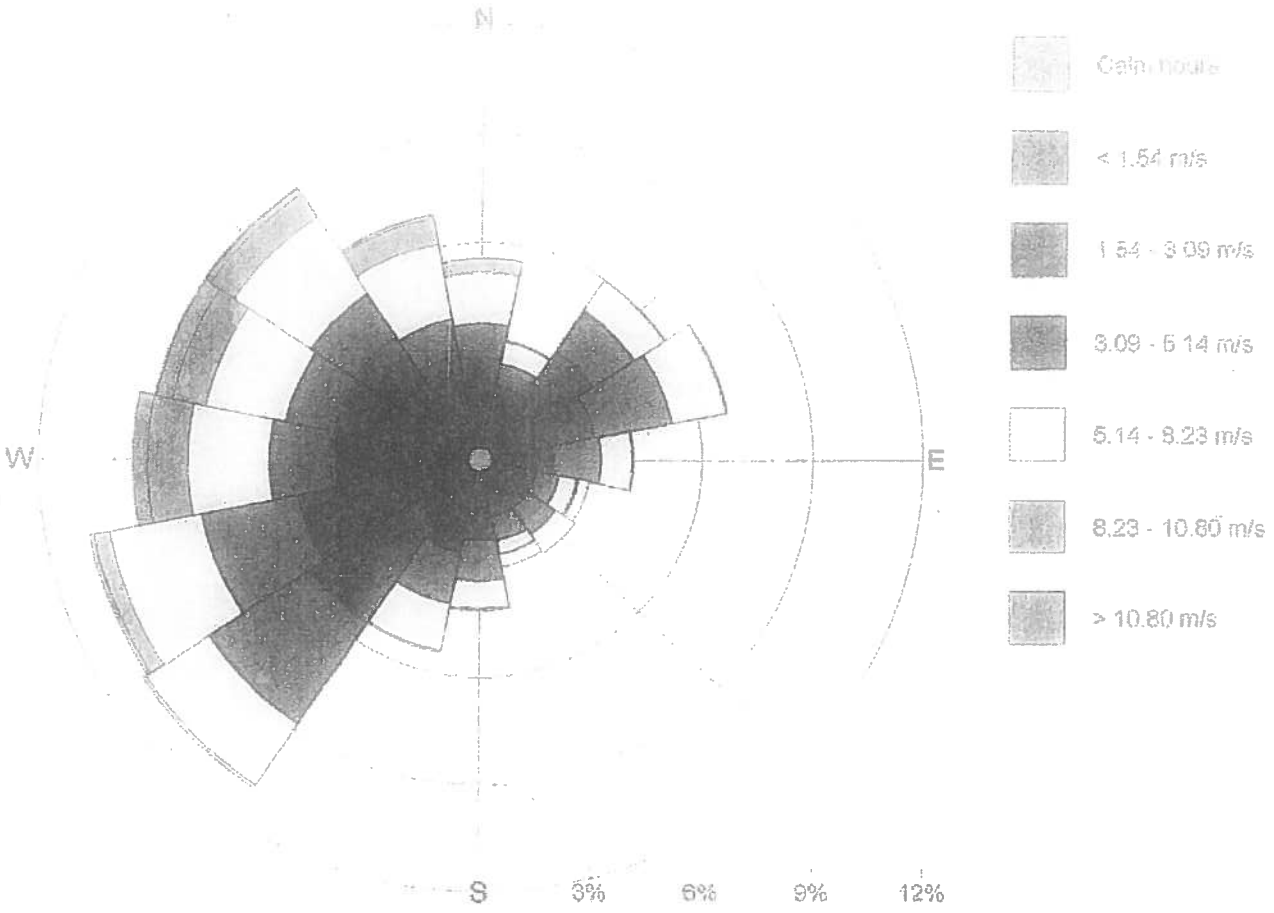
Christine H. Heath
Consultant

cc: Michael K. Tsakaloyannis (Trinity)

# ATTACHMENT 1

## Windrose Diagrams

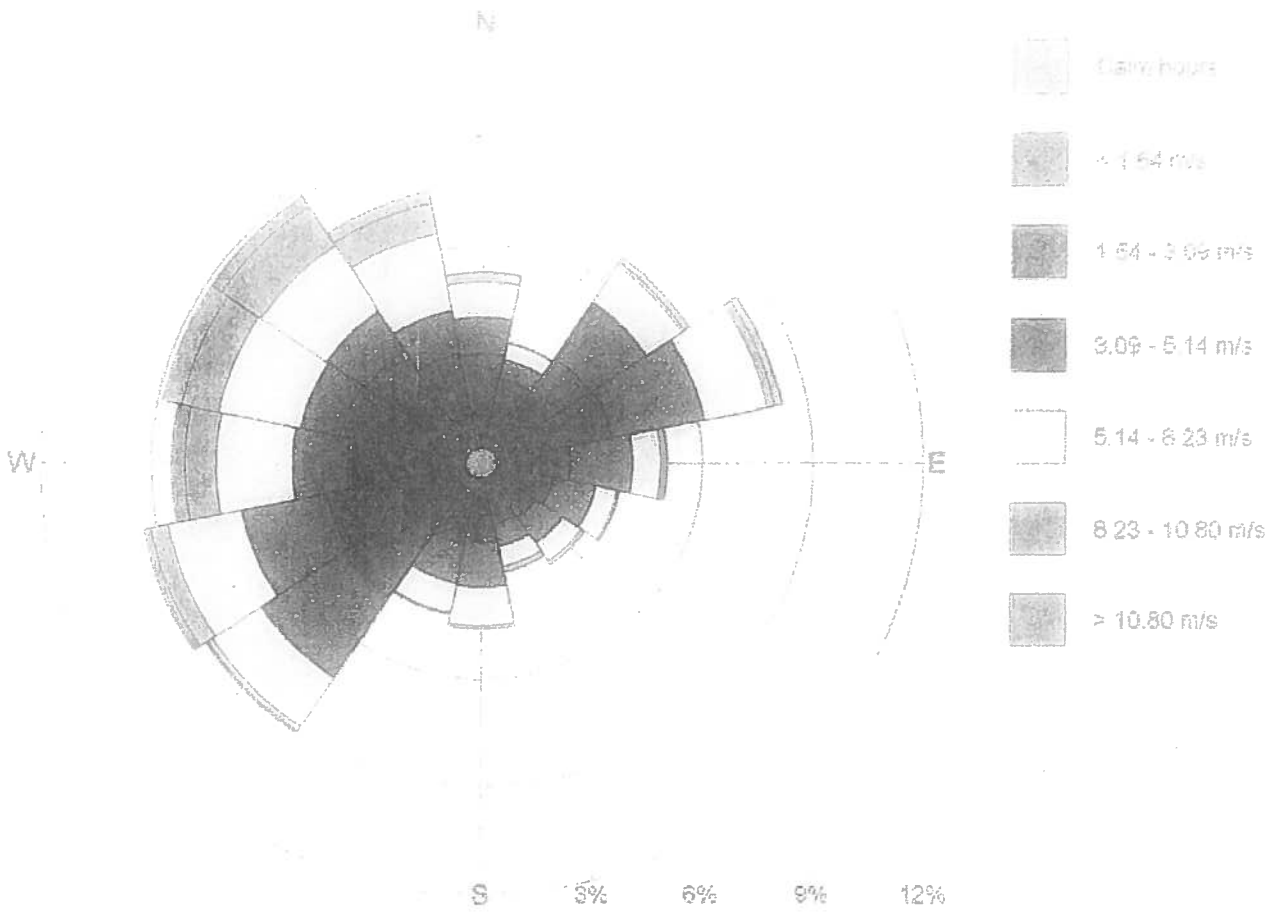
Windrose




**1991 Windrose**
**Allentown, Pennsylvania**
**Station No. 14737**

Trinity Consultants

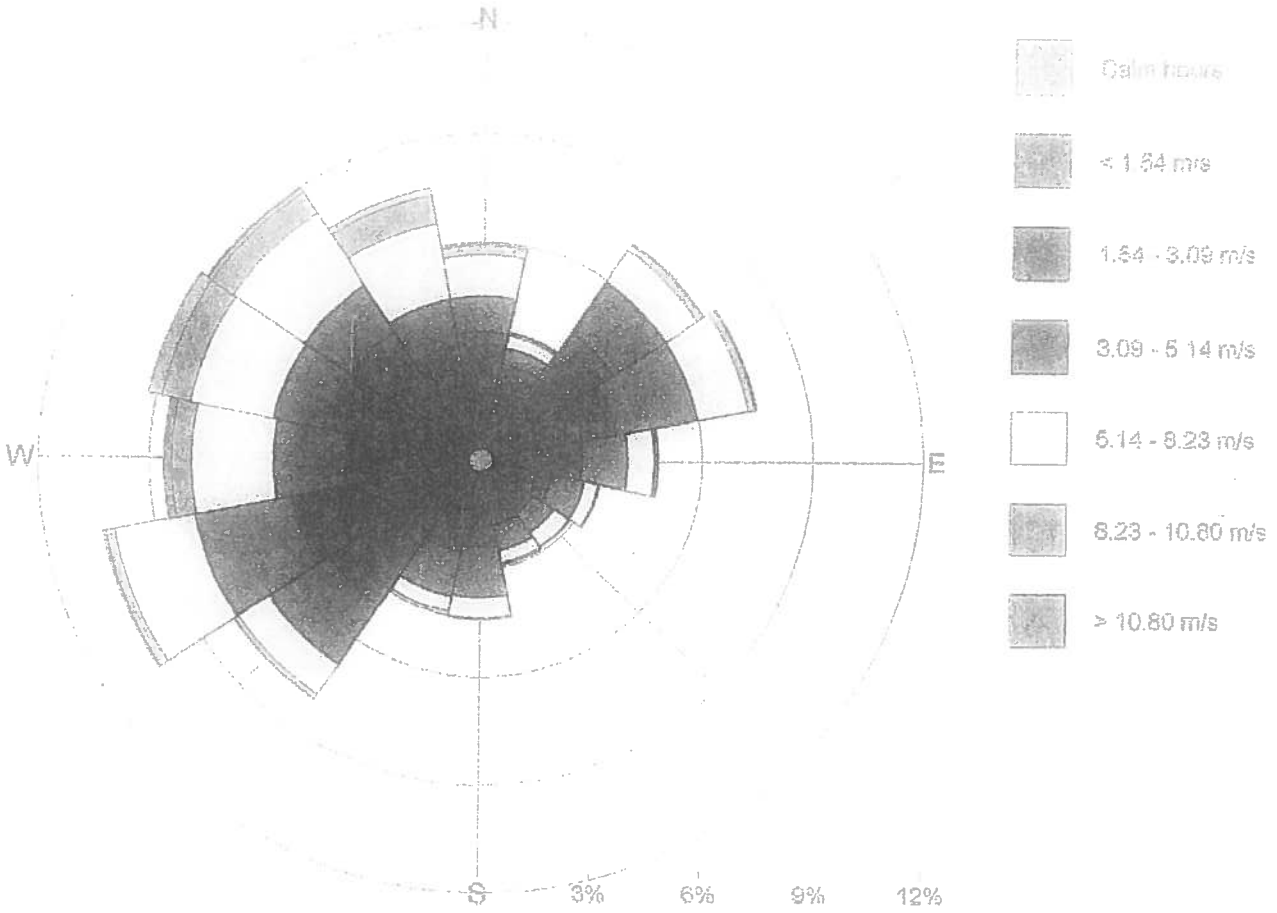
Windrose




**1992 Windrose**
**Allentown, Pennsylvania**
**Station No. 14737**

Trinity Consultants

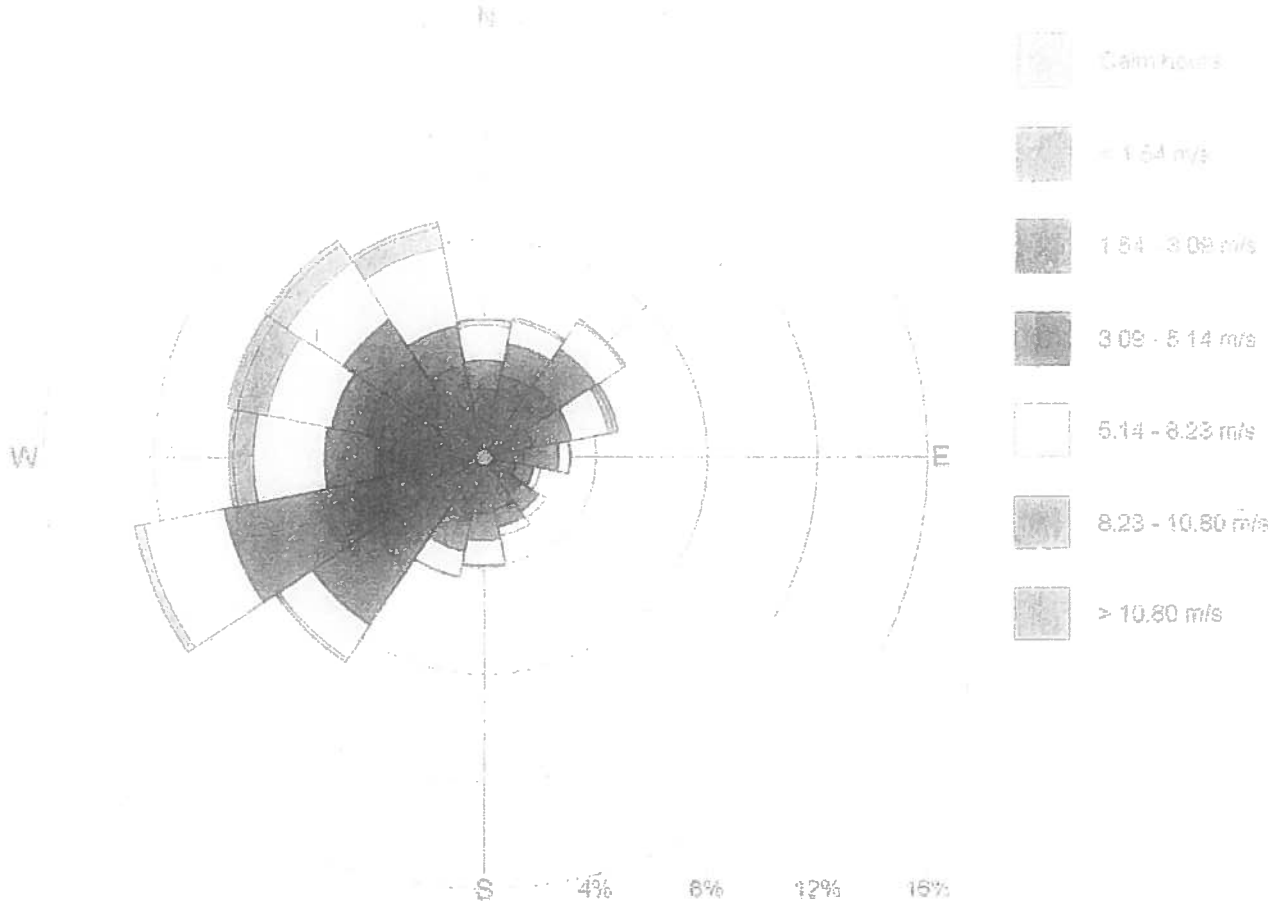
Windrose




**1993 Windrose**
**Allentown, Pennsylvania**
**Station No. 14737**

Trinity Consultants

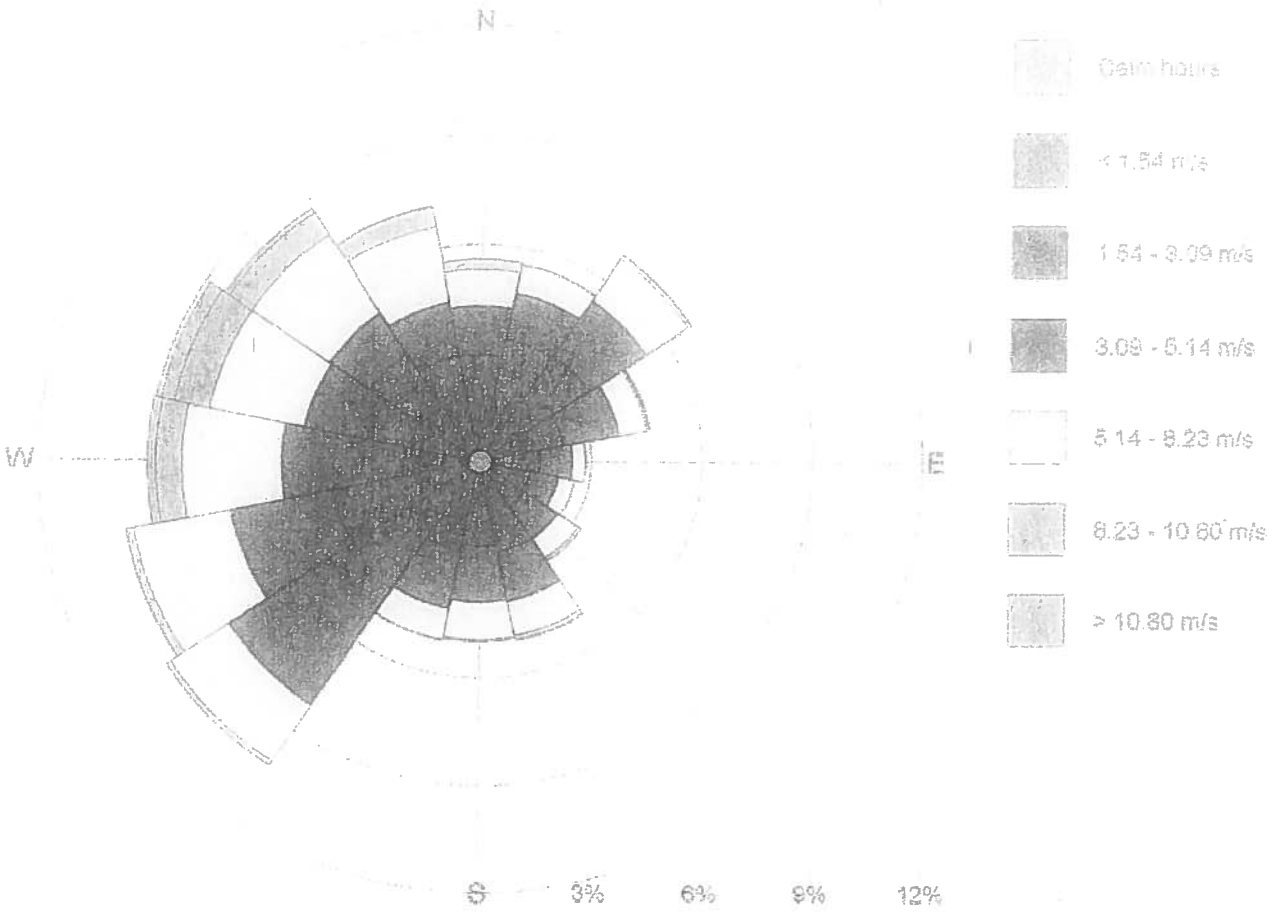
Windrose




**1994 Windrose**
**Allentown, Pennsylvania**
**Station No. 14737**

Trinity Consultants

Windrose



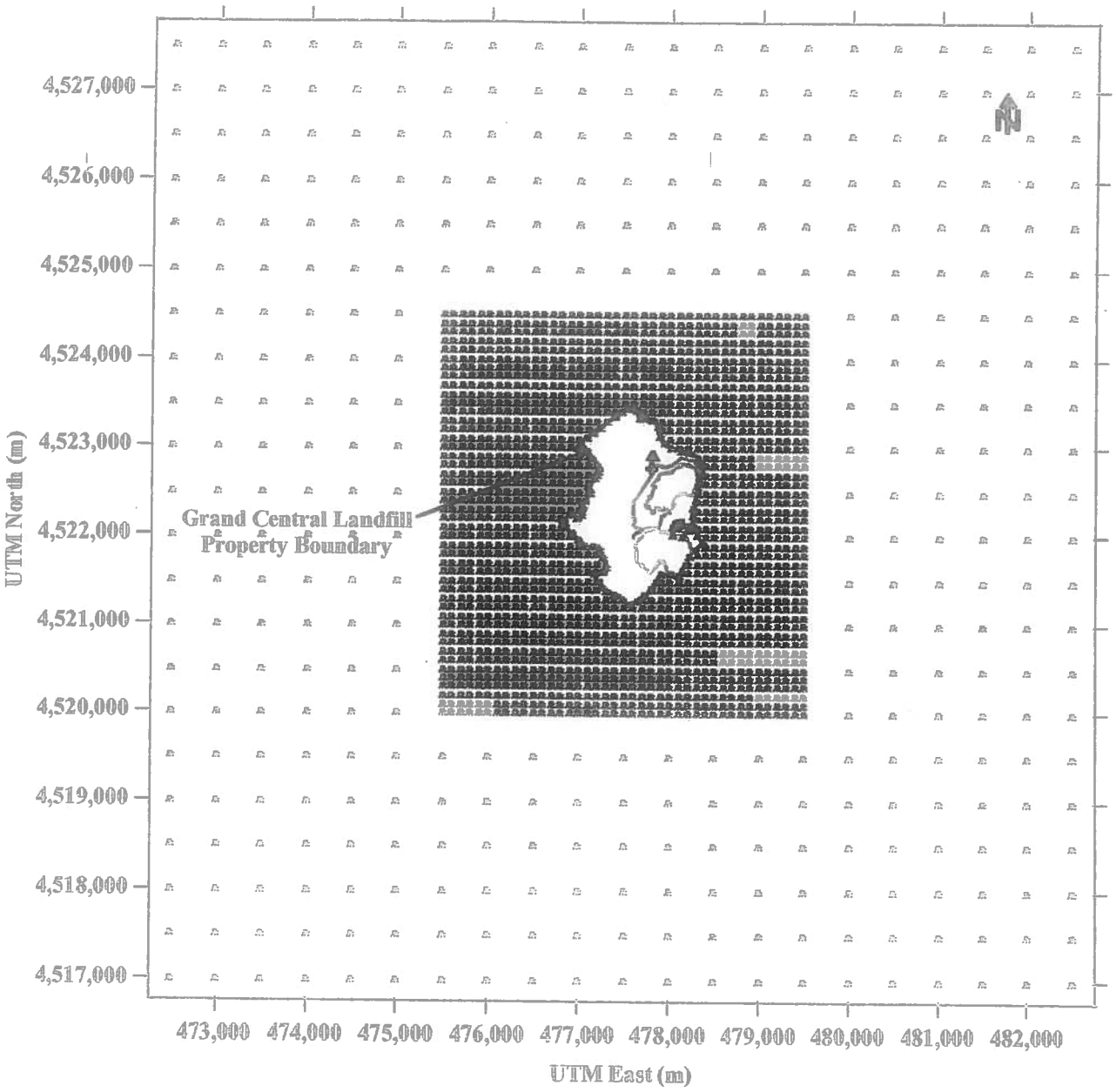

**1995 Windrose**
**Allentown, Pennsylvania**
**Station No. 14737**

Trinity Consultants

# ATTACHMENT 2

## Receptor Locations

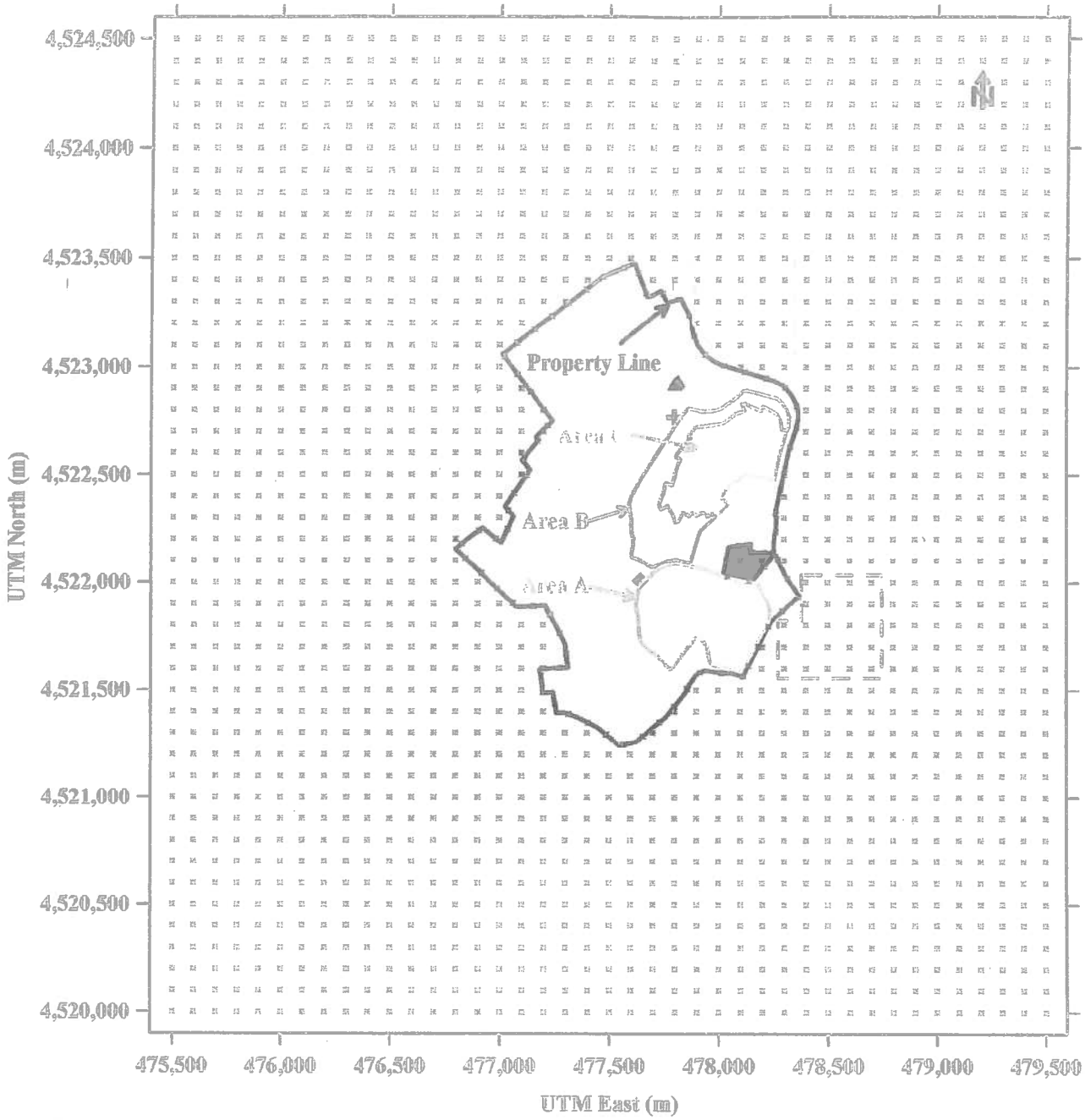
# Landfill Areas A, B, and C and Modeled Receptors
# Grand Central, PA




Trinity Consultants

REC4.SRF

# Grand Central Sanitary Landfill Air Dispersion Modeling
# Plainfield Township, PA




**Legend:**

- Denotes the location of the 3 Turbine Stacks
- Denotes the location of the Flare 2 Stack.
- Denotes the location of the Flare 1 Stack.
- Denotes Area 1.
- Denotes Area 2.
- Denotes Area 3.
- Denotes 100 m spaced receptor points modeled using ISCST3.

**Scale:**

0 500 1000 1500 2000
meters

0 1000 2000 3000 4000 5000
feet

Trinity Consultants

REC_FIN6.SRF

# Appendix F

# Detailed Chronic and Acute Risk Assessment Results

**TABLE 1**
**CALCULATION OF POTENTIAL FOR NONCANCER HEALTH EFFECTS FROM INHALATION -- CHILDREN AND ADULTS**
**Area 1 - area nearest active landfill (Areas B and C) where concentrations were highest**

| Compound | Modeled Air Concentration [b] (µg/m³) | Average Daily Intake [a] | | RfDi [c] (mg/kg/day) | Hazard Quotient [d] | |
|---|---|---|---|---|---|---|
| | | child (mg/kg/day) | adult (mg/kg/day) | | child (unitless) | adult (unitless) |
| *Volatile organic compounds* | | | | | | |
| 1,1,1-Trichloroethane | 1.60E-02 | 7.4E-06 | 3.3E-06 | 6.3E-01 | 1E-05 | 5E-06 |
| 1,1-Dichloroethane | 1.81E-02 | 8.3E-06 | 3.8E-06 | 1.0E-01 | 8E-05 | 4E-05 |
| 1,2,4-Trimethylbenzene | 6.63E-02 | 3.1E-05 | 1.4E-05 | 1.7E-03 | 2E-02 | 8E-03 |
| 1,3,5-Trimethylbenzene | 2.50E-02 | 1.1E-05 | 5.2E-06 | 1.7E-03 | 7E-03 | 3E-03 |
| 1,4-Dichlorobenzene | 1.46E-02 | 6.7E-06 | 3.0E-06 | 2.3E-01 | 3E-05 | 1E-05 |
| 2-Butanone | 4.55E-01 | 2.1E-04 | 9.4E-05 | 2.9E-01 | 7E-04 | 3E-04 |
| 2-Propanol | 2.17E-01 | 1.0E-04 | 4.5E-05 | 2.0E+00 | 5E-05 | 2E-05 |
| 4-Ethyltoluene | 6.10E-02 | 2.8E-05 | 1.3E-05 | 2.9E-02 | 1E-03 | 4E-04 |
| 4-Methyl-2-pentanone | 4.98E-02 | 2.3E-05 | 1.0E-05 | 8.6E-01 | 3E-05 | 1E-05 |
| Acetone | 2.75E-01 | 1.3E-04 | 5.7E-05 | 8.8E+00 | 1E-05 | 6E-06 |
| Benzene | 1.02E-02 | 4.7E-06 | 2.1E-06 | 8.6E-03 | 5E-04 | 2E-04 |
| Carbon Disulfide | 8.44E-03 | 3.9E-06 | 1.7E-06 | 2.0E-01 | 2E-05 | 9E-06 |
| Chlorobenzene | 2.25E-03 | 1.0E-06 | 4.7E-07 | 5.7E-03 | 2E-04 | 8E-05 |
| Chloroethane | 5.77E-03 | 2.7E-06 | 1.2E-06 | 2.9E+00 | 9E-07 | 4E-07 |
| cis-1,2-Dichloroethene | 5.29E-03 | 2.4E-06 | 1.1E-06 | 1.0E-02 | 2E-04 | 1E-04 |
| Cyclohexane | 4.69E-02 | 2.2E-05 | 9.7E-06 | 7.1E+00 | 3E-06 | 1E-06 |
| Ethanol | 1.34E+00 | 6.1E-04 | 2.8E-04 | 1.3E+00 | 5E-04 | 2E-04 |
| Ethylbenzene | 1.65E-01 | 7.6E-05 | 3.4E-05 | 2.9E-01 | 3E-04 | 1E-04 |
| Freon-11 | 4.23E-02 | 1.9E-05 | 8.8E-06 | 2.0E-01 | 1E-04 | 4E-05 |
| Freon-114 | 5.33E-03 | 2.5E-06 | 1.1E-06 | 4.9E+00 | 5E-07 | 2E-07 |
| Freon-12 | 6.47E-02 | 3.0E-05 | 1.3E-05 | 5.7E-02 | 5E-04 | 2E-04 |
| Heptane | 8.71E-02 | 4.0E-05 | 1.8E-05 | 1.1E+00 | 4E-05 | 2E-05 |
| Hexane | 1.03E-01 | 4.7E-05 | 2.1E-05 | 5.7E-02 | 8E-04 | 4E-04 |
| m,p-Xylenes | 2.23E-01 | 1.0E-04 | 4.6E-05 | 2.9E-02 | 4E-03 | 2E-03 |
| Methyl tert butyl ether | 1.61E-02 | 7.4E-06 | 3.3E-06 | 8.6E-01 | 9E-06 | 4E-06 |
| Methylene chloride | 9.28E-02 | 4.3E-05 | 1.9E-05 | 8.6E-01 | 5E-05 | 2E-05 |
| o-Xylene | 7.16E-02 | 3.3E-05 | 1.5E-05 | 2.9E-02 | 1E-03 | 5E-04 |
| Styrene | 4.19E-02 | 1.9E-05 | 8.7E-06 | 2.9E-01 | 7E-05 | 3E-05 |
| Tetrachloroethene | 6.51E-02 | 3.0E-05 | 1.3E-05 | 1.4E-01 | 2E-04 | 1E-04 |
| Tetrahydrofuran | 4.12E-02 | 1.9E-05 | 8.5E-06 | 8.6E-02 | 2E-04 | 1E-04 |
| Toluene | 3.92E-01 | 1.8E-04 | 8.1E-05 | 1.1E-01 | 2E-03 | 7E-04 |
| Trichloroethene | 2.42E-02 | 1.1E-05 | 5.0E-06 | 1.0E-02 | 1E-03 | 5E-04 |
| Vinyl Chloride | 1.75E-02 | 8.1E-06 | 3.6E-06 | 2.9E-02 | 3E-04 | 1E-04 |
| *Sulfur Compounds* | | | | | | |
| 2-Ethylthiophene | 1.94E-02 | 8.9E-06 | 4.0E-06 | 2.5E-01 | 4E-05 | 2E-05 |
| 2,5-Dimethylthiophene | 1.87E-02 | 8.6E-06 | 3.9E-06 | 2.5E-01 | 3E-05 | 2E-05 |
| Diethyl disulfide | 2.43E-02 | 1.1E-05 | 5.0E-06 | 2.9E-04 | 4E-02 | 2E-02 |
| Hydrogen sulfide | 1.33E-02 | 6.1E-06 | 2.8E-06 | 2.9E-04 | 2E-02 | 1E-02 |
| Isopropyl mercaptan | 1.80E-02 | 8.3E-06 | 3.7E-06 | 6.6E-04 | 1E-02 | 6E-03 |
| Methyl mercaptan | 1.76E-02 | 8.1E-06 | 3.6E-06 | 6.6E-04 | 1E-02 | 6E-03 |
| | | | | Total Hazard Index [e] | 1E-01 | 6E-02 |

-- = Not available/Not calculated

(a) Chemical-specific Average Daily Intakes (ADIs) are calculated for both child and adult residents. ADIs for noncarcinogens are calculated as follows: ADI (mg/kg/day) = Modeled Air Concentration (µg/m³) * Inhalation Rate (m³/hr) * Exposure Time (hrs/day) * Exposure Duration (yrs) * 0.001 (mg/µg) / ( Body Weight (kg) * Averaging Time (days) ). The values for inhalation rates (0.30 m³/hr [child]; 0.63 m³/hr [adult]), exposure time (24 hrs/day [child and adult]), exposure frequency (350 days/year [child and adult], exposure durations (6 years [child]; 30 years [adult], and body weights (15 kg [child] and 70 kg [adult]) were obtained from Table C-2-2 of USEPA 1998. The averaging times for noncarcinogens are numerically the same as the exposure durations in years for child and adult residents, converted to days.

(b) Ambient air concentrations are based on site-specific modeling performed by Trinity Consultants. Concentrations reflect the combined influence of acitve and inactive landfill areas, flares and the power plant.

(c) Reference dose inhalation (RfDi) toxicity values presented in chronic inhalation toxicity criteria table.

(d) Chemical-specific noncarcinogenic hazard quotients are calculated as follows: hazard quotient = ADI (mg/kg/day) / RfDi (mg/kg/day).

(e) Screening-level total hazard index values were conservatively based on the sum of all hazard quotients, regardless of differences in types of health effects endpoints. If a total hazard index is >1, then hazard quotients should be recalculated for groups of compounds having similar health effects endpoints.

**TABLE 2**
**CALCULATION OF POTENTIAL FOR NONCANCER HEALTH EFFECTS FROM INHALATION -- CHILDREN AND ADULTS**
**Area 2 - area nearest closed landfill (Area A) where concentrations were highest**

| Compound | Modeled Air Concentration [b] (µg/m³) | Average Daily Intake [a] | | RfDi [c] (mg/kg/day) | Hazard Quotient [d] | |
|---|---|---|---|---|---|---|
| | | child (mg/kg/day) | adult (mg/kg/day) | | child (unitless) | adult (unitless) |
| *Volatile organic compounds* | | | | | | |
| 1,1,1-Trichloroethane | 5.18E-03 | 2.4E-06 | 1 1E-06 | 6.3E-01 | 4E-06 | 2E-06 |
| 1,1-Dichloroethane | 5.87E-03 | 2.7E-06 | 1.2E-06 | 1.0E-01 | 3E-05 | 1E-05 |
| 1,2,4-Trimethylbenzene | 2.14E-02 | 9.9E-06 | 4 4E-06 | 1.7E-03 | 6E-03 | 3E-03 |
| 1,3,5-Trimethylbenzene | 8.08E-03 | 3.7E-06 | 1.7E-06 | 1.7E-03 | 2E-03 | 1E-03 |
| 1,4-Dichlorobenzene | 4.74E-03 | 2.2E-06 | 9.8E-07 | 2.3E-01 | 1E-05 | 4E-06 |
| 2-Butanone | 1.47E-01 | 6.8E-05 | 3.0E-05 | 2.9E-01 | 2E-04 | 1E-04 |
| 2-Propanol | 7.01E-02 | 3.2E-05 | 1.5E-05 | 2.0E+00 | 2E-05 | 7E-06 |
| 4-Ethyltoluene | 1.97E-02 | 9.1E-06 | 4.1E-06 | 2.9E-02 | 3E-04 | 1E-04 |
| 4-Methyl-2-pentanone | 1.61E-02 | 7.4E-06 | 3.3E-06 | 8.6E-01 | 9E-06 | 4E-06 |
| Acetone | 8.88E-02 | 4.1E-05 | 1.8E-05 | 8.8E+00 | 5E-06 | 2E-06 |
| Benzene | 3.30E-03 | 1.5E-06 | 6.8E-07 | 8.6E-03 | 2E-04 | 8E-05 |
| Carbon Disulfide | 2.73E-03 | 1.3E-06 | 5.7E-07 | 2.0E-01 | 6E-06 | 3E-06 |
| Chlorobenzene | 7.27E-04 | 3.3E-07 | 1.5E-07 | 5.7E-03 | 6E-05 | 3E-05 |
| Chloroethane | 1.87E-03 | 8.6E-07 | 3.9E-07 | 2.9E+00 | 3E-07 | 1E-07 |
| cis-1,2-Dichloroethane | 1.71E-03 | 7.9E-07 | 3.5E-07 | 1.0E-02 | 8E-05 | 4E-05 |
| Cyclohexane | 1.52E-02 | 7.0E-06 | 3.1E-06 | 7.1E+00 | 1E-06 | 4E-07 |
| Ethanol | 4.32E-01 | 2.0E-04 | 8.9E-05 | 1.3E+00 | 2E-04 | 7E-05 |
| Ethylbenzene | 5.32E-02 | 2.5E-05 | 1.1E-05 | 2.9E-01 | 8E-05 | 4E-05 |
| Freon-11 | 1.37E-02 | 6.3E-06 | 2.8E-06 | 2.0E-01 | 3E-05 | 1E-05 |
| Freon-114 | 1.72E-03 | 7.9E-07 | 3.6E-07 | 4.9E+00 | 2E-07 | 7E-08 |
| Freon-12 | 2.09E-02 | 9.6E-06 | 4.3E-06 | 5.7E-02 | 2E-04 | 8E-05 |
| Heptane | 2.82E-02 | 1.3E-05 | 5.8E-06 | 1.1E+00 | 1E-05 | 5E-06 |
| Hexane | 3.32E-02 | 1.5E-05 | 6.9E-06 | 5.7E-02 | 3E-04 | 1E-04 |
| m,p-Xylenes | 7.23E-02 | 3.3E-05 | 1.5E-05 | 2.9E-02 | 1E-03 | 5E-04 |
| Methyl tert butyl ether | 5.21E-03 | 2.4E-06 | 1.1E-06 | 8.6E-01 | 3E-06 | 1E-06 |
| Methylene chloride | 3.00E-02 | 1.4E-05 | 6.2E-06 | 8.6E-01 | 2E-05 | 7E-06 |
| o-Xylene | 2.32E-02 | 1.1E-05 | 4.8E-06 | 2.9E-02 | 4E-04 | 2E-04 |
| Styrene | 1.36E-02 | 6.2E-06 | 2.8E-06 | 2.9E-01 | 2E-05 | 1E-05 |
| Tetrachloroethene | 2.11E-02 | 9.7E-06 | 4.4E-06 | 1.4E-01 | 7E-05 | 3E-05 |
| Tetrahydrofuran | 1.33E-02 | 6.1E-06 | 2.8E-06 | 8.6E-02 | 7E-05 | 3E-05 |
| Toluene | 1.27E-01 | 5.8E-05 | 2.6E-05 | 1.1E-01 | 5E-04 | 2E-04 |
| Trichloroethene | 7.84E-03 | 3.6E-06 | 1.6E-06 | 1.0E-02 | 4E-04 | 2E-04 |
| Vinyl Chloride | 5.67E-03 | 2.6E-06 | 1.2E-06 | 2.9E-02 | 9E-05 | 4E-05 |
| *Sulfur Compounds* | | | | | | |
| 2-Ethylthiophene | 6.24E-03 | 2.9E-06 | 1.3E-06 | 2.5E-01 | 1E-05 | 5E-06 |
| 2,5-Dimethylthiophene | 6.01E-03 | 2.8E-06 | 1.2E-06 | 2.5E-01 | 1E-05 | 5E-06 |
| Diethyl disulfide | 7.81E-03 | 3.6E-06 | 1.6E-06 | 2.9E-04 | 1E-02 | 6E-03 |
| Hydrogen sulfide | 4.28E-03 | 2.0E-06 | 8.9E-07 | 2.9E-04 | 7E-03 | 3E-03 |
| Isopropyl mercaptan | 5.77E-03 | 2.7E-06 | 1.2E-06 | 6.6E-04 | 4E-03 | 2E-03 |
| Methyl mercaptan | 5.63E-03 | 2.6E-06 | 1.2E-06 | 6.6E-04 | 4E-03 | 2E-03 |
| | | | | Total Hazard Index (e) | 4E-02 | 2E-02 |

-- = Not available/Not calculated.

(a) Chemical-specific Average Daily Intakes (ADIs) are calculated for both child and adult residents. ADIs for noncarcinogens are calculated as follows: ADI (mg/kg/day) = Modeled Air Concentration (µg/m³) * Inhalation Rate (m³/hr) * Exposure Time (hrs/day) * Exposure Duration (yrs) * 0.001 (mg/µg) / ( Body Weight (kg) * Averaging Time (days) ). The values for inhalation rates (0.30 m³/hr [child]; 0.63 m³/hr [adult]), exposure time (24 hrs/day [child and adult]), exposure frequency (350 days/year [child and adult], exposure durations (6 years [child]; 30 years [adult], and body weights (15 kg [child] and 70 kg [adult]) were obtained from Table C-2-2 of USEPA 1998. The averaging times for noncarcinogens are numerically the same as the exposure durations in years for child and adult residents, converted to days.

(b) Ambient air concentrations are based on site-specific modeling performed by Trinity Consultants. Concentrations reflect the combined influence of acitve and inactive landfill areas, flares and the power plant.

(c) Reference dose inhalation (RfDi) toxicity values presented in chronic inhalation toxicity criteria table.

(d) Chemical-specific noncarcinogenic hazard quotients are calculated as follows: hazard quotient = ADI (mg/kg/day) / RfDi (mg/kg/day).

(e) Screening-level total hazard index values were conservatively based on the sum of all hazard quotients, regardless of differences in types of health effects endpoints. If a total hazard index is >1, then hazard quotients should be recalculated for groups of compounds having similar health effects endpoints.

**TABLE 3**
**CALCULATION OF POTENTIAL FOR NONCANCER HEALTH EFFECTS FROM INHALATION -- CHILDREN AND ADULTS**
**Area 3 - area in Pen Argyl where concentrations were highest**

| Compound | Modeled Air Concentration [b] (µg/m³) | Average Daily Intake [a] | | RfDi [c] (mg/kg/day) | Hazard Quotient [d] | |
|---|---|---|---|---|---|---|
| | | child (mg/kg/day) | adult (mg/kg/day) | | child (unitless) | adult (unitless) |
| *Volatile organic compounds* | | | | | | |
| 1,1,1-Trichloroethane | 3.92E-03 | 1.8E-06 | 8.1E-07 | 6.3E-01 | 3E-06 | 1E-06 |
| 1,1-Dichloroethane | 4.45E-03 | 2.0E-06 | 9.2E-07 | 1.0E-01 | 2E-05 | 9E-06 |
| 1,2,4-Trimethylbenzene | 1.62E-02 | 7.5E-06 | 3.4E-06 | 1.7E-03 | 4E-03 | 2E-03 |
| 1,3,5-Trimethylbenzene | 6.12E-03 | 2.8E-06 | 1.3E-06 | 1.7E-03 | 2E-03 | 7E-04 |
| 1,4-Dichlorobenzene | 3.59E-03 | 1.7E-06 | 7.4E-07 | 2.3E-01 | 7E-06 | 3E-06 |
| 2-Butanone | 1.12E-01 | 5.1E-05 | 2.3E-05 | 2.9E-01 | 2E-04 | 8E-05 |
| 2-Propanol | 5.32E-02 | 2.4E-05 | 1.1E-05 | 2.0E+00 | 1E-05 | 6E-06 |
| 4-Ethyltoluene | 1.50E-02 | 6.9E-06 | 3.1E-06 | 2.9E-02 | 2E-04 | 1E-04 |
| 4-Methyl-2-pentanone | 1.22E-02 | 5.6E-06 | 2.5E-06 | 8.6E-01 | 7E-06 | 3E-06 |
| Acetone | 6.73E-02 | 3.1E-05 | 1.4E-05 | 8.8E+00 | 4E-06 | 2E-06 |
| Benzene | 2.50E-03 | 1.2E-06 | 5.2E-07 | 8.6E-03 | 1E-04 | 6E-05 |
| Carbon Disulfide | 2.07E-03 | 9.5E-07 | 4.3E-07 | 2.0E-01 | 5E-06 | 2E-06 |
| Chlorobenzene | 5.51E-04 | 2.5E-07 | 1.1E-07 | 5.7E-03 | 4E-05 | 2E-05 |
| Chloroethane | 1.41E-03 | 6.5E-07 | 2.9E-07 | 2.9E+00 | 2E-07 | 1E-07 |
| cis-1,2-Dichloroethane | 1.30E-03 | 6.0E-07 | 2.7E-07 | 1.0E-02 | 6E-05 | 3E-05 |
| Cyclohexane | 1.15E-02 | 5.3E-06 | 2.4E-06 | 7.1E+00 | 7E-07 | 3E-07 |
| Ethanol | 3.27E-01 | 1.5E-04 | 6.8E-05 | 1.3E+00 | 1E-04 | 5E-05 |
| Ethylbenzene | 4.04E-02 | 1.9E-05 | 8.4E-06 | 2.9E-01 | 6E-05 | 3E-05 |
| Freon-11 | 1.04E-02 | 4.8E-06 | 2.1E-06 | 2.0E-01 | 2E-05 | 1E-05 |
| Freon-114 | 1.31E-03 | 6.0E-07 | 2.7E-07 | 4.9E+00 | 1E-07 | 6E-08 |
| Freon-12 | 1.59E-02 | 7.3E-06 | 3.3E-06 | 5.7E-02 | 1E-04 | 6E-05 |
| Heptane | 2.14E-02 | 9.8E-06 | 4.4E-06 | 1.1E+00 | 9E-06 | 4E-06 |
| Hexane | 2.51E-02 | 1.2E-05 | 5.2E-06 | 5.7E-02 | 2E-04 | 9E-05 |
| m,p-Xylenes | 5.48E-02 | 2.5E-05 | 1.1E-05 | 2.9E-02 | 9E-04 | 4E-04 |
| Methyl tert butyl ether | 3.95E-03 | 1.8E-06 | 8.2E-07 | 8.6E-01 | 2E-06 | 1E-06 |
| Methylene chloride | 2.28E-02 | 1.0E-05 | 4.7E-06 | 8.6E-01 | 1E-05 | 6E-06 |
| o-Xylene | 1.76E-02 | 8.1E-06 | 3.6E-06 | 2.9E-02 | 3E-04 | 1E-04 |
| Styrene | 1.03E-02 | 4.7E-06 | 2.1E-06 | 2.9E-01 | 2E-05 | 7E-06 |
| Tetrachloroethene | 1.60E-02 | 7.3E-06 | 3.3E-06 | 1.4E-01 | 5E-05 | 2E-05 |
| Tetrahydrofuran | 1.01E-02 | 4.6E-06 | 2.1E-06 | 8.6E-02 | 5E-05 | 2E-05 |
| Toluene | 9.62E-02 | 4.4E-05 | 2.0E-05 | 1.1E-01 | 4E-04 | 2E-04 |
| Trichloroethene | 5.94E-03 | 2.7E-06 | 1.2E-06 | 1.0E-02 | 3E-04 | 1E-04 |
| Vinyl Chloride | 4.30E-03 | 2.0E-06 | 8.9E-07 | 2.9E-02 | 7E-05 | 3E-05 |
| *Sulfur Compounds* | | | | | | |
| 2-Ethylthiophene | 4.75E-03 | 2.2E-06 | 9.8E-07 | 2.5E-01 | 9E-06 | 4E-06 |
| 2,5-Dimethylthiophene | 4.57E-03 | 2.1E-06 | 9.5E-07 | 2.5E-01 | 8E-06 | 4E-06 |
| Diethyl disulfide | 5.95E-03 | 2.7E-06 | 1.2E-06 | 2.9E-04 | 1E-02 | 4E-03 |
| Hydrogen sulfide | 3.26E-03 | 1.5E-06 | 6.7E-07 | 2.9E-04 | 5E-03 | 2E-03 |
| Isopropyl mercaptan | 4.40E-03 | 2.0E-06 | 9.1E-07 | 6.6E-04 | 3E-03 | 1E-03 |
| Methyl mercaptan | 4.29E-03 | 2.0E-06 | 8.9E-07 | 6.6E-04 | 3E-03 | 1E-03 |
| | | | | **Total Hazard Index (e)** | 3E-02 | 1E-02 |

-- = Not available/Not calculated

(a) Chemical-specific Average Daily Intakes (ADIs) are calculated for both child and adult residents. ADIs for noncarcinogens are calculated as follows: ADI (mg/kg/day) = Modeled Air Concentration (µg/m³) * Inhalation Rate (m³/hr) * Exposure Time (hrs/day) * Exposure Duration (yrs) * 0.001 (mg/µg) / ( Body Weight (kg) * Averaging Time (days) ). The values for inhalation rates (0.30 m³/hr [child]; 0.63 m³/hr [adult]), exposure time (24 hrs/day [child and adult]), exposure frequency (350 days/year [child and adult], exposure durations (6 years [child]; 30 years [adult], and body weights (15 kg [child] and 70 kg [adult]) were obtained from Table C-2-2 of USEPA 1998. The averaging times for noncarcinogens are numerically the same as the exposure durations in years for child and adult residents, converted to days.

(b) Ambient air concentrations are based on site-specific modeling performed by Trinity Consultants. Concentrations reflect the combined influence of acitve and inactive landfill areas, flares and the power plant.

(c) Reference dose inhalation (RfDi) toxicity values presented in chronic inhalation toxicity criteria table.

(d) Chemical-specific noncarcinogenic hazard quotients are calculated as follows: hazard quotient = ADI (mg/kg/day) / RfDi (mg/kg/day).

(e) Screening-level total hazard index values were conservatively based on the sum of all hazard quotients, regardless of differences in types of health effects endpoints. If a total hazard index is >1, then hazard quotients should be recalculated for groups of compounds having similar health effects endpoints.

TABLE 4
CALCULATION OF POTENTIAL EXCESS LIFETIME CANCER RISKS FROM INHALATION - CHILDREN AND ADULTS
Area 1 - area nearest active landfill (Areas B and C) where concentrations were highest

| Compound | Modeled Air Concentration [b] ($\mu g/m^3$) | Average Daily Intake [a] | | CSFi [c] $(mg/kg/day)^{-1}$ | Carcinogenicity Weight of Evidence | Excess Lifetime Cancer Risk [d] | |
|---|---|---|---|---|---|---|---|
| | | child (mg/kg/day) | adult (mg/kg/day) | | | child (unitless) | adult (unitless) |
| *Volatile organic compounds* | | | | | | | |
| 1,1,1-Trichloroethane | 1.60E-02 | 6.3E-07 | 1.4E-06 | – | D | – | – |
| 1,1-Dichloroethane | 1.81E-02 | 7.2E-07 | 1.6E-06 | – | C | – | – |
| 1,2,4-Trimethylbenzene | 6.63E-02 | 2.6E-06 | 5.9E-06 | – | – | – | – |
| 1,3,5-Trimethylbenzene | 2.50E-02 | 9.9E-07 | 2.2E-06 | – | – | – | – |
| 1,4-Dichlorobenzene | 1.46E-02 | 5.8E-07 | 1.3E-06 | 2.2E-02 | – | 1E-08 | 3E-08 |
| 2-Butanone | 4.55E-01 | 1.8E-05 | 4.0E-05 | – | D | – | – |
| 2-Propanol | 2.17E-01 | 8.6E-06 | 1.9E-05 | – | – | – | – |
| 4-Ethyltoluene | 6.10E-02 | 2.4E-06 | 5.4E-06 | – | – | – | – |
| 4-Methyl-2-pentanone | 4.98E-02 | 2.0E-06 | 4.4E-06 | – | – | – | – |
| Acetone | 2.75E-01 | 1.1E-05 | 2.4E-05 | – | D | – | – |
| Benzene | 1.02E-02 | 4.0E-07 | 9.1E-07 | 2.7E-02 | A | 1E-08 | 2E-08 |
| Carbon Disulfide | 8.44E-03 | 3.3E-07 | 7.5E-07 | – | – | – | – |
| Chlorobenzene | 2.25E-03 | 8.9E-08 | 2.0E-07 | – | D | – | – |
| Chloroethane | 5.77E-03 | 2.3E-07 | 5.1E-07 | – | – | – | – |
| cis-1,2-Dichloroethane | 5.29E-03 | 2.1E-07 | 4.7E-07 | – | D | – | – |
| Cyclohexane | 4.69E-02 | 1.8E-06 | 4.2E-06 | – | – | – | – |
| Ethanol | 1.34E+00 | 5.3E-05 | 1.2E-04 | – | – | – | – |
| Ethylbenzene | 1.65E-01 | 6.5E-06 | 1.5E-05 | – | D | – | – |
| Freon-11 | 4.23E-02 | 1.7E-06 | 3.8E-06 | – | – | – | – |
| Freon-114 | 5.33E-03 | 2.1E-07 | 4.7E-07 | – | – | – | – |
| Freon-12 | 6.47E-02 | 2.6E-06 | 5.7E-06 | – | – | – | – |
| Heptane | 8.71E-02 | 3.4E-06 | 7.7E-06 | – | D | – | – |
| Hexane | 1.03E-01 | 4.0E-06 | 9.1E-06 | – | – | – | – |
| m,p-Xylenes | 2.23E-01 | 8.8E-06 | 2.0E-05 | – | – | – | – |
| Methyl tert butyl ether | 1.61E-02 | 6.4E-07 | 1.4E-06 | – | – | – | – |
| Methylene chloride | 9.28E-02 | 3.7E-06 | 8.2E-06 | 1.6E-03 | B2 | 6E-09 | 1E-08 |
| o-Xylene | 7.16E-02 | 2.8E-06 | 6.4E-06 | – | – | – | – |
| Styrene | 4.19E-02 | 1.7E-06 | 3.7E-06 | – | – | – | – |
| Tetrachloroethene | 6.51E-02 | 2.6E-06 | 5.8E-06 | 2.0E-02 | D | 5E-08 | 1E-07 |
| Tetrahydrofuran | 4.12E-02 | 1.6E-06 | 3.7E-06 | 6.8E-03 | – | 1E-08 | 2E-08 |
| Toluene | 3.92E-01 | 1.5E-05 | 3.5E-05 | – | D | – | – |
| Trichloroethene | 2.42E-02 | 9.6E-07 | 2.2E-06 | 4.0E-01 | – | 4E-07 | 9E-07 |
| Vinyl Chloride | 1.75E-02 | 6.9E-07 | 1.6E-06 | 3.0E-02 | A | 2E-08 | 5E-08 |
| *Sulfur Compounds* | | | | | | | |
| 2-Ethylthiophene | 1.94E-02 | 7.7E-07 | 1.7E-06 | – | – | – | |
| 2,5-Dimethylthiophene | 1.87E-02 | 7.4E-07 | 1.7E-06 | – | – | – | |
| Diethyl disulfide | 2.43E-02 | 9.6E-07 | 2.2E-06 | – | – | – | |
| Hydrogen sulfide | 1.33E-02 | 5.3E-07 | 1.2E-06 | – | – | – | |
| Isopropyl mercaptan | 1.80E-02 | 7.1E-07 | 1.6E-06 | – | – | – | |
| Methyl mercaptan | 1.76E-02 | 6.9E-07 | 1.6E-06 | – | – | – | |
| | | | | | Total Cancer Risk | 5E-07 | 1E-06 |

Notes:

– = Not available/Not calculated.

(a) Chemical-specific lifetime Average Daily Intakes (ADIs) are calculated for both child and adult residents. ADIs for carcinogens are calculated as follows: ADI (mg/kg/day) = Modeled Air Concentration ($\mu g/m^3$) * Inhalation Rate ($m^3/hr$) * Exposure Time (hrs/day) * Exposure Duration (yrs) * 0.001 (mg/$\mu g$) / ( Body Weight (kg) * Averaging Time (days) ). The values for inhalation rates (0.30 $m^3/hr$ [child]; 0.63 $m^3/hr$ [adult]), exposure time (24 hrs/day [child and adult]), exposure frequency (350 days/year [child and adult], exposure duration (6 years [child]; 30 years [adult], and body weight (15 kg [child] and 70 kg [adult]) were obtained from Table C-2-1 of USEPA 1998. The averaging time for carcinogens represents an averaged exposure over a 70 year duration, converted to days.

(b) Ambient air concentrations are based on site-specific modeling performed by Trinity Consultants. Concentrations reflect the combined influence of active and inactive landfill areas, flares and the power plant.

(c) Cancer slope factor inhalation (CSFi) values and carcinogenicity weight of evidence classification presented in chronic inhalation toxicity criteria table.

(d) Chemical-specific excess lifetime cancer risks are calculated as follows: excess lifetime cancer risk = lifetime ADI $(mg/kg/day)^{-1}$ * CSFi $(mg/kg/day)^{-1}$

TABLE 5
CALCULATION OF POTENTIAL EXCESS LIFETIME CANCER RISKS FROM INHALATION - CHILDREN AND ADULTS
Area 2 - area nearest closed landfill (Area A) where concentrations were highest

| Compound | Modeled Air Concentration [b] ($\mu g/m^3$) | Average Daily Intake [a] | | CSFi [c] $(mg/kg/day)^{-1}$ | Carcinogenicty Weight of Evidence | Excess Lifetime Cancer Risk [d] | |
|---|---|---|---|---|---|---|---|
| | | child (mg/kg/day) | adult (mg/kg/day) | | | child (unitless) | adult (unitless) |
| *Volatile organic compounds* | | | | | | | |
| 1,1,1-Trichloroethane | 5.18E-03 | 2.0E-07 | 4.6E-07 | – | D | – | – |
| 1,1-Dichloroethane | 5.87E-03 | 2.3E-07 | 5.2E-07 | – | C | – | – |
| 1,2,4-Trimethylbenzene | 2.14E-02 | 8.5E-07 | 1.9E-06 | – | – | – | – |
| 1,3,5-Trimethylbenzene | 8.08E-03 | 3.2E-07 | 7.2E-07 | – | – | – | – |
| 1,4-Dichlorobenzene | 4.74E-03 | 1.9E-07 | 4.2E-07 | 2.2E-02 | – | 4E-09 | 9E-09 |
| 2-Butanone | 1.47E-01 | 5.8E-06 | 1.3E-05 | – | D | – | – |
| 2-Propanol | 7.01E-02 | 2.8E-06 | 6.2E-06 | – | – | – | – |
| 4-Ethyltoluene | 1.97E-02 | 7.8E-07 | 1.8E-06 | – | – | – | – |
| 4-Methyl-2-pentanone | 1.61E-02 | 6.4E-07 | 1.4E-06 | – | – | – | – |
| Acetone | 8.88E-02 | 3.5E-06 | 7.9E-06 | – | D | – | – |
| Benzene | 3.30E-03 | 1.3E-07 | 2.9E-07 | 2.7E-02 | A | 4E-09 | 8E-09 |
| Carbon Disulfide | 2.73E-03 | 1.1E-07 | 2.4E-07 | – | – | – | – |
| Chlorobenzene | 7.27E-04 | 2.9E-08 | 6.5E-08 | – | D | – | – |
| Chloroethane | 1.87E-03 | 7.4E-08 | 1.7E-07 | – | – | – | – |
| cis-1,2-Dichloroethane | 1.71E-03 | 6.7E-08 | 1.5E-07 | – | D | – | – |
| Cyclohexane | 1.52E-02 | 6.0E-07 | 1.3E-06 | – | – | – | – |
| Ethanol | 4.32E-01 | 1.7E-05 | 3.8E-05 | – | – | – | – |
| Ethylbenzene | 5.32E-02 | 2.1E-06 | 4.7E-06 | – | D | – | – |
| Freon-11 | 1.37E-02 | 5.4E-07 | 1.2E-06 | – | – | – | – |
| Freon-114 | 1.72E-03 | 6.8E-08 | 1.5E-07 | – | – | – | – |
| Freon-12 | 2.09E-02 | 8.3E-07 | 1.9E-06 | – | – | – | – |
| Heptane | 2.82E-02 | 1.1E-06 | 2.5E-06 | – | D | – | – |
| Hexane | 3.32E-02 | 1.3E-06 | 2.9E-06 | – | – | – | – |
| m,p-Xylenes | 7.23E-02 | 2.9E-06 | 6.4E-06 | – | – | – | – |
| Methyl tert butyl ether | 5.21E-03 | 2.1E-07 | 4.6E-07 | – | – | – | – |
| Methylene chloride | 3.00E-02 | 1.2E-06 | 2.7E-06 | 1.6E-03 | B2 | 2E-09 | 4E-09 |
| o-Xylene | 2.32E-02 | 9.1E-07 | 2.1E-06 | – | – | – | – |
| Styrene | 1.36E-02 | 5.4E-07 | 1.2E-06 | – | – | – | – |
| Tetrachloroethene | 2.11E-02 | 8.3E-07 | 1.9E-06 | 2.0E-02 | D | 2E-08 | 4E-08 |
| Tetrahydrofuran | 1.33E-02 | 5.3E-07 | 1.2E-06 | 6.8E-03 | – | 4E-09 | 8E-09 |
| Toluene | 1.27E-01 | 5.0E-06 | 1.1E-05 | – | D | – | – |
| Trichloroethene | 7.84E-03 | 3.1E-07 | 7.0E-07 | 4.0E-01 | – | 1E-07 | 3E-07 |
| Vinyl Chloride | 5.67E-03 | 2.2E-07 | 5.0E-07 | 3.0E-02 | A | 7E-09 | 2E-08 |
| *Sulfur Compounds* | | | | | | | |
| 2-Ethylthiophene | 6.24E-03 | 2.5E-07 | 5.5E-07 | – | – | – | – |
| 2,5-Dimethylthiophene | 6.01E-03 | 2.4E-07 | 5.3E-07 | – | – | – | – |
| Diethyl disulfide | 7.81E-03 | 3.1E-07 | 6.9E-07 | – | – | – | – |
| Hydrogen sulfide | 4.28E-03 | 1.7E-07 | 3.8E-07 | – | – | – | – |
| Isopropyl mercaptan | 5.77E-03 | 2.3E-07 | 5.1E-07 | – | – | – | – |
| Methyl mercaptan | 5.63E-03 | 2.2E-07 | 5.0E-07 | – | – | – | – |
| | | | | | Total Cancer Risk | 2E-07 | 4E-07 |

Notes:

– = Not available/Not calculated

(a) Chemical-specific lifetime Average Daily Intakes (ADIs) are calculated for both child and adult residents. ADIs for carcinogens are calculated as follows: ADI (mg/kg/day) = Modeled Air Concentration ($\mu g/m^3$) * Inhalation Rate ($m^3$/hr) * Exposure Time (hrs/day) * Exposure Duration (yrs) * 0.001 (mg/$\mu$g) / ( Body Weight (kg) * Averaging Time (days) ). The values for inhalation rates (0.30 $m^3$/hr [child]; 0.63 $m^3$/hr [adult]), exposure time (24 hrs/day [child and adult]), exposure frequency (350 days/year [child and adult], exposure duration (6 years [child]; 30 years [adult], and body weight (15 kg [child] and 70 kg [adult]) were obtained from Table C-2-1 of USEPA 1998. The averaging time for carcinogens represents an averaged exposure over a 70 year duration, converted to days.

(b) Ambient air concentrations are based on site-specific modeling performed by Trinity Consultants. Concentrations reflect the combined influence of active and inactive landfill areas, flares and the power plant.

(c) Cancer slope factor inhalation (CSFi) values and carcinogenicty weight of evidence classification presented in chronic inhalation toxicity criteria table.

(d) Chemical-specific excess lifetime cancer risks are calculated as follows: excess lifetime cancer risk = lifetime ADI $(mg/kg/day)^{-1}$ * CSFi $(mg/kg/day)^{-1}$.

TABLE 6
CALCULATION OF POTENTIAL EXCESS LIFETIME CANCER RISKS FROM INHALATION - CHILDREN AND ADULTS
Area 3 - area in Pen Argyl where concentrations were highest

| Compound | Modeled Air Concentration [b] ($\mu g/m^3$) | Average Daily Intake [a] | | CSFi [c] $(mg/kg/day)^{-1}$ | Carcinogenicty Weight of Evidence | Excess Lifetime Cancer Risk [d] | |
|---|---|---|---|---|---|---|---|
| | | child (mg/kg/day) | adult (mg/kg/day) | | | child (unitless) | adult (unitless) |
| *Volatile organic compounds* | | | | | | | |
| 1,1,1-Trichloroethane | 3.92E-03 | 1.5E-07 | 3.5E-07 | – | D | – | – |
| 1,1-Dichloroethane | 4.45E-03 | 1.8E-07 | 3.9E-07 | – | C | – | – |
| 1,2,4-Trimethylbenzene | 1.62E-02 | 6.4E-07 | 1.4E-06 | – | – | – | – |
| 1,3,5-Trimethylbenzene | 6.12E-03 | 2.4E-07 | 5.4E-07 | – | – | – | – |
| 1,4-Dichlorobenzene | 3.59E-03 | 1.4E-07 | 3.2E-07 | 2.2E-02 | – | 3E-09 | 7E-09 |
| 2-Butanone | 1.12E-01 | 4.4E-06 | 9.9E-06 | – | D | – | – |
| 2-Propanol | 5.32E-02 | 2.1E-06 | 4.7E-06 | – | – | – | – |
| 4-Ethyltoluene | 1.50E-02 | 5.9E-07 | 1.3E-06 | – | – | – | – |
| 4-Methyl-2-pentanone | 1.22E-02 | 4.8E-07 | 1.1E-06 | – | – | – | – |
| Acetone | 6.73E-02 | 2.7E-06 | 6.0E-06 | – | D | – | – |
| Benzene | 2.50E-03 | 9.9E-08 | 2.2E-07 | 2.7E-02 | A | 3E-09 | 6E-09 |
| Carbon Disulfide | 2.07E-03 | 8.2E-08 | 1.8E-07 | – | – | – | – |
| Chlorobenzene | 5.51E-04 | 2.2E-08 | 4.9E-08 | – | D | – | – |
| Chloroethane | 1.41E-03 | 5.6E-08 | 1.3E-07 | – | – | – | – |
| cis-1,2-Dichloroethene | 1.30E-03 | 5.1E-08 | 1.2E-07 | – | D | – | – |
| Cyclohexane | 1.15E-02 | 4.5E-07 | 1.0E-06 | – | – | – | – |
| Ethanol | 3.27E-01 | 1.3E-05 | 2.9E-05 | – | – | – | – |
| Ethylbenzene | 4.04E-02 | 1.6E-06 | 3.6E-06 | – | D | – | – |
| Freon-11 | 1.04E-02 | 4.1E-07 | 9.2E-07 | – | – | – | – |
| Freon-114 | 1.31E-03 | 5.2E-08 | 1.2E-07 | – | – | – | – |
| Freon-12 | 1.59E-02 | 6.3E-07 | 1.4E-06 | – | – | – | – |
| Heptane | 2.14E-02 | 8.4E-07 | 1.9E-06 | – | D | – | – |
| Hexane | 2.51E-02 | 9.9E-07 | 2.2E-06 | – | – | – | – |
| m,p-Xylenes | 5.48E-02 | 2.2E-06 | 4.9E-06 | – | – | – | – |
| Methyl tert butyl ether | 3.95E-03 | 1.6E-07 | 3.5E-07 | – | – | – | – |
| Methylene chloride | 2.28E-02 | 9.0E-07 | 2.0E-06 | 1.6E-03 | B2 | 1E-09 | 3E-09 |
| o-Xylene | 1.76E-02 | 6.9E-07 | 1.6E-06 | – | – | – | – |
| Styrene | 1.03E-02 | 4.1E-07 | 9.1E-07 | – | – | – | – |
| Tetrachloroethene | 1.60E-02 | 6.3E-07 | 1.4E-06 | 2.0E-02 | D | 1E-08 | 3E-08 |
| Tetrahydrofuran | 1.01E-02 | 4.0E-07 | 9.0E-07 | 6.8E-03 | – | 3E-09 | 6E-09 |
| Toluene | 9.62E-02 | 3.8E-06 | 8.5E-06 | – | D | – | – |
| Trichloroethene | 5.94E-03 | 2.3E-07 | 5.3E-07 | 4.0E-01 | – | 9E-08 | 2E-07 |
| Vinyl Chloride | 4.30E-03 | 1.7E-07 | 3.8E-07 | 3.0E-02 | A | 5E-09 | 1E-08 |
| *Sulfur Compounds* | | | | | | | |
| 2-Ethylthiophene | 4.75E-03 | 1.9E-07 | 4.2E-07 | – | – | – | – |
| 2,5-Dimethylthiophene | 4.57E-03 | 1.8E-07 | 4.1E-07 | – | – | – | – |
| Diethyl disulfide | 5.95E-03 | 2.3E-07 | 5.3E-07 | – | – | – | – |
| Hydrogen sulfide | 3.26E-03 | 1.3E-07 | 2.9E-07 | – | – | – | – |
| Isopropyl mercaptan | 4.40E-03 | 1.7E-07 | 3.9E-07 | – | – | – | – |
| Methyl mercaptan | 4.29E-03 | 1.7E-07 | 3.8E-07 | – | – | – | – |
| | | | | | Total Cancer Risk | 1E-07 | 3E-07 |

Notes:

– = Not available/Not calculated.

(a) Chemical-specific lifetime Average Daily Intakes (ADIs) are calculated for both child and adult residents. ADIs for carcinogens are calculated as follows: ADI (mg/kg/day) = Modeled Air Concentration ($\mu g/m^3$) * Inhalation Rate ($m^3/hr$) * Exposure Time (hrs/day) * Exposure Duration (yrs) * 0.001 (mg/$\mu g$) / ( Body Weight (kg) * Averaging Time (days) ). The values for inhalation rates (0.30 $m^3/hr$ [child]; 0.83 $m^3/hr$ [adult]), exposure time (24 hrs/day [child and adult]), exposure frequency (350 days/year [child and adult], exposure duration (6 years [child]; 30 years [adult], and body weight (15 kg [child] and 70 kg [adult]) were obtained from Table C-2-1 of USEPA 1998. The averaging time for carcinogens represents an averaged exposure over a 70 year duration, converted to days.

(b) Ambient air concentrations are based on site-specific modeling performed by Trinity Consultants. Concentrations reflect the combined influence of active and inactive landfill areas, flares and the power plant.

(c) Cancer slope factor inhalation (CSFi) values and carcinogenicty weight of evidence classification presented in chronic inhalation toxicity criteria table.

(d) Chemical-specific excess lifetime cancer risks are calculated as follows: excess lifetime cancer risk = lifetime ADI $(mg/kg/day)^{-1}$ * CSFi $(mg/kg/day)^{-1}$.

**TABLE 7**
**CALCULATION OF POTENTIAL FOR ACUTE INHALATION EFFECTS**
**Area 1 - area nearest active landfill**
**(Areas B and C) where concentrations were highest**

| Compound | Modeled 1-Hour Average Ambient Air Concentration (µg/m3) [a] | Acute Inhalation Reference Concentration (µg/m3) | Hazard Quotient [b] |
|---|---|---|---|
| *Volatile organic compounds* | | | |
| 1,1,1-Trichloroethane | 8.10E-01 | 1.3E+06 | 6E-07 |
| 1,1-Dichloroethane | 9.18E-01 | 1.3E+06 | 7E-07 |
| 1,2,4-Trimethylbenzene | 3.35E+00 | 1.5E+05 | 2E-05 |
| 1,3,5-Trimethylbenzene | 1.26E+00 | 1.5E+05 | 8E-06 |
| 1,4-Dichlorobenzene | 7.41E-01 | 6.0E+05 | 1E-06 |
| 2-Butanone | 2.30E+01 | 3.0E+05 | 8E-05 |
| 2-Propanol | 1.10E+01 | 1.0E+06 | 1E-05 |
| 4-Ethyltoluene | 3.09E+00 | 1.3E+05 | 2E-05 |
| 4-Methyl-2-pentanone | 2.52E+00 | 3.0E+05 | 8E-06 |
| Acetone | 1.39E+01 | 4.8E+05 | 3E-05 |
| Benzene | 5.16E-01 | 1.6E+05 | 3E-06 |
| Carbon Disulfide | 4.27E-01 | 1.2E+04 | 4E-05 |
| Chlorobenzene | 1.14E-01 | 1.3E+05 | 9E-07 |
| Chloroethane | 2.92E-01 | 2.5E+06 | 1E-07 |
| cis-1,2-Dichloroethene | 2.68E-01 | 5.5E+05 | 5E-07 |
| Cyclohexane | 2.37E+00 | 3.0E+06 | 8E-07 |
| Ethanol | 6.76E+01 | 5.0E+06 | 1E-05 |
| Ethylbenzene | 8.33E+00 | 5.0E+05 | 2E-05 |
| Freon-11 | 2.14E+00 | 2.5E+06 | 9E-07 |
| Freon-114 | 2.70E-01 | 2.0E+07 | 1E-08 |
| Freon-12 | 3.27E+00 | 1.5E+07 | 2E-07 |
| Heptane | 4.41E+00 | 1.5E+06 | 3E-06 |
| Hexane | 5.19E+00 | 5.0E+05 | 1E-05 |
| m,p-Xylenes | 1.13E+01 | 5.6E+05 | 2E-05 |
| Methyl tert butyl ether | 8.15E-01 | 5.0E+05 | 2E-06 |
| Methylene chloride | 4.70E+00 | 6.9E+05 | 7E-06 |
| o-Xylene | 3.62E+00 | 5.6E+05 | 6E-06 |
| Styrene | 2.12E+00 | 2.1E+05 | 1E-05 |
| Tetrachloroethene | 3.30E+00 | 2.4E+05 | 1E-05 |
| Tetrahydrofuran | 2.08E+00 | 7.5E+05 | 3E-06 |
| Toluene | 1.99E+01 | 3.1E+05 | 6E-05 |
| Trichloroethene | 1.23E+00 | 6.7E+05 | 2E-06 |
| Vinyl Chloride | 8.87E-01 | 1.8E+05 | 5E-06 |
| *Sulfur Compounds* | | | |
| 2-Ethylthiophene | 9.83E-01 | -- | -- |
| 2,5-Dimethylthiophene | 9.47E-01 | -- | -- |
| Diethyl disulfide | 1.23E+00 | 7.1E+02 | 2E-03 |
| Hydrogen sulfide | 6.74E-01 | 7.1E+02 | 9E-04 |
| Isopropyl mercaptan | 9.10E-01 | 1.0E+01 | 9E-02 |
| Methyl mercaptan | 8.88E-01 | 1.0E+01 | 9E-02 |

(a) Ambient air concentrations are based on site-specific modeling performed by Trinity Consultants. Concentrations reflect the combined influence of acitve and inactive landfill areas, flares and the power plant.

(b) Hazard quotient calculated as follows: 1-hour air concentration / reference concentration.

**TABLE 8**
**CALCULATION OF POTENTIAL FOR ACUTE INHALATION EFFECTS**
**Area 2 - area nearest closed landfill (Area A)**
**where concentrations were highest**

| Compound | Modeled 1-Hour Average Ambient Air Concentration (µg/m3) [a] | Acute Inhalation Reference Concentration (µg/m3) | Hazard Quotient [b] |
|---|---|---|---|
| *Volatile organic compounds* | | | |
| 1,1,1-Trichloroethane | 5.22E-01 | 1.3E+06 | 4E-07 |
| 1,1-Dichloroethane | 5.91E-01 | 1.3E+06 | 5E-07 |
| 1,2,4-Trimethylbenzene | 2.16E+00 | 1.5E+05 | 1E-05 |
| 1,3,5-Trimethylbenzene | 8.15E-01 | 1.5E+05 | 5E-06 |
| 1,4-Dichlorobenzene | 4.77E-01 | 6.0E+05 | 8E-07 |
| 2-Butanone | 1.48E+01 | 3.0E+05 | 5E-05 |
| 2-Propanol | 7.07E+00 | 1.0E+06 | 7E-06 |
| 4-Ethyltoluene | 1.99E+00 | 1.3E+05 | 2E-05 |
| 4-Methyl-2-pentanone | 1.62E+00 | 3.0E+05 | 5E-06 |
| Acetone | 8.95E+00 | 4.8E+05 | 2E-05 |
| Benzene | 3.33E-01 | 1.6E+05 | 2E-06 |
| Carbon Disulfide | 2.75E-01 | 1.2E+04 | 2E-05 |
| Chlorobenzene | 7.33E-02 | 1.3E+05 | 6E-07 |
| Chloroethane | 1.88E-01 | 2.5E+06 | 8E-08 |
| cis-1,2-Dichloroethane | 1.72E-01 | 5.5E+05 | 3E-07 |
| Cyclohexane | 1.53E+00 | 3.0E+06 | 5E-07 |
| Ethanol | 4.35E+01 | 5.0E+06 | 9E-06 |
| Ethylbenzene | 5.37E+00 | 5.0E+05 | 1E-05 |
| Freon-11 | 1.38E+00 | 2.5E+06 | 6E-07 |
| Freon-114 | 1.74E-01 | 2.0E+07 | 9E-09 |
| Freon-12 | 2.11E+00 | 1.5E+07 | 1E-07 |
| Heptane | 2.84E+00 | 1.5E+06 | 2E-06 |
| Hexane | 3.34E+00 | 5.0E+05 | 7E-06 |
| m,p-Xylenes | 7.28E+00 | 5.6E+05 | 1E-05 |
| Methyl tert butyl ether | 5.25E-01 | 5.0E+05 | 1E-06 |
| Methylene chloride | 3.03E+00 | 6.9E+05 | 4E-06 |
| o-Xylene | 2.33E+00 | 5.6E+05 | 4E-06 |
| Styrene | 1.37E+00 | 2.1E+05 | 7E-06 |
| Tetrachloroethene | 2.12E+00 | 2.4E+05 | 9E-06 |
| Tetrahydrofuran | 1.34E+00 | 7.5E+05 | 2E-06 |
| Toluene | 1.28E+01 | 3.1E+05 | 4E-05 |
| Trichloroethene | 7.90E-01 | 6.7E+05 | 1E-06 |
| Vinyl Chloride | 5.71E-01 | 1.8E+05 | 3E-06 |
| *Sulfur Compounds* | | | |
| 2-Ethylthiophene | 6.31E-01 | -- | -- |
| 2,5-Dimethylthiophene | 6.08E-01 | -- | -- |
| Diethyl disulfide | 7.91E-01 | 7.1E+02 | 1E-03 |
| Hydrogen sulfide | 4.33E-01 | 7.1E+02 | 6E-04 |
| Isopropyl mercaptan | 5.84E-01 | 1.0E+01 | 6E-02 |
| Methyl mercaptan | 5.70E-01 | 1.0E+01 | 6E-02 |

(a) Ambient air concentrations are based on site-specific modeling performed by Trinity Consultants. Concentrations reflect the combined influence of active and inactive landfill areas, flares and the power plant.

(b) Hazard quotient calculated as follows: 1-hour air concentration / reference concentration.

**TABLE 9**
**CALCULATION OF POTENTIAL FOR ACUTE INHALATION EFFECTS**
**Area 3 - area in Pen Argyl where concentrations were highest**

| Compound | Modeled 1-Hour Average Ambient Air Concentration (µg/m3) [a] | Acute Inhalation Reference Concentration (µg/m3) | Hazard Quotient [b] |
|---|---|---|---|
| *Volatile organic compounds* | | | |
| 1,1,1-Trichloroethane | 4.46E-01 | 1.3E+06 | 3E-07 |
| 1,1-Dichloroethane | 5.05E-01 | 1.3E+06 | 4E-07 |
| 1,2,4-Trimethylbenzene | 1.85E+00 | 1.5E+05 | 1E-05 |
| 1,3,5-Trimethylbenzene | 6.96E-01 | 1.5E+05 | 5E-06 |
| 1,4-Dichlorobenzene | 4.08E-01 | 6.0E+05 | 7E-07 |
| 2-Butanone | 1.27E+01 | 3.0E+05 | 4E-05 |
| 2-Propanol | 6.04E+00 | 1.0E+06 | 6E-06 |
| 4-Ethyltoluene | 1.70E+00 | 1.3E+05 | 1E-05 |
| 4-Methyl-2-pentanone | 1.39E+00 | 3.0E+05 | 5E-06 |
| Acetone | 7.65E+00 | 4.8E+05 | 2E-05 |
| Benzene | 2.84E-01 | 1.6E+05 | 2E-06 |
| Carbon Disulfide | 2.35E-01 | 1.2E+04 | 2E-05 |
| Chlorobenzene | 6.26E-02 | 1.3E+05 | 5E-07 |
| Chloroethane | 1.61E-01 | 2.5E+06 | 6E-08 |
| cis-1,2-Dichloroethane | 1.47E-01 | 5.5E+05 | 3E-07 |
| Cyclohexane | 1.31E+00 | 3.0E+06 | 4E-07 |
| Ethanol | 3.72E+01 | 5.0E+06 | 7E-06 |
| Ethylbenzene | 4.59E+00 | 5.0E+05 | 9E-06 |
| Freon-11 | 1.18E+00 | 2.5E+06 | 5E-07 |
| Freon-114 | 1.48E-01 | 2.0E+07 | 7E-09 |
| Freon-12 | 1.80E+00 | 1.5E+07 | 1E-07 |
| Heptane | 2.43E+00 | 1.5E+06 | 2E-06 |
| Hexane | 2.86E+00 | 5.0E+05 | 6E-06 |
| m,p-Xylenes | 6.22E+00 | 5.6E+05 | 1E-05 |
| Methyl tert butyl ether | 4.49E-01 | 5.0E+05 | 9E-07 |
| Methylene chloride | 2.59E+00 | 6.9E+05 | 4E-06 |
| o-Xylene | 1.99E+00 | 5.6E+05 | 4E-06 |
| Styrene | 1.17E+00 | 2.1E+05 | 6E-06 |
| Tetrachloroethene | 1.81E+00 | 2.4E+05 | 8E-06 |
| Tetrahydrofuran | 1.15E+00 | 7.5E+05 | 2E-06 |
| Toluene | 1.09E+01 | 3.1E+05 | 4E-05 |
| Trichloroethene | 6.75E-01 | 6.7E+05 | 1E-06 |
| Vinyl Chloride | 4.88E-01 | 1.8E+05 | 3E-06 |
| *Sulfur Compounds* | | | |
| 2-Ethylthiophene | 5.40E-01 | -- | -- |
| 2,5-Dimethylthiophene | 5.20E-01 | -- | -- |
| Diethyl disulfide | 6.77E-01 | 7.1E+02 | 1E-03 |
| Hydrogen sulfide | 3.70E-01 | 7.1E+02 | 5E-04 |
| Isopropyl mercaptan | 5.00E-01 | 1.0E+01 | 5E-02 |
| Methyl mercaptan | 4.88E-01 | 1.0E+01 | 5E-02 |

(a) Ambient air concentrations are based on site-specific modeling performed by Trinity Consultants. Concentrations reflect the combined influence of acitve and inactive landfill areas, flares and the power plant.

(b) Hazard quotient calculated as follows: 1-hour air concentration / reference concentration.