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Air Toxics Inhalation – Screening Level Health Hazard Assessment in Area with High Concentration of Natural Gas Production

Roger O. McClellan<sup>a</sup> and M. Burton Snipes<sup>b</sup> Albuquerque, NM

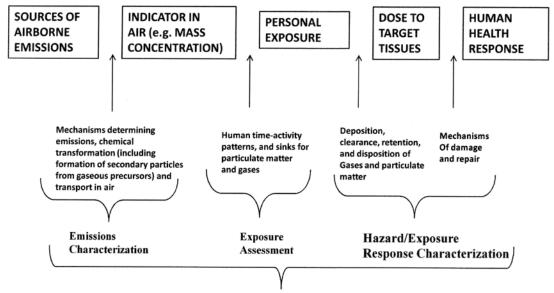
The Pinedale Anticline, Sublette County, WY, has in recent decades been a site of major development and production activity for gas and oil making extensive use of hydraulic fracturing and directional drilling. In response to local concerns for air quality impacts, the Sublette County Human Health Risk Assessment Air Toxics Project was conducted by Sublette County and the Wyoming Department of Environmental Quality in 2009-2010. The concentrations of 49 chemicals were measured at 14 locations over a one-year period using vacuum canisters or sorbent samplers with samples taken for 24 hours every 6 days. The samples were analyzed using EPA recommended methods. The ambient air concentrations measured represented contributions from multiple sources, including gas and oil production activities, diesel engines and forest fires. The Air Toxics Project data were made available to the public. The authors were engaged by Shell Exploration and Production to conduct a screening level Health Hazard Assessment using EPA recommended methodology. The average ambient air concentration data for each of the 14 sites was compared to human chronic health hazard indicators obtained from public sources to yield a Hazard Quotient. All of the calculated Hazard Quotients were less than 1.0. Of the 49 chemicals identified, 3 have been categorized as human carcinogens (benzene, butadiene and vinyl chloride), 8 as probable human carcinogens, and 3 as possible human carcinogens. The calculated excess cancer risks for each of the chemicals at each site were less than 1 in 10,000. These results suggested that additional investigation, focusing on potential health hazard from exposure to mixtures of chemicals in the ambient air, were not warranted. The results of this very extensive monitoring campaign should be considered in planning any potential monitoring, risk assessment or epidemiological investigations related to gas and oil production, including use of so-called "unconventional methods."

<sup>a</sup>Advisor, Inhalation Toxicology and Risk Assessment, Albuquerque, NM 87111 <sup>b</sup>Consultant, Inhalation Toxicology, Tijeras, NM 87059

# **OBJECTIVES**

- Address citizen concerns for potential health effects from air toxics and ozone related to gas and oil production
- Conduct extensive air sampling at 12 locations, 24 hr samples every 6 days on 61 occasions during 2009-2010
- Measured 48 chemicals by GC/MS and acetaldehyde and formaldehyde by HPLC
- Measurements for chemicals of potential concern compared to EPA inhalation health reference concentrations
- Excess lifetime cancer risks calculated for chemicals
- Cost of ~ \$1.5 million

## **RISK CHARACTERIZATION PARADIGM**

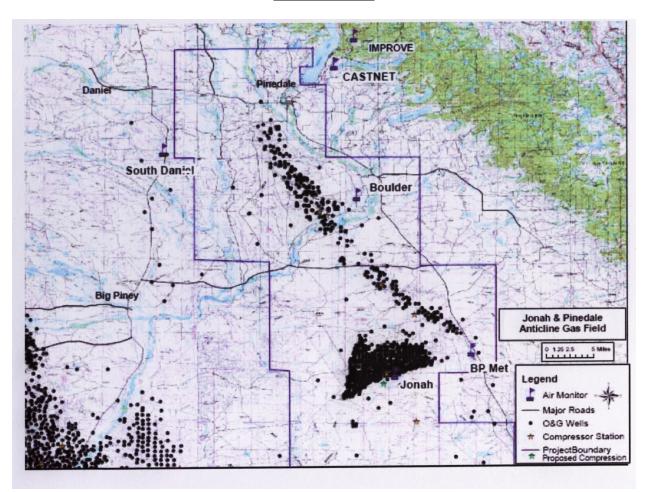


**Risk Characterization** 

### **Monitoring Locations**



#### Area Monitors



# **RESULTS**

- 50 chemicals identified as Chemicals of Potential Concern (COPC) compared to Acute and Chronic Inhalation Health Reference Concentrations
- Hazard Quotients were all less than 1.0 indicating that the <u>ambient concentrations did not pose unacceptable</u> <u>health risks</u>
- 6 chemicals known to cause human cancer or having potential to cause human cancer were detected
- The calculated <u>excess lifetime cancer risk for all 6</u> <u>chemicals at the 12 sites were less than 1 in 10,000</u>
- In special study, additional 78 chemicals were identified and characterized as <u>Tentatively</u> <u>Identified</u> <u>Compounds</u> (TIC)
- None of COPC or TIC chemicals were unique to Sublette County or oil and gas operations. Data are not sufficient to determine various sources:
- (a) oil and gas operations, (b) biogenic sources, including fires, or (c) other sources within the county or upwind
- Results of this extensive study should be considered in planning any future ambient monitoring, hazard screening and/or epidemiological studies related to oil and gas production

#### PINEDALE #1: Ambient Air Concentrations and Health Reference Concentrations for Chemicals of Potential Concern

1.1.1-Trichloroethane (71-55-6)  1  57  0    1.1.2.2-Tetrachloroethane (79-00-5)  9  49  0    1.1.Dichloroethane (79-00-5)  9  49  0    1.1.Dichloroethane (79-00-5)  9  49  0    1.1.Dichloroethane (79-00-5)  9  49  0.34  0.53  1.    1.1.Dichloroethane (75-34-3)  39  19  0.34  0.53  1.    1.2.4-Trinethylbenzene (95-63-6)  22  36  1.64  4.53  37    1.2.2-Dichloropropane (78-87-5)  2  56  1.  1.3.5  1.3.5  0  1.3.5  1.3.5  0  1.4.10xane (102-90.0)  3  55  0  1.  1.3.4  2.4.7 Trimethylbenzene (108-67-8)  5  53  1.1  1.3.3  3.68  1.33  3.68  1.9  2.2.4.7 Trimethylbenzene (108-04-1.1)  3  55  7.  2.  2.6  1.  1.3.3  3.68  1.9  2.4.4  4.4  20.49  43.68  1.99  4.4  4.4  20.49  43.68  1.99  4.4  4.4  1.4  20.49  43.68 <td< th=""><th>Inhalation 1-Day Reference entration Concentration <math>a(m^3)</math></th><th>Computed Acute</th><th>Inhalation Reference Concentration</th><th>Computed Chronic</th></td<>	Inhalation 1-Day Reference entration Concentration $a(m^3)$	Computed Acute	Inhalation Reference Concentration	Computed Chronic
1.1,2.2-Tetrachloroethane (79-34-5)25621.1,2-Trichloroethane (75-34-3)39190.340.531.1-Dichloroethane (175-34-3)39190.340.531.1-Dichloroethylene [1.1-DCE] (75-35-4)355001.2.4-Trimethylbenzene (05-63-6)22361.644.531.2.2-Dichloroethane (107-06-2)42160.360.551.3.5-Trimethylbenzene (108-67-8)553111.3.5-Trimethylpentane (166-99-0)355772.2.4-Trimethylpentane (540-84-1)355772.3-Butanone (Methyl Ethyl Ketone) (78-93-3)58022.4528.32.Propanol (67-63-0)4454552.Propanol (67-63-0)441420.4943.684-Ethytoluene (622-96-8)15431.333.68294-Ethytoluene (622-96-8)15431.333.6444Acetaldehyde (75-07-0)6101.542.1055Acetaldehyde (75-07-0)4547.210Chloroethane [Ethyl chloride] (75-03)10486.328.5316Chloroethane [Ethyl chloride] (75-07-3)11570014Chloroethylene (18-59-2)15731062.10Chloroethylene (196-59-2)15731.062.10Chloroethylene (10-41-4)5531.062.108.Cyclokeane (110-82-7)8502.	g/m <sup>3</sup> ) (μg/m <sup>3</sup> ) 0.39 10900	Inhalation HQ 0.000036	(µg/m <sup>3</sup> ) 5000	Inhalation HQ
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1.1-Dichloroethane (75-34-3)  39  19  0.34  0.53  1.1    1.1-Dichloroethylene [1,1-DCE] (75-35-4)  3  55  00    1.2,4-Trimethylbenzene (95-63-6)  22  36  1.64  4.53  37    1,2-Dichloroethane (107-06-2)  42  16  0.36  0.55  1.1    1,3-Trimethylbenzene (108-67-8)  5  53  11  1.3    1,3-Trimethylbenzene (108-67-8)  5  53  11  1.3    1,3-Butadiene (106-99-0)  3  55  77  2    2,4-Trimethylpenzen (540-84-1)  3  55  77    2-Butanone (Methyl Ethyl Ketone) (78-93-3)  58  0  22.45  28.3  91    2-Hexanone (591-78-6)  4  54  55  2-7  2-9  56  77    2-Butanone (622-96-8)  15  43  1.33  3.68  29  4    4-Ethyltoluene (622-96-8)  15  43  1.33  3.68  199    6-actone (67-64-1)  58  0  1.17  2.10  57    Chloroethylene (108-10-1)  2  56 <td>0.43 550</td> <td>0.00078</td> <td>55</td> <td></td>	0.43 550	0.00078	55	
1.1-Dichloroethylen [1.1-DCE] (75-35-4)35501.2.4-Trimethylbenzen (95-63-6)22361.644.53371.2-Dichloropropane (78-87-5)2561.11.3-Trimethylbenzen (106-67-8)553111.3-Butadien (106-99-0)35501.4-Dioxane (123-91-1)05872.2.4-Trimethylpenzen (540-84-1)35572.Butanoe (Methyl Ethyl Ketone) (78-93-3)58022.4528.32.Perponal (67-63-0)441420.4943.681994-Ethyltoluene (622-96-8)15431.333.68294-Methyl-2-pentanoe (108-10-1)23350.931.634.Acetadehyde (75-07-0)6101.542.1055Carbon Disulfide (75-10)454770Chloroethane (14-32)2561.17Chloroethane (14-83-9)2561.07Chloroethane (16-59-2)15707Chloroethane (16-10-1)5531.52119.01Chloroethylene (156-59-2)15700Chloroethylene (16-75-0)454710Chloroethylene (16-6-39-2)15731.062.10Chloroethylene (156-59-2)15731.062.10Chloroethylene (156-59-2)15731.062.10Chloroethylene (156-59-2)157 <td>.46 4000</td> <td>0.00013</td> <td>400</td> <td>0.0013</td>	.46 4000	0.00013	400	0.0013
1.2.4-Trimethylbenzene (95-63-6)22361.644.53571.2-Dichloroperbane (107-06-2)42160.360.551.1.3.5-Trimethylbenzene (108-67-8)553111.3-Butadiene (106-99-0)35553111.4-Dioxane (123-91-1)0587.2.2.4-Trimethylpentane (540-84-1)3557.2-Butanone (Methyl Ethyl Ketone) (78-93-3)58022.4528.32-Hexanone (591-78-6)4545.2-Propanol (67-63-0)441420.4943.684-Ethyltoluene (622-96-8)15431.333.68294-Methyl-2-pentanone (108-10-1)23350.931.634. Acetaldehyde (75-07-0)6101.542.1055Acetone (67-64-1)5802.114.0719Bromomethane (74-83-9)2561.7.Chloronethane (74-83-9)2561.1.00Chloronethane (74-63.3)157100100Chloronethane (74-63.3)1571.00Chloronethane (106-104.1)5531.52.119.011445531.062.108.502.25531.52.119.016101.571.723.705531.52.119.01717274113.994.8727414 <t< td=""><td>0.10 210</td><td>0.00048</td><td>200</td><td>0.0015</td></t<>	0.10 210	0.00048	200	0.0015
1.2.Dichloropethane (107-06-2)  42  16  0.36  0.55  1.    1.3.5-Trimethylbenzene (108-67-8)  5  53  11    1.3.5-Trimethylbenzene (108-67-8)  5  53  11    1.3.5-Trimethylbenzene (108-67-8)  5  53  11    1.4.Dioxane (123-91-1)  0  58  7.    2.4.Trimethylpentane (540-84-1)  3  55  7.    2.Butanone (Methyl Ethyl Ketone) (78-93-3)  58  0  22.45  28.3  91    2.Hexanone (591-78-6)  4  54  5.	7.34 1250	0.0036	125	0.036
1.2-Dichloropropane (78-87-5)  2  56  1.    1.3.5-Trimethylbenzene (108-67-8)  5  53  11    1.3-Butadiene (106-99-0)  3  55  00    1.4-Dioxane (123-91-1)  0  58  7.    2.Butanone (Methyl Ethyl Ketone) (78-93-3)  58  0  22.45  28.3  91    2.Hexanone (591-78-6)  4  54  5.  5.  5.  5.  2.  2.  2.83.3  91  2.  4.  4.  20.49  43.68  194    4-Ethyltoluene (622-96-8)  4  4.4  1.4  20.49  43.68  194    4-Acetaldehyde (75-07-0)  61  0  1.54  2.10  5.    Acetone (67-64-1)  58  0  17.47  22.27  907    Benzne (71-43-2)  58  0  17.47  22.27  907    Benzne (71-43-2)  58  0  17.47  22.07  907    Chloroethane [Ethyl chloride] (75-00-3)  10  48  6.32  8.53  55    Chloroethane [Ethyl chloride] (74-87-3)  58  0  3.	.58 160	0.0034	2430	0.00023
1,3.5-Trimethylbenzene (108-67-8)  5  53  11    1,3-Butadiene (106-99-0)  3  55  0.    1,4-Dioxane (123-91-1)  0  58  7.    2.2,4-Trimethylpentane (540-84-1)  3  55  7.    2-Butanone (Methyl Ethyl Ketone) (78-93-3)  58  0  22.45  28.3  94    2-Hexanone (591-78-6)  4  54  5.  5.  2.Propanol (67-63-0)  44  14  20.49  43.68  199    4-Ethyltoluene (622-96-8)  15  43  1.33  3.68  29    4-Methyl-2-pentanone (108-10-1)  23  35  0.93  1.63  4.    Accetaldehyde (75-07-0)  61  0  1.54  2.10  5.    Accetone (67-64-1)  58  0  2.11  4.07  19    Bromomethane (74-83-9)  2  56  1.  1.0    Carbon Disulfide (75-10-3)  10  48  6.32  8.53  50    Chloroethane [Ethyl chloride] (74-87-3)  58  0  3.40  3.93  12    Cish-1,2-Dichloroethylene (156-59-2)  1	.34 230	0.0058	4	0.00025
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2-Butanone (Methyl Ethyl Ketone) (78-93-3)  58  0  22.45  28.3  91    2-Hexanone (591-78-6)  4  54  5.    2-Propanol (67-63-0)  44  14  20.49  43.68  190    4-Ethyltoluene (622-96-8)  15  43  1.33  3.68  29    4-Methyl-2-pentanone (108-10-1)  23  35  0.93  1.63  4.    Acetaldehyde (75-07-0)  61  0  1.54  2.10  5.    Acetone (67-64-1)  58  0  2.11  4.07  199    Bromomethane (74-83-9)  2  56  1.  7.    Chloroethane [Ethyl chloride] (75-00-3)  10  48  6.32  8.53  50    Chloroethane [Ethyl chloride] (74-87-3)  58  0  3.40  3.93  12    Cis-1,2-Dichloroethylene (156-59-2)  1  57  0.  0.  14    Cyclohexane (110-82-7)  8  50  2.10  14  14    Ethyll Benzene (100-41-4)  55  3  1.52.1  19.01  144    Ethyll Benzene (100-41-4)  55 <td>.94 3500</td> <td>0.0023</td> <td>350</td> <td></td>	.94 3500	0.0023	350	
2-Hexanone (591-78-6)454542-Propanol (67-63-0)441420.4943.681964-Ethyltoluene (622-96-8)15431.333.68294-Methyl-2-pentanone (108-10-1)23350.931.634.Acetaldehyde (75-07-0)6101.542.105.Acetone (67-64-1)580174.7222.7900Benzene (71-43-2)5802.114.0719Bromomethane (74-83-9)2561.7.Chloroethane [Ethyl chloride] (75-00-3)10486.328.5350Chlorooform (67-66-3)15700101001.54100Chloromethane [Methyl chloride] (74-87-3)5803.403.931212Cis-1,2-Dichloroethylene (156-59-2)1570.0.1.14Cyclohexane (110-82-7)8502.2.561.1.Ethanol (64-17-5)5531.52.119.0114414Ethyl Benzene (100-41-4)5531.062.108.6.Formaldehyde (50-00-0)6101.571.723.3.2.0Ithyl Benzene (100-41-4)5531.062.108.1.641.64Formaldehyde (50-00-0)6101.571.723.3.2.01.431.64Heyl Benzene (100-41-4)5531.062.	1.37 3900	0.0073	5000	0.0057
2-Propanol (67-63-0)  44  14  20.49  43.68  19    4-Ethyltoluene (622-96-8)  15  43  1.33  3.68  29    4-Methyl-2-pentanone (108-10-1)  23  35  0.93  1.63  4.    Acetaldehyde (75-07-0)  61  0  1.54  2.10  5.    Acetone (67-64-1)  58  0  2.11  4.07  19    Benzene (71-43-2)  58  0  2.11  4.07  19    Bromomethane (74-83-9)  2  56   1.  7.    Chloroethane [Ethyl chloride] (75-00-3)  10  48  6.32  8.53  56    Chloroform (67-66-3)  1  57   00  100  133  122    Chloroform (67-66-3)  1  57    00  100  133  122  100    Chloroform (67-66-3)  1  57  3  15.21  19.01  144    Ethyl Benzene (100-41-4)  55  3  1.521  19.01  144    Ethanol (64-17-5)  55  3 <t< td=""><td>5.73 40</td><td>0.14</td><td>30</td><td>010007</td></t<>	5.73 40	0.14	30	010007
4-Ethyltoluene (622-96-8)  15  43  1.33  3.68  29    4-Methyl-2-pentanone (108-10-1)  23  35  0.93  1.63  4.    Acetaldehyde (75-07-0)  61  0  1.54  2.10  5.    Acetaldehyde (75-07-0)  58  0  174.7  222.7  900    Benzene (71-43-2)  58  0  2.11  4.07  19    Bromomethane (74-83-9)  2  56   1.    Carbon Disulfide (75-15-0)  4  54   7.    Chloroethane [Ethyl chloride] (75-00-3)  10  48  6.32  8.53  50    Chloroform (67-66-3)  1  57   00  0.	6.51 7850 [odor]	0.0056	785 [odor]	0.056
4-Methyl-2-pentanone (108-10-1)  23  35  0.93  1.63  4.    Acetaldehyde (75-07-0)  61  0  1.54  2.10  5.    Acetaldehyde (75-07-0)  61  0  1.54  2.10  5.    Acetone (67-64-1)  58  0  2.11  4.07  19    Benzene (71-43-2)  58  0  2.11  4.07  19    Bromomethane (74-83-9)  2  56	9.97 1250	0.0029	125	0.029
Acetaldehyde (75-07-0)  61  0  1.54  2.10  5.    Acetone (67-64-1)  58  0  174.7  222.7  902    Benzene (71-43-2)  58  0  2.11  4.07  19    Bromomethane (74-83-9)  2  56  1.  1.    Carbon Disulfide (75-15-0)  4  54  7.  10    Chloroethane [Ethyl chloride] (75-00-3)  10  48  6.32  8.53  50    Chloromethane [Methyl chloride] (74-87-3)  58  0  3.40  3.93  12    cis-1,2-Dichloroethylene (156-59-2)  1  57  0.  0  0  58  0  2.10  8    Cyclohexane (110-82-7)  8  50  2.11  19.01  144    Ethyl Benzene (100-41-4)  55  3  15.21  19.01  144    Ethyl Benzene (100-41-4)  55  3  1.06  2.10  8    Formaldehyde (50-00-0)  61  0  1.57  1.72  3.    Freen 11 [Trichlorofluoromethane] (75-69-4)  40  18  0.91  1.17  1.<	.91 2050	0.00080	3000	0.00054
Acetone (67-64-1)  58  0  174.7  222.7  902    Benzene (71-43-2)  58  0  2.11  4.07  19    Bromomethane (74-83-9)  2  56  1.  1.    Carbon Disulfide (75-15-0)  4  54  7.  10    Chloroethane [Ethyl chloride] (75-00-3)  10  48  6.32  8.53  56    Chloroform (67-66-3)  1  57  10  10  10  48  6.32  8.53  50    Chloroform (67-66-3)  1  57  00  10  14  57  00    Curene (98-82-8)  0  58  0  3.40  3.93  12    Cyclohexane (110-82-7)  8  50  2.10  14    Ethyl Benzene (100-41-4)  55  3  1.5.21  19.01  144    Ethyl Benzene (100-41-4)  55  3  1.06  2.10  8    Formaldehyde (50-00-0)  61  0  1.57  1.72  3.    Freon 11 [Trichlorofluoromethane] (75-69-4)  40  18  0.91  1.17  1.	5.16 90	0.023	9	0.23
Benzene (71-43-2)  58  0  2.11  4.07  19    Bromomethane (74-83-9)  2  56  1.    Carbon Disulfide (75-15-0)  4  54  7.    Chloroethane [Ethyl chloride] (75-00-3)  10  48  6.32  8.53  50    Chloroofm (67-66-3)  1  57  10  10  48  6.32  8.53  50    Chloroothane [Methyl chloride] (74-87-3)  58  0  3.40  3.93  12    cis-1,2-Dichloroethylene (156-59-2)  1  57  0.  0  58  0  3.40  3.93  12    Cyclohexane (110-82-7)  8  50  2.  2.  61  0  1.57  1.4    Ethyl Benzene (100-41-4)  55  3  1.06  2.10  8.    Formaldehyde (50-00-0)  61  0  1.57  1.72  3.    Freon 11 [Trichlorofluoromethane] (75-69-4)  40  18  0.91  1.17  1.    Freon 12 [Dichlorodifluoromethane] (75-71-8)  58  0  2.11  2.17  2.    Heptane [n-Heptane] (142-82-	2.11 61800	0.0036	30880	0.0072
Bromomethane (74-83-9)  2  56  1.    Carbon Disulfide (75-15-0)  4  54  7.    Chloroethane [Ethyl chloride] (75-00-3)  10  48  6.32  8.53  50    Chloroofm (67-66-3)  1  57  10    Chloroomethane [Methyl chloride] (74-87-3)  58  0  3.40  3.93  12    cis-1,2-Dichloroethylene (156-59-2)  1  57  0.  0    Cumene (98-82-8)  0  58  2.  2.    Ethyl Benzene (100-41-4)  55  3  15.21  19.01  144    Ethyl Benzene (100-41-4)  55  3  1.06  2.10  8.    Formaldehyde (50-00-0)  61  0  1.57  1.72  3.    Freon 11 [Trichlorofluoromethane] (75-69-4)  40  18  0.91  1.17  1.    Freon 12 [Dichlorodifluoromethane] (75-71-8)  58  0  2.11  2.17  2.    Heptane [n-Heptane] (142-82-5)  47  11  3.39  4.38  166    Hexane [n-Heptane] (142-82-5)  57  3  5.09  11.98  78	9.80 29	0.14	30	0.14
Carbon Disulfide (75-15-0)  4  54  7.    Chloroethane [Ethyl chloride] (75-00-3)  10  48  6.32  8.53  56    Chlorooform (67-66-3)  1  57  10    Chloroothane [Methyl chloride] (74-87-3)  58  0  3.40  3.93  12    cis-1,2-Dichloroethylene (156-59-2)  1  57  0.  0.    Cumene (98-82-8)  0  58  2.  0.    Cyclohexane (110-82-7)  8  50  2.  1.43    Ethanol (64-17-5)  55  3  15.21  19.01  144    Ethyl Benzene (100-41-4)  55  3  1.06  2.10  8.    Formaldehyde (50-00-0)  61  0  1.57  1.72  3.    Freon 11 [Trichlorofluoromethane] (75-69-4)  40  18  0.91  1.17  1.    Freon 12 [Dichlorodifluoromethane] (75-71-8)  58  0  2.11  2.17  2.    Heptane [n-Heptane] (142-82-5)  47  11  3.39  4.38  16    Methylene Chloride [Dichloromethane] (75-09-2)  38  20  1.92	.51 190	0.0079	5	0.14
Chloroethane [Ethyl chloride] (75-00-3)  10  48  6.32  8.53  50    Chloroform (67-66-3)  1  57  10    Chloromethane [Methyl chloride] (74-87-3)  58  0  3.40  3.93  12    cis-1,2-Dichloroethylene (156-59-2)  1  57  0.    Cumene (98-82-8)  0  58  2.    Cyclohexane (110-82-7)  8  50  2.    Ethanol (64-17-5)  55  3  15.21  19.01  144    Ethyl Benzene (100-41-4)  55  3  1.06  2.10  8.    Formaldehyde (50-00-0)  61  0  1.57  1.72  3.    Freon 11 [Trichlorofluoromethane] (75-69-4)  40  18  0.91  1.17  1.    Freon 12 [Dichlorodifluoromethane] (75-71-8)  58  0  2.11  2.17  2.    Heptane [n-Heptane] (142-82-5)  47  11  3.39  4.38  16    Hexane [n-Heptane] (110-54-3)  130-20-7]  55  3  5.09  11.98  78    Methylene Chloride [Dichloromethane] (75-09-2)  38  20 <td< td=""><td>v.16 1000</td><td>0.0072</td><td>700</td><td></td></td<>	v.16 1000	0.0072	700	
Chloroform (67-66-3)  1  57  10    Chloromethane [Methyl chloride] (74-87-3)  58  0  3.40  3.93  12    cis-1,2-Dichloroethylene (156-59-2)  1  57  0  0    Cumene (98-82-8)  0  58  2  0    Cyclohexane (110-82-7)  8  50  2  2    Ethanol (64-17-5)  55  3  15.21  19.01  144    Ethyl Benzene (100-41-4)  55  3  1.06  2.10  8    Formaldehyde (50-00-0)  61  0  1.57  1.72  3    Freon 11 [Trichlorofluoromethane] (75-69-4)  40  18  0.91  1.17  1    Freon 12 [Dichlorodifluoromethane] (75-71-8)  58  0  2.11  2.17  2    Heptane [n-Heptane] (142-82-5)  47  11  3.39  4.38  16    Hexane [n-Hexane] (110-54-3)  40  18  1.59  3.38  20    m,p-Xylene (108-38-3/106-42-3) [1330-20-7]  55  3  5.09  11.98  78    Methylene Chloride [Dichloromethane] (75-09-2)  38	i0.1 39600	0.00022	10000	0.00085
Chloromethane [Methyl chloride] (74-87-3)  58  0  3.40  3.93  12    cis-1,2-Dichloroethylene (156-59-2)  1  57  0.    Cumene (98-82-8)  0  58  0    Cyclohexane (110-82-7)  8  50  2.    Ethanol (64-17-5)  55  3  15.21  19.01  144    Ethyl Benzene (100-41-4)  55  3  1.06  2.10  8.    Formaldehyde (50-00-0)  61  0  1.57  1.72  3.    Freon 11 [Trichlorofluoromethane] (75-69-4)  40  18  0.91  1.17  1.    Freon 12 [Dichlorodifluoromethane] (75-71-8)  58  0  2.11  2.17  2.    Heptane [n-Heptane] (142-82-5)  47  11  3.39  4.38  16    Hexane [n-Heptane] (110-54-3)  40  18  1.59  3.38  20    m.p-Xylene (108-38-3/106-42-3) [1330-20-7]  55  3  5.09  11.98  78    Methylene Chloride [Dichloromethane] (75-09-2)  38  20  1.95  3.11  10    o-Xylene (95-47-6) [1330-20-7]  56	0.25 490	0.021	98	0.00005
cis-1,2-Dichloroethylene (156-59-2)  1  57  0    Cumene (98-82-8)  0  58  2.    Cyclohexane (110-82-7)  8  50  2.    Ethanol (64-17-5)  55  3  15.21  19.01  148    Ethyl Benzene (100-41-4)  55  3  1.06  2.10  8.    Formaldehyde (50-00-0)  61  0  1.57  1.72  3.    Freon 11 [Trichlorofluoromethane] (75-69-4)  40  18  0.91  1.17  1.    Freon 12 [Dichlorodifluoromethane] (75-71-8)  58  0  2.11  2.17  2.    Heptane [n-Heptane] (142-82-5)  47  11  3.39  4.38  16    Hexane [n-Heptane] (110-54-3)  40  18  1.59  3.38  20    m,p-Xylene (108-38-3/106-42-3) [1330-20-7]  55  3  5.09  11.98  78    Methylene Chloride [Dichloromethane] (75-09-2)  38  20  1.95  3.11  10    o-Xylene (95-47-6) [1330-20-7]  56  2  1.92  5.30  43    Propylbenzene (103-65-1)  3  55	2.79 1030	0.0038	90.00	0.044
Cumene (98-82-8)  0  58    Cyclohexane (110-82-7)  8  50  2.    Ethanol (64-17-5)  55  3  15.21  19.01  143    Ethyl Benzene (100-41-4)  55  3  1.06  2.10  8.    Formaldehyde (50-00-0)  61  0  1.57  1.72  3.    Freon 11 [Trichlorofluoromethane] (75-69-4)  40  18  0.91  1.17  1.    Freon 12 [Dichlorodifluoromethane] (75-71-8)  58  0  2.11  2.17  2.    Heptane [n-Heptane] (142-82-5)  47  11  3.39  4.38  16    Hexane [n-Heptane] (110-54-3)  40  18  1.59  3.38  20    m,p-Xylene (108-38-3/106-42-3) [1330-20-7]  55  3  5.09  11.98  78    Methylene Chloride [Dichloromethane] (75-09-2)  38  20  1.95  3.11  10    o-Xylene (95-47-6) [1330-20-7]  56  2  1.92  5.30  43    Propylbenzene (103-65-1)  3  55  1.  5.  1.    Styrene (100-42-5)  5  5 <td>0.13 210</td> <td>0.00062</td> <td>200</td> <td></td>	0.13 210	0.00062	200	
Cyclohexane (110-82-7)  8  50  2.    Ethanol (64-17-5)  55  3  15.21  19.01  148    Ethyl Benzene (100-41-4)  55  3  1.06  2.10  8.    Formaldehyde (50-00-0)  61  0  1.57  1.72  3.    Freon 11 [Trichlorofluoromethane] (75-69-4)  40  18  0.91  1.17  1.    Freon 12 [Dichlorodifluoromethane] (75-71-8)  58  0  2.11  2.17  2.    Heptane [n-Heptane] (142-82-5)  47  11  3.39  4.38  16    Hexane [n-Hexane] (110-54-3)  40  18  1.59  3.38  20    m,p-Xylene (108-38-3/106-42-3) [1330-20-7]  55  3  5.09  11.98  78    Methylene Chloride [Dichloromethane] (75-09-2)  38  20  1.95  3.11  10    o-Xylene (95-47-6) [1330-20-7]  56  2  1.92  5.30  43    Propylbenzene (103-65-1)  3  55  1.  55  1.    Styrene (100-42-5)  5  53  53  1.	500		400	
Ethanol (64-17-5)  55  3  15.21  19.01  148    Ethyl Benzene (100-41-4)  55  3  1.06  2.10  8.    Formaldehyde (50-00-0)  61  0  1.57  1.72  3.    Freon 11 [Trichlorofluoromethane] (75-69-4)  40  18  0.91  1.17  1.    Freon 12 [Dichlorodifluoromethane] (75-71-8)  58  0  2.11  2.17  2.    Heptane [n-Heptane] (142-82-5)  47  11  3.39  4.38  16    Hexane [n-Heptane] (110-54-3)  40  18  1.59  3.38  20    m,p-Xylene (108-38-3/106-42-3) [1330-20-7]  55  3  5.09  11.98  78    Methylene Chloride [Dichloromethane] (75-09-2)  38  20  1.95  3.11  10    o-Xylene (95-47-6) [1330-20-7]  56  2  1.92  5.30  43    Propylbenzene (103-65-1)  3  55  1.  1.  1.    Styrene (100-42-5)  5  53  53  1.  1.	2.27 1400	0.0016	6000	
Ethyl Benzene (100-41-4)5531.062.108.Formaldehyde (50-00-0)6101.571.723.Freon 11 [Trichlorofluoromethane] (75-69-4)40180.911.171.Freon 12 [Dichlorodifluoromethane] (75-71-8)5802.112.172.Heptane [n-Heptane] (142-82-5)47113.394.3816Hexane [n-Heptane] (110-54-3)40181.593.3820m,p-Xylene (108-38-3/106-42-3) [1330-20-7]5535.0911.9878Methylene Chloride [Dichloromethane] (75-09-2)38201.953.1110o-Xylene (95-47-6) [1330-20-7]5621.925.3043Propylbenzene (103-65-1)3551.531.59	8.76 18800	0.0010	1880	0.010
Formaldehyde (50-00-0)  61  0  1.57  1.72  3.    Freon 11 [Trichlorofluoromethane] (75-69-4)  40  18  0.91  1.17  1.    Freon 12 [Dichlorodifluoromethane] (75-71-8)  58  0  2.11  2.17  2.    Heptane [n-Heptane] (142-82-5)  47  11  3.39  4.38  16    Hexane [n-Hexane] (110-54-3)  40  18  1.59  3.38  20    m,p-Xylene (108-38-3/106-42-3) [1330-20-7]  55  3  5.09  11.98  78    Methylene Chloride [Dichloromethane] (75-09-2)  38  20  1.95  3.11  10    o-Xylene (95-47-6) [1330-20-7]  56  2  1.92  5.30  43    Propylbenzene (103-65-1)  3  55  1.  5  5  1.	3.68 43400	0.000048	1000	0.0021
Freon 11 [Trichlorofluoromethane] (75-69-4)40180.911.171.Freon 12 [Dichlorodifluoromethane] (75-71-8)5802.112.172.Heptane [n-Heptane] (142-82-5)47113.394.3816Hexane [n-Hexane] (110-54-3)40181.593.3820m,p-Xylene (108-38-3/106-42-3) [1330-20-7]5535.0911.9878Methylene Chloride [Dichloromethane] (75-09-2)38201.953.1110o-Xylene (95-47-6) [1330-20-7]5621.925.3043Propylbenzene (103-65-1)3551.1.Styrene (100-42-5)55391.95	6.77 49	0.035	10	0.17
Freon 12 [Dichlorodifluoromethane] (75-71-8)5802.112.172.Heptane [n-Heptane] (142-82-5)47113.394.3816Hexane [n-Hexane] (110-54-3)40181.593.3820m,p-Xylene (108-38-3/106-42-3) [1330-20-7]5535.0911.9878Methylene Chloride [Dichloromethane] (75-09-2)38201.953.1110o-Xylene (95-47-6) [1330-20-7]5621.925.3043Propylbenzene (103-65-1)3551.1.Styrene (100-42-5)55391.95	.63 28000 [odor]	0.000042	2800 [odor]	0.00042
Heptane [n-Heptane] (142-82-5)47113.394.3816Hexane [n-Hexane] (110-54-3)40181.593.3820m,p-Xylene (108-38-3/106-42-3) [1330-20-7]5535.0911.9878Methylene Chloride [Dichloromethane] (75-09-2)38201.953.1110o-Xylene (95-47-6) [1330-20-7]5621.925.3043Propylbenzene (103-65-1)3551.55319	2.87 49500	0.000044	4950	0.00044
Hexane [n-Hexane] (110-54-3)  40  18  1.59  3.38  20    m,p-Xylene (108-38-3/106-42-3) [1330-20-7]  55  3  5.09  11.98  78    Methylene Chloride [Dichloromethane] (75-09-2)  38  20  1.95  3.11  10    o-Xylene (95-47-6) [1330-20-7]  56  2  1.92  5.30  43    Propylbenzene (103-65-1)  3  55  1.  11    Styrene (100-42-5)  5  53  19	6.79 3500	0.0013	350	0.013
m,p-Xylene (108-38-3/106-42-3) [1330-20-7]5535.0911.9878Methylene Chloride [Dichloromethane] (75-09-2)38201.953.1110o-Xylene (95-47-6) [1330-20-7]5621.925.3043Propylbenzene (103-65-1)3551.1.Styrene (100-42-5)55319	0.43 5300	0.00064	700	0.0048
Methylene Chloride [Dichloromethane] (75-09-2)  38  20  1.95  3.11  10    o-Xylene (95-47-6) [1330-20-7]  56  2  1.92  5.30  43    Propylbenzene (103-65-1)  3  55  1.  10    Styrene (100-42-5)  5  53  19	8.11 8700	0.0014	100	0.12
o-Xylene (95-47-6) [1330-20-7]5621.925.3043Propylbenzene (103-65-1)3551.Styrene (100-42-5)55319	0.76 2100	0.0015	1040	0.0030
Propylbenzene (103-65-1)  3  55  1.    Styrene (100-42-5)  5  53  19	3.39 8700	0.00061	100	0.053
Styrene (100-42-5) 5 53 19	.82 1250	0.0015	125	
	9.58 8500	0.0023	1000	
	2.71 1360	0.0020	270	
Tetrahydrofuran (109-99-9) 0 58	5900		590	
	9.09 3800	0.0038	5000	0.0029
Trichloroethylene (79-01-6) 0 58	10700	0.0000	54	0.002)
• • • •	3.07 1300	0.00068	100	
Hazard Index (Sum of Hazard Quotients)	1500	0.00000	.00	0.93
Hazard Index (Sum of Hazard Quotients) Hazard Index (Sum of Hazard Quotients, excluding HQ values based on odor)		0.49		0.93

<sup>a</sup> Mean concentration and 95% upper confidence level of the mean @ 25 °C, as determined by EPAs ProUCL software (version 4.00.05).

	Selected Chemicals and Values for Unit Excess Cancer Risk												
	1,2-Dichloroethane $(2.6\text{E}-5/\mu\text{g/m}^3)$		Acetaldehyde (2.2E-6/µg/m <sup>3</sup> )		Benzene (7.8E-6/µg/m <sup>3</sup> )		Formaldehyde $(1.3\text{E-}5/\mu\text{g/m}^3)$		Methylene Chloride (4.7E-7/µg/m <sup>3</sup> )		Vinyl Chloride (4.4E-6/µg/m <sup>3</sup> )		
Monitoring Sites	Mean Conc. <sup>a</sup> (µg/m <sup>3</sup> )	Excess Cancer Risk <sup>b</sup>	Mean Conc. <sup>a</sup> (µg/m <sup>3</sup> )	Excess Cancer Risk <sup>b</sup>	Mean Conc. <sup>a</sup> (µg/m <sup>3</sup> )	Excess Cancer Risk <sup>b</sup>	Mean Conc. <sup>a</sup> (µg/m <sup>3</sup> )	Excess Cancer Risk <sup>b</sup>	Mean Conc. <sup>a</sup> (µg/m <sup>3</sup> )	Excess Cancer Risk <sup>b</sup>	Mean Conc. <sup>a</sup> (µg/m <sup>3</sup> )	Excess Cancer Risk <sup>b</sup>	Total Excess Cancer Risk
Bargerville			1.26	2.8E-6	1.64	13E-6	1.39	18E-6	_				34E-6
Big Sandy	0.52	14E-6	0.97	2.1E-6	2.53	20E-6	1.10	14E-6	3.80	1.8E-6	0.97	4.3E-6	56E-6
Bondurant			1.16	2.6E-6	1.30	10E-6	1.06	14E-6					27E-6
Boulder			0.93	2.0E-6	2.05	16E-6	0.93	12E-6					30E-6
CASTnet	0.08	2.1E-6	1.14	3.6E-6	2.42	19E-6	1.11	14E-6					39E-6
Daniel	0.17	4.4E-6	1.26	2.5E-6	1.26	9.8E-6	1.32	17E-6	1.11	0.52E-6	0.33	1.5E-6	36E-6
Farson-Eden			1.54	3.4E-6	1.85	14E-6	1.33	17E-6					34E-6
La Barge #1			1.55	3.4E-6	3.70	29E-6	1.90	25E-6					57E-6
Marbleton East			1.36	3.0E-6	1.97	15E-6	1.26	16E-6	0.76	0.36E-6			34E-6
Marbleton/Big Piney	0.26	6.8E-6	1.61	3.5E-6	1.49	12E-6	1.89	25E-6	1.50	0.71E-6	0.52	2.3E-6	50E-6
Pinedale #1	0.36	9.4E-6	1.54	3.4E-6	2.11	16E-6	1.57	20E-6	1.95	0.92E-6	0.70	3.1E-6	53E-6
Sand Draw	0.22	5.7E-6	1.46	3.2E-6	2.45	19E-6	1.80	23E-6	1.98	0.93E-6	0.41	1.8E-6	54E-6

Calculated Excess Lifetime Cancer Risk for Chronic Exposure to Selected Chemicals of Potential Concern in Ambient Air Based on Mean Concentration (April 2009-March 2010)

<sup>a</sup> Mean concentration, as determined using EPA's *ProUCL* software (version 4.00.05). Units are  $\mu g/m^3$  at 25°C.

<sup>b</sup> Product of (unit excess cancer risk ) x (mean concentration).