

# Austin – Round Rock Toxics Study (ARTS)

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URS Corporation

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# ARTS Objectives

- Measure and report levels of common urban air toxics
- Identify chemicals of potential concern
- Establish baseline for measuring trends
- Inform the public

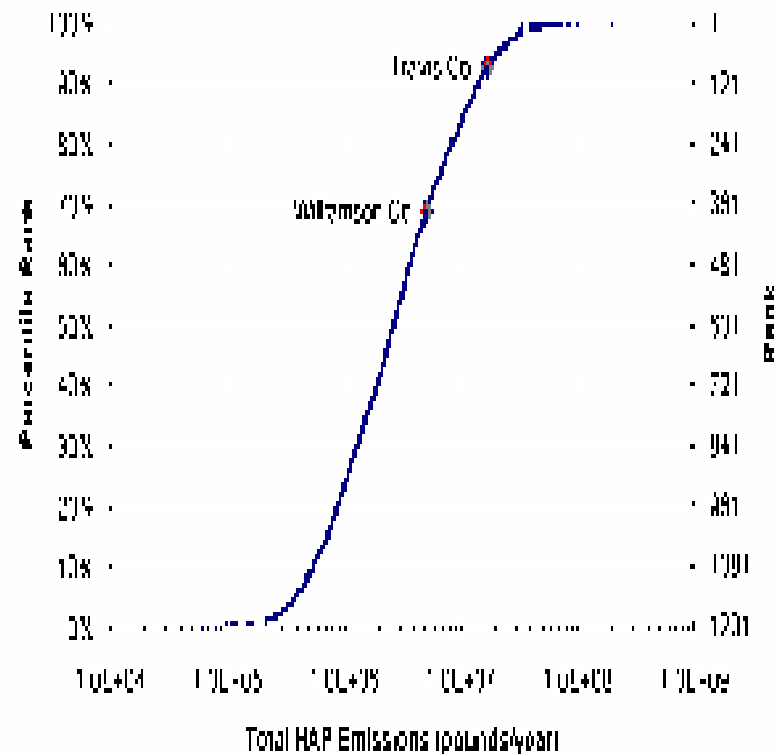
# Project Team

- Sponsored by U.S. EPA Region 6
- Managed by Capital Area Council of Governments (CAPCOG)
- Field sampling by URS Corporation
- Laboratory Analysis by ERG

# Austin-Round Rock Quick Facts

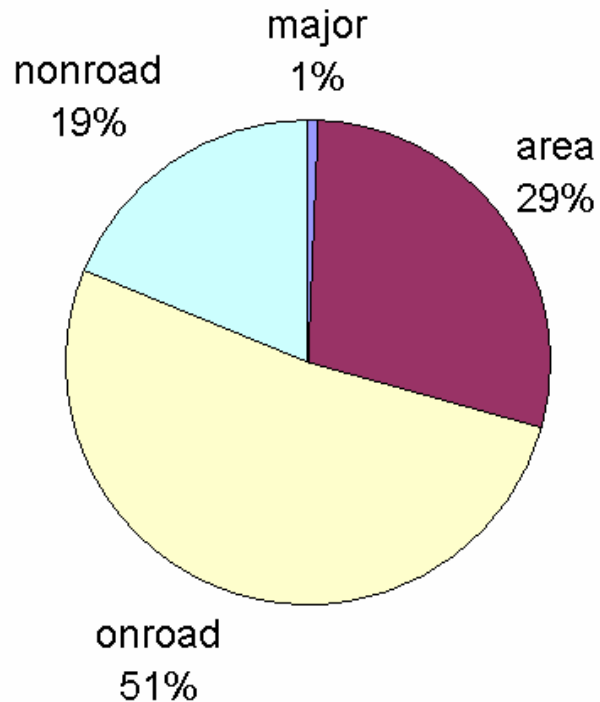
- 2005 population estimate – 1.2 million
  - 38<sup>th</sup> largest U.S. MSA in 2000
- Two largest counties, Travis and Williamson, ranked 85<sup>th</sup> and 376<sup>th</sup> in 1999 total NEI HAPS Emissions (among 1207 U.S. urban counties)

Travis and Williamson HAPS Emissions Rankings  
(U.S. Urban Counties: 1999 NEI)

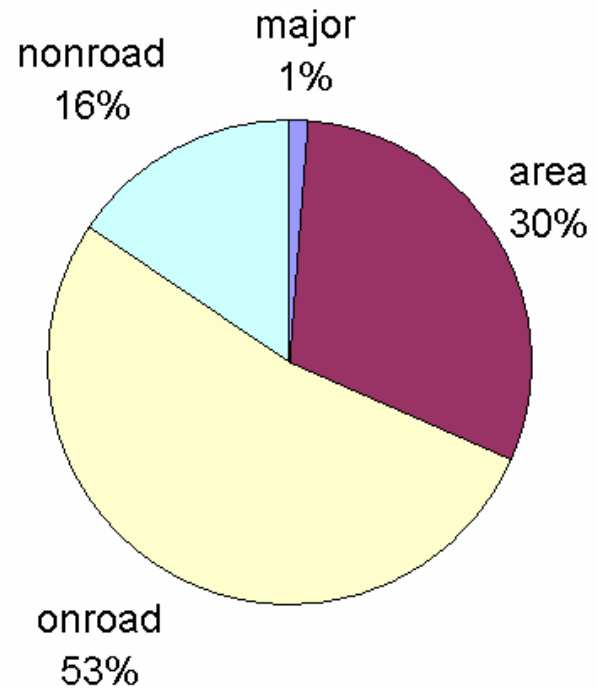


# Travis and Williamson County Total HAP Emissions

Travis Co.

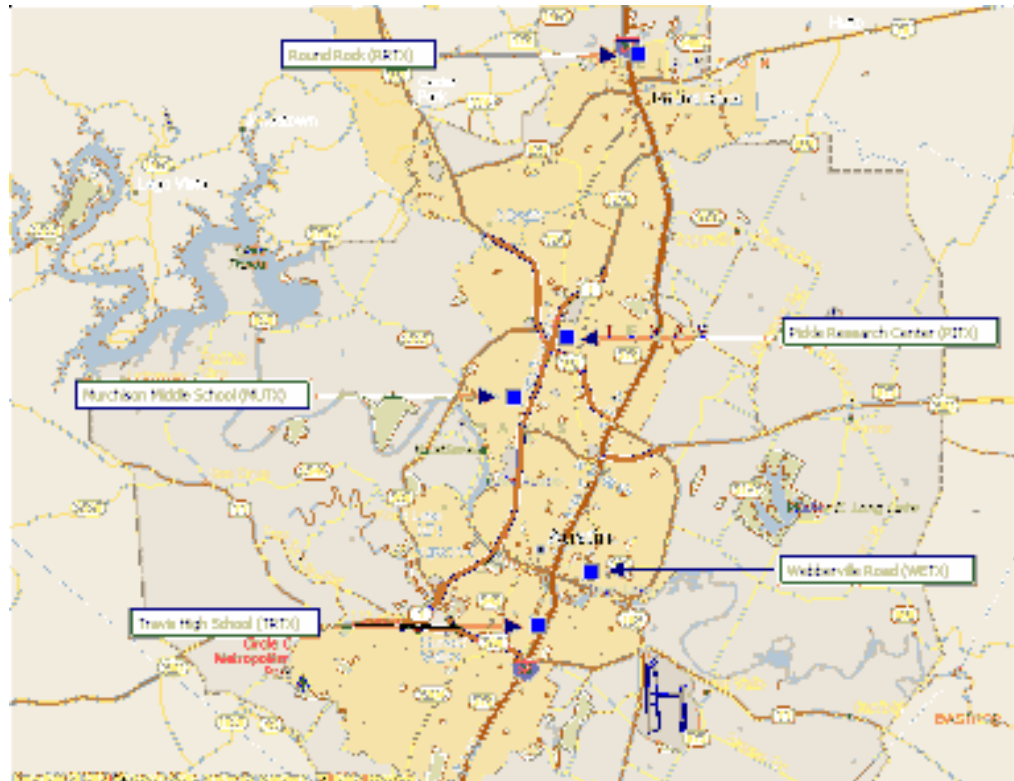


Williamson Co.



# ARTS Overview

- 5 sampling sites
- 12-month sampling duration
  - Jun 05 – Jun 06
- 24-hour sampling period
- Every 12<sup>th</sup> day sampling frequency
  - Approximately 30 samples per site
  - Field duplicates at one site
- 83 chemicals target chemicals:
  - 59 volatile organic compounds
  - 12 carbonyls
  - 12 metals



# Measurement Methods

| <b>Target Chemicals</b> | <b>Method</b>     | <b>Sampling Media</b>                     | <b>Analysis Technique</b> |
|-------------------------|-------------------|---|---------------------------|
| 59 VOC                  | TO-15             | SS canister                               | GC-MS                     |
| 12 Carbonyls            | TO-11A            | DNPH cartridge                            | HPLC                      |
| 12 Metals               | IO-3.5            | Quartz Fiber Filters                      | ICP/MS                    |
| Hexavalent Chromium     | Modified CARB 039 | Bicarbonate-impregnated cellulose filters | IC                        |

# ARTS Sampling Equipment





# Data Treatment

- $\frac{1}{2}$  the detection limit (DL) was substituted for all non detects
- $\frac{1}{2}$  the DL was substituted for all values reported below the DL
- Average field blank levels for carbonyls and metals were subtracted from reported ambient values

# Data Analysis

- Comparison with reference levels
- Estimation of excess cancer risks
- Analysis of spatial variation
- Comparison with other cities

# Reference Concentration Levels and Unit Risk Estimates

- EPA NATA health effects criteria
  - <http://www.epa.gov/ttn/atw/nata1999/99pdfs/healtheffectsinfo.pdf>
- RfC: reference concentration level used to screen for possible non-cancer adverse exposures
- URE: upper-bound excess cancer risk estimated to result from a lifetime of continuous exposure to  $1 \mu\text{g}/\text{m}^3$

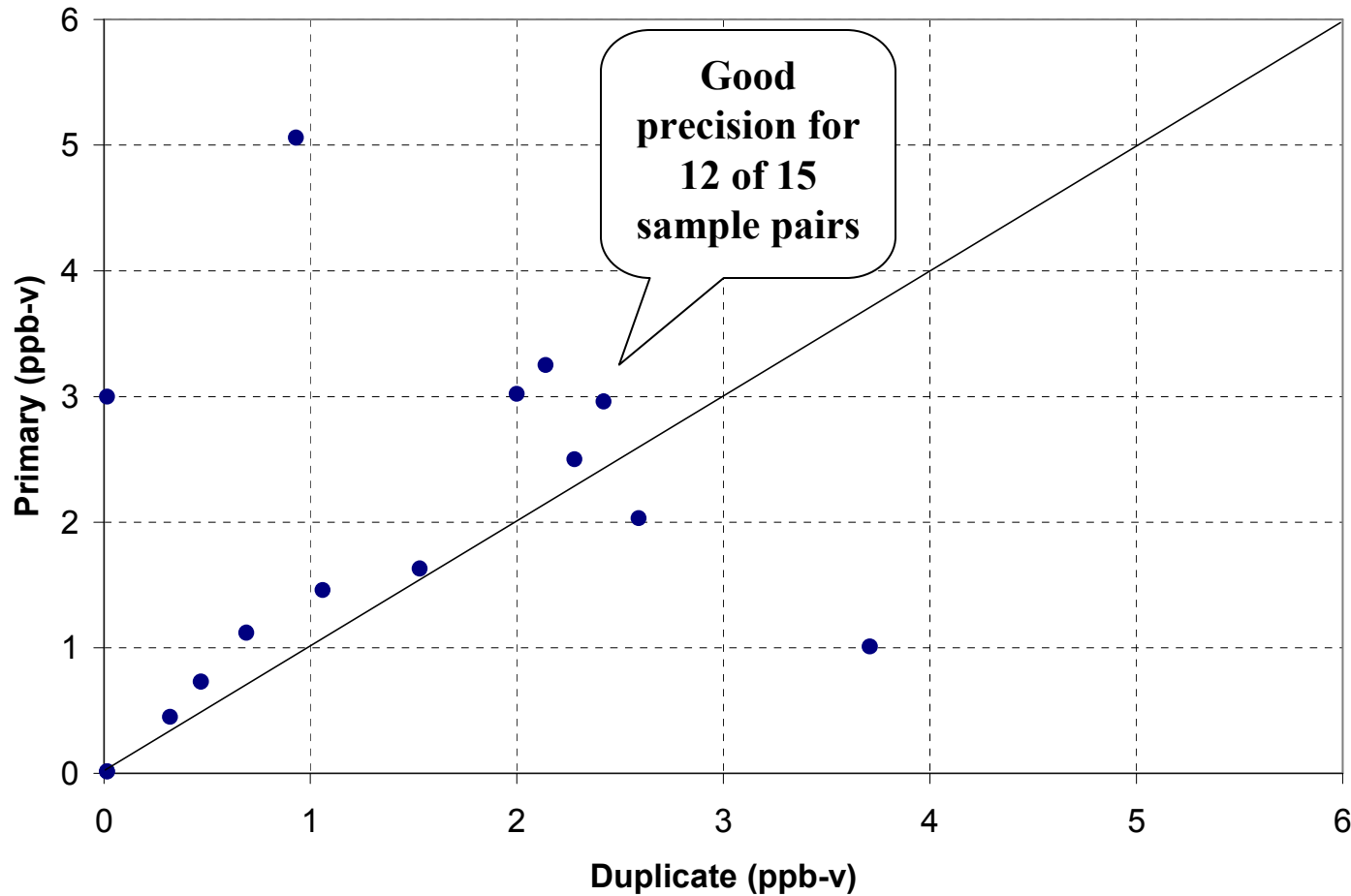
# Top 10 Non-Cancer Hazard Quotients

(Hazard Quotient = Avg. Conc. ÷ RfC)

| Chemical          | Average Concentrations (µg/m <sup>3</sup> ) |             |             |             |             | RfC (µg/m <sup>3</sup> ) | Highest Hazard Quotient |
|-------------------|---|-------------|-------------|-------------|-------------|--------------------------|-------------------------|
|                   | MUTX  | PITX        | RRTX        | TRTX        | WETX        |                          |                         |
| <b>Acrolein</b>   | <b>3.73</b>                                 | <b>2.51</b> | <b>4.60</b> | <b>2.58</b> | <b>4.24</b> | <b>0.02</b>              | <b>230</b>              |
| Formaldehyde      | 2.77  | 2.84        | 3.26        | 2.97        | 2.72        | 9.8                      | 0.33                    |
| Acetaldehyde      | 1.33  | 1.32        | 1.37        | 1.39        | 1.61        | 9                        | 0.18                    |
| 1,3-Butadiene     | 0.07  | 0.07        | 0.07        | 0.14        | 0.29        | 2                        | 0.14                    |
| Manganese         | 0.005                                       | 0.006       | 0.006       | 0.005       | 0.007       | 0.05                     | 0.14                    |
| 1,2-Dibromoethane | 0.10  | 0.10        | 0.10        | 0.11        | 0.10        | 0.8                      | 0.14                    |
| Acrylonitrile     | 0.07  | 0.06        | 0.06        | 0.06        | 0.14        | 2                        | 0.07                    |
| Benzene           | 0.94  | 0.80        | 0.98        | 1.11        | 1.77        | 30                       | 0.06                    |
| m,p-Xylene        | 0.89  | 0.80        | 0.90        | 1.02        | 4.69        | 100                      | 0.05                    |
| Arsenic           | 0.0005                                      | 0.0005      | 0.0005      | 0.001       | 0.001       | 0.03                     | 0.04                    |

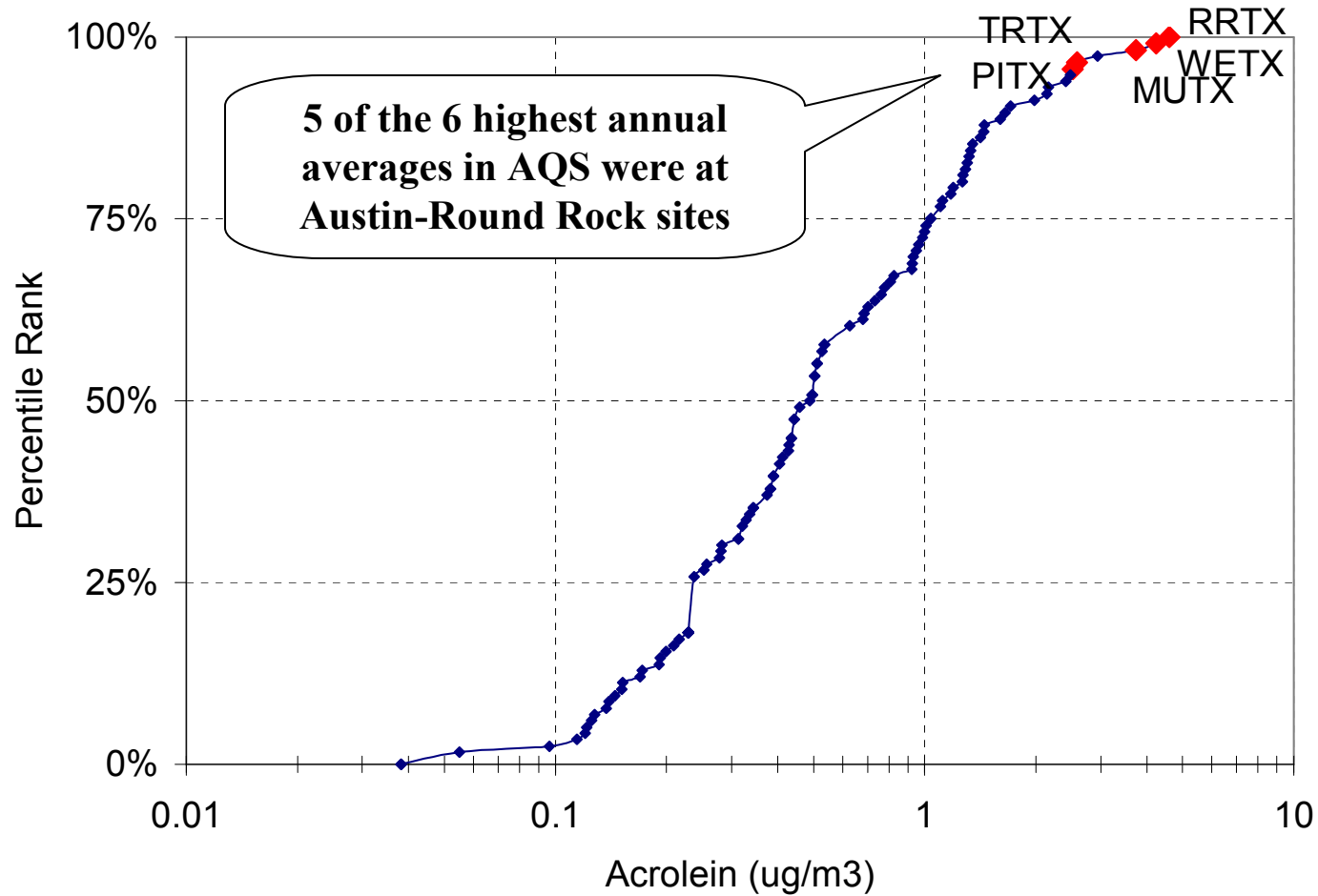
# Acrolein Canister Duplicates

Average RPD = 50% (N=15)



# U.S. 2005 Annual Average Acrolein Levels

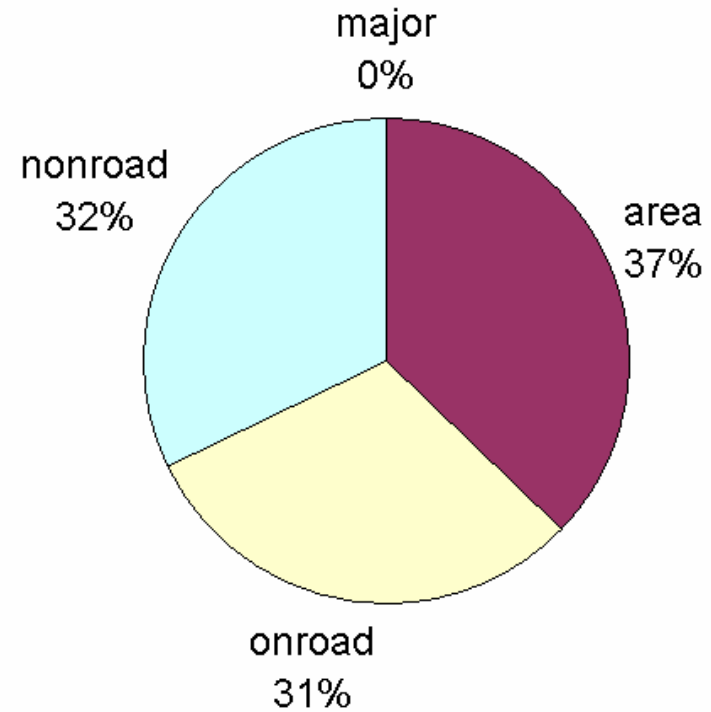
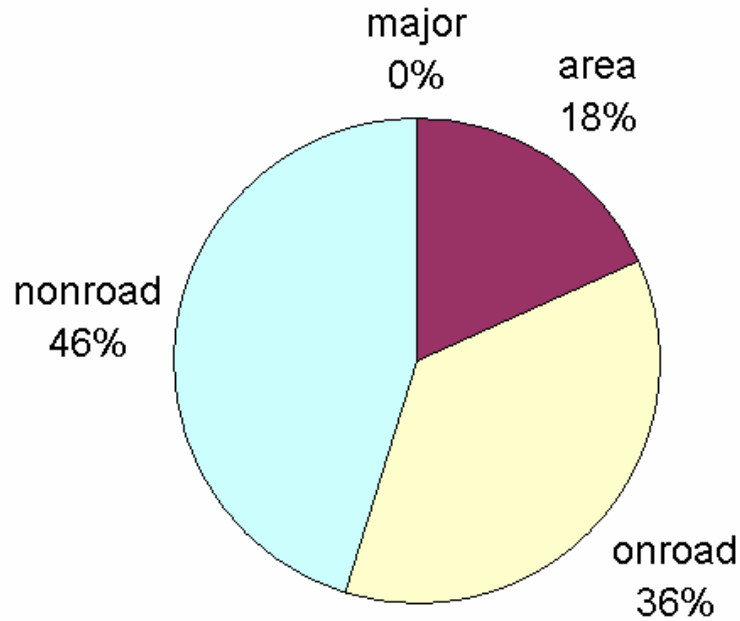
from <http://www.epa.gov/air/data/index.html>



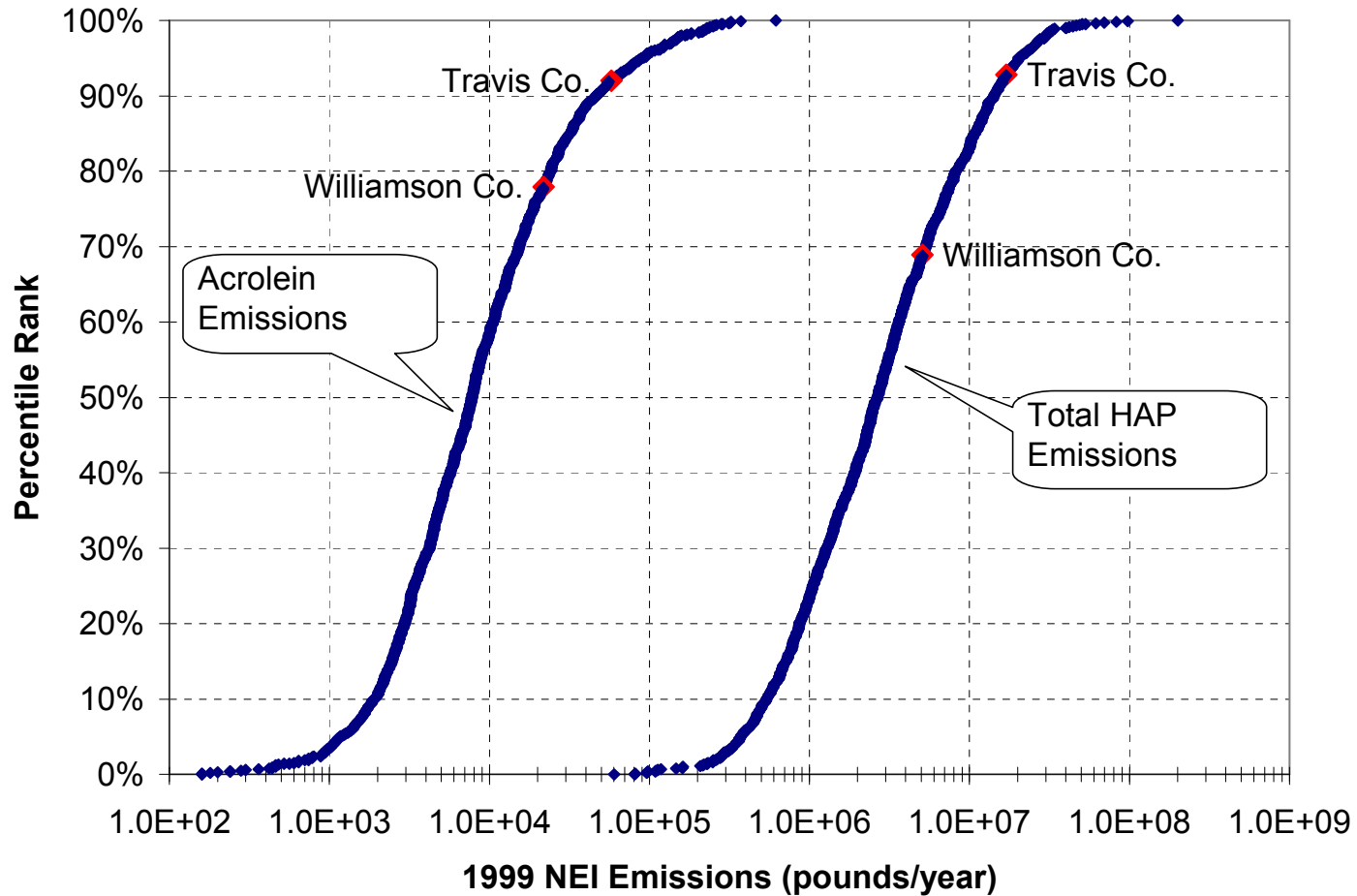
# Travis and Williamson County Acrolein Sources (1999 NEI)

Travis Co.

Williamson Co.

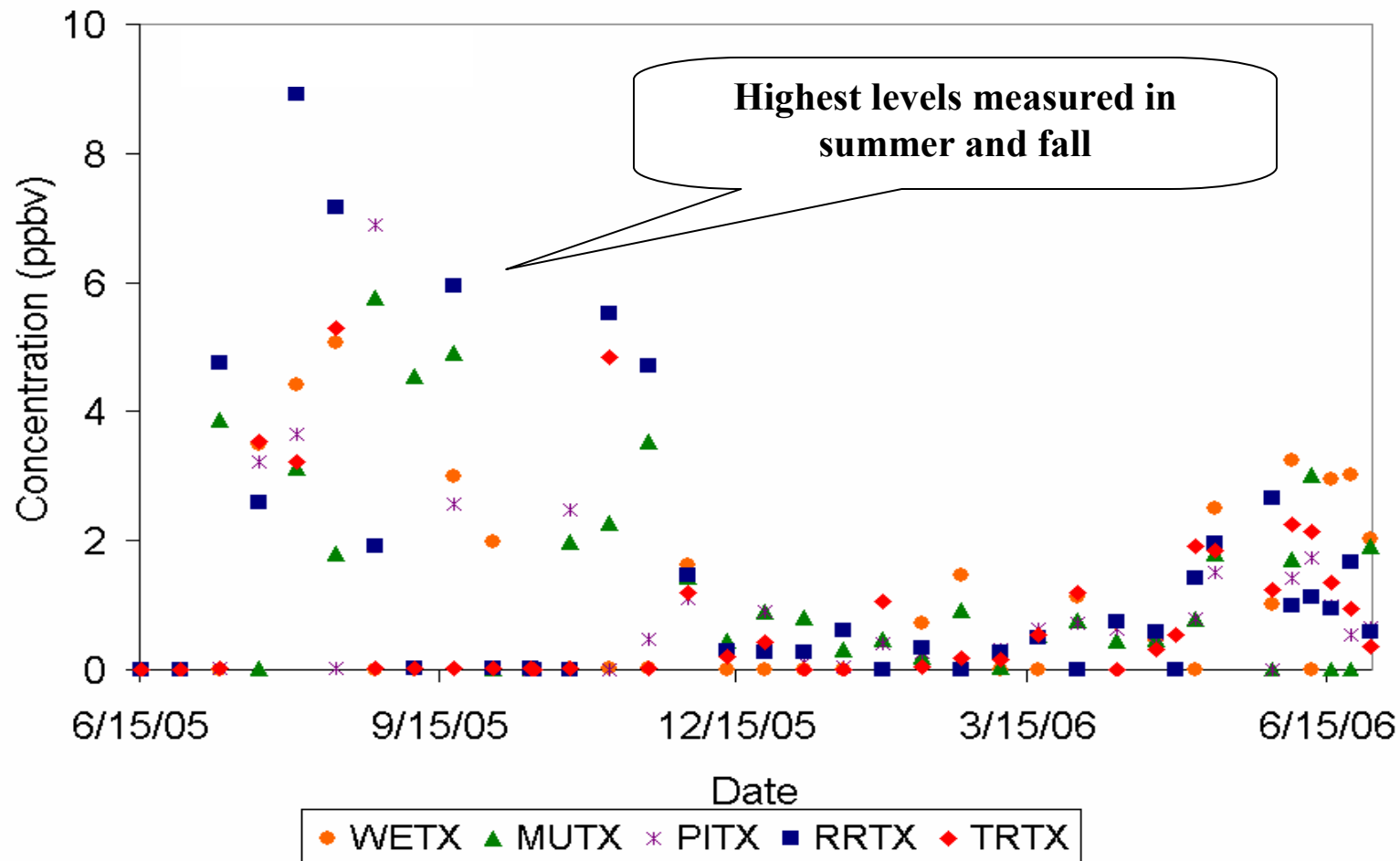


# Travis and Williamson County Acrolein and Total HAP Emissions Rankings (U.S. Urban Counties)

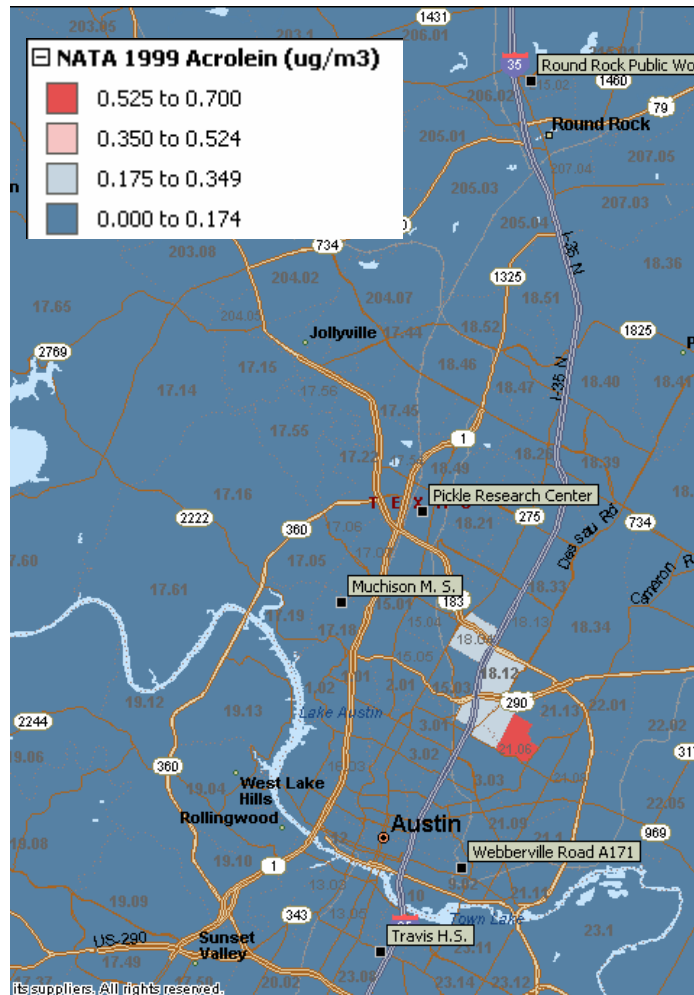




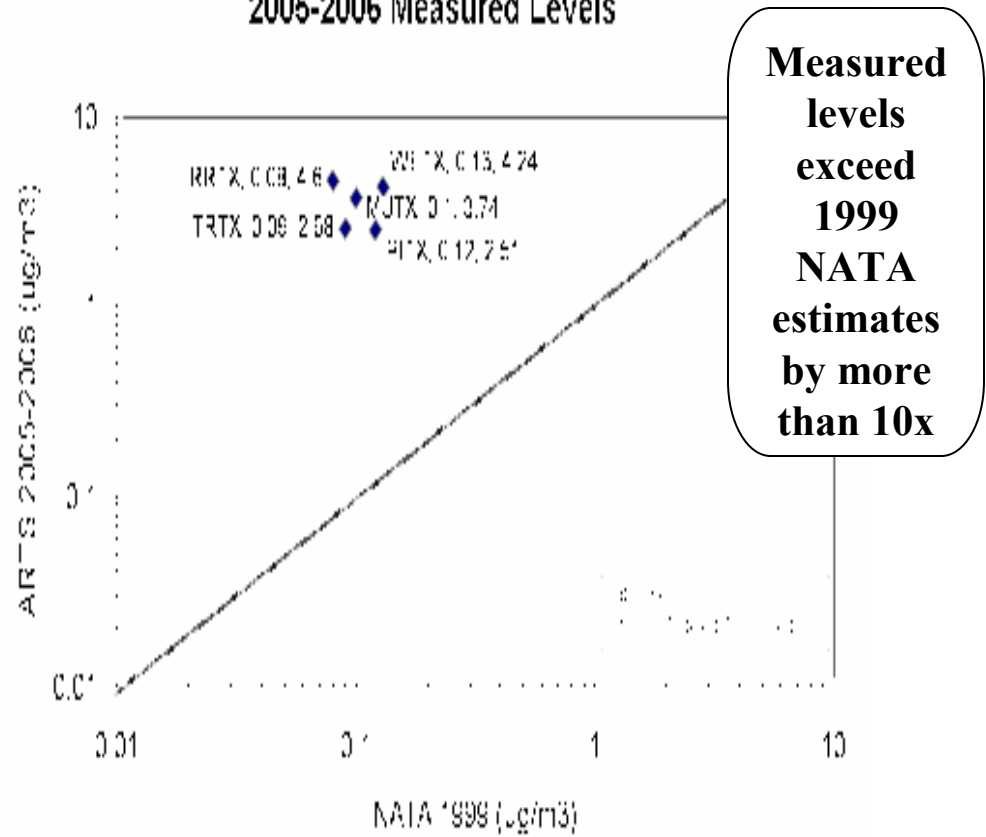
# Acrolein Time Series



# Comparison of NATA 1999 Acrolein Estimates with ARTS 2005-06 Measured Concentrations



Comparison of NATA 1999 Estimates with ARTS 2005-2006 Measured Levels



# Top 15 Cancer Risks

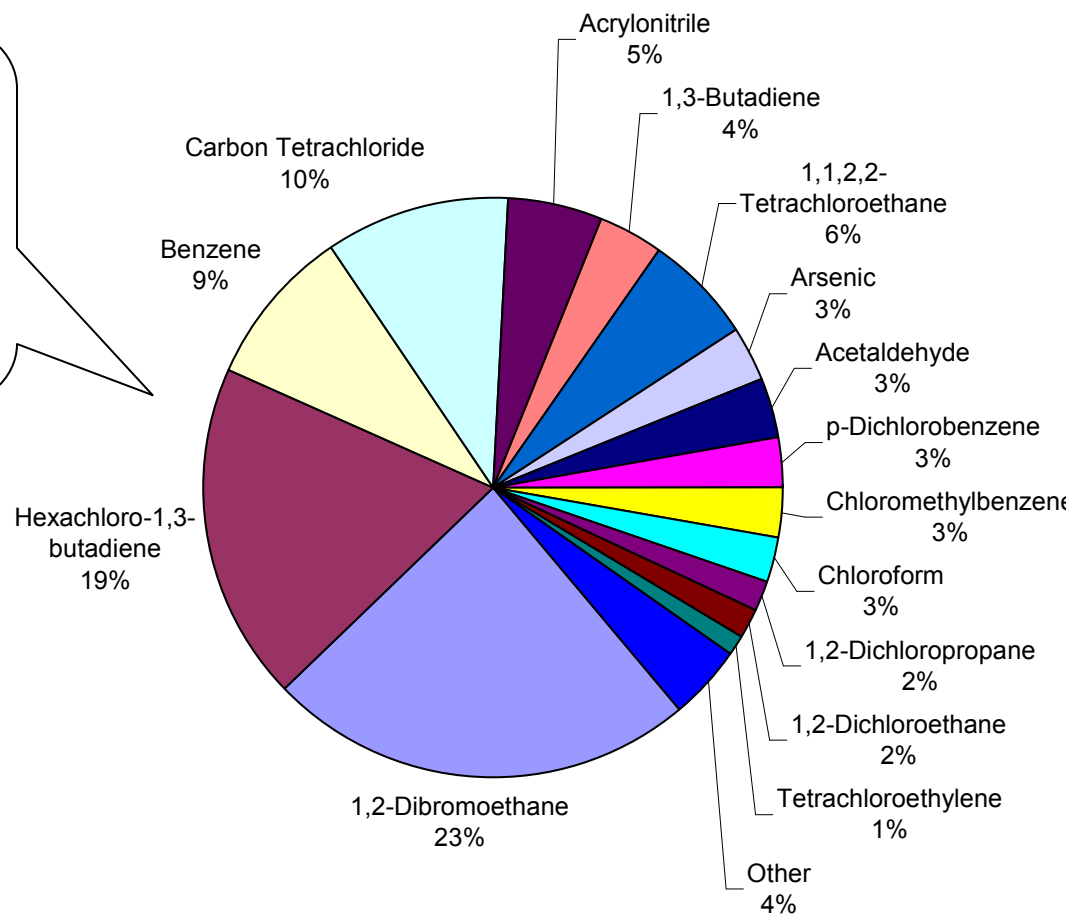
(Excess Risk = Avg. Conc. × URE × 10<sup>6</sup>)

| Chemical Name (% > DL)        | Average Concentrations (µg/m <sup>3</sup> ) |        |        |        |        | URE (µg/m <sup>3</sup> ) <sup>-1</sup> | Highest Excess Risk (per million) |
|-------------------------------|---|--------|--------|--------|--------|--|-----------------------------------|
|                               | MUTX  | PITX   | RRTX   | TRTX   | WETX   |  |                                   |
| 1,2-Dibromoethane (1)         | 0.10  | 0.10   | 0.10   | 0.11   | 0.10   | 0.00022                                | 24.2                              |
| Hexachloro-1,3-butadiene (1)  | 0.83  | 0.86   | 0.80   | 0.80   | 0.80   | 0.000022                               | 18.9                              |
| Benzene (100)                 | 0.94  | 0.80   | 0.98   | 1.11   | 1.77   | 7.8E-06                                | 13.8                              |
| Carbon Tetrachloride (100)    | 0.63  | 0.68   | 0.66   | 0.68   | 0.69   | 0.000015                               | 10.4                              |
| Acrylonitrile (3)             | 0.07  | 0.06   | 0.06   | 0.06   | 0.14   | 0.000068                               | 9.7                               |
| 1,3-Butadiene (60)            | 0.07  | 0.07   | 0.07   | 0.14   | 0.29   | 0.00003                                | 8.7                               |
| 1,1,1,2-Tetrachloroethane (9) | 0.10  | 0.10   | 0.10   | 0.10   | 0.10   | 0.000058                               | 5.9                               |
| Arsenic (100)                 | 0.0005                                      | 0.0005 | 0.0005 | 0.0010 | 0.0011 | 0.0043                                 | 4.6                               |
| Chloroform (10)               | 0.07  | 0.11   | 0.18   | 0.09   | 0.10   | 0.000023                               | 4.2                               |
| Acetaldehyde (100)            | 1.33  | 1.32   | 1.37   | 1.39   | 1.61   | 2.2E-06                                | 3.5                               |
| p-Dichlorobenzene (9)         | 0.23  | 0.24   | 0.26   | 0.26   | 0.29   | 0.000011                               | 3.2                               |
| Chloromethylbenzene (0)       | 0.06  | 0.05   | 0.05   | 0.06   | 0.05   | 0.000049                               | 2.7                               |
| 1,2-Dichloropropane (0)       | 0.08  | 0.08   | 0.09   | 0.08   | 0.09   | 0.000019                               | 1.7                               |
| 1,2-Dichloroethane (0)        | 0.06  | 0.05   | 0.05   | 0.06   | 0.06   | 0.000026                               | 1.7                               |
| Tetrachloroethylene (46)      | 0.27  | 0.11   | 0.26   | 0.19   | 0.18   | 5.6E-06                                | 1.5                               |

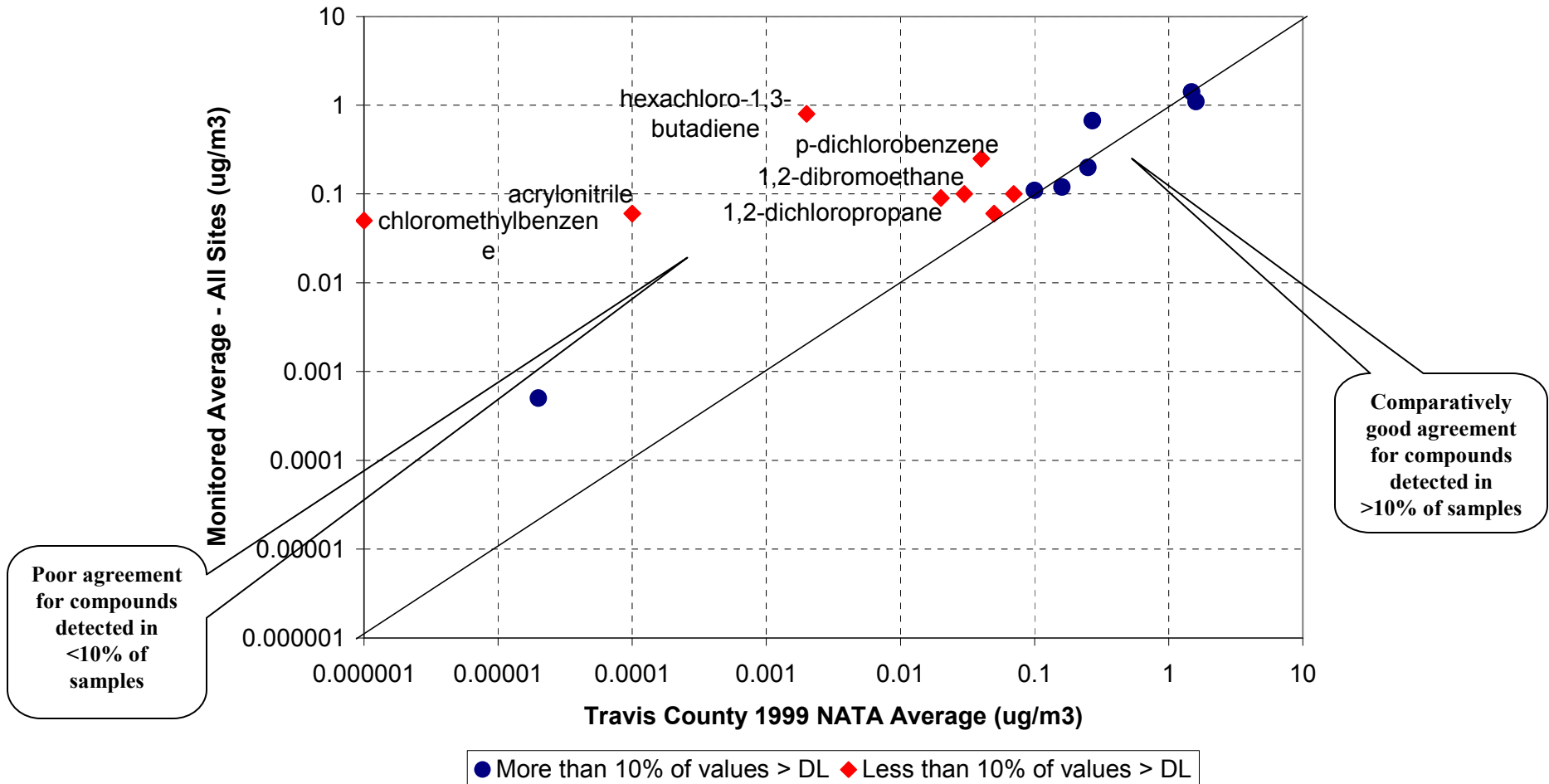
# Percentages of Total Excess Cancer Risk Attributed to ARTS Pollutants – All Sites

**½ DL Substituted for Non-Detects**

**Compounds detected in less than 10% of the samples accounted for greater than 60% of the estimated excess risk**



# Comparison of Measured Levels with 1999 NATA Average Concentrations for Travis County



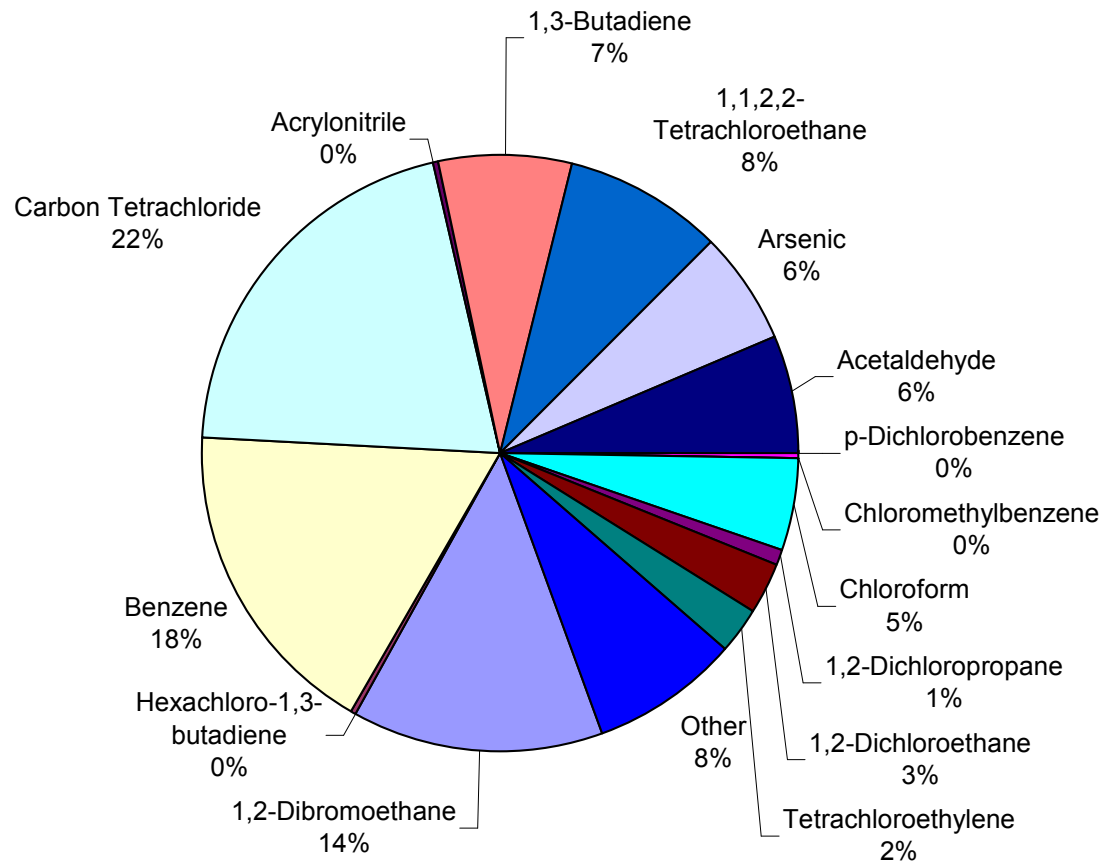
# Top 10 Cancer Risks

(Risk Estimated with 1999 NATA Travis County Average Concentrations Substituted for Compounds with <10% of Values > DL)

| Chemical Name (% > DL)        | Average Concentrations ( $\mu\text{g}/\text{m}^3$ )<br>(1999 NATA Travis County Average Concentrations Substituted for Compounds with <10% of Values > DL) |        |        |        |        | URE<br>( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup> | Highest Excess Risk (per million) |
|-------------------------------|--|--------|--------|--------|--------|---|-----------------------------------|
|                               | MUTX   | PITX   | RRTX   | TRTX   | WETX   |   |                                   |
| Benzene (100)                 | 0.94   | 0.80   | 0.98   | 1.11   | 1.77   | 7.8E-06   | 13.8                              |
| Carbon Tetrachloride (100)    | 0.63   | 0.68   | 0.66   | 0.68   | 0.69   | 0.000015  | 10.4                              |
| 1,3-Butadiene (60)            | 0.07   | 0.07   | 0.07   | 0.14   | 0.29   | 0.00003   | 8.7                               |
| 1,2-Dibromoethane (1)         | 0.03   | 0.03   | 0.03   | 0.03   | 0.03   | 0.00022   | 6.6                               |
| Arsenic (100)                 | 0.0005   | 0.0005 | 0.0005 | 0.0010 | 0.0011 | 0.0043  | 4.6                               |
| Chloroform (10)               | 0.07   | 0.11   | 0.18   | 0.09   | 0.10   | 0.000023  | 4.2                               |
| 1,1,2,2-Tetrachloroethane (0) | 0.07   | 0.07   | 0.07   | 0.07   | 0.07   | 0.000058  | 4.1                               |
| Acetaldehyde (100)            | 1.33   | 1.32   | 1.37   | 1.39   | 1.61   | 2.2E-06   | 3.5                               |
| Tetrachloroethylene (46)      | 0.27   | 0.11   | 0.26   | 0.19   | 0.18   | 5.6E-06   | 1.5                               |
| 1,2-Dichloroethane (0)        | 0.05   | 0.05   | 0.05   | 0.05   | 0.05   | 0.000026  | 1.3                               |

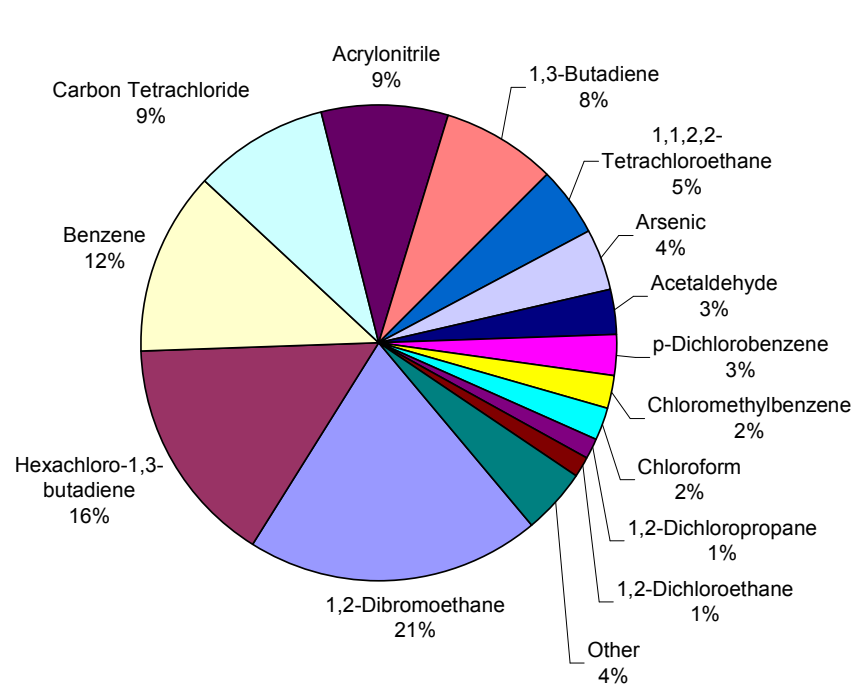
# Percentages of Total Excess Cancer Risk Attributed to ARTS Pollutants – All Sites

**Travis County 1999 NATA Average Concentrations Substituted for Compounds w <10% of Values > DL**

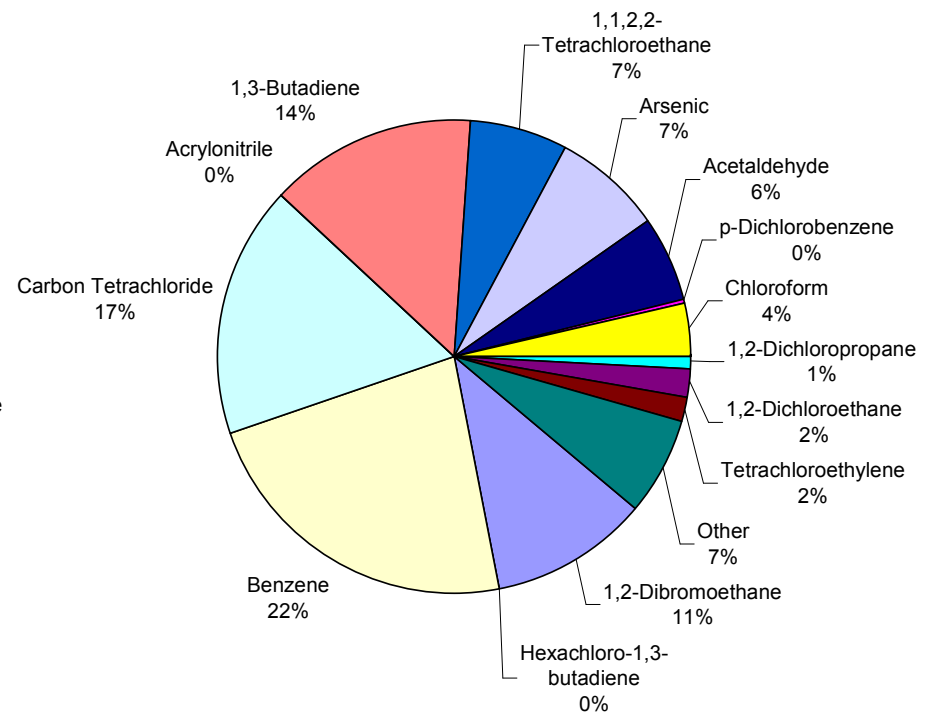


# Percentages of Total Excess Cancer Risk Attributed to ARTS Pollutants – Webberville Rd.

**½ DL Substituted for Non-Detects**



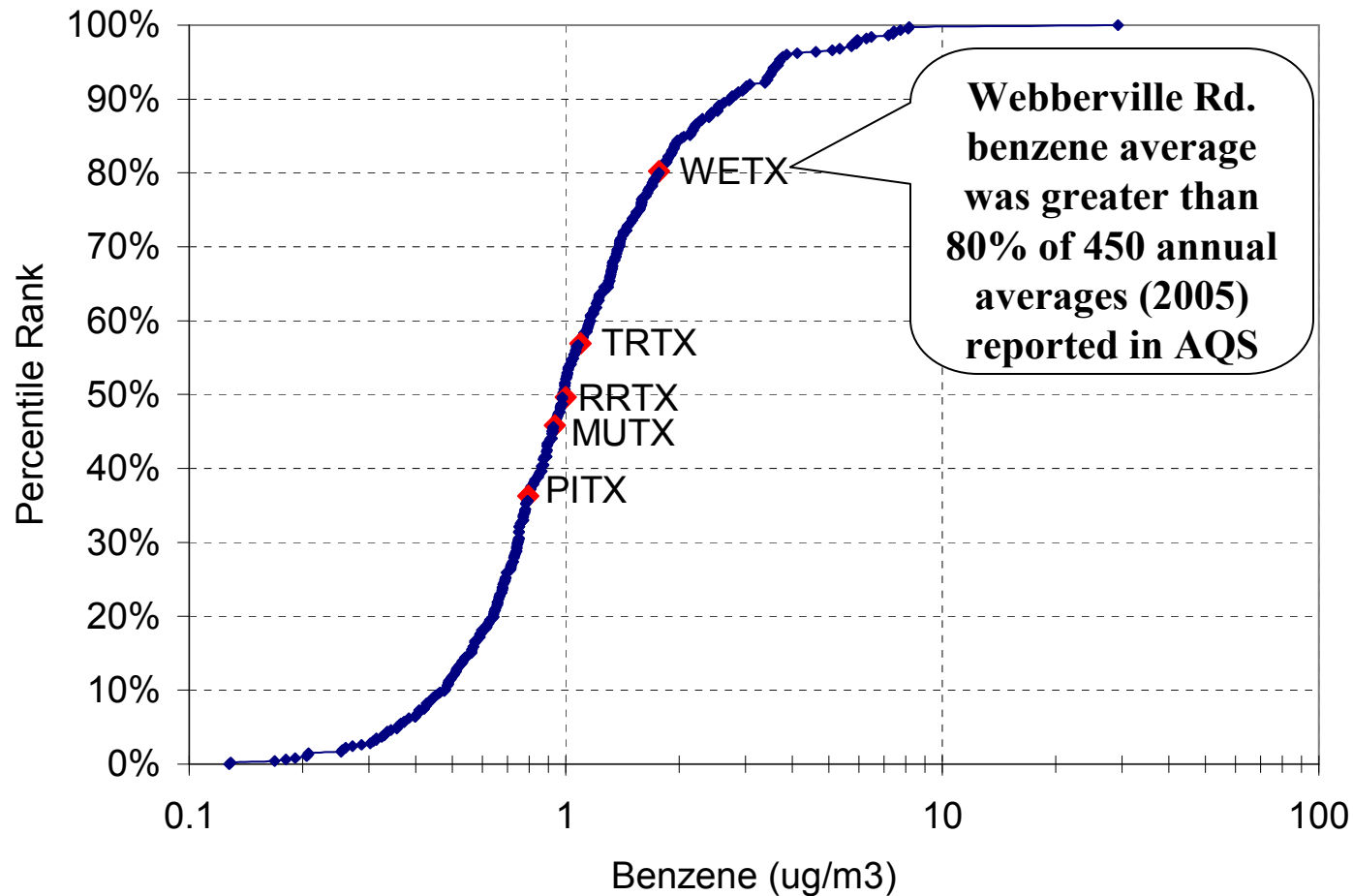
**Travis County 1999 NATA Average  
Concentrations Substituted for  
Compounds w <10% of Values > DL**





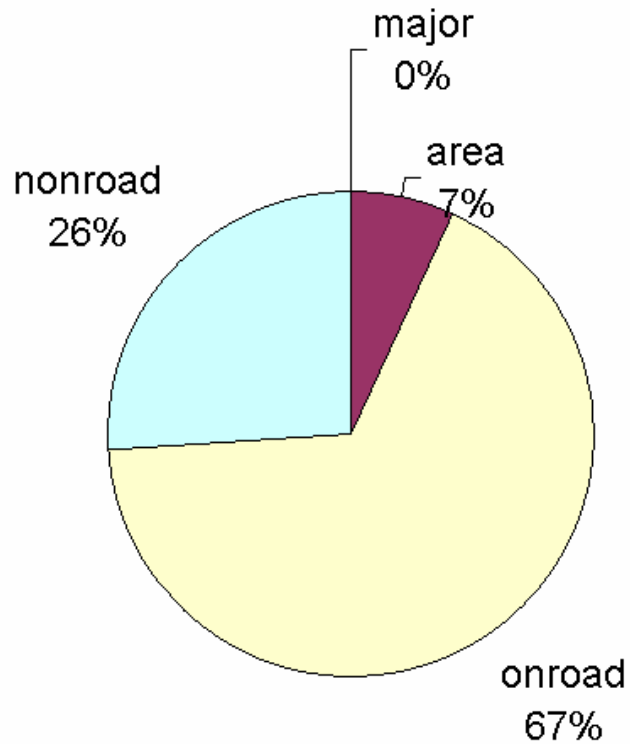
# U.S. 2005 Annual Average Benzene Levels

from <http://www.epa.gov/air/data/index.html>

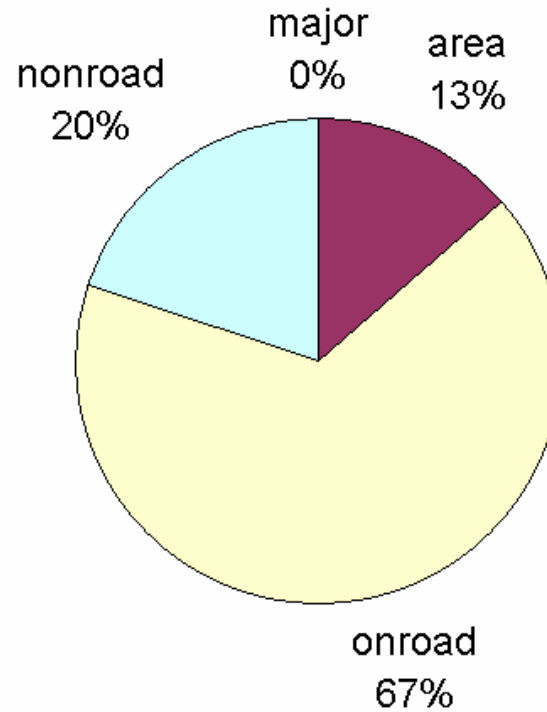


# Travis and Williamson County Benzene Sources (1999 NEI)

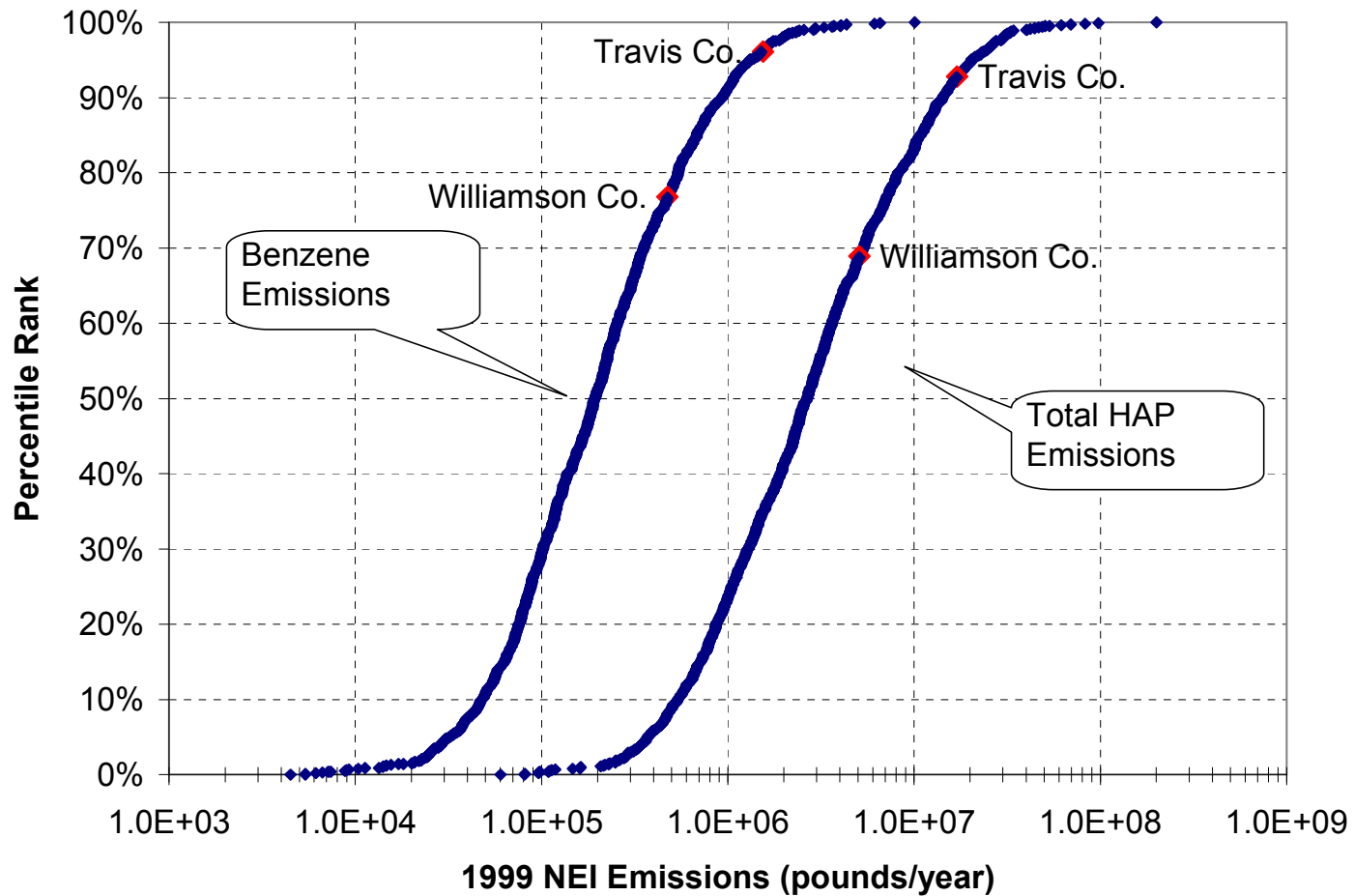
Travis Co.



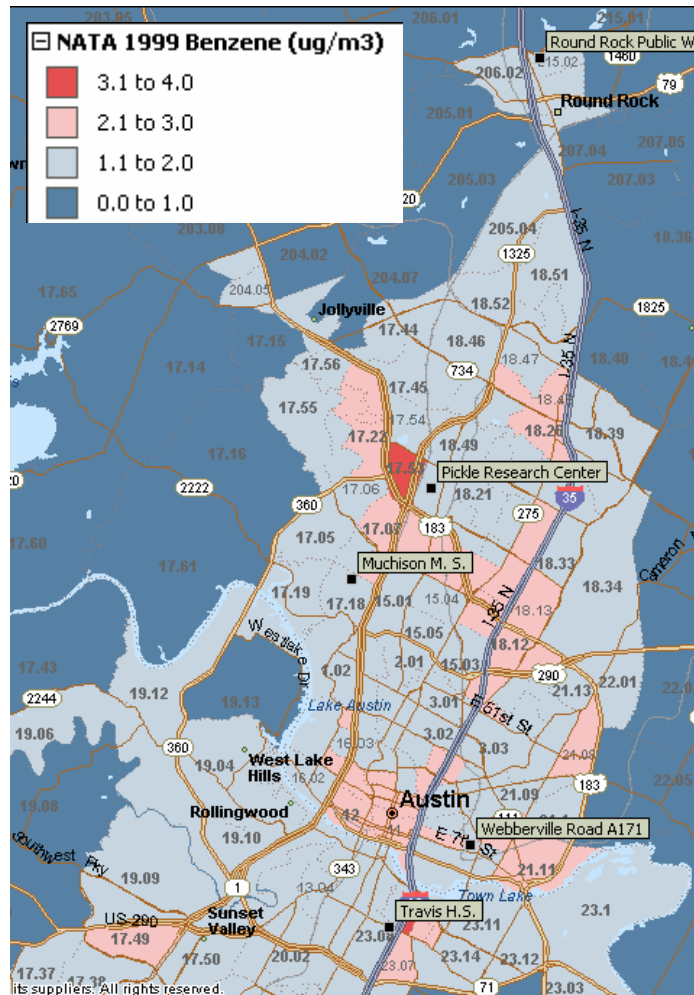
Williamson Co.



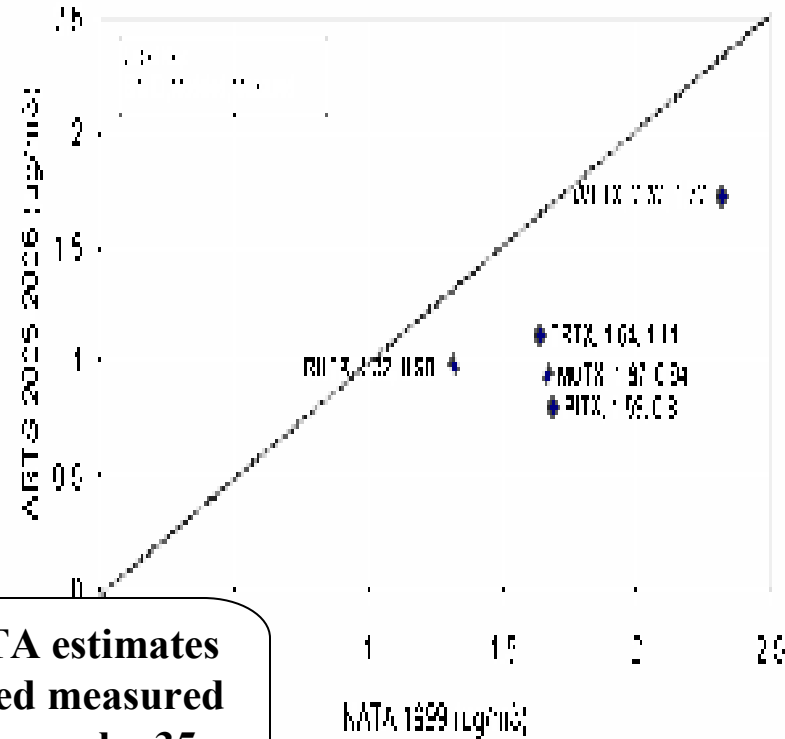
# Travis and Williamson County Benzene and Total HAP Emissions Rankings (U.S. Urban Counties)



# Comparison of NATA 1999 Benzene Estimates with ARTS 2005-06 Measured Concentrations

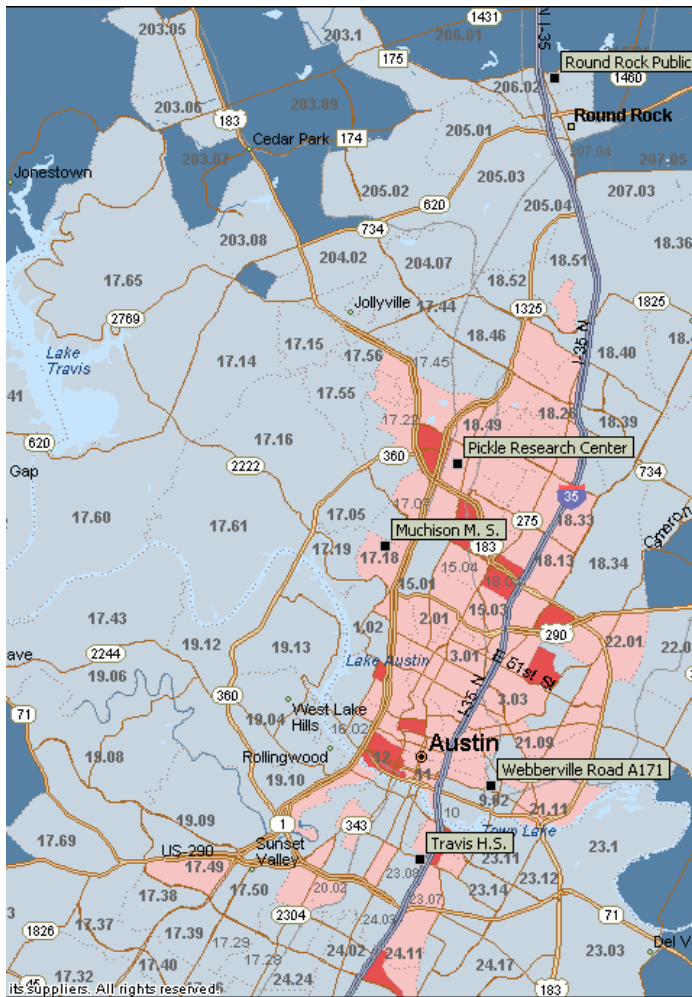


Comparison of NATA 1999 Estimates with ARTS 2005-2006 Measured Levels

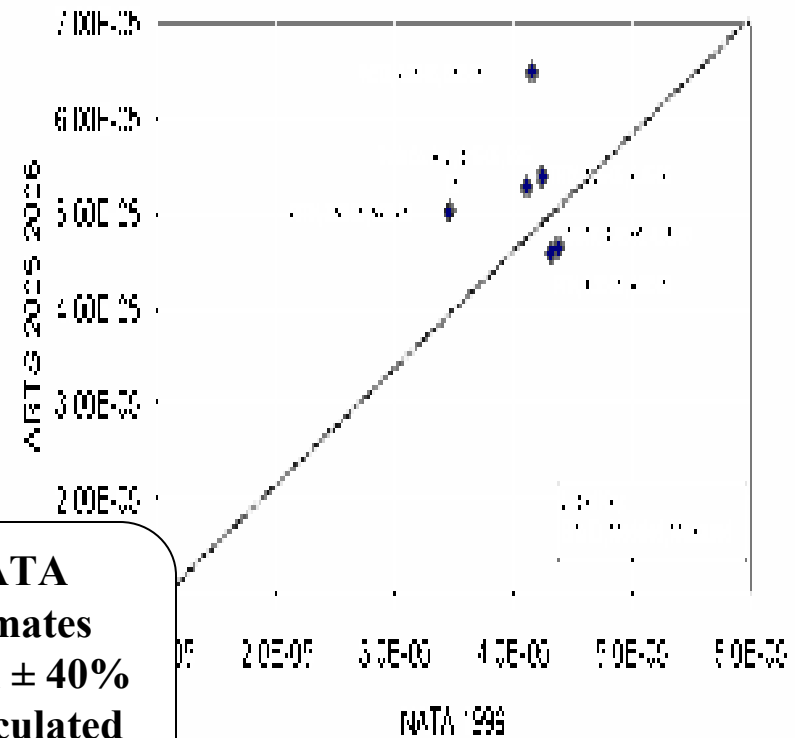


**NATA estimates exceed measured averages by 35-111%**

# Comparison of NATA 1999 Excess Cancer Risk Estimates with ARTS 2005-06 Measured Levels



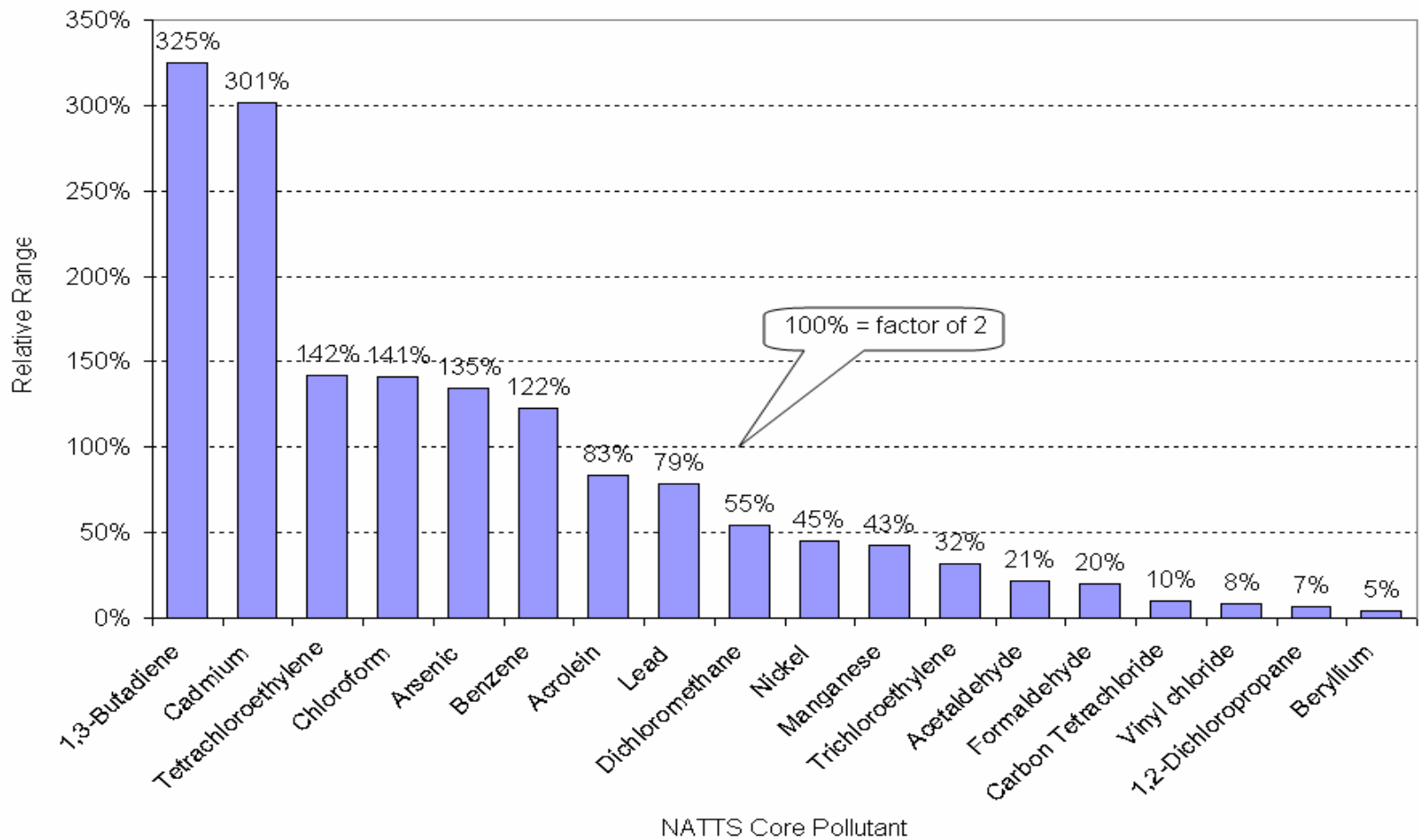
Comparison of NATA 1999 Excess Cancer Risk Estimates with ARTS 2005-2006 Calculated Levels



**NATA estimates within  $\pm 40\%$  of calculated excess risks**

# ARTS Spatial Variability

(Highest Site Average – Lowest Average) ÷ Lowest Average



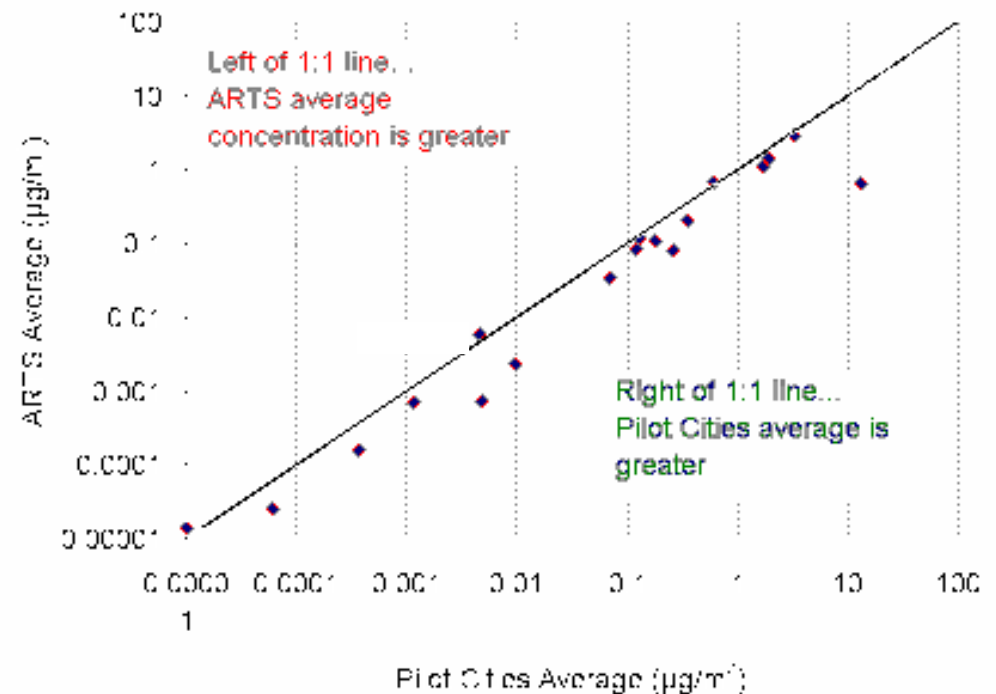
# Comparison of Results with Data from Other Cities

- 10-city air toxics pilot study
- 2001-2002
- <http://www.ladco.org/toxics.html>



# ARTS Average Levels Compared to Pilot Cities Average Levels

| ANALYTE              | Average ( $\mu\text{g}/\text{m}^3$ ) |              |
|----------------------|--------------------------------------|--------------|
|                      | ARTS                                 | Pilot Cities |
| 1,2-Dichloropropane  | 0.085                                | 0.120        |
| 1,3-Butadiene        | 0.118                                | 0.130        |
| Acetaldehyde         | 1.411                                | 1.910        |
| Acrolein             | 3.474                                |              |
| Arsenic              | 6.99E-04                             | 1.15E-03     |
| Benzene              | 1.079                                | 1.700        |
| Beryllium            | 1.37E-05                             | 1.00E-05     |
| Cadmium              | 1.58E-04                             | 3.70E-04     |
| Carbon Tetrachloride | 0.666                                | 0.610        |
| Chloroform           | 0.110                                | 0.180        |
| Formaldehyde         | 2.924                                | 3.290        |
| Hexavalent Chromium  | 2.56E-05                             | 6.00E-05     |
| Lead                 | 2.33E-03                             | 9.68E-03     |
| Manganese            | 5.82E-03                             | 4.59E-03     |
| Dichloromethane      | 0.643                                | 13.100       |
| Nickel               | 7.20E-04                             | 4.85E-03     |
| Tetrachloroethylene  | 0.202                                | 0.350        |
| Trichloroethylene    | 0.079                                | 0.260        |
| Vinyl chloride       | 0.034                                | 0.070        |





# Summary (Page 1 of 3)

- 83 chemicals in ambient air measured by the Austin-Round Rock Toxics Study...
- Acrolein levels exceeded EPA non-cancer RfC by wide margin
  - Among the highest average levels reported in U.S.
  - Duplicate precision appears good
  - Strong seasonal variation (summer-fall maximum)
  - No known sources that would distinguish Austin from other U.S. cities
  - No agreement with NATA 1999 predictions
  - Only target chemical with hazard quotient > 1

# Summary (Page 2 of 3)

- Compounds that were detected less than 10% of the time accounted for greater than 60% of the estimated excess cancer risk when  $\frac{1}{2}$  DL was substituted for non-detects
  - 1,2-dibromoethane; hexachloro-1,3-butadiene were greatest factors
- Alternate approach for treating compounds with <10% frequency of detection substituted 1999 NATA average concentrations for Travis County
  - Comparatively good agreement between average measured levels and Travis County NATA averages for compounds detected >10% of the time
  - Poor agreement for compounds detected <10% of the time
- Benzene, carbon tetrachloride, and 1,2-dibromoethane accounted for greatest fractions of estimated excess cancer risk when NATA substitution was used
  - 1,3-butadiene also comparatively high at site having greatest estimated risk

# Summary (Page 3 of 3)

- Average levels of 62 of the measured chemicals varied by less than a factor of two from site to site
  - Includes 12 of 18 NATTS core pollutants
  - Site with highest levels of several VOC appears to have greater mobile source influence
- The average levels of core pollutants measured in Austin-Round Rock were generally lower than the average levels measured in the 10 Cities Air Toxics Pilot Study

# Future Work

- Source apportionment using Positive Matrix Factorization (in progress)
- More comprehensive comparison with 1999 NATA estimates
- Additional field measurements, quality assurance, and methods comparison for acrolein (discussing possible scope with TCEQ)