

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

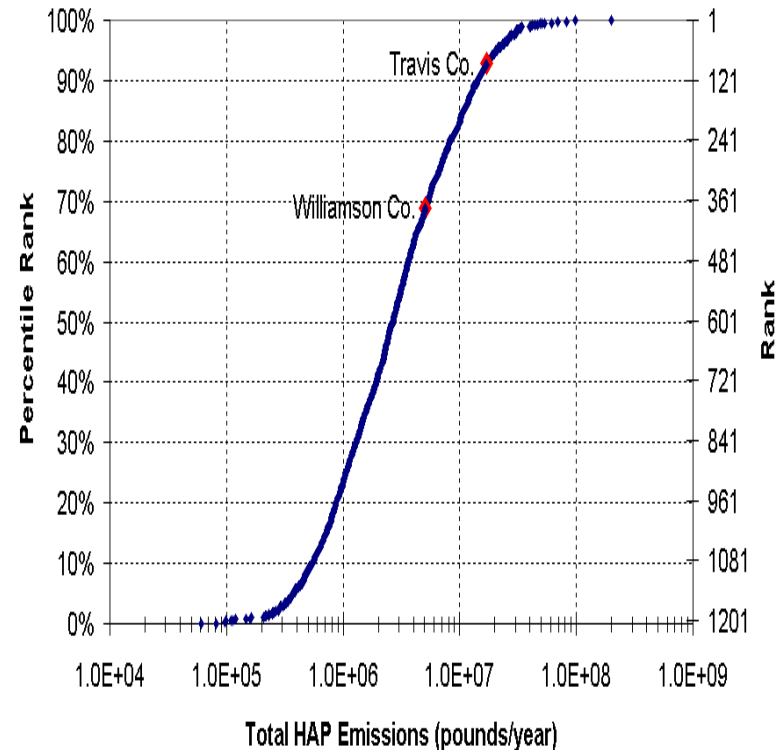
Project Team

- 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

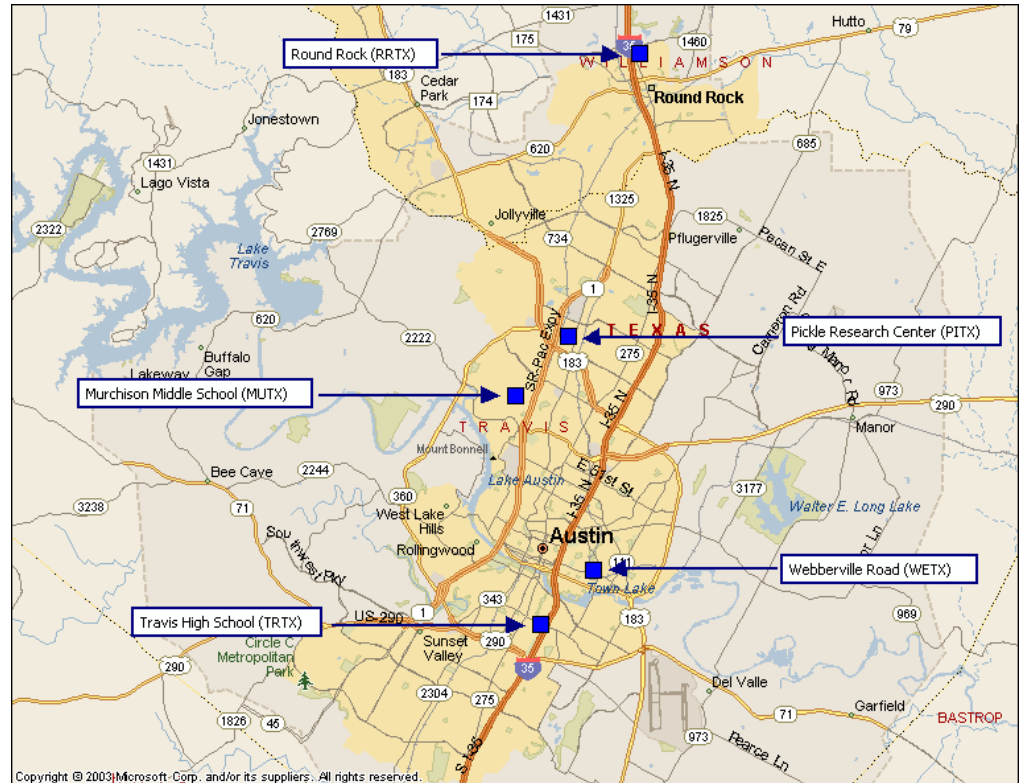
- 2005 population estimate – 1.2 million
 - 38th largest U.S. MSA in 2000
- Two largest counties, Travis and Williamson, ranked 85th and 376th in 1999 total NEI HAPS Emissions (among 1207 U.S. urban counties)

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



ARTS Overview

- 5 sampling sites
- 12-month sampling duration
 - Jun 05 – Jun 06
- 24-hour sampling period
- Every 12th 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

ARTS Target Chemicals	Sampling/Analysis Method	Method Description
59 volatile organic compounds (VOC), including: Benzene Carbon tetrachloride Vinyl chloride Trichloroethylene Acrolein Chloroform 1,3-Butadiene 1,2-Dichloropropane Methylene chloride Tetrachloroethylene	EPA Method TO-15	Sample collection in stainless steel canister with subsequent laboratory analysis by gas chromatography using mass spectroscopy
12 carbonyl compounds, including: Acetaldehyde Formaldehyde	EPA Method TO-11A	Sample collection using DNPH-treated cartridges followed by laboratory analysis using high pressure liquid chromatography
11 metals, including: Arsenic Beryllium Cadmium Lead Manganese Nickel	EPA Method IO-3.5	Sample collection using high volume PM10 samplers with subsequent laboratory analysis using inductively coupled plasma/mass spectrometry (ICP/MS)
Hexavalent chromium (Cr ⁶⁺) (measured only at one site, Webberville Road)	Modified CARB Method 039	Sample collection using bicarbonate-impregnated cellulose filters followed by laboratory analysis using ion chromatography

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

- “Health Effects Information used in Cancer and Noncancer Risk Characterization for the 1999 National-Scale Assessment”
 - <http://www.epa.gov/ttn/atw/nata1999/99pdfs/healtheffectsinfo.pdf>
- RfC: estimate, with uncertainty spanning perhaps an order of magnitude, of inhalation exposure that is likely to be without appreciable risks of non-cancer effects
- URE: upper-bound excess cancer risk estimated to result from a lifetime of continuous exposure to $1 \mu\text{g}/\text{m}^3$

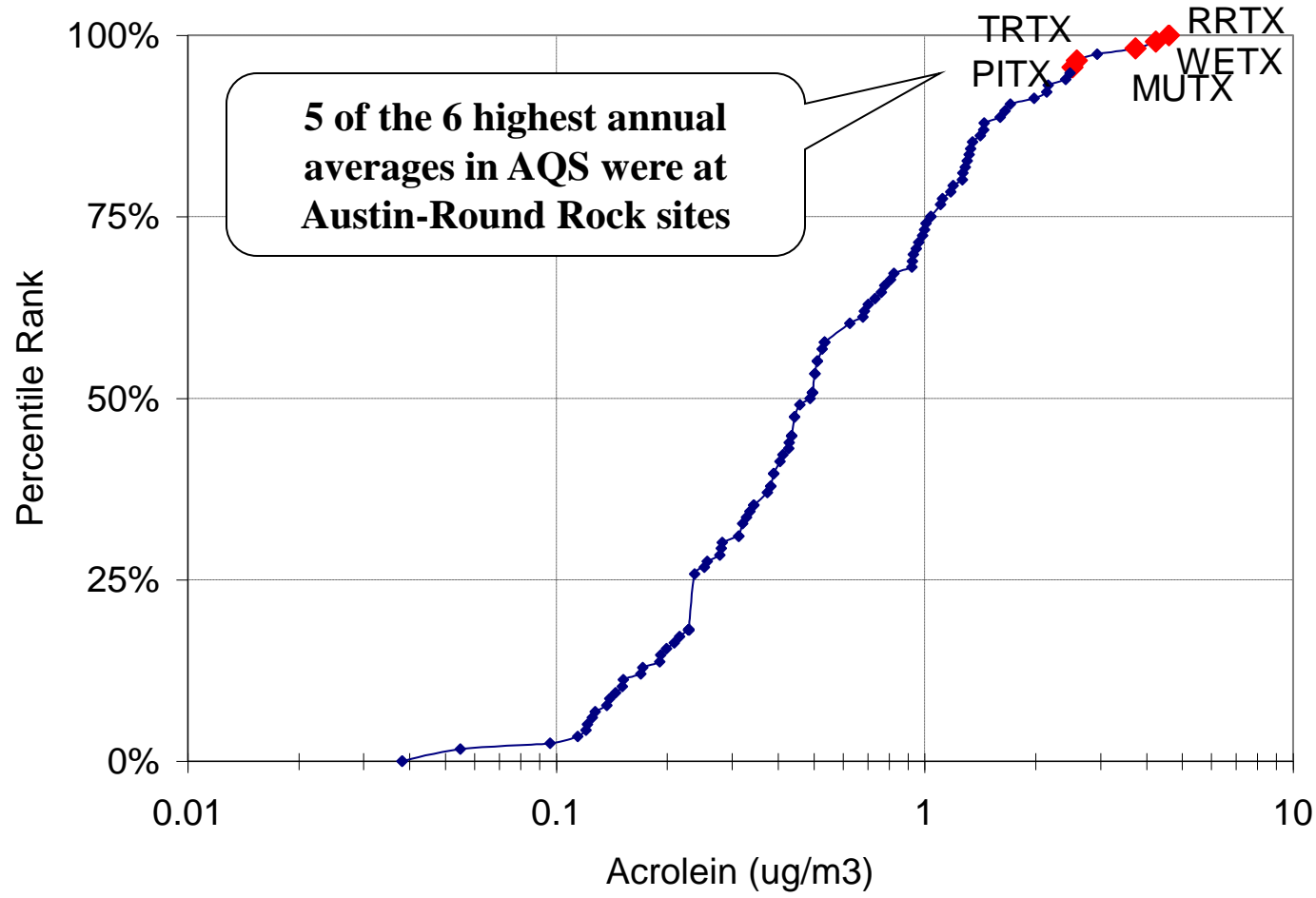
Top 10 Non-Cancer Hazard Quotients

(Hazard Quotient = Avg. Conc. RfC)

Chemical	Average Concentrations ($\mu\text{g}/\text{m}^3$)					RfC ($\mu\text{g}/\text{m}^3$)	Highest Hazard Quotient
	MUTX	PITX	RRTX	TRTX	WETX		
Acrolein	3.73	2.51	4.60	2.58	4.24	0.02	230
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

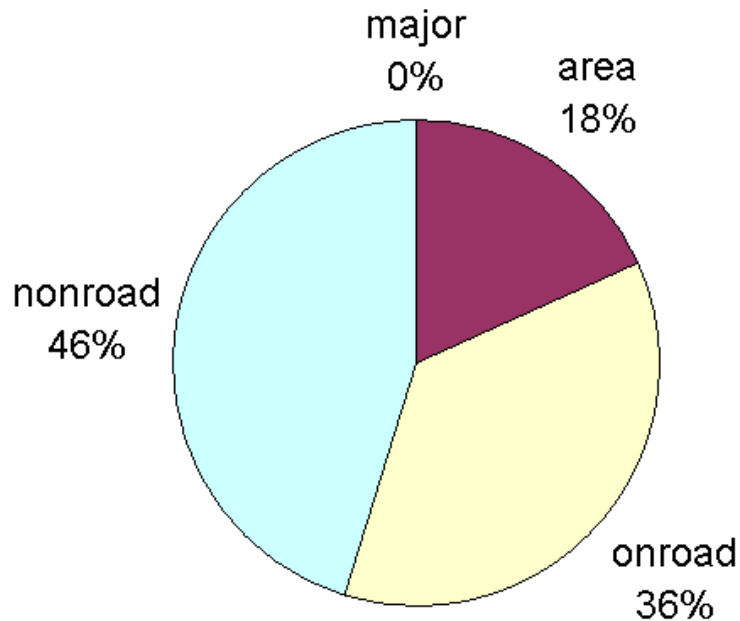
U.S. 2005 Annual Average Acrolein Levels

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

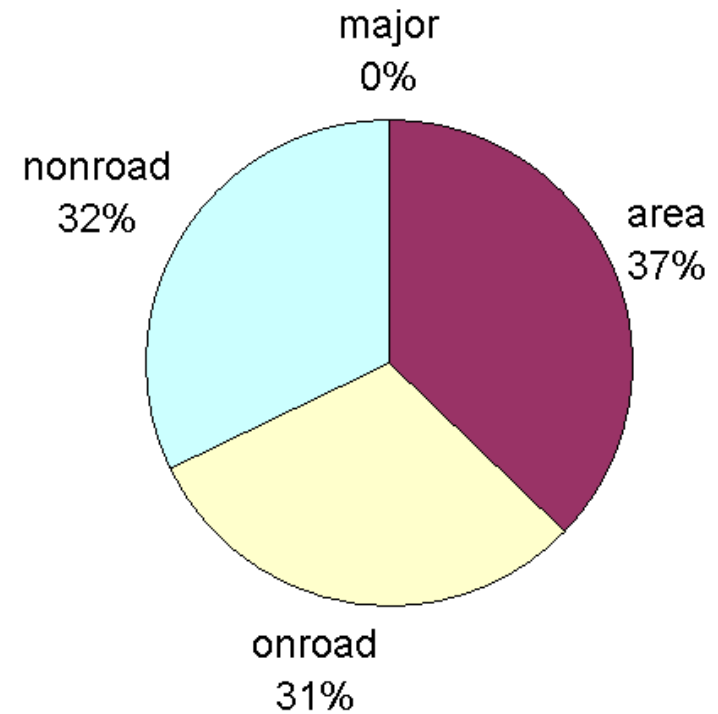


Travis and Williamson County Acrolein Sources (1999 NEI)

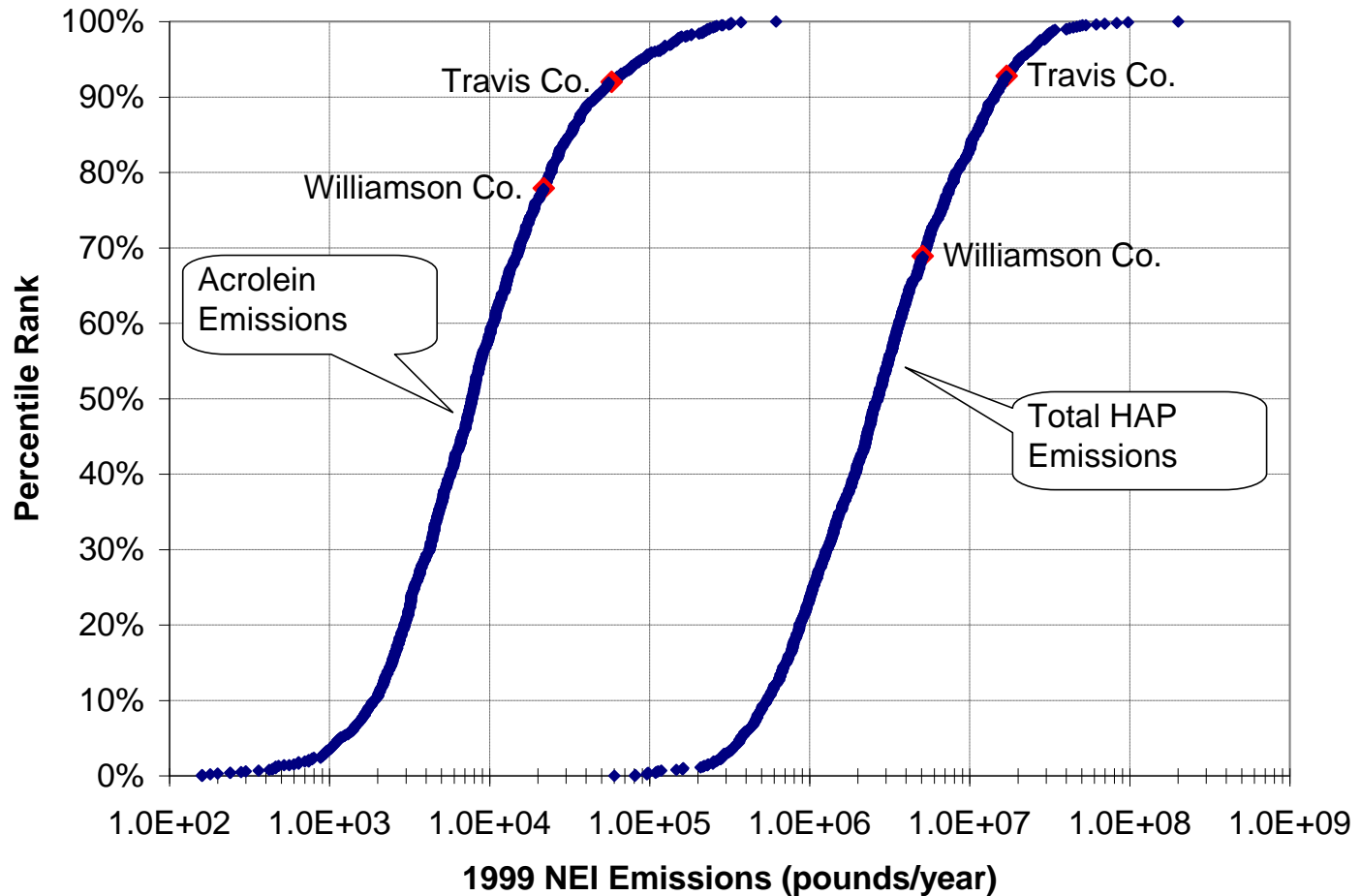
Travis Co.



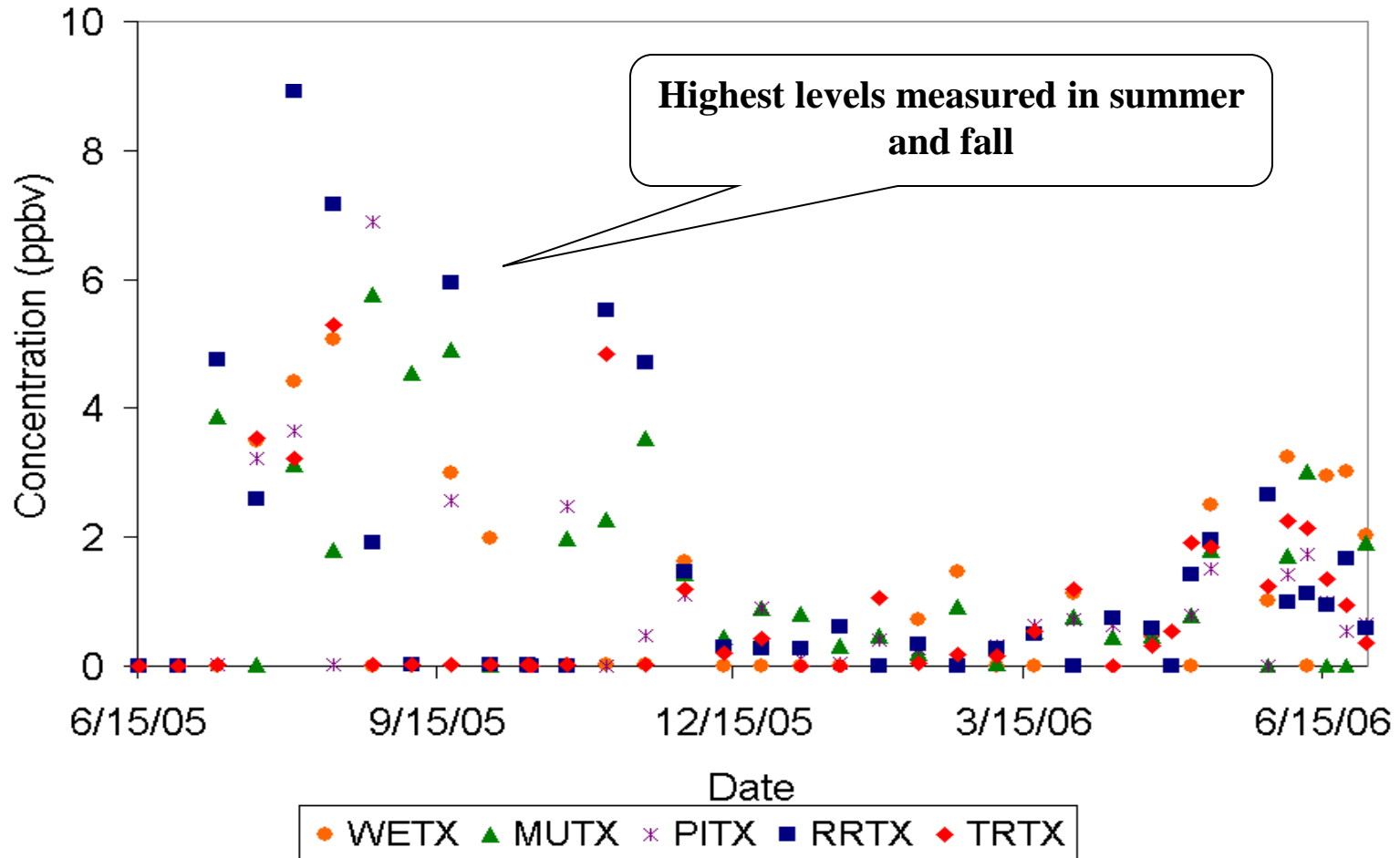
Williamson Co.



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

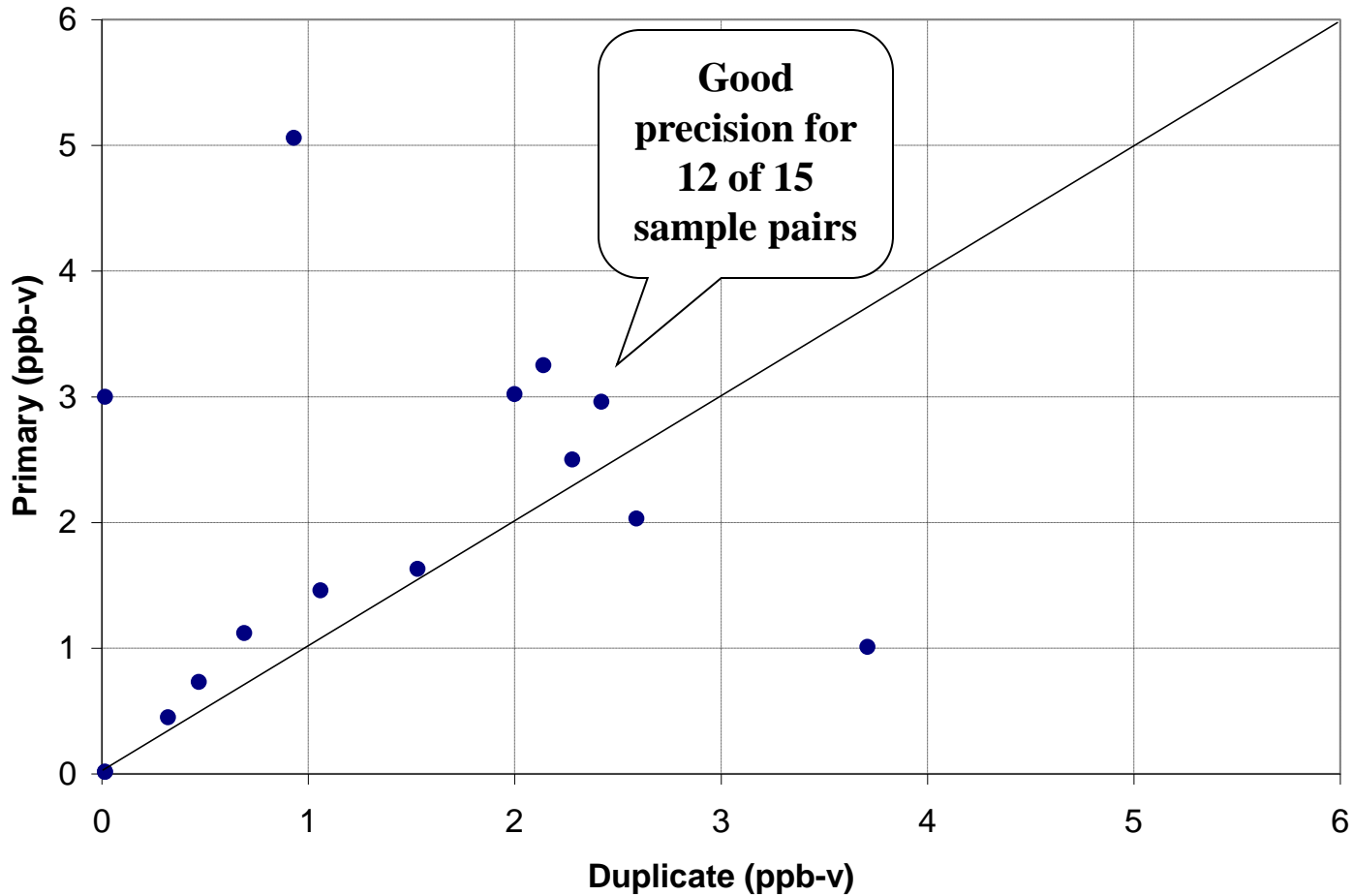


Acrolein Time Series

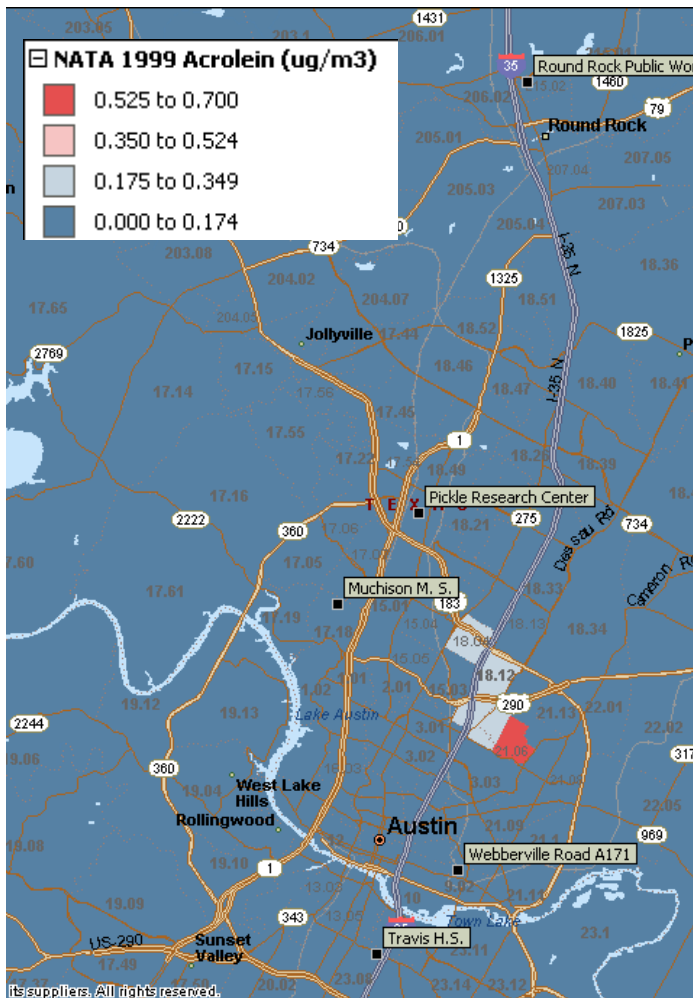


Acrolein Canister Duplicates

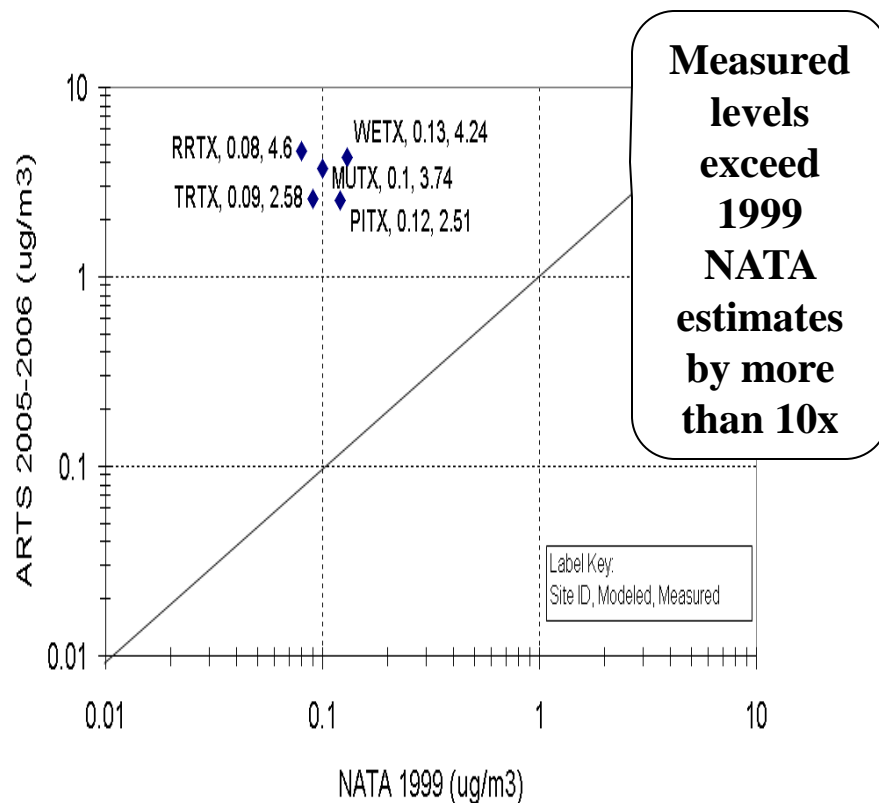
Average RPD = 50% (N=15)



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



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



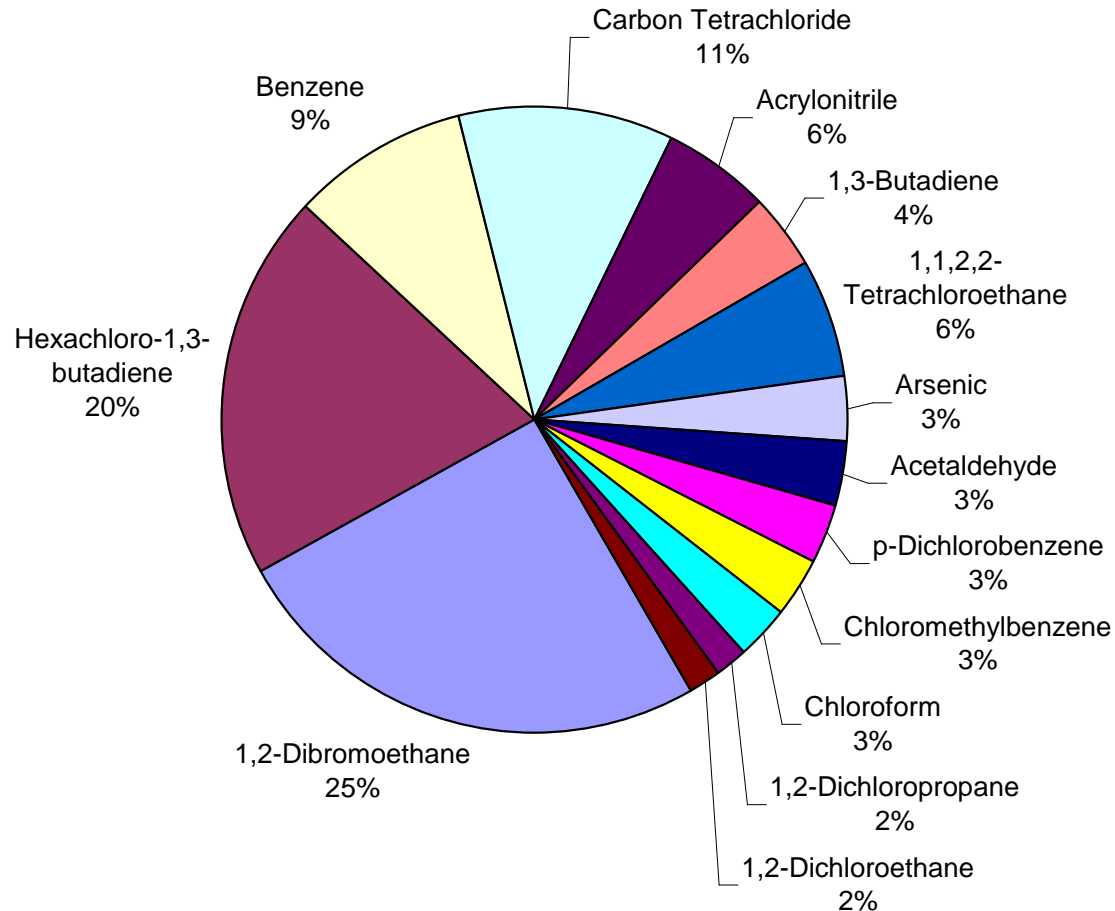
Top 15 Cancer Risks

(Excess Risk = Avg. Conc. URE 10^6)

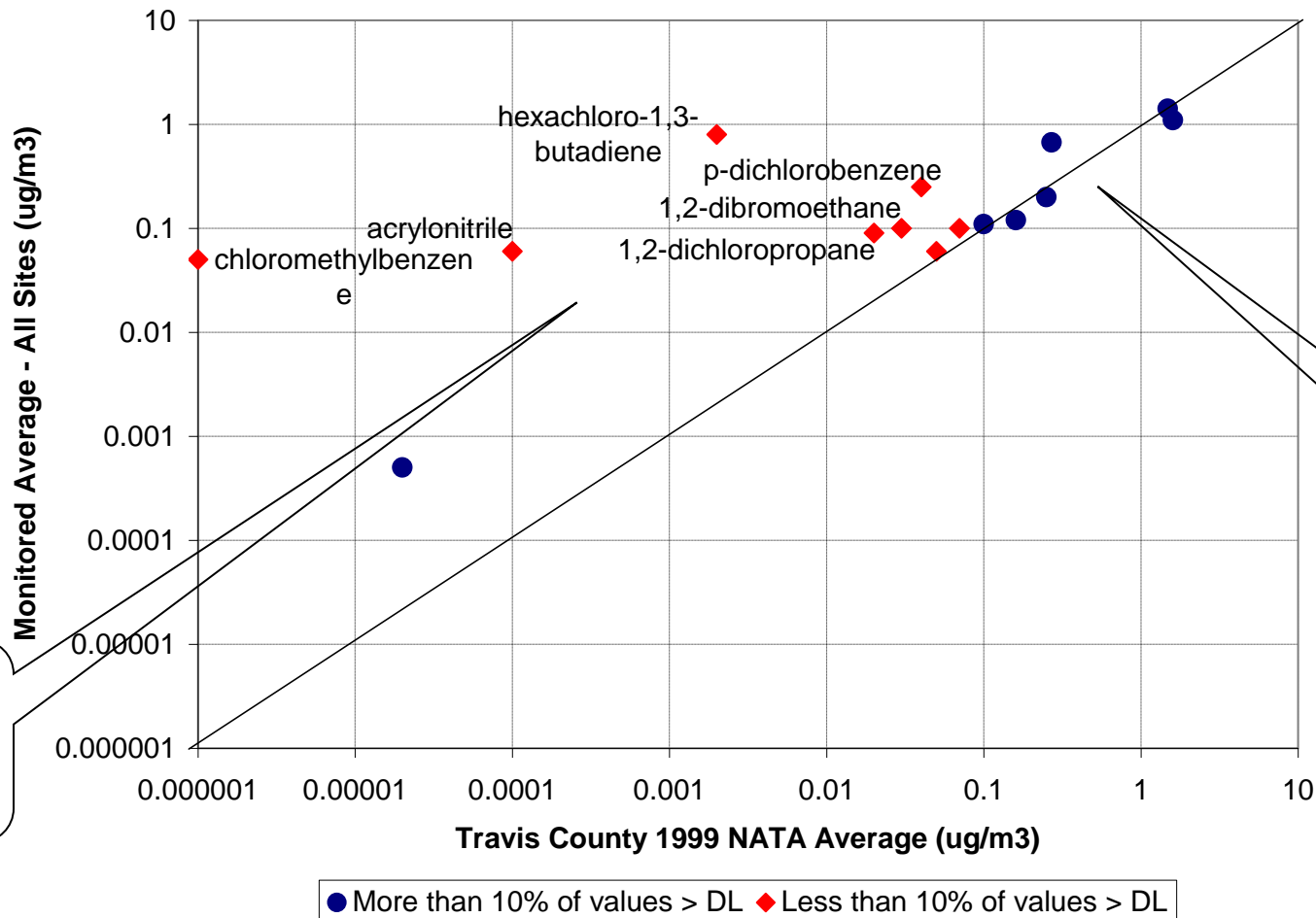
Chemical Name (% > DL)	Average Concentrations ($\mu\text{g}/\text{m}^3$)					URE ($\mu\text{g}/\text{m}^3$) ⁻¹	Highest Excess Risk (per million)
	MUTX	PITX	RRTX	TRTX	WETX		
1,2-Dibromoethane (1)	0.10	0.10	0.10	0.11	0.10	0.00022	24.2
Hexachloro-1,3-butadiene (1)	0.83	0.86	0.80	0.80	0.80	0.000022	18.9
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
1,1,2,2-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



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



Poor agreement for compounds detected in <10% of samples

Comparatively good agreement for compounds detected in >10% of samples

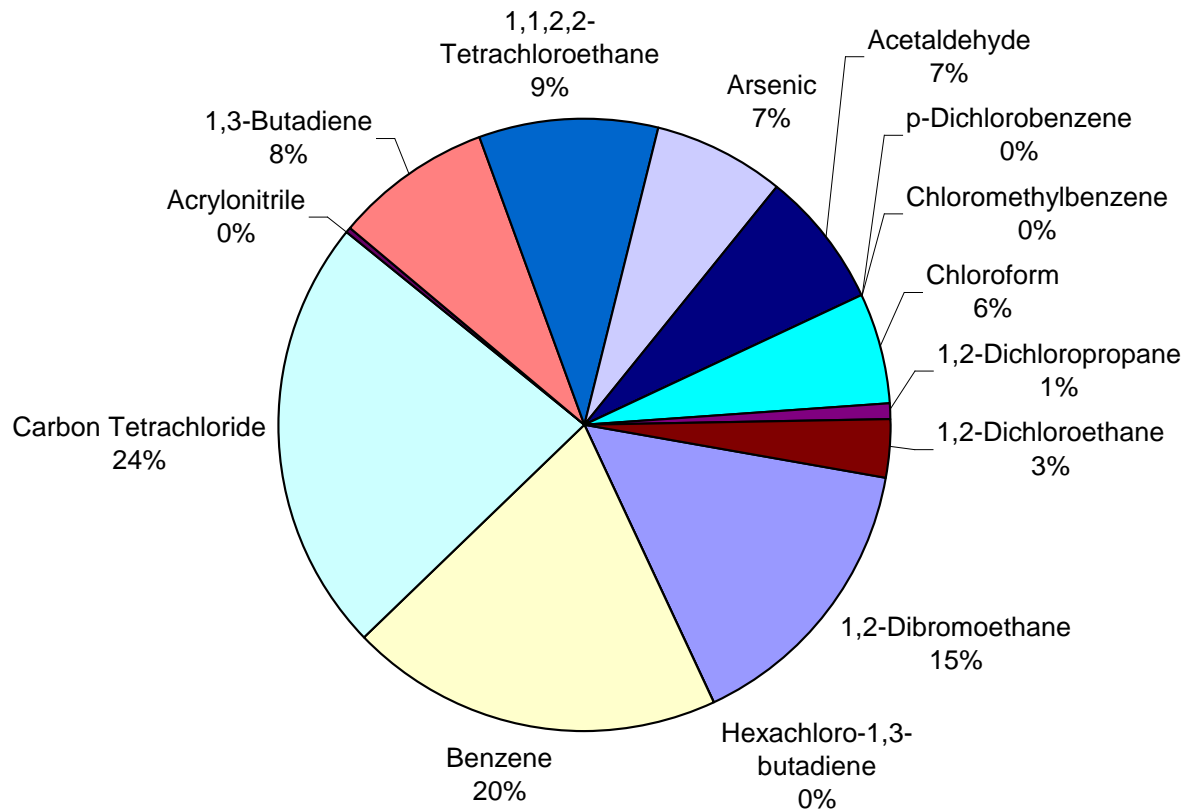
Top 10 Cancer Risks

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

Chemical Name (% > DL)	Average Concentrations ($\mu\text{g}/\text{m}^3$) (1999 NATA Travis County Average Concentrations Substituted for Compounds with <10% of Values > DL)					URE ($\mu\text{g}/\text{m}^3$) ⁻¹	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

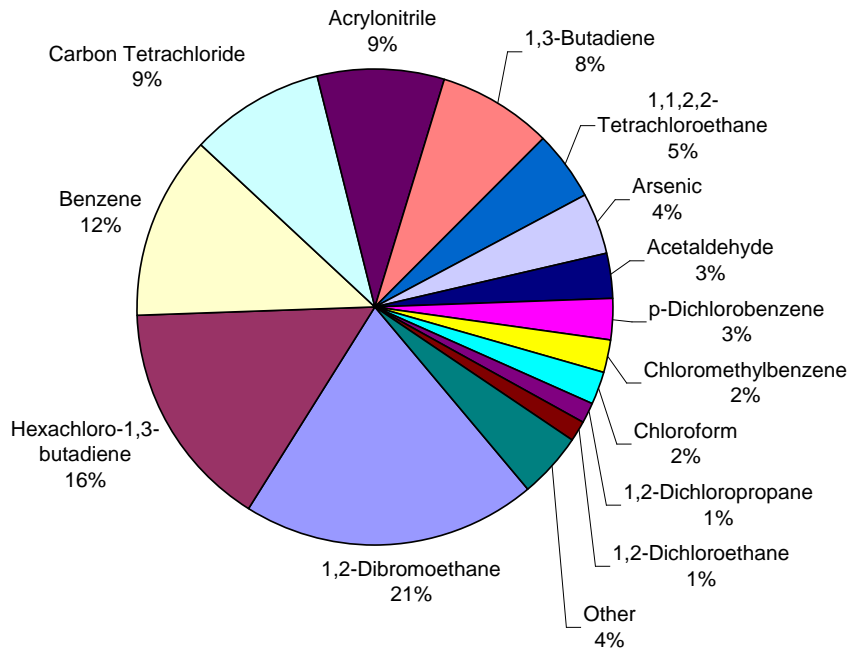
Percentages of Total Excess Cancer Risk Attributed to ARTS Pollutants – All Sites

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

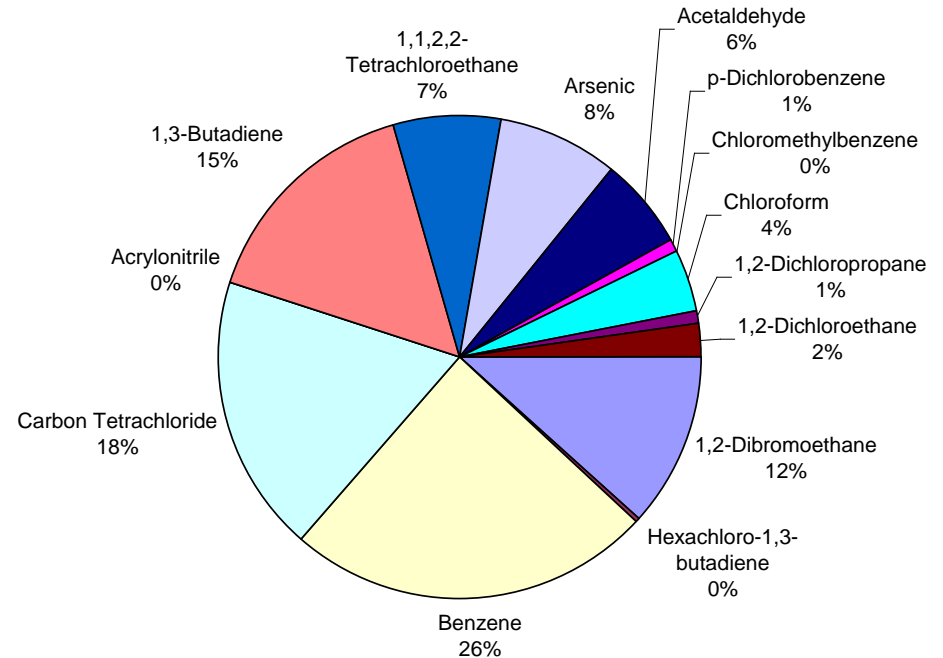


Percentages of Total Excess Cancer Risk Attributed to ARTS Pollutants – Webberville Rd.

1/2 DL Substituted for Non-Detects

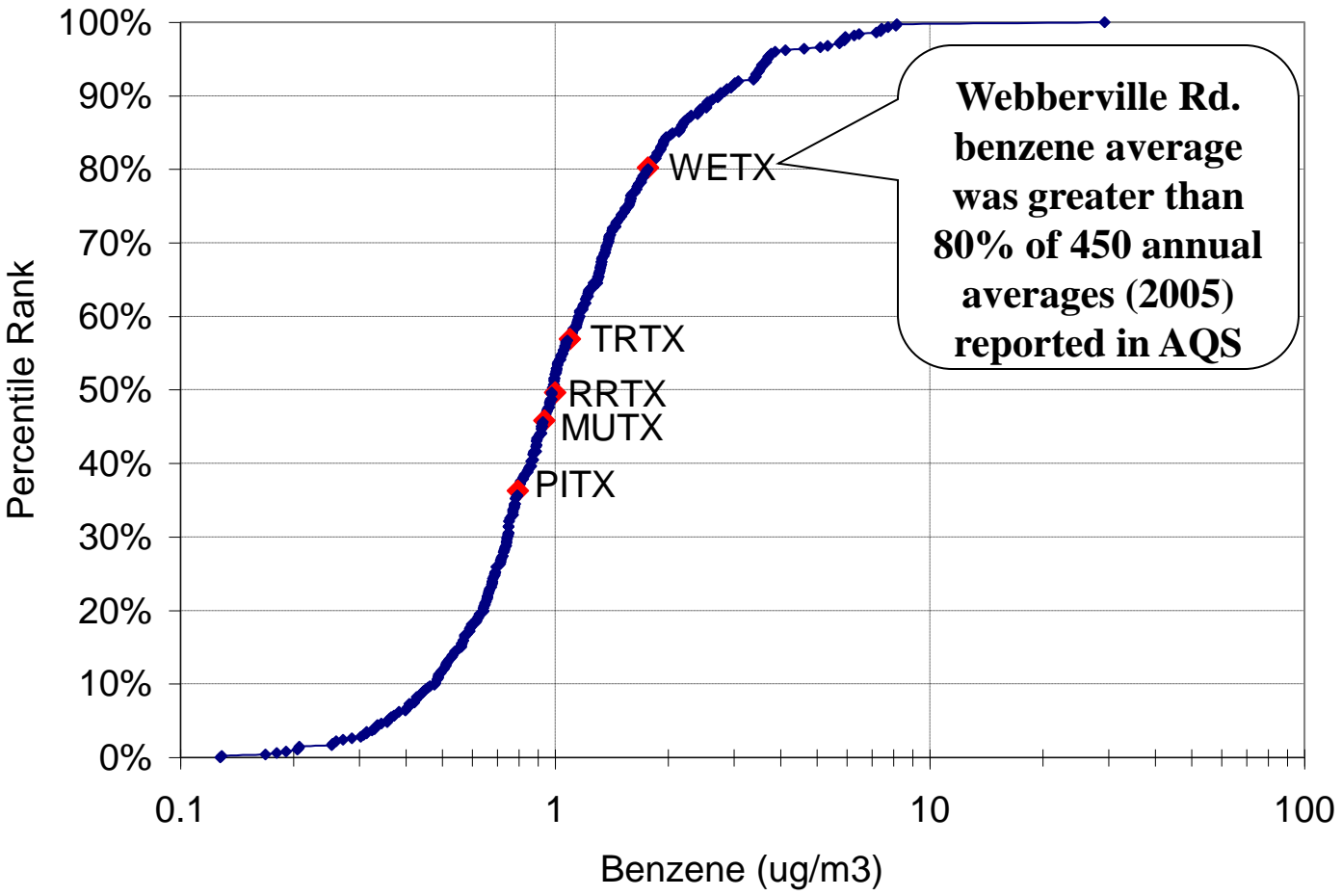


**Travis County 1999 NATA Average
Concentrations Substituted for
Compounds w <10% of Values > DL**



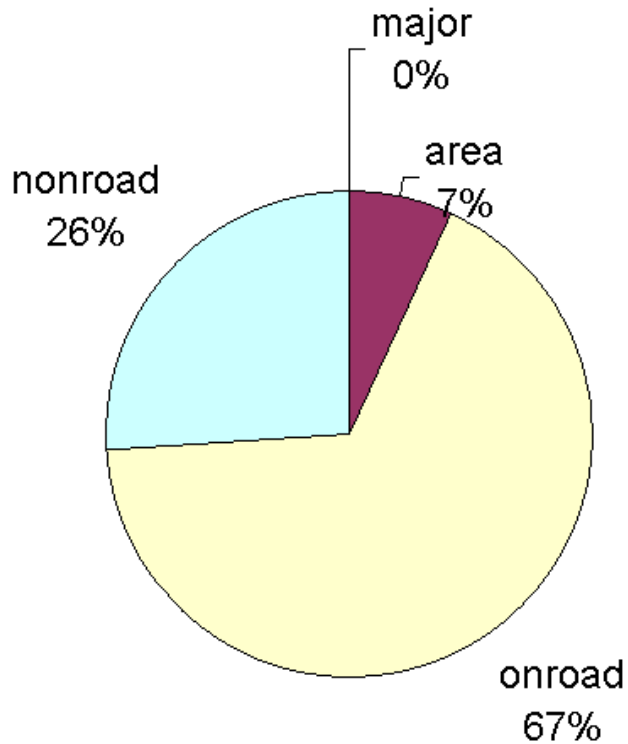
U.S. 2005 Annual Average Benzene Levels

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

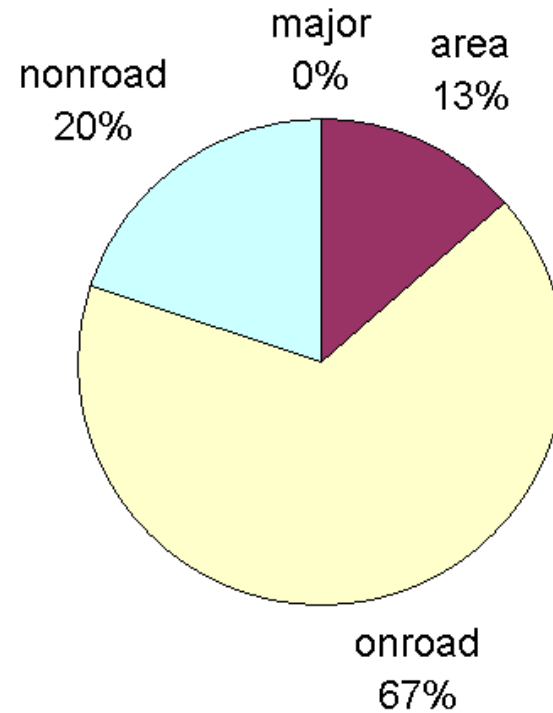


Travis and Williamson County Benzene Sources (1999 NEI)

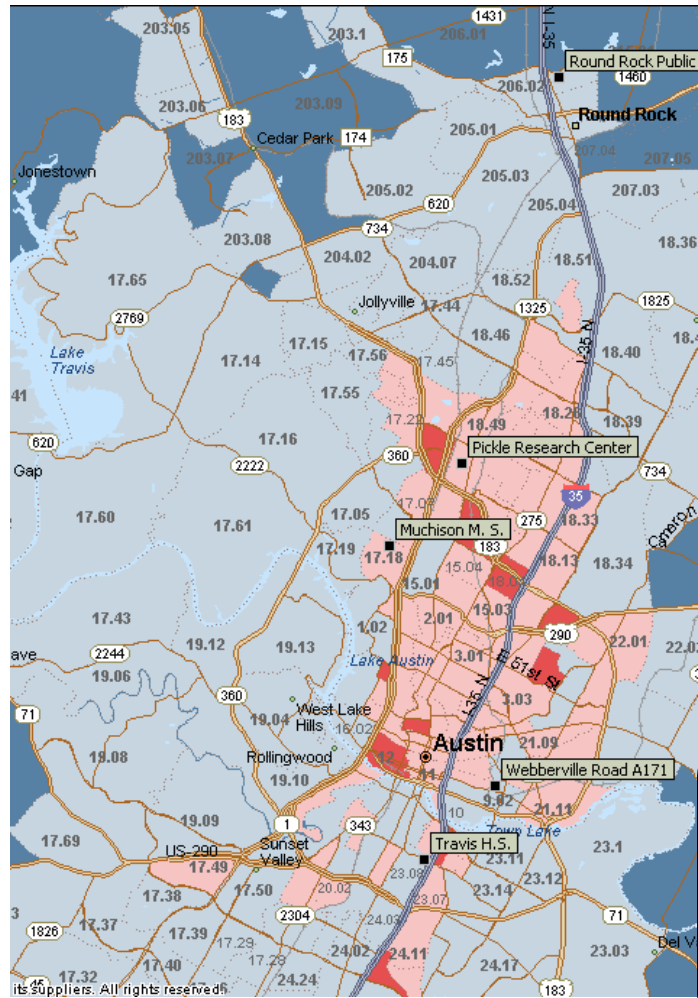
Travis Co.



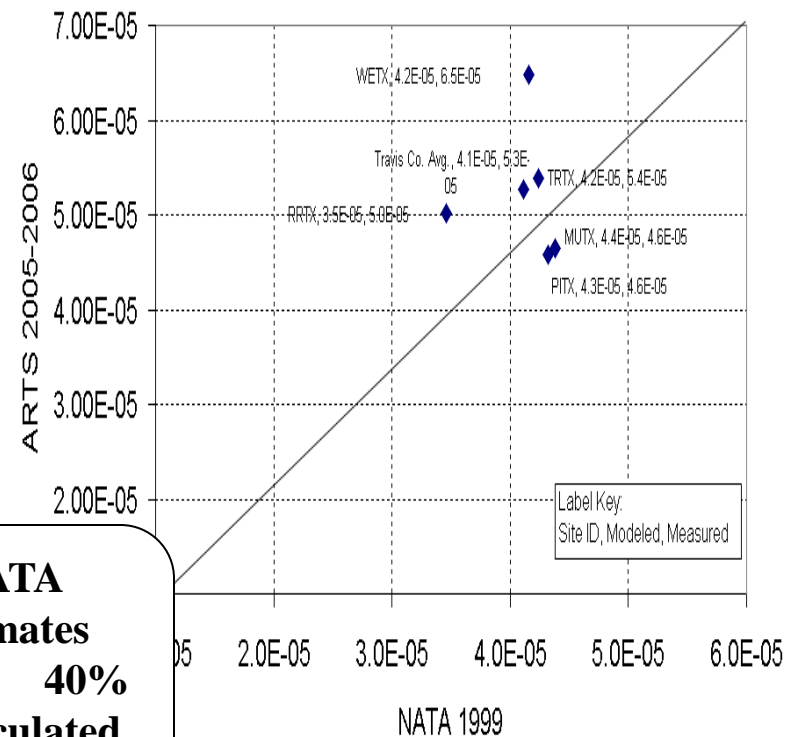
Williamson Co.



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



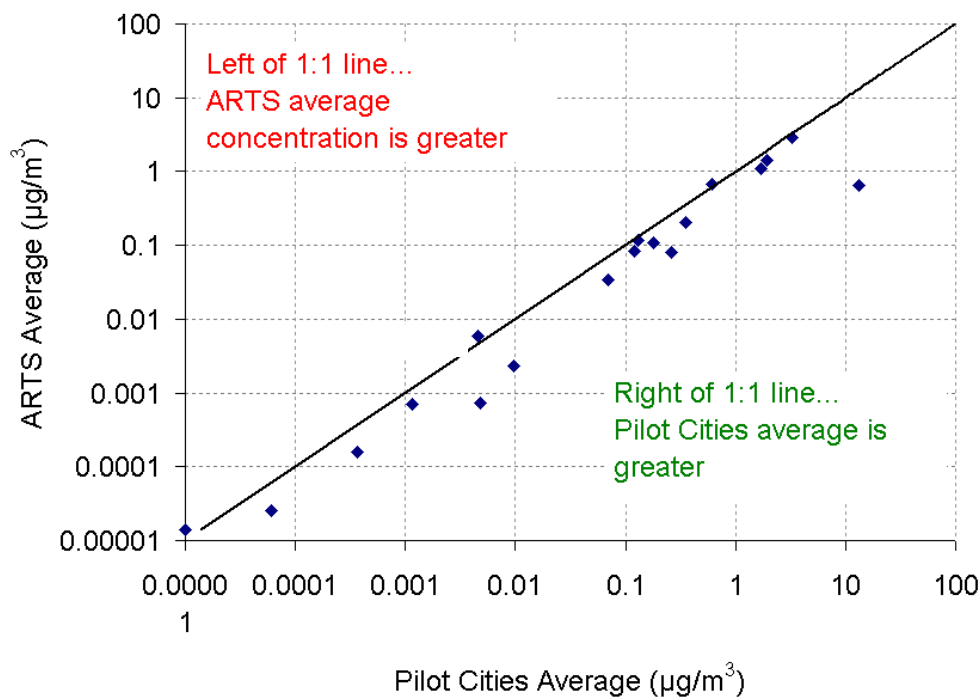
Comparison of Results with Data from Other Cities

- 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

Summary (Page 2 of 3)

- 1,2-Dibromoethane, hexachloro-1,3-butadiene and other rarely detected compounds make up greater than 50% of the estimated excess cancer risk when $\frac{1}{2}$ DL is substituted for non-detects
- Poor agreement between estimated average concentrations and 1999 NATA Travis County estimates for compounds detected less than 10% of the time
- Comparatively good agreement for compounds detected greater than 10% of the time
- Benzene, carbon tetrachloride, and 1,2-dibromoethane are greatest contributors to estimated excess risk when 1999 NATA Travis County average concentrations are used for chemicals detected above DL in less than 10% of samples
- Contributions from benzene and 1,3-butadiene are greatest at Webberville Rd., where mobile source influence appears to be greatest

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)