

Case Study: Diffusion Tube (Passive) Sampling of Air Toxics Across the Chicago Urbanized Area

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Large Area Monitoring Program (LAMP)

Project Overall Objectives

- A. Measure community-oriented population exposure over and annual average period
- B. Obtain baseline data
- C. Characterize BETX concentrations across the Chicago urbanized area
- D. Comparison of the sorbent tube method to other methods

Phase I

Initial Tasks:

Selection of optimal sorbent media

Development of analytical method

Correlation to known methods

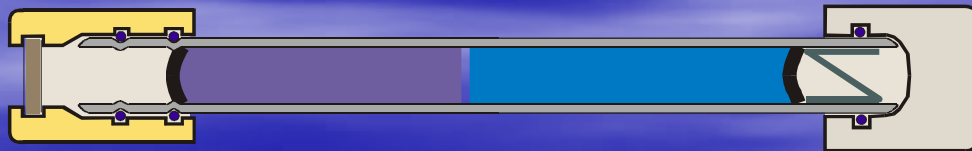
Activity:

2 sampling periods, 3 weeks duration, at 12 sites primarily in Chicago

Sorbent Sampling Tube

Tubes purchased from
Perkin Elmer / Supelco

Sorbent material was CarboPack B, targeting
BTEX compounds



Cross section view of sorbent tube

Example of Sampler and Placement



Phase II

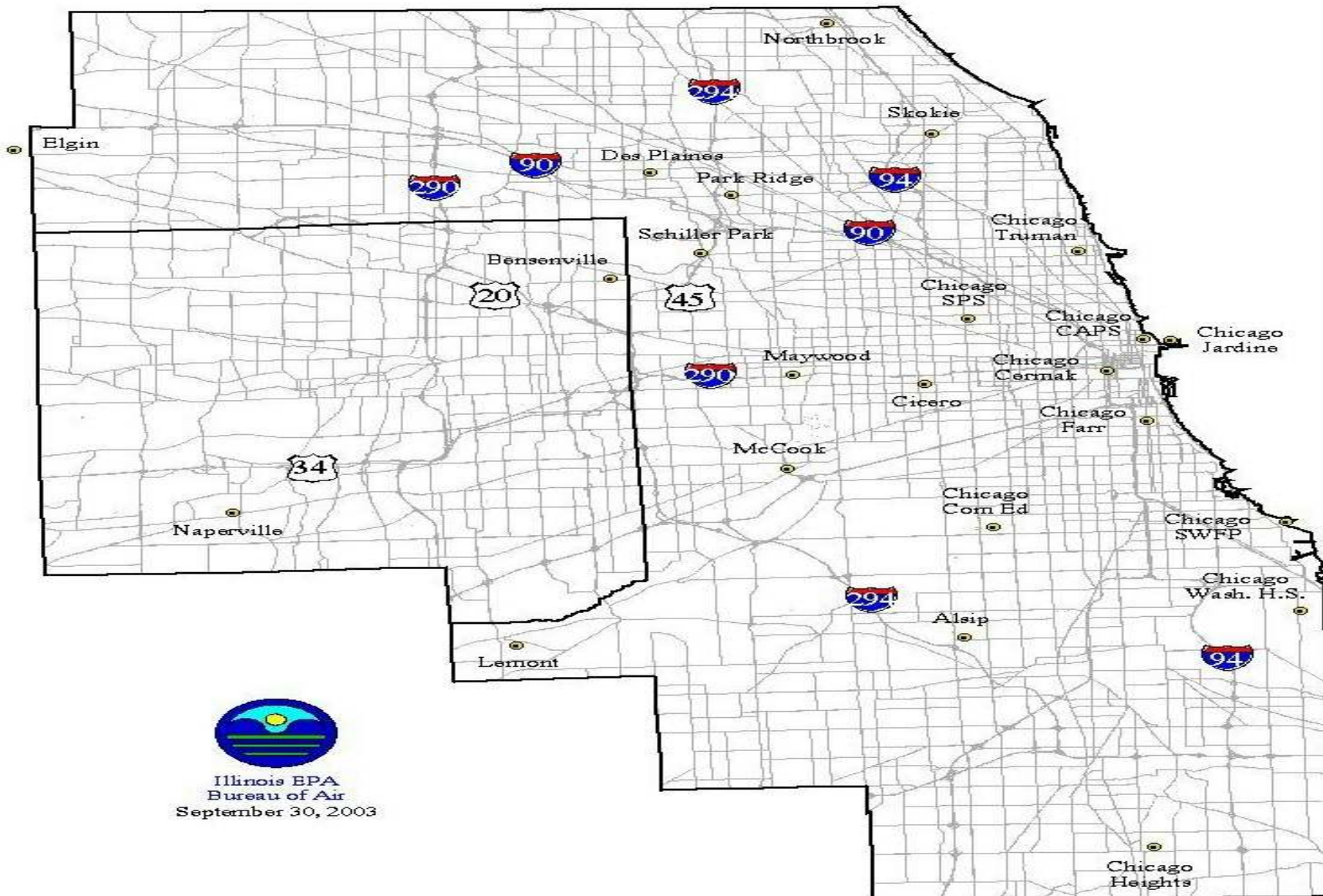
Part 1

Sampling at three sites in Chicago area over a 12 month period

Part 2

Saturation sampling at 15 sites for one month in Chicago, including O'Hare airport

LAMP Network Sites



Illinois EPA
Bureau of Air
September 30, 2003

Legend
● LAMP Network Sites
— Highways
□ County Boundaries



Comparisons Made

- Sorbent tube (LAMP) sampling performed at existing toxics sites performing canister sampling
- Sorbent tube (LAMP) sampling performed at existing PAMS sites with continuous gas chromatography systems

LAMP Samples versus Canisters, Jan – Dec, 2005

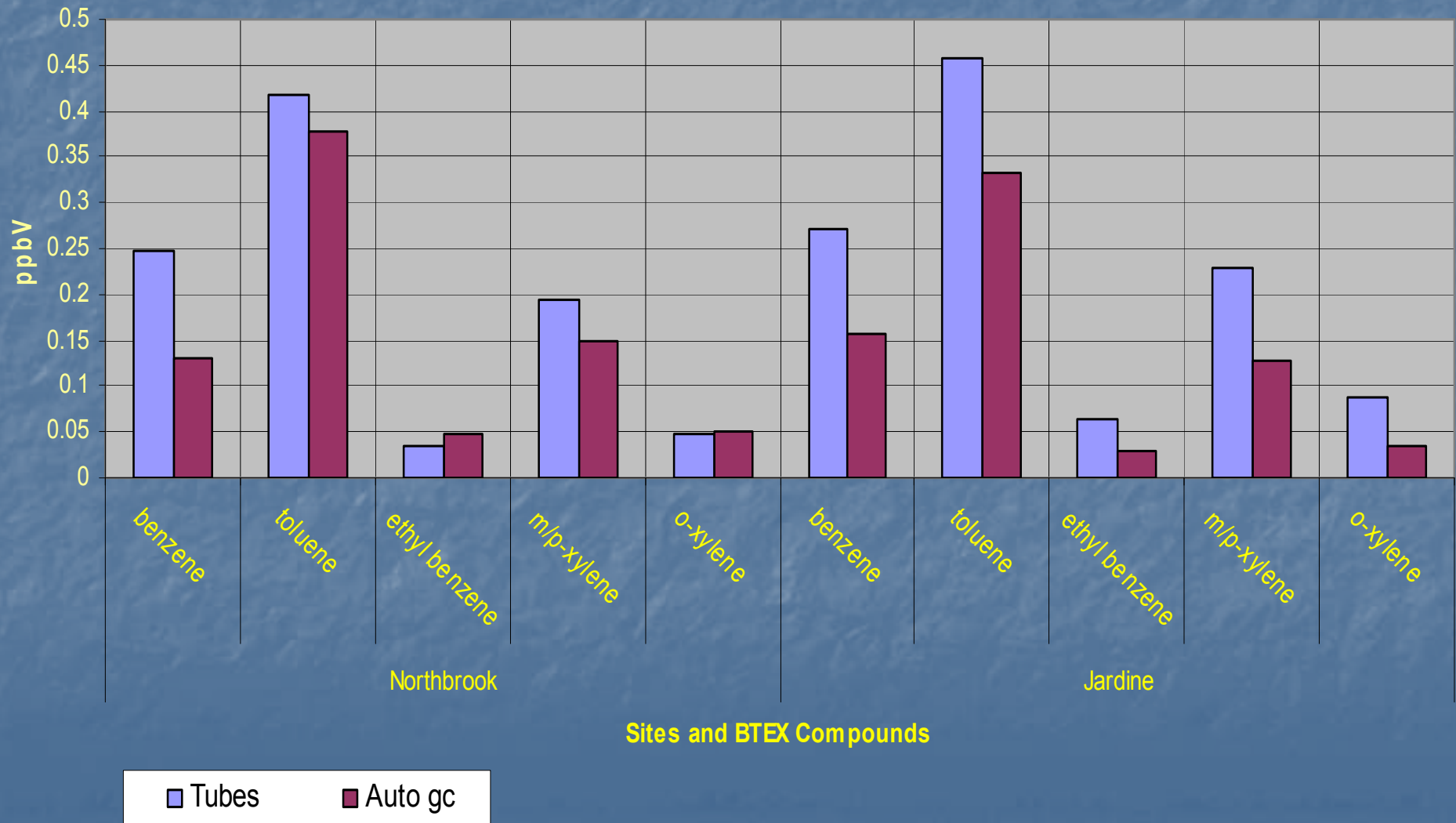
Compound	Northbrook		Schiller Park		% Difference
	LAMP	CANISTER	LAMP	CANISTER	
benzene	0.29	0.19	0.42	0.42	16.4
toluene	0.44	0.4	0.68	0.69	2.7
ethyl-benzene	0.05	0.07	0.09	0.12	-26.3
m/p xylene	0.18	0.19	0.31	0.29	2.1
o-xylene	0.06	0.07	0.11	0.13	-15

*all values expressed in ppb(v)

LAMP 2005

LAMP Samples vs Canisters

January – December, 2005



LAMP Samples versus GC Data

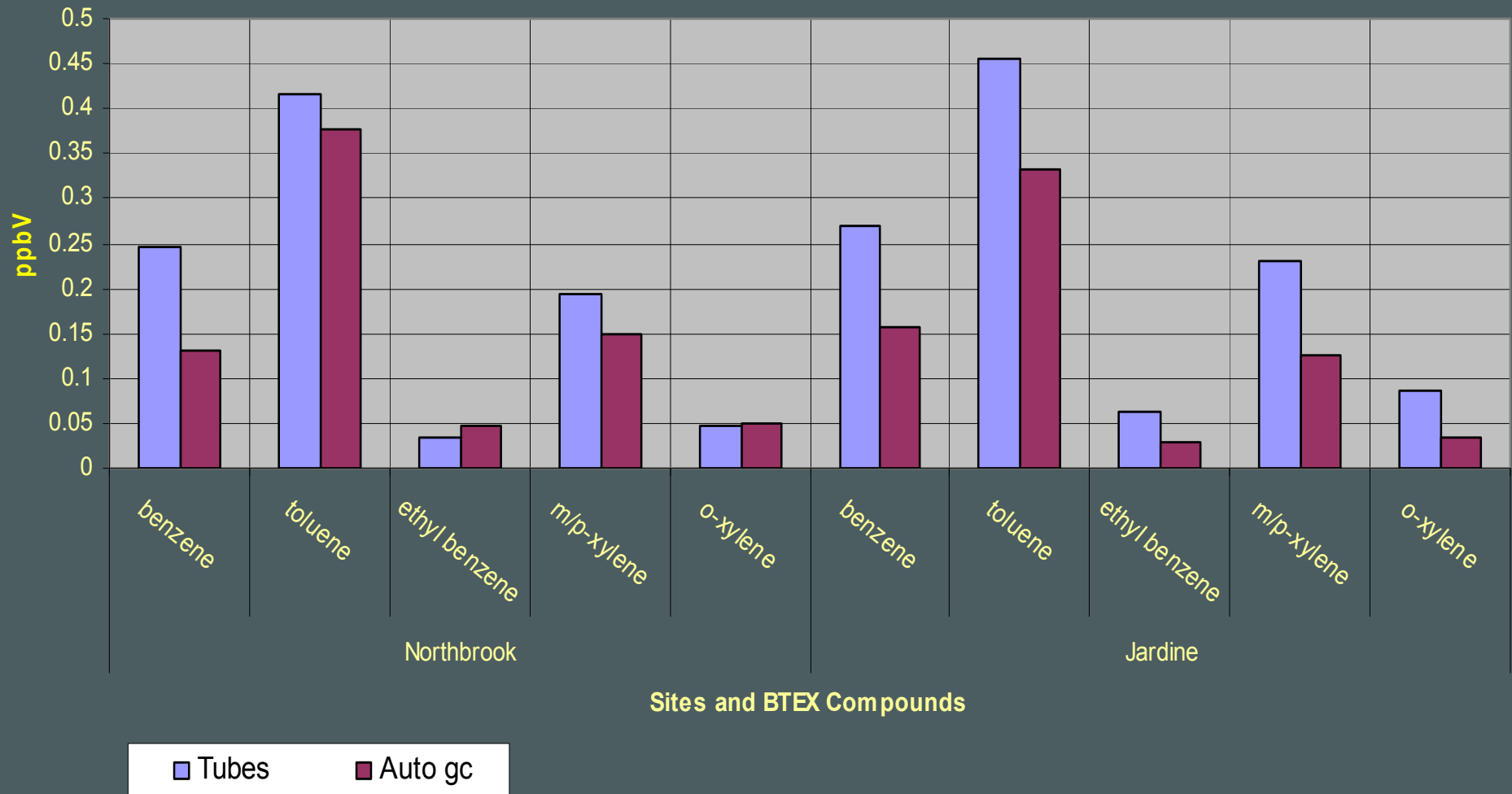
Compound	Northbrook		Chicago-Jardine		% difference
	LAMP	AUTO - GC	LAMP	AUTO - GC	
benzene	0.25	0.13	0.27	0.16	79.3
toluene	0.42	0.38	0.46	0.33	23.6
ethyl- benzene	0.04	0.05	0.06	0.03	25
m/p-xylene	0.19	0.15	0.23	0.13	50
o-xylene	0.05	0.05	0.09	0.03	75

*all values expressed in ppb(v)

LAMP 2005

LAMP Samples vs Auto GC

June – August, 2005



LAMP Data, January thru June, 2005

	Jan	Feb	March	April	May	June
Northbrook						
benzene	NA	NA	0.49	0.3	0.22	0.23
toluene	0.53	0.56	0.32	0.25	0.29	0.4
ethyl-benzene	0.03	0.08	0.02*	0.02*	0.02*	0.02*
m/p-xylene	0.19	0.26	0.11	0.07	0.11	0.17
o-xylene	0.03	0.08	0.02*	0.03	0.02*	0.02*
Schiller Park						
benzene	0.6	0.5	0.49	0.42	0.34	0.35
toluene	0.78	0.69	0.55	0.58	0.64	0.73
ethyl-benzene	0.1	0.08	0.06	0.06	0.08	0.09
m/p-xylene	0.34	0.31	0.22	0.22	0.29	0.31
o-xylene	0.12	0.11	0.09	0.09	0.1	0.13
Chicago-Jardine						
benzene	0.46	0.41	0.32	0.29	0.22	0.31
toluene	0.59	0.51	0.28	0.25	0.32	0.56
ethyl-benzene	0.02	0.06	0.02*	0.02*	0.04	0.09
m/p-xylene	0.08	0.19	0.08	0.08	0.13	0.35
o-xylene	0.03	0.07	0.03	0.02*	0.05	0.14

All values expressed in ppb(v)

NA – Not available, data invalidated

MDL is 0.03 ppbV – any result of 0.02* indicates a value below the MDL

LAMP Data, July thru December, 2005

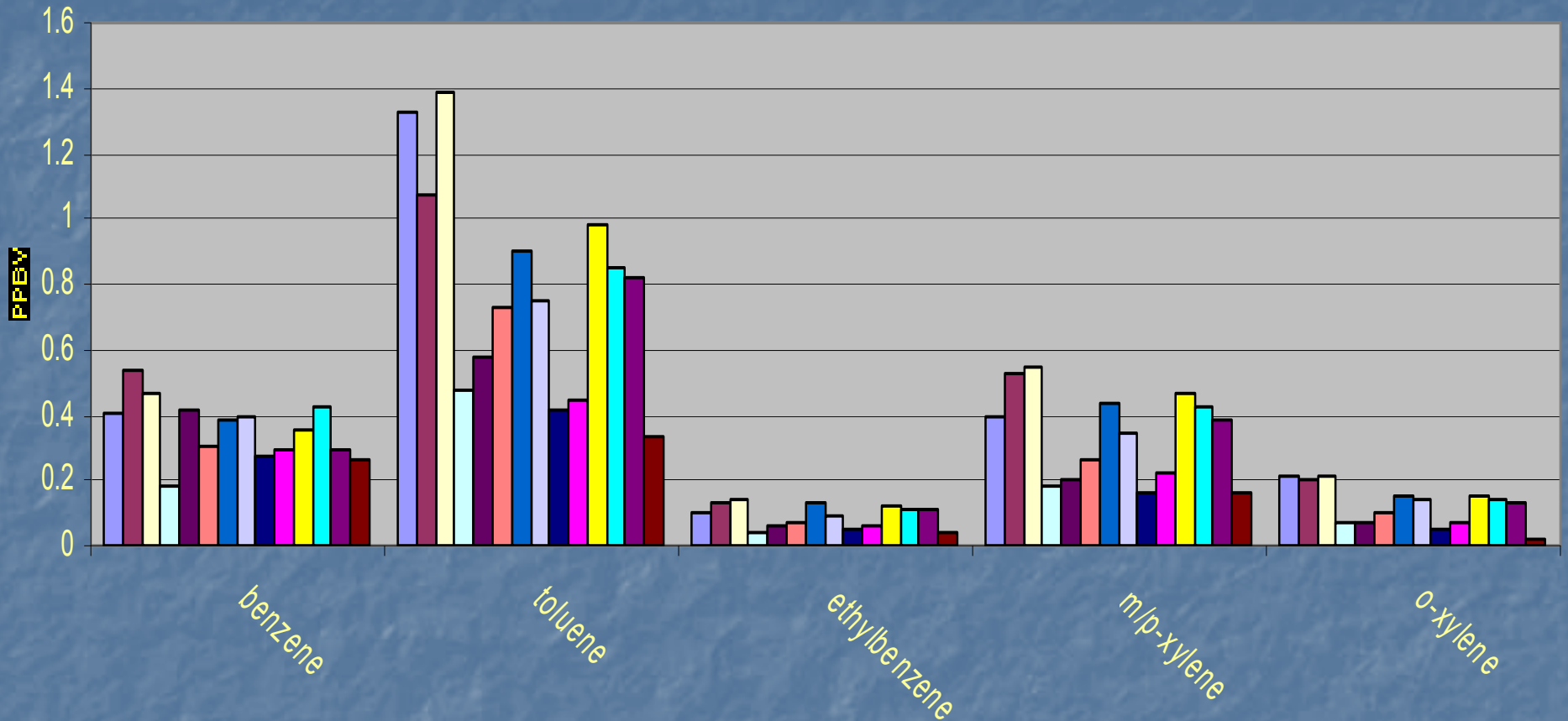
	July	August	Sept	Oct	Nov	Dec	12 month Average
Northbrook							
benzene	0.22	0.29	0.27	0.25	0.31	0.3	0.29
toluene	0.4	0.45	0.62	0.46	0.56	0.42	0.44
ethyl-benzene	0.04	0.06	0.08	0.05	0.07	0.06	0.04
m/p-xylene	0.19	0.22	0.32	0.21	0.18	0.18	0.18
o-xylene	0.07	0.07	0.12	0.08	0.11	0.08	0.06
Schiller Park							
benzene	0.32	0.43	0.39	0.42	0.43	0.43	0.42
toluene	0.65	0.85	0.83	0.8	0.6	0.6	0.68
ethyl-benzene	0.07	0.11	0.12	0.1	0.08	0.08	0.09
m/p-xylene	0.26	0.43	0.42	0.36	0.28	0.28	0.31
o-xylene	0.1	0.14	0.14	0.12	0.09	0.1	0.11
Chicago-Jardine							
benzene	0.23	0.27	0.23	0.22	0.25	0.3	0.29
toluene	0.39	0.42	0.39	0.34	0.41	0.45	0.41
ethyl-benzene	0.05	0.05	0.04	0.04	0.04	0.06	0.04
m/p-xylene	0.18	0.16	0.17	0.14	0.15	0.2	0.16
o-xylene	0.07	0.05	0.06	0.05	0.06	0.08	0.06

All values expressed in ppb(v)

NA – Not available, data invalidated

MDL is 0.03 ppbV – any result of 0.02* indicates a value below the MDL

Saturation Study Data, August 2005

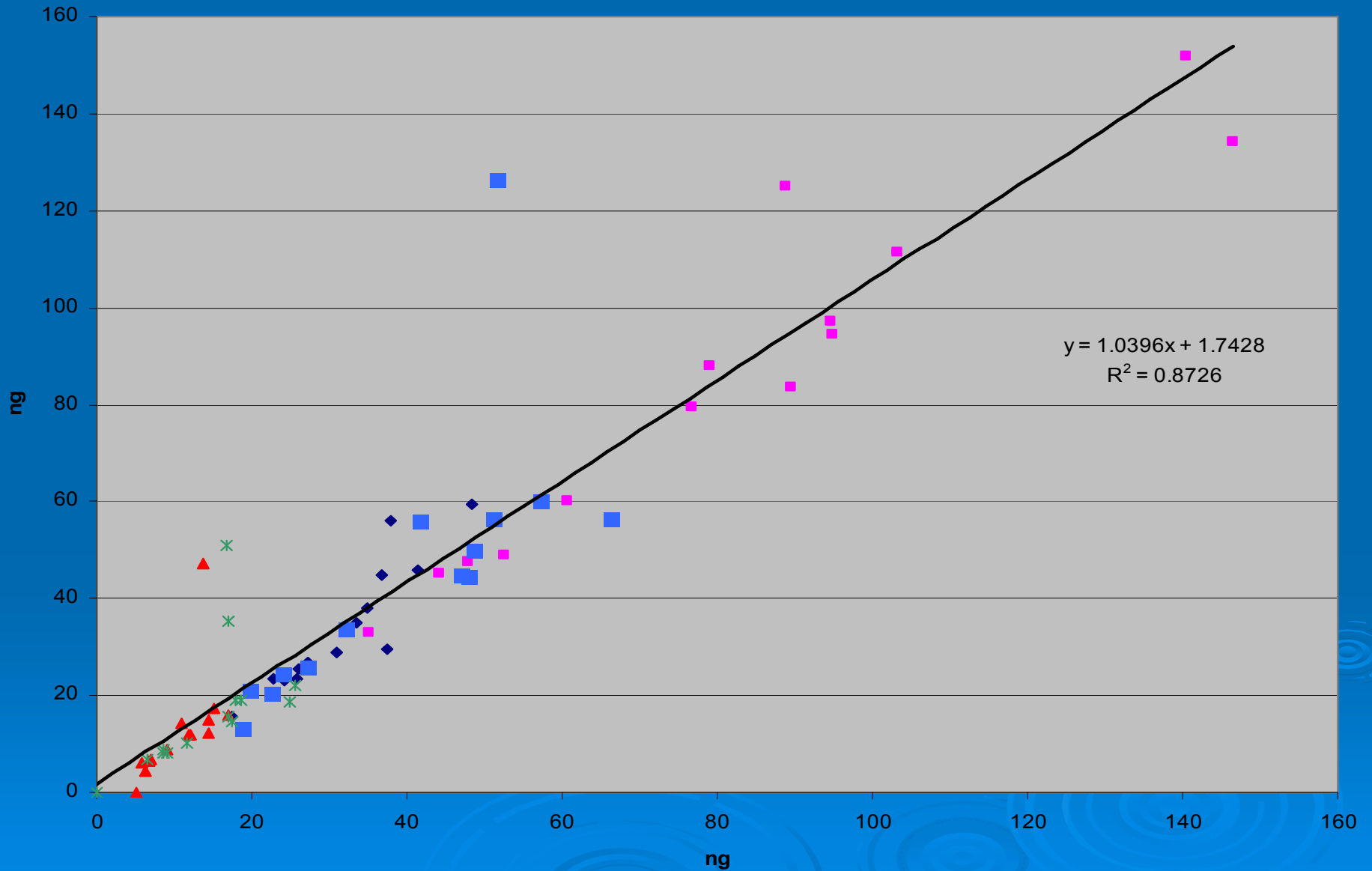


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|---------------------|----------------|----------------------|-----------|------------------|
| ■ Bensenville | ■ Cermak | ■ Cicero | ■ Decatur | ■ DesPlaines-off |
| ■ DesPlaines-school | ■ E St Louis | ■ Firestation - CAPS | ■ Jardine | ■ Northbrook |
| ■ Park Ridge | ■ Shiller Park | ■ Springfield | ■ Zion | |

LAMP Precision Data, Collocated Samples

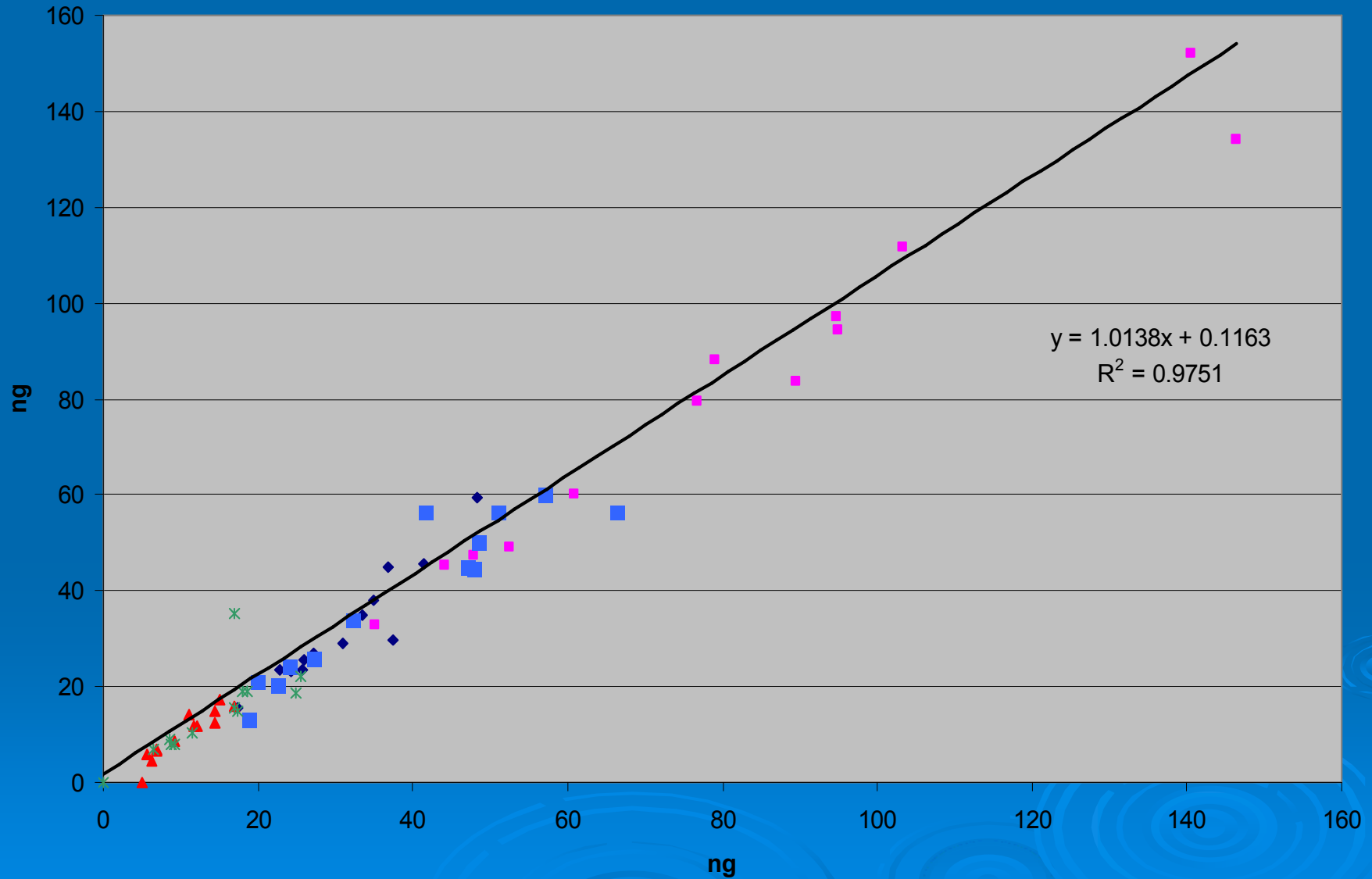
Benzene		Toluene		Ethyl-benzene		m/p xylene		o-xylene	
36.8	44.8	140.5	152	12.2	11.8	48.6	50.1	25.5	22.1
48.3	59.3	94.9	94.3	11.8	11.8	47	44.9	17.4	14.7
41.5	45.7	146.5	134.1	16.9	15.8	66.3	56.5	24.9	18.7
17.4	15.6	52.5	48.9	6.2	4.5	22.5	20.3	8.7	8
37.4	29.6	60.8	60.2	6.8	6.4	24	24.3	9.1	8
27.1	26.9	76.7	79.5	9.1	8.7	32.2	33.8	11.6	10.3
33.5	35	94.7	97.1	15	17.3	51.1	56.3	18	19.1
34.9	37.9	79	88.1	11	14.2	41.6	56.2	17	35.2
24.3	23	44.1	45.1	5.7	6	19.8	21.1	6.4	6.8
25.7	23.5	47.8	47.5	6.9	6.8	27.2	25.8	8.5	8.9
30.9	29	103.3	111.5	14.4	15	57.2	60.1	18.6	19.1
37.9	56.1	88.8	124.9	13.8	47.1	51.6	126.5	16.7	51
26	25.5	89.5	83.5	14.4	12.3	47.8	44.5	16.9	15.7
22.7	23.6	35.1	32.9	5.1	0	18.9	13.2	0	0

LAMP Precision Data, Collocated Samples



◆ Benzene ■ Toluene ▲ Ethyl-benzene ■ m/p xylene * o-xylene — Linear

LAMP Precision Data, Outlier Excluded



◆ Benzene ■ Toluene ▲ Ethyl-benzene ■ m/p xylene * o-xylene — Linear

Summary

Objectives were:

- Measure community-oriented population exposure over an annual average period
- Obtain baseline data
- Characterize BETX concentrations across the Chicago urbanized area
- Comparison of the sorbent tube method to other methods

The diffusion tube method was found to provide acceptable results.

The LAMP Phase II results showed that the diffusion tube method provided long-term (annual average) data comparable to those provided by the currently accepted summa-polished canister method. Additionally, the study results found that the diffusion tube method to provided a high degree of reproducibility.

The LAMP Phase II Saturation Study found BETX concentrations to vary geographically.

The LAMP Phase II data showed that areas near expressways are likely to experience the highest levels of BETX and that the urban population areas are markedly higher than background. Emissions from Chicago O'Hare Airport and the traffic in and around it result in higher BETX levels in that area than were found in the other urban population areas of Chicago.

Average BETX concentrations in Chicago were found to vary from month to month.

The LAMP Phase II results show that there is significant variation in BETX levels from month to month. The highest monthly concentrations were approximately 100% higher than the lowest months. The monthly average data showed that the months with the highest concentrations were January- February and August-September. This supported the choice of August as a good month for a saturation study since it also included summertime PAMS sampling for BETX. The lowest months were shown to be March and April, not surprisingly, as in Chicago they are the wettest, windiest and least conducive period for accumulation of pollutant concentrations.

Further study is needed to compare the diffusion tube and the field gas chromatography methods.

The limited study results showed that the diffusion tubes generally over-predicted the BETX concentrations as measured by the field gas chromatographs. A previous LAMP study had shown a much better comparability, but it also was based upon limited sampling data. Before any judgment can be made relative to the correlation of these two methods, further review and study is needed, including more comprehensive field comparison testing.