

# MIAMI-DADE COUNTY BACKGROUND STUDY

**PRESENTED TO THE CONTAMINATED MEDIA  
FORUM -BACKGROUND WORK GROUP**

Presented by

Wilbur Mayorga, M.S.,P.E., Chief

Environmental Monitoring and Restoration Division

DERM

February 27, 2014 and updated April 28, 2014

# Objectives

1. To illustrate Miami-Dade County's evolving background data set which are centralized and accessible to the regulated community.
2. To present an overview of Miami-Dade County's anthropogenic background study
3. Use MDC's experience as a case study for initiating discussions regarding regulatory framework for addressing the issues and challenges to the use of regional background concentrations.

# The need

- Risk assessors and environmental regulators need information regarding the distribution and concentrations of chemicals in soils
  - Naturally occurring or,
  - Resulting from anthropogenic impacts
- Increasing need for specific regional and local information
- More flexible options for closing contaminated sites means the regulatory community needs access to information
- Few studies targeting background soil concentrations locally and nationally



# Literature Research

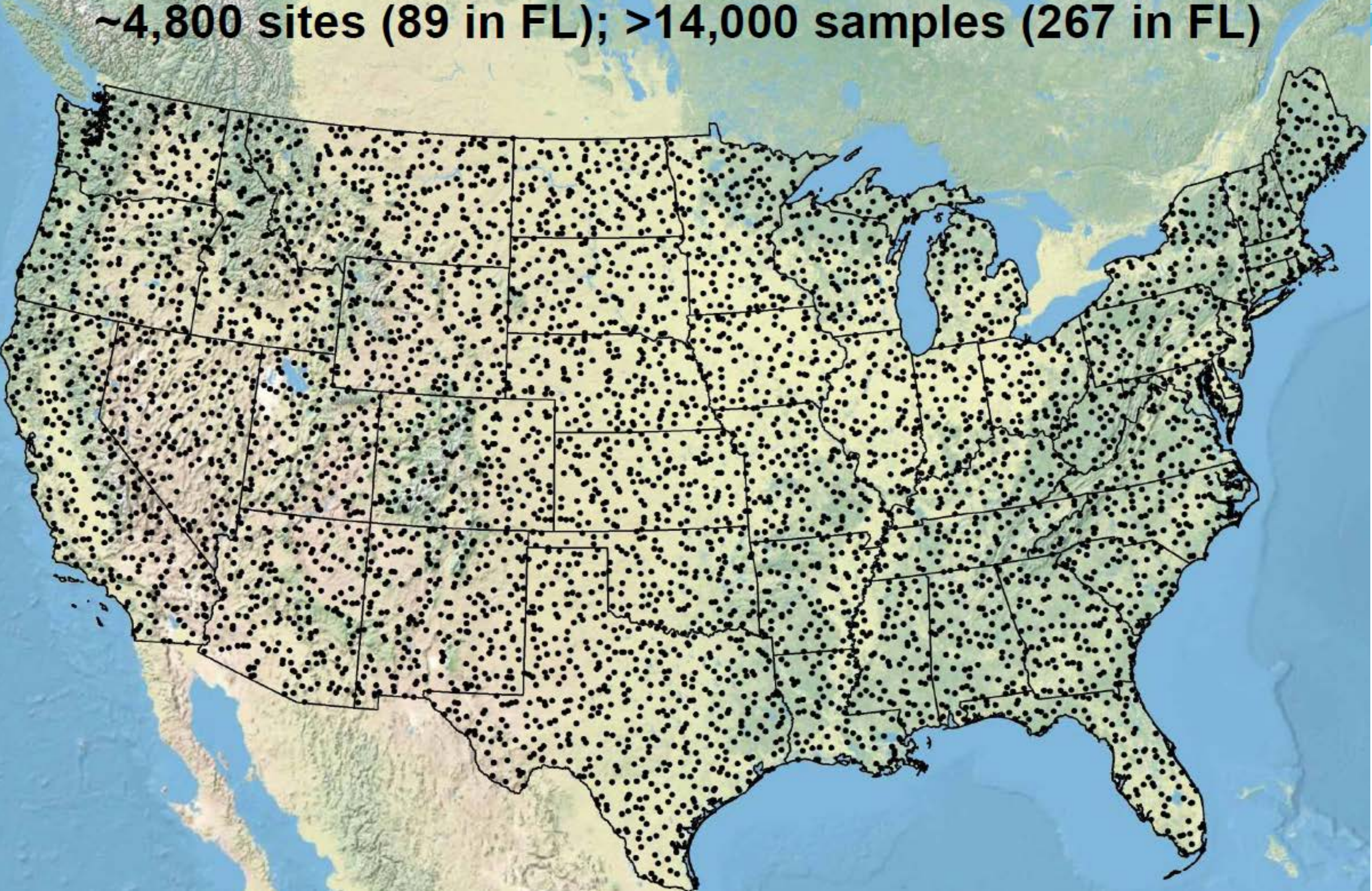
Previous Studies

# Previous Studies

- National (non-exhaustive list)
  - *Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States.*  
Shacklette and Boerngen (1984), U.S. GEOLOGICAL SURVEY PROFESSIONAL PAPER 1270  
[http://pubs.usgs.gov/pp/1270/pdf/PP1270\\_508.pdf](http://pubs.usgs.gov/pp/1270/pdf/PP1270_508.pdf)
  - *Cadmium, lead, zinc, copper, and nickel in agricultural soils of the United States of America.*  
Holmgren G.G.S, M.W Meyer, R.L.Chaney, R.B. Daniel, 1993  
<http://nature.berkeley.edu/classes/espm-120/Website/Holmgren1993.pdf>
  - *Major- and Trace-Element Concentrations in Soils from Two Continental-Scale Transects of the United States and Canada*  
D.B. Smith et al. (2005) U.S. GEOLOGICAL SURVEY PROFESSIONAL PAPER 1253  
<http://pubs.usgs.gov/of/2005/1253/>



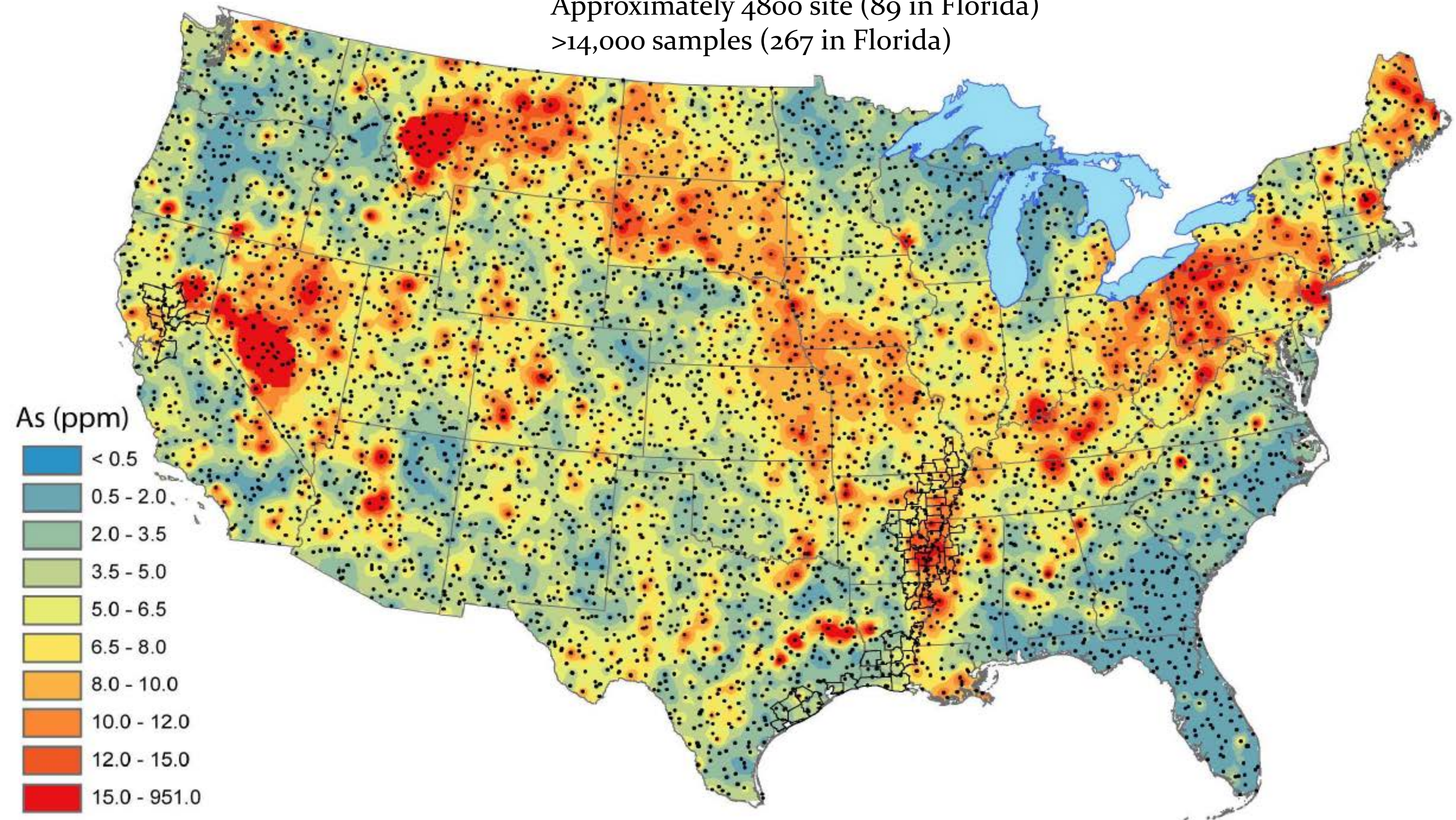
**~4,800 sites (89 in FL); >14,000 samples (267 in FL)**





# ARSENIC IN SURFACE (0-5 CM) SOIL

Approximately 4800 site (89 in Florida)  
>14,000 samples (267 in Florida)





# Previous Studies

- States
  - Several states provide generic statewide background values for inorganic chemicals and allow the use of these background values in lieu of site specific backgrounds. However, this information is not necessarily centrally located and easily accessible.
  - Although Florida does not have published generic state background numbers several studies have been conducted

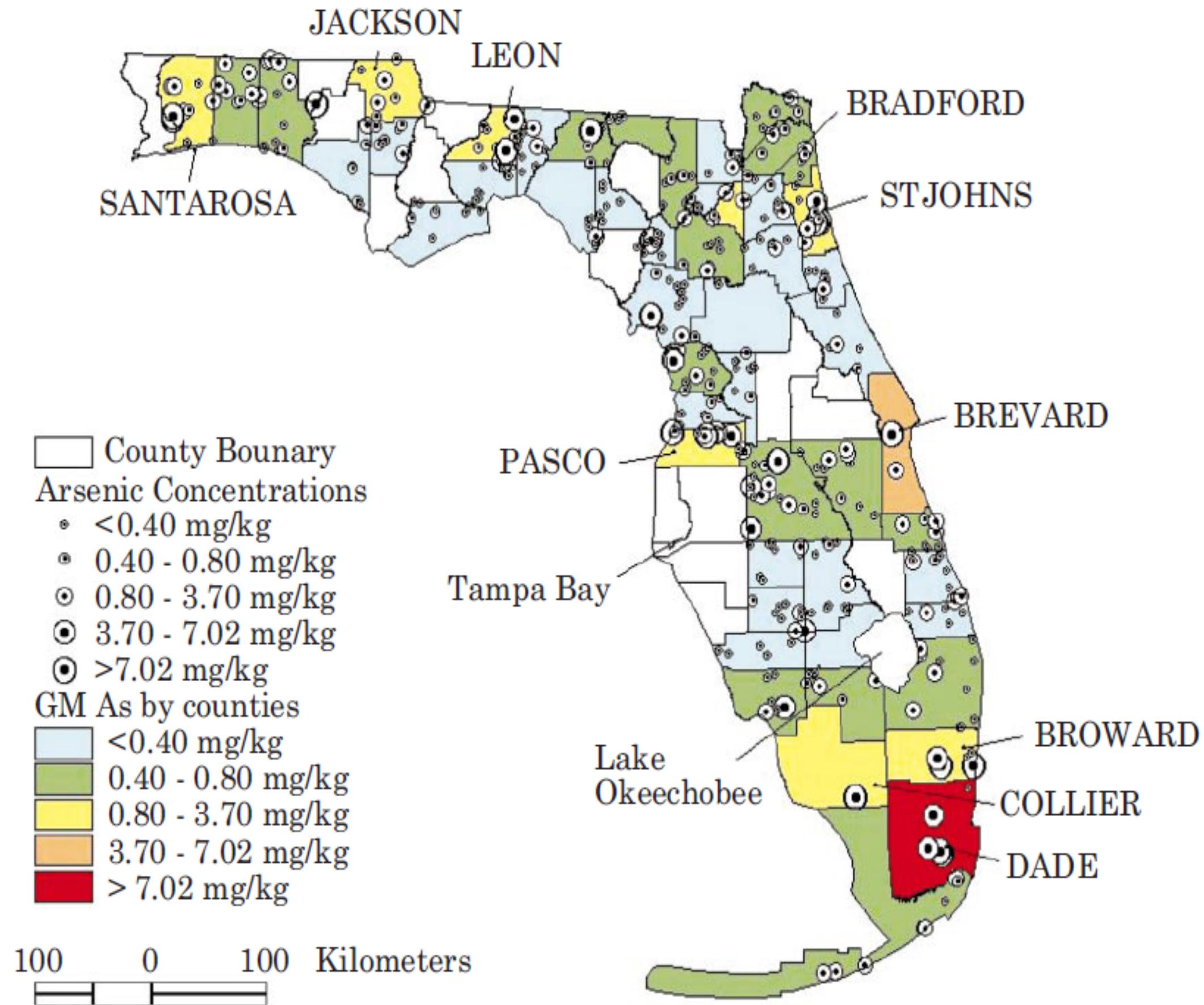


# Florida Studies

## Non exhaustive list

- Ma, et al. (1997)  
Concentrations and Distributions of Eleven Metals in Florida Soils  
<http://lqma.ifas.ufl.edu/PUBLICATION/Ma-97c.pdf>
- Chirenje, Ma, Chen and Zillioux (2002)  
Comparison between background concentrations of arsenic in urban and non-urban areas of Florida  
<http://lqma.ifas.ufl.edu/Publication/Tait-03b.pdf>
- Ming Chen, Lena Q. Ma and Willie G. Harris (1999)  
Baseline Concentrations of 15 Trace Elements in Florida Surface Soils  
<http://lqma.ifas.ufl.edu/PUBLICATION/Chen-99.pdf>
- Schropp, S.J. and H.L. Windom. 1988.  
A guide to the interpretation of metal concentrations in estuarine sediments.  
Coastal Zone Management Section. Florida Department of Environmental Regulation. Tallahassee,
- Scarlatos and Scarlatos (1997)  
Ecological impact of arsenic and other trace metals from application of recovered screen material on Florida soils. FCSHWM special waste publication No. 97-5.







**Table 1. Summary statistics for soil arsenic concentrations in different land uses in Gainesville and Miami (all calculations done after eliminating outliers).**

Statistic	Residential	Commercial	Public parks	Public buildings	Combined
	$\text{mg kg}^{-1}$				
	<u>Miami</u>				
Samples	58	60	60	59	237
AM	5.37	2.56	4.67	3.46	4.00
ASD	5.72	3.21	0.67	3.41	4.34
Median	3.47	2.11	3.29	2.39	2.60
Geomean	3.72	1.93	3.49	2.49	2.80
Lgmean [As]	0.57	0.28	0.54	0.42	0.46
Lgstdev	0.35	0.30	0.33	0.39	0.02
	<u>Gainesville</u>				
Samples	79	39	38	40	196
AM	0.68	1.19	0.52	0.57	0.73
ASD	0.53	2.23	0.67	0.34	1.13
Median	0.52	0.52	0.35	0.48	0.50
Geomean	0.46	0.63	0.23	0.34	0.40
Lgmean [As]	-0.35	-0.20	-0.65	-0.27	-0.34
Lgstdev	0.49	0.41	0.68	0.83	0.05

† AM, arithmetic mean; ASD, arithmetic standard deviation; Geomean, geometric mean; Lgmean [As] and Lgstdev, mean of log-transformed concentrations and standard deviation.



**Table 2. The upper confidence limit (UCL), 95th percentile, and percentage of soil samples with arsenic concentrations exceeding the soil cleanup target level (SCTL) (residential and commercial) in different land uses in Florida.**

Statistic	Residential	Commercial	Public parks	Public buildings	Combined
			<u>Miami</u>		
UCL	6.47	2.90	5.70	4.30	4.32
95th percentile	25.3	4.73	16.3	15.4	16.4
Percent > 0.8 mg kg <sup>-1</sup> †	100	88.3	98.3	91.7	94.6
Percent > 3.7 mg kg <sup>-1</sup> ‡	48.3	10.0	43.3	28.3	32.5
			<u>Gainesville</u>		
UCL	1.25	1.59	1.38	1.03	0.99
95th percentile	1.74	5.65	1.86	1.65	3.53
Percent > 0.8 mg kg <sup>-1</sup>	30.4	30.0	26.3	29.5	29.4
Percent > 3.7 mg kg <sup>-1</sup>	0.00	10.0	2.63	9.10	4.00

† The Florida soil clean up target level for residential areas.

‡ The Florida soil clean up target level for commercial areas.



## The data from referenced studies indicated

- Concentrations were significantly influenced by soil geochemistry as well as land use.
- A need for a better understanding of distribution at local levels to establish local and sub-regional soil background levels



# Miami-Dade County

Studies



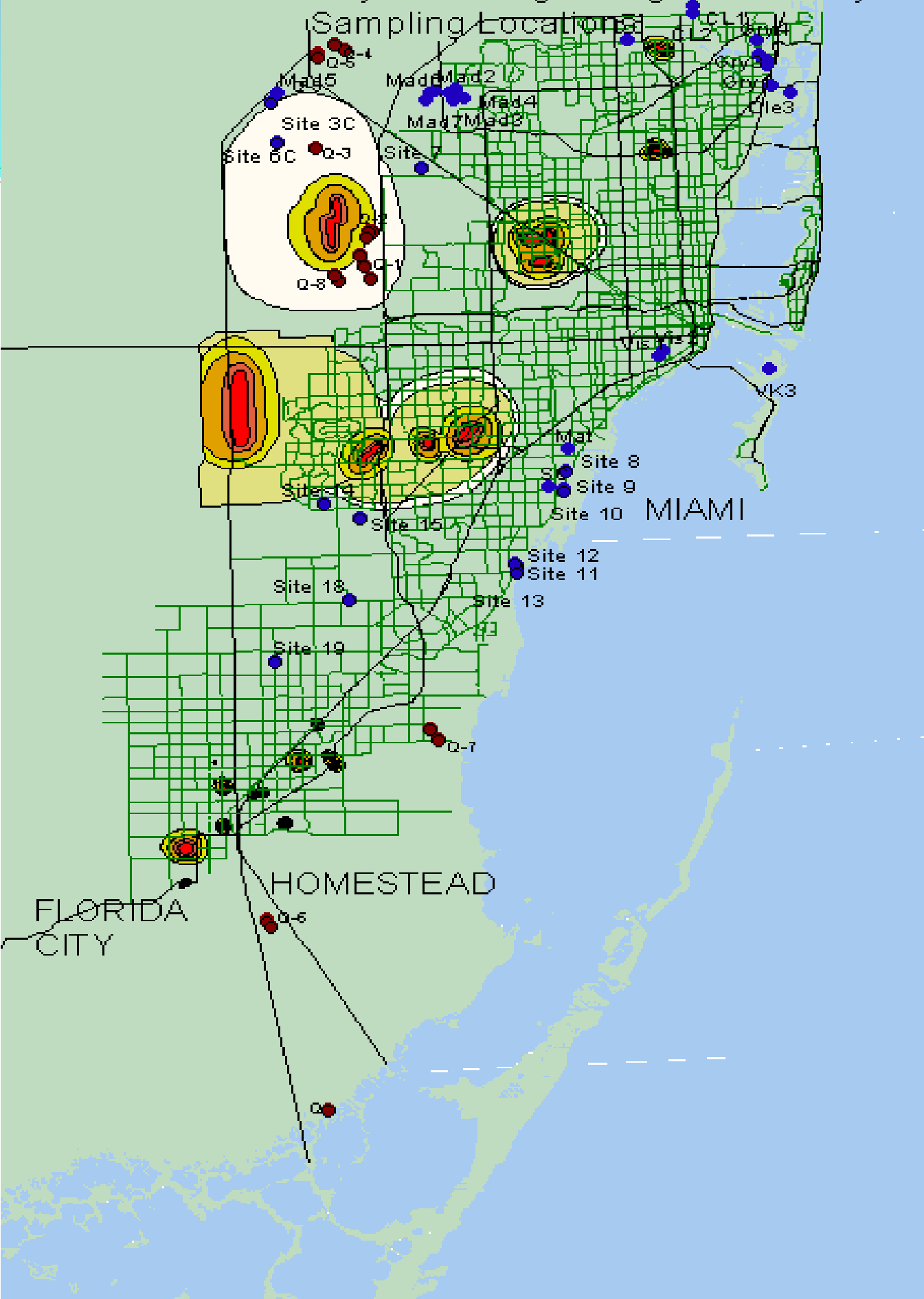
# Miami-Dade Studies

- 2001 – County wide natural background
- 2001 - Lime rock quarry material
- 2004 - Barrier Island Background Soil Concentrations
- Specific anthropogenic background
  - 2002 - Golf Course Study
  - 2002, 2003 and 2013 - Area wide atmospheric deposition – 3 former incinerators
- Muck soils (various)

# MDC COUNTYWIDE NATURAL BACKGROUND STUDY

(2001)

- 38 sampling locations (hardwood hammocks, pinelands, lowland)
- Undisturbed (natural) protected areas
- 0-2 feet interval
- Inorganics - 14 trace elements
- Arsenic - only element consistently exceed SCTL

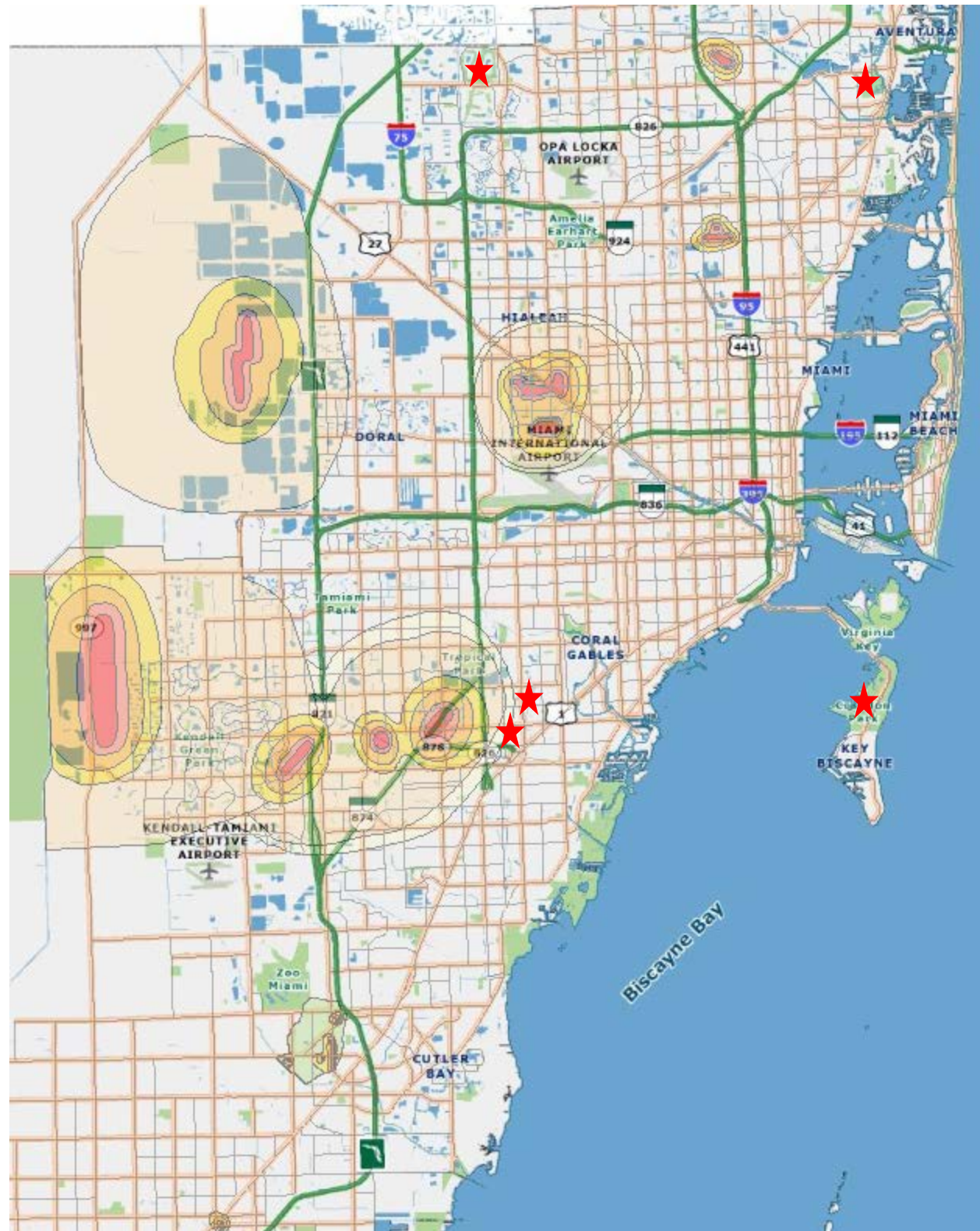


Chemical Name	Natural Background Concentration (mg/kg)	Chemical Name	Natural Background Concentration (mg/kg)
Arsenic	1.2	Lead	26
Aluminum	2656	Manganese	55
Barium	7	Mercury	0.08
Cadmium	0.1	Nickel	2.1
Chromium	6.8	Selenium*	<0.45
Copper	4.1	Silver*	<0.025
Iron	2176	Zinc	12

\* The data for selenium and silver were not analyzed statistically because all of the selenium results were below the detection limit and silver was detected in only one sample.



# Golf Course Study

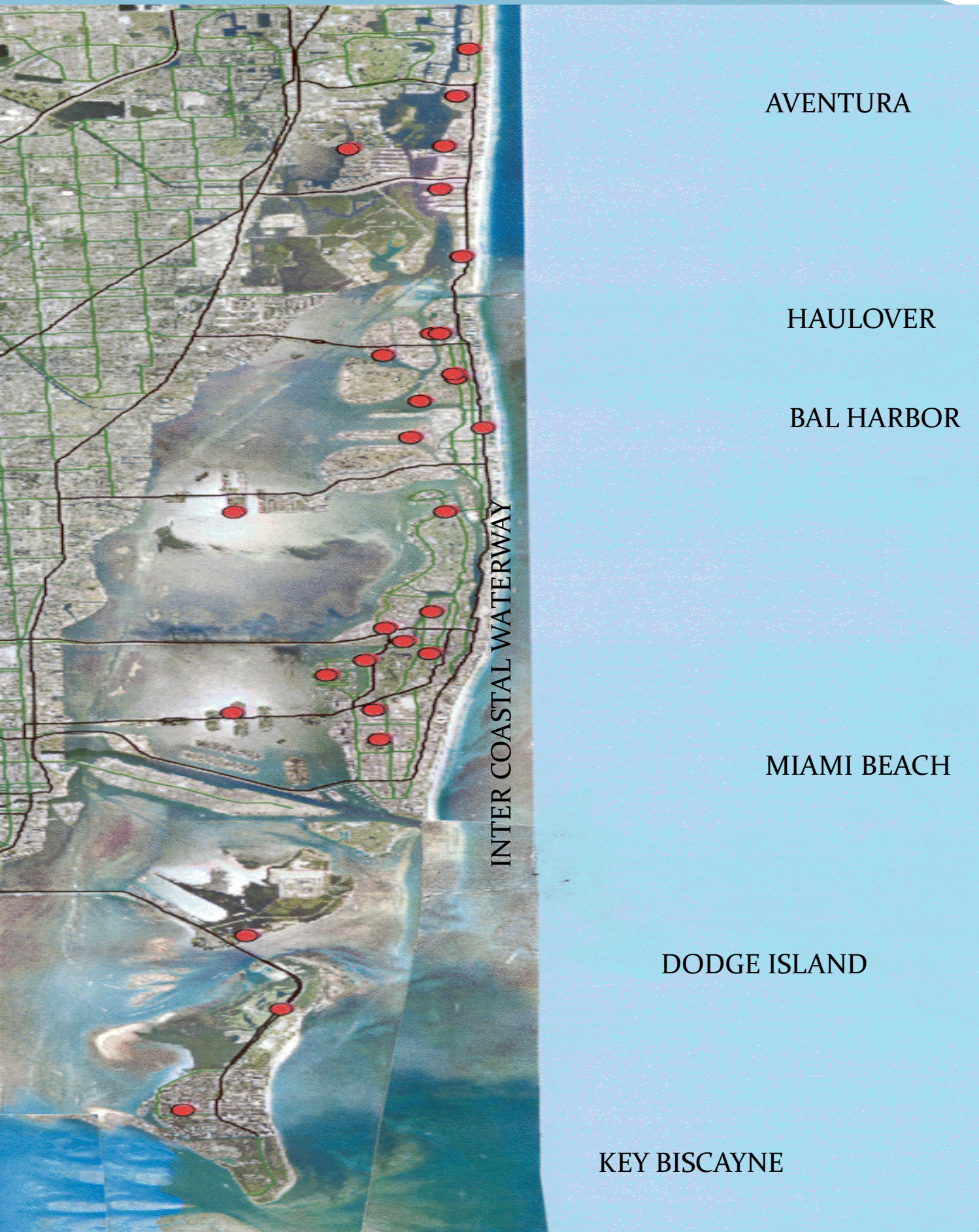


- 5 public golf courses
- COC's Inorganics and pesticides
- Arsenic only COC consistently above RSCTL

	Mixing/Loading Area	Play Area
N	10	31
Min	0.3	0.2
Max	33.5*	54.8
Mean	10	16
MVUE	11.8	25.1
95% UCL	32.6	26.3



# MIAMI-DADE COUNTY BARRIER ISLANDS BACKGROUND STUDY (2004)



- 51 sampling locations (residential lawns)
- Inorganics only
- 0-1 foot and 1-2 feet intervals sampled
- In presenting the data the intervals were combined if not statistically different

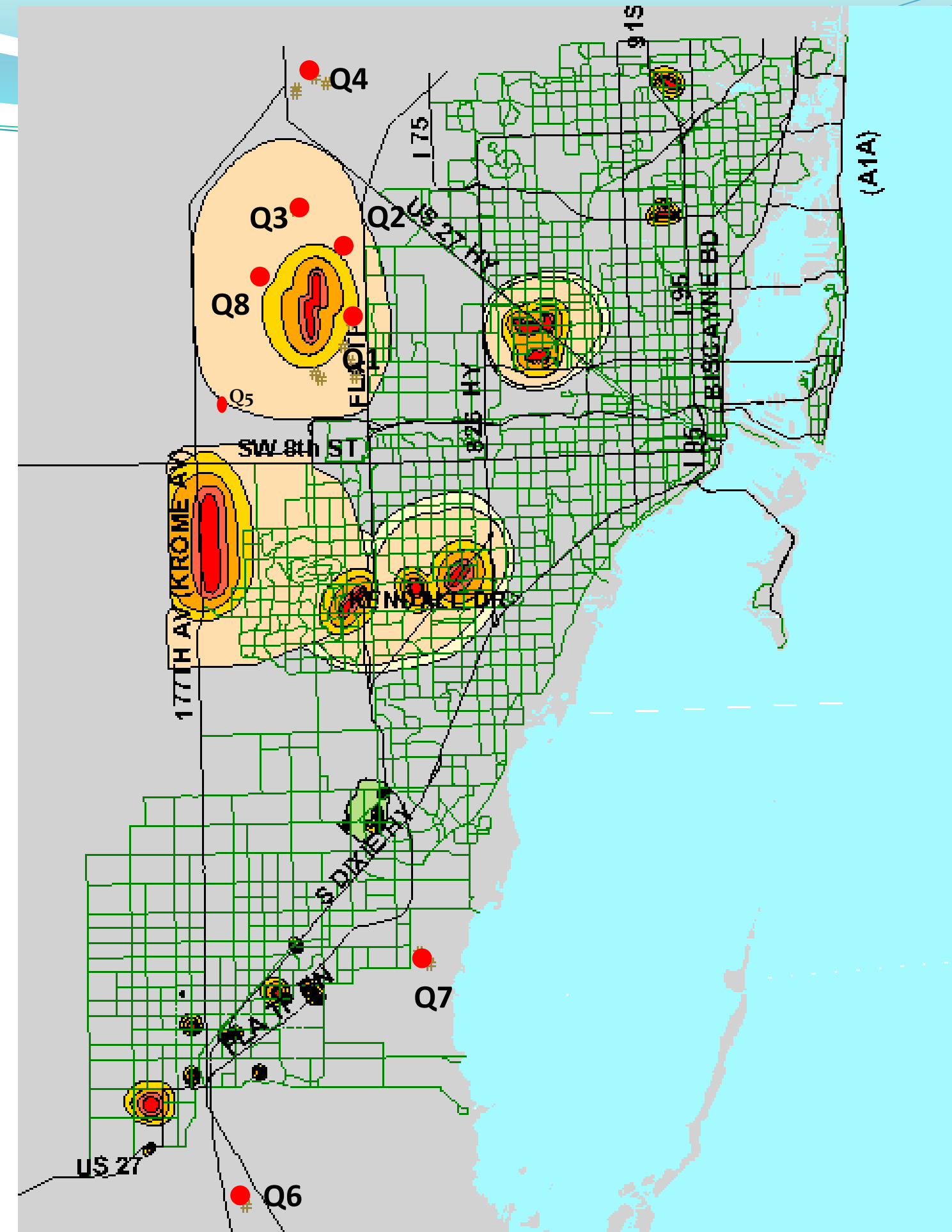
Chemical Name	Natural Background Concentration (mg/kg)	
	0-2 ft interval	
Arsenic	5.2	
Aluminum	798.7	
Cadmium	0.3	
Iron	2050.7	
Selenium**	<0.5	
Zinc	13.1	
Silver*	0.4	
	0-1 ft interval	1-2 ft interval
Barium	8.1	5.9
Chromium	7.9	5.7
Copper	5.4*	2.3*
Lead	15.0	5.2*
Mercury	0.054	0.026*
Nickel	1.08*	0.66*

Available at <http://www.miamidade.gov/environment/research-reports.asp>

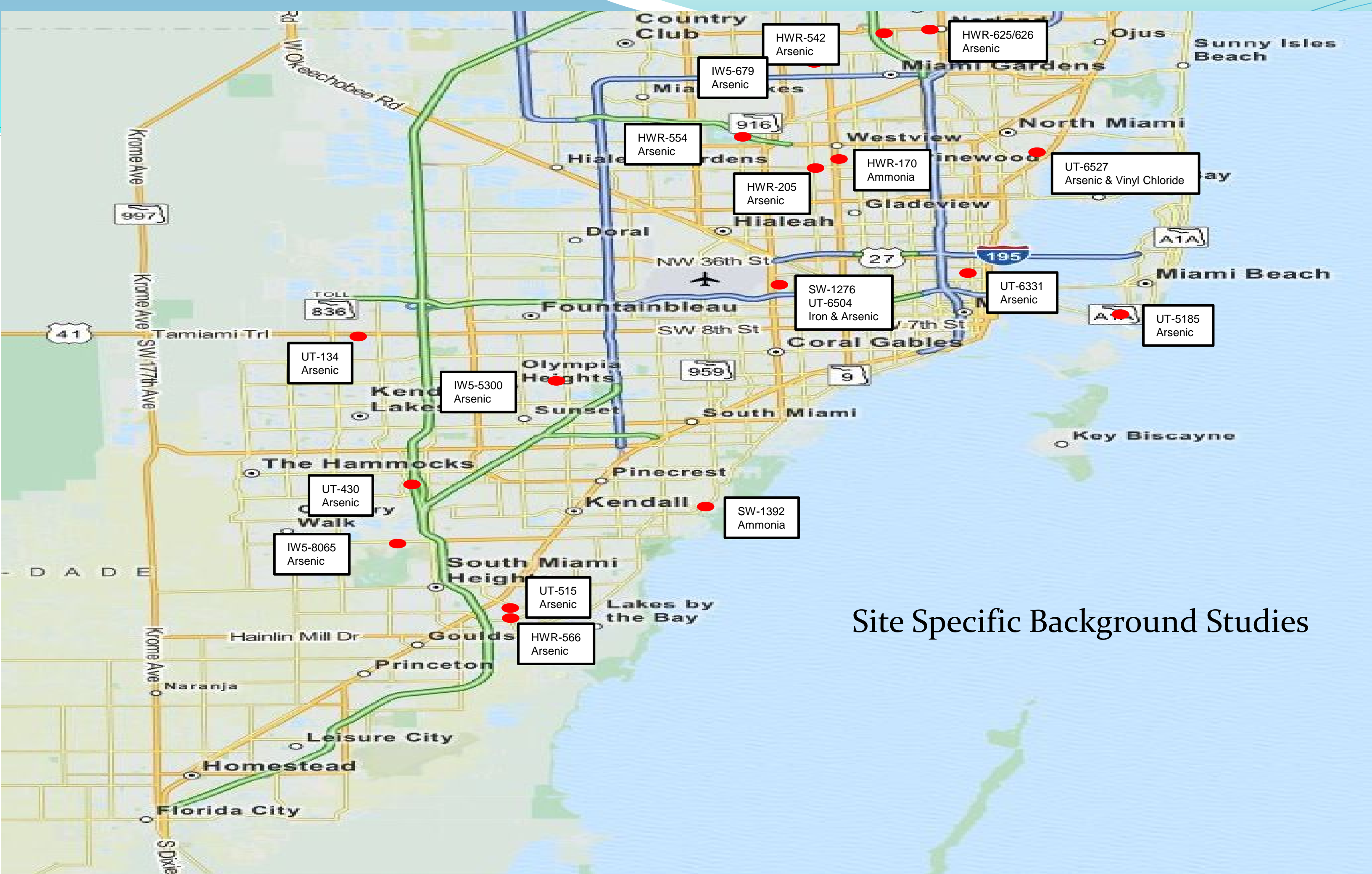


# MDC Background Concentration of Trace Elements in Native Quarry Material

- 8 sampling locations ( rock mining quarries in MDC),
- 22 samples (from dragline bucket, stockpiled material and processed material
- 13 inorganic.
- All results below RSCT
- Arsenic below detection in all samples (MDL 0.2mg/kg)



• Quarry sample locations



UT-134  
Arsenic

IW5-5300  
Arsenic

UT-430  
Arsenic

IW5-8065  
Arsenic

UT-515  
Arsenic

HWR-566  
Arsenic

SW-1392  
Ammonia

SW-1276  
UT-6504  
Iron & Arsenic

HWR-554  
Arsenic

IW5-679  
Arsenic

HWR-205  
Arsenic

HWR-542  
Arsenic

HWR-625/626  
Arsenic

HWR-170  
Ammonia

UT-6527  
Arsenic & Vinyl Chloride

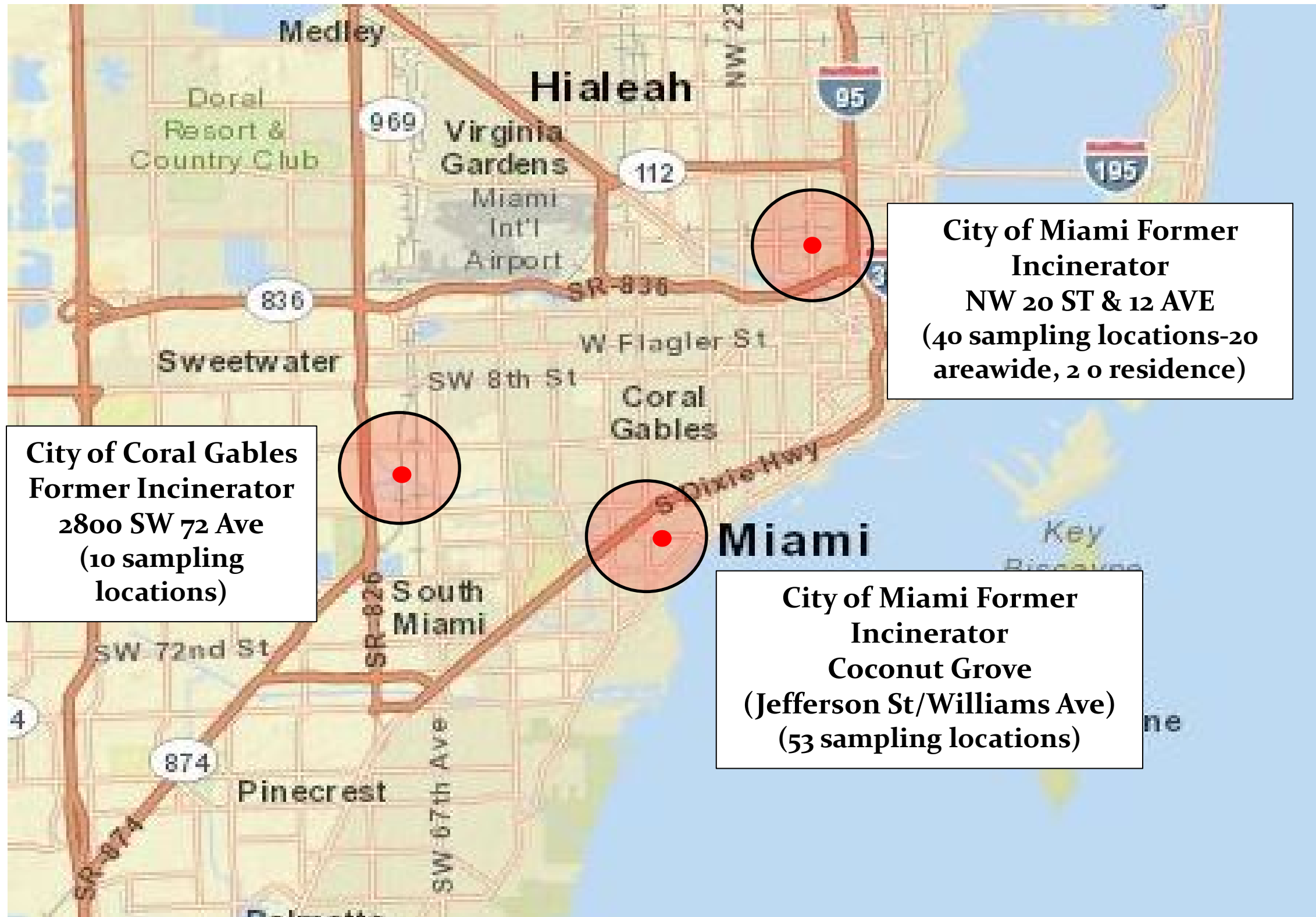
UT-6331  
Arsenic

UT-5185  
Arsenic

## Site Specific Background Studies



# Former Incinerator 1 Mile Radius Study Areas



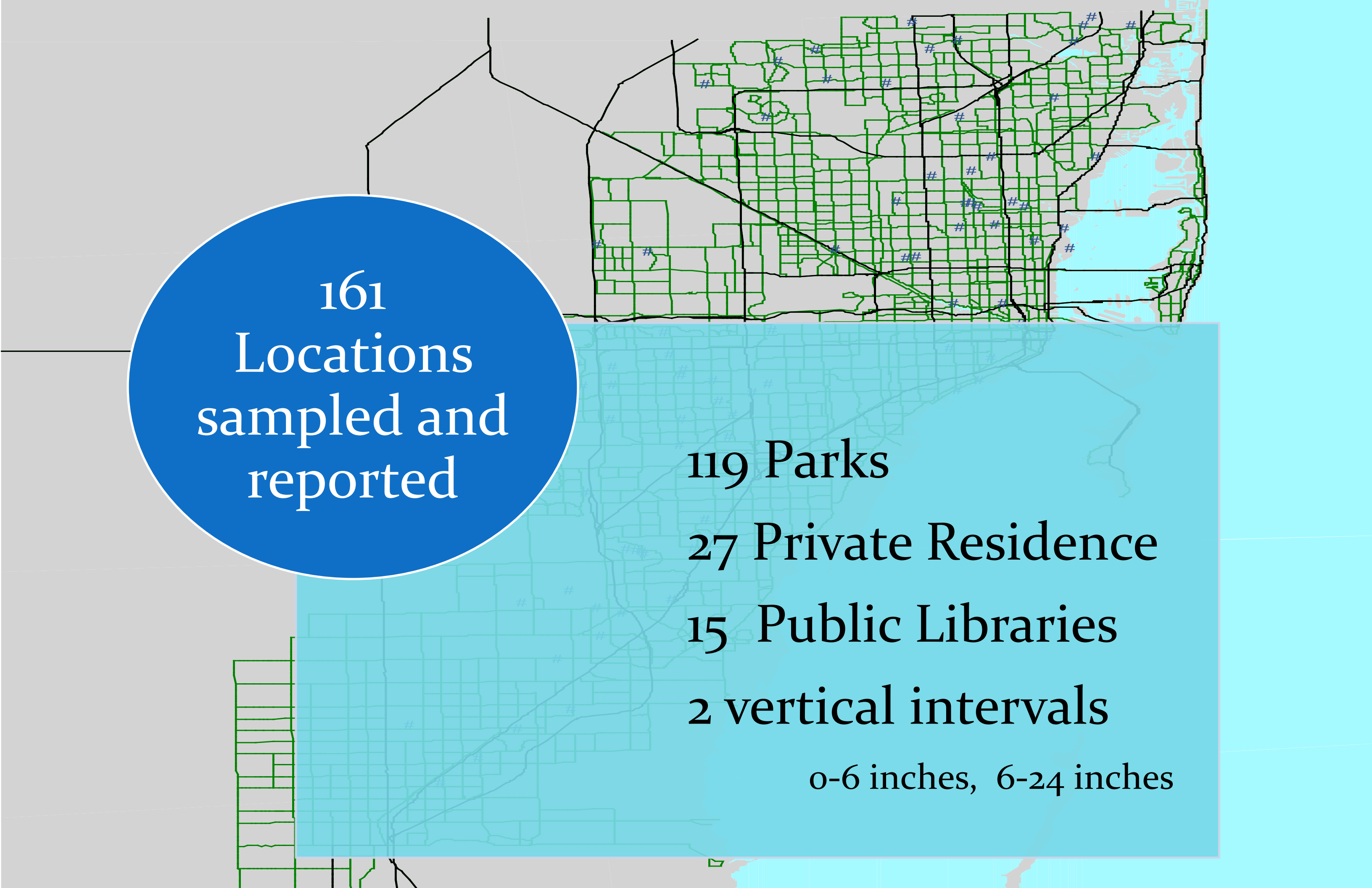
- 10-53 locations sampled.
- 0-6 and 6-24 inch interval
- Metals, Dioxin and PCBs
- Arsenic primary contaminant of concern.



MIAMI-DADE COUNTY

Anthropogenic Background





161  
Locations  
sampled and  
reported

119 Parks

27 Private Residence

15 Public Libraries

2 vertical intervals

0-6 inches, 6-24 inches

COC's

METALS

PAH's

PESTICIDES\*

DIOXIN\*

\* 10% of samples analyzed for dioxin and pesticides

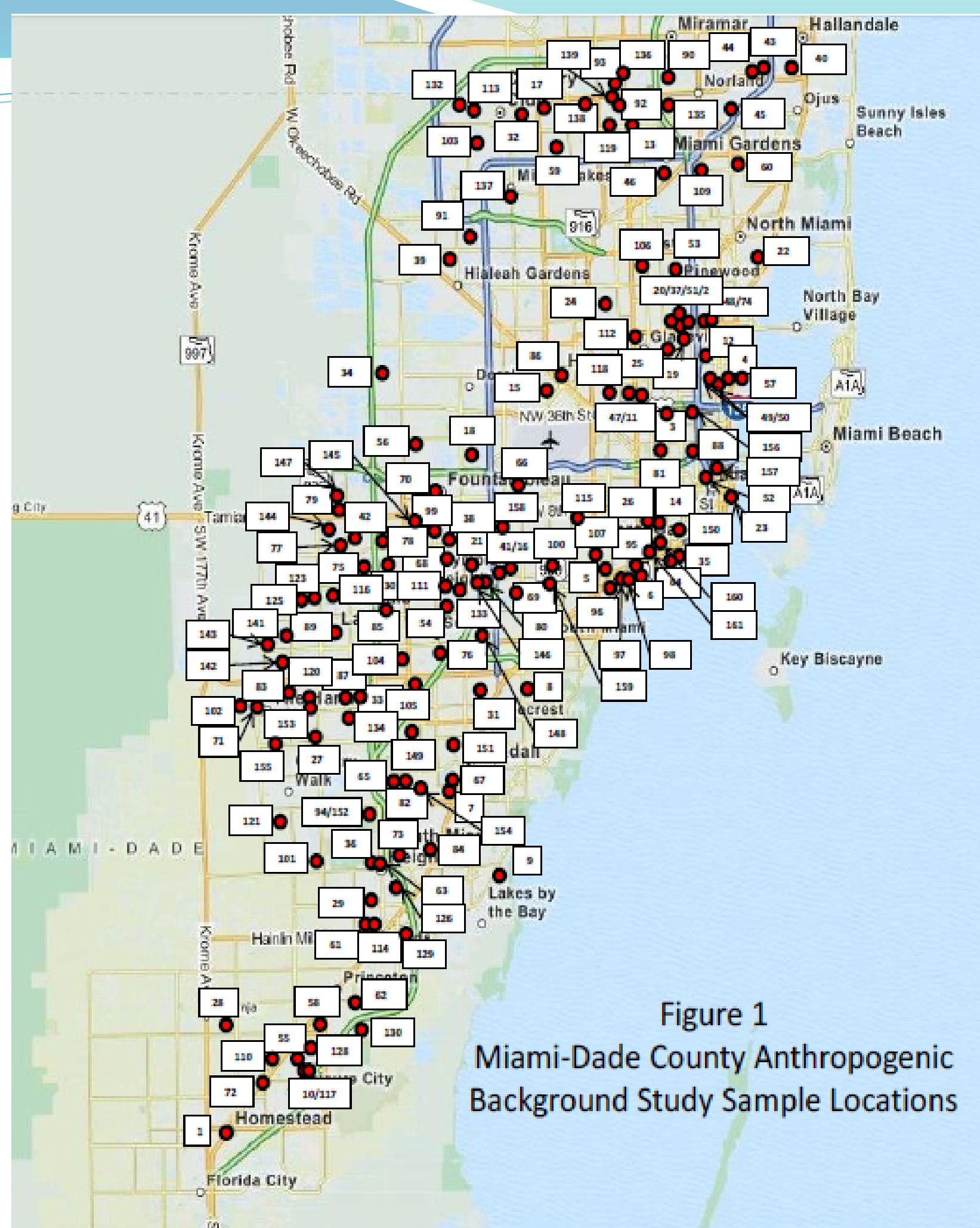


Figure 1  
Miami-Dade County Anthropogenic  
Background Study Sample Locations



# RESULTS

Arsenic and PAHs are the only COC with concentrations exceeding direct exposure SCTL

Chromium and Lead sporadically exceeded groundwater leachability SCTL

# MIAMI-DADE COUNTY ANTHROPOGENIC BACKGROUND STUDY

## SUMMARY STATISTICS

*(Contaminants with no exceedence of the Residential Soil Cleanup Target Level)*

	Al		Ba		Cd		Cr		Cu		Pb	
	0 - 6"	6 - 24"	0 - 6"	6 - 24"	0 - 6"	6 - 24"	0 - 6"	6 - 24"	0 - 6"	6 - 24"	0 - 6"	6 - 24"
<b>Number of Samples</b>	155	147	160	147	156	147	157	147	151	146	160	147
<b>Minimum</b>	84	81.3	2.1	0.56	0.04	0.01	1.27	0.57	1.2	0.3	0.15	0.15
<b>Maximum</b>	24700	27600	93.5	79.5	2.5	1.2	57.4	62.9	53.9	37.6	158	176
<b>Mean</b>	2539	2334	12.1	9.42	0.27	0.15	13.7	10.52	9.75	6.05	25.5	16.9
<b>MVUE</b>	2510	2345	11.91	9.18	0.28	0.15	12.7	10.6	9.77	6.39	26	16
<b>95% UCL</b>	3483	2740	15.23	13.13	38	0.21	13.96	11.97	10.99	7.89	31.2	20.4
<b>Distribution</b>	NonP	LogN	NonP	NonP	NonP	NonP	LogN	LogN	LogN	LogN	LogN	LogN

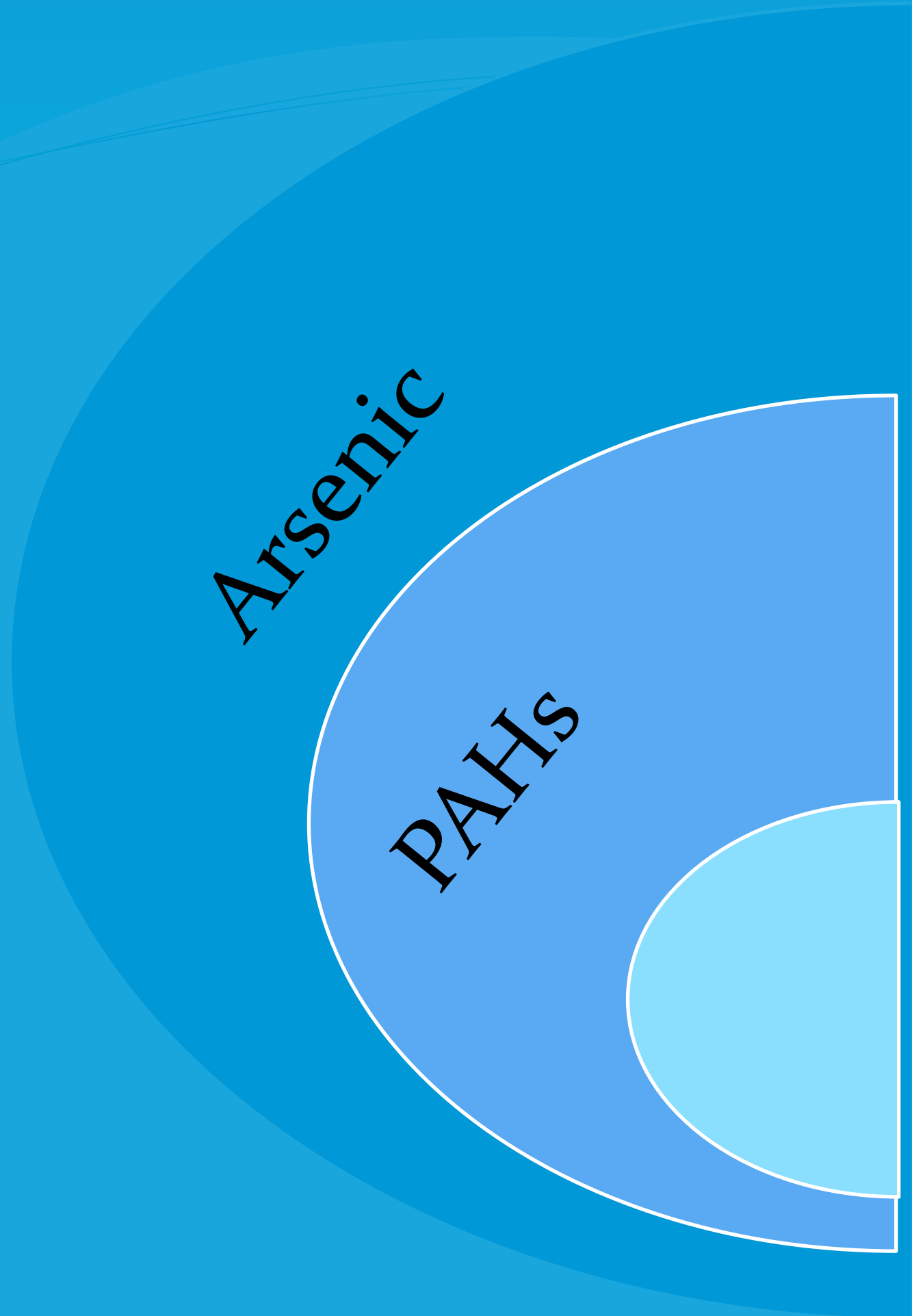
	Fe		Hg		Mn		Ni		Zn	
	0 - 6"	6 - 24"	0 - 6"	6 - 24"	0 - 6"	6 - 24"	0 - 6"	6 - 24"	0 - 6"	6 - 24"
<b>Number of Samples</b>	155	147	154	147	147	147	149	145	149	146
<b>Minimum</b>	119	56	0.11	0.006	5.86	1	0.25	0.09	4	1
<b>Maximum</b>	14600	16100	1.2	0.81	36.6	273	12.1	12.7	249	231
<b>Mean</b>	2624	2108	0.35	0.36	55	35.1	2.3	2.1	44.3	24.3
<b>MVUE</b>	2629	2170	0.4	0.4	53.9	35.9	2.2	2.1	39.6	23.2
<b>95% UCL</b>	3390	2510	0.42	0.42	61.2	43.3	2.9	2.7	44.9	28.8
<b>Distribution</b>	LogN	LogN	NonP	NonP	LogN	LogN	NonP	NonP	LogN	LogN

*Arsenic*

*PAHs*

DATA

EVALUATION





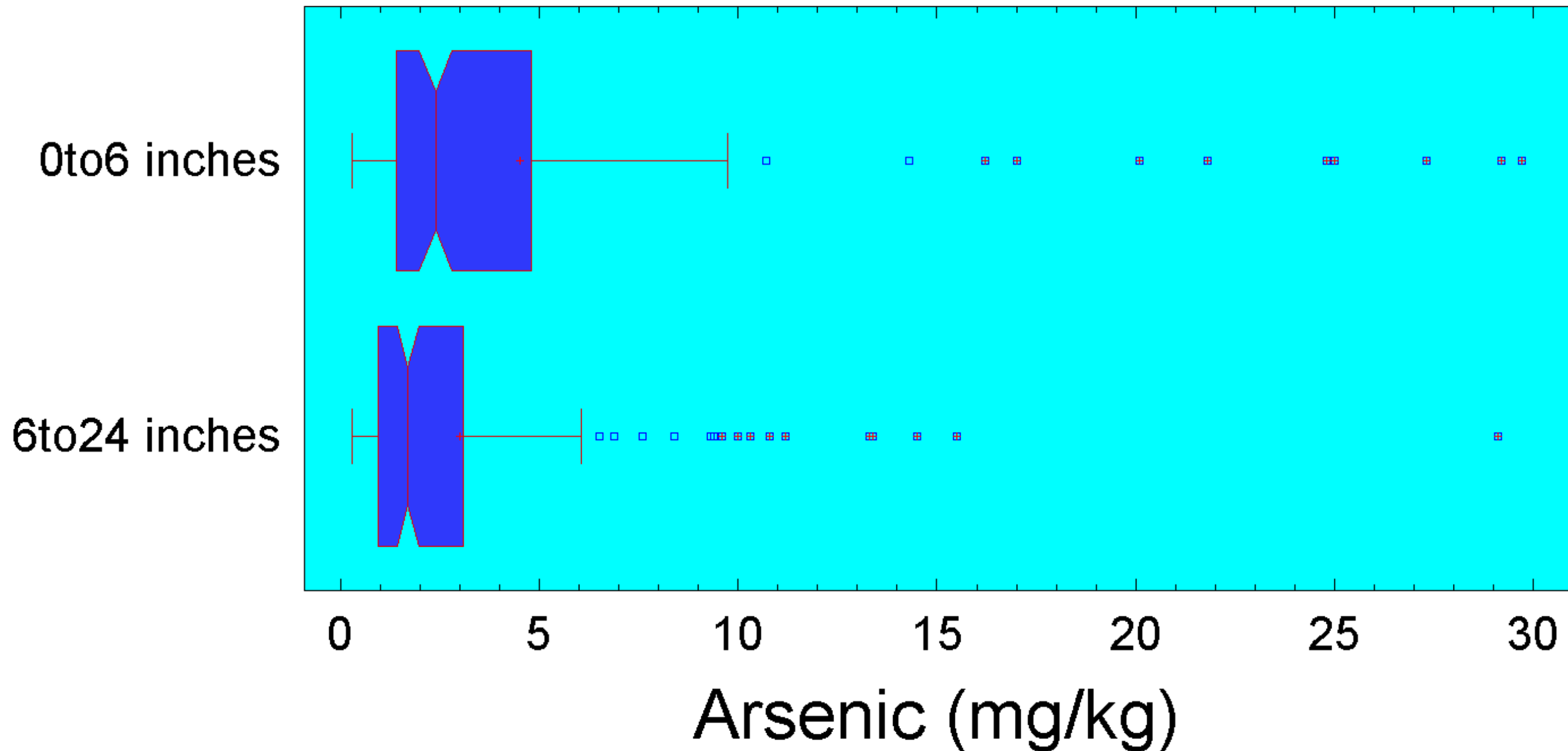
**VERTICAL PROFILE**

**LAND USE**

**ARSENIC  
CONCENTRATION  
DISTRIBUTION**

**SPATIAL DISTRIBUTION**

# Arsenic Vertical Distribution



## Kolmogorov-Smirnov Test

- K-S statistic = 2.03437
- Approximate P value = 0.000508435
- Given P value less than 0.05, the conclusion is that there is significant difference between the two distributions are at the 95% confidence level



# Land Use Evaluation

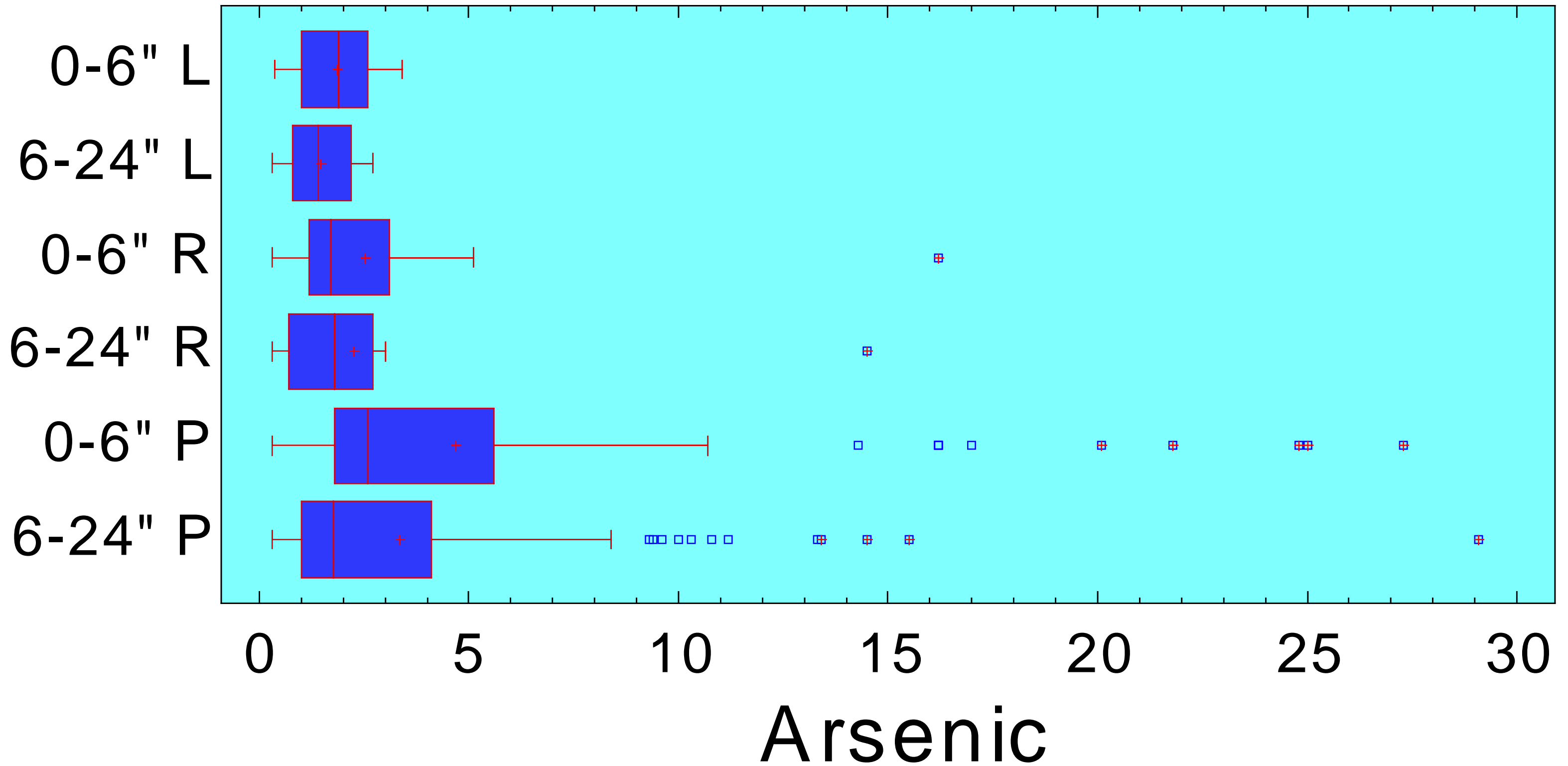
- Parks vs Libraries vs Residence

There is a statistically significant difference amongst the medians at the 95.0% confidence level. Parks population different from libraries and residence

- Libraries vs residence:

There is not a statistically significant difference between the two distributions at the 95.0% confidence level.

# Land Use Versus Vertical Profile



L: Library, R: Residence, P: Park

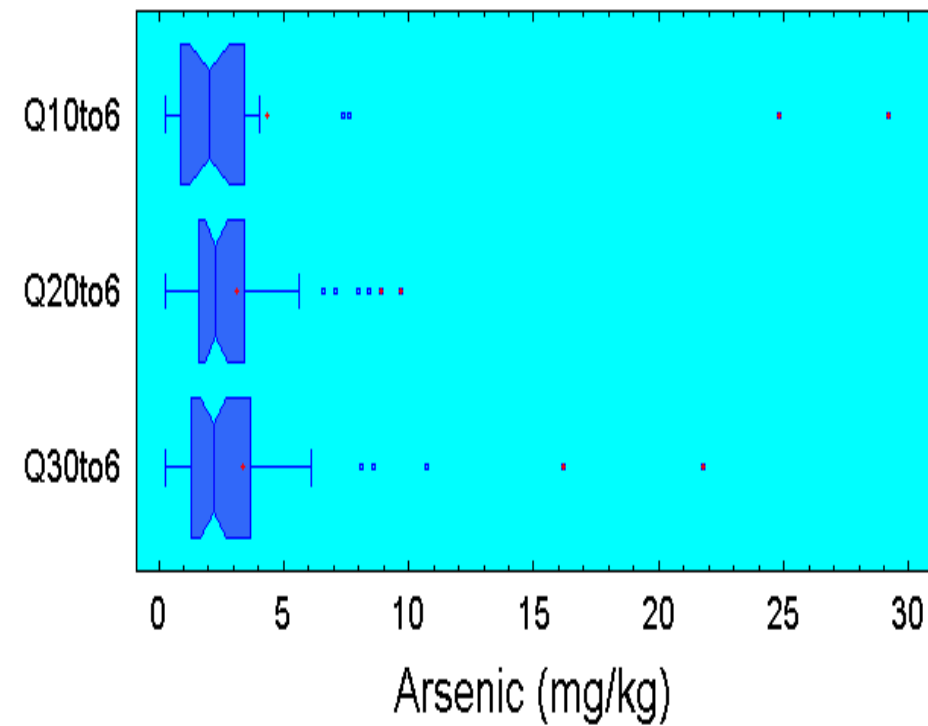


# Spatial Evaluation

- For this evaluation the county was divided into four quadrants along the north/south axis.
  - Q1: Countyline Road to NW 135<sup>th</sup> Street
  - Q2: NW 135<sup>th</sup> Street to West Flagler Street
  - Q3: West Flagler Street to SW 88 Street (South Kendall Drive)
  - Q4: South of SW 88<sup>th</sup> Street
- An evaluation of the data indicated a statistically significant difference in the median concentration of the data set for south of SW 88<sup>th</sup> Street (Q4) vs the rest of the county.

# Spatial Evaluation

Arsenic Spatial Distribution North and Central MDC

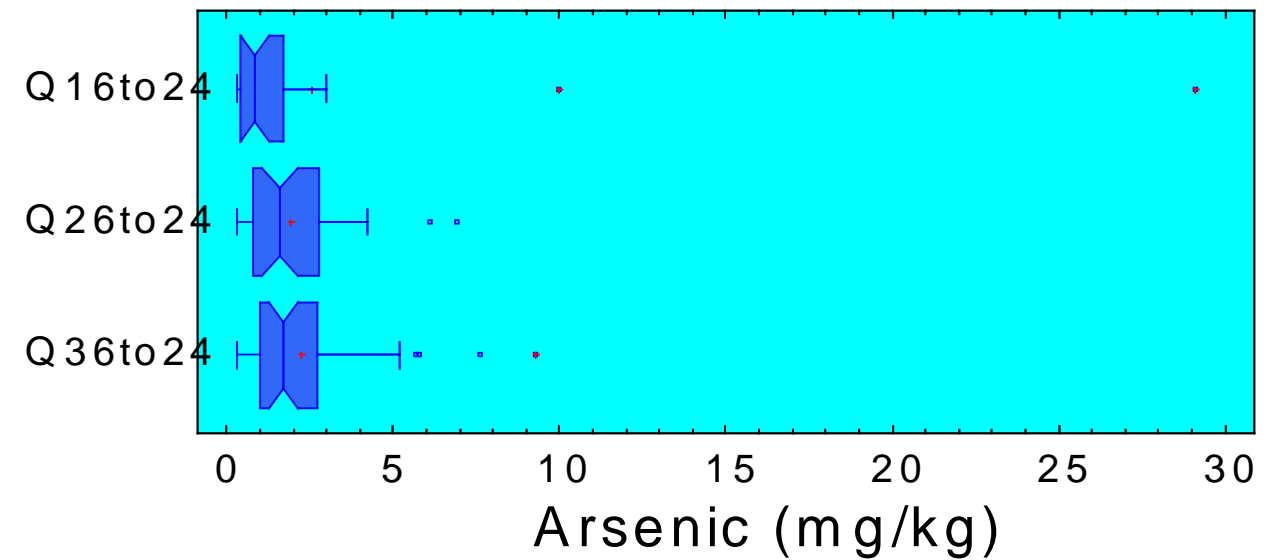


Kruskal-Wallis test

Test statistic = 0.546622 P-Value = 0.760856

Since the P-value is greater than or equal to 0.05, there is not a statistically significant difference amongst the medians at the 95.0% confidence level.

Arsenic Spatial Distribution North and Central



Kruskal-Wallis test

Test statistic = 5.44012 P-Value = 0.065870

Since the P-value is greater than or equal to 0.05, there is not a statistically significant difference amongst the medians at the 95.0% confidence level.

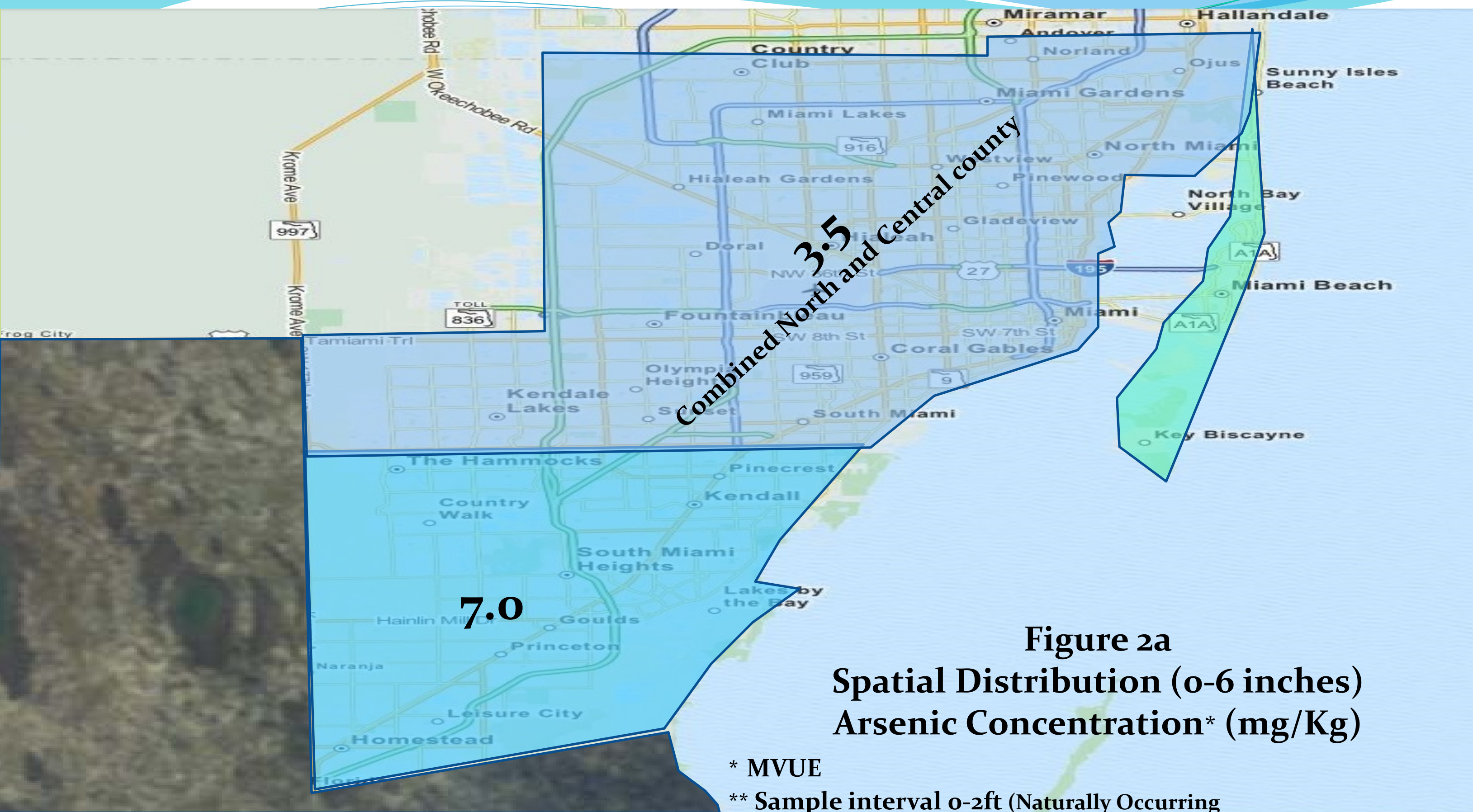
# Spatial Evaluation

**Table 2: MIAMI-DADE COUNTY ANTHROPOGENIC BACKGROUND STUDY  
ARSENIC SUMMARY STATISTICS**

	Arsenic- County-Wide			Arsenic-North of SW 88 Street			Arsenic-South of SW 88Street		
	0 - 6"	6 - 24"	0-2 ft*	0 - 6"	6 - 24"	0-2 ft*	0 - 6"	6 - 24"	0-2 ft*
<b>Number of Samples</b>	153	142	142	111	100	100	40	39	39
<b>Minimum</b>	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
<b>Maximum</b>	27.3	14.5	16.2	24.8	10.0	13.7	27.3	14.5	16.2
<b>Mean</b>	3.9	2.6	2.9	3.3	1.9	2.2	5.9	4.2	4.7
<b>MVUE</b>	4.2	2.9	3.0	3.5	2.1	2.3	7	5	5.2
<b>95% UCL</b>	5.6	3.5	3.7	4.8	2.6	2.8	10.6	7.1	7.9

Concentrations in mg/kg  
 Outliers removed for data analysis  
 \* Weighted Concentration





**3.5**  
 Combined North and Central county

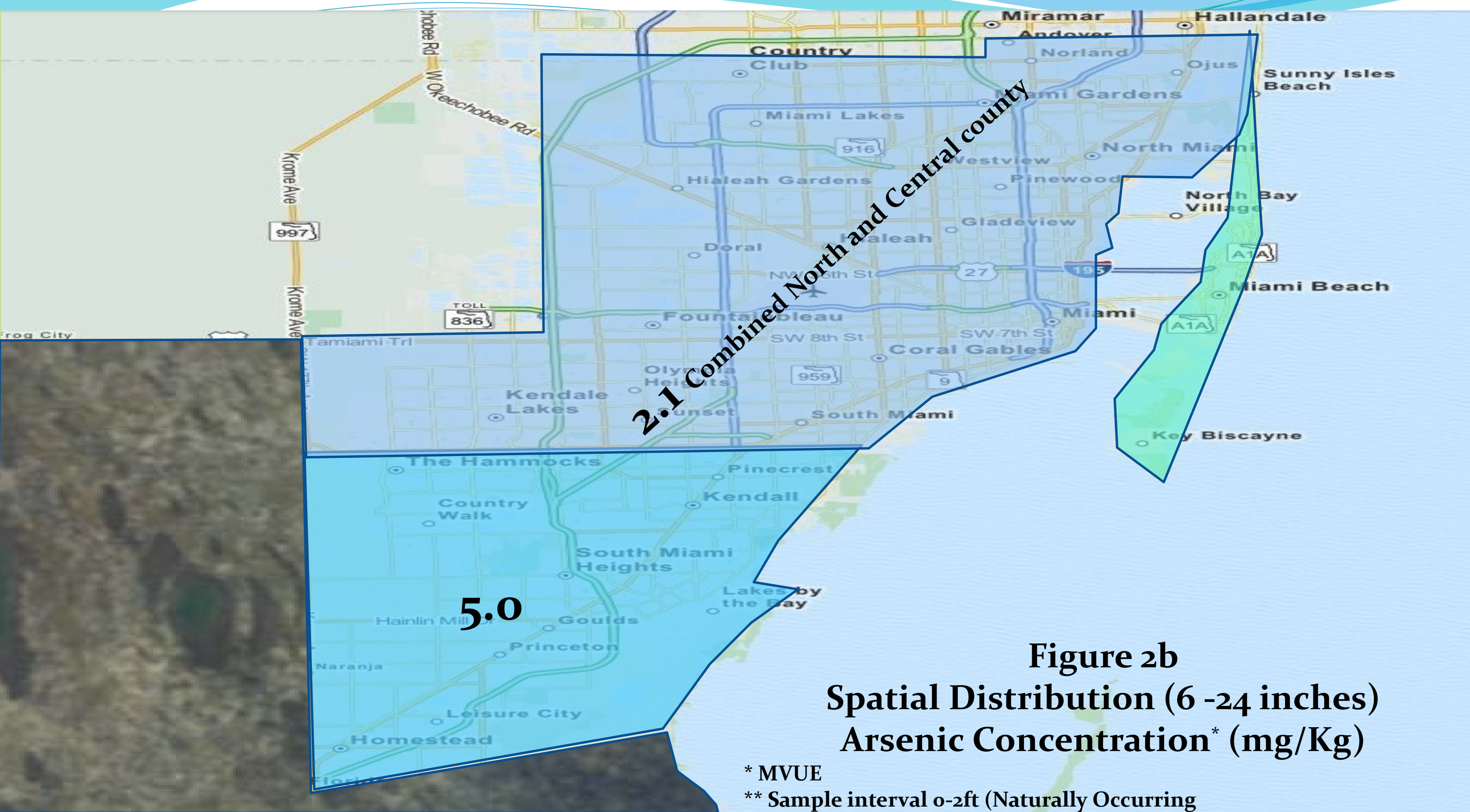
**7.0**

**Figure 2a**  
**Spatial Distribution (0-6 inches)**  
**Arsenic Concentration\* (mg/Kg)**

\* MVUE

\*\* Sample interval 0-2ft (Naturally Occurring Background Concentrations)





**2.1 Combined North and Central county**

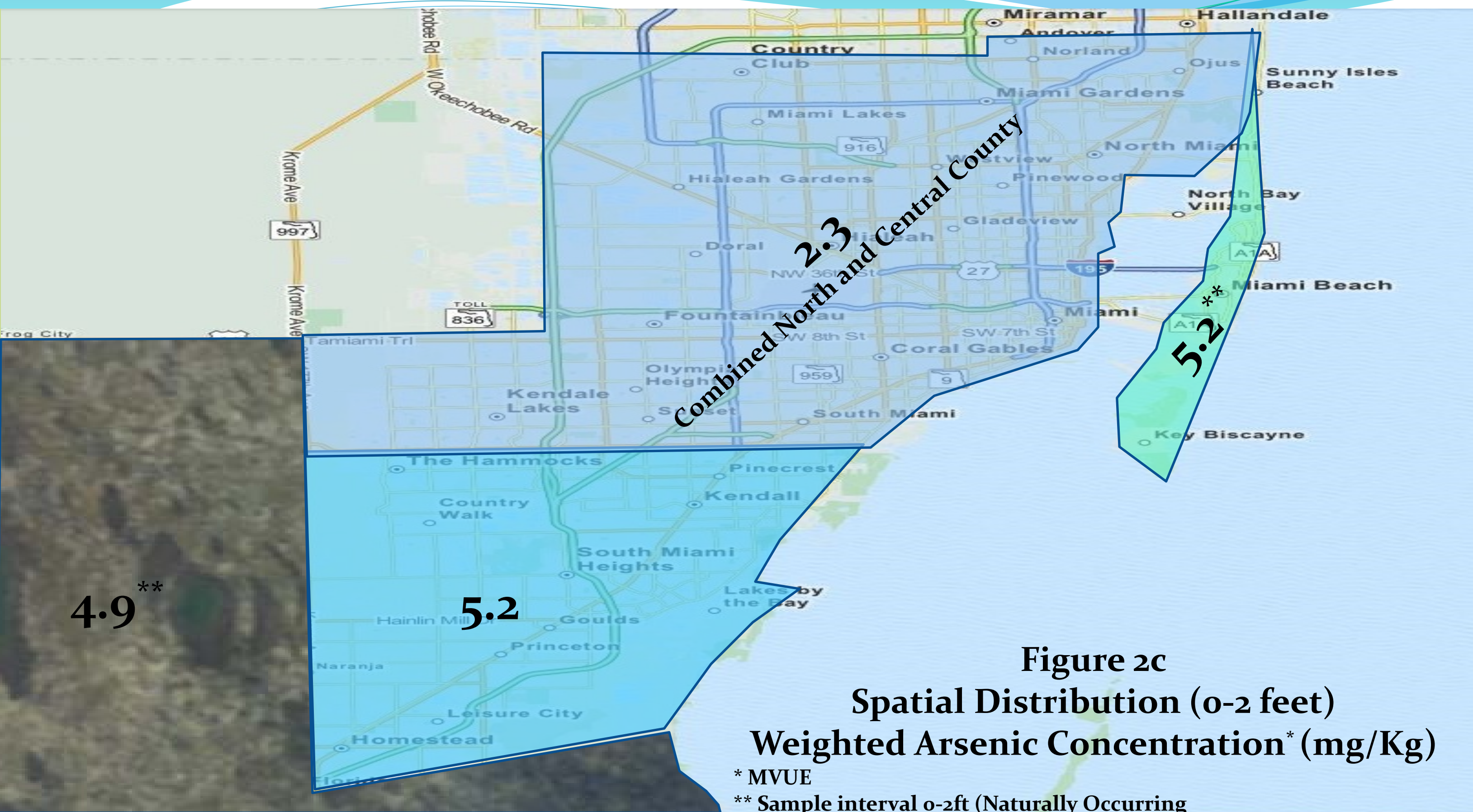
**5.0**

**Figure 2b**  
**Spatial Distribution (6 -24 inches)**  
**Arsenic Concentration\* (mg/Kg)**

\* MVUE

\*\* Sample interval 0-2ft (Naturally Occurring Background Concentrations)





4.9\*\*

5.2

5.2\*\*

2.3  
Combined North and Central County

**Figure 2c**  
**Spatial Distribution (0-2 feet)**  
**Weighted Arsenic Concentration\* (mg/Kg)**

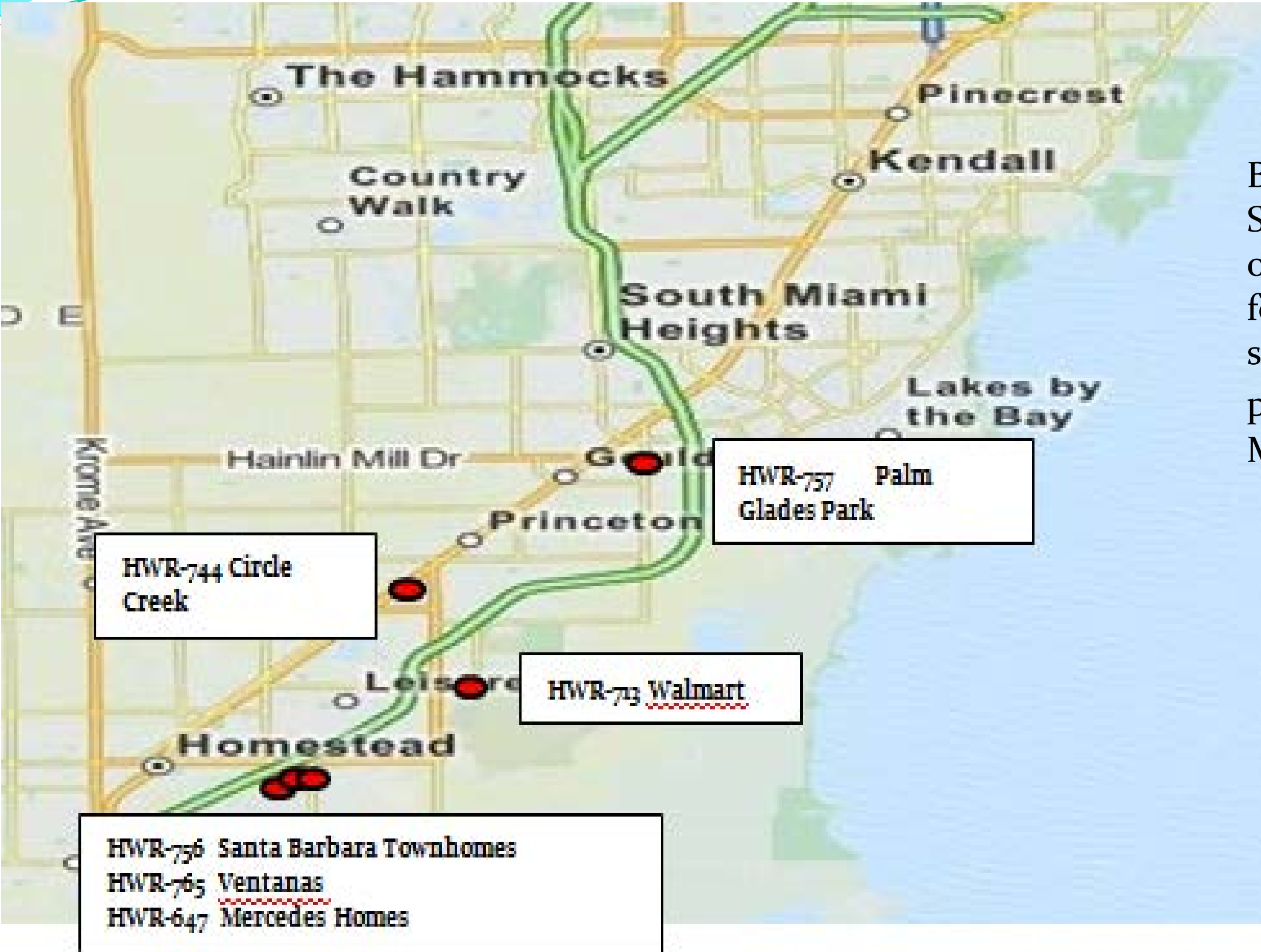
\* MVUE

\*\* Sample interval 0-2ft (Naturally Occurring Background Concentrations)

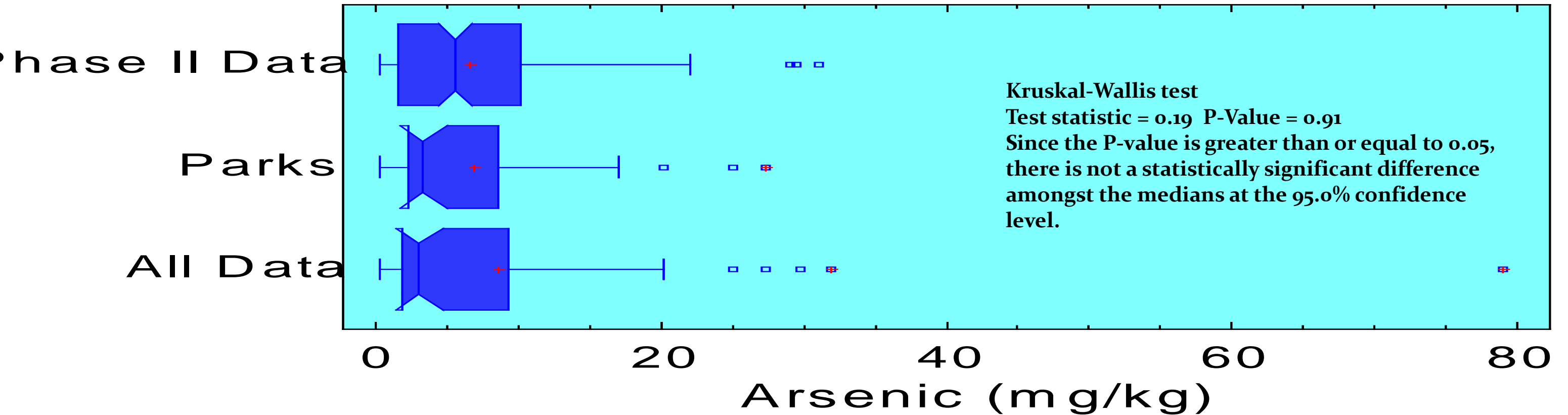


# Former Agricultural Sites Phase II

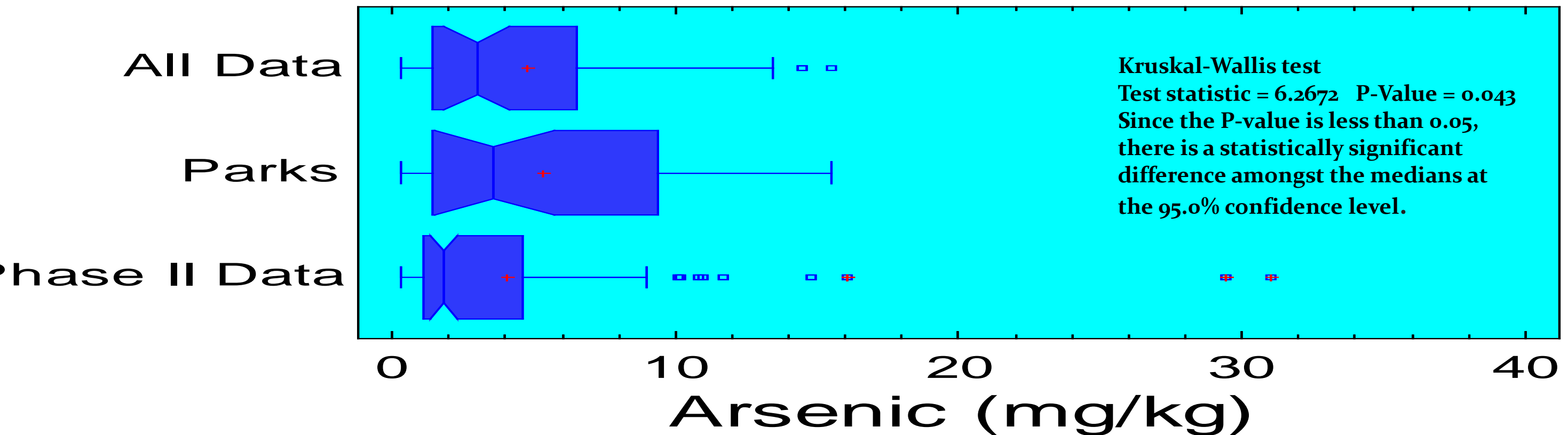
Background data for the area south of SW 88<sup>th</sup> Street compared to data obtained from DERM's records for Phase II Environmental audits submitted for former agricultural properties located in south west Miami Dade County.



# Arsenic Distribution South of Kenda



# Arsenic Distribution South of Kendall (6 to 24)



## VERTICAL PROFILE

Concentration gradient  
Overall higher concentrations at 0-6 inches

## LAND USE

Soil concentration in soils from library sites consistently higher than other land uses

PAHs

## SPATIAL DISTRIBUTION

No spatial trends observed



# Vertical Profile

**Table 3: MIAMI-DADE COUNTY ANTHROPOGENIC BACKGROUND STUDY  
BaPTE SUMMARY STATISTICS**

	BaPTE		
	0 - 6"	6 - 24"	0-2 ft*
<b>Number of Samples</b>	146	143	140
<b>Minimum</b>	0.01	0.01	0.01
<b>Maximum</b>	1.38	1.79	1.5
<b>Mean</b>	0.13	0.09	0.1
<b>MVUE</b>	0.14	0.07	0.11
<b>95% UCL</b>	0.2	0.13	0.13

Concentrations in mg/kg

Outliers removed for data analysis

\* Weighted Concentration

# Land Use Data

	Parks		Residence		Library	
	0-6 in	6-24 in	0-6 in	6-24 in	0-6 in	6-24 in
N	113	109	18	15	15	15
MEAN	0.1	0.1	0.1	0.04	0.37	0.19
MVUE	0.1	0.07	0.1	0.04	0.43	0.19
95% UCL	0.15	0.12	0.22	0.11	1.15	0.52
% Exceed RCSTL	16.8	9.2	16.6	6.6	66	33
Distribution						

- Significant difference between data from libraries when compared to Parks and residences. The difference is indicated at both sampling intervals

**Key Site Specific Factors to  
Consider when Evaluating  
Potential Subregional  
Anthropogenic Background  
Impacts ...**



# Notwithstanding the background data just presented it is critical to understand the site

- Historical land use and former sources
- Historical aerials: former quarries or lakes
- Fill sources
- Adjacent canals sediment quality
- Flooding history
- Lithology of the site and surrounding areas
- Elevation of the site and adjacent properties, roads, swales drainage
- Current use and potential sources
- Horizontal and vertical distribution of the chemicals
- and so much more ....

# Report

- April 3, 2014

Miami-Dade County releases background soil concentration report:

<http://www.miamidade.gov/environment/library/reports/2014-anthropogenic-background-study.pdf>