CC Plume - USGS PowerPoint Presentation

Stephen Smith to: Leif Palmer 01/24/2011 05:41 PM

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CC Plume - USGS Slide Show.pdf

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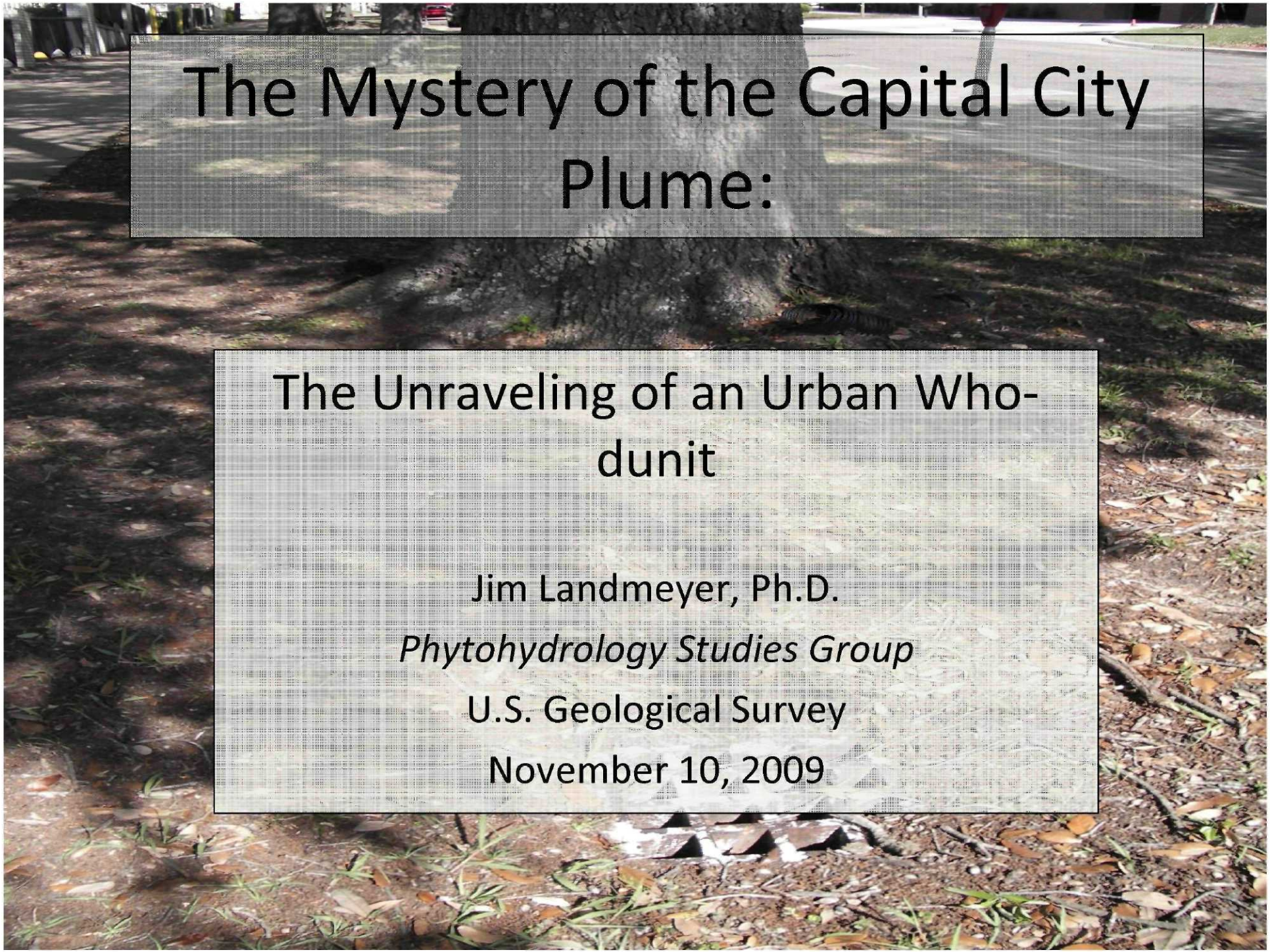


The Mystery of the Capital City Plume:

The Unraveling of an Urban Who-dunit

Jim Landmeyer, Ph.D.

Phytohydrology Studies Group

U.S. Geological Survey

November 10, 2009

Outline

1-Provide the answers to the CCP

- who did it,
- with what,
- where,
- and when

Outline

- CCP timeline of events

2-The clues:

- Previous field work
- USGS passive tree-water (PTW) survey (8/2008)
- USGS groundwater sample event (4/2009)
- Comparison of historical groundwater plumes, possible source location(s)
- Background on the Newspaper Print Manufacturing Industry
- Tree-ring record of contaminant release times
- Summary

1.PCE and TCE contaminated groundwater beneath the RSA chiller plant

- Who – Montgomery Advertiser
- What – Blanket wash and fountain solutions used in running offset presses
- Where-Released from 200 Washington Street to floor drains, sumps, and sinks that drain to the sanitary sewer system
- When – between 1955 and 1970

2.PCE and TCE contaminated soil and groundwater along 200 Washington Street

- Who – Montgomery Advertiser
- What – Blanket wash and fountain solutions used in running offset presses
- Where-Released from 200 Washington Street to sumps that drain to the stormwater system
- When – between 1970 and 1980

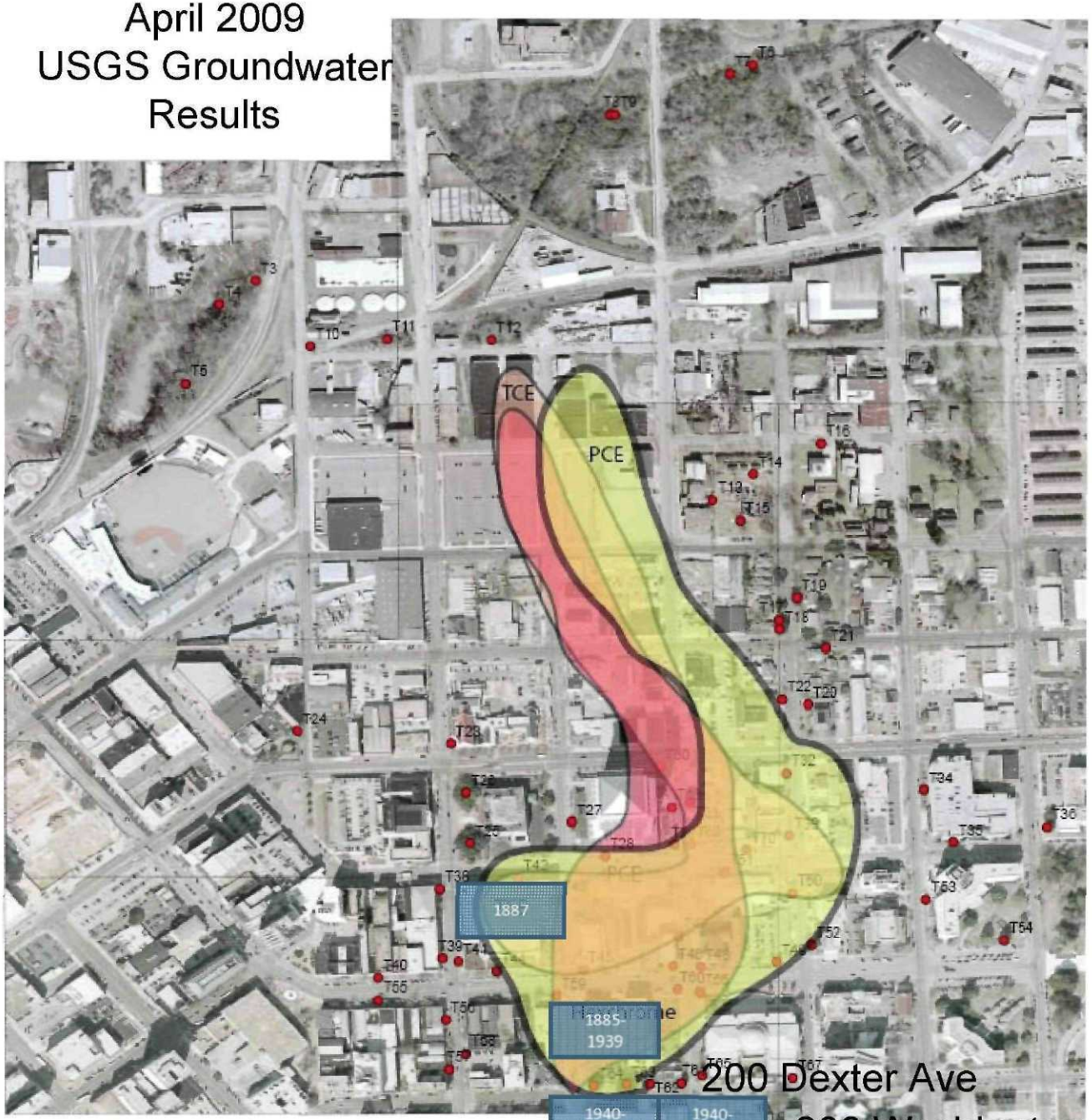
3.Chromium contaminated soil and groundwater along 200 Washington Street

- Who – Montgomery Advertiser
- What –chromic acid fountain solutions used in running offset presses
- Where-Released from 200 Washington Street to sumps that drain to the stormwater system
- When – between 1970 and 1980

4.Chromium contaminated groundwater near RSA chiller plant and Park

- Who – Montgomery Advertiser
- What –inks used in lithographic offset presses
- Where-Released from 200 Dexter Avenue to sinks and sumps that drain to the sanitary sewer system; some contribution from Lawrence Street location
- When – between 1910 and 1940

April 2009 USGS Groundwater Results



1. CCP investigation Implications:

- All city-wide 'isolated hot spots' are related to release from MA activities
- So is the source of the contamination of PSW #9E and 9W as detected in 1992
- So is the source of hits in Cypress Creek bed-sediment porewater (USGS in 2007-2008)
- And the hits on banks of Alabama River (USGS in 2008)

2. CCP investigtion implications:

- The chlorinated solvents PCE and TCE continue to be above MCLs (5 ppb)

- No longer the chromium(VI), or hexavalent ("hex") chrome plume

  (chrome ***was*** released, as were other metals, and is still detectable, but not at or above MCLs (100 ppb))

Let's backup a bit: The Dilemma of the Capital City Plume (post 1993)

- Why was the contamination there?
- Where exactly was it?
- Who or whom caused it?
- When were the contaminants released?

Timeline of Capital City Plume

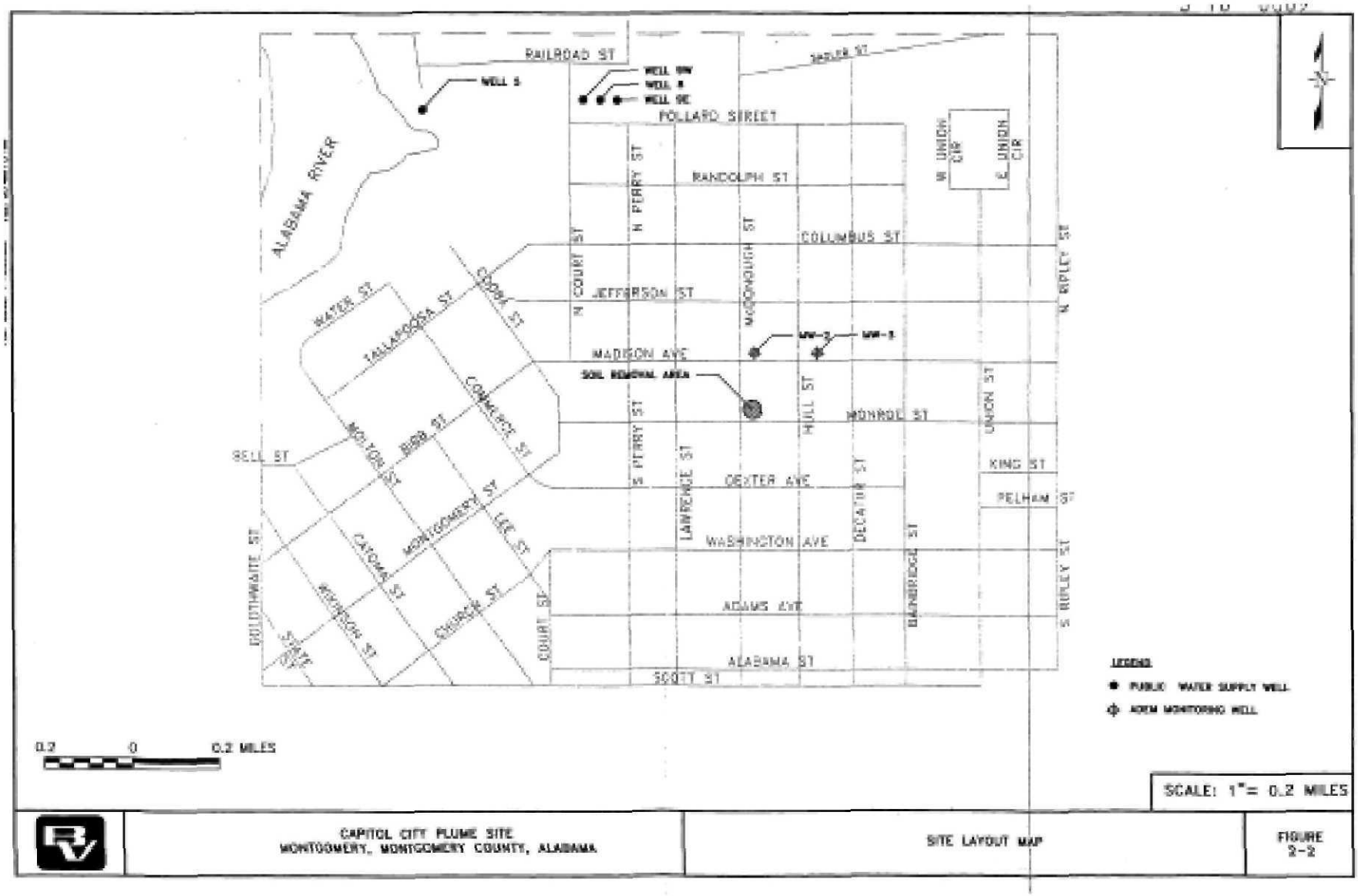
- 1992 – MWW&SSB detects PCE in wells 9W and 9E (North Well Field) that pump from shallow groundwater

  (samples were collected b/c of EPA's Wellhead Protection Program!)
- 1992-Well 9E shut down
- Sept 1993 – solvent **vapors** detected during construction of the RSA tower chiller plant at **25-bls** near the water table
- 1997- Well 9W shut down

Timeline of CCP

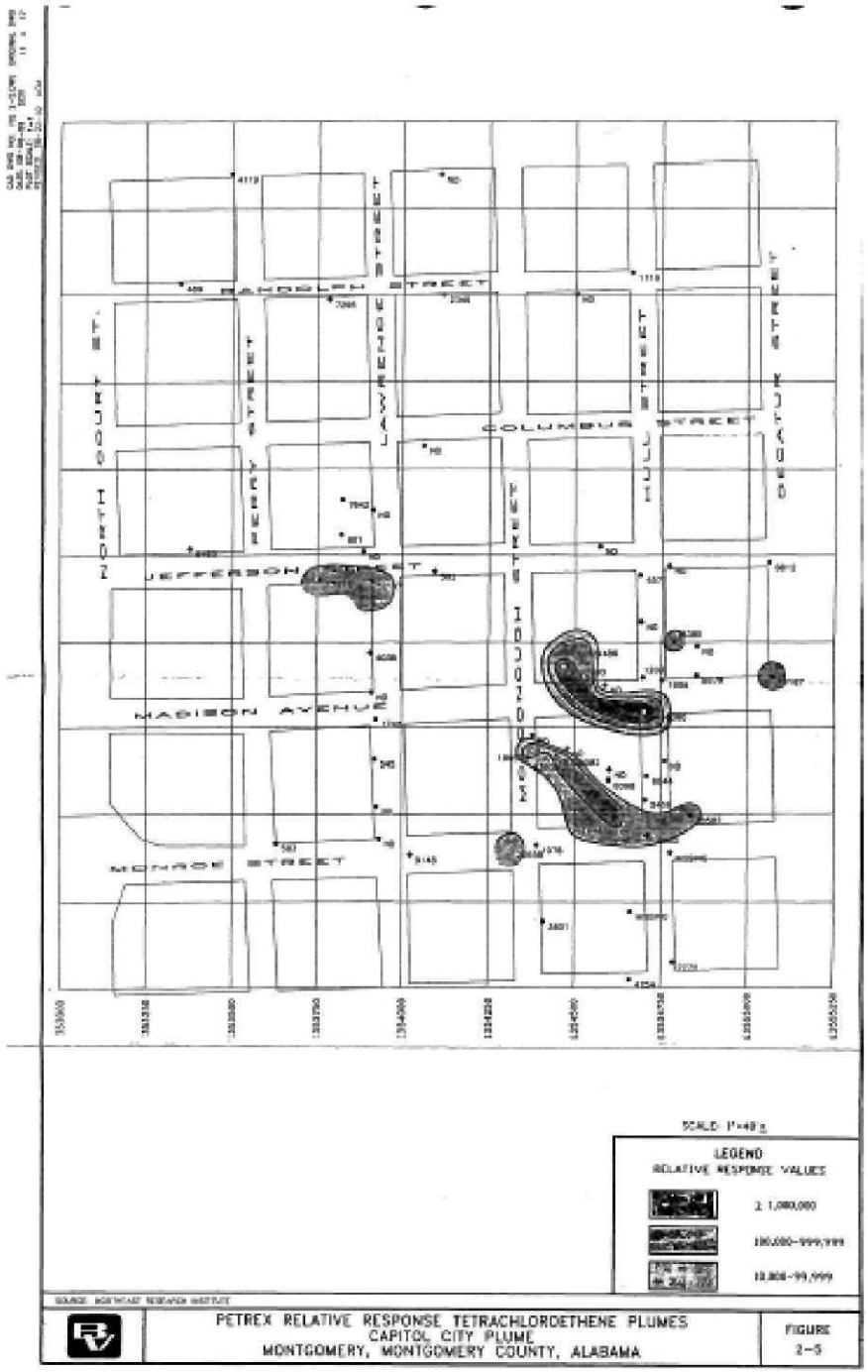
- 2002 – Black & Veatch
- 2003 – Malcom-Pirnie FS report
- 2003 – CoM EMC report on 200 Washington St pre-buy
- CoM groundwater sampling (Hall report)- 2007

- USGS site PTW survey – August 2008
- USGS groundwater sampling – April 2009
- USGS dendrochronology sampling – January 2009

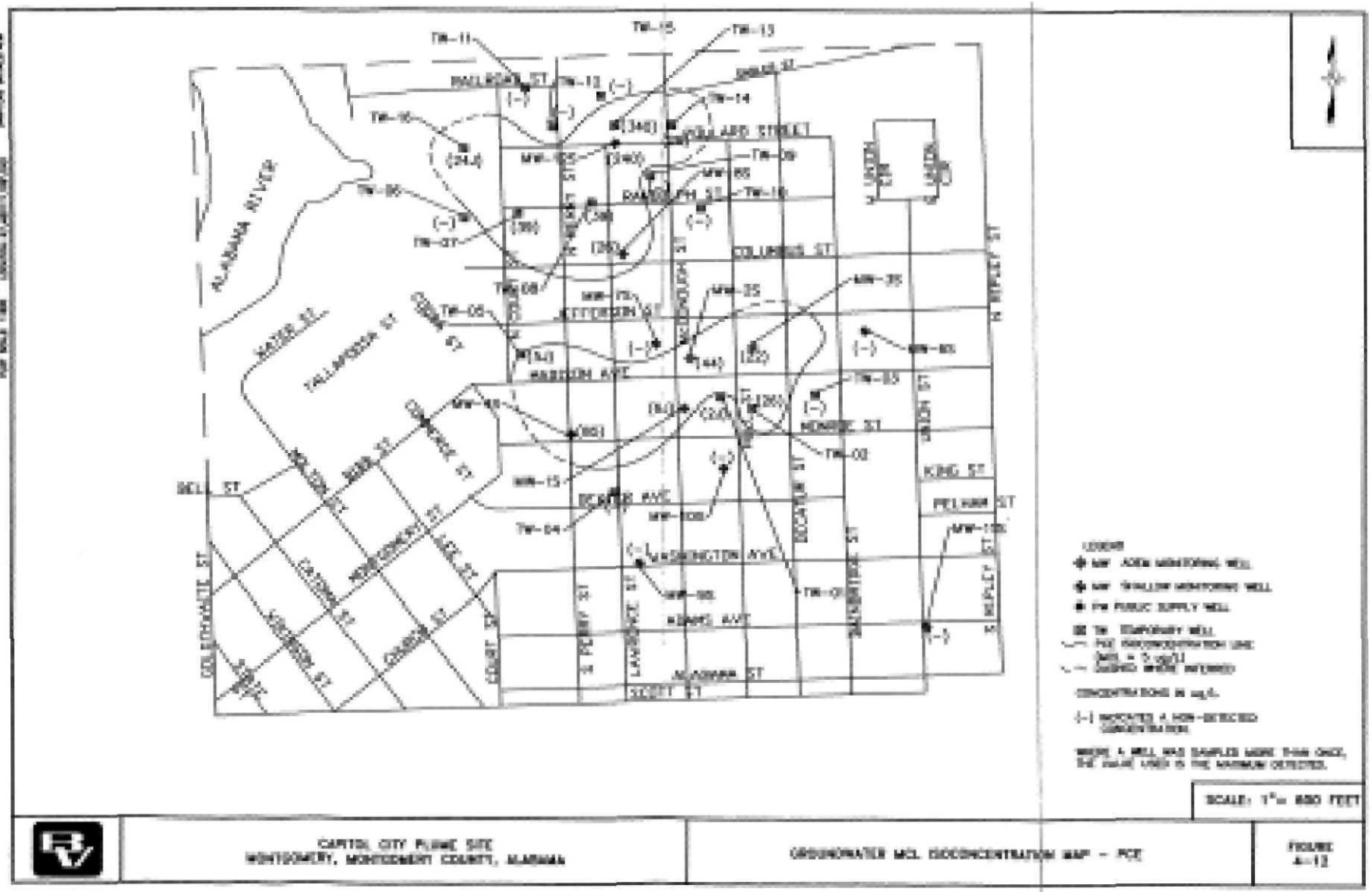


Black & Veatch (2002)

PCE vapors

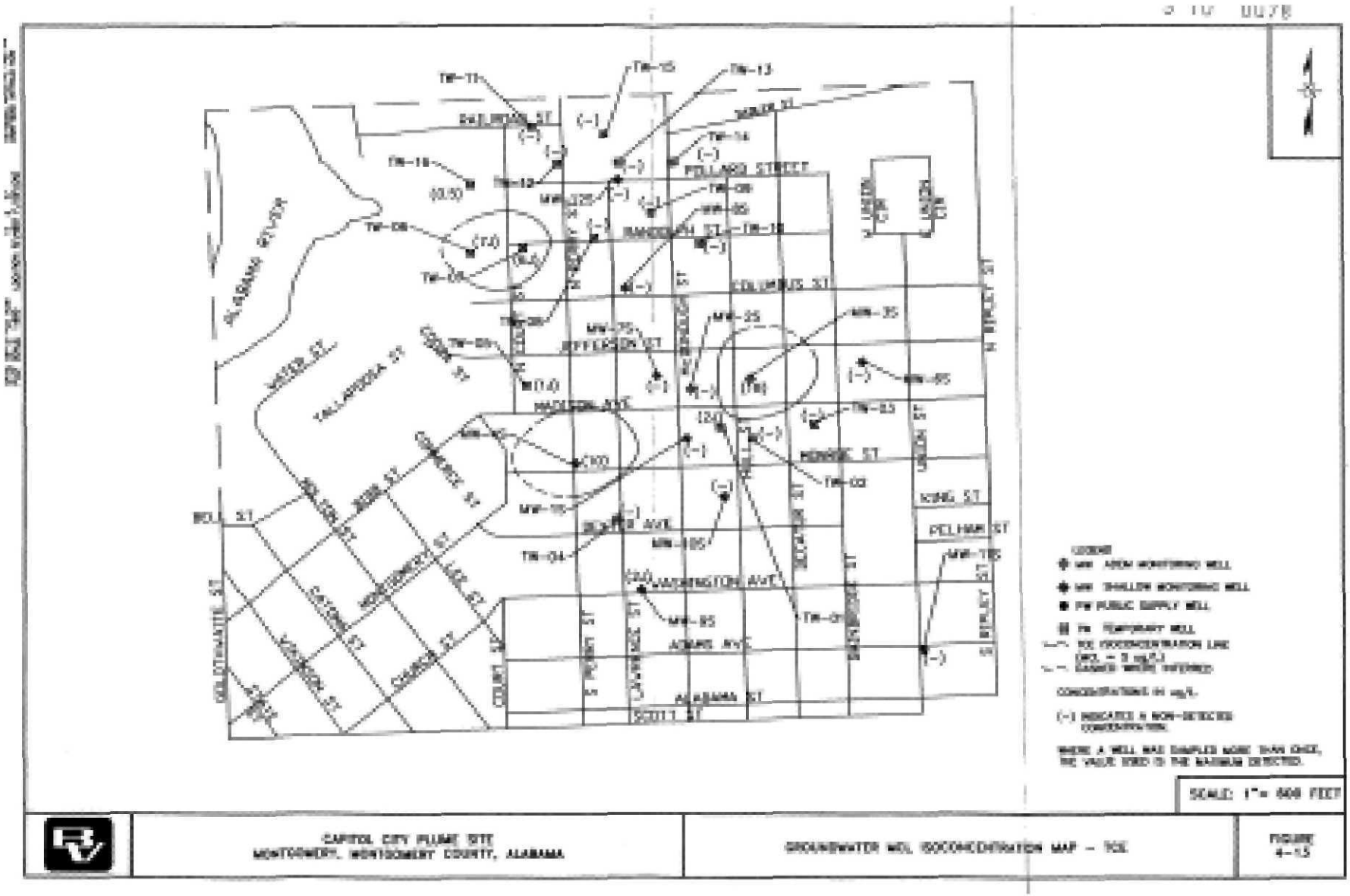


Black & Veatch (2002)



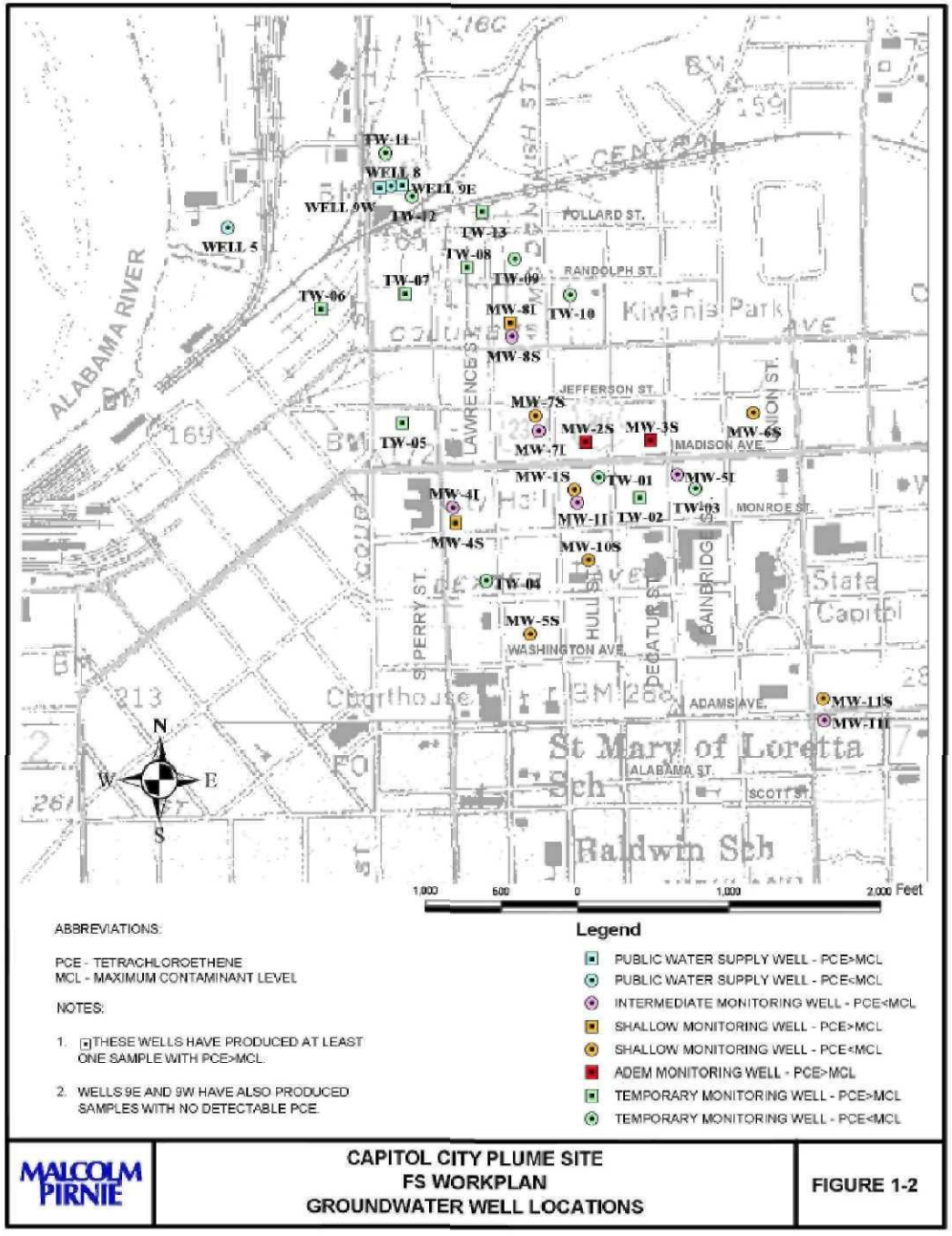
PCE groundwater

Black & Veatch (2002)



TCE groundwater

Black & Veatch (2002)



ABBREVIATIONS:

PCE - TETRACHLOROETHENE
MCL - MAXIMUM CONTAMINANT LEVEL

NOTES:

1. ⊡THESE WELLS HAVE PRODUCED AT LEAST ONE SAMPLE WITH PCE>MCL.
2. WELLS 9E AND 9W HAVE ALSO PRODUCED SAMPLES WITH NO DETECTABLE PCE.

Legend

- PUBLIC WATER SUPPLY WELL - PCE>MCL
- PUBLIC WATER SUPPLY WELL - PCE<MCL
- INTERMEDIATE MONITORING WELL - PCE<MCL
- SHALLOW MONITORING WELL - PCE>MCL
- SHALLOW MONITORING WELL - PCE<MCL
- ADEM MONITORING WELL - PCE>MCL
- TEMPORARY MONITORING WELL - PCE>MCL
- TEMPORARY MONITORING WELL - PCE<MCL

MALCOLM PIRNIE

CAPITOL CITY PLUME SITE
FS WORKPLAN
GROUNDWATER WELL LOCATIONS

FIGURE 1-2

Malcolm Pirnie (2003)

5.4 Limited Phase 2 Testing

The Montgomery Advertiser Building site is known to be located within the boundaries of the Capitol City Plume, a sixty block area of downtown Montgomery where the groundwater is contaminated with chemicals typically found in various cleaning solvents. Because solvents have historically been used to clean printing presses a limited phase 2 assessment was performed to assess the Montgomery Advertiser Building site for the specific solvents that have been associated with the Capitol City Plume; benzene, toluene, ethylbenzene and xylenes (BTEX) and tetrachloroethylene (PCE).

To assess the soils beneath the building we attempted to core through the concrete slab of the lowest floor at ten locations and then collect and analyze soil samples. These locations were generally disbursed throughout the lower floor with four across the south side, two across the middle and four across the north side. At three of the ten locations the concrete thickness exceeded one foot and we were unable to penetrate it with the coring equipment. At seven locations we were able to penetrate the slab and sample the underlying soils. At each of those locations soil samples were collected with a hand auger to a depth of about ten feet and screened for volatile organic compounds with a photo Ionization detector. The sample from each boring with the highest screening level was forwarded to the laboratory for BTEX and PCE analyses. The analyses revealed that the concentrations of these compounds within all seven of the samples were below the detection limit of the analytical method.

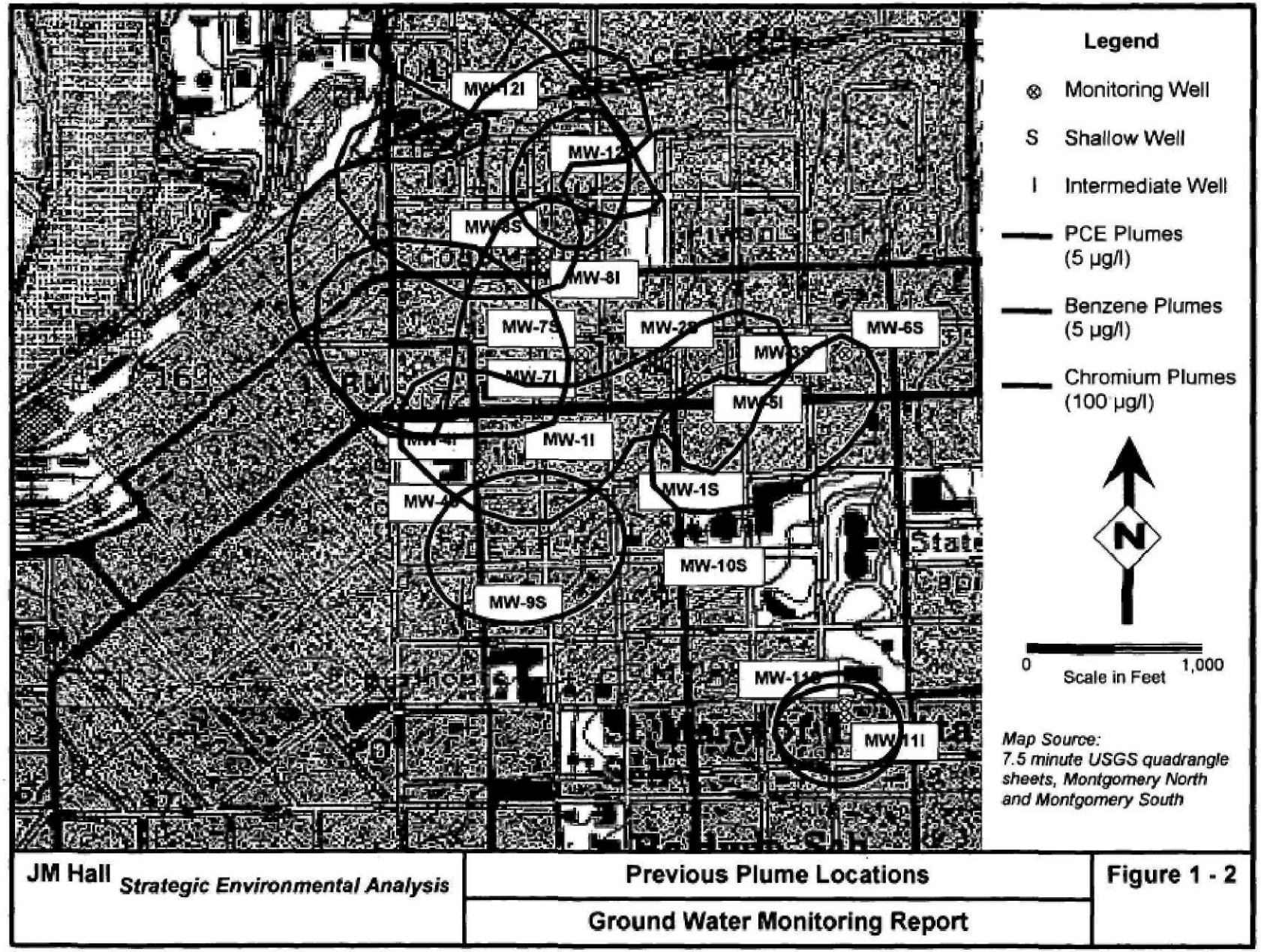
EMC report (2003)

c) Potential Sources of Subsurface Contamination

The on-site visual reconnaissance included observation of potential or existing sources of subsurface contamination. Beginning in the early 1900's and continuing until recently, the Montgomery Advertiser Building site has housed several newspaper businesses. Because this site is within the Capitol City Plume boundaries and because solvents have historically been used to clean printing presses, subsurface exploration activities were conducted at this site in May 2003.

Soil and groundwater samples were collected from three temporary monitoring wells placed around the property. Soil samples were also collected from seven cored locations on the lowest floor of the building. All samples were submitted for BTEX (benzene, toluene, ethyl benzene and xylenes) and PCE (perchloroethylene) analysis. Laboratory results indicated all BTEX and PCE levels were below the analytical detection limit of 5 ppb (parts per billion).

EMC report (2003)


MW-12I
MW-8I
MW-7S
MW-7I
MW-6S
MW-5I
MW-1I
MW-1S
MW-10S
MW-9S
MW-11I
Legend
Monitoring Well
S Shallow Well
I Intermediate Well
PCE Plumes (5 µg/l)
Benzene Plumes (5 µg/l)
Chromium Plumes (100 µg/l)
N
0
1,000
Scale in Feet
Map Source:
7.5 minute USGS quadrangle sheets, Montgomery North and Montgomery South
JM Hall
Strategic Environmental Analysis
Previous Plume Locations
Ground Water Monitoring Report
Figure 1 - 2

Hall (2007)

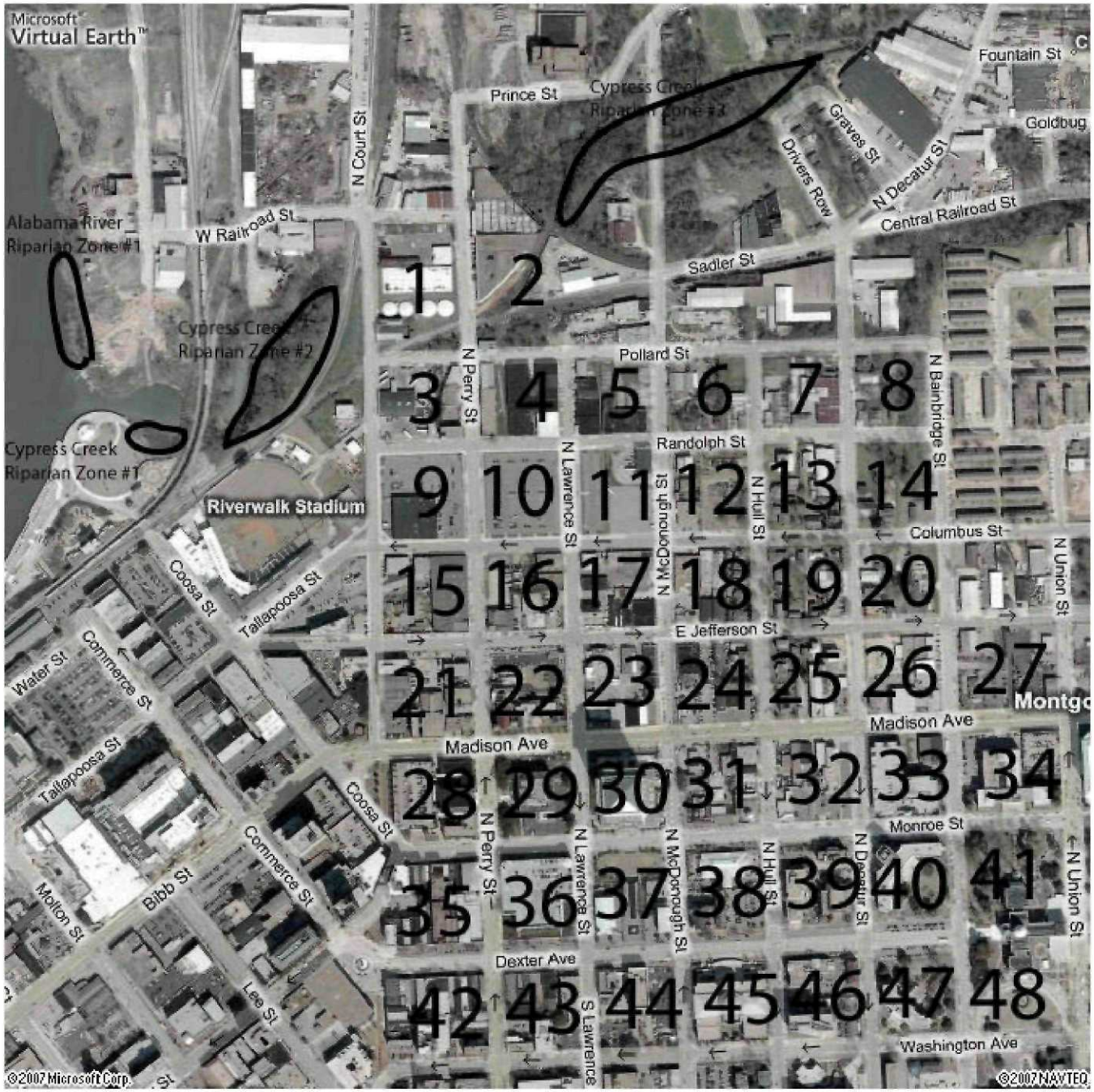
So, since 1993 (from NPL Site Narrative for CCP):

"...there is no known source of the PCE contamination..."

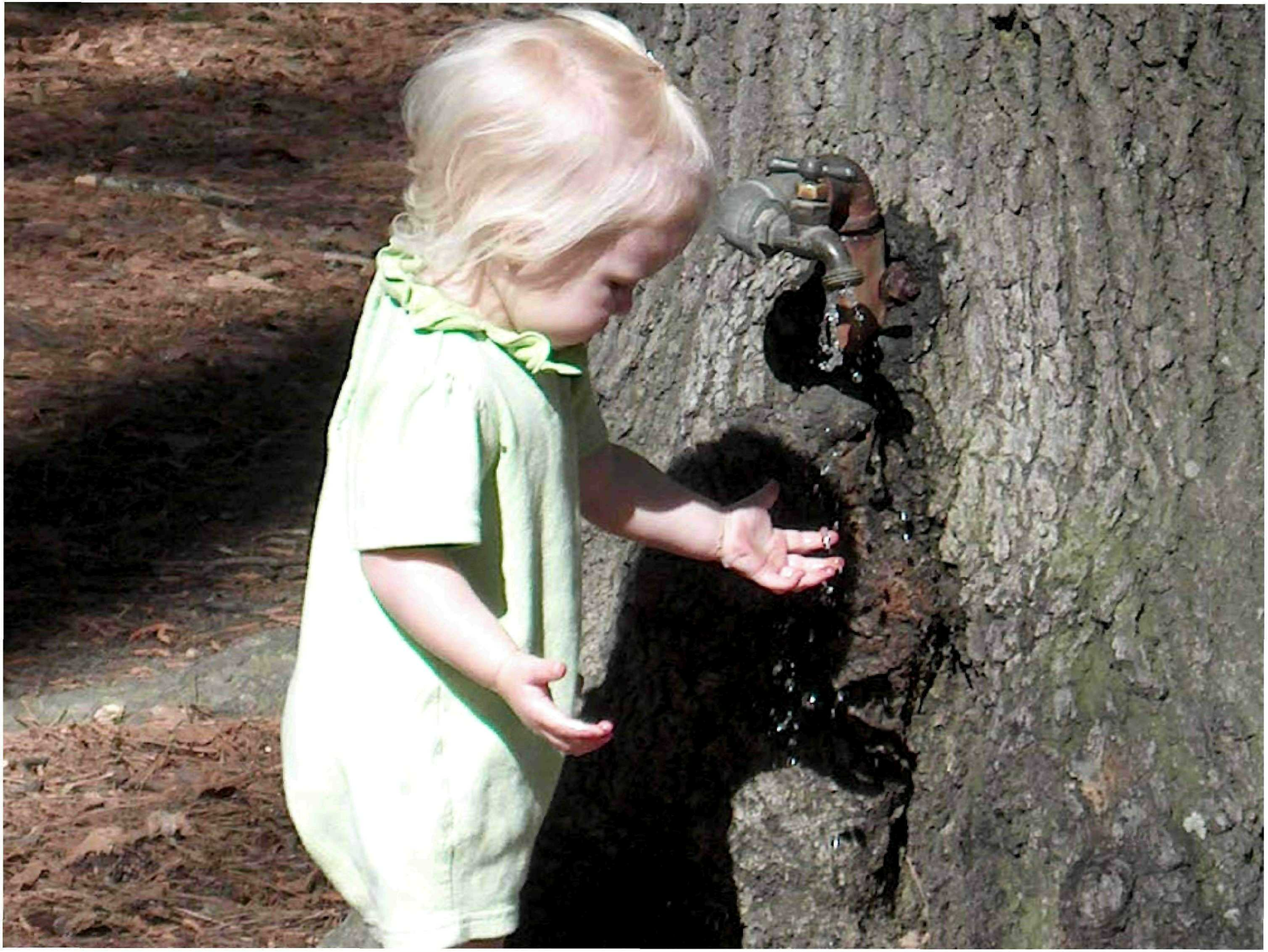
"The source or sources of contamination, or the time-frame which the contaminant entered the environment at the CCP site have not been identified."

USGS
Site visit
August
2008
(pre-plan)

USGS
Site visit
August
2008



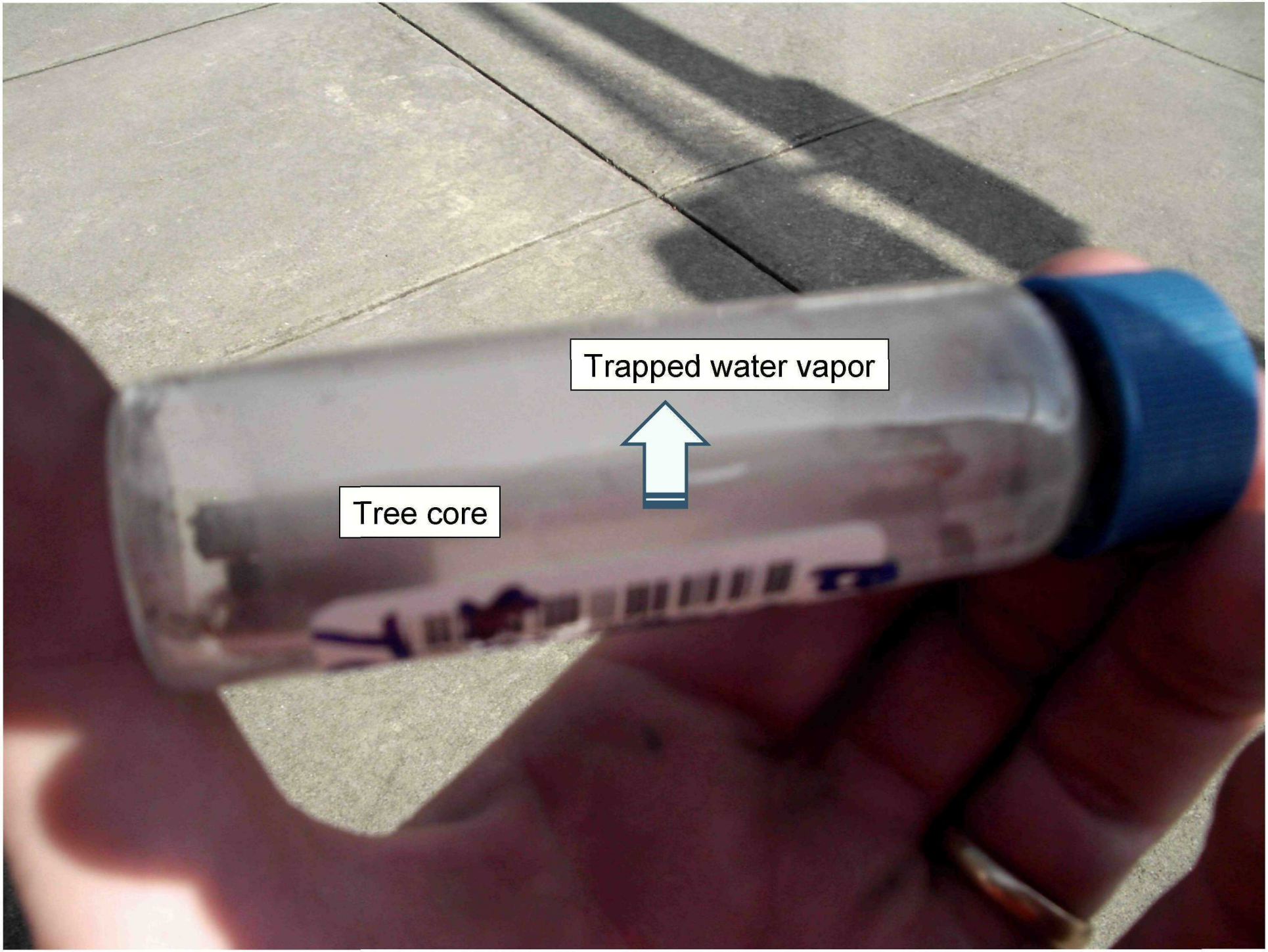
Cypress Creek
Hyporheic zone “bed sediment” investigation



USGS
August 2008
Conduct passive, low-key Assessment

Passive tree-water (PTW) survey:
- Contaminant vapor
- Dissolved-phase contaminant

Started @ Alabama River and Cypress Creek Riparian zones


Trapped water vapor
Tree core

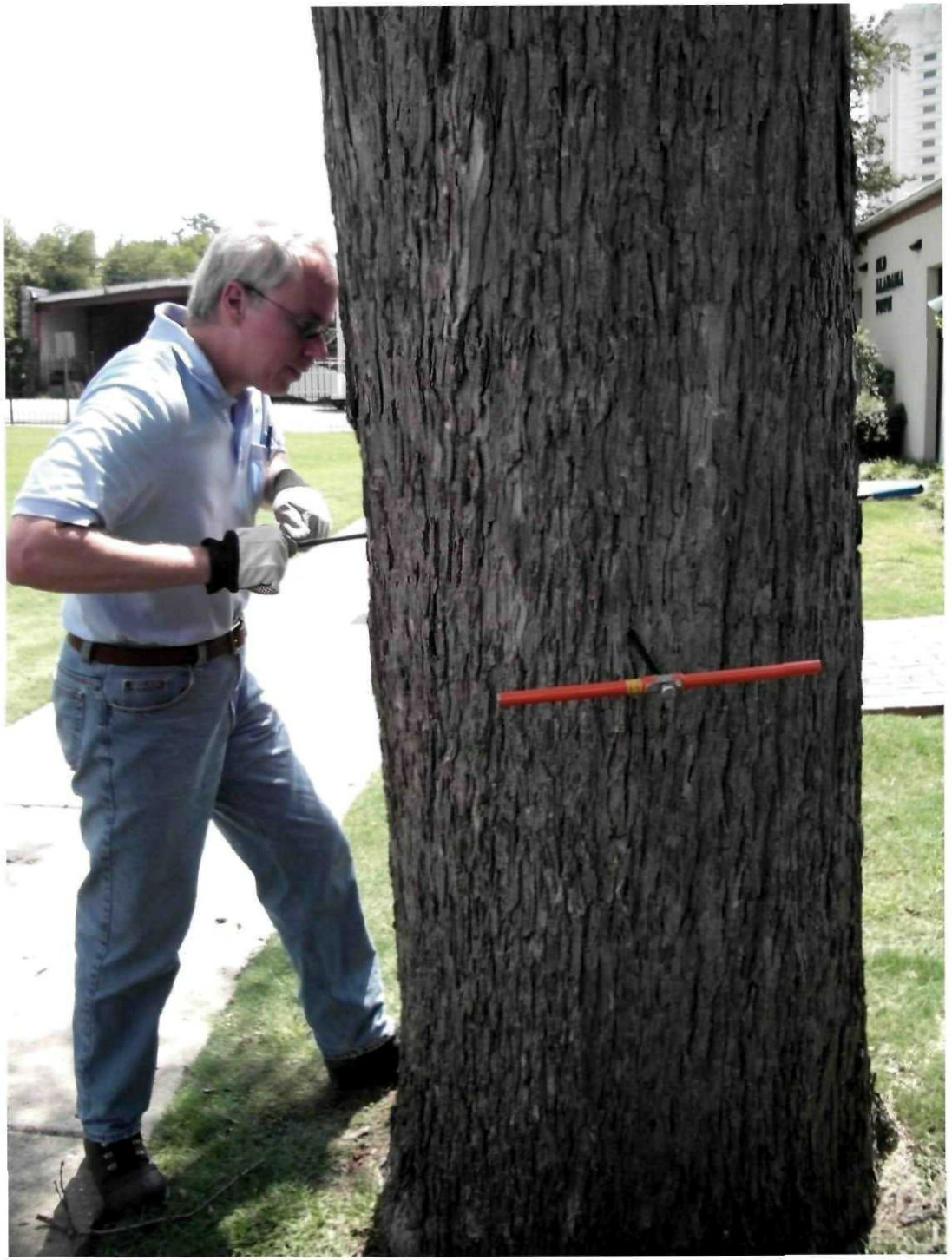
Metals – PIXE

Photon Induced X-ray Emisison

Continued on Page

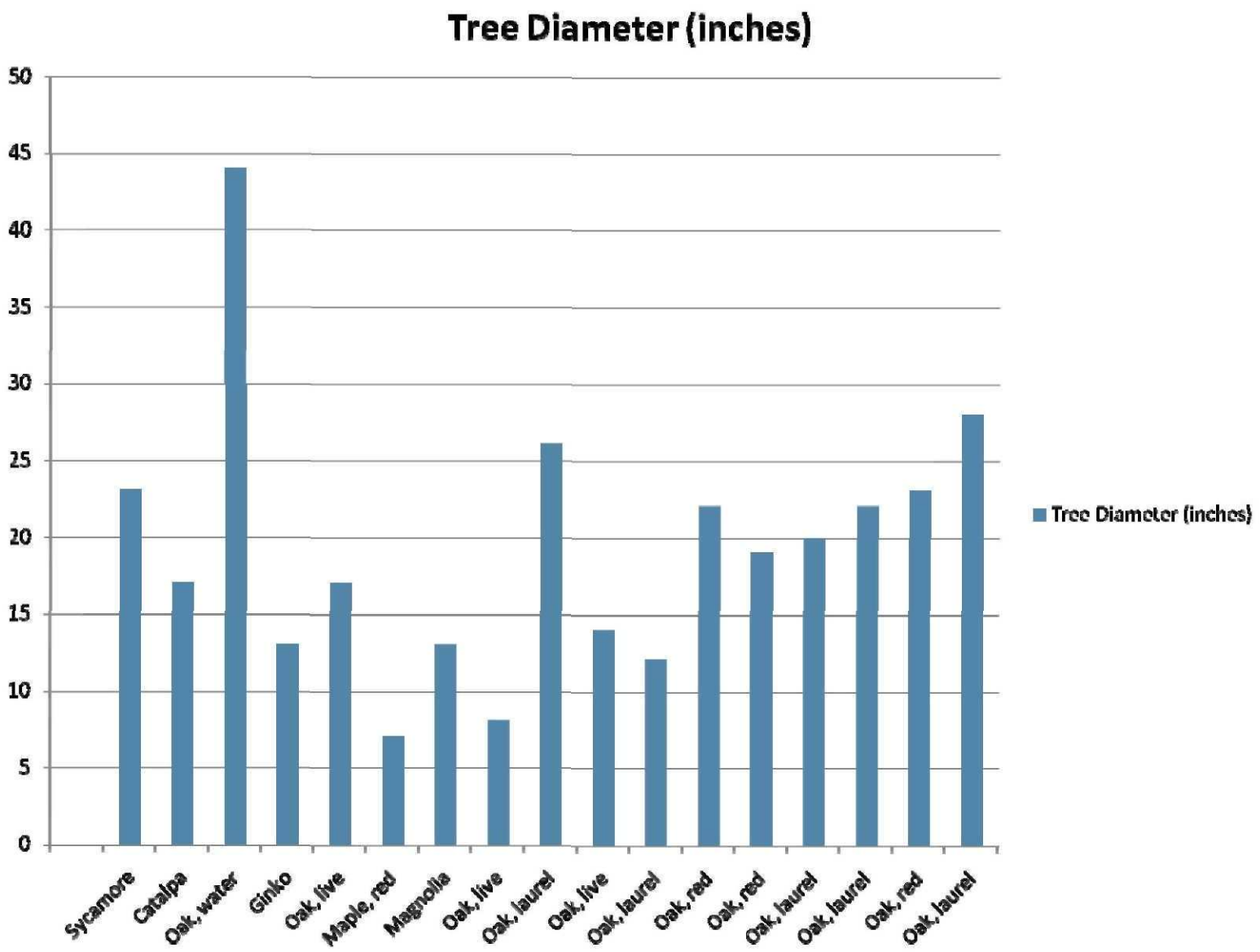

RESERVED
PARKING
2 HOUR
LIMIT

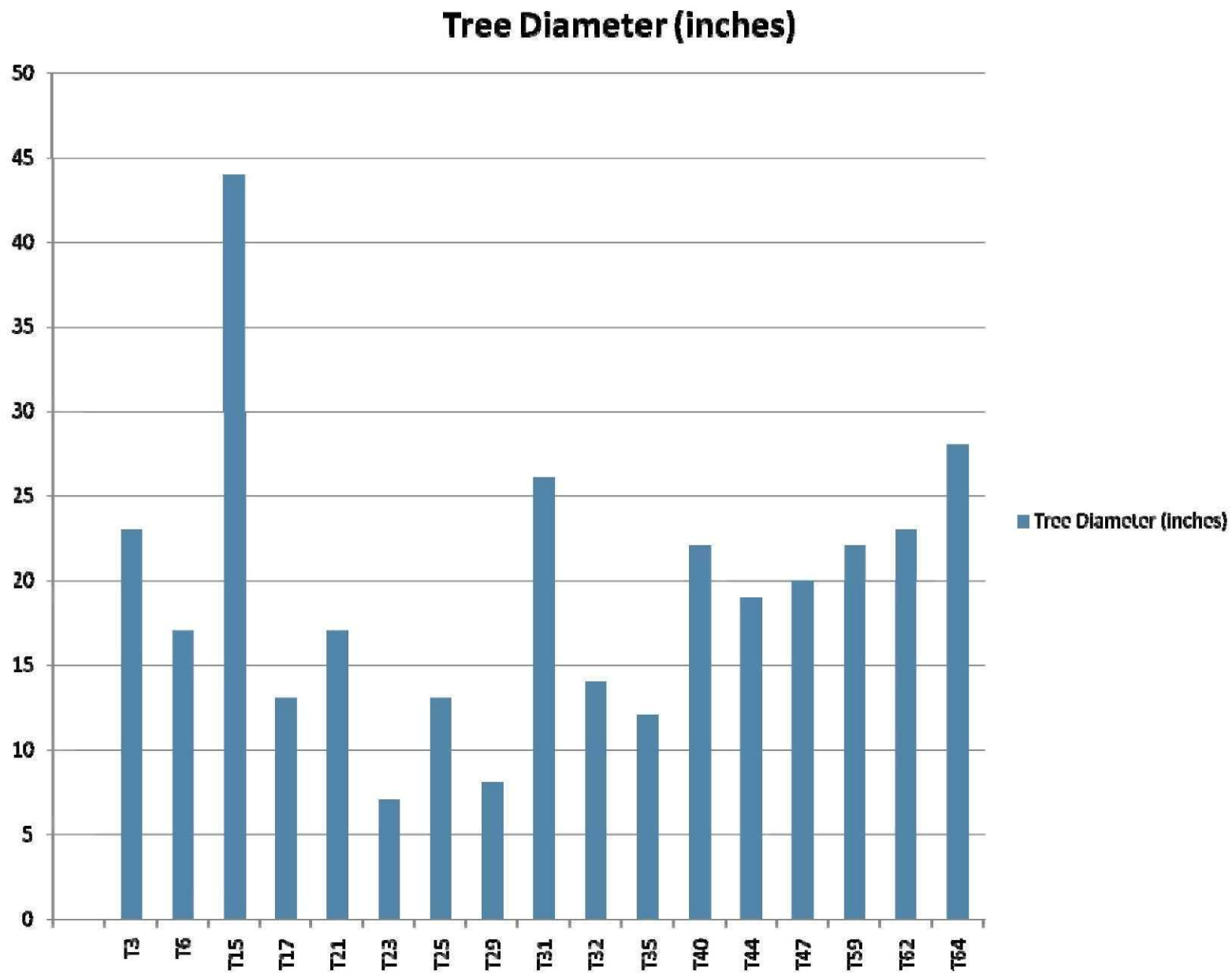
These trees have to be using groundwater!



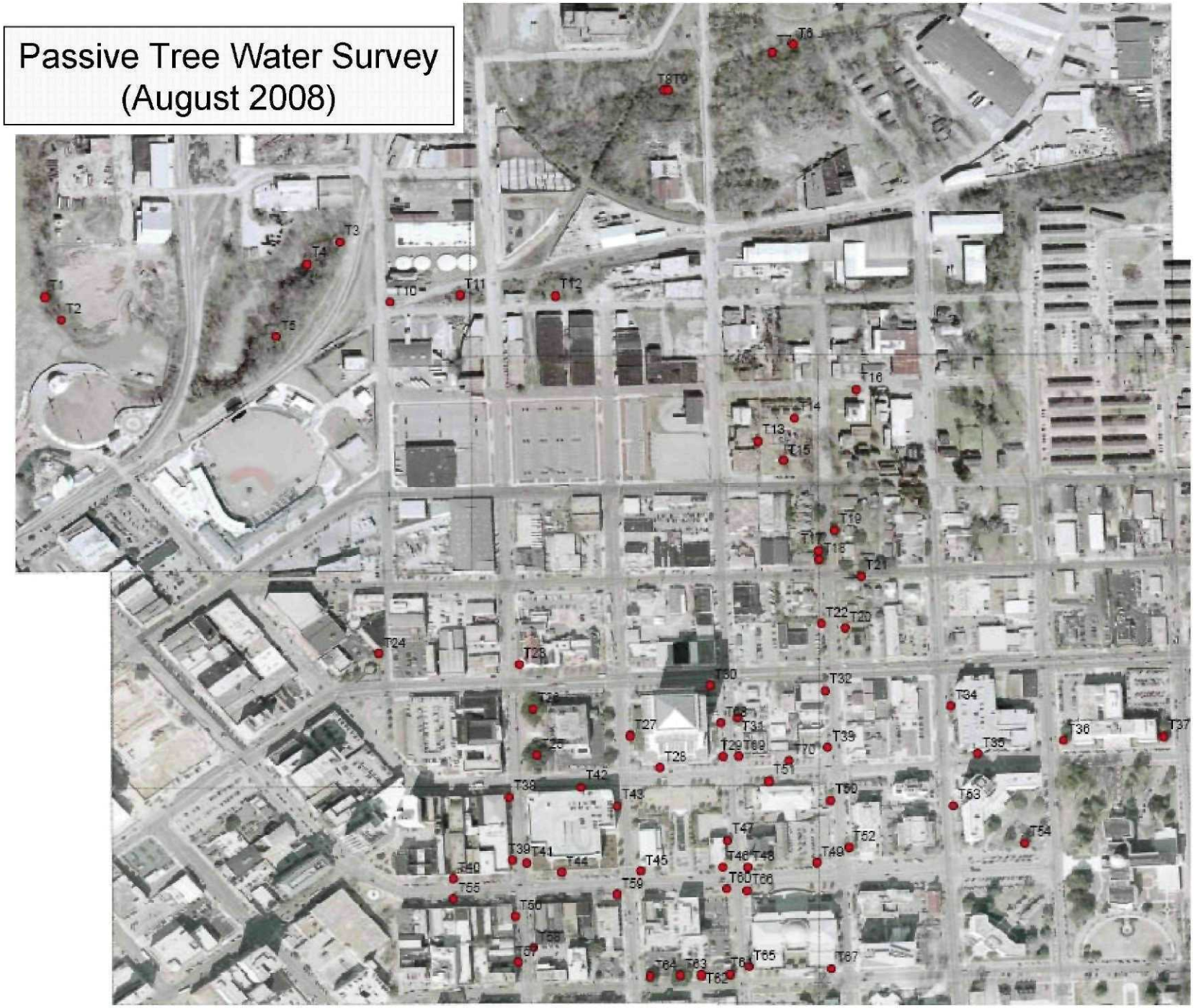

Scott “the hammer” Miller

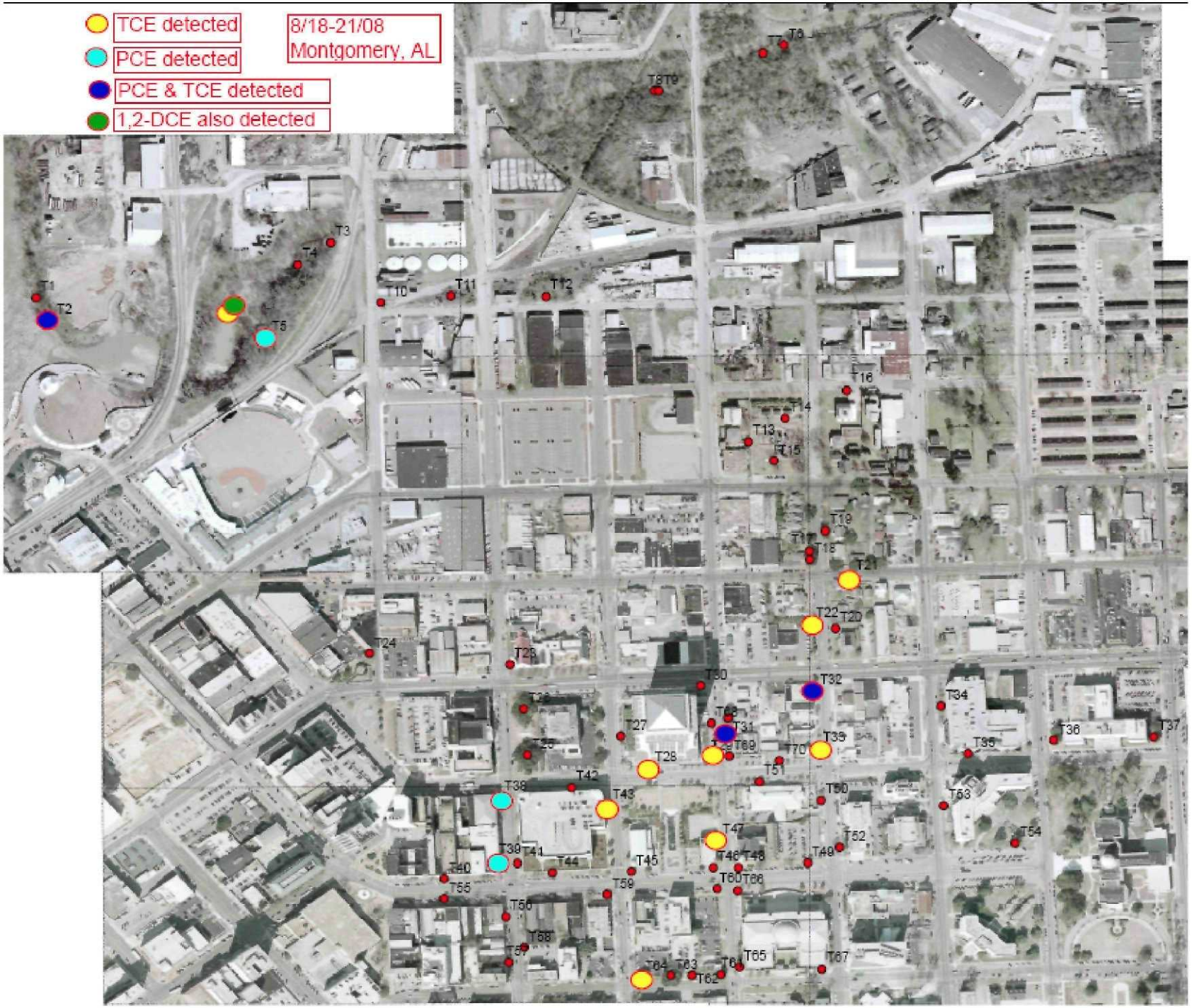

200 Washington Street

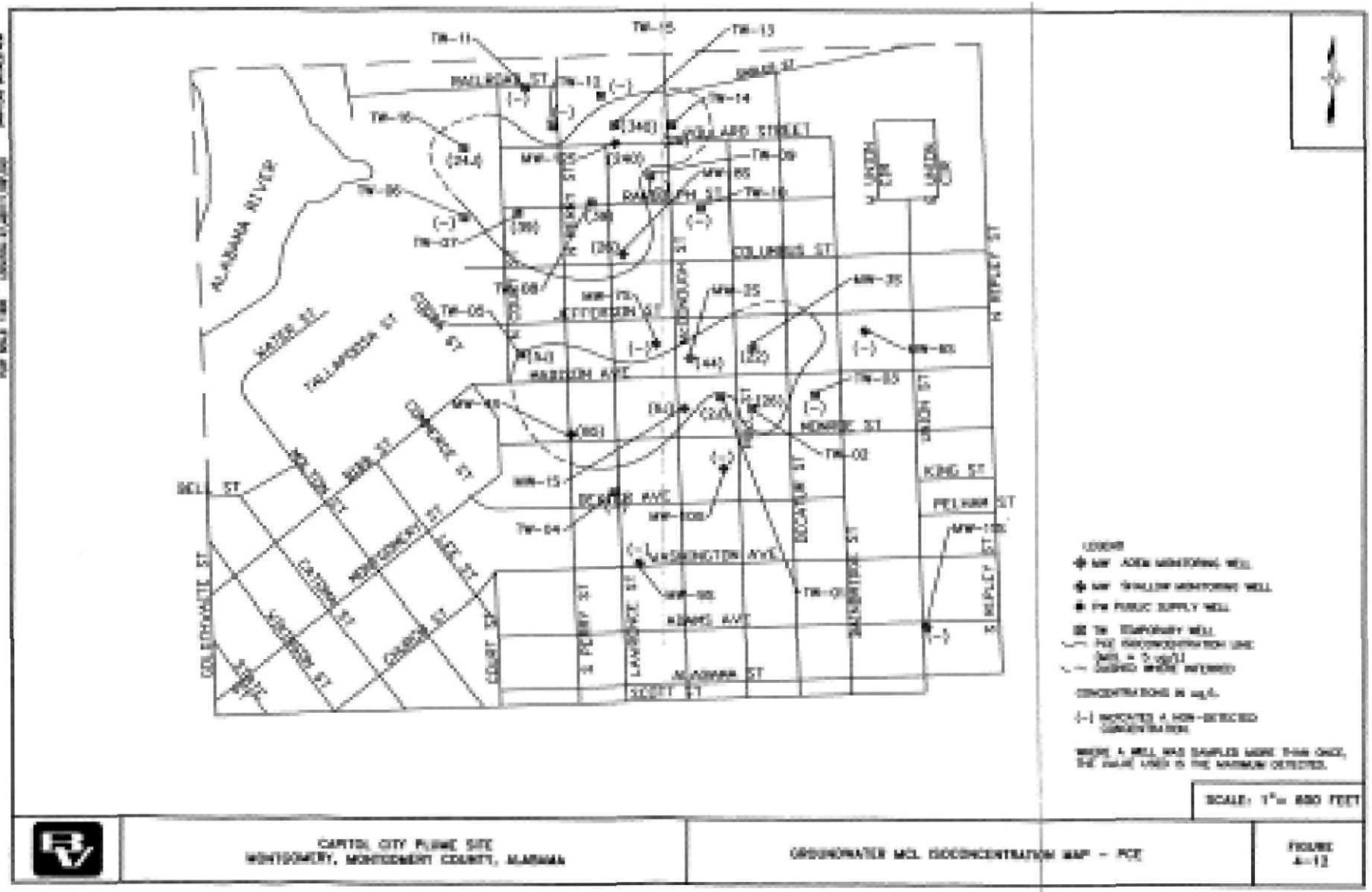

Tree Diameter (inches)
50
45
40
35
30
25
20
15
10
5
0
Sycamore
Catalpa
Oak, water
Ginko
Oak, live
Maple, red
Magnolia
Oak, live
Oak, laurel
Oak, live
Oak, laurel
Oak, red
Oak, red
Oak, laurel
Oak, laurel
Oak, red
Oak, laurel
Tree Diameter (inches)


Tree Diameter (inches)
50
45
40
35
30
25
20
15
10
5
0
T3
T6
T15
T17
T21
T23
T25
T29
T31
T32
T35
T40
T44
T47
T59
T62
T64
Tree Diameter (inches)

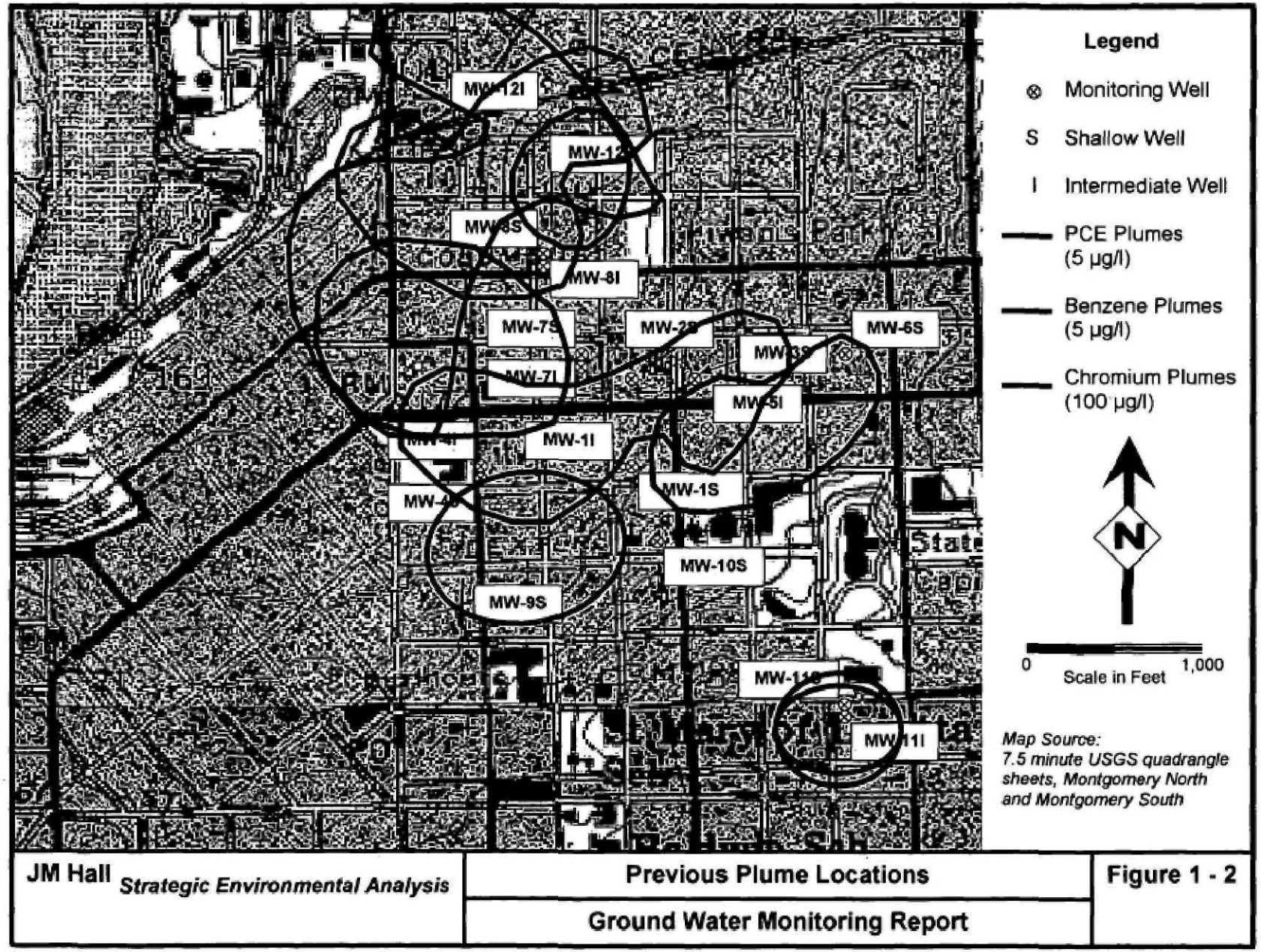
Passive Tree Water Survey (August 2008)




TCE detected
PCE detected
PCE & TCE detected
1,2-DCE also detected
8/18-21/08
Montgomery, AL



Black & Veatch (2002)


MW-12I
MW-8I
MW-7S
MW-7I
MW-6S
MW-5I
MW-1I
MW-1S
MW-10S
MW-9S
MW-11I
Legend
Monitoring Well
S Shallow Well
I Intermediate Well
PCE Plumes (5 µg/l)
Benzene Plumes (5 µg/l)
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0
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Scale in Feet
Map Source:
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JM Hall
Strategic Environmental Analysis
Previous Plume Locations
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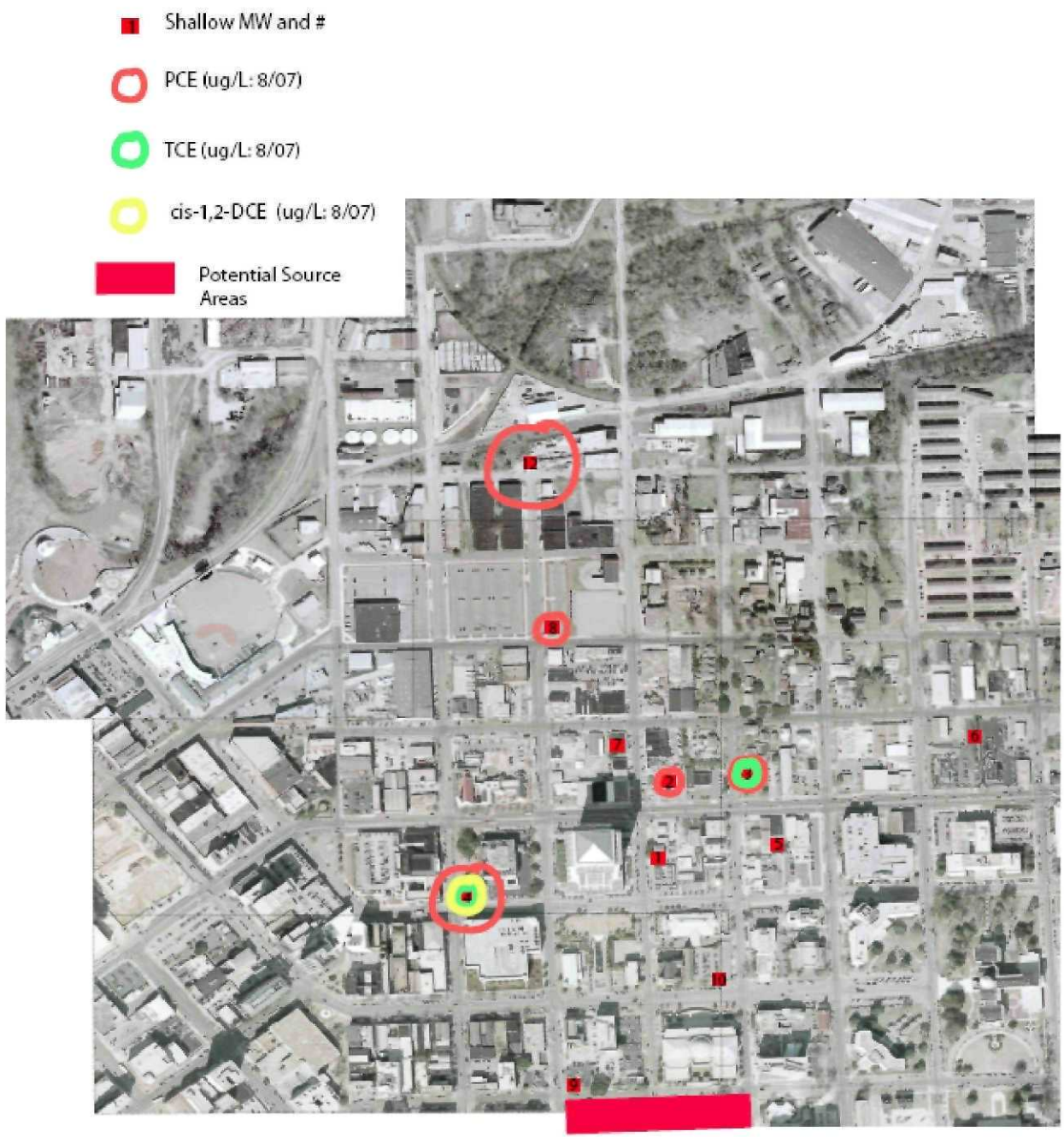
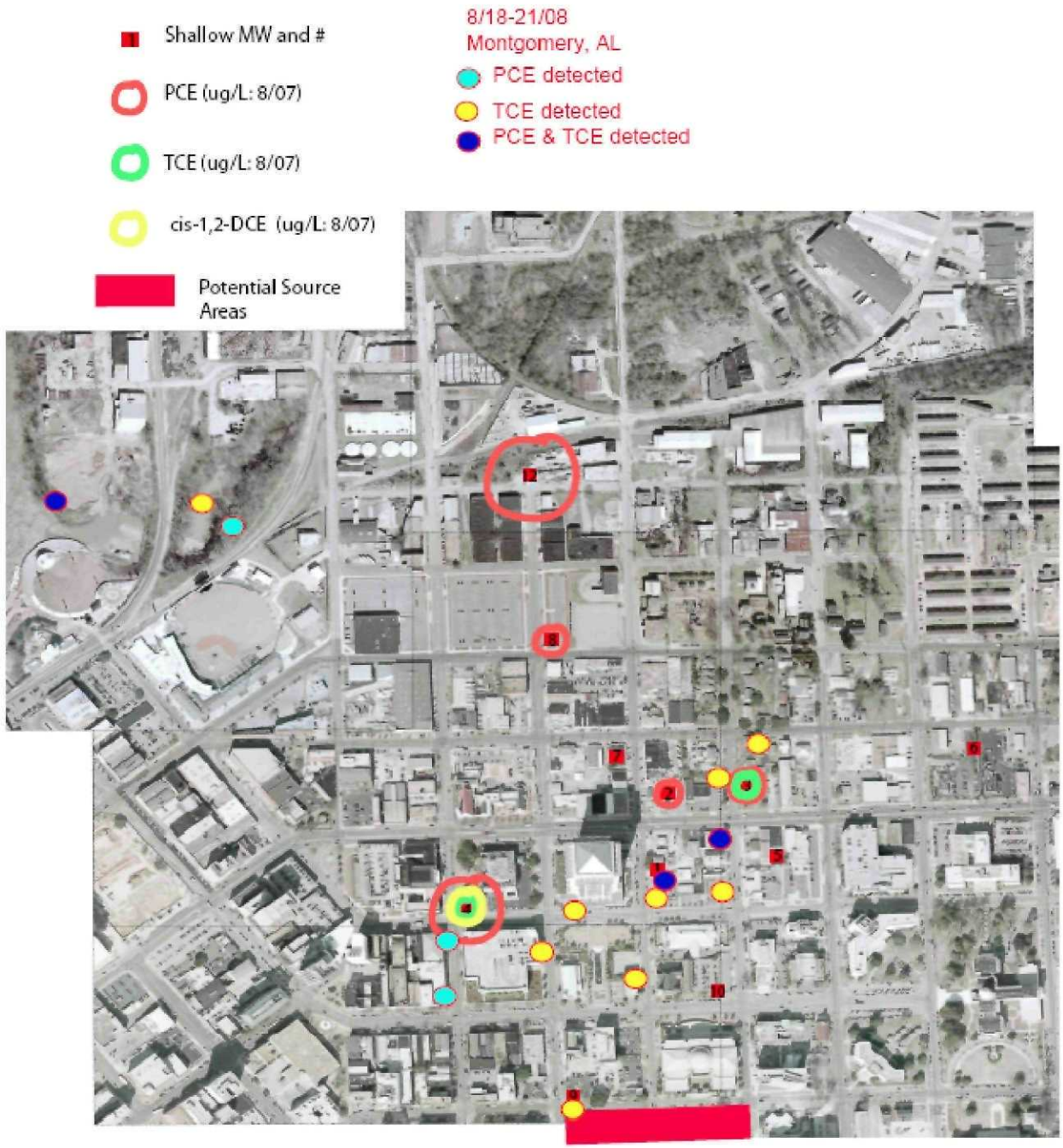
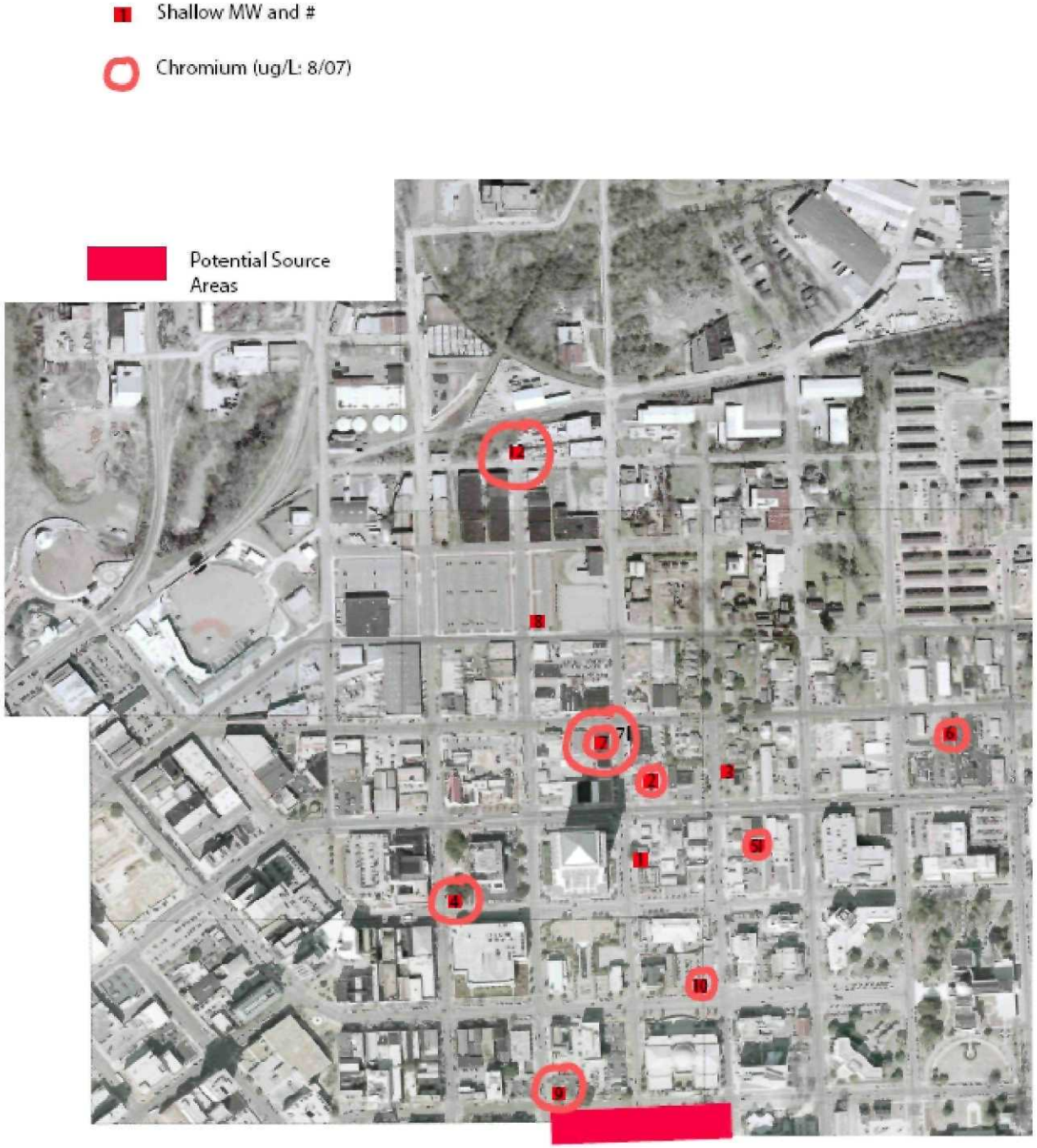
Figure 1 - 2

Hall (2007)

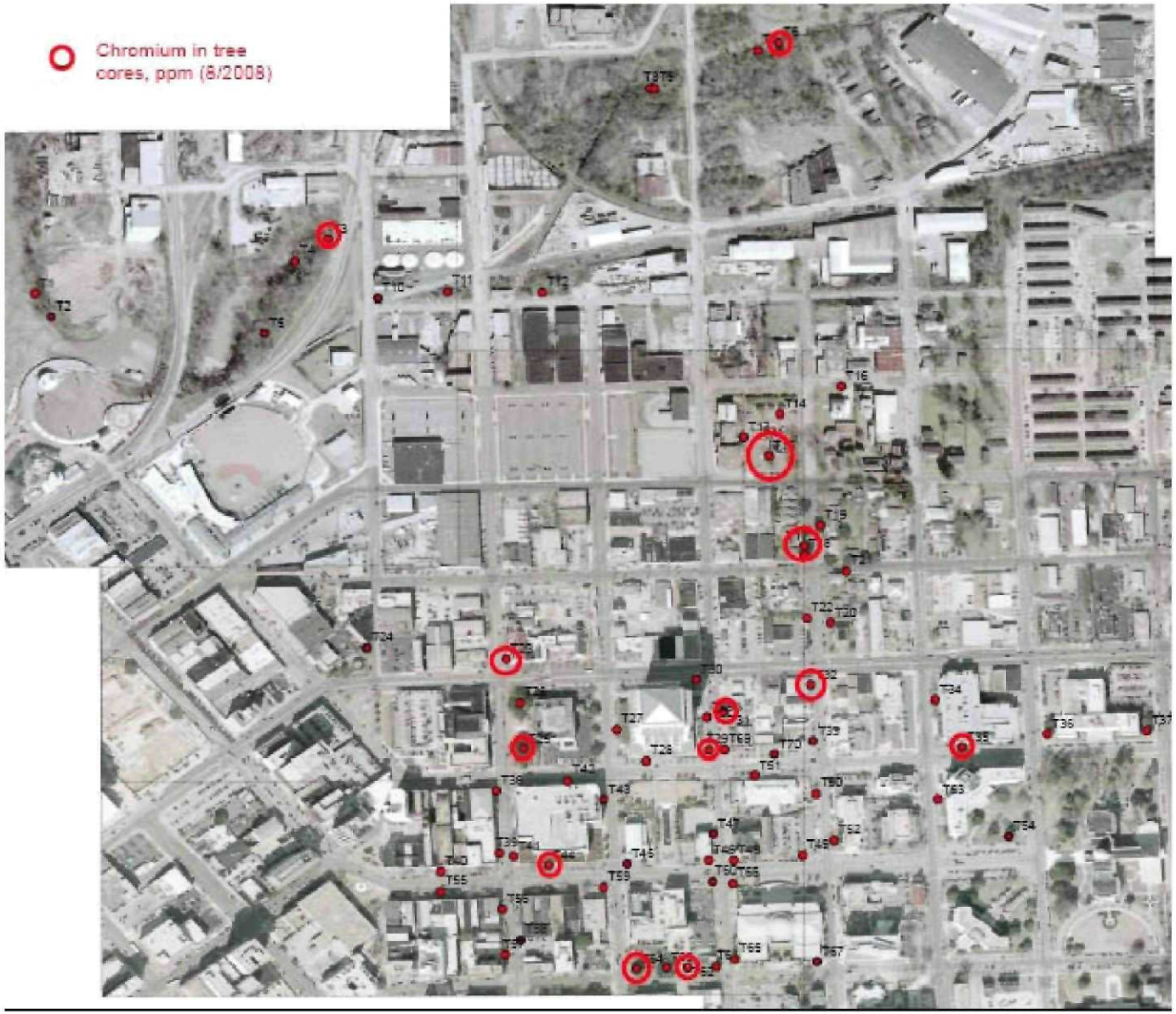

Shallow MW and #
PCE (ug/L: 8/07)
TCE (ug/L: 8/07)
cis-1,2-DCE (ug/L: 8/07)
Potential Source Areas

Hall (2007)


Shallow MW and #
PCE (ug/L: 8/07)
TCE (ug/L: 8/07)
cis-1,2-DCE (ug/L: 8/07)
Potential Source Areas
8/18-21/08
Montgomery, AL
PCE detected
TCE detected
PCE & TCE detected

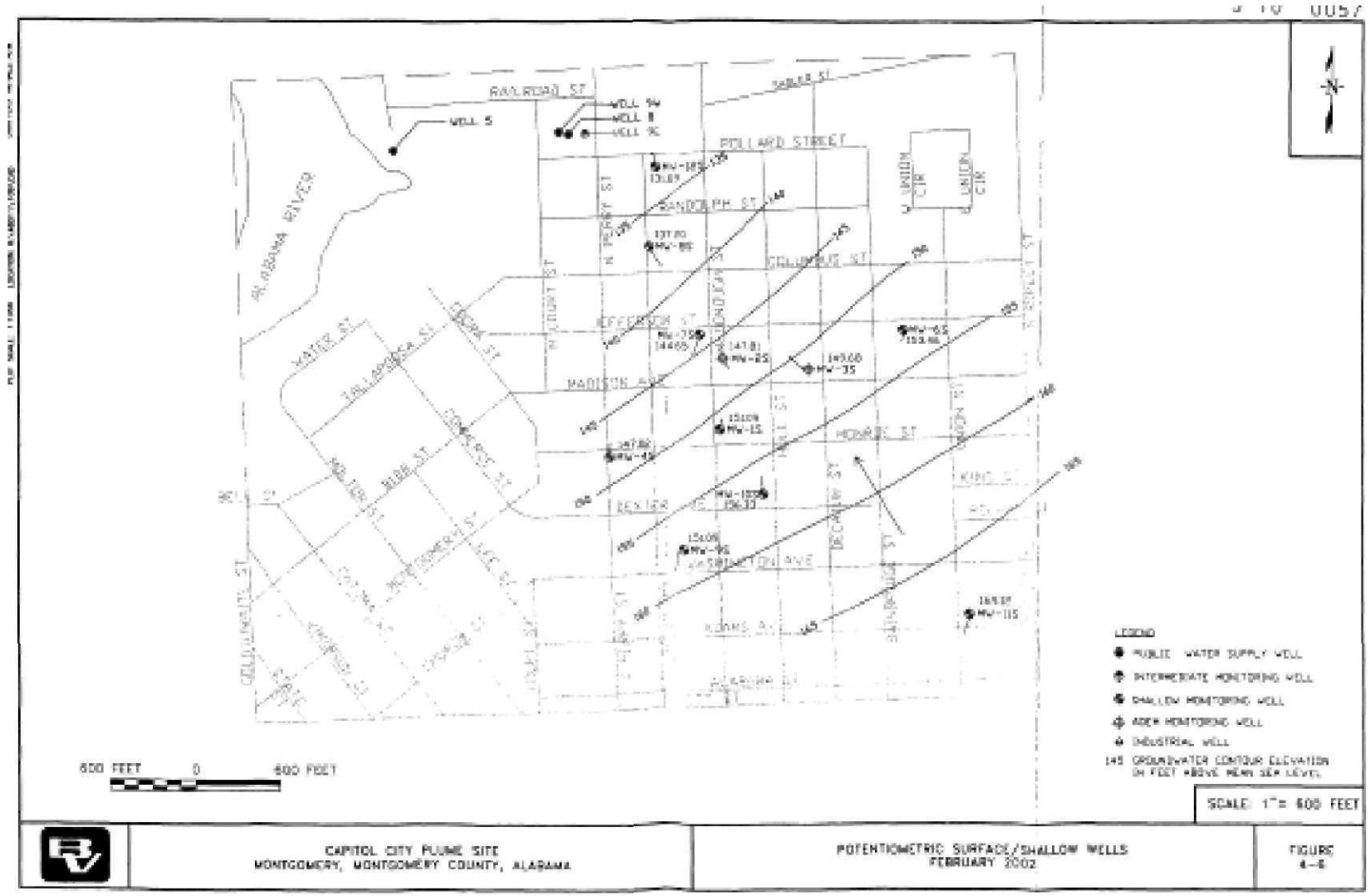


Hall (2007)

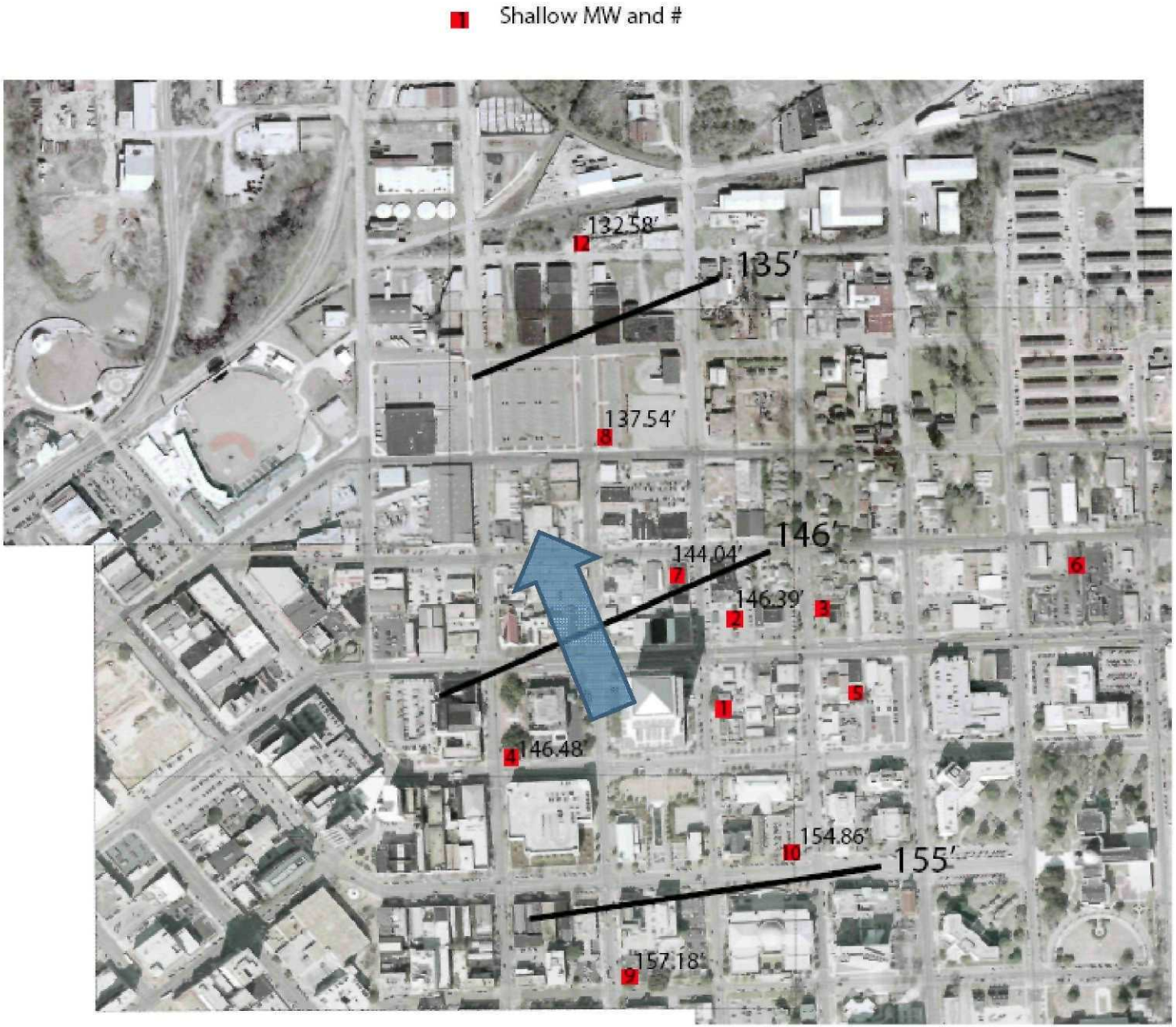

Chromium in tree cores, ppm (8/2008)

USGS Alabama WSC Intensive Groundwater sampling event, spring 2009

1-groundwater levels
2-groundwater properties (DO, pH)
3-groundwater contaminants (VOCs, hex chrome, others)



Black & Veatch (2002)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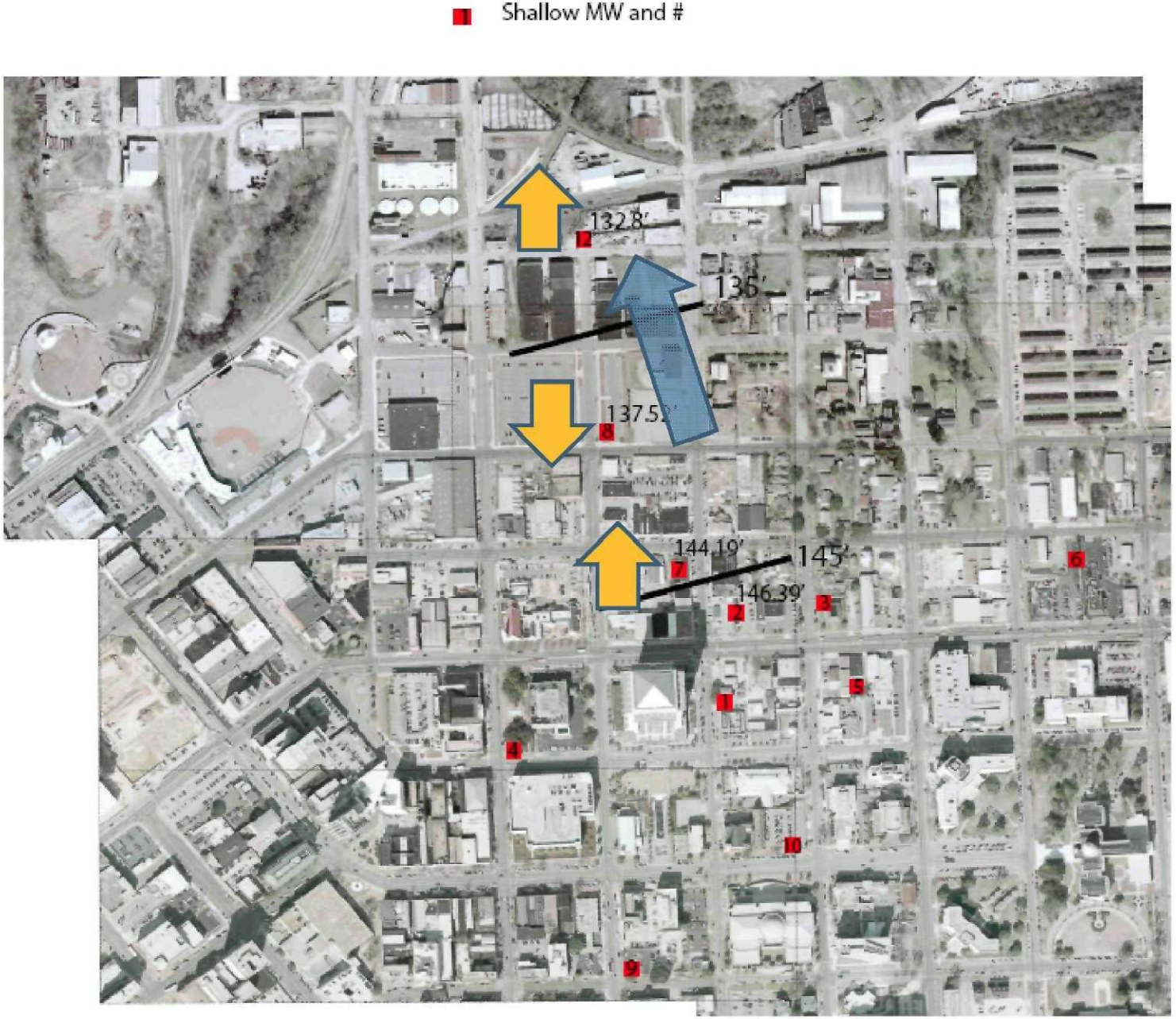
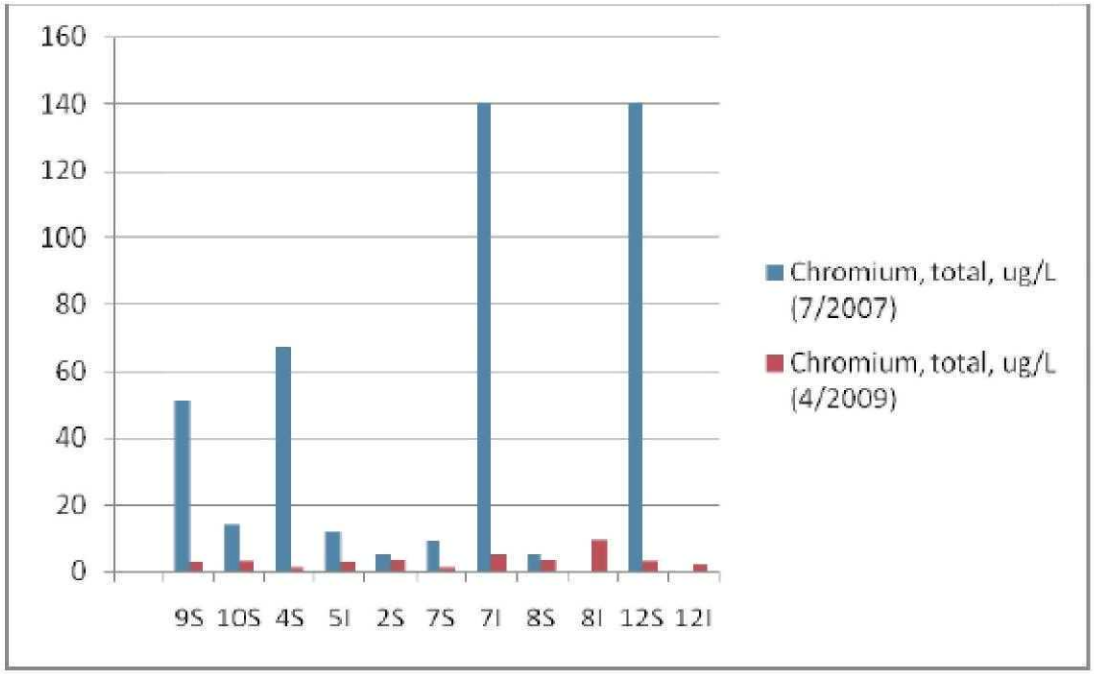
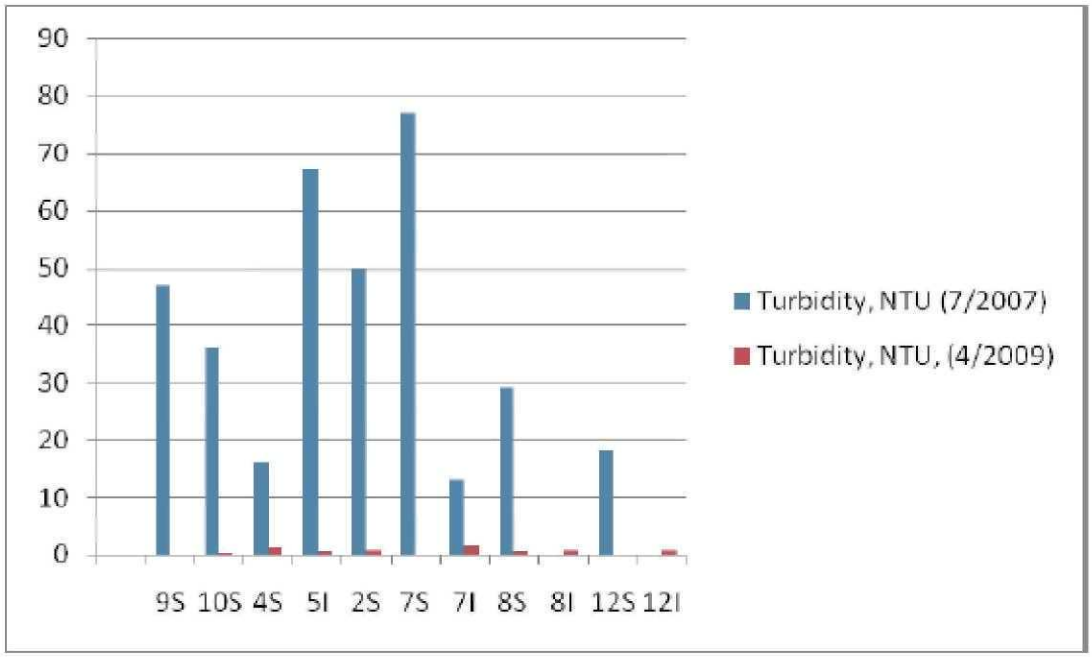
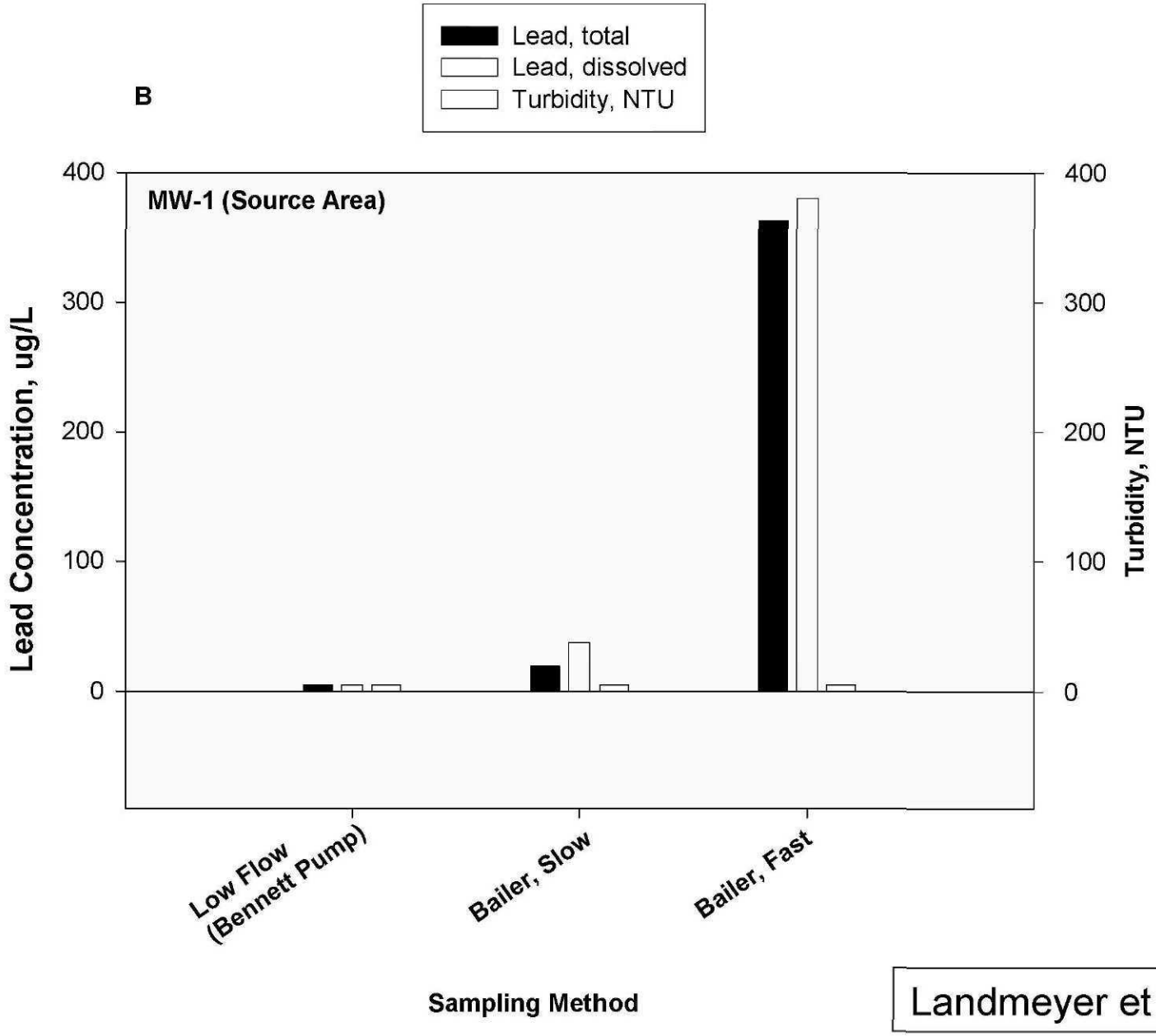
135'
137.54'
146'
144.04'
146.39'
146.48'
154.86'
155'
157.18'


Shallow MW and #
132.8'
135'
137.52'
144.19'
145'
146.39'
1
2
3
4
5
6
7
8
9
10

SiName	Latitude	Longitude	Sample Date	Sample Time	Well Depth	TOC elevation, ft above MSL	Depth to Water from TOC	Elevation of ground water, ft AMSL	Hach - Dissolved Oxygen	Hach-Sulfide	Hach-Sulfate	Hach-Nitrate	Hach-Ferrous Iron	Hach-Turbidity	Chemetrics - Hexavalent Chromium	YSI Meter - Temperature	YSI Meter - Dissolved Oxygen	YSI Meter - Specific Conductance	YSI Meter - pH
					feet	feet AMSL	feet	feet AMSL	mg/L	mg/L	mg/L	mg/L	mg/L	ntu	mg/L	degrees Celsius	mg/L	microsiemens/cm	pH units
CCP01S	32.379352	-86.304856							NYS										
CCP01I	32.379355	-86.304840							NYS										
CCP02S	32.380342	-86.304729	04/07/09	15:00	59.87	188.59	42.20	146.39	6.3	0.01	8	6.3	0.05	0.8	0.033	21.85	5.9	212	5.2
CCP03S	32.380562	-86.303344				206.18			Not Sampled										
CCP04S	32.378892	-86.307361	04/21/09	9:30	38.75	178.72	32.24	146.48	6.4	0	19	4.5	0	1.34	0.034	21.54	4.9	322	5.6
CCP04I	32.378900	-86.307384				178.90			Not Sampled										
CCP05I	32.379827	-86.302799	04/08/09	13:10	159.87	210.98	59.52	151.46	6.6	0	1	2.2	0	0.6	0.056	21.75	5.4	60	5.8
CCP06S	32.380882	-86.300851				224.26			Not Sampled										
CCP07S	32.380606	-86.305495	04/09/09	11:15	96.71	179.65	35.61	144.04	4	0	4	1.5	0.04		0.109	21.81	2.6	70	5.8
CCP07I	32.380584	-86.305491	04/09/09	14:40	126.85	179.76	35.57	144.19	6.4	0	6	6.6	0	1.7	0 or 0.047	22.06	6.9	212	5.2
CCP08S	32.382272	-86.306258	04/20/09	11:40	51.77	173.48	35.92	137.54	5.9	0	9	6.1	0	0.49	0	22.25	6.6	219	5
CCP08I	32.382258	-86.306258	04/21/09	13:40	119.73	173.42	35.90	137.52	3.6	0.01	2	1.7	0.05	0.78	0	21.34	3.35	72	6
CCP09S	32.376452	-86.305846	04/27/09	14:00	71.76	213.41	58.23	157.18	5.5	0	6	1.5	0	0.19	undrm g	22.99	6	177	5.1
CCP10S	32.378256	-86.303973	04/27/09	10:15	71.91	212.67	57.81	154.86	5.1	0	13	6.4	0	0.47	0	22.69	5.2	249	5.3
~~CCP11S~~	~~32.375305~~	~~-86.299420~~	-		~~Destroyed~~	-	-		-	-	-	-	-	-	-	-	-	-	-
~~CCP11I~~	~~32.375283~~	~~-86.299417~~	-		~~Destroyed~~	-	-		-	-	-	-	-	-	-	-	-	-	-
CCP12S	32.384398	-86.306438	04/23/09	11:30	41.88	157.58	25.00	132.58	5.5	0.01	5	7.1	0.02	0.11	0.083	22.04	4.9	254	5.5
CCP12I	32.384409	-86.306454	04/22/09	12:35	104.69	157.82	25.02	132.80	2.2	0.02	3	0.7	0.12	0.842	0/0.01	21.22	1.8	91	6.1

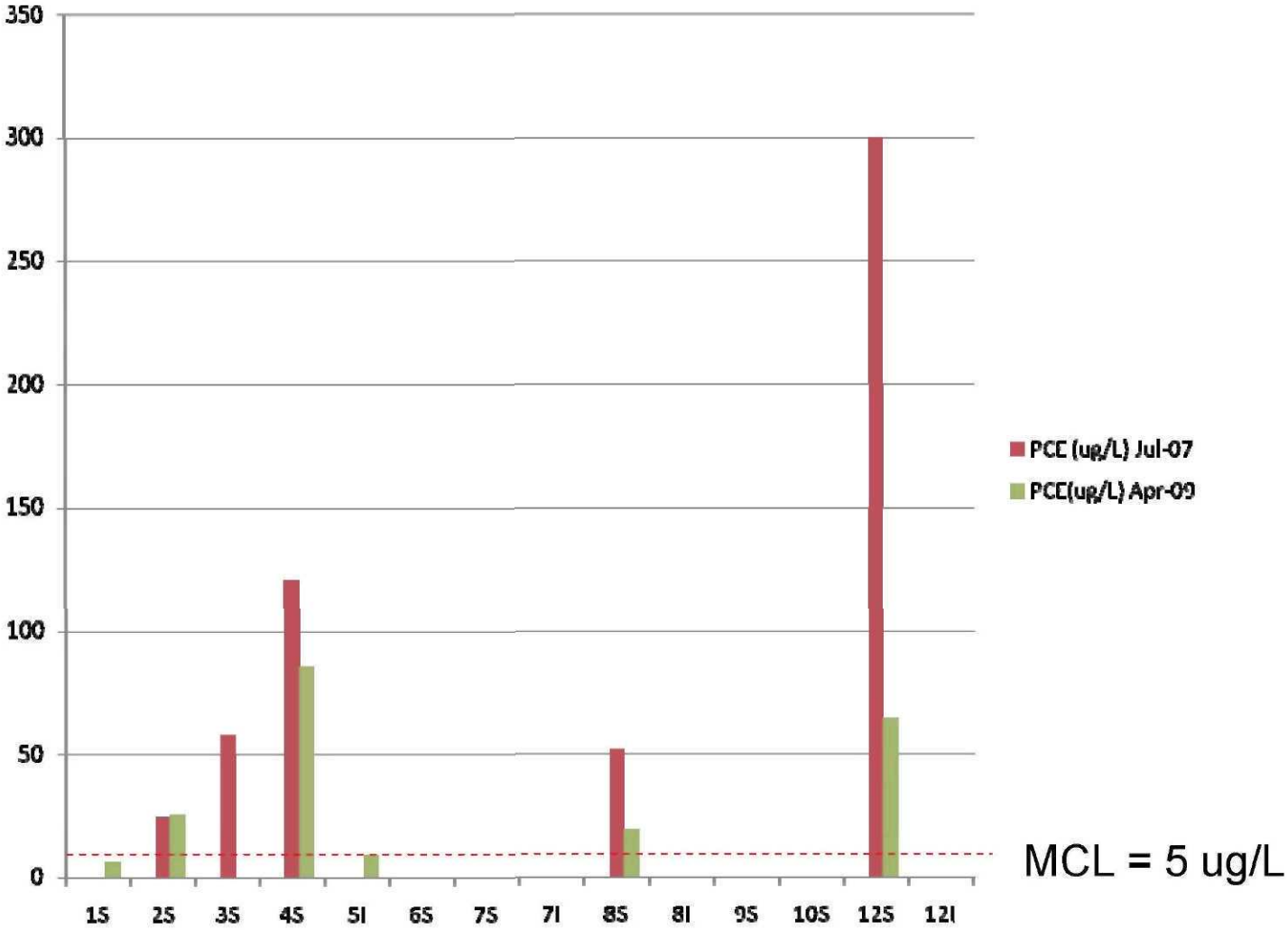

160
140
120
100
80
60
40
20
0
9S 10S 4S 5I 2S 7S 7I 8S 8I 12S 12I
Chromium, total, ug/L (7/2007)
Chromium, total, ug/L (4/2009)


90
80
70
60
50
40
30
20
10
0
9S 10S 4S 5I 2S 7S 7I 8S 8I 12S 12I
Turbidity, NTU (7/2007)
Turbidity, NTU, (4/2009)

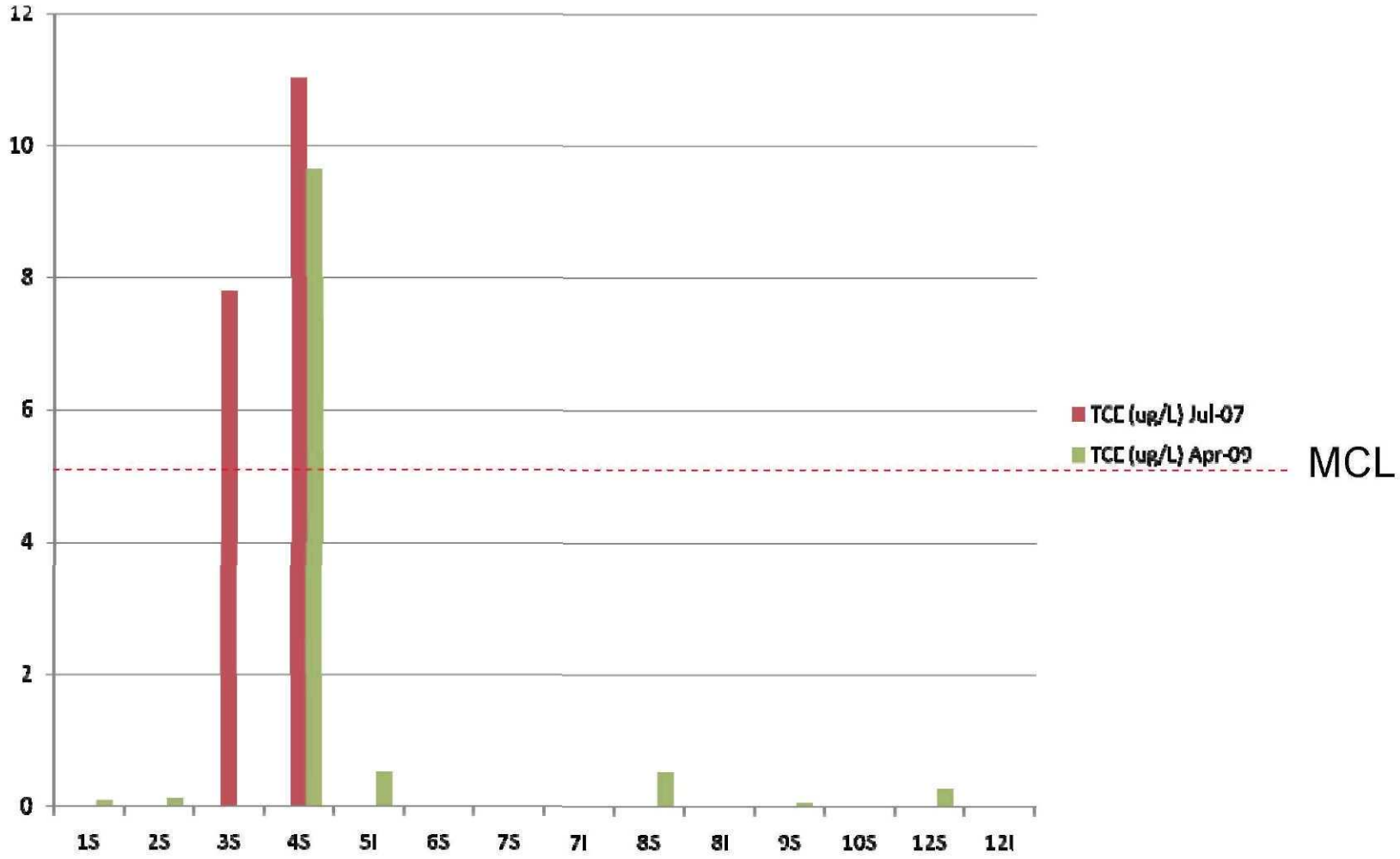


Landmeyer et al. (2003)

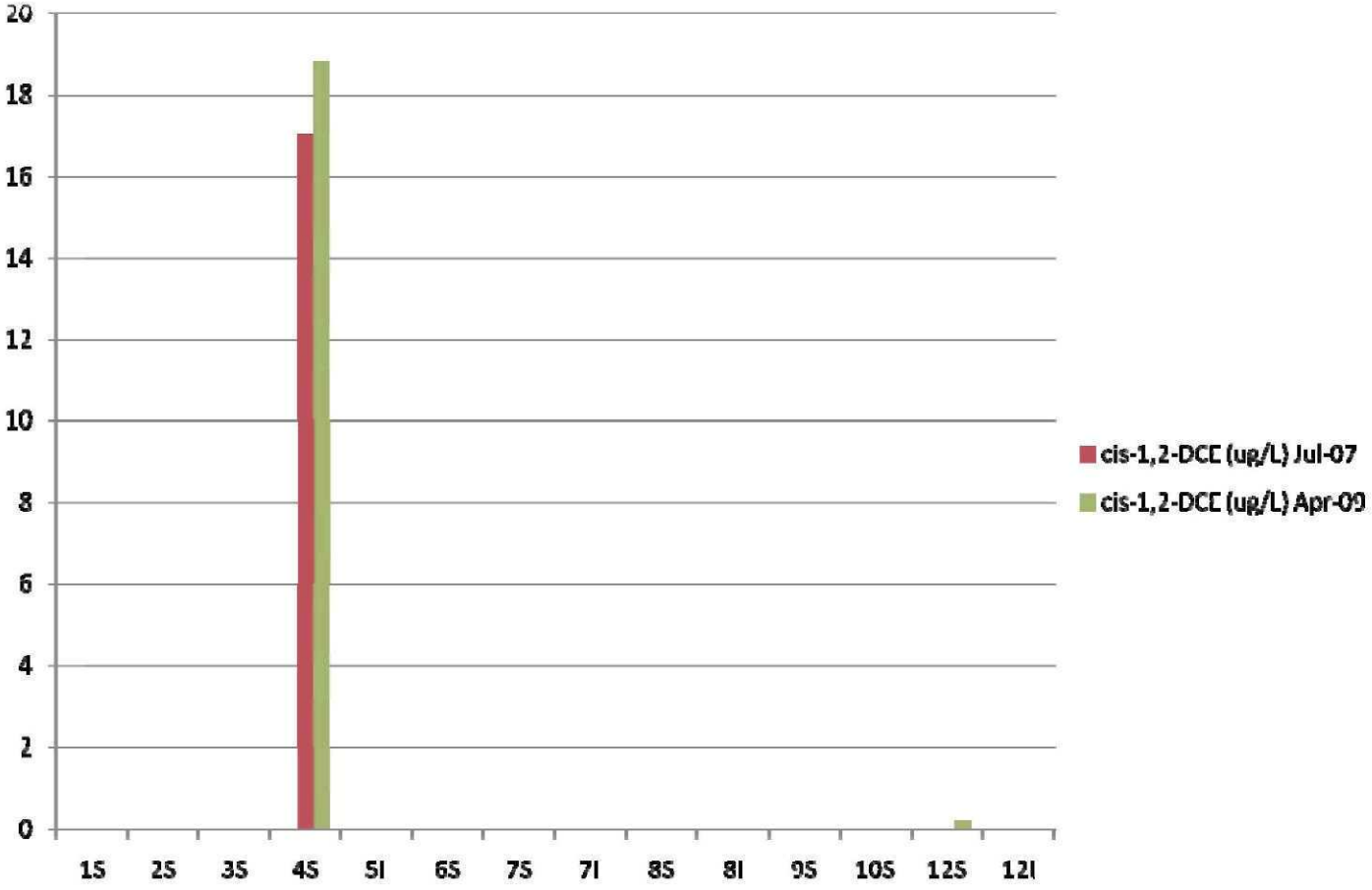
PCE in groundwater



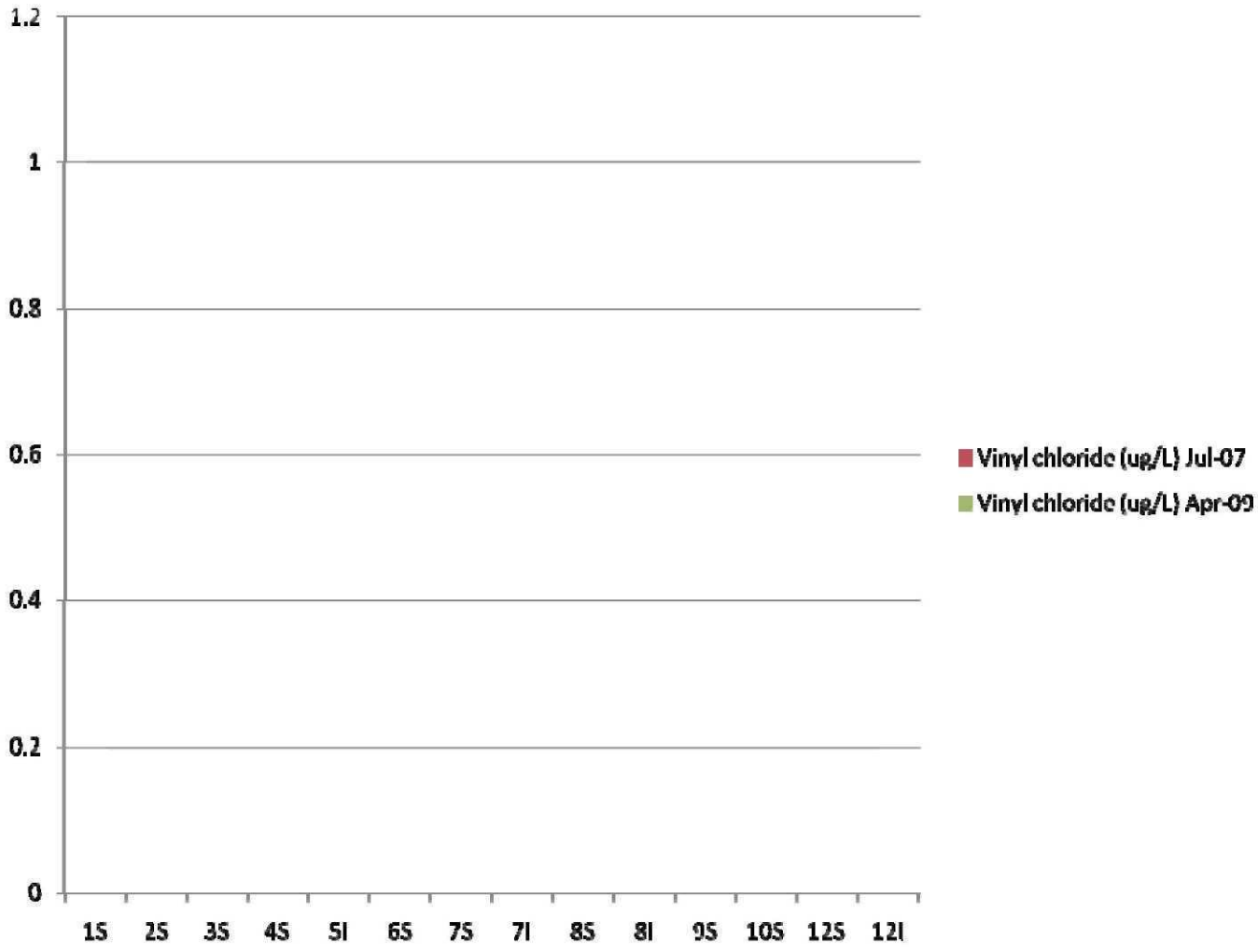
TCE in groundwater



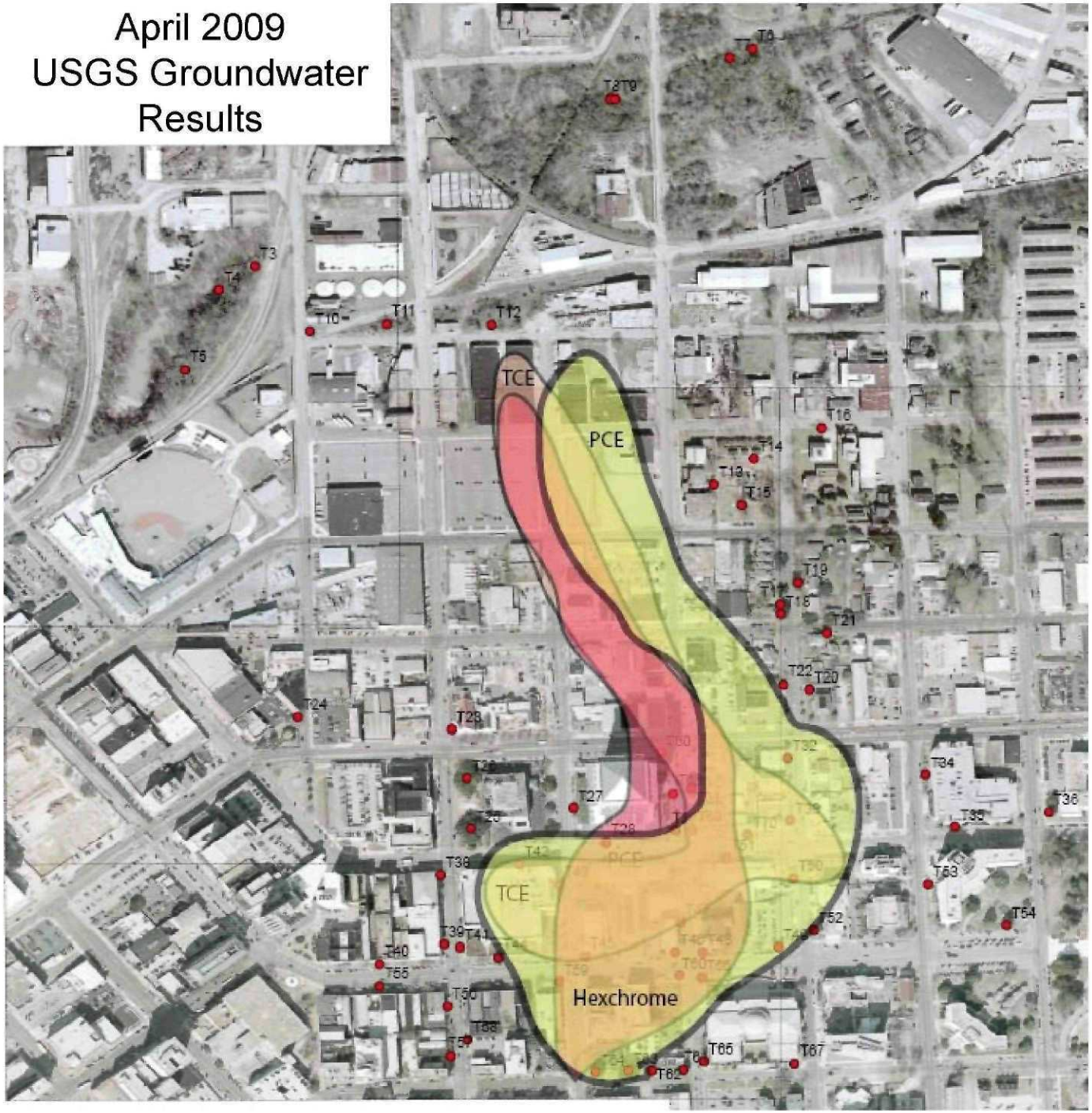
cis-1,2-DCE in groundwater



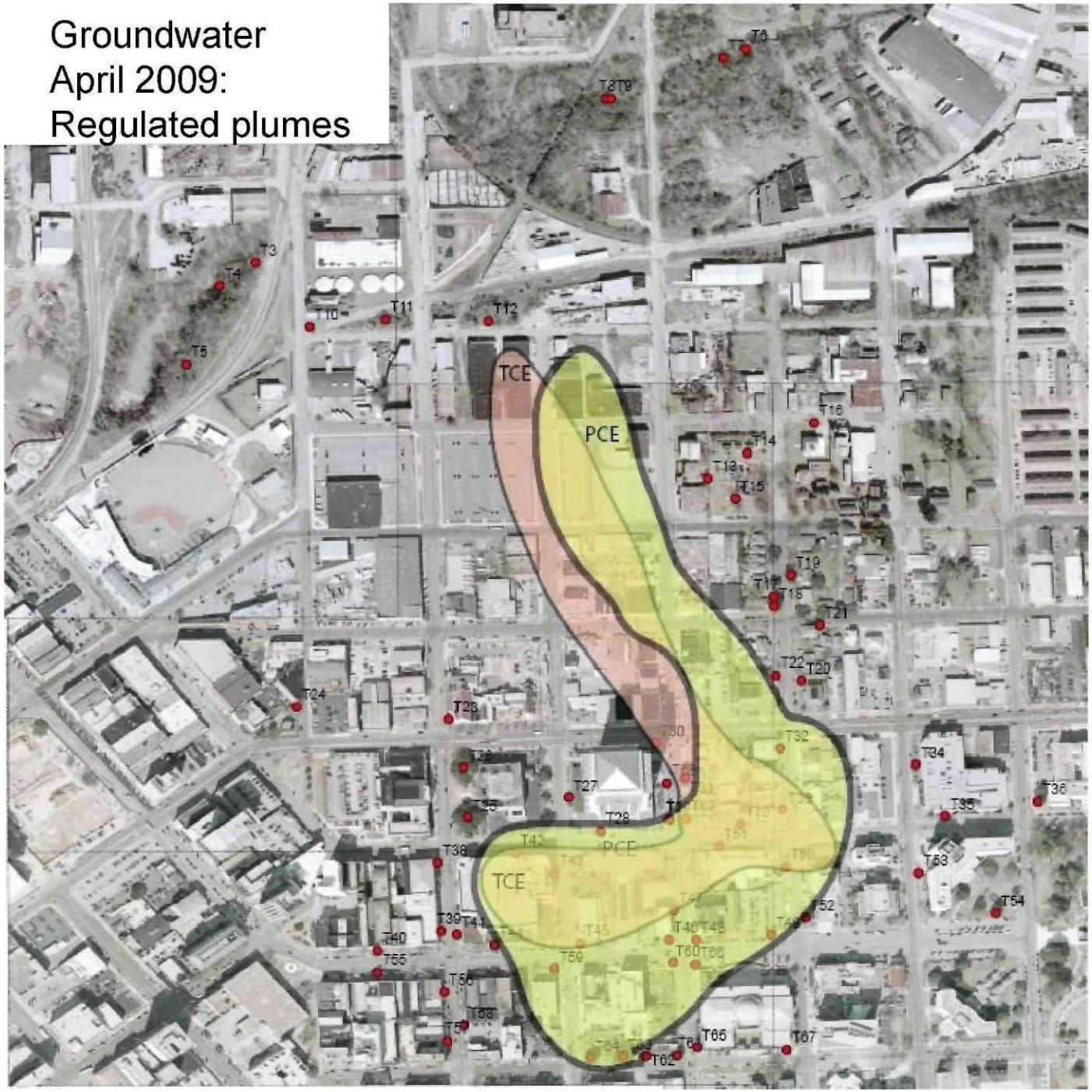
Vinyl chloride in groundwater



April 2009
USGS Groundwater
Results

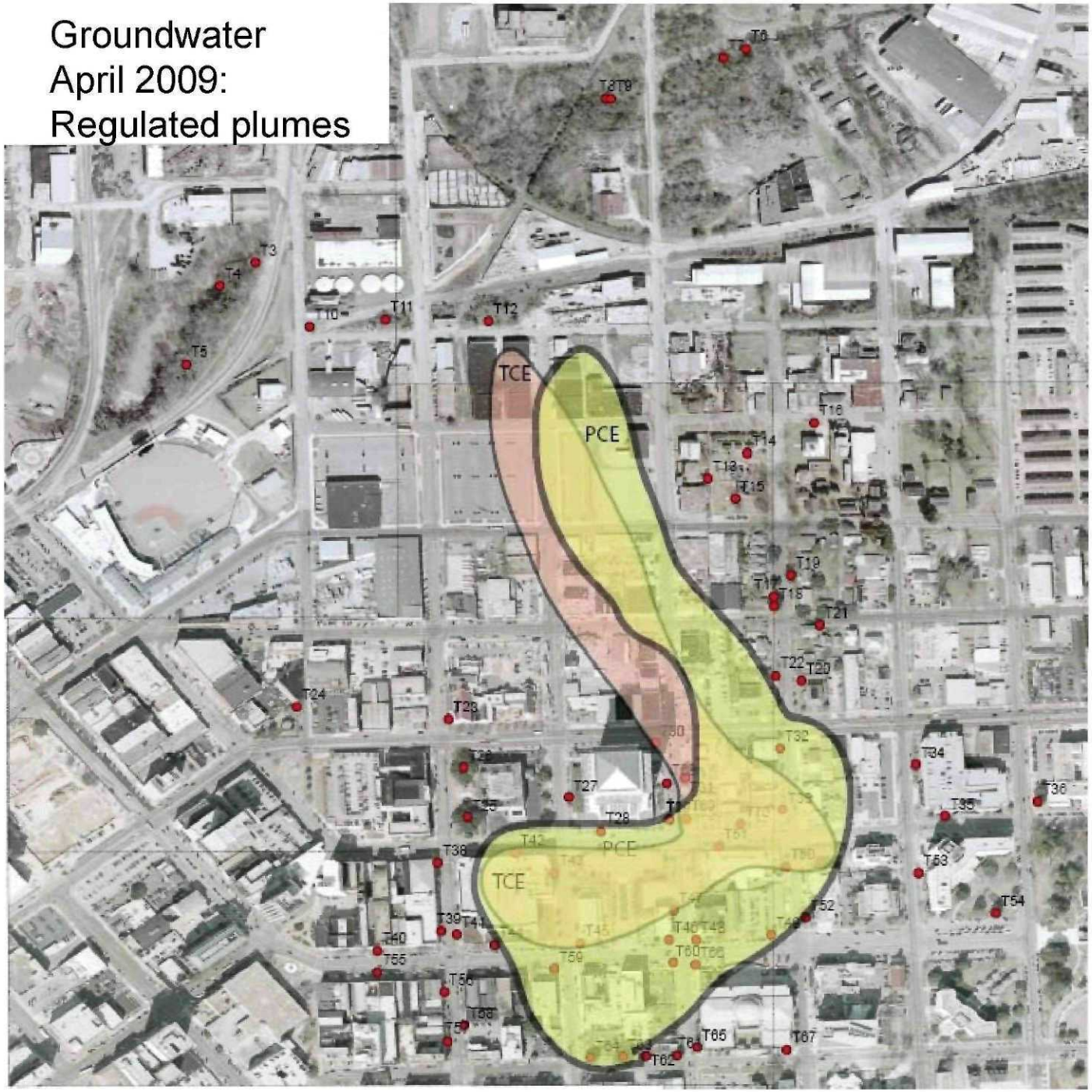


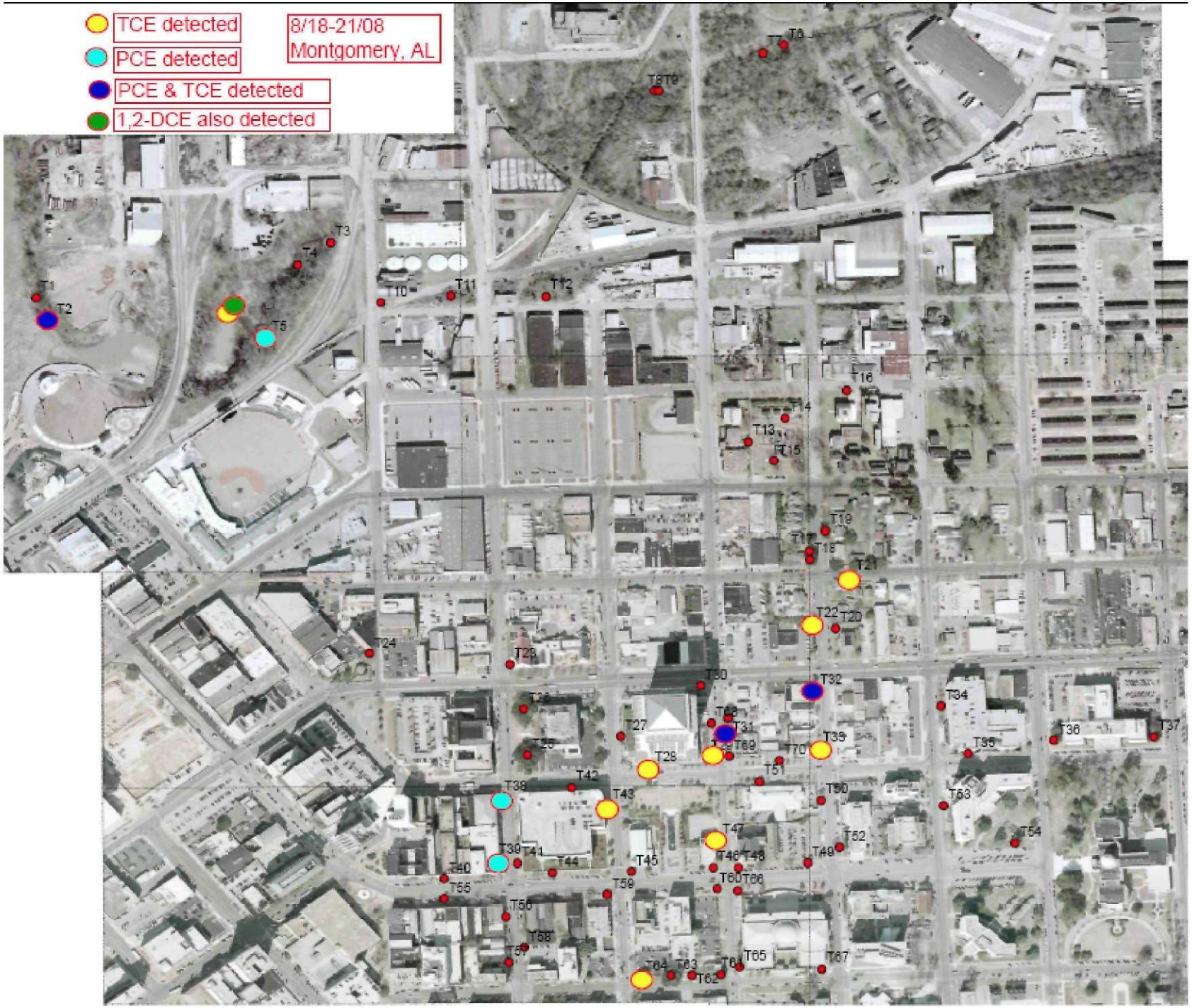
Groundwater April 2009: Regulated plumes



Good agreement between groundwater results (4/09) and PTW results (8/08)

Groundwater April 2009: Regulated plumes




TCE detected
PCE detected
PCE & TCE detected
1,2-DCE also detected
8/18-21/08
Montgomery, AL

So, to date the newer data show:

- PCE/TCE detected in trees above clean groundwater suggests presence of an unsaturated zone residual contaminant source
- PCE/TCE detected in trees above groundwater with PCE/TCE
- Chromium detected in trees where chromium also was in the groundwater

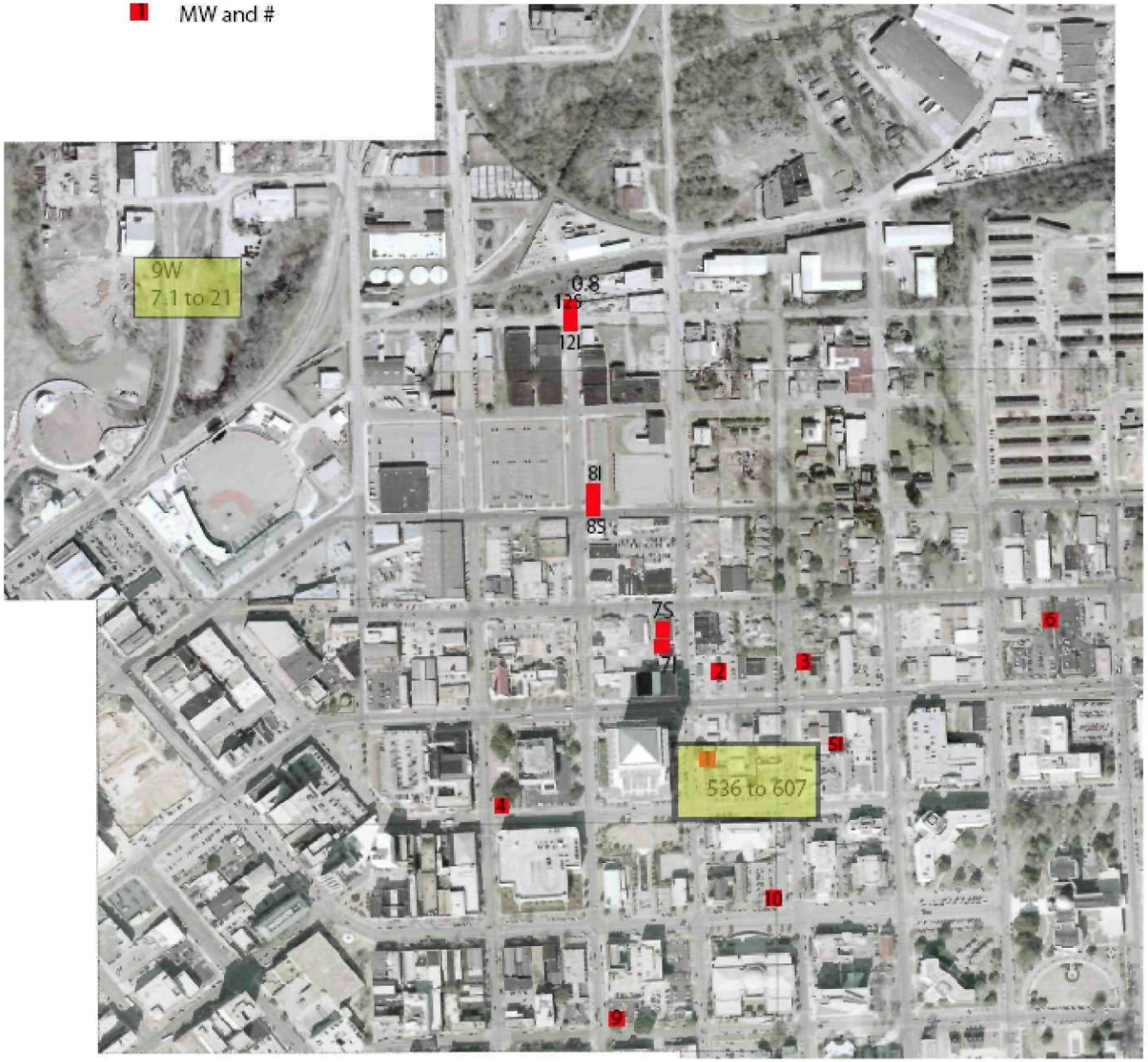
- What do these facts say about sources and

Look at trends of PCE/TCE in groundwater over time

Then look at PTW data for hints at sources

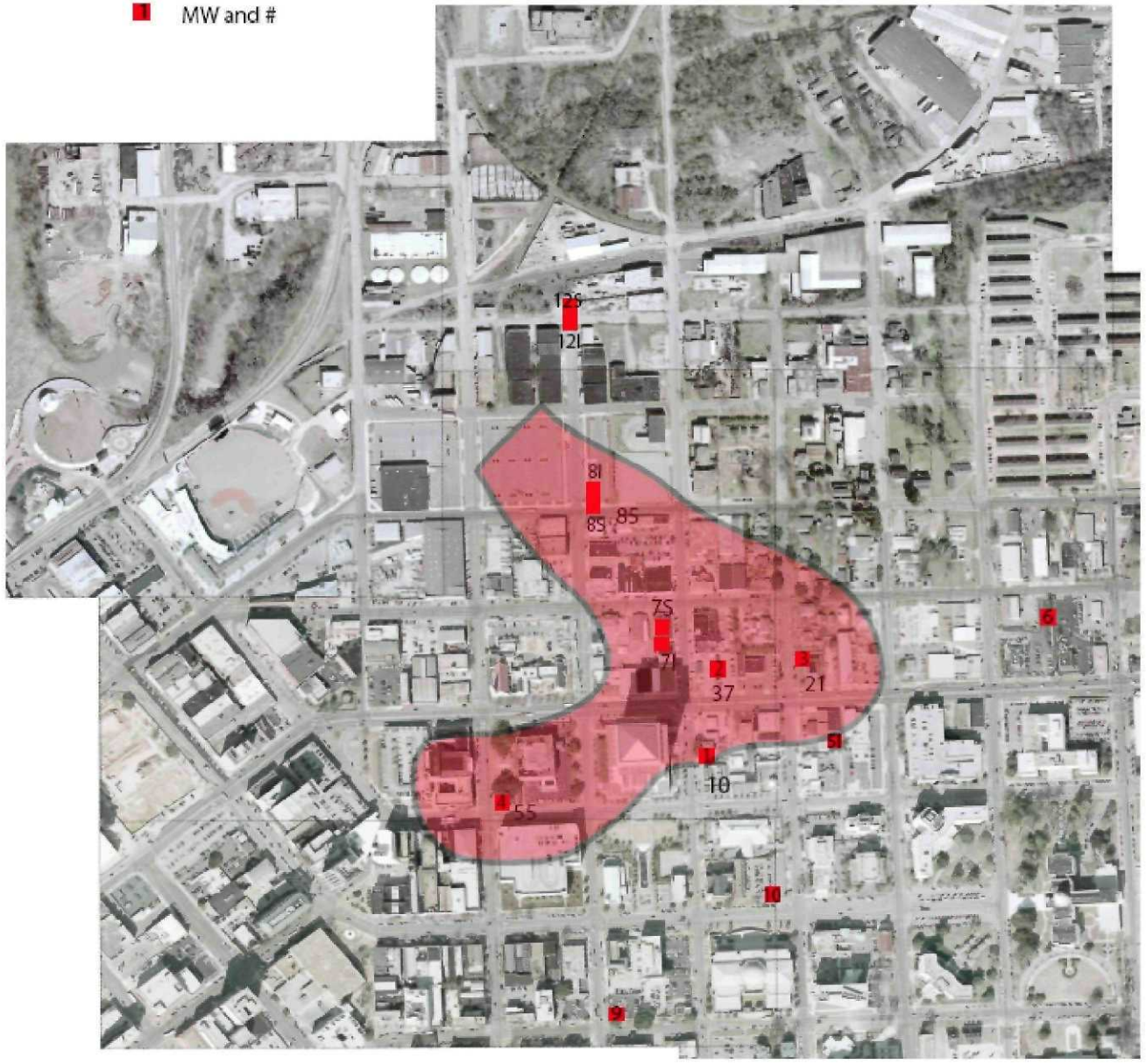
PCE, Groundwater Results, ug/L
10/15/1993

MW and #



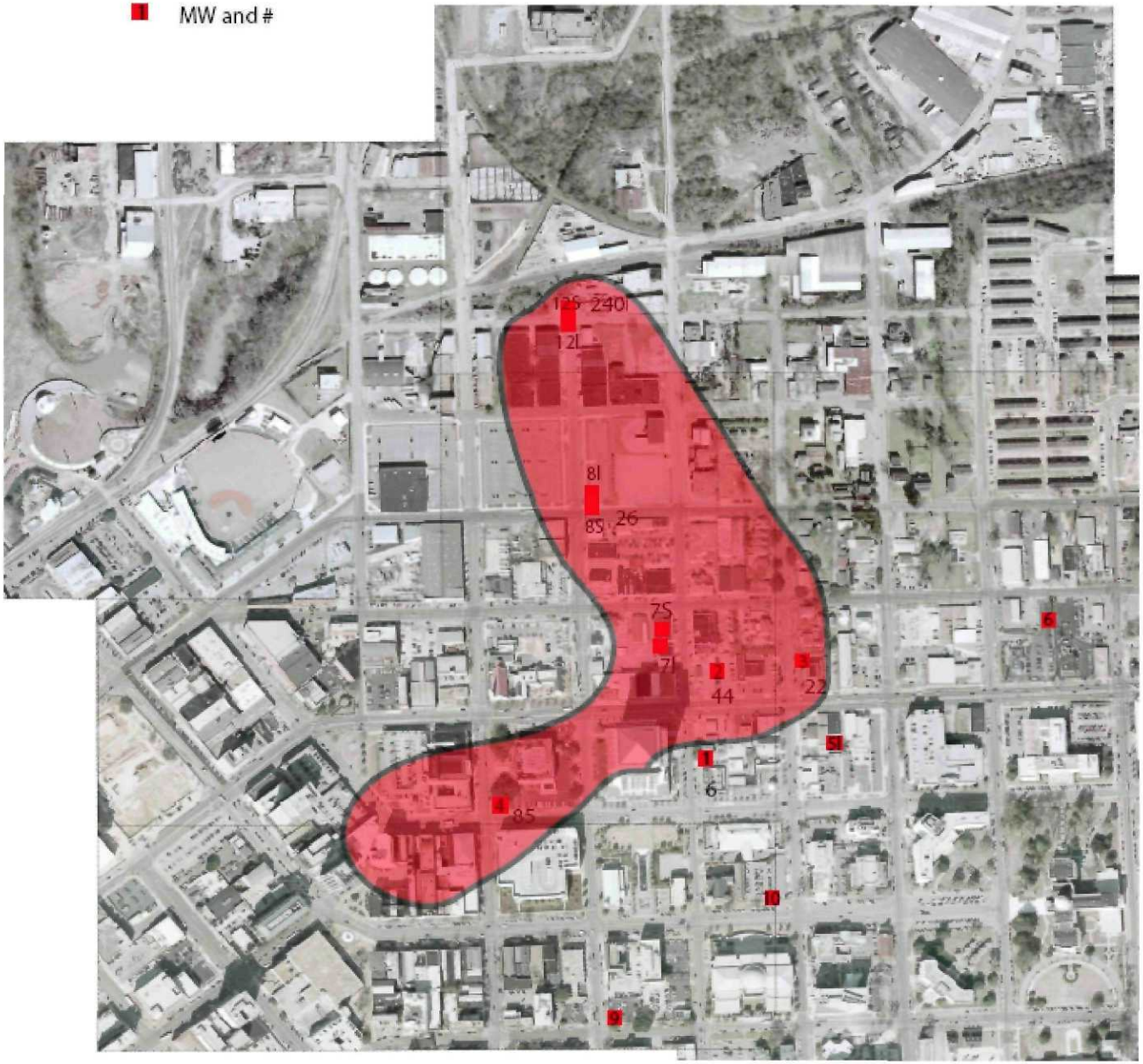
PCE, Groundwater Results, ug/L
5/2000

MW and #



PCE, Groundwater Results, ug/L
1/2001

MW and #

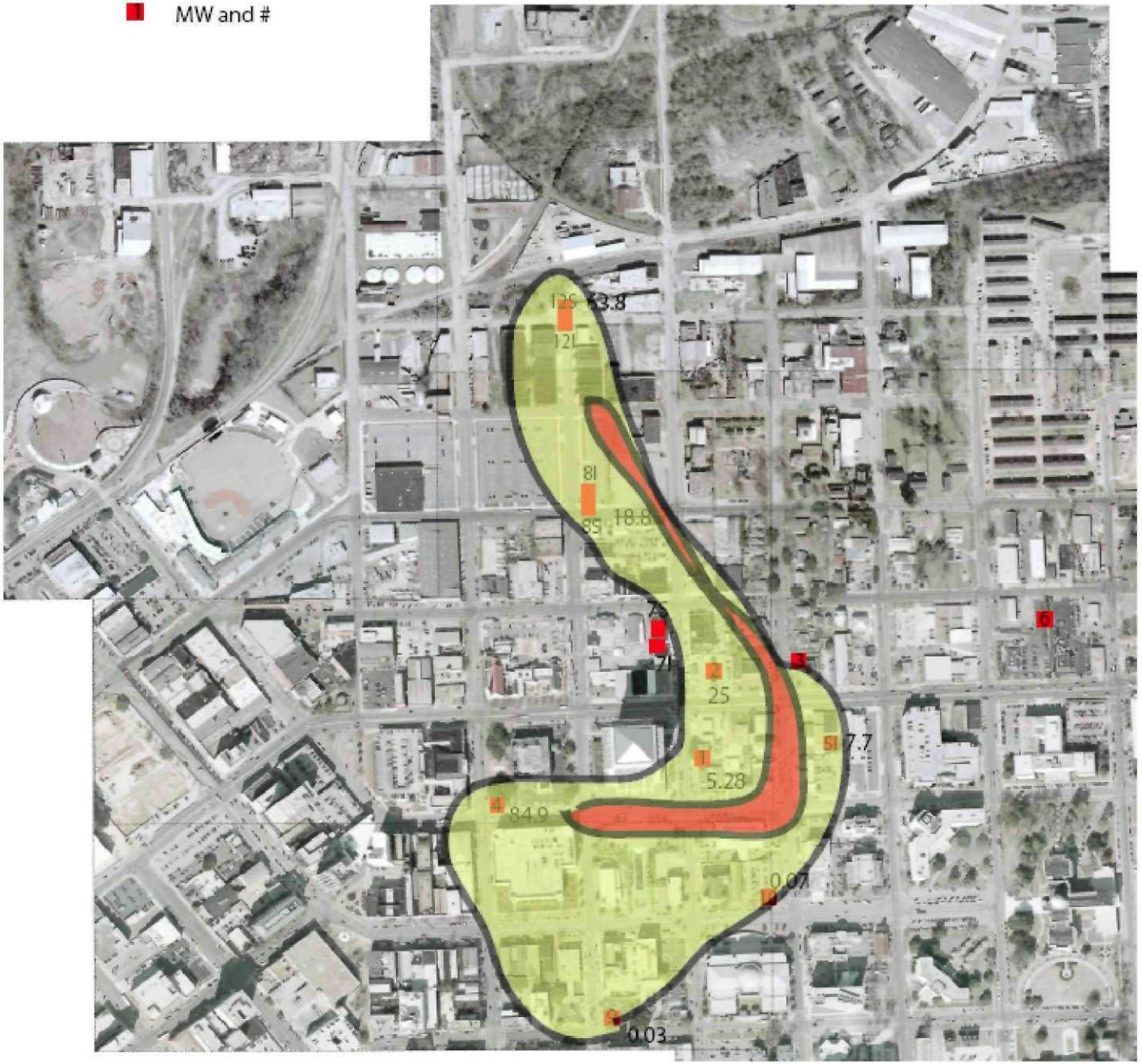


PCE, Groundwater Results, ug/L
7/2007

MW and #

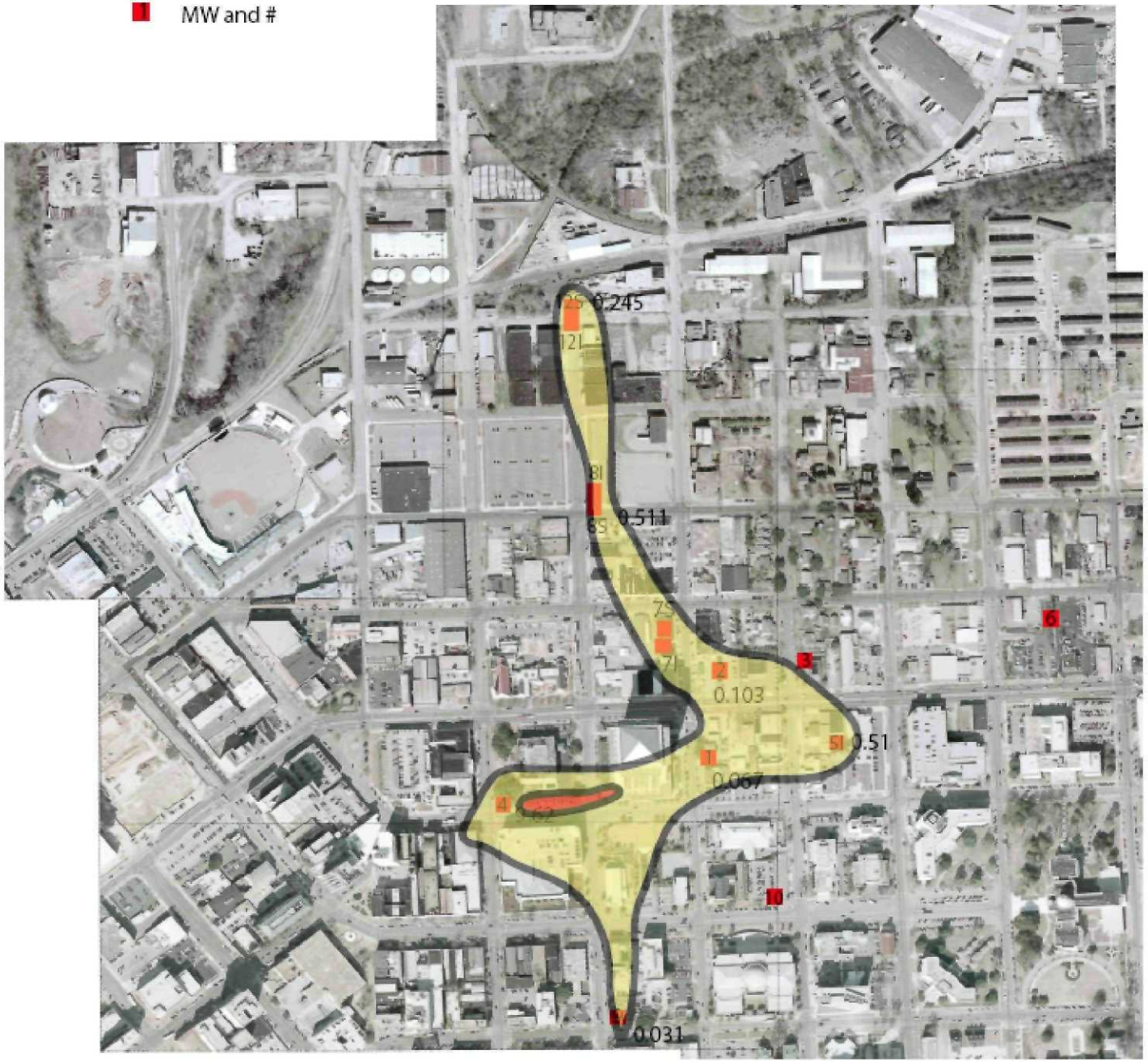
PCE, Groundwater Results, ug/L
4/2009

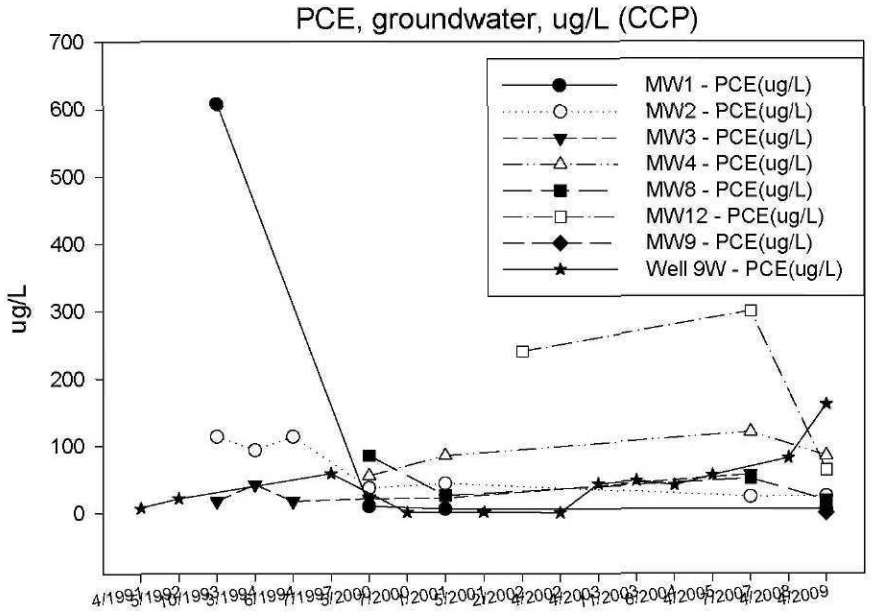
MW and #

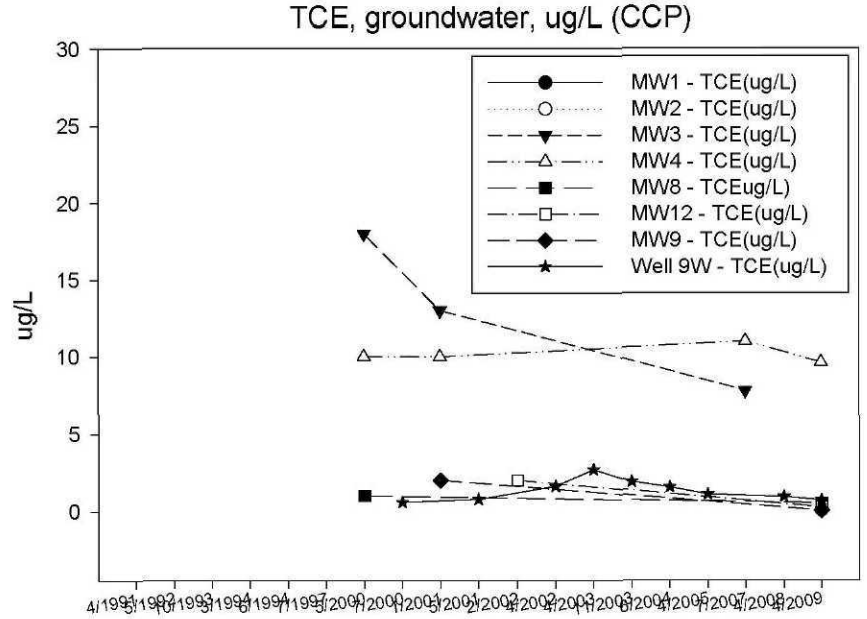


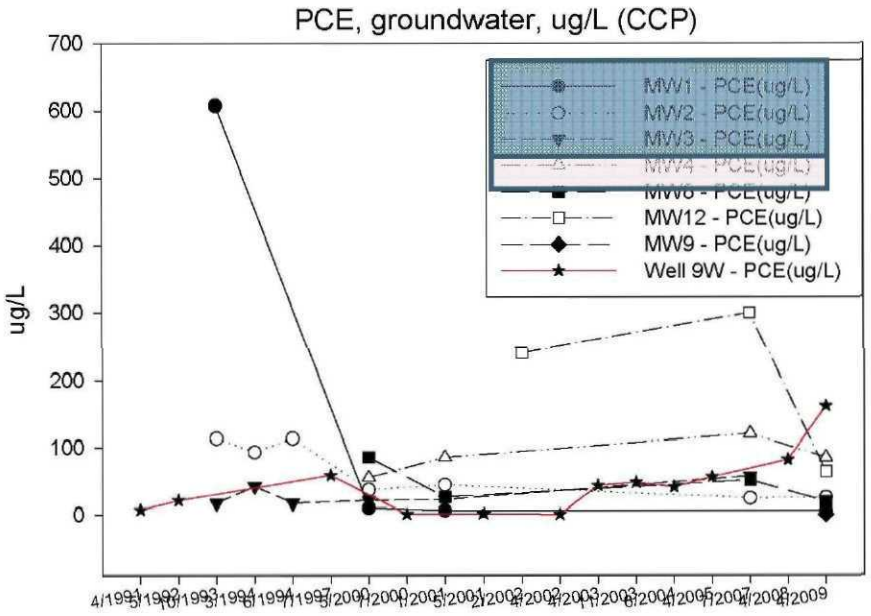
TCE, Groundwater Results, ug/L
4/2009

1 MW and #



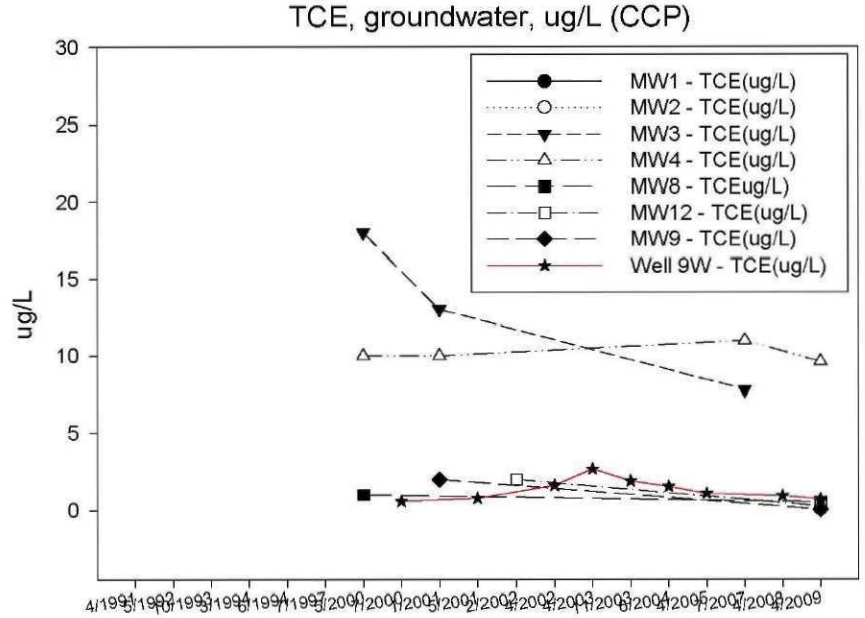

PCE, groundwater, ug/L (CCP)
ug/L
700
600
500
400
300
200
100
0
MW1 - PCE(ug/L)
MW2 - PCE(ug/L)
MW3 - PCE(ug/L)
MW4 - PCE(ug/L)
MW8 - PCE(ug/L)
MW12 - PCE(ug/L)
MW9 - PCE(ug/L)
Well 9W - PCE(ug/L)


TCE, groundwater, ug/L (CCP)
ug/L
30
25
20
15
10
5
0
MW1 - TCE(ug/L)
MW2 - TCE(ug/L)
MW3 - TCE(ug/L)
MW4 - TCE(ug/L)
MW8 - TCEug/L)
MW12 - TCE(ug/L)
MW9 - TCE(ug/L)
Well 9W - TCE(ug/L)

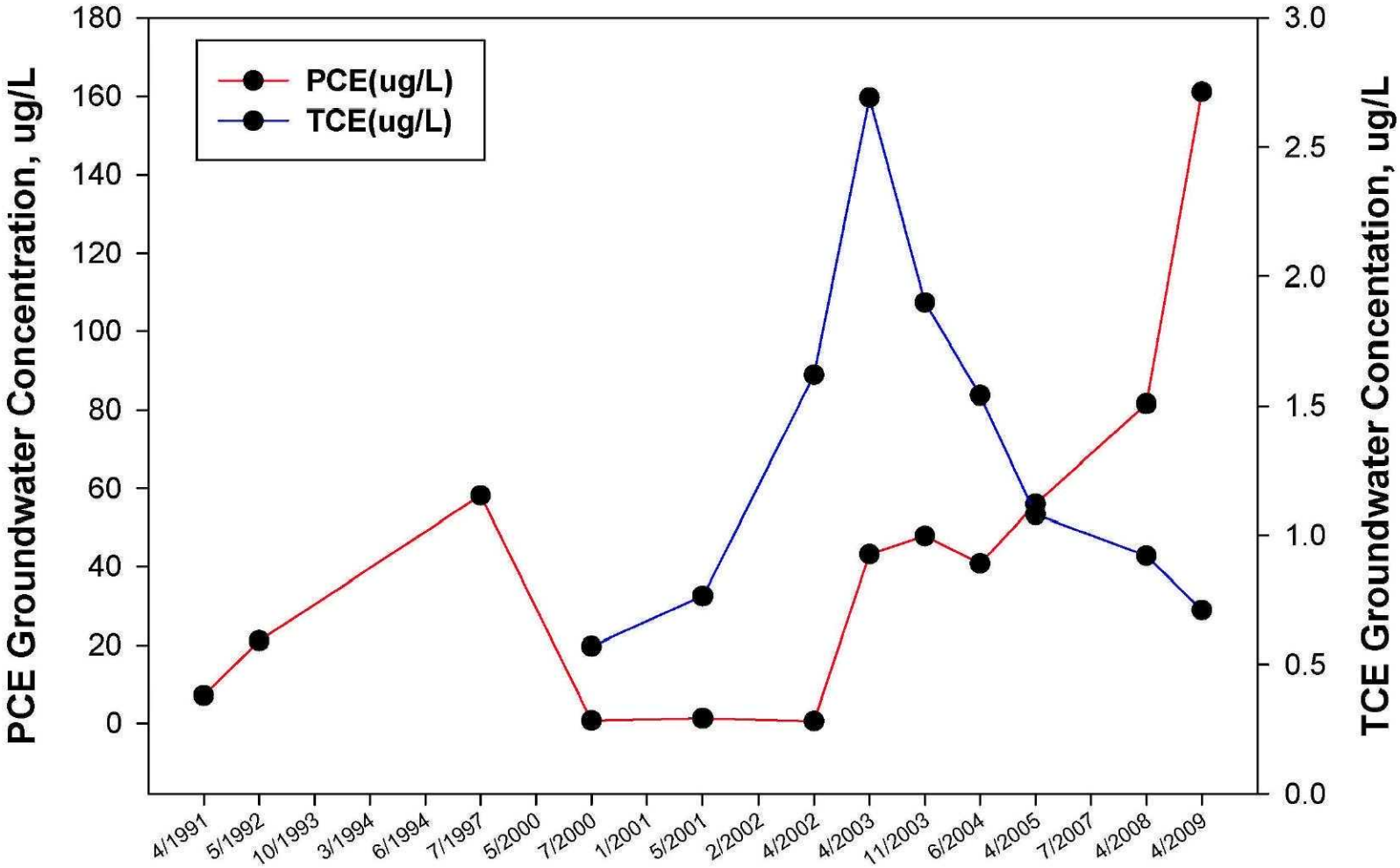


Primary source

Secondary source



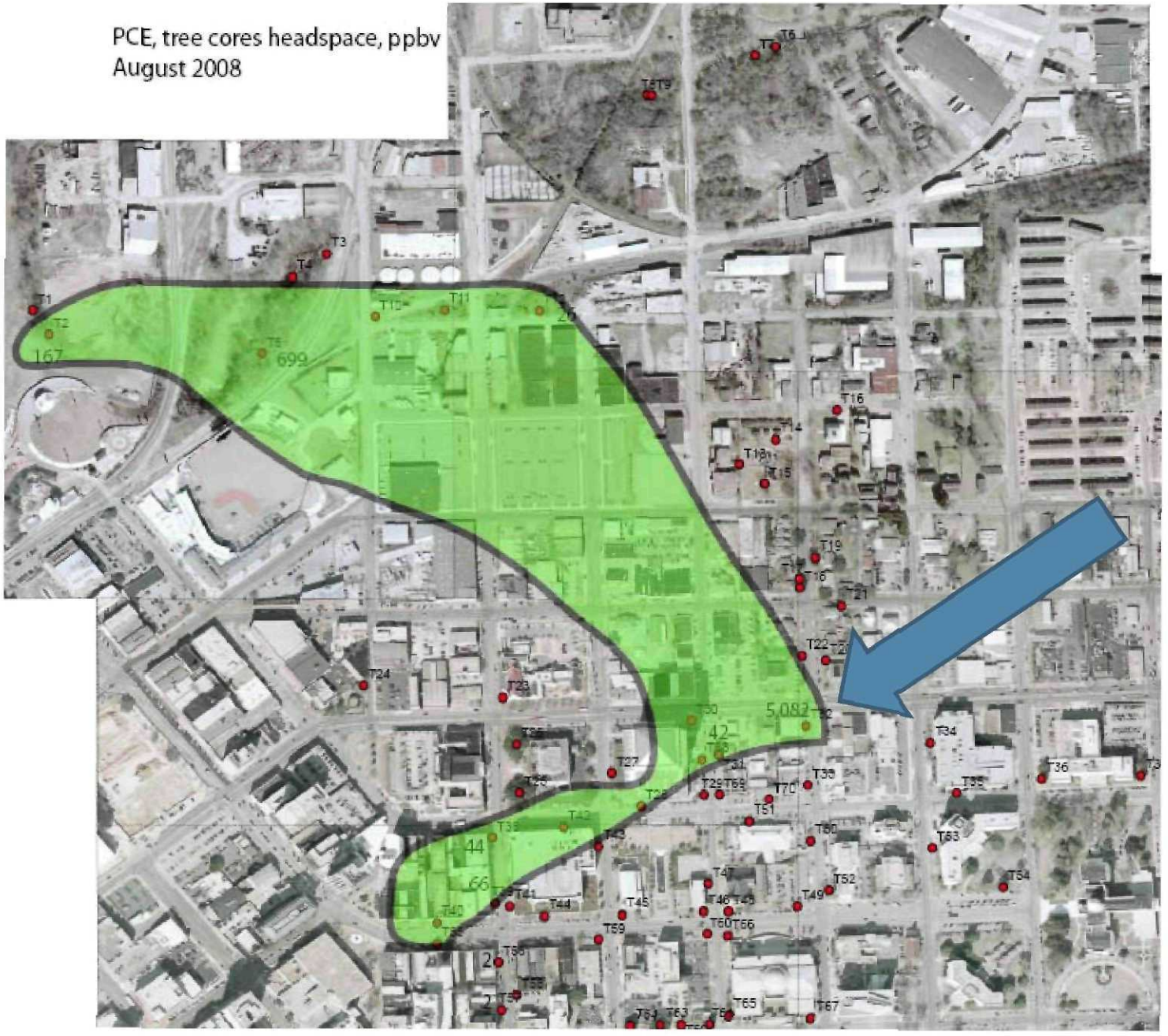
Montgomery, AL CCP, Well 9W

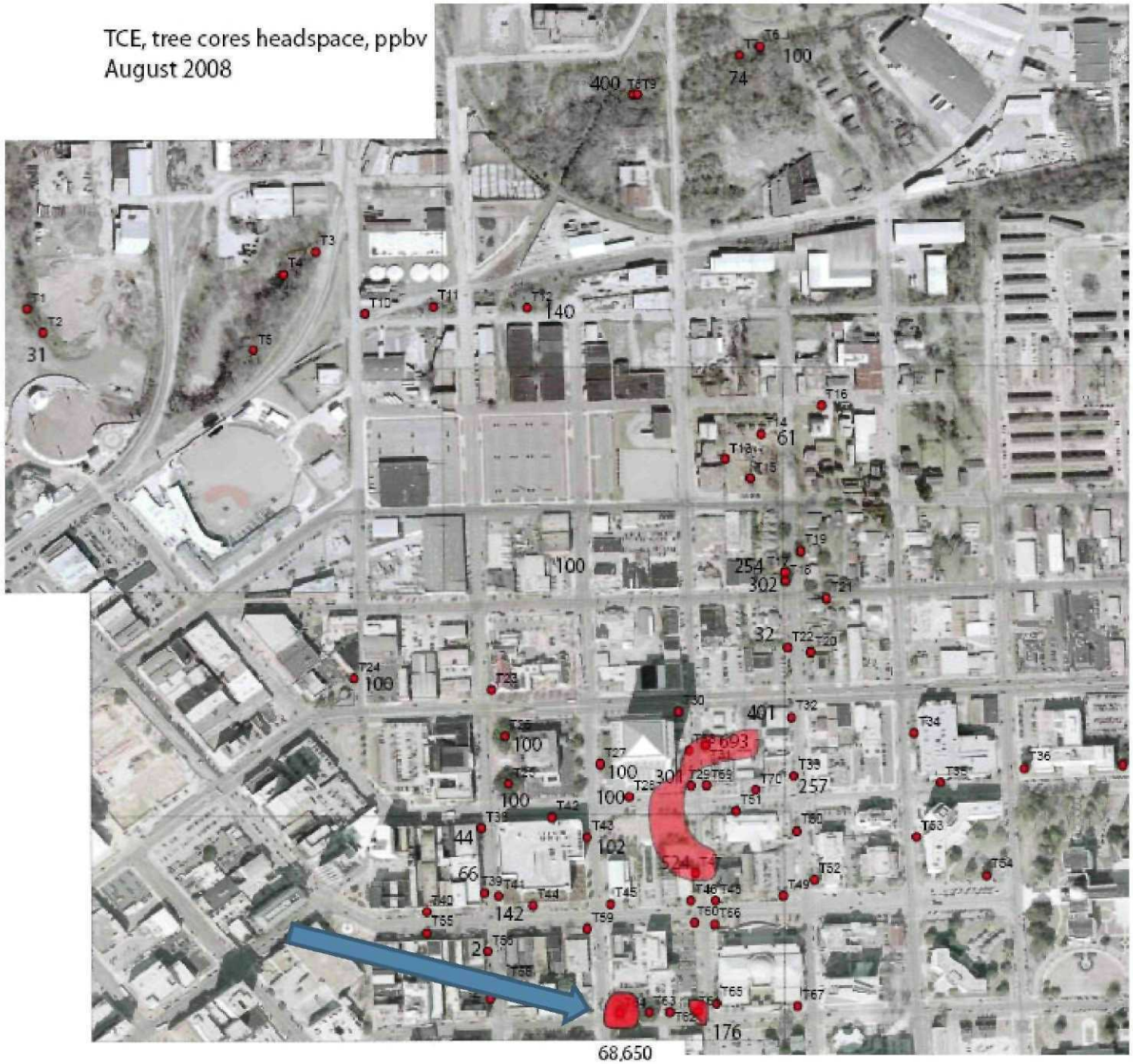


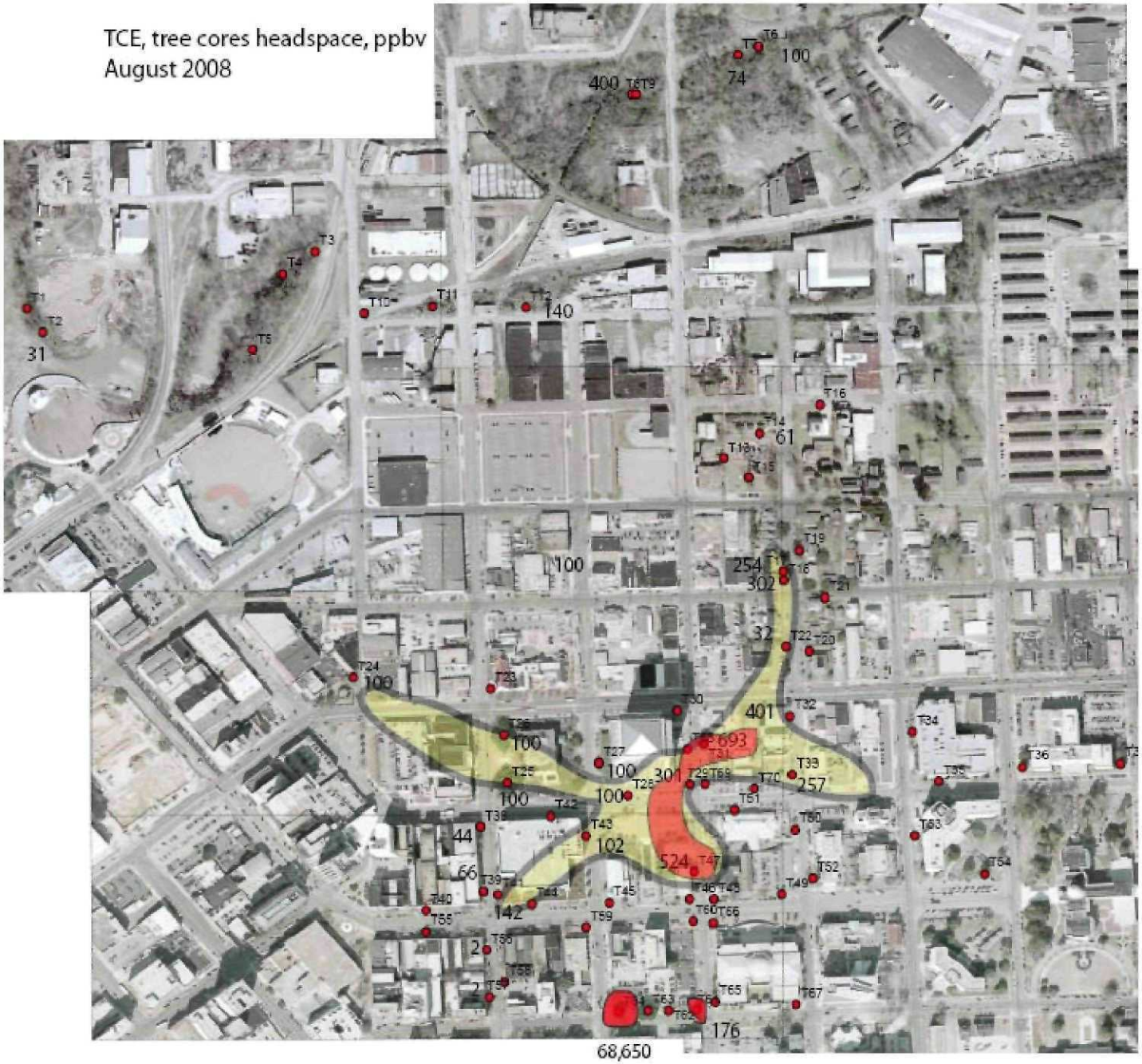
The PTW data:

What do they reveal about possible sources?

PCE, tree cores headspace, ppbv
August 2008



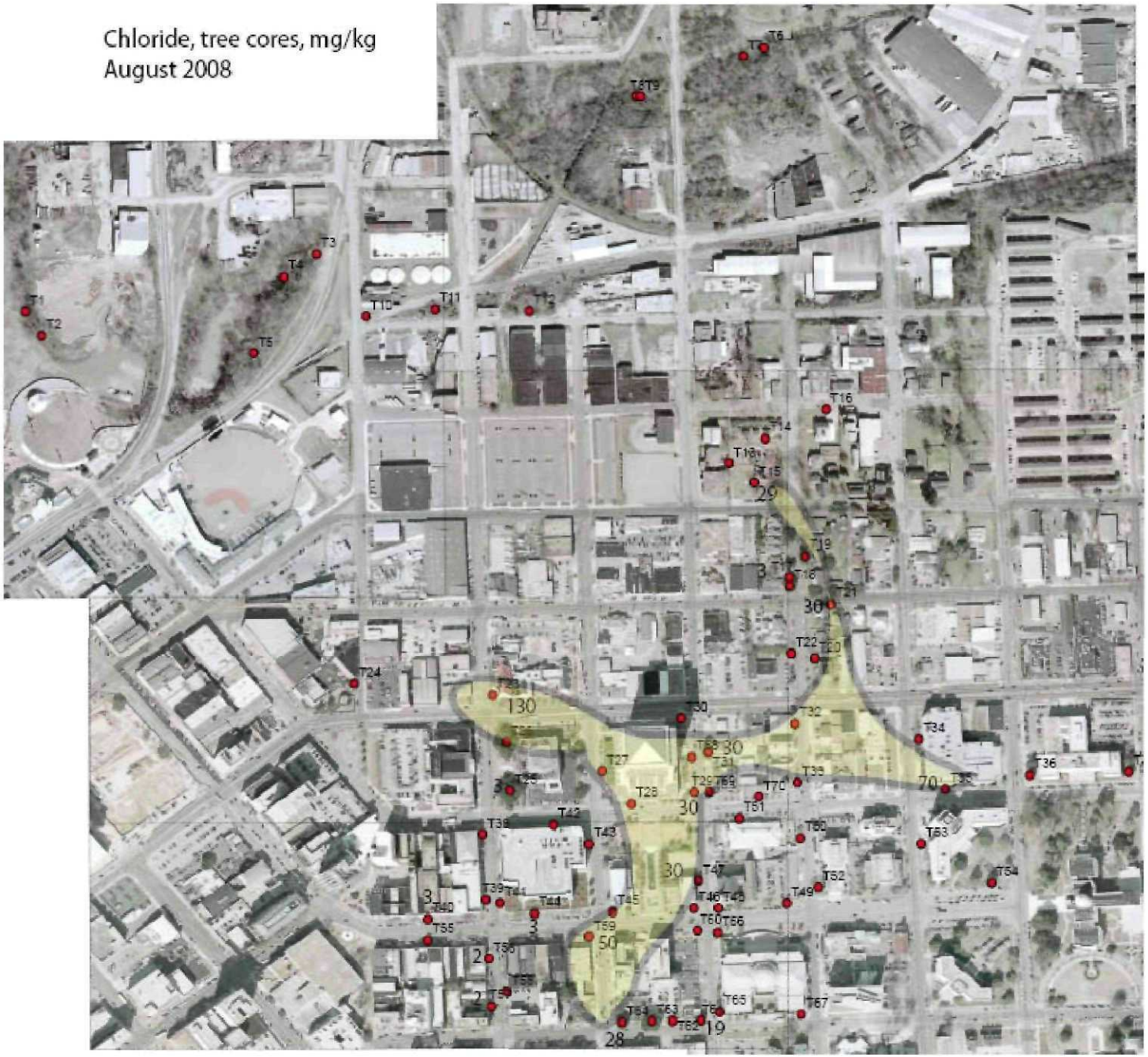

TCE, tree cores headspace, ppbv
August 2008
400
74
100
140
31
61
100
254
302
32
100
401
2693
100
100
100
257
44
102
524
66
142
2
68,650
176


TCE, tree cores headspace, ppbv
August 2008
400
74
100
140
31
61
100
254
302
32
100
401
693
301
257
100
100
100
44
102
524
66
142
2
2
176
68,650

This detection of PCE and TCE in trees represents recently uptaken contaminants = still a source there

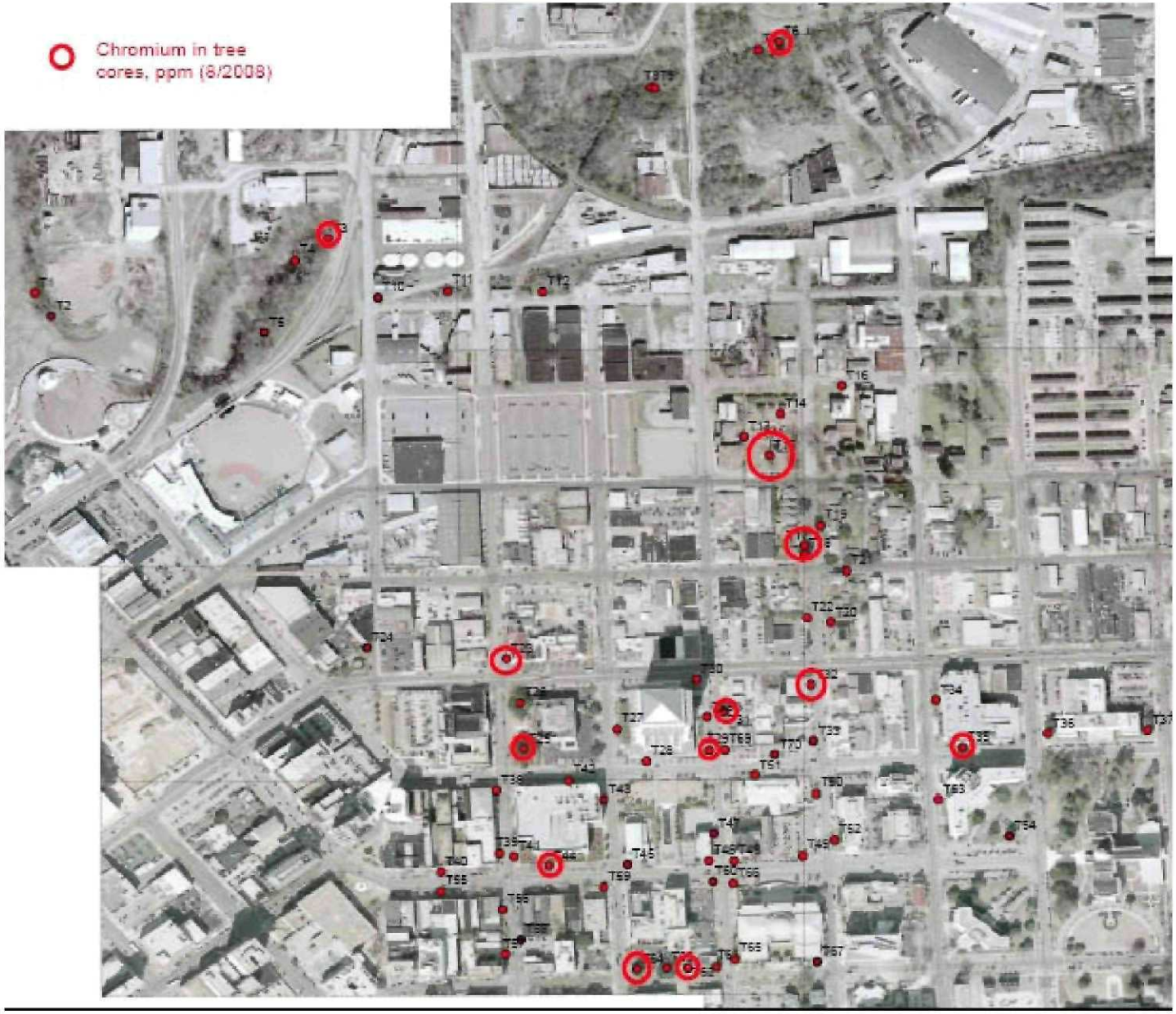
What about evidence for long-term uptake (and, therefore, an older source?)

Chloride, tree cores, mg/kg
August 2008



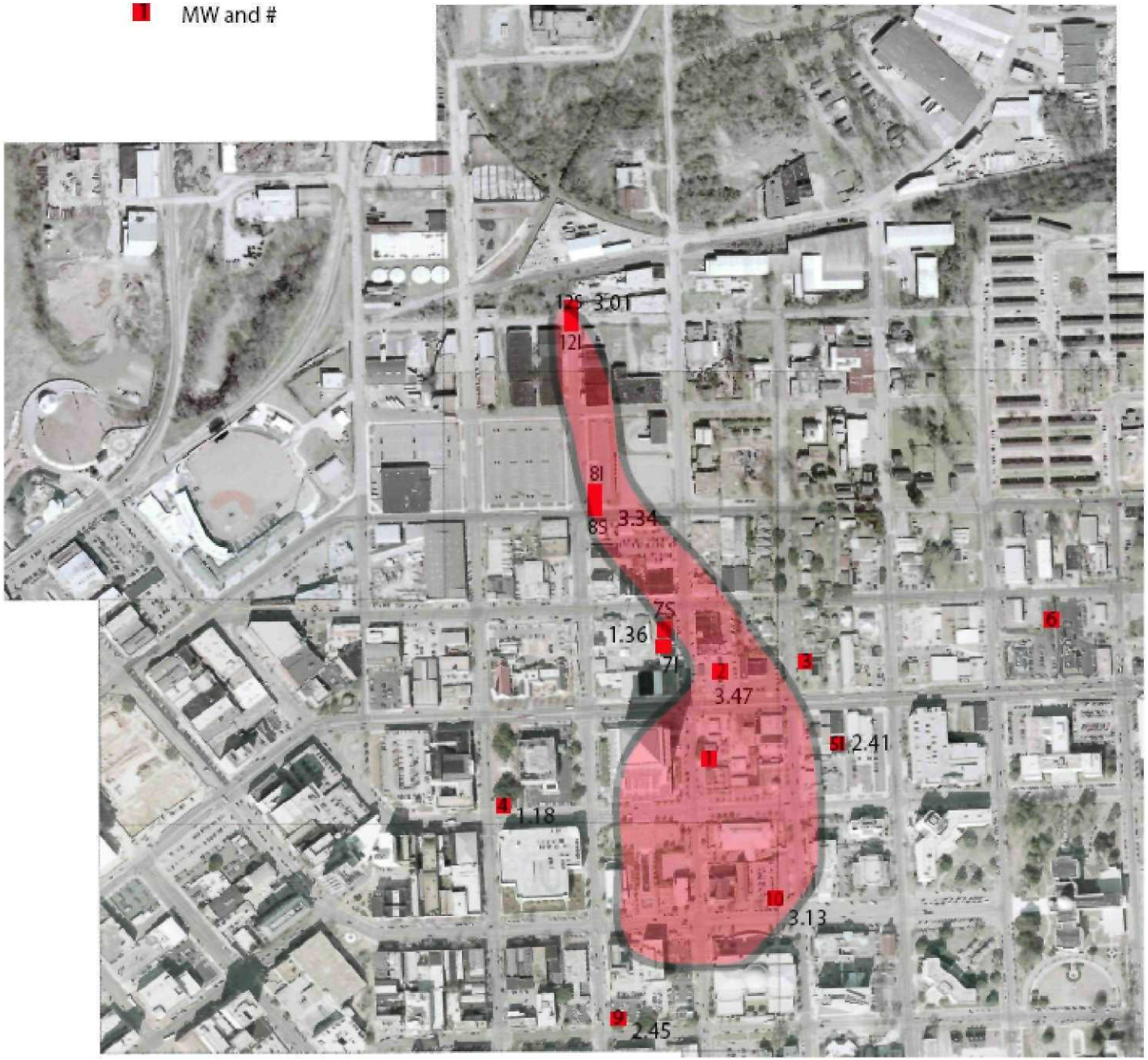
Chromium

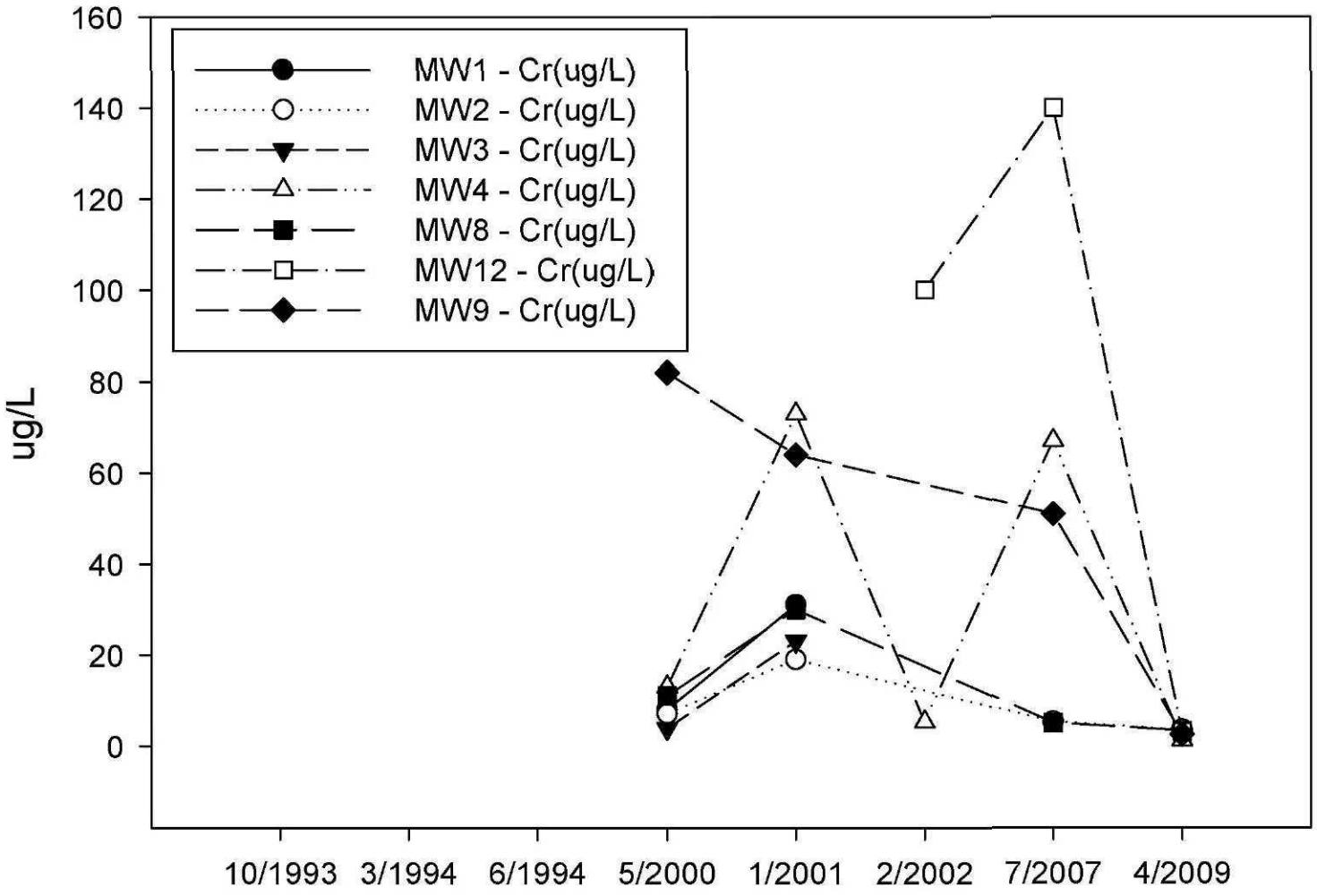
- Not measured as a vapor, like PCE and TCE can be
- Hence, detection provides a direct linkage between soil water or groundwater and tree


Chromium in tree cores, ppm (6/2008)

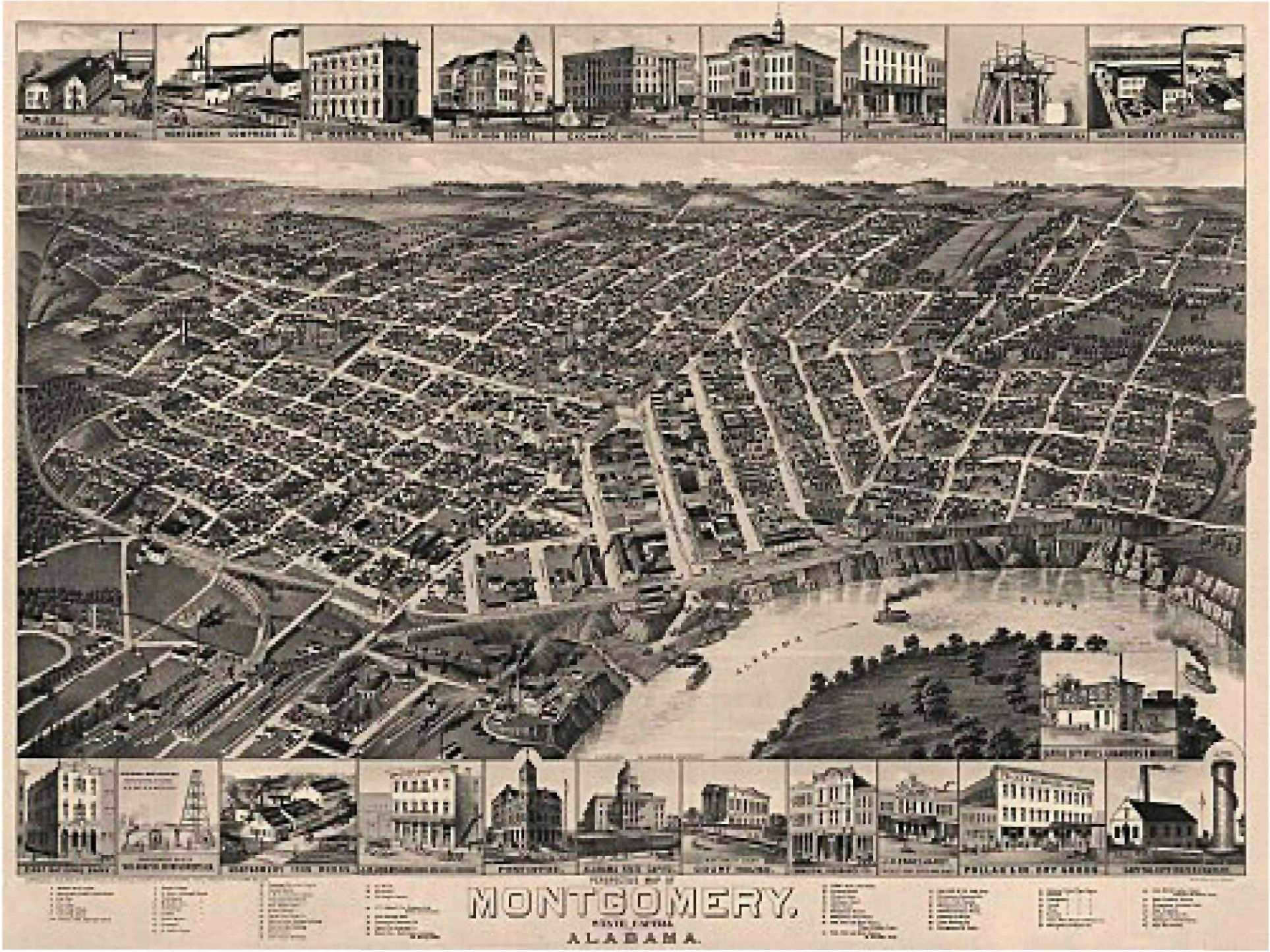
Chromium, Groundwater Results, ug/L
4/2009

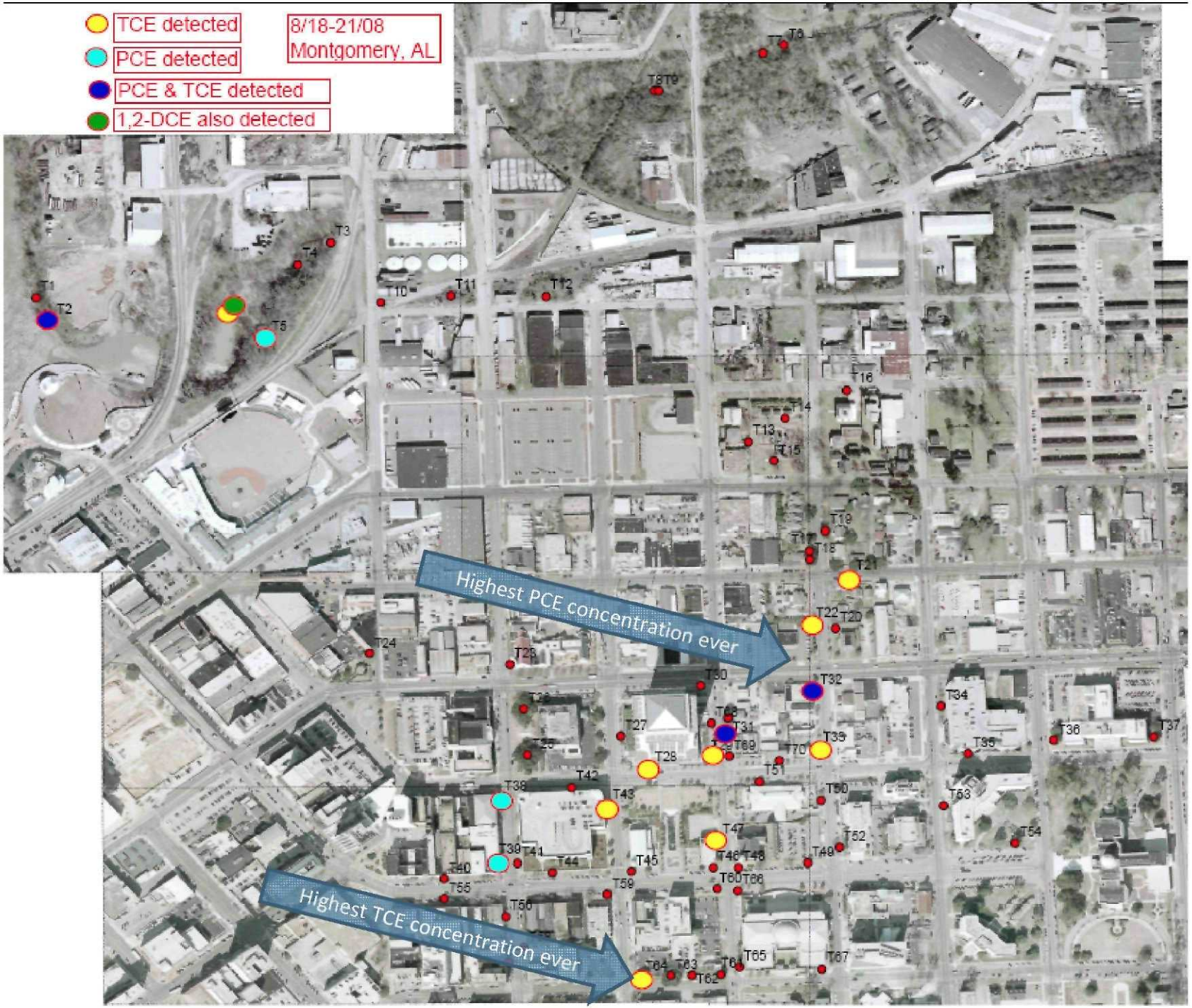
MW and #



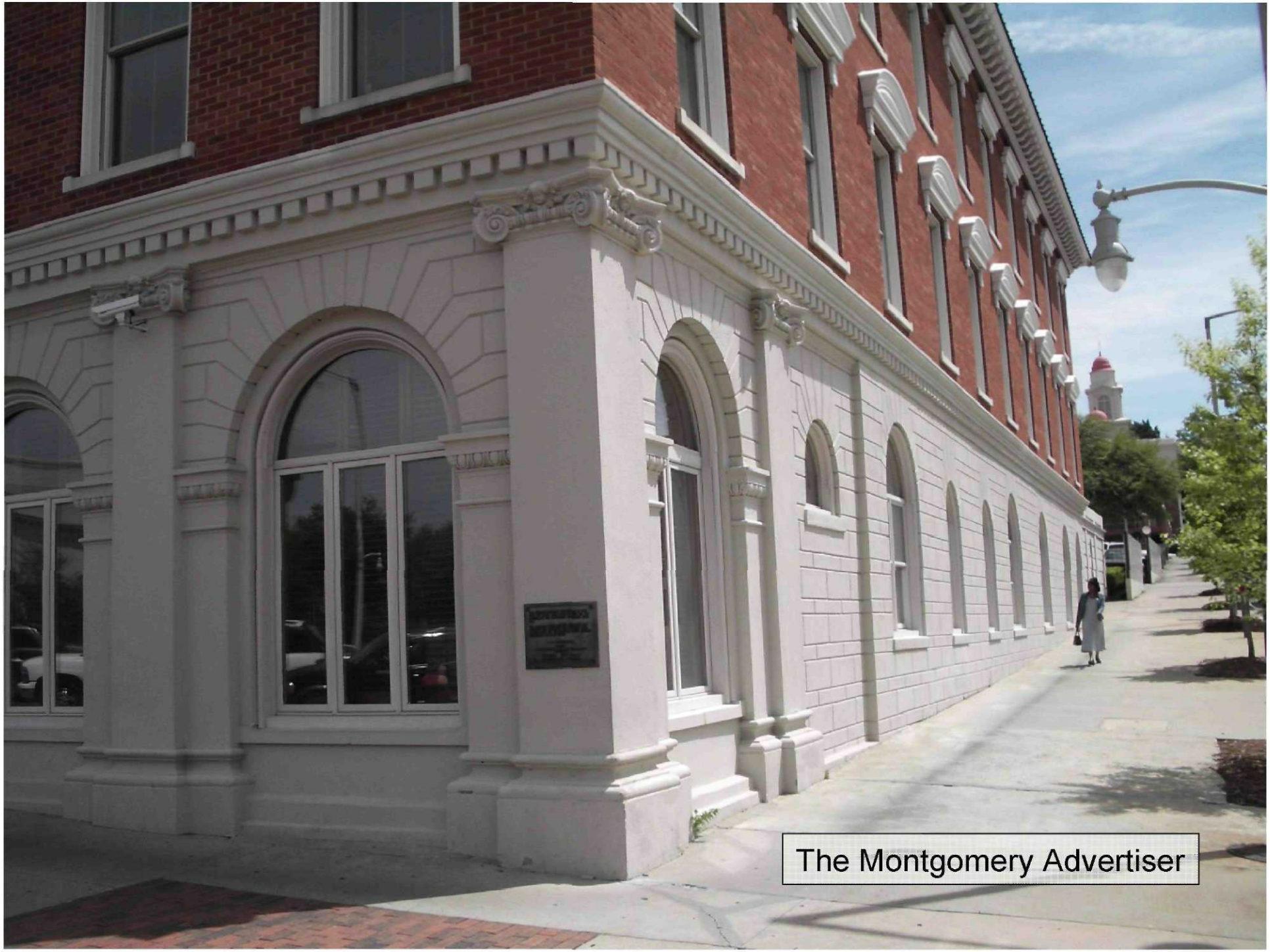

Chromium, total, ug/L, groundwater (CCP)
ug/L
160
140
120
100
80
60
40
20
0
MW1 - Cr(ug/L)
MW2 - Cr(ug/L)
MW3 - Cr(ug/L)
MW4 - Cr(ug/L)
MW8 - Cr(ug/L)
MW12 - Cr(ug/L)
MW9 - Cr(ug/L)
10/1993
3/1994
6/1994
5/2000
1/2001
2/2002
7/2007
4/2009

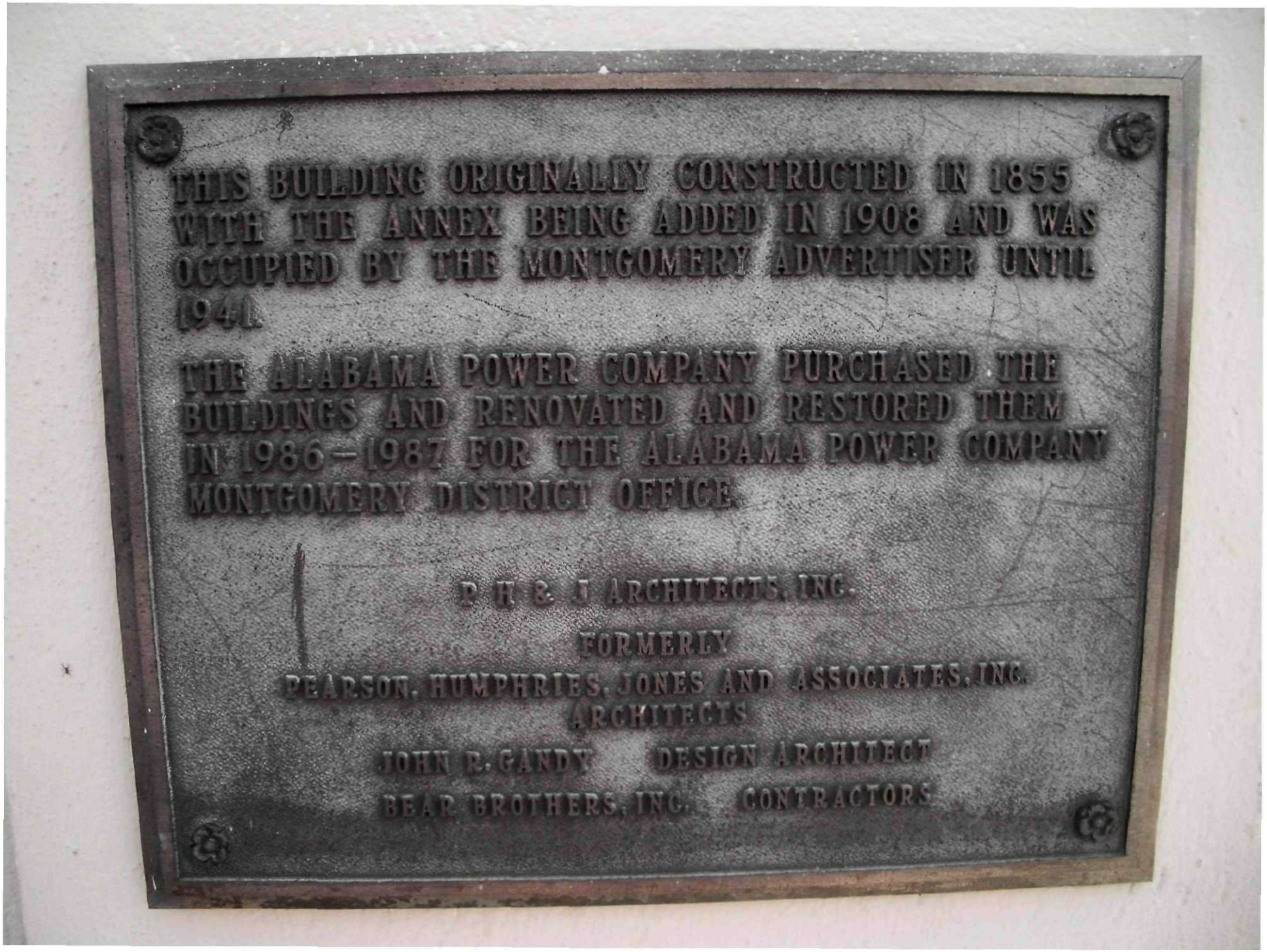
So, what does the combination of the PTW survey and groundwater sampling say about potential source locations?


CITY HALL
MONTGOMERY.
STATE CAPITAL
ALABAMA.


TCE detected
PCE detected
PCE & TCE detected
1,2-DCE also detected
8/18-21/08
Montgomery, AL
Highest PCE concentration ever
Highest TCE concentration ever


The Montgomery Advertiser
200 Washington Street


The Montgomery Advertiser


THIS BUILDING ORIGINALLY CONSTRUCTED IN 1855
WITH THE ANNEX BEING ADDED IN 1908 AND WAS
OCCUPIED BY THE MONTGOMERY ADVERTISER UNTIL
1941.
THE ALABAMA POWER COMPANY PURCHASED THE
BUILDINGS AND RENOVATED AND RESTORED THEM
IN 1986-1987 FOR THE ALABAMA POWER COMPANY
MONTGOMERY DISTRICT OFFICE.
P H & J ARCHITECTS, INC.
FORMERLY
PEARSON, HUMPHRIES, JONES AND ASSOCIATES, INC.
ARCHITECTS
JOHN R. GANDY DESIGN ARCHITECT
BEAR BROTHERS, INC. CONTRACTORS

Historically active potential source

- Montgomery Advertiser (1833-today)
- Inks (metals, solvents)
- Cleaning solvents (PCE/TCE)to de-ink printing machines
- Fountain solutions contain chromates
- Multiple locations within CCP boundary
- Anecdotal evidence
- Possession is 95% of conviction

Timeline of Montgomery Newspaper Manufacturing Print Industry

- 1829 The Planter's Gazette
- 1833 The Montgomery Advertiser (MA) aka Advertiser
- 1850 MA at Commerce Street (until 1930)
- 1855 MA at Dexter Ave.
- 1940 MA purchases Alabama Journal (1889-1940)
- 1940 MA at 200 Washington Ave.
- 1997 MA printing stops at 200 Washington Ave.
- 2002 MA at 425 Moulton St.
- 2003 MA sells 200 Washington/115 and 116 S. McDonough St. to Montgomery County Commission

Timeline of Montgomery Newspaper Manufacturing Print Industry

- 1829 The Planter's Gazette
- 1833 The Montgomery Advertiser (MA) aka Advertiser
- 1850 MA at Commerce Street (until 1930)
- 1855 MA at Dexter Ave.
- 1940 Operated 8-unit Goss headliner **letterpress**
  Made zinc-plates on-site
- 1970 Made aluminum plates on-site
- 1977 Operated 9-unit lithographic **offset press**
  (Ink and water mixture)
- 1997 MA printing stops at 200 Washington Ave.

Timeline of Montgomery Newspaper Manufacturing Print Industry

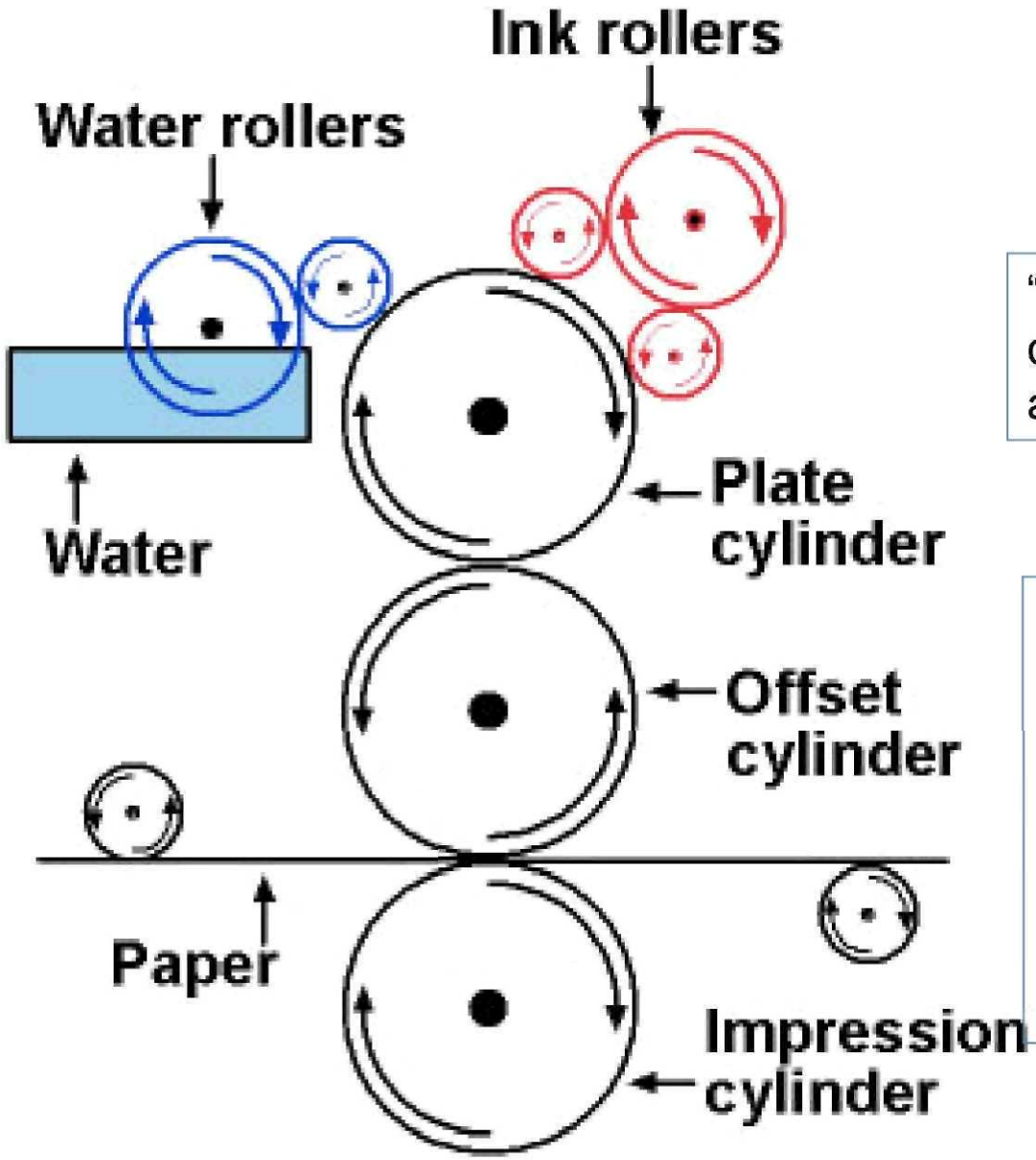
- 1821 PCE first synthesized
- 1829 Petroleum-based inks
- 1833 Petroleum-based inks
- 1850 Petroleum-based inks
- 1855 Petroleum-based inks
- 1920 TCE invented
- 1940 Petroleum-based inks
- 1950-60s NMPI switched from flammable alcohols to non-flammable chlorinated solvents (PCE and TCE) to decrease drying times
- 1970 First sewage treatment plant built in Montgomery (Econchate WWTP)
- 1990s Soy-based inks

The NMPI is one of the largest industries in the U.S.

www.pneac.org

(Printers' National Environmental Assistance Center)

Offset Press



Where did this water go?

"fountain solution" consisted of acid chromates

Rubber "blanket" Wiped down with Rags soaked in Blanket wash

Cleaned at end of each shift with solvent

Blanket wash

1) Toluene
2) Methyl Ethyl Ketone (MEK)
3) Glycol Ethers
4) Xylene (mixed isomers)
5) Tetrachloroethylene
6) Methyl Isobutyl Ketone (MIBK)
7) Methanol
8) 1,1,1-Trichloroethane (TCA)
9) Dichloromethane
10) Ethylene Glycol

Inks are derived from heavy metals

- Cyano = barium
- Magenta (blue) = copper
- Yellow = zinc or chromium
- Black = most metals, carbon black (soot)

- School buses are ‘chrome yellow’

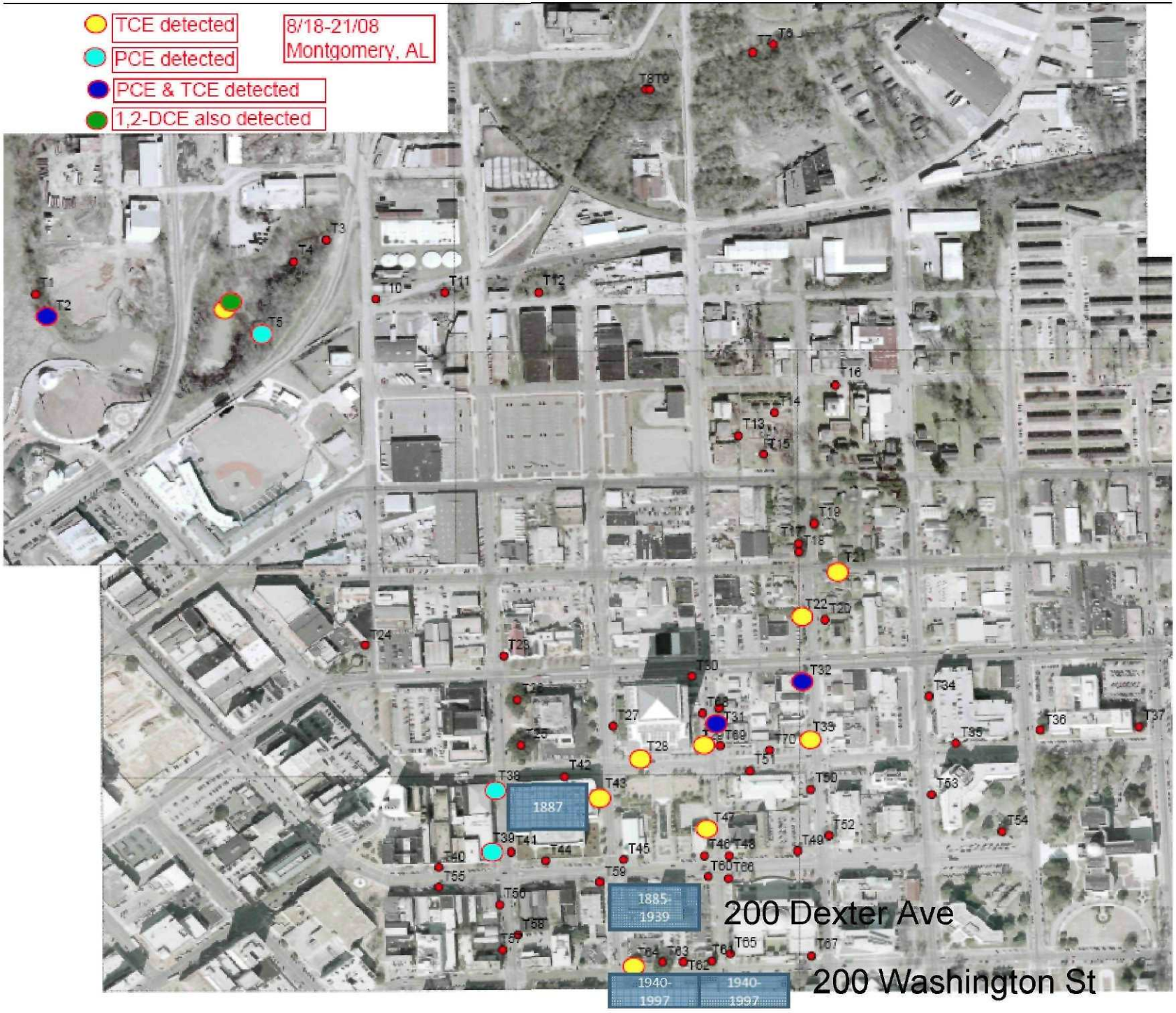
Think of Oil/watercolor paint kits

- Cadmium lemon
- Cadmium red
- Cobalt violet
- Manganese violet
- White lead
- Titanium white

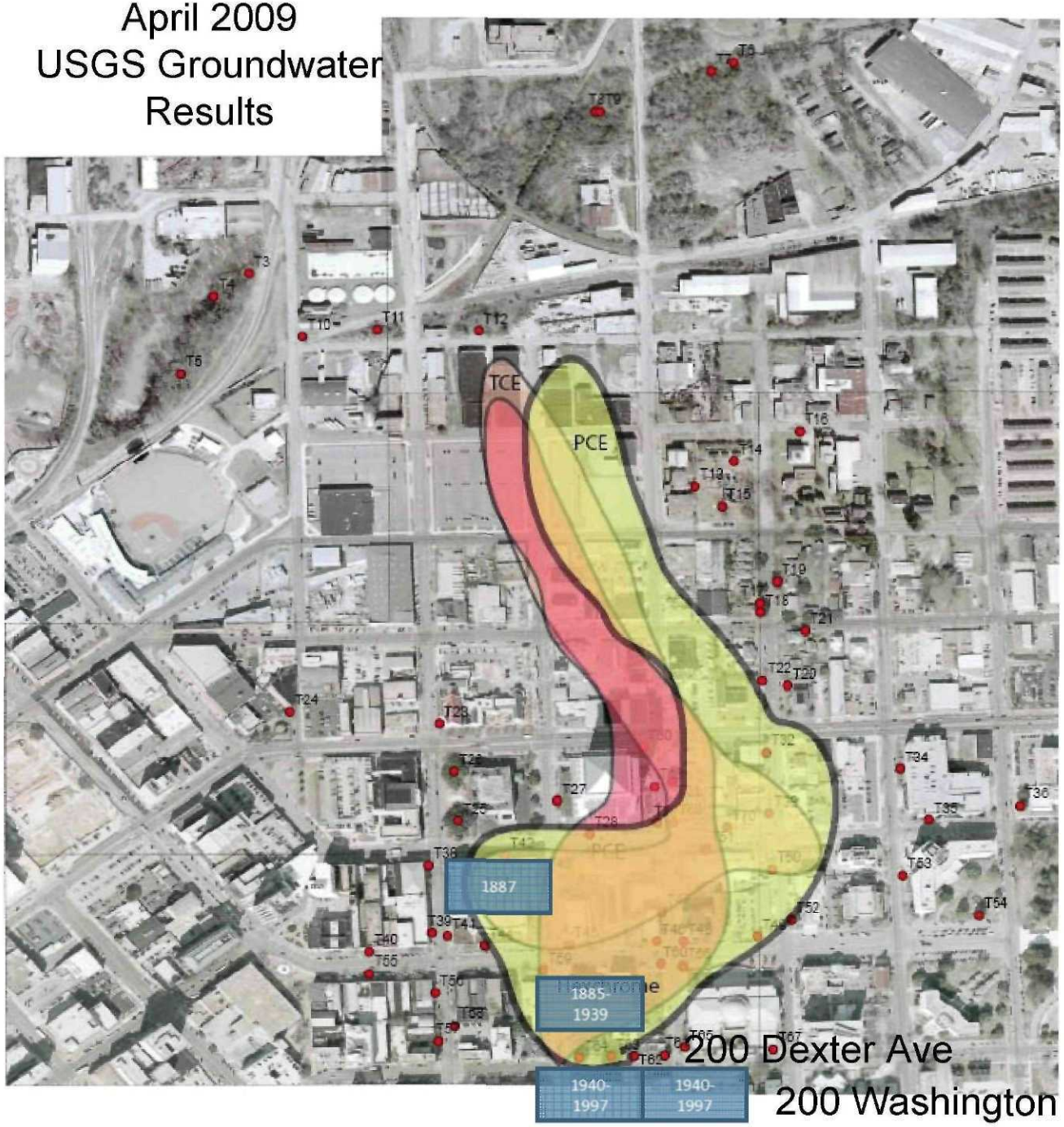
What would they do with all the daily “trade wastes” generated?

How do the various historic locations of the MA relate to the data collected?:

- The PTW results for PCE and TCE and metals
- Past and current PCE and TCE plumes in groundwater


TCE detected
PCE detected
PCE & TCE detected
1,2-DCE also detected
8/18-21/08
Montgomery, AL
1887
1885-1939
1940-1997
1940-1997
200 Dexter Ave
200 Washington St

April 2009 USGS Groundwater Results



So, how are these upgradient sources of PCE and TCE related to the PCE and TCE groundwater contamination beneath the RSA chiller plant?

Remember - RSA chiller plant:

- No soil contamination down to about 25' bls, or near water table
- When ADEM sampled in September 1993, water table was at seasonal lows

Responses to EPA Information Request:

- *"…employees installed a washing machine in the basement to wash rags. The drain from the washing machine was connected to a basement-level floor drain which was believed to discharge to the sanitary sewer system. When the machine was used for the first time in quickly became apparent that the floor drain was connected to the pipe leading to the street. The material released most likely consisted of water, soap, and trace residues of ink and blanket wash."*

(dates post 1940 but pre 1980s)

Responses to EPA Information Request:

- *"some of the buildings floor drains, namely those in the pre-press area, drained to two sump pumps that were connected to the sanitary sewer system."*
- *At 116 McDounough Street, used "about 100 pounds of ink a year, and perhaps 10 gallons of cleaning solvent."*
- *"Any waste fountain solution removed from the presses was drained down a sink."*
- *"…the used (plate) developer was drained directly into a sink."*

Two proposed pathways:

- PCE and TCE released upgradient to the subsurface via sewer system as part of trade waste practices
- PCE and TCE released to surface and stormwater system as part of trade waste practices

- Both systems are historic, with brick construction and/or clay pipes
- Prone to leaks due to cracks, settling, tree root invasion

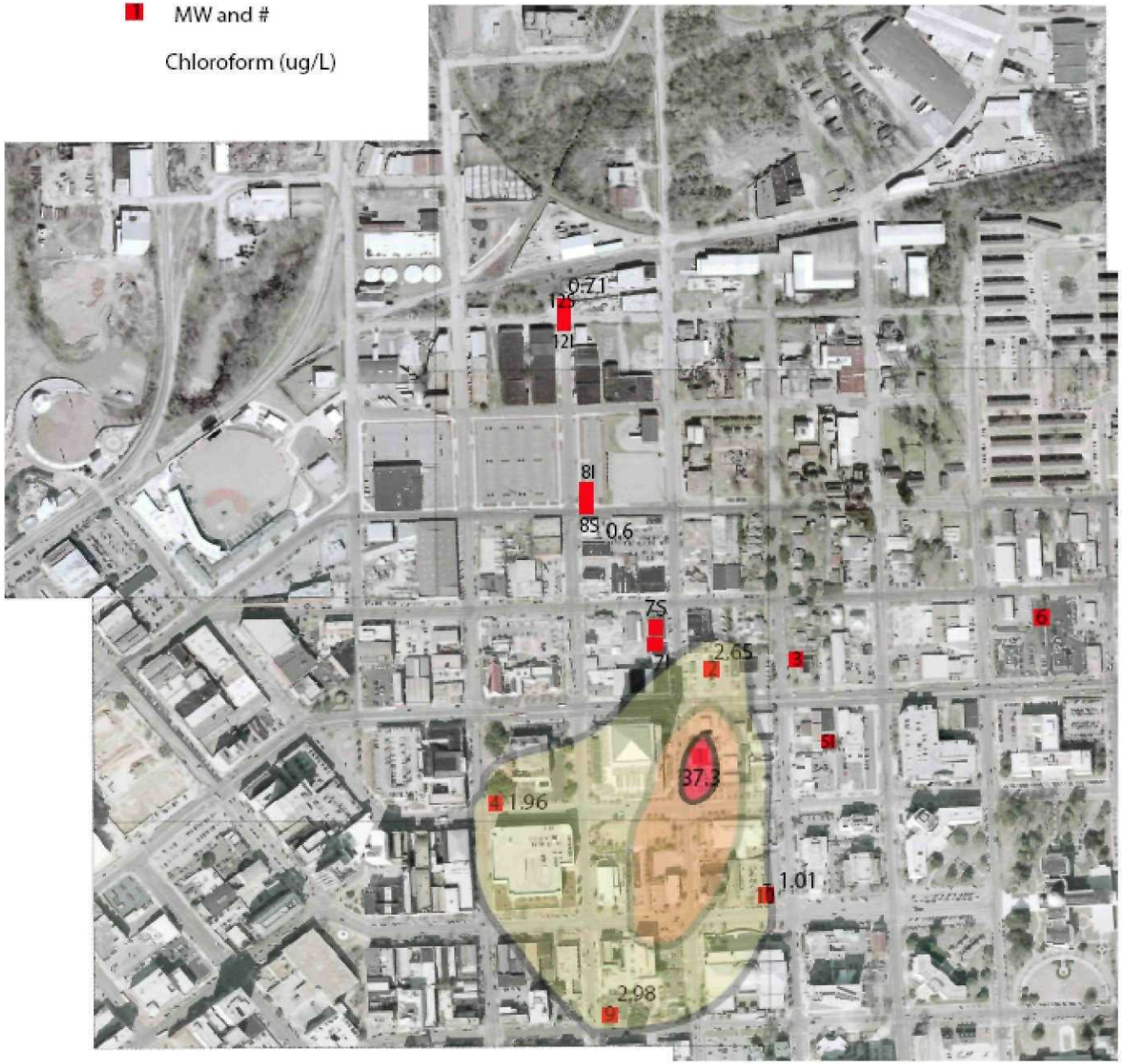
How can these pathways be tested?

Geochemical forensics

April 2009 Groundwater Results

MW and #

Chloroform (ug/L)



Chloroform in groundwater

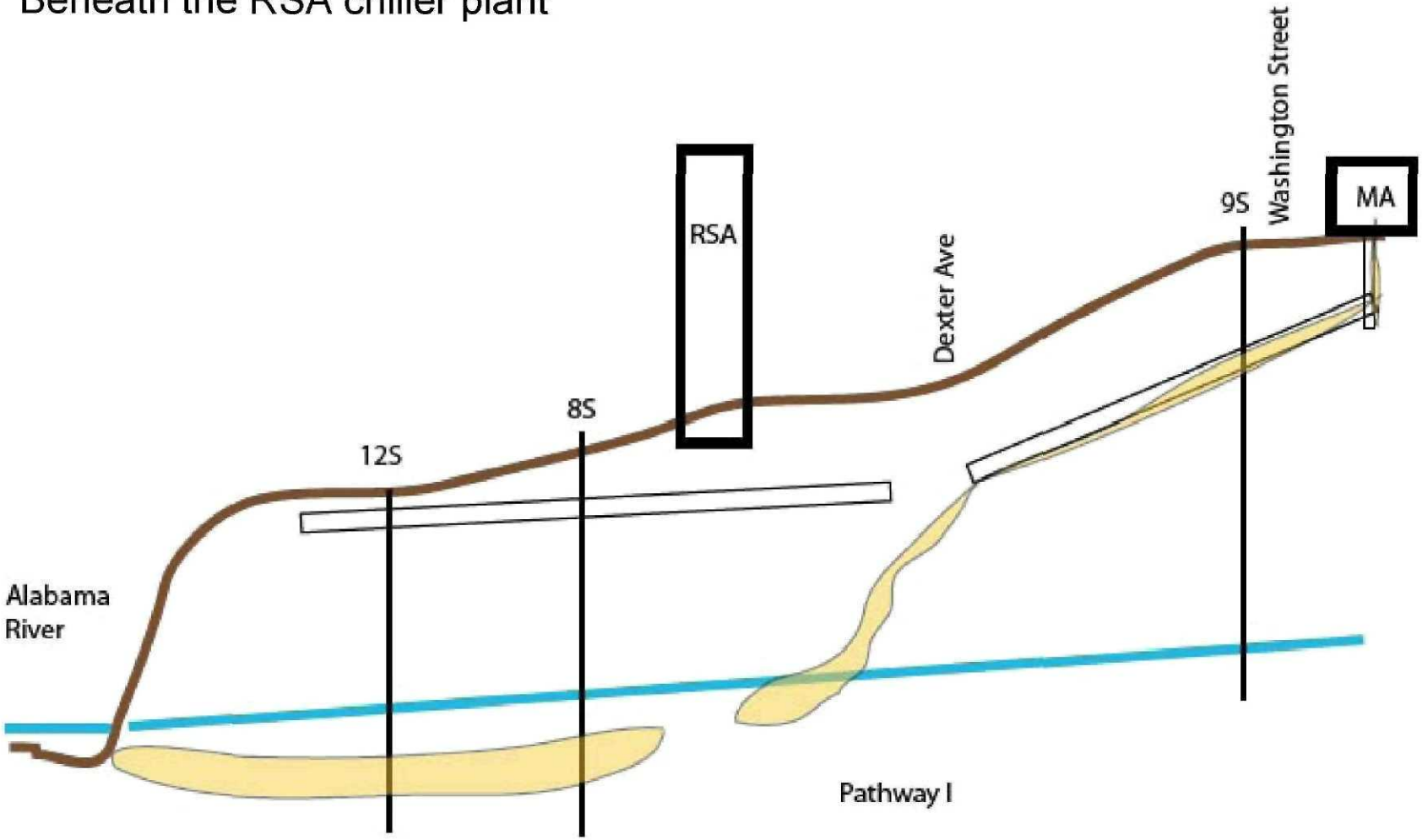
- Chloroform added to water at the C.T. Perry Water Purification Plant since at least 1965 (surface water source mixed with groundwater)
- Range in drinking water from 2 to 44 ug/L
- 37.3 ug/L in groundwater from MW1 (shallow only) = treated municipal water
- pH in MW1 (shallow) is highest of all wells sampled at 7.3 (buffered municipal water)
- Well had highest specific conductance at 261 uS/cm

Chloroform in groundwater

- How did treated municipal water that contained chloroform get to the water table beneath the RSA chiller plant?
- Trade waste practice and leak in sewer system
- Implication – what has been put into the sewer in upgradient area also can reach the water table
- Where is the leak????


SW1/4 SEC.07 T16N R18E 6807-3 103
SEE SHEET 102
JEFFERSON STREET
MADISON AVENUE
MONROE AVENUE
LOT A
THE MADISON MOTEL
1-A
1-B
2.9% slope
4.2% slope
7% slope
8% slope
3.8% slope
9.6 % slope
11.8% slope
16.8% slope
21.3% slope
8.2% slope
6.3% slope
12% slope
12.7% slope
STATE CAPITOL
HALL STREET
DEXTER AVENUE
ADAMS AVENUE
LOVE STREET
ALABAMA STREET
SEE SHEET 115
SEE SHEET 104
103
07683
March 2005

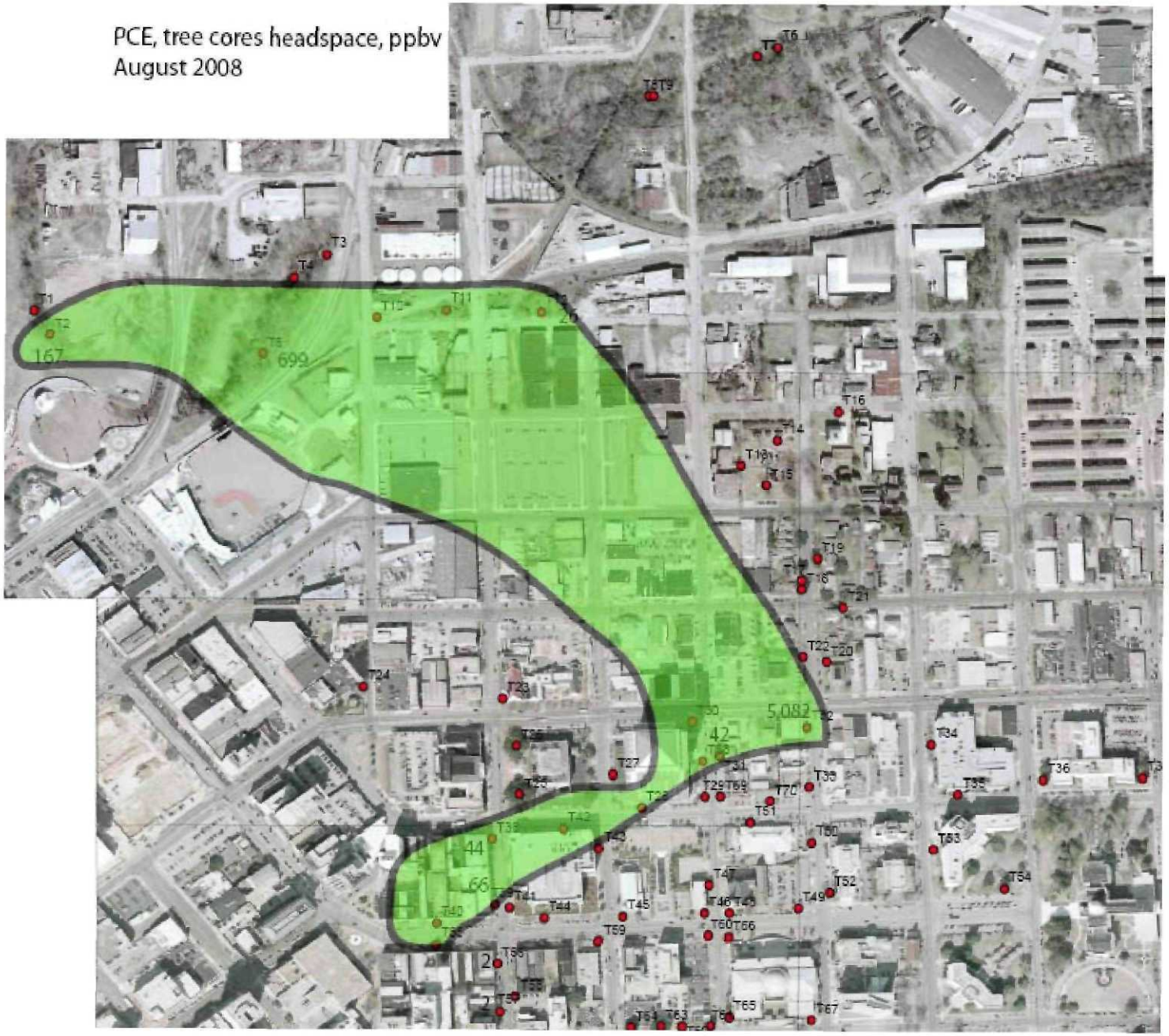
How PCE, TCE, and chloroform got into the groundwater
Beneath the RSA chiller plant

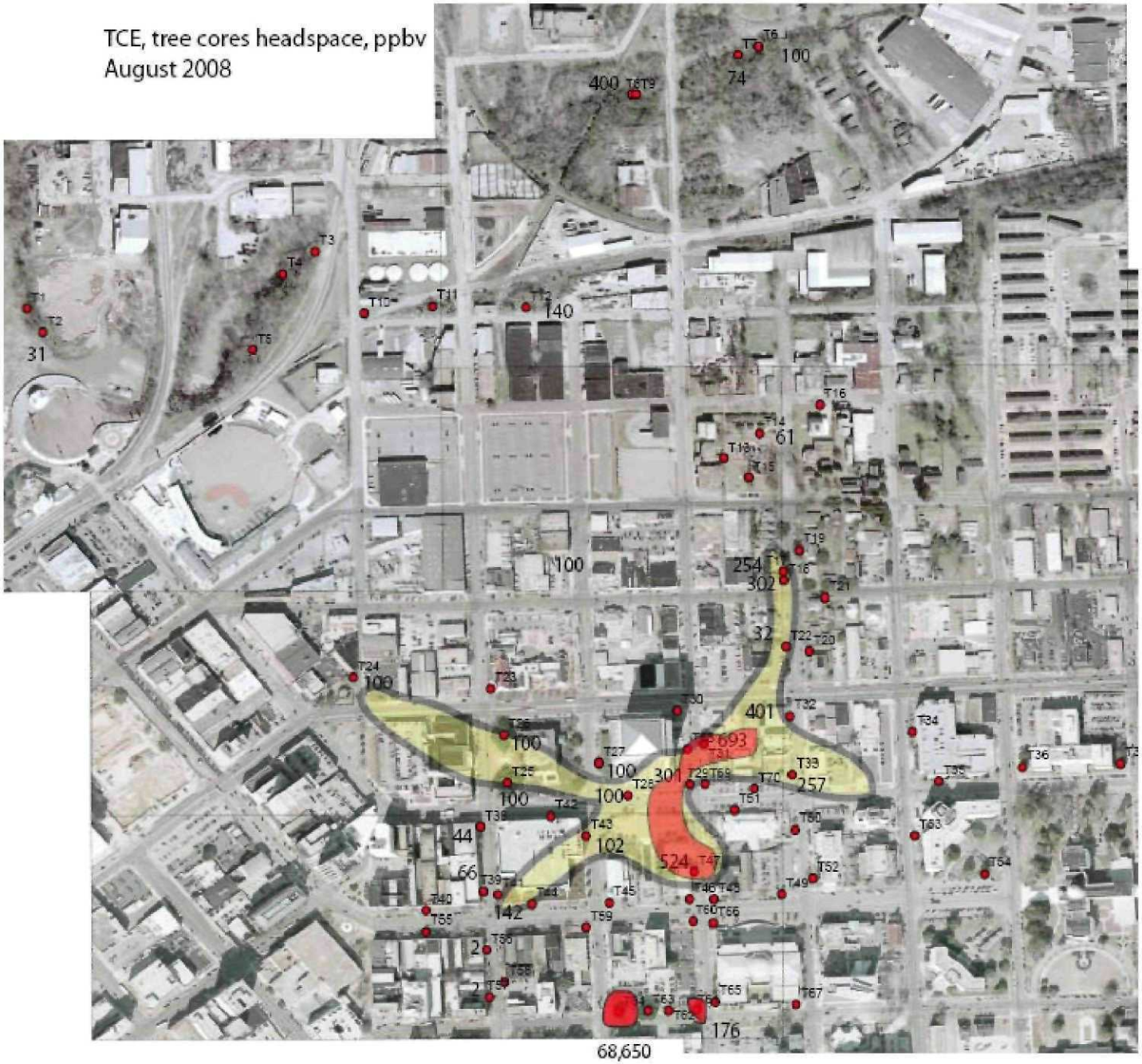


Also, in the trees sampled:

- No VOC hits in the trees along McDonough Street
- T-61
- T-65
- T-60
- etc

PCE, tree cores headspace, ppbv
August 2008



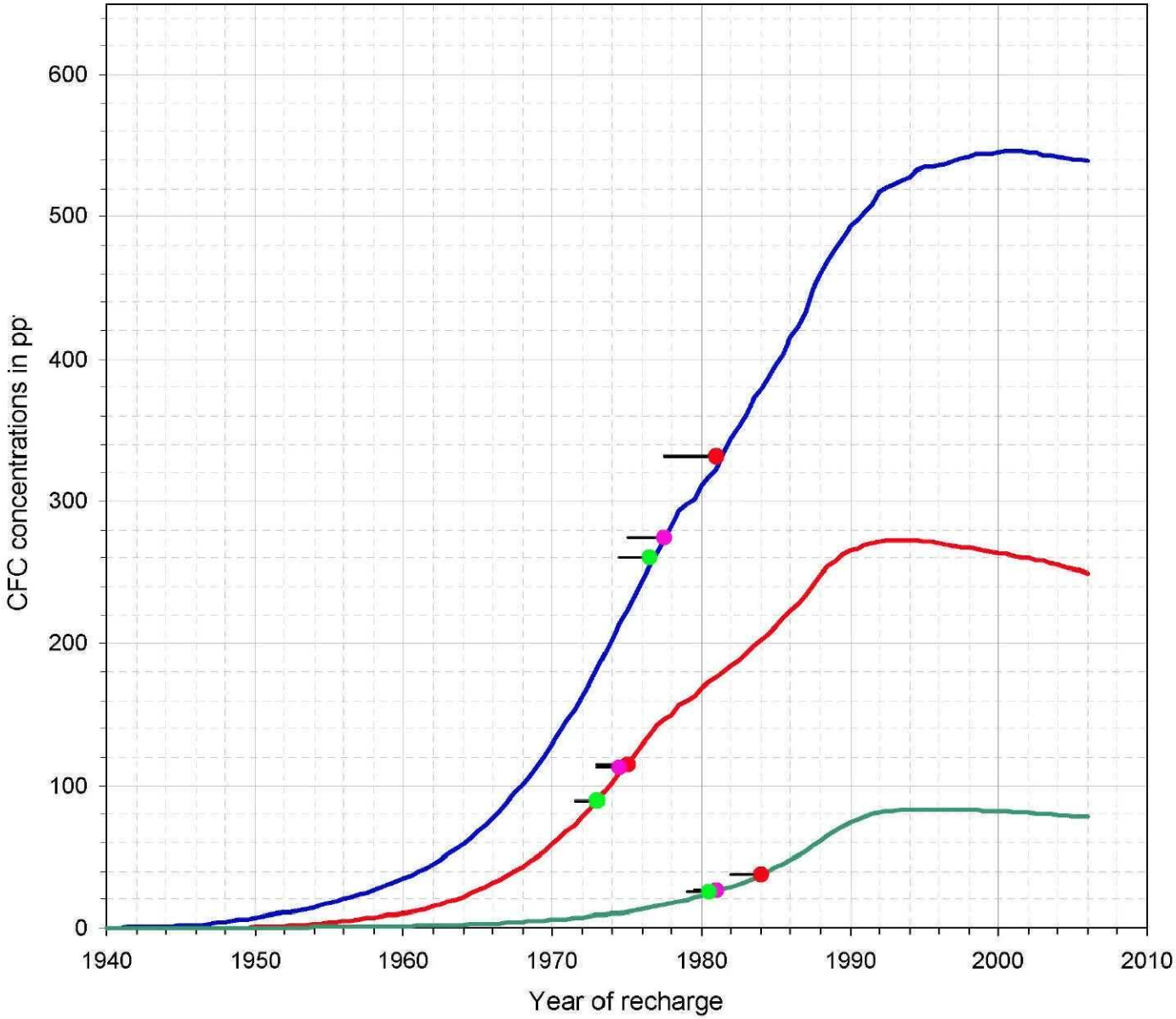

TCE, tree cores headspace, ppbv
August 2008
400
74
100
140
31
61
100
254
302
32
100
401
693
301
257
100
100
100
44
102
524
66
142
2
2
176
68,650

How can these pathways be tested?

Geochemical forensics

CFCs in groundwater

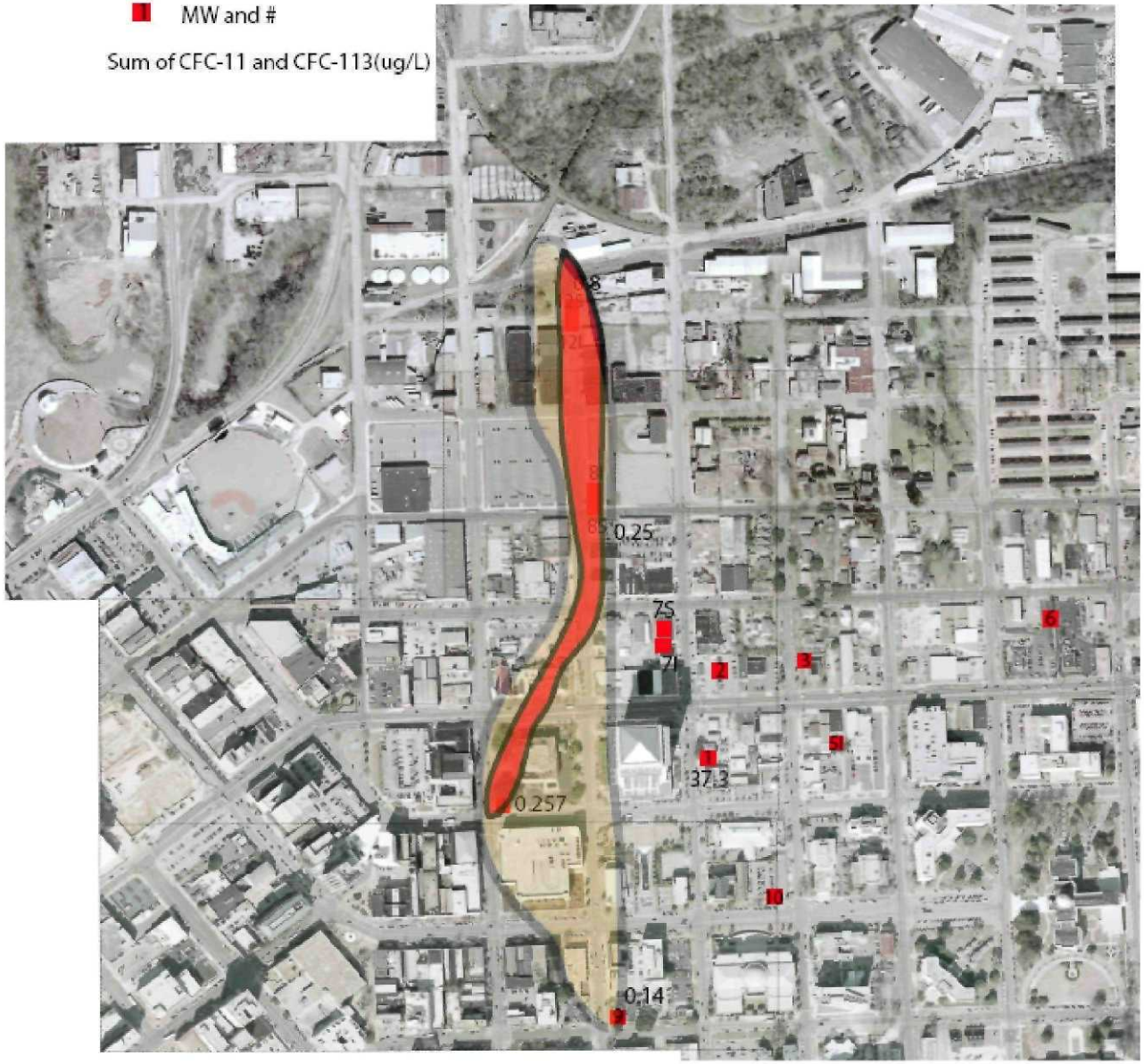
- CFC (-11 and -113) are man-made
- All water older than 1940 has 0 ug/L CFCs
- If detected in water, it is no older than 1940
- CFC are in recharge everywhere
- CFCs are enriched over urban areas (USGS Fact Sheet 022-02)


CFC concentrations in pp
600
500
400
300
200
100
0
1940
1950
1960
1970
1980
1990
2000
2010
Year of recharge

April 2009 Groundwater Results

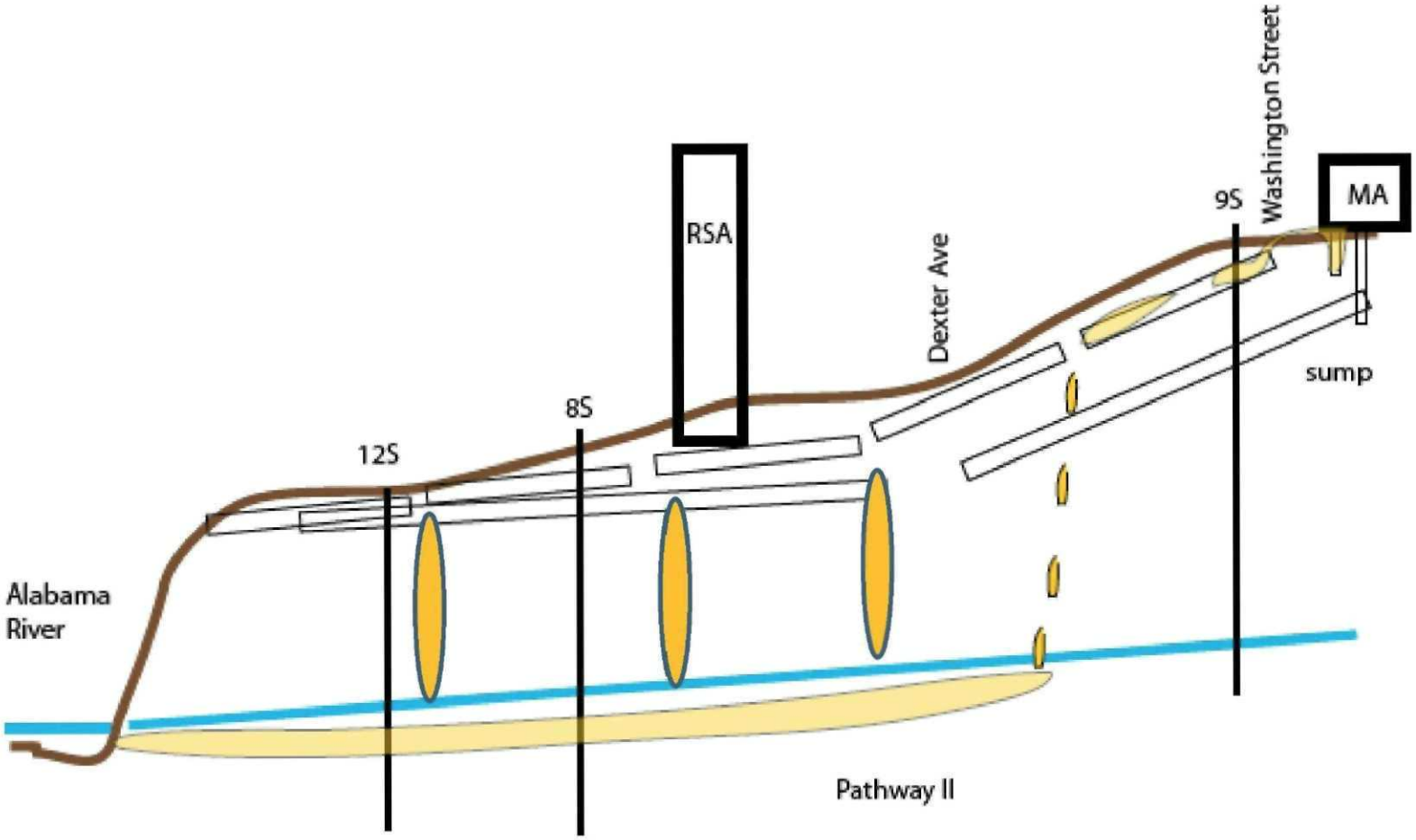
MW and #

Sum of CFC-11 and CFC-113(ug/L)



CFCs in groundwater- implications

- Present in only the **shallow** well pairs
- Not present in all wells
- In groundwater at concentrations greater than possible for equilibrium with CFC-enriched air
- Implication – CFC-enriched water is evidence of leaky stormwater or sewer pipes that contain modern water that has reached the water table since at least 1940


Washington Street
MA
9S
RSA
Dexter Ave
sump
8S
12S
Alabama
River
Pathway II

So the Chloroform and CFC detections in groundwater at the CCP:

- Are tracers of modern water
- Reveals persistent long-term leakage of modern municipal water at some focused "hot spots"
- Indicate that what is applied at land surface WILL get to the groundwater

Do these pathways pass basic groundwater hydrology and contaminant transport ‘common sense’?

Table 4-11
Groundwater Velocity Calculation Summary
Capitol City Plume, Montgomery, Alabama

Hydraulic Conductivity (K)		Hydraulic Gradient (i)[1]		Assumed Effective Porosity (n)[2,3]	min/year	Calculated Horizontal Groundwater Velocity (V_h)[4]
Shallow Wells						
High	7.22×10^{-3}	High	1.38×10^{-2}	25 %	525,600	2094
Low	8.16×10^{-4}	Low	8.33×10^{-3}	25 %	525,600	14.29
g.m.	4.45×10^{-3}	Median	1.12×10^{-2}	25 %	525,600	104
Deep Wells						
High	8.62×10^{-3}	High	1.28×10^{-2}	25 %	525,600	231
Low	5.51×10^{-4}	Low	7.93×10^{-3}	25 %	525,600	9.1
g.m.	2.48×10^{-3}	Median	1.17×10^{-2}	25 %	525,600	61

Notes.

1. Estimated from water levels measured on February 15, 2002.
2. Value listed is a percentage
3. Effective porosity has been assumed to be the lowest value in the range of total porosity per matrix in Groundwater, Freeze and Cherry, 1979. A significant underestimate or overestimate of "n" when the actual effective porosity is near 10 to 20% or less, will greatly effect the resulting V_h; however, if the effective porosity is higher, any underestimate or overestimate will be less significant to the resulting V_h
4. Darcy's Equation. $V_h = K/n$

Where

V_h = horizontal groundwater velocity, measured in foot/year
K = estimated hydraulic conductivity, measured in foot/minute
I = estimated hydraulic gradient, measured in feet/foot
N = assumed effective porosity of subsurface materials

g.m. geometric mean

Black & Veatch (2002)

$$V=LT$$

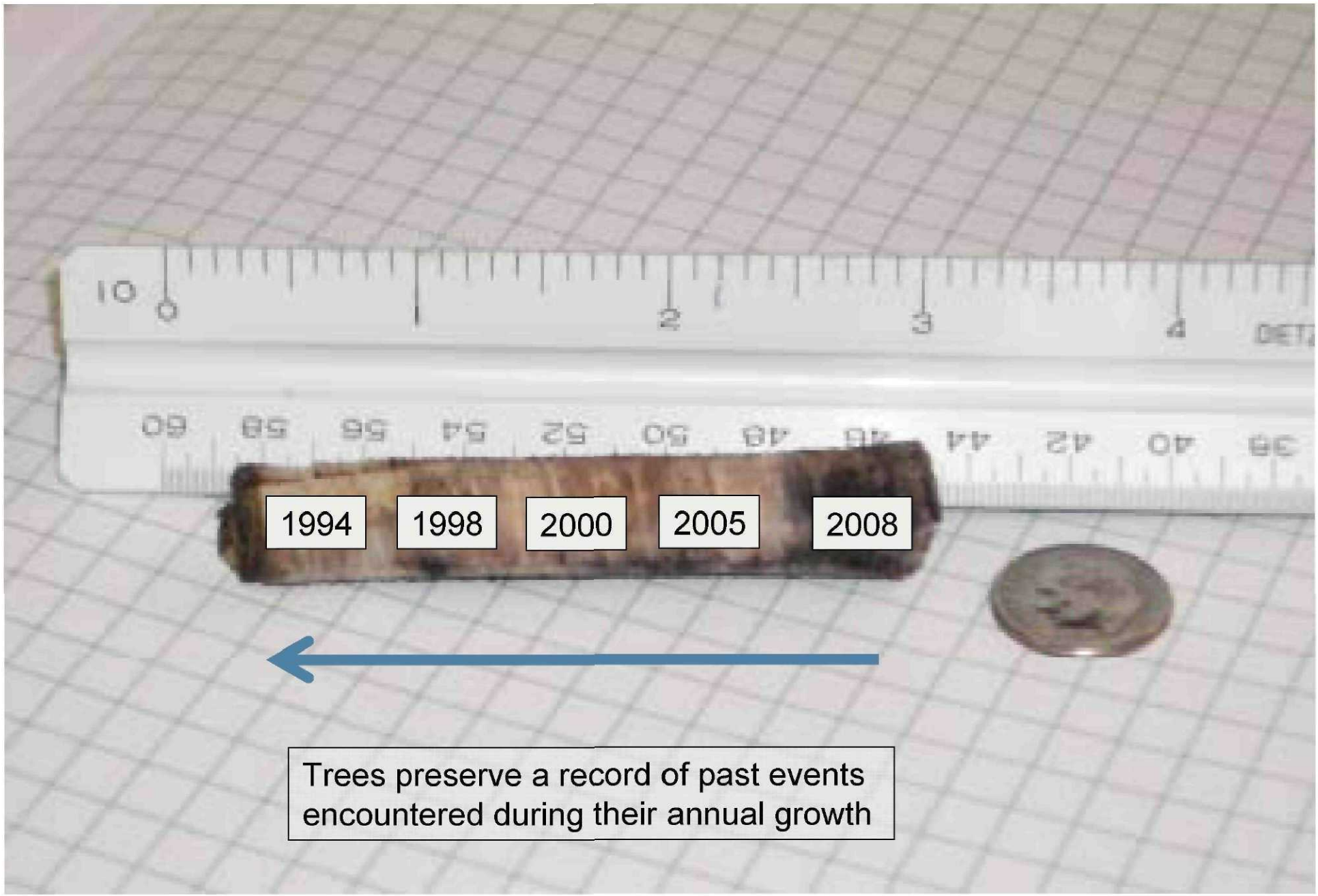
$$T=L/V$$

- Distance from Washington Street to Well 9W and 9E 4,200 ft
- MA left 200 Washington Street in 1997
- Groundwater flow rate about 100 ft/yr (B&V, 2003, RI)
- T= 4,200 ft/100ft/yr = about 42 years
- Potential release time:

1997-42 years = 1955

What about the timing of the release(s)?

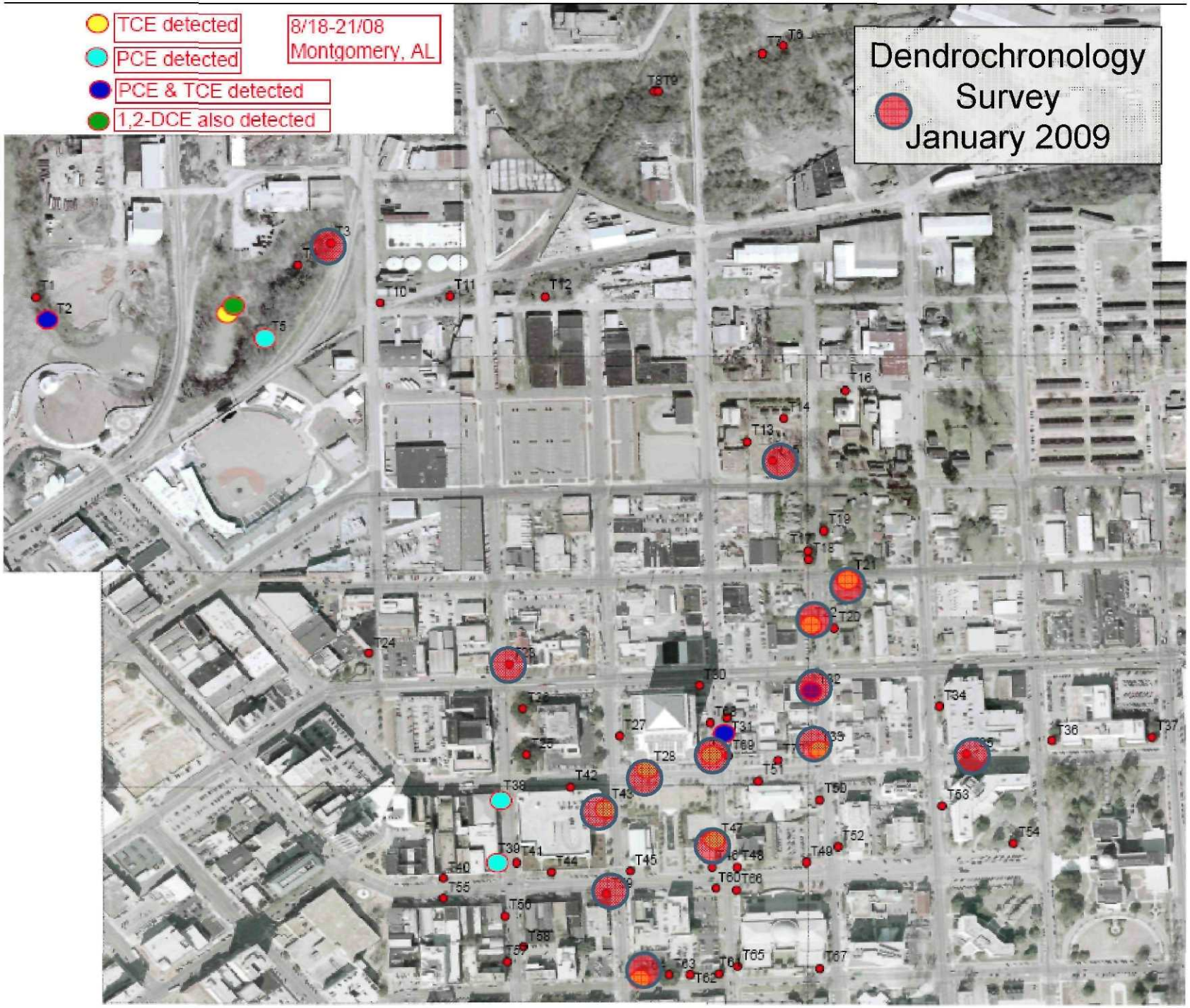
- Years businesses operated related to age of plume?


1994
1998
2000
2005
2008
Trees preserve a record of past events
encountered during their annual growth

Contaminants preserved?

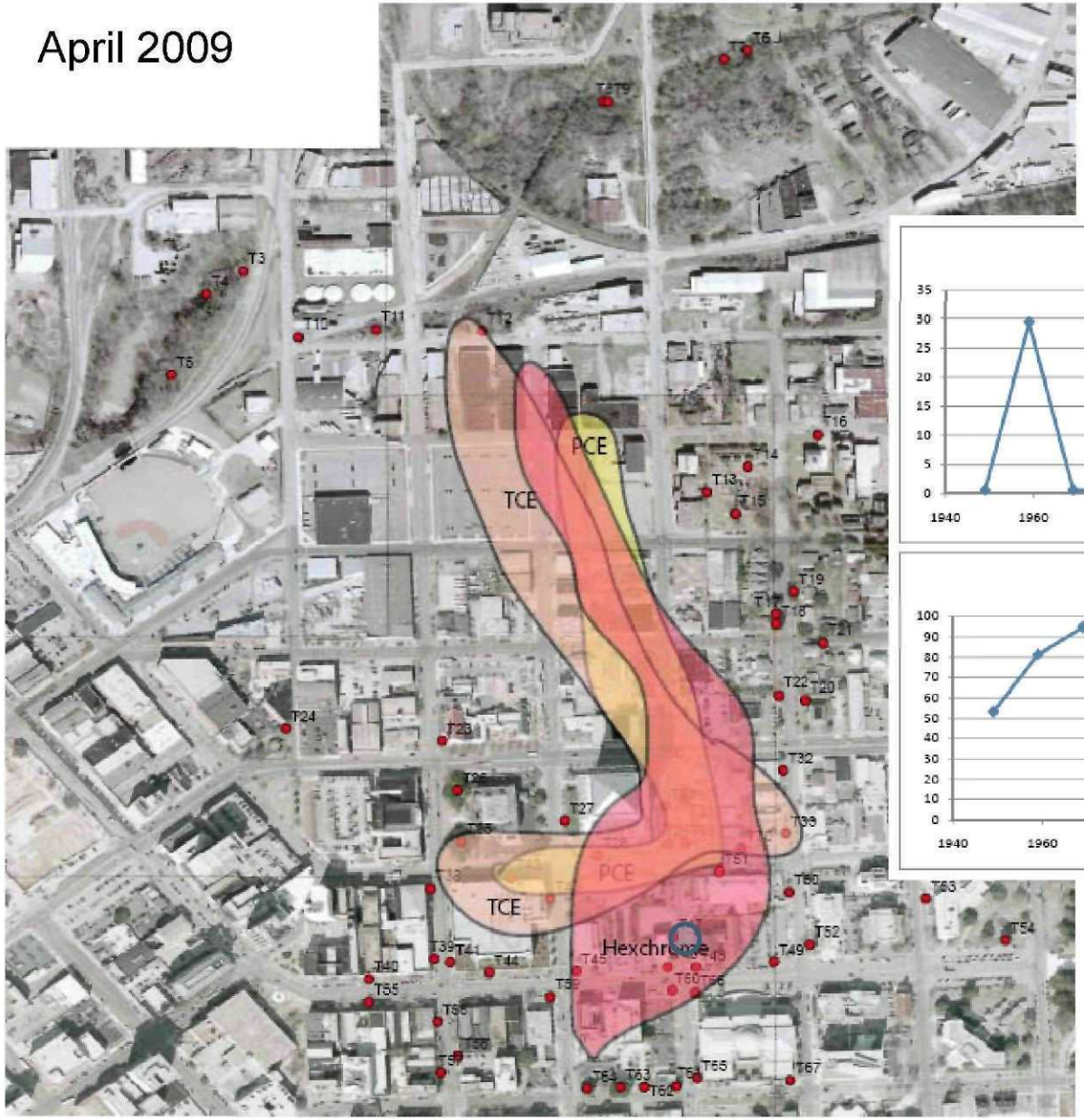
- Inorganics, yes
- Organics, no
- But
- PCE and TCE leave behind Cl-, yes

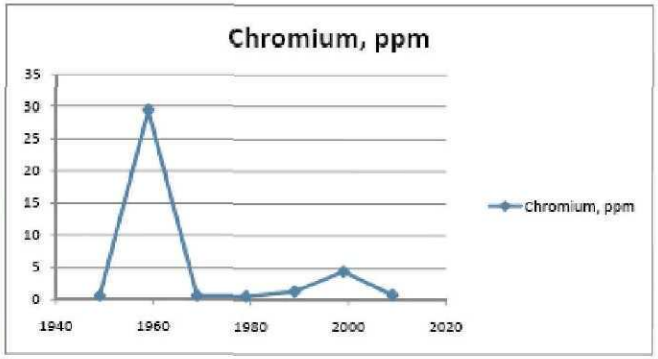
- Caveat – some inorganics are transported within the tree over space and time

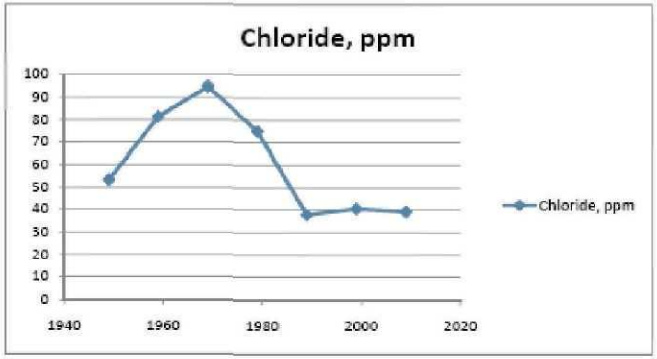

TCE detected
PCE detected
PCE & TCE detected
1,2-DCE also detected
8/18-21/08
Montgomery, AL
Dendrochronology
Survey
January 2009


Bark
Bark
T-39
97
98
99
100

April 2009

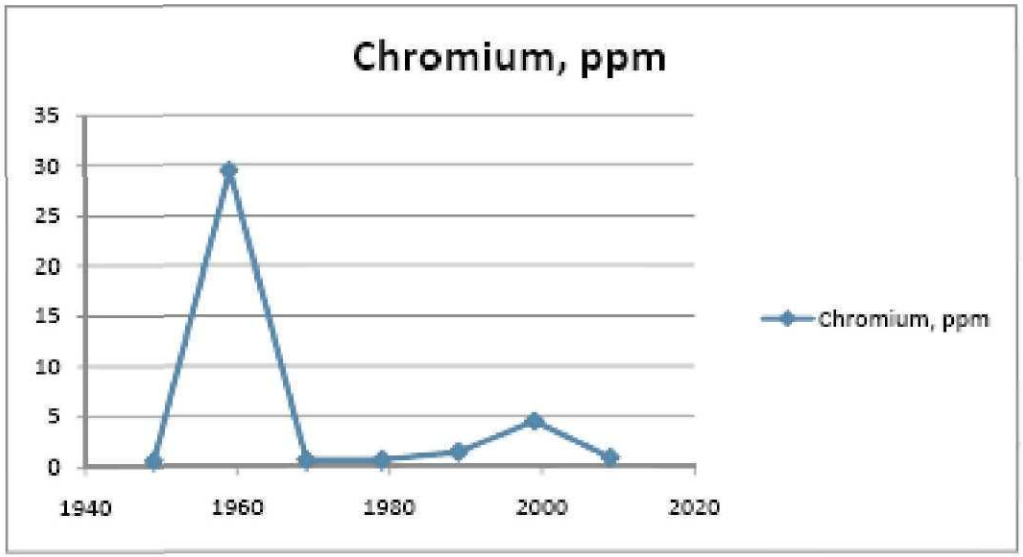


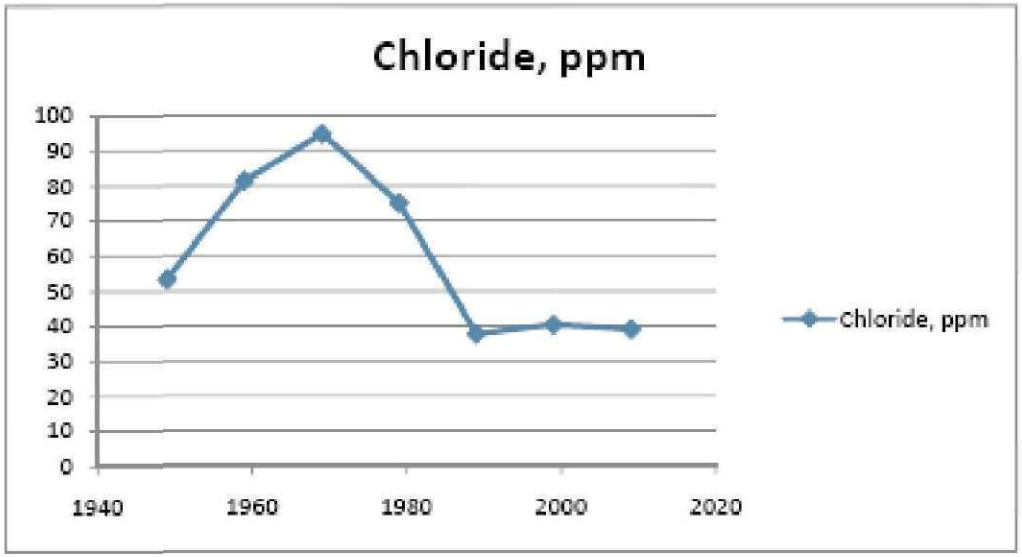




1960-1970s

Tree 47

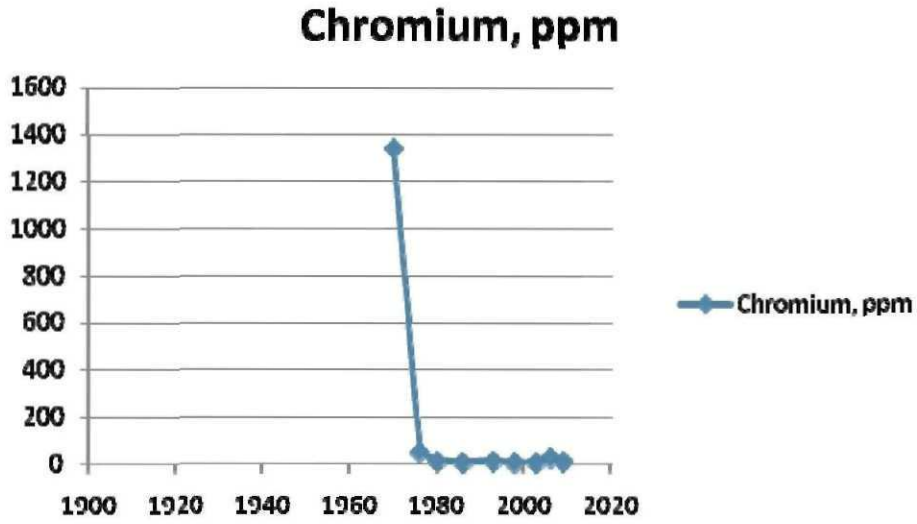


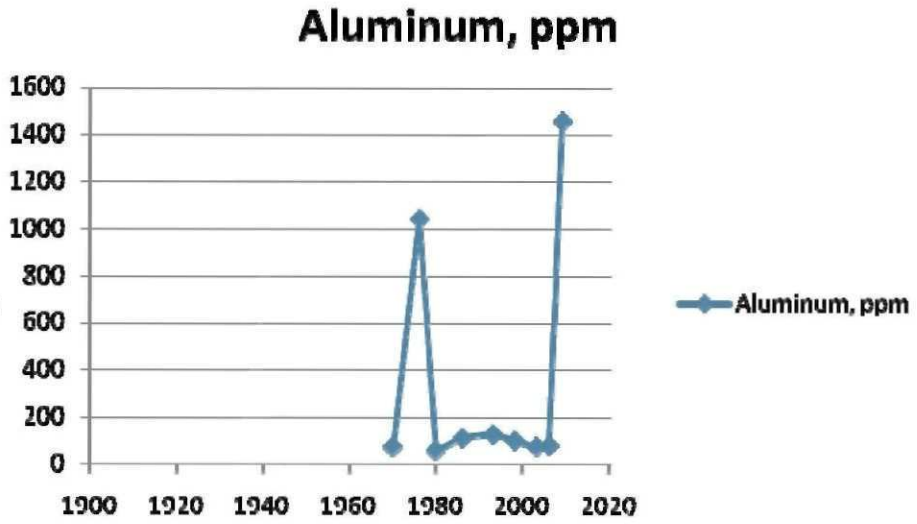


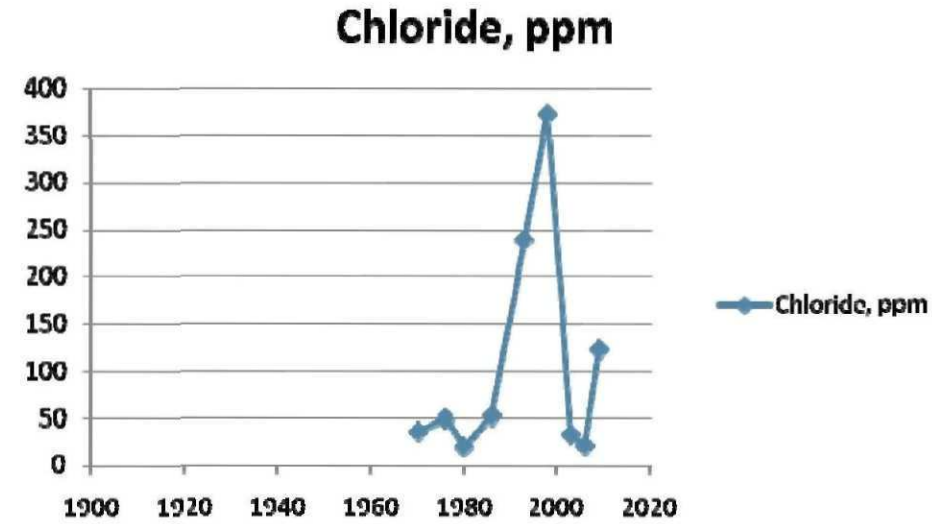
1955-1970s

…from the PCE and TCE

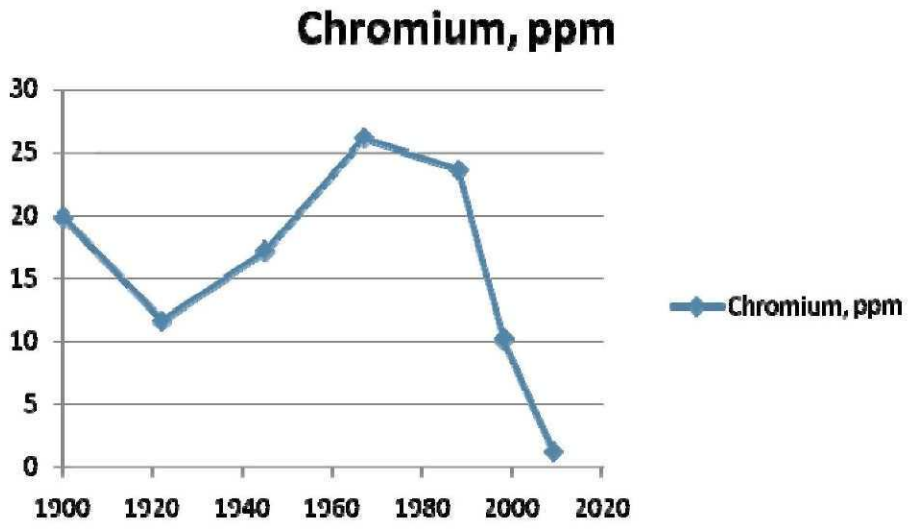
Tree T-15 (Old Alabama Town)

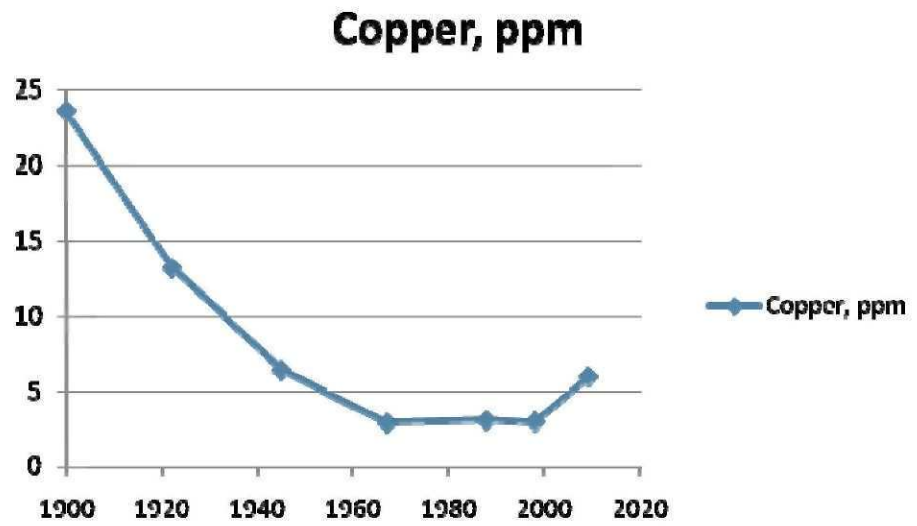


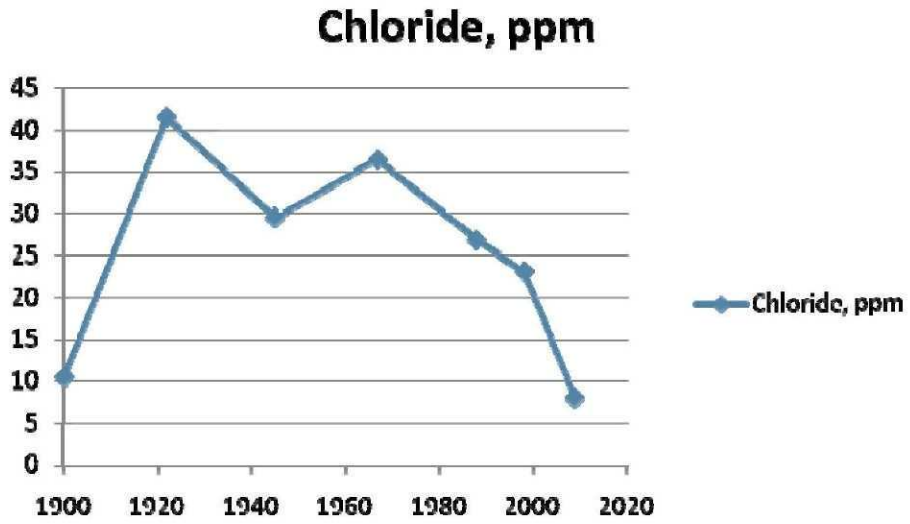


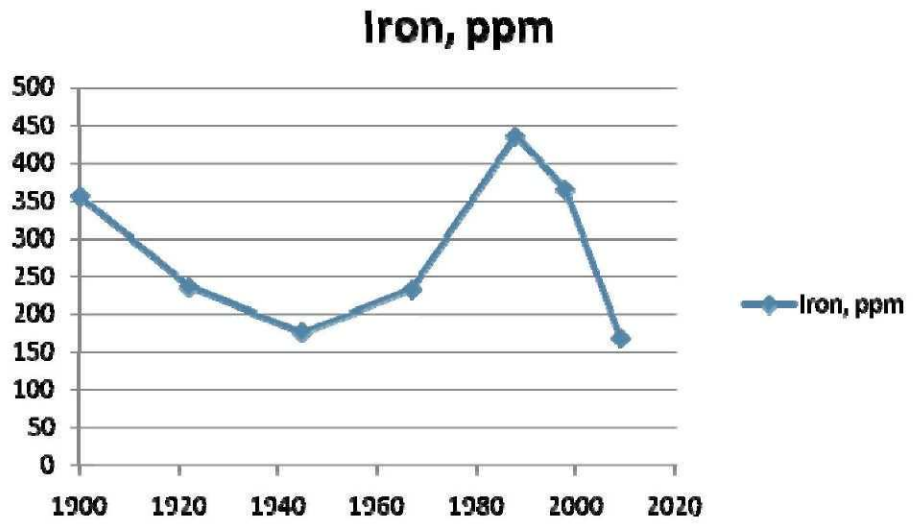


Tree T-22

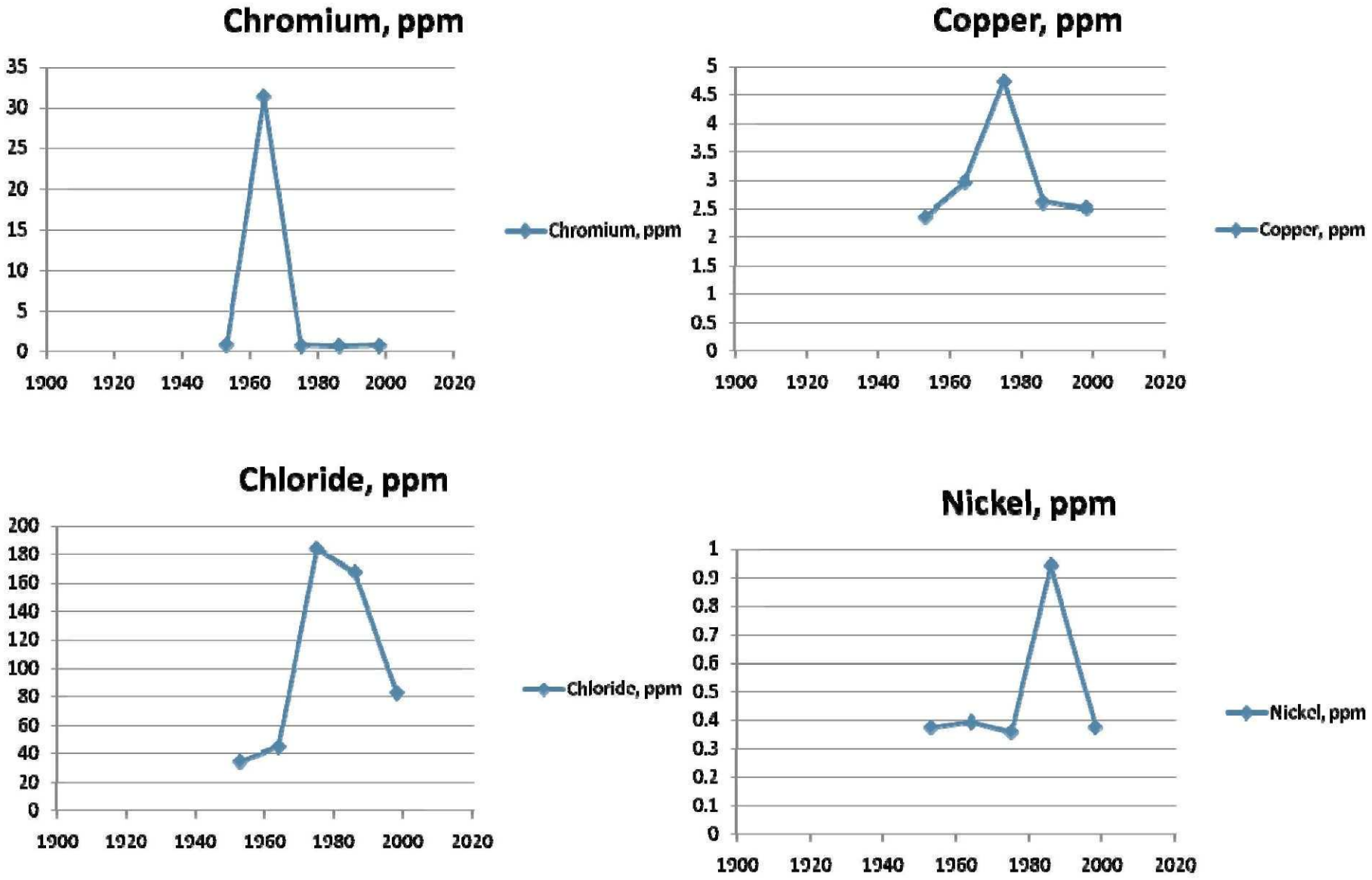

Chromium, ppm
30
25
20
15
10
5
0
1900
1920
1940
1960
1980
2000
2020
Chromium, ppm


Copper, ppm
25
20
15
10
5
0
1900
1920
1940
1960
1980
2000
2020
Copper, ppm

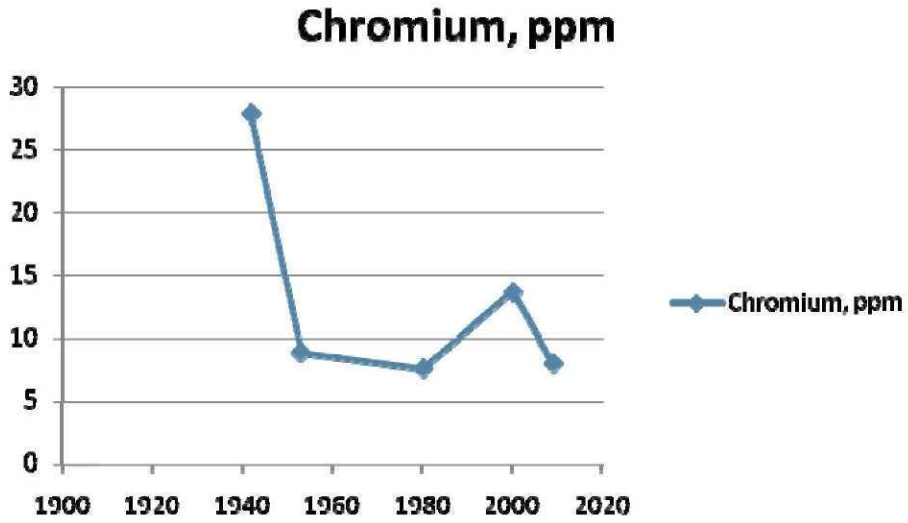

Chloride, ppm
45
40
35
30
25
20
15
10
5
0
1900
1920
1940
1960
1980
2000
2020
Chloride, ppm


Iron, ppm
500
450
400
350
300
250
200
150
100
50
0
1900
1920
1940
1960
1980
2000
2020
Iron, ppm

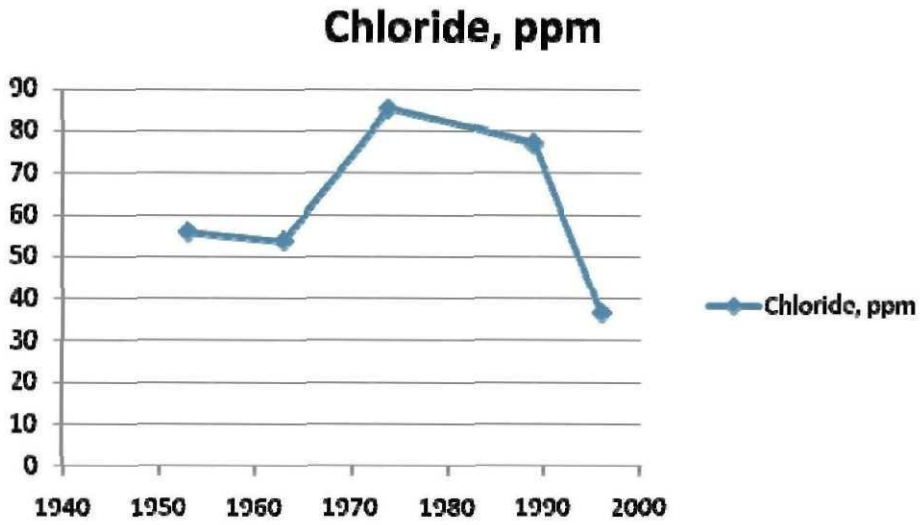
Tree T-23

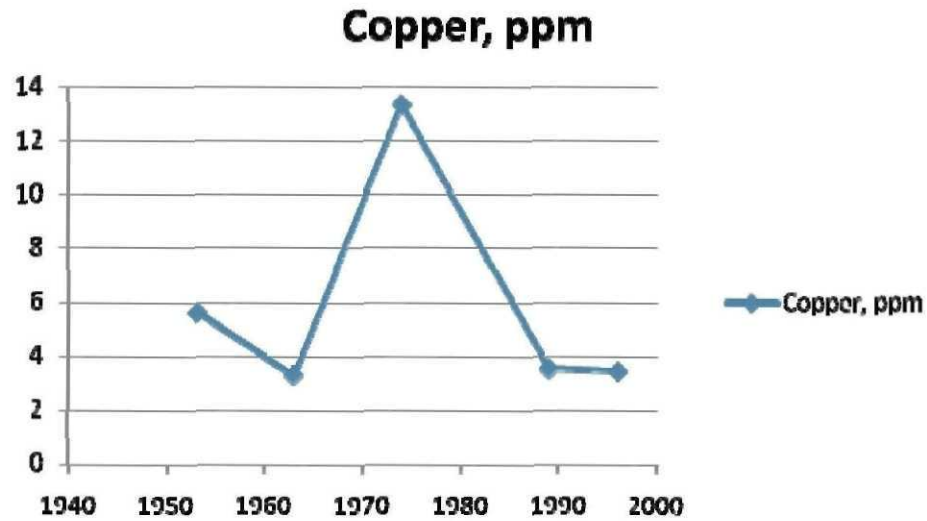

Chromium, ppm
35
30
25
20
15
10
5
0
1900
1920
1940
1960
1980
2000
2020
Chromium, ppm
Copper, ppm
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
1900
1920
1940
1960
1980
2000
2020
Copper, ppm
Chloride, ppm
200
180
160
140
120
100
80
60
40
20
0
1900
1920
1940
1960
1980
2000
2020
Chloride, ppm
Nickel, ppm
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1900
1920
1940
1960
1980
2000
2020
Nickel, ppm

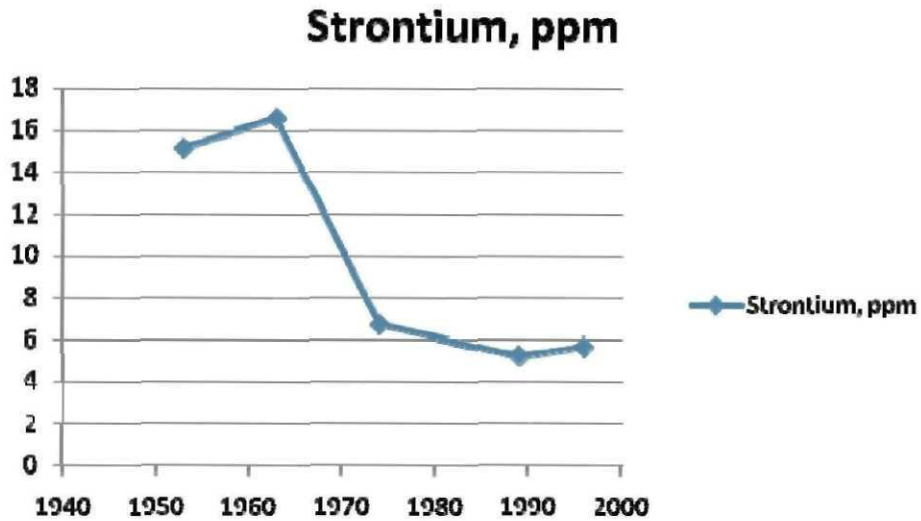
Tree T-32


Chromium, ppm
30
25
20
15
10
5
0
1900
1920
1940
1960
1980
2000
2020
Chromium, ppm

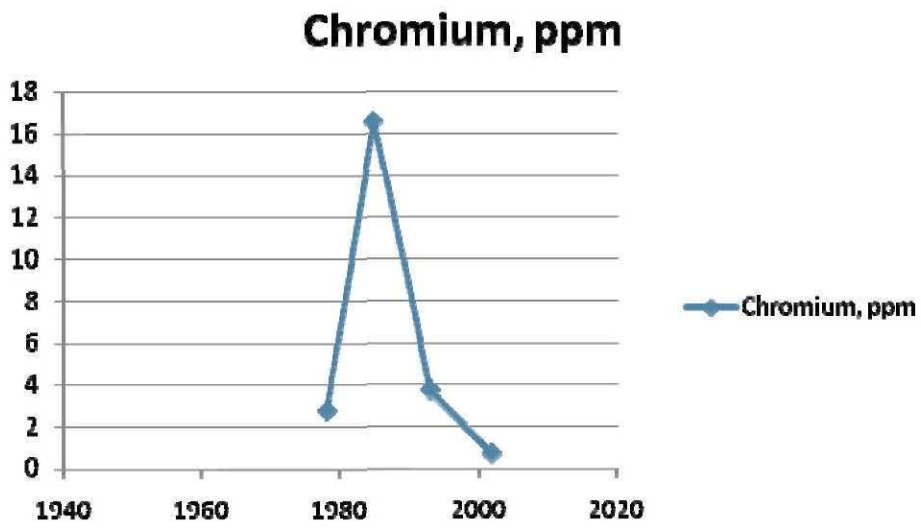
Tree T-33

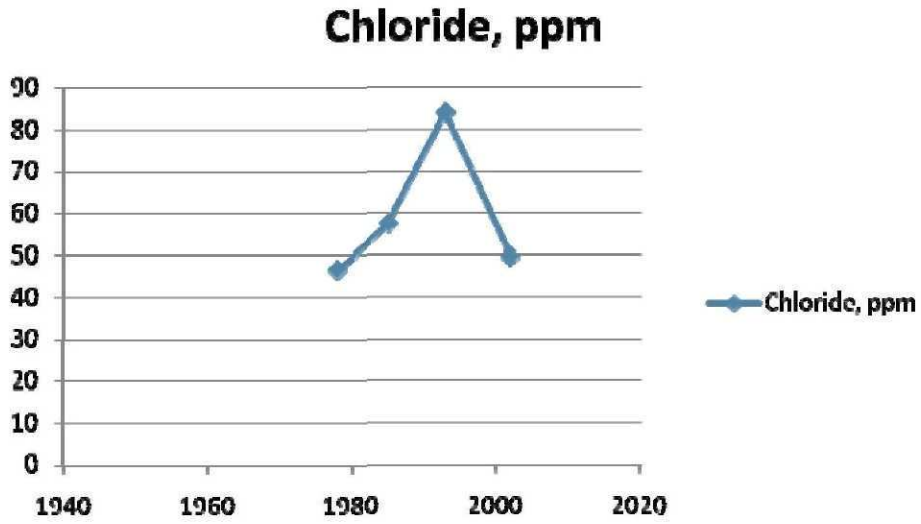

Chloride, ppm
90
80
70
60
50
40
30
20
10
0
1940
1950
1960
1970
1980
1990
2000
Chloride, ppm


Copper, ppm
14
12
10
8
6
4
2
0
1940
1950
1960
1970
1980
1990
2000
Copper, ppm

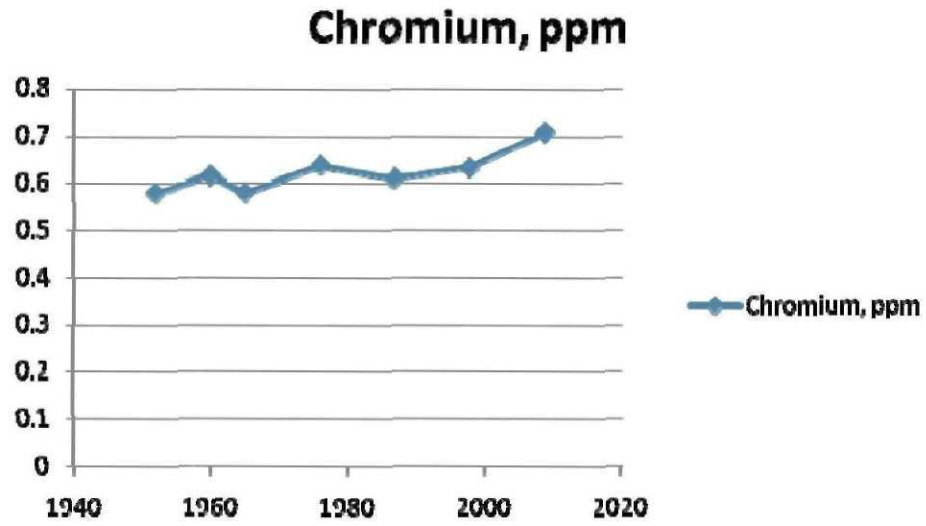

Strontium, ppm
18
16
14
12
10
8
6
4
2
0
1940
1950
1960
1970
1980
1990
2000
Strontium, ppm

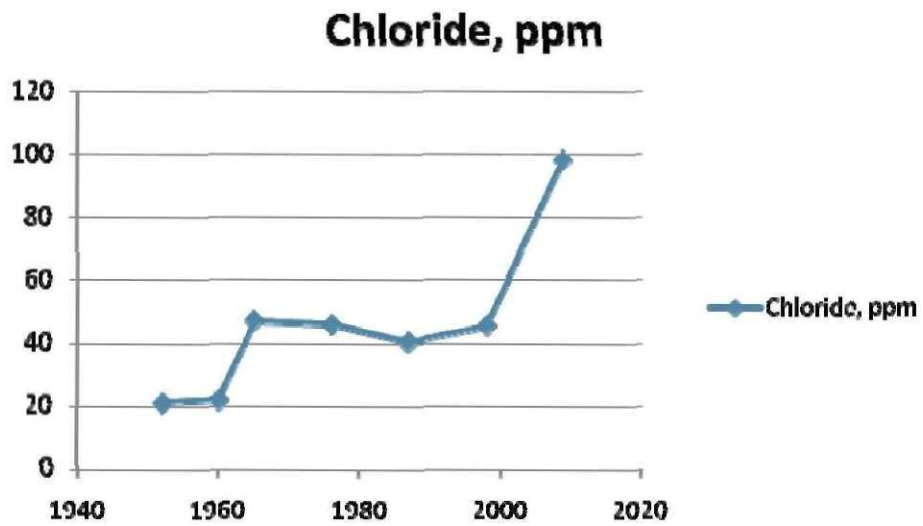
Tree T- 35


Chromium, ppm
18
16
14
12
10
8
6
4
2
0
1940
1960
1980
2000
2020
Chromium, ppm

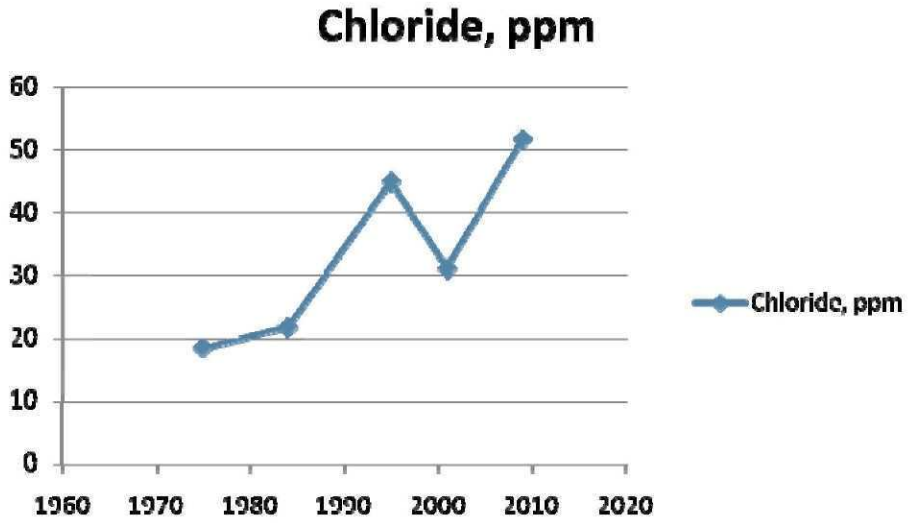

Chloride, ppm
90
80
70
60
50
40
30
20
10
0
1940
1960
1980
2000
2020
Chloride, ppm

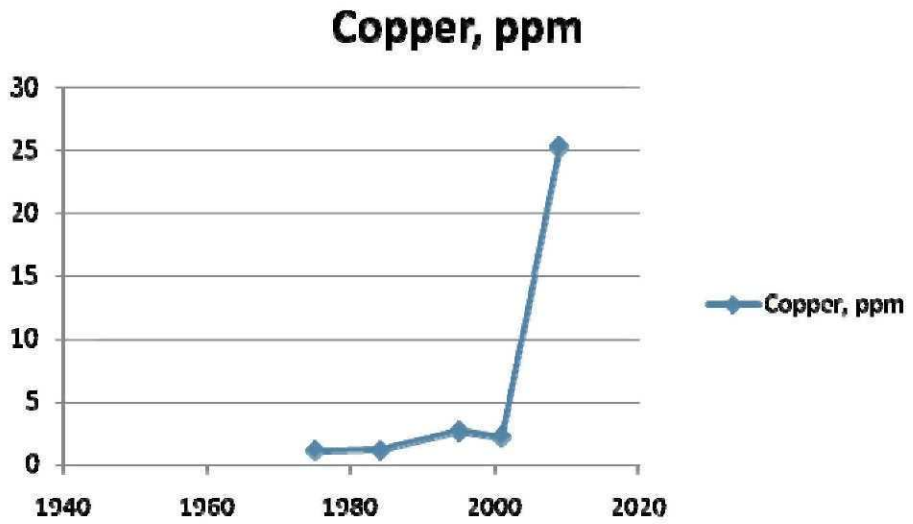
Tree T-31 (RSA chiller block)

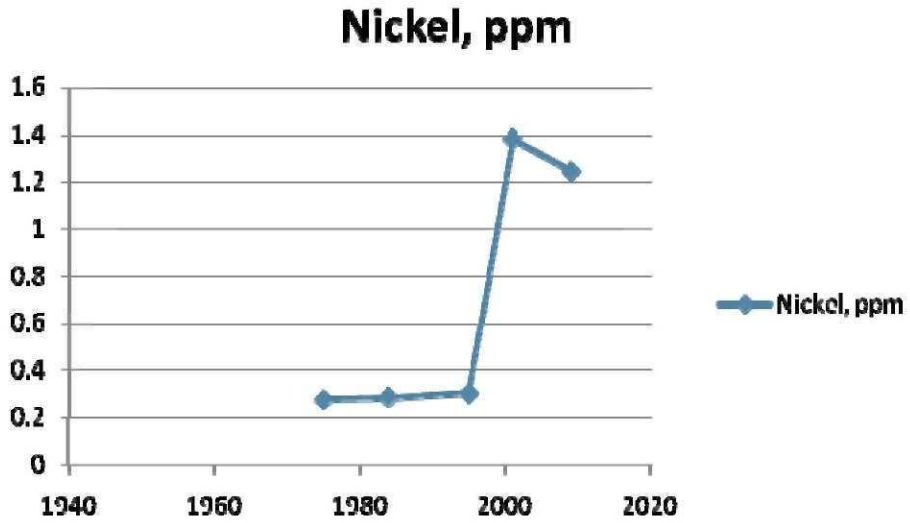




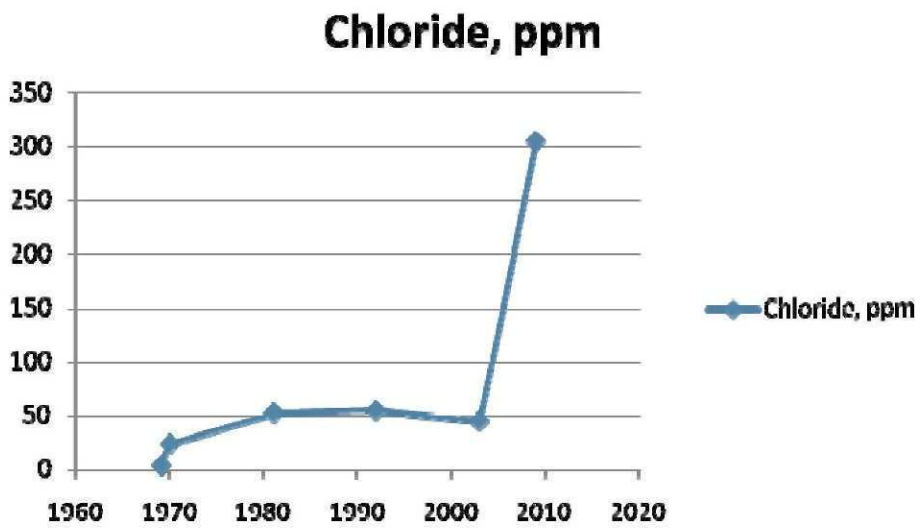
Tree T-28 (front of RSA tower)

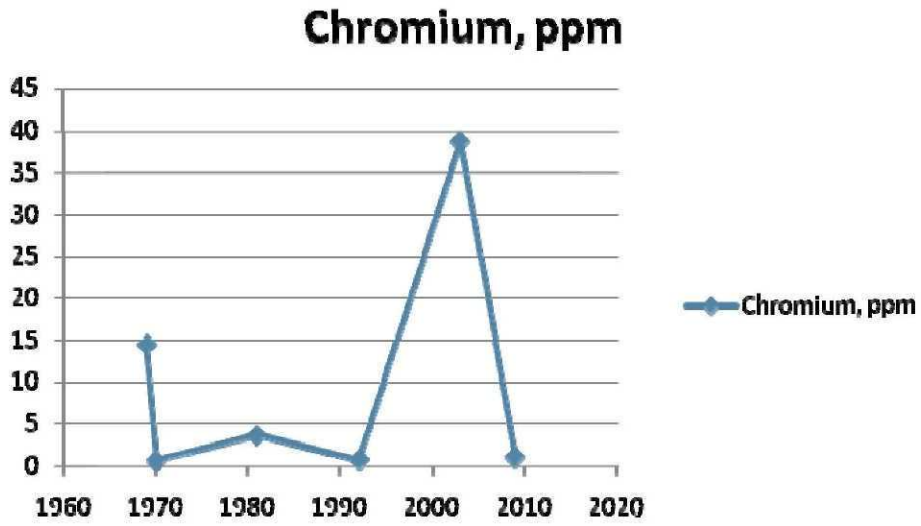




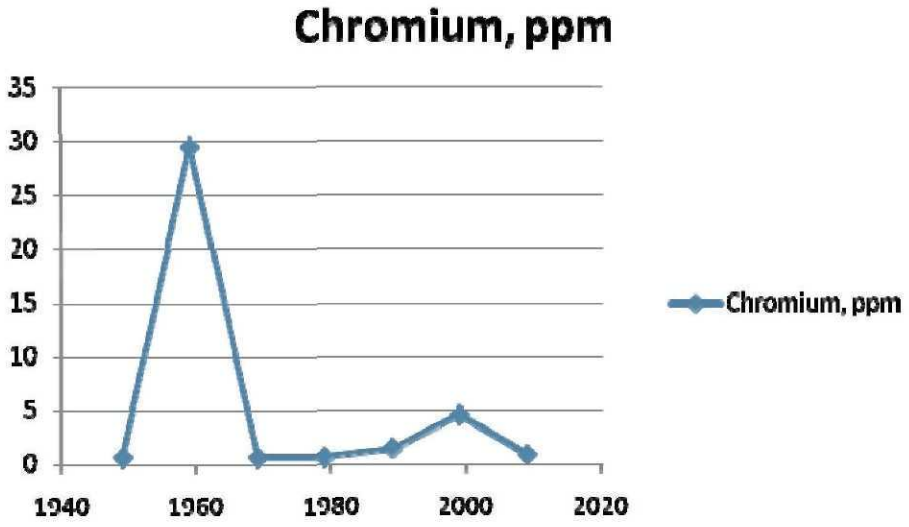


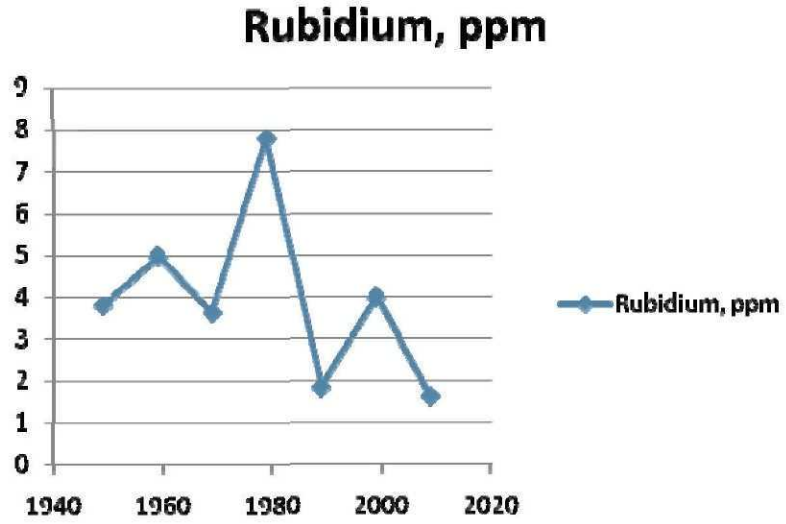
Tree T-64

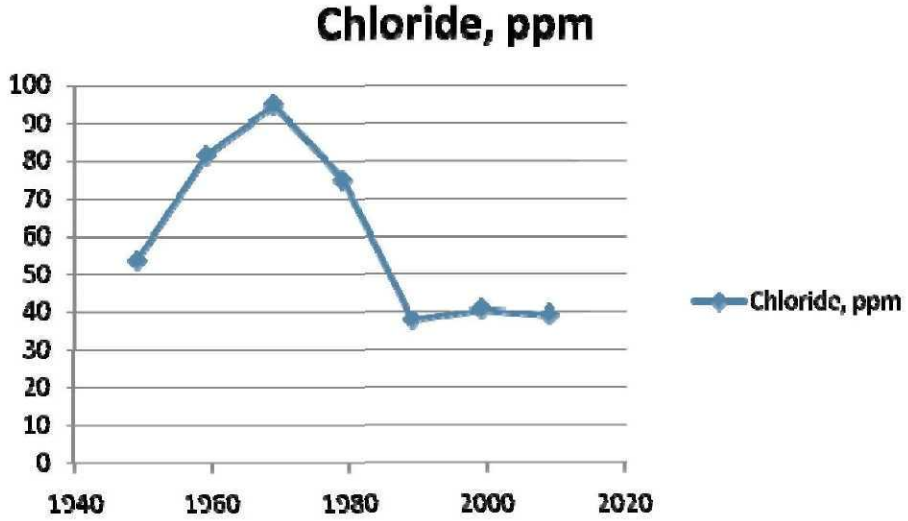

Chloride, ppm
350
300
250
200
150
100
50
0
1960
1970
1980
1990
2000
2010
2020
Chloride, ppm


Chromium, ppm
45
40
35
30
25
20
15
10
5
0
1960
1970
1980
1990
2000
2010
2020
Chromium, ppm

Tree T-47 (downgradient of break in sewer line at McDonough andDexter)







1.PCE and TCE contaminated groundwater beneath the RSA chiller plant

- Who – Montgomery Advertiser
- What – Blanket wash and fountain solutions used in running offset presses
- Where-Released from 200 Washington Street to floor drains, sumps, and sinks that drain to the sanitary sewer system
- When – between 1955 and 1970

2.PCE and TCE contaminated soil and groundwater along 200 Washington Street

- Who – Montgomery Advertiser
- What – Blanket wash and fountain solutions used in running offset presses
- Where-Released from 200 Washington Street to sumps that drain to the stormwater system
- When – between 1970 and 1980

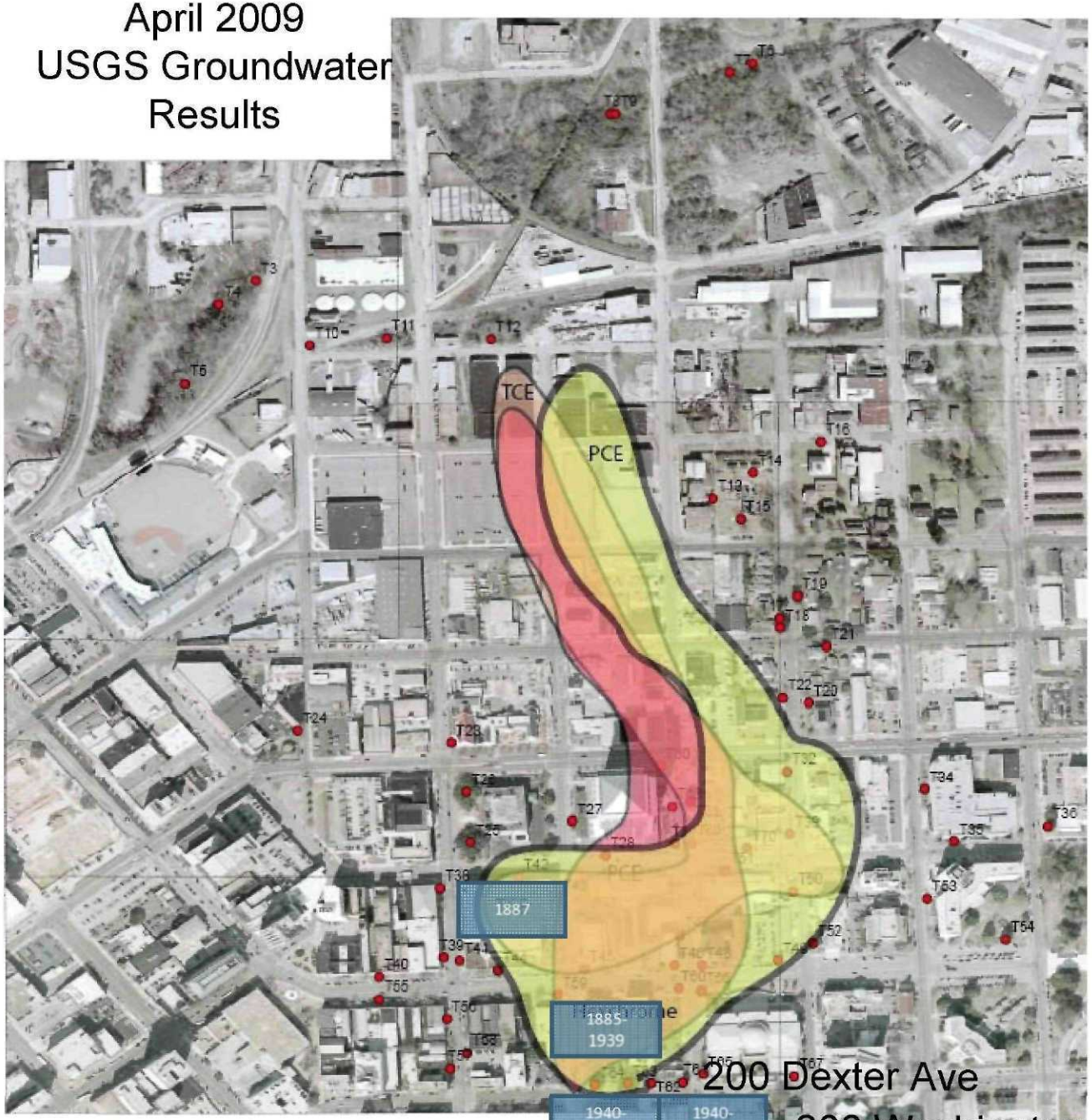
3.Chromium contaminated soil and groundwater along 200 Washington Street

- Who – Montgomery Advertiser
- What –chromic acid fountain solutions used in running offset presses
- Where-Released from 200 Washington Street to sumps that drain to the stormwater system
- When – between 1970 and 1980

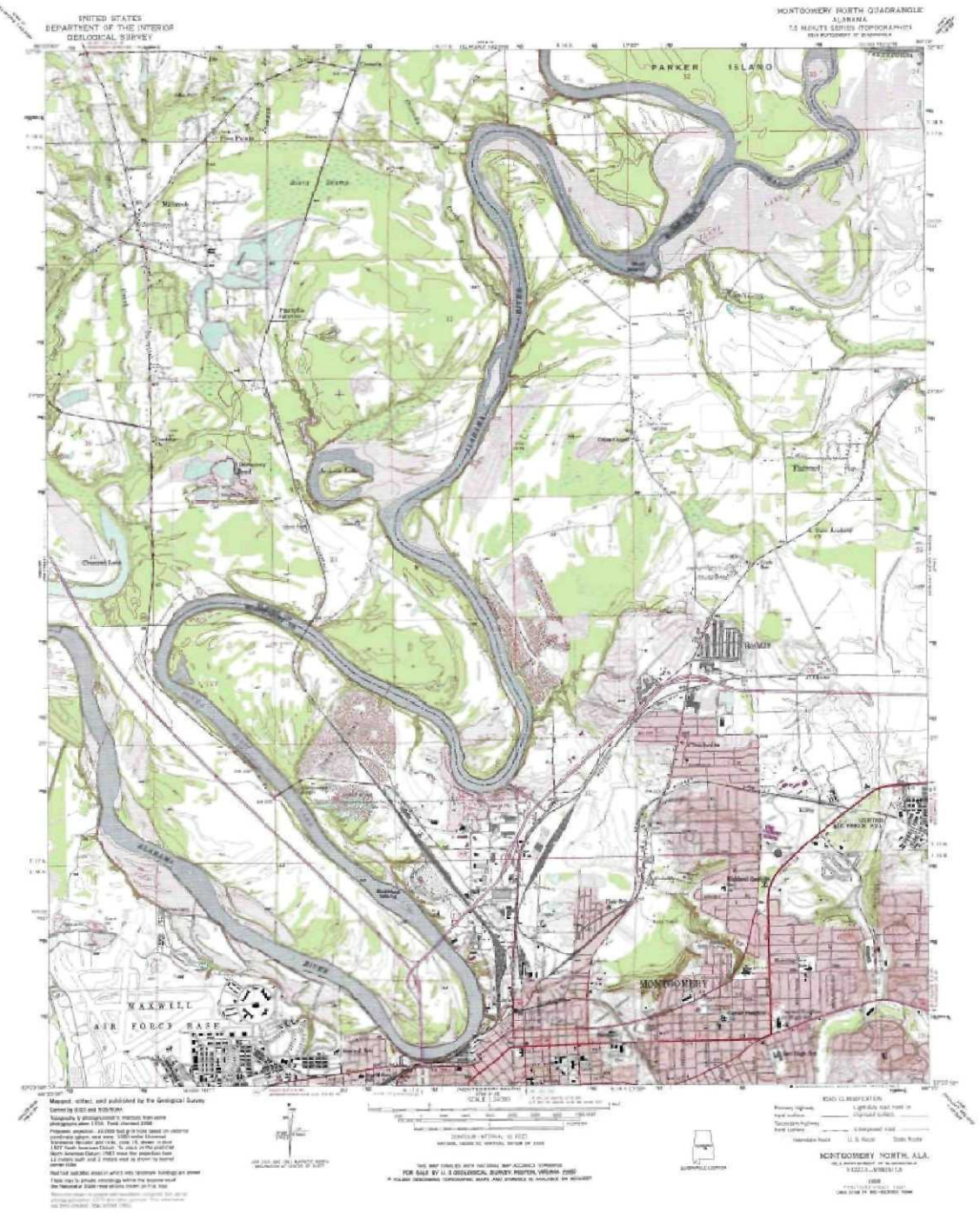
4.Chromium contaminated groundwater near RSA chiller plant and Park

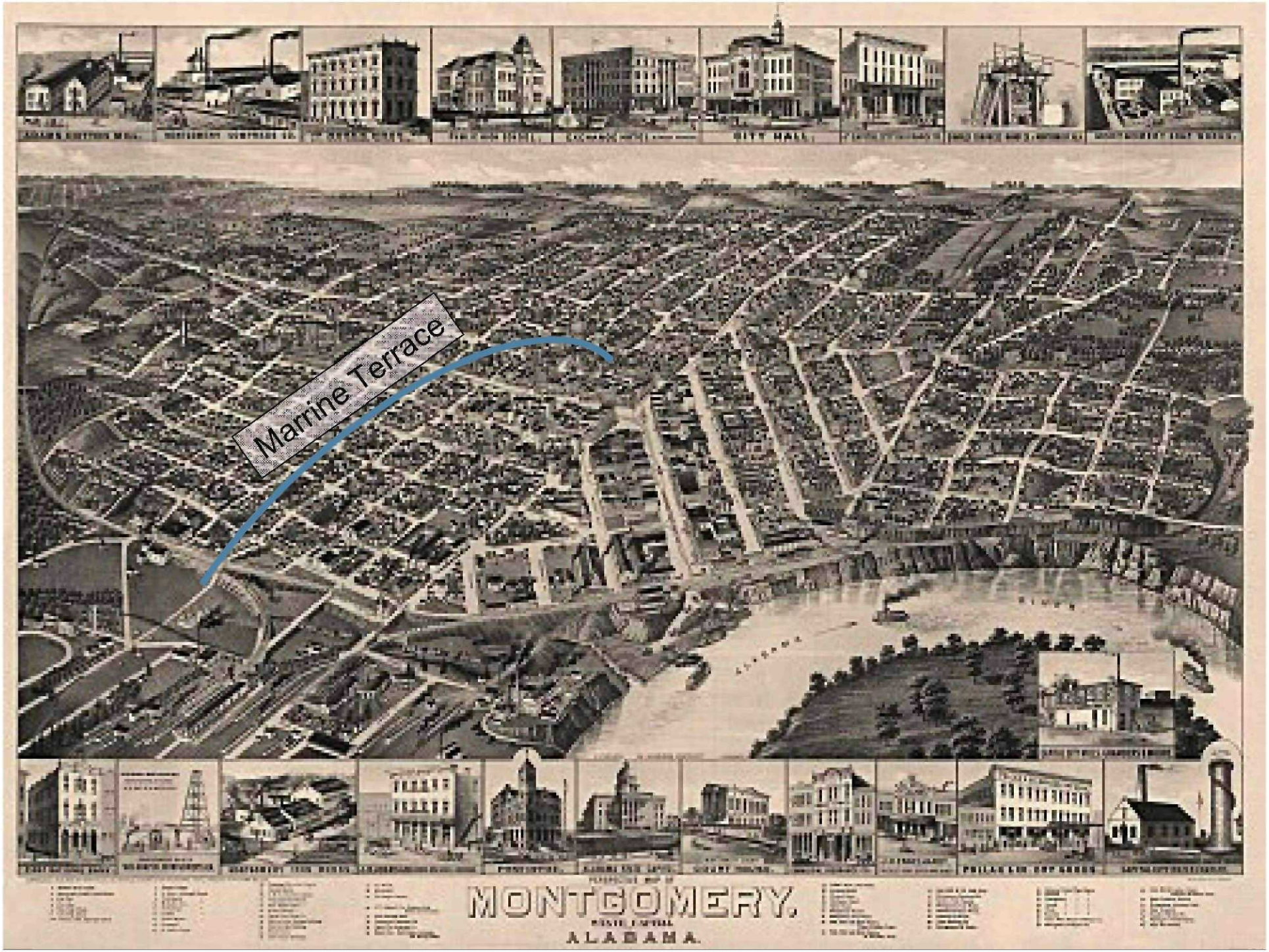
- Who – Montgomery Advertiser
- What –inks used in lithographic offset presses
- Where-Released from 200 Dexter Avenue to sinks and sumps that drain to the sanitary sewer system; some contribution from Lawrence Street location
- When – between 1910 and 1940

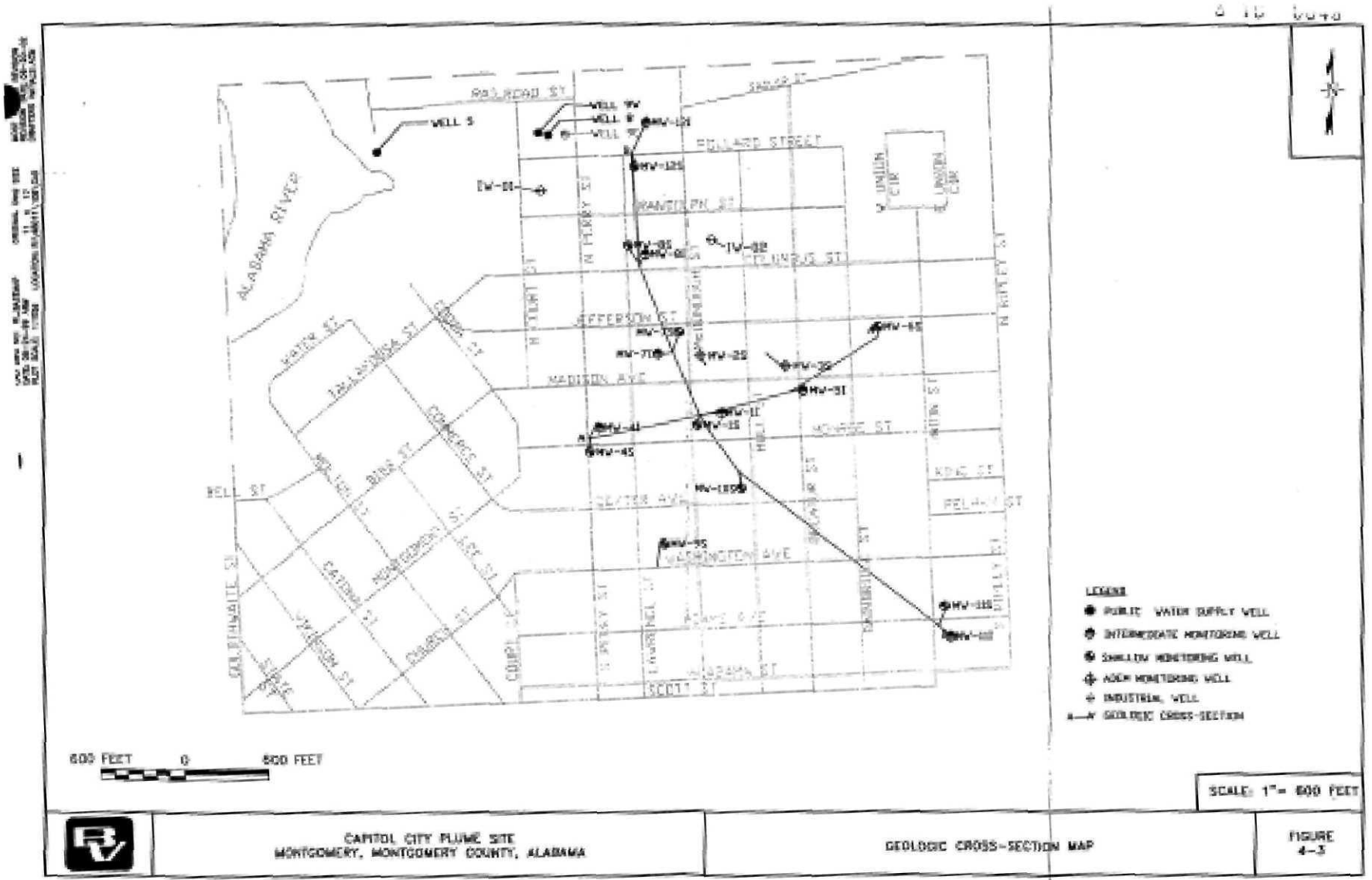
April 2009 USGS Groundwater Results



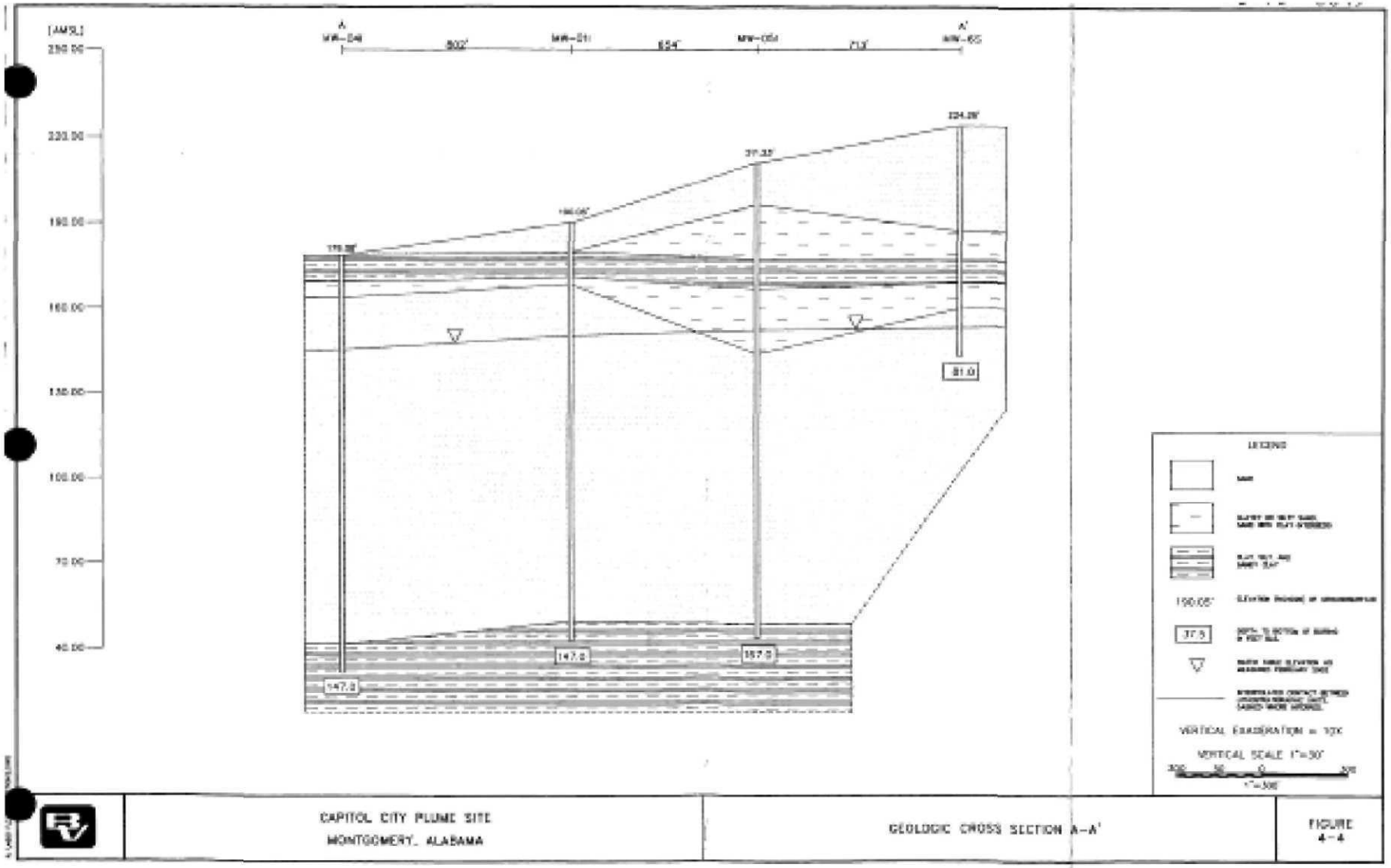
Floodplain hydrogeology



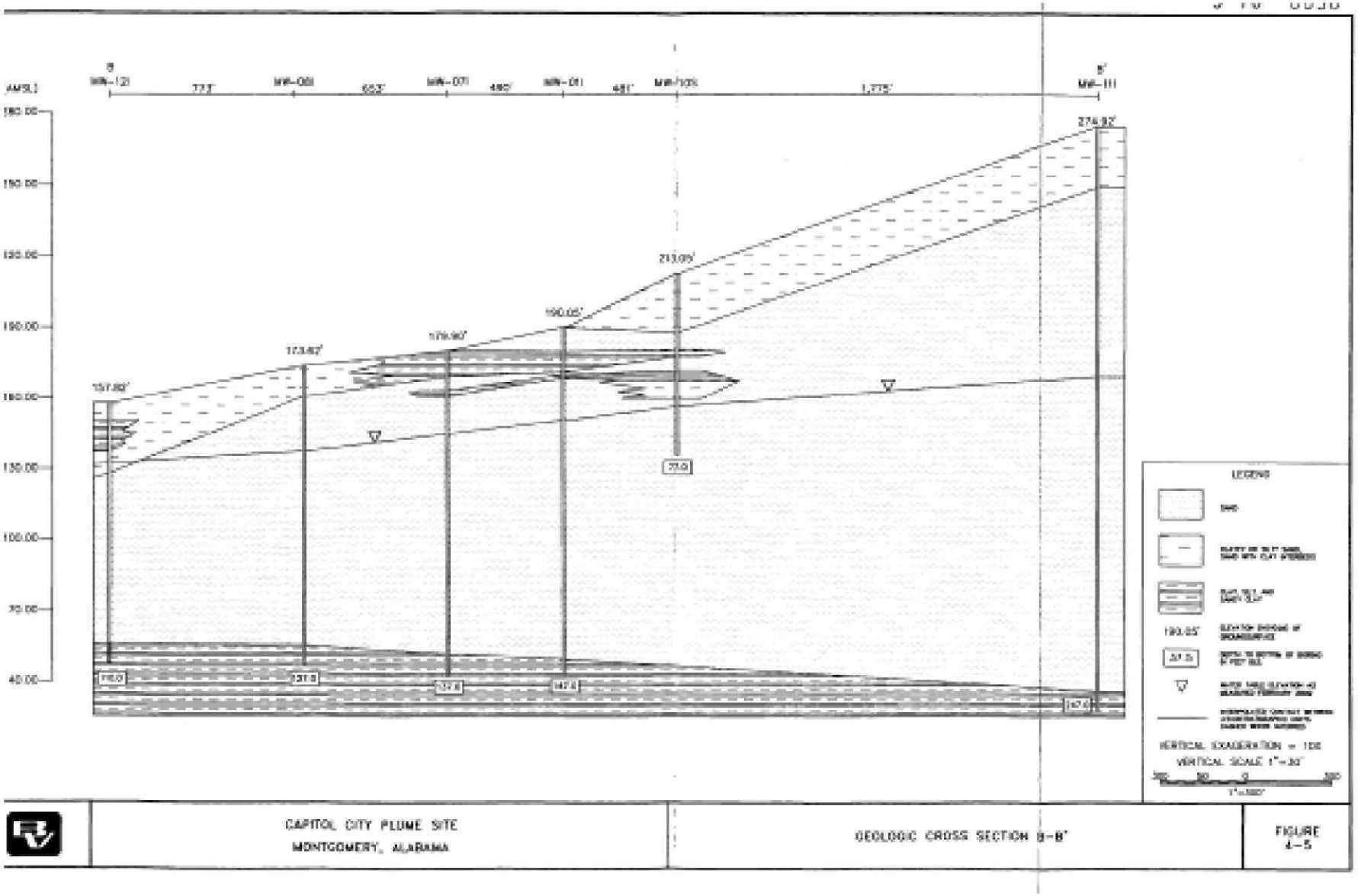

Marrine Terrace
MONTGOMERY.
STATE CAPITAL
ALABAMA.



Black & Veatch (2002)



Black & Veatch (2002)



Black & Veatch (2002)

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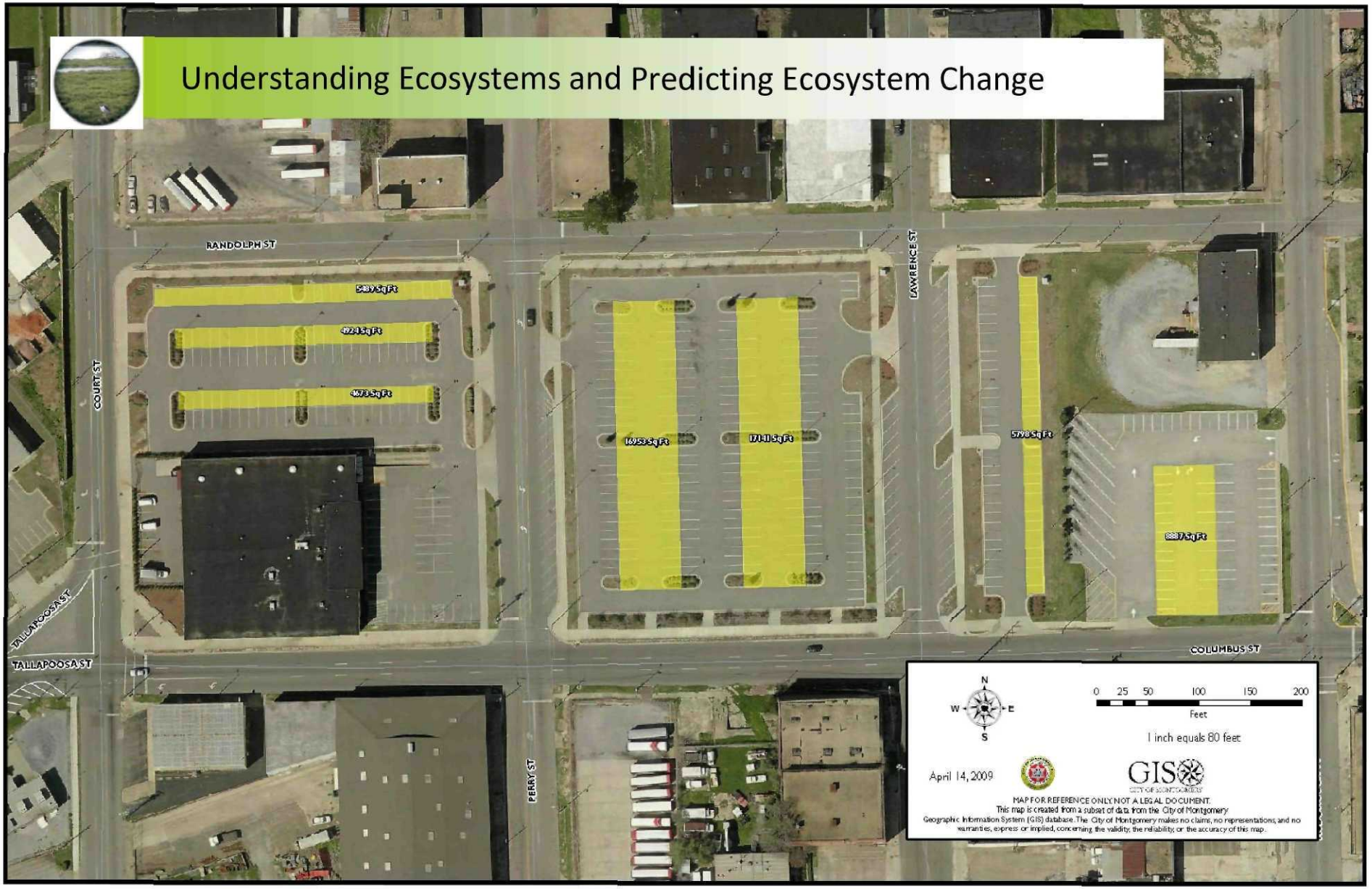

Planned phytoremediation project by City of Montgomery to protect a downgradient surface-water body

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