# Dioxin Fingerprinting in the HSC

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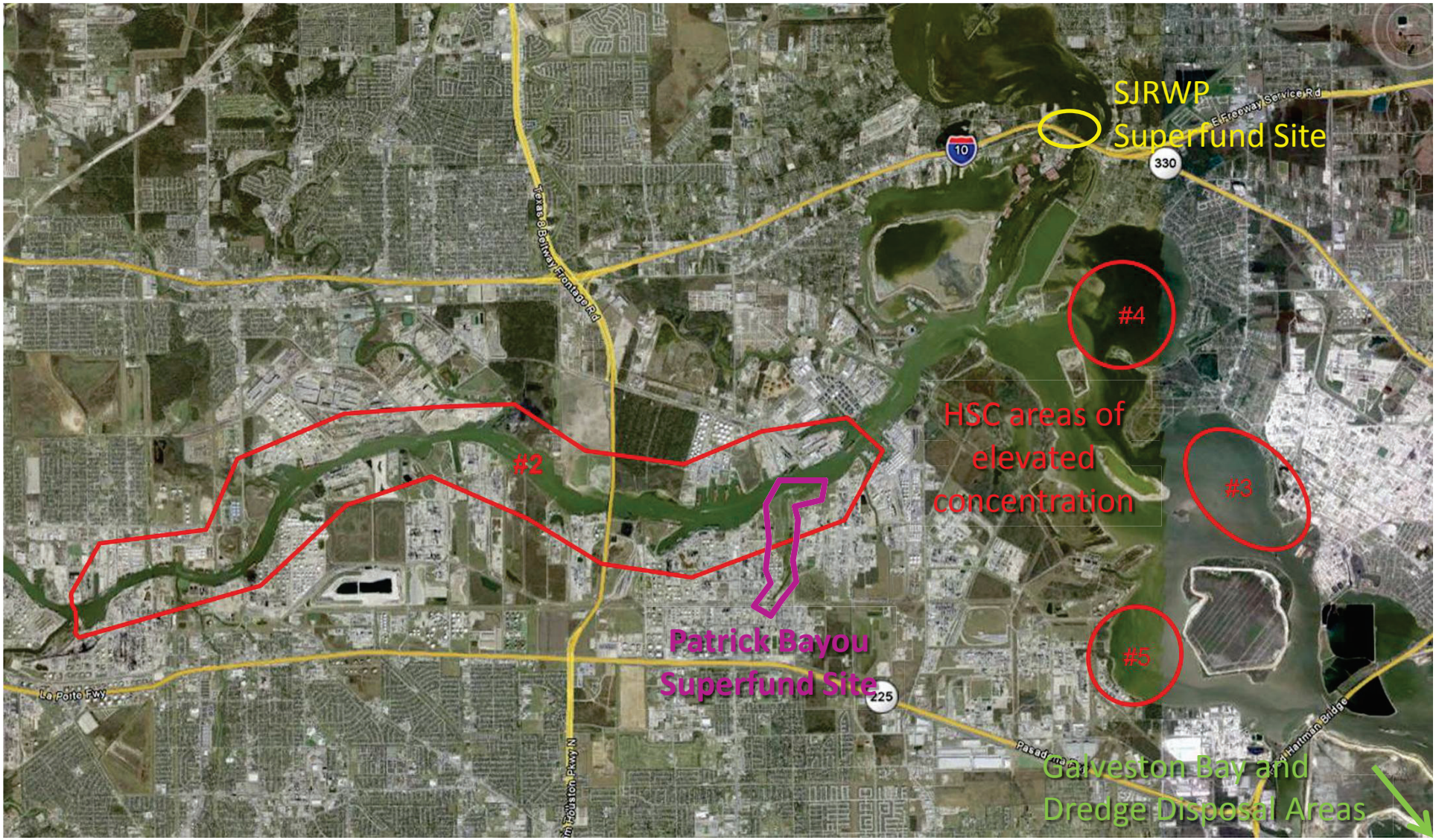
# Objectives

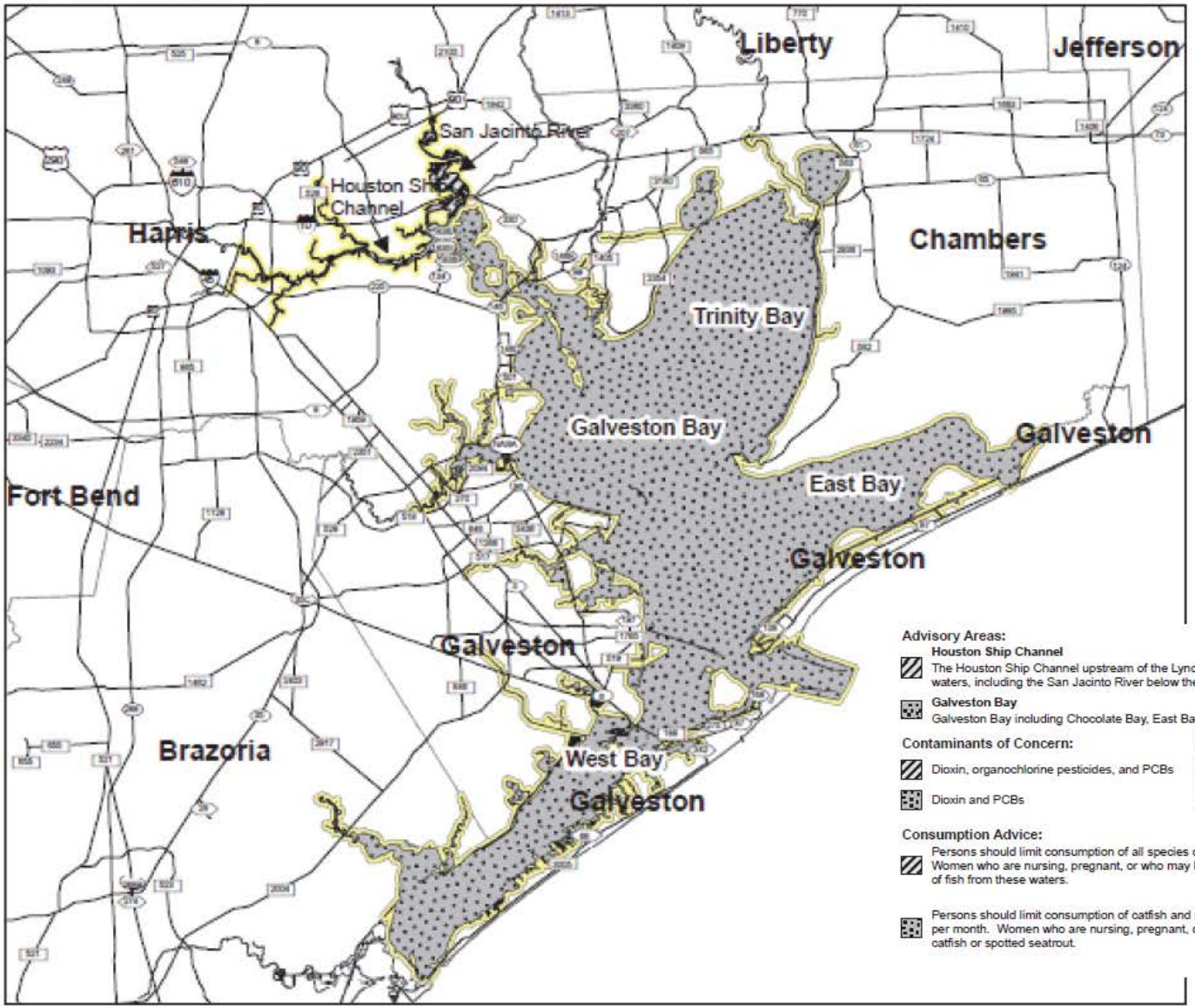
- Compare dioxin fingerprints from several areas of the HSC to the SJRWP superfund site:
  - Patrick Bayou superfund site
  - HSC from Sims Bayou to Tucker Bayou
  - Burnett Bay
  - Scott Bay
  - San Jacinto Bay
  - Galveston Bay along the HSC

# Areas of Interest for this project:



# Houston Ship Channel and Galveston Bay

**Brazoria, Chambers, Galveston, and Harris Counties**
**ADV-20 Issued October 9, 2001**
**ADV-35 Issued July 8, 2008**




**Advisory Areas:**

**Houston Ship Channel**
The Houston Ship Channel upstream of the Lynchburg Ferry crossing and all contiguous waters, including the San Jacinto River below the U.S. Highway 90 bridge.

**Galveston Bay**
Galveston Bay including Chocolate Bay, East Bay, Trinity Bay, and West Bay and contiguous waters

**Contaminants of Concern:**

Dioxin, organochlorine pesticides, and PCBs

Dioxin and PCBs

**Species Affected:**

All species of fish

All catfish species and spotted seatrout

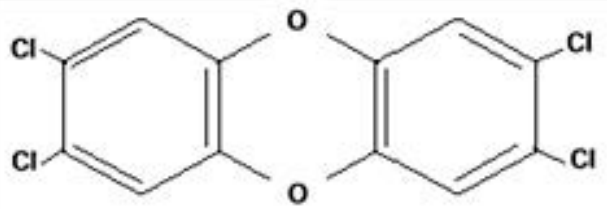
**Consumption Advice:**

Persons should limit consumption of all species of fish from this area to no more than one eight-ounce meal per month. Women who are nursing, pregnant, or who may become pregnant and children under 12 should not consume any species of fish from these waters.

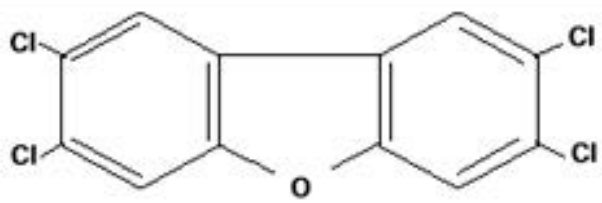
Persons should limit consumption of catfish and spotted seatrout from this area to no more than one eight-ounce meal per month. Women who are nursing, pregnant, or who may become pregnant and children under 12 should not consume catfish or spotted seatrout.

# Methods

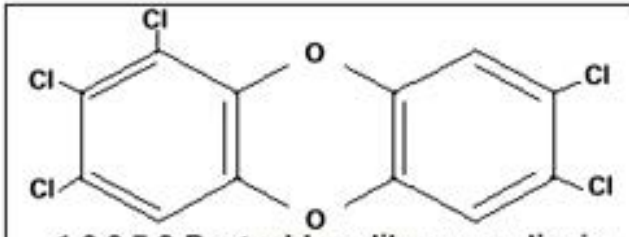
- Used Surface Sediment data from SJRWP site geodatabase, Patrick Bayou site database, and EPA Marine and Coastal Studies report
- Used 2 upstream stations in the SJR as background – 11200 and 16622
- Plotted highest 12 samples from inside SJRWP to describe pit "fingerprint"
- All values given are station averages, if more than one sample was available for a site
- TEQs computed using 2008 WHO TEFs with ND=0
- Fingerprint is computed by dividing each congener by the total for all 2,3,7,8 dioxin and furan congeners except OCDD, which was omitted for clarity



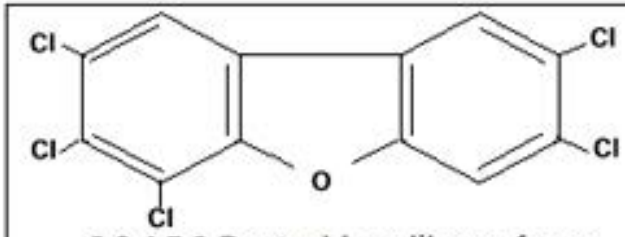

2,3,7,8-Tetrachlorodibenzo-p-dioxin




2,3,7,8-Tetrachlorodibenzofuran



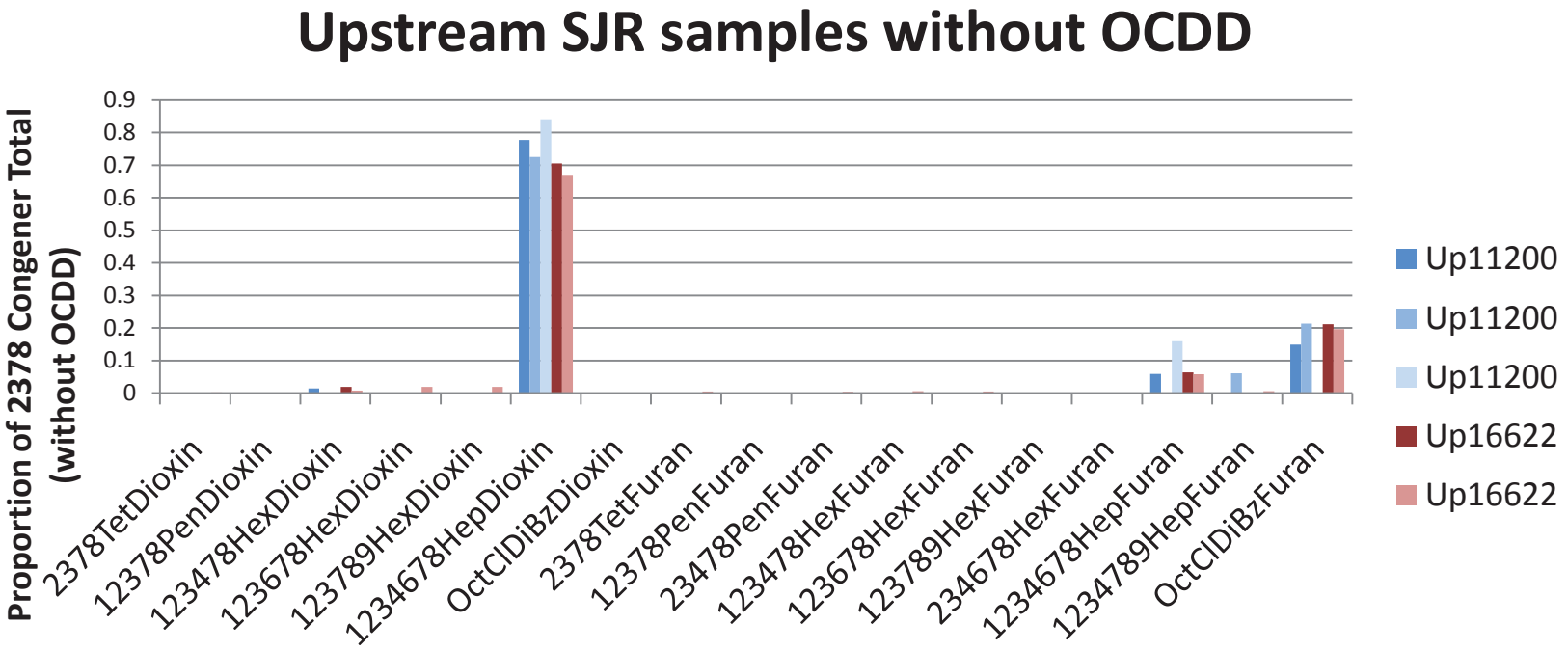

1,2,3,7,8-Pentachlorodibenzo-p-dioxin

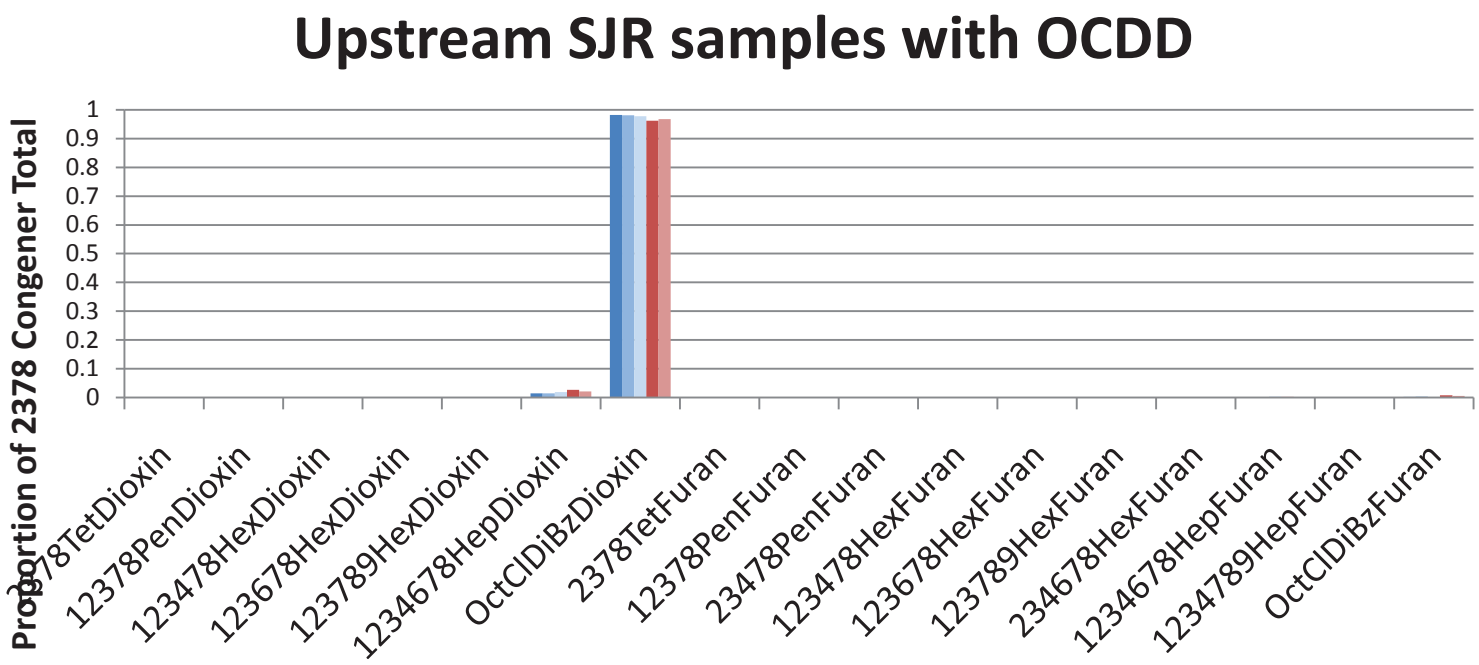


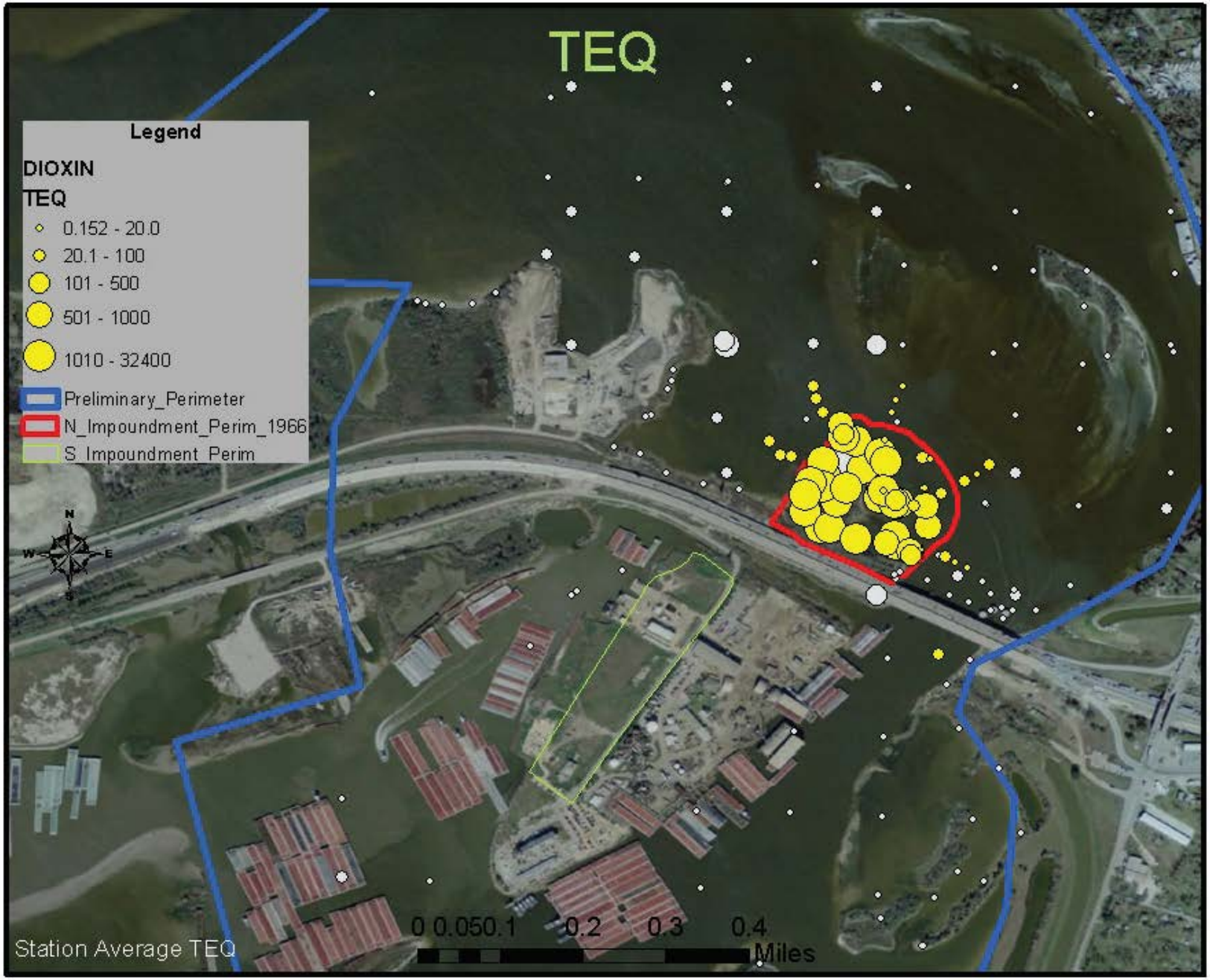

2,3,4,7,8-Pentachlorodibenzofuran

# TOXIC EQUIVALENCY FACTORS (TEFs)

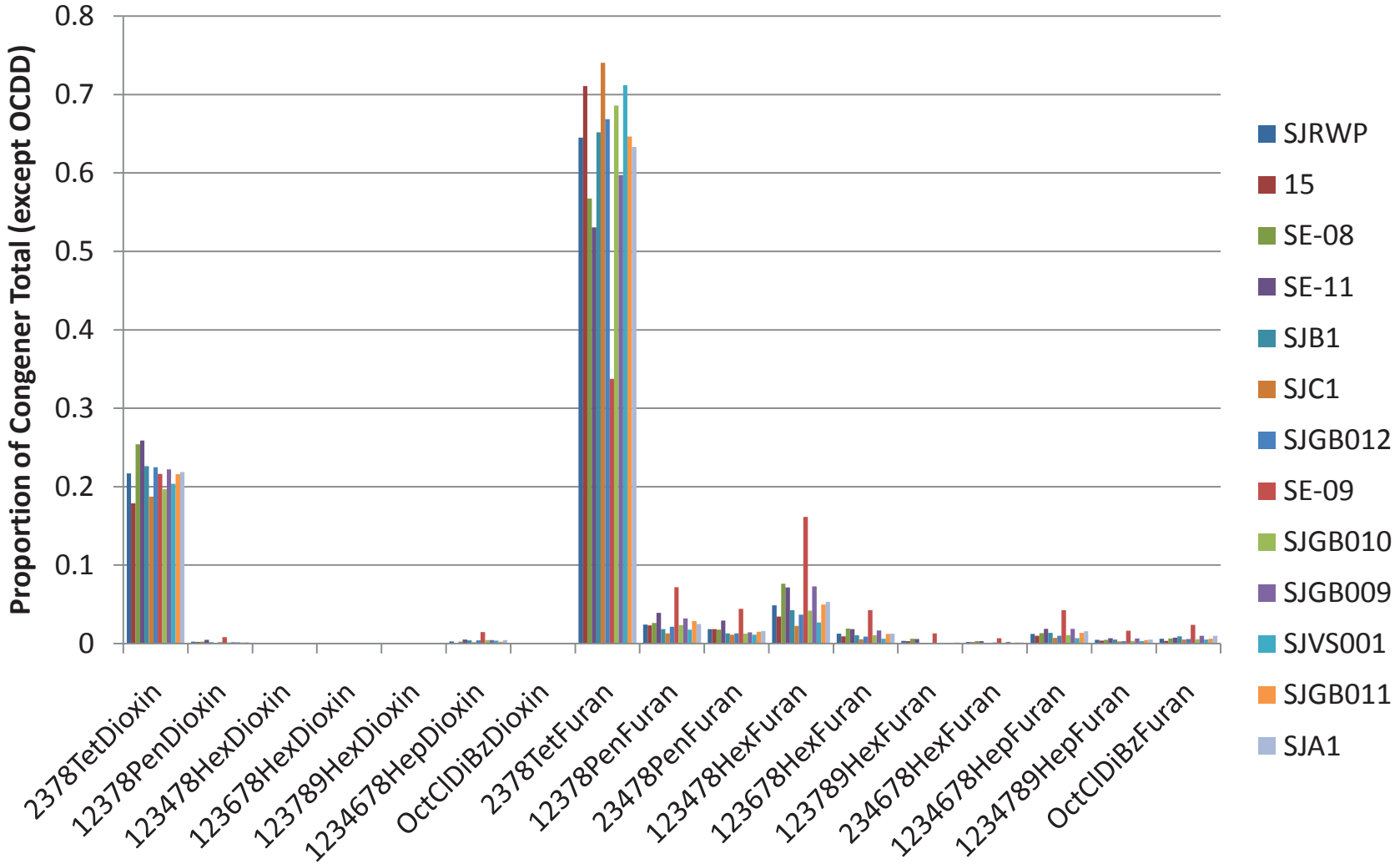
| | TEF |
|---|---|
| 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) | 1 |
| 1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD) | 1 |
| 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD) | 0.1 |
| 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD) | 0.1 |
| 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD) | 0.1 |
| 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD) | 0.01 |
| 1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD) | 0.0003 |
| | |
| 2,3,7,8-Tetrachlorodibenzofuran (TCDF) | 0.1 |
| 1,2,3,7,8-Pentachlorodibenzofuran (PeCDF) | 0.03 |
| 2,3,4,7,8-Pentachlorodibenzofuran (PeCDF) | 0.3 |
| 1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF) | 0.1 |
| 1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF) | 0.1 |
| 1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF) | 0.1 |
| 2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF) | 0.1 |
| 1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF) | 0.01 |
| 1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF) | 0.01 |
| 1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF) | 0.0003 |


Upstream SJR samples without OCDD
Proportion of 2378 Congener Total (without OCDD)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2378TetDioxin
12378PenDioxin
123478HexDioxin
123678HexDioxin
123789HexDioxin
1234678HepDioxin
OctClDiBzDioxin
2378TetFuran
12378PenFuran
23478PenFuran
123478HexFuran
123678HexFuran
123789HexFuran
234678HexFuran
1234678HepFuran
1234789HepFuran
OctClDiBzFuran
Up11200
Up11200
Up11200
Up16622
Up16622


Upstream SJR samples with OCDD
Proportion of 2378 Congener Total
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2378TetDioxin
12378PenDioxin
123478HexDioxin
123678HexDioxin
123789HexDioxin
1234678HepDioxin
OctClDiBzDioxin
2378TetFuran
12378PenFuran
23478PenFuran
123478HexFuran
123678HexFuran
123789HexFuran
234678HexFuran
1234678HepFuran
1234789HepFuran
OctClDiBzFuran


TEQ
Legend
DIOXIN
TEQ
0.152 - 20.0
20.1 - 100
101 - 500
501 - 1000
1010 - 32400
Preliminary_Perimeter
N_Impoundment_Perim_1966
S_Impoundment_Perim
N
W
E
S
0 0.050.1 0.2 0.3 0.4
Miles
Station Average TEQ

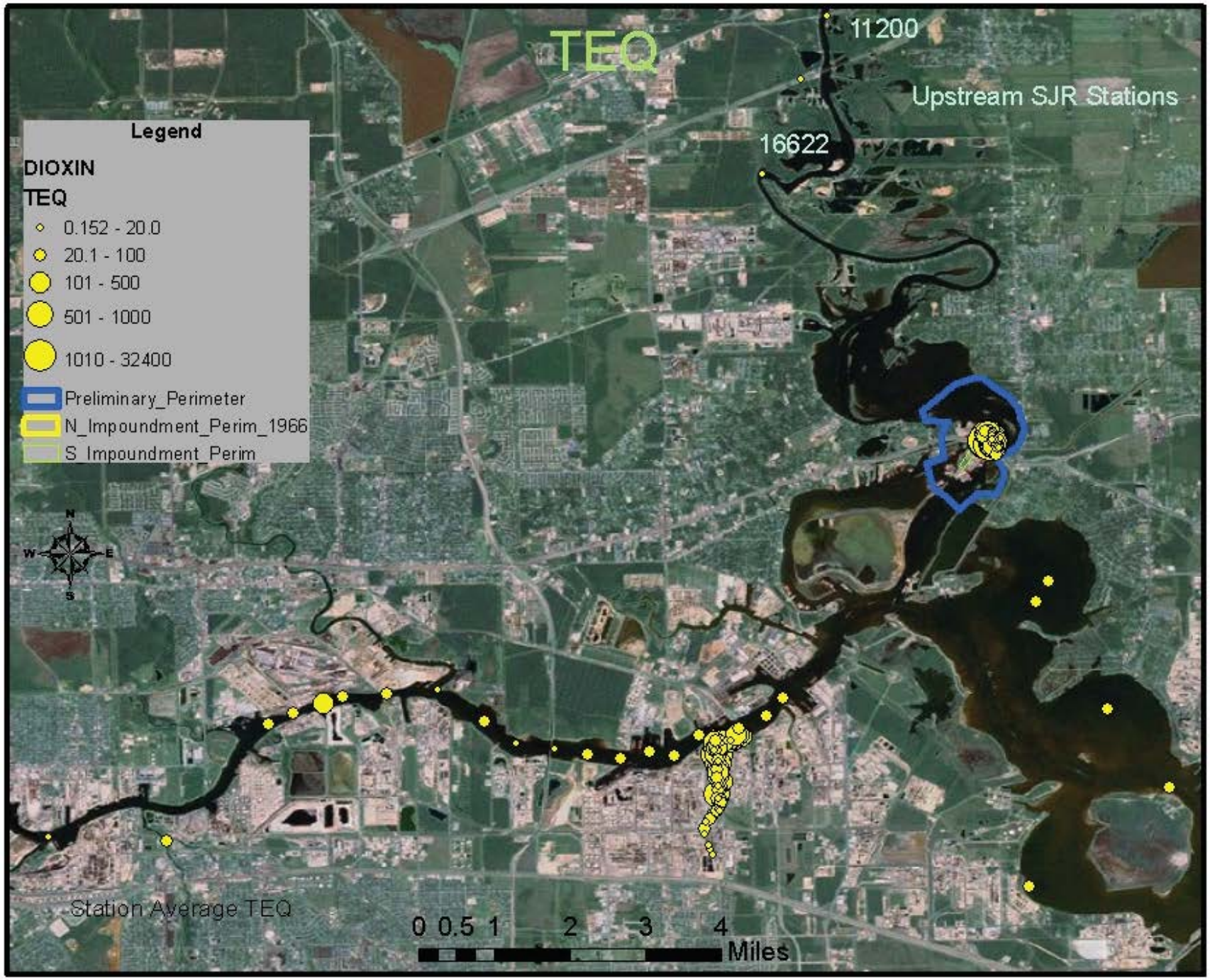
# SJRWP Congener Fingerprint



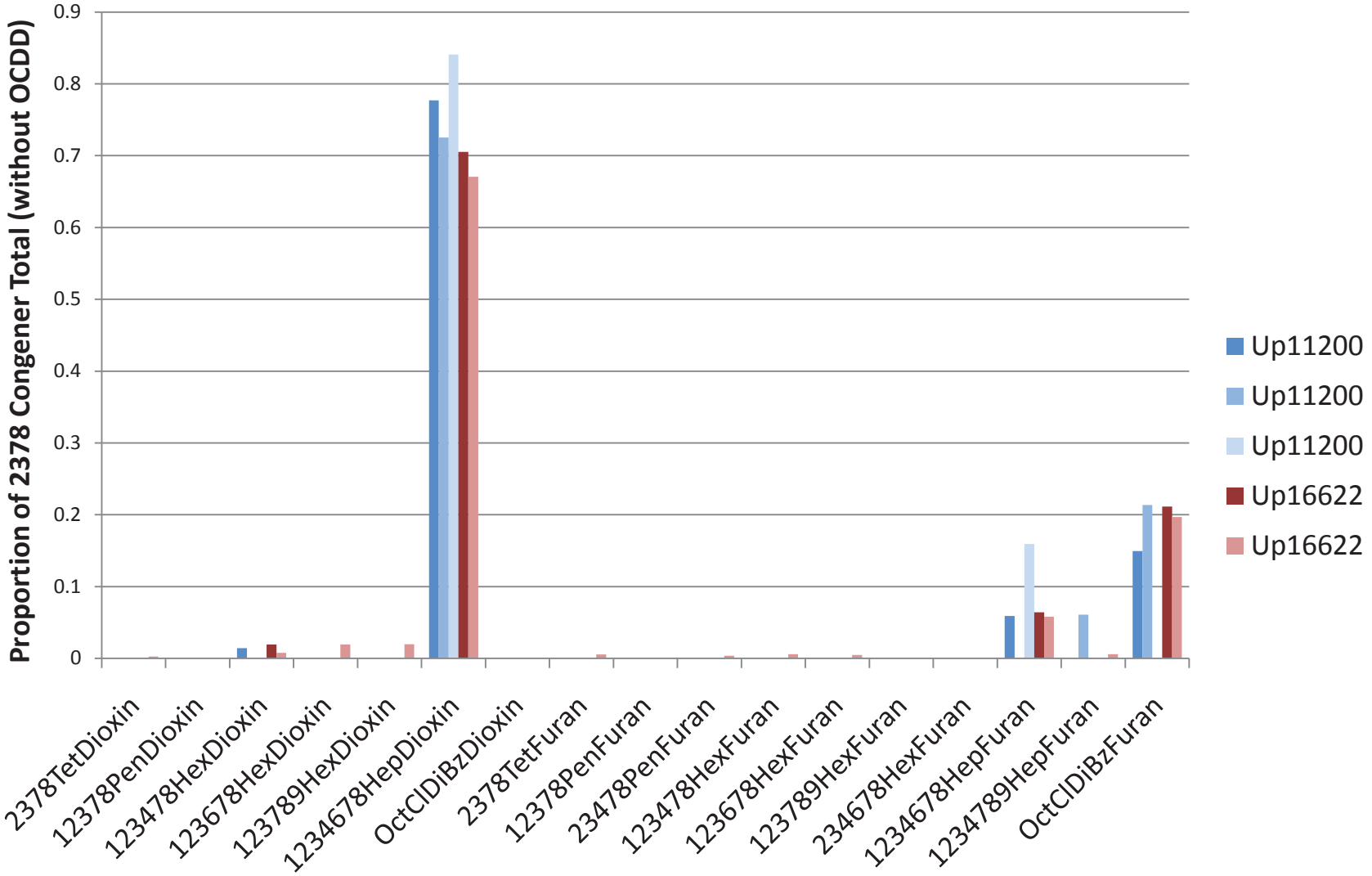

TEQ range = 10,080 to 32,400 ppt

# Observations - SJRWP

- SJRW Pits are not homogenous
- Clear evidence of deposition from other sources and “clean” mud
- Congener fingerprint is dominated by
  - **2378 Tetra-furan (TCDF),**
  - **2378 Tetra-dioxin (TCDD)**,
    - smaller amounts of other furans


TEQ
11200
Upstream SJR Stations
16622
Legend
DIOXIN
TEQ
0.152 - 20.0
20.1 - 100
101 - 500
501 - 1000
1010 - 32400
Preliminary_Perimeter
N_Impoundment_Perim_1966
S_Impoundment_Perim
N
W
E
S
Station Average TEQ
0 0.5 1 2 3 4
Miles

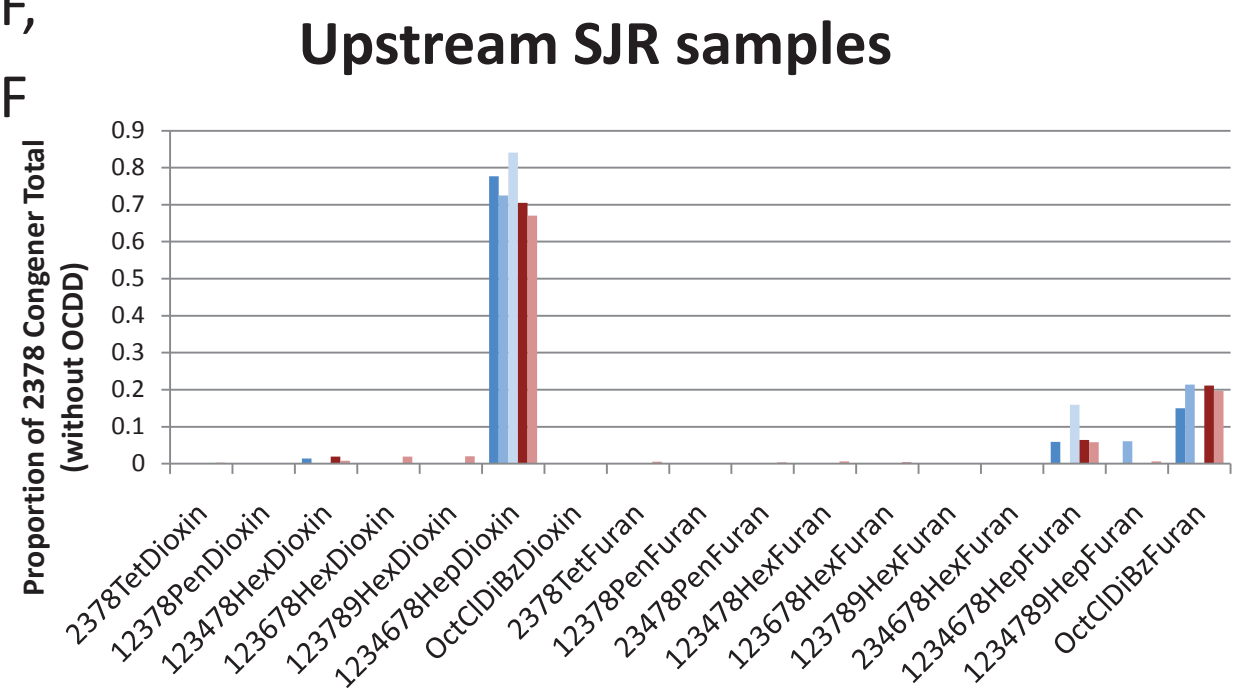
# Upstream SJR samples



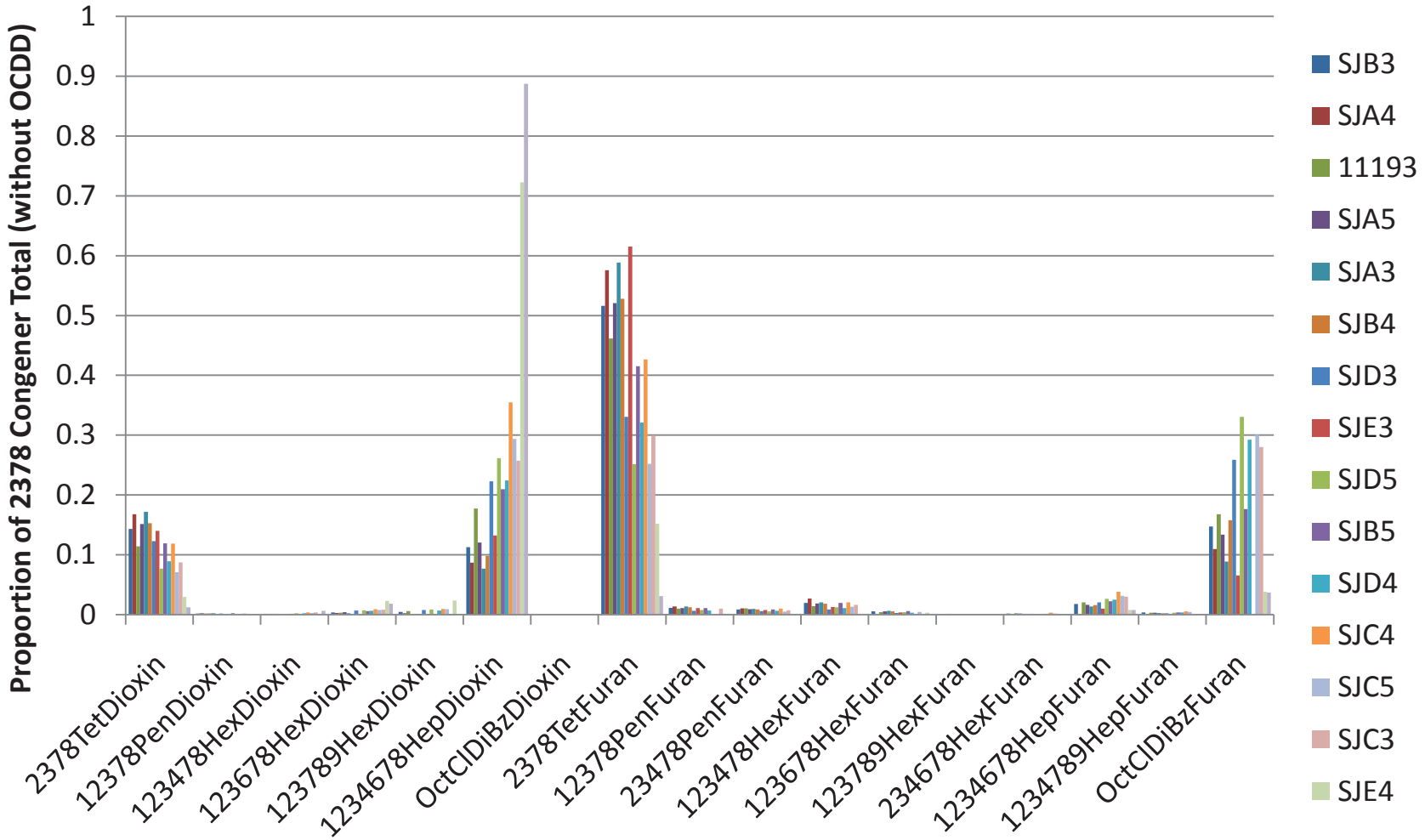

TEQ range = 0.4 to 3.1 ppt

# Observations - Upstream SJR

- Upstream (background) fingerprint dominated by
  - 1234678 HpCDD,
  - OCDF,
  - 1234678 HpCDF,
  - 1234789 HpCDF



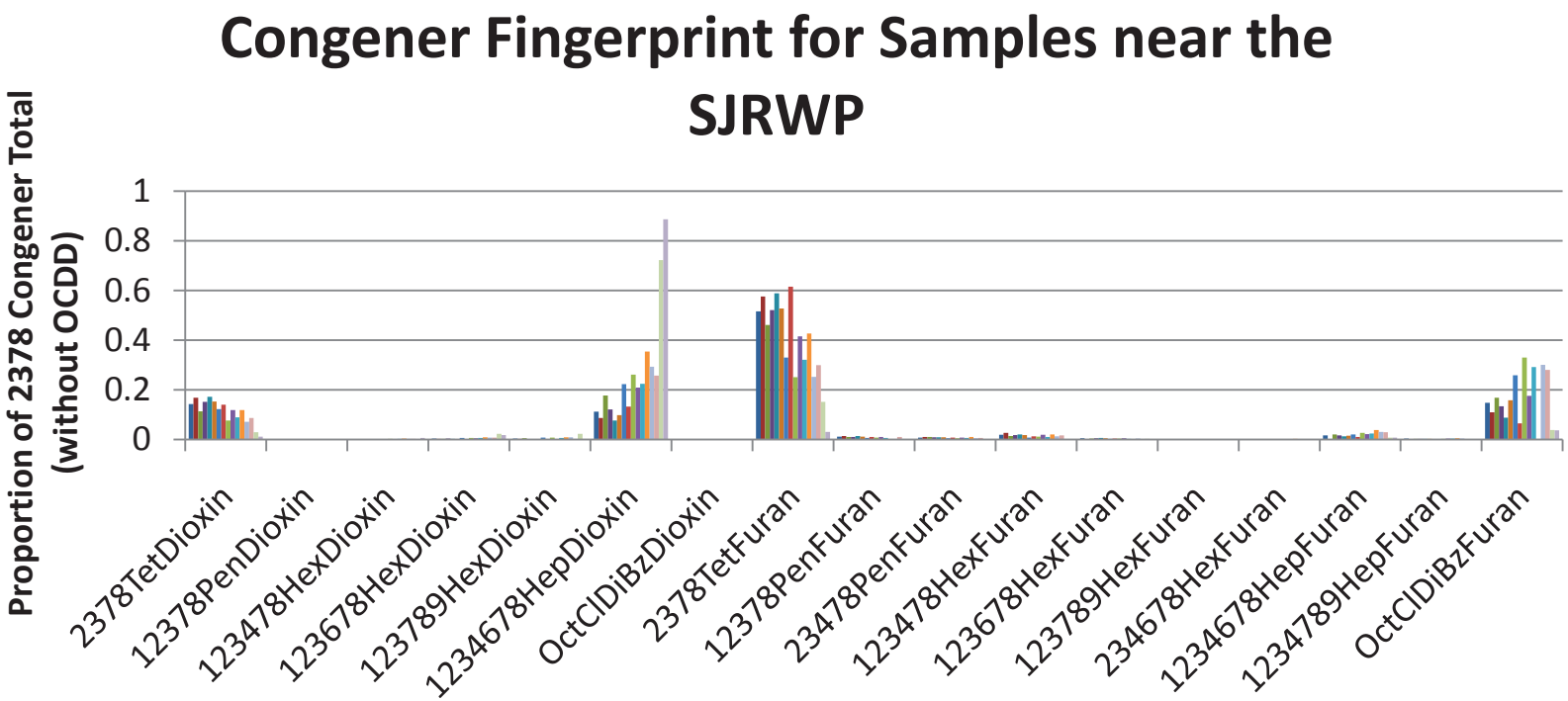
# Congener Fingerprint for Samples near the SJRWP




TEQ range for these samples = 2.4 to 93 ppt

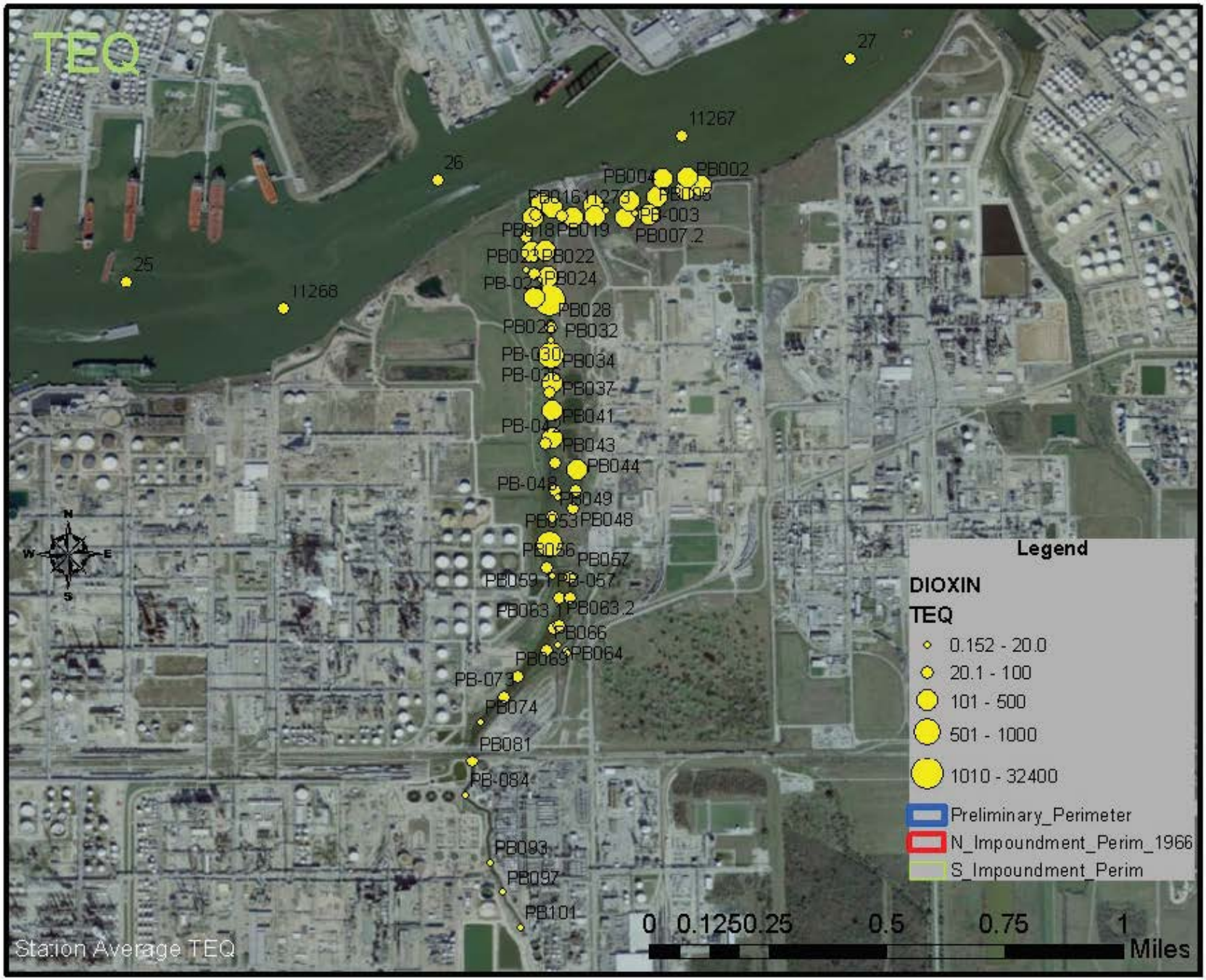
# Observations - Near Pit samples

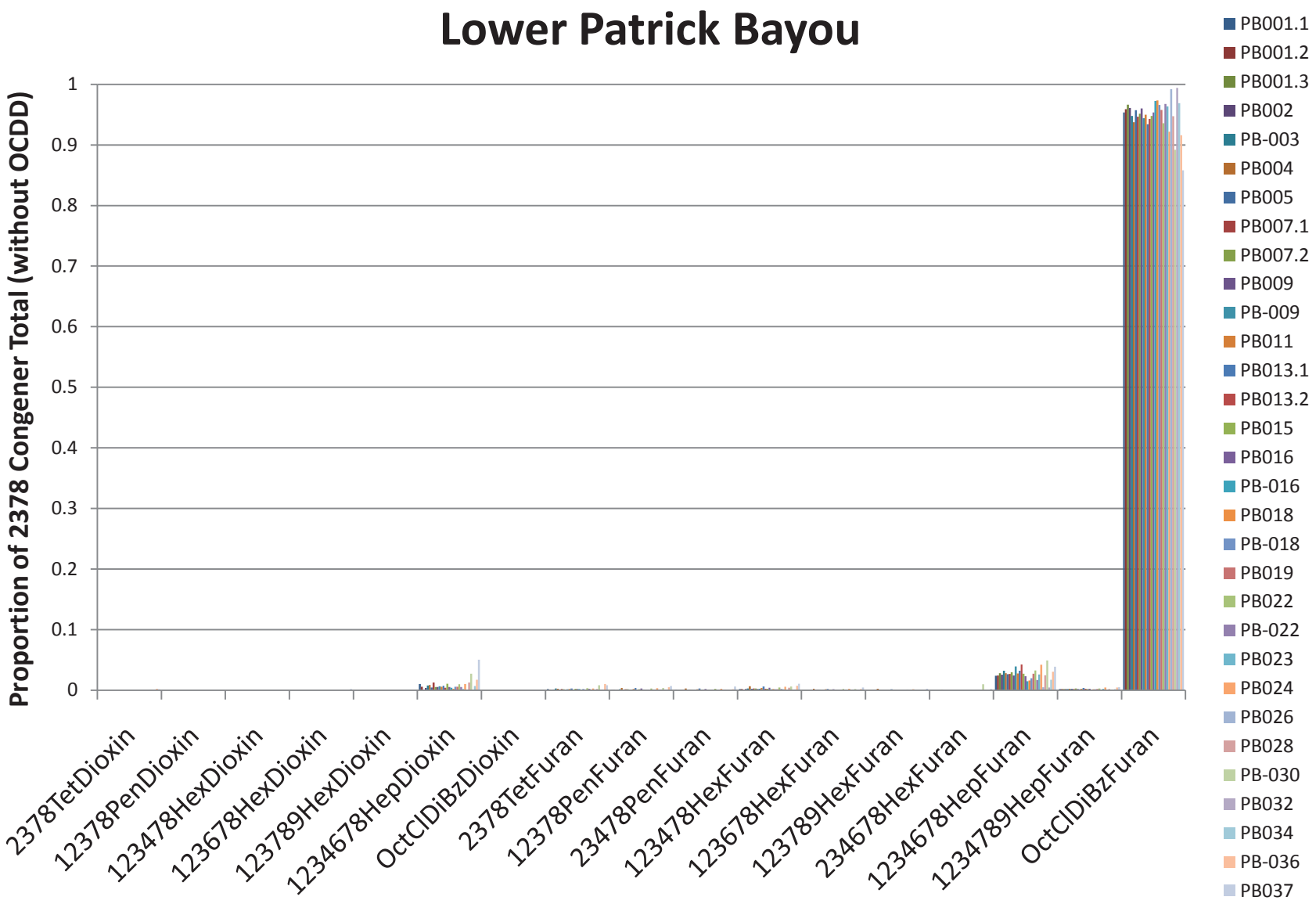
- Near-pit fingerprints are similar to pits,
  - but with lots more HpCDDs and OCDFs
  - and less PeCDFs and HxCDFs
- You can see the decline in %TCDF and %TCDD with the increase in %HpCDD



# Patrick Bayou

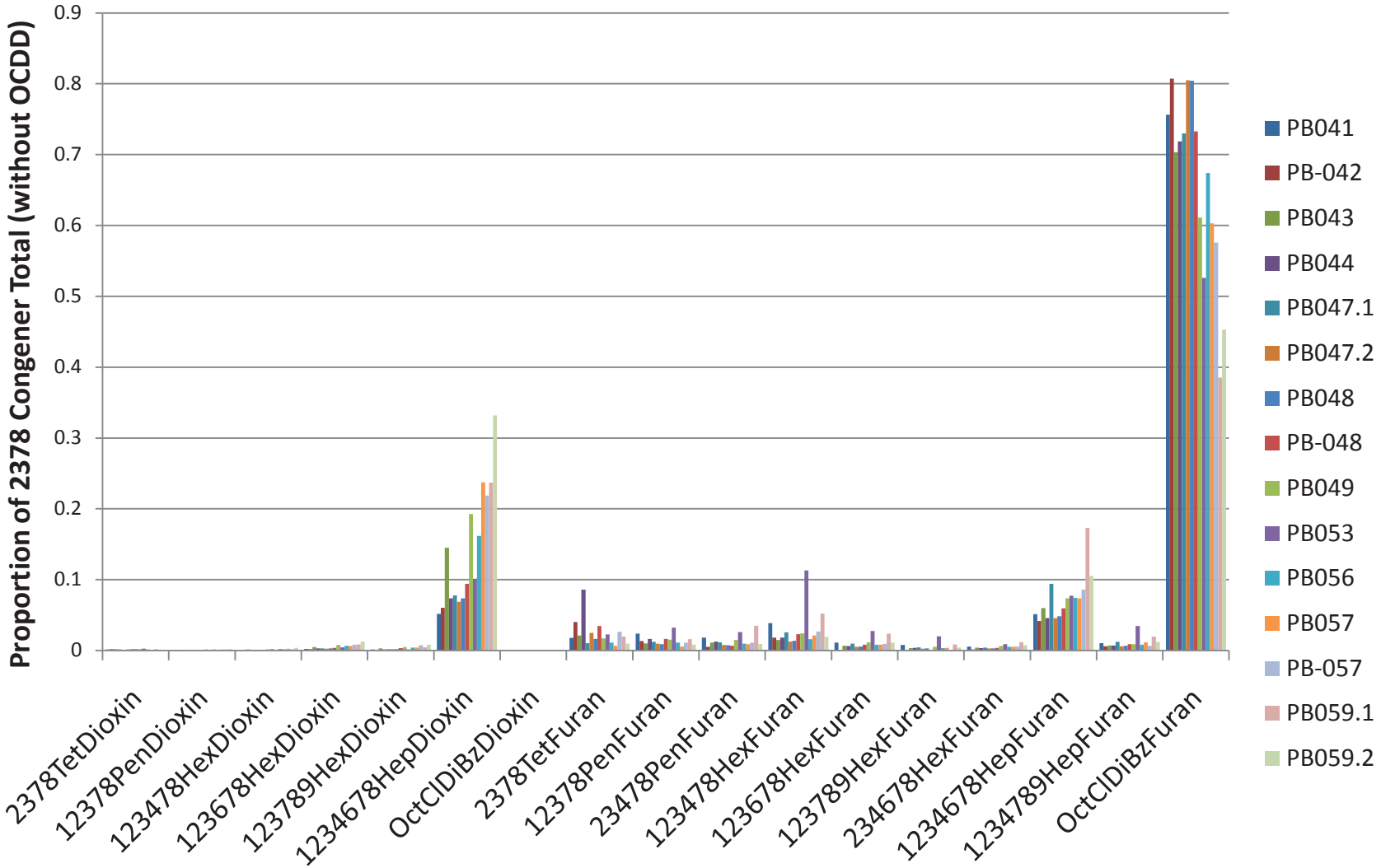
- 60 stations
- TEQ range:  0.2 to 2224 ppt
  - Average TEQ = 133 ppt  (Median = 73 ppt)
- High OCDF in lower reach
- Middle and upper reaches have various fingerprints


TEQ
27
11267
26
25
11268
PB002
PB007.2
PB022
PB024
PB028
PB032
PB034
PB037
PB041
PB043
PB044
PB049
PB048
PB057
PB063.2
PB066
PB064
PB074
PB081
PB093
PB097
PB101
N
S
E
W
Legend
DIOXIN
TEQ
0.152 - 20.0
20.1 - 100
101 - 500
501 - 1000
1010 - 32400
Preliminary_Perimeter
N_Impoundment_Perim_1966
S_Impoundment_Perim
0 0.1250.25 0.5 0.75 1
Miles
Station Average TEQ



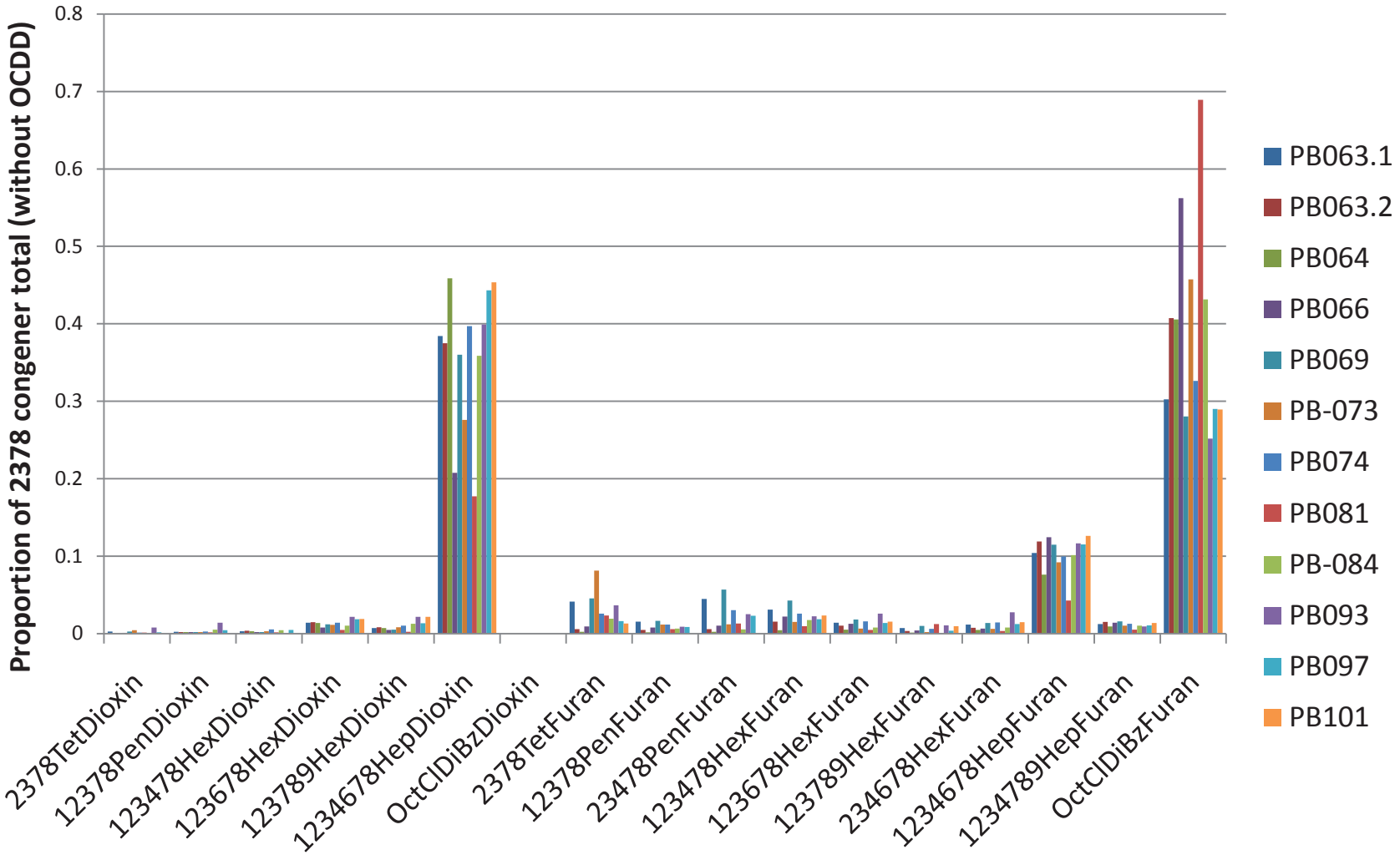

31 sites, average TEQ = 209 ppt, max TEQ = 2224 ppt at PB026

# Middle Patrick Bayou



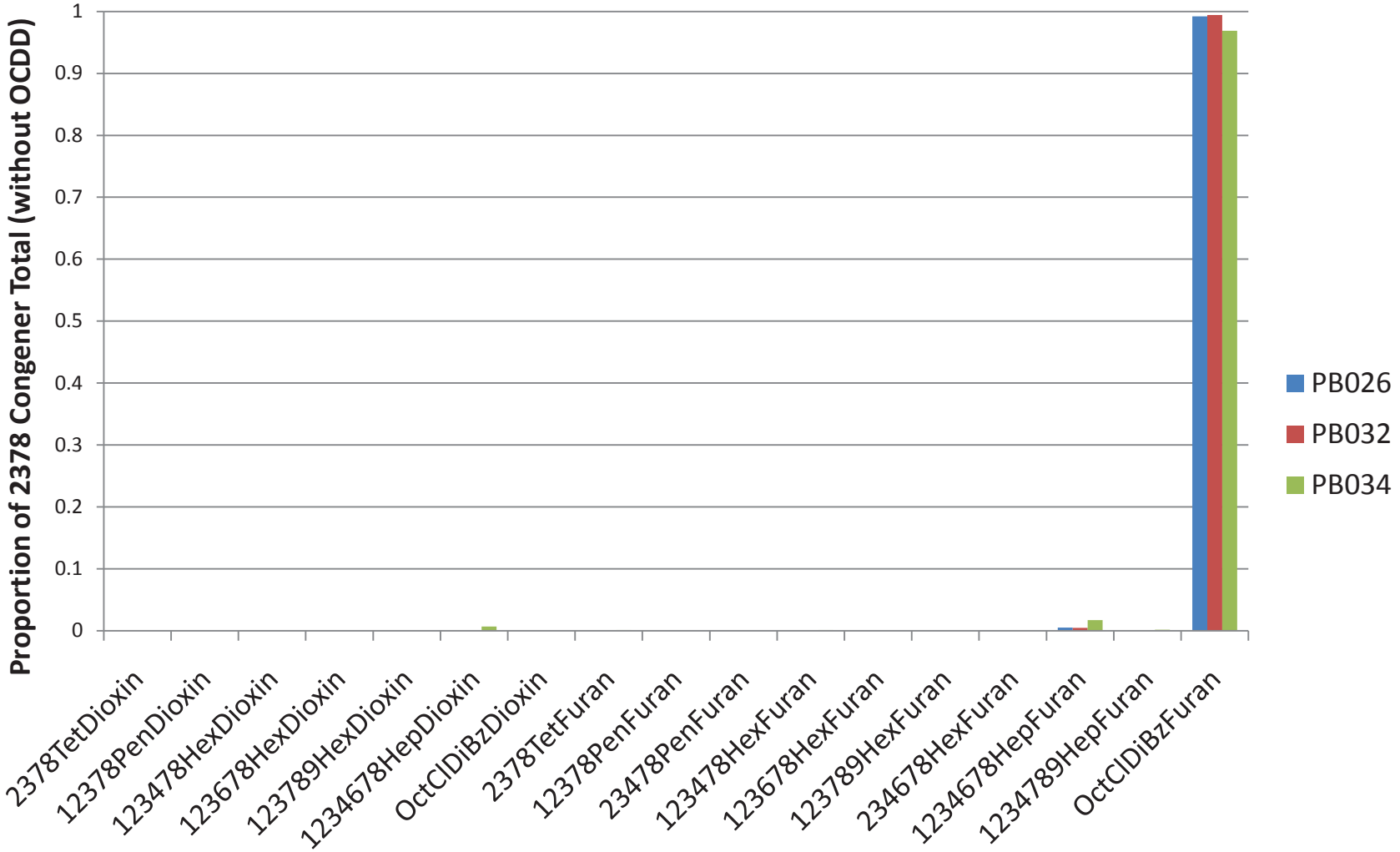

15 sites, average TEQ = 99 ppt, max TEQ = 610 ppt at PB053

# Upper Patrick Bayou




12 sites, average TEQ = 26 ppt, max TEQ = 84 ppt at PB069

# Patrick Bayou  Highest TEQ reach

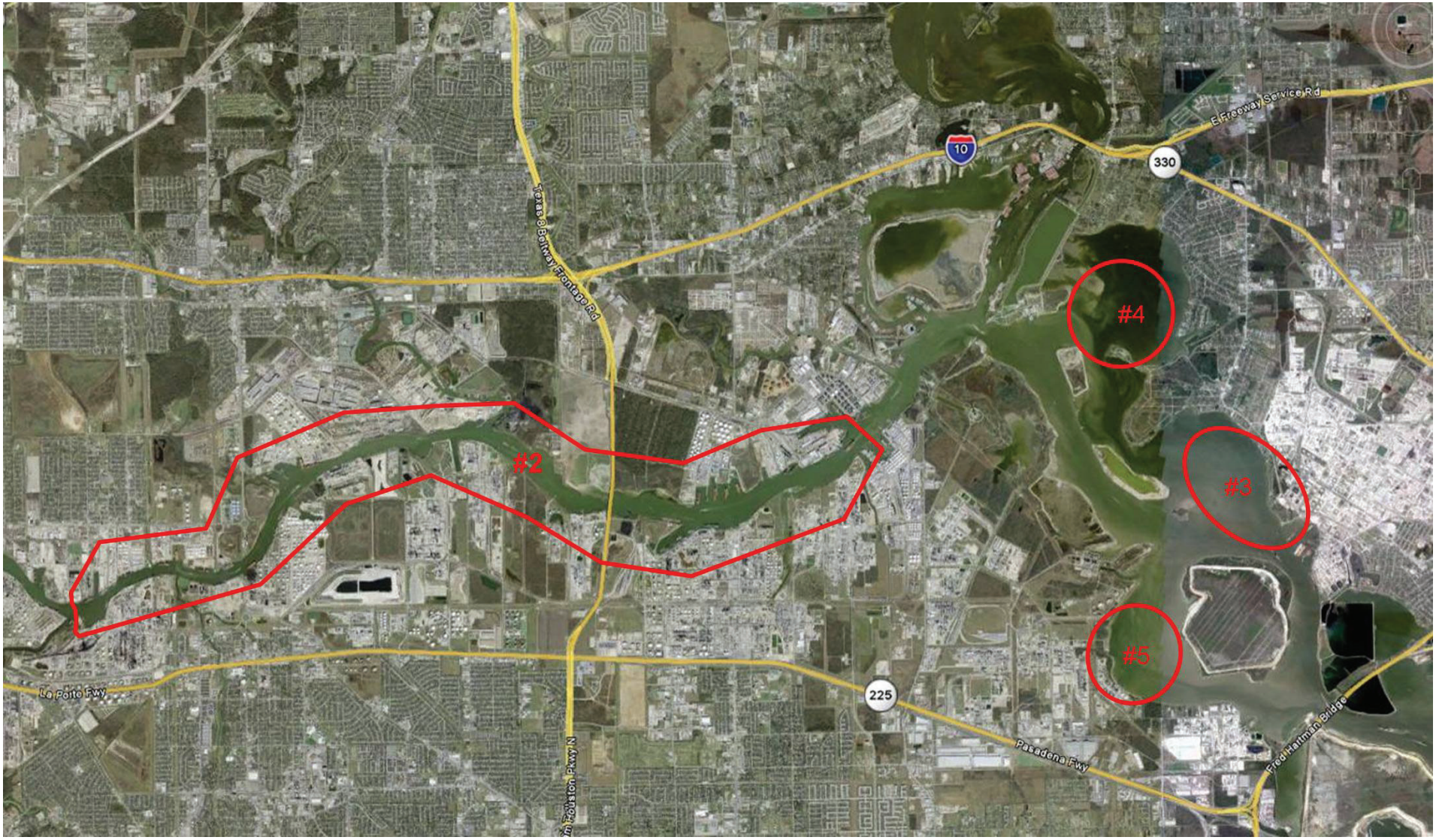



TEQ = 2224, 756, & 356 ppt

# Observations – Patrick Bayou

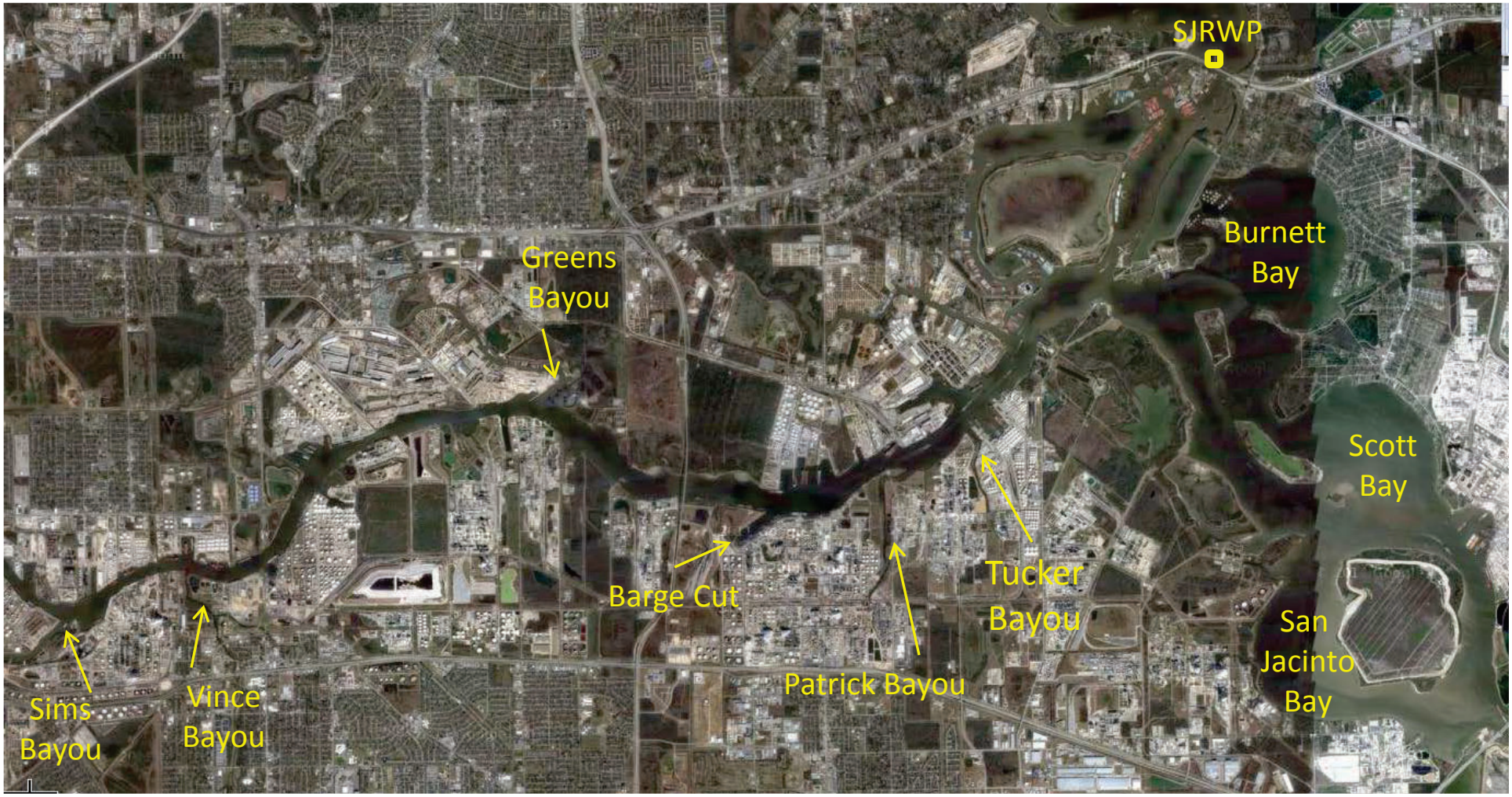
- Patrick Bayou downstream fingerprint dominated by OCDF
- Upstream fingerprint includes HpCDD and one of the HpCDFs, in addition to the OCDF
- Cleaner signal downstream, and as move upstream (away from HSC) more congeners appear
- In HSC,  strong decrease in OCDFs away from Patrick Bayou

# HSC – areas of noted elevated concentrations

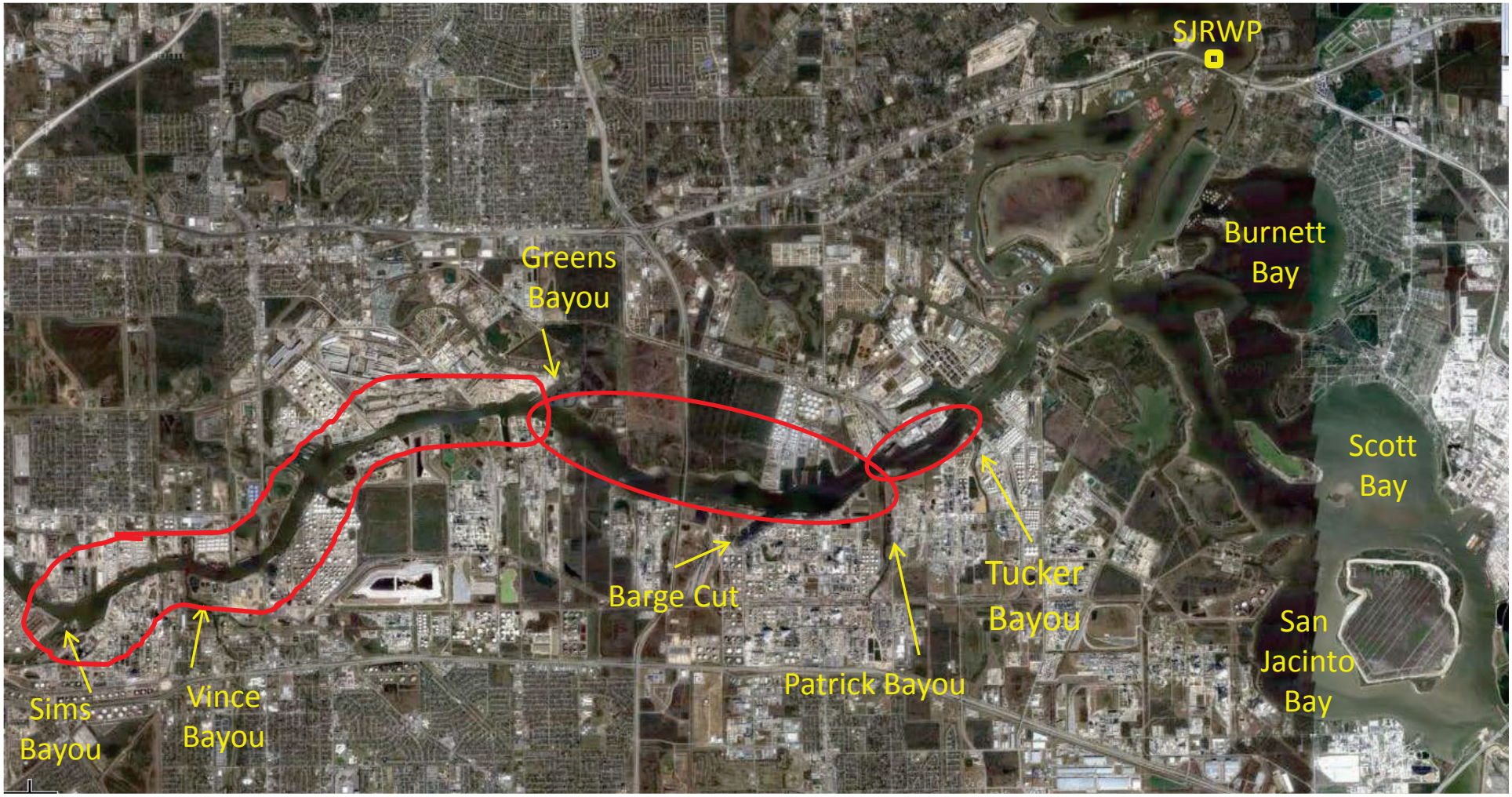


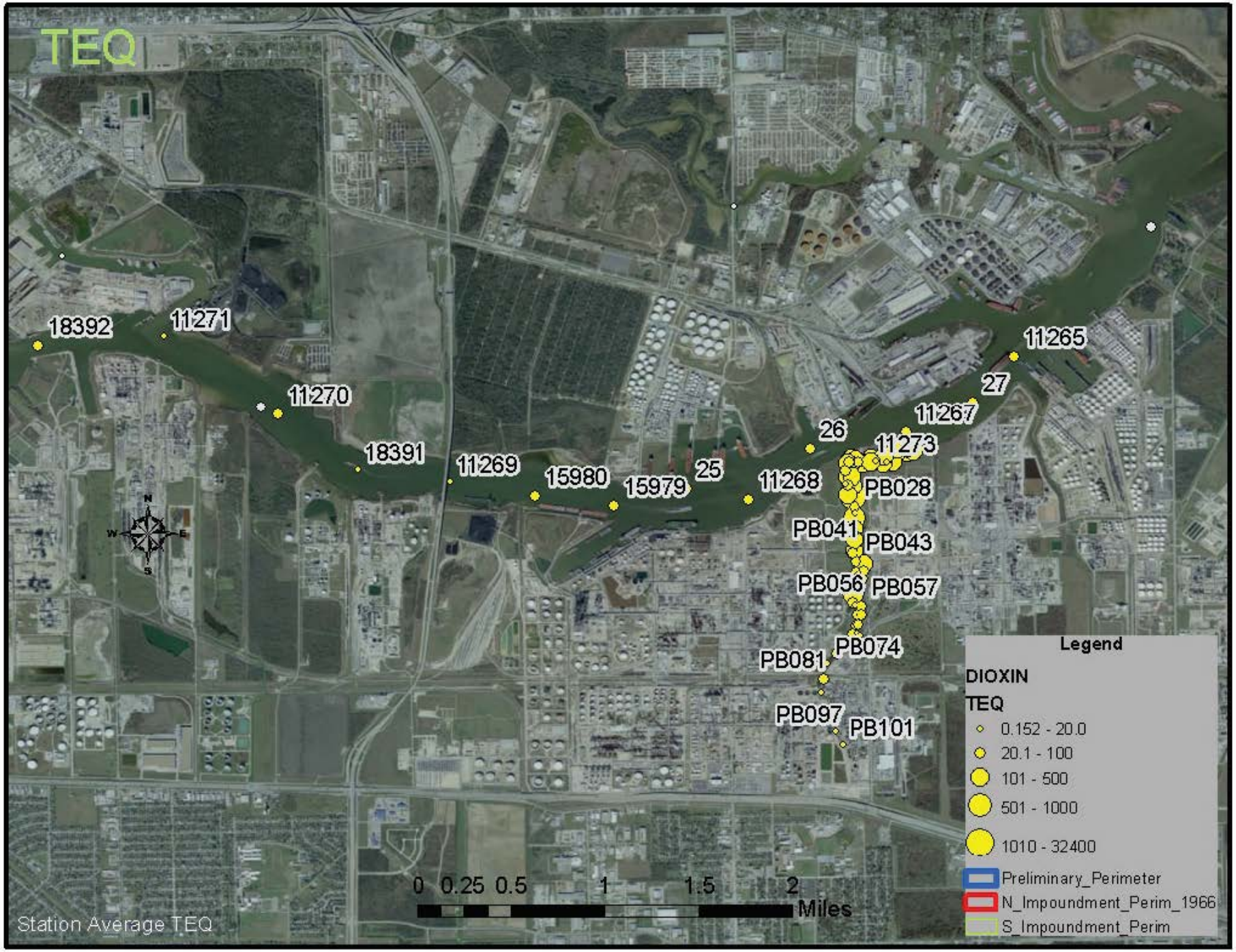

#2 = Buffalo Bayou of HSC; #3 = Scot Bay; #4 = Burnett Bay; #5 = San Jacinto Bay

# HSC Tributaries and Side Bays

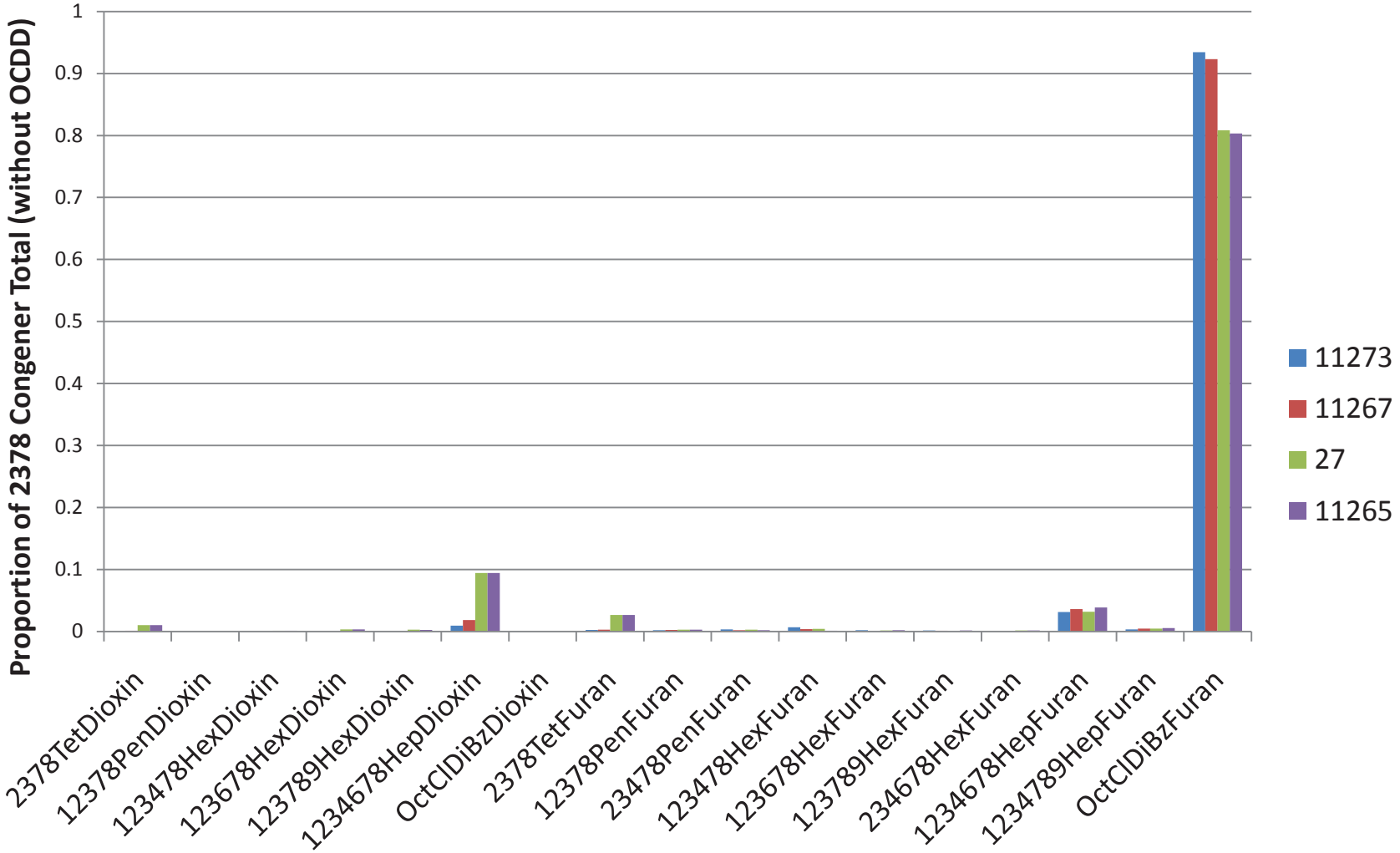


# HSC Tributaries and Side Bays



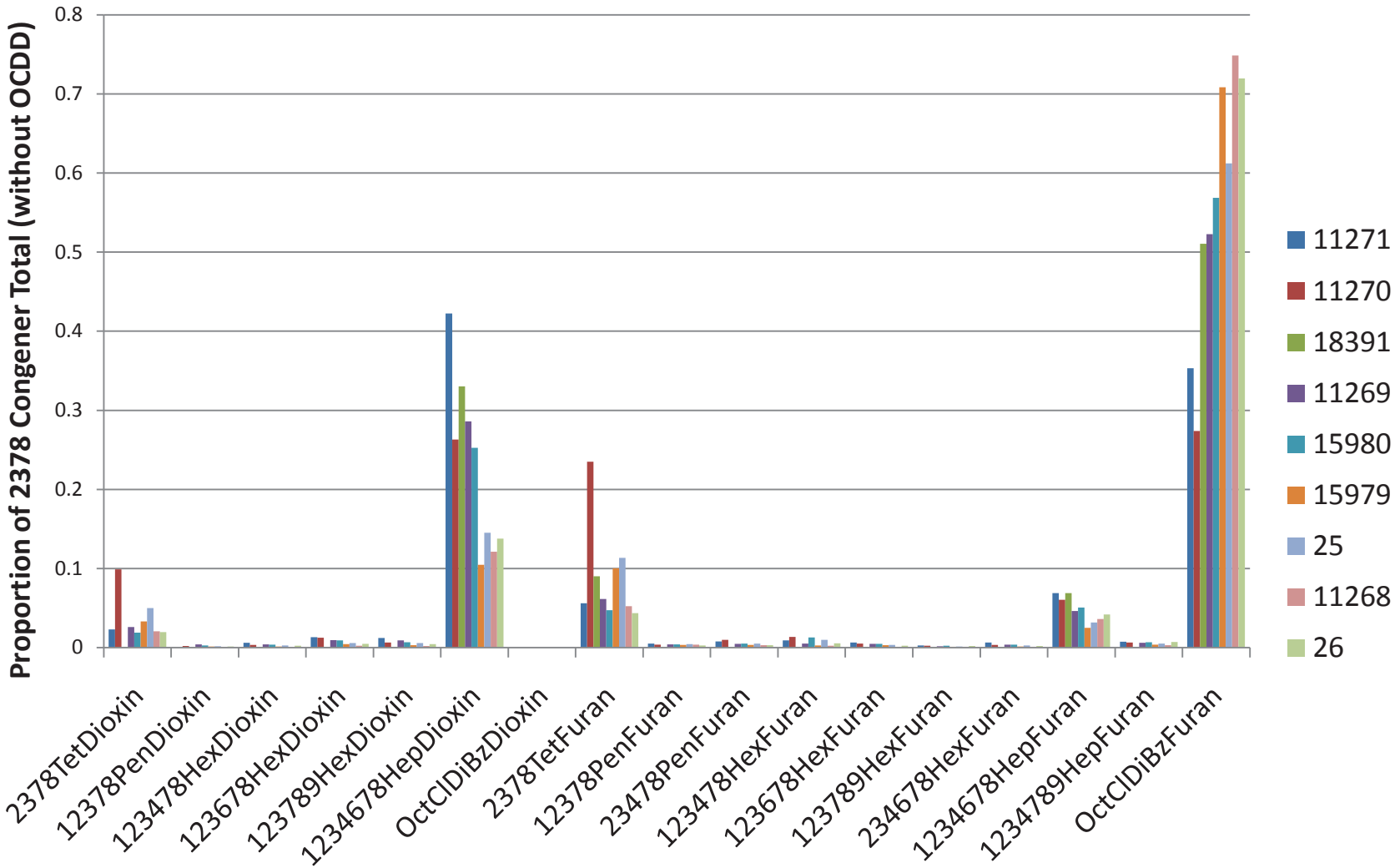

TEQ
18392
11271
11270
18391
11269
15980
15979
25
11268
26
11273
11267
27
11265
PB028
PB041
PB043
PB056
PB057
PB074
PB081
PB097
PB101
N
S
E
W
0 0.25 0.5 1 1.5 2
Miles
Station Average TEQ
Legend
DIOXIN
TEQ
0.152 - 20.0
20.1 - 100
101 - 500
501 - 1000
1010 - 32400
Preliminary_Perimeter
N_Impoundment_Perim_1966
S_Impoundment_Perim

# HSC - Patrick Bayou to Tucker Bayou

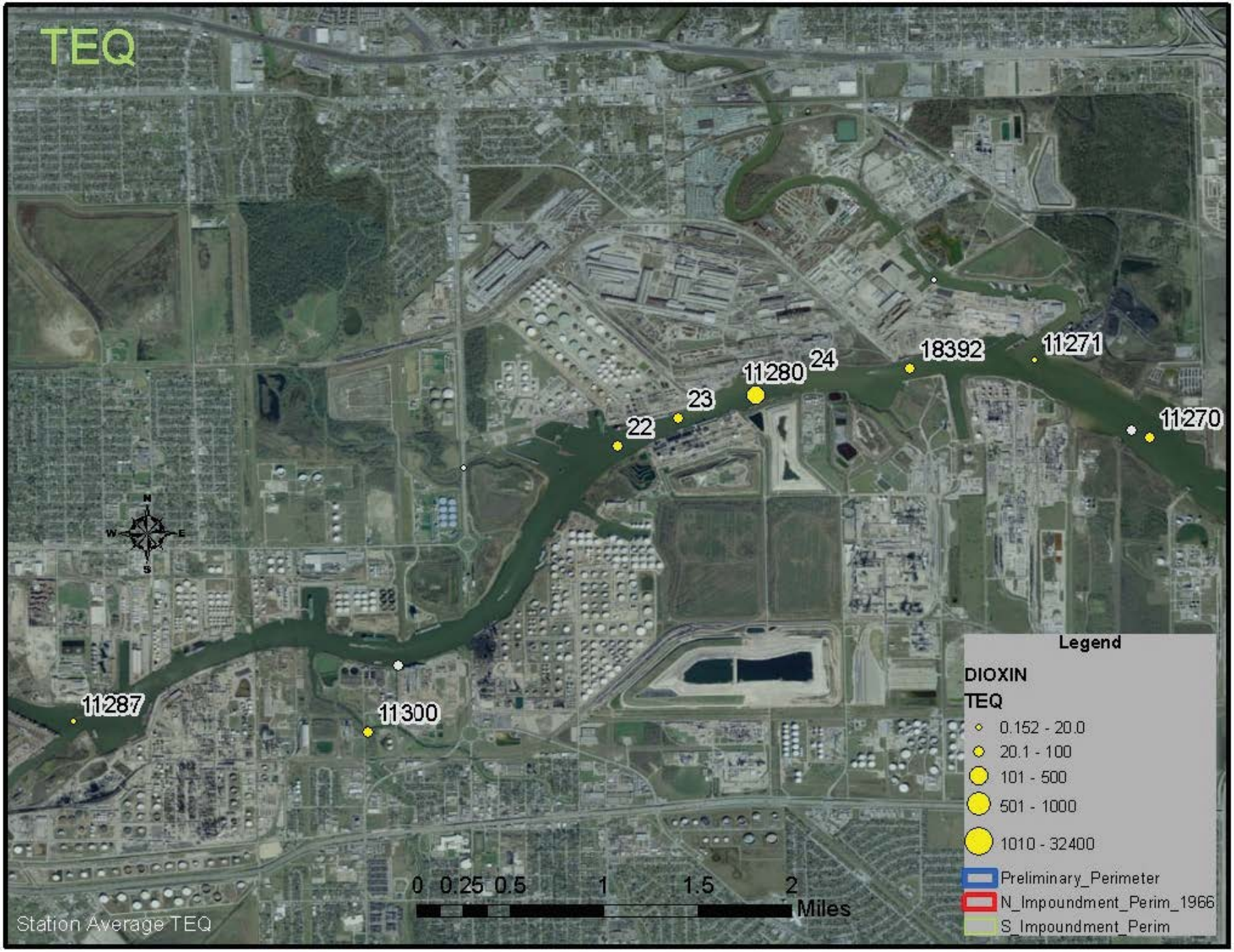


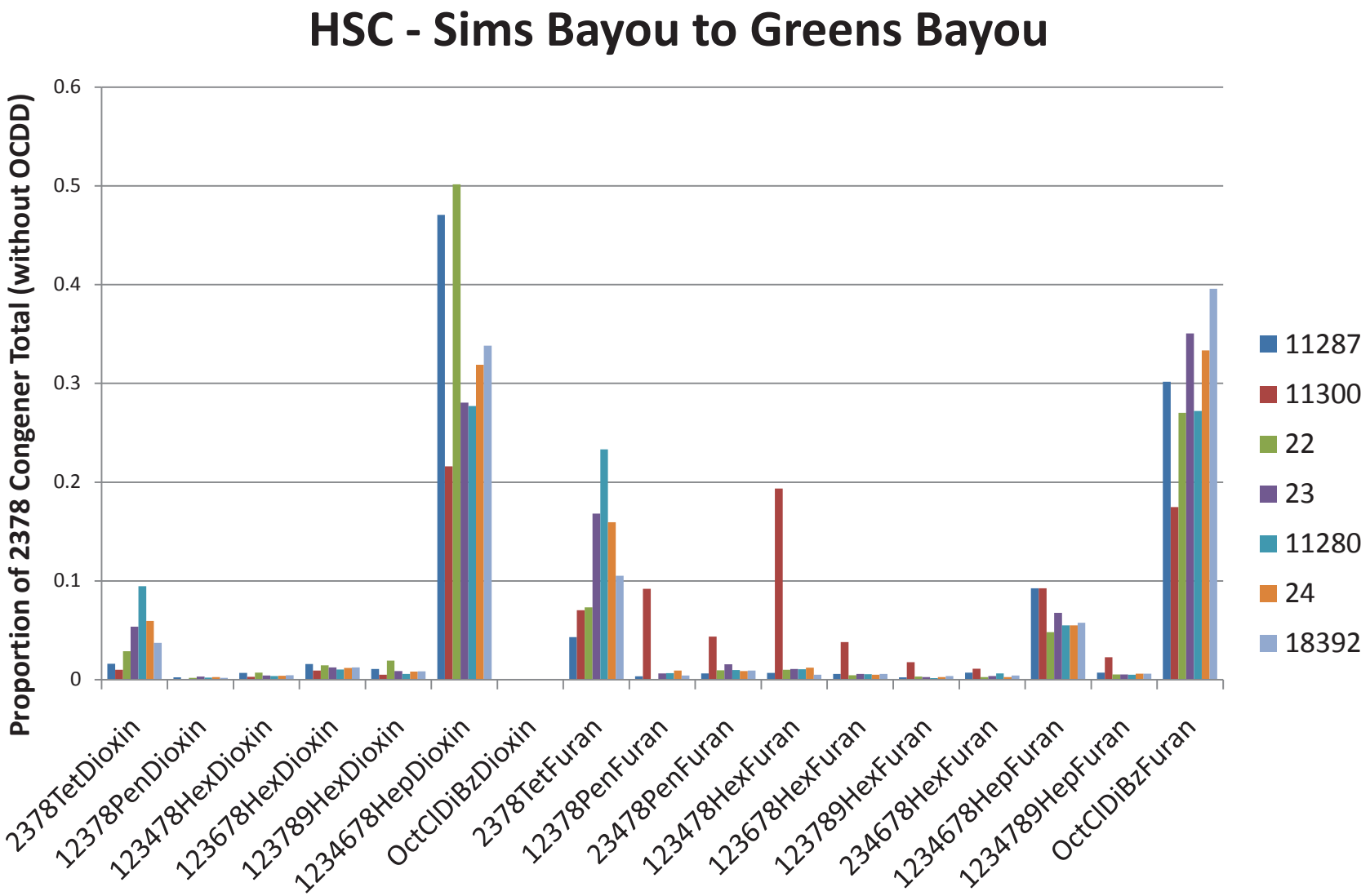

TEQ range = 22 to 159 ppt

# HSC - Greens Bayou to Patrick Bayou




11270 TEQ = 74 ppt, 15979 TEQ = 71 ppt, Others < 44 ppt


TEQ
11271
18392
24
11280
23
22
11270
11287
11300
N
W
E
S
Legend
DIOXIN
TEQ
0.152 - 20.0
20.1 - 100
101 - 500
501 - 1000
1010 - 32400
Preliminary_Perimeter
N_Impoundment_Perim_1966
S_Impoundment_Perim
0 0.25 0.5 1 1.5 2
Miles
Station Average TEQ




11287 TEQ = 14 ppt, 11300 TEQ = 84 ppt 11280 TEQ = 194 ppt, others < 63 ppt

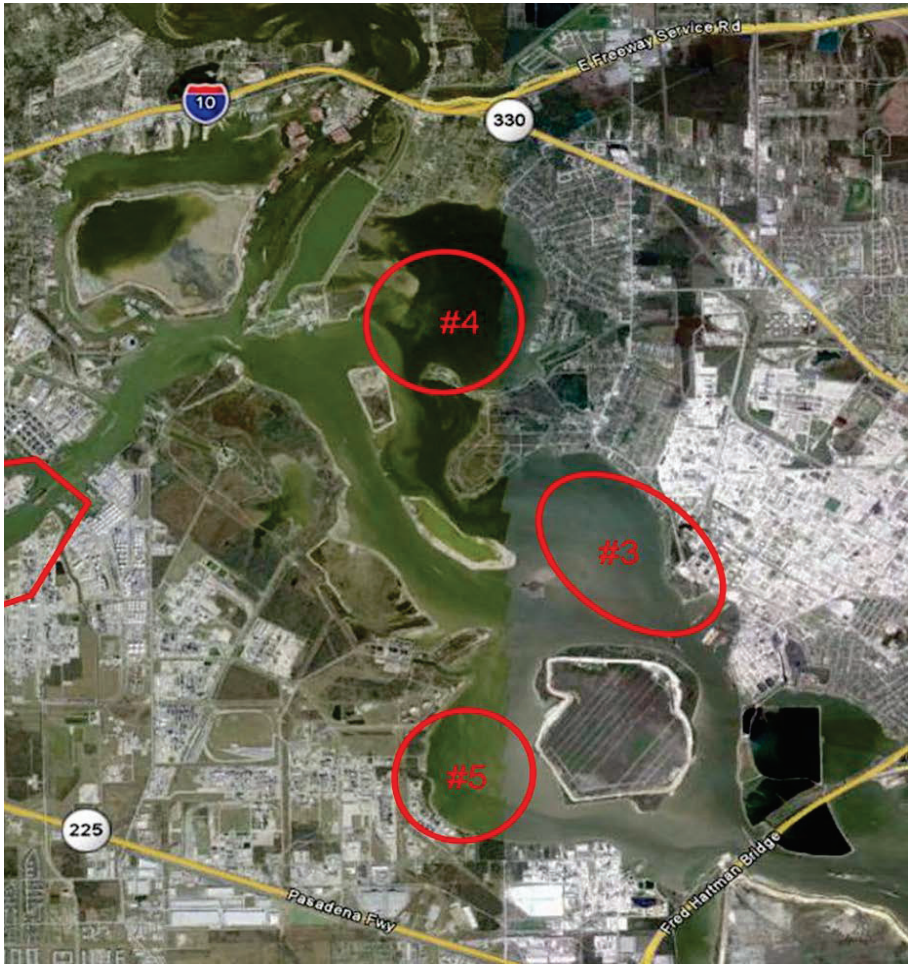
# Observations – HSC/Buffalo Bayou

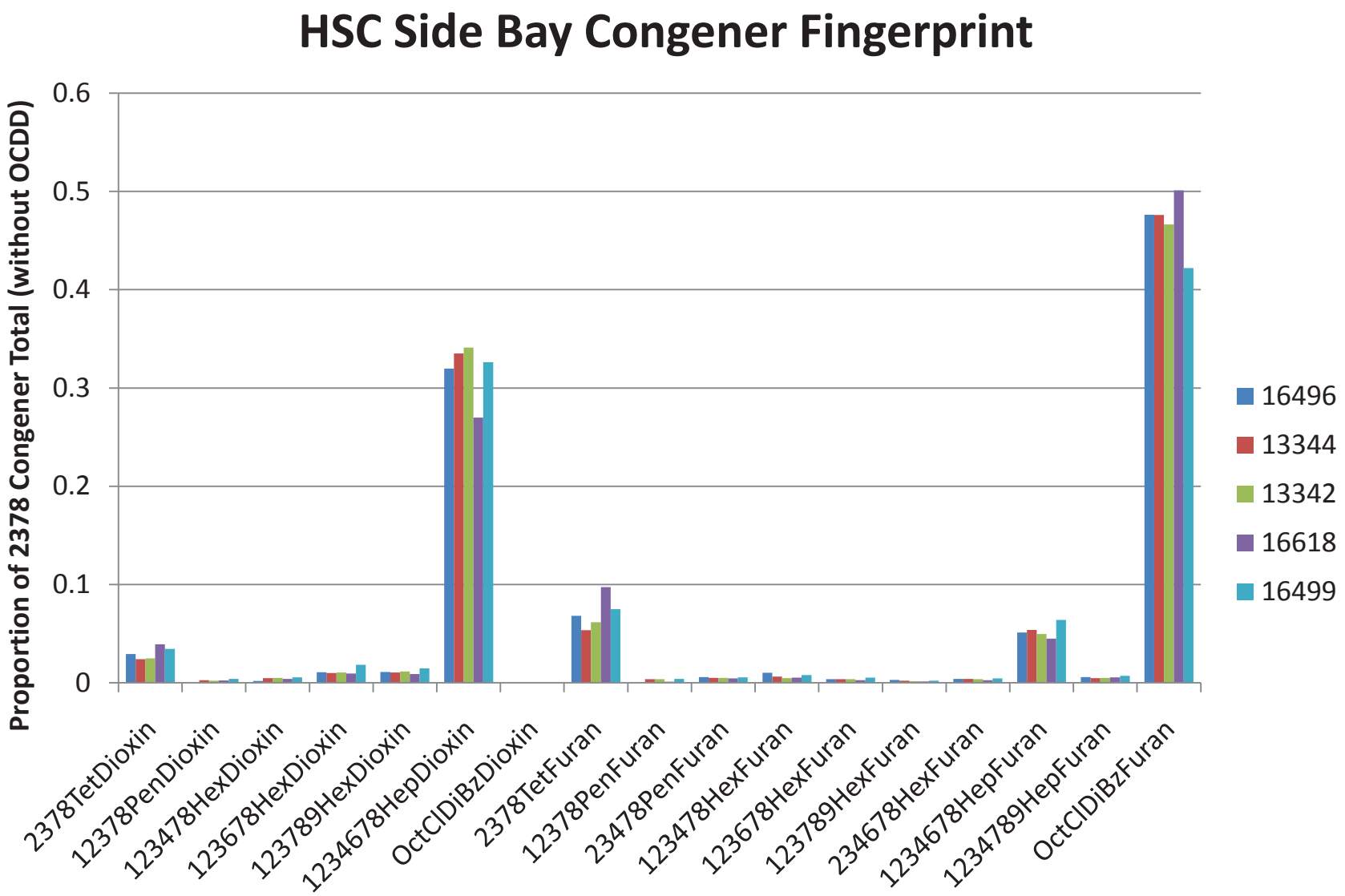
- Patrick Bayou to Tucker Bayou: fingerprint dominated by OCDF
  - some HpCDDs, TCDFs, and HpCDFs
- Greens Bayou to Patrick Bayou: fingerprint dominated by OCDF
  - Some HpCDDs, more TCDFs, and HpCDFs
- Sims Bayou to Greens Bayou: fingerprint dominated by OCDF
  - some HpCDDs, TCDFs, and HpCDFs
  - Small amounts of numerous other congeners

# HSC Side Bays

- All have similar fingerprints and TEQ levels

- Burnett Bay
  - 16496, TEQ = 34 ppt
  - 13344, TEQ = 29 ppt
- Scott Bay
  - 13342, TEQ = 29 ppt
  - 16618, TEQ = 24 ppt
- San Jacinto Bay
  - 16499, TEQ = 21.6 ppt




HSC Side Bay Congener Fingerprint
Proportion of 2378 Congener Total (without OCDD)
0.6
0.5
0.4
0.3
0.2
0.1
0
2378TetDioxin
12378PenDioxin
123478HexDioxin
123678HexDioxin
123789HexDioxin
1234678HepDioxin
OctClDiBzDioxin
2378TetFuran
12378PenFuran
23478PenFuran
123478HexFuran
123678HexFuran
123789HexFuran
234678HexFuran
1234678HepFuran
1234789HepFuran
OctClDiBzFuran
16496
13344
13342
16618
16499

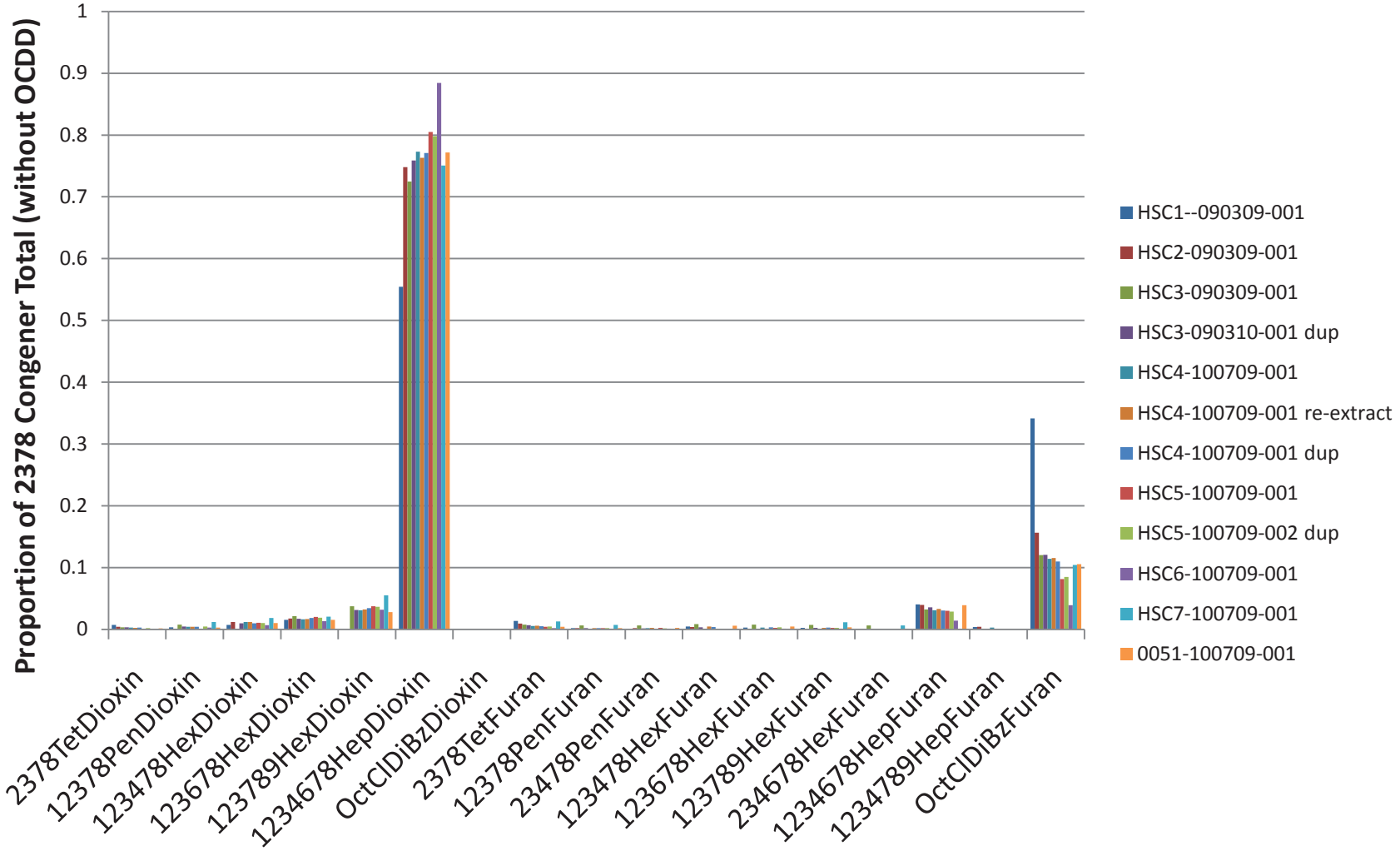
# Observations – HSC Side Bays

- All three side bays have very similar fingerprints
  - All three are dominated by OCDF; followed by HpCDDs, TCDFs, HpCDFs and TCDDs.
  - Each also has small amounts of other congeners
  - It is worth noting that this fingerprint appears similar to upstream HSC (OCDF, HpCDDs, HpCDFs) and San Jacinto (TCDDs & TCDFs) though the upstream HSC signal is more prominent

# Galveston Bay Samples

- TEQs range from 6.4 ppt to less than 1 ppt
- Fingerprint similar to Upstream SJR background fingerprint
- TEQs on the picture (right) were calculated using WHO 2005 TEFs

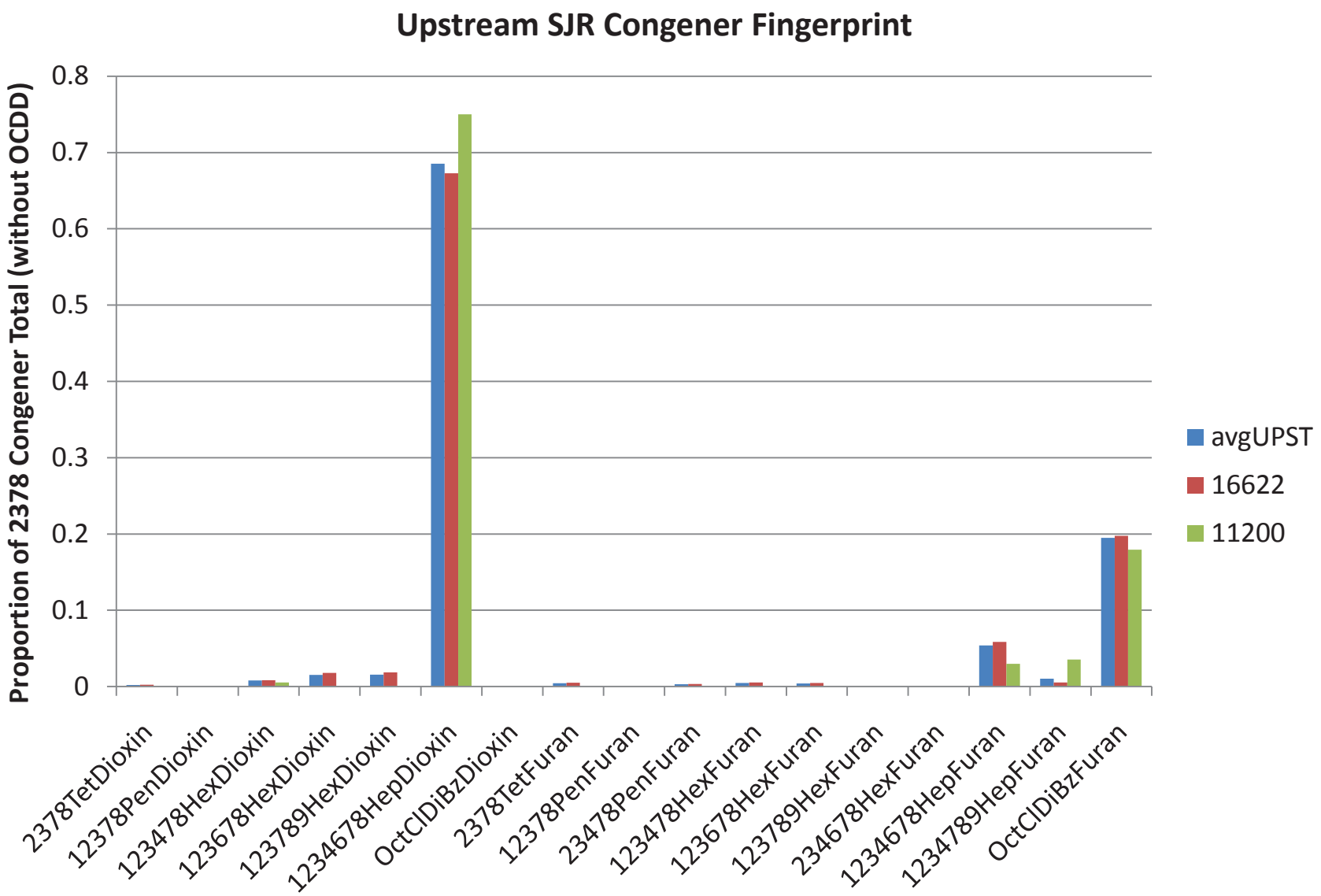
# Galveston Bay Samples




TEQ range from 0.2 to 6.4 ppt

# Obserevations – HSC/Galveston Bay

- Fingerprint for all stations dominated by HpCDDs; followed by OCDF, HpCDDs and HpCDFs
  - Small amounts of most other congeners
- HSC1 exhibited highest TEQ
- Decreasing TEQ with distance downstream
- Looks much like the upstream SJR samples once you get into Galveston Bay




TEQ range = 0.4 to 3.1 ppt