Detroit River Phosphorus Loading Determination

Debbie Burniston[1], Robert McCrea[2], Paul Klawunn[1], Rosanne Ellison [3] , Aaron Thompson[4] , Jacob Bruxer[4]

1 Environment Canada, Water Quality Monitoring and Surveillance Office, Canada Center for Inland Waters, 867 Lakeshore Rd. Burlington, Ontario, L7R 4A6

2 Environment Canada-Retired

3 United States Environmental Protection Agency-Great Lakes National Program Office, 9311 Groh Road, Grosse Ile, Michigan 48138

4 Environment Canada, Boundary Waters Issues Unit, Canada Center for Inland Waters, 867 Lakeshore Rd. Burlington, Ontario, L7R 4A6

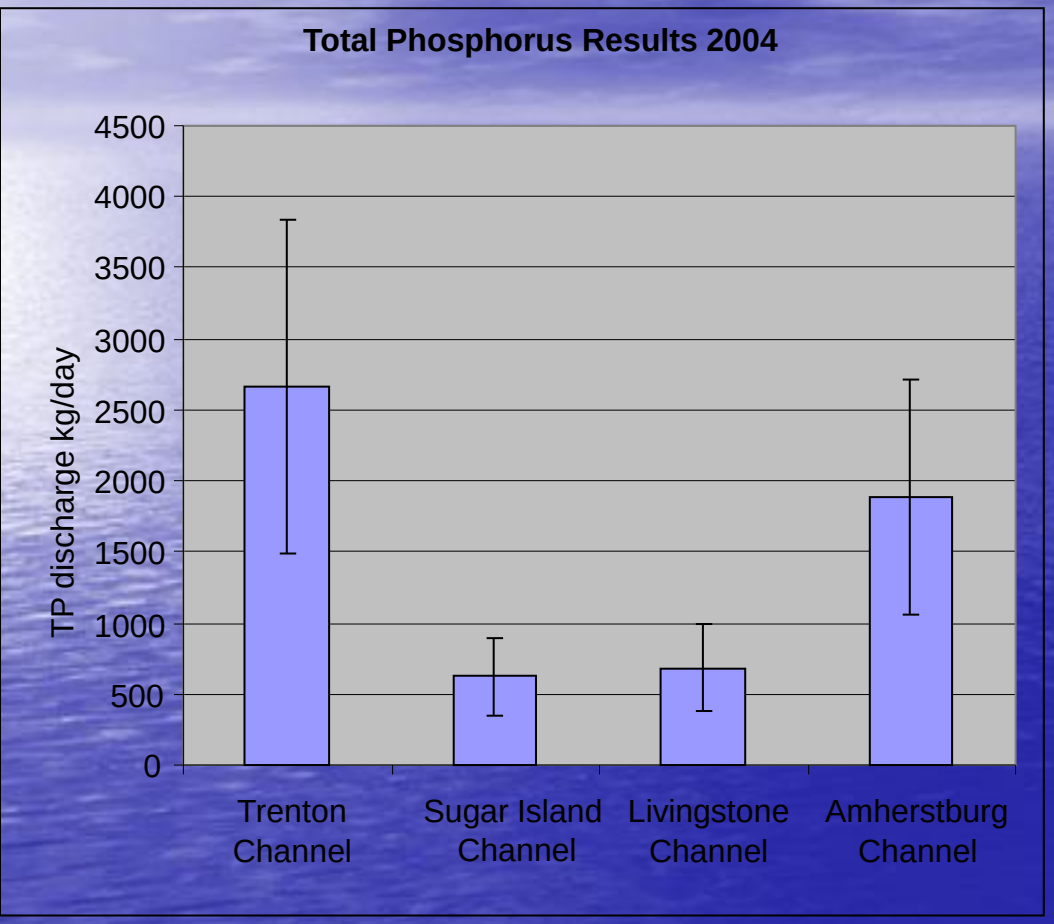
Objective

- Characterize Detroit River water concentrations across the river
- To determine the % soluble reactive phosphorus
- Estimate daily TP discharge into Lake Erie from the Detroit R.

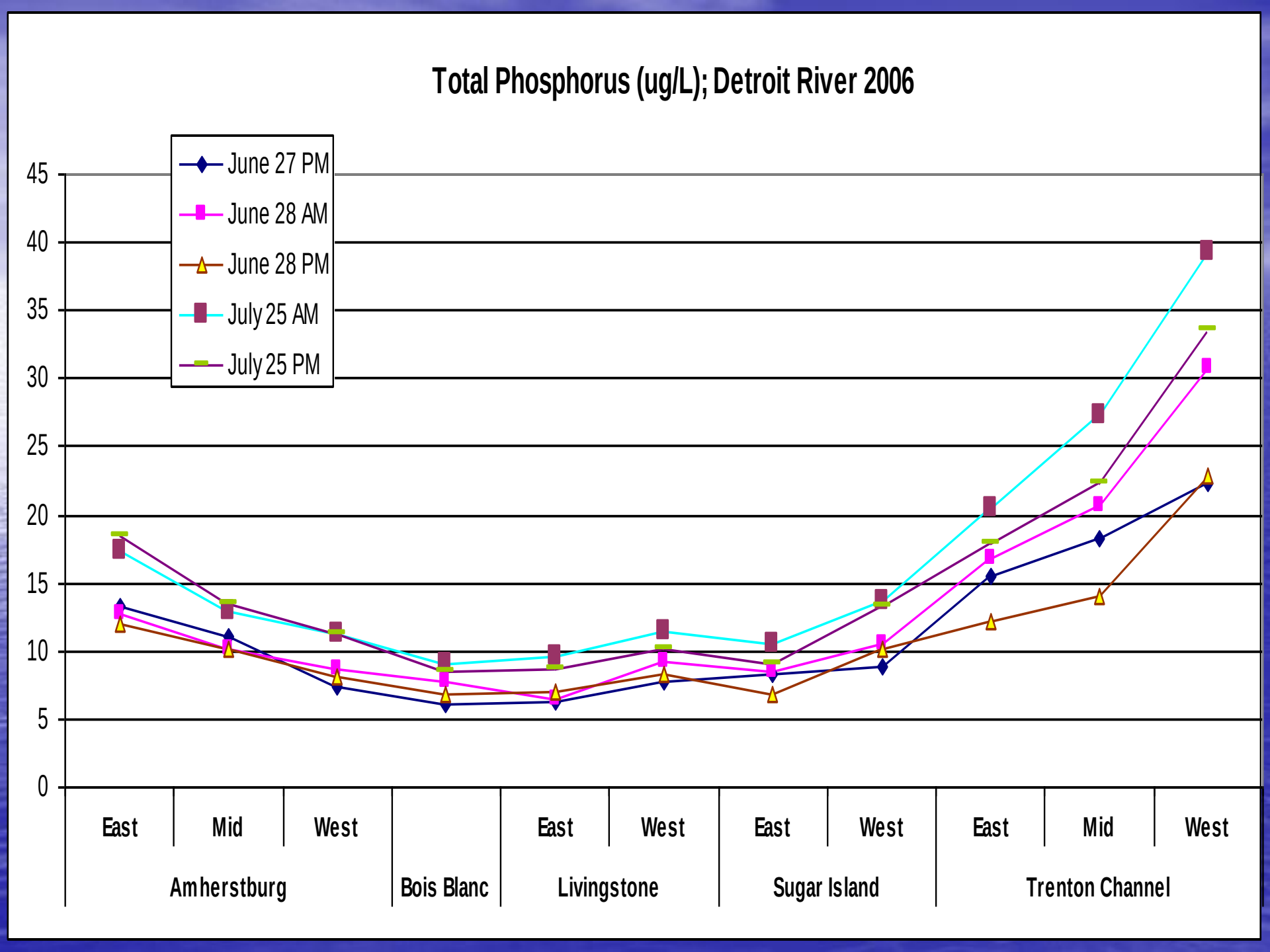
Methods

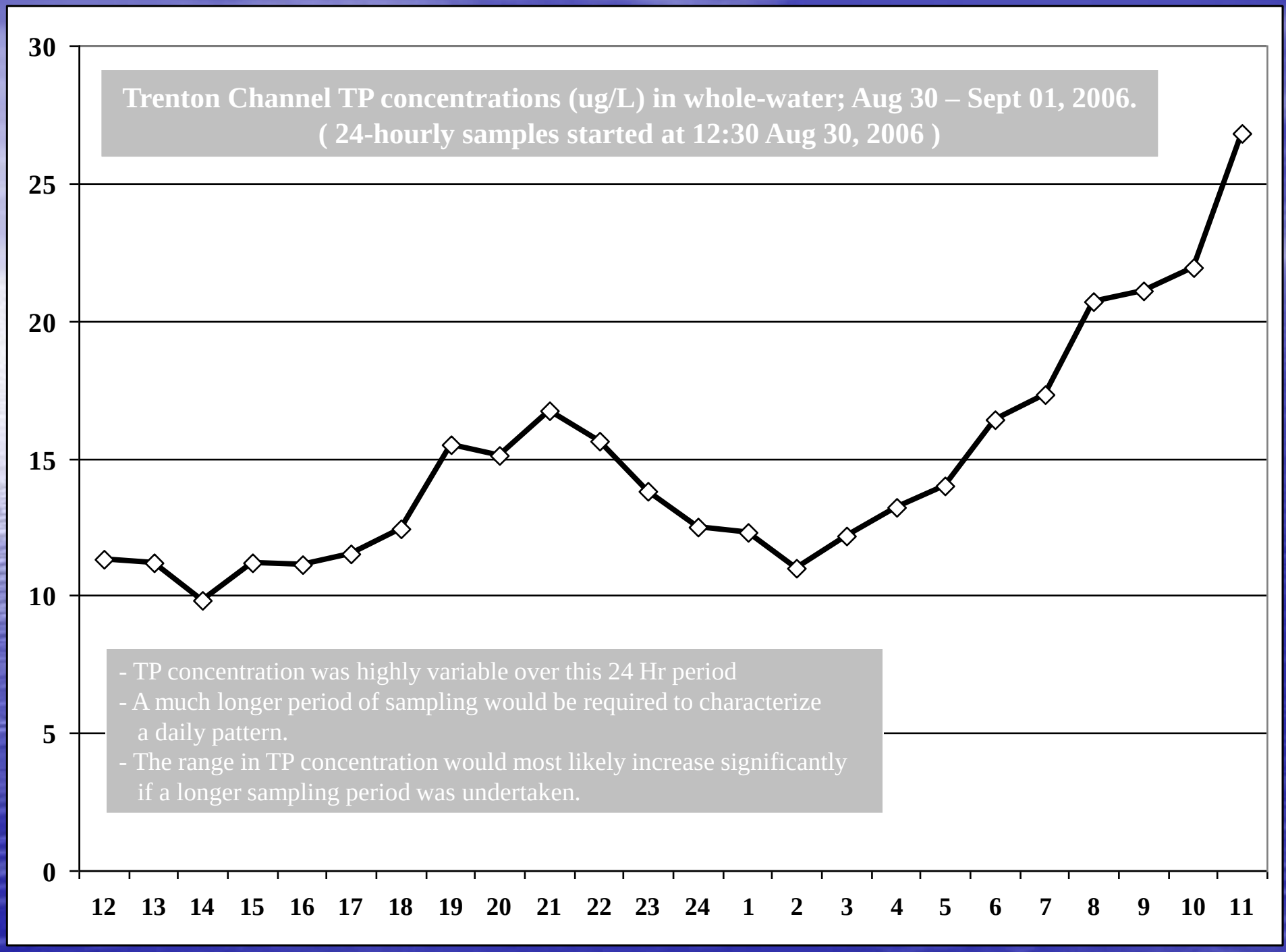
- Two preliminary studies, 2004 and 2006
  - Grab samples taken across the channels to determine horizontal variability
  - Depth profile taken to determine vertical variability
  - ISCO sampler24 hr continuous sampling to determine daily temporal variability (Trenton Ch)
- Comprehensive study 2007

2004 Study Results



- There were no significant differences in TP concentration between the water entering and exiting Lake St. Clair
- There were no significant changes in TP concentrations from water entering the Detroit R. and the concentration found in the middle channels of the lower Detroit R;
- Significant increases in TP concentration were found in both the Amherstburg and Trenton channel water.


Total Phosphorus (ug/L); Detroit River 2006
June 27 PM
June 28 AM
June 28 PM
July 25 AM
July 25 PM
45
40
35
30
25
20
15
10
5
0
East
Mid
West
East
West
East
West
East
Mid
West
Amherstburg
Bois Blanc
Livingstone
Sugar Island
Trenton Channel


Trenton Channel TP concentrations (ug/L) in whole-water; Aug 30 – Sept 01, 2006.
(24-hourly samples started at 12:30 Aug 30, 2006)
30
25
20
15
10
5
0
12 13 14 15 16 17 18 19 20 21 22 23 24 1 2 3 4 5 6 7 8 9 10 11
- TP concentration was highly variable over this 24 Hr period
- A much longer period of sampling would be required to characterize a daily pattern.
- The range in TP concentration would most likely increase significantly if a longer sampling period was undertaken.

2006 Nutrient Pilot Study (5 sample runs)

Findings - Variation of TP concentration:

- Large temporal variation in the Trenton Channel

- Large variation across the Trenton Ch., Amherstburg Ch. and Detroit River at all times.

- Minimal variation across the Bois Blanc, Livingstone and Sugar Is. Channels at all times; these channels were minimally impacted by TP sources within the Detroit River.

- Minimal variation with depth at all sites and at all times.

- Trenton Channel had the highest TP concentrations, greatest cross-channel variation and the greatest temporal variation.

Challenges

- Incorporate TP concentration variability in the Trenton and Amherstburg channels
- Account for difference in flow across the channels
- Consider tributary inputs

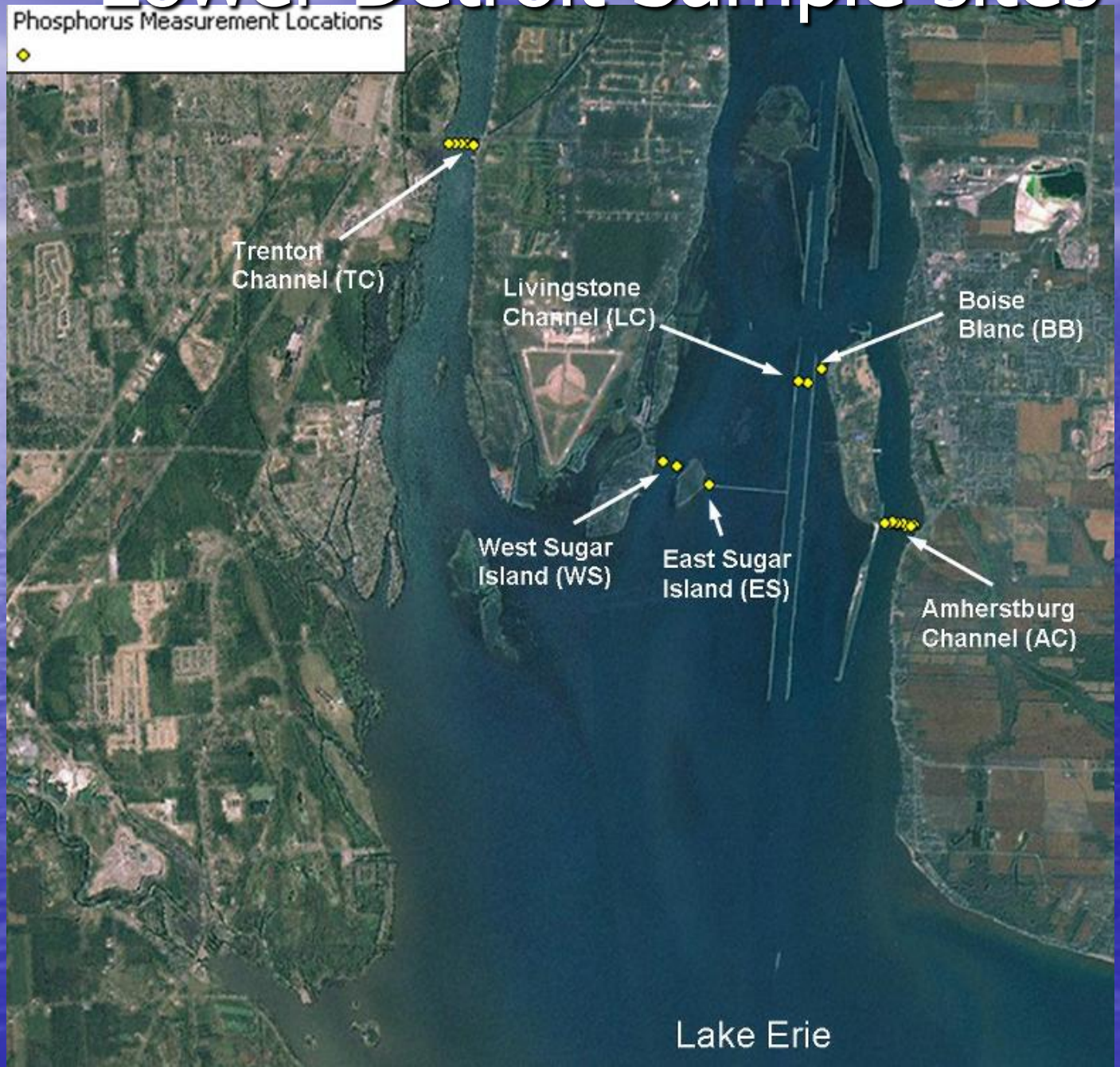
Method

- Two preliminary studies, 2004 and 2006
- **Comprehensive study 2007**
  - ISCO 24 hr integrated samples and multiple (17) grab sample sites across the lower Detroit R.
  - Developed relationships between grab samples and ISCO samples
  - Modified and validated an existing two dimensional hydrodynamic model (USGS RMA2) and determined flow factors for each grab sample site
  - Calculated (where possible) near continuous phosphorus loading estimates across the river
  - Determined % SRP across the channels

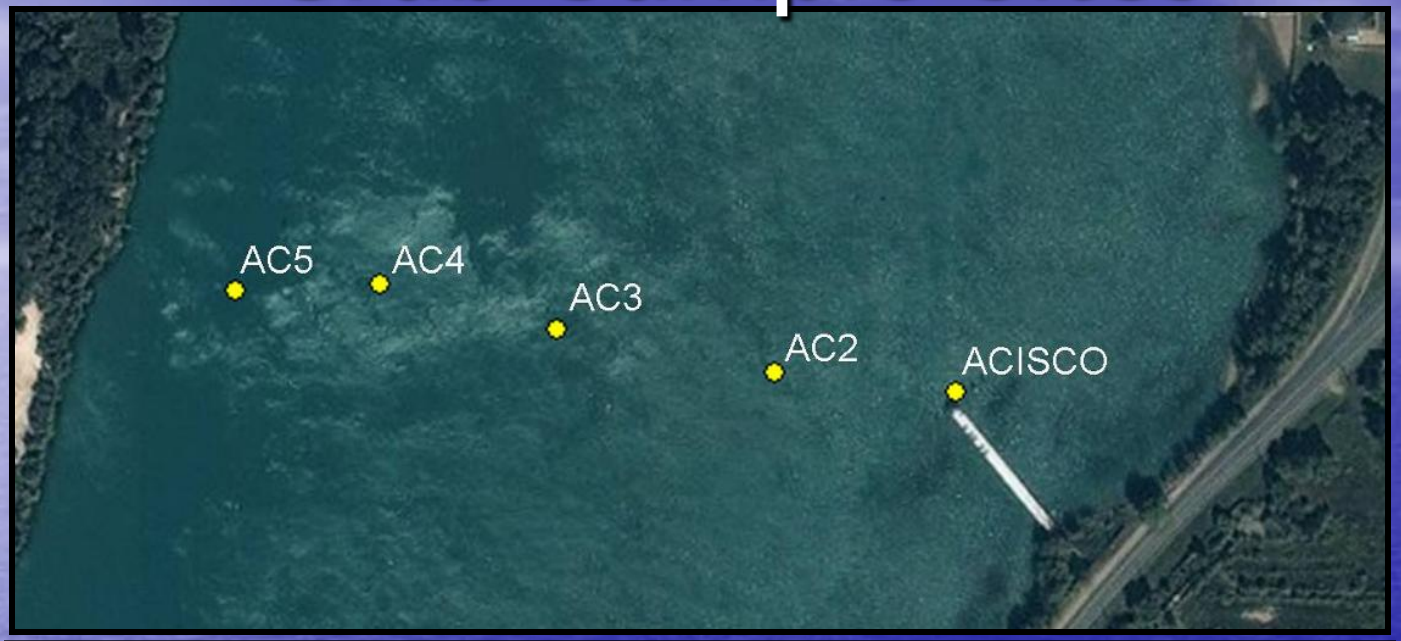
Upper Detroit R. Sites

Location(s)	Measured TP Concentration (mg/L)	
	Mean (all dates)	Mean (common dates)
Peche Isl. (Can. Side)	*0.0167*	***0.0177***
Fleming Ch. (Can. Side)	*0.0143*	***0.0145***
Fleming Ch. (U.S. Side)	*0.0107*	***0.0111***
North Belle Isl. (U.S. Side)	*0.0074*	***0.0077***
Amherstburg Channel	*0.0191*	*0.0173*
Livingstone & Boise Blanc Channels	*0.0112*	*0.00970*
East and West Sugar Island Channels	*0.0118*	*0.0120*
Trenton Channel	*0.0260*	*0.0282*

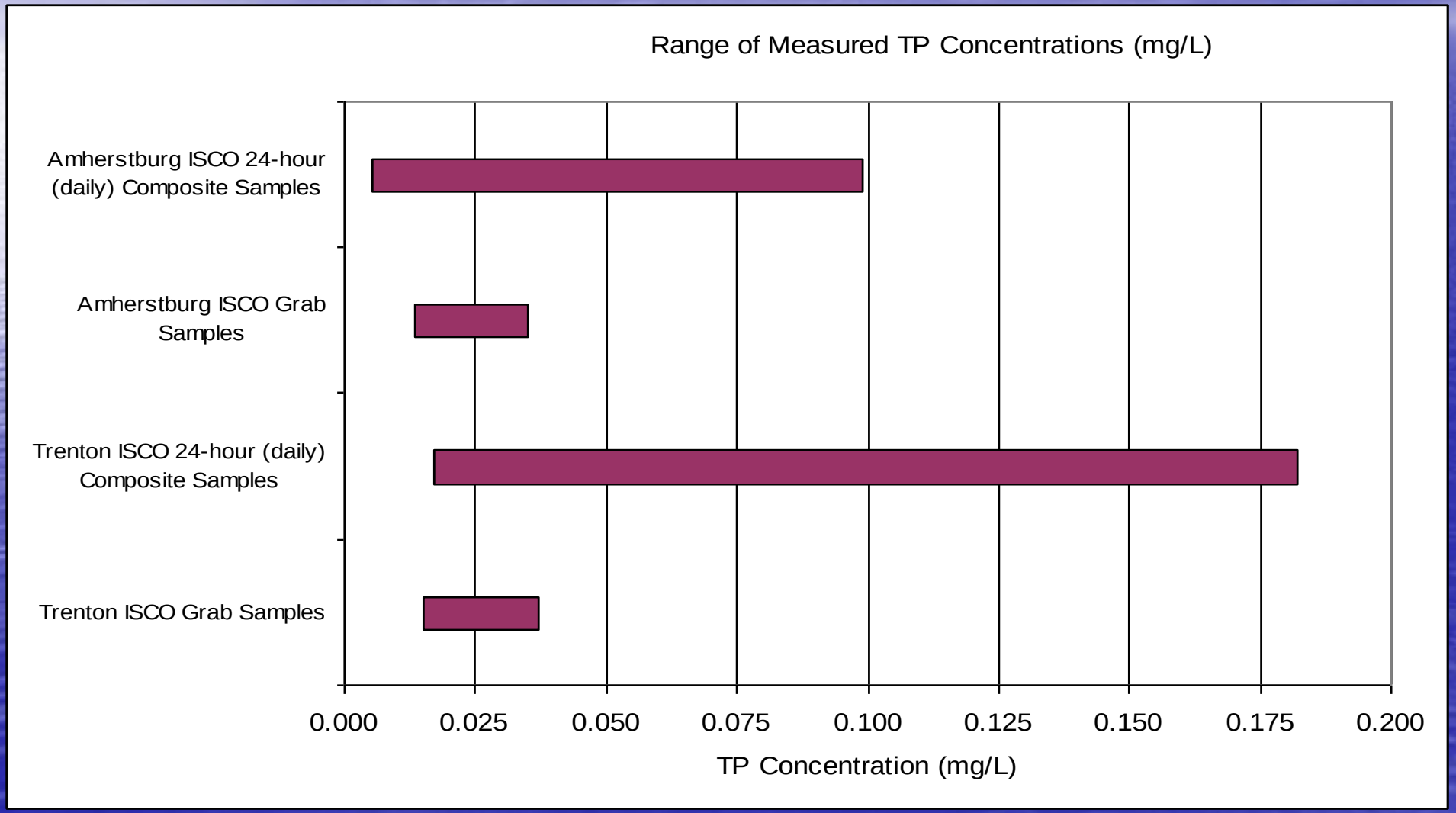
Lower Detroit Sample sites

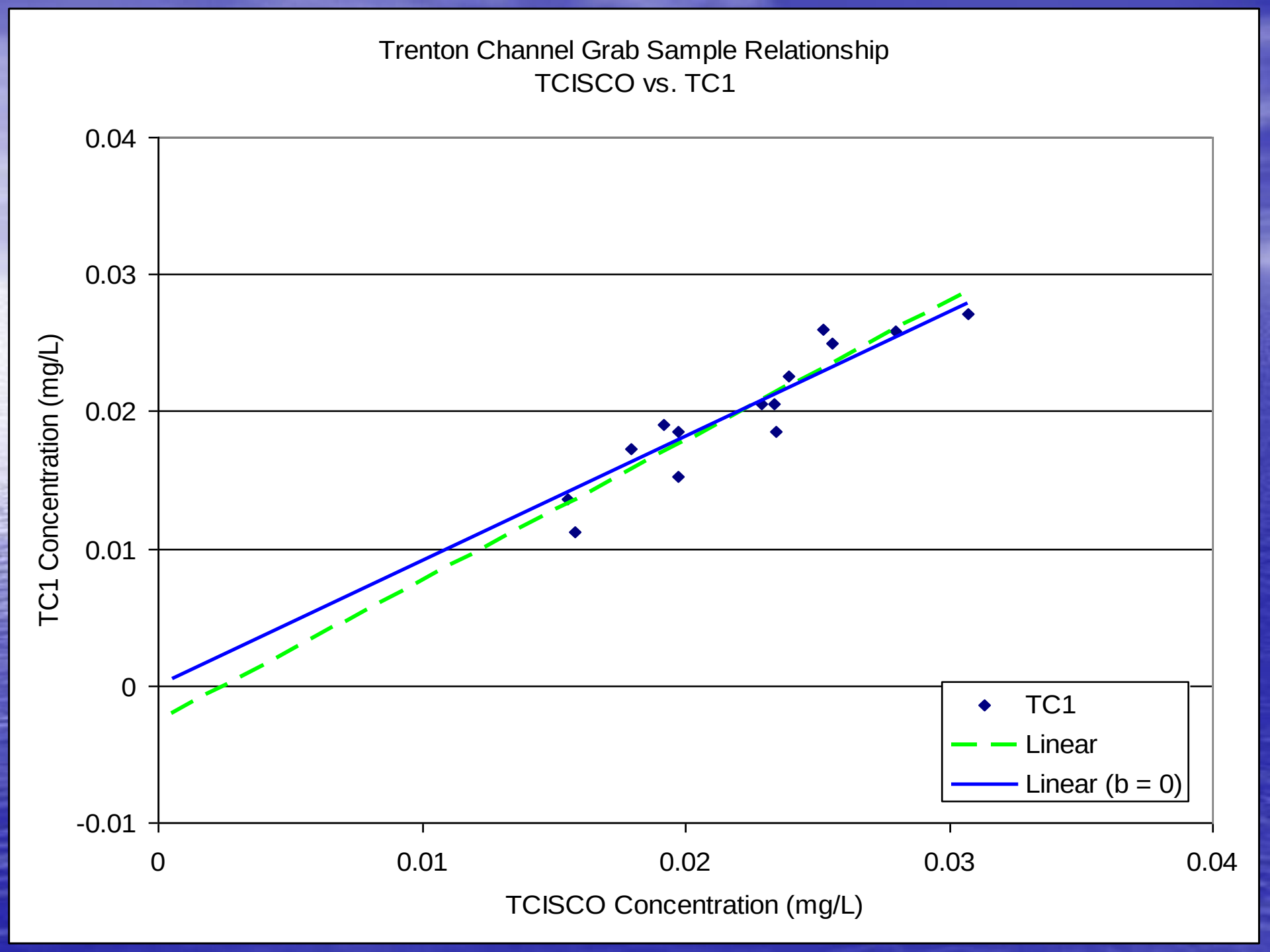


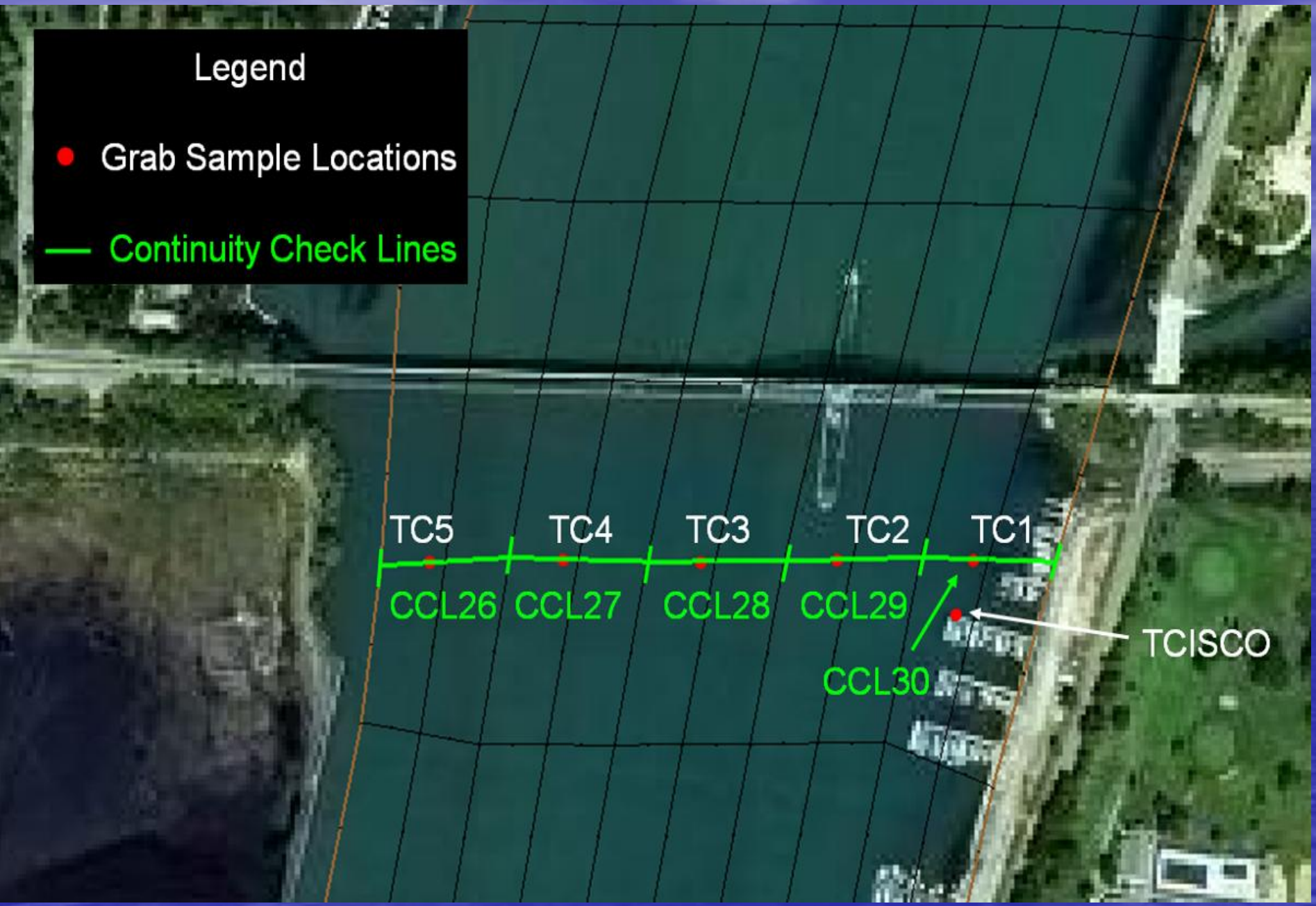
Grab Sample Sites



TP Concentration Ranges




Trenton Channel Grab Sample Relationship
TCISCO vs. TC1
0.04
0.03
0.02
0.01
0
-0.01
TC1 Concentration (mg/L)
0
0.01
0.02
0.03
0.04
TCISCO Concentration (mg/L)
TC1
Linear
Linear (b = 0)


Legend
Grab Sample Locations
Continuity Check Lines
TC5
TC4
TC3
TC2
TC1
CCL26
CCL27
CCL28
CCL29
CCL30
TCISCO

Trenton Channel TP Load

Method	Linear w/Intercept			Linear w/o Intercept			ISCO = grab sample		
Flow Factor	Mean	Upper 95%	Lower 95%	Mean	Upper 95%	Lower 95%	Mean	Upper 95%	Lower 95 %
TP: Sampled (1000 kg)	786.8	820.9	752.7	662.3	691.2	633.4	505.6	528.3	483.0
Total Days	122	122	122	122	122	122	122	122	122
Days Sampled	109	109	109	109	109	109	109	109	109
Mean Sampled TP/day (1000 kg)	7.2	7.5	6.9	6.1	6.3	5.8	4.6	4.8	4.4
TP Aug. – Nov. (1000 kg)	880.4	918.4	842.4	741.6	773.1	708.8	565.4	590.7	540.2
TP (mta)	2641	2755	2527	2225	2319	2126	1696	1772	1621

EC Sampling Location *(Corresponding Holtschlag and Koschik, 2002b, Flow Proportion Location)*	Fleming Ch. (U.S. Side) *(Peche Island North)*	Peche Isl. (Can. Side) *(Peche Island South)*	North Belle Isl. (U.S. Side) *(Scott Middle Ground)*	Fleming Ch. (Can. Side) *(Fleming Channel)*
Flow Proportion (Holtschlag and Koschik, 2002b)	0.7350	0.2650	0.3085	0.6916
Total Volume Aug-Nov (10^9 m^3)	37.10	13.37	15.57	34.91
Mean TP Concentration Aug-Nov (mg/L)	0.0107	0.0167	0.00740	0.0143
TP Load Aug-Nov (1000 kg)	397.0	223.3	115.2	499.2
TP Load Upper River Aug-Nov (1000 kg)	620.3		614.4	
TP Load Upper River (mta)	1861		1843	

Location No.	Location Name	Lat	Long	Location	Mean Q (m^3/s)	Mean TP (mg/L)	TP Load (kg/day)	Over est. TP Load* (kg/day)
1	Sand Pt. Beach (Lake St. Clair Outflow)	42.3379	-82.9137	Lake St. Clair, Can. Shore, near mouth of Detroit River	*5270*	*0.0276*	*12600*	--
2	Little River	42.3401	-82.9307	Can. shore, near mouth of Detroit River	NA	0.126	NA	96
3	Conners Creek	42.3548	-82.9541	US shore, near mouth of Detroit River	NA	0.0176	NA	13
4	Rouge River	42.2736	-83.1101	US shore, approx. halfway between St. Clair and Erie	8.8	0.0415	32	32
5	Turkey Creek	42.2439	-83.1088	Can. shore, approx. halfway between St. Clair and Erie	NA	0.0982	NA	75
6	Ecorse Creek	42.2349	-83.148	US shore, approx. halfway between St. Clair and Erie	NA	0.114	NA	87
7	Brownstown & Frank and Poet Creeks	42.0812	-83.1942	US shore, near Lake Erie	NA	0.086	NA	66
8	Canard River	42.1601	-83.1085	Can. shore, across from Grosse Island	NA	0.0371	NA	28
* Estimated using average discharge of Rouge R.				Max	*5270*	*0.126*	*12600*	*96*
				Min	NA	0.0176	32	13
** The mean and sum include only the tributaries, and not Sand Point Beach				Mean**	NA	0.0685	--	57**
NA- Not Available/Not applicable				Sum**	NA	--	--	397**

Soluble Reactive Phosphorus

Site ID	Percent-SRP (SRP/TP, %)	
	MEAN	SD
AC1/ISCO	11.0	3.8
AC2	11.4	2.2
AC3	12.5	2.5
AC4	13.0	4.6
AC5	13.1	4.1
BB	16.7	13.4
ES	25.9	6.3
LC1	18.1	9.3
LC2	20.8	9.6
TCISCO	44.9	13.4
TC1	47.1	17.2
TC2	48.3	19.3
TC3	49.2	21.2
TC4	50.3	19.2
TC5	51.0	20.7
WS1	11.4	2.2
WS2	11.4	2.2

Best Estimate

Channel	Data Used For Estimate	Current Estimate Range (mta)	
		Low	High
Trenton Ch. (TC)	grab sample relationships and ISCO 24 hour (daily) composite data	2000	2500
West Sugar Is. (WS)	grab sample data	225.3	271.2
East Sugar Is. (ES)	grab sample data	76.8	99.6
Livingstone Ch. (LC)	grab sample data	314.4	354.9
Bois Blanc Ch. (BB)	grab sample data	60.0	84.9
Amherstburg Ch. (AC)*	grab sample data	870.9	1006.2
Total Load	--	3547	4317

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