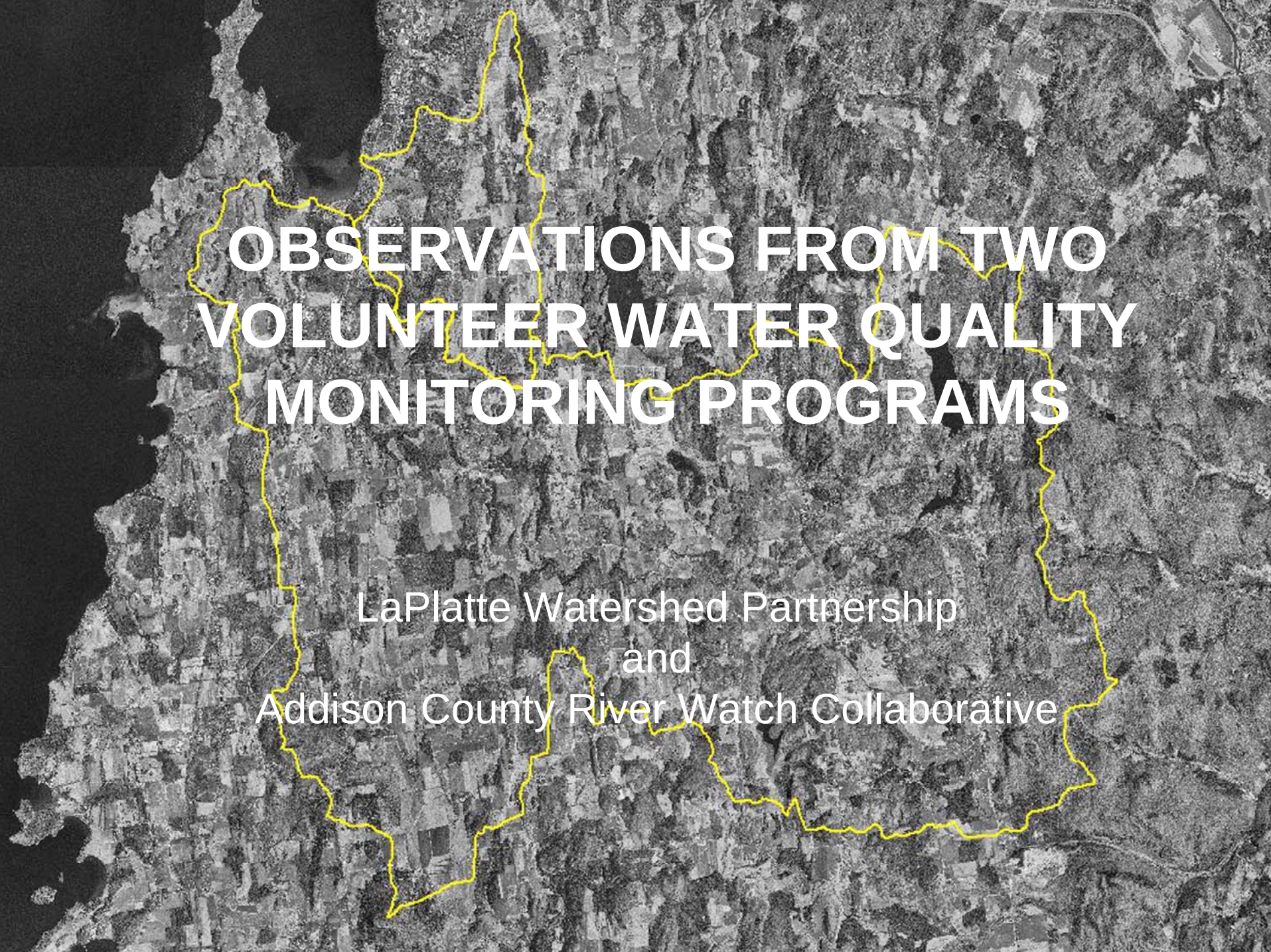


OBSERVATIONS FROM TWO VOLUNTEER WATER QUALITY MONITORING PROGRAMS

LaPlatte Watershed Partnership
and
Addison County River Watch Collaborative

Purpose

- Review observations drawn from two volunteer monitoring organizations
  - Considerations in planning and refining a volunteer monitoring program
  - Analysis and interpretation of data
  - Putting findings to use
- Identify issues and points for discussion

PROJECT AREAS

- Two watersheds draining to Shelburne Bay
  - Shelburne Bay
    - TP standard 0.014 mg/l
    - Aquatic weeds
    - Drinking water source for Champlain Water District
    - Chlorides increasing in Lake Champlain?
    - Algal blooms
    - Heavy recreational use
  - LaPlatte River Watershed
    - Major tributary to Shelburne Bay
    - Impaired: Fecal coliforms, mercury/ Agriculture
    - Drainage Area: 53 mi^2
    - Mostly rural: ~60% forested, ~25% cultivated
    - Treated sewage discharges from:
      - Hinesburg (LaPlatte River)
      - Shelburne (McCabe's Brook)
    - Issues
      - Erosion
      - Lawn management
      - Buffers
      - Stormwater
  - Munroe Brook Watershed
    - Small tributary to Shelburne Bay
    - Impaired: Biological Condition/stormwater
    - Drainage area: 5.2 mi^2
    - Open areas and developed neighborhoods
    - Issues
      - Development
      - Lawn management
      - Stormwater

PROJECT AREAS (Continued)

- Three watersheds draining to Lake Champlain
  - Lewis Creek
    - Impaired: *E. coli*/Agriculture
    - Drainage area: 81 mi^2
    - Issues:
      - Buffers - Agriculture
  - Otter Creek-Middlebury River
    - Impaired: *E. coli*, mercury, PCBs/ WWTFs, agriculture
    - Issues:
      - Buffers - Agriculture
      - Treated Sewage Discharges from:
        - » Vergennes
        - » Rutland
  - Little Otter Creek
    - Impaired: *E. coli*, mercury/Agriculture
    - Issues:
      - Buffers - Agriculture

I. SETTING OBJECTIVES - Project Purpose

- To identify and understand important aspects of water quality and water quality issues in basin
  - Important parameters
  - Factors affecting behavior of important parameters
  - Relationships among parameters and influencing factors
- To monitor water quality over time
  - To establish data bases where needed
  - To build on existing water quality databases where they exist (State and STORET)
- To Analyze and interpret data temporally, spatially, and in relation to the physical environment and human activities in the watershed
- To identify existing and potential problems
- To identify and rationalize actions and interventions to:
  - Avoid deterioration in water quality
  - Assess need for and potential for improving water quality
  - Mitigate existing problems
- To inform residents of the watershed about water quality and related issues, impacts, and needs

II. SELECTING PARAMETERS

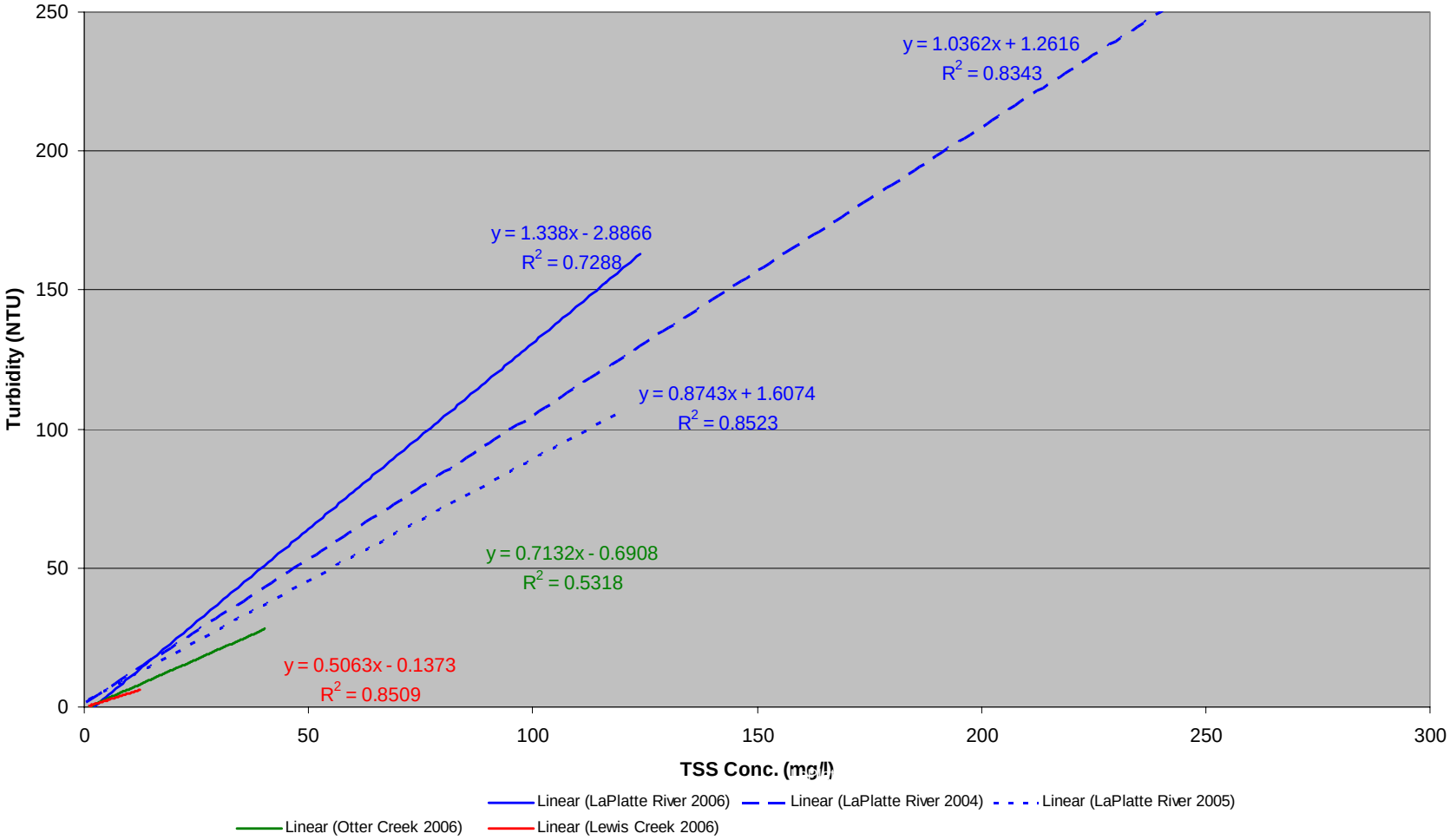
- Total suspended solids - Turbidity
- Total nitrogen - Nitrate + nitrite
- Total phosphorus - Dissolved phosphorus
- Chlorides
- *Escherichia coli*

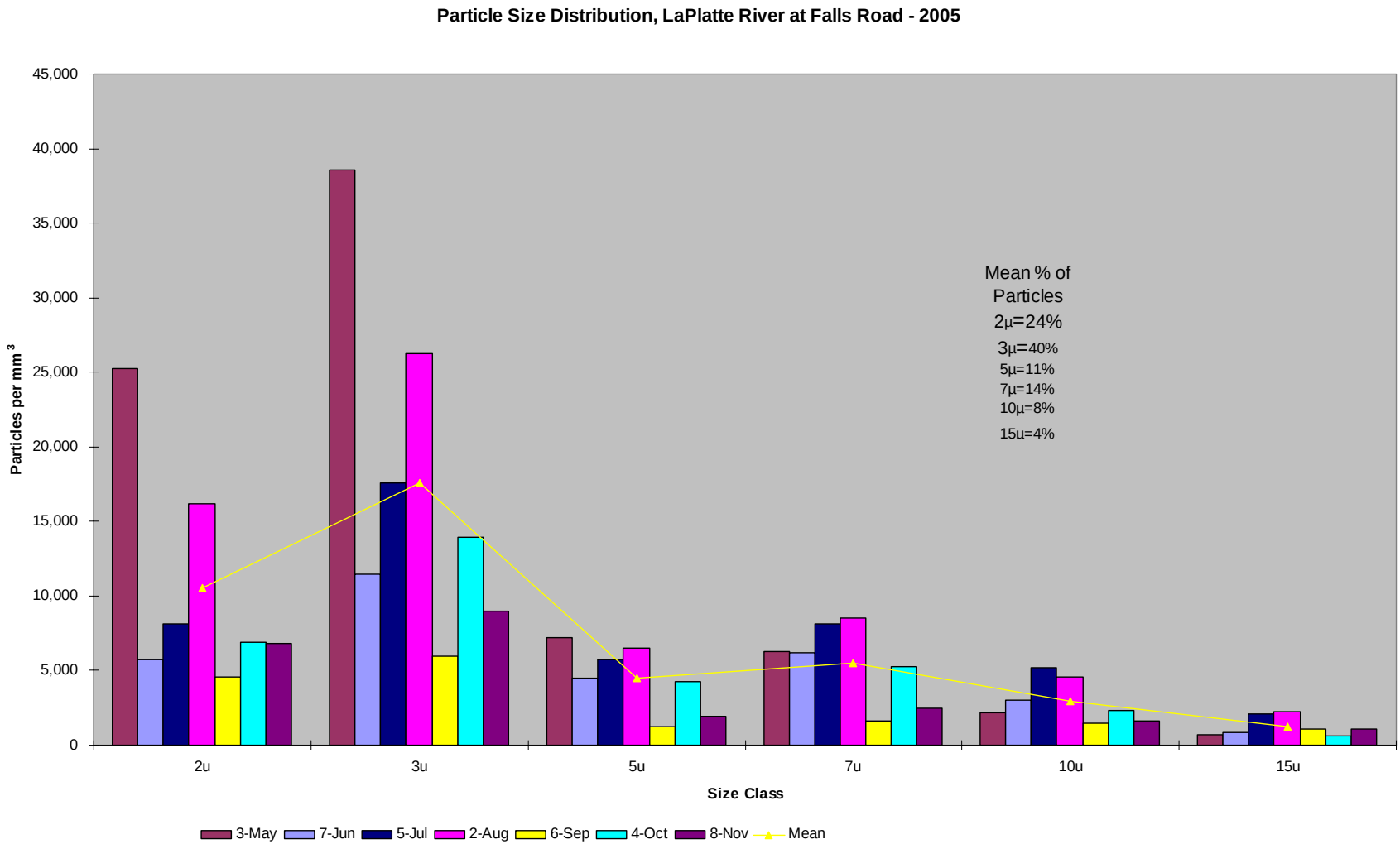
III. ANALYSIS AND INTERPRETATION OF RESULTS – SOME EXAMPLES

Solids and Particulates

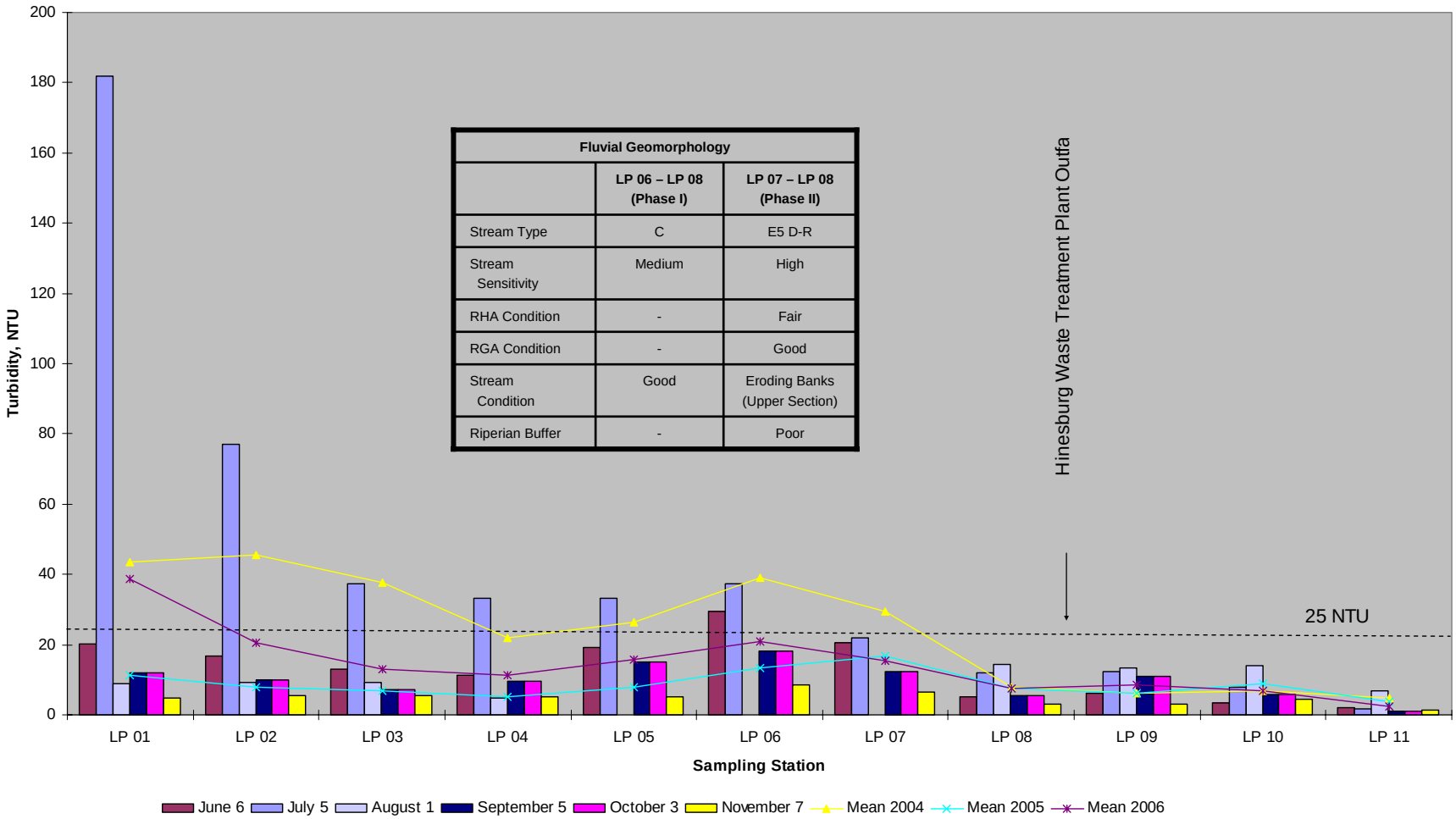
- Measured as Total Suspended Solids or Turbidity
- Importance:
  - Effects on aquatic organisms
  - Transport of phosphorus
- Vermont turbidity standard for class B streams: 25 NTU
- Relationship between TSS and Turbidity

Turbidity vs. Total Suspended Solids, in the LaPlatte River, Lewis Creek, and Otter Creek Watersheds · 2004 to 2006




Particle Size Distribution, LaPlatte River at Falls Road - 2005
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Particles per mm 3
2u
3u
5u
7u
10u
15u
Size Class
Mean % of Particles
2µ=24%
3µ=40%
5µ=11%
7µ=14%
10µ=8%
15µ=4%
3-May
7-Jun
5-Jul
2-Aug
6-Sep
4-Oct
8-Nov
Mean

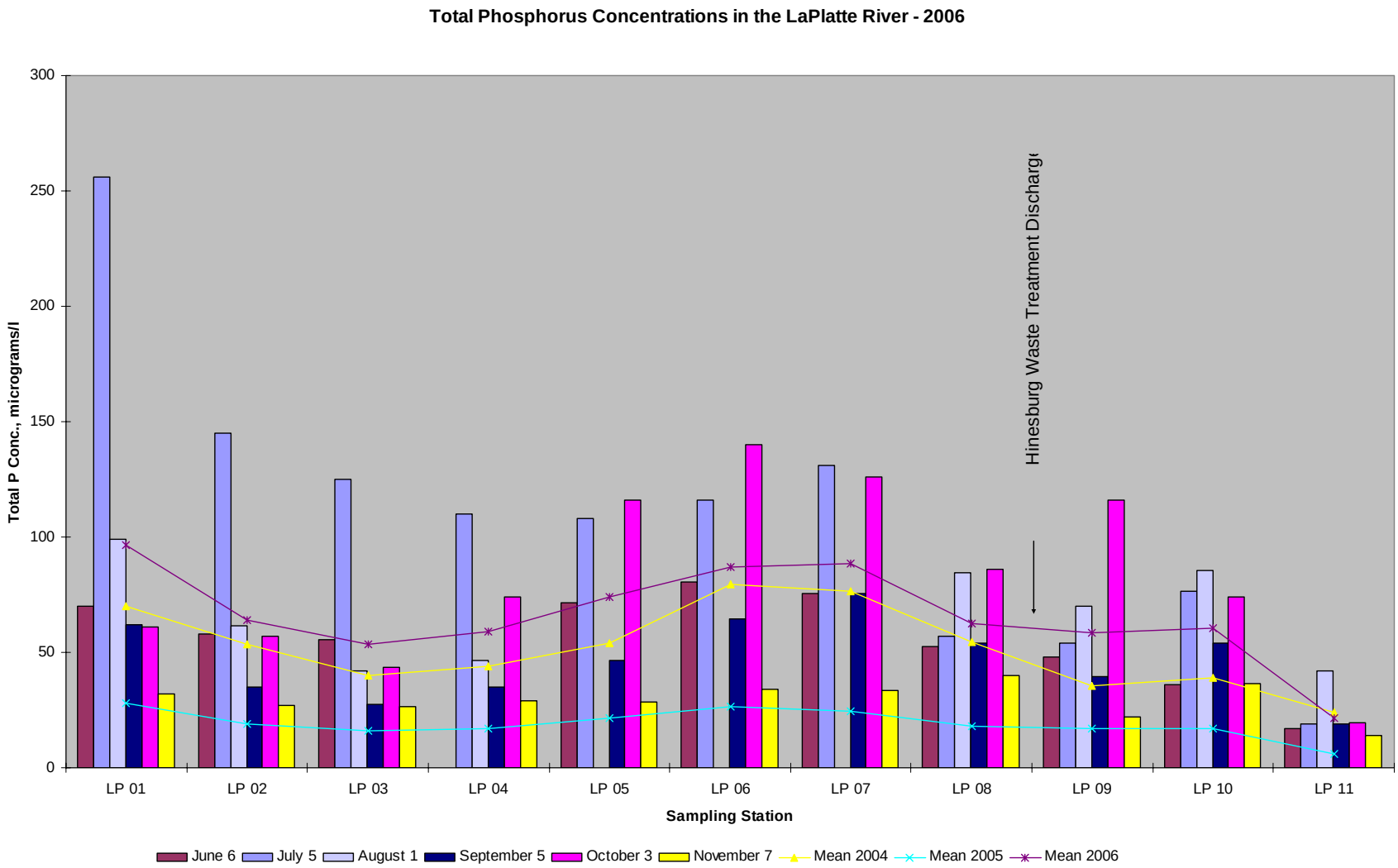
Turbidity in the LaPlatte River, 2006



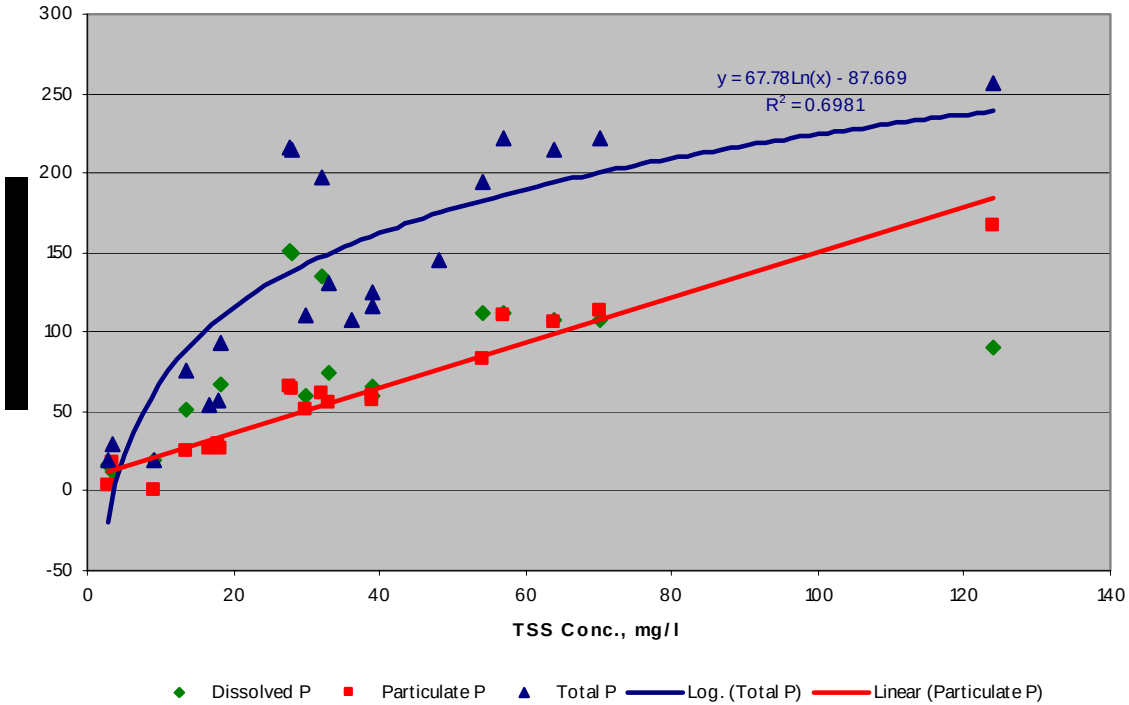
Fluvial Geomorphology		
	LP 06 – LP 08 (Phase I)	LP 07 – LP 08 (Phase II)
Stream Type	C	E5 D-R
Stream Sensitivity	Medium	High
RHA Condition	-	Fair
RGA Condition	-	Good
Stream Condition	Good	Eroding Banks (Upper Section)
Riperian Buffer	-	Poor

Phosphorus

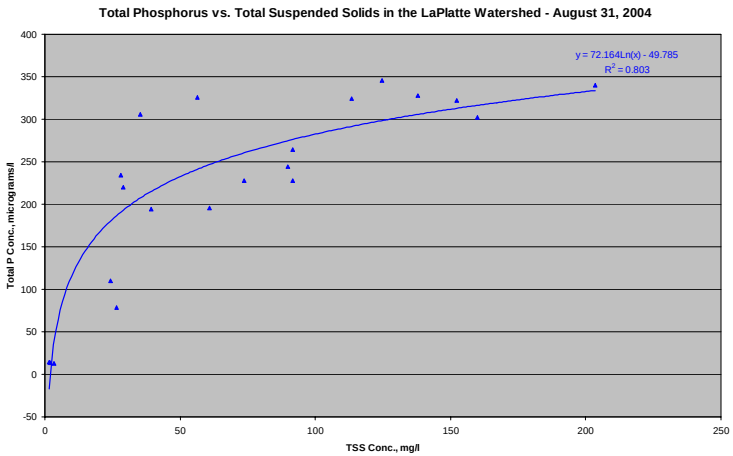
- Importance:
  - generally considered the limiting nutrient in Lake Champlain, but not always the only limiting nutrient
- Standards
  - Total phosphorus limited so as not to contribute to acceleration of eutrophication
  - Discharges into lake segments must comply with applicable basin plans
- Sources:
  - Waste discharges
  - Erosion
  - Runoff from cultivated areas and lawns
- Behavior:
  - Reacts with, and is transported by, solid particles

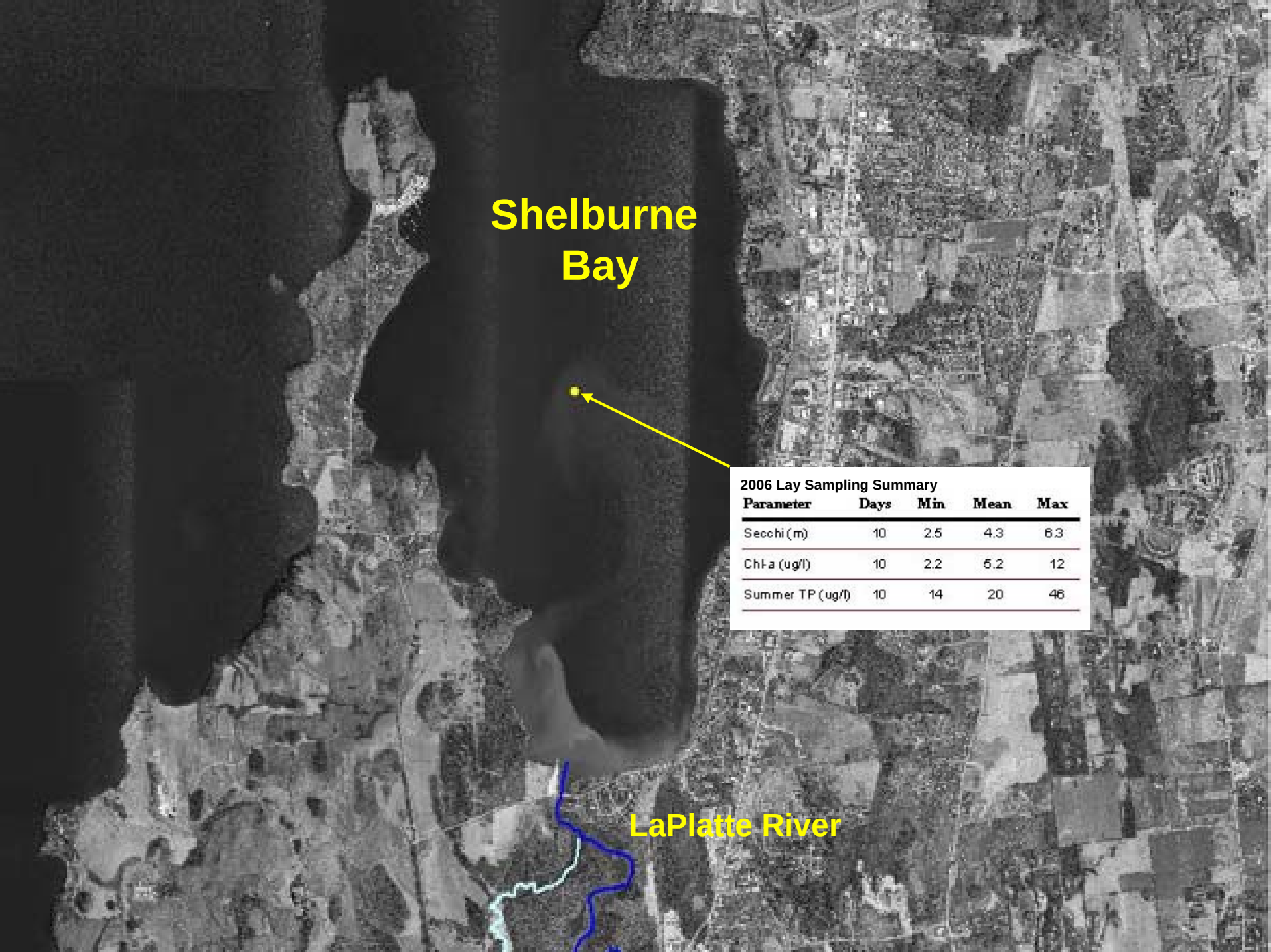

Total Phosphorus Concentrations in the LaPlatte River - 2006
Total P Conc., micrograms/l
300
250
200
150
100
50
0
Hinesburg Waste Treatment Discharg
LP 01
LP 02
LP 03
LP 04
LP 05
LP 06
LP 07
LP 08
LP 09
LP 10
LP 11
Sampling Station
June 6
July 5
August 1
September 5
October 3
November 7
Mean 2004
Mean 2005
Mean 2006

Phosphorus vs. Total Suspended Solids Concentrations in the LaPlatte Watershed - July 5, 2006



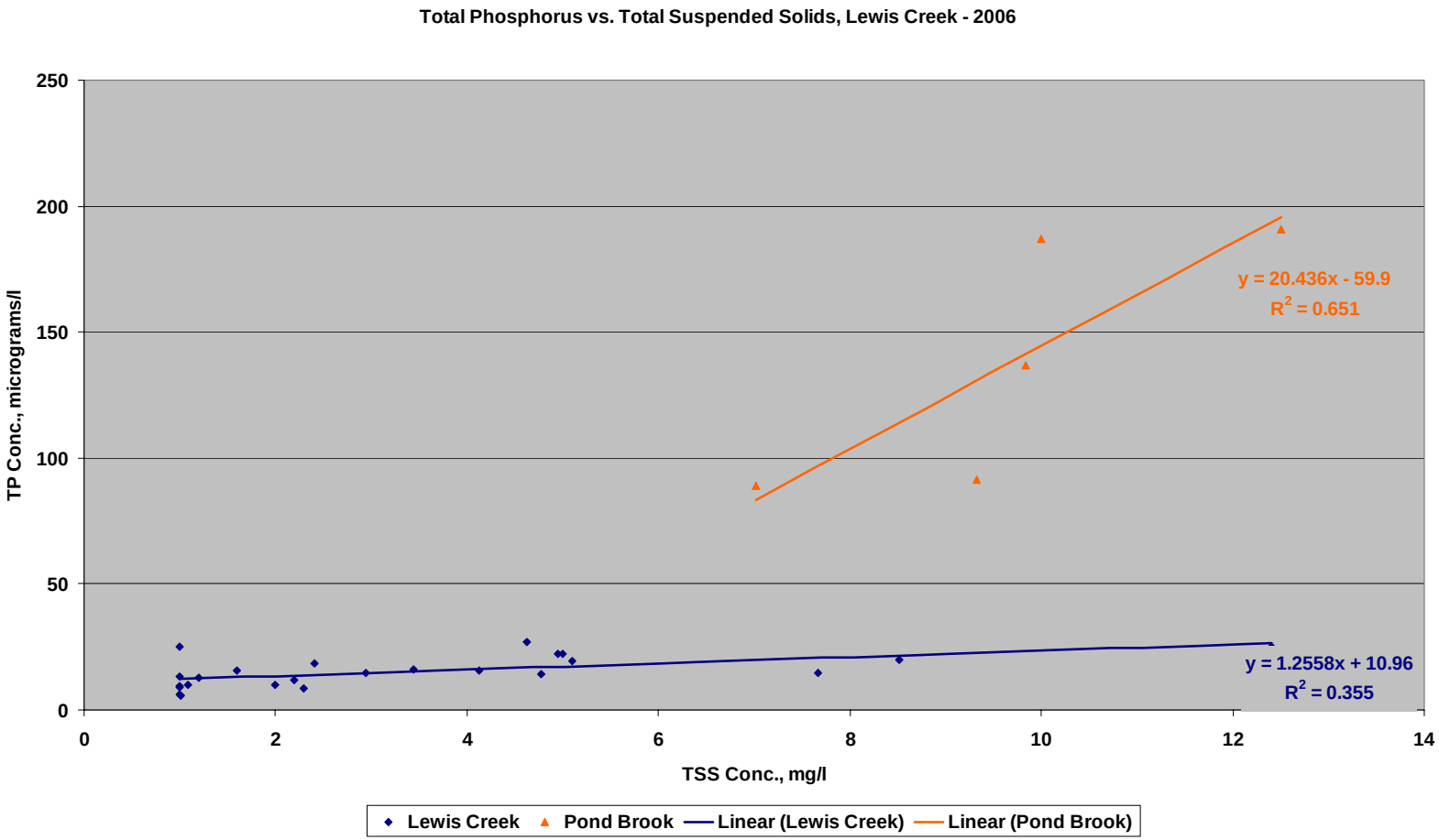
Percent Dissolved P	
Mean	55.80
Standard Error	4.58
Median	52.32
Standard Deviation	13.74
Sample Variance	188.72
Minimum	35.00
Maximum	84.57
Count	9.00

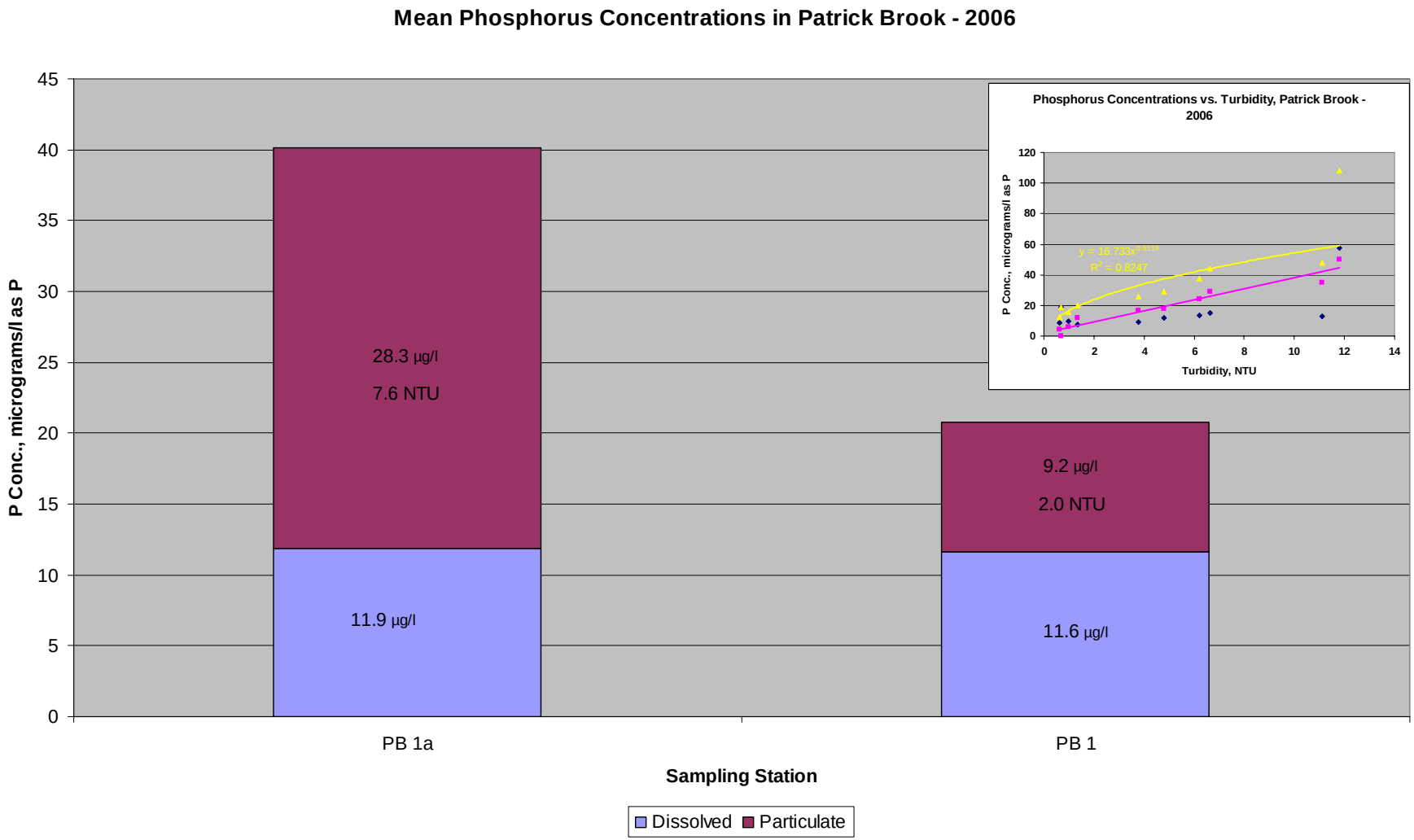


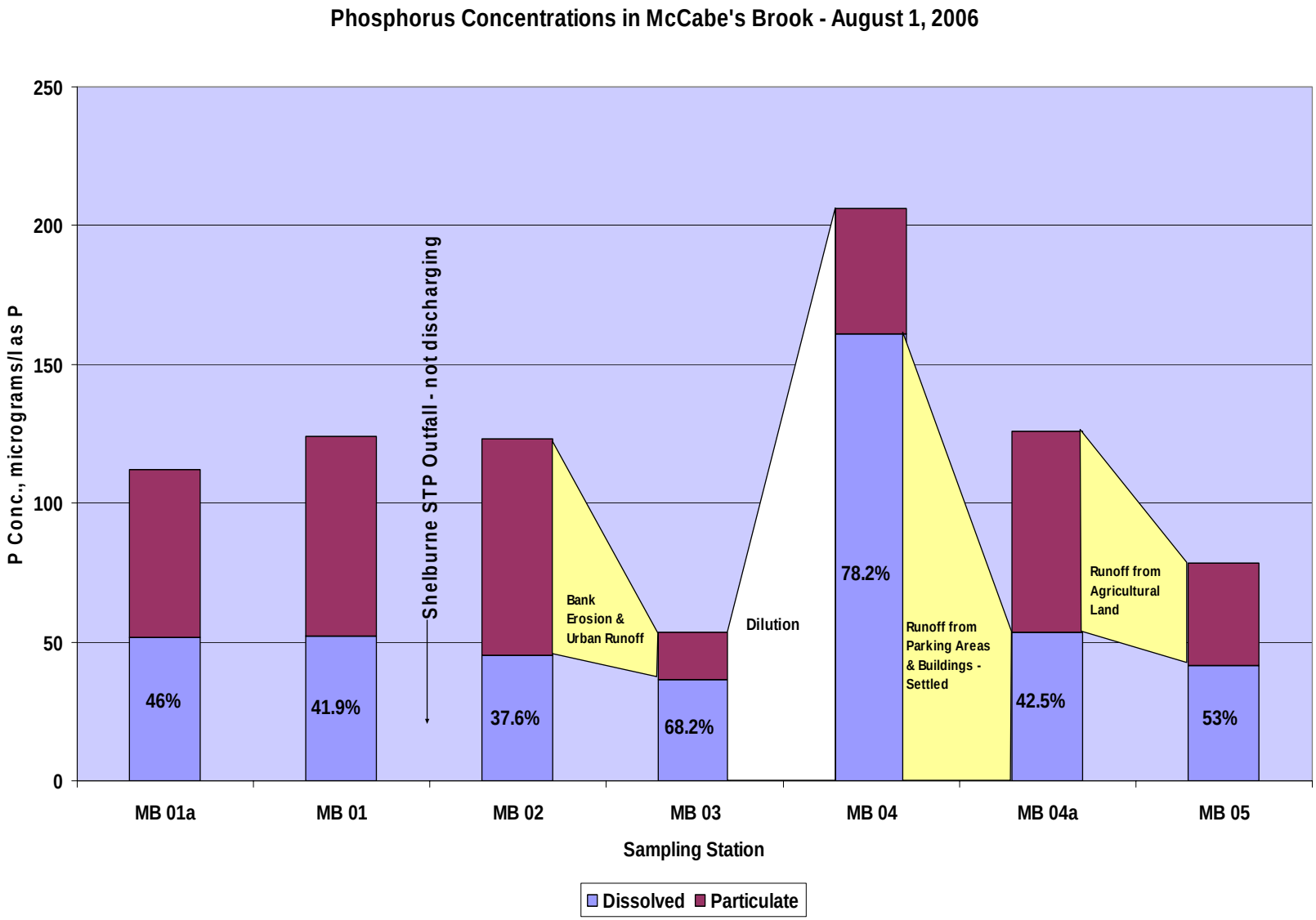


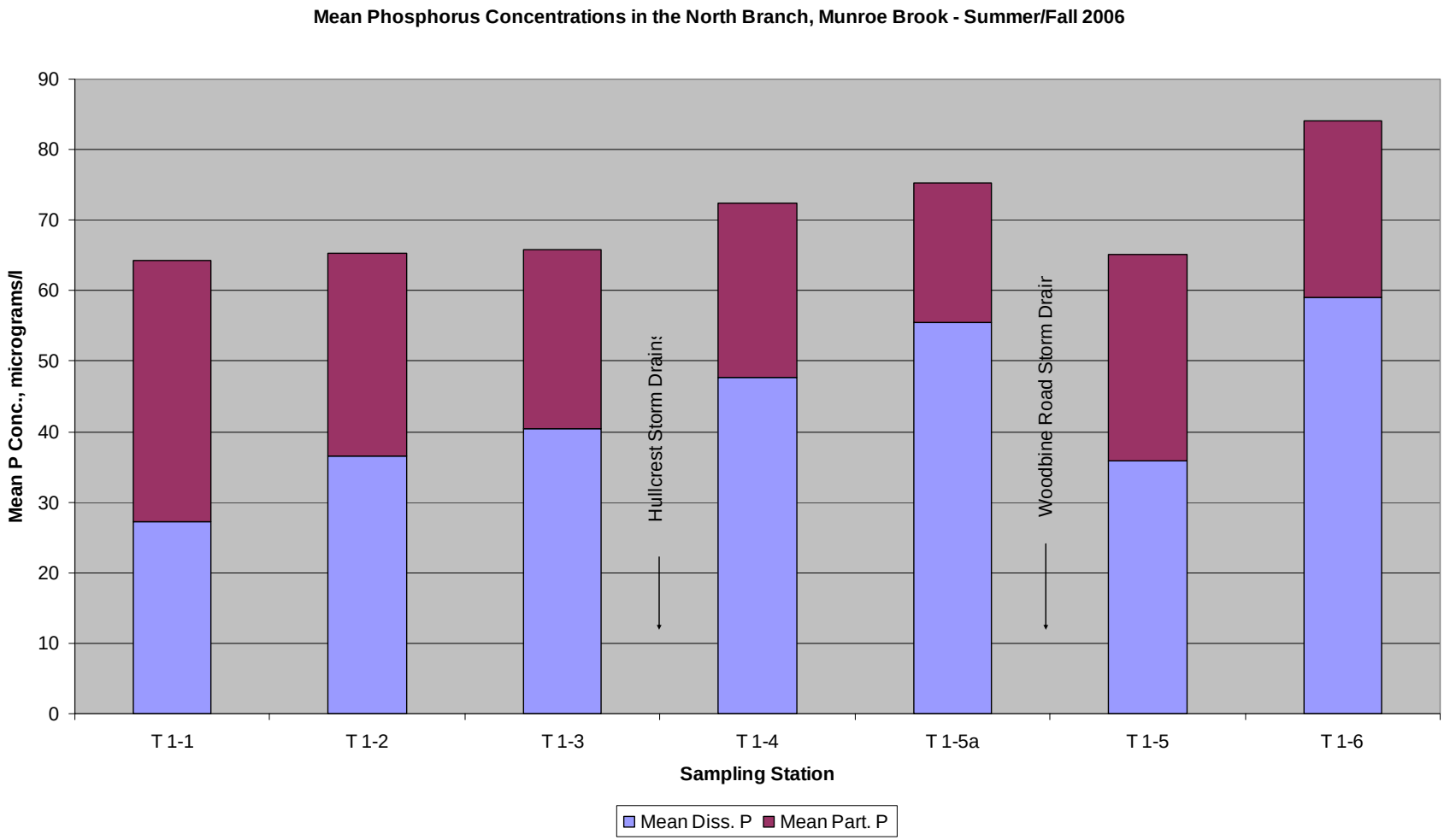
2006 Lay Sampling Summary

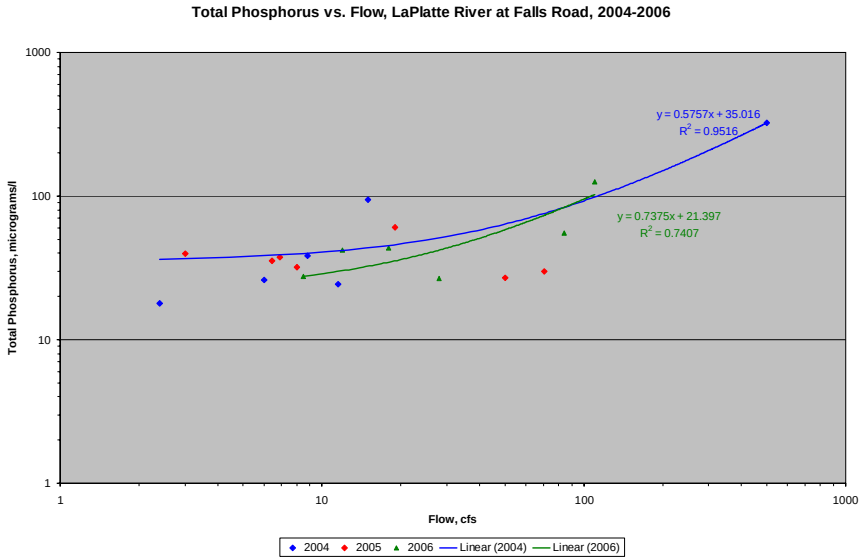
Parameter	Days	Min	Mean	Max
Secchi (m)	10	2.5	4.3	6.3
Chl-a (ug/l)	10	2.2	5.2	12
Summer TP (ug/l)	10	14	20	46

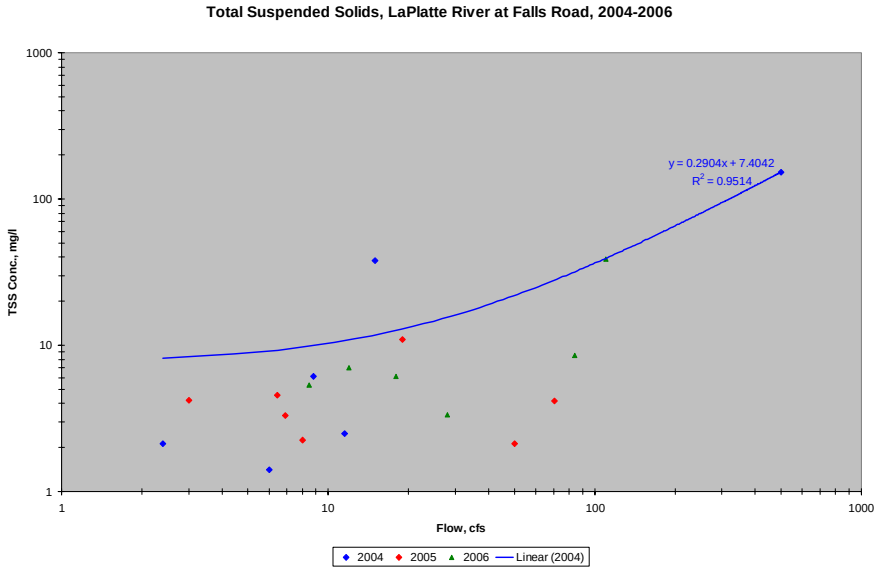

Total Phosphorus vs. Total Suspended Solids, Lewis Creek - 2006
TP Conc., micrograms/l
250
200
150
100
50
0
0
2
4
6
8
10
12
14
TSS Conc., mg/l
y = 20.436x - 59.9
R2 = 0.651
y = 1.2558x + 10.96
R2 = 0.355
Lewis Creek
Pond Brook
Linear (Lewis Creek)
Linear (Pond Brook)

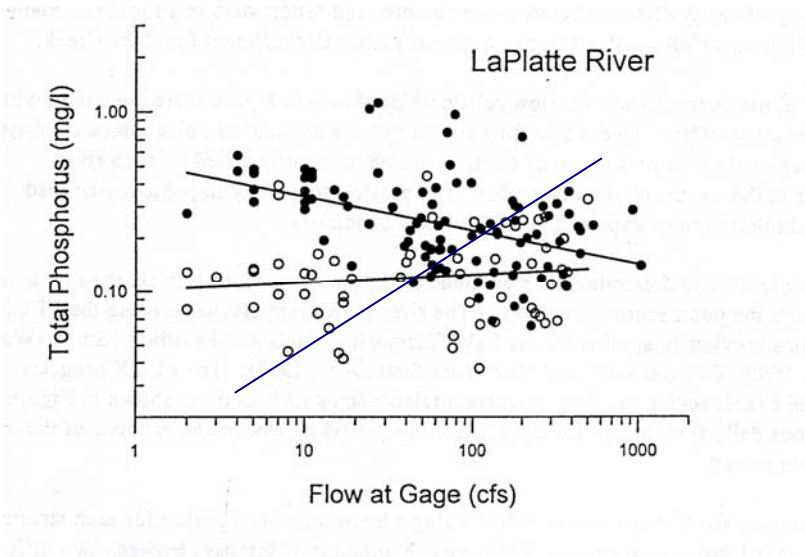

Mean Phosphorus Concentrations in Patrick Brook - 2006
P Conc., micrograms/l as P
45
40
35
30
25
20
15
10
5
0
28.3 µg/l
7.6 NTU
11.9 µg/l
9.2 µg/l
2.0 NTU
11.6 µg/l
PB 1a
PB 1
Sampling Station
Dissolved
Particulate
Phosphorus Concentrations vs. Turbidity, Patrick Brook - 2006
P Conc., micrograms/l as P
120
100
80
60
40
20
0
0
2
4
6
8
10
12
14
Turbidity, NTU

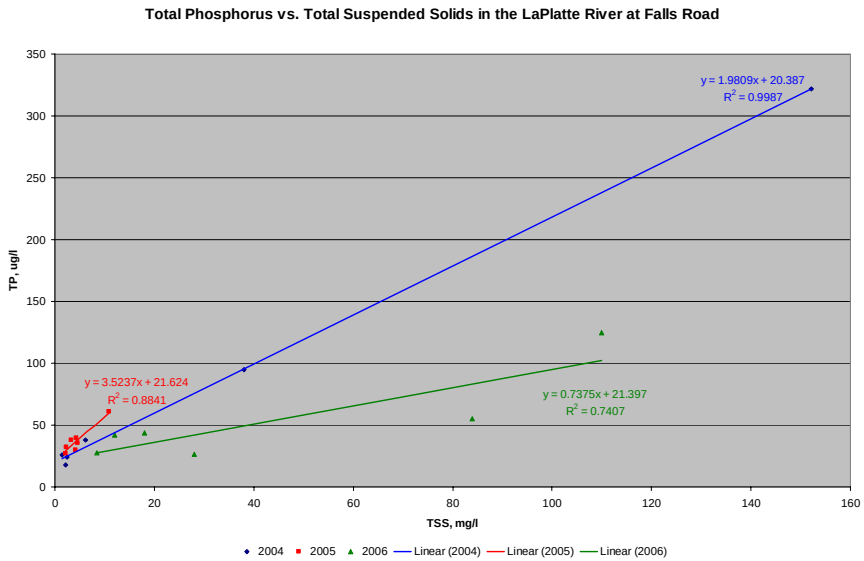

Phosphorus Concentrations in McCabe's Brook - August 1, 2006
P Conc., micrograms/l as P
250
200
150
100
50
0
Shelburne STP Outfall - not discharging
Bank Erosion & Urban Runoff
Dilution
Runoff from Parking Areas & Buildings - Settled
Runoff from Agricultural Land
46%
41.9%
37.6%
68.2%
78.2%
42.5%
53%
MB 01a
MB 01
MB 02
MB 03
MB 04
MB 04a
MB 05
Sampling Station
Dissolved
Particulate


Mean Phosphorus Concentrations in the North Branch, Munroe Brook - Summer/Fall 2006
Mean P Conc., micrograms/l
90
80
70
60
50
40
30
20
10
0
Hullcrest Storm Drain
Woodbine Road Storm Drain
T 1-1
T 1-2
T 1-3
T 1-4
T 1-5a
T 1-5
T 1-6
Sampling Station
Mean Diss. P
Mean Part. P


Total Phosphorus vs. Flow, LaPlatte River at Falls Road, 2004-2006
Total Phosphorus, micrograms/l
1000
100
10
1
1
10
100
1000
Flow, cfs
y = 0.5757x + 35.016
R2 = 0.9516
y = 0.7375x + 21.397
R2 = 0.7407
2004
2005
2006
Linear (2004)
Linear (2006)

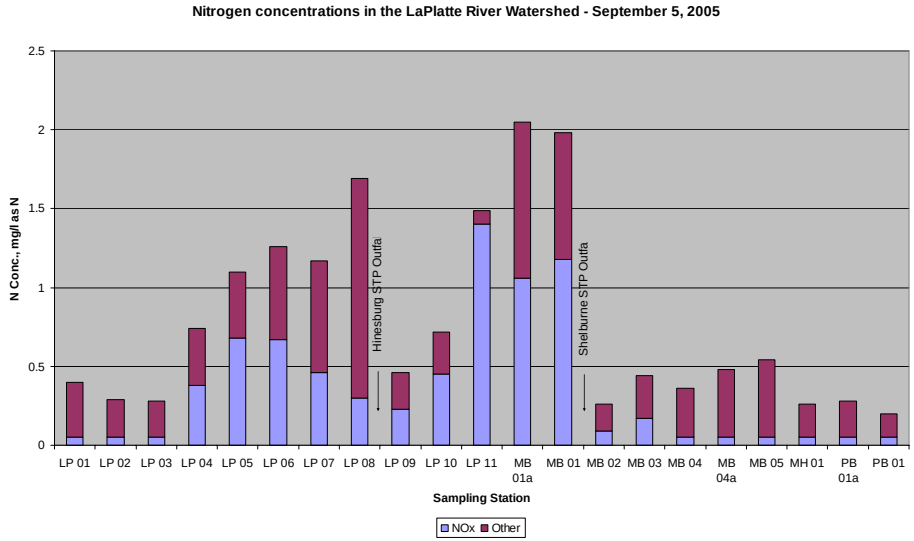

Total Suspended Solids, LaPlatte River at Falls Road, 2004-2006
TSS Conc., mg/l
1000
100
10
1
1
10
100
1000
Flow, cfs
y = 0.2904x + 7.4042
R2 = 0.9514
2004
2005
2006
Linear (2004)

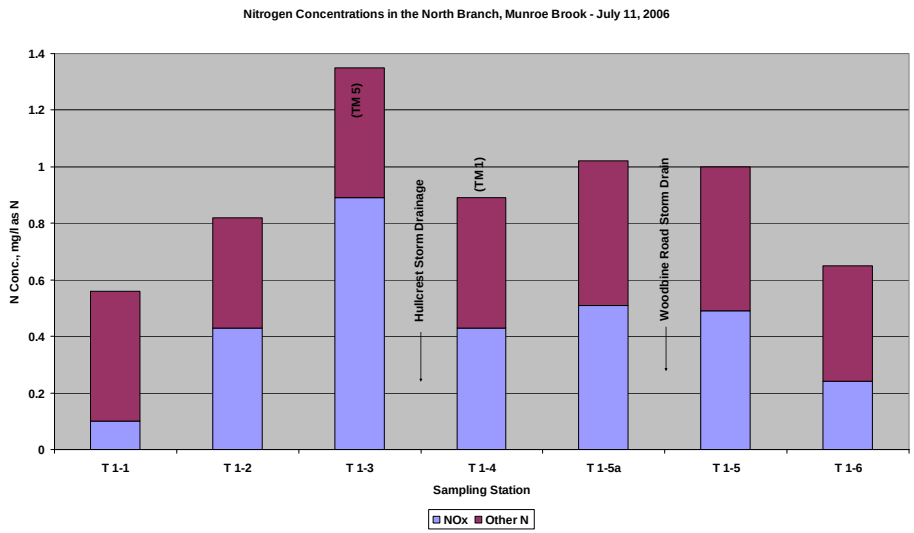

LaPlatte River
Total Phosphorus (mg/l)
1.00
0.10
1
10
100
1000
Flow at Gage (cfs)


Total Phosphorus vs. Total Suspended Solids in the LaPlatte River at Falls Road
TP, ug/l
350
300
250
200
150
100
50
0
0
20
40
60
80
100
120
140
160
TSS, mg/l
y = 1.9809x + 20.387
R2 = 0.9987
y = 3.5237x + 21.624
R2 = 0.8841
y = 0.7375x + 21.397
R2 = 0.7407
2004
2005
2006
Linear (2004)
Linear (2005)
Linear (2006)

Nitrogen

- Importance
  - Nutrient
    - Can be the limiting nutrient
  - Health
    - Methaemoglobinaemia
    - Spontaneous abortion
- Nitrate Standards
  - Streams
    - Limited so as not to contribute to eutrophication
    - 5.0 mg/l as N (Class B streams)
  - Drinking water
    - 10 mg/l as N
- Sources
  - Waste discharges
  - Surface runoff from lawns and cultivated land

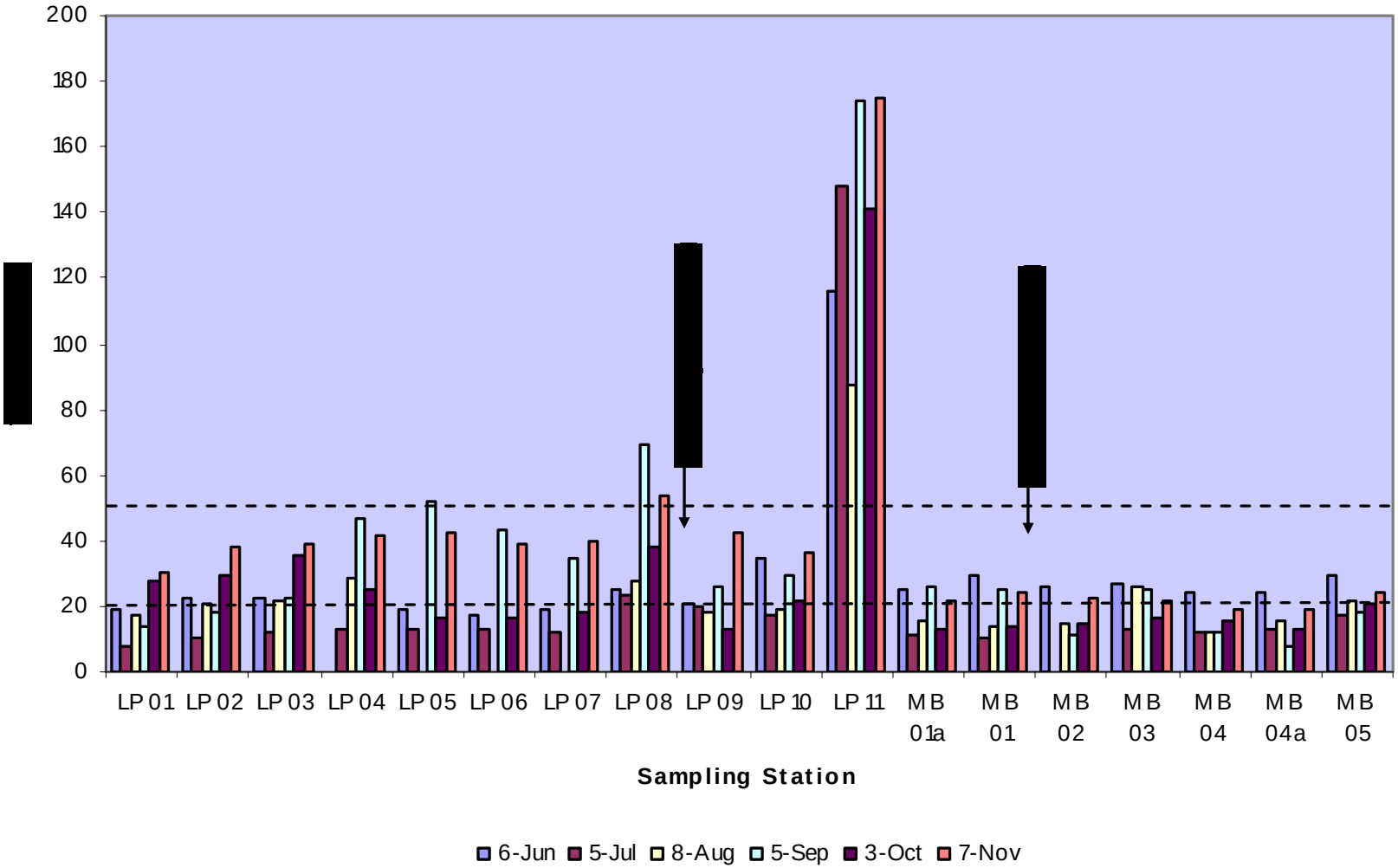

Nitrogen concentrations in the LaPlatte River Watershed - September 5, 2005
N Conc., mg/l as N
2.5
2
1.5
1
0.5
0
Hinesburg STP Outfa
Shelburne STP Outfa
LP 01
LP 02
LP 03
LP 04
LP 05
LP 06
LP 07
LP 08
LP 09
LP 10
LP 11
MB 01a
MB 01
MB 02
MB 03
MB 04
MB 04a
MB 05
MH 01
PB 01a
PB 01
Sampling Station
NOx
Other


Nitrogen Concentrations in the North Branch, Munroe Brook - July 11, 2006
N Conc., mg/l as N
1.4
1.2
1
0.8
0.6
0.4
0.2
0
(TM 5)
Hullcrest Storm Drainage
(TM 1)
Woodbine Road Storm Drain
T 1-1
T 1-2
T 1-3
T 1-4
T 1-5a
T 1-5
T 1-6
Sampling Station
NOx
Other N

Nutrient Relationships

- TN:TP Ratio (molar)
  - Lakes (rule of thumb):
    - <20 nitrogen limiting
    - >50 phosphorus limiting
  - Streams:
    - Ratio appears to impact more on the composition of periphyton communities

Total Nitrogen to Total phosphorus Ratios in the LaPlatte River and McCabe's Brook - 2006



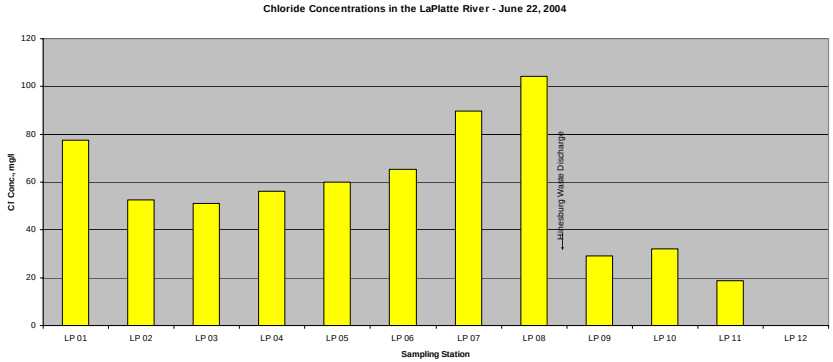
TN:TP	*Lewis Creek*	*Pond Brook*
Mean	100.92	9.89
Median	93.22	9.04
Standard Deviation	49.92	3.12
Range	201.43	6.90
Minimum	40.35	7.29
Maximum	241.78	14.19
Count	25	4

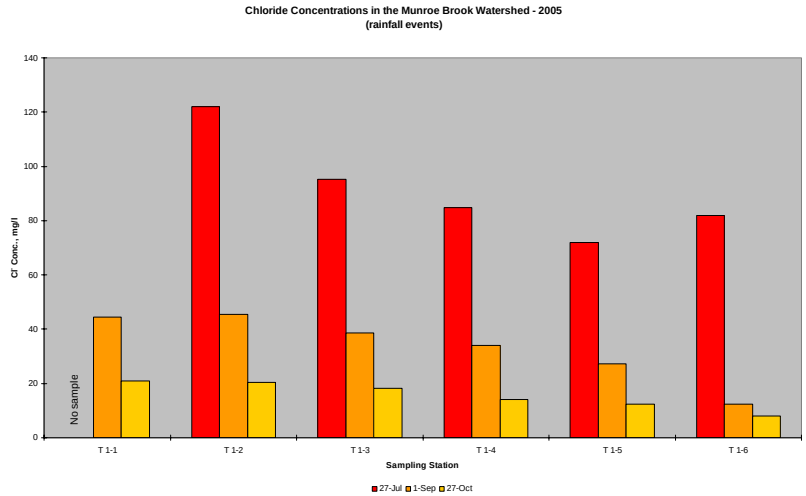
TN:TP	*Lemon Fair-Otter Creek*	*New Haven River*
Mean	17.96	120.83
Median	16.00	124.15
Standard Deviation	7.74	53.55
Range	35.53	179.71
Minimum	7.25	22.03
Maximum	42.79	201.74
Count	24	15

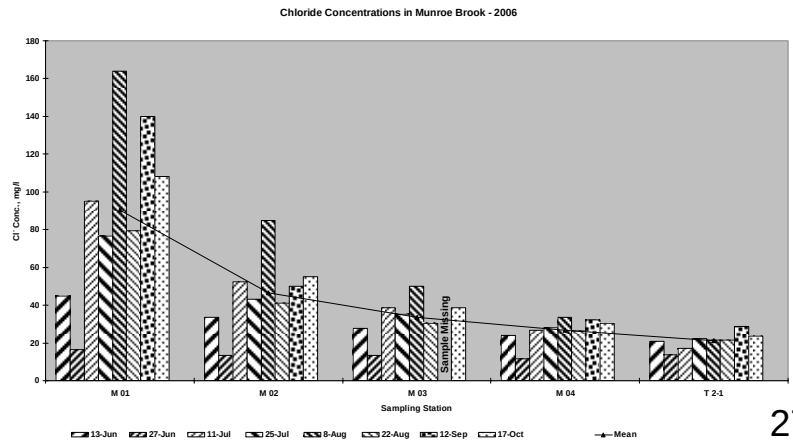
Little Otter Creek			
	All	**LOC7.8**	**LOC14.4**
Mean	50.43	21.66	79.19
Median	29.74	22.01	86.24
Standard Deviation	45.92	8.54	50.39
Range	166.25	26.23	165.56
Minimum	4.28	4.28	4.97
Maximum	170.53	30.51	170.53
Count	20	10	10

CHLORIDES

- Conservative element (non-reactive)
- Sources
  - Waste discharges (point sources)
  - Road salt in runoff (non-point)
- Significance
  - Indicator of waste discharge
  - Tracer of pollution
  - Indicator of dilution
  - Indicator of storm runoff containing salt
  - Effect on aquatic life (?)


Chloride Concentrations in the LaPlatte River - June 22, 2004
Cl Conc., mg/l
120
100
80
60
40
20
0
LP 01
LP 02
LP 03
LP 04
LP 05
LP 06
LP 07
LP 08
LP 09
LP 10
LP 11
LP 12
Sampling Station
Shelburne Waste Discharge

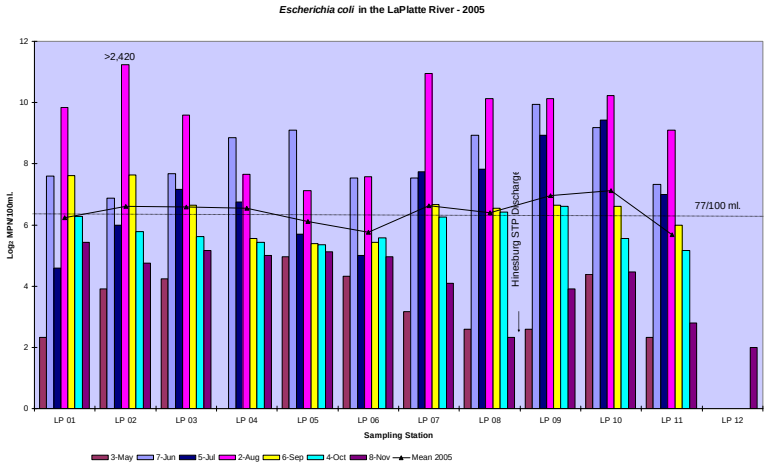

Chloride Concentrations in the Munroe Brook Watershed - 2005
(rainfall events)
Cl Conc., mg/l
140
120
100
80
60
40
20
0
No sample
T 1-1
T 1-2
T 1-3
T 1-4
T 1-5
T 1-6
Sampling Station
27-Jul
1-Sep
27-Oct

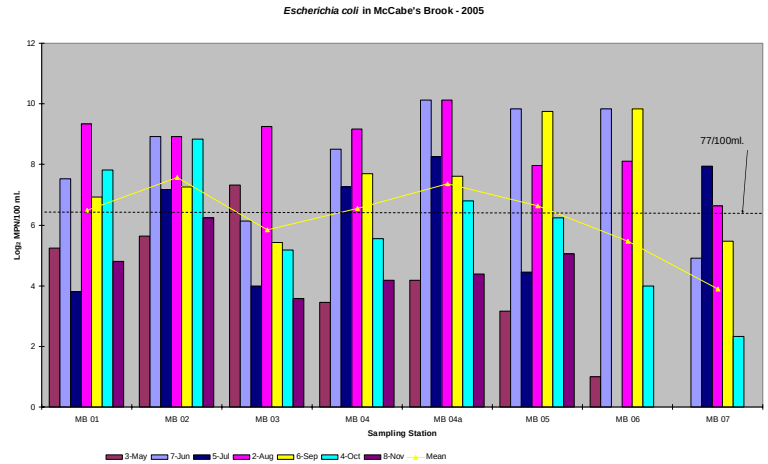

Chloride Concentrations in Munroe Brook - 2006
Cl Conc., mg/l
180
160
140
120
100
80
60
40
20
0
Sample Missing
M 01
M 02
M 03
M 04
T 2-1
Sampling Station
13-Jun
27-Jun
11-Jul
25-Jul
8-Aug
22-Aug
12-Sep
17-Oct
Mean

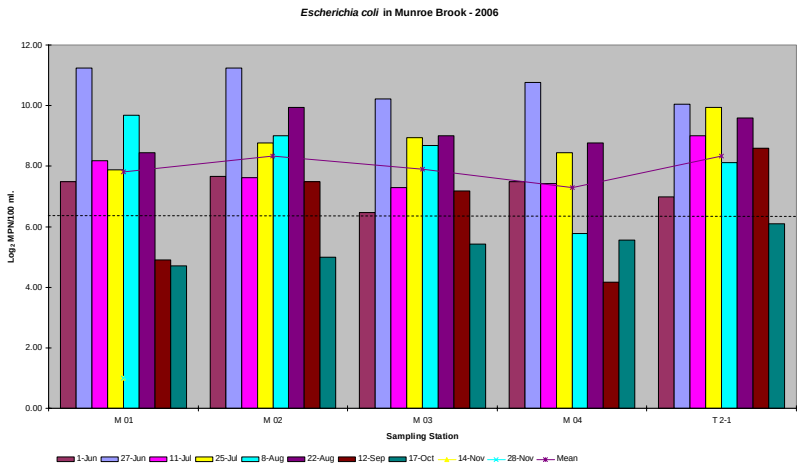
Bacteriology

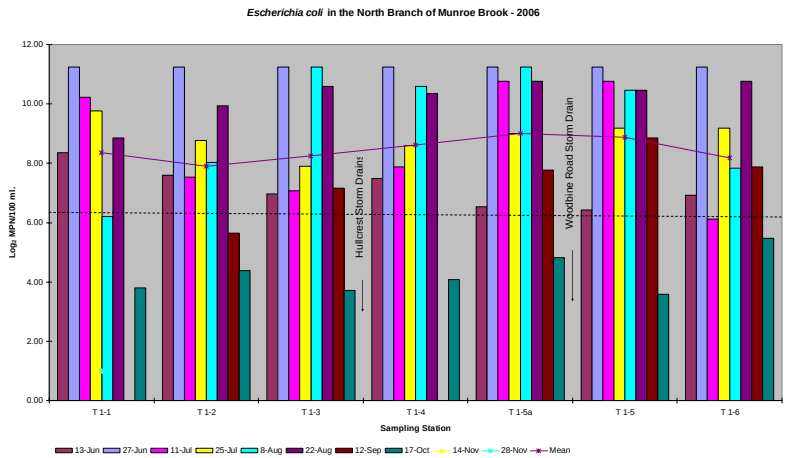
- *Escherichia coli*
  - Sources
    - Human or animal fecal material
  - Standards
    - Surface waters – 77 per 100ml.
    - Drinking water - zero
- Fecal coliform:Fecal streptococci
  - Human feces ~4.4
  - Sewage 4.3-8.6
  - Cows 0.2
  - Pigs and sheep 0.4

Escherichia coli in the LaPlatte Watershed and Munroe Brook









IV. Follow-up: Putting Results to Work

- Identification of existing or potential water quality problems and the need for interventions to protect water quality
- Monitoring change over time
- Monitoring benefits of interventions
- Providing support for corridor and town planning
- Reporting and public education

V. Issues and Points for Discussion

- How can volunteer monitoring groups best plan programs and analyze and interpret results. Data analysis and interpretation are complex and time consuming
  - How should we be going about it
  - How do we find meaning in our data
  - How do results relate to historical data if they exist
  - How do results relate to other related studies
  - How do we identify needs for follow-up action
- How can we make the best use of the data being collected
- How can volunteer monitoring groups develop their own understanding of water quality issues
  - What skills do Volunteer Monitoring Groups need to help them analyze and interpret data
  - How can such groups get training?
- How will volunteer monitoring programs be sustained