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LaPlatte Watershed Partnership

Water Quality Supplement
LaPlatte River

2010 Data and Pilot Flow Study

Prepared for

Water Quality Section
Vermont Department of Environmental Conservation

and

The Town of Shelburne, Vermont
April, 2011

I. INTRODUCTION

The LaPlatte Watershed Partnership has implemented a volunteer water quality monitoring program in the LaPlatte watershed on a bi-weekly or monthly basis during the summer and fall seasons since 2004. The monitoring effort has been provided laboratory support through the State of Vermont's LaRosa Volunteer Water Quality Monitoring Analytical Partnerships program, support for the analysis of particle size from the Champlain Water District, and financial support from the Town of Shelburne for laboratory supplies, establishment of flow gaging stations, data analysis and review, and public education under special environmental projects. Quality assurance under the monitoring program is carried out following the protocols contained in the State's EPA approved *Vermont General Quality Assurance Project Plan for Volunteer, Educational and Local Community Monitoring and Reporting*.

The LaPlatte Watershed Partnership prepared a review of the first four years of water quality monitoring in the watershed in 2008, and a supplemental report of 2008 results in 2010. A revised monitoring plan for the LaPlatte River and its upstream tributaries coordinated with the 5-year basin planning schedule proposed by the Department of Environmental Conservation and including scheduled reduced skeleton sampling was introduced in 2010. The present report discusses results of the limited water quality monitoring carried out in 2010 included a pilot project to determine the feasibility and value of incorporating flow measurement and analysis of nutrient and sediment loadings as part of volunteer water quality monitoring programs. The monitoring program in 2010 also continued the analysis of particle sizes in water samples collected at Falls Road (LP 03) begun in 2005 with assistance from the Champlain Water District to understand better the nature of suspended solids and turbidity and their associated phosphorus burden. The present report includes the results and interpretation of the pilot flow measurement initiative carried out in 2010 and provides an update to results of studies of particulate size in water samples from the LaPlatte River carried out with laboratory support from the Champlain Water District.

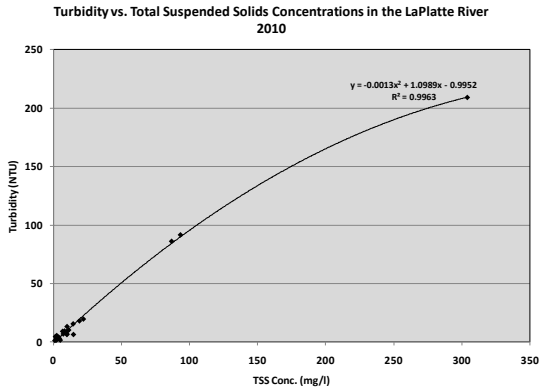
II. RESULTS

Limited monitoring of solids and phosphorus in the LaPlatte River, as well as the pilot assessment of flow, was undertaken at four locations on the LaPlatte River during the summer and fall of 2010. Full water quality monitoring at five locations on McCabe's Brook and flow monitoring at two locations as part of the pilot program are discussed in a separate report.

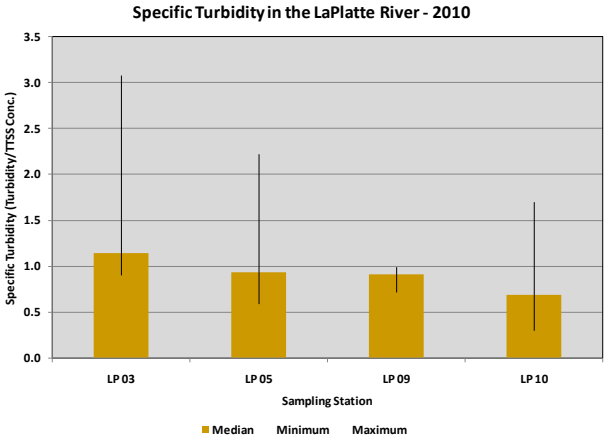
a. Suspended Sediment

The primary purpose of sampling for solids in the LaPlatte River during 2010, as for phosphorus discussed below, was not the routine monitoring of water quality at all LaPlatte River sampling sites. Rather, sampling was undertaken at pilot sentinel locations where staff gages were established. The results are briefly considered in the context of historical experience.

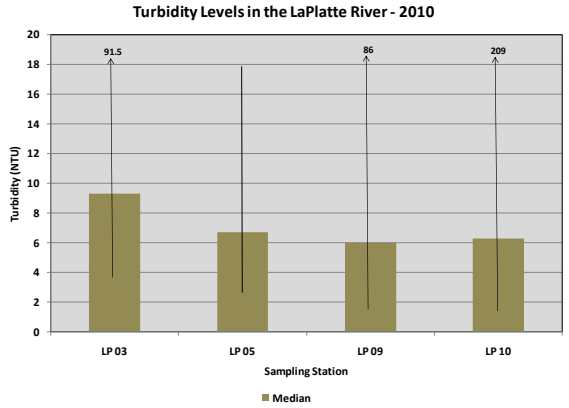
Turbidity correlated well with total suspended solids concentrations as can be seen below:

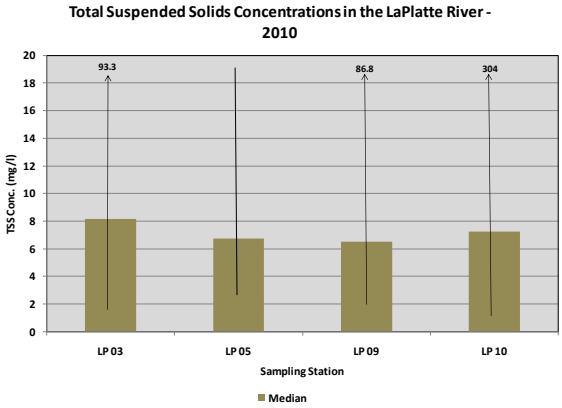


On the other hand, the relationship changes progressively within the stream as seen in the following graph of specific turbidity (Turbidity/TSS Concentration). The steadily increasing ratios of turbidity to total suspended solids concentrations and their range is consistent with trends observed during previous sampling years. Of interest too is the increase from levels generally observed in streams draining more highly forested watersheds such as the Middlebury and New Haven Rivers and Otter and Lewis Creeks which generally fall below 0.65, to levels observed in the Champlain Valley watersheds which are less highly forested, such as Little Otter Creek where values tend to be around 1.35, and the Lemon Fair River where values tend to exceed 2.3.



Levels of turbidity were relatively low, increasing slightly downstream, and were consistent with levels observed over the period 2004-2008. Although turbidity levels in most samples fell well below the State standard of 25 NTU for Class B warm water streams, they did exceed the standard at 3 stations on August 4, 2010 following a period of rainfall.

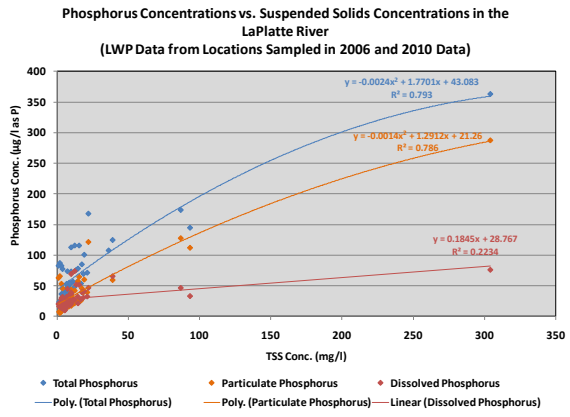


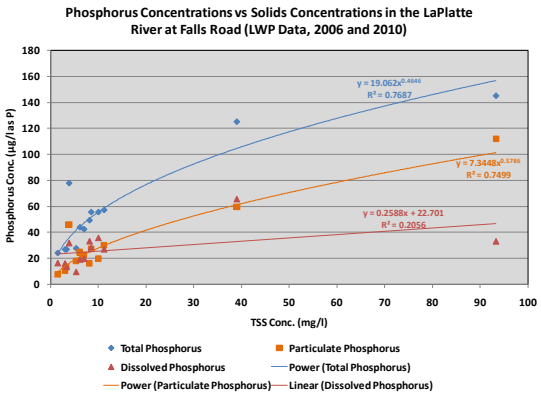


Total suspended solids concentrations generally followed the pattern observed for turbidity, and were consistent levels observed during previous years at the upstream locations. Increasing concentrations observed at Falls Road (LP 03) in 2010 contrasted with the observations during 2004-2006 which tended to decrease to about 4.6 mg/l. Maximum values fell well below historical maxima.

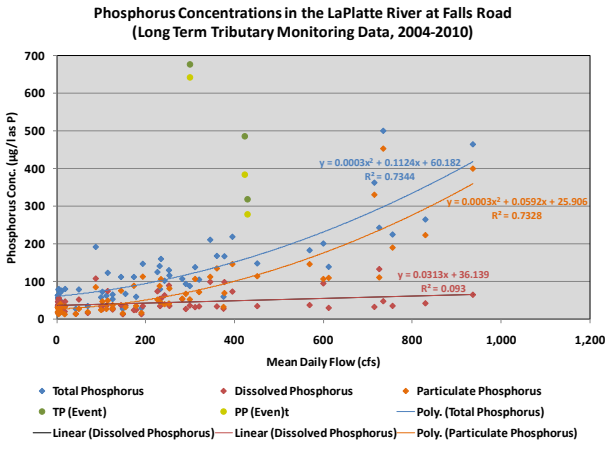
b. Phosphorus

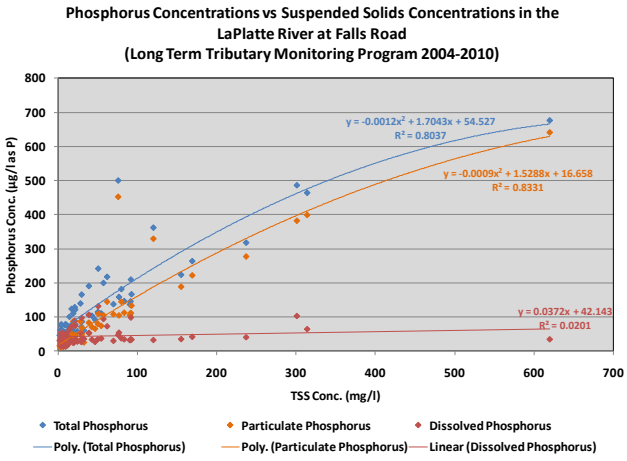
Phosphorus concentrations in the LaPlatte River are determined primarily by concentrations of suspended sediment and the particulate phosphorus associated with it. Concentrations of dissolved phosphorus tend to be low, falling generally below 100 µg/l. That this is so is illustrated in the following curves based on phosphorus and solids concentrations in water samples from the LaPlatte River at locations sampled in 2010 in 2006 and 2010, and from the LaPlatte River at Falls Road, also in 2006 and 2010.



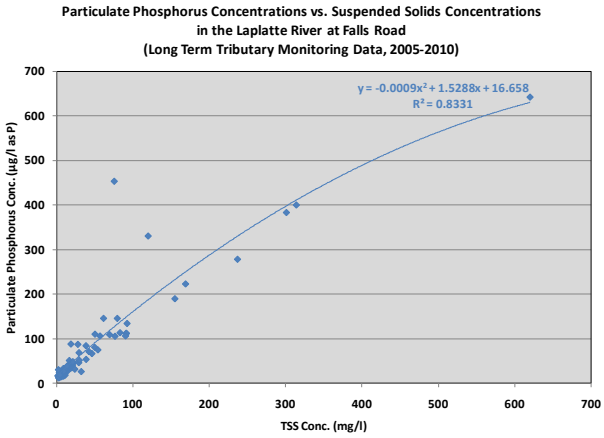


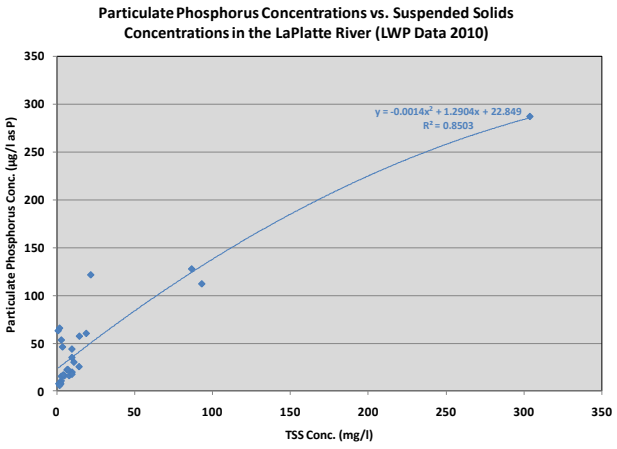
The predominant role of sediment load in determining phosphorus concentrations in the LaPlatte River is illustrated also by Long Term Tributary Monitoring Program data for the LaPlatte River at Falls Road which provides data on high flows and high sediment loads associated with them (shown below for the years during which water quality was monitored under the volunteer water quality monitoring program).



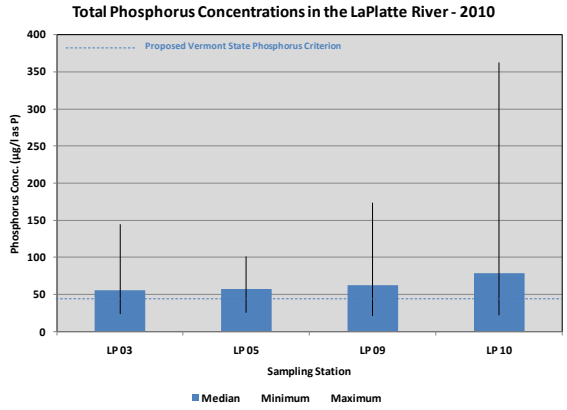


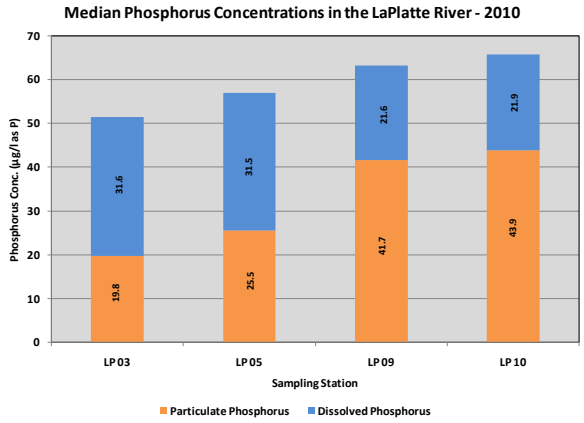
The similarity of the relationships between particulate phosphorus and total suspended solids concentrations exhibited by Long Term Tributary Monitoring data for the LaPlatte River at Falls Road in Shelburne over the period 2005-2010 and 2010 volunteer water quality monitoring data from the LaPlatte River from Hinesburg to Falls Road is striking.



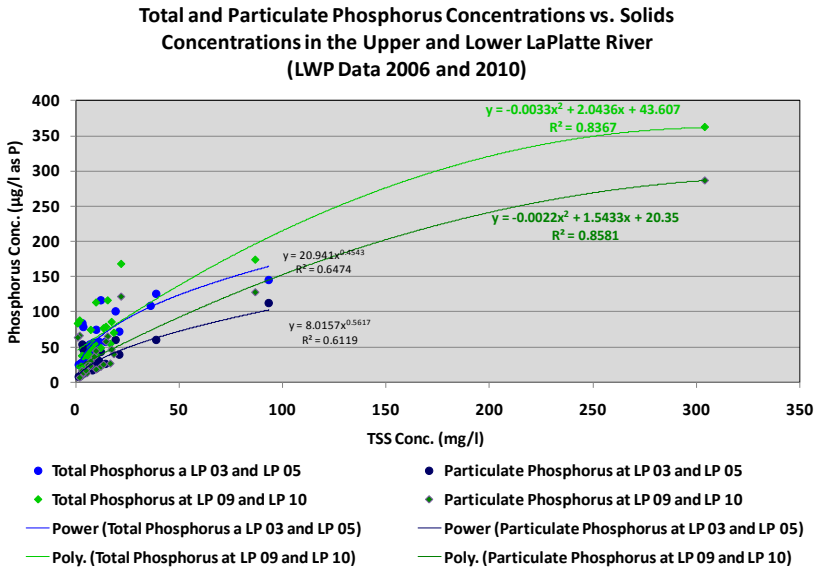


In spite of the slightly increasing solids concentrations between Hinesburg and Falls Road in Shelburne during 2010, a general pattern of decreasing total phosphorus concentrations at the stations sampled during 2010 resembled that observed during previous years. Levels were slightly higher on average than during past years, although decreasing maximum concentrations contrasted with the past increases downstream. While on the one hand, total phosphorus concentrations historically have been strongly influenced by suspended sediment loads, the distribution of phosphorus between the dissolved and particulate phases showed a different pattern in 2010 when particulate phosphorus concentrations decreased between the upstream and downstream stations, while dissolved phosphorus concentrations increased.



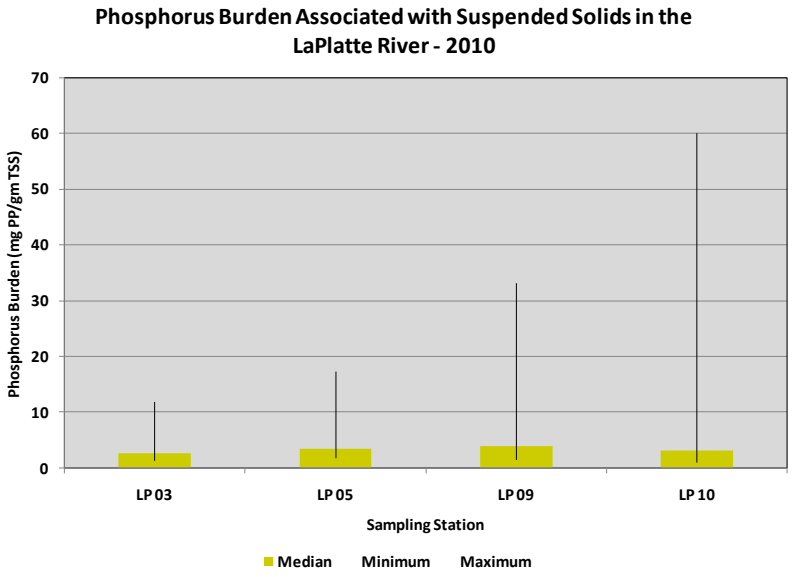


The contrast between upstream and downstream stations during 2010 is illustrated also in the following graph.



The higher phosphorus concentrations observed at upstream locations, and in particular those associated with the particulate phosphorus fraction, may be explained also in part by higher

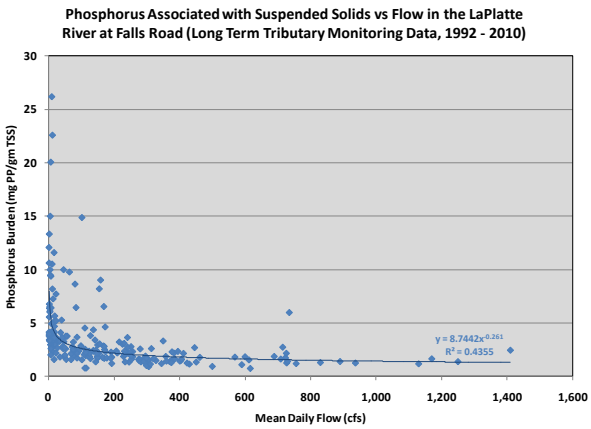
burdens of phosphorus at times associated with particulate matter at the upstream stations than at the downstream stations.

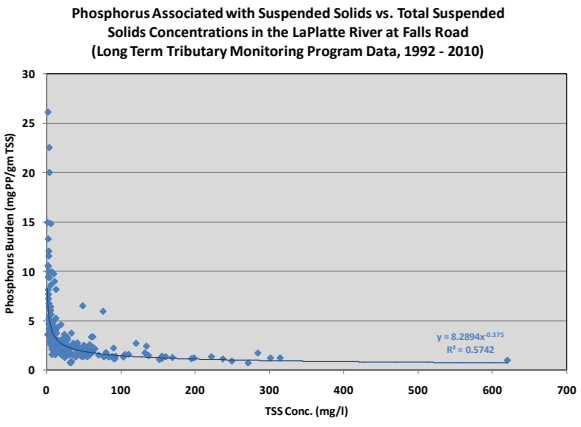


It is noted that, although total phosphorus concentrations at times fell below the proposed State criterion in Class B warm water streams, the criterion was exceeded in most samples from all locations sampled.

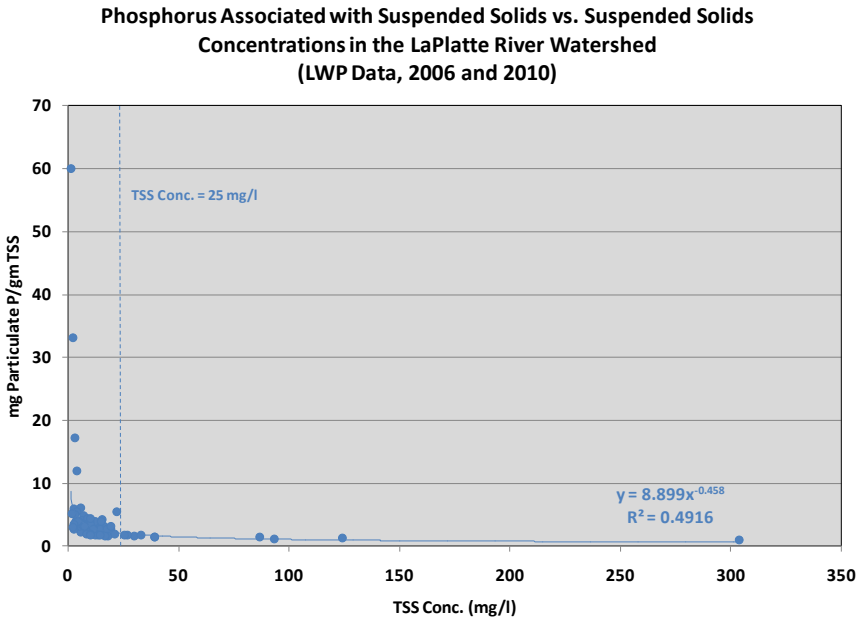
c. Phosphorus - Suspended Sediment Relationships

An examination of the burden of particulate phosphorus associated with suspended sediment in the LaPlatte River (as well as other Vermont rivers discharging into Lake Champlain) in relation to flow and to concentrations of total suspended solids suggests questions related to the dynamics of sediment and associated phosphorus transported by the river and their fate in Shelburne Bay.





The data indicate that high phosphorus burdens in excess of the generally recognized normal range of 1 – 3 mg P/gm solids (equivalent to 1 – 3 gms P/Kg TSS) seldom are observed in the LaPlatte River at flows greater than about 200 cfs[1], or total suspended solids concentrations of generally about 25-75 mg/l at Falls Road (Long Term Tributary Monitoring program data). Furthermore, phosphorus burdens at very low flows and solids concentrations can reach very high levels (a maximum of over 26 mg P/gm TSS). A similar pattern of higher



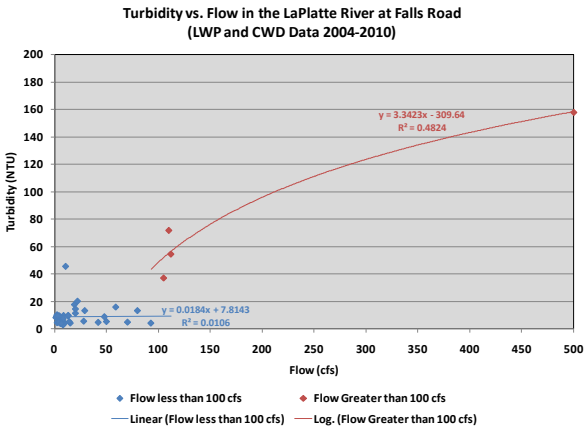
phosphorus burdens at low solids concentrations has been demonstrated in limited water samples from throughout the LaPlatte watershed (LaPlatte Watershed Partnership), where values higher than 3 were limited to solids concentrations below 25 mg/l, and where a value as high as 60 mgP/gm TSS has been observed. These results strongly suggest that sediment transported by the LaPlatte River at low flow rates and consequently low solids concentrations, consists largely of clay and fine silt particles with high surface area relative to their mass and a high affinity for phosphorus.

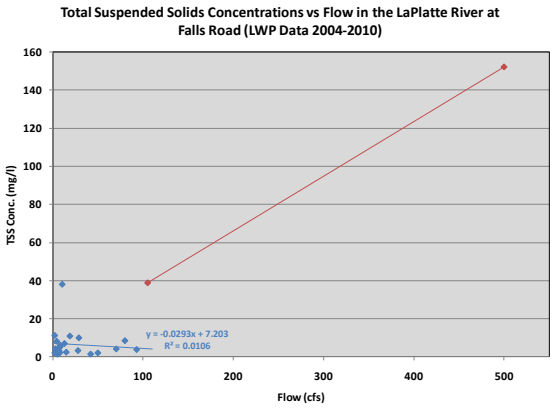
In view of the importance of sediments as determinants of phosphorus loads in the LaPlatte River system, and the evidence suggesting that fine particulate matter rich in phosphorus predominates at lower flows below a critical flow and solids concentration, the LaPlatte Watershed Partnership, with laboratory support from the Champlain Water District, has determined particle size distributions on samples collected from the LaPlatte River at Falls Road (LP 03) in Shelburne since 2005. The following discussion is based on results of sampling

[1] It is noted that the discharge values were mean daily flows. It would have been preferable to use instantaneous flows recorded at the time samples were taken as which can vary widely during the day. The use of mean daily flows could introduce considerable variability into the analysis.

carried out by both the Champlain Water District and the volunteer water quality monitoring program. The data set is limited, particularly at high flows. This has limited the ability to draw solid conclusions. On the other hand, the data are highly suggestive, and it is recommended that sampling be continued targeting high flows and including turbidity, total suspended solids, total phosphorus, dissolved phosphorus, and particle size analyses.

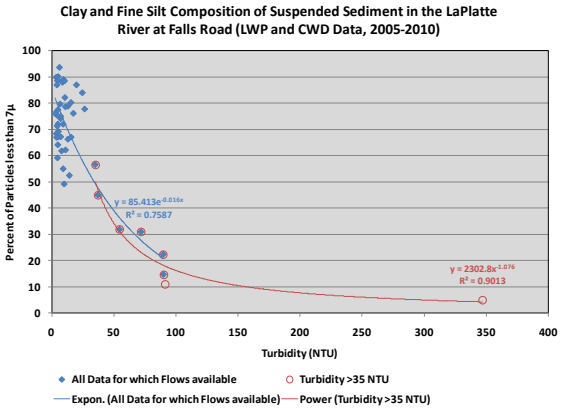
Results of turbidity analyses carried out by the Champlain Water District and the volunteer monitoring program in conjunction with the study of particle size distribution suggest that turbidities tend to remain relatively constant and at a low level in the LaPlatte River at Falls Road, irrespective of flow rate up to a flow of about 90 to 100 cfs. Above 100 cfs, the turbidity appears initially to increase rapidly in proportion to flow rate and then begins to level off at very high flow. A similar increase in the solids concentrations appears to take place at flows greater than 100 cfs. Although samples taken at flows greater than 100 cfs were very limited, the data again suggest that below some critical flow and solids concentration, sediment consists primarily of clay and fine silt which can be relatively rich in phosphorus, and above which the river has the energy necessary to mobilize, maintain in suspension, and transport larger sediment particles.

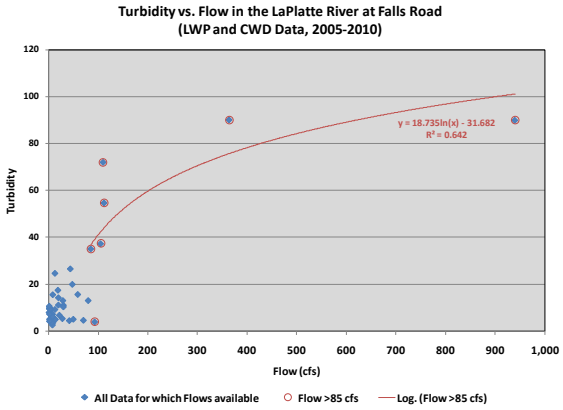




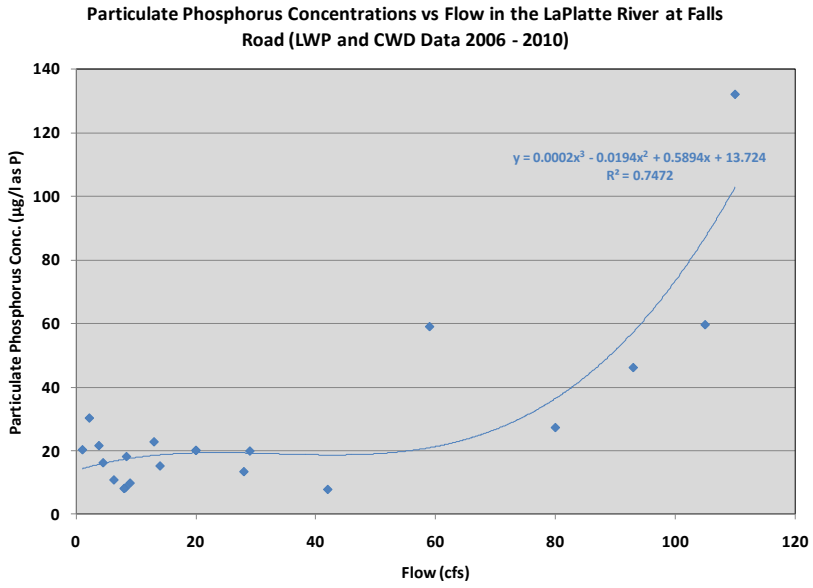
Similar, although very much less clear, results were observed when solids concentrations obtained under the Long Term Tributary Monitoring program were presented in relation to flow.

The pattern exhibited by turbidity in relation to flow was reflected very well in the composition of particles in water samples examined. Particles in the 2µ, 3µ, and 5µ size classes (<7µ), comprised of clay and fine silt, predominated at turbidity levels below about 25 NTU, varying between about 60% and 90% of the particles present, decreasing to about 10% at and above 100 NTU. The data available for flows greater than 100 cfs, although limited, were highly suggestive and the study should be extended with an emphasis on sampling at flows greater than 100 cfs.





Similarly, concentrations of particulate phosphorus appeared to begin to increase over a base level when the flow reached a level between 100 and 120 cfs as illustrated also by Long Term Tributary Monitoring Data, although considerable scatter occurred among suspended solids values as flows increased. Again, however, the data are very limited, and the study should be extended with a focus on higher flows.



d. Pilot Flow Studies

It has for several years been a vision of the LaPlatte Watershed Partnership to establish flow gaging stations on the LaPlatte River and its tributary, McCabe's Brook, to i) assess the practicality of incorporating flow measurement into volunteer water quality monitoring programs, ii) replace subjective assessment of flow conditions with more a accurate measurement of flow, iii) provide greater understanding of flows in small Champlain Valley streams, and iv) provide an information base required to determine nutrient and sediment loadings transported by the stream, assess their relative significance, and determine where the

major sources impacting on loadings discharged to Shelburne Bay are located. The incorporation of flow measurements on a pilot basis was made possible in 2010 through financial support from the Town of Shelburne under a Special Environmental Project, and technical assistance from Roy Schiff and Jessica Clark of Milone & MacBroom, Inc. to establish three gaging stations on the LaPlatte River.

Establishment of Gaging Stations. Suitable sites for location of staff gages on the LaPlatte River were somewhat limited by the morphometry of the stream which includes wetlands, riffles, and other structures. Staff gages were installed in late June at three locations, one just downstream from Silver Street in Hinesburg (LP 10), one upstream from the Hinesburg sewage treatment plant outfall (LP 09), and one downstream from Carpenter Road in Charlotte (LP 05). Flows are available at Falls Road in Shelburne (LP 03) from a USGS gaging station at that location.

The gage downstream from Silver Street captures flow from the stream upstream from Hinesburg as well as storm drainage from portions of Hinesburg discharging into the river at Silver Street. The gage above the Hinesburg sewage treatment plant outfall captures stream flow and storm drainage from the town of Hinesburg and Patrick Brook. The gages at Carpenter Road and Falls Road capture runoff to the river at strategic points over the length of the river.

Calibration of staff gages and discharge rating curves were prepared by Milone & MacBroom (Attachment d).

Samplers were provided with instructions for reading staff gages, and readings were entered on field data forms at the time samples were taken. Results indicate that samplers had difficulty reading gages correctly part of the time at certain locations, and with highly questionable accuracy at others. In future, additional training will be provided to assure that reading of staff gages is performed accurately.

Flow Study Results. Reported readings of staff gages by volunteer samplers on the LaPlatte River suggest that some samplers had difficulty. Specific problems included:

1. Readings that exceeded the height of the gage, e.g., 6.5 ft
2. Readings at upstream stations that resulted in flows far exceeding flows at downstream stations.
3. Readings including only 2 digits, suggesting that tenths readings were at times reported as feet, and hundredths readings as tenths of feet.

Nutrient and Total Suspended Solids Loadings in the LaPlatte River, 2010

Date	Sampling Station	Flow (cfs)	Total Phosphorus Conc. (mg/l)	Total Phosphorus Load (Kg/day)	Particulate Phosphorus Conc. (mg/l)	Particulate Phosphorus Load (Kg/day)	Dissolved Phosphorus Conc. (mg/l)	Dissolved Phosphorus Load (Kg/day)	Total Suspended Solids Conc. (mg/l)	Total Suspended Solids Load (Kg/day)
5/5/2010	LP 03	93	0.078	17.68	0.046	10.49	0.0316	7.19	3.87	880.51
6/2/2010	LP 03	6.3	0.027	0.41	0.011	0.16	0.0159	0.25	3.01	46.39
7/7/2010	LP 03	4.5	0.049	0.54	0.016	0.18	0.033	0.36	8.14	89.61
	LP 05	[4.75]	0.054		0.022		0.0315		6.73	
	LP 09	3.71	0.168	1.53	0.122	1.10	0.0465	0.42	22	199.81
	LP 10	2.41	0.113	0.67	0.044	0.26	0.0691	0.41	9.9	58.30
8/4/2010	LP 03	19.00	0.145	6.74	0.112	5.21	0.0329	1.53	93.3	4,336.85
	LP 05	7.79	0.101	1.93	0.06	1.15	0.0407	0.78	19.1	364.21
	LP 09	[24.50]	0.174		0.128		0.0463		86.8	
	LP 10	*	0.363		0.2871		0.0759		304	*
9/1/2010	LP 03	2.2	0.057	0.31	0.03	0.16	0.0268	0.14	11.2	60.28
	LP 05	0.74	0.045	0.08	0.017	0.03	0.0277	0.05	4.36	7.91
	LP 09	-	-		-		-		-	-
	LP 10	*	0.078		0.057		0.021		14.7	*
10/6/2010	LP 03	29	0.055	3.93	0.02	1.40	0.0356	2.53	10	709.48
	LP 05	[37.89]	0.058		0.026		0.0322		14.5	
	LP 09	[42.05]	0.038		0.018		0.0206		9.95	
	LP 10	18.26	0.048	2.15	0.023	1.01	0.0255	1.14	7.24	323.44
11/4/2010	LP 03	42	0.024	2.46	0.008	0.79	0.0162	1.66	1.48	152.07
	LP 05	[51.45]	0.025		0.008		0.0169		2.43	
	LP 09	[117.58]	0.022		0.008		0.014		2.76	-
	LP 10	16.80	0.022	0.90	0.006	0.24	0.0159	0.65	2	82.22

NOTES: Loading in Kg/Day = (Flow in cfs)x(Conc. in mg/l)x(2.446848)

Flows at LP 03 from USGS Gaging Station

* indicates invalid staff gage reading

[ ] indicates highly suspect reading

It is noted, based on results of chloride analyses in the LaPlatte River during previous sampling years, that in general, flows at Falls Road appear to be about double those at the staff gage located at the Hinesburg waste treatment plant outfall, although on rare occasions flows at Carpenter Road appeared to exceed those at Falls Road. These observations are consistent with flow determinations made during the calibration of staff gages as indicated in the Table (see also Attachment d):

Flow at Falls Road Relative to Flow at Upstream Sampling Locations (Calibration Data)

	7/8/2010	6/3/2010	6/11/2010	10/18/2010	12/14/2010
Flow at LP 03 (cfs)	5.4	10	67	158	459
			Ratio $Flow_{LP03}$:$Flow_{upsream\ Station}$		
LP 05	1.04	1.27	1.07	1.39	1.31
LP 09	1.64	1.59	1.21	2.31	3.04
LP 10	2.84	2.86	3.81	6.10	7.78

It is noted that as flow increases, it increases at a higher rate at Falls Road than at upstream stations, suggesting that runoff is in general greater in the portion of the watershed draining to the lower reaches of the river. This can seen more clearly when flows are viewed on an areal basis:

Flow per mi.^{2} (Calibration Data)

	7/8/2010		6/3/2010		6/11/2010		10/18/2010		12/14/2010	
	Total Drainage	**Reach**	**Total Drainage**	**Reach**	**Total Drainage**	**Reach**	**Total Drainage**	**Reach**	**Total Drainage**	**Reach**
Falls Road	0.121		0.224		1.502		3.543		10.291	
		0.015		0.157		0.313		3.306		8.104
Carpenter Road	0.167		0.253		2.013		3.644		11.231	
		0.141		0.119		0.563		3.348		14.778
Hinesburg STP Outfall	0.186		0.356		3.119		3.870		8.525	
		0.159		0.318		4.273		4.841		10.443
Silver Street	0.213		0.393		1.978		2.910		6.629	

Notable were the increase in the runoff per mi.^{2} within reach drainages in Hinesburg between Silver Street and the sewage treatment plant, and the shifts in patterns from low to high flows.

Overall, the results of the pilot flow measuring effort in the LaPlatte River during the summer of 2010 confirmed both the practicality of flow measurement by volunteer water quality samplers and the value of flow data to putting sources of pollutants into perspective (see also McCabe's Brook Report for 2010). The uncertainties associated with the staff gage readings from the LaPlatte River highlight the need for intensive training before the program is extended in 2011.

III. CONCLUSIONS AND RECOMMENDATIONS

The volunteer monitoring effort in the LaPlatte River watershed has provided many insights into factors impacting on water quality within the watershed, identified issues relating water quality within the watershed and impacting on Shelburne Bay, and highlighted specific needs and directions for further investigation. These are summarized below, together with recommendations applicable to all volunteer water quality monitoring programs based on lessons learned, as well as specific recommendations relating to sediment and nutrients in the LaPlatte River and its watershed. In addition, results of water quality monitoring have a broader value to overall planning activities within the Lake Champlain Basin.

a. Suspended Sediments

Suspended sediment, measured as turbidity and total suspended solids concentrations, is a key measure of water quality in the LaPlatte River and its tributaries in view of its direct impact on aquatic life in the river system, its effect on the esthetic quality of the river and Shelburne Bay, its potential impact on the raw water supply for the Champlain Water District, and of particular importance, its role in the mobilization and transport of phosphorus in the river system and Shelburne Bay.

Although turbidity in general correlated well with concentrations of total suspended solids in the LaPlatte River during 2010, the relationship expressed as specific turbidity (turbidity/TSS Conc.) changed progressively from about 0.7 upstream in Hinesburg (LP 10) to about 1.1 at Falls Road in Shelburne (LP 03), reflecting characteristics of more highly forested higher elevation streams in Hinesburg, and more sparsely forested Champlain Valley streams in Shelburne.

Although the sampling program as implemented during 2010 was not designed to detail sediment levels throughout the river, results were consistent with results observed during previous years at upstream and downstream locations. Furthermore, whereas turbidity levels in general fell well below the State standard for Class B warm water streams, they exceeded it when flows reached 93 cfs at Falls Road.

RECOMMENDATIONS

- Monitoring of suspended sediment levels should continue as an integral part of the volunteer water quality monitoring program in the LaPlatte River watershed.
  - Monitoring of turbidity should be continued in view of its importance to aquatic life and esthetic quality of the river and Shelburne Bay as well as the analysis of particle size data.
  - Monitoring of total suspended solids should be continued in view of its importance in relation to the analysis of phosphorus data and phosphorus loadings on Shelburne Bay.
- Total suspended solids data should be interpreted in conjunction with results of fluvial geomorphic studies and which together should be applied to the mitigation of erosion and to land use and local, regional, and basin planning.

b. Phosphorus and Phosphorus-Sediment Relationships

Phosphorus concentrations in the LaPlatte River consistently exceeded the proposed Vermont State criterion for Class B warm water streams, driven primarily by suspended sediment loads carried by the river waters.

Total phosphorus concentrations tend to increase in relation to total suspended solids concentrations as stream flow and sediment loads increase. At the same time, dissolved phosphorus concentrations tend to remain relatively constant at levels generally below 100 µg/l (median equal to about 44 µg/l based on Long Term Tributary Monitoring Data, 1992-2010) and are independent of both suspended solids concentrations and discharge.

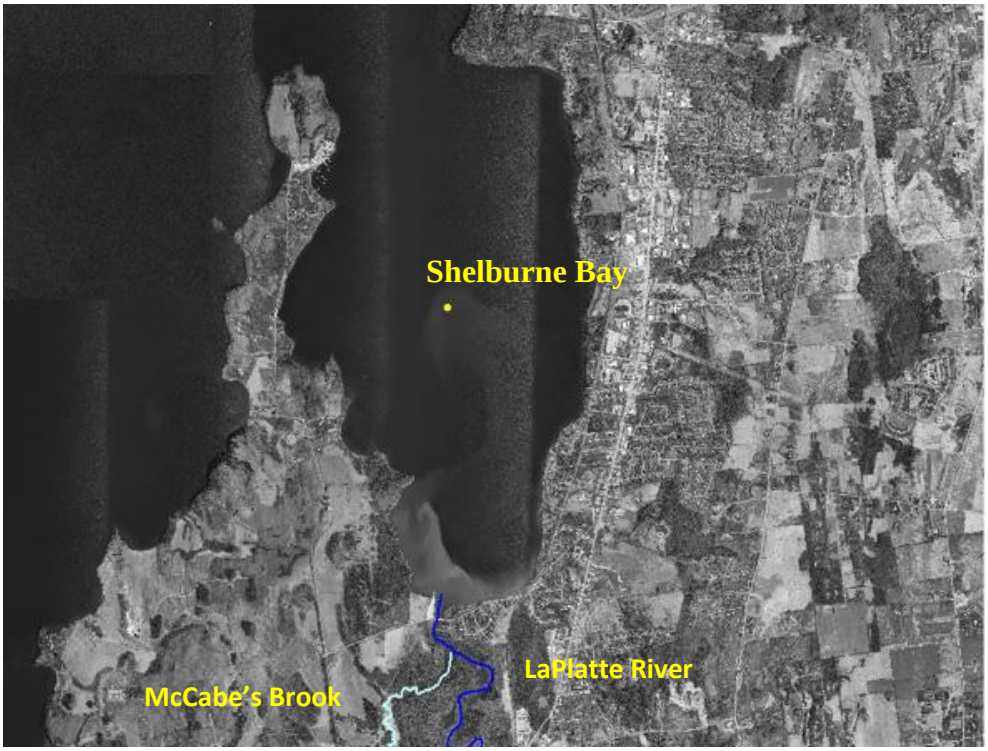
Within the LaPlatte River system, the concentrations and proportions of phosphorus associated with suspended sediment tended to decrease downstream (in contrast to suspended solids concentrations). The apparent inconsistency of suspended solids and phosphorus concentrations can be understood in the context of the nature of the sediment load in suspension. Because suspended sediment concentrations tend to increase downstream while at the same time particulate phosphorus concentrations tend to decrease, calculated phosphorus burdens tend to be higher at upstream locations than at downstream locations. Such a pattern of phosphorus burdens could be related to a difference in the nature of the suspended sediment at the upstream

and downstream locations, and would be expected if suspended sediment in the upper watershed were rich in clay and fine silt relative to that in the lower reaches of the river.

The association of high burdens of phosphorus with low concentrations of suspended sediment and low flows on the LaPlatte River at Falls Road is evident in data provided under the Long Term Tributary Monitoring Program, as well as data collected under the volunteer monitoring program. This again suggests that the suspended sediment load at low flow and low concentrations of suspended solids may be relatively rich in clay and fine silt which in turn would be expected to be richly endowed with active adsorptive sites relative to mass.

Further investigation by the LaPlate River Watershed Partnership in collaboration with the Champlain Water District, do in fact suggests that at Falls Road counts of clay and fine silt particles (<7μ in size) predominate among suspended solids in water samples when turbidities are low and flows are less than about 100 cfs. Limited results also suggest that i) turbidity tends to remain relatively constant up to a "critical," or threshold, flow of about 100 cfs, and ii) above the "critical" flow, larger particles make up a higher proportion of the particles in suspension. At the same time, particulate phosphorus concentrations appear to remain relative constant up to about the same "critical" flow above which they begin to increase. The data are very limited, however, and the study should be expanded assure inclusion of more data collected at flows exceeding 100 cfs.

The above analyses suggest questions relating to the fate of sediment and phosphorus within the backwater from Lake Champlain, in Shelburne Bay, and the lake itself. An indication of the way sediment may be carried into Shelburne Bay and transported within the Bay is illustrated in the following orthophoto:



In this context, the phosphorus loading on the lake might be thought of as being made up of three components, or phases:

- Particulate phosphorus associated with clay and fine silt particles carrying a heavy burden of phosphorus which may be transported into the bay and the open lake.
- Particulate phosphorus associated with larger particles carrying a lower burden of phosphorus which may settle in the backwaters of the lake and in the near-shore areas of Shelburne Bay and the lake.
- Dissolved phosphorus which can be carried with water currents into the open lake.

The data suggest that at times of higher flow (>100 cfs) the bulk of the phosphorus discharged from the LaPlatte River is associated with larger particles which are more likely to remain in the lower reaches of the river and near shore areas of Shelburne Bay where it may contribute to the development of algal blooms and growth of floating and rooted aquatic plants.

Of the Long Term Monitoring Program samples taken between 1992 and 2010, about 42% were taken on days during which the mean daily flow was 100 cfs or less when fine particles appear to predominate. Over the period 1990-2010, mean daily flows equaled or exceeded 100 cfs on only 12.6% of days. Dissolved phosphorus in the discharge from the LaPlatte River constitutes a very small portion of the total phosphorus loading on the lake. On the other hand, it may be that dissolved and fine particulate phosphorus contribute the bulk of the phosphorus reaching the open water of Shelburne Bay.

RECOMMENDATIONS

- Continue total and dissolved phosphorus analyses in conjunction with turbidity and total suspended solids analyses on samples from sentinel pilot flow locations on the LaPlatte River.
- Continue particle size analyses on samples from Falls Road and extend to include at least three unscheduled samples during flows exceeding 100 cfs and including total and dissolved phosphorus, turbidity, and total suspended solids.
- Extend particle size analyses on scheduled sampling dates and three unscheduled high flow dates, together with total and dissolved phosphorus, turbidity, and total suspended solids analyses to the Silver Street sampling location in Hinesburg.
- Results of geomorphic and water quality studies along with floodplain reconnaissance, particularly with regard to phosphorus, should be utilized to provide a basis for formulating policies relating to land management and protection of the environment and Lake Champlain and for drafting land use and basin plans.

c. Pilot Flow Studies

Flow monitoring was initiated on a pilot basis in the LaPlatte River and its tributary, McCabe's Brook, during the 2010 sampling season to i) assess the practicality of incorporating flow measurement into volunteer water quality monitoring programs, ii) replace subjective assessment of flow conditions with more a accurate measurement of flow, iii) provide greater understanding of flows in small Champlain Valley streams, and iv) provide an information base required to determine nutrient and sediment loadings transported by the stream, assess their relative significance, and determine where the major sources impacting on loadings discharged to Shelburne Bay are located.

The results of the pilot flow measuring effort during the summer of 2010 varied. Within McCabe's Brook, results confirmed both the practicality of flow measurement by volunteer water quality samplers and the value of flow data for determining sediment and nutrient loadings, for locating regions of interest, and for establishing the relative importance of sources and loadings of pollutants. Some volunteers had difficulty reading staff gages located in the LaPlatte River, and the resulting flow data are in many cases either questionable or wrong. Additional training in the reading of gages is required, but based on results obtained for McCabe's Brook, results can be useful and the pilot study should be extended in 2010.

It is noted that although chlorides were not determined during 2010, during past years when chlorides were determined, results indicated that flows tended to double between sampling station LP 08 located downstream from the Hinesburg sewage treatment plant outfall, and about 100 meters downstream from the location of the staff gage at LP 09, and Falls Road in Shelburne. Their determination should be included as an adjunct in future studies of flow.

RECOMMENDATIONS

- The pilot program for monitoring of flow measurement under the volunteer water quality monitoring program in the LaPlatte River should be continued in 2011.
- Training of volunteers should be continued to assure the accuracy of staff gage readings by volunteers.
- As an additional check on estimates of flow in the future, chlorides should be determined at LP 08, LP 05, and LP 03 as an adjunct to the flow studies.
- The possibility of enlisting volunteers to read staff gages on a daily basis should be investigated to provide a better understanding of ranges and magnitudes of flow in LaPlatte River.
- The possibility of enlisting volunteers to measure rainfall in the LaPlatte watershed should be investigated.

IV. ATTACHMENTS

a. Sampling Stations

Site Location	Site Latitude	Site Longitude	Parameter					
			Flow	Temp.	TSS	Turbidity	Total P	Diss. P
LP 03 - LaPlatte River at Falls Road	44.37022	-73.21577	X	X	X	X	X	X
LP 05 - LaPlatte River at Carpenter Road	44.34176	-73.18383	X	X	X	X	X	X
LP 07 - LaPlatte River at Leavenworth Road*	44.33887	-73.14931		X	X	X	X	X
LP 09 - LaPlatte River above Hinesburg STP Outfall	44.33395	-73.12598	X	X	X	X	X	X
LP 10 - LaPlatte River at Silver Street	44.32524	-73.11015	X	X	X	X	X	X

* Sampled May 5, 2010 only

b. Water Quality Data

Solids Concentrations in the LaPlatte River - 2010

	Station No.	5/5/2010	6/2/2010	7/7/2010	8/4/2010	9/1/2010	10/6/2010	11/3/2010	Median	Minimum	Maximum
TSS	LP 03	3.87	3.01	8.14	93.3	11.2	10	1.48	8.14	1.48	93.3
	LP 05	3.1	9.91	6.73	19.1	4.36	14.5	2.43	6.73	2.43	19.1
	LP 09	1.99	3.07	22	86.8		9.95	2.76	6.51	1.99	86.8
	LP 10	1.05	5.03	9.9	304	14.7	7.24	2	7.24	1.05	304
Turbidity	LP 03	3.99	3.72	9.3	91.5	10.1	13.1	4.55	9.3	3.72	91.5
	LP 05	2.82	6.7	9	17.9	2.57	15.4	5.39	6.7	2.57	17.9
	LP 09	1.42	3.02	19.5	86		8.95	2.54	5.985	1.42	86
	LP 10	1.18	1.49	6.26	209	6.28	6.75	3.4	6.26	1.18	209
Specific	LP 03	1.03	1.24	1.14	0.98	0.90	1.31	3.07	1.14	0.90	3.07
Turbidity	LP 05	0.91	0.68	1.34	0.94	0.59	1.06	2.22	0.94	0.59	2.22
	LP 09	0.71	0.98	0.89	0.99		0.90	0.92	0.91	0.71	0.99
	LP 10	1.12	0.30	0.63	0.69	0.43	0.93	1.70	0.69	0.30	1.70

Phosphorus Concentrations in the Laplatte River - 2010

	Station No.	5/5/2010	6/2/2010	7/7/2010	8/4/2010	9/1/2010	10/6/2010	11/3/2010	Median	Minimum	Maximum
TP	LP 03	77.7	26.6	49.1	145	57	55.4	23.9	55.4	23.9	145
	LP 05		73.7	53.6	101	44.6	57.7	25.3	57.7	25.3	101
	LP 06	83									
	LP 09	87.4	37	168	174		38.2	21.6	62.8	21.6	174
	LP 10	83.1	37.8	113	363	78.4	48.1	21.8	78.4	21.8	363
PP	LP 03	46.1	10.7	16.1	112.1	30.2	19.8	7.7	19.8	7.7	112.1
	LP 05	53.4	35.1	22.1	60.3	16.9	25.5	8.4	25.5	8.4	60.3
	LP 09	65.8	15.4	121.5	127.7		17.6	7.6	41.7	7.6	127.7
	LP 10	63.1	15.9	43.9	287.1	57.4	22.6	5.9	43.9	5.9	287.1
DP	LP 03	31.6	15.9	33	32.9	26.8	35.6	16.2	31.6	15.9	35.6
	LP 05	29.6	38.6	31.5	40.7	27.7	32.2	16.9	31.5	16.9	40.7
	LP 09	21.6	21.6	46.5	46.3		20.6	14	21.6	14	46.5
	LP 10	20	21.9	69.1	75.9	21	25.5	15.9	21.9	15.9	75.9
% DP	LP 03	40.67	59.77	67.21	22.69	47.02	64.26	67.78	59.77	22.69	67.78
	LP 05	35.66	52.37	58.77	40.30	62.11	55.81	66.80	55.81	35.66	66.80
	LP 09	24.71	58.38	27.68	26.61		53.93	64.81	40.80	24.71	64.81
	LP 10	24.07	57.94	61.15	20.91	26.79	53.01	72.94	53.01	20.91	72.94
TSS	LP 03	3.87	3.01	8.14	93.3	11.2	10	1.48	8.14	1.48	93.3
	LP 05	3.1	9.91	6.73	19.1	4.36	14.5	2.43	6.73	2.43	19.1
	LP 09	1.99	3.07	22	86.8		9.95	2.76	6.51	1.99	86.8
	LP 10	1.05	5.03	9.9	304	14.7	7.24	2	7.24	1.05	304
PP/TSS	LP 03	11.91	3.55	1.98	1.20	2.70	1.98	5.20	2.70	1.20	11.91
	LP 05	17.23	3.54	3.28	3.16	3.88	1.76	3.46	3.46	1.76	17.23
	LP 09	33.07	5.02	5.52	1.47		1.77	2.75	3.88	1.47	33.07
	LP 10	60.10	3.16	4.43	0.94	3.90	3.12	2.95	3.16	0.94	60.10

c. Quality Assurance

Completeness of Sampling and Field Duplicates

	No. of Stations	Date	No. of Stations Sampled	Turbidity	TSS	Total P	Diss. P
	4	5/5/2010	4	4	4	4	4
	4	6/2/2010	4	4	4	4	4
	4	7/7/2010	4	4	4	4	4
	4	8/4/2010	4	4	4	4	4
	4	9/1/2010	3	3	3	3	3
	4	10/6/2010	4	4	4	4	4
	4	11/3/2010	4	4	4	4	4
Total No. of Stations	28		27	27	27	27	27
Percent			96.4	96.4	96.4	96.4	96.4
Target Percent				≥80%	≥80%	≥80%	≥80%
Number of Duplicates				14	14	14	14
Percent of Total				51.9	51.9	51.9	51.9
Target Percent				10%	10%	10%	10%

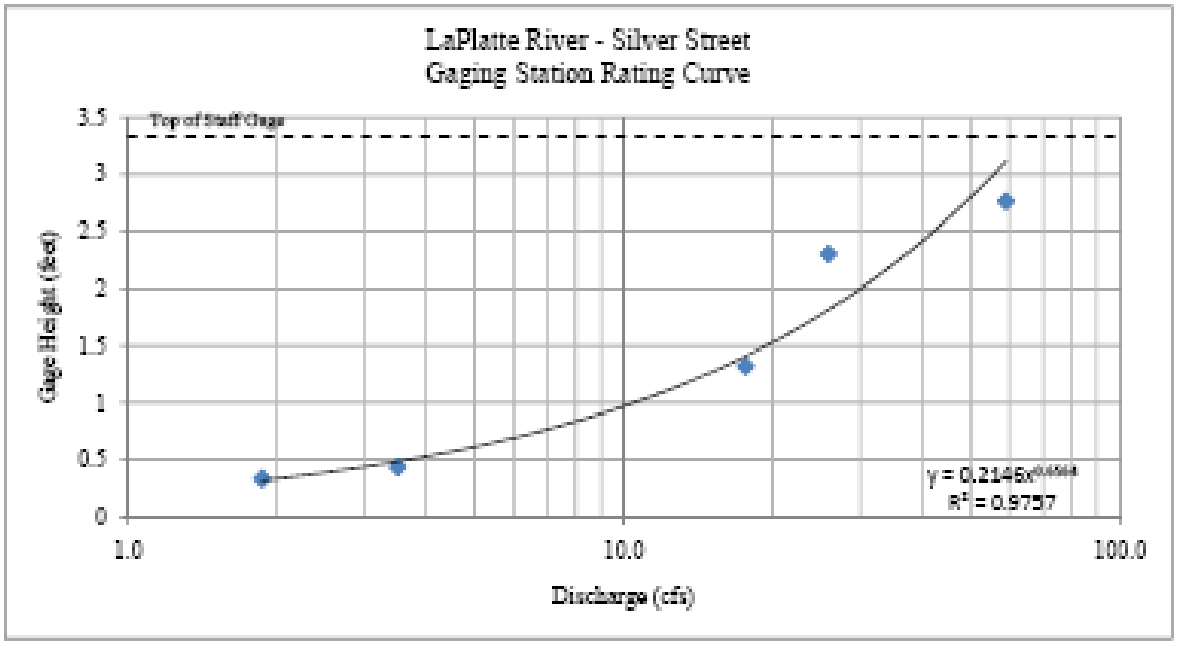
Summary of Relative Percent Differences

Parameter	Target Precision	Mean RPD
Turbidity	15%	6.73
TSS	15%	8.74
Total P	15%	1.40
Diss. P	15%	2.15

Attachment d. Gaging Station Rating Curves

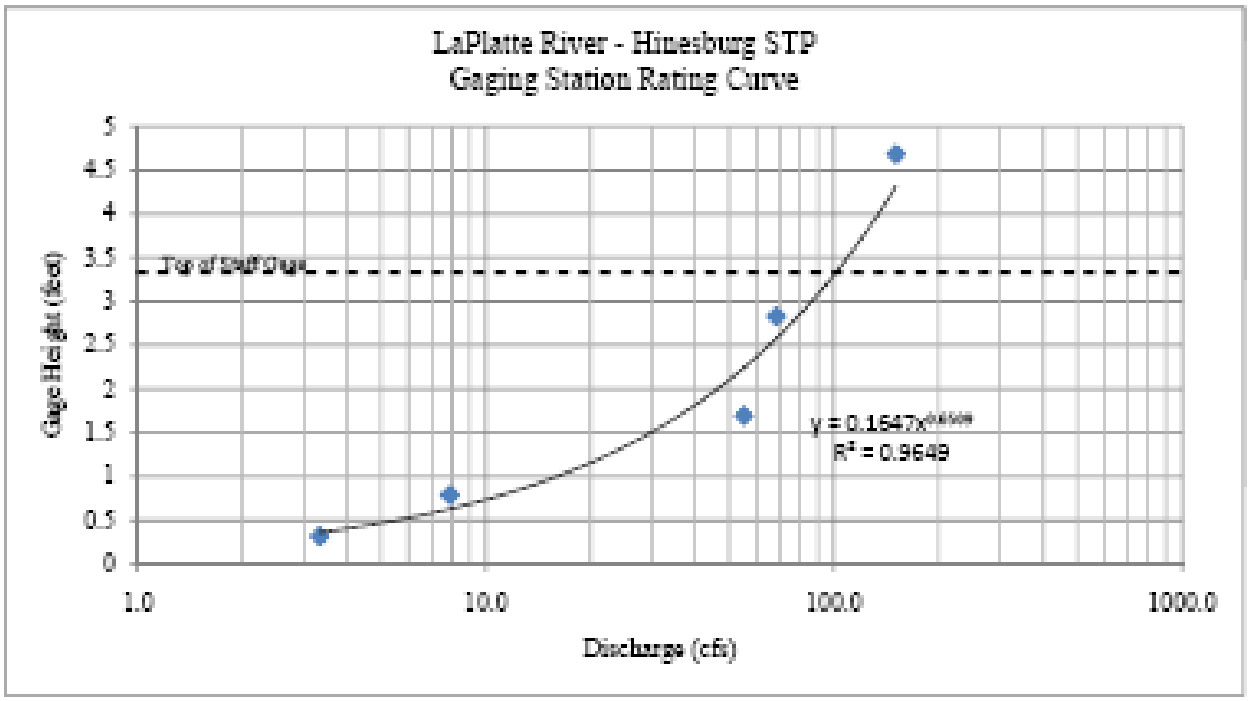
LaPlatte River - Silver Street

Date	Stage (feet)	Discharge (cfs)	Notes:
6/3/2010	0.44	3.5	
6/11/2010	1.325	17.6	
7/8/2010	0.34	1.9	
10/18/2010	2.305	25.9	Discharge also measured at Charlotte Road Culvert to be 28.3 cfs.
12/14/2010	2.8	59.0	Gage straightened to read measurement. Discharge at Charlotte Road Culvert measured to be 68.8 cfs.



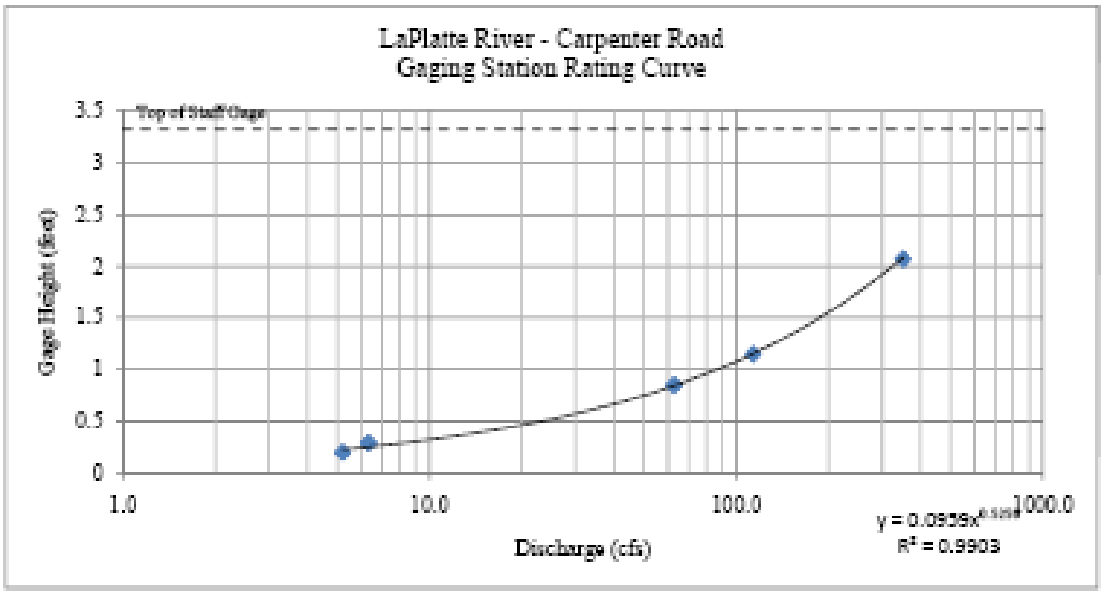
LaPlatte River - Hinesburg STP

Date	Stage (feet)	Discharge (cfs)	Notes:
6/3/2010	0.79	7.9	
6/11/2010	1.695	55.2	
7/8/2010	0.32	3.3	
10/18/2010	2.83	68.5	
12/14/2010	4.7	150.9	Staff Gage Submerged. Measured flow at Charlotte Rd Culvert, Patrick Brook Culvert, Patrick Canal Dam, and Trib Culvert.

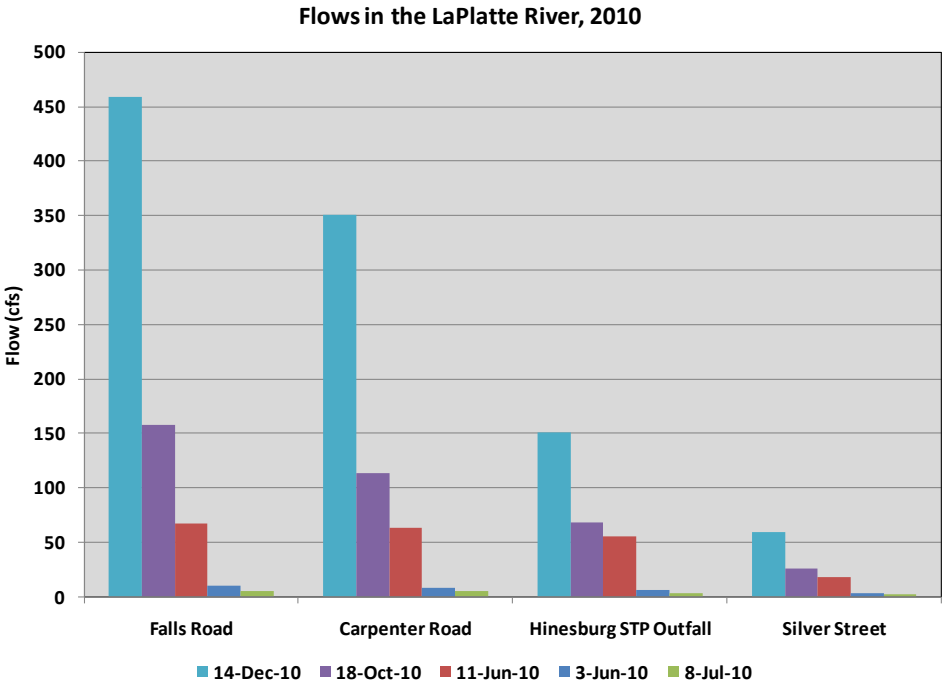


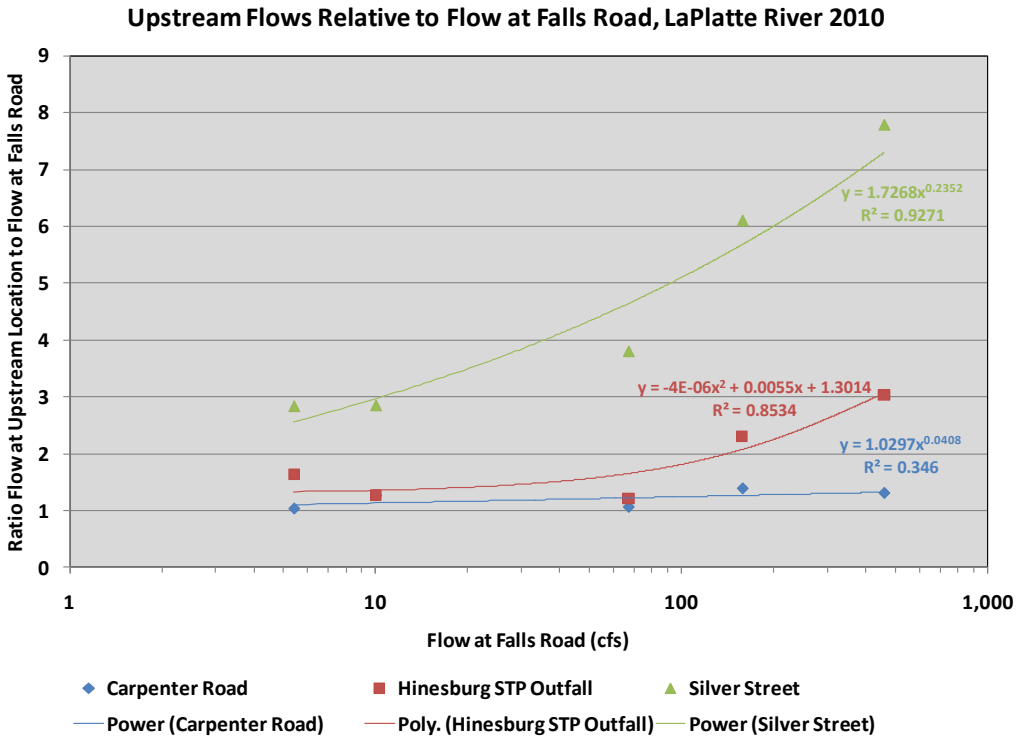
LaPlatte River - Carpenter Road

Date	Stage (feet)	Discharge (cfs)	Notes:
6/3/2010	0.29	6.3	
6/11/2010	0.85	62.8	
7/8/2010	0.2	5.2	
10/18/2010	*1.15*	113.7	Staff gage leaning over and angled downstream. Height determined from difference between staff gage and depth.
12/14/2010	2.1	350.4	Measured from bridge with weight

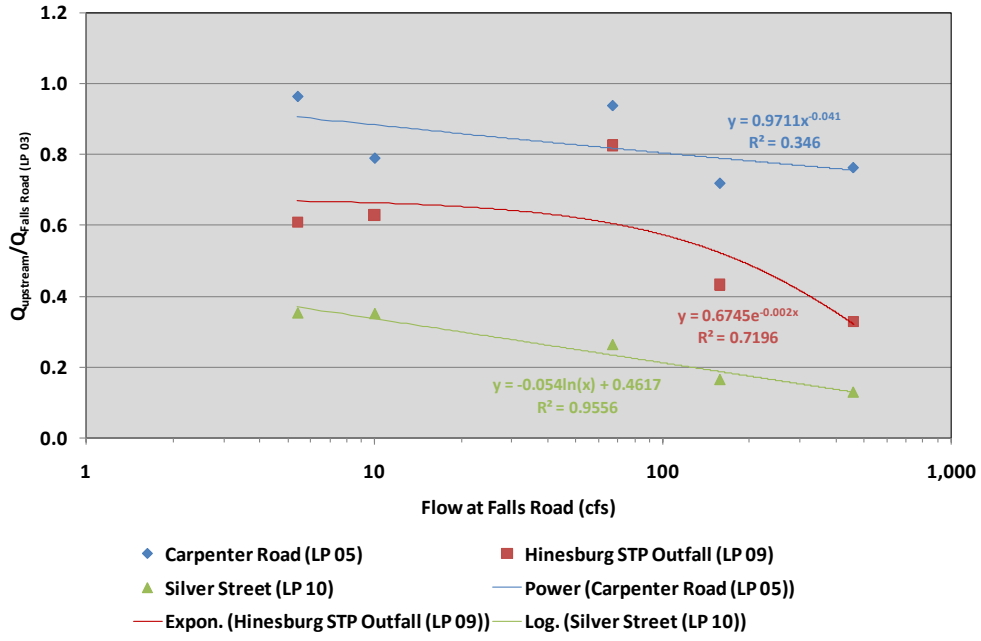


Analysis of Flows in the LaPlatte River





Upstream Flows in the LaPlatte River relative to Flow at Falls Road (Calibration Data 2010)



Flow per Square Mile Drainage Area in Relation to Flow in the LaPlatte River - 2010