

Pine River Watershed and Van Etten Lake 2013 Phosphorous and Suspended Solids Monitoring

SUMMARY

In contrast to the heavy spring rains which contributed large amounts of phosphorous (P) and suspended solids (TSS) to the lake in 2011, more normal conditions prevailed over the summer of 2013 although there was one very significant rain event sampled in July. The estimated amounts of both P (5.99 tons) and TSS (1,318 tons) for the year were about 17 percent more for phosphorous and 27 percent less for solids than the estimated four year mean amounts. The estimated amounts of both P and TSS entering the lake continued to be more than that leaving as most of these solids settle out. Flow/stage measurements planned for higher flow periods in 2013 were not completed as a flow meter was not on site. Continuing attempts will be made to strengthen the curves in 2014.

TRIBUTARY STREAM SAMPLING PROGRAM OVERVIEW

As a continuation of the sampling started in 2009, four tributary streams to Van Etten Lake (Pine River, Huron Creek, Phalen Creek, and Coppler Creek) and the Van Etten River (Lower Van Etten Creek) where it leaves the lake were monitored in 2013 to determine the relative impact of upstream and lake shore nutrients and solids. Sampling was also started in 2013 on Van Etten Creek at the corner of Barlow Road and Pine River Trail. The results of the Van Etten Creek sampling become a subpart of the Pine River sampling. Samples were collected from the six locations shown in Figure 1 and analyzed for total phosphorous (P) and total suspended solids (TSS). One sample was also collected from Hill Creek, which joins the Pine just downstream from County Line Road. The results of this sampling are additive to the Pine River in flow to Van Etten Lake. Water level (stage) measurements were taken at the time of sampling to obtain an estimate of the flow. Samples were collected during both high flow and low flow conditions from April through October in an attempt to characterize the quantity and quality of inflows to the lake.

At different times, the discharge at each location was measured using standard velocity and area measurement techniques. These measurements along with stream water level measurements and curves developed for the 2002 study by The Michigan Water Research Center entitled "Nutrient and Sediment Loading to Van Etten Lake, Iosco Co., Michigan" (McNaught report) were used to develop a rating curve (water level versus flow) for each sampling location. Through the good graces of Huron Pines, a flow meter is being made available so that stage/flow measurements can continue and the curves can be refined. The stage/flow curves, the sampling location details and a summary of stream flow measurement and sampling methods used are available on request as appendices to this report.

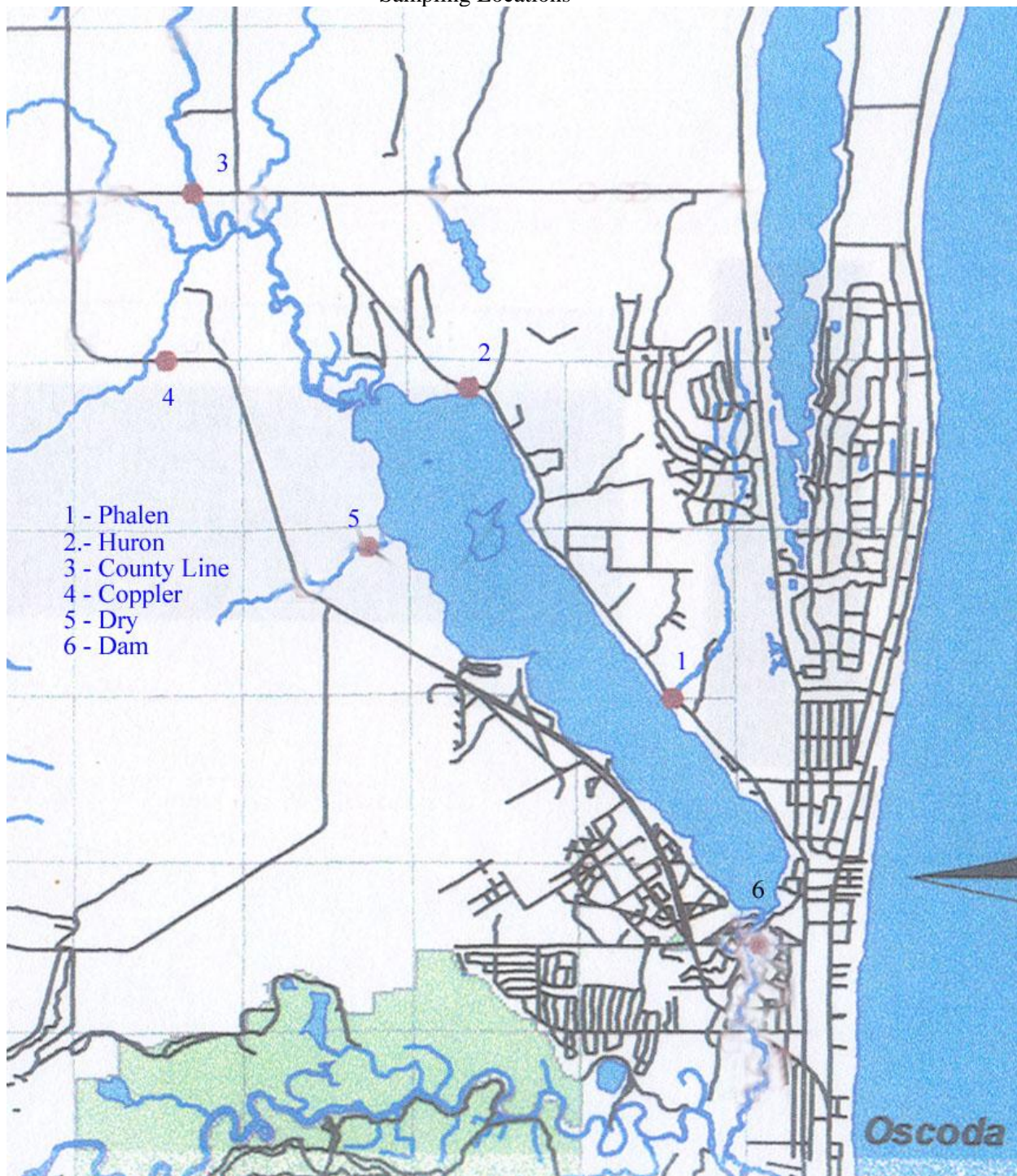
NUTRIENT AND SEDIMENT LOADINGS TO VAN ETTEN LAKE

Nutrients and sediments can enter Van Etten Lake through stream input, overland flow, ground water seepage and within lake processes. The McNaught study and this sampling are designed to assess stream input. The Pine River, Huron (Sims) Creek, Phalen Creek, Coppler Creek and Dry Creek (near Colbath Road) add nutrients and sediments directly to Van Etten Lake. The total contribution from each stream depends on the concentration of nutrient or sediment in the stream and the rate of stream flow (discharge). The contribution from each stream, called "load", is calculated as pounds or kilograms per day. Streams with high concentrations and high discharge will contribute the most nutrients and sediments to the lake. The Pine River is the primary source of nutrients and sediments. By also measuring the water that flows out of the lake for nutrients and sediments, the total contribution (or deduction) from non-stream related sources (runoff, seepage and within-lake processes) can be estimated. Most of the sediments entering the lake are carried by the inlet streams following storm events. After stream water enters the lake, sediment quickly settles to the bottom as the velocity decreases. Many of the settling particles have phosphorous and nitrogen molecules bound to their surface. These attached nutrients become part of the stored nutrient pool at the bottom of the lake.

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This continuation of the type of sampling conducted for the McNaught report over an extended period is intended to provide a complementary estimate of the phosphorous and sediment loadings from the inlet streams to the lake. In addition, it will allow for an estimate of the loadings from Coppler Creek, a tributary not sampled during that study. The sampling of Dry Creek was discontinued in 2011 because of the low flow and its relatively small contribution of P and TSS to the lake.

Figure 1
Sampling Locations



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RESULTS

Three samples were taken over the summer from each of the smaller tributaries and six samples were collected monthly from the Pine River and on Van Etten River (Lower Van Etten Creek) below the dam. The 2013 sampling results are presented in Appendix A. A summary of the estimated quantities of phosphorus (P) and total suspended solids (TSS) contributed to the lake by the Pine River and the other tributaries are shown in Figures 2 and 3. The estimated quantity calculations are based on the geometric mean estimates as the quantities estimated during relatively infrequent high flow periods tend to skew the arithmetic mean to the high side.

The data continue to show more P and TSS entering the lake from the rivers and streams than leaving via the Van Etten River. The estimated amount of P entering the lake was **32.8 lbs/day**, 17 percent more than the four year mean, and the amount of TSS was **3.61 tons/day**, 27 percent less than the four year mean. The amounts of P and TSS contributed to the lake by the Pine River continue to be significantly greater than the combined contribution from the other tributaries. The estimated loads from the Pine River may be overstated as they are based on stages not encountered during the development of the curves. This was particularly true in 2011 because of the very high flows which occurred in the spring and to a lesser extent in the fall. The measurement of flows is planned for 2014 to improve the accuracy of the stage/flow curves.

Figure 2

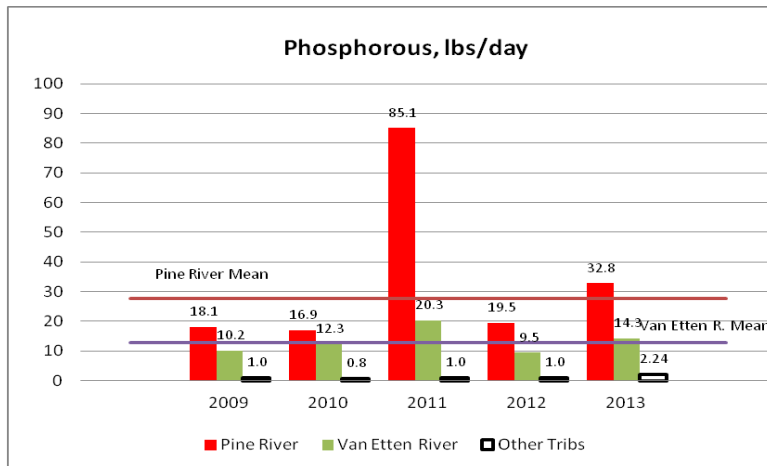
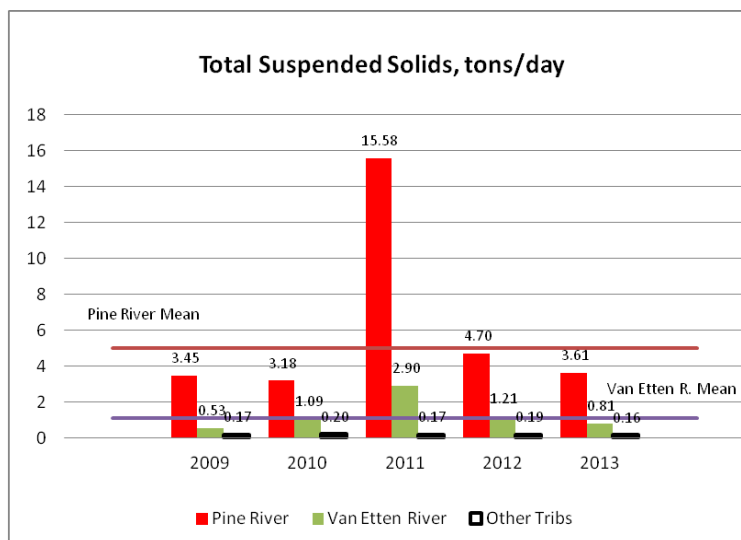


Figure 3



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DISCUSSION

The current preliminary estimates of phosphorus and total suspended solids contributions to the lake from all sources are summarized in Table 1. These are initial estimates from a mass balance model for the lake under development and which will continue to be refined as additional sampling is completed.

Source	Phosphorous	Total Suspended Solids
In	Lbs/yr	Tons/yr
Pine River	7,610	1,818
Other Tributaries	296	59
Septic Systems	1,236	---
Lawn and Woods Runoff	219	Not Estimated
Waterfowl	351	---
Release of settled P	190	---
Precipitation	84	---
Out		
Sedimentation by difference	(4,438)	(1,472)
Van Etten River	5,548	405

The data suggests the following:

1. The Pine River is by far the major contributor of P and TSS to the lake. Preliminary indications are that the bulk of P and TSS are carried to the lake during spring melt runoff.
2. There are no indications that either Phalen Creek or Huron (Sims) Creek contribute high amounts of P from golf course runoff.
3. Over the long term, the amounts of P and TSS leaving via the Van Etten River are significantly less than the amounts entering from all sources. The difference is due to a combination of settlement of solids after they enter the lake and uptake of P by aquatic growth which becomes a part of an internal recycle. Although there are indications that a considerable amount of P which entered the lake in 2011, left over the summer in the form of algae.
4. The rating curves are in need of refinement, particularly at higher flow periods, through the collection of additional stage/flow measurements using an accurate flow meter and standard procedures.
5. Additional multi-year sampling should be continued to establish a more accurate mean and if possible detect any trends.

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2013				Appendix A			
Location	Date	Stage	Flow, CFS	P, mg/L	P, lbs/day	TSS, mg/L	TSS, lbs/day
Pine River @ County Line							
	9-Apr-13	10.1	787	0.070	297	42.0	177,967
	15-May-13	13.7	242	0.005*	7	10.0	13,018
	12-Jun-13	14.5	125	0.127	86	3.2	2,137
	9-Jul-13	8.7	998	0.219	1,179	23.8	127,798
	21-Sep-13	14.8	81	0.024	11	6.1	2,667
	15-Oct-13	14.7	91	0.016	8	2.3	1,101
(Spring runoff taken as mean flow for one month)							
Geometric mean =			236	0.039	33	8.7	7,121
			w/o spring runoff sample		15		3,006
Van Etten River (Lower Van Etten Creek)							
	9-Apr-13	13.0	304	0.010	16.35	2.5*	4,088
	15-May-13	13.8	207	0.005*	5.56	2.5*	2,782
	12-Jun-13	14.5	107	0.018	10.31	1.1	603
	9-Jul-13	11.4	526	0.024	68.70	2.8	7,823
	21-Sep-13	14.8	70	0.025	9.33	1.3	498
	15-Oct-13	14.5	110	0.030	17.76	1.1	655
Geometric mean =			190	0.014	14	2.5*	1,612
			w/o spring runoff sample		15		1,338
Location	Date	Stage	Flow, CFS	P, mg/L	P, lbs/day	TSS, mg/L	TSS, lbs/day
Coppler Creek							
	15-May-13	2.23	9.8	0.005*	0.26	2.5*	132
	9-Jul-13	2.26	10.4	0.045	2.56	7.9	444
	21-Sep-13	2.40	13.4	0.008	0.58	4.8	346
Geometric mean =			11.1	0.012	0.73	4.4	272
Phalen Creek							
	15-May-13	96.5	5.9	0.040	1.26	2.5*	79
	9-Jul-13	85.0	9.8	0.035	1.86	4.0	211
	22-Sep-13	100.5	4.5	0.029	0.70	48.7	1,175
Geometric mean =			6.4	0.035	1.18	7.9	269
Huron (Sims) Creek							
	15-May-13	17.3	3.4	0.005*	0.09	2.5*	46
	9-Jul-13	13.3	2.4	0.053	0.70	7.3	96
	21-Sep-13	13.3	2.4	0.014	0.19	1.2	16
Geometric mean =			2.7	0.016	0.23	2.8	41

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Tributaries to the Pine River

Van Etten Creek

9-Jul-13	8.9	49.3	0.269	71.27	93.8	24,866
21-Sep-13	11.3	2.7	0.044	0.63	7.2	104
15-Oct-13	11.3	4.3	0.031	0.71	2.9	67

Geometric mean =		8.3	0.071	3.18	12.5	556
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Hill Creek

15-May-13	125.5	7.6	0.005*	0.20	2.5*	102
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P and TSS concentration values shown with an * are suspected as possibly being unreliable