Watershed Analysis: Tributary Flow and Nutrient Loading Analysis

Deer Lake, Polk County, WI

April 2022-Sept. 2025

Sponsored by: Deer Lake Conservancy and Wisconsin Dept. of Natural Resources

Data collected and analyzed by: Ecological Integrity Service, LLC

Introduction

From April 2022 to September 2025, the impact of seven sub-watersheds drained by intermittent tributaries into Deer Lake was evaluated. This evaluation included updating watershed boundaries, land cover, and the identification of internally drained areas by the Polk County Land and Water Conservation Department. Flow and nutrients (total phosphorus, orthophosphate, and total suspended solids) were monitored in each tributary that drains each sub-watershed during the entire period from April 2022 to September 2025. The original protocol was to collect through 2024, but since 2022 and 2023 were drought years, the data collection was extended one year to acquire better runoff data. This was beneficial as 2022 and 2023 were below normal precipitation, while 2024 was above and 2025 was near normal.

Numerous best management practices (BMPs) have been implemented in many of these sub-watersheds, mostly on Deer Lake Conservancy-owned land within the sub-watersheds. The data collected can help reflect the benefits of these practices as well as allow for more precise loading predictions to better evaluate the impact on Deer Lake. These results can also be used to prioritize sub-watersheds to target for management practices.

More information about the Deer Lake Conservancy lands and management practices can be found in the Deer Lake Conservancy Conservation Tour Guide.

Sub-watershed Overview

Polk County Land and Water Conservation Dept. updated the watershed boundaries. The sub-watershed boundaries were stopped at the locations of the flow monitoring devices, with any area below these locations as part of the direct-drained watershed. Figure 1 is a map[1] showing the designation of the boundaries of the sub-watersheds around Deer Lake, with internally drained areas included. Internally drained areas are areas that do not lead to runoff draining into Deer Lake during less than very intense rain events (less than 4.5 inches in 24 hours).

In addition to updating the boundaries, Polk County updated the land cover (aka land use) data within each sub-watershed. This land cover allows managers to identify areas that would be best to target with future management practices due to certain land cover contributing more runoff volume and nutrients into Deer Lake. Figure 2 is a map showing the land cover with the sub-watershed boundaries. Each sub-watershed will be summarized. Forested areas create the lowest runoff and nutrient loading, while row crop agriculture and high-density residential typically contribute the highest runoff and nutrient loading. This analysis was from data collected only in sub-watersheds 1-7. The direct-drained sub-watershed was not monitored for this study.

[1] Map created by Polk County, WI Land and Water Conservation Dept.

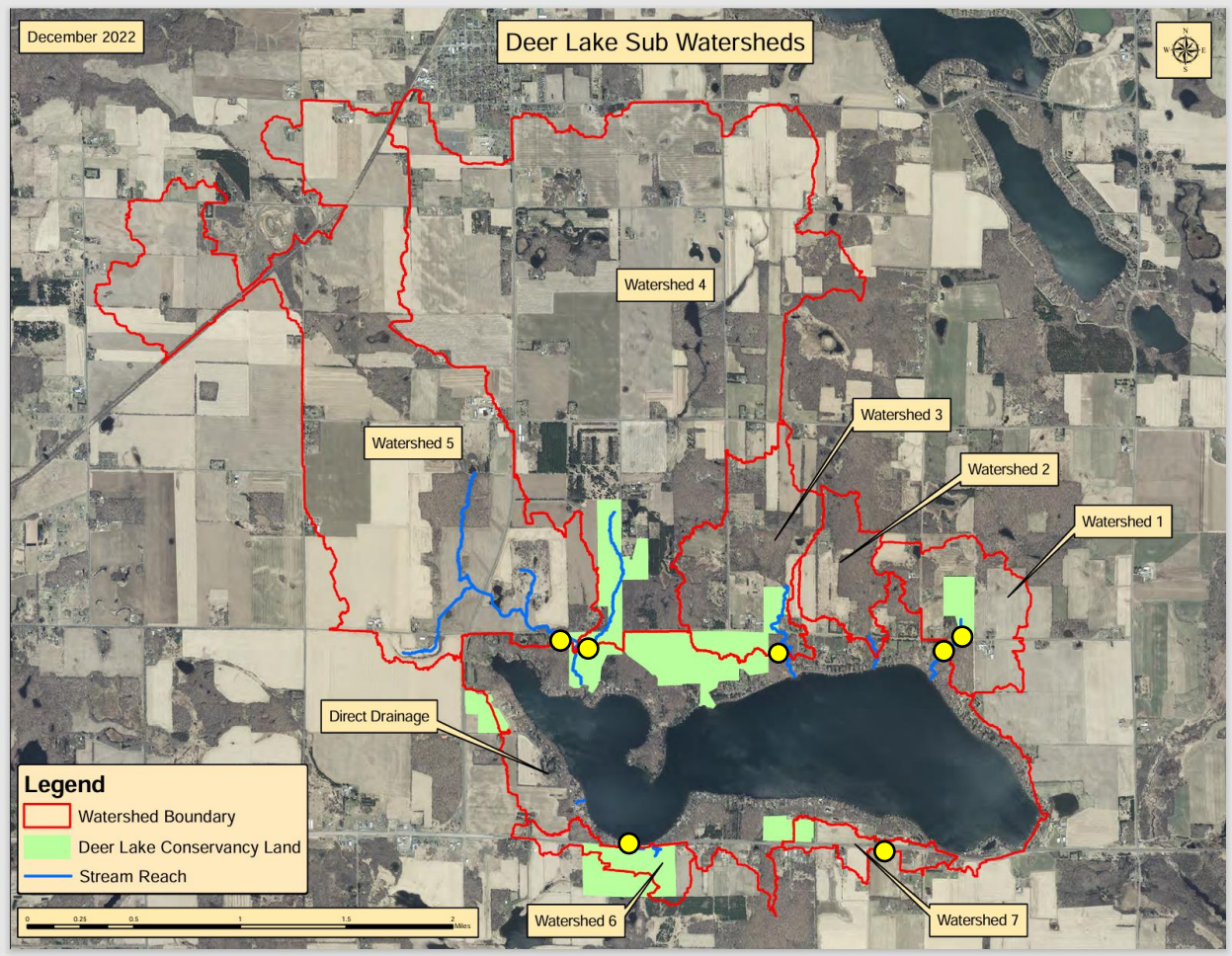


Figure 1: Watershed map showing sub-watershed boundaries. The yellow dots are the sites where flow and water samples were collected. Any area "downstream" (toward the lake) from these points is part of the direct-drained sub-watershed, where no monitoring occurred.

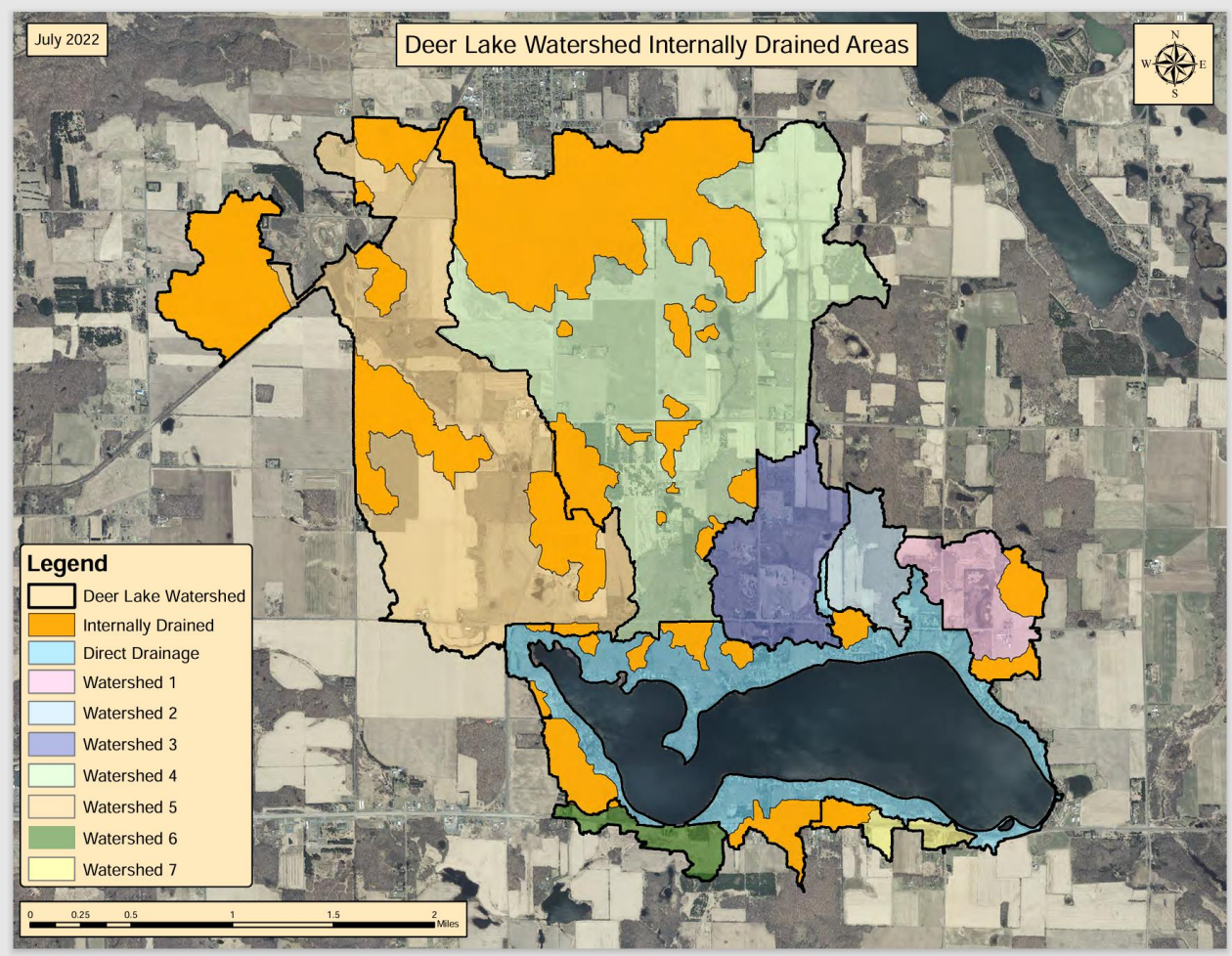


Figure 2: Map of sub-watersheds around Deer Lake with internally drained areas.

Internally drained areas were designated using a flow analysis tool (conducted by the Polk County Land and Water Conservation Dept). These areas do not contribute runoff into Deer Lake when precipitation amounts are less than 4.2 inches in 24 hours (10-year events). More intense rain events could result in runoff from these areas (and a higher probability during spring melt).

Figure 2 shows internally drained areas within the Deer Lake watershed. WS-4 and WS-5 (the two largest sub-watersheds) have the largest internally drained areas. The direct-drained sub-watershed also has 178 acres of designated internally drained areas. This reduces the predicted runoff volumes and nutrient loading.

Sub Watershed	Internally Drained Acres
Direct Drainage	178
Sub 1	59
Sub 2	0
Sub 3	0
Sub 4	767
Sub 5	542
Sub 6	1.6
Sub 7	21
Total	**1568.6**

Table 1: Internally drained areas in each sub-watershed.

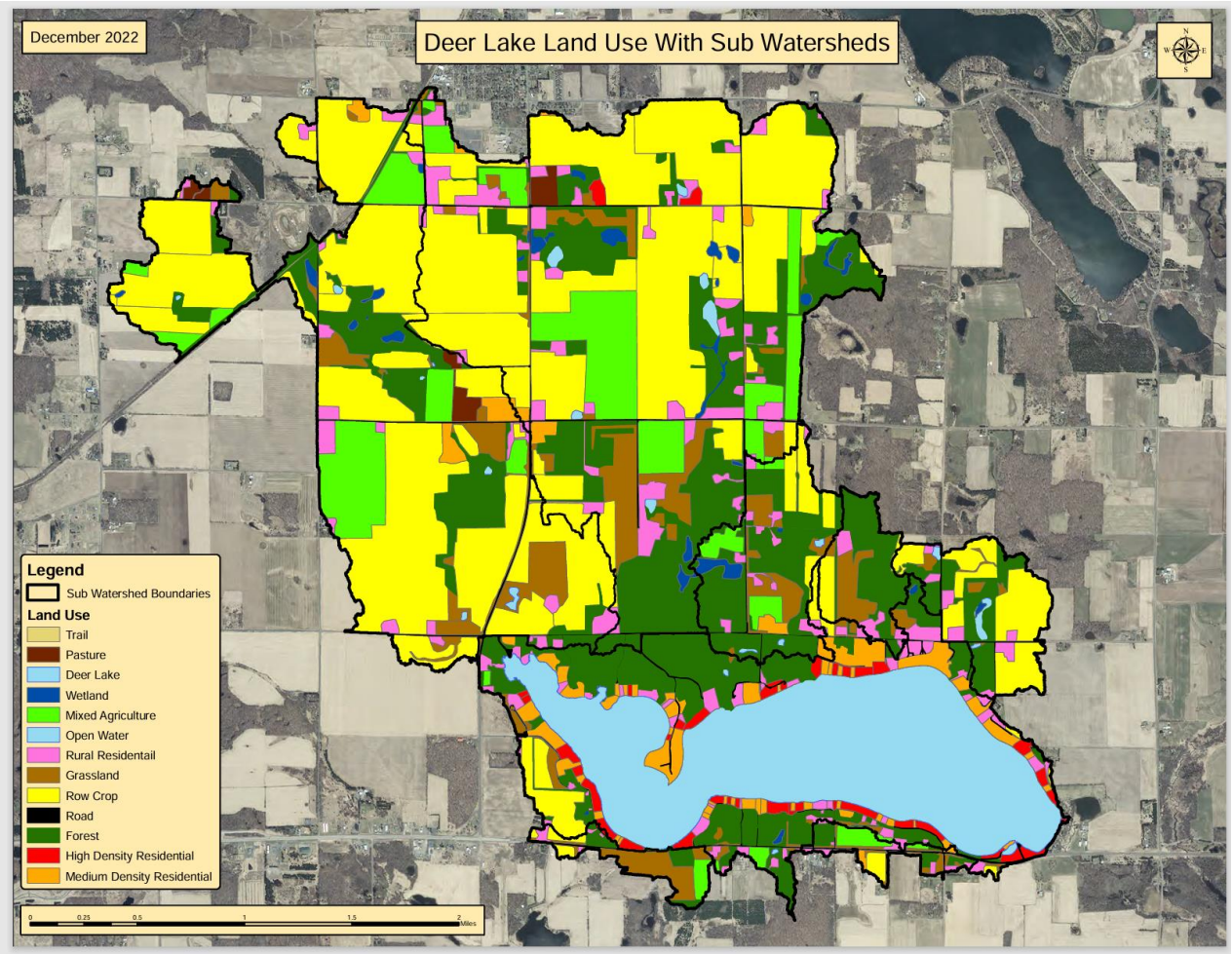


Figure 3: Map of land cover for sub-watersheds around Deer Lake.

Land Use	Definitions
Row Crop	Corn, soybeans
Forest	Canopy cover
Deer Lake	Deer Lake
Mixed Agriculture	Alfalfa, small gain, grasses harvested as hay, most likely in a crop rotation with row crop
Grassland	Grasses that are not cut, idle fields
Rural Residential	Single-family dwelling, 1 per acre
Medium-Density Residential	2-4 dwellings per acre
High-Density Residential	Greater than 4 dwellings per acre
Road	Blacktop or gravel
Wetland	Wetlands/depressions
Pasture	Lands grazed by livestock
Open Water	Ponds/lakes other than Deer Lake
Trail	Gandy Dancer Trail

Table 2: Land use types definitions (from Polk County Land and Water Conservation Dept.)

Full Watershed Land Use (includes 1569 internally drained acres)	
Land Use	**Acres**
Row Crop	2146.7
Forest	1280.8
Deer Lake	821.2
Mixed Ag	470.9
Grassland	387.3
Rural Residential	335.0
Mid-Density Residential	168.5
Road	84.7
High-Density Residential	76.2
Wetland	55.3
Pasture	33.2
Open Water	29.3
Trail	3.9
Total	5893.0

Table 3: Land use types of area, entire Deer Lake watershed (including internally drained areas).

Sub-watershed 1

Sub-watershed 1 has two ponds that retain water. One of the ponds is on the north side of 140th and is large (approximately 4.1 acres) and retains large amounts of runoff before it empties into a smaller pond (approximately 0.3 acres). This smaller pond also receives runoff from south of 140th via a road ditch. There is conservancy-owned land on the north and east shore of the larger pond. Two sediment basins were constructed on the north side of 140th Ave to capture runoff from a farm field. Table 4 shows the land cover types and area with internally drained areas removed.

Sub Watershed 1 Land Use	
Land Use	**Acres**
Row Crop	66.4
Forest	54.3
RR	14.4
Grassland	7.2
Open Water	6.1
Road	3.6
Wetland	1.1
MDR	0.0
Total	**152.9**

Table 4: Sub-watershed 1 land use type areas.

Sub-Watershed 2

This sub-watershed flows under 140th Ave into a deep valley into the lake. It is the smallest in area on the north side of Deer Lake and has no internally drained areas. The Deer Lake Conservancy owns 10 acres in WS2 that includes an earthen berm, which creates a 5-acre holding pond, surrounded by prairie (which reduces runoff and phosphorus loading). Table 5 shows the land cover types.

Sub Watershed 2 Land Use	
Land Use	**Acres**
Forest	71.7
Grassland	28.2
Row Crop	15.3
RR	11.6
Road	0.7
MDR	0.4
Total	**128.0**

Table 5: Sub-watershed 2 land use type areas.

Sub-watershed 3

Sub-watershed three is just under 300 acres in area, with no internally drained areas in the watershed. It flows under 140th Ave into a deep valley just before the lake. There is conservancy land in the southern portion of the sub-watershed, totaling 13 acres. There are two large sediment basins, restored wetlands, and a restored prairie (converted from row crop) to mitigate runoff and phosphorus loading. A stream stabilization project was completed south of 140th Ave after this data collection, which should help reduce runoff and loading. Table 6 lists the land cover types and area.

Sub Watershed 3 Land Use	
Land Use	**Acres**
Forest	153.5
Row Crop	38.6
Grassland	37.0
Mixed Ag	26.4
RR	17.8
MDR	8.7
Wetland	8.6
Road	4.6
Open Water	2.2
HDR	0.1
Total	**297.7**

Table 6: Sub-watershed 3 land use type areas.

Sub-watershed 4

Sub-watershed 4 is drained by Rock Creek. Although this creek is named, it is not perennial. Sub-watershed 4 is the largest sub-watershed with an area of 1340 acres, with an additional 767 acres that are determined to be internally drained. Deer Lake Conservancy owns 51 acres north of 140th Ave, which includes 20 acres of restored prairie. There are also 32 acres protected along Rock Creek, south of 140th Ave. Table 7 lists the land cover types and areas.

Sub Watershed 4 Land Use	
Land Use	**Acres**
Row Crop	567.9
Forest	346.5
Mixed Ag	197.1
RR	80.0
Grassland	102.6
Wetland	14.5
Road	15.3
MDR	5.7
Open Water	9.9
Pasture	0.3
HDR	0.2
Trail	0.0
Total	**1339.9**

Table 7: Sub-watershed 5 land use type areas.

Sub-watershed 5

Sub-watershed 5 is the second-largest sub-watershed with an area of 989 acres. This watershed flows into Rock Creek, just upstream from the lake. There is a retention pond at the end of the drainage just before Rock Creek. This retention pond is approximately five feet deep and seems to retain much of the water, reducing the flow into Rock Creek. Table 8 lists the land cover types and areas.

Sub Watershed 5 Land Use	
Land Use	**Acres**
Row Crop	543.6
Forest	177.6
Mixed Ag	116.2
Grassland	68.4
RR	30.2
MDR	12.2
Pasture	14.7
Road	11.0
Wetland	9.3
Open Water	4.2
Trail	1.9
Total	**989.3**

Table 8: Sub-watershed 5 land use type areas.

Sub-watershed 6

This sub-watershed is a small sub-watershed that contains a large area of conservancy-owned land (Flagstad Farm) that is restored prairie from row crop agriculture. The watershed is 70 acres in size. The watershed drains into a culvert that flows under US Highway 8. Table 9 lists the land cover types and areas.

Sub Watershed 6 Land Use	
Land Use	**Acres**
Grassland	34.8
Forest	12.9
Mixed Ag	8.1
Row Crop	7.5
RR	3.3
Road	3.0
HDR	0.4
Total	**70.1**

Table 9: Sub-watershed 6 land use type areas.

Sub-watershed 7

This is the smallest sub-watershed with an area of 36 acres, with 21 acres of internally drained area. It flows from a culvert under US Hwy 8 and drains the ditches. The flow culminates between two houses adjacent to Hwy 8. There is a small area of conservancy land in the western portion of this watershed. Table 10 lists the land cover types and areas.

Sub Watershed 7 Land Use	
Land Use	**Acres**
Mixed Ag	5.1
Forest	5.2
Grassland	8.3
RR	5.5
Row Crop	6.9
Road	3.3
MDR	1.9
Total	**36.3**

Table 10: Sub-watershed 7 land use type areas.

Methods

In each tributary, an Onset pressure transducer was installed just below the soil surface in the deepest part of the flow channel. In the tributaries with culverts (WS-1 and WS-6), the transducer was placed at the bottom of the culvert. The transducer was programmed to log the depth every 15 minutes. During flow events, the flow was measured by measuring the depth and width of the flow (cross-sectional area of water), and the velocity was measured using a velocity meter. A flow curve was created by plotting flow against the depth of water to predict flow during unmeasured events.

WS-1 had two monitoring stations and sample sites. One was at the end of the large pond north of 140th Ave., and the other was below the pond that lies south of 140th. This was done to separate the flow and nutrients leaving the upper pond and flowing into the lower pond. The lower pond volumes and nutrient concentrations included the upper pond flow and concentrations. Due to some transducer technical issues and beavers clogging the upper pond culvert, the data from this pond is inconsistent. However, enough data was available to establish the difference associated with each pond outflow. Regardless, the lower pond volumes and concentrations reflect the runoff from the entire sub-watershed one.

Using mean concentrations, the total loads of phosphorus, orthophosphate, and sediment were calculated for each monitored year. Using mean concentrations likely introduces some error in the calculated loads compared to actual loads during any non-sampled flow event, since concentrations

varied widely between events. However, because the flow was inconsistent and limited samples were collected, there was no ability to correlate concentrations with flow volume. Regardless, these calculations should be more precise than estimates derived from export coefficients.

Runoff volumes were predicted using the land cover type, runoff coefficients, and precipitation amounts. A weighted runoff coefficient was determined by multiplying the land cover type coefficient by the fraction of the total area in the sub-watershed. Phosphorus loading was predicted using export coefficients for land cover types.

Results

As stated, 2022 and 2023 were drought years. Due to limited runoff in the monitored tributaries, the data collection was extended to obtain better flow curves, which would lead to better flow volume and nutrient loading data. Table 11 shows a summary of the flow volumes measured along with the amount of precipitation for that water year (Oct. 1 to Sept. 30 of the following year).

Sub-WS	**2022(hm^3)**	**2023(hm^3)**	**2024[#](hm^3)**	**2025(hm^3)**	**Avg. monitoring period(hm^3)**	**Predicted from avg year (hm^3)***
WS-1	0.019	0.066	0.084	0.0675	0.073	0.11
WS-2	0.001	0.008	0.0096	0.0055	0.008	0.06
WS-3	0.008	0.09	0.0283	0.03	0.049	0.16
WS-4	0.034	0.25	0.093	0.065	0.136	0.87
WS-5	0.00017	0.001	0.00015	0.00045	0.001	0.71
WS-6	0.006	0.0041	0.0045	0.0083	0.006	0.05
WS-7	0.0003	0.0048	0.003	0.0038	0.004	0.03
2022 data from April 4 to Oct 1		*2023-2025 data from Oct 1-Sept 30*				
[#]No spring melt observed in 2024						

*1 hm^3 is equivalent to 810.7 acre-feet. The unit hm^3 is convenient for inputting into lake nutrient modeling.

Table 11: Runoff volumes for each sub-watershed each year.

The data in Table 11 shows that the volume of runoff in the tributaries from the sub-watersheds varied greatly. WS-4 (drained by Rock Creek) had the highest volume of all the sub-watersheds. It is also the largest by area. WS-5, which has the second largest area, was consistently the lowest volume. WS-1 had the second-highest volume of runoff over the monitoring period. All sub-watersheds had smaller runoff volumes than runoff coefficients would predict.

The 2023 volumes are higher than they would typically be with the amount of annual precipitation received due to the large amount of snow in the 2022-23 winter. There was approximately a water

equivalent of more than 12 inches of precipitation that melted in the spring of 2023. The melt was intense as warm temperatures occurred suddenly with frozen soils, resulting in intense runoff and limited infiltration. In 2024, there was little to no spring runoff recorded, which was the result of very little winter precipitation. However, the growing season had several large rain events, bringing the annual precipitation amount above the 30-year average. Precipitation amounts in 2025 were near normal, with some spring runoff occurring. The runoff volumes that occurred in 2025 may be a good reflection of an average year.

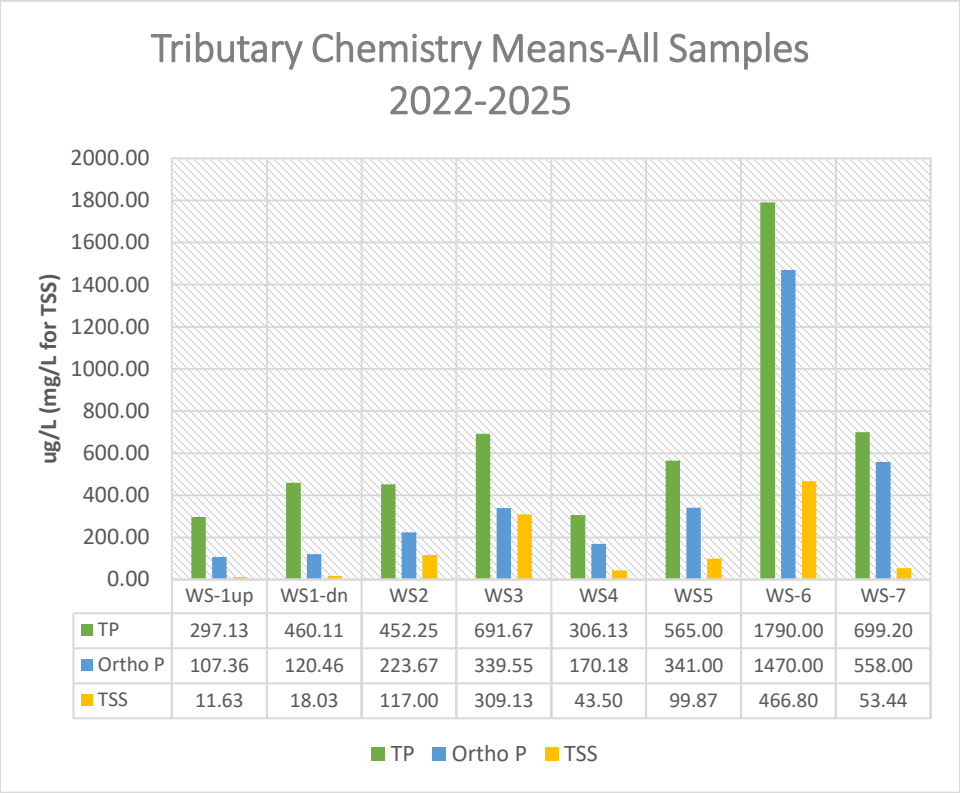


Figure 4: Mean nutrient concentrations for each sub-watershed from water sample analysis 2022-2025. The

Water sample analysis shows that WS-6 (which drains the Flagstad Farm area) had the highest concentration on average of all the sub-watersheds. This may not accurately represent the true mean, as there were few samples collected (due to a lack of flow when other samples were collected), and these few only occurred during intense events. Two of these events resulted in washing out the driveway adjacent to the culvert, which would increase nutrient and sediment concentration. WS-4 and WS-1 had the lowest mean concentrations, which interestingly had the highest volumes due to more consistent flow. The mean concentration may be skewed high due to the intense runoff events when samples were collected.

Using the flows and nutrient concentrations, the load for each year 2022 (only growing season)-2025 (full years) was calculated. The mean for 2023-2025 was calculated and is shown in Table 12. In

addition, the predicted load using export coefficients for the land cover types within each watershed was used to predict loads. WS-1 and WS-3 both had higher measured loads than predicted. The other sub-watershed measured loads were significantly less than the predicted from export coefficients.

Mean Loads during Period	mean TP load (kg)	Ortho load (kg)	Sediment load (kg)	Predicted TP load avg year (kg)	% of Predicted load measured
WS-1	33.34	8.71	1305.00	30.4	109.7%
WS-2	3.48	1.72	901.00	10.4	33.5%
WS-3	34.16	16.76	15275.00	28.5	119.8%
WS-4	41.62	23.12	5984.00	244.7	17.0%
WS-5	0.31	0.18	53.33	231.6	0.13%
WS-6	6.14	5.01	1322.40	9.8	62.6%
WS-7	2.71	2.15	204.80	6.8	39.8%

Table 12: Mean loading of total phosphorus, orthophosphate, and suspended solids by sub-watershed, years 2023-2025.

Orthophosphate is bioavailable, meaning that this form of phosphorus could be taken up and used to grow tissue in plants and algae. The higher the fraction of total phosphorus that is orthophosphate, the more available the phosphorus is for tissue growth. High amounts of orthophosphate can suggest the sources of phosphorus. Typical sources of phosphorus that are in the orthophosphate form include the following: Decaying organic matter, human (anthropogenic) sources, primarily agricultural runoff (fertilizers, manure), and urban runoff (detergents, pet waste). All sub-watershed water samples had orthophosphate concentrations that were >50% of the total phosphorus concentrations, indicating that agriculture (manure and fertilizers) and residential development are likely contributors to the runoff. It also indicates that the runoff occurring from these sub-watersheds during the growing season could have an immediate impact on productivity in Deer Lake. The land cover map would support this data.

The larger the area of a sub-watershed, the more likely the total load is higher. By determining the load per acre, the impact that the sub-watershed has is better reflected and can be used to prioritize management. The highest phosphorus loading per acre was WS-1, followed by WS-3. WS-4 and WS-5 are the two largest by area, yet showed the two lowest loading rates.

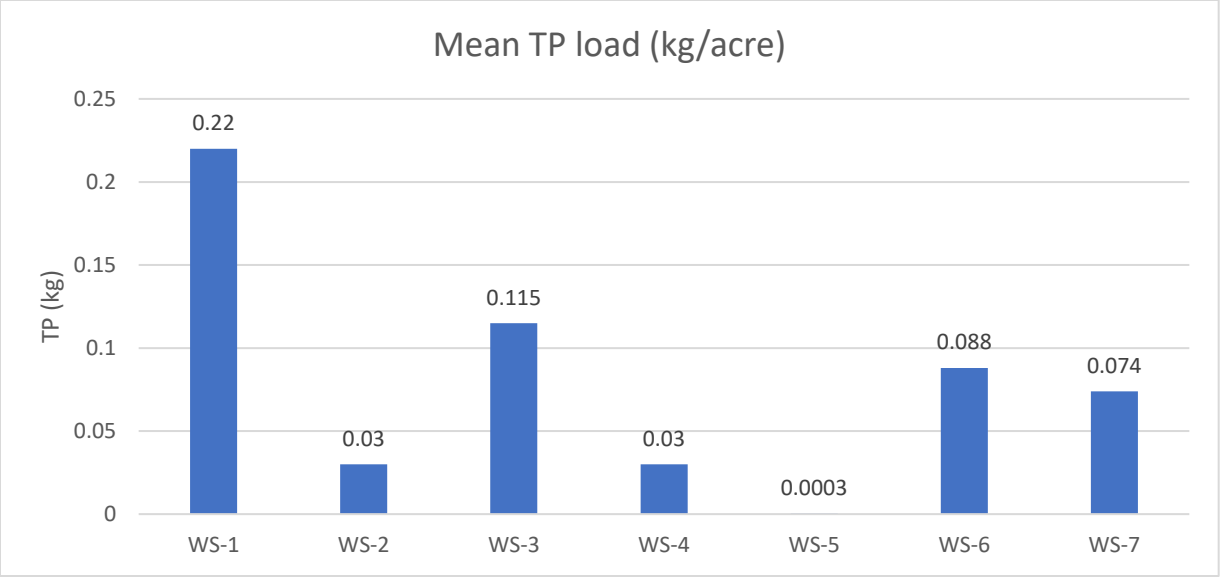


Figure 5: Mean total phosphorus load rate in kg/acre/yr. This considers the years 2023-2025.

WS-3 showed the highest sediment loading rate, followed by WS-6. However, WS-6 had only three samples where TSS was analyzed, and two of them were less than 20 mg/L. One sample was very high when an adjacent driveway washed out, causing a high mean. WS-5 had the lowest sediment rate.

Figure 6: Picture showing the Flagstad Farm driveway washout in 2025, following an intense rain event. The water flowed to the ditch and into the culvert leading to Deer Lake.

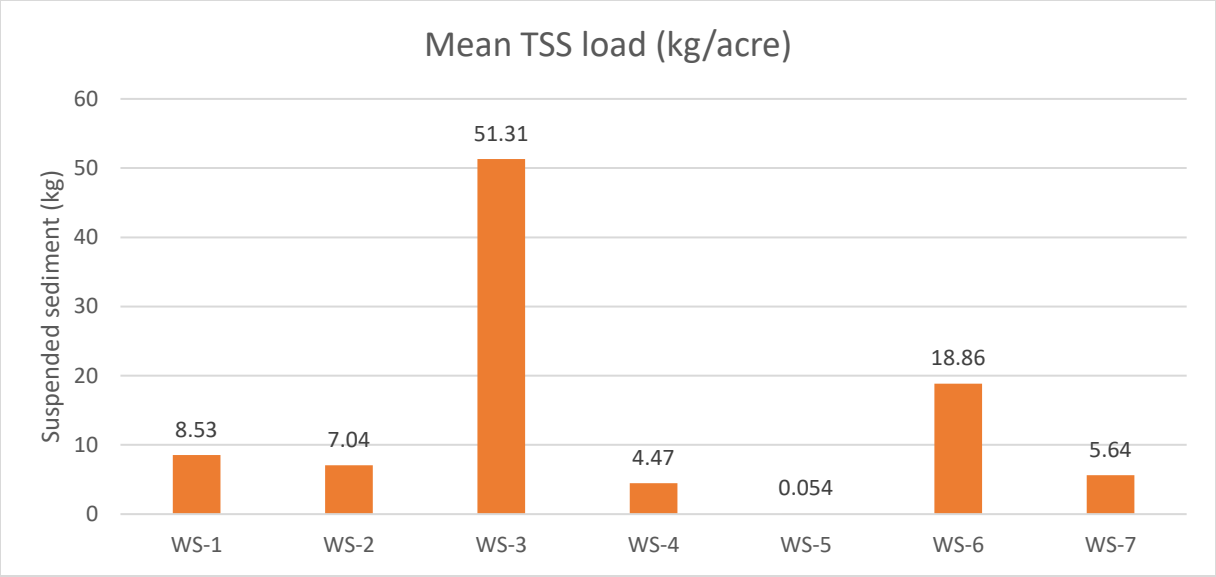


Figure 7: Mean total suspended solids loading rate in kg/acre/yr, 2023-2025.

Figure 8 compares the measured phosphorus loading and the predicted from export coefficients. The graph shows that for most sub-watersheds, the measured value was less than the predicted, except for WS-1 and WS-3.

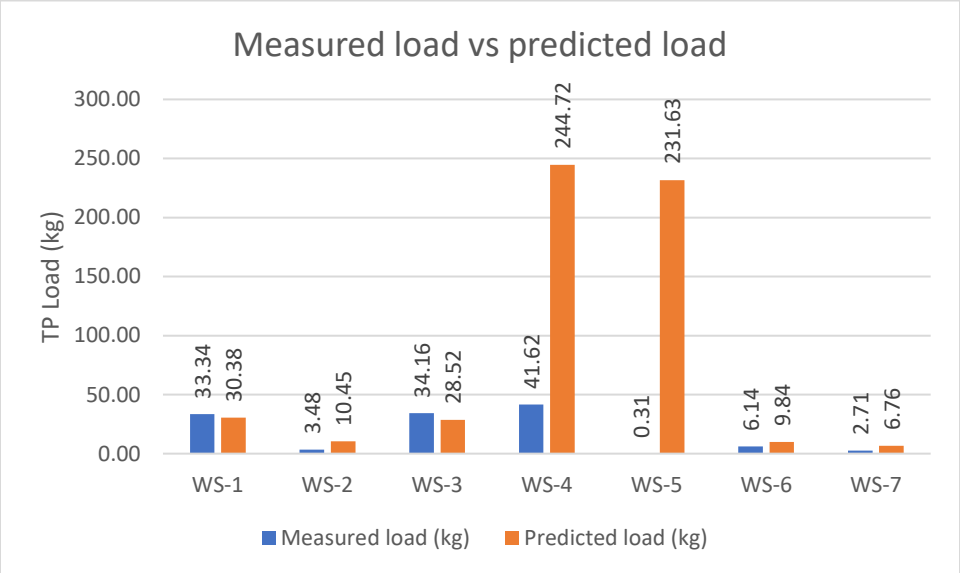


Figure 8: Graph showing the measured total phosphorus loading and the predicted loading using export coefficients.

The total predicted load from the sub-watersheds is 560.3 kg/year. The mean monitored loading was 121.6 kg/year. The monitored loading was 21.7% of the predicted export coefficient loading.

WS-1 upper pond vs lower pond runoff

As stated in the methods, there were two monitoring/sampling sites in WS-1. This was to differentiate the volume and nutrient loading from the upper pond into the lower pond. This was to evaluate a concern that the lower pond is loading significantly higher nutrients than the upper pond, showing that the portion of WS-1 that does not flow into the upper pond is contributing more nutrient loading. The data from the upper pond is inconsistent because there were some battery issues with that transducer, and the beavers in the upper pond were damming the outflow culvert. Table 13 shows the difference in mean nutrient concentrations. Table 14 shows the volume of runoff from each culvert (2023 had the best data available for the upper pond, with no technical issues and no beaver activity). This allows for a comparison.

Culvert in WS-1	Mean total phosphorus (ug/L)	Mean orthophosphate (ug/L)	Mean TSS (mg/L)
Upper pond	297.1	107.4	11.6
Lower pond	460.1	120.5	18.0

Table 13: Data comparing the mean concentrations of water samples from the upper pond outflow to lower pond outflows.

Culvert in WS-1	2023 Volume of runoff (hm^3)	2023 phosphorus load (kg)
Upper pond	0.037	10.99
Lower pond	0.066	30.37
Difference (amount from WS-1 not part of the upper pond portion of WS or sediment from lower pond)	**0.029**	**19.38**

Table 14: Runoff volume and phosphorus loading for the upper pond outflow vs the lower pond outflow. Since the lower pond outflow includes the upper pond water, the difference reflects water and nutrients from WS-1 that does not flow into the upper pond.

The data show that the upper pond concentrations are lower than those in the lower pond. This indicates that the WS-1 portion, located below the upper pond, is contributing significant nutrients from this sub-watershed. The upper pond is large and can accept a significant amount of runoff before it fills and contributes outflow. In addition, the water slows and allows nutrients to settle out, reducing the nutrient loading. The lower pond is much smaller, so it has less capacity to hold and/or slow the water outflow, thus having less impact on nutrient reductions.

Potential for error in measured values

Monitoring the flow and loading of these sub-watersheds is likely a better reflection of real-time loading than using export coefficients. However, these measurements are subject to significant error. The pressure transducers have high precision when fully submerged. During low runoff events, the transducers may not log depths that allow for a flow calculation. In WS-1, the transducer was submerged

most of the time, so this error would be reduced at that sample site. During the winter months, the transducers can become impacted by snow/ice, which gives false readings of large depths, indicating large flow when no flow is occurring. We removed those readings, but could lose some actual flow events that occurred. Lastly, to create a more valid flow curve, at least ten depth/flow measurements are desired. In most cases, the number of data points to create a flow curve was far below ten, causing an error in the flow determined solely from the transducer-logged water depth.
Due to difficult water collection logistics (guessing when the tributaries are flowing), samples were mostly collected during intense runoff events, which could skew the average concentrations toward a higher mean. The flow volumes are likely somewhat less than what occurred, and the concentrations are likely higher than the actual mean. Since the loading is calculated from these two values, the loading means may have less error ultimately. Regardless, the estimated loads are most likely more valid than predictions from export coefficients.

Discussion

The results of the 2022-2024 Deer Lake tributary analysis showed that WS-1 has the highest phosphorus loading per acre, followed by WS-3. More nutrients are coming from the portion of WS-1 that does not flow into the upper pond north of 140th Ave. Interestingly, the two largest sub-watersheds (WS-4 and WS-5) showed the lowest phosphorus loading per acre. The sediment pond installed in WS-5, adjacent to Rock Creek, appears to be functioning well in reducing runoff of nutrient loading into Deer Lake. Practices in WS-4 also seem to reduce nutrient loading. WS-3 had the highest sediment loading per acre by a significant amount. Sediment accumulation not only can increase nutrients in Deer Lake, but accumulated sediments on the lake bottom can degrade the benthic habitat (bottom) for plants and other organisms.

WS-6, which drains the Flagstad Farm area, had the highest concentration of phosphorus. However, this culvert rarely flowed and only tended to flow during intense precipitation events. Therefore, the loading from this sub-watershed is less impactful than the concentration might suggest.

In all cases, the sub-watershed runoff volumes were significantly less than what is predicted using runoff coefficients for land cover types. Except for two sub-watersheds (WS-1 and WS-3), the phosphorus loading is less than is predicted by export coefficients. Since many of the sub-watersheds have conservancy land and management practices implemented, the data suggest these practices are making a big impact on reducing nutrient loading into Deer Lake. WS-5, especially, with only a fraction of the phosphorus loading occurring during the monitoring period compared to the predicted loading. Some of the reduced loading can be attributed to drought conditions in 2022 and 2023, but 2024 and 2025 had above-normal and near-normal precipitation, respectively.

During this monitoring period, a wide array of weather events occurred. This ranged from long periods to below normal precipitation, followed by intense rain/snow events. This can cause a high variation in

runoff. For example, during long periods of drought, soils and wetlands can become very dry. When an intense rain event occurs after these drought periods, the wetlands and other areas can absorb/infiltrate water, reducing runoff. If the soils are moist and the wetlands are full of water, then the intense rain events can result in higher runoff amounts.

It is predicted that climate change can lead to more frequent, intense weather events, including drought and precipitation. Long periods of below normal precipitation will be followed by more intense storms and rain/snow events. This can make management practice more important to reduce runoff and nutrient loading into Deer Lake. The data collected in this analysis shows that the management practices that have been implemented in these sub-watersheds are making a significant difference.

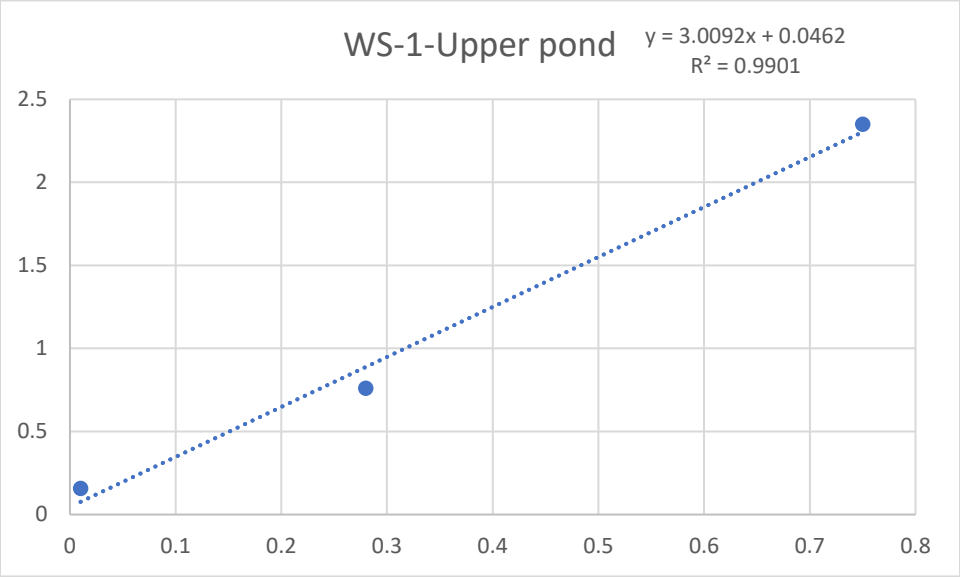
Based on the data collected, management practices should likely be focused on WS-3 and WS-1. At the writing of this summary, WS-3 is having runoff reduction practices implemented, which should reduce the impact of that sub-watershed. In WS-1, the lower pond does not appear to be functioning as well as the upper pond, likely due to size and the possibility that the rest of WS-1 has high nutrient loading. Any potential improvements in the ability of the lower pond to reduce flow amounts and nutrient loading would be warranted. In WS-6, it may be beneficial to stabilize the driveway leading into the Flagstad Farm parking areas, as it blew out twice during this monitoring period, with large concentrations of nutrients flowing into Deer Lake. All other sub-watersheds seem to be in good standing, with minimal impact comparatively.

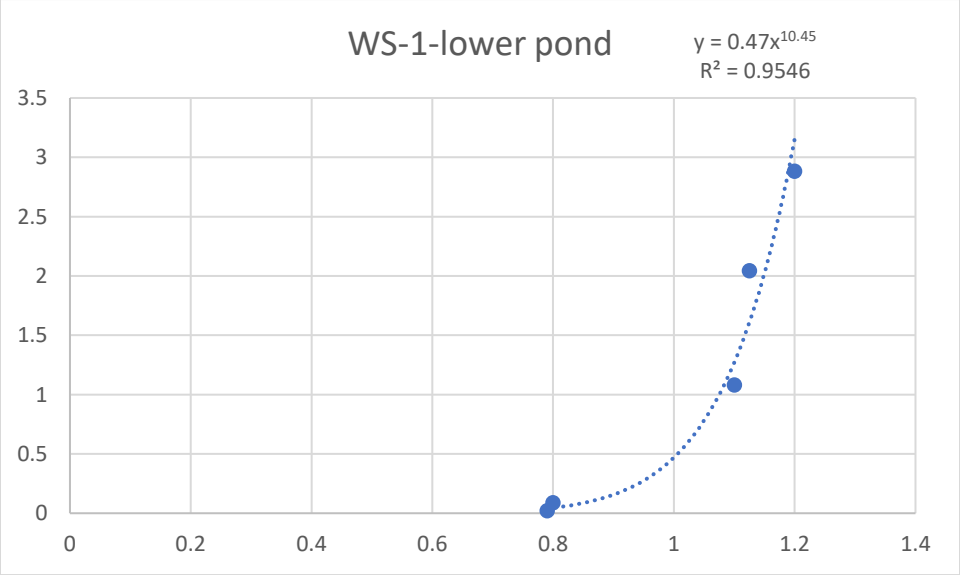
Figure 9: Picture showing the runoff in across a property in WS-7 during a rain event in 2025.

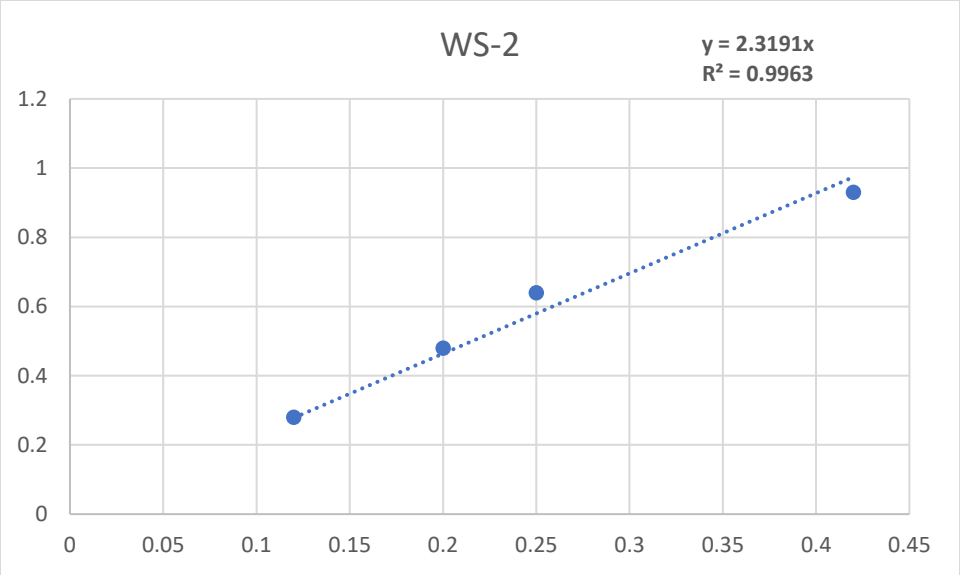
WS-7 is the smallest by area but the loading per acres is somewhat high compared to the other sub-watersheds. This is likely due to the large number of road/impervious surfaces and the steep slope to the lake where it drains. During a rain event in 2025, intense flow was occurring across the lawn of the property adjacent to the monitoring site (see Figure 9). This water was coming from the western portion of WS-7 and the road and driveway adjacent to the property. It may be worthwhile to explore management practice options at or near this location.

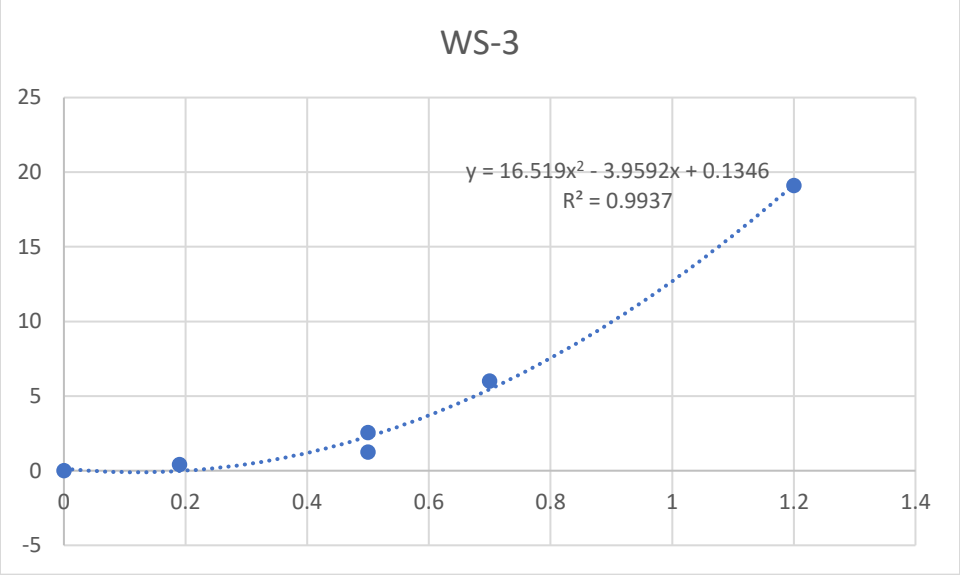
Appendix (Data used):

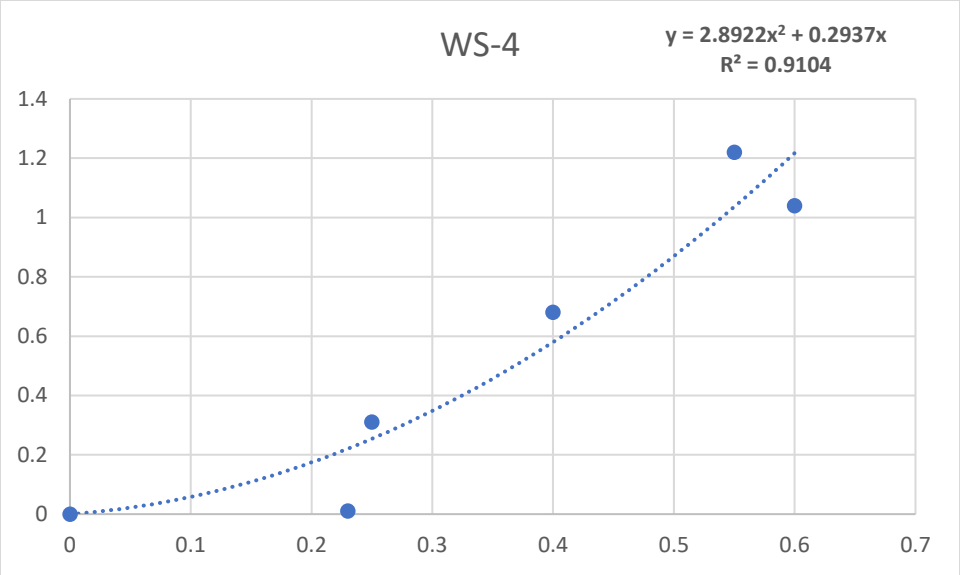
Flow curves

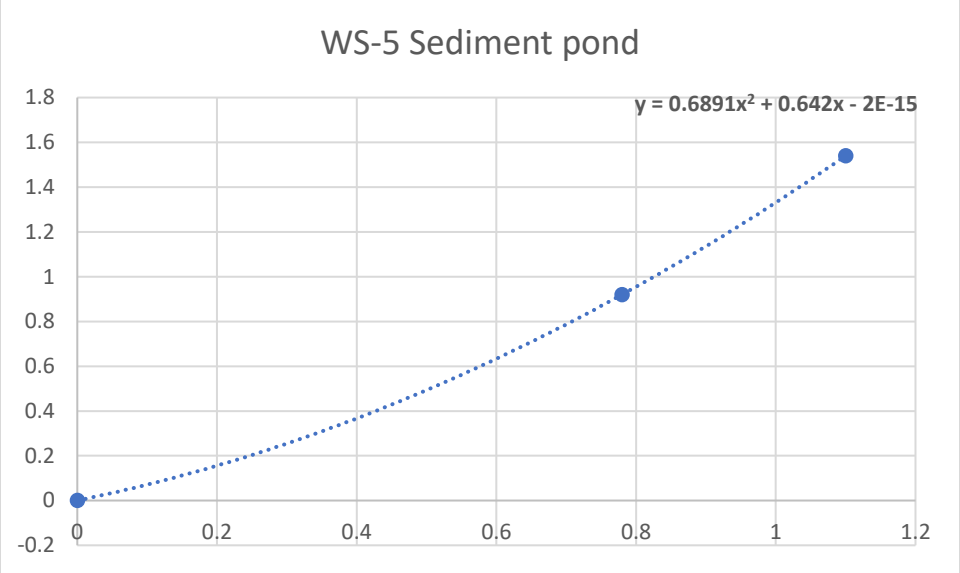


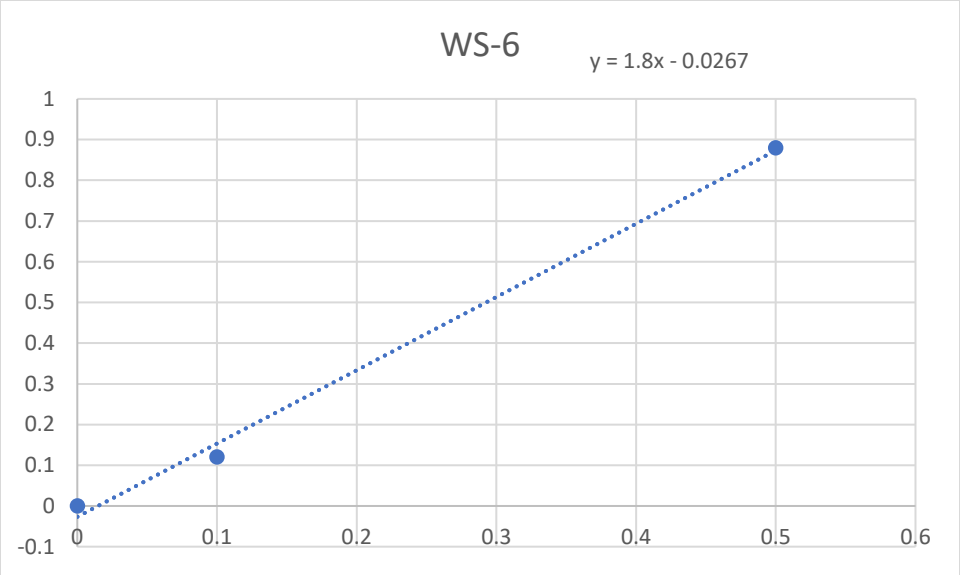


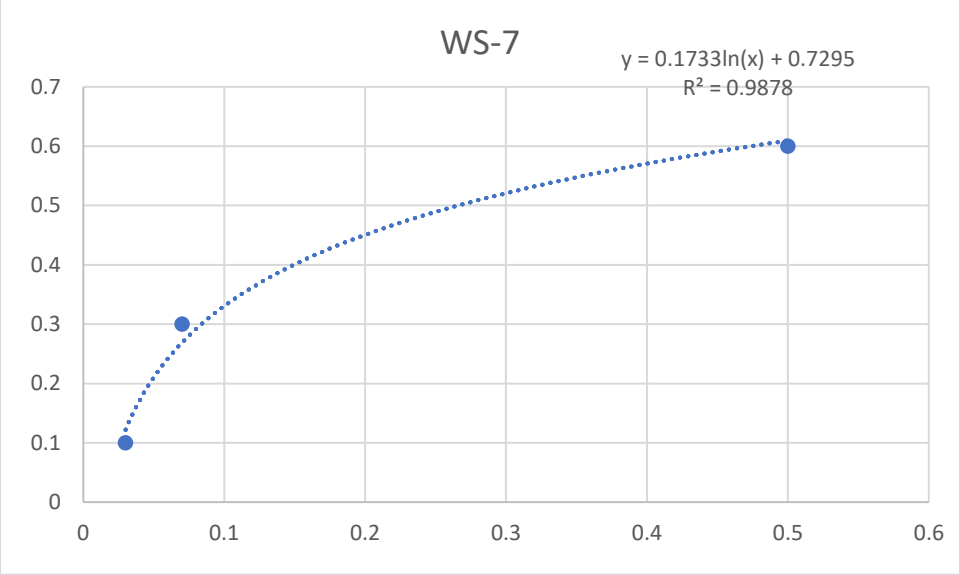

WS-2
y = 2.3191x
R² = 0.9963
1.2
1
0.8
0.6
0.4
0.2
0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45


WS-3
y = 16.519x² - 3.9592x + 0.1346
R² = 0.9937
25
20
15
10
5
0
-5
0
0.2
0.4
0.6
0.8
1
1.2
1.4


WS-4
y = 2.8922x² + 0.2937x
R² = 0.9104
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7


WS-5 Sediment pond
y = 0.6891x² + 0.642x - 2E-15
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
0
0.2
0.4
0.6
0.8
1
1.2


WS-6
y = 1.8x - 0.0267
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6


WS-7
y = 0.1733ln(x) + 0.7295
R² = 0.9878
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.1
0.2
0.3
0.4
0.5
0.6

Precipitation

2021-22	2021-22		2022-23	2022-23		2023-24	2023-24		2024-25	2024-25
Oct	1.69		Oct	0.18		Oct	4.27		Oct	1.07
Nov	0.91		Nov	1.65		Nov	0.03		Nov	2.57
Dec	1.28		Dec	2.15		Dec	2.32		Dec	1.3
Jan	0.28		Jan	1.93		Jan	0.12		Jan	0.3
Feb	0.44		Feb	2.01		Feb	0.47		Feb	0.74
March	2.14		March	2.22		March	2.16		March	2.15
April	2.45		April	5.37		April	4.41		April	2.02
May	3.15		May	1.63		May	6.08		May	2.75
June	2.62		June	0.73		June	8.73		June	6.62
July	1.6		July	3.85		July	3.85		July	5.49
August	7.62		August	1.38		August	5.89		August	2.53
Sept	0.85		Sept	4.79		Sept	0.69		Sept	2.2
Total yr (in)	25.03			27.89			39.02			29.74
Total April-Sept (in)	18.29			17.75			29.65			21.61
meters/yr	0.64			0.71			0.99			0.76
meters/gs	0.46			0.45			0.75			0.55

Loading amounts by year (2022 is only growing season)

2022*	TP load	Ortho load	Sediment load	2023	TP load	Ortho load	Sediment load	2024	TP load	Ortho load	Sediment load	2025	TP load	Ortho load	Sediment load
WS-1	8.74	2.28	342		30.36	7.92	1188		38.6	10.1	1512		31.05	8.1	1215
WS-2	0.452	0.22	117		3.62	1.79	936		4.34	2.15	1123		2.49	1.23	644
WS-3	5.53	2.71	2472		62.19	30.51	27810		19.55	9.59	8745		20.73	10.17	9270
WS-4	10.4	5.78	1496		76.5	42.5	11000		28.46	15.81	4092		19.89	11.05	2860
WS-5	0.1	0.06	17		0.565	0.34	100		0.1	0.05	15		0.25	0.15	45
WS-6	4.36	3.56	1868		4.47	3.65	43.5		4.9	4	47.7		9.04	7.39	3876
WS-7	0.21	0.17	15.9		3.36	2.67	254.4		2.1	1.67	159		2.66	2.12	201

Export coefficients used for predictions (loading based on average precipitation and evaporation)

Land Cover	**Low P (lb./mi^2/yr)**	**Med P (lb./mi^2/yr)**	**High P (lb./mi^2/yr)**	**runoff coefficient** (no units-represents fraction of total precipitation)
Rural Residential	29	57	143	0.15
Medium-Density Urban	171	286	457	0.26
High-Density Urban	571	856	1142	0.5
Pasture/Grass	57	171	286	0.25
Row Crop Agriculture	286	571	1713	0.25
Forest	29	54	103	0.1
Wetland	22	56	85	0.08