# technical memo

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| **Project** | Moody Lake Sequential Diagnostics | **Date** | December 11, 2014 |
| **To** | CLFLWD Board of Managers | **Contact Info** | |
| **Cc** | | **Contact Info** | |
| **From** | Meghan Jacobson, PhD | **Contact Info** | |
| **Regarding** | Final Technical Memorandum | | |

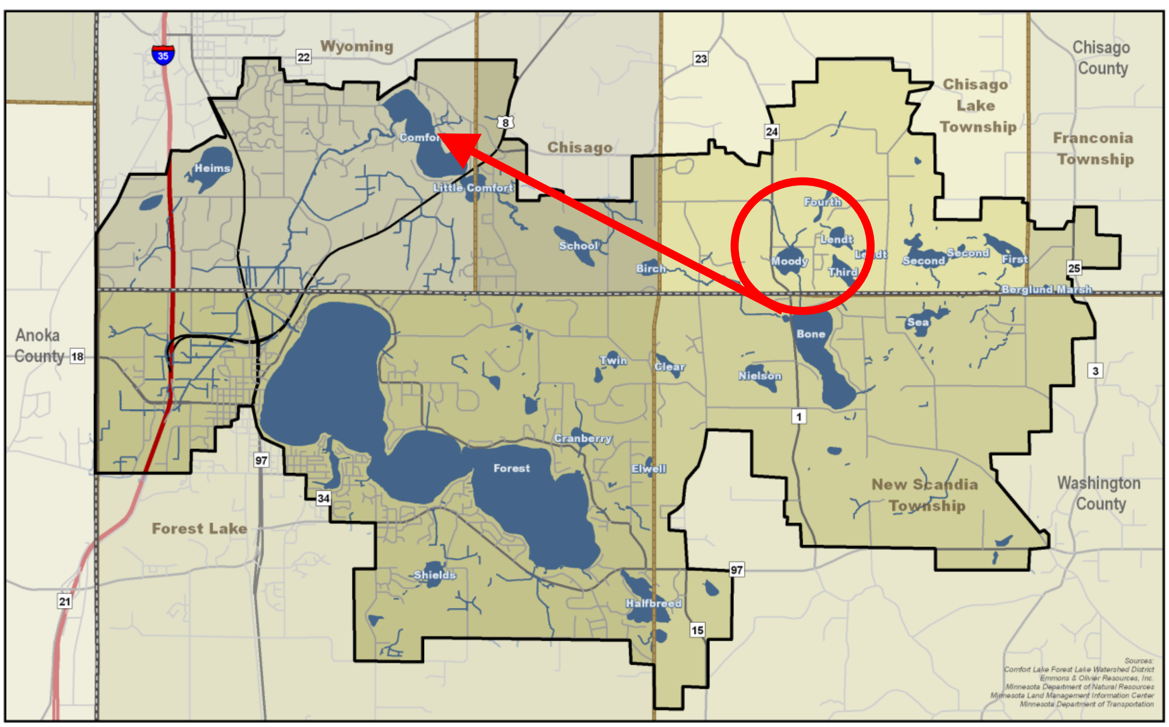
Moody Lake is the headwaters of the CLFLWD northern flow network (Figure 1), and as such, its water quality sets the stage for downstream waters, beginning with Bone Lake. The objective of this diagnostic study was to ultimately determine **whether Moody Lake should receive a whole lake alum treatment.** To make that determination, EOR recommended to the Board in 2013 to address the following questions prior to a potential alum treatment of Moody Lake using an intensive watershed monitoring diagnostic study:

1. Have upland agricultural BMPs sufficiently reduced watershed phosphorus loads; and
2. Are upstream wetland complexes retaining or releasing phosphorus?

This memo is organized into the following sections:

1. Watershed Characteristics
2. Flow and Water Quality Monitoring
3. Watershed Phosphorus Loads
4. Moody Lake Monitoring
5. Key Findings and Recommendations
6. Next Steps

**Figure 1. Comfort Lake Forest Lake Watershed District Northern Flow Network**



## Watershed Characteristics

The distribution of hydrologic soil groups in the Moody Lake Watershed are illustrated in Figure 2 and summarized in Table 1. Note that the direct drainage of Moody Lake, Fourth Lake and Lendt Lake subwatersheds contain A soils with high infiltration capacity. The rest of the watershed consists of a mixture of B and C soils, with a larger fraction of saturated soils (A/D, B/D, and C/D) than the Fourth Lake and Lendt lake subwatersheds.

The distribution of land cover in the Moody Lake Watershed are illustrated in Figure 3 and summarized in Table 2. Approximately half of the watershed is covered by cropland and pasture.

**Table 1. Moody Lake Watershed Hydrologic Soil Groups by Subwatershed**

| Subshed | A | B | A/D | B/D | C/D |
|---|---|---|---|---|---|
| 256th | 0% | 29% | 24% | 16% | 30% |
| Fourth | 7% | 36% | 9% | 14% | 34% |
| 250th | 0% | 36% | 17% | 19% | 27% |
| Peterson | 0% | 58% | 0% | 8% | 32% |
| Lofton | 0% | 79% | 0% | 19% | 2% |
| Lendt | 9% | 50% | 19% | 7% | 13% |
| Direct | 55% | 9% | 36% | 0% | 0.02% |
| Total | 7% | 35% | 17% | 14% | 27% |

**Table 2. Moody Lake Watershed Land Cover by Subwatershed (NLCD 2011)**

| Subshed | Cropland | Developed | Forest/ Grassland | Pasture | Water | Wetlands |
|---|---|---|---|---|---|---|
| 256th | 30% | 5% | 21% | 20% | 0% | 23% |
| Fourth | 30% | 3% | 24% | 26% | 4% | 12% |
| 250th | 28% | 6% | 23% | 31% | 0% | 12% |
| Peterson | 26% | 16% | 17% | 38% | 0.1% | 3% |
| Lofton | 0% | 2% | 16% | 67% | 16% | 0% |
| Lendt | 11% | 4% | 19% | 29% | 18% | 19% |
| Direct | 6% | 10% | 33% | 20% | 22% | 10% |
| Total | 26% | 5% | 23% | 26% | 5% | 15% |

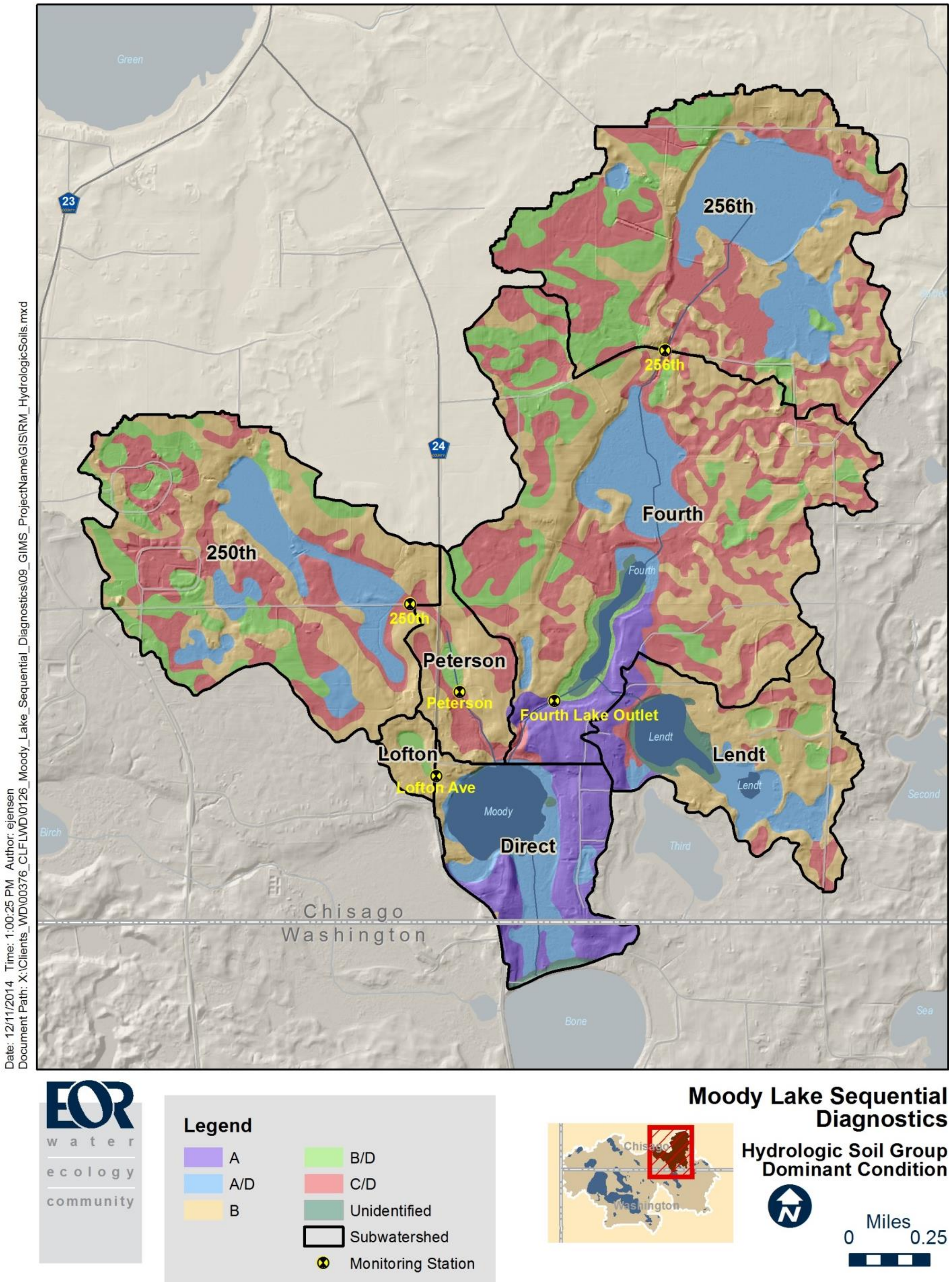



**Figure 2. Moody Lake Watershed Hydrologic Soil Groups**

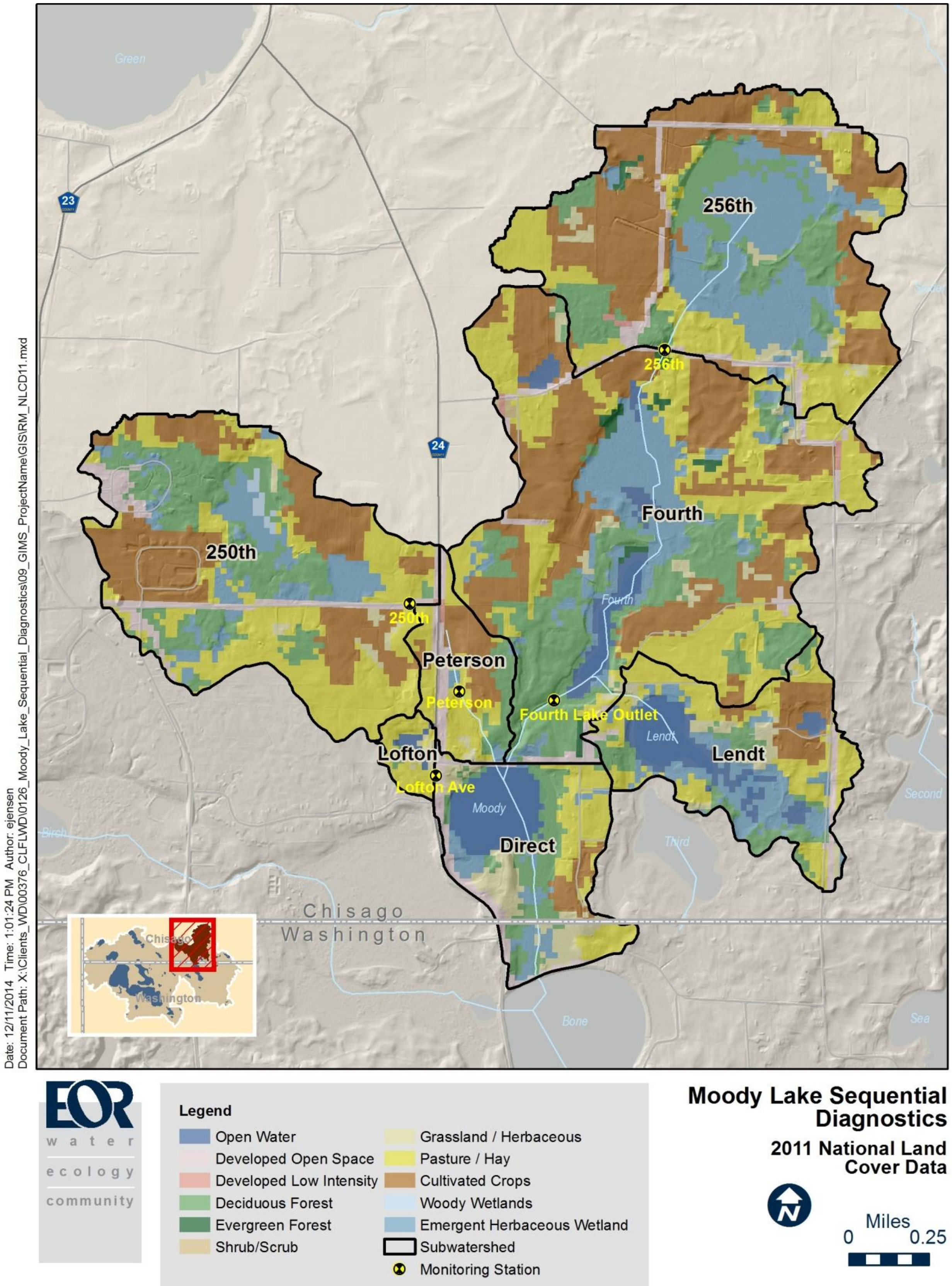



**Figure 3. Moody Lake Watershed Land Cover (NLCD 2011)**

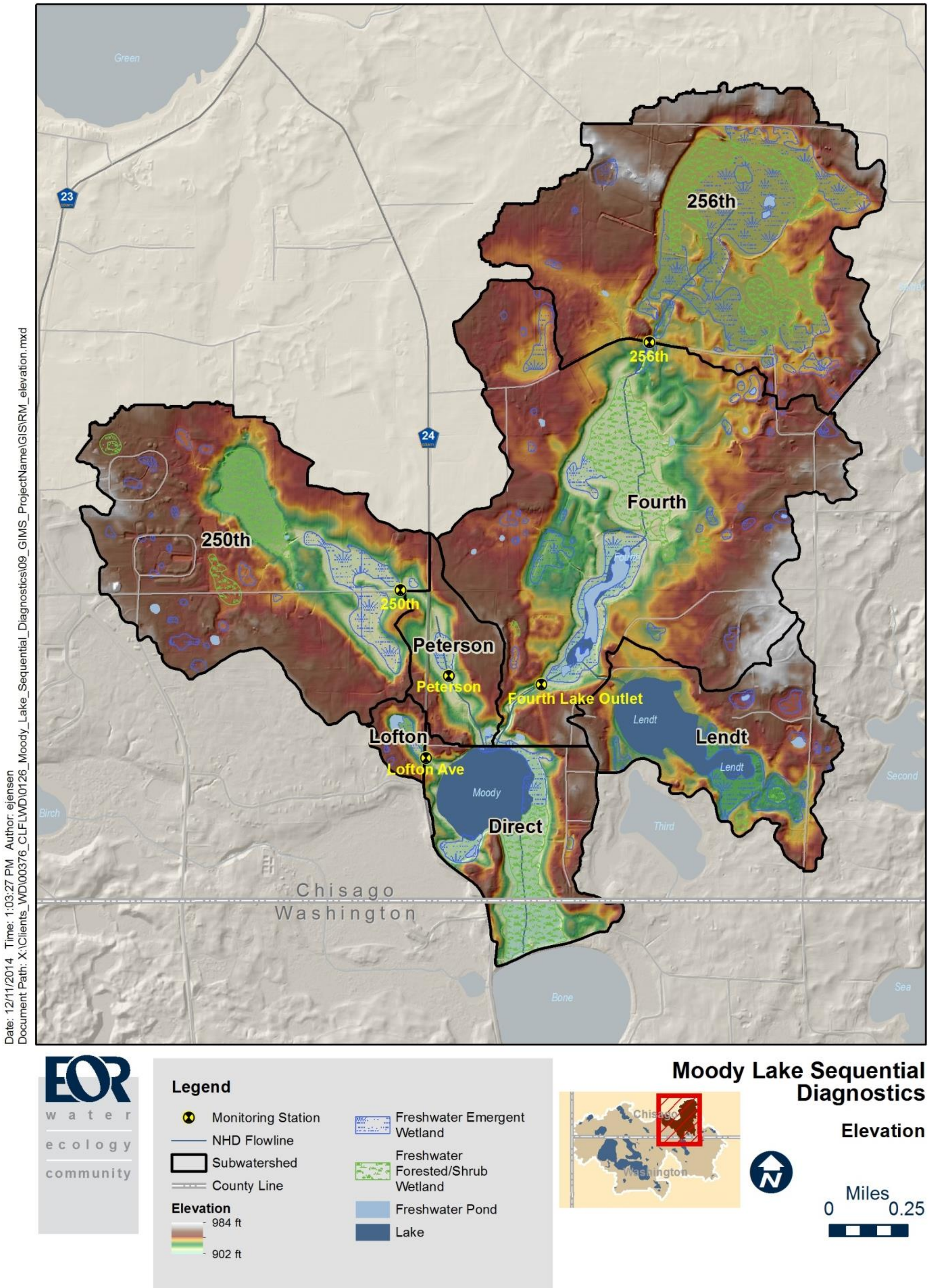



**Figure 4. Moody Lake Watershed Elevation**

## Flow and Water Quality Monitoring

Flow and water quality samples were collected at five sites in the Moody Watershed in 2014 (Figure 5). These sites were chosen to characterize the runoff from the upper and lower portions of the northeast and northwest watershed lobes of the watershed, and the horse pond just northwest of Moody Lake at Lofton Avenue. The 256th Street monitoring site was located at the road crossing culvert. Good flow was observed at this site with no vegetation or backwater issues. A natural channel was located immediately downstream of the culvert which discharged into a large, wetland complex north of Fourth Lake. The Fourth Lake Outlet monitoring site was location in a ditched channel between Fourth and Moody Lakes. Backwater was observed at this site when Moody Lake levels were high. The channel substrate was predominantly fine sand with no in-stream vegetation, little herbaceous cover along the channel banks, and heavy tree canopy over the channel. The 250th Street monitoring site was located in a small ditch with open water and no backwater observed. The ditch headwaters begin in the wetland complex just upstream of this site. The Peterson monitoring site was located in the upstream end of the driveway culvert. The culvert was downstream of a small wetland dominated by cattail. No channel existed in the cattails but water was flowing freely through the culvert into a channel of open water downstream. The Lofton Avenue monitoring site was located at a partially blocked culvert. Flow was rarely observed at this site.

Continuous flow was monitored at the Fourth Lake outlet from April 21 through November 10, 2014 using a level logger. Instantaneous flow measurements were collected at all sites using a Marsh McBirney flow meter several times in spring and early summer when there was stream flow at all sites (April 10, 21, and 25, and June 2, 15, 20), and following two large events that produced stream flow in late summer (August 11 and September 10). Note that the August 11 rainfall event only produced stream flow at the upper monitoring sites (250th and 256th), indicating that the watershed retains a lot of rainfall through wetland evapotranspiration and infiltration in A and B soils (Figure 2). No surface flow was observed discharging from Lendt Lake to Fourth Lake during the duration of the 2014 monitoring period. Lendt Lake may outlet to Fourth Lake when Lendt Lake levels are sufficiently high to discharge through a forested gully that passes under a field road through a poorly maintained culvert.

A rating curve was developed for the Fourth Lake outlet site using instantaneous flow measurements collected during grab sampling. Due to Moody Lake backwater effects on flow at the Fourth Lake outlet site during high lake levels, separate rating curves were developed for periods of low lake levels (April – May and September – November; Figure 7) and high lake levels (June – August; Figure 8). These rating curves had very strong goodness of fit with high $R^2$ (>0.98). Continuous flow at the other sites was estimated based on regressions with the Fourth Lake outlet flow using instantaneous flow measurements collected during grab sampling (Table 3). There was no relationship between flow at the Lofton site and the Fourth Lake outlet due to the presence of thick vegetation and partially plugged culvert upstream of the Lofton site. Therefore, no continuous flow record is available for the Lofton site.

Water quality samples were collected during the grab sampling for total phosphorus (TP), ortho-phosphorus (OP), total iron (Total Fe), total suspended solids (TSS), pH, alkalinity, and hardness at 256th Street (Table 4), Fourth Lake outlet (Table 5), 250th Street (Table 6), Peterson (Table 7), and Lofton (Table 8). Continuous flow records and grab sample total phosphorus concentrations are illustrated for 256th Street (Figure 9), Fourth Lake outlet (Figure 10), 250th Street (Figure 11), and Peterson (Figure 12). These data were used as inputs to the FLUX32 model to calculate phosphorus loads, and to characterize the reactivity and availability of those phosphorus loads for algal growth.

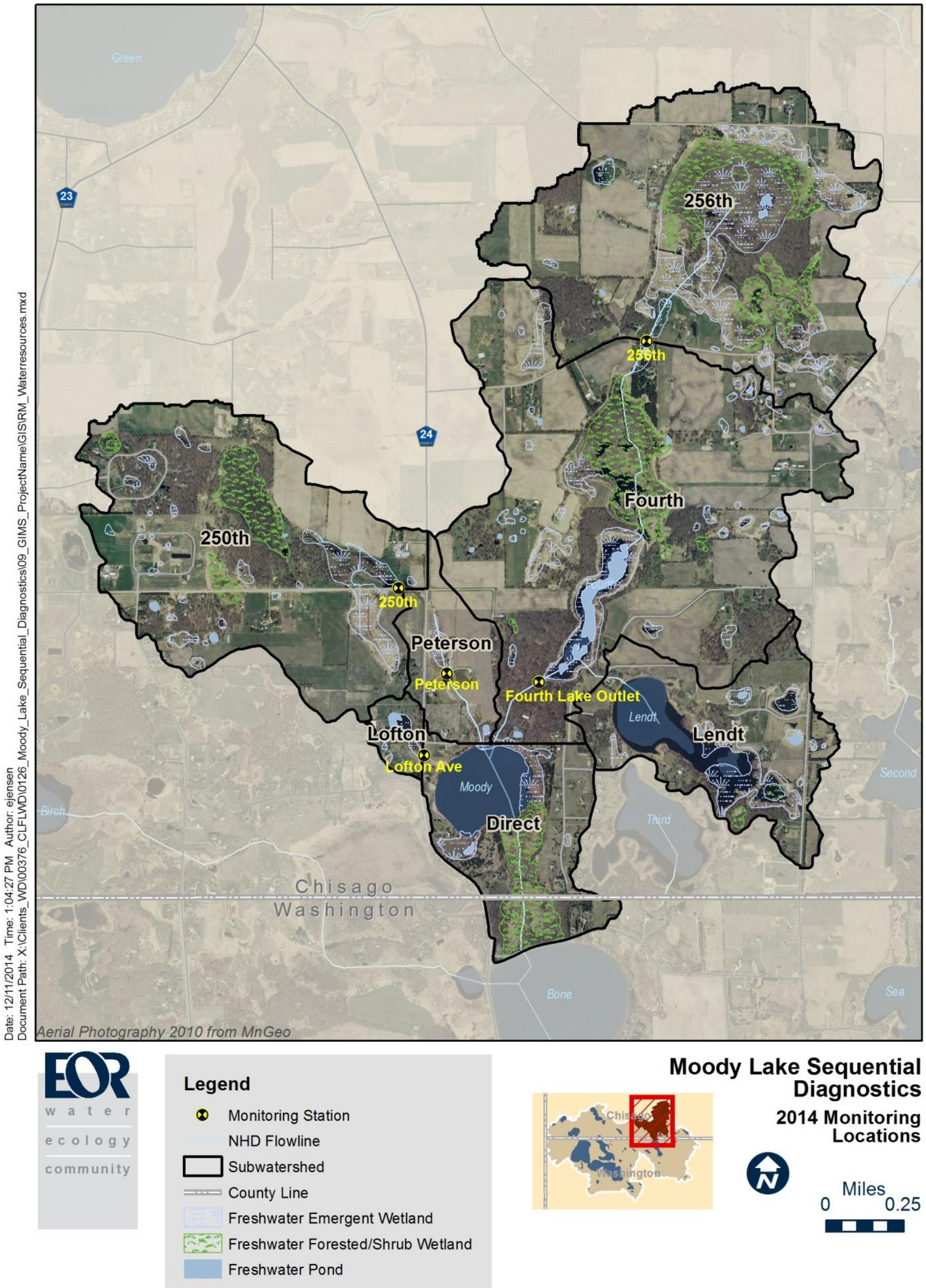



**Figure 5. Moody Lake 2014 Monitoring Sites**

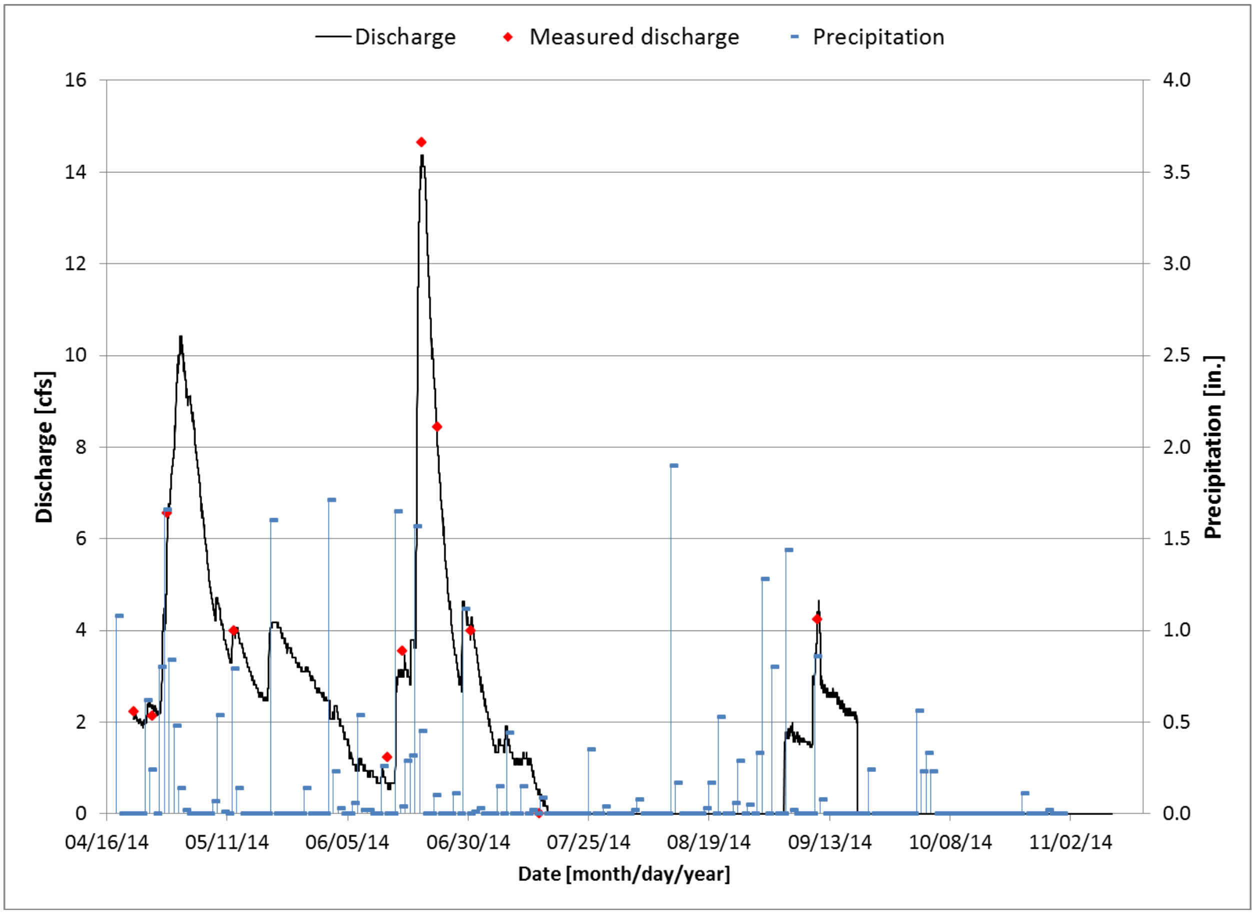



**Figure 6. Continuous flow and precipitation at the Fourth Lake Outlet, 2014**

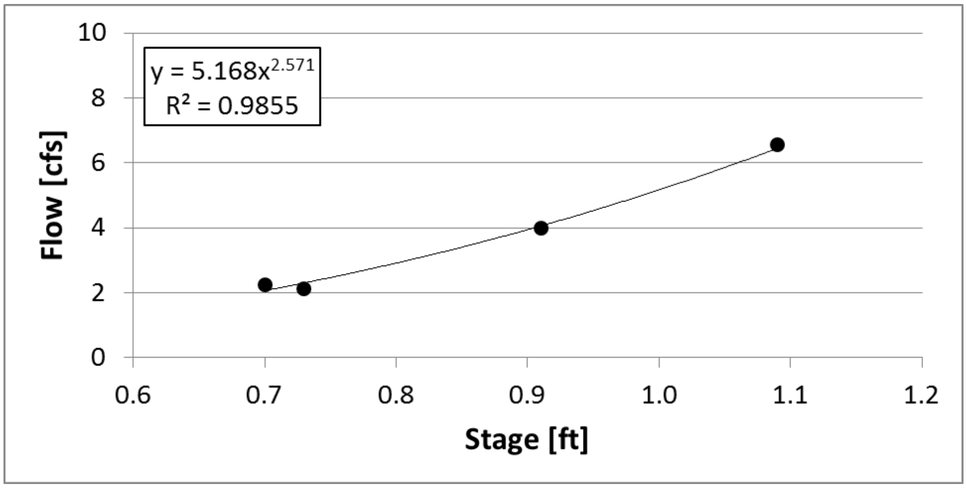



**Figure 7. Fourth Lake Outlet Rating Curve (April - May, September - November)**

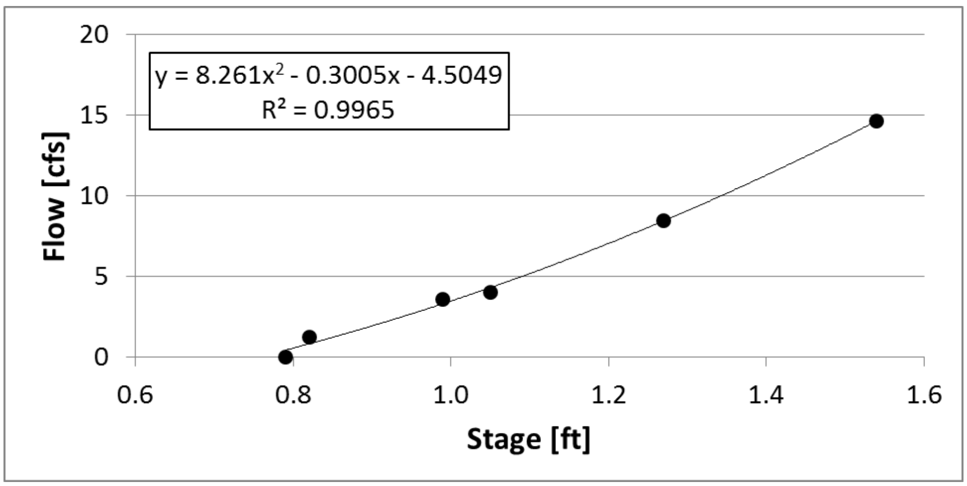



**Figure 8. Fourth Lake Outlet Rating Curve (June - August)**

**Table 3. Monitoring site instantaneous flow data and regressions with Fourth Lake Outlet**

| Flow (cfs) | Fourth Lake | 256th | 250th | Peterson | Lofton |
|---|---|---|---|---|---|
| 4/21/2014 | 2.23 | 0.97 | 1.38 | 0.86 | 0.05 |
| 4/25/2014 | 2.13 | 1.14 | 1.06 | 0.78 | 0.05 |
| 6/16/2014 | 3.55 | 2.84 | 1.44 | 1.51 | 0.07 |
| 6/20/2014 | 14.64 | 12.91 | 6.14 | 5.99 | 0.05 |
| 9/10/2014 | 4.25 | 0.96 | 0.18 | 0.30 | 0.22 |
| Regression with Fourth | | 0.44*Fourth+0.365 | 0.419*Fourth-0.204 | 0.42*Fourth-0.4 | N/A |
| Adjusted R2 | | 0.84 | 0.95 | 0.92 | 0.03 |

Table 4. 256th Water Quality Data (upstream of Fourth Lake in northeastern watershed)

| Date | TP (mg/L) | OP (mg/L) | Total Fe (mg/L) | TSS (mg/L) | pH | Alkalinity (mg/L) | Hardness (mg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|---|---|
| 4/10/14 | 0.29 | 0.2 | 0.16 | 2.5 | | | | 1 |
| 4/21/14 | 0.1 | 0.041 | 0.26 | 8.5 | 6.9 | | | 0.97 |
| 4/25/14 | 0.12 | 0.077 | 0.32 | 2.5 | 7.44 | | | 1.14 |
| 6/2/14 | 0.18 | 0.097 | 1.4 | 16 | 7.18 | | | 2.86 |
| 6/16/14 | 0.11 | 0.048 | 1.1 | 12 | 6.4 | 28 | 35 | 2.84 |
| 6/20/14 | 0.21 | 0.1 | 1.8 | 17 | 6.44 | 36 | 41 | 12.91 |
| 8/11/14 | 0.25 | 0.11 | 0.499 | 5 | 6.44 | | | 0.21 |
| 9/10/14 | 0.19 | 0.087 | 1.68 | 14 | 7.6 | | | 0.96 |

Table 5. Fourth Lake Water Quality Data (northeastern watershed)

| Date | TP (mg/L) | OP (mg/L) | Total Fe (mg/L) | TSS (mg/L) | pH | Alkalinity (mg/L) | Hardness (mg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|---|---|
| 4/10/14 | 0.12 | 0.014 | 1.2 | 8.5 | | | | 2.5 |
| 4/21/14 | 0.075 | 0.003 | 0.35 | 2.5 | 6.95 | | | 2.1 |
| 4/25/14 | 0.061 | 0.003 | 0.29 | 2.5 | 7.46 | | | 2.31 |
| 6/2/14 | 0.08 | 0.025 | 0.83 | 5 | 7.17 | | | 2.3 |
| 6/16/14 | 0.096 | 0.023 | 1 | 2.5 | 6.62 | 44 | 46 | 3.11 |
| 6/20/14 | 0.11 | 0.041 | 0.8 | 2.5 | 6.68 | 36 | 45 | 14.1 |
| 9/10/14 | 0.048 | 0.0092 | 0.534 | 0 | 7.45 | | | 2.93 |

Table 6. 250th Water Quality Data (upstream of Peterson in northwestern watershed)

| Date | TP (mg/L) | OP (mg/L) | Total Fe (mg/L) | TSS (mg/L) | pH | Alkalinity (mg/L) | Hardness (mg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|---|---|
| 4/10/14 | 0.47 | 0.41 | 0.31 | 2.5 | | | | 1 |
| 4/21/14 | 0.24 | 0.15 | 0.22 | 2.5 | 6.94 | | | 1.4 |
| 4/25/14 | 0.25 | 0.19 | 0.35 | 2.5 | 7.8 | | | 1.1 |
| 6/2/14 | 0.76 | 0.41 | 2 | 5.5 | 7.2 | | | 1.36 |
| 6/16/14 | 0.39 | 0.26 | 1.3 | 2.5 | 6.57 | 44 | 47 | 1.44 |
| 6/20/14 | 0.43 | 0.3 | 1.6 | 7.5 | 6.5 | 40 | 49 | 6.14 |
| 8/11/14 | 5.1 | 4.1 | 0.824 | 14 | 6.5 | | | 0.07 |
| 9/10/14 | 3 | 2.2 | 2.35 | 0 | 7.4 | | | 0.18 |

**Table 7. Peterson Water Quality Data (northwestern watershed)**

| Date | TP (mg/L) | OP (mg/L) | Total Fe (mg/L) | TSS (mg/L) | pH | Alkalinity (mg/L) | Hardness (mg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|---|---|
| 4/10/14 | 0.6 | 0.51 | 0.26 | 2.5 | | | | 1.51 |
| 4/21/14 | 0.24 | 0.15 | 0.22 | 2.5 | 6.88 | | | 0.86 |
| 4/25/14 | 0.26 | 0.2 | 0.34 | 2.5 | 7.52 | | | 0.78 |
| 6/2/14 | 0.86 | 0.55 | 2.2 | 14 | 7.33 | | | 1.08 |
| 6/16/14 | 0.5 | 0.33 | 1.7 | 2.5 | 6.64 | 52 | 60 | 1.51 |
| 6/20/14 | 0.72 | 0.56 | 1.6 | 2.5 | 6.68 | 48 | 50 | 5.99 |
| 9/10/14 | 0.69 | 0.34 | 2.68 | 0 | 7.9 | | | 0.3 |

**Table 8. Lofton Water Quality Data (directly drains to Moody Lake from west)**

| Date | TP (mg/L) | OP (mg/L) | Total Fe (mg/L) | TSS (mg/L) | pH | Alkalinity (mg/L) | Hardness (mg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|---|---|
| 4/21/14 | 0.18 | 0.067 | 460 | <5.0 | 6.68 | | | 0.05 |
| 4/25/14 | 0.14 | 0.076 | 420 | <5.0 | 7.08 | | | 0.05 |
| 6/2/14 | 0.51 | 0.23 | 2300 | 5 | 7.9 | | | -- |
| 6/16/14 | 0.37 | 0.14 | 2400 | <5.0 | 6.83 | 56 | 51 | 0.07 |
| 6/20/14 | 0.36 | 0.16 | 1600 | 6 | 6.8 | 48 | 47 | 0.05 |
| 9/10/14 | 0.51 | 0.095 | 1060 | No Detection | 7.8 | | | 0.22 |

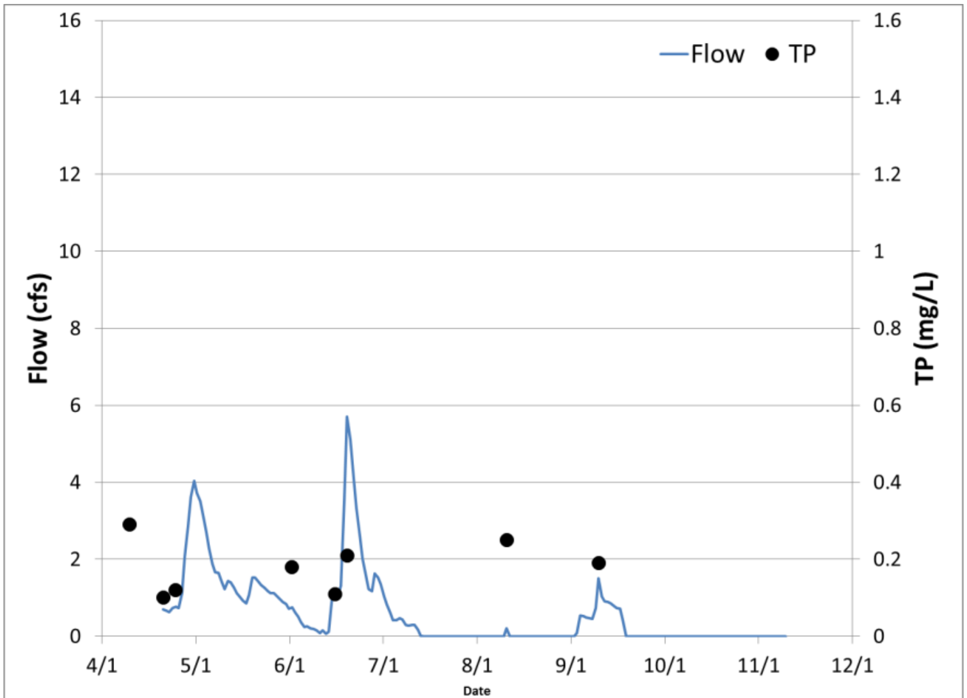


Figure 9. 256th site total phosphorus (TP) and flow data

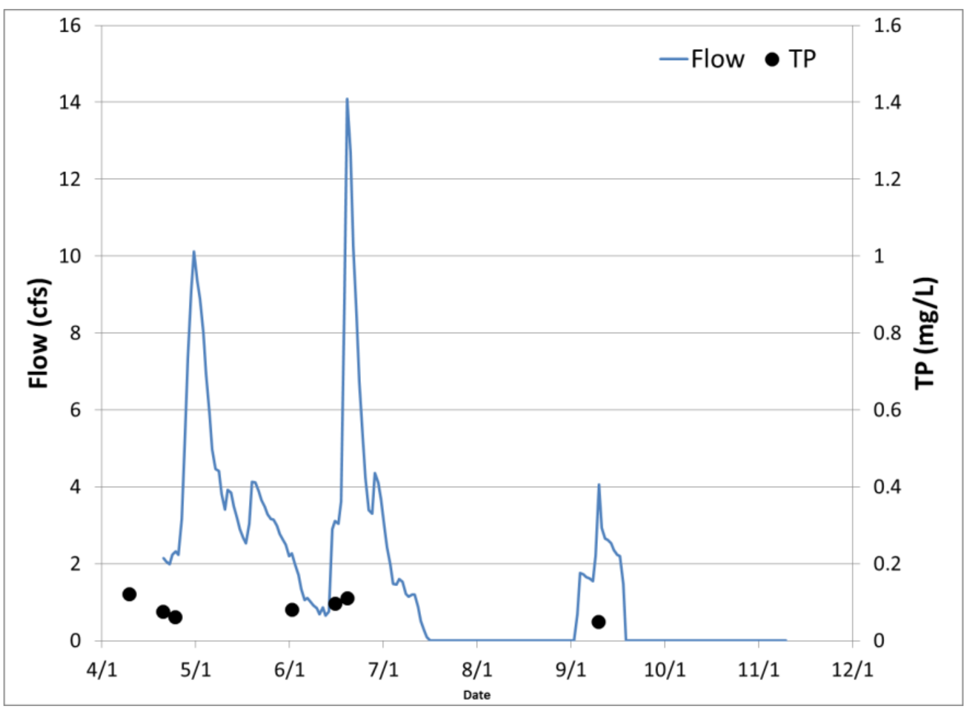


Figure 10. Fourth Lake Outlet total phosphorus (TP) and flow data

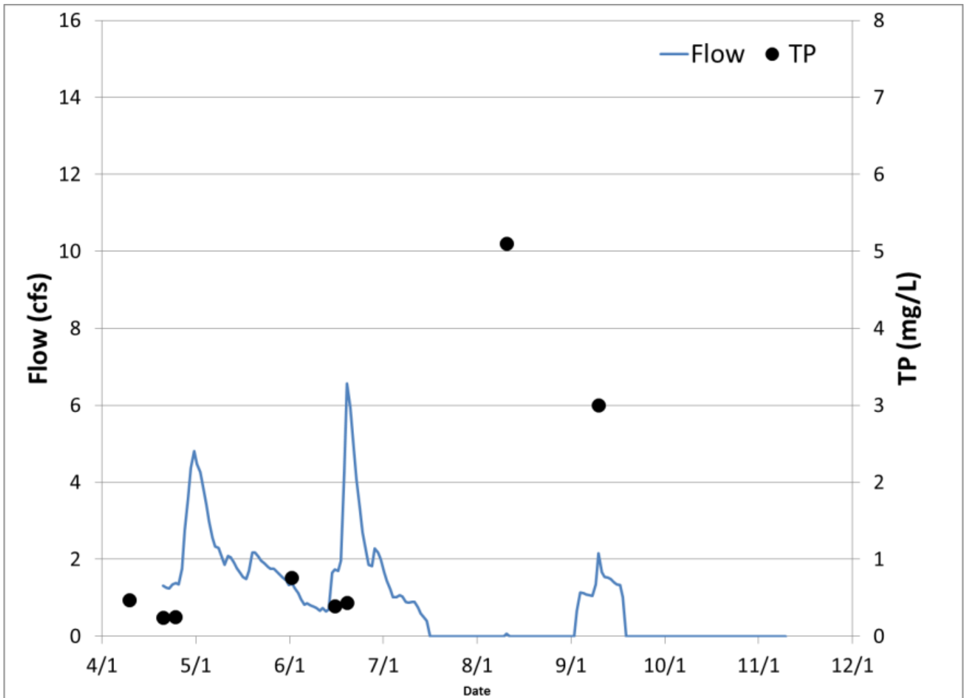



**Figure 11. 250th site total phosphorus (TP) and flow data**

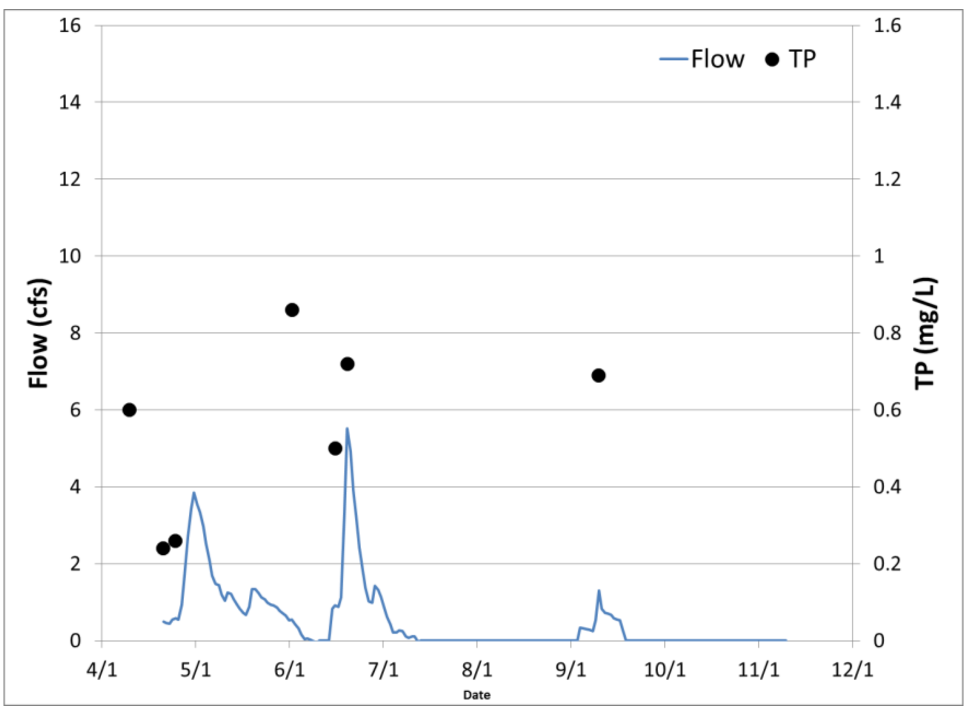



**Figure 12. Peterson site total phosphorus (TP) and flow data**

## Watershed Phosphorus Loads

The FLUX32 program calculates annual phosphorus loads based on the total volume of runoff estimated from a continuous flow record and an annual flow weighted average phosphorus concentration based on paired grab samples of phosphorus and flow collected across a range of flows. The FLUX32 program also calculates the uncertainty of the load estimates with a Coefficient of Variation (CV). The total volume of runoff, annual flow weighted average phosphorus concentration, annual phosphorus load, and CV for each monitoring site are provided in Table 9 and illustrated in Figure 13. There was insufficient data to calculate phosphorus loads for the Lofton site using FLUX32. The phosphorus load at the Lofton site was estimated by multiplying the average flow by the average phosphorus concentration of grab samples. Overall, the CVs were low (less than 0.2) providing high certainty in the phosphorus loads calculated using FLUX.

The northeast portion of the watershed (256th and Fourth Lake outlet) contributes three-quarters of the total flow but only one-third of the total load to Moody Lake. In contrast, the northwest portion of the watershed (250th and Peterson) contributes one-quarter of the total flow but two-thirds of the total phosphorus load to Moody Lake. In addition, the phosphorus originating in the northwest watershed also has a low iron to phosphorus ratio, meaning that there is little natural retention of phosphorus in watershed soils, and a high fraction of reactive phosphorus, meaning that the phosphorus is a more potent fertilizer for algae growth (Figure 14).

**Table 9. FLUX annual runoff volume, flow weighted average phosphorus concentration, and phosphorus load**

| Site | Runoff volume (cfs) | Flow weighted average phosphorus (mg/L) | Phosphorus load (lb/yr) | CV |
|---|---|---|---|---|
| 256$^{th}$ (upstream of Fourth) | 0.6 | 0.19 | 226 | 0.16 |
| **Fourth Lake Outlet** | **1.7** | **0.09** | **317** | **0.15** |
| 250$^{th}$ (upstream of Peterson) | 0.9 | 0.43 | 782 | 0.24 |
| **Peterson** | **0.5** | **0.63** | **640** | **0.16** |
| **Lofton*** | **<0.1** | **0.35** | **<65** | **N/A** |
| **Estimated Total (sum of bolded sites)** | **2.3** | | **1,022** | |

* Estimated by multiplying the average flow by the average phosphorus concentration of grab samples

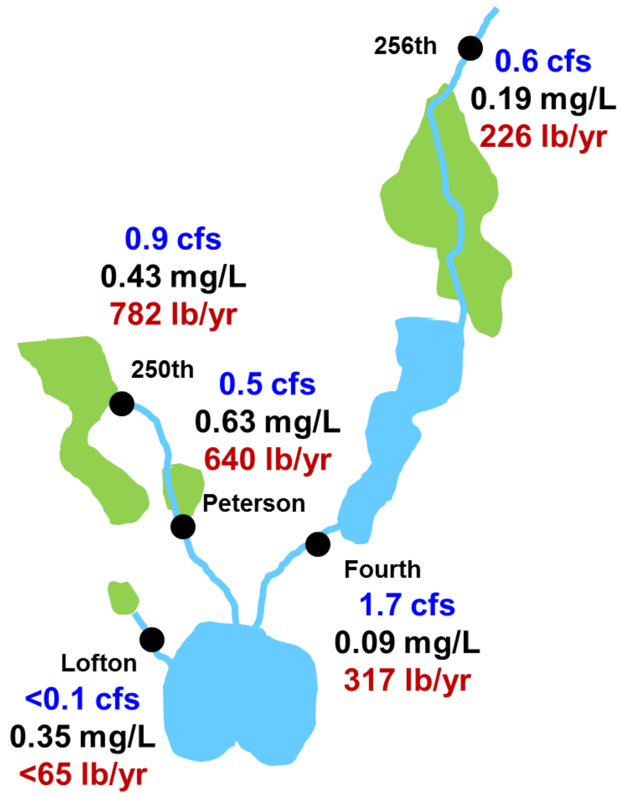



**Figure 13. Moody Lake Watershed Flow, Total Phosphorus Concentration, and Total Phosphorus Loads**

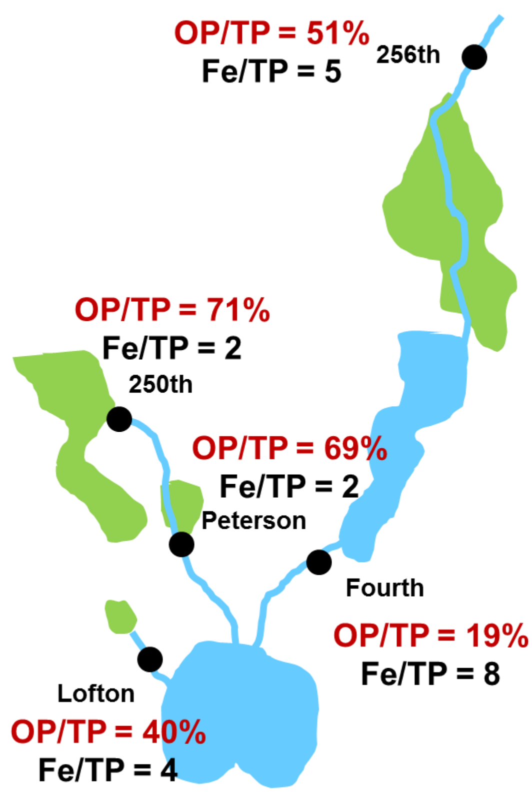



**Figure 14. Moody Lake Watershed Reactivity (Fe/TP) and Availability (OP/TP) of Phosphorus Loads**

## Moody Lake Monitoring

Water profile measurements, and surface and bottom water quality sampling was conducted in Moody Lake to refine future internal loading and alum treatment dosing estimates during implementation. Water temperature and dissolved oxygen profile measurements were collected by the Washington Conservation District twice a month between May and October at the deepest point in Moody Lake (Figure 16 and Figure 17), and on three occasions in the morning and afternoon in the shallower, eastern portion of Moody Lake (Figure 18 and Figure 19). Strong stratification of surface and bottom waters occurred in Moody Lake from May through September, with the top 4 meters forming the surface water layer and the bottom 9 meters forming the bottom water layer (Figure 16). There was no dissolved oxygen in water depths below 3 meters at both the deep site (Figure 17) and the shallow site (Figure 19) by August, indicating very high rates of oxygen depletion in the entire bottom water layer. Fall mixing of surface and bottom waters was observed in mid-October from the nearly uniform temperature and dissolved oxygen profile. These profile data indicate that Moody is a strongly stratified lake during the growing season, with high bottom water oxygen depletion rates and high internal phosphorus loading. In addition, the lack of oxygen below 3 meters in the shallow site profile measurements suggests that high internal phosphorus loading rates are likely in the shallow portions of Moody Lake as well.

Iron (Fe), total phosphorus (TP), chlorophyll-a (Chl-a), hardness, alkalinity, and pH were also collected on three dates in the shallower, eastern portion of Moody Lake (Table 10), and sediment total phosphorus and iron were analyzed from a composite of three sediment cores collected at the deepest point in Moody Lake and the Lofton Pond (Figure 15 and Table 11). These measurements will be used for future internal loading and alum treatment dosing estimates.

**Table 10. East Moody Water Quality Summary**

| Date | Fe (mg/L) | TP (mg/L) | Fe/TP | Chl-a (ug/L) | Hardness (mg/L) | Alkalinity (mg/L) | pH |
|---|---|---|---|---|---|---|---|
| 6/26/2014 | 1 | 0.375 | 2.7 | 49 | 44 | 41 | 7.9 |
| 7/22/2014 | 0.55 | 0.087 | 6.3 | 78 | 62 | 42 | 9 |
| 8/21/2014 | 0.4 | 0.092 | 4.3 | 68 | 64 | 45 | 7.5 |

**Table 11. Sediment Phosphorus and Iron**

| Sediment Core | TP (mg/kg) | Fe (mg/kg) |
|---|---|---|
| Lofton Pond | 62 | 7,910 |
| Moody Lake | 174 | 27,500 |

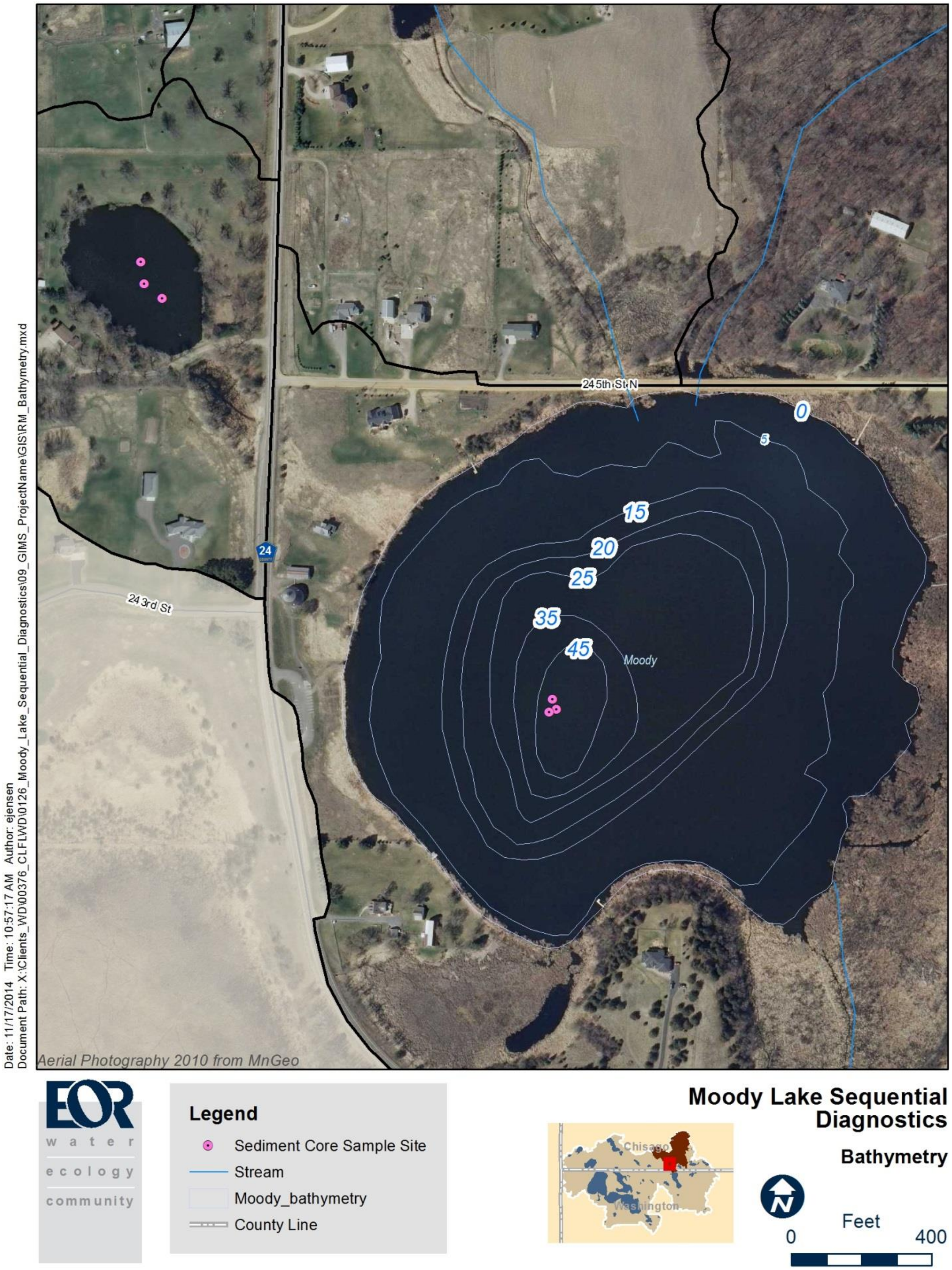



**Figure 15. Moody Lake Bathymetry and Sediment Core Locations**

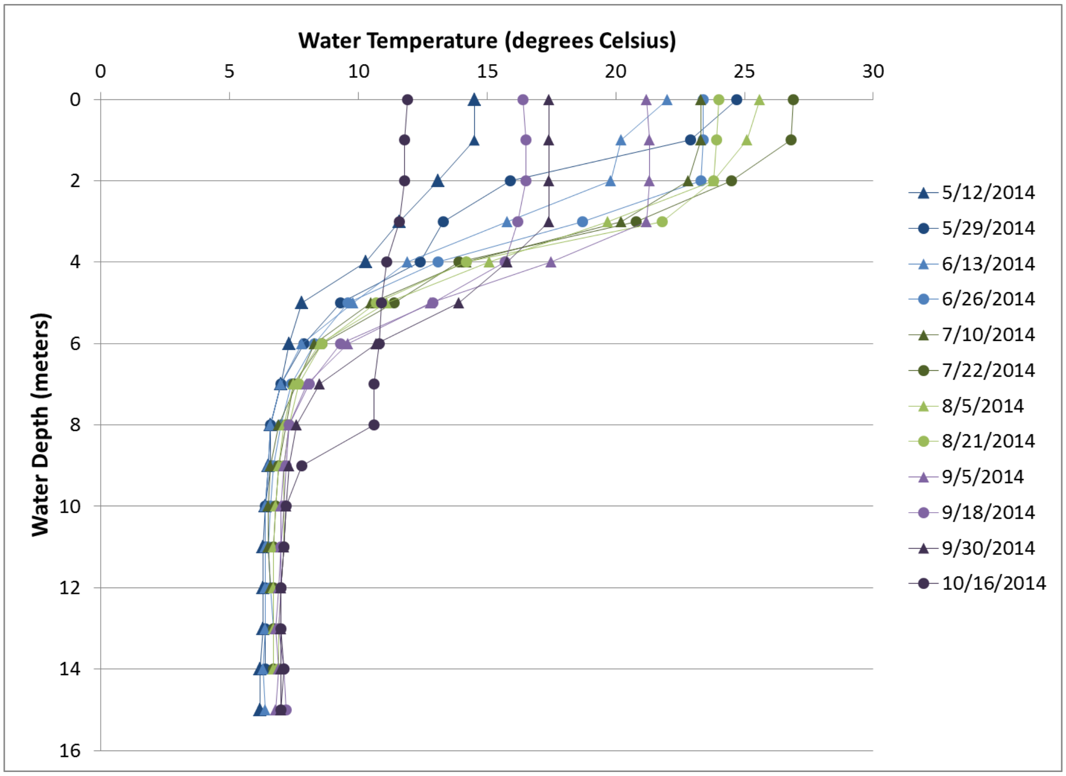



**Figure 16. Deep Water Temperature (degrees Celsius) Depth Profile**

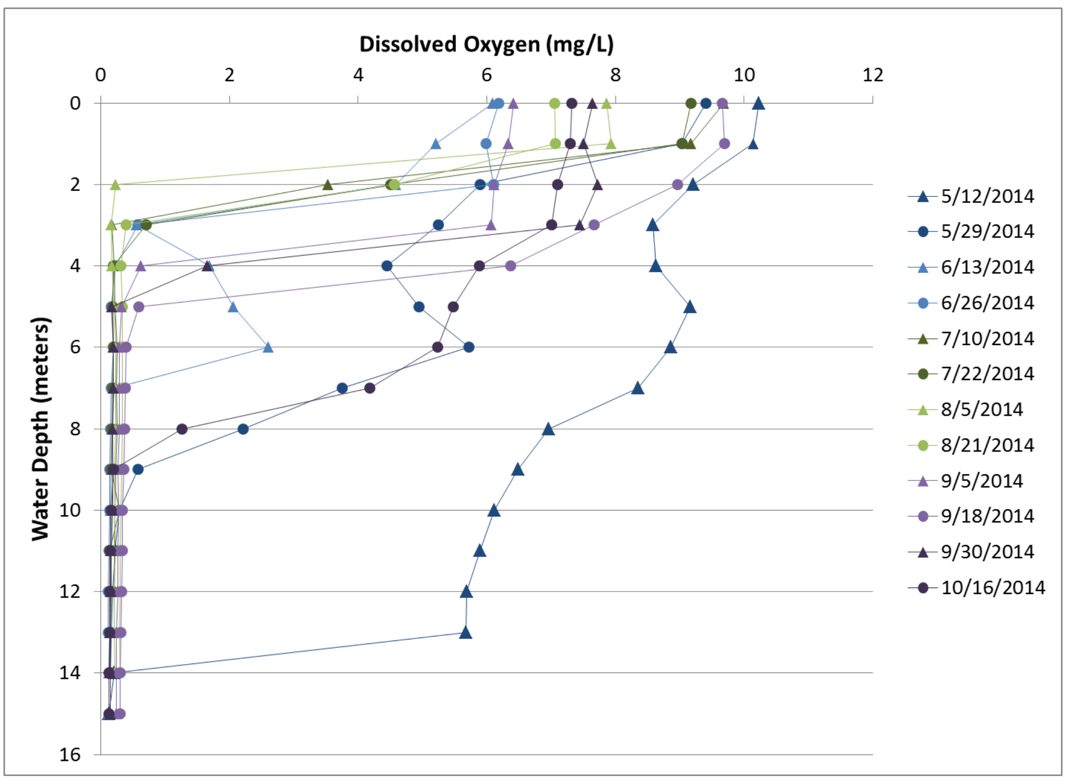



**Figure 17. Deep Dissolved Oxygen (mg/L) Depth Profile**

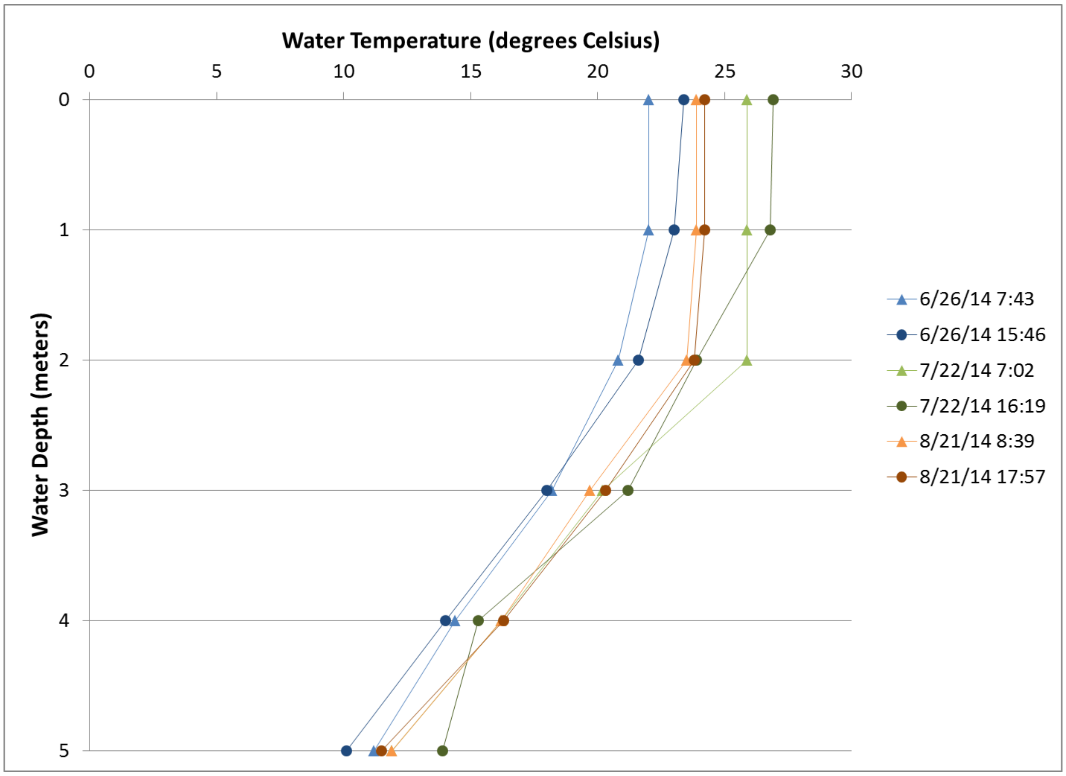


Figure 18. Shallow Water Temperature (degrees Celsius) Depth Profile

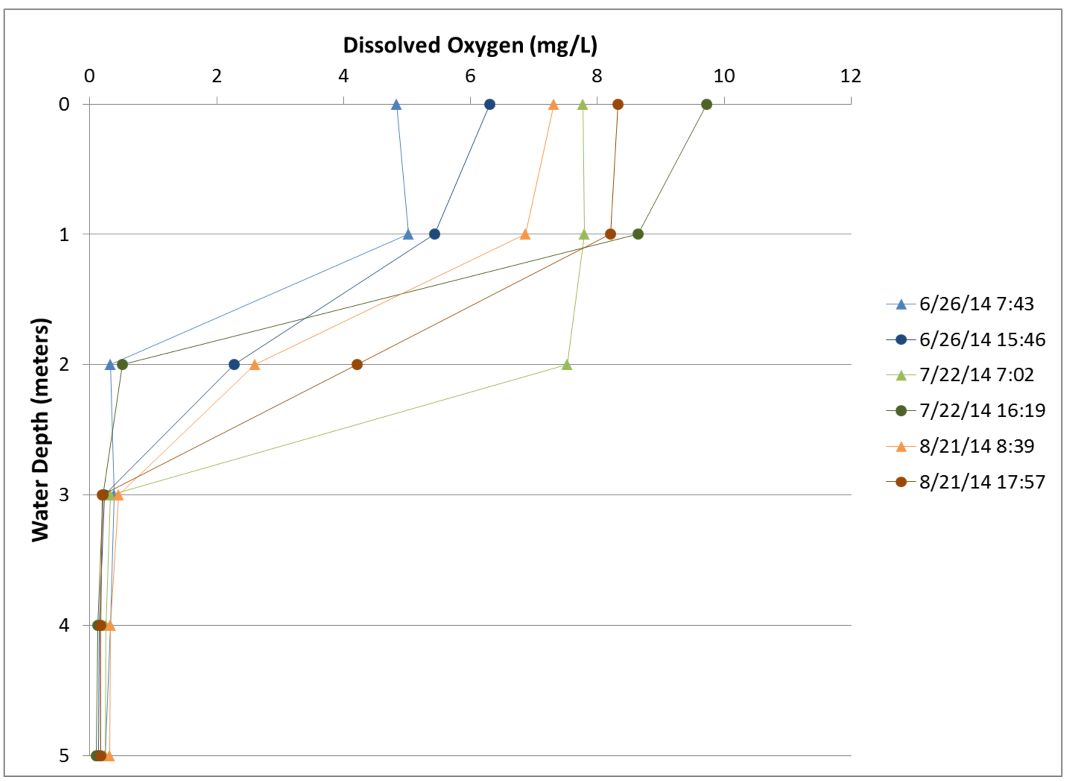


Figure 19. Shallow Dissolved Oxygen (mg/L) Depth Profile

## Key Findings

1. Portions of Moody Lake's northwest watershed have exceptionally high phosphorus concentrations and contribute the majority of the phosphorus load to Moody Lake. The phosphorus originating in the northwest watershed also has a low iron to phosphorus ratio, meaning that there is little natural retention of phosphorus in watershed soils, and a high fraction of reactive phosphorus, meaning that the phosphorus is a more potent fertilizer for algae growth.
2. The Pine Lake wetland discharge at 256th Street (that goes through two wetland complexes prior to reaching Fourth Lake) has a higher fraction of reactive phosphorus and a lower iron to phosphorus ratio than the Fourth Lake discharge and warrants monitoring over time. Fourth Lake contributes three-quarters of the total flow but only one-third of the total phosphorus load to Moody Lake, and appears to be sufficiently treating the northeast watershed runoff.
3. The Lofton Avenue ponds are discharging small amounts of phosphorus but at very high concentrations despite implementation of best practices by the land owner.
4. Lake profile data support Moody as a strongly stratified lake during the growing season, with high bottom water oxygen depletion rates and high internal phosphorus loading. In addition, the lack of oxygen below 3 meters in the shallow site profile measurements suggests that high internal phosphorus loading rates are likely in the shallow portions of Moody Lake as well.

## Recommendations

The following rehabilitative actions are recommended, in the following order:

1. **Targeted management in the northwest watershed (Figure 20):**
   a. **Additional Agricultural BMPs.** The high phosphorus concentrations and loads from the northwest watershed indicate that existing agricultural BMPs are not providing sufficient treatment of watershed runoff and likely require maintenance. Additional agricultural BMPs are also needed in the northwest portion of the Moody Lake watershed upstream of the Peterson wetland. We recommend beginning with construction of a vegetated buffer along the southern edge of the cropped field to filter sediment from runoff discharging to the wetland (**A** in Figure 20). The main purpose of this buffer would be to reduce future sediment accumulation in the downstream rehabilitated wetlands. Similarly a narrow livestock exclosure and permanent saturated buffer should be installed between the small easterly wetland and the ditch on the north side of 250th (**B** in Figure 20).
   b. **Wetland Rehabilitation.** The wetland complexes upstream of the 250th monitoring site and upstream of the Peterson monitoring site discharge runoff with very high phosphorus concentrations. The first recommended action is to collect soil samples from the small easterly basin and the larger westerly basin in the 250th wetland (**A** in Figure 20) and in the main basin of the Peterson wetland (**C** in Figure 20) to determine phosphorus content and soil stratigraphy. If this information indicates just high phosphorus content in the accumulated sediment overlying organic or peat soils with low phosphorus content, we recommend a wetland scraping of the accumulated sediment followed by reseeding and vegetation reestablishment. If both the accumulated sediment and underlying organic or peat soils have high phosphorus content, we recommend a wetland scraping of the accumulated sediment followed by chemical (alum or ferric chloride) incorporation into the organic and peat soils to immobilize soil phosphorus and prevent phosphorus leaching downstream.

c. **Lofton Pond Rehabilitation.** The wetland ponds upstream of the Lofton monitoring site discharges runoff with very high phosphorus concentrations (**D** in Figure 20). We recommend a pond alum treatment and/or removal of accumulated sediment. Sediment cores were collected as part of this study to guide alum dosing and application. Prior to an alum treatment, the livestock exclosure should be assessed and reinforced to ensure livestock do not disturb or ingest the pond alum floc layer.

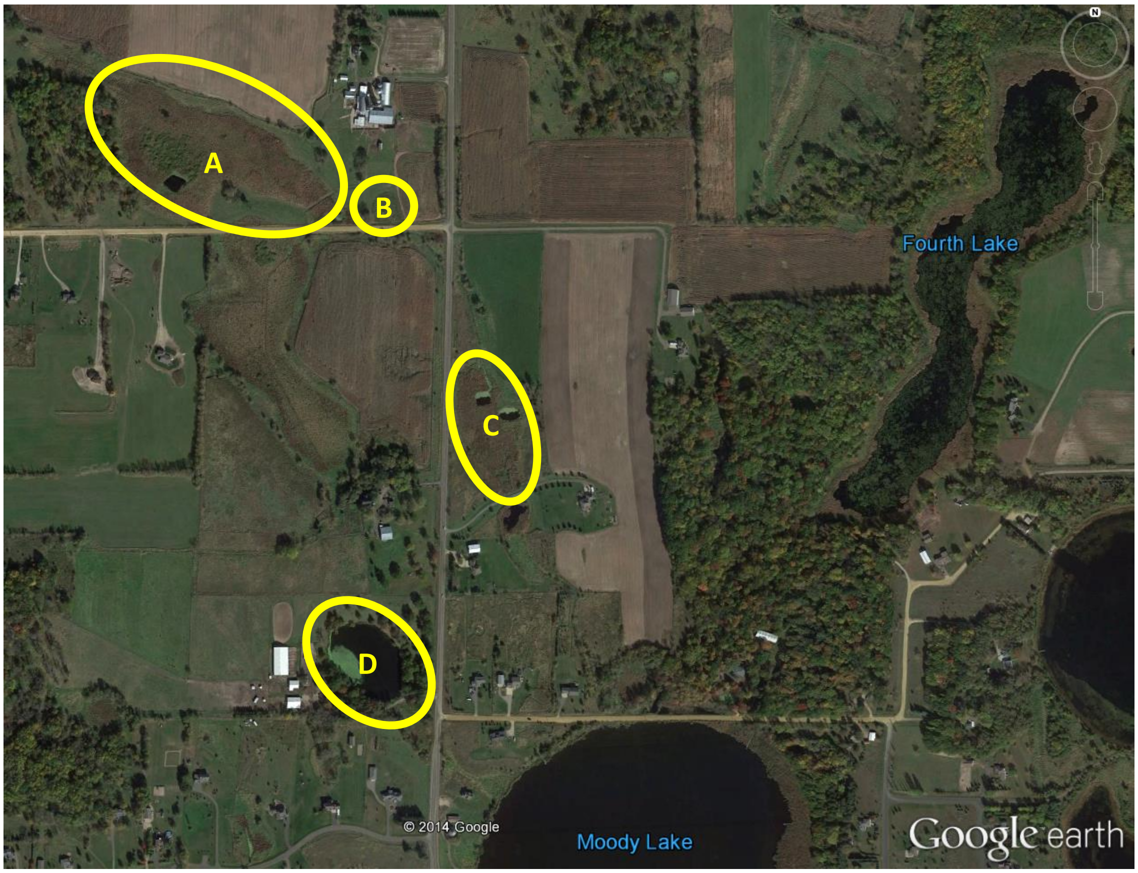



**Figure 20. Recommended rehabilitative actions in the northwest Moody Lake watershed**

2. **Moody Lake Alum Treatment.** Following closely the wetland and pond treatments and carp control, Moody Lake should receive maximum dosage whole lake alum treatment including shallow areas, particularly along the lake's eastern perimeter into its outlet. A spring treatment should be considered for facilitating alum treatment of shallow areas prior to aquatic plant establishment. Improvement of Moody Lake water quality and winter aeration will help maintain native fish and control carp. Summer aeration following alum treatment will need to be assessed more closely. However, summer aeration without a whole lake alum treatment is not advisable due to potential for unintentional increase in lake sediment internal loading.

3. **Long-term BMP Maintenance.** Due to the high sediment and phosphorus watershed loads, long-term maintenance of BMPs is critical to maintain phosphorus removal efficiency. This will require dedicated budgets and labor for maintaining buffer strips, wet ponds, wetlands, stream flows, and channels.

4. **Performance Tracking.** Grab sample monitoring of watershed phosphorus concentration along with Moody Lake volunteer Secchi monitoring to track general performance.
    a. 8-10 summer lake surface total phosphorus with corresponding Secchi transparency measurements to track improvements in Moody lake water quality.
    b. Spring and summer storm runoff sampling at the 'Peterson' culvert for TP, OP and TFe to track performance of buffers, ponds, and wetlands and corresponding improvements in northwestern runoff quality.
    c. Longer-term tracking of the Pine Lake discharge and water quality is warranted. If phosphorus concentrations increase, additional wetland restoration measures may be needed.

## Next Steps

The next step is to conduct feasibility and preliminary design of recommended projects in the northwest Moody watershed. Initial steps for determining the feasibility of wetland scraping includes:

1. Contact the permitting regulatory authorities: Wetland Conservation Act representatives, Army Corps of Engineers and MN Department of Natural Resources.
2. Evaluate wetland vegetation
3. Collect soil samples to determine depth of accumulated sediment over the organic soil horizons