East Alaska Lake

Kewaunee County, Wisconsin

Alum Treatment Plan

April 2011

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The development of this alum treatment plan relied upon the assistance of the following individuals:

Tri-Lakes Association

Patrick Robinson
William Iwen

Wisconsin Dept. of Natural Resources

Mary Gansberg
Paul Garrison

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Please note: Map 1 is the same in this document and the plan addendum.

1.0 INTRODUCTION

A comprehensive management plan was developed for East Alaska Lake (Map 1) in 1999 (NES 1999). The planning project included a delineation of the lake's drainage basin, digital elevation modeling of watershed drainage patterns, identification of existing land uses in the East Alaska Lake watershed, examination of the impacts of existing land uses on water quality, water quality monitoring, and aquatic vegetation surveys. The management plan contained several recommendations to improve and protect the lake; including future monitoring needs, work within the lake's watershed aimed at reducing nutrient loads to the lake, and preservation of environmentally sensitive areas.

East Alaska Lake's plan also discusses the lake's potentially high rate of internal phosphorus loading and the use of alum (aluminum sulfate, $Al_2(SO4)_3$) to reduce it. However, the plan recommends that a diagnostic/feasibility study be completed to determine if an alum treatment is the appropriate next step for the lake's management. In the end, while the report obviously supports an investigation regarding the use of an alum treatment, it stops short of recommending it as a part of the actual management plan for the lake. Therefore, before an alum treatment can be completed, especially one that is to be partially funded through WDNR grants, the management action must be included within the lake's plan. In addition, that plan must be complete by containing data supporting the action and an accounting of the plan's acceptance by the lake's stakeholder group.

In April 2011, a project funded through a WDNR Lake Management Planning Grant (LPL-1405-11) fulfilled the management planning requirements in regards to completing an alum treatment on East Alaska Lake. The East Alaska Lake Management Plan Addendum (Attachment A) includes an updated water quality assessment for the lake, an introduction to the use of alum in lakes to reduce internal nutrient loading, a description of the public's participation in approving the plan, and an implementation plan outlining the steps needed to construct a specific alum treatment plan for East Alaska Lake. Portions of the plan addendum are used within this document verbatim, as opposed to referencing it, to allow this document to be distributed independently of the addendum.

2.0 EAST ALASKA LAKE WATER QUALITY

In 2005, a project to determine the feasibility of using alum for phosphorus inactivation on East Alaska Lake was completed (Onterra 2005). The project focused efforts on determining phosphorus levels entering the lake from its two primary sources: the lake's inlet entering from West Alaska Lake, and an agricultural draintile entering the lake at its west shore. The project also included specific water quality data collection used in modeling of the lake's suspected internal nutrient load.

The results of the 2005 project indicated that while both external sources provide phosphorus to East Alaska Lake, the load originating from the draintile was found to be much more significant in the lake's phosphorus budget than that of the inlet. Essentially, the phosphorus loads from each source were about the same at 17.6 kg (inlet) and 18.8 kg (draintile) during the study period. The annual estimates were also similar at 25.4 and 27.4 kg, respectively. However, to understand each source's contribution to the phosphorus budget of East Alaska Lake, we must also consider the accompanying volume of water each source contributes to the lake. During the study period, the inlet delivered 16 times more water than the draintile (922,000 m^3/yr vs. 63,000 m^3/yr), which of course means that the inlet is contributing much more to the flushing rate of the lake leading to less impact to the lake's production through the inlet's phosphorus contribution.

Phosphorus inputs through internal loading were also found to be significant by the 2005 study. The modeling procedure resulted in an annual load of 131 kg to the lake's phosphorus budget. Further modeling showed that while this estimated load was surely an exaggeration, it was still a considerable indication that significant internal cycling of phosphorus may be occurring in East Alaska Lake. Unfortunately, that modeling procedure was not able to predict an accurate estimate of internal loading to East Alaska Lake or make a determination of how the lake might be improved by reducing the internal load.

In the end, the 2005 report stated that completing an alum treatment would be premature at that time due to the possibility of continued septic system issues around the lake and the high load originating from the draintile. The report went on to recommend septic system inspections around the lake and the construction of a sedimentation basin to treat incoming water from the draintile outfall before it reaches the lake.

The Tri-Lakes Association (TLA) followed through on the recommendations stated in the 2005 report and in 2006, with assistance from Kewaunee County and the US Fish and Wildlife Service, completed construction of an approximate 1-acre sedimentation basin on the lake's west shore to treat water entering the lake from the agricultural draintile. Further, in 2007 the TLA initiated the inspection of all private onsite wastewater treatment systems (POWTS) around the lake. The inspections resulted in 11 corrective actions.

Figures 2.0-1 – 2.0-3 contain historical and recent water quality data collected from East Alaska Lake over the last four decades. A detailed introduction to lake water quality data can be found in Onterra 2005.

The Wisconsin 2010 Consolidated Assessment and Listing Methodology (WisCALM), created by the WDNR, is a process by which the general condition of Wisconsin surface waters are assessed to determine if they meet federal requirements under the Clean Water Act. It is also very useful in helping lake stakeholders understand the health of their lake compared to others within the state. This method incorporates both biological and physical-chemical indicators to assess a given waterbody's condition. One of the assessment methods utilized is Carlson's Trophic State Index (TSI). The WisCALM assessment prioritizes the use of chlorophyll-*a* to calculate TSI values as this is a direct measure of lake productivity. However, if these data are not available, TSI values may be calculated using Secchi disk transparencies.

Once the TSI value has been calculated for a given waterbody, it can be compared to threshold TSI values established for different lake classification categories (Table 2.0-1). Thresholds were established for different lake types because these lakes differ naturally in their nutrient concentrations and natural communities. This allows the trophic state of a given lake to be compared to other lakes in the state with similar morphology and water regimes.

For this assessment, the lakes are classified into two main groups: *shallow (mixed)*, and *deep (stratified)* lakes. Shallow lakes tend to not strongly stratify during the growing season, remain well-oxygenated, and may support aquatic plant growth across most of the lake. Deep lakes tend to stratify during the growing season and have the potential to have low oxygen levels in the bottom layer of water. Aquatic plants are usually restricted to the shallower areas around the perimeter of the lake. The lakes are further divided into classifications based on their hydrology and watershed size:

Seepage Lakes have no surface water inflow or outflow in the form of rivers and/or streams.

Drainage Lakes have surface water inflow and/or outflow in the form of rivers and/or streams.

Headwater drainage lakes have a watershed of less than 4 square miles.

Lowland drainage lakes have a watershed of greater than 4 square miles.

Table 2.0-1. Trophic State Index (TSI) Thresholds for Wisconsin lake classifications. Adapted from WDNR PUB WT- 913 2009.

Condition Level	Shallow (Mixed)			Deep Stratified		
	Drainage			Drainage		
	Headwater	Lowland	Seepage	Headwater	Lowland	Seepage
Excellent	< 53	< 53	< 45	< 48	< 47	< 43
Good	53-61	53-61	45-57	48-55	47-54	43-52
Fair	62-70	62-70	58-70	56-62	55-62	53-62
Poor	≥ 71	≥ 71	≥ 71	≥ 63	≥ 63	≥ 63

East Alaska Lake is considered a deep stratified, headwater drainage lake within the WisCALM classification system. The condition levels found in Table 2.0-1 are also indicated on Figures 2.0-1 – 2.0-3. Please note that the sparse data available for East Alaska did not truly fulfill the standards used during normal WisCALM analysis; therefore, comparisons with that classification scheme should be taken in that light and not held as absolute.

Total phosphorus data has been collected sporadically from East Alaska Lake since the early 1970's. Mean surface value data collected during the growing season months (April – October) and summer months (June – August) can be found in Figure 2.0-1. Total phosphorus data prior to 2002 is limited with each year only containing 1 or 2 sampling events during the summer and/or growing season months. After 2002, the data consistency is better with the exception 2005 and 2006, which again only contain one or two sample events. Overall, the mean surface values are better than those found in the Southeast Region and most would be considered as "Good" to "Fair" based upon WisCALM classifications.

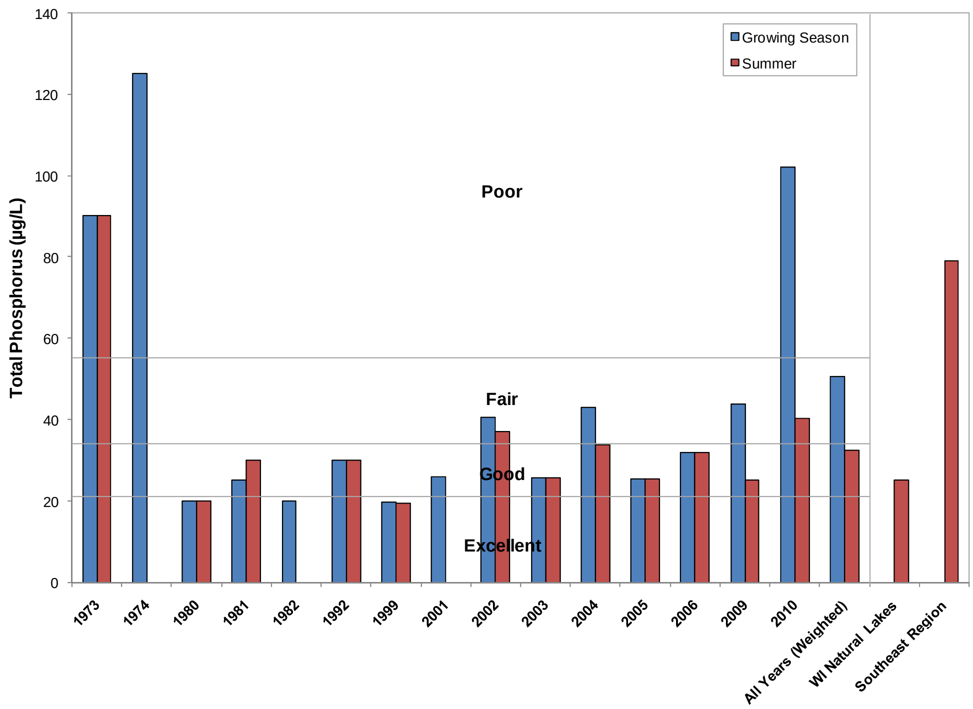

Figure 2.0-1. East Alaska Lake, regional, and state surface total phosphorus concentrations. Mean values calculated with growing season and summer month surface sample data collected at the lake's deep hole. WisCALM narrative classifications from WDNR (2009). State and regional mean values from Lillie and Mason (1983).

The 2009 and 2010 means were determined with data collected by WDNR Water Resource Management Specialist, Mary Gansberg. During both of these years, Ms. Gansberg collected seven samples during the growing season and three during the summer months. While the data were collected in a similar fashion and only one-year apart, they are obviously quite different. Based upon information provided by Paul Garrison, WDNR, the higher concentrations of phosphorus found during 2010 are likely due to increased runoff resulting from greater precipitation rates in 2010 compared to 2009. In fact, climatic data compiled by Garrison from the National Oceanic and Atmospheric Administration station in Green Bay indicates the total rainfall during April-October, 2009 was 19.2 inches while in 2010 the rainfall during the same period was 32.9 inches. This increased rainfall is likely responsible for the elevated phosphorus levels measured in East Alaska Lake during 2010 and is also an indicator that external sources can still have a significant impact on the lake's phosphorus budget.

Summer and growing season chlorophyll-*a* mean values calculated with surface samples from East Alaska Lake can be found in Figure 2.0-2. As with the phosphorus data, the chlorophyll-*a* data are sporadic and with the exception of the 2009 and 2010 data, are composed of one or two samples throughout the growing season. Still, the data available indicates that East Alaska Lake's values are lower than those found in other Southeast Region lakes and primarily remain within the WisCALM range of "Good" and "Fair". Further, due to the direct relationship between phosphorus concentrations and those of chlorophyll-*a*, the values in Figure 2.0-2 closely mimic those in Figure 2.0-1.

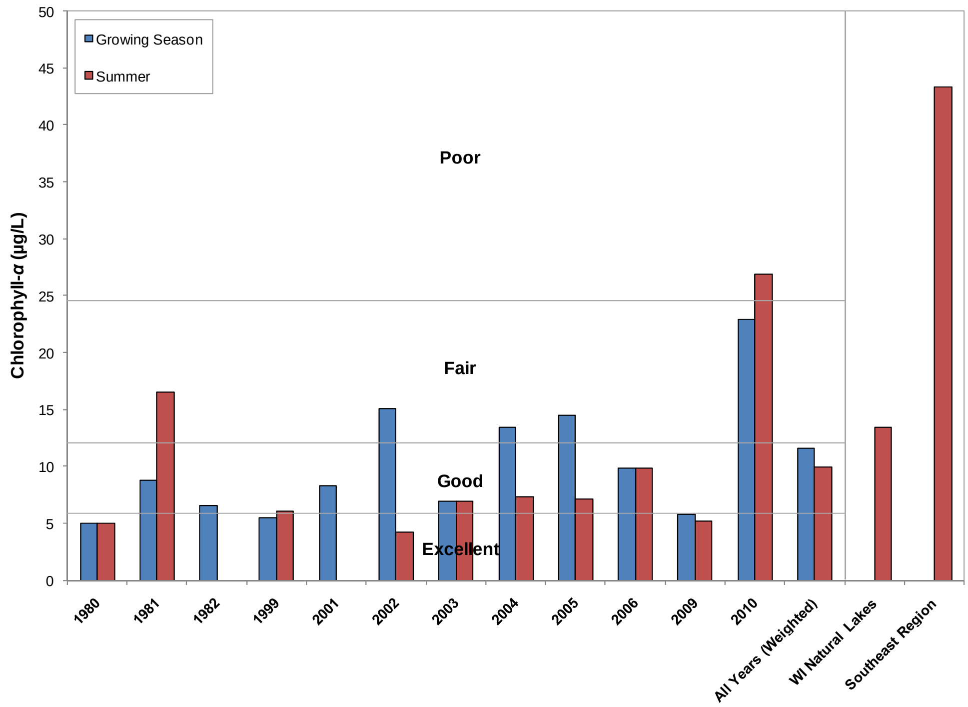

Figure 2.0-2. East Alaska Lake, regional, and state chlorophyll-*a* concentrations. Mean values calculated with growing season and summer month surface sample data collected at the lake's deep hole. WisCALM narrative classifications from WDNR (2009). State and regional mean values from Lillie and Mason (1983).

Secchi disk transparency values have been collected on East Alaska Lake since the early 1990's. Like the phosphorus and chlorophyll-*a* values, transparency fluctuates greatly within East Alaska Lake over the dataset, with some means being calculated with only a single reading. For instance, 1995, 1996, and 2001 only have a single reading each. Since 2002, the data has been collected consistently over the growing season. Within that six year period, only 2005 and 2010 showed transparency levels that would not be considered as "Good" or "Excellent" within WisCALM. Further, all values were higher than Southeast Region averages and many were near or higher than state natural lake averages.

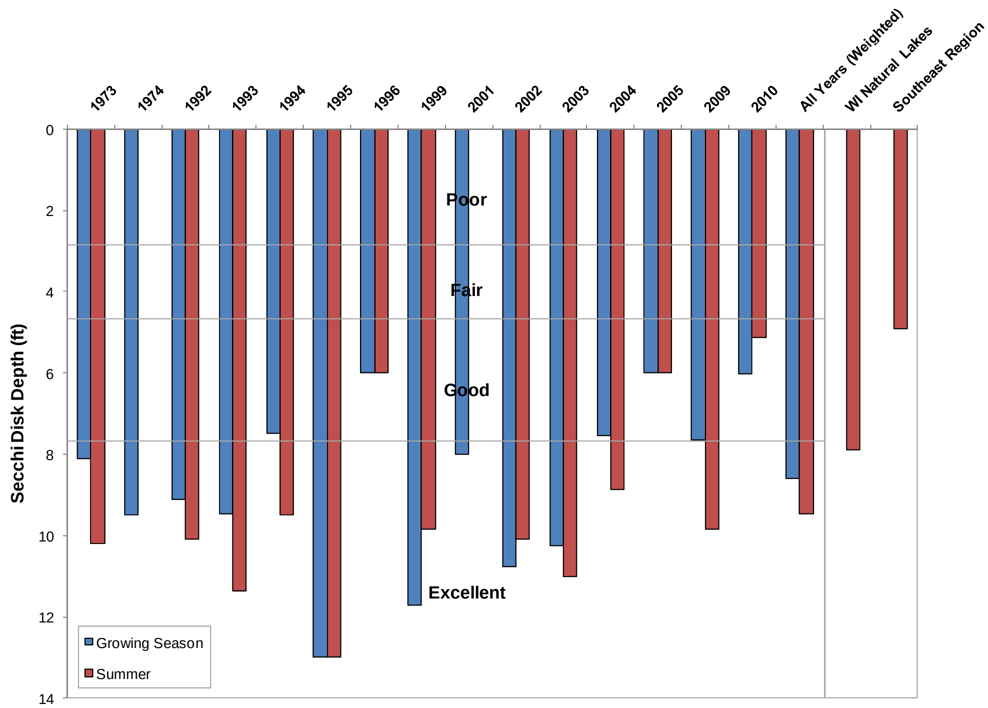

Figure 2.0-3. East Alaska Lake, regional, and state Secchi disk clarity values. Mean values calculated with growing season and summer month sample data collected at the lake's deep hole. WisCALM narrative classifications from WDNR (2009). State and regional mean values from Lillie and Mason (1983).

Overall, East Alaska Lake's water quality is relatively good, especially when compared to other lakes in the Southeast Region as described in Lillie and Mason (1983). Still, a great deal of evidence points to internal nutrient loading as being a significant contributor to the lake's annual phosphorus budget. Some of the most compelling evidence is that of hypolimnetic phosphorus concentrations (Figure 2.0-4). In a personal communication with John Panuska, who at the time was conducting lake and watershed research for the WDNR, Dr. Panuska stated that lakes exhibiting hypolimnetic phosphorus levels of 500 µg/l or greater were sure to have significant levels of internal loading and lakes with concentrations of 300 µg/l or greater where highly suspect. Over the course of the sporadic dataset displayed in Figure 2.0-4, the average growing season phosphorus concentration is 503 µg/l and the summer mean is 606 µg/l. The highest values were collected in the late summer and early fall of 2010 and ranged between 1380 and 1810 µg/l.

While the hypolimnetic phosphorus concentrations in East Alaska Lake are incredibly high, it is not absolutely clear if phosphorus from the hypolimnion is entrained to the epilimnion, especially during the mid summer, where it would fuel algae growth. Based upon the data above, it is clear that spring turnover phosphorus concentrations may be elevated within the water column as hypolimnetic water is mixed throughout the lake. Further, it is likely that these high spring values carry into the summer and fuel algal growth; however, the extent of this carryover has not been well-documented. Nor has the continued entrainment of hypolimnetic phosphorus to the epilimnion during the summer months, which to occur, would require periodic lake mixing during those months. These periodic mixing events may not occur in relatively small, but deep lakes like East Alaska.

Osgood (1988) created an index, which is useful in determining the likelihood of periodic summer mixing in stratified lakes. The Osgood Index uses a ratio of mean depth to square root of lake surface area (mean depth (meters) divided by the square root of lake surface area (square kilometers)). Lakes with ratios exceeding 8 were strongly stratified and exhibit little chance of destratification during summer months, which in turn prevented transport of hypolimnetic phosphorus to the epilimnion. Using East Alaska Lake's mean depth of 17 feet (5.2 m) and surface area of 53 acres (.214 km^2), an Osgood Index of 11 is calculated indicating the lake's strong resistance to summer destratification. Further, if we look simply at the southern basin of the lake, which has two moderately deep holes of 20 feet each, the Osgood Index is still high at 10 (mean depth = 3.2 m, surface area = .103 km^2). This analysis may indicate that while East Alaska Lake may have incredibly high hypolimnetic phosphorus values as shown in Figure 2.0-4, only a portion of that phosphorus may be transported to the epiliminion where it could be utilized by algae during the summer months. Still, the high hypolimnetic phosphorus concentrations may impact surface concentrations during and after seasonal mixing events. In the case of spring turnover, those elevated phosphorus concentrations may sustain higher levels during the remainder of the growing season.

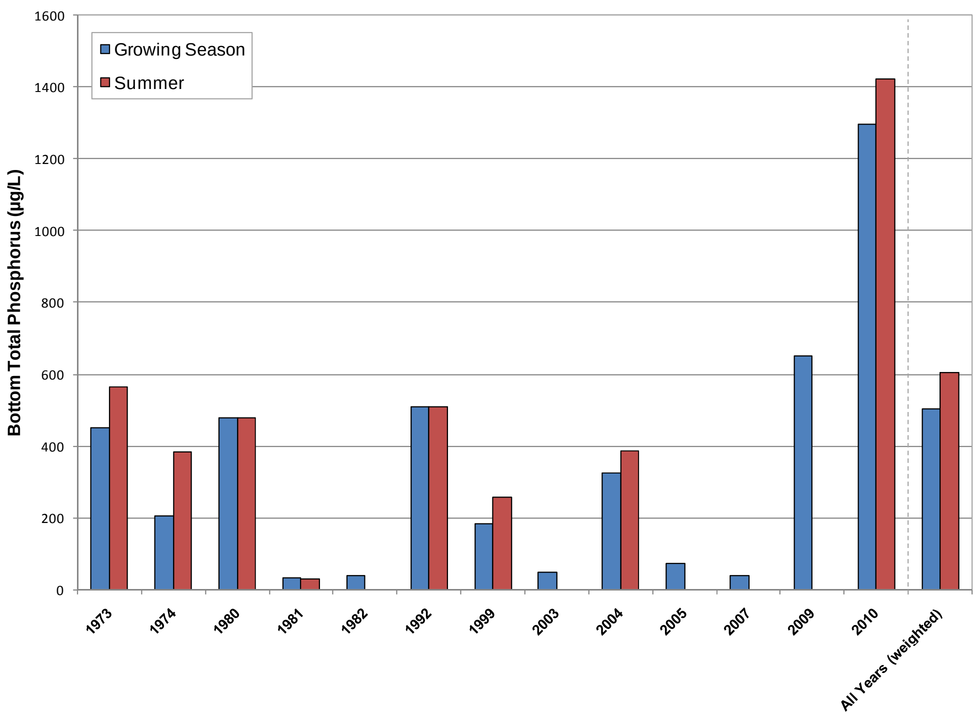

Figure 2.0-4. East Alaska Lake near-bottom total phosphorus concentrations. Mean values calculated with growing season and summer month bottom sample data collected at the lake's deep hole.

3.0 SEDIMENT CORE ANALYSIS RESULTS

During the summer of 2010, WDNR staff members Paul Garrison and Mary Gansberg collected sediment cores from 8 sites throughout East Alaska Lake (Map 1). The cores were analyzed by Bill James of the US Army Corps of Engineers for different fractions of sediment phosphorus (Table 3.0-1).

Table 3.0-1. East Alaska Lake sediment core analysis results. Sediment textural characteristics, biologically labile phosphorus fraction concentrations and rates of phosphorus release under anoxic conditions. LOI = loss-on-ignition organic matter content, Loose-P = loosely-bound phosphorus, Fe-P = iron-bound phosphorus, Redox-P = sum of loose-P and Fe-P, LOP = labile organic phosphorus.

Site	Depth (ft)	Depth (m)	Moisture (%)	Bulk Density (g/cm^3)	LOI (%)	Loose-P (mg/g)	Fe-P (mg/g)	Redox-P (mg/g)	LOP (mg/g)	P release ($mg/m^2/d^1$)
1	49.7	15.1	94.056	1.038	27.4%	0.239	0.077	0.316	0.159	11.5
2	26.3	8.0	93.126	1.044	29.9%	0.154	0.070	0.224	0.161	2.1
3	38.5	11.7	93.759	1.040	27.7%	0.060	0.016	0.076	0.033	2.5
4	20.3	6.2	95.709	1.027	43.6%	0.166	0.084	0.250	0.226	1.3
5	20.0	6.1	90.558	1.062	27.8%	0.194	0.045	0.239	0.090	0.7
6	12.8	3.9	93.675	1.040	36.0%	0.184	0.048	0.232	0.100	1.3
7	16.1	4.9	92.434	1.049	32.2%	0.170	0.051	0.221	0.130	0.9
8	23.1	7.0	90.223	1.064	25.3%	0.196	0.036	0.232	0.115	3.9
Average			92.943	1.045	31.2%	0.170	0.053	0.224	0.127	3.0

The core analysis results indicate that under anaerobic conditions, all of the sites will release phosphorus to the overlaying water. The sediments from the northern basin have the greatest release rates, yet the sites in the southern basin also exhibit significant release. The alum treatment, if completed, would target two fractions of phosphorus found within the sediment; loose-P, and Fe-P. Loose-P is essentially phosphorus that is loosely bound to other chemicals or particulate matter. Fe-P is iron-bound phosphorus. As mentioned above, iron, in the presence of oxygen, will bind phosphorus, but in anoxic conditions, it releases it. Together, these two phosphorus fractions are considered Redox-P, or the phosphorus fraction that is susceptible to being released from the sediment into overlaying waters during anoxia.

4.0 INTERNAL LOADING ESTIMATE AND ANTICIPATED RESULTS OF ALUM TREATMENT

An annual internal phosphorus load can be calculated by multiplying a site's release rate by the number of days the site is anoxic and then multiplying that product by the sediment surface area. To estimate the annual internal load in East Alaska Lake, the lake was split into a north and south basin. The north basin included sediment core sites 1-4 and 8. The southern basin included sites 5-7. The release rates for each basin were averaged to represent the basin as a whole (north basin: 4.3 $mg/m^2/d$, south basin: 1.0 $mg/m^2/d$). Using oxygen profiles collected in each basin during 2010, an average depth of anoxia (north basin: 13.4 feet, south basin: 8.2) and average number of days of anoxia (north basin: 184 d, south basin: 104 d) were estimated. The depth of anoxia for each basin was used to estimate area of bottom exposed to anoxic conditions (north basin: 13.4 ac, south basin 8.2 ac).

The analysis resulted in an annual internal load of phosphorus for the north and south basins of 39.2 kg and 3.3 kg, respectively. Therefore, based primarily on the sediment core phosphorus release analysis and profile data collected in 2010, East Alaska Lake's annual internal phosphorus load is estimated to be approximately 43 kg. Actually, this result is likely underestimating the annual load because it does not include the phosphorus that is released from the sediment during the winter months; however, sufficient data was not available to estimate that portion of the load accurately.

As detailed in the beginning of this section, the 2005 study, estimated phosphorus loads entering East Alaska Lake from its two primary external sources; the inlet entering from West Alaska Lake and the draintile outfalling on the lake's west shore. The study also paired each load with a flow. Using those data in conjunction with an estimated amount of phosphorus and water entering from the atmosphere (6 kg phosphorus and 18,533 m^3 water), and the annual internal load estimated above, a total annual phosphorus load for East Alaska Lake can be estimated. That value can then be used as the basis for changes that may be seen in the lake as a result of a successful alum treatment (Table 4.0-1). Please note that using the loading estimates determined during the 2005 study does not account for changes in the draintile load following the installation of the sedimentation basin in 2006. However, the anticipated and unaccounted for decrease in the draintile load is likely made up for in the internal load unaccounted for during the winter months as described above.

An average growing season surface total phosphorus value can be estimated by inputting the annual hydraulic and phosphorus loads to East Alaska Lake within model developed by Canfield and Bachmann (1981). The result of that modeling scenario calculates an average growing season phosphorus value of approximately 43 µg/l, which is slightly higher than the lake's actual May-September average from 2004-2010 of 37 µg/l (Table 4.0-1). As mentioned above and based upon the results of the Osmond Index calculations, it is likely that only a portion of the phosphorus released to the hypolimnion is actually mixed with waters from the upper layers of the lake where it can be utilized by algae (and would be reflected in the surface phosphorus samples). Therefore, in order to better model the actual surface phosphorus levels, only a portion of the internal load should be added to the model to determine the average surface value.

Reducing the internal load by 40% (25.8 kg) and rerunning the model, an average growing season surface phosphorus value of 37 µg/l is estimated (Table 4.0-1). Using predictive equations developed by Carlson (1977), average chlorophyll-*a* and Secchi disk transparency values can be estimated using the average growing season surface phosphorus value of 37 µg/l. The estimated value for chlorophyll-*a* (17 µg/l) is slightly higher than an average of 12 µg/l calculated with water samples collected at East Alaska Lake during the months of May-September, 2004-2010 (Table 4.0-1). Accounting for this difference is difficult; however, much of it may due to variance in the model and in-lake conditions, such as light availability, sample timing, phosphorus binding, etc.

Utilizing a similar predictive formula from Carlson (1977), an estimated average growing season Secchi disk transparency of 4.5 feet is calculated using the modeled phosphorus average of 37 µg/l. This value is much lower than the actual value of 8 feet measured during the months of May-September 2004-2010. Again, much of this difference can be attributed to error in the model because the relationships used to develop the model were largely based upon the assumption that the lakes were algae-dominated, which is not necessarily the case with East Alaska Lake. Further, we would expect a lower than actual Secchi disk value because a related equation resulted in a higher than actual chlorophyll-*a* value. Higher chlorophyll-*a* values indicate higher algal abundance which results in lower water transparency values.

Although there are obvious discrepancies between modeled values and those measured in East Alaska Lake, the modeling procedures can still shed light on how the lake may change following a successful alum treatment that would reduce the internal loading by 90% (Table 4.0-1). Using the proportional internal load value of 25.8 kg/yr, a 90% reduction would result in a post treatment annual internal load of approximately 2.6 kg. That reduction in internal loading would equate to a predicted 27% reduction in total loading to East Alaska Lake. Inputting that figure within the Canfield Bachmann model results in an average phosphorus value of 29 µg/l. Using that value within Carlson's predictive equations results in an average chlorophyll-*a* value of 12 µg/l and an average Secchi disk value of 5.8 feet. In other words, a successful alum treatment may result in an increase in water clarity of nearly 1.5 feet. Considering the underestimation of the predictive models compared to in-lake average values, the actual results after an alum treatment may be greater.

Overall, it is likely that a successful alum treatment at East Alaska Lake would exhibit itself not by showing a dramatic increase in water clarity, year after year. Instead the positive results would be shown by decreased severity and frequency of the years considered "bad" by lake stakeholders.

Table 4.0-1. East Alaska Lake predictive modeling results. External phosphorus values are the sum of annual surface inputs (6 kg) and loads entering from the sources discussed in Onterra 2005 (inlet (25.4 kg) and draintile (27.4 kg)). Target growing season mean phosphorus for calibrating model is 2004-2010 May-September average of 37 µg/l. Predicted in-lake phosphorus estimated using equations from Bachmann & Canfield (1981). Secchi clarities and chlorophyll-*a* values predicted from phosphorus concentrations using equations from Carlson (1977).

	Annual Phosphorus Load (kg)			Predicted In-lake Growing Season Mean Values		
Scenario	External	Internal	Total	Phosphorus (µg/l)	Secchi Clarity (ft)	Chlorophyll *a* (µg/l)
East Alaska Lake Current Model (uncalibrated)	59	43	102	43	4.0	20
East Alaska Lake Calibrated: Current Less 40% of Internal Load	59	26	85	37	4.5	17
East Alaska Lake Calibrated Less 90% of Internal Load	59	3	62	29	5.8	12

5.0 ALUM TREATMENT SPECIFICS

5.1 Alum Dosing, Treatment Area, and Timing

As a part of his sediment analysis, Bill James, US Army Corps of Engineers, provided alum dosing scenarios based upon the phosphorus content of two sediment layers and the desired percentage of Redox-P reduction (Table 5.1-1). Higher alum dose rates lead to greater amounts of phosphorus being tied up in the sediment, which results in greater reductions in internal loading and the longevity of the positive impacts of the treatment.

Table 5.1-1. East Alaska Lake alum dosing scenarios. Information adapted from results provided by Bill James, US Army Corps of Engineers.

Redox-P Reduction	Sediment Depth Interval (cm)	Total Redox-P (g/m2)	Al Dose Required (g/m^2)
90%	0-5	0.756	65.8
90%	5-10	1.511	131.5
75%	0-5	0.756	43.1
75%	5-10	1.511	86.2

Based upon the information provided during the public information meeting on April 4, 2011, the Tri-Lakes Association agreed that the best treatment scenario to implement would be to dose the areas of the lake with depths equal to and greater than 10 feet (33.0 acres) at a rate of 132 g/m^2. Following advice provided by Sweetwater Technologies, the contractor that would likely complete the alum application, the treatment area was expanded to include the bottom area between the depths of 5-10 feet (7.6 acres) at a moderate dose of 40 g/m^2 (Map 2). The treatment of depths between 5-10 feet was selected in order to reduce filamentous algae growth, which frequently reaches nuisance levels in East Alaska Lake and is a primary concern of lake stakeholders.

Dependent upon state funding through the WDNR Lake Management Protection Grant Program, this treatment would be completed during the fall of 2011 or during the early spring of 2012. A final treatment date would be set following funding notification by the department and based upon the availability of the applicator.

5.2 Application Process and Equipment

Application Equipment The alum application equipment consists of a specially designed barge fitted with surface application spray bars that apply alum evenly over a 60-foot path width. Dual 65 hp hydraulic motors power the barge. It is transported to and from the job site on a trailer pulled by a truck owned and operated by the contractor.

The stainless steel hull of the barge is 4’ x 8’6” x 24’ and contains two stainless steel tanks on which are mounted a deck that supports all the attendant distribution equipment as well as a wheelhouse. The wheelhouse holds the computer that controls the application process, the navigation system, and the barge operating controls. The output valves on the pumping system are automatically controlled by computer to vary the application rate with the barge speed and water depth to maintain a uniform dose. Depth and speed are monitored electronically by the computer. Each of the computer control functions has a redundant manual back-up system. In the event of a failure of the computer system, the application can continue under the manual backup system.

Capacity Barge capacity is 25,000 lbs or 2,250 gallons of 8.3% alum. This is one half of a tank truck load of alum. Based upon the dosing plan outlined above, the East Alaska Lake project would require 18 truckloads of alum.

Navigation The navigation system is a custom Differential Satellite Global Positioning System (DGPS). Signals from three or more GPS satellites are processed by an on-board computerized receiver (roving receiver). A parallel receiver (base receiver) on shore measures any drift from the satellite signal and automatically broadcasts a correction to the roving receiver.

Speed Detection The application barge utilizes two electronic speedometers that are read directly by the control computer. The GPS receiver also has a visual display that can be read by the operator to check the computer readings or to enter the speed manually in case both the computers directed systems fail. These speed readings are used by the application software to calculate the rate of chemical delivery at any given moment during the application.

Depth Detection There are two electronic depth detection systems on board the application barge. A detector is read directly by the control computer. These readings are used by the computer program to calculate the rate of chemical delivery during volumetric applications.

A backup graphics depth meter provides the operator with a display of the lake bottom to help anticipate required control actions. It is also used to check the computer readings or to allow the operator to manually input depth readings in the event that the computer depth meter fails.

Dose Monitoring and Reporting The onboard computer records average water depth, application path length, amount of each material applied and the area treated for each load delivered. These data are also recorded manually by the barge operator along with other pertinent data and comments on a "Daily Operation Log". At the end of each day, this information is summarized and recorder on a "Daily Operations Log Summary". All delivery truck bills of lading are recorded and a running total of material received is kept on a "Material Delivery Log".

Chemical Storage and Spill Containment The tank trucks' discharge valves are shut and locked when the equipment is unsupervised. Any spills would be hosed down with lake water immediately. The contractor would maintain all pumps and hoses to wash down the site.

Staging Area The staging area must be accessible to large trucks. The East Alaska Lake public landing parking lot would serve as the primary staging area. A minimum of 42 inches of depth is needed for the barge. Tankers would load the barge from the parking lot via a hose connected to a raft anchored off shore in adequate depth.

Equipment Decontamination To prevent the spread of exotic species, all equipment would be decontaminated before entering and leaving the area. Chlorine bleach would be used as the disinfectant.

5.3 Public Notice Items and Responsibilities

Significant public notice was completed and input considered as a part of the management planning project completed in 2010 and 2011, as described in the introduction. Those items included an informative article in the Kewaunee Star News that was prompted by a press release to the paper, a Frequently Asked Questions (FAQ) document mailed to all shoreland property owners on Krohns, West Alaska, and East Alaska Lakes, and a public information meeting held near the lake on April 4, 2011. These items can be found in Appendix A of the East Alaska Lake Management Plan Addendum (Attachment A).

Further public notice would be completed by the Tri-Lakes Association once the treatment date is set. Those elements would include a second press release announcing the successful grant funding request and the treatment date, the mailing of an announcement to the shoreland property owners on Krohns, West Alaska, and East Alaska Lakes, and posting at East Alaska Lake's single public landing.

5.4 Monitoring Plan

Pre-Alum Application Monitoring WDNR Water Resource Specialist, Mary Gansberg, under special department funding, has been monitoring water quality in the north and south basins of East Alaska Lake since 2009. Ms. Gansberg's monitoring, which includes depth-profiling of dissolved oxygen, temperature, and phosphorus levels, and surface monitoring of chlorophyll-*a*, alkalinity and pH, will continue through at least June 2011.

Application Monitoring A few weeks prior to application, the lake's most current alkalinity levels will be used to calculate expected changes in pH due to the alum dosing. If pH levels are expected to drop below 5.5, the treatment plan would be adjusted to assure that the levels remain above that threshold. Depending on the results of the calculation, the treatment plan may be adjusted to include a single application at a lighter dose, or two applications occurring a year apart with the sum of the doses equaling the doses outlined above.

On the days of application, Onterra staff would monitor pH at a multiple sites within East Alaska Lake. If pH levels at those sites reach 6.0, operations would be halted and the situation would be assessed as to whether the application should be continued. It should be noted here that there is no reason to believe that pH levels would approach 6.0 based upon historic alkalinity values measured at the lake (October 2010 alkalinity: 209 mg/L as $CaCO_3$).

Post Alum Application Monitoring Beginning in the spring following the application, Onterra staff would monitor water quality in both basins utilizing the same sample points as Ms. Gansberg. Monitoring parameters and collection timing are displayed in Table 5.4-1. During each visit and within both basins, a dissolved oxygen/temperature profile would be created and a Secchi disk clarity would be recorded.

Table 5.4-1. Post alum application water quality sample parameters and timing. This monitoring scheme would be utilized in both the north and south basins of East Alaska Lake using the same locations as used by the WDNR in 2009-2011. S = near-surface, B = near-bottom.

	Spring		**June**		**July**		**August**		**Fall**		**Winter**	
Parameter	**S**	**B**	**S**	**B**	**S**	**B**	**S**	**B**	**S**	**B**	**S**	**B**
Total Phosphorus	●	●	●	●	●	●	●	●	●	●	●	●
Chlorophyll a	●		●		●		●		●			
Laboratory Conductivity	●	●			●	●						
Laboratory pH	●	●			●	●						
Total Alkalinity	●	●			●	●						

Results of the sample collections would be compared with those from prior to the application and discussed in a report that would be completed during winter 2013.

6.0 PROJECT COST ESTIMATE

The estimated project costs are contained below. The alum application estimate utilizes a cost of $1.65 per gallon of alum applied.

	Cash Cost	Donated Value
Onterra Fees		
Project Setup & Administration	$2,225.00	
Water Quality Monitoring	$4,260.00	
Data Analysis and Report/Plan Creation	$1,160.00	
Printing, Shipping, & Plant Vouchering Materials	$100.00	
Travel Mileage ($0.58/mi)	$365.00	
Other Fees		
State Laboratory of Hygiene Fees	$1,100.22	
Notice Posting and Mailing	$500.00	
Alum Application Fees		
10 Foot Contour and Deeper (132g/m^2)	$138,500	
5-10 Foot Contour (40g/m^2)	$10,000	
Mobilization	$6,000	
Volunteer & In-kind Match Opportunities		
TLA Project Administration (50 hours)		$600.00
Subtotal	*$164,210*	*$600.00*
Project Total	**$164,810.22**	
State Share Requested	**$123,607.67**	

7.0 LITERATURE CITED

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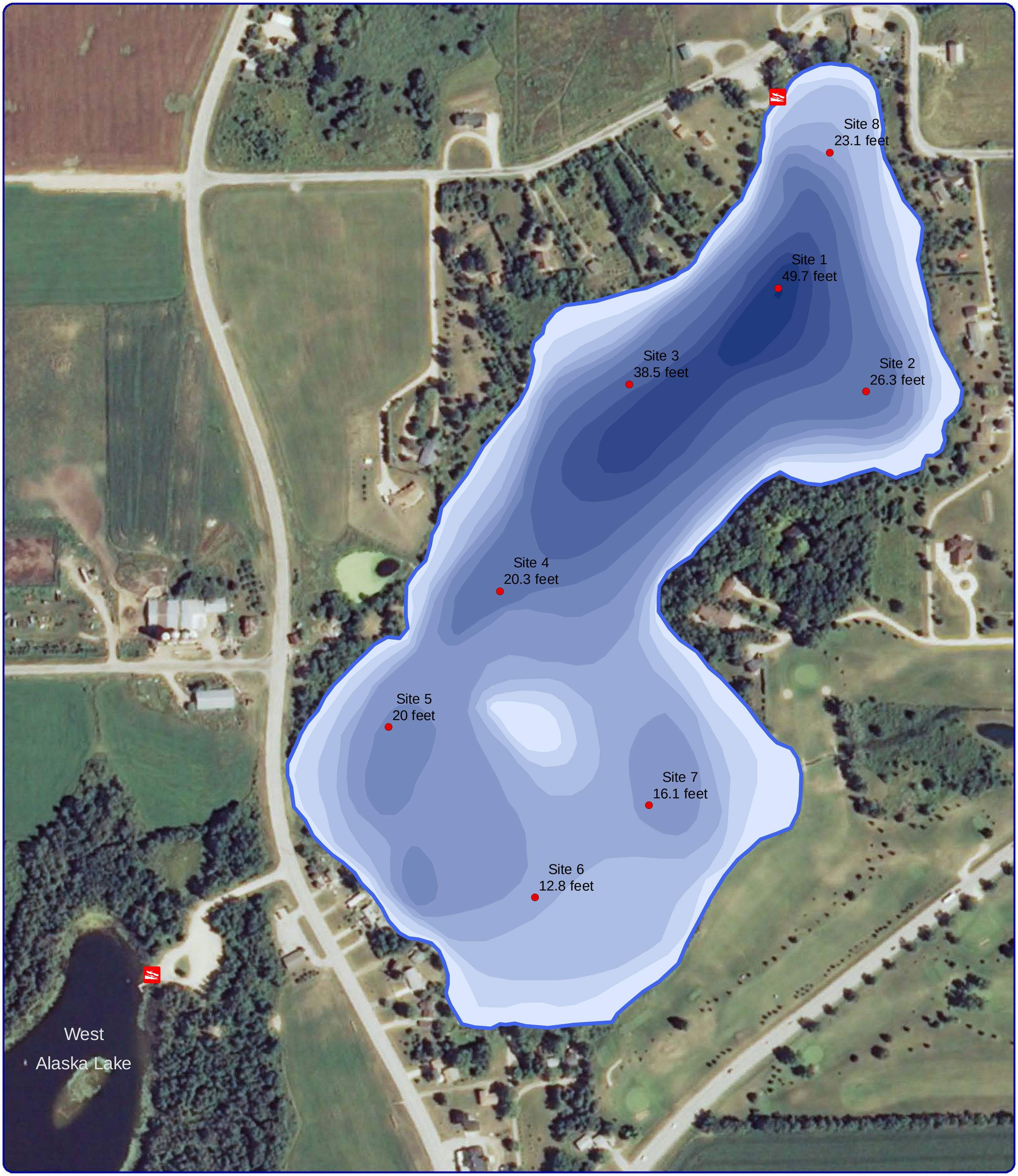

N
W E
S

350

Feet

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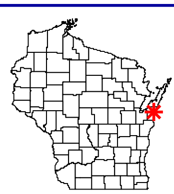
Sources:
Roads & Hydro: WDNR
Orthophotography: NAIP, 2005
Map date: February 10, 2011



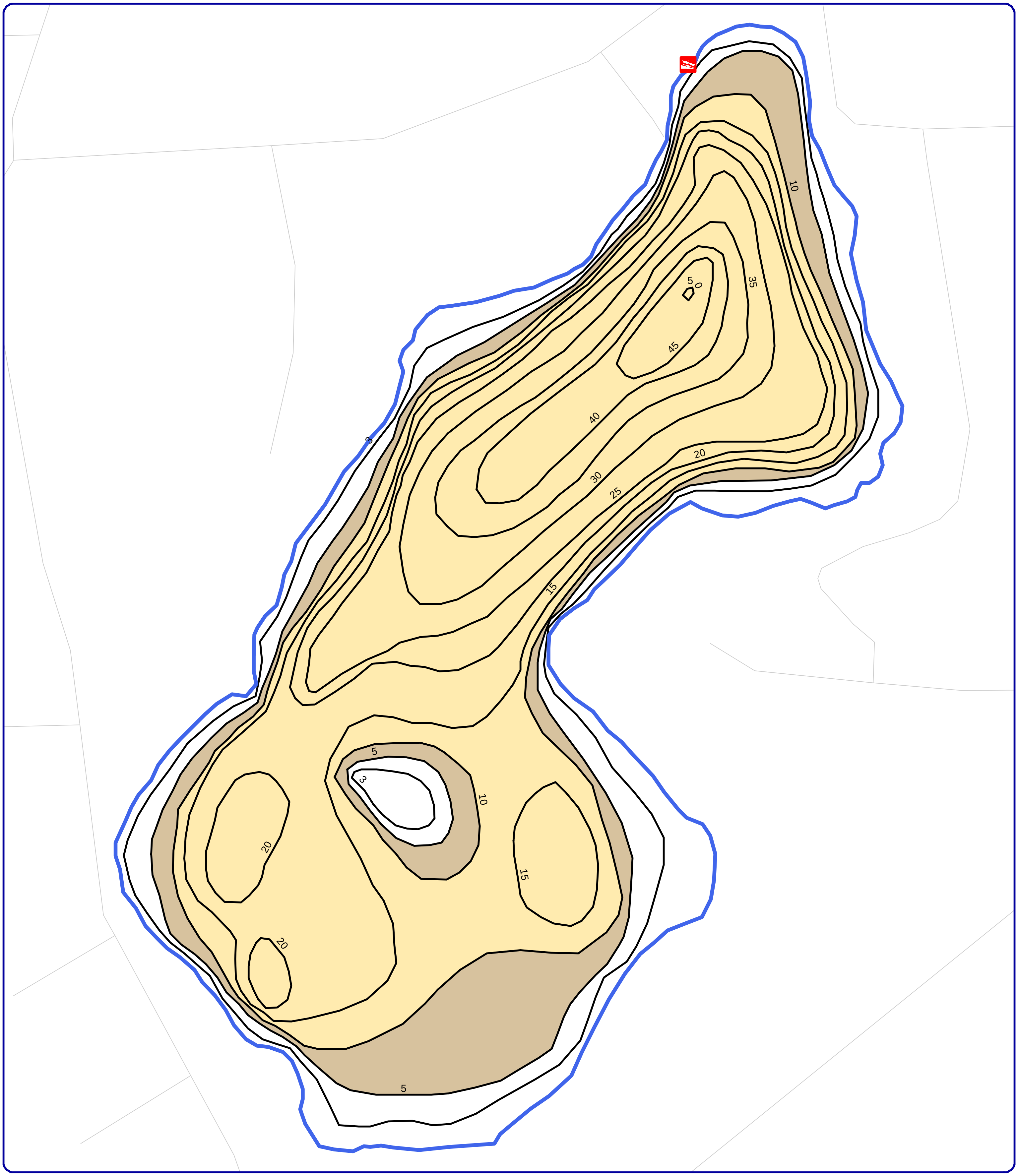
Project Location in Wisconsin

Legend

East Alaska Lake~ 50 acres
WDNR Definition

Sediment Core
Sample Site

Map1
East Alaska Lake
Kewaunee County, Wisconsin
Sediment Core Sample Sites



300
Feet

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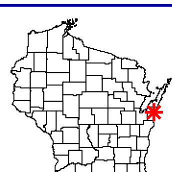
Sources:
Roads & Hydro: WDNR
Orthophotography: NAIP, 2005
Dosing Plan: Onterra, 2011
Map date: April 27, 2011



Project Location in Wisconsin

Legend

East Alaska Lake~ 50 acres
WDNR Definition

Alum dose: 132 g/m^2 (33.0 acres)

Alum dose: 70 g/m^2 (7.6 acres)

Map2
East Alaska Lake
Kewaunee County, Wisconsin

Alum Dosing Plan