ATTACHMENT A - PROJECT DESCRIPTION

INTRODUCTION & PROJECT BACKGROUND

Ticklenaked Pond is a 57-acre waterbody located in the town of Ryegate which provides valuable wetland habitat and recreational opportunities for area residents. Ticklenaked Pond has a history of water quality problems due to excessive phosphorus loading from the watershed and historic loadings have also resulted in a significant recycling of internal phosphorus from the pond sediments. Assessment and characterization of the external and internal phosphorus loading was completed as part of the Phosphorus Total Maximum Daily Load (TMDL) prepared by the Vermont Agency of Natural Resources. In addition to watershed controls, the TMDL recommended eliminating the internal from the pond through a phosphorus inactivation treatment. This recommendation was further refined in the September 2011 "Ticklenaked Pond Loading and Management Analysis" performed by AECOM and Water Resource Services (WRS).

PROJECT DESCRIPTION

The goal of proposed treatment is to strip the water column of phosphorus and inactivate the phosphorus in the bottom sediments. This is accomplished by applying an aluminum salt to the pond (aluminum sulfate) which reacts with the water to form an insoluble aluminum hydroxide solid (floc). This floc falls through the water column chemically and physically removing phosphorus and then settles to the bottom forming a "blanket", which effectively inactivates the phosphorus in the sediment.

Once applied, the reaction of alum and water (especially soft water lakes) causes the water to become acidic (low pH). To counter this effect, a buffer solution of sodium aluminate is applied simultaneously along with the alum. At a volumetric ratio of typically 2 parts alum to 1 part sodium aluminate, the pH will remain near background throughout the treatment process. The use of sodium aluminate is preferred over other buffer solutions because it also contributes to the aluminum dose.

Chemical Dosing

The primary objective of the treatment is to apply enough aluminum to "inactivate" the available amount of phosphorus in the top later of sediment which interacts with the water column. As specified in the project documents, 9.57 hectacres (23.65 acres) of Ticklenaked Pond will be subject to treatment. This roughly corresponds to areas of the lake with water depths greater than 13 feet and where anoxic conditions promote the release of phosphorus. The treatment area is further broken down into two sections as shown in Figure 1 (attached). Based on sediment phosphorus data collected by AECOM/WRS, the dose in Area ABD was set at 60 g/m^2 and Area C, which had higher available phosphorus content, was set at 105 g/m^2. In Area ABD, the application rate is 477 and 238 gallons per acre of alum and sodium aluminate, respectively. In Area C, the application rate is 834 gallons and 417 gallons per acre of alum and sodium aluminate, respectively. The total quantity of alum to be applied is 12,264 gallons and 6,132 gallons of sodium aluminate. Product specification and Material Safety Data Sheets (MSDS) for each product are attached.

For this project, the treatment dose will be "split" with the first half dose applied over the entire area followed by a second traverse of the treatment area (in a perpendicular direction, if feasible) to apply the second half. There will be at least 24 hours allowed for floc settling before any area is treated with the second half of the dose. This process requires more time, but reduces the "effective" dose applied to the pond in half and provides a further safeguard against adverse effects to the fish population. Additionally, when the treatment area is split into sectors, no two adjacent sectors will be treated consecutively, allowing for more dilution and refuge for fish.

Chemical Application

Treatment will be conducted with a specially designed alum barge. The barge has rough dimensions of 25 feet long by 15 feet wide and is powered by two 50 HP four-stroke engines. The barge is extremely stable in the water and maneuvering and steering is excellent. The treatment vessel will be equipped with a fathometer and speedometer. A calibration table for chemical delivery (gal.) versus vessel speed (mph) will insure even distribution of the alum and sodium aluminate. Suitable in-line pressure gauges and flowmeters to measure chemical delivery rates will also be utilized.

The treatment vessel is equipped with 2 translucent, polyethylene tanks with a combined capacity of up to ~500-800 gallons. These tanks are also calibrated on the outside, which allow operators to visually monitor chemical delivery to insure the desired volumetric ratio is met.

Since the two chemicals cannot be tank-mixed prior to application, there are two separate pumping systems for each product including individual spray booms and nozzles. Centrifugal, gasoline powered pumps are used on the vessels. The boom is mounted off the stern of the barge and has variable depth ability powered by a hydraulic motor. This application will occur subsurface, at an agreed upon water depth. Along the entire length of both booms, nozzles (wide-angle, full cone spray pattern) are evenly spaced at prescribed distance intervals. The nozzles along the two booms are positioned in opposite pairs angled towards one another. With the nozzles evenly dispersing chemical forward of the horizontal boom, excellent floc is formed as the chemicals pass/mix around the boom's turbulent waters.

The specified treatment areas will split into discrete treatment sectors and installed to the GIS system on-board the treatment vessel. Treatment will be guided with on-board differential GPS. The treatment vessel is equipped with a field portable laptop connected to a Trimble XT GPS receiver. The laptop screen will show the pond and treatment area/sector boundary with a grid overlay. The system logs the path of the treatment vessel with an accuracy of ± 1 meter. Each and every vessel load of chemical is logged and monitored; chemical volumes applied to each sector are pre-determined and checked for accuracy daily.

As an additional safeguard and to evaluate the proposed treatment protocol, a ~5-acre portion (See Figure1) of the pond will be treated on the first day of application, to evaluate 1) chemical dosage, 2) floc characteristics and drift, 3) equipment calibration, 4) navigability to ensure even chemical

distribution, 5) to allow for underwater camera inspections to assess floc formation and 6) allow observations of any unexpected effects. The pilot treatment is to tentatively occur on a Thursday with results to be collected and evaluated on Friday-Sunday before making a final decision on whether or not to continue the full scale treatment on the following Monday.

Chemical Delivery & Loading

The chemical products for this treatment will be provided from the Holland Company of North Adams, MA. The quantities of both products for a day's treatment will be delivered by either a "split" tanker truck or two separate trucks. The truck(s) will remain on site for the entire day and will be operated by an experienced driver.

Chemical from trucks is conveyed to the treatment vessel tanks by lengths of 3" diameter reinforced hose, rated to handle these types of materials. There are shutoff valves at each hose connection and there is an emergency shutoff valve at the tanker. Hoses for each chemical are clearly marked to avoid confusion and misconnection. Since the treatment vessel cannot move all the way to shore given its increased draft after filling, we will need to put a 10-15 foot temporary aluminum dock out into the pond for accessing and loading the treatment vessel.

The State Boat Launch located in the northeast corner of the pond will be used the launch the barge into the pond. The down beach located just west of the boat launch will serve as the Base of Operations for chemical transfer. The tanker trucks should be able to drive to within 100 feet of the water's edge to allow for the chemical transfer.

Treatment Timing/Duration

We expect the actual application will require approximately 3-4 extended (10-12 hour) workdays to complete, plus the time involved in mobilization/demobilization. Alum treatments are best conducted in the spring or fall in order to avoid peak recreational use periods and potential interference from algal blooms. Water temperature should be at or above 45° F for optimal chemical reaction rates and flow formation/settling times.

Past data from Ticklenaked Pond has shown that high algal density will artificially elevate pH values into the 8-9 S.U. range. This has typically occurred between the beginning of May and the end of September, but varies from year to year. Since the alum treatment process is highly sensitive to pH, it will be necessary to avoid treating while algae growth is elevating pH.

Water-Use /Recreational Restrictions

Although not required, we recommend that all recreational activity on the lake be restricted during the treatment. Other water use restrictions (i.e. irrigation, potable use) during the treatment should be discussed and determined in cooperation with the DEC, the Town and the applicator.

Monitoring

Monitoring is a key component when conducting alum treatments both to ensure that the application is maintaining stable water quality and to evaluate effectiveness. During the treatment, pH and alkalinity will be monitored to ensure both parameters remain stable. This would occur multiple times during the

day at stations both within and outside the treatment areas and at multiple depths. Additionally, floc settling will be monitored periodically with the use of an underwater camera system. While on the water, all staff will continuously monitor for dead or distressed fish.

Staffing/Safety

An applicator from Aquatic Control Technology, licensed by the VT Department of Environmental Conservation will be on-site at all times during the chemical application. Experienced Biologists/Technicians will be conducting all testing and monitoring during the project. Our staff has received instruction in the proper and safe handling of the chemicals. Required Personal Protective Equipment (PPE) is provided for all employees. A spill containment kit is maintained on shore in the unlikely event of leakage during chemical transfer from the tank-truck to the barge.

IMPACT ASSESSMENT

Alum treatment is an effective phosphorus management technique as long as proper planning and application methodologies are employed. While no significant detrimental impacts are anticipated, the potential exists for the following:

- Certain species of invertebrates such as Chironomidae (midge flies) and Oligochaetes (worms), which inhabit the targeted areas of benthic sediments may be impacted by the treatment. As the floc settles and interacts with bottom sediment, these species can be smothered and some mortality may occur. Recovery within these communities has been documented within one year post-treatment.

- The potential for harm to the aquatic biota arises when the aluminum salts are first applied to the water. If the pond has a low acid neutralizing capacity (i.e., poorly buffered), the pH will fall and the ionic form of aluminum, Al+3 will be present. The ionic form of Al can be toxic to the aquatic biota, including macroinvertebrates and fish. For this reason, the application to Ticklenaked Pond will use a mixture of aluminum sulfate and sodium aluminate, in order to increase the acid neutralizing capacity of the pond water, maintain stable/ambient pH and minimize soluble aluminum. Ticklenaked Pond also has higher ambient alkalinity which will naturally help to buffer the treatment reaction.

- The potential for high concentrations of alum to come in contact with freshwater mussels may occur. Based on a 2011report entitled *2011 Freshwater Mussel Survey in Mystic Lake (Barnstable, Massachusetts)* by Biodrawversity, LLC, mussel response to alum treatment was inconclusive (i.e. showed no observable effect). Another study, entitled *Pre- and Post-Alum Treatment Survey of Honeoye Lake Macrobenthos* by Dr. Bruce Gilman describes the response of freshwater mussels to alum treatment of the Honeoye Lake in the Finger Lakes Region of New York in 2005 and 2006. Dr. Gilman reported that, 'Despite changes in species richness and total abundance, a comparison of the relative dominance of species before and after alum treatment suggests little change in macrobenthos community structure and no apparent negative impact from the chemical [alum]." Based on these studies, we anticipate negligible impact to the freshwater mussel community.

- Incidental exposure and potential mortality is possible if fish were to pass through the injection area at the time the chemical is being released. Some laboratory experiments have documented mortality at approximately 30% within an hour after exposure to neonatal (juvenile) fish. Monitoring will be conducted to evaluate any fish mortality, though the likelihood of such from direct exposure is anticipated to be minor. The split and patchwork application method will also reduce the instantaneous alum concentration that fish may be exposed to.

- Although theoretical to date, the question of whether the addition of sulfate to the pond might stimulate the biochemical activity of sulfate reducing bacteria, and consequently enhance the potential for mercury present in the pond to undergo methylation. Mercury methylation requires three conditions: mercury (not affected by this proposal), sulfate (and sulfate reducing bacteria), and anoxic sediments rich in organic carbon. Based on extensive review of scientific literature and consultation with experts in the aquatic chemistry field, the understanding that the alum treatmentprogram is unlikely to increase mercury methylation is based several factors. First, the ambient sulfate concentrations in regional groundwater are relatively high; the population of sulfate reducing bacteria in the pond muds are consequently more likely to be limited by another substance, if sulfate is present in excess. Additional sulfate will not overcome a limiting factor for these bacteria and is therefore not likely to stimulate their growth. Second, the alum treatment program will reduce phosphorus flux from the sediments and consequently algal production. Less algal production means less decomposition in the deep waters, and ultimately improved dissolved oxygen concentrations. With improved oxygen, the conditions that can lead to mercury methylation are mitigated. To date, however we are not aware of any detailed monitoring of mercury cycling before, during and after an alum treatment program.

- Wind and wave activity could move the floc beyond the target area and into outlying areas. No impacts are anticipated if such an event were to occur, but monitoring and subsurface injection will be maintained so as to minimize floc migration outside of the target area.

- It is recommended that human recreational activities such as swimming, fishing, kayaking, etc. be restricted during the application period so as to minimize direct contact with treated waters. Since the treatment is proposed outside the prime recreational season, a time when such activities are minimal, impact is not anticipated. Should a person partake in such activities during treatment however, it is unlikely that they would suffer any side effects. To date, no human illness from contact with alum treated waters has been documented.

The most serious impact is the possibility for fish or invertebrate kills following treatment in low alkalinity lakes, but such impacts are preventable. Minimal adverse impacts are expected to either surface or groundwater supplies. Aluminum, iron and calcium are commonly added in water and wastewater treatment facilities with no significant adverse impacts (and generally a marked improvement in water quality).

ALTERNATIVES ANALYSIS

Alternatives techniques to address the internal loading of phosphorus in Ticklenaked Pond have been evaluated and include dredging, increased circulation and aeration. Another undesirable but valid alternative is to do nothing. The following is a brief discussion of these alternatives.

- **Do Nothing** – This alternative is obviously less costly, however not addressing the excessive phosphorus loading from internal recycling will allow nuisance algae to grow unabated – continuing the adverse impacts to water quality, fish/wildlife habitat and recreation. Overabundant algae growth will increase the rate of deposition of phosphorus on the lake bottom, increasing oxygen demand and promoting the release of more phosphorus in the summer. Conditions will be expected to worsen over time unless this cycle is broken.

- **Dredging** – This involves physically removing the phosphorus laden sediments with conventional or hydraulic dredging operations. Although dredging, if properly designed would likely accomplish the same goal as alum treatment, the cost of such a project is expected to be multiple orders of magnitude more expensive and permitting of such activities is uncertain. The disruption to the resource area and its flora and fauna would also be extensive.

- **Increase circulation and aeration** – Because the chemical mechanisms allowing phosphorus to be released from the sediment are dependent on low oxygen levels, increasing oxygen levels through improved circulation and/or aeration may also reduce internal recycling in Ticklenaked Pond. Improving circulation or aerating the water column would also be more difficult and expensive given the pond's relatively shallow depth. Systems to accomplish this are also expensive to install and operate. Any improvements from these methods are also temporary and go away once the systems were turned off.

- **Reduce Watershed Loading** – Reduction of watershed loading is an important part of the restoration and management plan for Ticklenaked Pond and improvements have already been made within the watershed. While some additional small improvements may still be evaluated, it has been determined that the reduction in internal phosphorus recycling from the bottom sediments is necessary to meet water quality criteria and goals.