SUMMARY REPORT OF THE HYDRAULIC CONVEYOR SYSTEM

TOMAHAWK LAKE ASSOCIATION
TOMAHAWK, WISCONSIN

March 16, 2009

330 South 4th Avenue
Park Falls, WI 54552
(715) 762-1544
(800) 498-3913
Fax (715) 762-1844
www.northernenvironmental.com

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March 16, 2009

Prepared For:

Tomahawk Lake Association
Mr. John Rybski
N7938 Highway D
Algoma, Wisconsin 54204

Prepared By:

Northern Environmental Technologies, Incorporated
330 South 4th Avenue
Park Falls, Wisconsin 54552

Project Number: 400-1067

Radley Z. Watkins
Project Scientist

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INTRODUCTION

The citizen non-profit group, Tomahawk Lake Association (TLA) that has taken responsibility for protecting native-plant diversity in Tomahawk Lake, Oneida County, Wisconsin applied for and was awarded a Wisconsin Department of Natural Resources (WDNR) Aquatic Invasive Species (AIS) Control Grant on February 1, 2008. The grant was to support a demonstration project to construct and operate a mechanical device designed to aid underwater divers in hand removing the invasive aquatic plant Eurasian watermilfoil (EWM). TLA called this system the Hydraulic Conveyor System (HCS).

The basic procedure for removing EWM with the hydraulic conveyor system entails a diver to descend on a targeted EWM plant with the conveyor intake in hand. The diver uses his/her fingers to dig out the root wad of the EWM, and then feeds the EWM roots and stalk into the intake. The plant is removed 100% by hand. Hydraulic suction transports the root wad and all other biomass to a catch basin located on a modified pontoon boat. The operators abroad the pontoon can then bag the EWM in the catch basin and dispose of it on land in a responsible manner.

Maintaining water clarity is a big problem when physically removing EWM. Substrate disturbance typically occurs during the hand removal process, and a trailing plume of suspended sediment is common when a diver swims to the surface to place the plants in a boat, or leaves the plants to sift around in a mesh diving "trash bag". Not only is this a problem because it creates turbid water, it often leaves many plant fragments floating about which can potentially lead to new EWM populations. When using the HCS, there is still the initial disturbance from a diver hand pulling a plant, but because the sediment is clinging to the root wad and the root wad is hydraulically transported to the surface in a hose, the water column stays clear and plant fragments are contained. Maintaining a clear water column provides for maximum visibility and allows a diver to work in the same location while remaining selective about the plants he/she removes by hand. The mechanical transport of the plant material to the catch basin also maximizes efficiency by allowing the diver to keep pulling plants without stopping to dispose of the pulled plants.

The hydraulic conveyor system demonstration field season lasted for 20 weeks in the summer of 2008. The hydraulic conveyor system was operated by a volunteer project manager and temporary employees of the lake association. The temporary employees worked from the second week in June to the second week in August. Northern Environmental Technologies, Incorporated (Northern Environmental) was hired as a third party monitor and to conduct an assessment of the HCS. Through this assessment of the HCS, Northern Environmental and TLA intend to allow lake managers to determine where this equipment may be best utilized.

METHODS

Mechanical Methods

Extending from the front of the pontoon boat itself there is a 20-foot long suction hose made of ribbed plastic, 8" in diameter (the hydraulic-siphon hose). At the end of the hose there is an intake with a handle and a water-surface facing flange (Figure 1). The surface facing flange is a design measure that insures that the suction tube cannot be placed in direct contact with the lake bottom substrate. There is no suction removal of non-suspended lake bottom substrate with the HCS. The HCS is not intended to be and dose not function as a dredge of any kind.

Figure 1. The upward facing flange (left) on the end of the HSC 8" diameter hose (right).

The hydraulic-siphon hose is attached to a pumping system that uses water under pressure and the venture effect to create suction. The Suction draws water and suspended plant material through the hose. The hose empties into a ten-foot by four-foot catch basin that stands just over three feet high (Figure 2). The catch basin is made out of a plastic-coated mesh, textile with pour spaces to allow water to drain from the catch basin, while retaining plant material. Modifications were made to the catch basin throughout the demonstration period so that water and sediment could pass more efficiently through the catch basin and efficient harvest could be maintained.

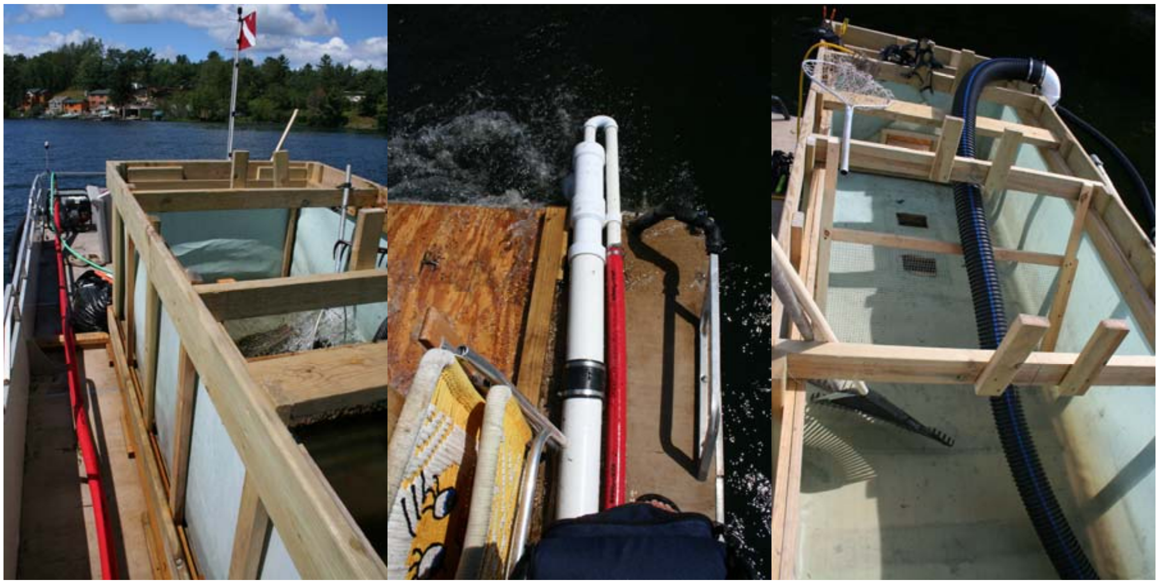

Figure 2. HCS pumps, hoses, and catch basin.

A hookah air-supply system that pumps surface air to a diver through a one-inch diameter hose is mounted on the pontoon boat's deck (Figure 3). The hose is attached to the dive's face-mask. A diving flag and text on the side of the boat warns boaters that divers are in the area (Figure 4).

Figure 3. HCS diver with the hookah air-supply system.

Figure 4. The modified pontoon boat that became known as the HCS.

Data Collection

Northern Environmental conducted a fall aquatic plant survey on Tomahawk Lake in September 2007 in accordance with existing WDNR pre and post-chemical treatment aquatic vegetation sampling protocol. This survey was conducted in EWM areas designated for the Hydraulic Conveyor System demonstration as well as areas to be treated with the chemical herbicide 2, 4-D. A similar survey was conducted in the fall of 2008 by Northern Environmental staff using the 2008 sampling WDNR protocol. During each survey, Northern Environmental staff moved a boat to a predetermined GPS location within designated polygons of EWM and threw a weighted-rakehead on a rope overboard. The rakehead was pulled back up and the presence of EWM was observed. A density was rating assigned to the EWM as a 1, 2, or 3 in accordance with the WDNR protocol.

An additional more refined pre and post-HCS plant survey was also conducted in two areas designated for the HCS demonstration. For these surveys the Northern Environmental Project Scientist threw a weighted-rakehead on a rope twenty times (as described above) based on a random number table and 360 degrees around the sampling boat. For this sampling all species present were noted along with their density. Samples with the twenty rake throws were collected before and after the HCS assisted hand pulling was conducted. The pre-HCS data were collected on May 11th, 2008 and the post-HCS data were collected on August 28th, 2008.

When the HCS crew arrived at a site they placed temporary fishing buoys in four corners of a work area to form a 20 by 20-foot plot (quadrant). The divers used a datasheet prepared for them by Northern Environmental (Appendix A). The datasheet contained a field for the area of use, quadrant, date, start time, water death, GPS location, bottom substrate, depth of loose bottom substrate, homogeneity of EWM in quadrant, average height of EWM from the lake bottom, average distance from the top of the EWM to the surface of the water, time to complete the quadrant, percent of quadrant completed in work day, unusual down time, and notes. Midway through the operating season the weight of daily biomass removed was added in the notes section of the datasheet. The divers collected this data while working on clearing a 20 by 20-foot quadrant.

The Northern Environmental staff project scientist visited the HCS eight (8) times when the system was in full operation. Photos and movie images were taken of the HCS in operation. A Secchi Disk was used to measure water clarity and suspended sediment. Official Secchi disks readings were not collected because the HCS was usually operating in water too shallow for meaningful measurements; that is water clarity extended too the bottom of the lake during HCS operation.

When on board the HCS-pontoon boat, the Project Scientist would monitor the by-catch of native plants as the divers would pull EWM. To monitor by-catch the Project Scientist placed a net into the stream that came from the hydraulic-siphon hose to the catch-basin on the boat. The net was held in place until sufficient plant material was fed through the system to partially fill the net. The plants were then identified by species and species-percent for each catch. Twenty (20) by-catch samples were taken during five (5) of the eight (8) HCS visits. The samples were taken on July 24th, July 31st, August 7th, August 12th, and August 14th, 2008.

Data Analysis

Northern Environmental compared the data collected for the 2007 and 2008 post-treatment surveys using the WDNR Pre and Post Treatment Computer worksheet for significant change determination. The worksheet is an MS Excel file that has equations built in for determining statistical significance. The significance of observed changes is determined by the Chi-square test. WDNR describes the worksheet as follows

> "We have set the alpha, or Type I error rate at 0.05. This means we have accepted a 5% chance of claiming there is significant change when no real change has occurred. This level is standard in ecological studies. If the test returns a significant result, we know that there is only a 5% probability the observed change is not a true change. We have set the beta, or Type II error rate at 0.80. This means there is an 80% chance of detecting a significant change if that change is really there. This corresponds to a 20% chance of NOT detecting significant changes, even though the change evaluated was indeed significant…In order for the chi-square distribution to be valid, the calculated expected values must not be too small. If you see the warning "Expected value too small", it means there is not enough information to confidently make a statistical conclusion."

Northern Environmental compared the data of the more refined pre and post-HCS survey using the same WDNR spreadsheet for averages of the 20 rake throws. The density collected during the 20 rake throws was averaged and the change (+ or -) was observed.

Data collected by the divers were used to determine the average time it took the divers to clear a 20 by 20-foot quadrant. The data were used to total the area of EWM removed during recorded HCS operation period. Weight of biomass removed was totaled to give an average weight of biomass removed, although this data was not collected for the total HCS operation period.

The by-catch data were tallied by species for the 20 samples collected and averaged over the five (5) sampling visits. The product of the averaging was rounded to the nearest whole number and is reported in Table 4.

RESULTS

There were two areas where the HCS was used for the demonstration project. The data collected in the fall 2008 post-treatment survey was used to compare to that of 2007 post-treatment survey and polygons 1 and 3 cover the two areas where data were collected. When using the WDNR protocol for the post-treatment sampling, Northern Environmental detected an increase in EWM in polygon 1 (Lake Tomahawk Town boat landing) and a decrease of EWM in polygon 3 (Windy Point's Eastside Bay), with no significant change in density (based on a score of 1, 2, or 3 for rake fullness). Neither change was statistically significant based on the data. Table 1 contains changes based on recorded data within polygons between 2007 and 2008.

Table 1. Changes in EWM areas where the HCS was used.

POLYGON	**1**	**3**
Total points 2007	4	7
Points with EWM 2007	3	7
% EWM 2007 in polygon	75.00%	100.00%
Average density 2007	1.00	1.00
Total points 2008	9	14
Points with EWM 2008	9	11
% EWM 2008 in polygon	100.00%	78.57%
Avg. Density 2008	1.00	1.18
% Change (coverage)	33.33%	-21.43%
% Change (D)	0.00%	18.18%
+, -, or SAME	+	-
Significant (.05)	**NO**	**NO**

When using a Chi-square test with a type-1 error rate (P-value) of 0.05 for evaluating the statistical significance of EWM coverage (area with EWM) between the years (2007 and 2008), the change in either polygon is not statistically significant. This statistical significance means that there is a 5% (0.05) chance of claiming there is significant change when no real change has occurred. The P-value of 0.05 is a standard measure of ecological studies and is used in the

WDNR aquatic plant analysis worksheets. Neither polygon contained enough sample points to confidently make a statistical conclusion. This is due to the small size of the polygon limiting the number of sample points (20 points are required for WDNR statistic worksheet to calculate significance). Ironically, the polygon that physically had the greatest reduction in EWM removed by the hydraulic conveyor (this was visually obvious) showed an increase in EWM. This illustrates the potential problem assessing any environmental parameter based on one particular sampling technique. It only takes one EWM plant left in a quadrant to fill a rakehead. That means that an almost monolithic EWM population could be cleared by the HCS and still have one missed EWM plant detected by a dragged rakehead, thus skewing the data to make it appear the quadrant has substantial EWM present.

For the refined pre and post-HCS plant survey the results differed for the two polygons, 1 and 3. Polygon 1 had thirteen (13) plant species detected during the pre and post-HCS sampling and had a reduction in EWM, which was non-statistically significant. Two native species, stiff water crowfoot (*Ranunculus longirostris*) and water moss (*Fontinalis antipyretica*), also showed a non-statistically significant decrease in polygon 1. Dwarf watermilfoil (*Myriophyllum tenellum*), fern-leaf pondweed (*Potamogeton robbinsii*), variable pondweed (*Potamogeton gramineus*), and wild celery (*Vallisneria americana*) all exhibited a significant increase observed during the post-HCS plant survey in Polygon 1 (Table 2). In Polygon 2 there were five (5) plant species detected during the pre and post-HCS plant surveys. The only species that increased was EWM and the change was significant. No other plant had a statistically significant change (Table 3).

The HCS crew recorded data starting on July 15th and only for polygon 1 (Lake Tomahawk Town boat landing site). Between July 15th and August 15th, 0.55 acres or 24,000 square feet (sixty 20 by 20-square foot quadrants) were cleared of EWM using the HCS. The average time to clear a 20 by 20-foot quadrant was 95.5 minutes over 22 days of operation. The total recorded biomass removed was 3820 pounds when drained of water. The biomass was not broken down by species.

The by-catch data recorded by Northern Environmental during visits to the HCS showed an average of 84% of the plant mass removed was EWM (Figure 5). Secchi Disk results were not recorded because much of the time the HCS was in operation the water was too shallow for a reading and water clarity extended to the bottom of the lake in that depth. The Secchi Disk was still used as a guide to water clarity (see example image in Figure 6), but only used to see if outflow created a sediment plume which could be perceived as a problem.

Figure 5. Typical by-catch for operation of HCS while targeting EWM (upper left).

Figure 6. Secchi Disk reading off bow of HCS while in operation.

Table 2. Polygon 1 pre and post-HCS results with significance of increase or decrease.

Polygon 1	**Pre-treatment survey total points**	**20**				
Lake Tomahawk Town Boat Landing	**Post-treatment survey total points**	**20**				
						Increase/Decrease
Common Species Name	**Scientific Name**	**PRE present**	**POST present**	**p**	**Significant change**	**(proportional to # sampling points)**
Elodea	*Elodea canadensis*	13	18	0.058330474	n.s.	+
Clasping-leaf pondweed	*Potamogeton richardsonii*	0	1	0.311184919	n.s.	+
Coontail	*Ceratophyllum demersum*	12	16	0.167546334	n.s.	+
Dwarf watermilfoil	*Myriophyllum tenellum*	0	7	0.003581164	**	+
Eurasian watermilfoil	***Myriophyllum spicatum***	**17**	**16**	**0.677318399**	**n.s.**	**-**
Fern-leaf pondweed	*Potamogeton robbinsii*	0	14	3.46803E-06	***	+
Flat-stem pondweed	*Potamogeton zosteriformis*	0	1	0.311184919	n.s.	+
Najas Spp.	*Najas flexilis*	1	3	0.29184077	n.s.	+
Northern watermilfoil	*Myriophyllum exalbescens*	14	8	0.056530285	n.s.	-
Stiff water crowfoot	*Ranunculus longirostris*	1	0	0.311184919	n.s.	-
Variable pondweed	*Potamogeton gramineus*	2	14	0.000107511	***	+
Water moss	*Fontinalis antipyretica*	1	0	0.311184919	n.s.	-
Wild Celery	*Vallisneria americana*	0	16	2.41756E-07	***	+

Table 3. Polygon 3 pre and post-HCS results with significance of increase or decrease.

Polygon 3	**Pre-treatment survey total points**	**20**				
Windy Point's Eastside Bay	**Post-treatment survey total points**	**20**				
						Increase/Decrease
Common Species Name	**Scientific Name**	**PRE present**	**POST present**	**p**	**Significant change**	**(proportional to # sampling points)**
Elodea	*Elodea canadensis*	12	16	0.167546334	n.s.	+
Coontail	*Ceratophyllum demersum*	11	15	1.85E-01	n.s.	+
Eurasian watermilfoil	***Myriophyllum spicatum***	**5**	**20**	**9.63357E-07**	*******	**+**
Fern-leaf pondweed	*Potamogeton robbinsii*	15	16	0.704954306	n.s.	+
Stiff water crowfoot	*Ranunculus longirostris*	1	0	0.311184919	n.s.	-

Table 4. EWM and by-catch by species from net-grab samples during HCS use.

Aquatic Plant Species	Spp Apreviation	Percent Catch Rounded (to the nearest whole number)
Crowsfoot	CF	1
Clasping-leaf Pondweed	CLPW	1
Coontail	CT	2
Elodea	El	1
Eurasian Watermilfoil	**EWM**	**84**
Fern Pondweed	FPW	2
Flat-stem Pondweed	FSPW	1
Large-leaf Pondweed	LLPW	0
Northern Water Milfoil	NWM	2
Ribbon-leaf Pondweed	RLPW	1
Slender Naiad	SN	0
Variable Pondweed	VPW	2
Wild Celery	WC	4
Total Plants		**100**

DISCUSSION

The Hydraulic Conveyor System operated under an approved WDNR mechanical harvesting permit was a work in progress throughout the summer of 2008. All modifications to the HCS were done by the divers and the project manager/engineer, collectively referred to as the crew. One factor that lead to the adaptive practices of the HCS was the late ice-out on Tomahawk Lake; occurring somewhere around May 15th. When operators began work in early June of 2008, EWM was barley visible from the deck of a boat and the divers reported difficulties finding enough EWM to remove for the demonstration project. However, by the middle of July this was no longer a problem and EWM began to tower in many of the operating locations.

As the crew began work and were refining their methods, Northern Environmental staff was working to tailor a protocol that was realistic and accurate in capturing the data WDNR and other were interested in. By the time all parties felt they had a protocol and data form that would work in the field a good portion of Polygon 3, Windy Point's Eastside Bay, was cleared. The crew reported to Northern Environmental staff the bay became difficult to work in because the water was getting too deep (10-12 feet) to be working on large monotypical stands. Unfortunately the crew did not get to the location in Polygon 3 where Northern Environmental staff conducted the pre-HCS aquatic plant survey. Therefore, this survey is better seen as a control area, and not as a pre and post-HCS test plot.

When the HCS project was being designed and effects of operation discussed with WDNR staff, suspended sediment in the outflow from the catch basin was brought up as a concern. The designer of the HCS and Northern Environmental staff meet with Dr. Susan Knight to discuss what pour size would be appropriate for containing EWM fragments in the catch basin, and capturing sediment while still allowing water to pass. Dr. Knight brought several sieves with a range of pour spaces. It became evident pours small enough to contain sediment would quickly become clogged and blocked water as well. While meeting with Dr. Knight the HCS designers decided that was to use a pour size that let water through and monitor how long any sediment stayed suspended. Using the sieves as a model, it appeared that disturbed sediment settled quickly and did not present an environmental risk.

The catch basin on the HCS was made of a poly-coated fabric screen used for draining paper pulp. It seemed to work well for containing all EWM fragments and sediment that was captured from the water column near the root wad of the plant removed (Figure 7). Sediment would, however, build up in the catch basin and not allow water to drain. This condition allowed water to fill up the catch basin and make the boat top heavy. When this situation occurred, all operations were halted and both divers cleaned the catch basin.

Figure 7. Sediment that was caught in the HCS catch basin.

For most of the operating season management of the catch basin was a major part of the operation. The crew sprayed the screen with a high pressure water hose to blast the sediment through the screening. This technique worked, but was very time consuming. The crew then cut a drainage hole in the base of the catch basin and modified a larger screen with approximately quarter inch pour spaces to contain EWM fragments. This let water drain much faster.

The crew members added several of these screened openings, including one off the front of the catch basin (Figure 8). Eventually they moved to a primary containment system that caught most of the EWM before it entered the catch basin (Figure 8) and they removed and bagged the EWM from this smaller area. Sometimes the crew had a fishing net at the end of the suction hose and used the net as a pre-primary containment system (Figure 9). This allowed for easy transportation of the EWM to the garbage bag. Even with these modifications the crew had to constantly maintain the opening using the high pressure hose (Figure 10) which kept clean water moving through the system.

Figure 8. Screened holes added to the HCS catch basin looking from the primary containment area.

Figure 9. HCS crew collecting and bagging EWM from the primary containment area.

Figure 10. HCS crew hosing of the screen of the primary containment area.

For the most part water flowing out of the HCS was very clear and carried relatively little sediment (Figure 11). Depending on how much of the root wad was removed along with the EWM plant there were pulses of water with a high degree of sediment moving through the system. The degree to which sediment was disturbed depended somewhat on the very localized type of lake bottom substrate in which the divers were working. If divers were in thick muck and the roots held a lot of bottom substrate, sediment would occasionally move through the system and cause a plume. When present the sediment plume settled quickly (less than five minutes) and the suspended sediment did not compare to the plume created by the diver's feet as seen in Figure 3.

Figure 11. Relatively clean water flowing through (left and middle) and off (right) the HCS.

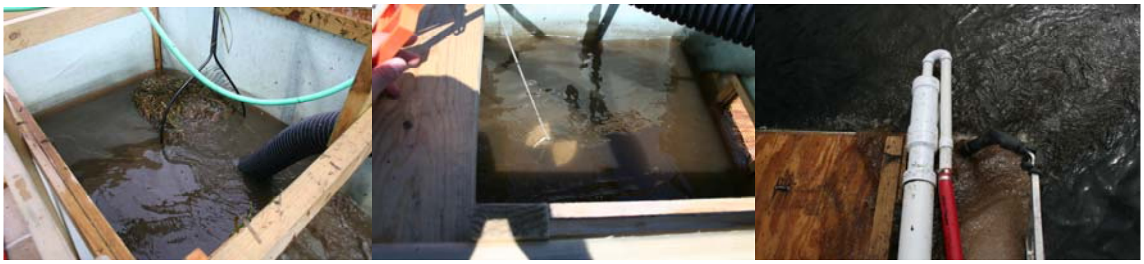

Figure 12. Water with a relatively high sediment load flowing through and off the HCS.

The HCS crew was paid $20 per hour, an entry hourly wage for professional divers. Using the 60 quadrants cleared over 22 days, or 0.55 acres, with a total operation time of 5730 minutes or 95.5 hours total, the cost for the crew alone was $3,820.00 to clear EWM in that area. This cost does not account for operation costs such as gas, insurance, up-front material investments, and daily mobilization time. Average EWM chemical treatment cost in Wisconsin for chemical supplies, labor and mobilization is about $500.00 per acre. Using this comparison the HCS could be too costly for practical use in most situations. It must be noted, however, that with the additional modification to the HCS the operation became more efficient over the course of the operating season. It was not until the last few weeks that the HCS was operating at peak performance conditions.

The Tomahawk Lake Association (TLA) realizes that the HCS is not the answer to remove all EWM from a lake that has substantial beds of EWM. The lake group never intended the HCS to be used in this manner, but participated in the demonstration project in order to assess the capabilities of the HCS and the associated environmental effects. In the future TLA would like to use the HCS in areas difficult to access with traditional chemical application systems, such as under large permanent docks (e.g. those at Lakeside Landing), in areas where chemical treatment is not appropriate (sensitive areas with small infestations), or in removing pioneering (new) infestations discovered after chemical treatment has occurred. The HCS could also be used to remove EWM that persists after chemical treatment. Such post-treatment removal may address the problem of EWM evolving and becoming resilient to chemical treatment: a concern for many managers and chemical applicators.

In his letter written in March of 2009 (Appendix B) describing the 2008 demonstration season, Mr. Ned Greedy, TLA Hydraulic Conveyor System Project Manager/Engineer, stated "The question will always be, can the H.C. be effective in halting the growth of new infestations, or the expansion of established isolated infestations and at what cost? The answer is that it can be, provided that the conditions of operation are efficient, and the measurement of that efficiency is based upon what were the original goals for the harvest. If the goals are to simply maximize the total acreage, or to minimize the dollars per acre cost, the H.C. will be seen as an inefficient. If the goals are to remove pioneer stands from around high traffic docks, to keep the area from becoming highly infested, or to remove pioneer plants from the backs of non-infested bays to halt EWM spread before it gets started there, the H.C. system may well be the only means of control." Mr. Greedy's statement expresses the potential for using the HCS in a way chemicals cannot be used. It is in these circumstances that the HCS may prove it true potential.

ACKNOWLEDGEMENTS

There are several people that need to be acknowledged for their work on the HCS project. The Wisconsin Department of Natural Resources and particularly the Lake Management Coordinator, Mr. Kevin Gauthier, have been generous in supporting the project with an AIS Demonstration Grant and management advice. Mr. Jon and Ms. Julia Wicke, owners of Minocqua Rental and Hardware, aided the project by providing mechanical supplies at cost. Jon Wicke provided a great deal of voluntary technical advice in the mechanical design. Several TLA members were involved with the pilot project and initial design of the HCS. Most of all, TLA member Mr. Ned Greedy should be recognized for the tremendous amount of volunteer time and technical knowledge he contributed to the project. Ned is a licensed captain and an extremely capable builder/engineer. Ned worked on the HCS as if it were a full time job even though he already had full time employment. Ned's contributions to the HCS and time away from personal activities made the HCS project the success it was. The HCS demonstration project would not have happened without Ned.

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APPENDIX A

HYDRAULIC CONVEYOR CREW DATASHEET

Northern Environmental℠
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Area #______ Quadrant #________

Hydraulic Conveyor System Data Sheet 2008

Date_________________ Start time on quadrant __________________am / pm

Water depth at quadrant center ________________________ft

GPS of quadrant at center ____

Bottom substrate type MUCK SAND SAND/GRAVEL GRAVEL/COBBLES
(circle one)

Depth of loose bottom substrate 0" 1-3" 4"-6" Greater than 6"
(circle one)

Homogeneity of EWM in quadrant 0-25% 25-50% 50-75% 75-100%
(circle one)

Density of EWM in quadrant by area 0-33% 33-66% 67-100%
(circle one)

Average height of EWM from the lake bottom ____________ ft

Average distance from the top of the EWM to the surface of the water ________ft

Time of quadrant completion or time at end of the day ______________am / pm

Percent quadrant complete ______________%

If additional days are needed to complete quadrant, time and date of quadrant start up on day two (resume time) should be noted below

Day two (2) date___________ Resume time on quadrant _________am / pm

Time of quadrant completion or time at end of the day ______________am / pm

Unusual down time ________ am / pm to _______ am / pm

Unusual down time ________ am / pm to _______ am / pm

Notes: ____
____
____
____
____
____

APPENDIX B

MR. NED GREEDY’S PROJECT SUMMARY LETTER

In the Fall of 2007, when the Board of Directors of the TLPOA initially considered the subject of the Hydraulic Conveyor, and it' potential as a tool in the fight against EWM, John Rybski asked for input from those individuals that had participated in a one day concept test during the month of July in 2007. The four people involved provided that feed back, and each person brought a unique perspective to the table. In my opinion letter I outlined what I believed would be the limiting factors in the H.C.'s potential, and what would be required to have the system be effective as a means of controlling EWM. As a result of the input that John received, we embarked on what was to become the Hydraulic Conveyor Study Project which was run in the summer of 2008.

With the invaluable assistance and funding support of the Wisconsin Department of Natural Resources, we constructed the system, trained operating personal, began and proceeded to harvest EWM, while at all times making changes in both the physical system and harvesting methodology to optimize it's potential. In the end, we learned a great deal about the systems potential, and where and how it should be used. The things that we learned came at a cost. We were not an efficient operation for the great majority of the time. For all intents and purposes, the entire harvesting season was an experimental laboratory, where we learned what worked and what didn't. We came up against variables the effected our progress that we hadn't anticipated, and we worked our way through them. In actuality we were operating at a fairly efficient level by the end of the study period, but I am sure that the future will hold more surprises that we will have to deal with.

Some conclusions that I have drawn from the study are

1. When configured correctly, the system can remove EWM efficiently, virtually without fragmentation and reseeding in areas <u>where it designed to work.</u>

2. If measured on a cost per acre basis, the system will never compete on a dollar per acre basis with chemical treatment because it is still a hand pulling method. It is a "targeted" methodology in that unlike Chemical treatment, it removes just those plants that the diver makes the decision to remove. In a high infestation area, the length of time required to remove each plant manually will not be efficient relative to chemical treatment. There are just too many plants to be harvested by a hand operation.

3. In specific areas, the H.C. may be the only key to halting and/or reducing the spread of EWM:

    A. In areas of low density pioneering stands where chemical control is not feasible, but new stands can be kept from becoming established. Back bays, remote sand bottom shorelines are examples of these.

B. In high boat traffic areas where constant passes of boat motor propellers through a relatively small area continually fragment and reseed EWM. These areas include but most certainly are not limited to boat docks, boat launch sites, shore side restaurants, boat thoroughfares and bridges.

c. Areas where pioneering stands have been discovered that are not adjacent to typical preferred infestation sites. An example might be a sunken island surrounded by deeper open water.

The question will always be can the H.C. be effective in halting the growth of new infestations, or the expansion of established isolated infestations and at what cost? The answer is that it can be, provided that the conditions of operation are efficient, and the measurement of that efficiency is based upon what were the original goals for the harvest. If the goals are to simply maximize the total acreage, or to minimize the dollars per acre cost, the H.C. will be seen as inefficient. If the goals are to remove pioneer stands from around high traffic docks, to keep the area from becoming highly infested, or to remove pioneer plants from the backs of non-infested bays to halt EWM spread before it gets started there, the H.C. system may well be the only means of control.

One last concern that was noted in my response to John Rybski is "How much of the EWM removed this year will return next year?" The answer awaits us this coming spring. One thing was true at that time, and is certainly true now. Even if harvested areas begin to grow again next year, the amount of adjacent areas which would have been "reseeded" by natural and unnatural means will be reduced. In and of itself, that will have a positive effect on the health of our lake, and should be considered when decisions are made about operating the H.C. in the future.

Ned Greedy
Hydraulic Conveyor System Project Manager

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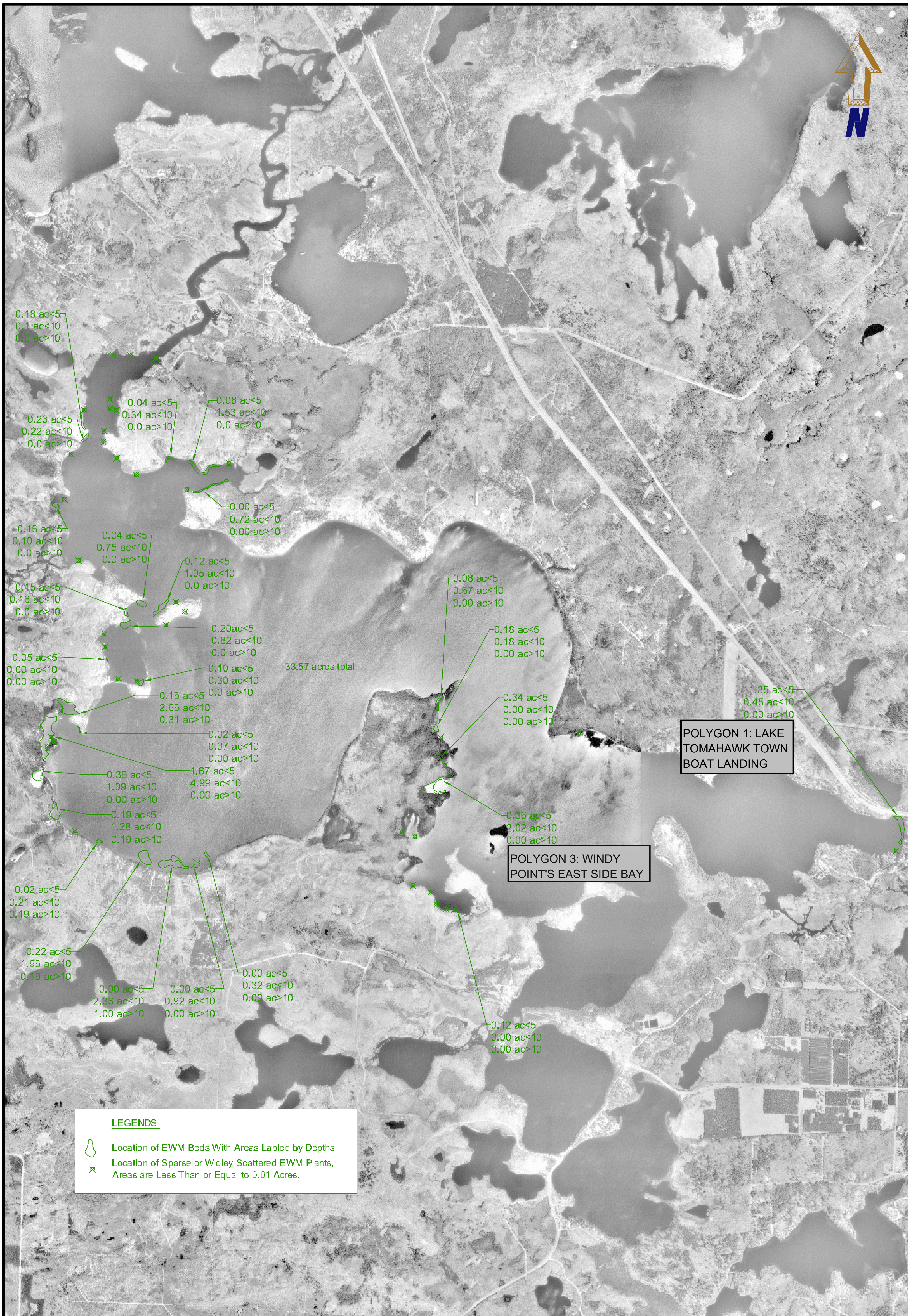
APPENDIX C

FALL 2007 EWM SURVEY



Northern Environmental

Hydrologists • Engineers • Surveyors • Scientists

1203 Storbeck Drive, Waupun, Wisconsin 53963
Phone: 800-498-3921 Fax: 920-324-3023

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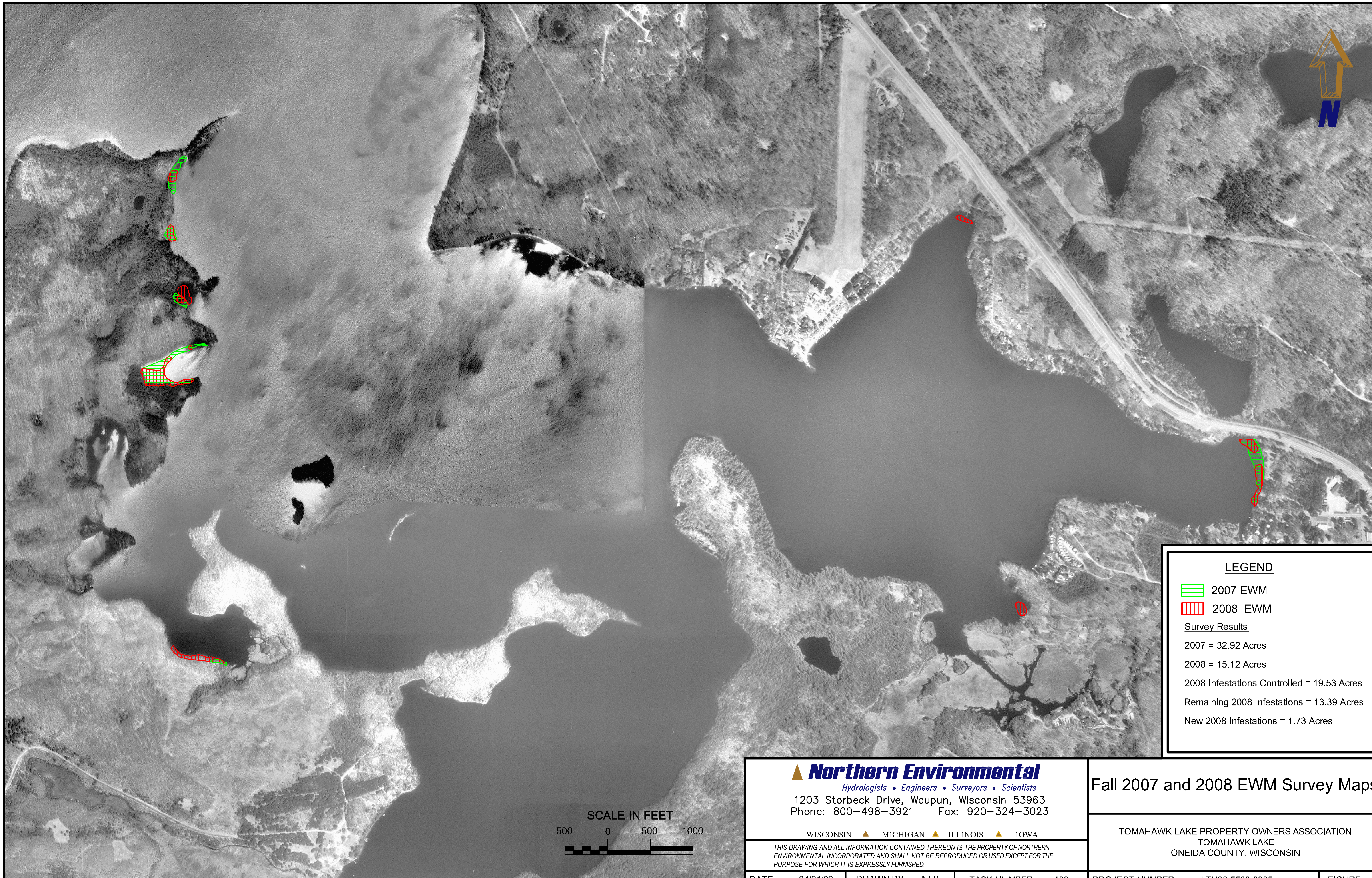
Fall 2007 EWM Survey

TOMAHAWK LAKE PROPERTY OWNERS ASSOCIATION
TOMAHAWK LAKE
ONEIDA COUNTY, WISCONSIN

DATE:	10/01/07	DRAWN BY:	DDP	TASK NUMBER:	100	PROJECT NUMBER:	LTH08-5500-0877	FIGURE	7



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Hydrologists • Engineers • Surveyors • Scientists
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Fall 2007 and 2008 EWM Survey Maps

TOMAHAWK LAKE PROPERTY OWNERS ASSOCIATION
TOMAHAWK LAKE
ONEIDA COUNTY, WISCONSIN

DATE: 04/21/09	DRAWN BY: NLB	TASK NUMBER: 100	PROJECT NUMBER: LTH08-5500-0905	FIGURE 4