Wilke Lake Aquatic Plant Management Plan

Prepared for:
The Town of Schleswig Sanitary District #2

Prepared by:
Stantec Consulting Services Inc.

May 29, 2015

Sign-off Sheet

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Executive Summary

The Town of Schleswig Sanitary District #2 (District) was formed in 1980 to address resource management concerns on Wilke Lake. The Committee has been active in a number of lake management activities on Wilke Lake including: aquatic plant management, purchasing of two harvesters, water quality sampling, invasive species sampling and community education activities. The District contracted Stantec Consulting Services Inc. (Stantec) to help develop an aquatic plant management (APM) plan for Wilke Lake. The current plan was created and approved in 2010 with recommendations for aquatic plant management to focus on mechanical harvesting. This practice has been used within Wilke Lake, having been in place since the 1980s and currently permitted for 52 acres within the lake.

Harvesting permits can be issued for 5-year periods and the current permit expired after the 2014 season and was based on data collected in 2009. Continuation of harvesting to help alleviate aquatic plant issues is desired by the District and Lake Association. In order to obtain a new mechanical harvesting permit, updated aquatic plant surveys were requested to form an updated aquatic plant management (APM) plan to reflect current conditions.

The updated APM is consistent with the goals and objectives of the District and lake users, to reduce invasive aquatic plants to a non-nuisance level in the lake (less than 33% coverage), while preserving recreation, habitat and water quality. The draft APM was presented by the District at an established education and outreach program (Memorial Day and Labor Day Lake Association Meetings) meeting on August 31, 2014 and May 24, 2015, as well, and was approved by the District at a public meeting.

1.0 LAKE INFORMATION

Name:	**Wilke**	Surface Area:	**95 acres**
County:	**Manitowoc**	Littoral Area:	**88 acres**
WBIC:	**58000**	Max Depth:	**21 feet**
		Median Depth:	**9 feet**

2.0 WATER QUALITY, PLANT COMMUNITY & PLANT MANAGEMENT HISTORY

2.1 WATER QUALITY

Table 1 Water quality measures observed in Wilke Lake

Water Quality Measures	Averages *(April-Sept)*	Observations	Monitored Years
Total Phosphorus [µg per L]	20.38 ppb	12	1988, 1994, 2003, 2012-2014
Chlorophyll-a µg per L]	7.28 ppb	11	1988, 1994, 2003, 2012-2014
Secchi Depth [Feet]	5.89 feet	22	1988, 1994, 2003-2004, 2009, 2012-2014

As a seepage lake, Wilke Lake's main source of water is precipitation or runoff, supplemented by groundwater from the immediate drainage area. Meaning, land use within the watershed directly affects the water quality of the lake. Different land use practices cause varying nutrient runoff. Largely vegetated land, such as forests, slows runoff and uptakes nutrients more than land with sparse vegetation or more intensely managed, such as land with high amounts of impervious surfaces (industrial/commercial) or lands with active agricultural that are regularly tilled or plowed.

Total size of the lake's watershed relative to its own size also plays an important role in water quality. The larger a lake's watershed to surface area ratio, the greater an impact the watershed has on water quality of the lake as more nutrient runoff can be input.

Wilke Lake's watershed is 595 acres with primarily agricultural land use. This gives a watershed to lake ratio of 6.3:1, which is relatively high. This means that Wilke Lake's watershed can have a large impact to water quality. However, even with this in mind, the water quality and trophic status within Wilke Lake has remained stable over recent periods.

A lake's trophic status index (TSI) relates to its productivity based on available nutrients within the water as measured by total phosphorus – the main nutrient for plant growth, chlorophyll *a* – planktonic algae within the water, and secchi – water clarity. As one parameter becomes affected, the other two typically follow suit, for example; as nutrients increase, the amount of planktonic algae increase due to more available food source, as the algae increases, the ability for light to penetrate the water decreases, which leads to lower secchi readings with all of these instances leading to increased TSI and decreased water quality.

TSI values range from 20-80+ and are divided into four segments below. The TSI for Wilke Lake is 50.99 – just barely eutrophic – driven above this threshold by secchi readings. However, chlorophyll-*a* and total phosphorus are mesotrophic, indicating good water quality for the lake with regard to its watershed. It is likely that the dense aquatic vegetation within the lake is up taking enough nutrients to help limit potential algal blooms.

Table 2: Trophic State Index, Wilke Lake, Manitowoc County, WI.

Category	TSI	Lake Characteristics	Total P (ug/l)	Chlorophyll a *(ug/l)*	Water Clarity *(feet)*
Oligotrophic	1-40	Clear water; oxygen rich at all depths, except if close to mesotrophic border; then may have low or no oxygen; cold-water fish likely in deeper lakes.	< 12	<2.6	>13
Mesotrophic	41-50	Moderately clear; increasing probability of low to no oxygen in bottom waters.	12 to 24	2.6 to 7.3	13 to 6.5
Eutrophic	51-70	Decreased water clarity; probably no oxygen in bottom waters during summer; warm-water fisheries only; blue-green algae likely in summer in upper range; plants also excessive.	24 to 96	7.3 to 56	6.5 to 1.6
Hyper-eutrophic	>70	Minimal water clarit; no oxygen in bottom water layers; excessive vegetation and and alagal mats	>96	>56	<1.6
Wilke Lake	**50.99**	**Eutrophic**	**20.38**	**7.28**	**5.89**

2.2 PLANT COMMUNITY

Aquatic plants are vital to the health of a water body. Unfortunately, they are often negatively referred to as "weeds". The misconceptions this type of attitude brings must be overcome in order to properly manage a lake ecosystem. Rooted aquatic plants are extremely important for the well-being of a lake community and possess many positive attributes. Despite their importance, they sometimes grow to nuisance levels that hamper recreational activities and are common in degraded ecosystems. The introduction of aquatic invasive species (AIS), such as Eurasian water-milfoil (EWM), often can increase nuisance conditions, particularly when they successfully out-compete native vegetation and occupy large portions of a lake.

To assess the state of the current plant communities, a full point-intercept survey was completed by Stantec on Wilke Lake. The survey followed all WDNR Point Intercept (PI) survey protocol and included sampling pre-determined locations to document the following at each site:

- Individual species present and their density
- Water depth
- Bottom substrate

Each location was assigned coordinates and loaded into a GPS unit, which was used to navigate to each point. Data collected at each point was then entered into a Wisconsin DNR (WDNR) spreadsheet, which outputs various aquatic plant community indexes and data, allowing for a comparison to past data to monitor changes over time. Information on methods and all referenced tables, figures or charts is included in Appendix A - C.

Past management plans for Wilke Lake also included aquatic plant surveys, providing historical background to document potential changes in the communities over time. Surveys were completed in 1992, 2003, and most recently in 2009 for the current management plan. Both the 1992 and 2003 sets of surveys were completed as line-transects surveys. These surveys focused on near-shore areas in limited locations throughout the lake.

Recently to help better and more consistently document aquatic communities, the WDNR adopted the point-intercept survey method above. This method allows for repetition of past surveys by reusing pre-established sample locations. Both recent surveys between the 2009 and

2014 surveys used the same methodology and points allowing for direct data comparisons over that 5 year period.

To compare changes in the plant community over time within Wilke Lake and to similar lakes in Wisconsin, the FQI can be used. FQI provides the ability to compare aquatic plant communities based on species presence. This value varies throughout Wisconsin, ranging from 3.0 to 44.6 with a statewide average of 22.2. To achieve this, each plant species, except for AIS, is assigned a coefficient of conservatism value (C values). A plant's C value relates to a plant species' ability to tolerate disturbance. Low C values (0-3) indicate that a species is very tolerant of disturbance, while high C values (7-10) indicate species with a low tolerance of disturbance. Intermediate C values (4-6) indicate plant species that can tolerate moderate disturbance.

Not only does this track changes over time within Wilke Lake, but allows for comparison of the Lake to lakes with similar environmental conditions within a delineated area, called an eco-region, to be compared.

Wilke Lake is located in the southern portion of the Southeastern Till Plains eco-region. Lakes within the Southeastern Till Plains are typically natural lakes that, due to higher population density in this area of the State, have developed shoreline. Increased development around the lake and overall use of these lakes leads to more disturbance form an expected natural condition, which can lead to lower plant community metrics like FQI and coefficient of conservatism.

2014 Point Intercept Survey:

The aquatic plant community of the lake was surveyed by Stantec on July 8, 2014. Sampling followed protocol according to the point intercept sampling method described by Madsen (1999) and as outlined in the Wisconsin DNR draft guidance entitled "Aquatic Plant Management in Wisconsin" (WDNR, 2005). This survey repeated the same sample points as completed in the last APM plan as surveyed on June 11, 2009.

Sample locations were created by the WDNR prior to field deployment by overlaying a 40 meter spaced grid over the lake. In total, 235 locations were sampled during the survey. The point intercept method was used to evaluate the existing emergent, submergent, floating-leaf and free-floating aquatic plants. If a species was not collected at a specific point, the space on the datasheet was left blank.

Typically, full point intercept surveys are completed in mid-late summer to capture the native plant community at its peak. However, this often misses the AIS curly-leaf pondweed (CLP), which has typically died back by then. To assure capture of actively growing CLP prior to natural die-off, the 2014 survey was carried out in early July. Being a fairly small, shallow lake the aquatic plant community of Wilke Lake is typically near mid-summer biomass peak earlier than most lakes, allowing for an early survey to capture native plants along with presence of CLP. The aquatic macrophyte community of Wilke Lake included 14 submerged, emergent, and free-floating aquatic vascular plant species and filamentous algae in the past (2009 survey).

In 2014, the aquatic plant survey identified a moderately diverse community in Wilke Lake. Total species identified was 14 (Table 3) with two AIS present: Eurasian water-milfoil (*Myriophyllum spicatum* – EWM) and curly-leaf pondweed (*Potamogeton crispus* – CLP). Species sampled in the Lake were present in three categories: emergent, near shore species which are rooted below the water's surface, but their growth extends above the water (arrowhead- *Sagittaria sp.*), submersed species which root on the lake bottom and remain below the water's surface (coontail – Ceratophyllum demersum), and floating-leaf species which root on the lake bottom with vegetation growing to and floating on the surface (white water lily – Nymphaea odorata).

The photic zone was similar to past surveys, with plant growth noted to 14 feet. Native species richness exhibited good diversity per sample point and with a moderately good spread throughout the system, as exhibited by a Simpson Diversity Index (SDI) of 0.80. A SDI value closer to 1.0 indicates a healthier, more evenly spread plant community (Table 4).

Plants were found growing to a maximum depth of 14 feet, with 180 of the 235 locations shallower than this and 82.6% of locations within the photic zone vegetated (Table 4). Muskgrass (*Chara sp.*), a macro-algae, was the most dominant species sampled in 2014, found at 61.1% of photic-zone locations. This species prefers sandy areas, often times creating a carpet in shallow locations. Much of Wilke Lake provides excellent habitat for muskgrass. Variable pondweed (*Potamogeton gramineus*) and slender naiad (Najas flexilis), both valuable for near-shore sediment stabilization and important food sources for waterfowl with variable pondweed providing excellent habitat for all life cycles of fish, were the next most common native species sampled and third and fourth most common overall (Table 5).

Two AIS were found; Eurasian water-milfoil (EWM) and curly-leaf pondweed (CLP). Both species have been present within the lake since 1993. EWM can grow rapidly and dense, reaching the surface and forming a canopy that shades out native species and hampers recreational use and spreads through fragmentation. Mechanical harvesting cuts growing plants and can potentially provide mechanism for EWM to spread throughout a system if all cut portions are not removed from the water. Even with an intensive harvesting program in place on Wilke Lake, EWM growth does not appear to have increased by harvesting or negatively impacting the native plant community. If this were to change or shift drastically, then re-evaluation of harvesting may need to be reconsidered in favor of another option, like chemical treatments or harvesting in combination with chemical treatments.

Though present, CLP growth on Wilke Lake has not been dense since first being documented. CLP relies on turions, seed-like vegetative structures, to reproduce. With an active early season harvesting program in place, turions are removed by the harvesting, limiting the reproductive potential of plants present. Combined with a moderately diverse plant community, which increases competition, the CLP population within Wilke Lake has simply become a part of the community, blending into the background and not requiring active, directed management.

The floristic quality index (FQI) for Wilke Lake has varied over time, from a low of 15.5 in 1992 to a high of 20.52 in 2003. Variation is not uncommon as a plant communities composition widely varies year to year based on numerous ecological and climatic conditions. In 2014, FQI was 20.2, relatively high for Wilke Lake's history and indicative of a moderate quality plant community. More important, however, are the individual species that make up that community. This is measured by average coefficient of conservatism (C). Each plant species is assigned a C value, which relates to its tolerance for disturbance. A higher average C for a community indicates one that is comprised of high-value plant species. The average C for Wilke Lake in 2014 was relative high at 6.09 (Table 6).

Use of FQI and average C can also be extrapolated out to lakes in similar eco-regions of Wisconsin to compare communities. Wilke Lake is within the Southeastern Till Plains eco-region and lakes here are typically more developed with higher recreational use. This impacts the plant communities and is shown by lakes in this eco-region typically having FQI and average C values below those found throughout the State. However, Wilke Lake has an elevated C value, due to the diverse community, which exceeds the upper quartile for all lakes in the eco-region while also comparing favorably to the mean C for the entire State. In conjunction, Wilke Lake's FQI is in line with the mean for the Southeastern Till Plains, indicating a very healthy community comparative that to an undisturbed, natural condition (Table 7).

2.3 AQUATIC PLANT MANAGEMENT HISTORY

The District has completed several management activities on Wilke Lake, including multiple lake management plans, actively managing AIS and harvesting nuisance aquatic plants. Management of aquatic plans in Wilke Lake began in the 1960s with a focus on chemical applications with a shift to occasional harvesting in the late 60s. By the 1970s, after a decade of little active management, aquatic plant growth became excessive and limited navigation and recreational uses. The District formed in 1980 to control and management aquatic plants within the lake, soon developing the first APM plan and purchasing new harvester in 1981.

Mechanical harvesting continued to be the primary focus of management activities with the current harvester purchased in 1993. On average, the District actively harvests approximately 52 acres with a primary focus on top-cutting EWM. In 2014, 72 loads were harvested and removed throughout the year. Since 2004, there has been an average of 59 loads harvested annually. The first harvester was purchased in 1993 a second harvester was purchased in 2004 and is aging, requiring increasing costs for upkeep and maintenance. The District is looking to replace this harvester in 2015-2016 and is planning to apply for grant funds under the Recreation Boating Fund program.

3.0 PROBLEM IDENTIFICATION

1. EWM surface matting impairs the recreational use of Wilke Lake.
2. EWM displaces native aquatic vegetation and has the potential to spread through the littoral area, in the past EWM was as high as 88% coverage in 1992 and is 41% currently with active management.
3. Increased algal blooms and nutrient release due to the natural, early die-back life cycle of CLP can lead to decreased water clarity and quality, though currently (2014 Survey) there is only 0.5 acres of CLP in the Lake.
4. Increasing costs of purchasing and operation of harvesters.

4.0 MANAGEMENT RECOMMENDATIONS AND OPTIONS

Management of aquatic plants can take many facets, depending on each lakes unique condition and desire by the community. To be successful, a management option must be accepted by its users. Though herbicide use has been done in the past within Wilke Lake, its use was eliminated in the 1970s. Herbicides for aquatic plant management can have negative connotations and be misunderstood by some users, making it potentially controversial. However, the combinations of periodic large scale "whole lake" type treatments for AIS have shown to reduce the need and frequency of harvesting for several years after treatment. This includes periodic triggers based on frequency of occurrence of the AIS and is a management option that is recommended be further explored by the District in the future (next APM update).

Currently, mechanical harvesting is practiced and an accepted approach by riparian owners and lake users based on the latest approved Comprehensive Lake Management Plan and the 2015 approval of the APM. Typically, this entails a high up-front cost to start with the purchase of harvesting equipment. Once started, however, cost can be minimal for upkeep and operation. With the general acceptance of this practice and overall minimal effect on the plant communities of Wilke Lake, continuation of mechanical harvesting is recommended. The following guidance for harvester operation and mechanical harvesting recommendations are based on historical aquatic plant management approaches and incorporate needs by lake users. This guidance and the harvesting map shall be discussed in detail with the harvester operator and/or any new operators to assure proper harvesting within permit guidelines.

GENERAL GUIDANCE FOR HARVESTER OPERATION – Figure 6, Appendix D

- PRIORITIZE HARVESTING AREAS TO FOCUS ON GREATEST NEED – Highest priority should be on maintaining navigation / recreation lane (100 feet off shore) and access to/from the boat landing. Maintain a lane 100' wide cutting to a depth up to 6' around the lake for safe navigation & recreational use. This area also coincides with the local ordinance requiring water-skiers to boat in a counterclockwise manner around the outside of the lake. **In these areas regardless of depth, you must leave at least 12 inches of plant on the lake bottom.**
- TOP CUT IN AREAS FOR SPECIFIC AIS MANAGEMENT – These areas are specific to AIS harvest management under NR 109. **Restrict cutting to 4 feet below the water's surface, leaving a minimum of 12 inches of plant growth on the lake bottom in areas shallower than 5 feet. Do not harvest in areas less than 4 feet deep, except in boat launch area. Harvesting shall not commence prior to June 1st.**
- **Intentional harvesting of native pondweeds and/or chara is prohibited.**
- ALL CUT MATERIAL SHOULD BE INSPECTED FOR FISH AND ANIMALS. ANY ORGANISMS FOUND SHOULD BE IMMEDIATELY RETURNED TO THE WATER.
- ALL CUT MATERIALS SHOULD BE COLLECTED AND DEPOSITED AT THE DESIGNATED DISPOSAL SITE – Mr. Ronald Rabe property at SW1/4 SW1/4 S3 T17N R21E, Rautmann Road, Kiel, WI.

Harvesting can spread infestations of EWM by not removing all fragments cut, and sometimes a multi-faceted approach should be used. For Wilke Lake, EWM populations currently exceed 40% frequency of occurrence. This is a large-scale infestation that may warrant whole-lake herbicide management and should be given consideration to reduce infestation, opening up habitat for native species. This will reduce presence and spread of AIS and reduce harvesting cost and frequency after control actions are initiated. If any herbicide management is desired, pre and post-treatment aquatic plant surveys should be completed to document results.

The size of the infestation tends to dictate the type of the treatment. Small treatment areas or beds less than 5 acres are many times consider spot treatments and usually targeted with granular type herbicides. When there are multiple "spot" treatment areas within a lake, it most often makes more sense from economic and efficacy standpoints to target the "whole" lake for treatment. This typically entails calculating the entire volume of water within the lake, in acre/feet, and applying a liquid herbicide, such as 2,4-d, at a low dose at a lake wide rate, typically between 250 – 350 parts per billion (PPB).

Many times the amount of herbicide in this type of whole lake treatment can be further reduced by timing the treatment as close as possible to lake stratification. After the thermocline develops in the lake, typically between 60 – 70 degrees surface temperature, this may effectively eliminate the area of the water column below the thermocline from the treatment, reducing the amount of herbicide needed for a whole lake treatment by 30- 40%. When this technique can be utilized it should be to reduce the amount of herbicide used within the lake and to more effectively target the whole lake treatment.

Prior to any whole-lake management, EWM present should be tested for hybridity, which can affect type of action taken. All actions should be based on the strain of hybrid water-milfoil (HWM) if present, using techniques located in Table 8. Currently, harvesting is the chosen approach, but the following table outlines action steps if herbicide management of EWM is chosen in the future.

Table 8: Optional **EWM Herbicide Management for Wilke Lake, Manitowoc County, WI**

EWM Littoral Zone Frequency	Management Action(s)		
	Task	Action	Timing
< 40.0%	1	Follow harvesting guidance	As needed throughout the year
>40.0%	1	Pre-treatment aquatic plant survey	Mid-late April
	2	Whole-lake Herbicide Application 810 ac/feet	May, prior to 65 degree water temperature
	3	Post-treatment aquatic plant survey	July/August
	4	Follow harvesting guidance	Beginning 30 days after herbicide application and continuing as needed throughout the year
Whole-lake Herbicide Application Information by EWM Strain		Pure-strain Eurasian water-milfoil	2,4-D whole-lake at 0.25-0.350 PPM
		Hyrbrid Eurasian water-milfoil	2,4-D / endothall mixture at 0.3 / 0.6 PPM
			Fluridone at 4-6 PPB maintaind for 90+ days

APPENDIX A

Appendix A – Supporting Aquatic Plant Documentation

The point intercept method was used to evaluate the existing emergent, submergent, floating-leaf, and free-floating aquatic plants. If a species was not collected at a specific point, the space on the datasheet was left blank. For the survey, the data for each sample point was entered into the WDNR "Worksheets" (i.e., a data-processing spreadsheet) to calculate the following statistics:

Taxonomic richness (the total number of taxa detected)

- **Maximum depth of plant growth**
- **Community frequency of occurrence** (number of intercept points where aquatic plants were detected divided by the number of intercept points shallower than the maximum depth of plant growth)
- **Mean intercept point taxonomic richness** (the average number of taxa per intercept point)
- **Mean intercept point native taxonomic richness** (the average number of native taxa per intercept point)
- **Taxonomic frequency of occurrence within vegetated areas** (the number of intercept points where a particular taxon (e.g., genus, species, etc.) was detected divided by the total number of intercept points where vegetation was present)
- **Taxonomic frequency of occurrence at sites within the photic zone** (the number of intercept points where a particular taxon (e.g., genus, species, etc.) was detected divided by the total number of intercept points which are equal to or shallower than the maximum depth of plant growth)
- **Relative taxonomic frequency of occurrence** (the number of intercept points where a particular taxon (e.g., genus, species, etc.) was detected divided by the sum of all species' occurrences)
- **Mean density** (the sum of the density values for a particular species divided by the number of sampling sites)
- **Simpson Diversity Index (SDI)** is an indicator of aquatic plant community diversity. SDI is calculated by taking one minus the sum of the relative frequencies squared for each species present. Based upon the index of community diversity, the closer the SDI is to one, the greater the diversity within the population.

Floristic Quality Index (FQI) (This method uses a predetermined Coefficient of Conservatism (C), that has been assigned to each native plant species in Wisconsin, based on that species' tolerance for disturbance. Non-native plants are not assigned conservatism coefficients. The aggregate conservatism of all the plants inhabiting a site determines its floristic quality. The mean C value for a given lake is the arithmetic mean of the coefficients of all native vascular plant species occurring on the entire site, without regard to dominance or frequency. The FQI value is the mean C times the square root of the total number of native species. This formula combines the conservatism of the species present with a measure of the species richness of the site.

APPENDIX B

Table 3: Taxa Detected During 2014 Aquatic Plant Survey, Wilke Lake, Manitowoc County, WI

Genus	Species	Common Name	Category
Myriophyllum	*spicatum*	Eurasian water-milfoil	Invasive
Potamogeton	*crispus*	Curly-leaf pondweed	Invasive
Chara	*sp.*	Muskgrass	Submersed
Najas	*flexilis*	Slender naiad	Submersed
Nymphaea	*odorata*	White water lily	Floating-leaf
Potamogeton	*amplifolius*	Large-leaf pondweed	Submersed
Potamogeton	*gramineus*	Variable pondweed	Submersed
Potamogeton	*illinoensis*	Illinois pondweed	Submersed
Potamogeton	*natans*	Floating-leaf pondweed	Submersed
Potamogeton	*praelongus*	White-stem pondweed	Submersed
Potamogeton	*richardsonii*	Clasping-leaf pondweed	Submersed
Sagittarai	*sp.*	Arrowhead species	Emergent
Stuckenia	*pectinata*	Sago pondweed	Submersed
Utricularia	*vulgaris*	Common bladderwort	Submersed

Table 4: 2014 Aquatic Plant Coummlnty Statistics, Wilke Lake, Manitowoc County, WI.

Date Sampled	7/8/2014
Points Sampled	235
Points with vegetation	180
Points shallower than maxium depth of plants	218
Frequency of occurrence	82.57%
Simpson Diversity Index	0.8
Maxiumum depth of plants (ft)	14
Average number of species per site (shallower than max depth)	1.63
Average number of species per site (veg. sites only)	1.98
Average number of native species per sire (hallower than max depth)	1.28
Average number of native species per site (veg. sites only)	1.87
Species Richness	14

Table 5: 2014 Aquatic Plant Taxa-Specific Statistics, Wilke Lake, Manitowoc County, WI

Common Name	Percent Frequency of Occurrence within vegetated areas	Percent Frequency of Occurrence at sites shallower than max depth of plants	Percent Relative Frequency of Occurrence	Number of Intercept Points Where Detected	Average Density
Eurasian water-milfoil	41.67	34.40	21.10	75	1.11
Curly-leaf pondweed	0.56	0.46	0.30	1	1.00
Muskgrass	61.11	50.46	30.90	110	1.02
Slender naiad	30.56	25.23	15.40	55	1.00
White water lily*	—	—	—	1	—
Large-leaf pondweed	1.11	0.92	0.60	2	1.00
Variable pondweed	33.89	27.98	17.10	61	1.00
Illinois pondweed	8.89	7.34	4.50	16	1.00
Floating-leaf pondweed	0.56	0.46	0.30	1	1.00
White-stem pondweed	2.22	1.83	1.10	4	1.00
Clasping-leaf pondweed	0.56	0.46	0.30	1	1.00
Arrowhead species	1.67	1.38	0.80	3	1.00
Sago pondweed	0.56	0.46	0.30	1	1.00
Common bladderwort	14.44	11.93	7.30	26	1.00

* - Species recorded visually only, not data calculated

APPENDIX B

Table 6: Historic and 2014 Floristic Quality Indicies, Wilke Lake, Manitowoc County, W

Common Name	1992	2003	2009	2014
Coontail	3	—	3	—
Muskgrass	7	7	7	7
Small duckweed	4	—	—	—
Northern water-milfoil	6	6	—	—
Slender naiad	6	6	—	6
Spatterdock	6	6	—	—
White water lily	6	6	—	6
Large-leaf pondweed	7	7	—	7
Water-thread pondweed	—	8	—	—
Leafy pondweed	—	6	—	—
Variable pondweed	—	7	7	7
Illinois pondweed	—	6	6	6
Floating-leaf pondweed	—	5	—	5
White-stem pondweed	—	—	8	8
Clasping-leaf pondweed	—	—	—	5
Sago pondweed	3	3	—	3
Broad-leaved cattail	1	1	—	—
Common bladderwort	—	—	7	7
Total Species	10	13	6	11
Mean C	4.90	5.69	6.33	6.09
Floristic Quality Index (FQI)	**15.50**	**20.52**	**15.51**	**20.20**

Please note: There is no Coefficient of Conservatism for exotic species such as Eurasian Water-Milfoil or plants not identified to the species level (*Sagittaria sp.*).

Coefficient of Conservatism C

0-3 taxa found in wide variety of plant communities and very tolerant of disturbance.
4-6 taxa typically associated with specific plant communities and tolerate moderate disturbance.
7-8 taxa found in narrow range of plant communities and tolerate minor disturbance.
9-10 taxa restricted to a narrow range of synecological conditions, with low tolerance of disturbance.

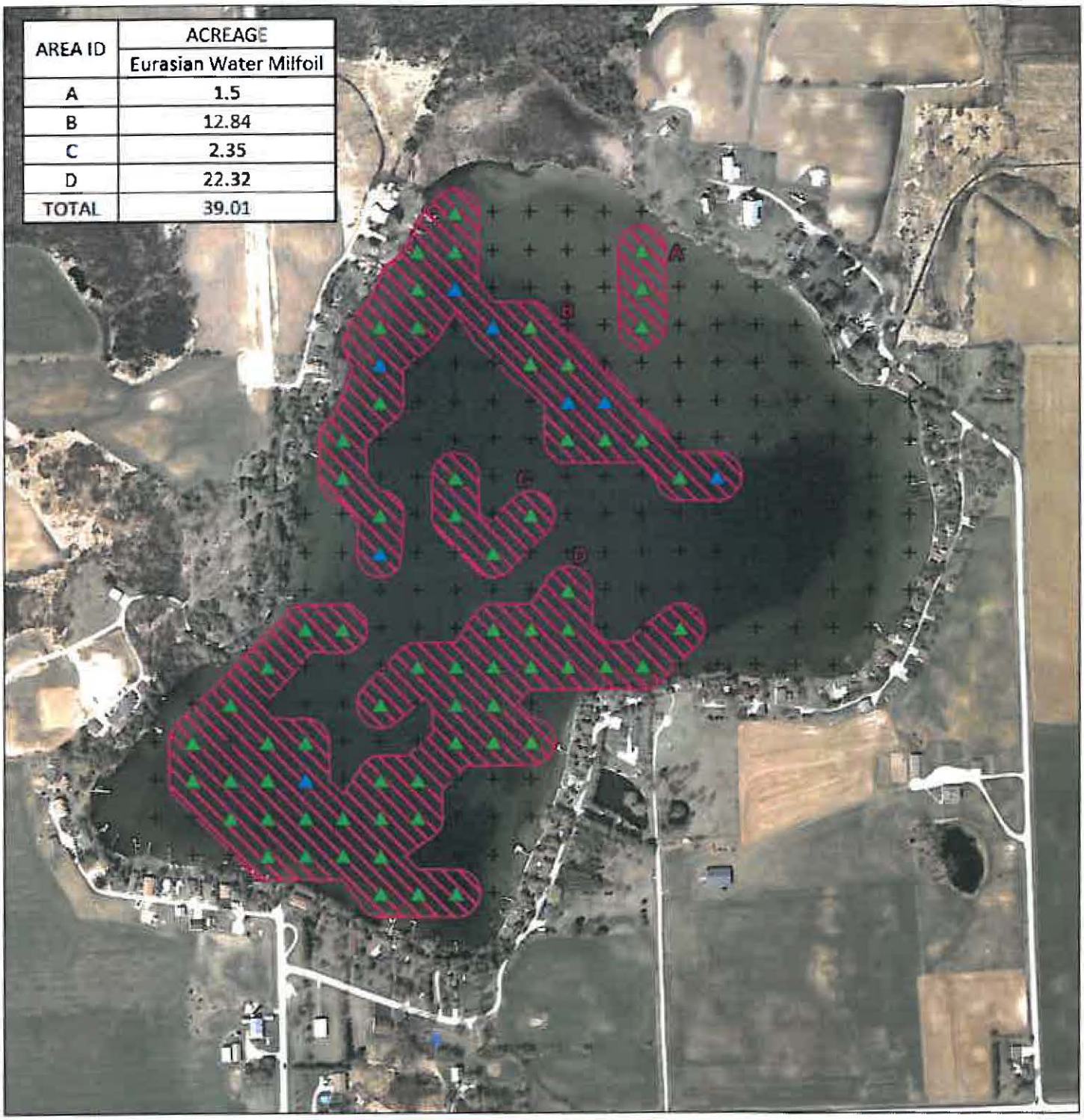
Table 7: FQI and Average Coefficient of Wilke Lake Compared to Wisconsin and Southeastern Till Plain lakes.

	Average Coefficient of Conservatism			Floristic Quality		
Quartile*	Lower	Mean	Upper	Lower	Mean	Upper
Wisconsin Lakes	5.5	6	6.9	16.9	22.2	27.5
Southeastern Till Plains	5.2	5.6	5.8	17	20.9	24.4
Wilke Lake - 2014	6.09			20.2		

* - Values indicate highest value of the lowest quartile, **mean**, and lowest value of the **upper** quartile

APPENDIX C

AREA ID	ACREAGE
	Eurasian Water Milfoil
A	1.5
B	12.84
C	2.35
D	22.32
TOTAL	39.01



Notes
1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources include: Stantec, WDNR
3. Orthophotography: 2010 WROC

Disclaimer, Stantec assumes no responsibility for data supplied in electronic format. The recipient accepts full responsibility for verifying the accuracy and completeness of the data. The recipient releases Stantec, its officers, employees, consultants and agents, from any and all claims arising in any way from the content or provision of the data.

Legend

- GPS Sample Points*
- Fullness Rating of 1
- Fullness Rating of 2
- Invasive Aquatic Plant Area

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

Figure No.
1

Title
2014 PI Survey - Wilke Lake
Eurasian Water Milfoil

Client/Project
Town of Schleswig

Project Location
T17N, R21E, S02 & S03
Town of Schleswig
Manitowoc Co., WI

193802854
Prepared by KAS on 2014-08-26
Technical Review by AB on 2014-08-27
Independent Review by BL on 2015-05-26

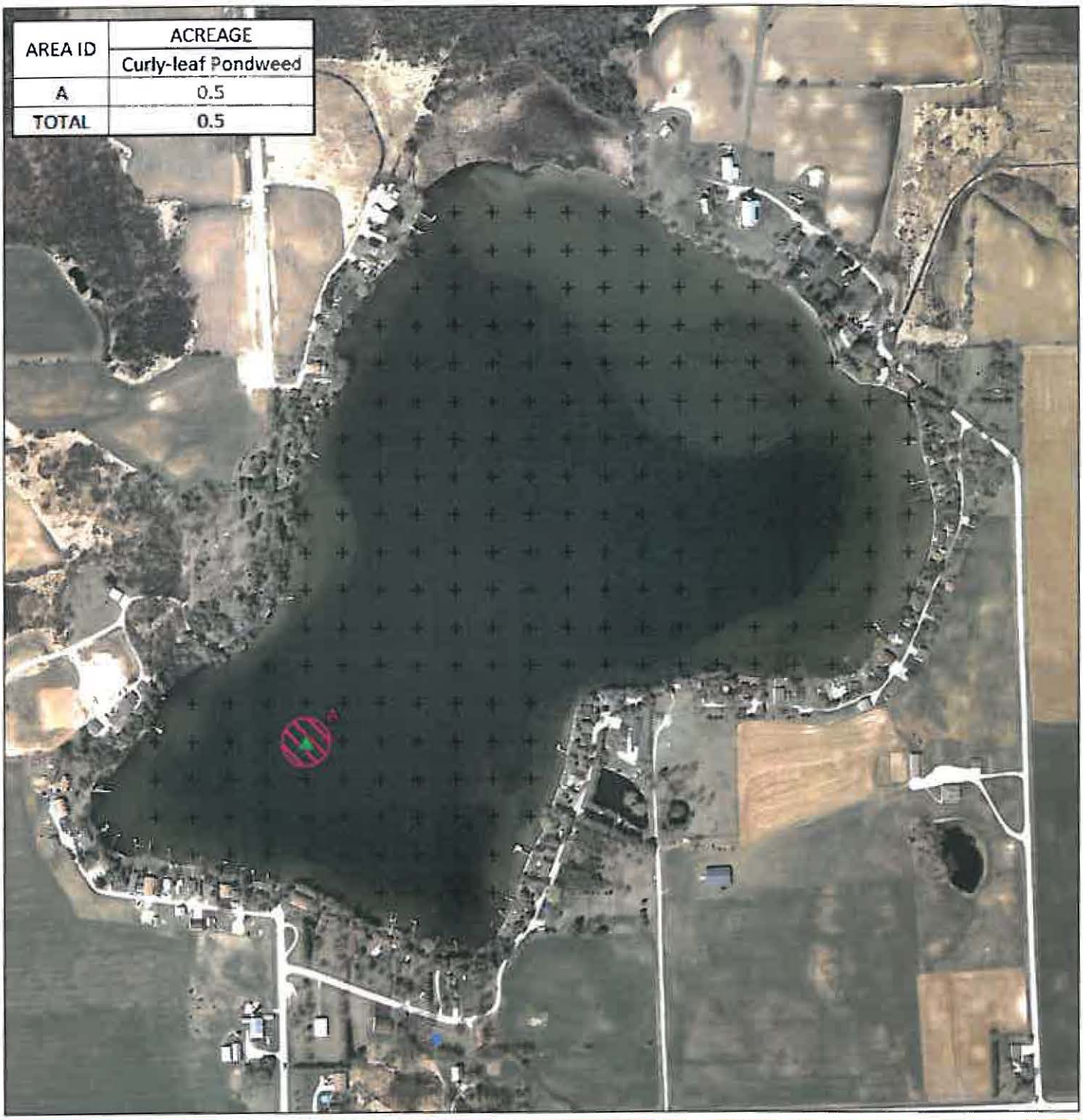
0 250 500 Feet
1:6,000 (at original document size of 8.5x11)

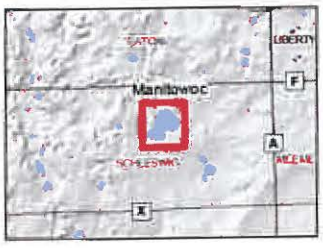
N

Stantec

*Survey completed on 2014/07/08 by James Schari & Tom Lamppa

AREA ID	ACREAGE
	Curly-leaf Pondweed
A	0.5
TOTAL	0.5





Notes
1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources include: Stantec, WDNR
3. Orthophotography: 2010 WROC

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Legend

- GPS Sample Points*
- Fullness Rating of 1
- Invasive Aquatic Plant Area

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

Figure No.
2

Title
2014 PI Survey - Wilke Lake
Curly-leaf Pondweed

Client/Project
Town of Schleswig

Project Location
T17N, R21E, S02 & S03
Town of Schleswig
Manitowoc Co., WI

193802854
Prepared by AB on 2014-08-27
Technical Review by MP on 2014-08-27
Independent Review by BL on 2015-05-28

0 250 500 Feet
1 inch = 1,000 feet original document size of 8.5x11

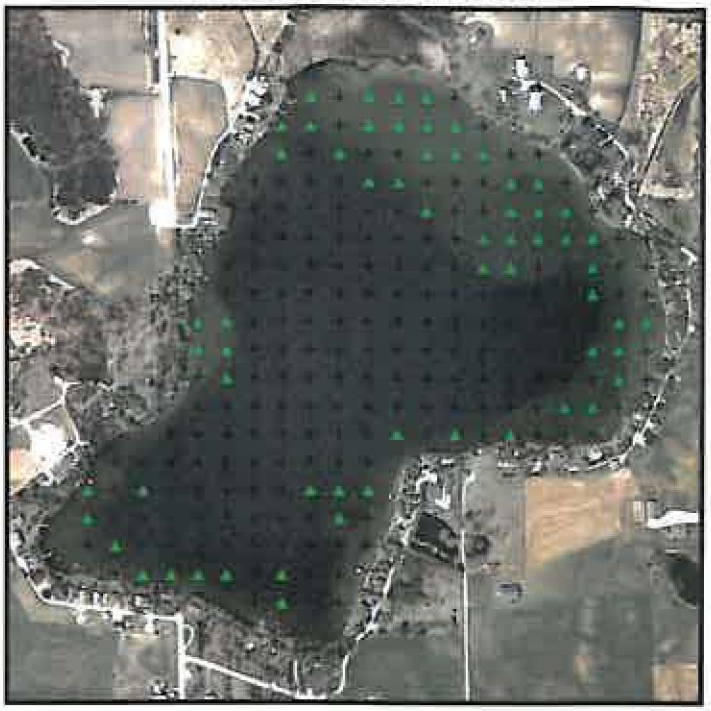
N

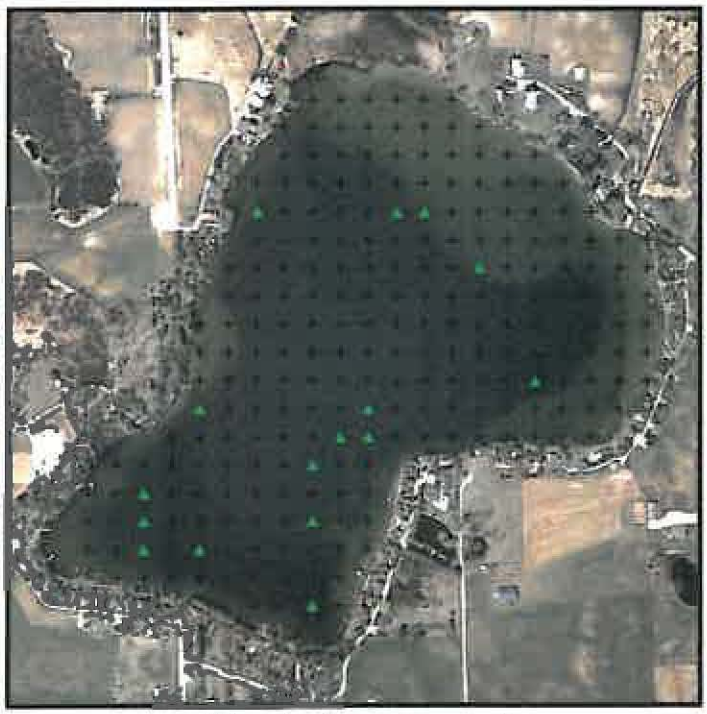
Stantec

*Survey completed on 2014/07/08 by James Schari & Tom Lamppa

Large-leaf Pondweed

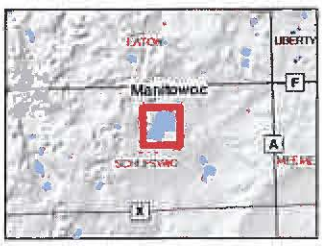
Variable Pondweed





Illinois Pondweed

Floating-leaf Pondweed



Notes

1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources Include: Stantec, WDNR
3. Orthophotography: 2010 WROC

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Legend

- \+ GPS Sample Points*
- ▲ Fullness Rating of 1

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible

Figure No.
3

Title
2014 PI Survey - Wilke Lake Large-leaf, Variable, Illinois, and Floating-leaf Pondweeds

Client/Project
Town of Schleswig

Project Location
T17N, R21E, S02 & S03
Town of Schleswig
Manitowoc Co., WI

193807285-4
Prepared by AB on 2014-08-27
Technical Review by MP on 2014-08-27
Independent Review by BL on 2015-05-28

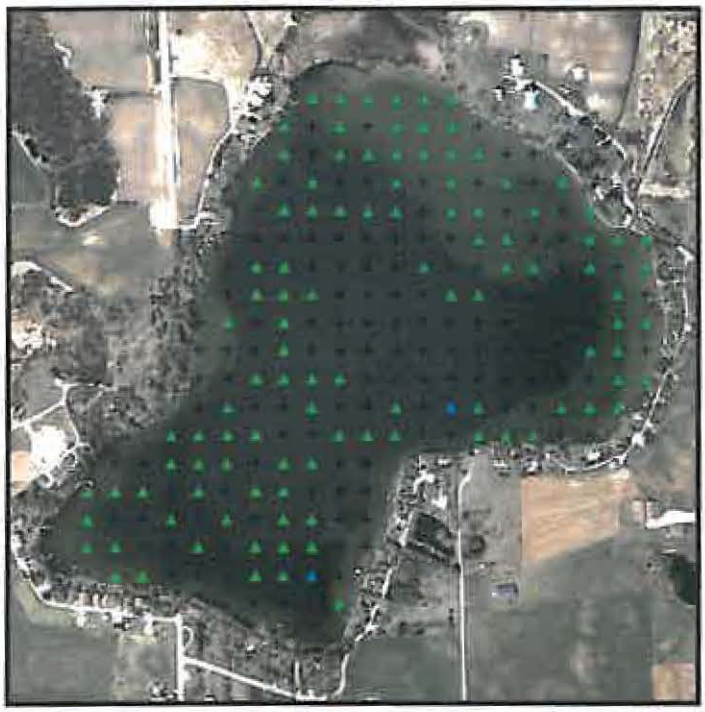
0 450 900 Feet
1:10,800 (at original document size of 8.5x11)

N

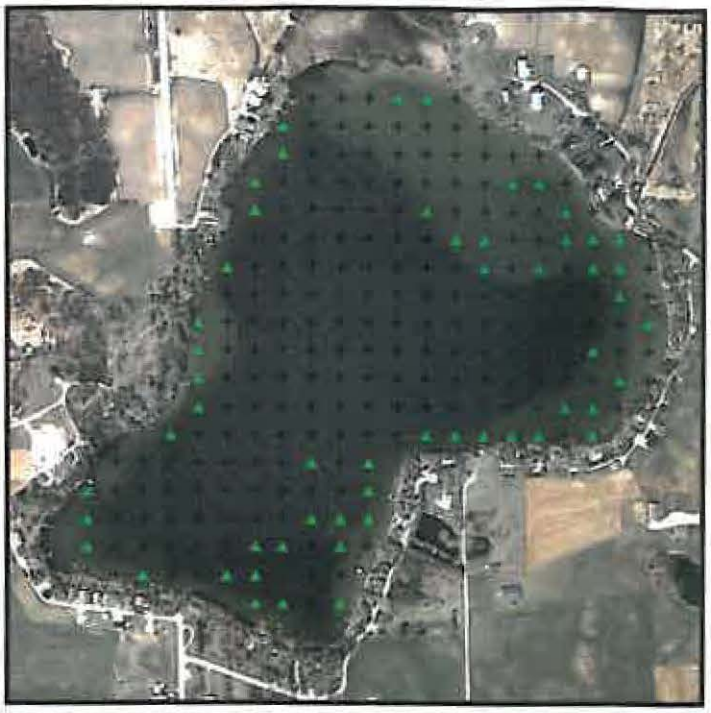
Stantec

*Survey completed on 2014/07/08 by James Schart & Tom Lamppa

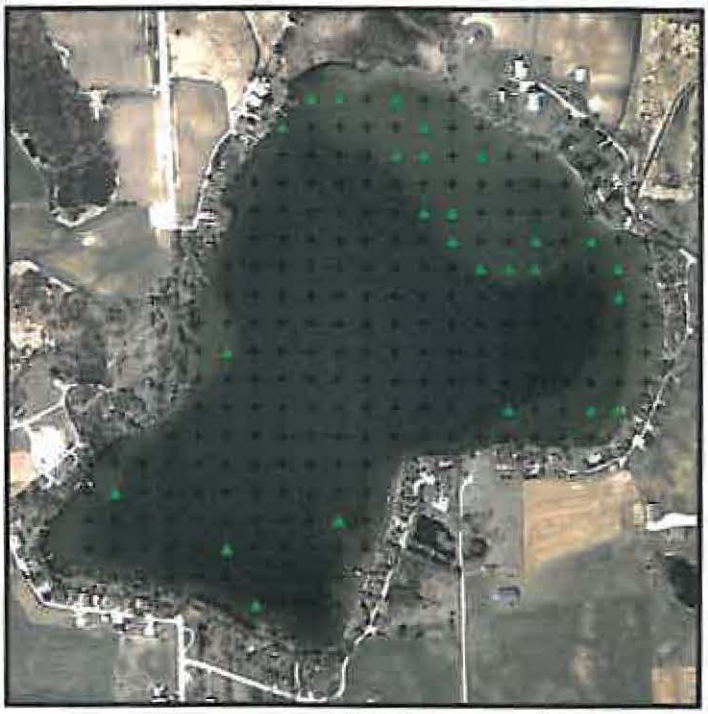
Chara



Slender Naiad



White Water Lily



Common Bladderwort

Notes
1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources Include: Stantec, WDNR
3. Orthophotography: 2010 WROC

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Legend

- + GPS Sample Points*
- V Visual
- ▲ Fullness Rating of 1
- ▲ Fullness Rating of 2

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible

Figure No.
4

Title
2014 PI Survey - Wilke Lake Chara, Slender Naiad, White Water Lily, and Common Bladderwort

Client/Project
Town of Schleswig

Project Location
T13N, R23E, S02 & S03
Town of Schleswig
Manitowoc Co., WI

193807854
Prepared by AB on 2014-06-27
Technical Review by MP on 2014-06-27
Independent Review by BL on 2015-05-28

0 450 900 Feet
1:10,800 (at original document size of 8.5x11)

N

Stantec

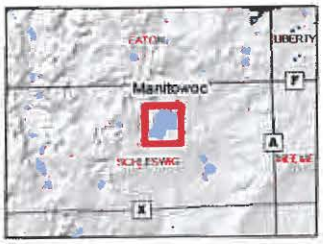
*Survey completed on 2014/07/08 by James Schari & Tom Lamppa

White-stem Pondweed

Clasping-leaf Pondweed

Sago Pondweed

Arrowhead species



Notes
1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources Include: Stantec, WDNR
3. Orthophotography: 2010 WROC

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Legend

+ GPS Sample Points*
▲ Fullness Rating of 1

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible

Figure No.
5

Title
2014 PI Survey - Wilke Lake White-stem, Clasping-leaf, & Sago Pondweeds and Arrowhead species

Client/Project
Town of Schleswig

Project Location
T17N, R21E, S02 & S03
Town of Schleswig
Manitowoc Co., WI

193802854
Prepared by AB on 2014-08-27
Technical Review by MP on 2014-08-27
Independent Review by BL on 2015-05-28

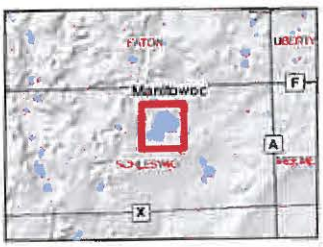
0 450 900 Feet
1:9,600 (at original document size of 8.5x11)

N

Stantec

*Survey completed on 2014/07/08 by James Schari & Tom Lamppa

APPENDIX D



Notes
1. Coordinate System: NAD 1983 StatePlane Wisconsin South FIPS 4803 Feet
2. Data Sources include: Stantec, WDNR, WSDOT
3. Orthophotography: 2010 WROC

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Legend

- Navigation / Recreation Lane (100 FT Wide) - 18.6 ac
- Nuisance Top-Cut (Depth to 4 FT) - 48.6 ac

Figure No.
6

Title
2015 Harvest Plan
Wilke Lake

Client/Project
Town of Schleswig

Project Location:
T17N, R21E, S02 & S03
Town of Schleswig
Manitowoc Co., WI

193802854
Prepared by KAS on 2015-02-10
Technical Review by MP on 2015-02-10
Independent Review by BL on 2015-05-26

0 250 500 Feet
1:6,000 (at original document size of 8.5x11)

N

Stantec