AQUATIC PLANT SURVEY

AND

AQUATIC PLANT MANAGEMENT PLAN

CAMP AND CENTER LAKE

KENOSHA COUNTY, WISCONSIN

Prepared for:

Camp and Center Lake Rehabilitation District

October, 1995

627 North Second Street, Libertyville, Illinois 60048 (708) 918-0888 FAX (708) 918-0892

INTRODUCTION

The purpose of this report is to document the existing aquatic plant communities, their relative densities and species composition within Camp and Center Lakes (Exhibit 1). In addition, the aquatic plant community information was used to formulate an aquatic plant management plan to increase beneficial lake uses, while protecting significant aquatic resources. The aquatic plant management plan outlines a strategy to implement an aquatic plant harvesting program that will promote recreational lakes uses (boating, fishing, etc.) through nuisance species control by mechanical removal. Sensitive environmental areas were identified and management strategies were formulated to prevent negative impacts to these areas.

PROBLEM

Degradation of surface water resources and use impairment has been a recognized problem for several decades in the United States and abroad. Nutrient enrichment, excess aquatic plant growth, sediment and toxic chemical inputs are among the most often cited water pollution problems related to changes in watershed characteristics, agricultural impacts, and urban and industrial inputs. Various management techniques have been utilized to deal with the problems, with varying degrees of success and costs (WDNR, 1974). Many modern attempts to curb lake eutrophication and related watershed related impacts rely on watershed protection strategies to slow nutrient inputs to lakes and streams.

Camp and Center Lakes have experienced degradation of water resource quality and ecosystem integrity similar to many lakes in Wisconsin (WDNR, 1983). In 1989, the Camp and Center Lake Rehabilitation District (District) was formed to address lake and watershed issues affecting the subject lakes An initial watershed study was commissioned to identify major problem areas and sources and to formulate preliminary management recommendations to address the identified problems (Applied Ecological Services, 1990). Sediment build-up and dense aquatic macrophytes were identified as the major areas of concern No water quality sampling was conducted as a part of the initial study.

The District commissioned a study to investigate perceived excessive sediment build-up, especially along near shore and channel areas, which was making recreational boating and swimming difficult or impossible The "Camp and Center Lake Dredging Feasibility Study" reported as much as 8 feet of soft sediment in Camp Lake and up to 12 feet in Center Lake (R.A. Smith and Associates, Inc., 1994). Average sediment depths along residential properties on Camp Lake generally were under 6 feet. Center Lake sediment depths along residential shorelines were highly variable.

STUDY AREAS

Camp and Center Lakes are two small (461 and 120 surface acres, respectively) drainage lakes located in southwestern Kenosha County, Wisconsin (Exhibit 1). Their watersheds are completely within the jurisdiction of the Town of Salem. Like most lakes in this region, these lakes were formed by shallow ice block depressions created by the retreating glaciers of the Wisconsonian glaciation, approximately 12,000 years before present. Center Lake discharges directly to Camp Lake through a low head water control structure. Camp Lake flows into a marsh complex associated with Peat Lake before the water discharges into the Fox River near the Illinois-Wisconsin border. Both lakes have been at least partially dredged to increase recreational boating and wildlife management opportunities, including the creation of new channels into marsh and upland areas.

The landscape surrounding these lakes is part of the gently sloping ground moraines of the eastern ridges and lowlands of Wisconsin (Martin, 1965). The region is part of the southeastern Wisconsin till plains ecoregion, as described by Omernik and Gallant (1988). The major land use in the region is dairy production and agricultural cash crops. Urbanization has steadily increased in past decades, causing increased pressure on the local natural environment.

The Southeastern Wisconsin Regional Planning Commission (SEWRPC) included these lakes in a recent assessment of watersheds for nonpoint source management (SEWRPC, 1993). In that report, Camp Lake was designated worthwhile for eligibility for a small scale or priority lake project. Camp Lake was selected mainly due to its expected response to nonpoint source control measures should they be implemented in the watershed.

The District has been approved for a Wisconsin Lake Planning Grant to receive cost-sharing funds from the Wisconsin Department of Natural Resources to conduct a watershed study, implement a hydraulic and hydrologic study and an aquatic macrophyte survey and management plan on both lakes Additional funds may be available at a later time for a 50 percent cost-share for the procurement of aquatic weed harvesting equipment through the Wisconsin Waterways Commission. The work described in this report would be used to document the need to purchase aquatic plant harvesting equipment and systematic implementation of an aquatic plant management plan.

EXISTING DATA

There has not been a great deal of data published for Camp and Center Lakes. These lakes were not surveyed very extensively during the early studies in the state (Juday, 1914). Both lakes had "Lake Use Reports" prepared for them in 1969, documenting the existing physical and biological conditions of the lakes at that time (WDNR, 1969a; WDNR, 1969b). These reports detailed the most up-to-date information on surrounding land uses of the lakes, cataloged existing resources and provided recommended resource protection and enhancement measures. In that same year, both lakes were included in the most comprehensive aquatic plant survey ever conducted within lakes of the Fox River (Illinois) watershed (Belonger, 1969).

Both lakes have developed shorelines in those areas where large wetland complexes have not limited residential development. The Center Lake shoreline is 50 percent developed and Camp Lake is estimated to be 44 percent developed (Exhibit 2, R.A. Smith and Associates, 1994). Most of the shoreline residential development was in place by the 1960s Table 1 provides overall lake statistics for both lakes

Table 1. Overall Lake Statistics Camp and Center Lakes

	Area (acres)	Watershed (sq. mi.)	Maximum Depth (ft.)	Average Depth (ft.)
Camp Lake	461	10 4	19	5
Center Lake	120	3.6	28	10

Water Quality

The most recent published data characterized both lakes as eutrophic, with a midsummer Secchi depth of 1.4 meters (WDNR, 1982). Both lakes have very low dissolved oxygen in the hypolimnion in midsummer. averaging less than 0.5 mg/l. Chlorophyll *a* values are in the range of 10-40 mg/m^3 for both lakes These values rank the lakes generally in the fair to poor water quality category for these parameters (WDNR, 1983).

Camp Lake is susceptible to winterkill, with a maximum depth of 19 feet. Center Lake's maximum depth is 28 feet. The bathymetric map for both lakes is provided as Exhibit 3

Recent water quality sampling (1993 and 1994) conducted as a part of the WDNR's self-help monitoring program and lake planning grant data collection indicate euthrophic conditions, and these lakes only partially meet their full recreational potential and environmental use classification (Helsel, 1995). It is estimated that a 59% reduction in annual phosphorous loading would be necessary for Center Lake to meet water goals of 20 ug/L spring turnover phosphorous concentration. Camp Lake would require an estimated 64% reduction to meet a 25 ug/L spring turnover phosphorous concentration. The water quality data are stored in the USEPA STORET database.

With decreases in annual phosphorous loading to both lakes, water clarity would be expected to increase. This likely would cause an increase in the growth of aquatic macrophytes, underscoring the need for a comprehensive aquatic plant management strategy for these lakes.

Vegetation

The management of aquatic macrophyte populations can be troublesome because of the life histories of the species involved and the complex interactions with the lake ecosystem as a whole (Engel, 1985). Often the beneficial values provided supported by aquatic vegetation, (e.g., shoreline stabilization, fish and wildlife habitat, etc.) are overshadowed by impaired lake uses by dense beds of aquatic plants (Nichols, 1991; Carpenter and Lodge, 1986; Engel, 1985; Engel, 1990).

Camp Lake

Belonger (1969) described the dominant vegetation as widgeon grass (*Ruppia maritima*), forming dense beds from 1 to 13 feet in depth in most areas of the lake except the east shore. Other common species included pondweeds (*Potamogeton crispus, P. praelongus, P. natans, P. pectinatus, Potamogeton spp.*), coontail (*Ceratophyllum demersum*) and muskgrass (*Chara vulgaris*) The east shore was dominated by milfoil (*Myriophyllum*), with a variety of associates, including pondweeds, coontail, muskgrass, eel grass (*Vallisneria americana*), bladderwort (*Utricularia vulgaris*), and water buttercup (*Ranunculus*). Beds of the floating leaved yellow water lily (*Nuphar*) were common, with scattered beds of white water lily (*Nymphaea*) amongst it. Emergent beds of narrow-leaved cattail (*Typha angustifolia*) occurred on all shorelines and beds of soft-stem bulrush (*Scirpus validus*) were found farther from shore.

Maximum rooting depth was found to be 13 feet. Extensive aquatic plants were considered a significant problem by many local landowners. Table 2 documents all species identified during that study. The Lake Use Report (WDNR, 1969a) provided little new data on aquatic plants.

Table 2. Presence and Relative Abundance of Aquatic Plants Camp and Center Lake

Species		Source: Belonger, 1969 Abundance		Source: Hey and Associates, 1995[1] Abundance	
Scientific Name	Common Name	Camp Lake	Center Lake	Camp Lake	Center Lake
Ceratophyllum demersum	Coontail	Sparse	Scattered	Abundant	Abundant
Chara vulgaris	Muskgrass	Sparse	Heavy	Very Common	Very Common
Decodon verticillatus		Sparse	Sparse		
Elodea canadensis	Common waterweed	Sparse	Sparse	Common	Rare
Heteranthera dubia	Water star grass			Common	Common
Lemna minor	Greater duckweed	—	Sparse	Common	Common
Myriophyllum exalbescens	N. water milfoil			Abundant	Common
Myriophyllum spicatum	Eurasian milfoil			Abundant	Abundant
Myriophyllum verticillatum	Whorled water milfoil			Common	Rare
Myriophyllum spp.		Moderate	Scattered		
Najas flexilis	Slender naiad			Rare	Rare
Najas guadelepensis	Southern naiad			Very Common	Common
Najas marina	Spiny naiad			Rare	Abundant
Najas spp.		Sparse	Heavy		
Nuphar advena	Yellow pondlily			Common	Common
Nuphar variegatum	Bullhead lily			Rare	Common
Nuphar spp		Moderate	Scattered		
Nymphaea odorata	White water lily			Common	Common
Nymphaea tuberosa	White water lily			Very Common	Common
Nymphaea spp.		Scattered	Scattered		
Polygonum amphibium	Water knotweed			Rare	Rare
Pontedaria cordata	Pickerel weed	Sparse	—	Rare	Rare
Potamogeton amplifolius	Large leaved pondweed	Scattered	—	Common	Rare
Potamogeton crispus	Curlyleaf pondweed	Sparse	Sparse	Rare	Very Common
Potamogeton gramineus	Grass-leaved pondweed	Sparse	—	Common	Common
Potamogeton illinoensis		Sparse	—		
Potamogeton natans	Common pondweed	Sparse	Sparse	Common	Rare
Potamogeton nodosus	Long-leaved pondweed	Sparse	—	Common	Rare
Potamogeton pectinatus	Sago pondweed	Sparse	Scattered	Very Common	Abundant
Potamogeton richardsonii	Richardson's pondweed			Very Common	Rare
Potamogeton robbinsii		Sparse	—		
Potamogeton zosteriformis	Flat-stemmed pondweed			Common	Rare
Potamogeton spp.	Pondweed	Sparse	Sparse	Common	Common
Ranunculus spp.	Water crowfoot	Sparse	—		
Ruppia maritima	Widgeon grass	Heavy	—	Abundant	Common
Sagittaria spp.	Arrow	—	Sparse		
Scirpus acutus	Hard stem bulrush			Common	Rare
Scirpus pungens	Chairmaker's rush			Rare	Rare
Scirpus validus		Scattered	Sparse		
Sparganium eurycarpum	Burreed	Sparse	—	Rare	Rare
Typha angustifolia	Narrow-leaved pondweed	Moderate	Moderate	Rare	Common
Utricularia vulgaris	Greater bladderwort	—	Sparse	Very Common	Common
Vallisneria americana	Eel grass	Sparse	Sparse	Very Common	Abundant
Zannichellia palustris	Horned pondweed			Common	Rare

[1] 1993 data from this study

Center Lake

Belonger (1969) found muskgrass and spiny naiad (*Najas marina*) to be the most common plants within Center Lake, especially from the shoreline to 4.5 feet. Coontail was also common in some areas Various other species such as pondweeds, milfoil, eel grass, (*Elodea canadensis*, previously *Anacharis*) and bladderwort were found throughout the vegetated areas. Stands of white and yellow water lilies occurred along many shorelines with some duckweed (*Lemna minor*). Emergents along the shorelines included cattail, water willow *(Decodon verticillatus*), soft-stem bulrush and arrowhead (*Sagittaria*). Maximum rooting depth was found to be 11 feet, although many areas having depths between 5 and 11 feet were devoid of vegetation.

Wildlife and Fishery Resources

Camp Lake

Camp Lake has extensive wetland and aquatic plant beds, both sustaining important wildlife and fishery resources. The floating mat of cattails along the entire southern part of the lake provide nesting habitat for muskrat, mink and beaver. Marsh-nesting birds, such as American Coot, Gallinule, and Pied-billed Grebe are likely nesters within the marshes, especially along the excavated channels. Canada Goose, Blue-winged Teal, and Mallards are commonly seen throughout the lake during the breeding season. Sandhill Cranes are known to nest within the Valmar Marsh, which flows into Camp Lake Canal.. During migration, large flocks of waterfowl congregate on the lake. The shallow, well-vegetated flats in the lake provide excellent feeding and stopover grounds for puddle and particularly diving ducks.

The Camp Lake fishery is moderate, although the lake is susceptible to periodic winterkill due to shallow depths. Panfish, northern pike and largemouth bass are the most common gamefish in the lake The panfish show signs of stunting, likely due to the dense aquatic plant beds and lack of access by predator fish. The size of the northern pike appears to be depressed, possibly due to overharvesting (Doug Welch, personal communication). Rough fish are a potential problem in the lake. Many attempts to establish walleye populations have been unsuccessful and efforts were discontinued in 1980.

Center Lake

Wildlife habitat within the lake system generally is provided by the wetland areas along the northeastern and eastern perimeter of the lake. Muskrat, mink and other common wetland-associated wildlife are likely inhabitants. Red-wing Blackbirds, Common Yellowthroat and Marsh Wrens would be expected throughout the marshes. Migratory waterfowl also use this lake for stopover but the greater overall depths limit use for puddle and diving ducks.

Center Lake's fishery is healthy and self-sustaining. The major game fish populations include crappie, bluegill, largemouth bass, northern pike and walleye. Fishkills do not occur due to adequate wintering depths.

RESULTS OF AQUATIC PLANT SAMPLING

Methodology

The aquatic plant survey was conducted using the guidelines adopted by the WDNR. The macrophyte survey procedures are based on the grid sampling methodology of Jessen and Lound (1962) and recently modified by Deppe and Lathrop (1992). The method utilizes a grid system determined by the size and morphology of the lake, adequate to achieve transects to survey all major submergent plant communities and specific areas of interest. No attempts were made to catalog riparian wetland areas. Transects were established on both lakes beginning in shallow water and continuing to deep water devoid of aquatic vegetation

Data were collected at regular depth intervals, with the most intensive sampling at shallower depths where most plant growth and diversity occurred. Depths were determined by use of a graduated pole. An electronic depth finder provided erroneous data due to interference caused by the density of aquatic plants Aquatic plants were sampled at the following depths: 1.5 ft. (5m), 3 ft. (1m), 4.5 ft. (1.4m), 6 ft (1.8m), 7 5ft (2.3m), 10 ft. (3m), 12.5 ft. (3.8 m) and 15 ft. (4.5m). Center Lake was sampled to the depth category of 3.8m due to lack of plants at deeper depths.

Utilizing a garden rake modified with an extended handle, the sample point was divided into four quadrants (i.e., four corners of the boat). The rake was then cast out and retrieved. Each encountered species was identified to species (when possible) and assigned a density rating (Deppe and Lathrop, 1992) based on the following scale:

Rake Coverage of Species	Density Rating
81–100% of rake head covered	5
61–80% of rake head covered	4
41–60% of rake head covered	3
21–40% of rake head covered	2
1–20% of rake head covered	1
No plants recorded	0

Figure One provides a graphical representation of the various rake densities.

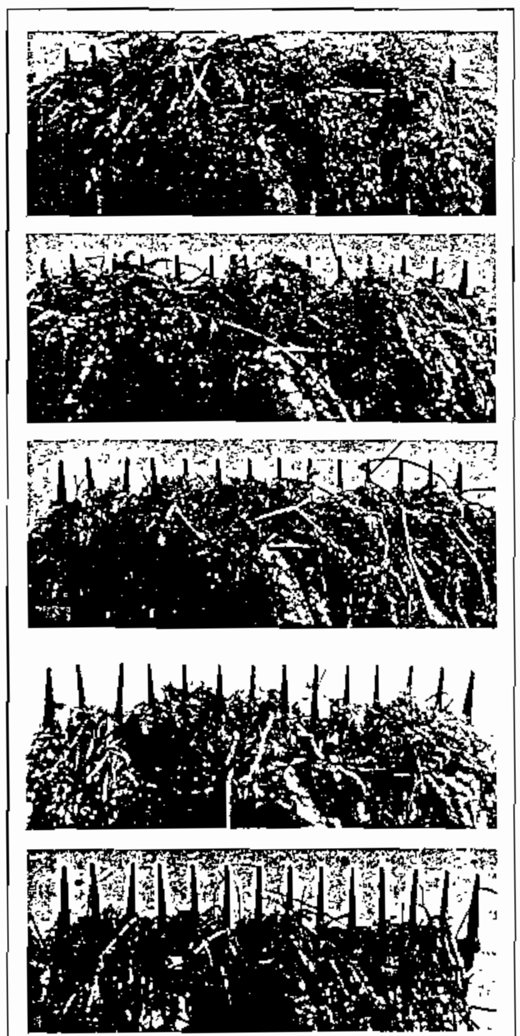

Figure One - Examples of rake fullness, illustrating density ratings assigned by the RC technique for an individual species. Ratings, from top to bottom are 5 to 1. (Deppe and Lathrop, 1993)

Total rake density estimates also were made as a visual estimate of all species encountered on the rake head. This sampling point data were used to compute mean density ratings, additive density ratings, transect densities, depth densities and overall species density statistics.

Additional information during the field work included substrate composition and wildlife observations. Secchi depth (Lind, 1979) was determined on each sampling day.

Plant nomenclature follows Swink and Wilhelm (1994). Other references used for plant identification included Winterringer and Lopinot (1966), Fassett (1969) and Voss (1967; 1972). Given the difficulty in differentiating species of *Myriophyllum*, it was assumed that unidentifiable fragments or non-flowering plants were Eurasian milfoil (M. *spicatum*) Representative plant specimens for most species were collected and pressed.

Camp Lake

A total of 15 transects were surveyed during late-July, 1993 to categorize the vegetation communities and distribution within Camp Lake (Exhibit 4). Exhibit 5 is an aquatic vegetation map representing the dominant species within major depth categories. Average Secchi depth was 4 feet during the sampling period. Maximum rooting depth was 15 feet, with vegetation found consistently to that depth. The littoral zone occupies 96% of the lake area, with only 16 acres devoid of submerged or emergent vegetation A total of 32 species were encountered during the transects surveys (Table 3). Species occurring along shorelines in very shallow water or in riparian wetlands were not included in the species list. Appendix A provides the summary data tables of the results of the rake surveys along the designated transects Appendix B provides transects summary data. Appendix C are the summary statistics of the depth categories.

By far the most commonly occurring plant within Camp Lake was widgeon grass, having been found in 92% of all sampling locations, with a mean density rating of 1.12. Densities of widgeon grass were highest in the 1.8m depth category and were especially common in the central portion of the southern lake, with densities approaching biological maximums. Widgeon grass is not considered a native plant in Wisconsin, although the plant is native to the northern prairie pothole region and the eastern Great Lakes (Fassett, 1969; Nichols and Vennie, 1991). This plant has been reported for only five lakes in Wisconsin (Nichols and Martin, 1990) The exact cause of the extensive population of widgeon grass in Camp Lake given the apparent scarce statewide distribution is unknown at this time.

Table 3. Species Summary Table (from Transect Survey) Camp Lake

Species	Mean Density Rating	Additive Density Rating	Number of Occurences	Total Possibilities	Relative Frequency	Stations Found	Number of Stations	Percent	Abundance
Ceratophyllum demersum	0.81	97.25	271	1230	0.22	89	109	81.65	Abundant
Chara vulgaris	0.07	8.25	22	1230	0.02	11	109	10.09	Very Common
Elodea canadensis	0.03	3.00	12	1230	0.01	6	109	5.50	Common
Heteranthera dubia	0.03	3.75	14	1230	0.01	10	109	9.17	Common
Lemna minor	0.02	2.75	11	1230	0.01	4	109	3.67	Common
Myriophyllum exalbescens	0.25	30.50	108	1230	0.09	56	109	51.38	Abundant
Myriophyllum spicatum	0.40	48.00	162	1230	0.13	67	109	61.47	Abundant
Myriophyllum verticillatum	0.01	1.75	7	1230	0.01	3	109	2.75	Common
Najas flexilis	0.00	0.25	1	1230	0.00	1	109	0.92	Rare
Najas guadelepensis	0.10	12.50	46	1230	0.04	19	109	17.43	Very Common
Najas marina	0.00	0.00	0	1230	0.00	0	109	0.00	Rare
Nuphar advena	0.02	2.25	9	1230	0.01	3	109	2.75	Common
Nuphar variegatum	0.00	0.25	1	1230	0.00	1	109	0.92	Rare
Nymphaea odorata	0.02	2.00	8	1230	0.01	6	109	5.50	Common
Nymphaea tuberosa	0.11	12.75	51	1230	0.04	19	109	17.43	Very Common
Polygonum amphibium	0.00	0.25	1	1230	0.00	1	109	0.92	Rare
Pontedaria cordata	0.00	0.25	1	1230	0.00	1	109	0.92	Rare
*Potamogeton amplifolius**	0.01	1.75	7	1230	0.01	5	109	4.59	Common
Potamogeton crispus	0.00	0.25	1	1230	0.00	1	109	0.92	Rare
Potamogeton gramineus	0.02	2.00	8	1230	0.01	6	109	5.50	Common
Potamogeton natans	0.02	2.00	8	1230	0.01	5	109	4.59	Common
Potamogeton nodosus	0.01	1.25	5	1230	0.00	3	109	2.75	Common
*Potamogeton pectinatus**	0.05	6.25	25	1230	0.02	17	109	15.60	Very Common
*Potamogeton richardsonii**	0.04	4.25	17	1230	0.01	11	109	10.09	Very Common
Potamogeton zosteriformus	0.01	1.50	6	1230	0.00	4	109	3.67	Common
Potamogeton spp.	0.03	3.50	12	1230	0.01	7	109	6.42	Common
Ruppia maritima	1.12	134.75	338	1230	0.27	100	109	91.74	Abundant
*Scirpus acutus**	0.01	1.75	7	1230	0.01	3	109	2.75	Common
Scirpus pungens	0.00	0.50	2	1230	0.00	1	109	0.92	Rare
Sparganium eurycarpum	0.00	0.25	1	1230	0.00	1	109	0.92	Rare
Typha angustifolia	0.00	0.25	1	1230	0.00	1	109	0.92	Rare
Utricularia vulgaris	0.07	8.50	31	1230	0.03	14	109	12.84	Very Common
*Vallisneria americana**	0.09	11.00	34	1230	0.03	20	109	18.35	Very Common
*Zannichellia palustris**	0.00	0.50	2	1230	0.00	2	109	1.83	Common

* High value plant species under Wisconsin Administrative Code NR 107

Coontail was the second most commonly encountered species at 82% of all sampling locations and a mean density of 0.81. Milfoil (both Eurasian and northern water milfoil) combined for a mean density of 0.65, in over 50% of all sample points. Overall diversity of aquatic plants was generally good in the shallow depth categories, with 27 species occurring in the 1m sampling depth. Diversity declined to 9 or less species below 2.3m. The substrate characteristics were primarily silts and muck, with limited sandy areas near shorelines.

Center Lake

A total of 10 transects were surveyed during early-mid August, 1993 on Center Lake (Exhibit 6). Exhibit 7 is the aquatic vegetation map for the lake. Overall plant density and diversity were lower than Camp Lake. Maximum rooting depth was found to be 12-12.5 feet. Secchi depth fluctuated between 2.25 and 3 feet during the sampling Table 4 is the species summary table for Center Lake. A total of 18 species were encountered during the transect surveys. Diversity declined to 5 or less species below 2.3m. The summary statistics for Center Lake are found in Appendixes D, E, and F.

Eurasian milfoil occurred in 84% of all samples, followed closely by coontail at 71%. Spiny naiad, essentially non-existent in Camp Lake, occurred in 45% of the samples. Sago pondweed also was abundant at 43% of all samples. Muskgrass was also common on the harder substrates at 29%. The littoral zone encompasses 82 acres, or 68% at the lake surface. The substrate was primarily silts and sands, with muck in the shallow channels.

Diversity and lower density of the aquatic vegetation in Center Lake as opposed to Camp Lake are likely due primarily to water quality and clarity impacts. Since clear water tends to grow more macrophytic vegetation than turbid water, the lower Secchi disk readings and general clarity of the water would suggest lower plant densities. The shallower rooting depth and limited Secchi depth follows similar trends found by Canfield et al (1985). Narrower littoral zones and limited light availability restricted the plant densities mostly to the near shore areas. Also, Center Lake does have sandier substrates in the non-channel areas than does Camp Lake, which naturally limits most plant densities.

Table 4. Species Summary Table (from Transect Survey) Center Lake

Species	Mean Density Rating	Additive Density Rating	Number of Occurences	Total Possibilities	Relative Frequency	Stations Found	Number of Stations	Percent	Abundance
Ceratophyllum demersum	0.39	31.25	91	430	0.21	35	49	71.43	Abundant
Chara vulgaris	0.09	7.50	23	430	0.05	14	49	28.57	Very Common
Elodea canadensis	0.00	0.00	0	430	0.00	0	49	0.00	Rare
Heteranthera dubia	0.02	1.50	5	430	0.01	4	49	8.16	Common
Lemna minor	0.00	0.25	1	430	0.00	1	49	2.04	Common
Myriophyllum exalbescens	0.02	1.25	5	430	0.01	2	49	4.08	Common
Myriophyllum spicatum	0.32	25.75	91	430	0.21	41	49	83.67	Abundant
Myriophyllum verticillatum	0.00	0.00	0	430	0.00	0	49	0.00	Rare
Najas flexilis	0.00	0.00	0	430	0.00	0	49	0.00	Rare
Najas guadelepensis	0.02	1.75	7	430	0.02	4	49	8.16	Common
Najas marina	0.25	19.75	65	430	0.15	22	49	44.90	Abundant
Nuphar advena	0.04	3.00	8	430	0.02	3	49	6.12	Common
Nuphar variegatum	0.00	0.25	1	430	0.00	1	49	2.04	Common
Nymphaea odorata	0.03	2.00	7	430	0.02	4	49	8.16	Common
Nymphaea tuberosa	0.05	3.75	11	430	0.03	4	49	8.16	Common
Polygonum amphibium	0.00	0.00	0	430	0.00	0	49	0.00	Rare
Pontedaria cordata	0.00	0.00	0	430	0.00	0	49	0.00	Rare
*Potamogeton amplifolius**	0.00	0.00	0	430	0.00	0	49	0.00	Rare
Potamogeton crispus	0.03	2.25	9	430	0.02	5	49	10.20	Very Common
Potamogeton gramineus	0.02	1.25	5	430	0.01	2	49	4.08	Common
Potamogeton natans	0.00	0.00	0	430	0.00	0	49	0.00	Rare
Potamogeton nodosus	0.00	0.00	0	430	0.00	0	49	0.00	Rare
*Potamogeton pectinatus**	0.11	8.50	32	430	0.07	21	49	42.86	Abundant
Potamogeton richardsonii	0.00	0.00	0	430	0.00	0	49	0.00	Rare
Potamogeton zosteriformis	0.00	0.00	0	430	0.00	0	49	0.00	Rare
Potamogeton spp.	0.02	1.50	6	430	0.01	4	49	8.16	Common
Ruppia maritima	0.01	1.00	4	430	0.01	3	49	6.12	Common
*Scirpus acutus**	0.00	0.00	0	430	0.00	0	49	0.00	Rare
Scirpus pungens	0.00	0.00	0	430	0.00	0	49	0.00	Rare
Sparganium eurycarpum	0.00	0.00	0	430	0.00	0	49	0.00	Rare
Typha angustifolia	0.01	0.50	2	430	0.00	2	49	4.08	Common
Utricularia vulgaris	0.02	1.75	6	430	0.01	2	49	4.08	Common
*Vallisneria americana**	0.19	15.25	51	430	0.12	20	49	40.82	Abundant
*Zannicheltia palustris**	0.00	0.00	0	430	0.00	0	49	0.00	Rare

* High value plant species under Wisconsin Administrative Code NR 107

The diversity could be affected by the water clarity and predominance of nuisance species such as coontail, milfoil and spiny naiad. Also, Center Lake has had aquatic herbicides applied to it in the past, which possibly decreased the diversity of native species. Center Lake is upstream of Camp Lake and acts as a large filtering pond, promoting sediment deposition and some nutrient uptake prior to discharge to Camp Lake.

ALTERNATIVES FOR AQUATIC PLANT CONTROL

Various methods of aquatic plant control are available to lake managers, including dredging, mechanical harvesting, herbicide usage, and shading, among others (Dunst, et al, 1974; Nichols, 1991; Engels, 1990,; Winkelman and Lathrop, 1993). Some of the techniques are impractical on a large scale, since the actual biomass and surface area for treatment are often too extensive for the techniques to be effective. Other techniques have drastic impacts on other lake functions. Appendix G provides an overall summary of aquatic plant management options.

Hand cutting tools and weed "rollers" are manufactured for use by private residence owners to clear areas along piers and docks. This equipment allows for "manicuring" small areas for recreational use, although it cannot remove much plant material on a large scale or in deeper water. Similarly, several types of specialty rakes and drags are made to clear small areas of aquatic plants. McComas (1993) provides a useful summary of available equipment and manufacturers. These items are relatively inexpensive but are labor intensive if the aquatic plants are dense.

Another technique available to limit aquatic plant growth is to install mats or barrier fabric on the lake bottom, thereby shading out the vegetation. These barriers are best installed in spring after fish spawning but before dense plant growth. The fabric is attached to the lake bottom during the growing season and removed during the winter. This technique works best in shallow water where installation is the easiest.

The potential for dredging specific areas in both lakes has been considered by the District, which commissioned a dredging feasibility (R.A. Smith and Associates, Inc., 1994). Cost constraints (estimated cost of over $1 million) and permitting requirements make dredging an unattractive option at this point in time Dredging would alleviate some of the access problems in shallow channels and near shore areas along private shorelines However, dredging can lead to a decrease in plant species diversity and cause a shift toward disturbancetolerant species such as Eurasion milfoil (Nichols, 1984). Also, the major aquatic plant problem areas on Camp Lake would not be addressed.

Aquatic herbicide usage can provide excellent plant control over large areas when properly applied. However, some research has shown that herbicide usage may have detrimental effects on lake ecosystem processes. Aquatic herbicides are available in various chemical forms and applications, with the proper chemical chosen depending on target species and growth forms. The average cost of commercial aquatic herbicide application runs approximately $200 -350/acre. Permits are needed from the WDNR, including approved quantities, chemicals and application areas

The District decided by popular vote at the 1991 annual meeting to adopt a policy of no District sponsored herbicide usage on either Camp or Center Lake. The most common choice by District constituents was to institute a mechanical harvesting program to be conducted by a private contractor At that same time, it was decided to begin budgeting set-aside monies in anticipation of the District purchasing its own harvesting equipment at some future time. Therefore, this report describes in detail a mechanical weed harvesting program.

PROPOSED MANAGEMENT PLAN

Overall Management Strategy -- Both Lakes

The overall goal of the aquatic plant management program should be to implement management strategies to provide lake access for private and public lake users, while trying to implement lake restoration techniques where possible (Nichols, 1991) The specific goals of the aquatic plant harvesting program are as follows:

1. Provide nuisance aquatic plant control to increase lake use and access, while protecting valuable natural resources.
2. Utilize mechanical harvesting techniques for aquatic plant management to limit disturbance to the lake ecosystem.
3. Educate district landowners about benefits of aquatic vegetation and various near shore aquatic plant control options.
4. Provide better fishery opportunities through aquatic plant management, especially nuisance plant species control.
5. Protect and restore valuable wildlife and fish habitats

Specific areas on both lakes will need to be harvested repeatedly each year, with the expressed goal of removing the most plant biomass possible (e.g., channels and access points). However, other areas in the lakes may be able to be harvested in ways which remove only nuisance plant materials in the upper water column to allow boating while promoting the growth of more desirable species. The key goal of the harvesting program must be adequate control of aquatic plants (especially nuisance species) in common use areas of the lakes, while protecting valuable aquatic resources (Table 5).

Table 5. Aquatic Plant Management Recommendations for Different Areas of Lakes

	No Restriction Area	Watch Area	Sensitive Area
Criteria	Areas of lake with limited plant diversity; high densities of nuisance species	Areas which contain increasing densities of desirable species, decreasing densities of nuisance species	High diversity of desirable native species; significant wildlife and fish habitat
Aquatic Plant Management	• Maximize plant harvesting to meet recreational demands • Concentrate on near pier and access areas • Prior to harvesting, monitor for relative densities of nuisance and desirable species	• Maximize harvesting if only nuisance species present • Management should emphasize harvesting of nuisance species by varying cutting depths when desirable species are encountered through rake sampling • Potential for lake plant restoration through long-term control of nuisance species	• Strictly prohibited except for channel clearing only • Harvesting restricted to boat access only • Some strategic harvesting possible for approved fish management projects
Aquatic Plant Harvesting	Maximized under most conditions	Few restrictions, unless desirable species dominate	Prohibited, except for channel clearing
Activity Restrictions	None	None	Limited boat traffic; No Wake zones

(Adapted from Winkleman and Lathrop, 1993)

Prior to the implementation of the annual harvesting program, it would be highly desirable to dispatch a "weed scout" to determine area-specific management strategies for that harvesting period. The "weed scout" could be any reasonably trained person familiar with overall aquatic plant management strategies and basic plant identification (e.g., harvesting contractor personnel, District consultant, lake volunteer, etc.). By executing spot monitoring of the aquatic plant communities within specific areas, priority harvesting zones, cutting depths and intensities can be formulated. Also, information on general plant community trends and water quality (e.g., Secchi depth) can be collected. It would be most appropriate to monitor those areas where plant densities change yearly and where harvesting is not always mandatory. In other words, detailed sampling in areas near access points or navigation channels where harvesting will likely take place perennially regardless of the species composition or relative densities may be less useful than in off-shore plant beds where cutting for fishing or water skiing is desirable. The "weed scout" should make an inspection in all non-channel areas at least once per month during the growing seasons to assess the overall species composition and densities to be able to make recommendations for harvesting priorities.

The best way to determine the desired harvesting intensity would be to conduct rake surveys at specific locations, estimating the rake densities of all encountered species. If undesirable or "weedy" species densities are medium or high, harvesting should be implemented. Conversely, if "weedy" species occur in limited densities, harvesting should be prioritized for other areas. The index for rake densities in this context is defined as: Low = 1-2; Medium = 3-4; High = 5 (Winkelman and Lathrop, 1993).

At this point in time, "weedy" species shall be defined as those species (native or exotic) which produce excessive biomass as to hinder realistic lake uses. For Camp Lake, these species are coontail, northern water milfoil, Eurasian milfoil and widgeon grass. For Center Lake, these species are coontail, northern water milfoil, Eurasian milfoil and spiny naiad.

Limiting disruption of native aquatic plant beds meets long-term lake management goals by maintaining plant materials for recolonization of areas of the lakes which now may be dominated by nuisance species. The cyclic nature of Eurasian milfoil, improvements in watershed protection and general effectiveness of the harvesting program may promote improved conditions for the increased densities of desirable native species whose growth forms and biomass production tendencies may be more compatible with lake uses (Engel, 1987, Nichols et al, 1988). For example, most pondweeds, wild celery, and water stargrass are desirable native species that generally do not become nuisance species. These species most often grow in lower densities than the nuisance plants and provide excellent wildlife and fish resources. Through the limited or reduced harvesting of these and similar species, their populations may flourish and compete with the "weedy" species that are being continually harvested. The protection of the desirable species will provide natural "seedbanks" or "plantbanks" for re-establishment into other areas of the lakes. Figure Two shows the implementation of this type of management strategy. Appendix H provides a flow chart to assist with the development of harvesting strategies based on the aquatic plant density and composition of that cutting period.

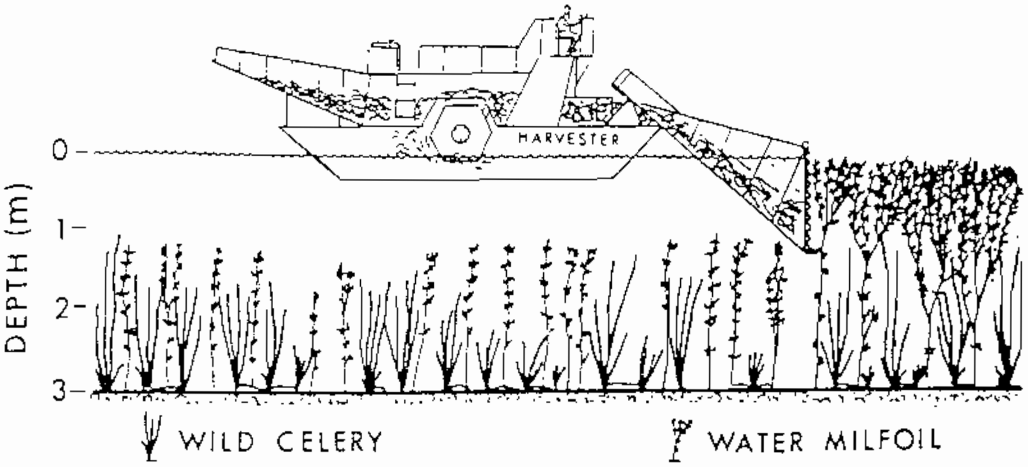

Figure Two - Selective harvesting by varying the cutting depth can promote the growth of desirable species (Engel, 1987).

Camp Lake

The primary goals of the aquatic plant management program are to increase recreational boating and fishing opportunities by clearing navigation access channels in the central lake, and channel cutting and near pier cutting along residential shoreline areas. By far the largest management hurdle is the extensive and dense aquatic plant beds which occupy much of the southern two-thirds of this lake. Water depths generally are less than six feet and often average only three feet The aquatic plant beds, both submerged and floating leaved growth forms, occupy most of the lake. The northern end of the lake is deeper and water depth tends to control plant growth in that area. However, the shallow shoreline areas also contain dense macrophyte beds.

Exhibit 8 shows the proposed harvesting zones and cutting intensities for Camp Lake. Access to and from all boat landings and private piers should be prioritized Navigation channels within the lake proper will be necessary to allow boat traffic to pass from the northern to the southern end of the lake. The main harvested channels should be at least two cutter width's wide, wider if time permits and plant densities are low.

Cutting needs to be limited in the southern and western ends of the lake, roughly corresponding with the water lily and hard stem bulrush beds. These areas contain high numbers of desirable native species and are not suitable for intense recreation uses. Spot harvesting in strategic areas for fishing access is acceptable, as long as the harvesting does not promote the expansion of undesirable species. Motor boat intrusions into these areas should be kept to a minimum to prevent fragmentation of species such as coontail and milfoils which may then invade the beds. Also, boat traffic and harvesting should be limited in near shore areas along developed shorelines which are found to contain low densities of the aforementioned "weedy" species.

Access for unloading harvested plants onto shore conveyors and into hauling trucks is available at three locations (Exhibit 8). It is estimated that a minimum of 4 weeks at roughly 150 hours of harvester time assuming a 9 foot harvester will be needed to implement one base cutting to maintain reasonable boat access and recreation, although much of the southern end of the lake will remain inaccessible even to small watercraft. This equates to approximately 75 acres of harvested area, roughly 30% of the non-sensitive area lake surface and including all channel areas. Another 25 acres of harvesting would open up approximately one half of the non-sensitive area lake surface to recreational uses. If plant densities are lower, greater channel widths could be opened up within the same time commitment. A second channel clearing of similar cutting intensity should be expected annually.

To protect spawning fish habitat; cutting should be limited until after June 15 (Doug Welch, WDNR; personal communication). The WDNR will not approve any harvesting plan that promotes large scale cutting in off-shore areas prior to June 15. However, realizing that weed growth already can be restrictive by late May, harvesting can begin along the more developed shoreline areas and access areas and avoid more natural shorelines and plant beds. This corresponds well with the general harvesting approach of promoting access. Cutting into larger plant beds away from shore should begin around June 10-20 to allow for spawning fish to complete their breeding and disperse from the nesting grounds. No wholesale harvesting should begin until channels have been cleared, or June 15, whichever comes first. The rapid growth rates of the plants in shallow water (e.g. channels) minimizes the effectiveness of cutting the plants too early in the season.

To increase fishery opportunities, lanes could be cut perpendicular to the main navigation lanes to open up access for fishing. Research conducted in Wisconsin has shown that areas at the edge of aquatic plant beds generally have the highest usage by bluegill and other prey species (Storlie, et al, 1995). This is likely due to the increased macroinvertebrate production along this ecotonal edge between plant beds and open water. By harvesting lanes in the previously dense plant beds, greater edge habitat could be created. This would provide greater food success for smaller fish and better access for larger fish to prey upon them. Also, fisherman access would be greater, allowing for more of the lake to be more successfully fished. A possible configuration for these "fishery enhancement lanes" is shown on Exhibit 8.

Center Lake

Aquatic plant harvesting is most imperative in the channels adjoining residential properties. Once out of the channels, harvesting locations depend on the specific locations of plant beds. Water depth, water clarity and to a lesser degree substrate are the main factors limiting aquatic plant growth within this lake. The channels are shallow and contain highly organic sediments, providing ideal growth conditions for macrophytes. Harvesting in the channels should optimize plant removal, since a high percentage of the species are undesirable.

Cutting depths should be raised in areas of high concentrations of eelgrass. Harvesting in the lily beds along the northeastern shore should be conducted for fishing access only. Similar fishery enhancement lanes as described for Camp Lake could be implemented in specific areas (Exhibit 9). No harvesting should be conducted in these areas until nuisance plant control has been achieved. The lily beds require only 2-3 weeks for growback, limiting the effectiveness of the harvesting. Motor boat access also should be restricted to limit disruption of the generally desirable plant species which grow there following the same reasoning as on Camp Lake.

AQUATIC PLANT HARVESTING EQUIPMENT

To achieve the goals and objectives of this aquatic plant management plan, certain pieces of harvesting and accessory equipment will be necessary. It has been estimated that a maximum of 220 acres (100 acres targeted) of Camp Lake and 45 acres (34 acres targeted) of Center Lake littoral zone could be harvested in any given season to implement the plan. Therefore, the equipment ultimately purchased will need to be adequate to begin the District-run harvesting program.

There are several different equipment scenarios that can be considered to implement the plan These scenarios vary on available funding, worker and maintenance requirements, auxiliary equipment needs, among other factors. Regardless of the combination of equipment that is decided upon by the District, the harvesting requirements of both lakes must be considered. The harvesting needs are considerably different on the two lakes, although baseline equipment needs are similar.

The actual amount of littoral zone that requires cutting every year will remain relatively constant on both lakes. However, additional time would be necessary to conduct restoration cuts or create lanes for fishery enhancements once the baseline cutting is completed. The equipment should allow for some flexibility to provide additional time for harvesting for more than utilitarian purposes (i.e., lake access).

Harvesting in areas between piers and in very shallow areas along residential shorelines would be best accomplished using small hand operated weed cutters or similar equipment. The District could encourage Homeowner Associations to purchase equipment for use by their member, or the District could purchase several cutters for use by the CCLRD members. The users of the equipment would be responsible for collecting the cut weeds and disposing of them properly.

Using the guidelines provided by a major manufacturer of harvesting equipment, the theoretical and practical harvesting acreages are provided below. These guidelines will help to decide which equipment is best suited for the cutting needs of these lakes. The guidelines are:

Harvester Width	Theoretical (ac/hr) Harvesting	Practical (ac/hr) Harvesting
5 foot	.61	.30
7 foot	.85	.425
9 foot	1.09	.505
10 foot	1.21	.61

For example, it would take a 5 foot harvester approximately 115 hours (34 acres/.3 ac/hr) to cut the projected 34 acres of Center Lake requiring harvesting. Therefore, it would take 3 weeks of cutting time to conduct one baseline cutting of the shallow littoral zone of Center Lake. Similarly, the required harvesting time would be around 70 hours (34 acres/.505 ac/hr) if a 9 foot harvester was used on the lake. The calculations would be similarly made for Camp Lake. The efficiency ratings can be greatly increased if the travel distances for unloading harvested plants to a shoreline drop-off location are short. Also, the use of a transport barge to collect the harvested plants directly from the harvester without the harvester having to return to shore can increase the harvesting efficiency to nearly 90 percent of theoretical.

With the large amount of combined littoral zone for both lakes, a single 5 foot harvester would be impractical to provide adequate harvesting to promote better lake usage. Also, virtually no "leisure cutting" time would be available to allow for restoration cutting or fishery management purposes. The smallest practical harvester for use on these lakes would be at least a 7 foot harvester, which would require approximately 8 weeks to conduct one base cutting on both lakes. The use of a transport barge would be highly desirable to maximize nuisance species control and allow better flexibility in aquatic plant management. This would decrease the harvesting time to approximately 4.5 weeks. For the 9 foot harvester, 6.6 weeks (3.5 weeks with a transport barge) would be necessary for one base cutting. These calculations assume a 40 hour work week.

The use of two harvesters (e.g., one 5 foot and one 7 foot harvester) would allow for the harvesting of weeds simultaneously on both lakes, minimizing conflicts between the lake district members. However, labor and equipments needs are higher for this scenario. Two harvesters, if they were not cutting on the same lake, would require two shore conveyors and likely would overburden one dump truck. If the harvesters would cut on the same lake, this could be avoided.

A trailer would be needed to transport the harvester (and/or barge) to and from the winter storage. Labor to operate the equipment would be at the District's expense, either with temporary summer help directly coordinated by the District or through a cooperative arrangement with the Town of Salem. Dump trucks for hauling harvested plant material to the disposal site either on private agricultural land or gravel pit may be rented or leased locally. Purchase of an older used dump truck by the District may provide the best cost savings in the long run. A truck would have to be available at all times during the harvesting operations.

Storage of the harvesting equipment preferably would be indoors during the winter. However, harvesting equipment could be left our during the winter, possibly on secured township property or private land within the District. Private for hire storage facilities are available should it be necessary.

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EXHIBIT 1

STUDY AREAS
CAMP AND CENTER LAKE
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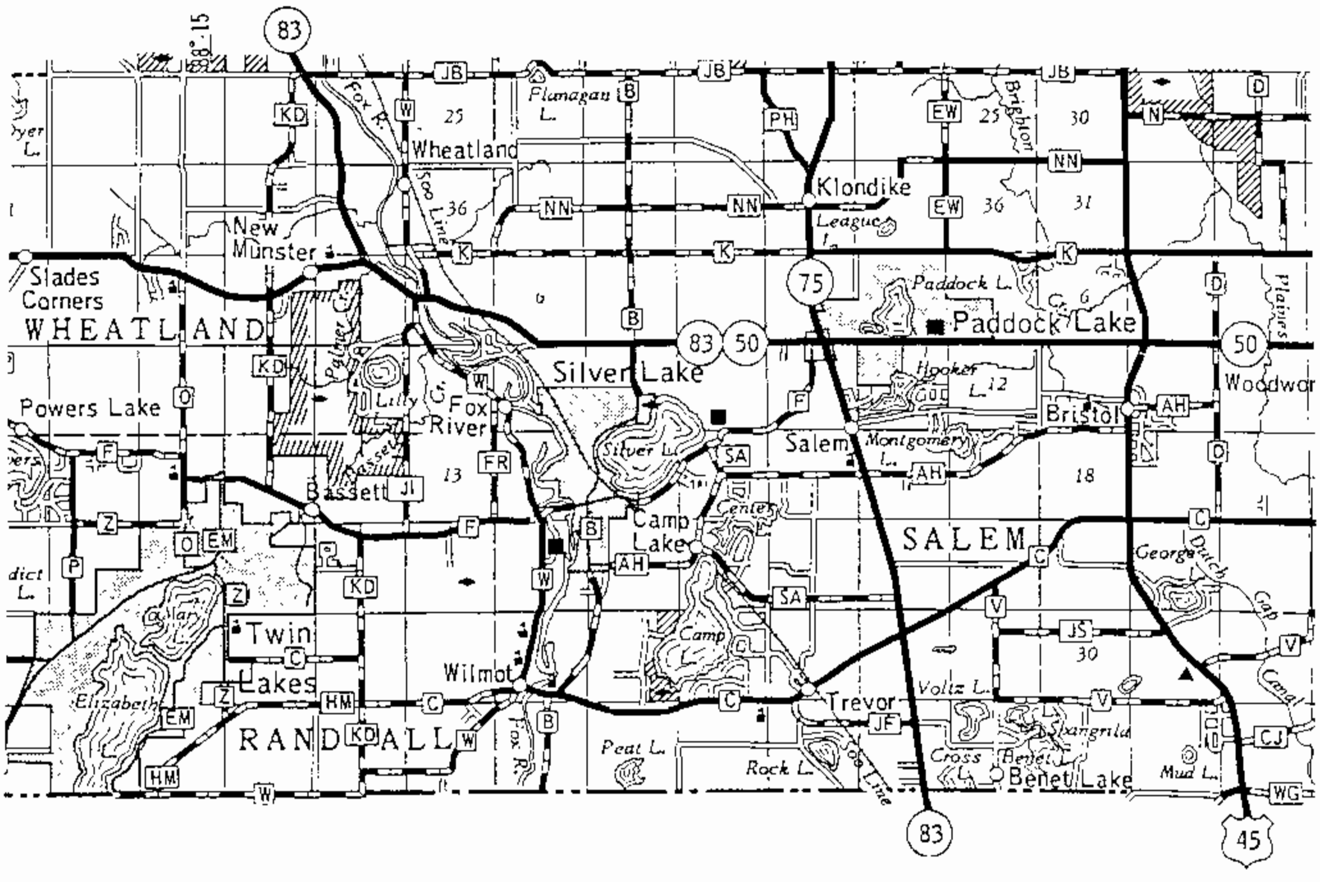

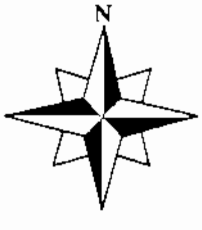

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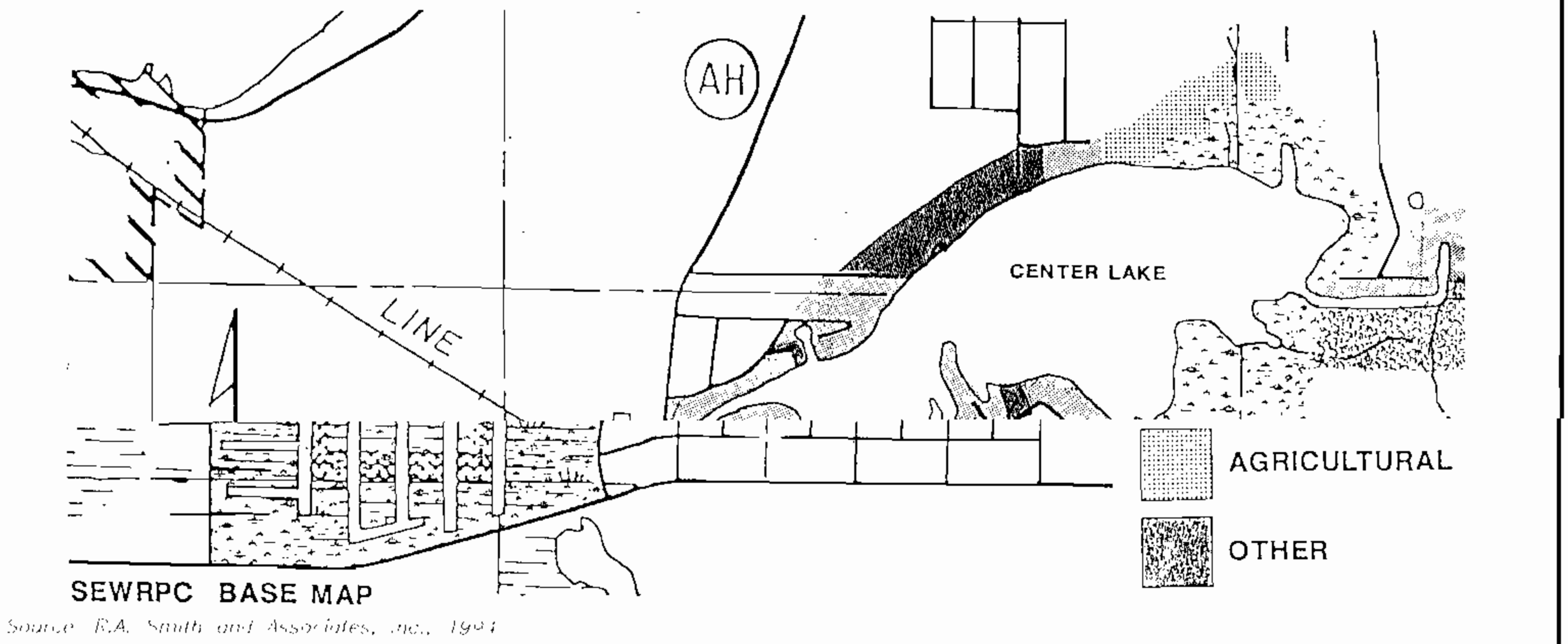

Camp and Center Lake Rehabilitation District

Shoreline Land Uses
Camp and Center Lake

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DRAWN BY	RJL	8/23/94
CHECKED BY	VJM	8/23/94
APPROVED BY		

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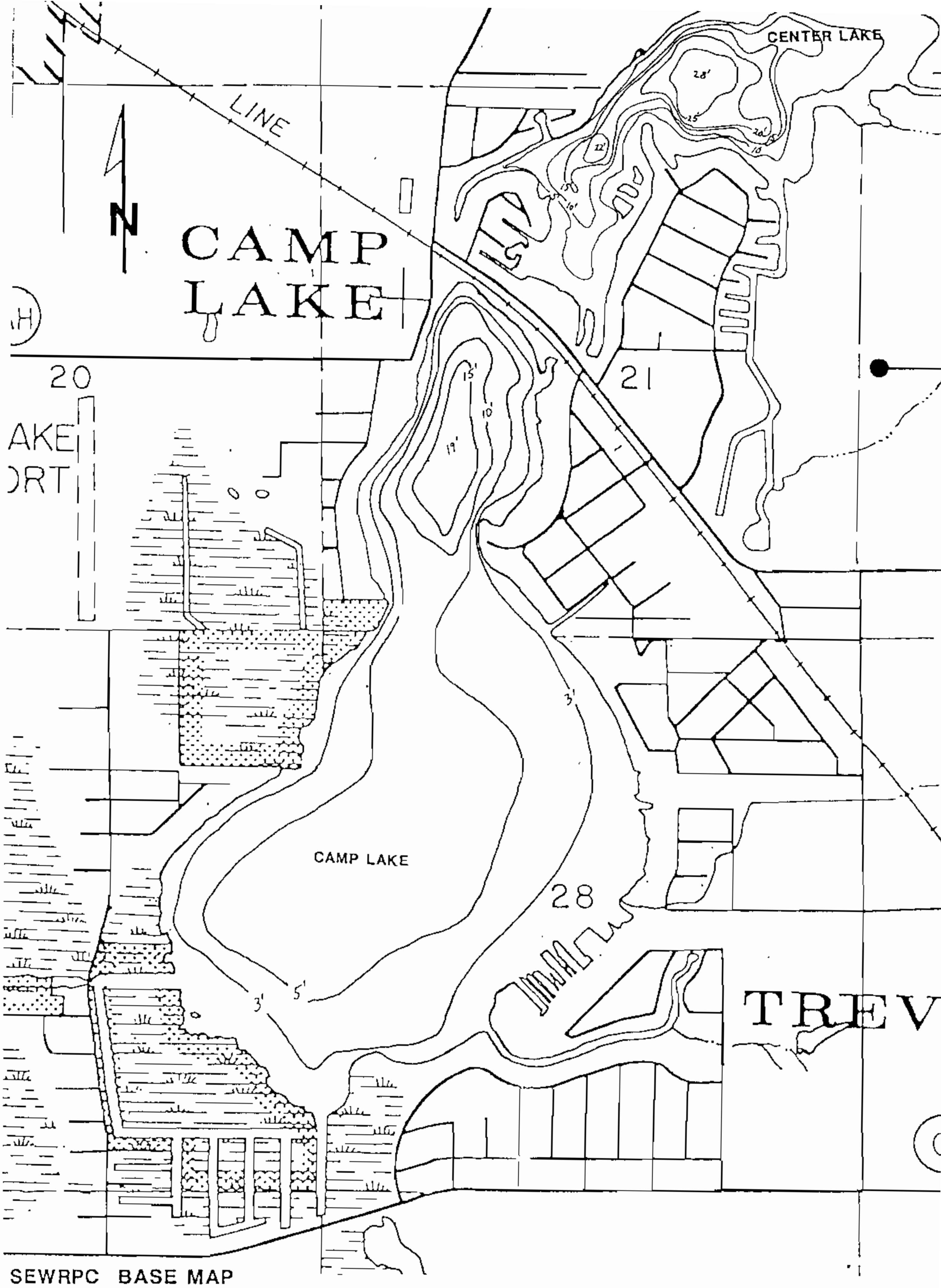
53 West Jackson Boulevard
Chicago, Illinois 60604
Office (312) 922-0777
Fax (312) 922-1823



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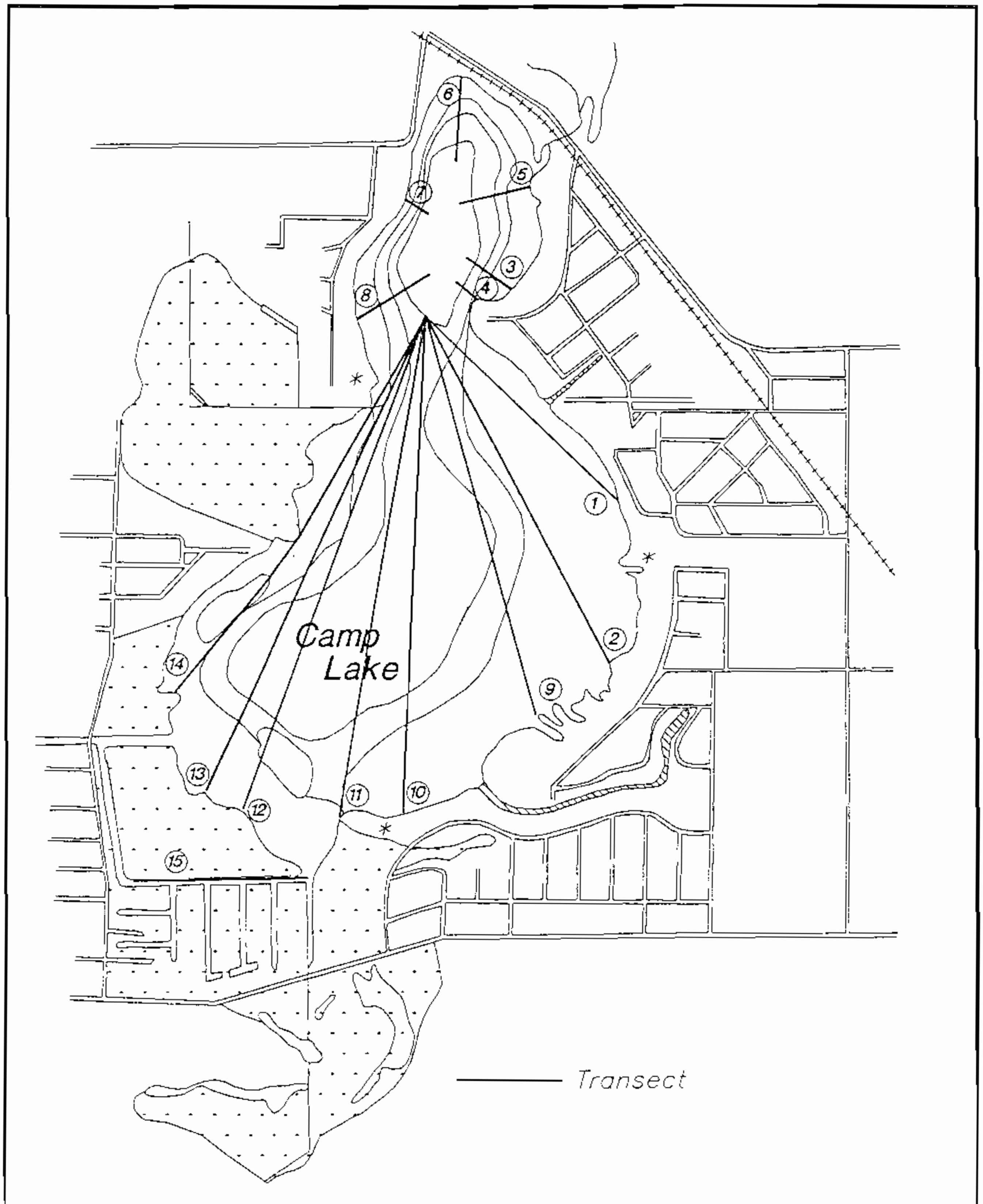

Camp and Center Lake Rehabilitation District

Aquatic Plant Monitoring Transects
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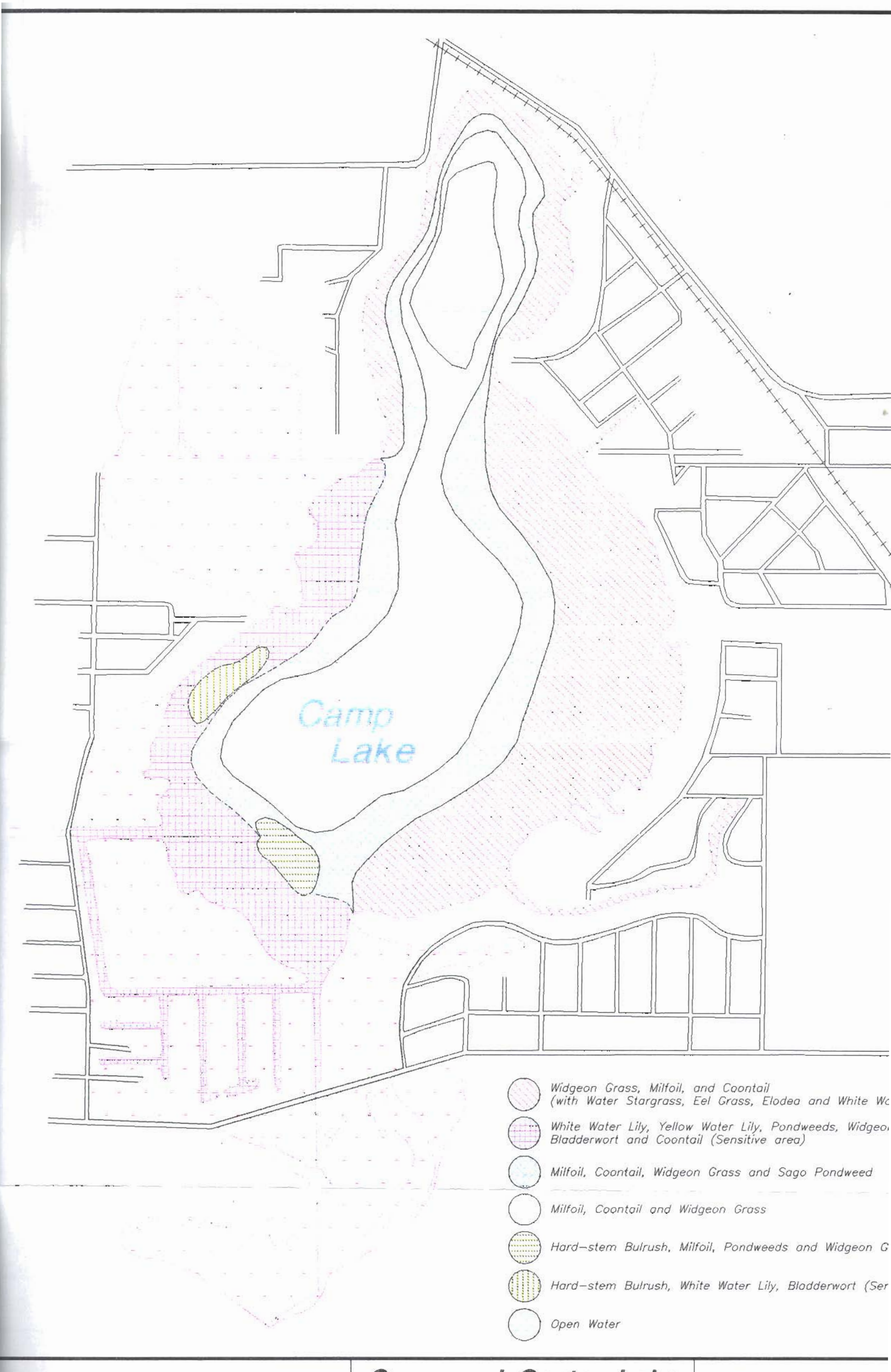

Camp and Center Lake Rehabilitation District

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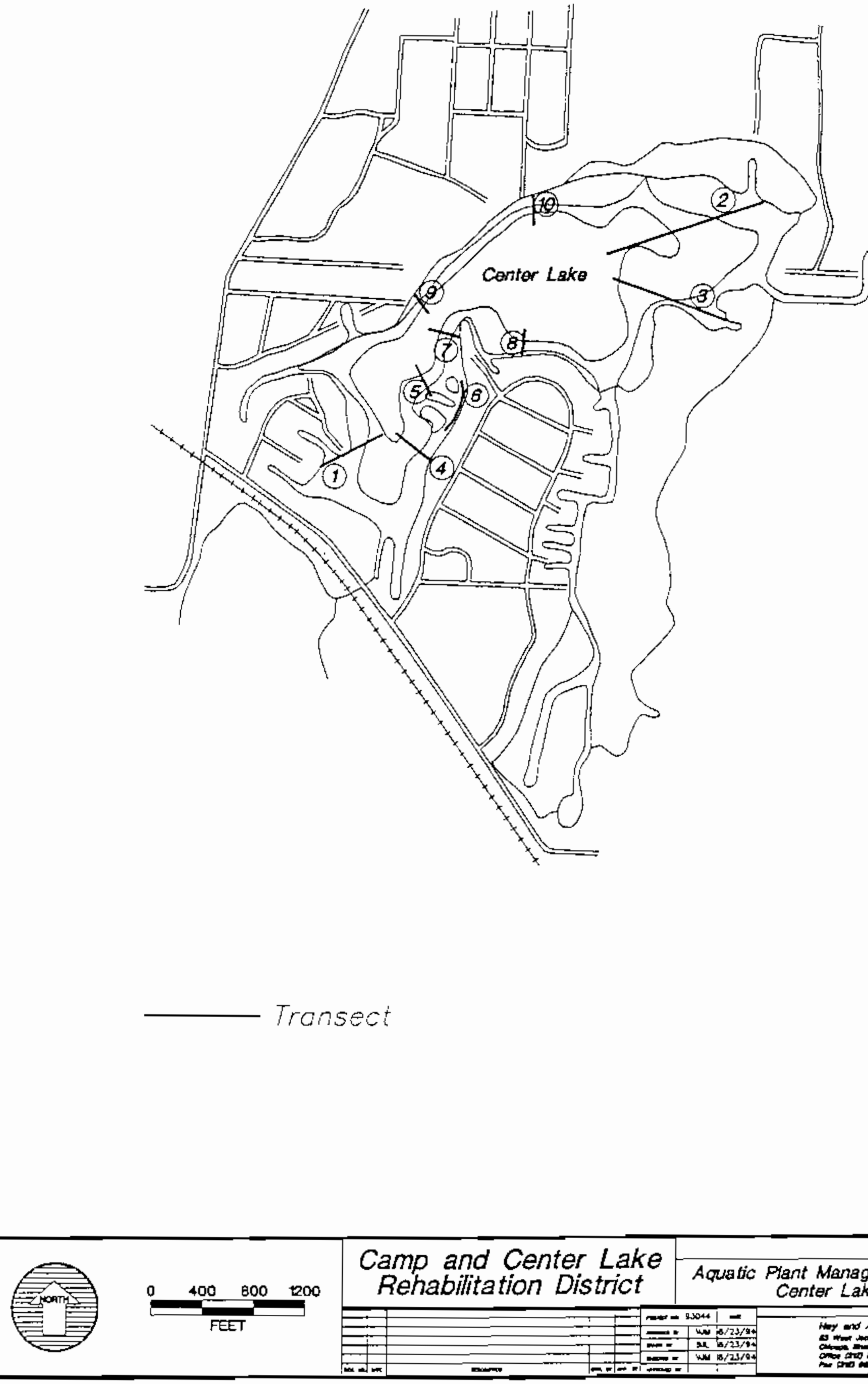

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Camp and Center Lake Rehabilitation District

Aquatic Plant Management Plan
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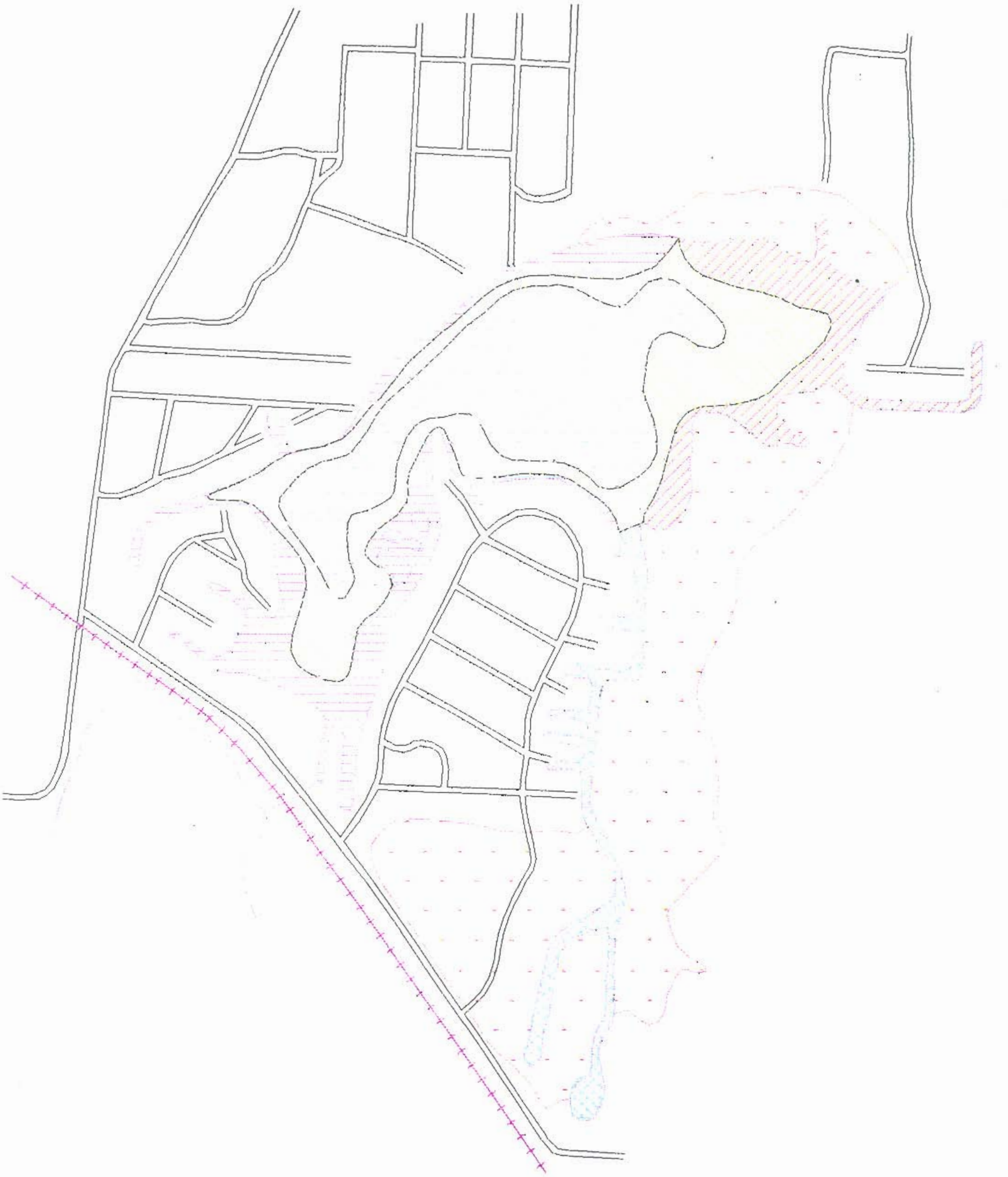


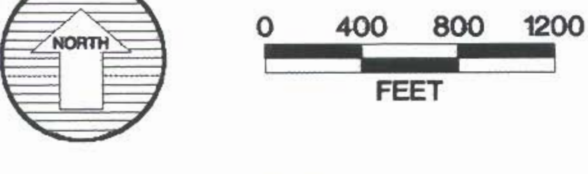
White Water Lily, Yellow water Lily, Coontail, Milfoil, Sago Pondweed and Bladderwort

Coontail, Milfoil and Duckweed

Milfoil, Coontail, Spiny Naiad, and Sago Pondweed

Coontail, Milfoil, and Muskgrass

Open Water



Camp and Center Lake Rehabilitation District

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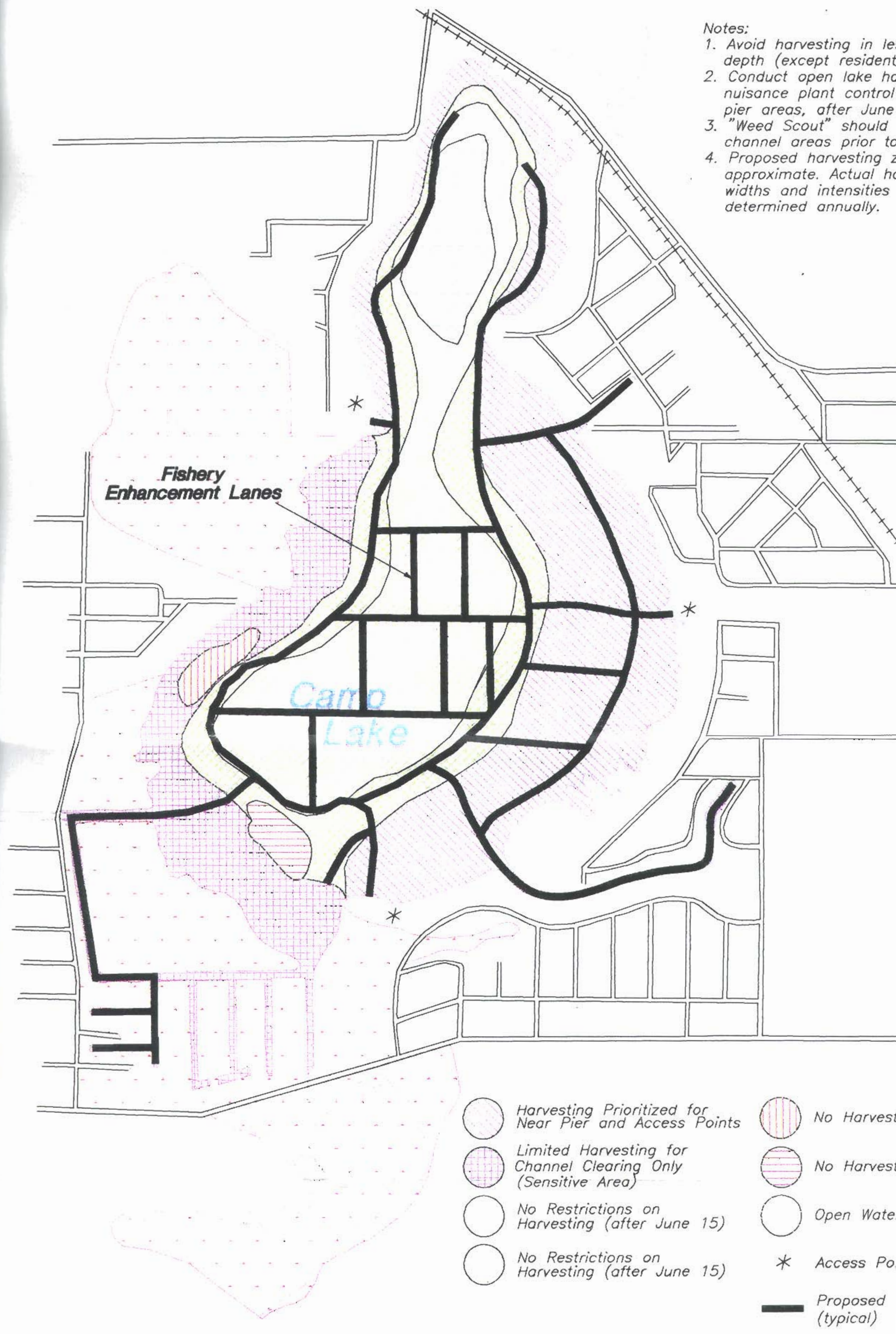

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