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STEEL LAKE

Integrated Aquatic Vegetation Management Plan

Final Report
May 2003

Prepared by:

City of Federal Way
Public Works Department
Surface Water Management Division

ACKNOWLEDGMENTS

The City of Federal Way wishes to acknowledge the significant contribution provided by the members of the Steel Lake Advisory Committee toward the completion of the 2003 Steel Lake Integrated Aquatic Management Plan. Steel Lake Advisory Committee Members include: Myrthelyne Thompson, Margaret Reyhner, Debbie O'Neal, Jack Porter, Art Bender, Bill Linehan and Tom DeZutter.

Staff from the City of Federal Way supporting the project also included: Cary Roe, Paul Bucich, Leslie Ryan-Connelly, and Dan Smith. Many thanks to Marj Currie-Hicks for formatting this report into a well-organized document.

The support of various agency staff is also appreciated, including those individuals who attended meetings and provided both regulatory and technical guidance. We wish to acknowledge: Kathy Hamel (Washington Department of Ecology), Sally Abella (King County Water and Land Resources Division), and Chad Jackson (Washington Department of Fish and Wildlife).

Special thanks to both Drew Kerr and Michael "Murph" Murphy (King County Water and Land Resources Division). Their efforts drafting the Spring Lake IAVMP provided much of the aquatic plant control alternative information and the basis for the integrated treatment plan in this report.

This project was funded in part by a Washington Department of Ecology Early Infestation Grant.

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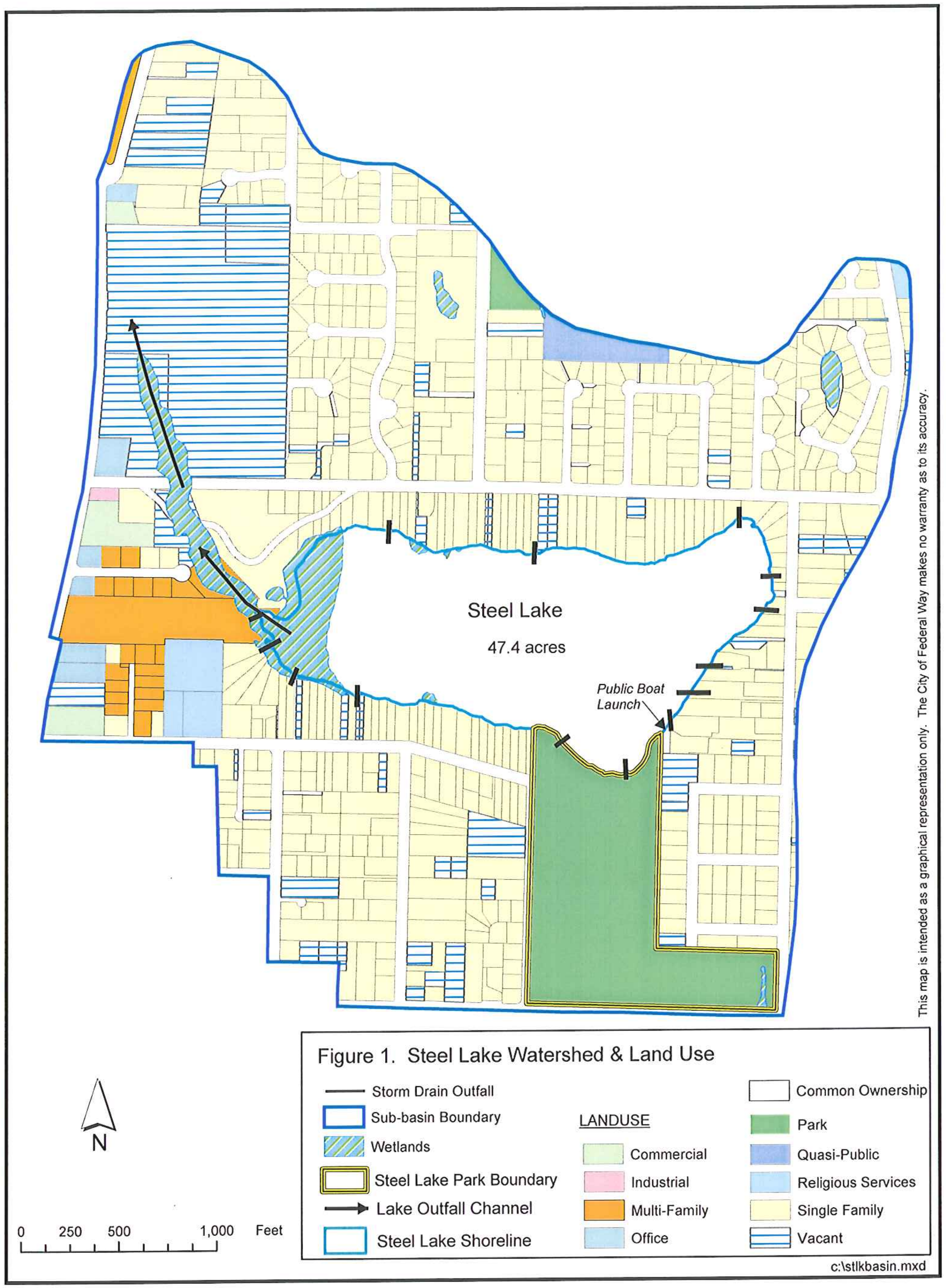

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47.4 acres
Public Boat Launch
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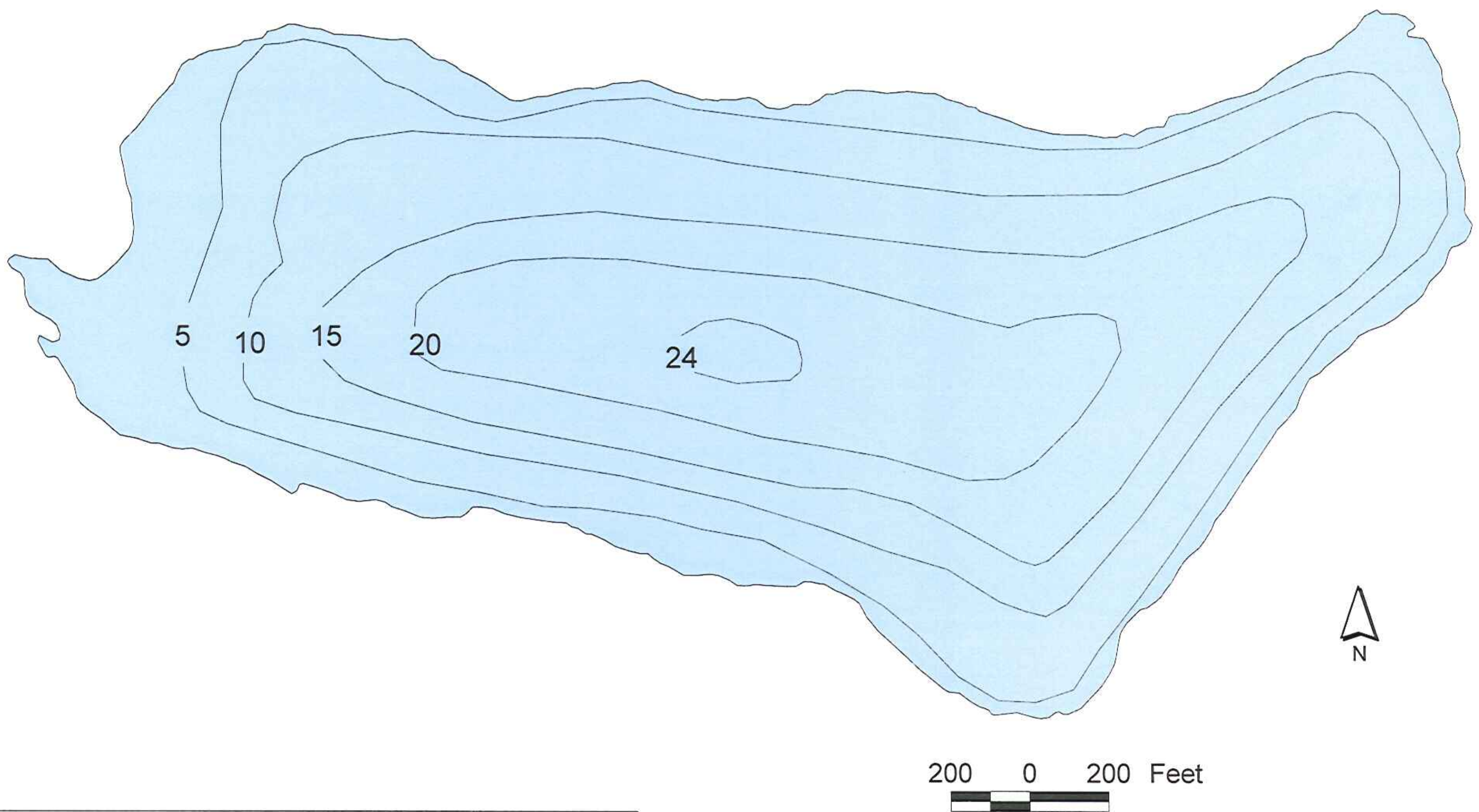

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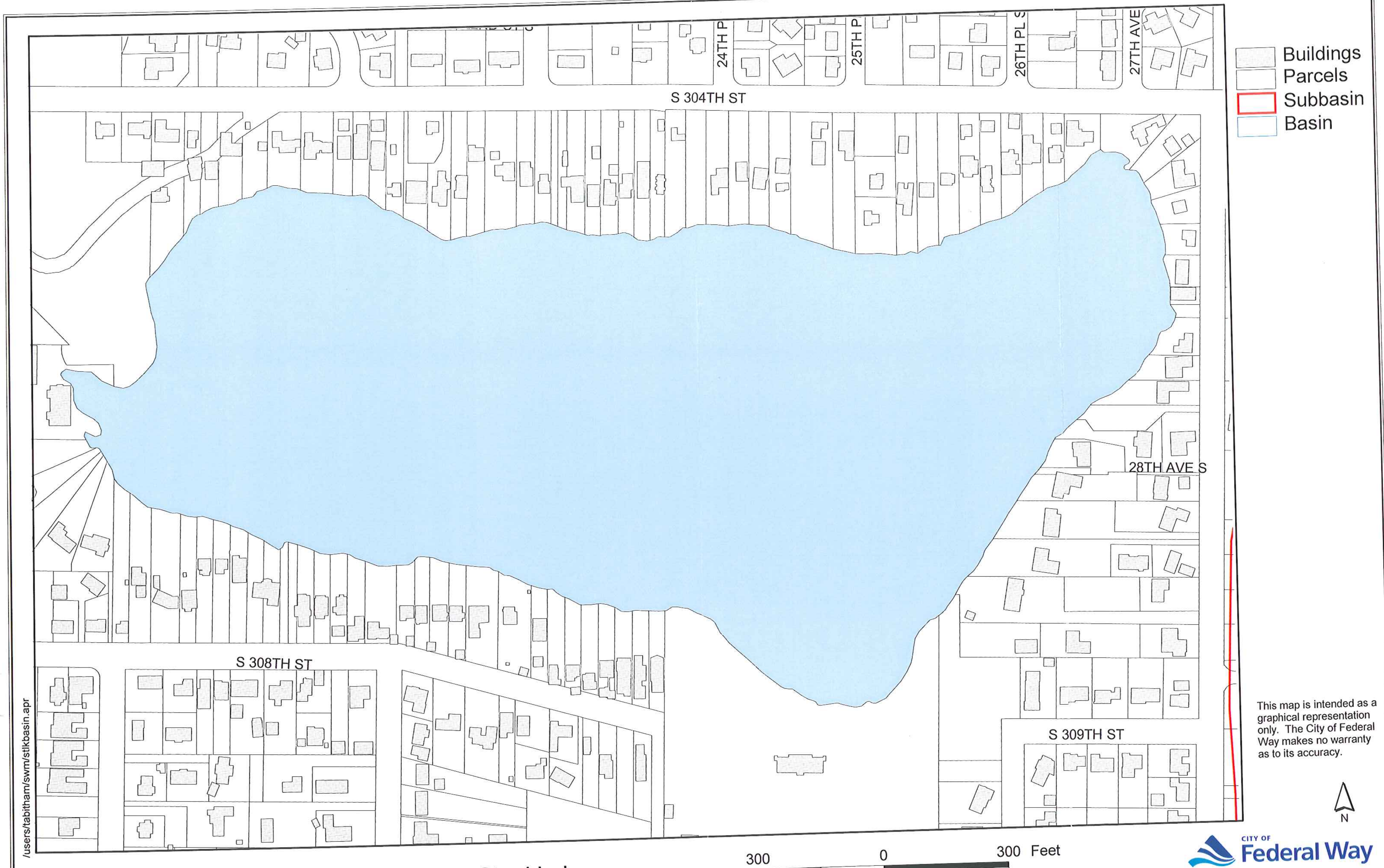

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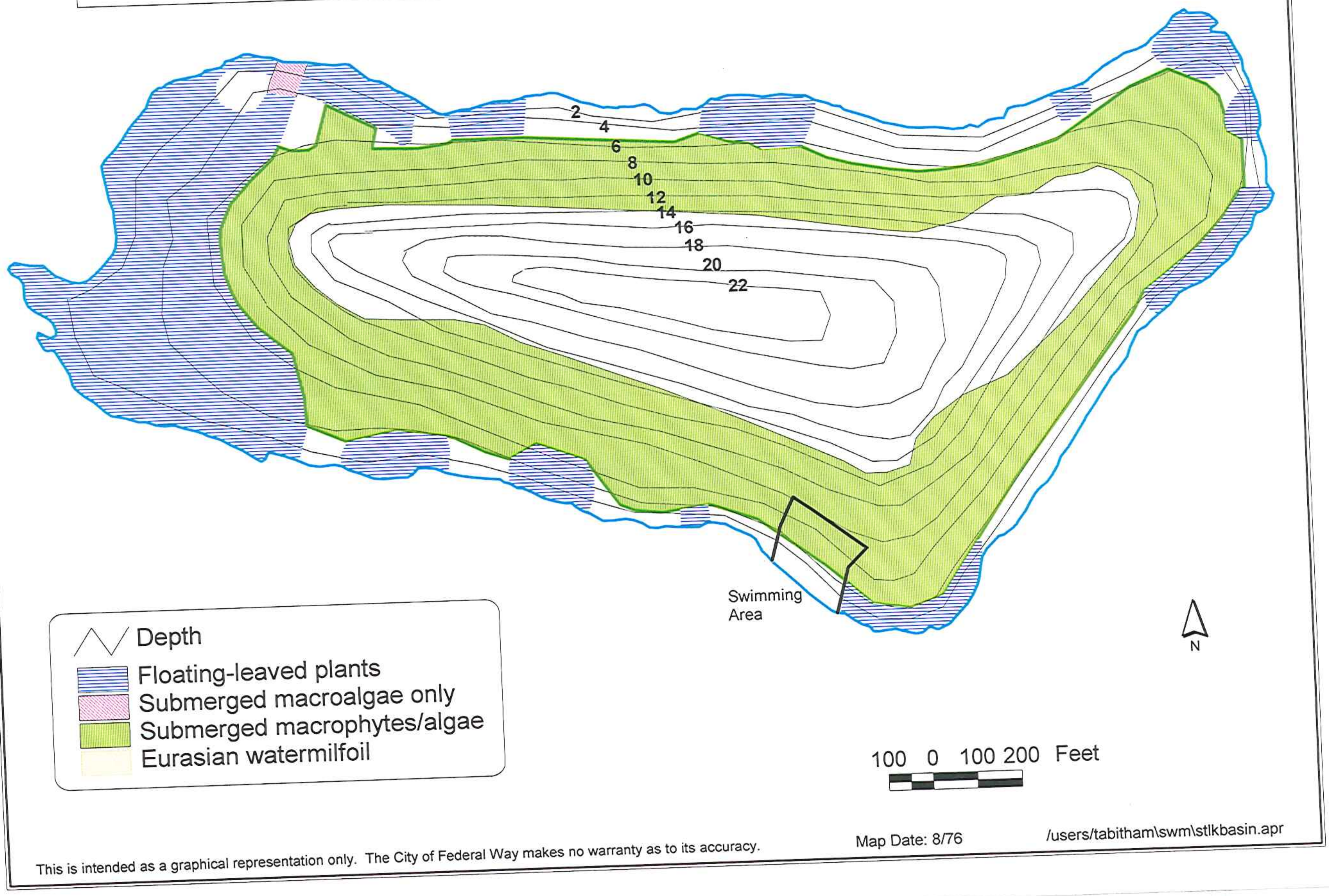

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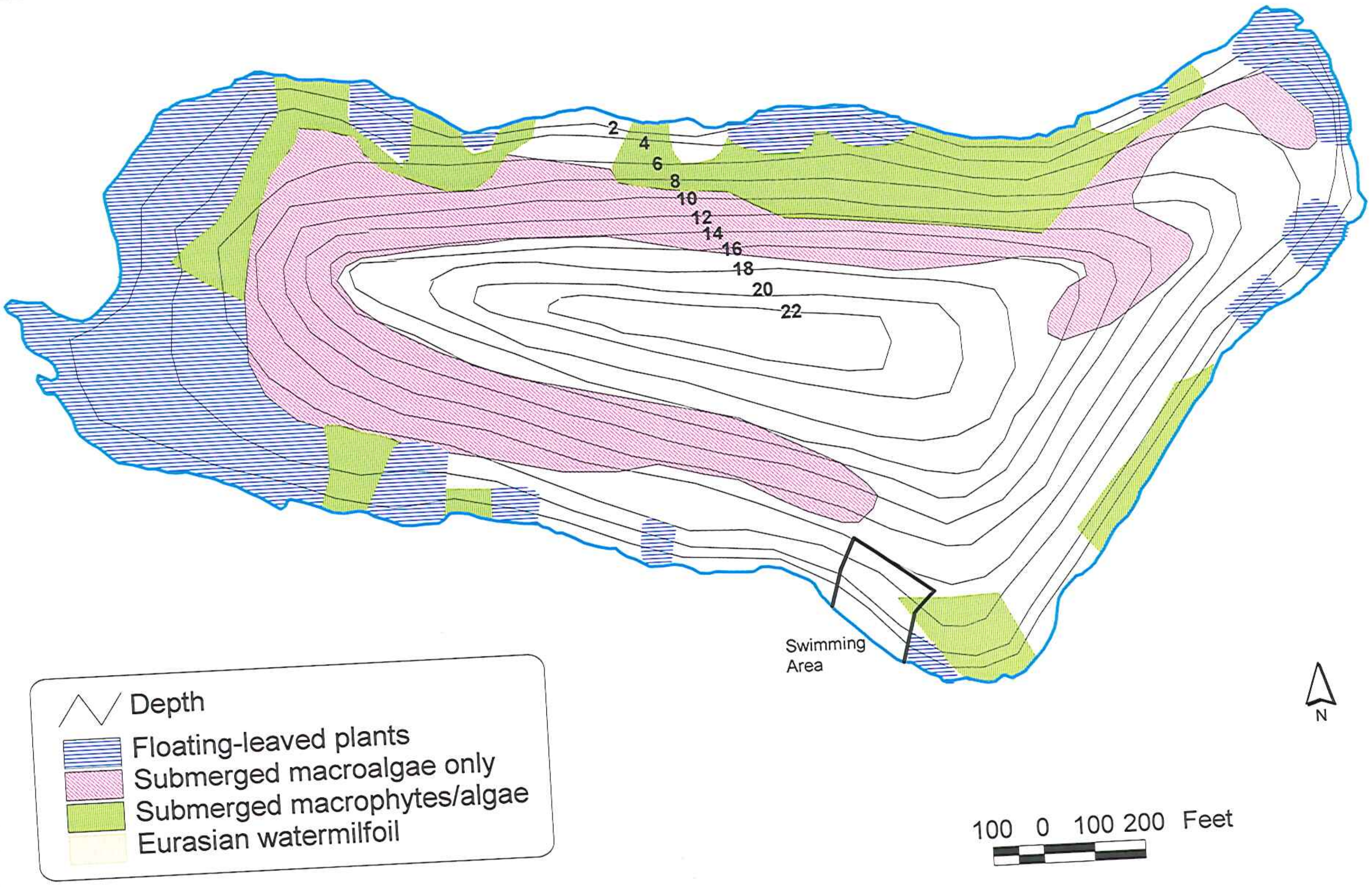

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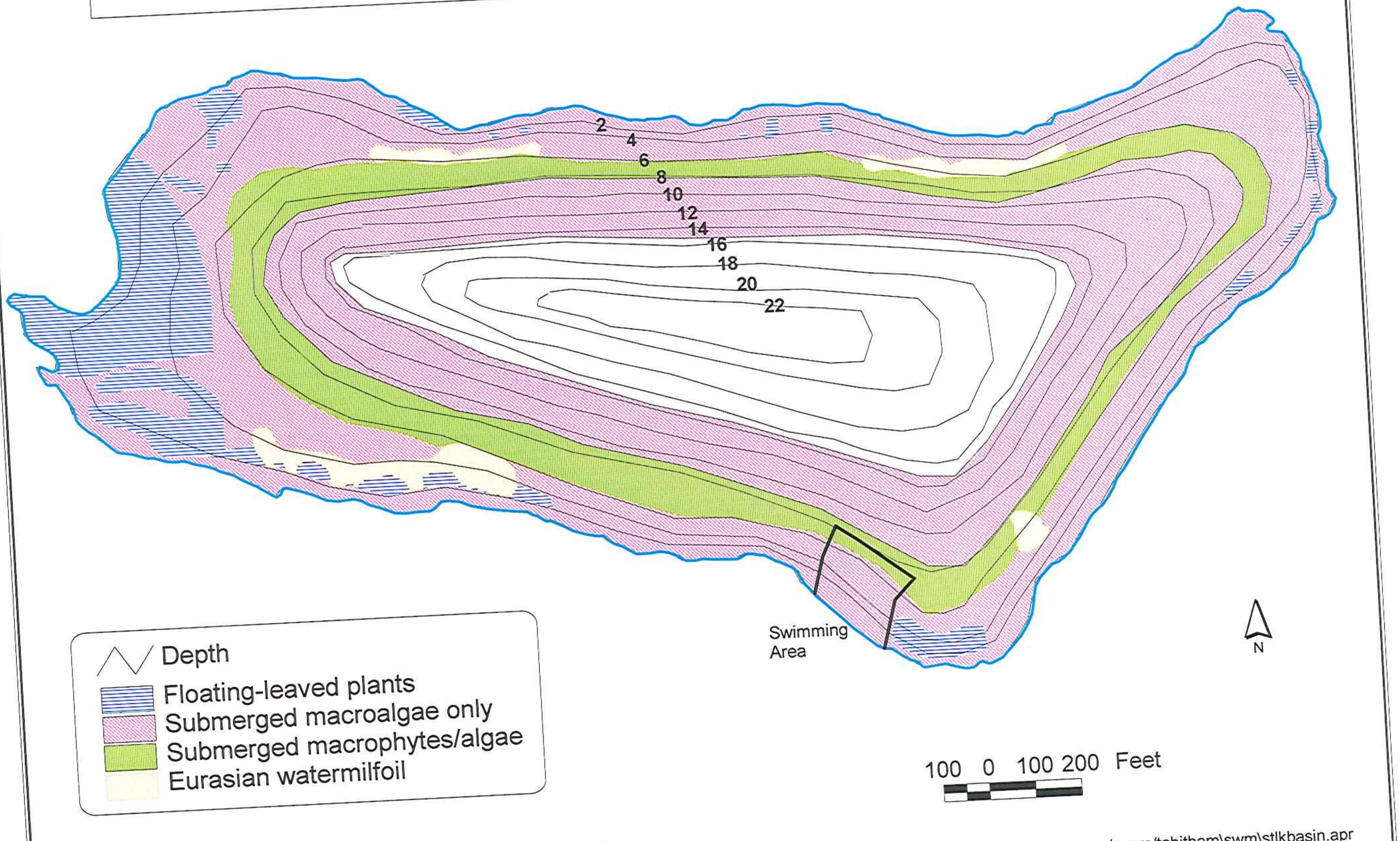

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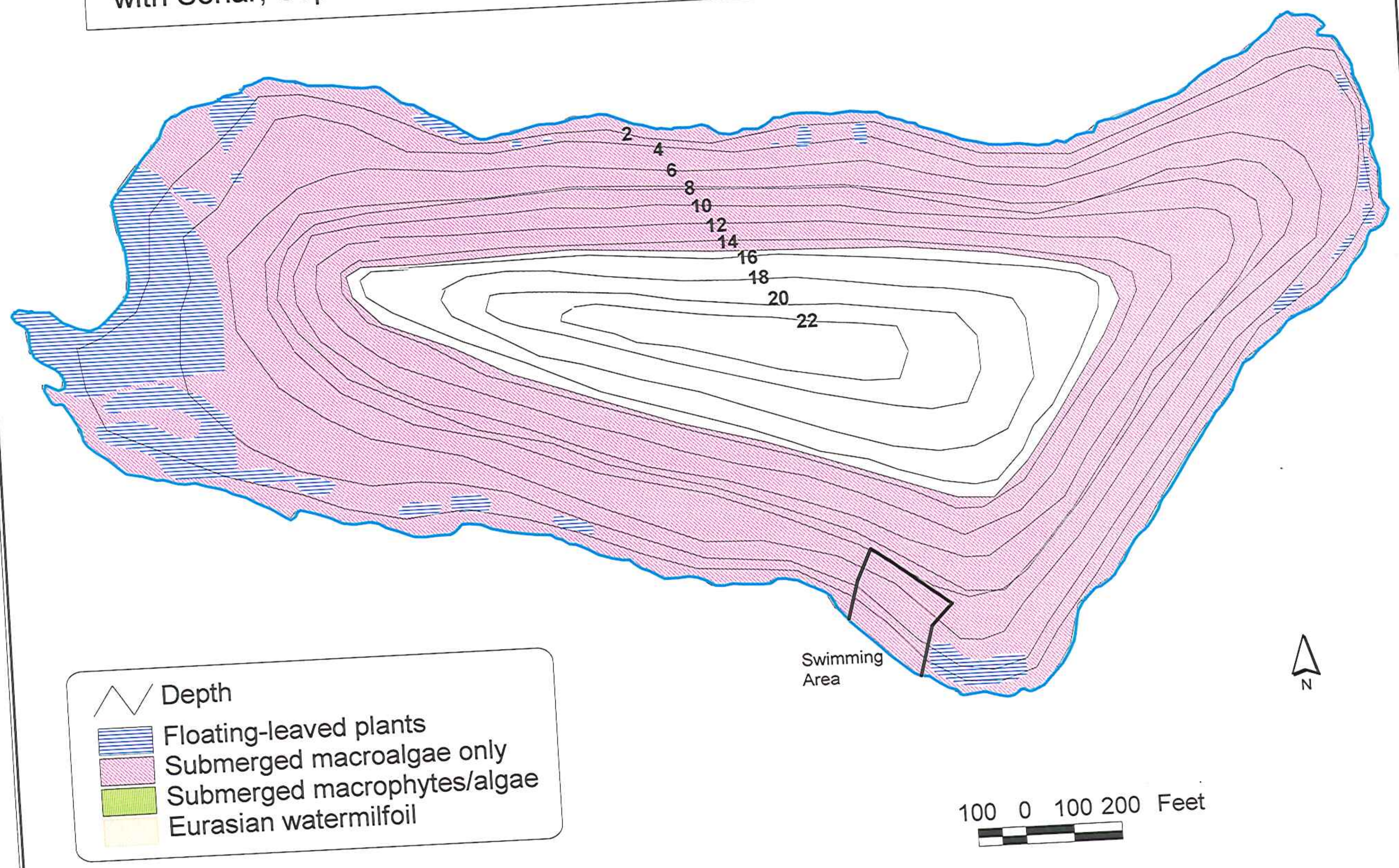

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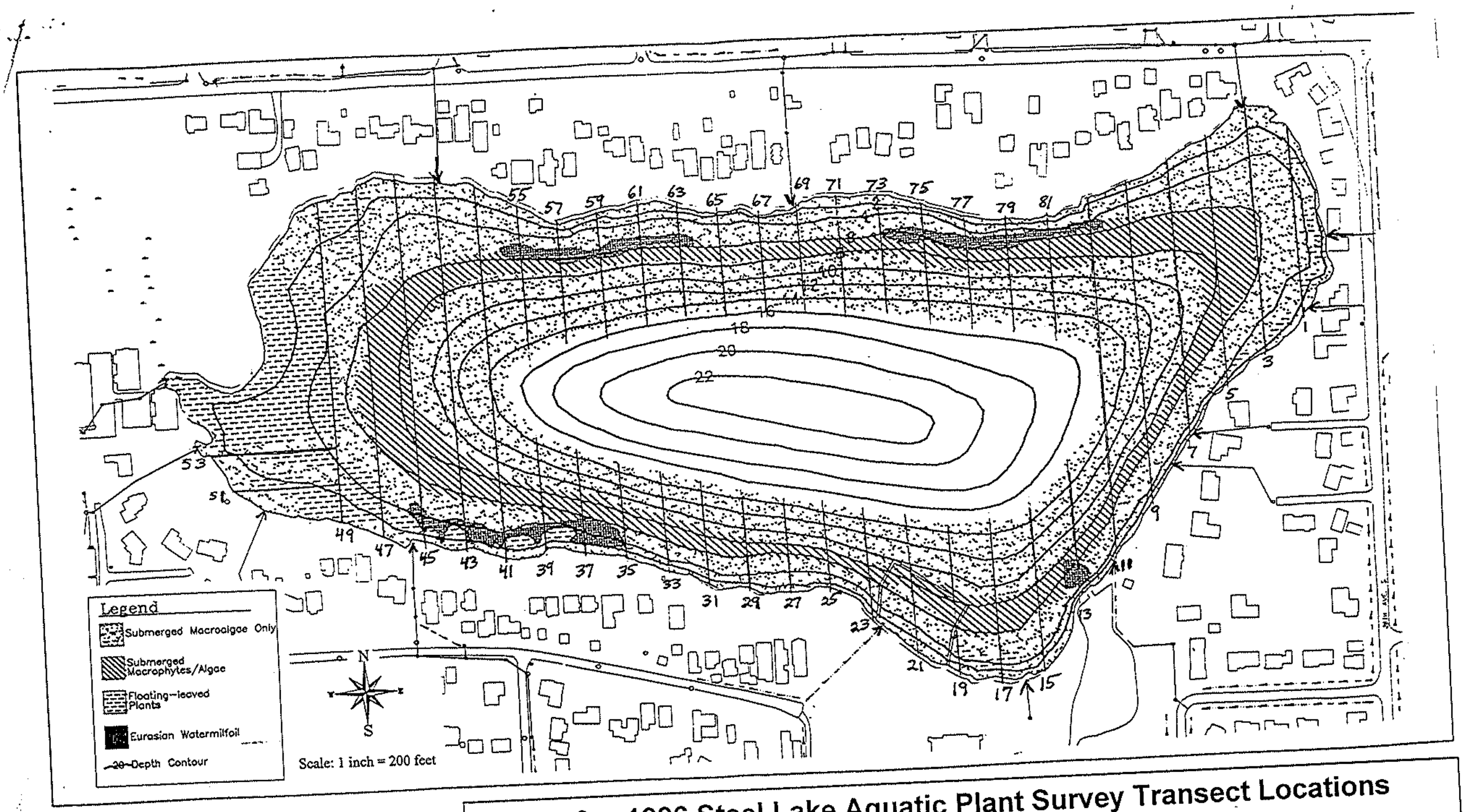

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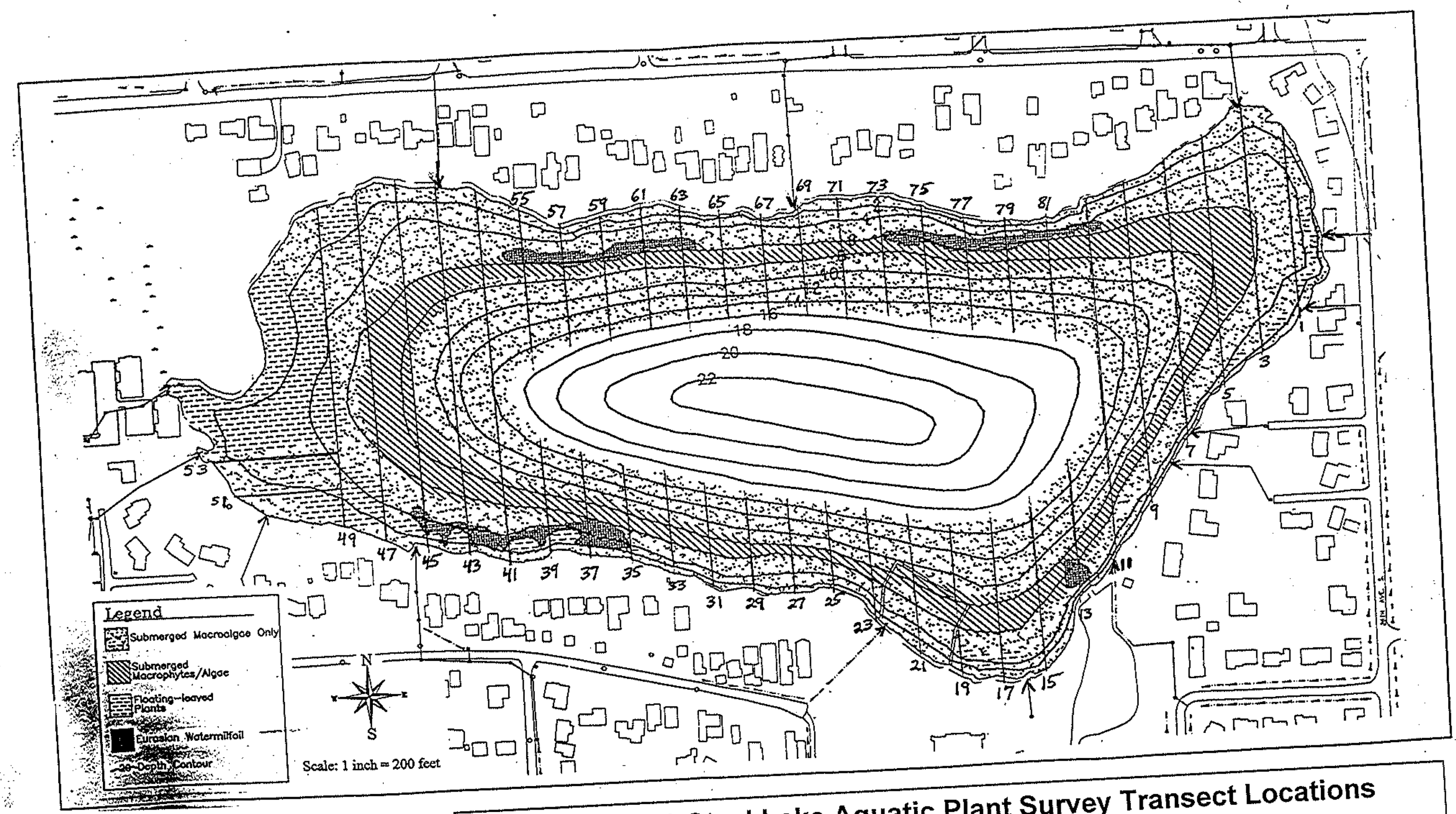

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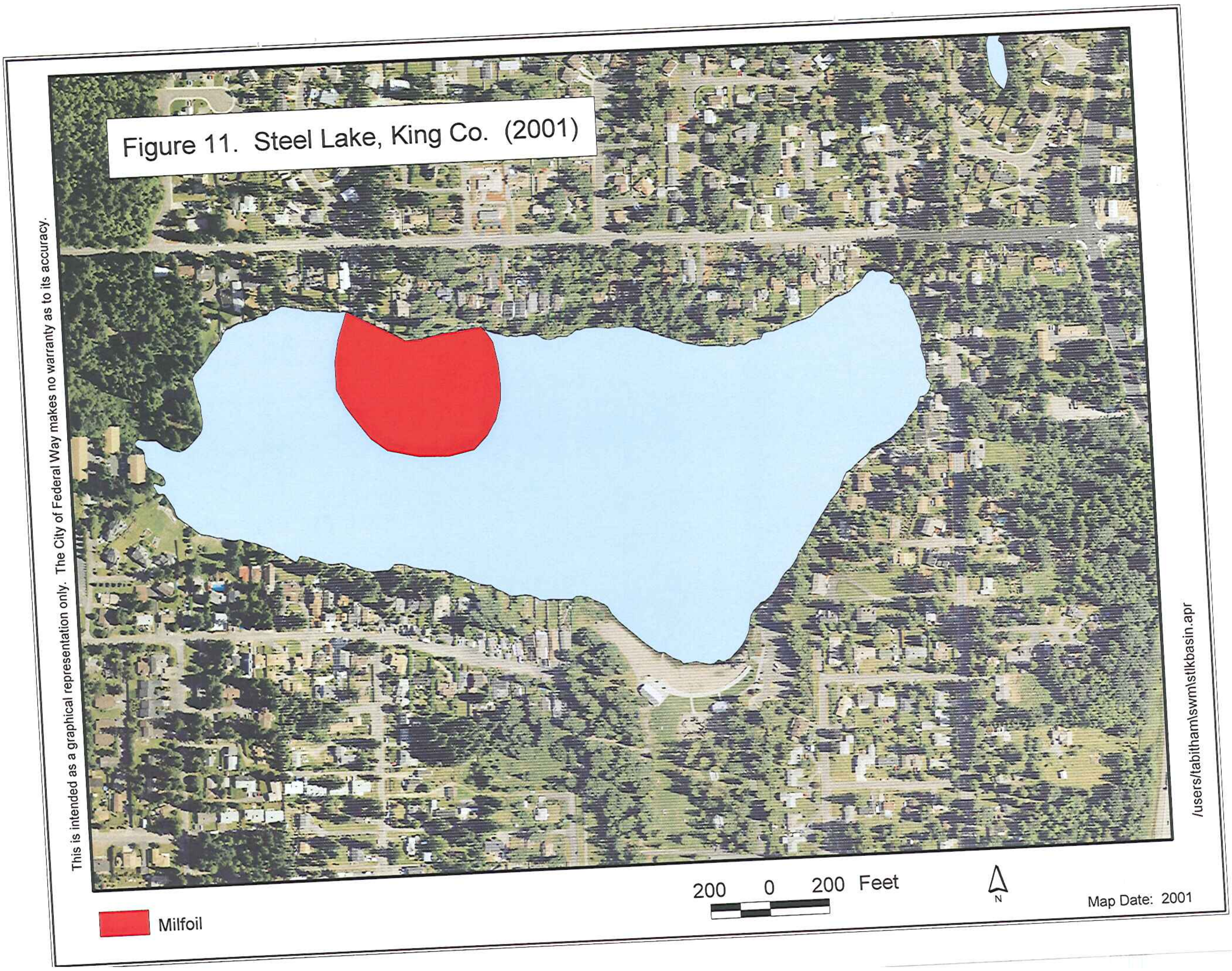
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Milfoil

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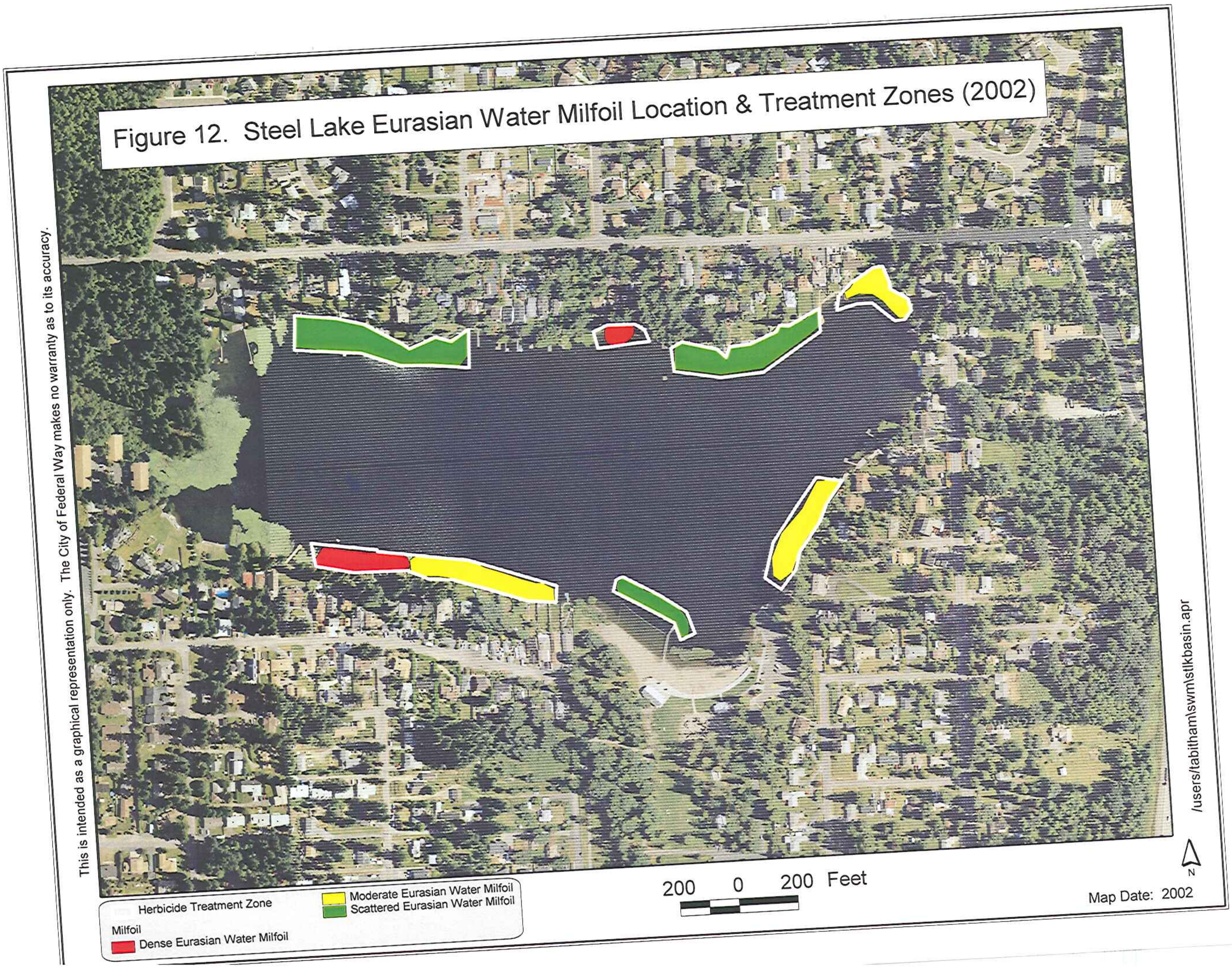

PROBLEM STATEMENT

Steel Lake is located in the City of Federal Way in King County, Washington. It is a small (47 acres), shallow (maximum depth 24 feet, mean depth 13 feet) lake with a watershed area of 304 acres that is primarily developed as residential and commercial property. The only source of surface water inflow to the lake is from city stormwater outfalls.

In the past decade, infestations of non-native aquatic plants Eurasian watermilfoil (*Myriophyllum spicatum*) and fragrant water lily (*Nymphae odorata*) have occurred on several occasions that colonized lake areas in large quantities. Because Steel Lake is a shallow system, a large portion of the surface area of this lake is available for aquatic weed colonization.

Aquatic weed infestations on Steel Lake, such as those exhibited by *M. Spicatum* (milfoil), are well documented. In the early 1990s, the lake became fully infested with milfoil, which dominated the entire littoral zone. Extensive milfoil colonies near the beach, shoreline, and homeowner docks posed serious threats to swimmers – and significantly reduced native plant communities. In addition, the public fishing dock was surrounded by milfoil beds that made fishing from the shore nearly impossible. A whole-lake application using fluridone (Sonar®) in 1994 was required to treat the aquatic plant problem. In 2001, milfoil re-infested Steel Lake, this time appearing as a pioneering colony. It was spot treated with 2,4-D (AquaKleen®) in August of 2002.

It is likely that milfoil is being spread on boats that enter the lake at the public boat launch. These boats tend to travel from lake to lake in the Federal Way region. Because Star Lake and Lake Killarney are within a few miles distance of Steel Lake, they (and other nearby systems) are threatened with introductions of milfoil if Steel Lake is not controlled.

Non-native fragrant water lily, a noxious weed, continues to colonize the western end of the lake and other scattered areas where water depths are limited. The lilies, in combination with the very shallow water depth have greatly restricted use of this portion of the lake. Large sections of root and plant masses break away and float to the surface of the lake, forming unsightly clumps and causing potential boating safety problems. Through the years, individual homeowners have implemented lily treatment and control, but these efforts are offset if adjacent properties are not maintained. Consequently, the lake requires a comprehensive aquatic weed management approach.

Aquatic weed infestations in Steel Lake threaten the investment that Steel Lake residents have made to protect their property values and to preserve the lake's aesthetic beauty, recreational attributes, and wildlife habitat. The Steel Lake Community recognizes that a concerted, long-term effort is necessary to control future aquatic weed infestations.

The facts listed above were used to create a problem statement for Steel Lake. The purpose of the problem statement is to describe as clearly as possible how the lake and its inhabitants are being negatively impacted by aquatic plants.

Problem Statement

Aquatic plants, including the non-native species Myriophyllum spicatum, (milfoil) in Steel Lake historically have impaired the use and aesthetic value of the lake. Dense aquatic plant beds have restricted access, fishing, swimming, sailing, and other types of boating to the mid-section of the lake, due to the obstruction caused by plants in the shallower, near shore area. In 1993, milfoil was reportedly colonizing areas up to the 15-foot depth interval. In addition, other regional lakes are in danger of becoming infested with milfoil originating in Steel Lake. Because of the lake's shallow characteristic, submerged plants have the potential to restrict the available area for recreation activities. The non-native lily, Nymphaea sp., (fragrant water lily) continues to colonize a large portion of the west end of the lake. The lilies, in combination with the very shallow water depth, have greatly restricted use of this portion of the lake. Personal efforts to control the lilies are offset if adjacent properties are not also maintained, and consequently suffer from the need for a lake-wide approach. Large sections of root and plant masses break away and float to the surface of the lake, forming unsightly clumps and create potential boating safety problems. Property values may be affected by the plant problems. This may be especially true of the western end of the lake, where water depth limitations in combination with lily beds are causing the "waterfront" to move farther from the existing shoreline. A long-term strategy is required for the control of aquatic plants, and to assure that milfoil does not become re-established in the lake.

MANAGEMENT GOALS

The Steel Lake Steering Committee has developed the following set of management goals for the long-term management of aquatic weeds in Steel Lake:

- Form a Lake Management District that creates a funding source for all future aquatic plant management activities, and continue to seek grant opportunities.
- Perform annual diver surveys to monitor changes in the aquatic plant community.
- Control and contain both milfoil populations and fragrant water lily populations at as low a density as is environmentally and economically feasible, and at levels that will not impact public safety or the beneficial uses of the lake.
- Reduce all other identified species of noxious weeds as listed in WAC 16-750 to levels that do not impact public safety or the beneficial uses of the lake.
- Use appropriate aquatic plant control and treatment methods as needed for all other problematic aquatic weeds, using the best available science to identify and understand their effects on human, aquatic and terrestrial ecosystems prior to implementation.
- Provide for adequate native vegetation for fish and, if necessary, mitigate for any negative impacts to fish habitat due to non-native plant removal activities.
- Continue public education to prevent the introduction of noxious weeds, nuisance plants and non-native animal species to the lake; and to aid in the early detection of aquatic weed re-infestations.
- Continue to involve the Steel Lake Community in the aquatic plant management process.

PAST MANAGEMENT EFFORTS

Prior to 1993, lake homeowners optioned to contract individually to have their near shore areas sprayed with glyphosate (Rodeo®) to control lilies. In 1993, the lake became heavily infested with milfoil. That year, the City of Federal Way and the Steel Lake Residents' Association (SLRA) formed an advisory committee and began aquatic plant management planning. The City and SLRA agreed to combine funds to eradicate the milfoil infestation. In the spring of 1994, fluridone (Sonar®) was applied by Resource Management (RMI).

In 1993, the City of Federal Way received an Aquatic Weeds Management Fund Grant from the Department of Ecology to provide long-term aquatic plant control. The AWMF Grant was used to contract with Envirovision for the development of an Integrated Aquatic Vegetation Management Plan (IAVMP). The IAVMP was completed in December 1995, and approved by the Department of Ecology in February 1996.

Funds collected by the SLRA, combined with a City match, were applied toward several post-treatment lake surveys. A one-year post-treatment aquatic plant survey performed by RMI in 1995 demonstrated that milfoil had not re-infested the lake. Additional follow-up systematic surveys performed by Herrera Environmental Consultants in 1996 and 1998 indicated that the lake had remained free of milfoil. Between 1998 and 2001, no aquatic weed management efforts (surveys, control, treatment, or public meetings) took place.

In the summer of 2001, the King County Department of Natural Resources and Parks (through a grant provided by the Department of Ecology), contracted with AquaTechnex (formerly RMI) to survey Steel Lake for noxious weeds. This simple survey confirmed that a pioneering level of milfoil had re-established itself in the lake. In the fall of 2001, the City of Federal Way provided notification of this re-infestation to all affected residents, primarily those concentrated along the northwest portion of the lake.

Thereafter, the City began to develop a strategy for future aquatic weeds management. In early 2002, the City applied for an Early Infestation Grant from the Department of Ecology for short-term milfoil identification, treatment, and control. Following the award of the grant, AquaTechnex was given City approval to perform a comprehensive underwater survey for milfoil in August.

In the interim, the City organized two well-attended (more than thirty people each) Steel Lake Residents' meetings in June and July of 2002 to discuss lake management issues, including future treatment options and funding alternatives. An overview of the Lake Management District (LMD) formation process was presented at these two public meetings. In order to discuss and plan aquatic plant management in further detail, volunteers were solicited to form the Steel Lake Steering Committee.

The underwater survey performed by Aqua Technex in August 2002, specific for milfoil, indicated that the noxious aquatic weed had spread throughout the littoral zone of the lake, colonizing a total of five acres. In late August, the lake was spot treated with 2,4-D (AquaKleen®). A follow-up visual evaluation performed approximately 5 weeks later verified that the treatment produced a significant weed kill. The Integrated Treatment Plan outlined in this IAVMP will address the future management of milfoil infestations.

In addition, some Steel Lake residents elected to spot treat their waterfront for white water lily in 2002 using Glycosate. Again, Aqua Technex applied the aquatic herbicide, contracting individually with the interested homeowners. A brief post-treatment evaluation indicated a moderate lily population reduction. Systematic lake surveys planned for 2003 will confirm the effectiveness of the lily treatment, and define future action.

In late 2002, the Steel Lake Steering Committee began to lay the groundwork for a long-term and effective aquatic weed management program. The Committee began meeting on a monthly basis to formulate a work plan. The feasibility of forming a LMD was closely examined and discussed.

During this time, industry professionals from both the public and private sectors were consulted concerning the LMD process. The Committee recognized that the Department of Ecology (DOE) is a strong proponent of special purpose districts for managing lakes; and that future DOE grant awards were more likely if a Steel Lake LMD was formed. These factors led to an agreement that a LMD would be the best solution in providing a stable source of funds for aquatic plant management activities.

On November 13, 2002, a Steel Lake Community public meeting was held to present the Committee LMD recommendation. An informal straw vote showed unanimous support for LMD formation. As of March 2003, the Steel Lake Committee is pursuing formation of the LMD through the district formation process defined in RCW 36.61.

LAKE AND WATERSHED CHARACTERISTICS

Location

The Steel Lake watershed is located approximately 20 miles south of Seattle, in the City of Federal Way, King County, Washington. The watershed is 304 acres in size and drains a gently sloping topographic area with elevations ranging from 440 feet to 500 feet (Figure 1). The maximum depth is 24 feet, and the mean depth is 13 feet. Lake depth contours are depicted in Figure 3. A Sediment Type Map for Steel Lake is depicted in Figure 4. The entire watershed of Steel Lake lies within the City of Federal Way.

Land Use

Land use in the watershed is primarily comprised of single-family residences (Figure 1, Figure 2, and Table 1). Steel Lake Park, multi-family residences, and vacant land comprise most of the remaining land in the watershed. It should be noted that the sub-basin boundary in Figure 1 and land use estimates in Table 1 are for Redondo Creek sub-basin CPR3, which includes an additional acreage to the north and west of the lake outlet. In addition, thirteen percent (13%) of the Central Puget Sound basin, which includes the Steel Lake and Redondo Creek watershed, is available for re-development, including 21 parcels on Steel Lake (11 vacant and 10 re-developable). There are 631 residential properties in CPR3.

Table 1. Land Use Estimates for the Steel Lake Watershed (Subbasin CPR3)

Land Use Classification	(Acres)	(Percent)
Commercial	2.9	0.96
Industrial	0.2	0.07
Multi-Family	11.1	3.6
Office	2.8	0.92
Common Ownership	1.7	0.57
Park	24.6	8.1
Quasi-public	2.2	0.73
Religious Services	3.8	1.2
Single Family	149.8	49.3
Vacant	47.0	15.4
Steel Lake	47.4	15.6
Wetlands	10.4	3.4
Watershed	303	100
TOTAL	303	

Shoreline Use

Steel Lake includes 7,123 feet of shoreline (Table 2). The majority of the shoreline includes lake frontage adjacent to single-family property (5,315 feet). Public access to the lake is from Steel Lake Park, owned and managed by the City of Federal Way. The Park is located on the south shore of the lake, and includes a public beach area. A public boat launch, also located on the south shore near the park, is owned by the Washington Department of Fish and Wildlife (WDFW). There are eleven (11) undeveloped parcels around the lake. The largest undeveloped parcel (092104 9012) is located at the northwest corner, and has a shoreline measuring 332 feet, with a portion classified as wetland.

Table 2. Shoreline Use Estimates for Steel Lake

Shoreline Use	Total Frontage (ft)	%
Single family residential	5315	75.0
Steel Lake Park	875	12.0
Undeveloped Parcels	477	6.7
Multi-family	392	5.5
Public Boat Launch	64	0.9

Stream and Wetland Locations

Steel Lake forms the headwaters of Redondo Creek. Outflow from the lake generally occurs only during the wet season (November through June). The lake outlet drains in a northwest direction from the west end of the lake, passing through a wetland to a culvert crossing at South 304th Street. The outlet continues to flow in a northwest direction, passing underneath Pacific Highway South and eventually discharging into Puget Sound at Redondo Beach in the City of Des Moines. Runoff from the wetland, open space, and development near the northwest portion does not drain into the lake.

Wetlands in the Steel Lake Watershed have been mapped by the US Department of Fish and Wildlife as part of the National Wetland Inventory (NWI, 1987). Wetlands in Steel Lake proper have been identified as either open water wetland (lacustrine-limnetic) or aquatic bed wetland (lacustrine-littoral).

This wetland areas was surveyed by Sheldon & Associates for the City of Federal Way in 1998, which identified it as a Category I wetland as defined by Federal Way city code. The vegetation of the wetland complex was described as a palustrine-scrub-shrub/forested-seasonally flooded wetland adjacent to Steel Lake and a palustrine-emergent-semi-permanently flooded wetland toward the beginning of Redondo Creek.

On February 24, 2003, a search was conducted by the Washington Department of Natural Resources of the National Heritage Program database for information on rare plants and high quality native ecosystems in the Steel Lake watershed. There is no information on significant features within this study area (Moody, 2003, DNR).

Non-point Nutrient Source Locations

The majority of surface water is conveyed to the lake from the 304-acre watershed through the City's stormwater system, and enters the lake via 14 stormwater outfalls located around the perimeter. (Figure 1). The largely urbanized nature of the watershed can be expected to contribute typical urban area nutrient-related pollutants to the lake, in particular nitrogen and phosphorous. Significant pollutant sources in the watershed – including landscaping, gardening, large flocks of Canada geese at Steel Lake Park, and vehicle washing – all have the potential to contribute nutrients into the lake.

Lakeshore residences and most of the development in the watershed are connected to the Lakehaven Utility District sanitary sewer system. Lakehaven Utility District does not have a record of a documented sanitary sewer overflow in the Steel Lake region. In addition, Lakehaven does not have records concerning on-site household septic systems (Asbury, 2003, personal communication).

Failing septic systems may also be a source of pollutants such as nutrients and bacteria to Steel Lake. The 1995 Steel Lake IAVMPA reported that approximately 35 acres of single-family residences, located in the northwest and northeast portions of the watershed, were served by on-site septic systems (Federal Way Water and Sewer and RPA, 1992). The King County Health Department does not maintain a list or map of household septic systems, or the incidence of septic system failure in the Steel Lake watershed.

Information and as-builts may only be obtained through a request that includes details concerning the specific address or parcel (Bishop, 2003, KC Health).

Large concentrations of non-point nutrients can increase the biological productivity of the lake, and stimulate plant growth. Data collected by the King County Lake Stewardship Volunteer Monitoring Program include levels of nitrogen and phosphorous; and concentrations of phytoplankton and chlorophyll. This information is used to calculate the Trophic State Index (TSI) for the lake, a measurement if the lake's health. The most up-to-date water quality data and TSI values provided by King County Lake Volunteers are included in the Water Quality section of the IAVMP.

Part of action plan to reduce nutrients

The City of Federal Way is participating in a Canada geese management program at Steel Lake Park with the US Department of Agriculture (USDA). In 2002, nuisance flocks of geese were removed from the park as a part of this program. In successive years, Parks Department staff will employ non-lethal geese management techniques (using bird-bangers and other harassment tools) to control populations. A reduction in numbers of Canada geese visiting the park will result in a reduction in nutrients entering the lake.

Water Source

Steel Lake, located in the City of Federal Way, is 46 acres in size with a watershed area of 243 acres. Steel lake is relatively shallow with a mean depth of 13 feet, a maximum depth of 24 feet, and a lake volume of 600 acre-feet. Physical characteristics of Steel Lake are summarized in Table 3.

The majority of surface water enters the lake via 14 stormwater outfalls located around the perimeter of the lake (Figure 1). No streams flow into the lake.

Table 3. Physical Characteristics of Steel Lake and Its Watershed

Characteristic	English Units	Metric Units
Watershed area	304 acres	98.3 hectares
Surface area	47 acres	18.6 hectares
Lake volume	600 acre-ft	7.4×10^5 cubic meters
Maximum depth	24 feet	7.3 meters
Mean depth	13 feet	4.0 meters
Lake altitude	440 feet	134.1 meters
Shoreline length	1.3 miles	2.1 kilometers
Flushing rate	0.77 times/year	0.77 times/year

Water Quality

The assessment of biological activity (or trophic state) can be classified into three general categories of lake water quality: oligotrophic, mesotrophic, and eutrophic. Lakes with low concentrations of nutrients and algae and high transparency (or clarity) are considered oligotrophic. A lake with high concentrations of nutrients and algae and low transparency is considered eutrophic. Lakes whose quality ranges between eutrophic and oligotrophic are considered mesotrophic.

One of the most common measures used to calculate a lake's water quality classification is the numerical trophic state index (TSI) developed by Robert Carlson (1977). This index allows the easy comparison of lake water quality by relating values for water clarity, phosphorous, and chlorophyll *a* along a trophic continuum based on a scale of 0 to 100 (Table 4).

Table 4. Summary of Summer Water Quality Parameters and Associated Values for the Trophic State Index

Trophic State/ Biological Activity	Secchi Depth (meter)	Chl-a** (ug/L)	TP** (Ug/L)	TSI**
Oligotrophic/Low	>4.0	<2.6	<12	<40
Mesotrophic/Moderate	2.0-4.0	2.6-6.4	12-24	40-50
Eutrophic/High	<2.0	>6.4	>24	>50

*Data Source: Carlson, 1977
** Chl-a chlorophyll *a*, TP = total phosphorous, and TSI = trophic state index

The King County Volunteer Lake Monitoring Program for Steel Lake began in the 1980s, and has continued through 2001, with a gap from1991 through 1993. The following data indicate that Steel Lake is relatively low in primary productivity (borderline oligotrophic to mesotrophic) with very good water quality. No significant trends in water quality were found based on the data record (A Trend Report on King County Small Lakes, November 2001). See historical TSI values for Steel Lake represented in Table 5.

Seems interesting for AN average depth of 13'

Table 5. Average Values for Select Trophic Parameters at Steel Lake*

Year	# Samples	Secchi (meter)	Chl-a** (ug/L)	TP** (Ug/L)	TSI** Secchi	TSI Chl *a*	TSI TP	TSI Ave
1985	12	3.5	2.6	16	42	40	44	42
1986	11	3.4	3.9	16	43	44	44	44
1987	11	3.4	3.1	15	42	43	43	43
1988	1	3.6	3.6	15	42	43	43	42
1989	12	3.0	4.1	18	44	46	46	45
1990	9	2.9	5.0	16	45	44	44	45
1991	--	--	--	--	--	--	--	--
1992	--	--	--	--	--	--	--	--
1993	--	--	--	--	--	--	--	--
1994	12	3.6	4.6	24	42	50	50	46
1995	12	3.7	5.3	19	41	46	46	45
1996	10	3.9	4.2	17	40	45	45	43
1997	12	3.5	3.8	21	42	48	48	44
1998	13	3.4	5.1	13	42	41	41	43
1999	12	3.7	4.3	12	41	40	40	42
2000	8	4.6	3.3	11	38	39	39	40

* Data Source: A Trend Report on King County Small Lakes, November 2001
** Chl-a chlorophyll *a* , TP=total phosphorous, and TSI=trophic state index

In 2001, Secchi transparency ranged from 1.0 to 6.0m through the year based on both Level I and Level II records. Water levels rose steadily through winter and dropped steadily after April. Annual water temperatures ranged from 4.5 to 22.5 degrees Celsius. Appendix A includes 2001 Secchi Depth graph (Figure 14), 2001 Precipitation/Lake Level graph (Figure 15), and 2001 Lake Temperature graph (Figure 16).

Phytoplankton made a peak in June 2001, and the population was climbing at the end of the sampling season. Early populations of the diatom *Cyclotella* were replaced by the chrysophyte *Dinobryon* and the bluegreen *Anabaena* at peak volume in June 2001. A variety of taxa were present over the summer, but none made a large population until October 2001 when another *Dinobryon* species began to increase rapidly. Chlorophyll content did not relate closely to the phytoplankton maximum in June 2001 , but did show an increase in October 2001.

Oscillatori sp., a blue-green algae, was found in small quantities in 2000 and 2001. Moderate blooms of *Oscillatori* sp. were noted in 2002, and generated a number of citizen complaints. The City of Federal way responded to these complaints by issuing a mild health notice to Steel Lake residents concerning the toxic effects of the algae. See Appendix A for 2001 Phytoplankton and Chlorophyll concentrations (Figures 17,18).

Total phosphorus and total nitrogen remained in proportion to each other through the sampling period, with the N:P ratio ranging from 23 to 35. In 2001, the TSI indicators were close together, just above the threshold between oligotrophy and mesotrophy. In 2000, the values were close together, but just below the threshold. Before 2000, relationships changed between the indicators, but all three values were never close together. See Attachment A for 2001 Total Phosphorous/Total Nitrogen graph (Figure 19).

The primary source of pollutants to Steel Lake is likely stormwater runoff discharged from 14 outfalls located at various points on the shoreline, in addition to the runoff that enters the lake directly from shoreline property. Typical pollutants of concern in urban runoff include; suspended solids, nutrients, bacteria, fertilizers, pesticides and toxic substances (e.g., metals and polycyclic aromatic hydrocarbons) Elfish (1986).

Eutrophication over time is a process that occurs naturally in some lakes and may be accelerated in others by human activities. An acceleration of the eutrophication process may result from normal daily activities that occur in the urban environment. For example, automobiles and road surfaces contribute metals and petroleum products and polycyclic aromatic hydrocarbons, gardening, cleaning and other household activities contribute fertilizers, pesticides, nutrients, and various toxic substances. There is no data available to determine whether these pollutants exist in Steel Lake, and no current evidence of toxic effects.

In addition, increases in impervious surfaces associated with land development activities, also result in increased quantities of surface water runoff flowing to the lake. These larger surface water flows often carry loads of nutrients and sediments that stimulate plant growth. This process may result in the overall eutrophication process (A Trend Report on King County Small Lakes, 2001). The Central Puget Sound basin, which includes the Steel Lake basin, is 43% impervious cover.

Beneficial and Recreational Uses

Table 6 contains a list of characteristic or beneficial uses that Steel Lake provides to area residents, visitors, and wildlife. In particular, the lake supports a large city park, excellent wetland habitat, and a trout-stocking program. It is also important to note that no motorized boats are allowed on the lake.

Table 6. List of Beneficial Uses for Steel Lake

Beneficial Use	Location
Swimming	Around homes and in City park
Non-motorized Boats	Entire Lake
Fishing	Whole lake (Fishing Derby at park site)
Sailing	Whole lake
Waterfowl Habitat	Concentrated along western shore
Aesthetic enjoyment	In lake and surrounding shoreline
Birdwatching	Throughout the lake
Irrigation	One water right and three claims exist
Wetland Habitat	Near the lake outlet (western end of the lake)
Wildlife Habitat	Crayfish, turtles, and frogs primarily near shore
Trout Stocking	Deep water habitat. No trout spawn in the lake.
City park	Approximately 700 feet of shoreline
Fish Habitat	Spawning (warmwater fish) occurs near docks and lilies in the west end. No salmon spawn in the lake.

Wildlife

Aquatic noxious weeds (non-native species) can adversely affect the ecological functions and aesthetics in lakes and streams by crowding out native vegetation and creating single species stands. Therefore, it is important to recognize the value of native plant species for fish and wildlife (WDFW, Aquatic Plants and Fish). The fish and wildlife habitat in Steel Lake will greatly improve by removing non-native aquatic plant species (milfoil, fragrant water lily, yellow flag iris), allowing the native vegetation to thrive.

Steel Lake is managed by the Washington Department of Fish and Wildlife (WDFW) as a trout and warm-water fishery. Between 1947 and 1969, the lake was rehabilitated on five occasions by treating with rotenone to reduce populations of spiny-ray fish, and was stocked each year with approximately 7,000 recently-hatched (fry) rainbow trout (*Salmo gairdneri*). Due to the mixed species character of the fish community and the poor survival of trout fry, the fish management program changed in the 1970's by eliminating rotenone treatments and by stocking with trout of catchable size (i.e. between 8 and 12 inches long) in the spring of each year (Pfeifer 1995 personal communication). During 1985 and 1995, a total of 46,635 trout were allotted for release into Steel Lake. During this period, surveys identified the presence of the following other fish species: largemouth bass (*Micropterus salmoides*), yellow perch (*Perca flavescens*), pumpkinseed (*Lepomis gibbosus*), and brown bullhead (*Ictalurus melas*).

Since 1991, an average of 6,000 trout were released into the lake each year. In most years, half of the trout were released directly into the lake during April, prior to opening day of the fishing season. The other half were released during June into a pen near the Steel Lake fishing pier for the opening day fishing derby. Trout not caught in the pen were released into the lake. WDFW stocked Steel Lake in April of 2002. Stocking included: 4,600 rainbow trout (8"-12"); and 650 triploid rainbow trout (sterile, trophy-sized).

On May 13 and 16, 2002, WDFW conducted a survey of Steel Lake to determine fish populations, organized by species count and length measurements. WDFW staff used electro-fishing boat, and gull and fyke nets during the survey. Table 7 contains the results of this survey.

Table 7. Steel Lake Total Fish counts by Species and Length Increments WDFW Survey 2002

	Total # Sampled	621	148	79	16	37
	Percent	68.9%	16.4%	8.8%	4.1	1.8%
	Species	Yellow Perch	Largemouth Bass	Pumpkin - seed	Rainbow Trout	Brown Bullhead
Size (inches)						
1-4		4	88	51	0	0
4-7		415	49	28	0	2
7-11		202	7	0	37	12
11-14		0	1	0	0	2
14-17		0	1	0	0	0
17-19		0	2	0	0	0

In addition, several red swamp crayfish (*Procambarus* clarkii) were captured during the 2002 WDFW survey. This exotic, aquatic-nuisance species is native to the south central United States, and was most likely introduced to Steel Lake as a result of its use as live bait by anglers, or during an aquarium dumping incident. The impact of this introduction is unknown, but most have had negative consequences (Mueller, 2003, WDFW). Red swamp crayfish are voracious herbivores, and may compete against native crayfish for food sources, presenting implications for Steel Lake if they multiply dramatically.

Not F/W ? Efforts to control red swamp crayfish in Steel Lake will be focused on public education. Signage, provided by the Department of Ecology, is in place at the public boat launch that visually identifies the species and warns lake-users of their presence. Lake residents will also be instructed to destroy the nuisance red swamp crayfish when captured.

The Washington Department of Fish and Wildlife (WDFW) conducted a search of the non-game data system for known occurrences of threatened, endangered, and sensitive species of animals in the watershed. Bald eagle nests have been sighted adjacent to Puget Sound, approximately two (2) miles west of Steel Lake. In addition, a Great Blue Heron rookery (breeding area) is present 2.5 miles southeast of the lake. Although these species may visit Steel Lake, no sightings of these or other priority (sensitive) species have been reported at Steel Lake (Envirovision, 1995 Steel Lake IAVMP). Other priority species that may visit the lake include the following cavity-nesting ducks: wood duck, Barrow's goldeneye, common goldeneye, bufflehead, and hooded merganser.

Aquatic Plants and Algae

The aquatic plant community in Steel Lake was surveyed by Metro in 1976, 1978, and 1979; by Resource Management, Inc. (RMI) in 1994 and 1995; by Herrera Environmental Consultants in 1996 and 1998; and by AquaTechnex in 2001 and 2002. The relative presence, density, and areal coverage of aquatic plants from 1976 through 2003 are summarized in Table 8. The scope and methodologies of each of these surveys were not similar. For example, some surveys were for all aquatic vegetation and some were only for milfoil and species identification was not consistent. Caution should be used when comparing the surveys The following are narratives describing aquatic plant community information and surveys from 1976 to 2003:

1976 – 1993 Metro Surveys

During this time period, aquatic plants inhabited approximately 27 acres (59 percent) of the lake (Figures 5 and 6), with submerged macrophytes and macroalgae comprising approximately 18 acres (67 percent) of the total plant area, and floating-leaved plants (waterlilies) comprising the remaining 9 acres (33 percent). Comparison of the 1979 and 1994 pre-treatment survey results indicate that although the total area coverage of submerged macrophytes did not change, the relative density of these plants increased. Therefore, the plant composition changed to include stands of milfoil. During the same time period, the area coverage of submerged macroalgae increased, while floating-leaved plants (waterlilies) decreased. The decrease in waterlilies was primarily due to approved herbicide (glyphosate) treatments in addition to non-chemical controls (i.e,. mechanical harvesting, bottom barriers, and hand cutting) that occurred during this time period.

1994 Survey

Immediately prior to the 1994 Sonar ® treatment, submerged macrophytes were present in 7.8 acres of the area currently occupied by *Nitella* (May 1994, Figure 7). Native pondweeds (*Potamogeton amplifolius* and *P. pusillus*) dominated the submerged macrophyte community. Eurasian watermilfoil (*Myriophyllum spicatum)*, was present in 1.3 acres of the lake. Milfoil was not detected during the September 1994 survey (Figure 8).

1995 RMI Survey

The RMI survey conducted in May 1995 showed no significant change when compared to the September 1994 post-treatment survey. Aquatic plants inhabited 35 acres (76 percent) of the lake, with submerged macroalgae (*Nitella sp.*) comprising 31.4 acres (90 percent) of the total plant area. Floating-leaved plants, primarily consisting of waterlilies (*Nymphaea odorata* and *Nuphar lutea spp. variegata*), comprised the remaining 3.6 acres (10 percent).

Waterlily growth was characterized by a large population which grew to a maximum depth of 5 feet at the west end of the lake. A few small patches of waterlily were also distributed along the remaining shoreline. Submerged macrophytes such as large-leaf pondweed (*Potamogeton amplifolius*) and thin-leaf pondweed (*Potamogeton pusillus*) were present between depths of 5 and 10 feet at densities too sparse to map. Although they are not shown in the figures, small stands of emergent plants grew along 1,400 feet (20 percent) of the shoreline, covering a total area of 0.4 acres. Yellow flag iris (*Iris pseudacorus*) and cattail (*Typha sp.*) dominated the emergent plant community. Marsh cinquefoil (*Potentilla palustris*) and rushes (*Juncas sp.* and *Eleocharis palustris*) were also present (RMI 1994, 1995; Parsons 1995 personal communication).

1996 Herrera Survey

An aquatic plant underwater survey was conducted on July 1 and 2, 1996. The survey was intended to document the presence, condition, and abundance of aquatic plant species in Steel Lake (Figure 9). Phytoplankton growth reduced visibility to approximately 10 feet, thus a limited area of the lake was surveyed. This level of effort was considered adequate by Herrera personnel for the purposes of the evaluation.

Neither milfoil nor other submerged, non-native, and invasive aquatic plants were present in the area surveyed. The composition, distribution, and density of the aquatic plant community was reported to be similar to that observed prior to the 1994 lake treatment with Sonar®.

Floating-leafed plants were dominated by fragrant waterlily, and distributed similarly as was documented in 1994 (at the west end of the lake). The only variation included a reduction in a small area between transects 49 and 53; and between transects 47 and 49 near the north shore.

Submerged macroalgae dominated the aquatic plant community, and again was similar to 1994 levels. *Chara schweinitzii* dominated the shallow region (shoreline to 12 feet); and *Nitella flexilis* dominated the deeper region of the lake between 12 and 17 feet. These populations appear to have been recovering from the 1994 Sonar® treatment, but had not become dense enough to significantly impair the recreational use of the lake.

Submerged macrophytes were typically present at relatively low densities (less than 25 percent coverage). Their distribution, density, and diversity appeared to have increased since the 1994 post-treatment survey – but not to nuisance levels. Small-leafed pondweed, (or thin-leafed pondweed), *Potamogeton pusillus,* was the dominant submerged macrophyte reported.

1998 Herrera Survey

An aquatic plant underwater survey was conducted on June 15 and 17, 1998. The survey was intended to document the presence, condition, and abundance of aquatic plant species in Steel Lake. Survey methods employed were similar to those used in 1996. Neither milfoil nor other submerged, non-native aquatic plants were present in the area surveyed. Native species of submerged macrophytes and macroalgae were present in a healthy condition along each transect from shore to a maximum depth of approximately 15 feet (Figure 10).

Floating-leafed plants were dominated by fragrant waterlily, and distributed similarly as was documented in the 1998 survey.

Again, as in 1996, *Potamogeton pusillus*, (small-leaved pondweed) was the dominant submerged macrophyte. *Najas fexilis* (naiad) was commonly present in shallow waters less than 8 feet deep. The distribution of naiad was higher in 1998 than in 1996.

Submerged macroalgae dominated the aquatic plant community again in 1998. *Chara schweinitzii* dominated the shallow region (less than 8 feet); and *Nitella flexilis* dominated the deeper region of the lake between 12 and 15 feet. These populations were still not dense enough to significantly impair the recreational use of the lake.

2001 AquaTechnex Survey

This survey, conducted in the summer of 2001 for King County through a grant from the Department of Ecology, was very limited. Milfoil plants were found along the north shoreline during the diver survey of the lake (Figure 11). The milfoil colonies were estimated to be less than 3 acres in size, and at a pioneering level of infestation.

The report stressed the threat posed to other local water bodies, and indicated that the objective should be eradication of the milfoil. It recommended that an intense survey of the littoral zone of the lake be conducted in 2002 to detect expansion of the population. In addition, the report pointed out that Steel Lake would be eligible for a Department of Ecology Early Infestation Grant, which should be pursued by the appropriate jurisdiction.

A yearly budget of $10,000 was presented that would cover aquatic plant management efforts if the control program started in 2002. The report warned that it was probable that the weed would expand dramatically by 2003 if no action were taken, and that a Sonar® treatment protocol might then be required to remove this plant. The estimated cost for this approach would be $38,000.

2002 AquaTechnex Survey

On August 16, a complete underwater survey was conducted to identify and map all milfoil plants and their densities. Milfoil was found in several locations throughout the littoral zone, with the southwest corner exhibiting the largest and most dense (heavy) colonies. Lesser dense colonies (moderate) were found along the eastern shoreline and in the bay in the north eastern corner of the lake. Most of the northern shoreline of the lake contained small patches (sparse) around residential docks (Figure 12).

The size of the milfoil plants ranged from single stems 6-12 inches long, to multiple stems 2-5 feet long originating from a single root crown. Many milfoil plants in the southwest corner of the lake had reproductive structures (flowers) above the surface of the water. At the time of the survey, milfoil was estimated to be colonizing approximately five (5) acres.

The survey indicated the presence of more than 50 milfoil plants. Diver hand removal, diver dredging and/or application of bottom burlap barriers were deemed to be impractical for the extent of infestation. AquaTechnex obtained an general NPDES Noxious Weed Permit to apply the aquatic herbicide 2,4-D (AquaKleen®). On August 26, affected areas of Steel Lake was treated with 2,4-D by spray gun at a rate of 100 pounds per acre.

On August 27 and 30, City of Federal Way Surface Water Management (SWM) staff collected post treatment lake samples pursuant to the Early Infestation Grant Agreement with the Department of Ecology. Samples were collected using a Wildco Alpha 2.2 liter Van Dorn style water bottle. Samples were retrieved from various depths, and combined into individual composite samples. Samples were analyzed for chlorinated herbicides by USEPA 8151 GC/MS Modified. Concentrations of 2,4-D were unexpectedly low.

On September 30, SWM staff inspected the lake to determine the effectiveness of treatment. Low light conditions prevented an accurate evaluation. On October 4, SWM staff accompanied AquaTechnex staff, and concluded that there were no surviving milfoil plants in the treated areas (north, eastern, and western portions) of the lake. The dead plants were brown in color, stripped of leaves, with only dead stems connected to their root crowns. No reproductive structures remained above the surface of the water.

2003 Survey

(INSERT 2003 SURVEY INFO IN SPRING)

Table 8. Relative Presence, Density, and Areal Coverage of Aquatic Plants in Steel Lake

Relative Presence	Common Name	1976 [a]	1978 [a]	1979 [a]	1994 [b] (Pre-Treat)	1994 [b] (Post-Treat)	1996 [d]	1998 [d]	2001 [a]	2002 [e]	2003 [f]
Rooted Floating-Leaved											
Nymphaea odorata	Waterlily	Dominant	Dominant	Dominant	Dominant	Dominant	Dominant	Dominant	No data	No data	
Nuphar lutea spp. v	Waterlily	Present	Present	Present	Present	Present	Absent	Absent	No data	No data	
Nuphar variegatum	Waterlily						Present	Present	No data	No data	
Brasenia schreberi	Watershield	Present	Absent	Absent	Absent	Absent	Absent	Absent	No data	No data	
Submerged macrophytes									No data	No data	
Potamageton amplifolius	Pondweed	Present	Present	Dominant	Dominant	Present	Present	Present	No data	No data	
Potamageton pusillus	Pondweed	Dominant	Dominant	Present	Dominant	Absent	Dominant	Dominant	No data	No data	
Ludwigia paulustris	Water purslane						Present	Present	No data	No data	
Elodea canadensis	Waterweed	Present	Present	Present	Present	Absent	Absent	Present	No data	No data	
Najas flexilis	Naiads	Dominant	Dominant	Dominant	Unknown	Unknown	Present	Present	No data	No data	
Myriophyllum spicatum	Milfoil	Absent	Absent	Absent	Present	Absent	Absent	Absent	Present	Present	
Utricularia vulgaris	Bladderwort	Absent	Absent	Present	Absent	Absent	Absent	Absent	No data	No data	
Ceratophyllum demersum	Coontail	Absent	Present	Absent	Absent	Absent	Absent	Absent	No data	No data	
Submerged macroalgae [f]											
Nitella sp.	Nitella	Present	Dominant	Dominant	Dominant	Dominant	Dominant	Dominant	No data	No data	
Chara sp.	Muskgrass	Dominant	Present	Present	Absent	Absent	Dominant	Dominant	No data	No data	
Relative Density of Submerged Macrophytes											
North Shore		Moderate	Sparse	Moderate	Dense	Sparse	Dense	Dense	Moderate	Moderate	
East Shore		Moderate	Sparse	Sparse	Dense	Sparse	Dense	Dense	None	Sparse	
South Shore		Moderate	Sparse	Sparse	Dense	Sparse	Moderate	Moderate	None	Sparse	
Areal Coverage (acres)											
Floating-leaved plants		9.6	8.5	8.2	3.6	3.6	No data	No data	No data	No data	
Submerged macrophytes/algae		19.1	8.6	6.2	6.5	0	No data	No data	No data	No data	
Eurasian watermilfoil		0	0	0	1.3	0	No data	No data	3	5	
Submerged macroalgae		0	8.9	12.6	23.6	31.4	No data	No data	No data	No data	
Total		**29**	**26**	**27**	**35**	**35**	**No data**	**No data**	**3 (milfoil)**	**5 (milfoil)**	

[a] Source: Metro 1976, 1978, 1979, 2001 (milfoil only)
[b] Source: RMI 1994
[c] Source: Herrera, 1996, 1998
[d] Source: AquaTechnex 2002 (milfoil only)
[e] Source: 2003
[f] These plants may have been misidentified in earlier surveys due to their similarity.

Table 8. The Relative Presence, Density, and Areal Coverage of Aquatic Plants from 1976 through 2003

(see preceding fold-out page for Table 8)

Plant Type Description

Based upon the findings contained in the 2003 Steel Lake Aquatic Plant Survey, the following includes the characteristics of the dominant species for each type of aquatic plants: Emergent; Rooted Floating-Leaved Plants; Submerged Macrophytes; and Submerged Macroalgae. The 2003 Steel Lake aquatic plant survey found three (3) listed noxious weed species: Eurasian watermilfoil (*Myriophyllum spicatum),* fragrant water lily (*Nymphaea odorata),* and yellow flag iris. These species will be the focus of the plant management efforts on Steel Lake.

Noxious weeds are legally defined by Washington's Noxious Weed Control Law (RCW 17.10). The term "noxious weed" refers to those non-native plants that are highly destructive, competitive, or difficult to control once established. Noxious weeds have usually been introduced accidentally as a contaminant or as ornamentals. Non-native plants often do not have natural predators (i.e., herbivores, pathogens) or strong competitors to control their numbers as they may have had in their home range. WAC 16.750 sets out three classes (A, B, C) of noxious weeds based on their distribution in the state, each class having different control requirements. County Weed Boards are given some discretion as to setting control priorities for Class B and C weeds.

Native Plant Species

NATIVE EMERGENT PLANTS

There are no dominant native Emergent Plant types noted in Steel Lake.

NATIVE ROOTED FLOATING-LEAVED PLANTS

There are no dominant native Rooted Floating-Leaved Plant types noted in Steel Lake.

NATIVE SUBMERGED MACROPHYTES

Small-leafed pondweed (*Potamogeton pusillus*)

(The following information was obtained in part from the Department of Ecology website)

Small and leafy pondweeds grow in similar habitats and look alike. They also resemble other aquatic plants with thin leaves and delicate stems. These pondweeds have long, narrow leaves and, except for an occasional flower spike that briefly rises above the water, they remain underwater for their entire lives. Because the narrow leaved pondweeds look so much alike, close attention must be paid to minute details to distinguish between them.

The stem is slender and profusely branched, often having small, paired yellowish glands at the leaf base. The flower appears in 1-4 whorls on spikes measuring 3-15 mm long, not always above the water. The root is fibrous, from the base of the plant, and is often non-rhizomatous. The plant's seeds and winter buds form at the lateral branch tips and near the leaf bases. Its seeds and vegetation provide cover and food for aquatic animals.

Naiads (*Naja flexilis*)

(The following information was obtained in part from the Department of Ecology website)

Naiads (or slender water-nymph and common water-nymph) are completely submerged annual plants, although they are often found as floating fragments. They have opposite leaves that are often clustered near the tips of the stems. The leaf base is much wider than the rest of the leaf blade, which helps to distinguish the naiads from other underwater plants. These plants have inconspicuous flowers and fruits that are almost completely hidden by the leaf bases. Naiad pollination takes place underwater.

The plants have glossy, green, and finely toothed leaves that are oppositely arranged, but appear to be whorled near ends of the stems. The leaves are long and narrow with broad bases that clasp the stem, and taper to a long point 1-3 cm long and 1-2 mm wide. The stem is slender, limp and branched up to 2 m long and easily broken. The flower is inconspicuous, tiny (2-3 mm), and is located in clusters at the base of the leaves. Male and female flowers occur separately on the same plant. Naiad pollen is transported by water currents. The fruit is a small, oval-shaped fruit located in the leaf bases, and is present in late summer.

The entire plant is eaten by waterfowl. Naiads are considered to be one of their most important food sources. They also provide shelter for small fish and insects.

NATIVE SUBMERGED MACROALGAE

(The following information was obtained in part from the Department of Ecology website)

Plant-like algae (*Chara, spp*)

Although these common lake inhabitants look similar to many underwater plants, they are actually algae. Chara are green or gray-green colored algae that grow completely submersed in shallow (4 cm) to deep (20 m) water. Individuals can vary greatly in size, ranging from 5 cm to 1 m in length. The main "stem" of Chara bear whorls of branchlets, clustered at regularly spaced joints. When growing in hard water, Chara sometimes become coated with lime, giving them a rough gritty feel. These algae are identifiable by their strong skunk-like or garlic odor, especially evident when crushed.

Algae lack true leaves. Six to 16 leaf-like branchlets of equal length grow in whorls around the stem, and are never divided. These branchlets often bear tiny thorn-like projections, which give the plant a rough or prickly appearance when magnified. They also lack true stems. The round, stem-like structure varies from 5 cm to over 1 m in length.

Chara, like other algae, do not produce flowers. Instead, microscopic, one-celled sex organs called oogonia are formed. These tiny organs and patterns in the cases that surround them are used to distinguish between species. Tiny spores are produced in fruiting bodies. In some species the fruiting bodies are orange and very conspicuous. In addition, Chara may be attached to the bottom by root-like structures called holdfasts.

Plant-like algae (*Nitella, sp.*)

Nitellas are bright green algae that often are mistaken for higher plants because they appear to have leaves and stems. These long, slender, delicate, smooth-textured algae lie on the bottom of a lake or pond and are seldom found in the water column. They are found growing in shallow to deep waters of soft water or acid lakes and bogs. They often grow in deeper water than flowering plants and frequently form a thick carpet or grow in clumps along the bottom. Whorls of forked branches are attached at regularly spaced intervals along the "stems". Nitellas sometime grow together with muskgrasses (*Chara* spp.), another plant-like algae, to form underwater meadows.

The plant has no true leaves. Six-eight evenly forked branchlets grow in whorls at regularly spaced intervals along the "stem". Unlike the rough branchlets of most muskgrasses (*Chara* spp.), nitella branchlets have a smooth texture.

Nitellas have no true stems, but have hollow, stem-like structures that have whorls of forked branches along their entire length. The largest nitella species have "stems" up to 2 m long.

The plant does not bear flowers. Instead nitellas have microscopic spore-producing organs. Male organs grow at the base of the branchlets. Female organs are located in a cluster on the sides of the branchlets below the male organs.

Nitellas produce spores (which are transported by wildlife) rather than fruits, and lack roots. The plants may be attached to the bottom by root-like structures called holdfasts or be floating free above the sediment.

They provide cover for fish, food for fish and waterfowl, and stabilize the sediment. Because nitellas have no roots, they remove nutrients directly from the water. Nitellas are considered desirable species in Washington.

Non-Native Plant Species

NON-NATIVE EMERGENT PLANTS

Yellow flag iris (Iris pseudacorus)

Yellow flag iris is native to mainland Europe, the British Isles, and the Mediterranean region of North Africa (Washington State Noxious Weed Control Board, 2001a). This plant was introduced widely as a garden ornamental. It has also been used for erosion control. The earliest collection in Washington is from Lake McMurray in Skagit County in 1948 (Washington State Noxious Weed Control Board, 2001a). The yellow flowers are a distinguishing characteristic, and when not flowering it may be confused with cattail (*Typha sp.*) or broad-fruited bur-reed (*Sparganium eurycarpum*).

Yellow flag iris is considered an obligate wetland species (OBL), with a >99% probability of occurring in wetlands as opposed to upland areas (Reed, 1988). The plants produce large fruit capsules and corky seeds in the late summer. Yellow flag iris spreads by rhizomes and seeds. Up to several hundred flowering plants may be connected rhizomatously. Rhizome fragments can form new plants. Yellow flag iris can spread by rhizome growth to form dense stands that can exclude even the toughest of our native wetland species, such as *Typha latifolia* (cattail). In addition to threatening plant diversity, this noxious weed can also alter hydrologic dynamics through sediment accretion along the shoreline. This species produces prolific seeds that could easily be transported downstream to invade other valuable resource areas.

NON-NATIVE ROOTED FLOATING-LEAVED PLANTS

Fragrant water lily, white water lily (*Nymphaea odorata*)

(The following information was obtained in part from the Department of Ecology website)

Fragrant water lily is a Class C Noxious Weed. Fragrant water lilies (*Nymphaea odorata*) are water plants with floating leaves and large, many-petaled fragrant blossoms. The hardy white and (sometimes) pink lilies have become naturalized in Washington lakes and rivers. These plants are native to the eastern United States and it is believed that the water lily was introduced to Washington in the late 1800s. Water lilies have been intentionally planted in many Washington lakes, especially those lakes in western Washington. Lake residents are strongly discouraged from planting fragrant waterlilies in lakes or natural waterbodies because they are aggressive plants, and sometimes "hitchhiker" plants such as hydrilla can also be introduced to our lakes when water lilies are planted. Of 15 lakes surveyed in 1994 in King County, *Nymphaea odorata* appeared on the species list of all 15 lakes. Shallow lakes are particularly vulnerable to being totally covered by fragrant waterlilies.

Left unmanaged, waterlilies will restrict lake-front access and eliminate swimming opportunities. Requests for waterlily control represent a high percentage of the herbicide permit requests received by the Department of Ecology. Water lilies grow in dense patches, excluding native species and even creating stagnant areas with low oxygen levels underneath the floating mats. These mats make it difficult to fish, water ski, swim, or even paddle a canoe through. Although relatively slow-spreading, water lilies will eventually colonize shallow water depths to six feet deep and can dominate the shorelines of shallow lakes. For this reason, planting water lilies in lakes is not recommended.

Waterlilies provide excellent cover for largemouth bass, sunfish, and frogs. However, when allowed to grow in dense stands, the floating leaves prevent wind mixing and extensive areas of low oxygen can develop under waterlily beds during the summer. When managed to form a patchy distribution interspersed with open water, waterlilies can provide excellent habitat.

Water lilies reproduce by seed and also by new plants sprouting from the large spreading roots (underground stems called rhizomes). A planted rhizome will cover about a 15-foot diameter in about five years. Each spring (April) new shoots appear from the rhizomes and grow up through the water until they reach the surface. The flowers appear from June to September. After the flowers have closed for the final time, the flower stalk "corkscrews" and draws the developing fruit below the water. The plant senesces in the fall and over-winters as the rhizome. Root systems are tenacious, and if pieces of the rhizome are broken off during control efforts, they will drift to other locations and establish a new patch of lilies

Because of their large, showy flowers, water lilies are easy to identify when flowering. They have white or pink showy flowers. When not in flower look for:

- Nearly-circular floating leaves, up-to-11 inches in diameter.
- The underside of the leaf is often red or purple with numerous veins.
- The stem is attached to the center of the leaf.
- The leaves each have a deep cleft to the stem.

NON-NATIVE SUBMERGED MACROPHYTES

(The following information was obtained in part from the Department of Ecology website)

Eurasian watermilfoil (*Myriophyllum spicatum*)

Eurasian watermilfoil (milfoil) is a Class B Noxious Weed. Milfoil is an attractive plant with feathery underwater foliage. Once commonly sold as an aquarium plant, milfoil originated from Europe and Asia. It was introduced to North America 50 to 100 years ago. The first known specimen of milfoil in Washington was collected from Lake Meridian near Seattle in 1965. By the mid 1970s it was also found in Lake Washington. Now milfoil is found throughout the Northwest; and in western Washington, has followed the Interstate 5 corridor.

Milfoil is an extremely adaptable plant, able to tolerate and even thrive in a variety of environmental conditions. It grows in still to flowing waters, grows rooted in water depths from 1 to 10 meters (regularly reaching the surface while growing in water 3 to 5 meters deep), and can survive under ice. Relative to other submersed plants, milfoil requires high light, has a high photosynthetic rate, and can grow over a broad temperature range. Milfoil grows best on fine-textured, inorganic sediments and relatively poorly on highly organic sediments.

Because it is widely distributed and difficult to control, milfoil is considered to be the most problematic plant in Washington. The introduction of milfoil can drastically alter a waterbody's ecology. Milfoil forms very dense mats of vegetation on the surface of the water. These mats interfere with recreational activities such as swimming, fishing, water skiing, and boating.

The sheer mass of plants can cause flooding and the stagnant mats can create good habitat for mosquitoes. Milfoil mats can rob oxygen from the water by preventing the wind from mixing the oxygenated surface waters to deeper water. The dense mats of vegetation can also increase the sedimentation rate by trapping sediments. Milfoil also starts spring growth sooner than native aquatic plants and can shade out these beneficial plants. When milfoil invades new territory, typically the species diversity of aquatic plants declines.

While some species of waterfowl will eat milfoil, it is not considered to be a good food source.

Milfoil adversely impacts aquatic ecosystems by forming dense canopies that often shade out native vegetation. Mono-specific stands of milfoil provide poor habitat for waterfowl, fish, and other wildlife. Significant rates of plant sloughing and leaf turnover, as well as the decomposition of high biomass at the end of the growing season, increase the internal loading of phosphorus and nitrogen to the water column. Dense milfoil mats alter water quality by raising pH, decreasing oxygen under the mats, and increasing temperature.

Milfoil exhibits an annual pattern of growth. In the spring, shoots begin to grow rapidly as water temperatures approach 15 degrees centigrade. When they near the surface, shoots branch profusely, forming a dense canopy. The leaves below 1-meter senesce in response to self-shading. Typically, plants flower upon reaching the surface (usually in mid- to late-July). After flowering, plant biomass declines as the result of the fragmentation of stems. Where flowering occurs early, plant biomass may increase again later in the growing season and a second flowering may occur. During fall, plants die back to the root crowns, which sprout again in the spring. In some areas, like western Washington, milfoil frequently over-winters in an evergreen form and may maintain considerable winter biomass. Milfoil plants do not form specialized over-wintering structures such as turions. Carbohydrate storage occurs throughout over-wintering shoots and roots.

Although Milfoil can potentially spread by both sexual and vegetative means, vegetative spread is considered the major method of reproduction. During the growing season, the plant undergoes auto-fragmentation. The abscising fragments often develop roots at the nodes before separation from the parent plants. Fragments are also produced by wind and wave action and boating activities, with each fragment having the potential to develop into a new plant. Milfoil can easily be transported from lake to lake on boat trailers or fishing gear. Once introduced, milfoil also may spread rapidly and can infest an entire lake within two years of introduction to the system.

Some tips to identify milfoil:

- Count the pairs of leaflets. Milfoil usually has twelve or more pairs on each leaf.
- Milfoil leaves tend to collapse around the stem when removed from the water. Other milfoil species have thicker stems and are usually more robust.
- The mature leaves are typically arranged in whorls of four around the stem.

AQUATIC PLANT CONTROL ALTERNATIVES

The aquatic plant management goals are based on controlling four plant communities: milfoil, fragrant water lily, native submerged plants, and yellow flag iris. The feasibility of different plant control techniques depends on the specific aquatic plant and the degree of control desired.

This section outlines common methods used to control aquatic weeds. Much of the information in this section is quoted directly from the Department of Ecology's website, and from information provided by King County Department of Water and Land Resources Division (King County, 2003 Draft Spring Lake IAVMP).

Control/eradication methods discussed herein include Aquatic Herbicide, Manual Methods, Bottom Screens, Diver Dredging, Biological Control, Rotovation, Cutting, Harvesting, and Drawdown.

Aquatic Herbicides

Description

Aquatic herbicides are chemicals specifically formulated for use in water to eradicate or control aquatic plants. Herbicides approved for aquatic use by the United States Environmental Protection Agency (EPA) have been reviewed and considered compatible with the aquatic environment when used according to label directions. However, individual states may also impose additional constraints on their use.

Aquatic herbicides are sprayed directly onto floating or emergent aquatic plants, or are applied to the water in either a liquid or pellet form. Systemic herbicides are capable of killing the entire plant by tranlocating from foliage or stems and killing the root. Contact herbicides cause the parts of the plant in contact with the herbicide to die back, leaving the roots alive and capable of re-growth (chemical mowing). Non-selective herbicides will generally affect all plants that they come in contact with, both monocots and dicots. Selective herbicides will affect only some plants (usually dicots – broad leafed plants like Eurasian watermilfoil will be affected by selective herbicides whereas monocots like Brazilian elodea and our native pondweeds may not be affected).

Because of environmental risks from improper application, aquatic herbicide use in Washington State waters is regulated and has certain restrictions. The Washington State Department of Agriculture must license aquatic applicators. In addition, because of a March 2001 court decision (Federal 9th Circuit District Court), coverage under a discharge permit called a National Pollutant Discharge Elimination System (NPDES) permit must be obtained before aquatic herbicides can be applied to some waters of the U.S. This ruling, referred to as the Talent Irrigation District decision, has further defined Section 402 of the Clean Water Act. Ecology has developed a general NPDES permit which is available for coverage under the Washington Department of Agriculture for the management of noxious weeds growing in an aquatic situation and a separate general permit for nuisance aquatic weeds (native plants) and algae control. For nuisance weeds (native species also referred to as beneficial vegetation) and algae, applicators and the local sponsor of the project must obtain a NPDES permit from the Washington Department of Ecology before applying herbicides to Washington water bodies.

Although there are a number of EPA registered aquatic herbicides, the Department of Ecology currently issues permits for four aquatic herbicides (as of 2002 treatment season). Several other herbicides are undergoing review and it is likely that other chemicals may be approved for use in Washington in the future. As an example, Garlon 3A is due to be approved by the U.S. EPA for aquatic use before spring 2003. The chemicals that are currently permitted for use in 2002 are:

Rodeo® or Aquamaster® is a systemic non-selective herbicide used to control floating-leaved plants like water lilies and shoreline plants like purple loosestrife and yellow flag iris. Its active ingredient is **glyphosate**. It is generally applied as a liquid to the leaves. Rodeo® or Aquamaster® does not work on underwater plants such as Eurasian watermilfoil. Although glyphosate is a non-selective herbicide, a good applicator can somewhat selectively remove targeted plants by focusing the spray only on the plants to be removed. Plants take several weeks to die. A repeat application is often necessary to remove plants that were missed during the first application. Note: there are other glyphosate products available, like Aquamaster®, with the exact formulation as Rodeo® but with different trade names now that the patent has expired. Additional surfactants are often added to improve the penetration of the leaf cuticle and help the herbicide stay on the plant long enough to be effective. Those that may be used for emergent weed control include X-77, LI-700, and R-11 as approved by the SEPA process.

2,4-D is a systemic, selective herbicide used for the control of Eurasian watermilfoil and other broad-leaved species. Formulations of 2,4-D include:

- **Navigate® and AquaKleen®** - Active ingredient **2,4-D BEE**. These granular products contain the low-volatile butoxyethyl-ester (BEE) formulation of 2,4-D. 2,4-D is a relatively fast acting selective, systemic herbicide. It is applied in a granular formulation and can be effective for spot treatment of Eurasian watermilfoil. When used at a rate of 100 pounds per acre, 2,4-D has shown to be selective to Eurasian watermilfoil, leaving native aquatic species relatively unaffected.
- **DMA*4IVM®** - Dimethylamine Salt of **2,4-D**. This is a liquid formulation that is labeled for aquatic weed control. Since 2,4-D DMA (like 2,4-D BEE) is rapidly converted to 2,4-D acid, the two products should be equally effective in controlling Eurasian watermilfoil. Previously, 2,4-D DMA was only registered for this use in dams and reservoirs of the Tennessee Valley Authority (TVA) System, but is now approved for use in Washington. It has recently been used to successfully control Eurasian watermilfoil in parts of Lake Washington, King County.
- **Sonar®** - Active ingredient **fluridone**. Sonar® is a slow-acting systemic herbicide used to control Eurasian watermilfoil and other underwater plants. It may be applied in pelleted form or as a liquid. Fluridone can show good control of submersed plants

where there is little water movement and an extended time for the treatment. Its use is most applicable to whole-lake or isolated bay treatments where dilution can be minimized. It is not effective for spot treatments. It may take six to twelve weeks before the dying plants fall to the sediment and decompose. When used to manage Eurasian watermilfoil, Sonar® is applied several times during the summer to maintain a low, but consistent concentration in the water. Although fluridone is considered to be a non-selective herbicide, when used at low concentrations, it can be used to selectively remove Eurasian watermilfoil. Some native aquatic plants, especially pondweeds, are minimally affected by low concentrations of fluridone.

- **Aquathol®** - Active ingredient the dipotassium salt of **endothall**. Aquathol® is a fast-acting non-selective <u>contact</u> herbicide, which destroys the vegetative part of the plant but does not kill the roots. Aquathol® may be applied in a granular or liquid form. Generally endothall compounds are used primarily for short-term (one season) control of a variety of aquatic plants. However, there has been some recent research that indicates that when used in low concentrations, Aquathol® can be used to selectively remove exotic weeds, leaving native species unaffected. Because it is fast acting, Aquathol® can be used to treat smaller areas effectively. There are water use restrictions associated with the use of Aquathol® in Washington.

Advantages

- Aquatic herbicide application can be less expensive than other aquatic plant control methods.
- Aquatic herbicides are easily applied around docks and underwater obstructions.
- 2,4-D DMA & 2,4-D BEE have been shown to be effective in controlling smaller infestations (not lake-wide) of Eurasian watermilfoil in Washington.
- Washington has had some success in eradicating Eurasian watermilfoil from some smaller lakes (320 acres or less) using Sonar®.

Disadvantages

- Some herbicides have swimming, drinking, fishing, irrigation, and water use restrictions.
- Herbicide use may have unwanted impacts to people who use the water and to the environment.
- Non-targeted plants as well as nuisance plants may be controlled or killed by some herbicides.

- Depending on the herbicide used, it may take several days to weeks or several treatments during a growing season before the herbicide controls or kills treated plants.
- Rapid-acting herbicides like Aquathol® may cause low oxygen conditions to develop as plants decompose. Low oxygen can cause fish kills.
- To be most effective, generally herbicides must be applied to rapidly-growing plants.
- Some expertise in using herbicides is necessary in order to be successful and to avoid unwanted impacts.
- Many people have strong feelings against using chemicals in water.
- Some cities or counties may have policies forbidding or discouraging the use of aquatic herbicides.

Permit Requirements

A NPDES permit is needed for the use of aquatic herbicides. Both the noxious and nuisance NPDES permits require the development of integrated aquatic vegetation management plan by the third year of control work. Monitoring may also be required. For noxious weed control, apply to the Washington Department of Agriculture for coverage under their NPDES permit each treatment season. There is no permit or application fee to obtain coverage under Agriculture's permit.

Costs

Approximate costs for one-acre herbicide treatment (costs will vary from site to site):

- DMA*4IVM®: $500-700
- Navigate® and AquaKleen®: $500-700
- Rodeo® or Aquamaster® : $250
- Sonar®: $900 to $1,000

Human Health and Fish and Wildlife Considerations

As far as restrictions for aquatic 2,4-D applications, there is a one-day swimming restriction, no fishing restriction, and three to five days after treatment the water is generally below the drinking water standard (70 ppb, irrigation standard is 100 ppb for broad-leafed plants). There is no irrigation restriction for watering lawns. This chemical has a low acute toxicity (from an LD50 standpoint, is less toxic than caffeine and slightly more toxic than aspirin). Based on the low dermal absorption of the chemical, the dose of the chemical received from skin contact with treated water is not considered significant

(Washington State Department of Ecology, 2001b). Recent, state-of-the-art EPA studies continue to find that it is not considered a carcinogen or mutagen, nor does it cause birth defects. It has a relatively short persistence in aquatic systems, since it tends to bind to organic matter in the sediments. The herbicide 2,4-D generally does not bioaccumulate to a great extent, and the small amounts which do accumulate are rapidly eliminated once exposure ceases (Washington State Department of Ecology, 2001b).

Based on laboratory data reported in the Department of Ecology's Risk Assessment of 2,4-D, 2,4-D DMA has a low acute toxicity to fish (LC50 = >100 to 524 mg a.i./L for the rainbow trout and bluegill sunfish respectively). No Federally sensitive/threatened or endangered species were tested with 2,4-D DMA. However, it is likely that endangered salmonids would not exhibit higher toxic effects to 2,4-D DMA than those seen in rainbow trout. Since the maximum use rate of 2,4-D DMA would be no higher than the maximum labeled use rate (4.8 mg a.i./L) even the most sensitive fish species within the biota should not suffer acute impacts from the effects of 2,4-D DMA. In conclusion, 2,4-D DMA will not effect fish or free-swimming invertebrate biota acutely or chronically when applied at typical use rates of 1.36 to 4.8 mg a.i./L (Washington State Department of Ecology, 2001b). However, more sensitive species of benthic invertebrates like glass shrimp may be affected by 2,4-D DMA, but 80 and 90% of the benthic species should be safe when exposed to 2,4-D DMA acutely or chronically at rates recommended on the label. Field work indicates that 2,4-D has no significant adverse impacts on fish, free-swimming invertebrates and benthic invertebrates, but well designed field studies are in short supply.

According to the Department of Ecology's Risk Assessment of 2,4-D, in the United States, 2,4-D BEE is the most common herbicide used to control aquatic weeds. 2,4-D BEE, has a high laboratory acute toxicity to fish (LC50 = 0.3 to 5.6 mg a.i./L for rainbow trout fry and fathead minnow fingerlings, respectively). Formal risk assessment indicates that short-term exposure to 2,4-D BEE should cause adverse impact to fish since the risk quotient is above the acute level of concern of 0.01 (RQ = 0.1 ppm/0.3 ppm = 0.33). However, the low solubility of 2,4-D BEE and its rapid hydrolysis to 2,4-D acid means fish are more likely to be exposed to the much less toxic 2,4-D acid. 2,4-D acid has a toxicity similar to 2,4-D DMA to fish (LC50 = 20 mg to 358 mg a.i./L for the common carp and rainbow trout, respectively). In contrast, formal risk assessment with 2,4-D acid indicates that short-term exposure to 2,4-D BEE should not cause adverse impact to fish since the risk quotient is below the federal level of concern of 0.01 (RQ = 0.1 ppm/20 ppm = 0.005). To conclude, 2,4-D BEE will have no significant impact on the animal biota acutely or chronically when using applied rates recommended on the label (Washington State Department of Ecology, 2001b). Although laboratory data indicates that 2,4-D BEE may be toxic to fish, free-swimming invertebrates and benthic invertebrates, data indicates that its toxic potential is not realized under typical concentrations and conditions found in the field. This lack of field toxicity is likely due to the low solubility of 2,4-D BEE and its rapid hydrolysis to the practically non-toxic 2,4-D acid within a few hours to a day following the application.

Glyphosate is practically nontoxic by ingestion, with a reported acute oral LD50 of 5600 mg/kg in the rat. Technically, glyphosate acid is practically nontoxic to fish and may be slightly toxic to aquatic invertebrates (EXTOXNET, 1996). Some formulations may be more toxic to fish and aquatic species due to differences in toxicity between the salts and the parent acid, or to surfactants used in the formulation. There is a very low potential for the compound to build up in the tissues of aquatic invertebrates or other aquatic organisms. Glyphosate is moderately persistent in soil, with an estimated average half-life of 47 days. It is strongly adsorbed to most soils, even those with lower organic and clay content. Thus, even though it is highly soluble in water, field and laboratory studies show it does not leach appreciably, and has low potential for runoff (except as adsorbed to colloidal matter). One estimate indicated that less than 2% of the applied chemical is lost to runoff. Microbes are primarily responsible for the breakdown of the product, and volatilization or photodegradation losses will be negligible. In water, glyphosate is strongly adsorbed to suspended organic and mineral matter and is broken down primarily by microorganisms.

Suitability for Steel Lake

Aquatic herbicides can provide an effective method for control and eventual eradication of noxious weeds. The use of a formulation of 2,4-D should provide excellent initial control of Eurasian watermilfoil while allowing for the more-appropriate spot treatments for future scattered infestation. Annual surveys, public education, effective and spot treatments as necessary will be sufficient to control and eradicate milfoil. Therefore, the potential for future lake-wide fluridone treatments with fluridone (Sonar®) will be reduced substantially.

The granular formulations of 2,4-D BEE found in Navigate® and AquaKleen® has been shown to be highly effective for spot treatment of milfoil in Steel Lake. The time-released nature of these granular formulations is less susceptible to drift. Liquid formulations can drift off target as a result of wind and/or boat activity. Therefore, liquid formulations have a slightly higher risk of injuring off-target organisms. In addition, granular applications are visible – the applicator can direct the product directly onto the target plants. The granules adhere to the leaves, increasing the effectiveness (Vandermeulen, personal communication). However, impacts to resident fish populations in the short term would be greatest with the use of 2,4-D BEE as it has a high acute toxicity before its hydrolysis to 2,4-D acid.

Steel Lake does not appear to have anadromous salmonids. According to King County's Hylebos and Lower Puget Sound Basin Plan, salmon habitat potentially exists on the lower reach of Redondo Creek into Federal Way. However, the stream is likely blocked to salmon migration due to a culvert at the mouth of the stream where the lower most 500 feet of the channel is piped, and likely presenting an impassable barrier to migrating fish. (Hylebos Creek and Lower Puget Sound Basins Current and Future Conditions Report). Therefore, the choice of treatment methodologies is not limited by the presence of anadromous salmonids.

Glyphosate should be very effective on the other target species: fragrant water lily, and yellow flag iris. Westerdahl and Getsinger (1988) report excellent control of the fragrant water lily with glyphosate. Generally glyphosate is the recommended herbicide for water lily control because it can be applied directly to the floating leaves, unlike fluridone or endothall which must be applied to the water. The application of glyphosate allows specific plants or areas of plants to be targeted for removal. Generally two applications of glyphosate are needed. The second application later in the summer controls the plants that were missed during the first herbicide application. The control effectiveness of fragrant water lily is easy to measure through visual surveys due to the floating leaves.

Glyphosate should also provide excellent systemic control of yellow flag iris. This species has an abundant leaf surface area to absorb the chemical for translocation to the rhizome. The use of an herbicide will enable the elimination of the mature plants without potentially destructive disturbance of the shoreline by excavation.

One of the main reasons to eradicate milfoil and fragrant water lily is to maintain the health of the native aquatic plant community for all of the species that utilize them in their life cycles, as well as for the human recreational uses. The nature of the control methods to be implemented will minimize impacts to native aquatic vegetation. The control of the Eurasian watermilfoil and fragrant water lily will be conducted by methods designed to preserve (and eventually enhance or conserve) the native plant communities. Herbicide selective to Eurasian watermilfoil will be used for its control and should not require a whole-lake treatment that would expose all the submersed plants to the herbicide. The herbicide for the fragrant water lily will be applied to the leaves and, therefore, should be easily focused to kill only the target vegetation.

The application of herbicide to the emergent species (yellow flag iris) will also be conducted by manual spot applications. An experienced herbicide applicator can selectively target individual weed species and limit collateral damage to other species to a minimum. This is especially true when infestations are small so that large areas with a diverse plant distribution don't have to be treated. Since the emergent noxious weed infestations at Steel Lake are still confined largely to the shoreline, it should be relatively simple for the control applicator to avoid collateral damage and preserve the native plant community.

The need to revegetate after controlling the milfoil and fragrant water lily is unknown at this time. It is anticipated that removal of the invasive vegetation will promote growth of native plants. The goal is to have at least 40% native aquatic vegetative cover. The annual survey will help determine whether there is sufficient native vegetation to support aquatic wildlife. In the terrestrial environment, bare ground will often be colonized rapidly by invasive species, but this is not usually a problem in lacustrine areas.

A drawback of using herbicides is the "uplifting" of mats of decomposing water lily roots that can form large floating islands in the waterbody after the herbicides have killed the plants. These floating mats may become problematic, especially at the west end of the lake where a larger area is covered with fragrant water lily. Often these large islands float to the east end of the lake landing on the shoreline.

Manual Methods

Hand-Pulling

Hand-pulling aquatic plants is similar to pulling weeds out of a garden. It involves removing entire plants (leaves, stems, and roots) from the area of concern and disposing of them in an area away from the shoreline. In water less than three feet deep no specialized equipment is required, although a spade, trowel, or long knife may be needed if the sediment is packed or heavy. In deeper water, hand-pulling is best accomplished by divers with SCUBA equipment and mesh bags for the collection of plant fragments. Some sites may not be suitable for hand pulling such as areas where deep flocculent sediments may cause a person hand pulling to sink deeply into the sediment.

Cutting

Cutting differs from hand pulling in that plants are cut and the roots are not removed. Cutting is performed by standing on a dock or on shore and throwing a cutting tool out into the water. A non-mechanical aquatic weed cutter is commercially available. Two single-sided, razor sharp stainless steel blades forming a "V" shape are connected to a handle, which is tied to a long rope. The cutter can be thrown about 20 – 30 feet into the water. As the cutter is pulled through the water, it cuts a 48-inch wide swath. Cut plants rise to the surface where they can be removed. Washington State requires that cut plants be removed from the water. The stainless steel blades that form the V are extremely sharp and great care must be taken with this implement. It should be stored in a secure area where children do not have access.

Raking

A sturdy rake makes a useful tool for removing aquatic plants. Attaching a rope to the rake allows removal of a greater area of weeds. Raking literally tears plants from the sediment, breaking some plants off and removing some roots as well. Specially designed aquatic plant rakes are available. Rakes can be equipped with floats to allow easier plant and fragment collection. The operator should pull towards the shore because a substantial amount of plant material can be collected in a short distance.

Cleanup

All of the manual control methods create plant fragments. It's important to remove all fragments from the water to prevent them from re-rooting or drifting onshore. Plants and fragments can be composted or added directly to a garden.

Advantages

- Manual methods are easy to use around docks and swimming areas.
- The equipment is inexpensive.
- Hand-pulling allows the flexibility to remove undesirable aquatic plants while leaving desirable plants.
- These methods are environmentally safe and will not harm aquatic wildlife.
- Manual methods don't require expensive permits, and can be performed on aquatic noxious weeds with Hydraulic Project Approval obtained by reading and following the pamphlet *Aquatic Plants and Fish* (publication #APF-1-98) available from the Washington Department of Fish & Wildlife.

Disadvantages

- As plants re-grow or fragments re-colonize the cleared area, the treatment may need to be repeated several times each summer.
- Because these methods are labor intensive, they may not be practical for large areas or for thick weed beds.
- Even with the best containment efforts, it is difficult to collect all plant fragments, leading to re-colonization.
- Some plants, like water lilies which have massive rhizomes, are difficult to remove by hand pulling.
- Pulling weeds and raking stirs up the sediment and making it difficult to see remaining plants.
- Sediment re-suspension can also increase nutrient levels in lake water. Hand pulling and raking impacts bottom-dwelling animals.
- The V-shaped cutting tool is extremely sharp and can be dangerous to use.

Permit Requirements

Permits are required for many types of manual projects in lakes and streams. The Washington State Department of Fish and Wildlife requires a *Hydraulic Project Approval* permit for all activities taking place in the water including hand pulling, raking, and cutting of aquatic plants. In addition, some projects may require a Shoreline Development permit from the City of Federal Way.

Costs

- Hand-pulling costs up to $130 for the average waterfront lot for a hired commercial puller.
- A commercial grade weed cutter costs about $130 with accessories. A commercial rake costs about $95 to $125.
- A homemade weed rake costs about $85 (asphalt rake is about $75 and the rope costs 35-75 cents per foot).

Other Considerations

- Manual methods must include regular scheduled surveys to determine the extent of the remaining weeds and/or the appearance of new plants after eradication has been attained.
- Manual methods have the potential for missing milfoil plants, especially after stirring up sediments.
- Manual methods have the potential for fragmentation, exacerbating the existing milfoil problem

Suitability for Steel Lake

- Annual diver hand-pulling should be sufficient to remove a portion of re-emerging milfoil plants. In combination with herbicide treatments (when needed), manual methods used to contain and control, can effectively combat milfoil re-infestations in subsequent years.
- Cutting can be used to control small areas of fragrant water lily, especially those close to the shoreline. Using this method out in the open water would require a stable boat (not canoe) and great care not to injure oneself or another passenger. Since repeated cutting over several seasons may be required to starve the roots, this would fit best as a supplement to other control methods.
- Manual efforts are much more difficult on yellow flag iris since the plants don't emerge from simple stems that can be cut, and they arise from massive rhizomes inhibiting pulling or digging. The growth area may also be dangerous for volunteers or homeowners due to the deep muck along the lakeshore.
- Because there is a large amount of root mass associated with the iris, a significant effort is necessary to remove by excavation, an activity that may potentially disturb other plant communities. This would also expose the face of the peat layer, which could contribute to desiccation and disintegration of the other beneficial plant colony edges. is could lead to water quality problems.

Diver Dredging

Diver dredging (suction dredging) is a method whereby SCUBA divers use hoses attached to small dredges (often dredges used by miners for mining gold from streams) to suck plant material from the sediment. The purpose of diver dredging is to remove all parts of the plant including the roots. A good operator can accurately remove target plants, like Eurasian watermilfoil, while leaving native species untouched. The suction hose pumps the plant material and the sediments to the surface where they are deposited into a screened basket. The water and sediment are returned back to the water column (if the permit allows this), and the plant material is retained. The turbid water is generally discharged to an area curtained off from the rest of the lake by a silt curtain. The plants are disposed of on shore. Removal rates vary from approximately 0.25 acres per day to one acre per day depending on plant density, sediment type, and diver efficiency. Diver dredging is more effective in areas where softer sediment allows easy removal of the entire plants, although water turbidity is increased with softer sediments. Harder sediment may require the use of a knife or tool to help loosen sediment from around the roots. In very hard sediments, milfoil plants tend to break off leaving the roots behind and defeating the purpose of diver dredging.

In a large-scale operation in western Washington, two years of diver dredging reduced the population of milfoil by 80 percent (Silver Lake, Everett). Diver dredging is less effective on plants where seeds, turions, or tubers remain in the sediments to sprout the next growing season. For that reason, Eurasian watermilfoil is generally the target plant for removal during diver dredging operations.

Advantages

- Diver dredging can be a very selective technique for removing pioneer colonies of Eurasian watermilfoil.
- Divers can remove plants around docks and in other difficult to reach areas.
- Diver dredging can be used in situations where herbicide use is not an option for aquatic plant management.

Disadvantages

- Diver dredging is very expensive.
- Dredging stirs up large amounts of sediment. This may lead to the release of nutrients or long-buried toxic materials into the water column.
- Only the tops of plants growing in rocky or hard sediments may be removed, leaving a viable root crown behind to initiate growth.
- Acquisition of permits may take more than a year.

Permit Requirements

Permits are required for many types of projects in lakes and streams. Diver dredging requires Hydraulic Approval from the Department of Fish and Wildlife and a Temporary Modification of Water Quality Standards from Ecology. The city and county must be reviewed for any local requirements before proceeding with a diver-dredging project. Also diver dredging may require a Section 404 permit from the U.S. Army Corps of Engineers.

Costs

Depending on the density of the plants, specific equipment used, and disposal requirements, costs can range from a minimum of $1,500 to $2,000 per day.

Other Considerations

- Might be good spot control method in subsequent years (coordinated with diver survey).

Suitability for Steel Lake

As with diver hand pulling, diver dredging could be used after the initial herbicide applications to remove plants that were missed or unaffected by the herbicide. However, permit costs may warrant having this work done as diver hand pulling since the roots should be largely removed from the loose sediments without the need for dredging.

Diver dredging greatly disturbs sediments and can affect nutrient concentrations and algal production in the lake (see Disadvantages above). If other removal techniques are suitable, diver dredging should not be considered.

Bottom Barriers

A bottom screen or benthic barrier covers the sediment like a blanket, compressing aquatic plants while reducing or blocking light. Materials such as burlap, plastics, perforated black Mylar, and woven synthetics can all be used as bottom screens. Some people report success using pond liner materials. There is also a commercial bottom screen fabric called Texel, a heavy, felt-like polyester material, which is specifically designed for aquatic plant control.

An ideal bottom screen should be durable, heavier than water, reduce or block light, prevent plants from growing into and under the fabric, be easy to install and maintain, and should readily allow gases produced by rotting weeds to escape without "ballooning" the fabric upwards.

Even the most porous materials, such as window screen, will billow due to gas buildup. Therefore, it is very important to anchor the bottom barrier securely to the bottom. Unsecured screens can create navigation hazards and are dangerous to swimmers.

Anchors must be effective in keeping the material down and must be regularly checked. Natural materials such as rocks or sandbags are preferred as anchors.

The duration of weed control depends on the rate that weeds can grow through or on top of the bottom screen, the rate that new sediment is deposited on the barrier, and the durability and longevity of the material. For example, burlap may rot within two years, plants can grow through window screening material, and can grow on top of felt-like Texel fabric. Regular maintenance is essential and can extend the life of most bottom barriers.

Bottom screens will control most aquatic plants, however freely-floating species will not be controlled by bottom screens. Plants like Eurasian watermilfoil will send out lateral surface shoots and may canopy over the area that has been screened giving less than adequate control.

In addition to controlling nuisance weeds around docks and in swimming beaches, bottom screening has become an important tool to help eradicate and contain early infestations of noxious weeds such as Eurasian watermilfoil and Brazilian elodea. Pioneering colonies that are too extensive to be hand pulled can sometimes be covered with bottom screening material. or these projects, burlap with rocks or burlap sandbags can be used for anchors. By the time the material decomposes, the milfoil patches will be dead as long as all plants were completely covered. Snohomish County staff reported native aquatic plants colonizing burlap areas that covered pioneering patches of Eurasian watermilfoil. When using this technique for Eurasian watermilfoil eradication projects, divers should recheck the screen within a few weeks to make sure that all milfoil plants remain covered and that no new fragments have taken root nearby.

Bottom screens can be installed by the homeowner or by a commercial plant control specialist. Installation is easier in winter or early spring when plants have died back. In summer, cutting or hand pulling the plants first will facilitate bottom screen installation. Research has shown that much more gas is produced under bottom screens that are installed over the top of aquatic plants. The less plant material that is present before installing the screen, the more successful the screen will be in staying in place. Bottom screens may also be attached to frames rather than placed directly onto the sediment. The frames may then be moved for control of a larger area.

Advantages

- Installation of a bottom screen creates an immediate open area of water.
- Bottom screens are easily installed around docks and in swimming areas.
- Properly installed bottom screens can control up to 100 percent of aquatic plants.
- Screen materials are readily available and can be installed by homeowners or by divers.

Disadvantages

- Because bottom screens reduce habitat by covering the sediment, they are suitable only for localized control.
- For safety and performance reasons, bottom screens must be regularly inspected and maintained.
- Harvesters, rotovators, fishing gear, propeller backwash, or boat anchors may damage or dislodge bottom screens.
- Improperly anchored bottom screens may create safety hazards for boaters and swimmers.
- Swimmers may be injured by poorly maintained anchors used to pin bottom screens to the sediment.
- Some bottom screens are difficult to anchor on deep muck sediments.
- Bottom screens interfere with fish spawning and bottom-dwelling animals.
- Without regular maintenance aquatic plants may quickly colonize the bottom screen.

Permit Requirements

Bottom screening in Washington requires hydraulic approval, obtained free from the Department of Fish and Wildlife. Check with your local jurisdiction to determine whether a shoreline permit is required.

Costs

Barrier materials cost $0.22 to $1.25 per square foot. The cost of some commercial barriers includes an installation fee.

Commercial installation costs vary depending on sediment characteristics and type of bottom screen selected. It costs up to about $750 to have 1,000 square feet of bottom screen installed. Maintenance costs for a waterfront lot are about $120 each year.

Other Considerations

- None

Suitability for Steel Lake

- Infested areas are too scattered or are too large to use a bottom barrier without becoming cost prohibitive.
- Barriers could be effective in dense milfoil areas that have shown resistance to 2,4-D herbicide applications.
- Barriers could be used to eradicate localized infestations.

Biological Control

General Overview

Many problematic aquatic plants in the western United States are non-indigenous species. Plants like Eurasian watermilfoil have been introduced to North America from other continents. Here they grow extremely aggressively, forming monocultures that exclude native aquatic plants and degrade fish and wildlife habitat. Yet, often these same species are not aggressive or invasive in their native range. This may be in part because their populations are kept under control by insects, diseases, or other factors not found in areas new to them.

The biological control of aquatic plants focuses on the selection and introduction of other organisms that have an impact on the growth or reproduction of a target plant, usually from their native ranges. Theoretically, by stocking an infested waterbody or wetland with these organisms, the target plant can be controlled and native plants can recover.

Classic biological control uses control agents that are host specific. These organisms attack only the species targeted for control. Generally these biocontrol agents are found in the native range of the nuisance aquatic plants and, like the targeted plant, these biocontrol agents are also non-indigenous species. With classic biological control an exotic species is introduced to control another exotic species. However, extensive research must be conducted before release to ensure that biological control agents are host specific and will not harm the environment in other ways. The authors of *Biological Control of Weeds – A World Catalogue of Agents and Their Target Weeds* state that after 100 years of using biocontrol agents, there are only eight examples, world-wide, of damage to non-target plants, "none of which has caused serious economic or environmental damage…"

Search for a classical biological control agent typically starts in the region of the world that is home to the nuisance aquatic plant. Researchers collect and rear insects and/or pathogens that appear to have an impact on the growth or reproduction of the target species. Those insects/pathogens that appear to be generalists (feeding or impacting other aquatic plant species) are rejected as biological control agents. Insects that impact the target species (or very closely related species) exclusively are considered for release.

Once collected, these insects are reared and tested for host specificity and other parameters. Only extensively researched, host-specific organisms are cleared by the United States for release. It generally takes a number of years of study and specific testing before a biological control agent is approved.

Even with an approved host-specific bio-control agent, control can be difficult to achieve. Some biological control organisms are very successful in controlling exotic species and others are of little value. A number of factors come into play. It is sometimes difficult to establish reproducing populations of a bio-control agent. The ease of collection of the bio-control and placement on the target species can also have a role in the effectiveness. Climate or other factors may prevent its establishment, with some species not proving capable of over-wintering in their new setting. Sometimes the bio-control insects become prey for native predator species, and sometimes the impact of the insect on the target plant just isn't enough to control the growth and reproduction of the species.

People who work in this field say that the more biological control species that you can put to work on a problem plant, the better success you will have in controlling the targeted species. There are some good examples where numerous biological control agents have had little effect on a targeted species, and other examples where one bio-control agent was responsible for the complete control of a problem species.

However, even when biological control works, a classic biological control agent generally does not totally eliminate all target plants. A predator-prey cycle establishes where increasing predator populations will reduce the targeted species. In response to decreased food supply (the target plant is the sole food source for the predator), the predator species will decline. The target plant species rebounds due to the decline of the predator species. The cycle continues with the predator populations building in response to an increased food supply.

Although a successful biological control agent rarely eradicates a problem species, it can reduce populations substantially, allowing native species to return. Used in an integrated approach with other control techniques, biological agents can stress target plants making them more susceptible to other control methods.

A number of exotic aquatic species have approved classic biological control agents available for release in the US. These species include Hydrilla, water hyacinth, alligator weed, and purple loosestrife.

Another type of biological control uses general agents such as grass carp (see below) to manage problem plants. Unlike classical bio-control agents, these fish are not host specific and will not target specific species. Although grass carp do have food preferences, under some circumstances, they can eliminate all submersed vegetation in a waterbody. Like classic biological control agents, grass carp are exotic species and originate from Asia. In Washington, all grass carp must be certified sterile before they can be imported into the state. There are many waterbodies in Washington (mostly smaller sites) where grass carp are being used to control the growth of aquatic plants.

During the past decade a third type of control agent has emerged. In this case, a native insect that feeds and reproduces on northern milfoil (*Myriophyllum sibericum*) which is native to North America, was found to also utilize the non-native Eurasian watermilfoil (*Myriophyllum spicatum*). Vermont government scientists first noticed that Eurasian watermilfoil had declined in some lakes and brought this to the attention of researchers. It was discovered that a native watermilfoil weevil (*Euhrychiopsis lecontei)* feeding on Eurasian watermilfoil caused the stems to collapse. Because native milfoil has thicker stems than Eurasian watermilfoil, the mining activity of the larvae does not cause it the same kind of damage. A number of declines of Eurasian watermilfoil have been documented around the United States and researchers believe that weevils may be implicated in many of these declines.

Several researchers around the United States (Vermont, Minnesota, Wisconsin, Ohio, and Washington) have been working to determine the suitability of this insect as a bio-control agent. The University of Washington is conducting research into the suitability of the milfoil weevil for the biological control of milfoil in Washington lakes and rivers. Surveys have shown that in Washington the weevil is found more often in eastern Washington lakes and it seems to prefer more alkaline waters. However, it is also present in cooler, wetter western Washington. The most likely candidates for use as biological controls are discussed in the following section.

Grass Carp

The grass carp (*Cteno pharynogodon)*, also known as the white amur, is a vegetarian fish native to the Amur River in Asia. Because this fish feeds on aquatic plants, it can be used as a biological tool to control nuisance aquatic plant growth. In some situations, sterile (triploid) grass carp may be permitted for introduction into Washington waters.

Permits are most readily obtained if the lake or pond is privately owned, has no inlet or outlet, and is fairly small. The objective of using grass carp to control aquatic plant growth is to end up with a lake that has about 20 to 40 percent plant cover, not a lake devoid of plants. In practice, grass carp often fail to control the plants, or in cases of overstocking, all the submersed plants are eliminated from the waterbody.

The Washington Department of Fish and Wildlife determines the appropriate stocking rate for each waterbody when they issue the grass carp-stocking permit. Stocking rates for Washington lakes generally range from 9 to 25 eight- to eleven-inch fish per vegetated acre. This number will depend on the amount and type of plants in the lake as well as spring and summer water temperatures. To prevent stocked grass carp from migrating out of the lake and into streams and rivers, all inlets and outlets to the pond or lake must be screened. For this reason, residents on waterbodies that support a salmon or steelhead run are rarely allowed to stock grass carp into these systems.

Once grass carp are stocked in a lake, it may take from two to five years for them to control nuisance plants. Survival rates of the fish will vary depending on factors like presence of otters, birds of prey, or fish disease. A lake will probably need restocking about every ten years.

Success with grass carp in Washington has been varied. Sometimes the same stocking rate results in no control, control, or even complete elimination of all underwater plants. Bonar *et. Al*. found that only 18 percent of 98 Washington lakes stocked with grass carp at a median level of 24 fish per vegetated acre had aquatic plants controlled to an intermediate level. In 39 percent of the lakes, all submersed plant species were eradicated. It has become the consensus among researchers and aquatic plant managers around the country that grass carp are an all or nothing control option. They should be stocked only in waterbodies where complete elimination of all submersed plant species can be tolerated.

Grass carp exhibit definite food preferences and some aquatic plant species will be consumed more readily than others. Pauley and Bonar performed experiments to evaluate the importance of 20 Pacific Northwest aquatic plant species as food items for grass carp. Grass carp did not remove plants in a preferred species-by-species sequence in multi-species plant communities. Instead they grazed simultaneously on palatable plants of similar preference before gradually switching to less preferred groups of plants. The relative preference of many plants was dependent upon what other plants were associated with them. The relative preference rank for the 20 aquatic plants tested was as follows: *Potamogeton crispus* (curly leaf pondweed) = *P. pectinatus* (sago pondweed) > *P. zosteriformes* (flat-stemmed pondweed) > *Chara* sp.(muskgrasses) = *Elodea canadensis* (American waterweed) = thin-leaved pondweeds *Potamogeton* spp. > *Egeria densa* (Brazilian elodea) (large fish only) > *P. praelongus* (white-stemmed pondweed) = *Vallisneria americana* (water celery) > *Myriophyllum spicatum* (Eurasian watermilfoil) > *Ceratophyllum demersum* (coontail) >*Utricularia vulgaris* (bladderwort) > *Polygonum amphibium* (water smartweed) > *P. natans* (floating leaved pondweed) > *P. amplifolius* (big leaf pondweed) > *Brasenia schreberi* (watershield) = *Juncus* sp.(rush) > *Egeria densa* (Brazilian elodea) (fingerling fish only) > *Nymphaea* sp. (fragrant water lily) > *Typha* sp. (cattail) > *Nuphar* sp. (spatterdock).

Generally in Washington, grass carp do not consume emergent wetland vegetation or water lilies even when the waterbody is heavily stocked or over stocked. A heavy stocking rate of triploid grass carp in Chambers Lake, Thurston County, resulted in the loss of most submersed species, whereas the fragrant water lilies, bog bean, and spatterdock remained at pre-stocking levels. A stocking of 83,000 triploid grass carp into Silver Lake, Washington, resulted in the total eradication of all submersed species, including Eurasian watermilfoil, Brazilian elodea, and swollen bladderwort. However, the extensive wetlands surrounding Silver Lake have generally remained intact. In southern states, grass carp have been shown to consume some emergent vegetation (Washington State Department of Ecology, 2002).

Grass carp stocked into Washington lakes must be certified disease free and sterile. Sterile fish, called triploids because they have an extra chromosome, are created when the fish eggs are subjected to a temperature or pressure shock. Fish are verified sterile by collecting and testing a blood sample. Triploid fish have slightly larger blood cells and can be differentiated from diploid (fertile) fish by this characteristic. Grass carp imported into Washington must be tested to ensure that they are sterile.

Because Washington does not allow fertile fish within the state, all grass carp are imported into Washington from out of state locations. Most grass carp farms are located in the southern United States where warmer weather allows for fast fish growth rates. Large shipments are transported in special trucks and small shipments arrive via air.

Some facts about grass carp:

- Are only distantly related to the undesirable European carp, and share few of its habits.

- Generally live for at least ten years and possibly much longer in Washington State waters.
- Will grow rapidly and reach at least ten pounds. They have been known to reach 40 pounds in the southern United States.
- Feed only on plants at the age they are stocked into Washington waters.
- Will not eat fish eggs, young fish or invertebrates, although baby grass carp are omnivorous.
- Feed from the top of the plant down so that mud is not stirred up. However, in ponds and lakes where grass carp have eliminated all submersed vegetation the water becomes turbid. Hungry fish will eat organic material out of the sediments.
- Have definite taste preferences. Plants like Eurasian milfoil and coontail are not preferred. American waterweed and thin leaved pondweeds are preferred. Water lilies are rarely consumed in Washington waters.
- Are dormant during the winter. Intensive feeding starts when water temperatures reach 68°F.
- Prefer flowing water to still waters (original habitat is fluvial).
- Are difficult to recapture once released.
- They may not feed in swimming areas, docks, boating areas, or other sites where there is heavy human activity.

Advantages

- Grass carp are inexpensive compared to some other control methods and offer long-term control, but fish may need to be restocked at intervals.
- Grass carp offer a biological alternative to aquatic plant control.

Disadvantages

- Depending on plant densities and types, it may take several years to achieve plant control using grass carp and in many cases control may not occur.
- If the waterbody is overstocked, all submersed aquatic plants may be eliminated. Removing excess fish is difficult and expensive.
- The type of plants grass carp prefer may also be those most important for habitat and for waterfowl food.
- If not enough fish are stocked, less-favored plants, such as Eurasian milfoil, may take over the lake.
- Stocking grass carp may lead to algae blooms.

- All inlets and outlets to the lake or pond must be screened to prevent grass carp from escaping into streams, rivers, or other lakes.

Permit Requirements

Stocking grass carp requires a fish-stocking permit from the Washington Department of Fish and Wildlife. Also, if inlets or outlets need to be screened, an Hydraulic Project Approval application must be completed for the screening project.

Costs

In quantities of 10,000 or more, 8 to 12 inch sterile grass carp can be purchased for about $5.00 each for truck delivery. The cost of small air freighted orders will vary and is estimated at $8 to $10 per fish.

The costs for researchers to locate, culture, and test bio-control agents is high. Once approved for use, insects can sell for $1.00 or more per insect. Sometimes it is possible to establish nurseries where weed specialists can collect insects for reestablishment elsewhere.

Other Considerations

- Would not achieve immediate results – takes time and is not guaranteed to work.
- Community may have concerns with introduced species.
- Potential damage to the native plant community of the lake, which could result in the establishment of aggressive other plant species as pioneers.
- Concerns from fishermen about grass carp.
- Initial investment very expensive.
- The introduction of grass carp has generally been discouraged by State agencies, especially in systems like Steel Lake.

Suitability for Steel Lake

Grass carp are not suitable for aquatic plant control in Steel Lake. The infestation of milfoil has not reached a level where a bio-control such as grass carp would be necessary.

Their preferred food species include the dominant submersed native aquatic species in Steel Lake, which might be grazed before the milfoil. They could remove all the beneficial plants that support a healthy fish population. Without cover and the invertebrates associated with beneficial native aquatic vegetation, the system would be degraded and some species (invertebrates, fish, etc.) may be extirpated.

The lake also has an outlet stream that eventually flows into Puget Sound, making it much more difficult to obtain the permits necessary to stock grass carp.

Watermilfoil Weevil

The following information and citations on the watermilfoil weevil are taken from the Washington State Department of Ecology's website on Aquatic Plant Management:

The milfoil weevil, *Euhrychiopsis lecontei*, has been associated with declines of Eurasian watermilfoil (*Myriophyllum spicatum*) in the United States (e.g., Illinois, Minnesota, Vermont, and Wisconsin). Researchers in Vermont found that the milfoil weevil can negatively impact Eurasian watermilfoil by suppressing the plants growth and reducing its buoyancy (Creed and Sheldon 1995). In 1989, state biologists reported that Eurasian watermilfoil in Brownington Pond, Vermont had declined from approximately 10 hectares (in 1986) to less than 0.5 hectares. Researchers from Middlebury College, Vermont hypothesized that the milfoil weevil, which was present in Brownington Pond, played a role in reducing Eurasian watermilfoil (Creed and Sheldon 1995). During 1990 through 1992, researchers monitored the populations of Eurasian watermilfoil and the milfoil weevil in Brownington Pond. They found that by 1991 Eurasian watermilfoil cover had increased to approximately 2.5 hectares (approximately 55-65 g/m^2) and then decreased to about 1 hectare (<15 g/m^2) in 1992. Weevil abundance began increasing in 1990 and peaked in June of 1992, where 3 – 4 weevils (adults and larvae) per stem were detected (Creed and Sheldon 1995). These results supported the hypothesis that the milfoil weevil played a role in reducing Eurasian watermilfoil in Brownington Pond.

Another documented example where a crash of Eurasian watermilfoil has been attributed to the milfoil weevil is in Cenaiko Lake, Minnesota. Researchers from the University of Minnesota reported a decline in the density of Eurasian watermilfoil from 123 g/m^2 in July of 1996 to 14 g/m^2 in September of 1996. Eurasian watermilfoil remained below 5 g/m^2 in 1997, then increased to 44 g/m^2 in June and July of 1998 and declined again to 12 g/m^2 in September of 1998 (Newman and Biesboer, in press). In contrast, researchers found that weevil abundance in Cenaiko Lake was 1.6 weevils (adults and larvae) per stem in July of 1996. Weevil abundance, however, decreased with declining densities of Eurasian watermilfoil in 1996 and by September 1997 weevils were undetectable. In September of 1998 weevil abundance had increased to >2 weevils per stem (Newman and Biesboer, in press). Based on observations made by researchers in Vermont, Ohio and Wisconsin it seems that having 2 weevils (or more) per stem is adequate to control Eurasian watermilfoil. However, as indicated by the study conducted in Cenaiko Lake, Minnesota, an abundance of 1.5 weevils per stem may be sufficient in some cases (Newman and Biesboer, in press).

In Washington State, the milfoil weevil is present primarily in eastern Washington and occurs on both Eurasian and northern watermilfoil (*M. sibiricum*), the latter plant being native to the state (Tamayo et. Al. 1999). During the summer of 1999, researchers from the University of Washington determined the abundance of the milfoil weevil in 11 lakes in Washington. They found, that weevil abundance ranged from undetectable levels to 0.3 weevils (adults and larvae) per stem. Fan Lake, Pend Oreille County, had the greatest density per stem of 0.6 weevils (adults, larvae and eggs per stem). The weevils were present on northern watermilfoil. These abundance results are well below the recommendations made by other researchers in Minnesota, Ohio, Vermont, and Wisconsin of having at least 1.5 – 2.0 weevils per stem in order to control Eurasian watermilfoil.

To date, there have not been any documented declines of Eurasian watermilfoil in Washington State that can be attributed to the milfoil weevil, although Creed speculated that declines of Eurasian watermilfoil in Lake Osoyoos and the Okanogan River may have been caused by the milfoil weevil. In Minnesota, Cenaiko Lake is the only lake in that state that has had a Eurasian watermilfoil crash due to the weevil; other weevil lakes are yet to show declines in Eurasian watermilfoil.

Researchers in Minnesota have suggested that sunfish predation may be limiting weevil densities in some lakes (Sutter and Newman 1997). The latter may be true for Washington State, as sunfish populations are present in many lakes in the state, including those with weevils. In addition, other environmental factors that may be keeping weevil populations in check in Washington, but have yet to be studied, include over-wintering survival and habitat quality and quantity (Jester et. Al. 1997; Tamayo et. Al., in press). Although the milfoil weevil shows potential as a biological control for Eurasian watermilfoil more work is needed to determine which factors limit weevil densities and what lakes are suitable candidates for weevil treatments in order to implement a cost and control effective program.

Advantages

- Milfoil weevils offer a biological alternative to aquatic plant control.
- They may be cheaper than other control strategies.
- Biocontrols enable weed control in hard-to-access areas and can become self-supporting in some systems.
- If they are capable of reaching a critical mass, biocontrols can decimate a weed population.

Disadvantages

- There are many uncertainties as to the effectiveness of this biocontrol in western Washington waters.
- There have not been any documented declines of Eurasian watermilfoil in Washington State that can be attributed to the milfoil weevil.
- Bio-controls often don't eradicate the target plant species, and there would be population fluctuations as the milfoil and weevil follow predator-prey cycles.

Permit Requirements

The milfoil weevil is native to Washington and is present in a number of lakes and rivers. It is found associated with both native northern milfoil and Eurasian watermilfoil. A company is selling milfoil weevils commercially. However, to import these out-of-state weevils into Washington requires a permit from the Washington Department of Agriculture. As of October 1, 2002, no permits have been issued for Washington.

Suitability for Steel Lake

Since the milfoil weevil is a new bio-control agent, it has not been released yet intentionally in western Washington to control Eurasian watermilfoil. It is uncertain how effective the weevil will be and whether populations per stem can be maintained at levels high enough to eradicate Eurasian watermilfoil. Also, as with the grass carp, the infestation of milfoil in Steel Lake is not heavy enough to warrant bio-control introduction when other methods are still available.

Rotovation

Rotovators use underwater rototiller-like blades to uproot Eurasian watermilfoil plants. The rotating blades churn seven to nine inches deep into the lake or river bottom to dislodge plant root crowns that are generally buoyant. The plants and roots may then be removed from the water using a weed rake attachment to the rototiller head or by harvester or manual collection.

Harvesting

Mechanical harvesters are large machines which both cut and collect aquatic plants. Cut plants are removed from the water by a conveyor belt system and stored on the harvester until disposal. A barge may be stationed near the harvesting site for temporary plant storage or the harvester carries the cut weeds to shore. The shore station equipment is usually a shore conveyor that mates to the harvester and lifts the cut plants into a dump truck. Harvested weeds are disposed of in landfills, used as compost, or in reclaiming spent gravel pits or similar sites.

Mechanical Cutting

Mechanical weed cutters cut aquatic plants several feet below the water's surface. Unlike harvesting, cut plants are not collected while the machinery operates.

Suitability for Steel Lake

None of these options are suitable for the level of infestation at Steel Lake. They are not eradication tools, but rather are used to manage and control heavy, widespread infestations of aquatic weeds. These processes create plant fragments, and therefore should not be used in systems where milfoil is not already widespread.

In infestation levels recently experienced by Steel Lake, these methods would probably serve to spread and expand the infestation. According to Ecology, "There is little or no reduction in plant density with mechanical harvesting." Since the aim of this project is to eliminate milfoil from the system, these are not compatible control strategies. Harvesting and cutting do not remove root systems. Rotovation would cause damage to the lake sediments and associated animals in a system that does not already receive dredging for navigability.

Drawdown

Lowering the water level of a lake or reservoir can have a dramatic impact on some aquatic weed problems. Water level drawdown can be used where there is a water control structure that allows the managers of lakes or reservoirs to drop the water level in the waterbody for extended periods of time. Water level drawdown often occurs regularly in reservoirs for power generation, flood control, or irrigation; a side benefit being the control of some aquatic plant species. However, regular drawdowns can also make it difficult to establish native aquatic plants for fish, wildlife, and waterfowl habitat in some reservoirs.

Suitability for Steel Lake

Drawdown is not a viable control strategy for Steel Lake. The outlet from Steel Lake flows through a wetland to a natural stream system, and does not have a control structure installed. Not only would drawdown be difficult to achieve, it would also cause significant damage to the ecosystem. The amount of drawdown required to impact milfoil would dry out the littoral zone of the lake. This would damage native plants and animals in both the lake and the adjacent wetland and have many negative consequences for residents living around the lake. Without a surface inflow to the system, returning the water level to a previous state would be both cost and time prohibitive.

INTEGRATED TREATMENT PLAN

High level of Control

The following outlines control measures to be implemented to contain listed noxious weed species, and other identified weed species, in Steel Lake and along the shoreline. These control measures will prevent and/or halt the spread of their invasions and reverse potential lake degradation. In addition, the eradication of noxious weed species will provide the opportunity for the reintroduction of native aquatic plants.

The target species are Eurasian watermilfoil (*Myriophyllum spicatum*), fragrant water lily (*Nymphaea odorata*), and yellow flag iris (*Iris pseudacorus*). In addition, native aquatic weeds (i.e., thin-leafed pondweed and submerged macro algae) will be controlled to levels that do not impact public safety or the beneficial uses of the lake; and will be preserved for fish and wildlife habitat.

Eurasian Watermilfoil (*Myriophyllum spicatum*)

The aquatic formulation of 2,4-D (Aquakleen®) was used in Steel Lake the summer of 2002 to control an early infestation of milfoil. Approximately five (5) acres were treated around the lake with this herbicide. A follow-up visual survey in late summer of 2002 indicated that the Aquakleen® formulation was extremely effective, and shown to be highly effective for spot treatment of milfoil in Steel Lake.

The time-released nature of this granular formulation is less susceptible to drift. Liquid formulations can drift off target as a result of wind and/or boat activity. Therefore, liquid formulations have a slightly higher risk of injuring off-target organisms. In addition, granular applications are visible – the applicator can direct the product directly onto the target plants. The granules adhere to the leaves, increasing the effectiveness (Vandermeulen, 2003, personal communication). The preferred formulation for the eradication of pioneering colonies of Eurasian watermilfoil is 2,4-D (Aquakleen® or Navigate®).

As described earlier, milfoil can easily be transported from lake to lake on boat trailers or fishing gear, and once introduced it can spread rapidly, infesting an entire lake within two years of introduction to the system. It is widely distributed in Washington and difficult to control. Because of Steel Lake's historical infestations of milfoil, and the danger the introduction of this aquatic weed poses to the lake's ecology, an aggressive but environmentally sound integrated treatment plan has been developed.

In Year One (2003), a systematic diver survey will be conducted at the beginning of the growing season (April-May) to identify milfoil colony locations. Selective diver hand-pulling will take place then. Manual methods don't require expensive permits, and can be performed on aquatic noxious weeds with Hydraulic Project Approval obtained by reading and following the pamphlet *Aquatic Plants and Fish* (publication #APF-1-98) available from the Washington Department of Fish & Wildlife.

Spot herbicide treatment with 2,4-D (Aquakleen® or Navigate®) will begin in late May to early June 2003. Approximately three (3) acres of milfoil will be estimated to have survived the 2002 treatment, and require selective spot herbicide treatments.

A second diver survey will be performed later in the 2003 growing season to detect stray or surviving milfoil plants; and to assess the effectiveness of the earlier manual and/or herbicide control methods used. During this time, diver hand-pulling will be performed again, if required, to remove milfoil remaining after the herbicide application has had time to take effect.

Each successive year will begin with diver surveys of the lake performed at the beginning of the growing season. Following these initial diver surveys, the level of milfoil infestation, if any, will be established. Using the survey information, the Steel Lake Aquatic Plant Advisory Committee will decide upon the preferred control strategy to contain milfoil populations at as low a density as is environmentally and economically feasible. The need for a second annual diver survey will also be determined by the Steel Lake Aquatic Plant Advisory Committee.

Triclopyr

If significant milfoil re-infestations occur over time (greater than three acres), it is possible that the aquatic weed has built-up herbicide resistance. In this case, Triclopyr (Garlon 3A) may be used if fully approved for aquatic use by U.S. EPA and by the State of Washington (late 2004).

Milfoil is not known to reproduce from seed in this region, so there is no seed bank to exhaust. Because the aquatic weed is introduced by boat traffic, the severity of re-infestations cannot be fully predicted or controlled. Potential reintroduction will remain a challenge. Due to this, an annual herbicide spot treatment application will be planned.

Since Steel Lake does not currently have prolific plant growth, milfoil should be located easily during the diver survey. Manual control methods should therefore prove to be very effective. The goal of the treatment plan will be to limit annual herbicide treatment, if possible, and control the majority of milfoil re-infestations by diver hand-pulling. But because of the continual threat of re-infestations, annual herbicide treatment of at least three acres of milfoil will be conservatively budgeted for each year.

Additionally, there should be no need to re-vegetate the areas of milfoil after treatment. Most of the native submersed species are monocots (*Potamogeton* sp.) that should be relatively unaffected by either the 2,4-D (or Triclopyr) application. Removing the noxious invaders will halt the degradation of the system and allow beneficial native vegetation to thrive.

Education

Community public education efforts will also continue, including lake resident training in milfoil identification and survey methods. In addition, improved signage will be located in a position approaching the public boat launch to warn boaters before their watercraft enter the water.

The NPDES permit coverage requires notification and posting of the waterbody, and these specific protocols will be followed. The NPDES permit also requires monitoring of the herbicide levels in the lake after treatment. Independent samples will be collected at the time of the application and again five days post treatment. One sample is taken from within the treatment area, and one from outside. These four samples (per application) will be sent to an independent laboratory for the analysis. Surveys after the initial application are essential to determining the success of the effort, and will be used to determine what measures need to be implemented to complete the milfoil control.

Problems may arise if the same firm that conducted the herbicide application also surveys for the success of the effort. To counter this potential conflict, City of Federal Way and/or lake volunteers will conduct these post-treatment surveys. Volunteers from the Steel Lake community will be directly involved with overseeing the implementation of control work to keep the contractors accountable.

Fragrant water lily (*Nymphaea odorata)*

Control and containment efforts for fragrant water lily will be conducted on an annual, as-needed basis. In 2002, approximately eight (8) acres of fragrant water lily were reported to be colonizing the lake, with the majority at the west end of the lake. (Vandermuelen, 2003, personal communication). In 2002, approximately three (3) acres of fragrant water lily were treated with Glyphosate, (primarily at the west end). Glyphosate was selected because of its effectiveness, low cost, and low environmental impact. This aquatic herbicide is a systemic herbicide absorbed by foliage and passed throughout the plant. Since it kills the tubers, it results in long-term control of the plant community. It also exhibits low toxicity to bottom-dwelling organisms, fish, birds and other mammals, and dissipates quickly. Therefore, it is considered to have a low environmental impact.

In Year One (2003), a systematic diver survey will be conducted at the beginning of the growing season (April-May) to identify and locate fragrant water lily colonies. The Steel Lake Aquatic Plant Advisory Committee will review the findings of the diver survey, and identify the necessary fragrant water lily control and containment methods (aquatic herbicide and/or manual methods) to be implemented.

Herbicide treatment (Glysophate), if required, will begin in late May to early June. The herbicide will be applied when floating leaves have formed on the water lily (late spring, early summer). The applications may be followed by cutting and removing operations if target plant areas are not killed by the herbicide.

· Diver Surveys
· Herbicides
· Weed cutter

Each year, the Steel Lake Aquatic Plant Advisory Committee will review the findings of the annual diver survey, and identify the most effective and ecologically safe control and containment methods required. This integrated approach should be sufficient to ensure the control and containment of fragrant water lily to levels that do not impact public safety or the beneficial uses of the lake. In addition, a year-by-year, systematic eradication of this noxious species will allow for the eventual re-introduction of desirable native aquatic plants. This integrated approach, combined with the Fish Habitat Mitigation Plan described in this IAVMP, will improve fish and wildlife habitat, and the overall ecological health of Steel Lake.

A commercially available non-mechanical aquatic weed cutter will be purchased with Lake Management District funds for targeted manual water lily removal when the total acreage is less than one acre. It would also be available to all property owners who wish to control populations near their docks and waterfronts. The primary advantage of hand-cutting is the low cost. The primary drawback is the high amount of labor required to provide adequate control.

There are no depth limitations for hand-cutting; therefore the control zone may include any portion of the lake containing water lily beds. However, since it requires manual labor, it is best suited for small patches of lilies that may be hindering lake access.

Hand-cutting should be performed by the end of the summer before the plants set seed. Because the plant roots (tubers) are not removed using these tools, the duration of the control is comparatively low. The frequency of the application will be dependant upon water depth. Monthly cuts will maintain deep areas, but more frequent cuts may be necessary for areas less than three (3) feet deep. Although cut fragments of waterlily will not re-root and grow as some submerged plants do, these fragments should be removed to prevent aesthetic impacts from floating debris and onshore decay of plant materials. Cut fragments float and are best removed with a modified fish seine that encircles small working areas, or is positioned down-wind of the working area. The net should have at least a one-inch mesh so that it will not trap small fish.

Another concern associated with the lily beds is the tendency for large "islands" to separate from the main beds and move out into the lake. These floating islands are a safety hazard; they can be unseen obstacles to boaters and attract children who can sometimes stand on the islands, but who could easily be hurt or drown if they broke through the mat of vegetation. Lake residents have tried various methods of removing these islands, but they are too large and awkward to handle. A technique that was successful at Lake Kathleen, King County, used a water pump and hose to wash sediment off the vegetation. Sections of washed vegetation were then removed by hand and placed on the boat for later disposal or composting. This technique is recommended for removing lily islands from Steel Lake.

The Steel Lake Aquatic Plant Advisory Committee will identify problematic water lily islands, and recruit volunteers from the community to remove these larger sediment mats on an as-needed basis. A Hydraulic Project Approval from Washington Fish & Wildlife is required for this work. Smaller mats may be towed to shore and remove the sediment with hand tools.

Other Submerged Plants

Immediately following the whole-lake Sonar® treatment in 1994, the submerged plant population (other than milfoil) in Steel Lake maintained at a moderate density. As a result, the small populations have not been causing a significant hindrance to recreational activity. Therefore, the intent of the control plan is to identify the dominant submerged plant community during the annual diver survey, and devise methods that can be used to maintain their density to levels that do not impact the beneficial uses of the lake. In addition, this program will not promote the growth of milfoil or other non-native submerged plants. Herbicide application is not anticipated.

A moderate level of control will allow the submerged plant community to thrive, and allow a diverse fish and wildlife habitat. Methods considered will be focused on controls that do not adversely affect the existing populations of other native plants. For example, native submerged plants such as *Nitella* and *Najas flexilis* do not grow tall enough or are not dense enough to hinder recreation in Steel Lake. These are important plants to protect since they provide valuable wildlife habitat and their presence eliminates plant habitat that might otherwise by available for invasion by one of the more nuisance plant types.

Each year, the Steel Lake Aquatic Plant Advisory Committee will review the findings of the annual diver survey, and determine the need for the implementation of manual methods to control targeted submerged plants. Manual methods do not require expensive permits, and can be performed on aquatic noxious weeds with Hydraulic Project Approval obtained by reading and following the pamphlet *Aquatic Plants and Fish* (Publication #APF-1-98) available from the Washington Department of Fish & Wildlife.

Examples of possible manual methods to be employed for control of submerged plants:

- Depending upon plant densities and whether exotics are detected, additional diver time during the annual survey will be planned for hand-pulling native plants in beds that have been identified as potential problems. In deeper water, hand-pulling is best accomplished by divers with SCUBA equipment and mesh bags for the collection of plant fragments.

- In water less than three feet deep, homeowners may perform this activity, as no specialized equipment is required, although a spade, trowel, or long knife may be needed if the sediment is packed or heavy. Some sites may not be suitable for hand pulling such as areas where deep flocculent sediments may cause a person hand pulling to sink deeply into the sediment. Hand-pulling of aquatic plants is similar to pulling weeds out of a garden. It involves removing entire plants (leaves, stems, and roots) from the area of concern. They are placed in a mesh bag, and disposed of in an area away from the shoreline, or composted.

- Cutting differs from hand pulling in that plants are cut and the roots are not removed. Cutting is performed by standing on a dock or on shore and throwing a commercially available non-mechanical aquatic weed cutting tool out into the water. Because of the lower pondweed biomass, hand-cutting for these plants is less labor intensive than that for water lily control. The equipment would be available to all property owners who wish to control small populations near their docks identified for control by the Aquatic Plant Advisory Committee.

- In some cases, raking may be identified as a preferred method in removing submerged plants. Attaching a rope to a rake allows removal of a greater area of weeds. Raking literally tears plants from the sediment, breaking some plants off and removing some roots as well. Specially designed aquatic plant rakes will be purchased for use by lake residents to control small populations near their docks identified for control by the Aquatic Plant Advisory Committee.

Yellow flag iris (*Iris pseudacorus*)

Control and containment efforts on yellow flag iris will be conducted on an annual, as-needed basis. Each year, the Steel Lake Aquatic Plant Advisory Committee will review the findings of the annual plant survey, and approve the methods to be used (aquatic herbicide and/or manual methods) for control and containment of yellow flag iris. Because yellow flag iris appears at the shoreline, individual homeowners will be responsible for the control of yellow flag iris colonies on their property.

Fish Habitat Mitigation Plan

The text below is adapted from "Aquatic Plants and Fish" published by the Department of Fish & Wildlife (Publication # APF-1-98).

Aquatic noxious weeds can adversely affect ecological functions by crowding out native vegetation and creating single species stands. While it is recognized that native aquatic plants can become a nuisance to swimmers and boaters due to excessive growth, it is important to recognize the value of native plant species for fish and wildlife. These native plants provide habitat for fish and wildlife, help stabilize shorelines, produce oxygen, trap beneficial nutrients, and keep sediment in place. For example, pondweed is a critical food source for waterfowl and marsh birds. Pondweed also provides cover from predators for warmwater fish such as perch and bass. Aquatic beneficial plants are defined as native plants (such as pondweeds, bladderwort, or coontail) or non-native plants not included on the King County noxious weed list.

Warmwater gamefish often utilize vegetation in the shallow waters of lakes for spawning, early rearing, and feeding. Largemouth and smallmouth bass generally prefer ponds and reservoirs with abundant aquatic vegetation. Bluegill, sunfish and crappie also inhabit vegetated quiet or slow-moving waters for protection from predators. Too much vegetation can result in overpopulation if predators are unable to access prey species, while too little vegetation can also adversely affect the predator-prey balance and result in a decline in the fishery.

Aquatic plants provide important living space for insects, snails and crustaceans, which in turn become food for fish and waterfowl. Vegetated areas support many times more of these tiny creatures than to do non-vegetated areas. The plants make important nurseries for young fish, frogs, salamanders, and other amphibians. Several species of reptiles, including turtles, garter snakes and water snakes use these areas for cover and forage.

Removal of all non-native plant species within Steel Lake may have a short-term negative impact on warmwater fish populations due to a loss of habitat cover. With removal of the non-native vegetation, areas will likely re-seed with native plant species over the long-term. The recommended extent of native vegetative cover for fish habitat needs is 40% of the lake acreage (Jackson, 2003, WDFW, personal communication). Previous surveys of the lake show an average of 23 acres (50% lake coverage) of submerged native aquatic vegetation. Based upon results of the annual plant survey, the acreage of the native vegetation will be calculated. If there is less than 19 acres (40% coverage of the lake) of native aquatic vegetation cover, the Steel Lake Aquatic Plant Advisory Committee should determine whether mitigation measures are necessary to support wildlife species.

If mitigation efforts are deemed necessary, native aquatic vegetation will be planted and/or wooden fish structures placed in the lake to supplement natural recovery efforts. Native vegetation may include floating leaved rooted plants such as *Brasenia schreberi* (water-shield); submerged plants such as *Ceratophyllum demersum* (coontail), *Utricularia vulgaris* (common bladderwort), and *Potamogeton spp.* (pondweeds); and submerged macroalgae such as Chara spp. (muskgrass) and *Nitella sp.* Fish structures may be composed of wood snags, root wads, or Engineered Large Wood™ secured to the bottom of the lake or some other stable environment.

COMMUNITY EDUCATION AND INVOLVEMENT PROGRAM

The community education and involvement program for Steel Lake consists of four parts: (1) an Aquatic Plant Advisory Committee to oversee implementation of the plan, (2) a non-native aquatic plant identification and prevention plan, and (3) informational and workshop activities to alert homeowners to stormwater pollution prevention and best management practices (lawn, garden, home care activities) that protect the lake's water quality.

Steel Lake Aquatic Plant Management Advisory Committee

Proper implementation of the described plan relies upon formation of a Steel Lake Aquatic Plant Management Advisory Committee. The Aquatic Plant Advisory Committee is to be composed of representatives from the lakefront residential community, the City of Federal Way Surface Water Utility, and the City of Federal Way Parks, Recreation and Cultural Services Department. The duties and responsibilities of the Advisory Committee may be transferred to the Steel Lake Management District Steering Committee when created.

The Advisory Committee will have the following responsibilities:

- Review annual plant survey information and determine the need for a second annual survey.
- Develop an annual aquatic plant management workplan based upon the information revealed in the annual plant surveys. The workplan will prioritize aquatic weed problem areas and identify preferred control methods for each species.
- Assist the City of Federal Way with oversight of control work to keep contractors accountable.
- Participate in preparation of an annual evaluation report that summarizes plant control activities, lake user's perspectives on the plant community, and recommendations for the next year's control strategy.
- Assist with presentation of aquatic plant management efforts to lake residents at an annual Steel Lake community meeting.
- Ensure that all lake residents, whether legal water rights users or not, receive proper notification pursuant to the requirements of the NPDES Noxious Weed Permit.
- Determine and participate in other annual community involvement and education strategies as needed.

Non-native Aquatic Plant Identification and Prevention

Eradication and control efforts will only be successful if future infestations are prevented, or detected and eliminated soon after detection. Since the re-introduction of non-native aquatic plants to Steel Lake is almost certain, a prevention and detection plan is essential. A more informed community of residents and lake-users will be more likely to identify and report noxious aquatic weeds and other potential problems.

There are four main elements to the prevention plan.

1. Annual distribution of educational materials. The Advisory Committee will compile published materials and generate literature specifically related to Steel Lake for distribution to all lakefront residents each year.
2. Annual plant identification workshops. At the annual Steel Lake community meeting, part of the meeting time will review native and non-native aquatic plant identification. Aquatic plant experts could be invited from the Department of Ecology, King County Noxious Weed Control Program, or other experts.
3. Improved signs. Improved noxious weed identification signs will be installed before and at the boat launch, in addition to the existing sign at the water's edge. The improved signs will identify the species of concern and illustrate how boat owners should clean their boats before entering and when leaving the lake. A trash receptacle will be provided next to the signs for proper disposal of the weeds.
4. Boater outreach. Volunteers from the Advisory Committee as well as other lake residents will conduct outreach efforts with boaters during opening day. Boaters will be given educational materials about non-native plants and instructed on how to prevent re-infestation of the lake. Boaters may be approached at the boat launch and/or on the water by other boaters.

Non-Point Pollution Prevention

Significant sources of nutrients can increase the occurrence of aquatic nuisance species such as cyanobacteria. Reducing the nutrient impacts to the lake will help reduce the outbreak of algae blooms. To protect the lake from water quality degradation, residents within the Steel Lake basin will be provided educational as well as instructional workshops on how to reduce the amount of nutrients running off of their yards, into the storm drain system, and into Steel Lake. One example of an effective program is King County's Natural Lawn Campaign including the Natural Yard Care program. The City of Federal Way currently participates in the Natural Lawn Campaign through the Solid Waste Division. The Natural Yard Care program is planned for implementation in the Steel Lake basin in Spring 2003.

Other issues of concern for the non-point pollution prevention program include: 1) maintenance of sewer system and septic fields, 2) reducing residential car washing activities, and 3) disposal of residential hazardous materials such as paints and car fluids.

These topics may also be included in the community education and involvement program as determined by the Advisory Committee.

PLAN EVALUATION

The results of the aquatic plant control program must be evaluated against the goals set for the lake. In short, the program will have been a success if: 1) milfoil re-infestations are prevented, 2) the herbicide (glyphosate) treatment and manual controls implemented in designated fragrant water lily areas are successful to an extent that is acceptable by the majority of the lake users, and, 3) manual controls for water lily and native submerged plants are successful, reducing the populations to levels where they do not significantly impact the beneficial uses of the lake; or do not negatively impact fish and wildlife habitat. It should be noted that this is a working plan. It is not necessary that all the goals be achieved by some given date, but instead that the lake plant community is continually being evaluated against these goals and each year's control plan is developed accordingly.

The annual aquatic plant survey will provide the primary support for the evaluation plan. The results will provide evidence to evaluate: 1) if milfoil continues to be eradicated; 2) the extent of coverage of fragrant water lily beds; 3) whether beneficial submerged plants are continuing to inhabit much of the submerged plant habitat; 4) whether there are changes in the density of other native submerged plants, and 5) the effectiveness of fish mitigation efforts.

Each year's plant survey results will be evaluated against the stated plant management goals to set the following year's plant control agenda. This evaluation will be supported by City of Federal Way Surface Water Management staff input.

PLAN ELEMENTS, COSTS, AND FUNDING

Table 9 provides a summary of each element identified in this plan and the associated costs. The total 10-year cost for the plan is estimated at $166,440, including a 5% rate of inflation each year, for an average of $16,644 per year. The majority of the cost occurs during the first year when equipment purchases all occur. Depending upon the revenue generated to support plan implementation, the Advisory Committee will determine which elements of the plan to implement on an annual basis. For example, the annual funds available may not cover all activities identified in this plan in Year One (2003). Therefore, the Advisory Committee will need to prioritize activities based upon funds available.

To implement this plan and provide a long-term funding source for continued plant control activities, public education, and evaluation, a stable, long-term funding source is needed. Funding through the formation of a special taxing district, a Lake Management District (LMD), is to be completed by 2004.

The Department of Ecology Aquatic Weeds Management Fund can be applied to for additional funds to augment funding provided by the LMD. However, Ecology grants require 25 % contribution from the applicant (City of Federal Way). Other possible funding sources include King County's Water Works and the Natural Resources Stewardship Network. In addition, the King County Noxious Weed Program has limited funds available to contribute to weed control projects.

Table 9. Estimated Cost for Implementation of the Steel Lake IAVMP

Plan Element	2004	2005	2006	2007	2008	2009-2013	Total 10 year
Aquatic Mapping/Survey and Report	$4,000	$4,200	$4,410	$4,630	$4,860	$28,170	$50,270
Milfoil eradication							
Spot herbicide treatment (2,4-D) (Note 1)	1,725	1,810	1,900	1,995	2,095	12,150	21,675
NPDES permit fee	100	100	100	100	100	500	1,000
NPDES permit notification (Note 2)	400	400	400	400	400	2,000	4,000
NPDES monitoring costs	1,000	1,050	1,100	1,155	1,210	7,000	12,515
Fragrant water lily control							
Spot herbicide treatment (glyphosate) (Note 3)	1,500	1,575	1,655	1,740	1,825	10,575	18,870
NPDES permit fee (Note 4)	--	--	--	--	--	--	--
NPDES permit notification (Note 4)	--	--	--	--	--	--	--
Contract cutting (Note 5)	1,200	1,260	1,360	1,385	1,455	8,420	15,040
Submerged plant control							
Diver hand-pulling (Note 6)	1,200	1,260	1,320	1,385	1,455	8,420	15,040
Equipment purchases							
Weed cutter	130	--	--	--	--	--	--
Rakes	200	--	--	--	--	--	--
Fish habitat structures	2,000	1,000	1,000	--	--	--	--
Pump, generator & hose	200	--	--	--	--	--	4,000
Public education				--	--	--	--
Printing and Mailing	1,500	1,500	1,500	1,500	1,500	7,500	15,000
Natural Yard Care Program	3,500	--	--	--	--	4,000	7,500
Boater outreach	1,000	--	--	--	--	--	1,000
Totals	**$19,655**	**$13,255**	**$14,745**	**$14,290**	**$14,900**	**$88,735**	**$166,440**

Total 10-Year Cost	**$166,440**
Average Annual Cost	**$16,644**

Costs are based on an annual increase of five percent (5%)

Note 1. Based on treating 3 acres of milfoil, one time per year.
Note 2. Beginning in 2003, a legal notice must be published in a local newspaper annually.
Note 3. An estimate based upon treating 2 acres fragrant water lily annually.
Note 4. The same NPDES Noxious Weed Permit for may be used both for milfoil and fragrant water lily work done in the same year.
Note 5. Assumes contract cutting at $150/hour for 2 days.
Note 6. Assumes divers working at $150/hour for 2 days.

STEEL LAKE COMMITTEE MEETING MINUTES

- August 23, 2002
- September 26, 2002
- October 23, 2002
- January 16, 2003
- February 6, 2003
- February 20, 2003
- March 11, 2003

Steel Lake Committee Meeting Notes
August 23, 2002
City Hall
7-9 PM

Attendance:
Karen Caisse
Tom Dezutter
Jack Porter
Margaret Reyhner
Myrthalyne Thompson
Sally Abella, King County Lakes Program
Paul Bucich, City of Federal Way
Dan Smith, City of Federal Way
Leslie Ryan-Connelly, City of Federal Way

Department of Ecology Grant/AquaTechnix Contract Update

Dan Smith gave an update on the status of the milfoil treatment program. Treatment of milfoil will be conducted on Monday, August 26. Tom stated that AquaTechnix would also be treating for water lilies through private contracts with the some of the residents. Jack and Myrthalyne stated the company had not been contacted them about water lily removal as requested.

The residents stated they had received a general notice of the application, but no notification of the specific day it would happen. Dan stated the general notice gave a two week window of when the application would occur. Karen stated she had called AquaTechnix to find out the specific day treatment would occur and was told that the treatment wouldn't be occurring this year. Dan confirmed that treatment is scheduled for August 26. The milfoil is already starting to autofragment; therefore, follow up treatment will be required next year. Tom questioned whether the window had passed for effective water lily removal also. He plans to call AquaTechnix to see if it should be canceled. AquaTechnix called Jack today to notify him of the herbicide application. Residents stated the general notice did not show where the treatment would occur in the lake. Dan passed around a map that showed the areas where the milfoil was found and where treatment would occur.

Dan passed around samples of the crayfish and blue green algae found in the lake. Residents stated they had received the city's flyer about the blue green algae.

King County Lakes Program

Sally Abella from the King County Lakes Program described the services provided by the County. The County collects water quality information, provides technical assistance to residents and cities, and keeps cities informed of any water quality trends. The County publishes various reports with water quality data and analysis. Sally distributed historical water quality information about Steel Lake. Overall, the water quality of the lake is ok.

Residents asked how they could improve the water quality of the lake to help control the blue green algae growth. Sally stated that phosphorous and fertilizers are contributors to algae growth in urban lakes. She stated education of the residents about the impacts of fertilizer applications and runoff can help limit these inputs into the lake. Highly maintained lawns are almost impervious surfaces in which the rainfall runs off the lawn directly into the lake. Tom stated that this runoff also comes from the lake drainage areas and neighbors in the greater area also need to be educated.

Karen stated one of the residents had filled in a drainage swale on their property that use to collect runoff. Paul stated that the City has been trying to get a no fee easement from the property owner to re-establish the swale.

Paul also stated that a water quality device would be installed at the storm drain off S 304th.

Cost Share Agreement

Sally Abella discussed other lakes that had successfully formed a Lake Management District (LMD). Beaver Lake and Lake Wilderness have LMDs in King County. She stated it takes about one year to establish the district. Residents do not need to hire a consultant, but may want to obtain legal support. The local jurisdiction conducts the voting. The residents were encouraged by the discussion and felt the process was not as onerous as originally presumed. Margaret stated the LMD should just include the lake residents because it would be more likely to pass a vote. Tom stated collecting funds every year under the LMD would be cheaper in the long run.

Paul presented a proposed cost share agreement based upon a $1.79 per foot per year assessment. The City would provide grant and contract management services in addition to the annual cash assessment. The residents discussed this proposal. Some residents felt the City should contribute a greater percentage than proposed in order to get more residents to agree to the proposal. Other residents felt that the City's in-kind contribution for program management showed the City's interest in providing more than the per linear foot cash share. The City is in the same position as the residents as a property owner since it is does not own the boat launch or have any responsibility for its use.

The committee discussed the pros and cons of establishment of the LMD versus voluntary participation. Some felt the voluntary approach might give residents a feeling that they are more in control of the program. Residents would be represented on a LMD committee to make sure their money was being spent appropriately.

Jack suggested asking for a voluntary contribution now to make sure lake management funds are secure for the next year and using the time to set up a LMD. Karen suggested a door-to-door survey to determine the support for a LMD. Jack requested the issue be brought back to the community with another neighborhood meeting. Tom suggested the committee reconvene to discuss LMD talking points before another neighborhood meeting is planned. Paul stated the City would start looking for a consultant to help with formation of the LMD. Jack requested the City let the committee know what the consultant recommends. Paul stated the City would invite a consultant to the next committee meeting. Jack stressed the need to bring the community together under this issue. Jack will research private grant opportunities for funding lake management.

Next Steps

- The City will work with the property owner to re-establish the drainage swale.
- The City will install a water quality device at the storm drain at S 304th
- The City will draft talking points for a neighborhood meeting.
- The City will draft a resident survey.
- The City will contact consultants about formation of a LMD.
- Jack will research private funding sources.

Steel Lake Committee Meeting Notes
September 26, 2002
City Hall
7-9 PM

Attendance:
Art Bender
Karen Caisse
Tom Dezutter
Jack Porter
Margaret Reyhner
Sue Shawgo
Mike Shawgo
Myrthalyne Thompson
Sharon Walton, Taylor Associates
Paul Bucich, City of Federal Way
Dan Smith, City of Federal Way
Leslie Ryan-Connelly, City of Federal Way

Milfoil Treatment update

Dan Smith gave an update on the status of the milfoil treatment program. Treatment of milfoil was conducted on Monday, August 26. Post treatment sampling of lake water quality occurred on August 27 and 30. Samples were taken near the O'Neal's dock and in the middle of the lake. The samples were required by the Department of Ecology grant as a method to determine if the herbicide application was applied at a regular rate. The sample results were sent to Kathy Hamel, Department of Ecology, who stated that the application rate might have been too low. Dan will be investigating the effectiveness of the milfoil treatment with AquaTechnex. Residents should let Dan know about the status of the milfoil in front of their houses.

Jack and Tom stated that there appeared to be a fair amount of kill of the milfoil but some areas didn't look complete. The really bad spots are not completely gone. Dan stated AquaTechnex must submit a follow-up report by the end of the year on the work done. Dan may request AquaTechnex to show him the results of their work out on the lake.

Other Updates

Paul is trying to determine if an easement was ever signed with the resident who filled in the drainage swale on his property. Paul cannot find a record of an easement in the city files. Karen will get Paul the resident's telephone number.

Surface Water Maintenance installed a manhole and "snout" in the culvert at 21st Ave. S. and S. 304th St. The snout will collect debris, oil and grease, improving stormwater quality before it enters Steel Lake. The snout will be cleaned on a regular basis. Leslie will send out the snout installation photos to the group. Maintenance has also identified all of the inlets to Steel Lake and will inspect them this winter to see how they are functioning.

Lake Management Districts

Sharon Walton, Aquatic Scientist with Taylor Associates, presented information about formation of a lake management district. Sharon distributed two handouts that highlighted the possible functions of a lake management districts and how one is formed. Sharon also illustrated two different approaches for implementing district fees.

She estimated that if the Steel Lake residents would like to hire Taylor Associates to assist with formation of the district it would cost $3,000 to $6,000, which can be paid for through district funds. As a consultant, she would assist with drafting the proposal and any attachment. The city would need to manage the city council and resident voting processes.

Sharon stated that, in general, lake management district tend to raise more money for lake management. Lake management districts provide stable funding for on-going maintenance and prevention programs. Voluntary fee collection tends to be more reactive.

Discussion

The committee agreed that the lake management district would be the preferred approach to recommend to the neighborhood. The committee will meet again to further define their recommendation.

Next Steps

- The City will work with the property owner to re-establish the drainage swale.
- The City will prepare materials for presentation to the neighborhood for approval by the committee. The materials need to address:
  - Cost for developing the lake management district,
  - Cost for implementing the lake management district,
  - Pros and cons of voluntary fee collection and a lake management district,
  - How to fund formation of the district,
  - What role a consultant would play in the process,
  - What role the city would play in the process, and
  - Time needed to start up a lake management district.

Next Meeting is October 23rd at 6:30 PM at City Hall.

Steel Lake Committee Meeting Notes
October 23, 2002
City Hall
6:30-8:00 PM

Attendance:
Art Bender
Karen Caisse
Tom Dezutter
Sue Shawgo
Dan Smith, City of Federal Way
Leslie Ryan-Connelly, City of Federal Way

Milfoil Treatment update

Dan Smith gave an update on the status of the milfoil treatment program. Dan toured the lake with Aquatechnex to determine treatment effectiveness. Dan stated that killing of the milfoil looks good. A follow-up survey will be conducted in spring. Residents stated the water lily treatment looks spotty.

To date, approximately $4,000 has been spent of the Early Infestation Grant from the Department of Ecology for the milfoil treatment. Approximately $24,000 remains for milfoil treatment and public education activities in 2003.

New Department of Ecology Grant

Dan is preparing a new grant proposal to the Department of Ecology. This proposal includes funds for creation of the Lake Management District as well as survey and treatment for water lilies and other aquatic plants. The proposal is due October 31, 2002. The maximum request allowed is $75,000. The City must provide a 25% match to the grant.

The Committee discussed the expenses related to hiring a consultant to assist with the district formation. The consultant would assist during the early stages with putting together the district proposal and fee structure. Sue stated she would be willing to assist with this step if it would help reduce the consultant expenses.

Dan contacted staff at Skagit County and City of Sammamish for additional research on formation of lake management districts. Staff stated it was labor intensive to form the district but was worth the effort to have a stable funding base for lake management. Skagit County shared their materials on district formation, county commission resolutions and ordinances, and cost sharing strategies. The County has been successful including public boat launch facilities in the lake management district assessments.

Neighborhood Meeting Preparation

Sue prepared a committee recommendation for presentation to the neighborhood. Leslie prepared supportive materials including a comparison of voluntary versus district funding and a questions and answer sheet. Committee members gave feedback on the materials. Sue and Leslie will update materials and distribute a final version to all committee members before the neighborhood meeting.

The neighborhood meeting will be held at 7 PM on November 13, 2002. Tom Dezutter volunteered to present the committee's recommendation to the neighborhood. Leslie will prepare a written informal poll for residents to respond to the committee's recommendation. The Committee discussed alternative plans in the event that the neighborhood does not agree with the Committee's recommendation.

Next Steps

- Dan will finalize grant proposal due October 31, 2002.
- Sue will finalize the committee's recommendation and distribute to all committee members.
- Leslie will finalize supporting materials and mail out to all committee members.
- Leslie will reserve a meeting room and mail out a meeting notice.
- Leslie will recruit volunteers to hand out the meeting notice door to door.
- Leslie will prepare brief presentation materials either on powerpoint or overheads.
- Leslie will prepare an informal poll for residents.
- Tom will contact Jack Porter about assisting with the neighborhood presentation.
- Tom will present the committee's recommendation to the neighborhood.
- The City will continue to work with the property owner to re-establish the drainage swale.

Neighborhood Meeting scheduled for November 13 at 7 PM. Location to be determined.

Steel Lake Committee Meeting Notes
January 16, 2003
City Hall
7:00 – 8:30 PM

Attendance:
Tom Dezutter
Jack Porter
Margaret Reyhner
Myrthalyne Thompson
Bill Linaham
Dan Smith, City of Federal Way
Leslie Ryan-Connelly, City of Federal Way
Paul Bucich, City of Federal Way
Sally Abella, King County

Department of Ecology Grant Update/Aquatic Plant Management Plan Scope of Work

Dan reported that of the total $28,000 project total, $8,000 has been spent for milfoil treatment. The next work item under the grant is to update the Aquatic Plant Management Plan from 1995. Envirovision submitted a scope of services for the update for $8,000. Dan will obtain a couple of more quotes. Committee members were asked to review the 1995 Plan and provide Dan will any comments for the scope of services.

Paul stated that the city was not successful in obtaining additional grant funding from the Department of Ecology for formation of the Lake Management District. Dan will check with Ecology to see if any remaining funds from the active Ecology grant can be used for formation of the district.

Lake Management District Formation

The committee discussed the timeline and scope of work needed to create the lake management district. The committee requested the city obtain examples of district petitions from other jurisdictions. The committee felt that as a group they could draft a petition without having to hire a consultant. The committee discussed potentially having a professional review the petition once drafted to address any outstanding issues.

Next Meeting

The Committee agreed to meet on the first and third Thursdays at 7 PM at City hall. The next meeting will be February 6th. The agenda for the next meeting will include:

- Review and comments on updating the aquatic plant management plan;
- Review of examples petitions from other jurisdictions;
- Identification of activities for the district work plan; and
- Initial discussion of possible rate structure scenarios.

Steel Lake Committee Meeting Notes
February 6, 2003
City Hall
7:00 – 9:00 PM

Attendance:
Tom Dezutter
Bill Linehan
Margaret Reyhner
Myrthalyne Thompson
Dan Smith, City of Federal Way
Leslie Ryan-Connelly, City of Federal Way

Water lily floating island

Myrthalyne reported that an island of water lilies has landed at her beach. She would like to have the island removed. Dan will stop by to look at the island. Leslie suggested that maybe a group of residents could help with the removal.

Aquatic Plant Management Plan

Dan has reviewed the scope of the management plan and received input from the Department of Ecology and King County on the recommended changes. Dan stated the city should be able to update the plan internally and not need to hire a consultant. If a lake is going to be sprayed more than two times within five years, an updated plan is required under new state permitting requirements.

The committee reviewed the goals of the 1995 plan. Dan presented some draft goals for consideration for the updated plan. The committee reviewed and made minor changes to these goals. At the next couple of meetings, the committee will review and discuss sections of the plan in detail.

Lake management district petition

The committee reviewed other jurisdictions petitions for lake district formation and made suggestions for the Steel Lake petition. Leslie presented a template for the Steel Lake petition. For the list of activities, the goals from the Aquatic Plant Management Plan should be used. Public education addressing invasive species, algae, and non-point source pollution will also be a key activity of the district.

Natural Yard Care Program

Leslie met with representatives from King County and The Frause Group to learn about the Natural Yard Care program. The goal is to reduce the amount of non-point source pollution coming from residential areas. The program teaches people about natural yard care techniques through workshops with local yard care experts. It was started two years ago and is focused on the neighborhood level. Leslie suggested this would be a good education program for the Steel Lake basin. It would cost the City at least $2,000 to participate. The committee recommended that the city pursue participation in this program. Leslie will follow-up with the county and consultant and discuss participation in the program with the Surface Water Manager.

Rate structures

Dan presented four different rate structure options. The committee preferred the flat rate structure. Once the scope of district activities and the necessary budget to accomplish them are finalized, an accurate rate structure can be developed based upon the flat rate option. The committee stated that there are likely more than 5 undeveloped parcels around the lake. The committee also asked city staff to find out the number of senior rate properties around the lake. The committee would like to consider a reduced district assessment for seniors qualifying for a reduced property tax.

Next meeting

The next meeting was scheduled for February 20, 2003 at 7 PM at City Hall. The committee discussed changing the meetings in March to the second and fourth Thursday to accommodate more member participation. At the next meeting, the committee will discuss the extent of communication needed with all the lake residents during the district formation process.

Steel Lake Committee Meeting Notes
February 20, 2003
City Hall
7:00 – 9:00 PM

Attendance:
Art Bender
Bill Linehan
Jack Porter
Margaret Reyhner
Myrthalyne Thompson
Dan Smith, City of Federal Way
Leslie Ryan-Connelly, City of Federal Way

Communication with residents

The level of communication between the committee and the residents during the process of developing the lake management district was discussed. Currently, those residents that participated in previous neighborhood meetings are receiving Surface Water Management's quarterly newsletter, *The Water Log*. The Committee plans to hold another neighborhood meeting before presenting the petition to the city council.

The committee made the following recommendation to improve communication with the residents during the lake formation process:

- The city should send *The Water Log* to all lake residents.
- The committee should send a memo to all residents once the final draft of the petition is completed along with the neighborhood meeting invitation.
- The committee members should telephone all residents before the meeting to make sure they received the memo and meeting notice and encourage residents' participation.
- Put a teaser on the mailing envelope to show that the enclosed materials concern Steel Lake.

The committee requested clarification on whether the final vote for the lake management district is a simply majority of all submitted ballots or a simply majority of all eligible voters. Leslie will follow-up on this question.

Septic systems

As part of the aquatic plant management plan, Dan has been investigating the number of septic systems in the basin. He was also called to investigate a groundwater seepage issue at S 304th and 28th St, which is draining to the storm system and into the lake. Lakehaven Utility District tested the seepage for fecal coliform contamination and the results were "high". The source of the fecal contamination is currently unknown. Dan has requested assistance from Lakehaven Utility District and the King County Health Department on locating the source of the pollution.

Follow-up on old business

The surface water maintenance crew checked the culvert on Redondo Creek at S 304th St. for any blockage. There was adequate flow coming through the culvert; no blockage was found. The crew was not able to search for blockage on the private property downstream.

Dan investigated the water lily island near Myrthalene's beach. The committee suggested Myrthalene wait until the weather warms up and then ask residents to help with removal of the island.

Natural Yard Care

The committee was supportive of the city proceeding with participation of the Natural Yard Care program offered by King County.

Lake management district petition

Leslie made the requested changes on the draft petition and had it review by the city attorney who had minor comments. The petition can be completed once the scope of the district activities and budget are finalized.

Aquatic plant management plan

The committee discussed a number of issues in the plan:

- The 1995 plan retained 25% of the fragrant water lilies for fish habitat. Now that the plant is a noxious weed, the level of water lily removal required is unclear. Other opportunities to encourage fish habitat may need to be considered.
- Annual surveys will be done to identify milfoil with spot treatments conducted as needed.
- Native plants have not been a big issue since 1995, however, some committee members expressed that they regularly remove native plants from their beach. The plan will continue to encourage hand pulling and diver pulling of native plants. The equipment to conduct the manual removal will also be included in the plan. A process to evaluate when and where native plant removal is necessary will need to be determined. Users of the hand pulling equipment will need to be trained. Perhaps the committee could organize work parties when weeding was deemed necessary.
- An aggressive public education program is envisioned. New or additional signage could be placed before the boat launch. Volunteers could educate anglers on opening day either at the launch site or on the water. Signs could be placed around milfoil areas to discourage boat activity in the area, thereby decreasing fragmentation.
- Whole lake application for treatment of milfoil was determined to be out of the scope of the plan. If a big treatment is deemed necessary, the district will need to raise additional funds either through another vote or other funding sources (e.g., grants).

Next steps

The district formation timeline and city council approval process was discussed. The committee asked whether they should conduct a briefing with the chair of the Land Use and Transportation Committee before the petition is presented. Leslie will follow-up on this question.

The next meeting was scheduled for March 11, 2003 at 7 PM at City Hall.

The neighborhood meeting will be the last week of March or first week of April depending upon room availability.

Steel Lake Committee Meeting Notes
March 11, 2003
City Hall
7:00 – 9:00 PM

Attendance:
Art Bender
Bill Linehan
Jack Porter
Margaret Reyhner
Myrthalyne Thompson
Dan Smith, City of Federal Way
Leslie Ryan-Connelly, City of Federal Way

Updates

- A dock broke off and floated down to Myrthalyne's house. The residents came down to get it.
- The King County Health Department inspected the sewage leak reported near S. 304th St. on March 10th.
- The definition of majority vote was clarified with the city's legal department. Majority vote for lake management district purposes is 51% of the votes submitted.
- Plans for the Natural Yard Care program are progressing. Three workshops will be held this April and May.

Aquatic Plant Management Plan

The committee discussed the aquatic plant management plan update. There was input from the committee on fish habitat needs and potential opportunities for mitigation. There may be a need to phase invasive plant removal to ensure there is enough vegetation for fish survival. The committee also discussed the possibility of installing fish habitat structures and planting native plants. The annual survey will help determine whether there is enough native vegetation in the lake and whether mitigation measures are needed. The Washington Department of Fish and Wildlife recommends 40% native vegetation cover for fish. A management goal was added to the plan to provide for fish habitat.

Petition

The number and types of parcels in the district need to be verified. The city will drive around the lake to verify that the information is accurate. The schedule calls for presentation of the petition at the April 21st meeting of the City Council Land Use and Transportation Committee.

Neighborhood Meeting

The committee preferred April 2nd for the neighborhood meeting date. Leslie will check with the school for room availability. The following items were set for the agenda: 1) update from last meeting; 2) review lake management district formation process; 3) highlight main elements of the Integrated Aquatic Vegetation Management Plan; and 4) review proposed petition and rate structure. A memo will be sent from the committee to the residents with the neighborhood meeting invitation. Leslie will draft a memo for committee review. A teaser will be put on the envelope to encourage people to open it. Committee members divided up the neighborhood to conduct door-to-door meeting recruitment.

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APPENDIX "A"

Graphs: 2001 Secchi, Precipitation, Temperature, Phytoplankton, Chlorophyll Total Phosphorous/Total Nitrogen

Figure 14. 2001 Steel Lake Secchi Depth (King County)

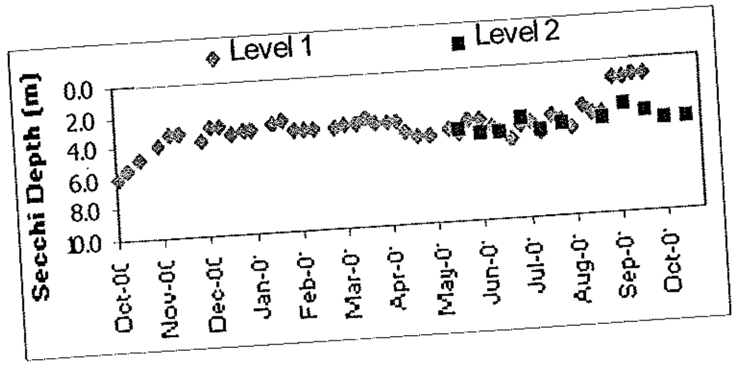


Figure 15. 2001 Steel Lake Precipitation (King County)

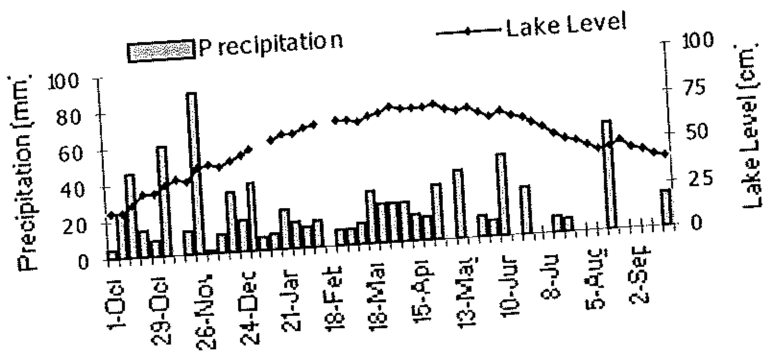


Figure 16. 2001 Steel Lake Temperature (King County)

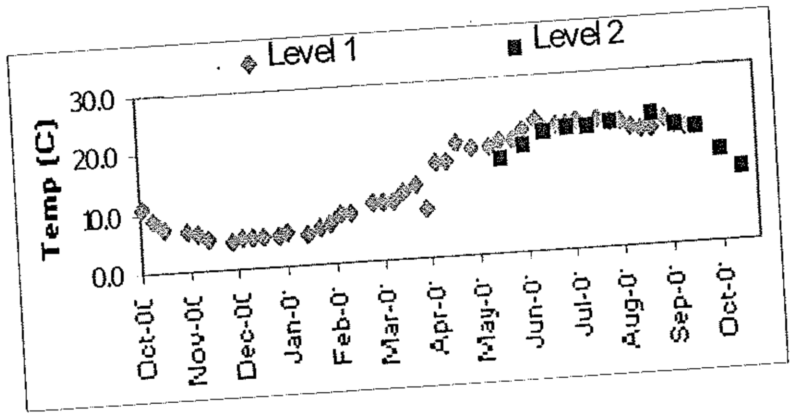
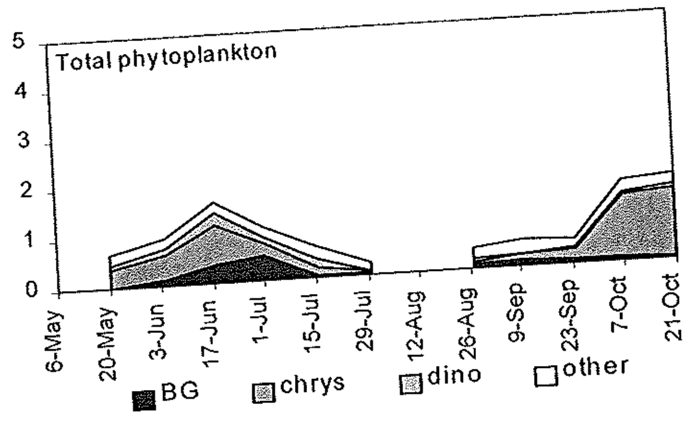


Figure 17. 2001 Steel Lake Phytoplankton Concentrations



Phytoplankton Chart:
BG=Bluegreens; **chrys**=Chrysophytes; **dino**=Dinoflagellates

Figure 18. 2001 Steel Lake Chlorophyll Concentrations

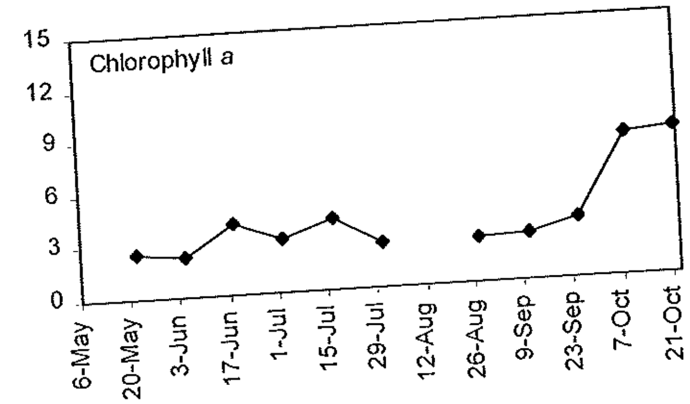


Figure 19. 2001 Steel Lake Total Phosphorous/Total Nitrogen