Lake Limerick
Integrated Aquatic Plant Management Plan

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September, 1996

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Introduction

Historical Background on Aquatic Plant Management in Lake Limerick

Lake Limerick (130 acres) is the largest of a two-lake system that also includes Lake Leprechaun (10 acres). In the early years following its creation, Lake Limerick demonstrated good overall water quality and little growth of aquatic plants (Bortleson et. al., 1976). However, aquatic weed growth has expanded considerably since the above-referenced USGS survey of the lake in 1974, which documented <1% surface area coverage by macrophytes. In the past 10 years, the lake has suffered from increasing coverage by rooted macrophytes, particularly, the **invasive, non-native weed, Brazilian elodea (*Egeria densa*)**, that greatly impedes usage of the waters. Localized dense growth of non-native bladderwort (*Utricularia inflata*) and common elodea (*Elodea canadensis*) also occurs around the lake. It is estimated that over half of the surface area of Lake Limerick (50-60 acres) is currently being impacted by problematic growth of aquatic weeds. As a result, this naturally productive lake is exhibiting progressive signs of deteriorating water quality and habitat. Brazilian elodea has yet to be documented in Lake Leprechaun. However, this small, shallow lake has also experienced nuisance growth of macrophytes and undergone periodic aquatic weed control, the most recent being the planting of sterile grass carp.

In the past decade, separate weed control efforts involving herbicide applications, mechanical harvesting, lake drawdown and partial bottom dredging were attempted to relieve the problem, but were largely unproductive. Increasing concerns over deteriorating water quality conditions and previously unsuccessful control attempts prompted the lake community to search for more effective, long-term means of combating current weed problems in order to restore and maintain beneficial uses of the lake.

Working with a team of limnologists and engineers, the Lake Limerick community initiated and funded a series of management programs on the lake. The first program on Lake Limerick involved a *scoping study* of nature and extent of aquatic plant problems, resulting in recommendations for further management actions (WATER, 1991a). The second program consisted of a lake *diagnostic study* to characterize lake and watershed, with development of a *preliminary Integrated Aquatic Plant Management Plan (IAPMP)* (WATER, 1991b). Successive programs *implemented integrated management* elements on the lakes, including monitoring and evaluation of annual small-scale control, plan modification, and public outreach (WATER, 1992, 1993). The fourth year program (1994) consisted of making formal application through Washington Department of Ecology's Aquatic Weed Management Fund Grant Program to help fund weed control activities in the lake.

A Holistic Plan View

As a direct result of these early planning/investigative efforts, the lake community and Mason County, with input from other agencies and local groups, have finalized a five year ***Integrated Aquatic Plant Management Plan (IAPMP)*** for Lake Limerick. This long-term Plan is in fulfillment of requirements of an Aquatic Weed Management Fund Grant (AWMF) awarded to Mason County/Lake Limerick Country Club by the Washington Department of Ecology (Ecology). The resultant Plan uses a ***holistic*** approach to aquatic plant control encompassing both lake and watershed to maximize beneficial uses of Lake Limerick.

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Develop Problem Statement
Step A

Project Site Description

The 1995 Lake Limerick project area (Figure A-1) is situated within the boundaries of the Lake Limerick Country Club Estates, which is located 5 miles northeast of Shelton, Washington in Mason County in south Puget Sound (T21N-R3W-27).

Lake Limerick lies at an elevation of 230 feet above sea level. The 130 acre lake has a volume of 1200 acre-feet, a mean depth of 9 feet and maximum depth of 24 feet (Bortelson et al., 1976). The drainage area is approximately 13.0 square miles containing mostly forested and wetland areas, with residential land use concentrated around the lakeshore. Lake Limerick Country Club Estates also includes Lake Leprechaun, a small, shallow, bog lake that drains directly into Lake Limerick at the northwestern corner.

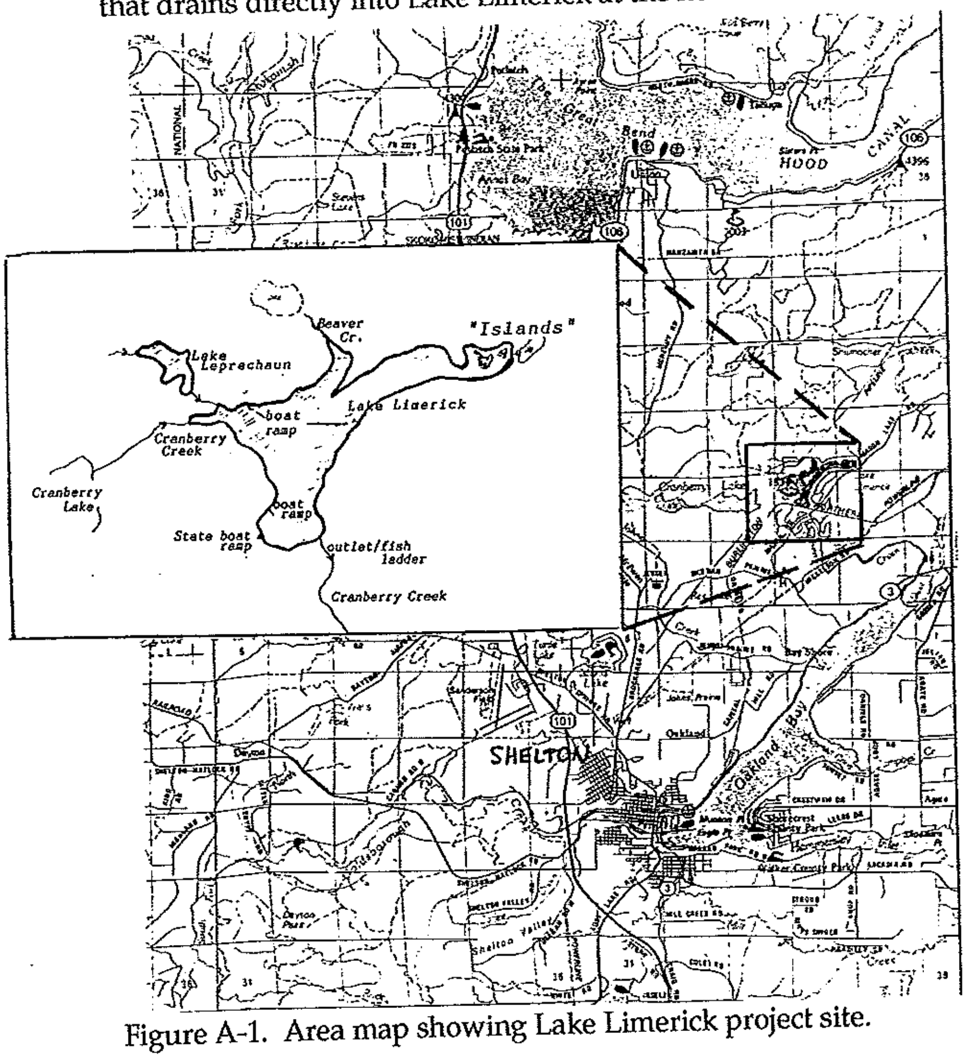

Figure A-1. Area map showing Lake Limerick project site.

Lake Limerick was formed in 1966 by construction of a dam on Cranberry Creek, which is the primary inlet that drains shallow Cranberry Lake upstream to the west. Other sources of perennial inflow to the lake are the Lake Leprechaun outlet, Beaver Creek, and two large culverts at the easternmost end of the lake draining an adjacent wetland area. A single outlet at the southeastern end of the lake flows year-round and consists of a cement spillway with fish ladder to allow upstream passage of migrating salmon from lower Cranberry Creek. The downstream segment of Cranberry Creek flows for about three miles before emptying into Oakland Bay in southern Puget Sound.

Aquatic Plant Species of Concern

In the early years following its creation, Lake Limerick demonstrated good overall water quality and little growth of aquatic plants (Bortleson et al, 1976). As a result of increasing aquatic weed growth, with time this naturally productive lake exhibited progressive signs of deteriorating water quality. In the past decade, lake residents have reported increasing surface coverage by rooted macrophytes, particularly the **invasive, non-native weed, Brazilian elodea** (*Egeria densa*), that greatly impedes usage of the waters. Of note is that *Egeria densa* is currently listed as a **Class B Noxious Weed** by the State of Washington. Dense populations of this exotic species are especially prevalent in the northern half of the lake, particularly the "Islands" arm. Moreover, in the last few years Brazilian elodea has been colonizing new shoreline areas, with the result that it now extends around most of the lake perimeter. Since *E. densa* propagates primarily by stem fragmentation, the plant is most likely being spread throughout the lake by motor boats and water currents. Recent surveys show aquatic plants colonizing much of the lake littoral out to depths in excess of 4 meters (See Step F). Brazilian elodea is currently estimated to occupy 50-60 acres in varying densities. Other submersed and floating-leaved plants, particularly non-native bladderwort (*Utricularia inflata*), common elodea (*Elodea canadensis*), and watershield (*Brasenia shreberi*) populate northern embayments in quantities that are also perceived as a nuisance. Unfortunately, **separate** weed control efforts conducted in the past decade involving harvesting, lake drawdown, and spot dredging proved largely unsuccessful. These discouraging results prompted a community search for a more lasting solution targeting Brazilian elodea for long-term control.

Water Use Limitations in Lake Limerick

Brazilian elodea is an aggressive, well-adapted competitor, capable of excluding native plant species and forming dense, monotypic stands. In Lake Limerick, this plant has become well-established in several areas over the years and has been expanding throughout the rest of the lake. Brazilian elodea is a robust plant and accounts for a large quantity of lake plant biomass (See Sections F and G). The *Egeria* beds themselves are undoubtedly a **major source of nutrient enrichment**, building up lake sediments as they increase coverage, grow and senesce each year. Without control, this noxious aquatic weed will most likely continue expanding its coverage in the lake. Eventually Brazilian elodea could occupy all available littoral area (up to 75% or about

100 acres). Dense growth will continue to cause **impairment of aesthetic enjoyment of and recreational activities** in the lake, as well as **degrade habitat**, decreasing availability of native, beneficial vegetation important to wildlife/fisheries. As there are several swimming areas around the lake, residents have a special concern about the **safety** of their children recreating along a weed-choked shoreline. Moreover, with the frequent occurrence of mild winters in the Pacific Northwest, extensive and pervasive growth of aquatic plants in Lake Limerick, particularly Brazilian elodea, is becoming a **year-round problem**.

Threat to Nearby Waterbodies

While heavy infestations of Brazilian elodea have plagued the southeastern U.S. (Getsinger, 1991, 1982; Tarver et al., 1979), the occurrence and establishment of *E. densa* isn't as prevalent in the Pacific Northwest, being somewhat sporadic West of the Cascades (Warrington, 1980; Peter Newroth, B.C. Min. Envir., pers. comm.; Kathy Hamel, Wash. Dept. Ecology, pers. comm.). Lake Limerick is located within 15 miles of a number of popular recreational lakes in Mason County, including Mason Lake, Island Lake, Isabella Lake, Lost Lake, Nahwatzel Lake, as well as Summit Lake in nearby Thurston County. There are <u>currently **no** other documented cases of *Egeria densa* in Mason County</u>, which makes its presence in Lake Limerick all the more critical as a source of infestation to other regional lakes. Therefore, an aggressive control project targeting Brazilian elodea on Lake Limerick has great significance for the region.

Regional Significance

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Define Management Goals
Step B

Project Goals

Aquatic plant management goals were established for Lake Limerick with the purpose of maximizing beneficial uses of the water body, preserving ecological functions, minimizing environmental disturbance, and optimizing control expenses. Moreover, the community will continue (as it has in the past) to **share results of integrated lake management activities on Lake Limerick** with other lake associations or interested groups.

Specifically, the Lake Limerick Integrated Aquatic Plant Management Goals are:

- to enhance water quality and beneficial uses of the lake by utilizing appropriate nuisance macrophyte control actions in an environmentally sensitive and cost-effective manner
- to aggressively remove noxious *Egeria densa* (Brazilian elodea) populations from the lake
- to keep priority areas, the boat launch, beaches and shoreline residential areas, clear of surfacing weeds for boating and swimming safety reasons
- to maintain sufficient lake habitat for fish, waterfowl, and wildlife
- to maintain contact with the local lake community and those with an interest in Lake Limerick regarding aquatic plant management activities, watershed protection (e.g., BMP's) and management results
- to evaluate program effectiveness on a regular basis and make modifications, as needed
- to prevent reintroduction of *Egeria densa* or other noxious invasive weeds into the lake
- to complement concurrent watershed management program activities
- to reduce overall management program costs by utilizing volunteer efforts where possible

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Involve the Public
Step C

From project start-up, the lake community as well as those with an interest in management of this lake were encouraged to actively participate in the planning process. The plan itself was crafted by a **steering committee** composed of individuals representing the County, lake community, local commerce, tribal concerns, State environmental agencies, and lake management professionals. The Lake Limerick IAPMP Steering Committee consisted of the following members:

Steering Committee Formed

- Wayne Clifford (Mason County)
- Dan Robinson (Lake Limerick Country Club)
- Carolyn Soehnlein (Lake Limerick Country Club)
- Michelle Stevie (Squaxin Island Tribe)
- Kathy Hamel (Washington Department of Ecology)
- Loree Randall (Washington Department of Ecology)
- Bill Freymond (Washington Department of Fish and Wildlife)
- Ernie Dahman (Dahman Shellfish Co.)
- Maribeth Gibbons (WATER Environmental Services, Inc.)

Throughout plan development, input and review by the committee were essential to insure crafting of a unique planning document that reflected widespread public and private support. In addition to maintaining frequent written and phone contact with each other, the Committee formally met twice during the course of the project: May 10, 1995 and November 14, 1995. Committee members also kept the larger community informed as to the status of the emerging plan through holding informal meetings and publishing newsletters.

Public Meetings Held

A special membership meeting was held on January 27, 1996 in the Great Hall of Lake Limerick Inn to review available management options proposed by the Steering Committee (Step J). This meeting provided a forum for presentation of in-lake treatment options, general discussion, and approval of a preferred option by formal vote of the membership (See Appendix).

Local Support for Project

The lake community has demonstrated active, long-term support for aquatic plant management efforts specifically targeting the nuisance non-native species Brazilian elodea in Lake Limerick. Since 1991, the lake association, Lake Limerick Country Club (LLCC), has been led by members of the **Lake-Dam Committee** in developing an effective, long-term management strategy for controlling nuisance plants in Lake Limerick and adjacent Lake Leprechaun. The LLCC established a dedicated **Lakes Management Fund**, raised through membership dues and special assessments. Using this fund, the LLCC has allocated approximately $25,000 for annual aquatic plant control expenses since 1991. In addition, for four years the Lake-Dam Committee has been **working closely with a consulting limnologist/aquatic plant expert**, Maribeth Gibbons with WATER Environmental Services, Inc. She has assisted the community in performing diagnostic lake studies and designing a preliminary integrated management program for the lakes, including monitoring and public involvement. **Semi-technical annual reports** have been prepared by the consultant for the lake community summarizing results of the year's lake management program (WATER, 1991a, 1991b, 1992, 1993). Since 1991, **annual town meetings** have been conducted on the status of aquatic plant management in the two lakes. Aquatic plant control activities have been featured in periodic **newsletters** distributed by the LLCC to all members, including special factsheet supplements on Watershed BMP's prepared by the consultant. Most importantly, the Lake Limerick Community has been working hard to **develop additional support for management activities** by reaching out to those with an interest in Lake Limerick, especially the Squaxin Island Tribe. The Appendix provides examples of community interest and support of integrated lake management activities on Lake Limerick/Leprechaun in the form of newsletters, general membership and committee meeting minutes, and citizens' letters.

Long-term Commitment to Implementing Control

As evidenced above, the LLCC has a very good record of active planning and implementation of integrated aquatic plant management in both Lake Limerick and Leprechaun Lake. These control efforts have most likely kept Brazilian elodea from becoming a much worse problem in Lake Limerick than it already is. Furthermore, the Lake Limerick community chose to produce a preliminary integrated management plan even before such plans were recommended or required by the State.

Identify Waterbody/Watershed Features
Step D

Lake Limerick and Lake Leprechaun watershed and lake water quality were recently characterized in a diagnostic study requested by the Lake Limerick Country Club (WATER, 1991). Other sources of background data on Lake Limerick include a single limnological survey performed by the USGS in 1973 (Bortleson et. al., 1976), a multi-lake water quality testing project (Funk et. al., 1972), and data generated through Ecology's Citizen Monitoring Program. The following is a brief summary of pertinent information on the Lake Limerick watershed condensed from the above-mentioned sources. The reader is referred to these documents for more specific data.

Physical Features

Lake Limerick, located 5 miles northeast of Shelton in the Puget Sound Basin, lies at an elevation of 230 feet above sea level. The 130 acre lake has an historical volume of 1200 acre-feet, a mean depth of 9 feet and maximum depth of 24 feet (Bortelson et al., 1976). The drainage area is approximately 13.0 square miles containing mostly forested and wetland areas, with residential land use concentrated around the lake (Lake Limerick Country Club Estates). Lake Leprechaun, a small, shallow bog lake (area=10 acres, max depth=1.5 m) is also located within the boundaries of the Estates.

Lake Limerick was formed in 1966 by construction of a dam on Cranberry Creek, which is the primary inlet that drains shallow Cranberry Lake to the west. There are at least three other inlets that contribute surface runoff to the lake during the year. Other points of inflow to the lake identified from previous diagnostic studies are the Lake Leprechaun outlet, Beaver Creek, and two large culverts at the easternmost end of the lake ("Islands") draining an adjacent wetland area. In addition, several other drainage influents have been observed around the shoreline that may represent seasonal (intermittent) inflows. A single outlet at the southeastern end of the lake flows year-round and consists of a cement spillway with fish ladder to allow upstream passage of migrating salmon from Cranberry Creek.

The Lake Limerick basin is tentacular in shape, with at least three different types of sub-basins (WATER, 1991). The **main basin** in the northwest end is moderately deep (4.5-5.0 m), receiving inflow from Beaver Creek, Leprechaun outlet and upper Cranberry Creek. The shallower (3.5-3.7m) **Islands Arm** extends to the northeast and culminates in several islands that are utilized by a variety of waterfowl and other bird species. The **deep basin** occurs in the southwestern portion of the lake near the perennial outlet, averaging 5.5 m in depth. The lake is oriented in a north-south direction, and general movement of flow appears to be from the north to the outlet in the south. During the summer, 1991 monitoring period, Beaver Creek, Cranberry Creek and Leprechaun outlet all maintained steady inflows, while Islands Arm culvert, which demonstrated high winter/spring flows, ceased to flow in summer. The three lake basins demonstrated similar epilimnetic physical/chemical characteristics with the deep basin showing slightly higher nutrient content during this time. The lakes appeared to be moderately to highly productive throughout with many eutrophic features.

Watershed Characteristics

The Lake Limerick watershed consists primarily of lowland forests and wetland areas (USGS National Wetland Inventory Regional Map). Approximately three quarters of the lake perimeter is **residentially developed** (230 lots). The topography is such that Lake Limerick forms a low point with surrounding elevations contributing drainage directly to the lake via surface flow and overland flow (runoff). The inlet streams, Beaver Creek, Cranberry Creek, Lake Leprechaun outlet, maintained persistent flow rates throughout the exceptionally dry summer of 1991, and probably represent perennial inflows. Beaver Creek had estimated flow rates of between 0.07-0.14 cubic feet per second (cfs) during the summer sampling months; Cranberry Creek which drains shallow Cranberry Lake to the west, produced estimated summer flow rates of 3-4 cfs, and Leprechaun outlet had measured flow rates of 0.75-2.25 cfs. Lake Limerick outlet had estimated summer flows of 4-16.5 cfs.

Stream flow measurements were also obtained on Beaver Creek, Cranberry Creek and Lake Leprechaun outlet on three dates during the spring of 1992: April 10, April 23, and May 14. Generally, flow rates were greatest in all three creeks on the early April, 1992 sampling date, gradually decreasing in value with each successive sampling date. Cranberry Creek demonstrated the highest relative flow rates, varying from about 19 cfs on 10 April to 14.6 cfs on 23 April to 6 cfs on 14 May. Beaver Creek and Leprechaun outlet showed lower sustained flow rates during the 5 week period in April and May. Flow rates at Leprechaun outlet varied very little during the study period, ranging from about 1 cfs on 10 April to 0.8 cfs on 23 April to 0.77 cfs on 14 May. On the other hand, Beaver Creek flow rates fluctuated during the same time frame, beginning with a low of 0.25 cfs on 10 April rising to a high of 0.8 cfs on 23 April and then dropping down to 0.262 cfs on 14 May. It is important to note that reduced flows on the last date were probably the cumulative result of a breach in the upstream beaver dam that occurred in late April, 1992 that ultimately filled the channel with debris and sediment, significantly impeding flow, as well as due to unseasonable low water conditions.

There is also evidence that considerable subsurface inflow of water may occur around the lake in the form of interflow or groundwater movement. The naturally saturated condition of the area is evident in the presence of soggy, marshy areas surrounding the lake, especially north and west of the lake. Upstream reaches of the Beaver Creek inflow (north) are characterized by shallow boggy ponds, impounded by recent beaver dam construction. The dual culverts emptying into the eastern arm of the lake ("bird sanctuary") represents seasonal drainage from a small adjacent wetland area. Persistent flow of the surface inlets and prevalence of marsh-like areas around the lake suggest that these areas may be acting as recharge sites for shallow and deep groundwater flow feeding into Lake Limerick. Thus, there is most likely natural movement of water and nutrients into Lake Limerick from the historically enriched marshland watershed.

Lake Sediments

It is important to note that the Lake-Limerick-Lake Leprechaun system is a naturally productive system. Historically, the lake basins were formed by the damming and resultant flooding of Cranberry Creek and adjacent lowlands. Thus, the newly-formed lake had sediments that had previously supported terrestrial vegetative growth for many, many years, accumulating a rich, deep, organic base. Over the years, the lake substrate continued to build up as sediment was washed into the lake, supporting healthy aquatic plant beds, which seasonally declined and decomposed, further adding organics to the lake bottom. The moderate size and shallow nature of the lake combined with enriched sediments translate into a large area of the lake potentially available for aquatic plant colonization. Indeed, Lake Limerick has supported substantial growth of rooted aquatic plants for the past decade.

Chemical Characteristics

The 1991 diagnostic study showed low to moderate concentrations of total and soluble nitrogen, with highest levels measured at the main basin and bottom of the deep (outlet) basin on September 10, 1991 (TPN=1.0 mg/l). Soluble phosphorus concentrations (SRP) were consistently low at all lake basins, ranging from <1 to 5 µg/l. Total phosphorus (TP) levels were also low to moderate (0.005 to 0.014 mg/l), but higher measures (0.024 mg/l) were recorded at the bottom of the deep station on the September sampling date. Summer secchi disk transparency measures were moderate, within the 2.25- 3 m range at all stations, reflecting in part the dark color of the water. The tea-colored waters of the lake are most likely due to dissolved humics/tannins associated with the boggy nature of the local region. In fact, throughout the course of the summer, 1991 study, pH measurements were consistently just below neutral (pH=7), ranging from 6.1 to 6.6 at all stations, reflecting the acidic bog background. While epilimnetic (upper) oxygen levels remained high (>7.5 mg/l) in all three basins during the summer 1991, oxygen depletion (<3.0 mg/l) was recorded in the hypolimnetic (bottom) waters at the main and deep stations.

Biological Characteristics

The Lake Limerick fishery includes largemouth bass, perch, and catchable rainbow trout that is stocked annually by the community (Dan Collins, Washington Department of Wildlife, pers. comm., 1991). Lower Cranberry Creek (Lake Limerick outflow) is know to support spawning runs of migrating salmonids, steelhead, coho and chum salmon, some of which move through the lake (via outlet fish ladder) and into the upper reaches of the creek (Dan Harring, Washington Department of Fisheries, pers. comm., 1991).

The summer, 1991 study revealed relatively low epilimnetic chlorophyll *a* concentrations (<5 µg/l) at all 3 stations, but the hypolimnion levels in the deep station were consistently high, increasing from 4.8 µg/l on 7/3/91 to 20.6 µg/l on 9/10/91. Phytoplankton samples from the deep station showed high numbers of the filamentous blue-green *Oscillatoria* sp. inhabiting the lower depths on all dates. Generally speaking, phytoplankton numbers were found to be low in all three lake basins during the summer of 1991 (around 100 cells/ml), with a slight peak occurring in all basins on 8/5/91 due to increases in three species of the siliceous chrysophyte *Dinobryon*. As mentioned above, the deep station did support higher algal numbers, mainly due to high blue-green algal densities (e.g. 4670 cells/ml on 9/10/91), which most likely accounted for higher chlorophyll *a* values. Zooplankton (micro-invertebrate) densities were moderately low in all lake basins during the 1991 summer season. The rotifers dominated the zooplankton community in terms of density, while the larger-bodied crustacean cladocerans made up the greatest biomass percentage. Higher numbers of rotifers suggest the presence of much minute bacterial and organic matter, since density of small, edible algae was found to be relatively low during the study. Low numbers of larger crustaceans, such as *Daphnia* sp. and *Diaptomus* sp., at that time may not only have reflected a scarcity of food resources, but may also have been the result of selective predation by planktivorous fish as well as predaceous *Chaoborus* immatures (Phantom midge) which appeared in the lake plankton during mid summer.

Trophic Characteristics

The limnological data from the summer 1991 study indicated that Lake Limerick is in an advanced meso-eutrophic stage. Computation of trophic state indices (Carlson, 1977) based on secchi reading, phosphorus and chl *a* for the three 1991 summer sampling dates all showed good agreement, ranging from 40-60, a mesotrophic-eutrophic range. This conclusion is also supported by results of Department of Ecology's Citizen Monitoring Program (DOE, unpubl. data, 1990). Lake water quality has apparently declined considerably since 1974 when Bortelson et. al. (1976) reported less weeds and more oligotrophic conditions (high secchi, dissolved oxygen, low phosphorus concentrations). The accelerated eutrophication (increased organic productivity and declining water quality) of the lake is probably the combined effect of an historically enriched lake substrate/watershed, recent invasion and development of extensive beds of Brazilian elodea that continually enrich lake sediments, and increased shoreline development.

Identify Waterbody Use Zones
Step E

Human Uses

Lake Limerick is a ***multi-use resource***, supporting a variety of human and wildlife uses (Figure E-1). The lake offers many recreational opportunities for residents and visitors alike. Lake Limerick is a private lake, but **year-round public access** is provided in the form of a Department of Fish and Wildlife launch located at the southwestern end of the lake. Boating access also occurs from private docks around the lake as well as three community launches. Primary uses of the lake water are for contact recreation: **fishing, boating, rowing, swimming, and water-skiing**. The lake receives heavy use by anglers, and as of 1994 is open for **year-round inland trout fishing**. The Lake Limerick community annually hosts an early season **fishing derby** (complete with prizes) that is open to the public. Lake Limerick also provides a source of **irrigation water** for grounds use within the Estates. Approximately three quarters of the lake perimeter is **residentially developed** (230 lots). Other recreational facilities utilized by residents include a swim **beach** and several **parks** providing swimming, picnicking and playgrounds. The upper Lake Limerick watershed (mostly lowland forest/wetland areas) also offers unique opportunities for **hiking and visual enjoyment**.

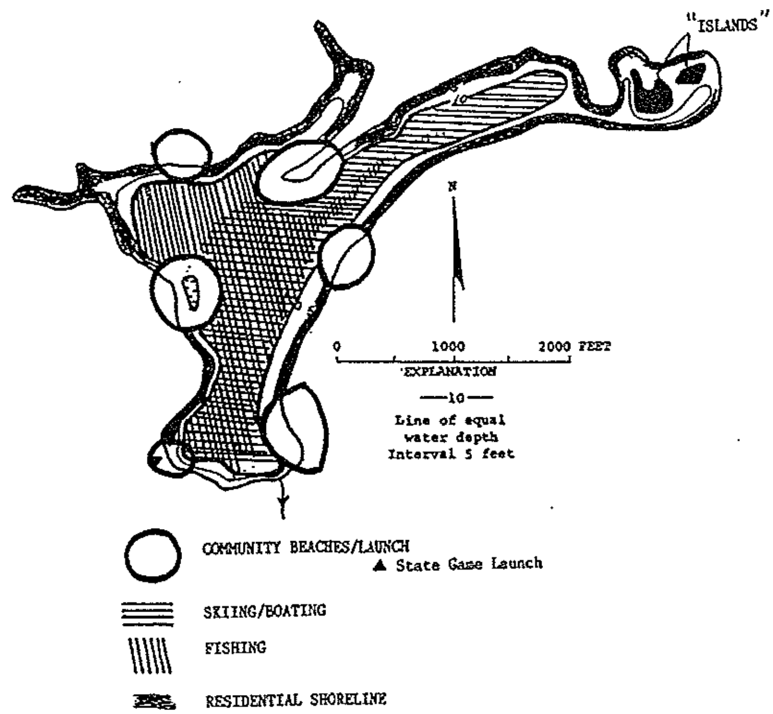

Figure E-1. Lake Limerick Use Zones (WATER, 1991b)

Fish, Waterfowl, and Wildlife Utilization

The lake system provides **nesting, forage and cover** for a variety of resident and migratory **fish, waterfowl and wildlife.** The local fishery includes largemouth bass, yellow perch and annually stocked rainbow trout (Dan Collins, Dept. Wildlife, pers. comm., 1991). Lower Cranberry Creek (Lake Limerick outflow) is known to support spawning runs of migrating salmonids (steelhead, coho and chum salmon), some of which move through the lake (via fish ladder at outlet) and into the upper reaches of the creek (Don Harring, Washington Department of Fisheries, pers. comm., 1991). Small vegetated islands ("the islands") in the shallow eastern arm of the lake offer habitat to a variety of waterfowl, including great blue herons, bald eagles, osprey, Canada Geese, and various ducks (M. Gibbons, pers. observ., 1993). In addition, a small wetland region abuts the far eastern end of the lake, providing additional habitat for migratory and resident waterfowl and other wildlife. The upper reaches of the Beaver Creek inflow are characterized by boggy ponds that support several families of beavers (M. Gibbons, pers. observ., 1993). An otter family resides at Lake Limerick as well.

Protected or Sensitive Flora or Fauna

A search of Washington Department of Natural Resources Natural Heritage Program data base revealed no current record of endangered, threatened or sensitive plant species residing in or around the immediate shoreline of Lake Limerick. The database identified a low elevation freshwater wetland to the north of Lake Limerick draining into Beaver Creek, and another freshwater wetland to the northwest of Lake Leprechaun (See Appendix). A similar search of the data base from the Priority Habitats and Species Division of Washington Department of Fish and Wildlife identified osprey and bald eagle nests and habitat outside the Lake Limerick perimeter to the west of the lake and in the Oakland Bay vicinity.

1995 Aquatic Plant Survey
Step F

Purpose of Survey

An aquatic plant survey was conducted on Lake Limerick during July, 1995. The main purpose of the survey was to document current composition, extent, and biomass of the aquatic plant community in the lake. Visual aquatic plant surveys had been conducted routinely on Lake Limerick since 1991 (WATER, 1991, 1992, 1993). These did include limited quantitative measurements of plant biomass and coverage. A primary aim of the present survey was to supply additional plant biomass and areal coverage data for the lake, so that better estimates of whole lake plant biomass could be obtained. The 1995 survey effort also included fathometer recordings of lake bottom along the primary transects to graphically depict plant bed extent and height, and to obtain an updated profile of lake bottom.

The 1995 Lake Limerick survey was a joint volunteer/consultant team venture. WATER staff performed an intensive, one day survey on July 13, while a team of lake volunteers conducted supplementary surveying around the lake during the latter part of July. The aquatic plant survey was conducted at this point in the mid-growth season in order to meet project timelines, particularly to complete surveying before implementation of any macrophyte management activities during the summer season (eg., harvesting or herbicide application).

Primary Survey

On July 13, 1995 WATER staff, assisted by lake resident Dan Robinson, conducted a physical survey of Lake Limerick to document aquatic plant community composition and extent of growth. Field data on aquatic plant distribution and biomass were obtained by means of a motorboat using a transect sampling system. A series of seven primary transects was established around the lake perimeter (Fig. G-1). Transect surveying commenced at the western end of the lake and continued around the lake at regular shoreline intervals, ending at the lake outlet in the southern end.

Except for Transect 1, physical surveying on a transect extended from shoreline to shoreline. At transect 1, surveying was performed along a calibrated floating line that was securely stretched between a fixed shoreline point and a buoy set in deep water. Presence of submersed plants was visually determined along each transect by observation through an underwater viewer. In addition, along each of the seven transects, an echogram of the lake bottom illustrating plant beds was obtained using a high-resolution chart-recording fathometer. Fathometer tracings were especially useful when plant beds were difficult to detect visually with the underwater viewer, particularly in deep or turbid waters.

The complete series of fathometer recordings is presented in the Appendix. Nearshore plant beds were inspected from the boat with the underwater viewer while traveling between designated transects to provide as much continuum as possible around the lake littoral for mapping purposes. Surface and underwater photographs were also obtained for further visual documentation.

Water depth measurements and aquatic plant samples were taken along selected transects at regular intervals using a modified rake sampler operated from the boat. In all, eight quantitative plant samples were obtained during the mid-July survey of Lake Limerick. Samples were later analyzed in the laboratory for plant community composition and dry weight biomass measures according to Standard Methods (APHA, 1985). Species identifications were made using published keys for regional macrophytes (Hotchkiss, 1972; Warrington, 1994, 1980; Hitchcock and Cronquist, 1981). Sediment brought up with each of the plant samples was also examined in order to provide a general characterization of local substrate type (e.g., mucky, sandy, clayey, gravely).

Plant Voucher Specimens

Whole plant specimens were also collected of the major aquatic plant species encountered in Lake Limerick during the summer, 1995 survey. These specimens were washed, dried, and mounted on specially labeled herbarium paper. These ***voucher specimens*** will serve as a permanent archival record of principal macrophytes occurring in the lake at this point in time.

Volunteer Survey

Citizen volunteers from the Lake Limerick community also participated in the summer, 1995 lake survey. WATER staff assisted the volunteer team in choosing locations of 11 supplementary survey points around the entire lakeshore (Fig. G-1). Volunteers, Bill and Glenna Buff, conducted their survey over a two week period from mid to late July, 1995. The surveying procedure utilized by the volunteers was a modification of that used by WATER's crew. Using rakes for sampling, the citizen crew performed water depth measurements and noted plant species types along each of these auxiliary survey transects. Sample specimens were collected of each type of aquatic plant encountered in the survey and presented to WATER for identification or verification. The plant and water depth information gathered by the volunteers formed an important supplement to quantitative and qualitative data collected by the consultant survey crew.

Aquatic Plant Map Produced

As a result of both volunteer and consultant efforts, a total of 18 survey transects were established around Lake Limerick as part of the summer 1995 survey. Measurements by both crews along these transects generated a substantial data base from which a generalized aquatic plant zone map (Fig. G-1) was constructed. It is important to note that the map reflects mid-summer, 1995 lake level conditions resulting from annual flow adjustment at the outlet structure that occurs in spring (under the Washington State Hydraulic Permit).

Lake Limerick Aquatic Plant Community
Step G

Plant Community Composition

The 1995 survey showed that aquatic plants in Lake Limerick occurred in mixed communities of varying densities around the entire lake and shoreline. More than ten different plant species were observed including floating-leaved and submersed vascular forms, and macrophytic algae. Table G-1 lists principal aquatic plant species found during the 1995 Lake Limerick survey along with their common names.

TABLE G-1.
MAJOR AQUATIC PLANT SPECIES FOUND DURING 1995 SURVEY OF LAKE LIMERICK

Species	Common Name
Egeria densa	Brazilian elodea
Elodea canadensis	Common elodea
Potamogeton amplifolius	Big-leaf pondweed
Potamogeton sp.	thin-leaved pondweed
Brasenia schreberi	Watershield
Utricularia inflata	Big floating bladderwort
Nitella spp.	Nitella (macroalgae)
Chara spp.	muskgrass (macroalgae)
Vallisneria americana	tapegrass
Myriophyllum sp.	milfoil (native)

Extent of Coverage

Macrophytic growth in Lake Limerick generally followed the shallow littoral shelf out to depths of approximately 4 meters (13-14 ft.) (Figure G-1). Plant growth was typically denser in the northern portion of the lake and particularly in the easternmost "Islands" arm, where filamentous green algal mats were also evident hugging the lake bottom. Rooted, ***floating-leaved*** vegetation was apparent in several nearshore areas of the lake where the littoral shelf broadens. Pockets of native watershield (*Brasenia schreberi*) were present within the "Islands" arm at the easternmost end and within Kings Cove in the northern end at the Beaver Creek inlet. Watershield generally occurred at depths less than 1.8 m (6 ft). Whereas historically waterlilies (*Nuphar*, *Nymphaea* spp.) were apparently problematic in Lake Limerick and targeted for treatment in past years, especially within the "Islands" embayment, these floating macrophytic forms were not observed in the lake during the 1995 survey.

Noxious Weed Species Present

The non-native species, **Brazilian elodea,** *Egeria densa,* was found to be a dominant member of the ***submersed macrophyte*** community of Lake Limerick. Brazilian elodea belongs to the

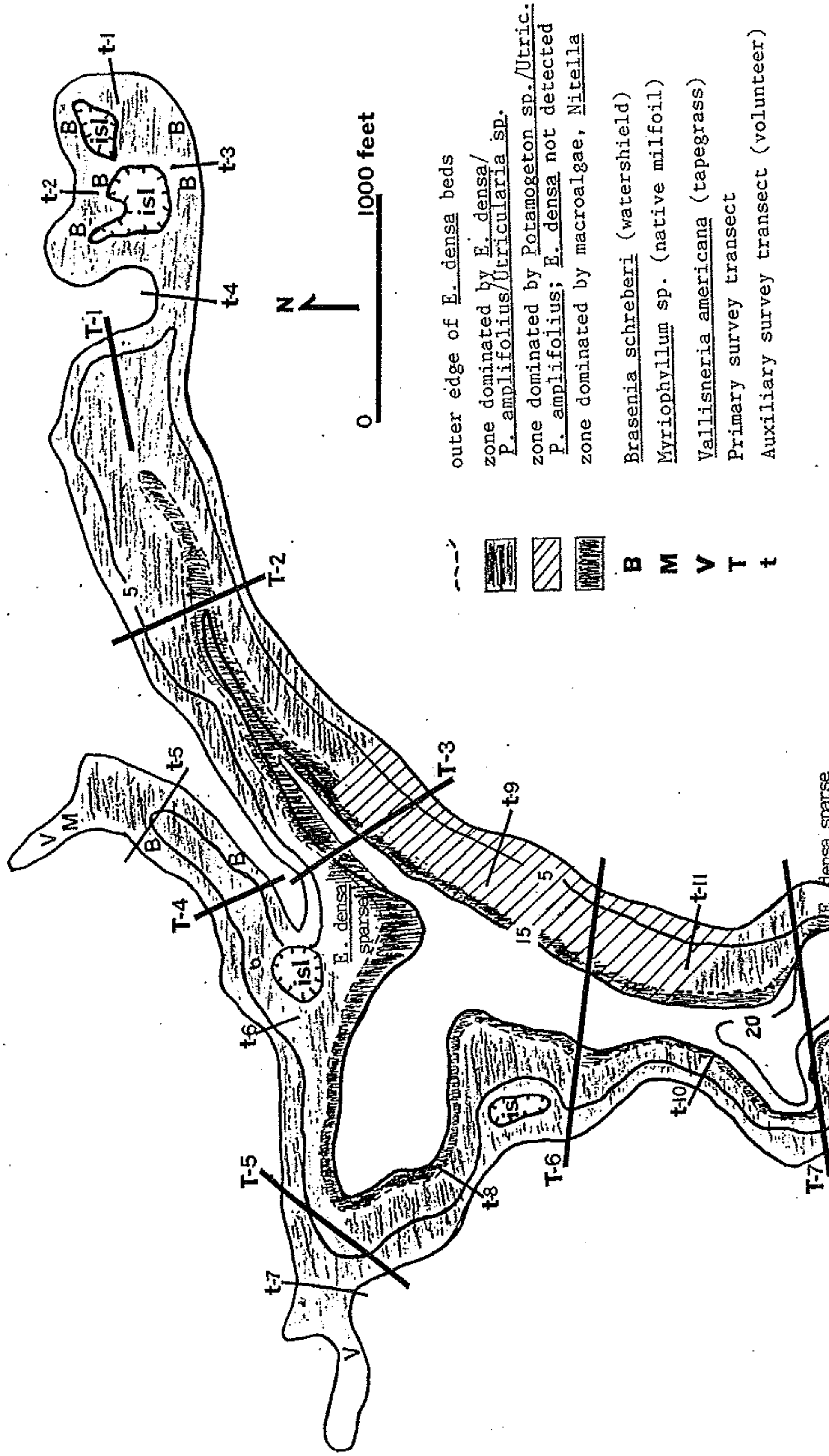

Figure G-1. Aquatic plant map showing distribution of major species in Lake Limerick as of survey date, July 13, 1995. Adapted from Bortleson, et. al. (1976).

family Hydrocharitaceae, which also includes the freshwater genera: *Elodea, Hydrilla,* and *Vallisneria*. This invasive, non-native species is notorious for its aggressive growth potential, and is listed as a Class B *noxious* plant in the State of Washington. Plants reproduce mainly by fragmentation of stems, and thus the potential for spread by water currents and boating equipment is very great. Accelerating growth of this invasive, exotic (non-native) weed has been documented in the lake for at least the past decade, with evidence of increased coverage and density occurring within just the past 5 years (WATER 1992, 1993). The summer, 1995 survey confirmed Brazilian elodea occurring around most of the lake shoreline, and was not observed only along a short shoreline segment on the southeastern end of the lake (See Fig. G-1). Brazilian elodea beds currently occupy an estimated area of 50 acres, inhabiting water depths between 1 and 4 meters. It is important to note that Brazilian elodea in Lake Limerick does occur in mixed communities with other native aquatic plants.

Potamogeton amplifolius (big-leaf pondweed) is another important member of the Lake Limerick macrophyte community. During the 1995 survey, big-leaf pondweed was observed growing around the entire lakeshore in low to moderate densities at depths between 1 and 4 meters. Growth of this pondweed was more substantial in the "Islands" arm and Kings Cove areas of the lake. Mixed communities of big-leaf pondweed and Brazilian elodea dominated plant beds around much of the lake. *P. amplifolius* is a large, robust submersed plant belonging to the family Potamogetonaceae, and is often found growing in deep quiet water (up to 4-5 meters). This species is characterized by upright growth of stems to water surface, (simple or branched, especially near the top) and perennial rhizomes (underground horizontal stems with nodes, buds, and roots) (Warrington, 1980). Floating leaves are often present. Seeds are produced, but germination occurs only after storage under cold and wet conditions for several months (Warrington, 1980). The species can form extensive beds with considerable biomass due to its robust nature, and can be a nuisance with regard to recreational activities such as boating, fishing and swimming. *P. amplifolius* apparently provides a good source of food and habitat for fish and waterfowl (Warrington, 1980).

Other Non-native Plants

Of particular note was the pervasive occurrence throughout most of Lake Limerick of a species of bladderwort relatively uncommon in the Northwest, *Utricularia inflata*, big floating bladderwort. This submersed species is more often found in the Coastal Plain of Eastern United States (Westerdahl and Getsinger, 1988), although isolated occurrences have been documented in a few lowland Western Washington lakes, such as Silver Lake, Cowlitz County, Washington (M. Gibbons, WATER Environmental Services, unpubl. data., 1993). A non-rooted, *submersed* macrophyte, bladderwort was typically found in Lake Limerick floating just below the water surface or densely entangled with other rooted aquatic plants. As a result of its rootless nature, bladderwort mats were most likely transported around the lake by wind and water currents, as well as boating equipment. Nuisance growth of this plant interfered greatly with recreational use of the lake, resulting in the need for mechanical removal (harvesting) by a private contractor during July and August, 1995.

Other important members of the submersed community in Lake Limerick occurring within the Brazilian elodea/big-leaf pondweed zones included mixed stands of *Elodea canadensis* (common elodea or waterweed) and *Potamogeton* sp. (narrow-leaved pondweed), the latter forming prominent beds along the same southeastern shoreline segment where Brazilian elodea has not yet visibly established (See Fig. G-1). *Vallisneria americana* (tapegrass) and *Myriophyllum* sp. (milfoil) also occurred in the Lake Limerick community, but appeared to be confined to the shallows of Kings Cove and Cranberry Creek inlet.

The rooted, submersed plant forms do not appear to cover the lake bottom uniformly, but exhibit a scattered, patchy distribution. Plant growth was sparse in waters deeper than 4 m (13 ft), with only the rootless, macrophytic algae, *Nitella* spp. (Charales) occurring in low to moderate densities at depth. The genus *Nitella* is a common algal inhabitant of soft-water or slightly acid lakes. The presence of this algae, which derives its nutrition from solution, suggests successful competition with planktonic algae for soluble nutrient reserves in the lake water column. Also, as a rootless algae, *Nitella* spp. does not directly compete with rooted macrophytes which extract nutrients primarily from the sediments (Smart, 1990). However, this macroalgae may come into competition with the submersed, non rooted species *Utricularia* sp. and submersed *Elodea canadensis*, which can detach from the bottom and form floating mats.

Emergents such as Iris (*Iris* spp.), rushes (*Juncus* spp., *Scirpus* spp.) and reeds (*Typha* sp.), sedges and grasses were also present in patches around the lakeshore perimeter. Bogs and marshes are present in the upper watershed of Lake Limerick, with a bog-type wetland area abutting the easternmost shoreline of the lake. The boggy nature of the surrounding watershed is most likely responsible for the tea-colored, humic nature of the lake water.

Outer Limits to Growth

The 1995 survey generally showed submersed plant growth extending from a depth of about 0.5 m (1.6 ft) to 4 m (13+ ft), representing about 60-70% of total lake surface area. Limits of submerged macrophytic growth are graphically depicted by fathometer tracings of lake bottom taken along the seven primary survey transects established around Lake Limerick for the 1995 survey (Appendix). Inspection of the fathometer recordings revealed aquatic plant beds occurring throughout the lake at depths up to approximately 14 feet. The outer growth limit was further verified by failure to obtain any biomass samples at the 5 m (16 ft) depth along the survey transects.

Mucky sediments brought up with biomass samples suggest that Lake Limerick sediments may be quite productive and a good potential source of nutrients for submersed plant growth. However, macrophytic growth in this lake may actually be more limited by light within the water column. Indeed, the presence of dissolved and particulate matter in the water column can result in greater attenuation of light with depth because of scattering and absorptive effects. Reduction of available light at greater depths can act to restrict submerged plant growth to shallower areas where light availability may be greater. The tea colored nature of the water most likely plays an important part in restricting plant growth in this lake. Using a regression model developed by Canfield et. al. (1985), the maximum depth of colonization in Lake Limerick was predicted to be 3.8 m (12.5 ft), based on a mean growth season secchi depth of 3.2 m (10.5 ft) obtained in 1992 (J. Rector, Department of Ecology Volunteer Lake Monitoring Program, 1992). Indeed, this depth was very close to the limits of growth observed during the 1995 macrophyte survey. [Note: Secchi depth is a measure of water transparency obtained by lowering a black and white disk into the water until it cannot be seen.]

Biomass Patterns

Table G-2 presents macrophyte species composition and biomass data (as grams per square meter, dry weight) for samples collected during the 1995 survey from selected depths along the three of the eight primary survey transects in Lake Limerick. Macrophyte biomass was found to vary both by water depth and sampling site within Lake Limerick. The rooted, submersed *Egeria densa* dominated macrophyte biomass measures for samples collected along these transects, composing from 44 to 99.8% of the total sample. The non rooted, submersed bladderwort, *Utricularia* spp., occurred in all but the mid-channel Kings Cove sample. These quantitative results confirmed other visual and qualitative observations of prominence of these species in the lake. For the mid-July, 1995 samples collected, Brazilian elodea biomass ranged from 23 to 235 g/m^2, averaging 121 g/m^2. Each sample site showed a trend of increasing Brazilian elodea biomass with increasing water depth to the outer limits of growth. *Elodea canadensis* and *Potamogeton amplifolius* also demonstrated moderate biomass levels within the shallows of Kings Cove, but considerably less than that of *E. densa*. The macroalgae, *Nitella* and *Chara* spp. occurred in low densities in the deeper water (> 6 ft) samples of all transects.

The biomass measures of the principal species of concern, *Egeria densa*, obtained during the mid-July, 1995 survey of Lake Limerick can be examined relative to quantitative data collected in April and September, 1992 and May and September, 1993 (WATER, 1993). The three surveys used comparative sampling methodology, but differed in timing of sampling and total number of samples collected at a site. The present survey conducted in mid-July demonstrated maximum *E. densa* biomass measures of approximately 200-250 g/m^2, with a pattern of increasing biomass with depth. While previous surveys do not include a similar mid-July sampling date, September survey dates in both years reveal much higher biomass occurring later in the growth

TABLE G-2.

Lake Limerick macrophyte biomass (grams/sq. m., dry wt) for samples collected from 1 meter depths along selected survey transects. Aquatic plant biomass survey was performed on July 13, 1995. Non-native, invasive species are listed in bold type.

Transect	Depth (m)	Species	Common Name	Dry Wt. (g/0.3sq. m)	Dry Wt. (g/sq. m)	Total Dry Wt. (g/sq. m)	% Composition
T-1 East Arm	1.5m (5 ft)	***Egeria densa***	Brazilian elodea	6.83	22.80		95.80%
		Utricularia spp.	Bladderwort	0.3	1.00		4.20%
						23.80	
	1.8m (6 ft)	***Egeria densa***	Brazilian elodea	24.39	81.30		93.99%
		Utricularia spp.	bladderwort	1.04	3.50		4.05%
		Chara spp.	Chara(macroalgae)	0.51	1.70		1.97%
						86.50	
	2.1m (7 ft)	***Egeria densa***	Brazilian elodea	49.61	165.40		89.36%
		Chara/Nitella spp.	Chara/Nitella	4.23	14.10		7.62%
		Utricularia spp.	bladderwort	1.57	5.20		2.81%
		Elodea canadensis (trace)	common elodea	0.13	0.40		0.22%
						185.10	
T-4 Kings Cove	1.0m (3.5 ft) 50ft from south shore	***Egeria densa***	Brazilian elodea	57.62	192.10		98.82%
		Utricularia spp.	bladderwort	0.69	2.30		1.18%
						194.40	
	1.0m (3.5 ft) 50ft from north shore	*Elodea canadensis*	common elodea	18.6	62.00		100.00%
						62.00	
	1.9m (6.25 ft) mid-channel	***Egeria densa***	Brazilian elodea	26.66	88.90		44.03%
		Potamogeton amplifolius	big-leaf pondweed	24.81	82.70		40.96%
		Elodea canadensis	common elodea	7.4	24.70		12.23%
		Utricularia spp.	bladderwort	1.67	5.60		2.77%
		Nitella spp.	Nitella	0.11	0.40		0.20%
						201.90	
T-7 outlet	1.8m (6 ft) 175 ft from State launch	***Egeria densa***	Brazilian elodea	19.01	63.40		99.48%
		Utricularia spp. (trace)	bladderwort	0.1	0.33		0.52%
						63.73	
	2.3m (7.5 ft) 100 ft from State launch	***Egeria densa***	Brazilian elodea	70.42	234.70		99.83%
		Utricularia spp. (trace)	bladderwort	0.12	0.40		0.17%
						235.10	

season at these same sites. It is very likely that plant biomass measures obtained during the mid-July, 1995 survey did not represent peak growth conditions for the year. Since warm, mild conditions in the region persisted well into October, growth of aquatic plants and correlative problems throughout Lake Limerick appeared to have continued as well. To address this possibility, additional biomass sampling was conducted along survey Transect 1 on October 10, 1995. Data (Table G-3) was compared

TABLE G-3
Lake Limerick macrophyte sample biomass (dry weight, no roots) for samples collected by diver along Transect 1 on October 10, 1995.

Depth (m)	Species	Dry Wt. (g/sq m)	Total Dry Wt (g/sq m)	% Composition
1.21 m (4 ft)	*Egeria densa*	648.4		99.3%
	Elodea canadensis	2.4		0.37%
	Potamogeton amplifolius	2.2		0.33%
			653	
1.5 m (5 ft)	*Egeria densa*	947.7		98.5%
	Potamogeton amplifolius	11.3		1.2%
	Utricularia inflata	2.8		0.3%
			961.8	
2.1 m (7 ft)	*Egeria densa*	1594		99.6%
	Potamogeton amplifolius	4.6		0.3%
	Utricularia inflata	1.9		0.1%
			1600.5	

with similar data collected on the July, 1995 date at the site. Analyses of both sets of data confirmed increased *E. densa* biomass production in the lake at this site between July and October, 1995. As was the case in July, a pattern of increasing biomass with depth was apparent along the transect, with *Egeria* measures ranging from 648 g/sq m at a depth of 1.2 m (4 ft) to 1594 g/sq m at the 2.1 m (7 ft) depth. Over this 3 month period in 1995, *E. densa* demonstrated an order of magnitude increase in dry weight biomass along Transect 1. It is very probable that significant *E. densa* biomass increases occurred throughout Lake Limerick during this time as well.

Problem Plant Zones

The entire shoreline area of the lake between depths of 1 m and 4 m (3 to 13 ft) is the highest priority problem zone because of the presence of the noxious weed, **Brazilian elodea (*Egeria densa*)**. These Brazilian elodea areas justify use of special, aggressive control action to remove nuisance populations, if possible. The *E. densa* beds in Lake Limerick are particularly well-established in the eastern arm of the lake, having persisted for at a decade or more, and are showing signs of increased coverage and density throughout the rest of the lake. Dense, surfacing plant beds make shoreline access as well as swimming, wading or other contact recreational use most difficult and dangerous. It is also important to note the recent occurrence of nuisance growth of bladderwort, *Utricularia inflata*, throughout the lake during 1995. Such an event may signal the onset of yet another non-native plant problem in the lake and should be monitored as well.

Beneficial Plant Zones

Lake Limerick supports an important salmon fishery, spiny-ray and planted trout fishery, as well as waterfowl and other wildlife. **Native beds** of pondweed and elodea do form an important source of food and refuge in the lake for these and other small aquatic life, and should be maintained at sufficient support levels. Most importantly, **wetland** stands adjacent to the eastern end of the lake and above the Beaver Creek inlet are recognized as valuable beneficial zones that should be protected as part of the overall aquatic plant management plan.

Investigate Control Alternatives
Step H

A variety of methods (chemical, mechanical, biological, physical) are currently available for treatment of nuisance aquatic plant populations, such as Brazilian elodea (*Egeria densa*), in order to protect beneficial uses of a waterbody. This section reviews selected treatment methodologies currently available for aquatic plant control in the State of Washington. These treatment options will be examined in terms of suitability for controlling nuisance plants in Lake Limerick, especially the non-native, rooted *Egeria densa*. Much of the following discussion on methods is drawn from Ecology's Citizen's Manual for Developing Integrated Aquatic Vegetation Management Plans (Gibbons et. al., 1994).

Integrated Control Approach

It is important to note that control tactics for maximum effectiveness against a target species depend on its morphology and structure, physiology, growth requirements, and growth habit. In other words, control methods that might be quite successful against one plant may not be appropriate for management of another type of plant. Thus, it is obvious that an integration of several control methods will be necessary to combat the multi-species macrophyte problem noted in Lake Limerick. Indeed, the State has identified as the preferred alternative for development of an aquatic plant management program the use of an **integrated approach** involving selection of the best combination of methods after careful evaluation of economic, ecological, socio-political consequences within the context of whole lake and watershed management (WDOE, 1992; Gibbons et. al, 1994).

No Action Alternative

Because of the current extent of Brazilian elodea growth in this lake, the review will focus on the most aggressive control methods aimed at killing or removing the entire plant, including root systems. With regard to exotic plant infestations, it is critical to consider possible consequences of a **no action alternative** on human use, habitat, and wildlife utilization of the resource. In particular, if aggressive, lakewide control tactics are not used to eliminate Brazilian elodea populations from Lake Limerick, this exotic plant can be expected to continue colonization of all available littoral area. Left unchecked, Brazilian elodea has the potential to eliminate current native stands, and create a worse weed problem that may ultimately result in higher future program costs and level of effort to manage this plant.

Potential Treatment Options Listed

The potential options presented for review are the large-scale treatments: aquatic herbicide application (e.g. fluridone, endothall, glyphosate), mechanical dredging, sterile grass carp introduction, and mechanical harvesting; also considered are methods appropriate for smaller areas: hand-removal, bottom barrier application, and diver-assisted suction dredging. These techniques do vary with respect to effectiveness against Brazilian elodea. Dredging, hand removal, bottom barrier and systemic chemical applications such as SONAR (fluridone) are intensive methods aimed at killing or removing *Egeria densa*, including roots, and are considered aggressive methods with the potential of achieving long-term reductions. Use of herbivorous grass carp, offering **potentially good** control of Brazilian elodea, is also treated in the review as a result of recent availability of this method in Washington State and recent introduction to local waters (e.g. Silver Lake in Cowlitz County). Mechanical harvesting and contact herbicides (e.g., Aquathol) are useful for short-term removal of large areas of surfacing plants, and is included in the discussion as a less intensive form of maintenance control. Other types of control methods, such as water column dyes, mechanical rotovation and lake level drawdown, are not considered appropriate for current use in Lake Limerick for reasons of site and species specific constraints, and are therefore, not discussed.

Each treatment alternative will be reviewed in terms of principle mode of action, effectiveness of treatment, human and environmental effects (safety, water quality, non-target organisms/plants), costs, and other special political/ administrative concerns. A summary of comparative data on these treatment alternatives (including others not currently considered appropriate for use in Lake Limerick) are presented in Table H-1. Potential mitigation measures will be presented along with estimates of mitigation costs, where possible.

Mechanical Control Methods

Hydraulic (Suction) Dredging

Principle This is an intensive technique that involves removal of littoral sediments and associated rooted aquatic plants using hydraulic dredging equipment. Lake sediment removal is most often performed by means of a cutter-head hydraulic pipeline dredge (Cooke et. al., 1993). In terms of operation, plants/sediment loosened by the cutter head travels to the pickup head. The slurry is then suctioned up and carried back to the dredge barge through hoses. The sediment slurry is then piped off-site for disposal.

Control Effectiveness And Duration Large-scale sediment removal techniques can often provide multiple benefits to an aquatic system (Cooke et. al., 1993). Depending on the waterbody, possible enhancements include not only rooted macrophyte control, but also increased depth of waterbody, and removal of nutrients or toxic substances. Efficiency of removal is dependent on equipment, sediment type and condition, with conventional dredges performing well on harder sediment. However, various types of portable hydraulic dredges are available in the U.S. that are more effective for small lakes with softer, flocculent substrate. Longevity of control is dependent on a number of factors including sedimentation rate (the lower the better), watershed-to-surface-area ratios (nominally 10:1), and hydraulic residence time (the longer the better).

Advantages Dredging removes entire plants, including root systems, so regrowth is minimized. Plant pieces are collected and retained, and fragmentation spread is minimized (very important for control of Brazilian elodea). It can be used to cover areas larger than practicable for diver-operated dredging or diver hand removal, or where herbicides cannot be used. Human health and safety concerns are negligible where operations are conducted prudently.

Drawbacks Hydraulic dredging is very expensive and highly disruptive to the local environment. A major problem often involves finding suitable offsite disposal areas and transporting dredged materials to these sites. As result, more specialized equipment and materials are required and the process is much more costly. Short-term environmental effects include resuspension of sediments and localized turbidity increases in the area of treatment. Release of nutrients and other contaminants from enriched sediments can also be a problem. In addition, some non-target aquatic organisms and vegetation may be inadvertently removed during the process. However, if only a portion of the lake bed is dredged, impacts on benthic aquatic life should be short-lived (Cooke et. al., 1993).

Costs Dredging costs can be very variable, depending on density and volume of sediment removed, equipment condition, transport requirements of dredged material, and eventual use of dredged material (Cooke et. al., 1993). Hydraulic dredging costs typically range from a minimum of $\$2.25/m^3$ to $\$6/m^3$, although figures as high as $\$20$ to $\$50/m^3$ have been reported for special cases.

Permits In the State of Washington, use of suction dredging does require hydraulic approval from Washington Department of Fisheries and/or Department of Wildlife. Its use also requires a temporary modification of water quality standards from Ecology for increased turbidity. A shoreline management permit may be needed. In addition, it will be necessary to obtain a letter of approval from Washington Department of Natural Resources.

Applicability to Lake Limerick This alternative is included in the review of possible controls because of the great extent of nutrient-enriched lake sediments and associated rooted aquatic vegetation. When used for large-scale applications, this alternative is likely to produce highly effective, immediate and long-term control, but is potentially the most costly and can result in extensive and immediate environmental impacts. Since the lake substrate is deep and flocculent, a large-scale dredging project removing, for example, 2-3 feet of sediment over 65 acres (1/2 lake area) at an estimated (mid-range) cost of $5.00/cubic yard, could total upwards of $1.25 Million. Although this alternative is probably the best large-area solution, the cost is prohibitive given the community resource base. A more practical, although still pricey alternative might be to use dredging for more localized application, dredging out most seriously affected or high quality areas such as the Islands embayment and Kings Cove, where Brazilian elodea is most problematic.

Diver-Operated Suction Dredging

Principle Diver dredging has been used since the late 1970s in British Columbia as an improvement to hand removal of sparse colonies of Eurasian watermilfoil. The technique utilizes a small barge or boat carrying portable dredges with suction heads that are operated by Scuba® divers to remove individual plants (including roots) from the sediment. Divers physically dislodge plants with sharp tools. The plant/sediment slurry is then suctioned up and carried back to the barge through hoses operated by the diver. On the barge, plant parts are sieved out and retained for later off-site disposal. The water sediment slurry can be discharged back to the water or piped off-site for upland disposal.

Control Effectiveness And Duration Diver dredging can be highly effective under appropriate conditions. Efficiency of removal is dependent on sediment condition, density of aquatic plants and underwater visibility. As it is <u>best used for localized infestations of low plant density where fragmentation must be minimized</u>, the technique has great potential for milfoil control. Depending on local conditions, milfoil removal efficiencies of 85-97% can be achieved by diver dredging. This technique is currently being used for aggressive control of milfoil populations in Silver Lake (City of Everett) and Long Lake (Thurston County) with preliminary reports indicating good results.

Advantages The method is species-selective and site-specific. Disruption of sediments are minimized. Plant pieces are collected and retained, and fragmentation spread is minimized (very important for control of milfoil). It can be used to cover areas larger than practicable for hand digging or diver hand removal, or where herbicides cannot be used. Diver-dredging can be conducted in tight places or around obstacles that would preclude use of larger machinery.

Drawbacks Diver-dredging is labor-intensive and expensive. In dense plant beds, the utility of this method may be much reduced and other methods (e.g., bottom barrier) may be more appropriate. Returning dredged residue directly to water may result in some fragment loss through sieves. Where upland disposal of dredged slurry is used, more specialized equipment and materials are required and the process is much more costly. Short-term environmental effects can include localized turbidity increases in the area of treatment. Release of nutrients and other contaminants from enriched sediments can also be a problem. In addition, some sediment and non-target vegetation may be inadvertently removed during the process.

Costs Dredging costs can be very variable, depending on density of plants, equipment condition and transport requirements of dredged material. In addition, the use of contract divers for dredging work is subject to stringent State regulations on certification, safety and hourly wage payment, which can affect total project cost. Costs range from a minimum of $1100/day to upwards of $2000/day (not including dredged material transport).

Permits In the State of Washington, use of suction dredging does require hydraulic approval from Washington Department of Fisheries and/or Department of Wildlife. Its use also requires a temporary modification of water quality standards from Ecology for increased turbidity. A shoreline management permit may be needed. In addition, it may be necessary to obtain a letter of approval from Washington Department of Natural Resources.

Applicability to Lake Limerick Diver operated dredging may be useful in Lake Limerick to remove small, isolated patches of Brazilian elodea and treat areas where herbicides could not be used, such as the colony located near the irrigation water intake. It's use in this lake is most appropriate for small-scale, supportive work.

Rotovation/Cultivation (Bottom Derooting)

Principle Mechanical rotovation/cultivation are bottom tillage methods that remove aquatic plant root systems. This results in reduced stem development and seriously impairs growth of rooted aquatic plants. Derooting methods were developed by aquatic plant experts with the British Columbia Ministry of Environment as a more effective milfoil control alternative to harvesting. Essentially two types of tillage machinery have been developed. Deep water tillage is performed in water depths of 1.5 to 11.5 ft using a barge-mounted rototiller equipped with a 6-10 ft wide rotating head. Cultivation in shallow water depths up to a few meters is accomplished by means of an amphibious tractor or modified WWII "DUCW" vehicle towing a cultivator. Both methods involve tilling the sediment to a depth of 4-6 in, which dislodges plants including roots. Certain plants like milfoil have roots that are buoyant and float on the surface where they can be collected. Treatments are made in an overlapping swath pattern. Bottom tillage is usually performed in the cold "off-season" months of winter and spring to reduce plant regrowth potential.

Control Effectiveness and Duration Bottom tillage has been used effectively for long-term control of milfoil where populations are well-established and prevention of stem fragments is not critical. Single treatments using a crisscross pattern have resulted in milfoil stem density reductions of 80-97 percent in bottom tillage treatments. Seasonal rototilling in an area is at least as effective as 3 to 4 harvests, and where repeated treatments have occurred at the same site over several years, carryover effectiveness may extend to greater than a year.

Advantages A high percentage of entire plants (roots and shoots) can be removed by bottom tillage methods. Depending on plant density, carryover effectiveness of rototilling can persist for up to 2 to 3 years without retreatment. Following treatment, rotovated areas in Washington and British Columbia have shown increases in species diversity of native plants, of potential benefit to fisheries. Fish are not removed through rototilling as they are by harvesting operations. Unlike harvesting which is conducted during summertime when plant growth is maximal, rototilling treatments for root removal can be performed during "off season" months of winter and spring. This results in no interference with peak summer-time recreational activities.

Drawbacks Bottom tillage is limited to areas with few bottom obstructions and should not be used where water intakes are located. Rototilling does create short-term turbidity increases in the area of operation, but increases are usually temporary with a rapid return to baseline conditions often within 24 hours. Since bottom sediments are disturbed, short-term impacts on water quality and the benthic invertebrate community can occur. Rototilling is not advised where bottom sediments have excessive nutrient and/or metals concentrations, because of potential release of contaminants into the overlying water. Rotovation is not species selective, except by location, and can result in unintentional removal of non-target plants. The method does result in production of plant fragments, and is not recommended for use in water bodies with new or sparse milfoil or Brazilian elodea infestations or where release of fragments is a concern. There are often timing restrictions to avoid interference with fish spawning or juvenile use.

Costs Bottom tillage costs vary according to treatment scale, density of plants, machinery used and other site constraints. Contract costs for rotovation in the State of Washington range from $1200-1700/acre depending on treatment size.

Permits In the State of Washington, bottom tillage methods do require hydraulic approval from Washington Department of Fisheries and Wildlife. Its use requires temporary modification of water quality standards from Ecology. In addition, you may need a shoreline permit, so local Shoreline Master Plan should be checked for compliance; contact your local Planning Department for information. It may also be necessary to obtain a letter of approval from Washington Department of Natural Resources.

Applicability to Lake Limerick Rotovation does result in production of plant stem fragments. Since *Egeria densa* reproduces primarily by stem fragmentation, use of this mechanical option as a main, large-scale control element of this species in Lake Limerick is not recommended. However, it might be useful in a more limited way. Given promising preliminary results in the Midwest of using this technique to control tapegrass (*Vallisneria americana*), rotovation could be useful in shallow areas of Lake Limerick where tapegrass may become a large problem.

Mechanical Harvesting

Principle Mechanical harvesting is considered a short-term technique to temporarily remove plants interfering with recreational or aesthetic enjoyment of a water body. Harvesting involves cutting plants below the water surface, with or without collection of cut fragments for offshore disposal. To achieve maximum removal of plant material, harvesting is usually performed during summer when submersed and floating-leafed plants have grown to the water's surface.

Conventional single-stage harvesters combine cutting, collecting, storing and transporting cut vegetation into one piece of machinery. Cutting machines are also available which perform only the cutting function. Maximum cutting depths for harvesters and cutting machines range from 5 to 8.2 ft with a swath width of 6.5 to 12.1 ft. Cooke et al. (1993) summarizes aquatic plant cutters and harvesters available in North America.

Control Effectiveness and Duration Since harvesting involves physical removal and disposal of vegetation from the water, the immediate effectiveness in creating open water areas is quite apparent. The duration of control is variable. Factors such as frequency and timing of harvest, water depth, and depth of cut are suspected to influence duration of control. Harvesting has **not** proven to be an effective means of sustaining long-term reductions in growth of milfoil. Regrowth of milfoil to pre-harvest levels typically occurs within 30 to 60 days (Perkins and Sytsma, 1987), depending on water depth and the depth of cut. Aquatic plant researchers Johnson and Bagwell (1978) and Schiller (1983) also suggest probable short-term benefits provided by mechanical harvesting of Brazilian elodea beds, but caution against possible spread of infestation through fragmentation.

Advantages Harvesting is most appropriately used for large, open areas with few surface obstructions. There is usually little interference with use of water body during harvesting operations. Harvesting also has the added benefit that removal of in-lake plant biomass also eliminates a possible source of nutrients often released during fall dieback and decay. This is of important consequence in those water bodies with extensive plant beds and low nutrient inputs from outside sources. Furthermore, harvesting can reduce sediment accumulation by removing organic matter that normally decays and adds to the bottom sediments. Depending on species content, harvested vegetation can be easily composted and used as a soil amendment. Mechanical harvesting costs can be relatively low compared to other physical/ mechanical techniques.

Drawbacks Since harvesting removes only the upper stem material, regrowth from roots does occur, requiring annual retreatment. Cut plant material requires collection and removal from the water. Harvesting creates plant fragments. While pondweeds do not reproduce by fragmentation, Brazilian elodea can rapidly disperse by stem breakage. Thus, if plant control program objectives involve reduction of Brazilian elodea spread in the system, harvesting would **not** be an appropriate technique. Harvesting can be detrimental to non-target plants and animals (e.g., fish, invertebrates), which are removed indiscriminately by the process. Harvesting can lead to enhancement of growth of opportunistic plant species that invade treated areas. Capital costs for machine purchase are high and equipment requires considerable maintenance.

Costs Harvesting program costs depend on factors such as program scale, composition and density of vegetation, equipment used, skill of personnel, and site-specific constraints. Detailed costs are not uniformly reported, so comparing project costs of one program with another can be difficult. However, average costs of local harvesting operations range from $200/acre to $700/acre. Most suitable as a maintenance operation, costs for harvesting would carry over year after year.

Permits Mechanical cutting (including battery-operated equipment) does require hydraulic approval from the Department of Fish and Wildlife. Also check with your local government to determine if local regulations apply to mechanical cutting operations.

Applicability to Lake Limerick Harvesting does result in production of plant stem fragments. Since Brazilian elodea (*Egeria densa*) reproduces primarily by stem fragmentation, use of this mechanical option as a main control element of this species in Lake Limerick is not recommended. Additionally, harvesting is incompatible with a major managment objective of aggressive removal of Brazilian elodea populations from Lake Limerick. However, harvesting could be used as part of an integrated control program against *Egeria* involving use of other large-scale treatments. For instance, harvesting could be employed to remove dead plant material from the water column after sufficient exposure time following systemic herbicide application (fluridone).

Chemical Control Methods

Historically, use of aquatic herbicides was the principal method of controlling nuisance aquatic weeds in Washington. However, in recent years there has been a move away from such a dominant practice and toward more selective herbicide use following thorough review of target effectiveness, as well as other environmental, economic, political and social implications (WDOE, 1992).

The State of Washington currently permits use of only four aquatic herbicides to control aquatic weeds. They are the systemic herbicides *fluridone* and *glyphosate*, the contact herbicide *endothall*, and certain copper compounds. *Systemic herbicides* are absorbed by and translocated throughout the plant, capable of killing the entire plant roots and shoots. In contrast, *contact herbicides* kill the plant surface with which it comes in contact, leaving roots alive and capable of regrowth. The systemic herbicides, Fluridone and glyphosate, have the best potential for use in Lake Limerick, especially against *Egeria densa*. Systemic and contact herbicides are reviewed in more detail below.

Fluridone

Principle Fluridone, 1-methyl-3-phenyl-5-[3-trifluoromethyl)phenyl]-4(1H)-pyridinone, is a slow-acting, systemic type herbicide. Fluridone is available as the EPA-registered herbicide SONAR® (SePRO) for use in the management of aquatic plants in freshwater ponds, lakes, reservoirs, and irrigation canals. It is formulated as a liquid (SONAR 4AS) sprayed above or below surface, and in controlled release pellets (SONAR 5P, SONAR SRP) spread on the water surface. Fluridone is effectively absorbed and translocated by both plant roots and shoots (Westerdahl and Getsinger, 1988)

Control Effectiveness And Duration Fluridone demonstrates good control of submersed and emergent aquatic plants, especially where there is little water movement. Its use is most applicable for lake-wide or isolated bay treatments to control a variety of exotic and native species. Eurasian watermilfoil is particularly susceptible to the effects of fluridone. Fluridone demonstrates "good" control of *Egeria densa, elodea canadensis*, and some *Potamogeton* spp (Westerdahl and Getsinger, 1988). Typical fluridone injury symptoms include retarded growth, "whitened" leaves and plant death. Effects of fluridone treatment become noticeable 7-10 days after application, with control of target plants often requiring 60-90 days to become evident (Westerdahl and Getsinger, 1988). Because of the delayed nature of toxicity, the herbicide is best applied during the early growth phase of the target plant, usually spring-early summer.

Advantages As a systemic herbicide, fluridone is capable of killing roots and shoots of aquatic plants, thus producing a more long-lasting effect. A variety of emergent and submersed aquatic plants are susceptible to fluridone treatment. As a result of human health risk studies, it has been determined that use of fluridone according to label instructions does not pose any threat to human health (WDOE, 1992). Fluridone also has a very low order of toxicity to zooplankton, benthic invertebrates, fish, and wildlife.

Drawbacks Fluridone is a very slow-acting herbicide, and its effects can sometimes take up to several months. Because of the long uptake time needed for absorption and herbicidal activity, fluridone is not effective in flowing water situations. Because of the potential for drift out of the treatment zone, fluridone is not suitable for treating a defined area within a large, open lake. The potential exists for release of nutrients to the water column and consumption of dissolved oxygen from the decaying plants. Non-target plants may be affected, as a variety of plants do show degrees of susceptibility to fluridone treatment. Mitigation of lost non-target vegetation may be necessary. As fluridone-treated water may result in injury to irrigated vegetation, there are label recommendations regarding irrigation delays following treatment.

Costs Treatment costs (materials and application) by private contractor for any of the formulations range from about $700 to $1000/acre, depending on scale of treatment.

Permits The use of aquatic herbicides does require receiving a short-term modification to State water quality standards from the Dept. of Ecology prior to treatment.

Applicability to Lake Limerick Of the small number of aquatic herbicide tools permitted for use in Washington State, proper use of fluridone (at optimal rates and exposure) offers the most practical, potentially effective means of controlling large infestations of the tenacious weed. A few limited block applications of this herbicide have been made recently in Lake Limerick with good results against Brazilian elodea (WATER, 1992, 1993). These limited treatments, while not significantly reducing the populations, have most likely kept this invader at least at bay. The potential for success is possible with a more sustained, large-scale, intensive treatment, especially given the success of such a control regimen used against another noxious invader, Eurasian watermilfoil (e.g., Long Lake, Thurston County).

Glyphosate

Principle Glyphosate (N-(phosphonomethyl)glycine) is a non-selective, broad spectrum herbicide used primarily for control of emergent or floating-leafed plants like water lilies and bladderwort. Glyphosate is a systemic herbicide that is applied to the foliage of actively growing plants. The herbicide is rapidly absorbed by foliage and translocated throughout plant tissues, affecting the entire plant, including roots. Glyphosate is formulated as RODEO® (Monsanto) for aquatic application.

Control Effectiveness And Duration Glyphosate is effective against many emergent and floating-leafed plants, such as water lilies (Nuphar and *Nymphaea* spp.) and purple loosestrife (*Lythrum salicaria*). According to the manufacturer, RODEO is **not** effective on submersed plants or those with most of the foliage below water. The herbicide binds tightly to soil particles on contact and thus is unavailable for root uptake by plants. As a result, proper application to emergent foliage is critical for herbicidal action to occur. Symptoms of herbicidal activity may not be apparent for up to 7 days, and include wilting and yellowing of plants, followed by complete browning and death.

Advantages As a systemic herbicide, glyphosate is capable of killing the entire plant, producing long-term control benefits. Glyphosate carries no swimming, fishing, or irrigation label restrictions. Glyphosate dissipates quickly from natural waters, with an average half-life of 2 weeks in an aquatic system. The herbicide has a low toxicity to benthic invertebrates, fish, birds and other mammals.

Drawbacks As a non-selective herbicide, glyphosate treatment can have an affect on non-target plant species susceptible to its effects. While the possibility of drift through aerial application exists, it is expected to be negligible if application is made according to label instructions and permit instructions. There are use restrictions where glyphosate is applied within 1/2 mile of potable intakes in either flowing or standing waters. Current label restrictions on use require that active potable water intakes be shut off for a minimum of 48 hours after application or until the laboratory measured glyphosate level in intake water is below 0.7 ppm.

Costs Treatment costs (materials and application) by private contractor for any of the formulations average approximately $250/acre, depending on scale of treatment.

Permits Use of aquatic herbicides requires receiving a short-term modification to State water quality standards from the Dept. of Ecology prior to treatment.

Applicability to Lake Limerick Since glyphosate is most effective against certain emergent or floating-leaved plants, it's use in Lake Limerick would be for small-scale, aggressive control of problem plants like waterlilies or watershield. In this way, it would be used more for local control, in support of different large-scale treatment element(s).

Endothall

Principle Endothall is a contact-type herbicide that is not readily translocated in plant tissues. Endothall formulations (active ingredient endothall acid, 7-oxabicyclo[2,2,1]heptane-2,3-dicarboxylic acid) are currently registered for aquatic use in Washington in either inorganic or amine salts. Aqueous or granular forms of the dipotassium salt of endothall, Aquathol (Elf Atochem), is permitted in State waters with stringent use restrictions on water contact, irrigation and domestic purposes over and above label restrictions. Due to its toxicity, the liquid amine form Hydrothol-191 is not permitted for use in fish-bearing waters.[1]

Control Effectiveness And Duration As a contact herbicide, endothall kills only plant tissues it contacts, usually the upper stem portions. Thus, the entire plant is not killed. It is therefore used primarily for short-term control of aquatic plants. Duration of control is a function of contact efficiency and regrowth from unaffected root masses. Effective reductions in plant biomass can range from a few weeks to several months. In some circumstances, season-long control can be achieved. Carryover effectiveness of endothall treatments into the following growth season is not typical.

Advantages Contact herbicides like endothall generally act faster than translocating herbicides such as fluridone; evidence of tissue death is often apparent in 1-2 weeks. There is usually little or no drift impact from proper application of this product. Overall costs of treatment are less than fluridone applications over the same area.

Drawbacks Because the entire plant is not killed, endothall causes temporary reductions in aquatic plant growth. As a variety of aquatic plants are susceptible to endothall, non-target plant impacts are possible. Although the recently amended label for Aquathol K has no swimming restriction (pending State approvals), Washington State requires an 8 day swimming restriction following treatment. There are also label restrictions on fish consumption and non-food crop irrigation.

Costs As with fluridone applications, endothall treatments vary with total area and dosage rate. Average costs for a small to moderate area application can run about $500-700/acre.

Permits Use of aquatic herbicides requires receiving a short-term modification to State water quality standards from the Dept. of Ecology prior to treatment.

Applicability to Lake Limerick Since endothall kills only plant tissues it contacts, usually the upper stem portions, its use is most appropriate for short-term control of aquatic plants. Thus, endothall treatment is incompatible with a major managment objective of aggressive removal of Brazilian elodea (*E. densa*) populations from Lake Limerick. However, it could be used as a first-strike method in an integrated control program against *Egeria* that relies on other intensive large-scale treatments for long-term control.

Biological Control Methods

Interest in using biocontrol agents for nuisance aquatic plant growth has been stimulated by a desire to find more "natural" means of long-term control as well as reduce use of expensive equipment or chemicals. The possibility of integrating biological controls with traditional physical, mechanical, or chemical methods is an appealing concept. While development and use of effective biocontrol agents for aquatic plant management is still in its childhood, potentially useful candidates have been identified such as plant-eating fish or insects, pathogenic organisms, and competitive plants. Except for exotic species infestation, a realistic objective of biocontrol of aquatic vegetation is not the eradication, but the reduction of target plant species to lower, more acceptable levels (Cooke et. al., 1993). More importantly, control of nuisance plants using biological agents will be a gradual process, although the effects should be long-lasting.

In the State of Washington, the only biological method currently available for aquatic plant control is the introduction of triploid (sterile) grass carp.

Triploid (Sterile) Grass Carp

Principle Grass carp or white amur (*Ctenopharyngodon idella* Val.) are exotic, plant-consuming fish native to large rivers of China and Siberia. Known for their high growth rates and wide range of plant food preference, these fish can control certain nuisance aquatic plants under the right circumstances. In theory, grass carp are most appropriately used for lake-wide, low-intensity control of submersed plants. However, achieving and sustaining a set plant density may be difficult. Stocking rates are dependent on climate, water temperature, type and extent of plant species and other site-specific constraints. Grass carp require a permit from the Washington Department of Fish and Wildlife (WDFW). To avoid problems encountered in other areas of the country, Washington State regulations adopted in 1990 require:

1. Only sterile (triploid) fish can be planted;
2. Outlets and possibly inlets must be screened to prevent fish from getting into other water bodies;
3. Stocking will be defined by Wildlife based on the current planting model. This is to insure that sufficient vegetation is retained for fishery and other habitat needs.

State fisheries personnel with WDFW should be contacted for more information on specific use and stocking of grass carp in State waters.

Control Effectiveness And Duration Effectiveness of grass carp in controlling aquatic weeds depends on feeding preferences and metabolism; rates do appear to be temperature-dependent (WDOE, 1992; Cooke et. al., 1993). Triploid grass carp exhibit distinct food preferences which apparently vary from region to region in the U.S. Recent research reveals that feeding preference and rates can also be dependent on fish age, water chemistry and plant composition (Pauley et. al., 1994). Laboratory and field studies in Washington State have shown that some plant species appear to be highly preferred, such as the thin-leaved pondweeds (*Potamogeton crispus*, *P. pectinatus* and *P. zosteriformis*); others were variably preferred as coontail (*Ceratophyllum demersum*), and some plants not preferred such as waterlily (*Nuphar*) and watershield (*Brasenia schreberi*). Grass carp appear to graze Brazilian elodea (*Egeria densa*) fairly effectively (Miller and Decell, 1984; Pine and Anderson, 1991). However, researchers in

Washington State report in lab tests that *Egeria densa* was highly preferred by large fish, but nearly unpalatable to fingerlings (Pauley et. al., 1994). Preliminary results of grass carp grazing impacts in Silver Lake (Cowlitz County) suggest drastic impacts have occurred within 2 years on Brazilian elodea, Eurasian watermilfoil, as well as other species of pondweed, coontail, bladderwort and watershield (M. Gibbons, unpubl. data, 1994). Grass carp control effectiveness and duration are site-specific. In general, management studies in Washington waters indicate that substantial removal of vegetation by sterile grass carp may not become apparent until 3-5 years after introduction.

Advantages Depending on the problem plant species and other site constraints, proper use of grass carp can achieve long-term reductions in nuisance growth of vegetation, although not immediately. In some cases, introduction of grass carp may result in improved water quality conditions, where water quality deterioration is associated with dense aquatic plant growth (Thomas et. al., 1990). Compared to other long-term aquatic plant control techniques (e.g., bottom tillage, bottom barriers), costs for grass carp implantation are relatively low.

Drawbacks Since sterile grass carp exhibit distinct food preferences, they do not graze all plants equally well, limiting their applicability. The fish may avoid areas of the water body experiencing heavy recreational use, resulting in less plant removal. Plant reductions may not become evident for several years.. Overstocking of grass carp could result in eradication of beneficial plants and have serious impacts on the overall ecology of the water body. Full ecological impacts of grass carp introductions in Northwest waters are still being determined. An escape barrier on the outlet (if present) is required to prevent movement of fish out of the system and avoid impacts on downstream non-target vegetation. Fish loss due to predation, especially by ospreys and otters is possible.

Costs Based on the few large-scale grass carp implantations made in the State of Washington since 1990, costs can range from approximately $50/acre to $2000/acre, at stocking rates ranging from 5 fish/acre to 200 fish/acre and average cost of $10/fish (range $7.50/fish to $15.00/fish).

Permits Washington Department of Fish and Wildlife requires a game fish planting permit prior to grass carp introduction to a water body. A State environmental policy checklist (SEPA) is required, describing the site to be stocked and potential impacts. In addition, if outlet screening is necessary, hydraulic approval is required from the WDFW. Department of Natural Resources National Heritage Program must be contacted for assessment of threatened or endangered plant species. Also necessary is production of a list of property owners with lots adjacent to the targeted waterbody and their consensus to the proposed grass carp planting.

Applicability to Lake Limerick Since Brazilian elodea is the primary problem species in Lake Limerick and appears to be a preferred food item of grass carp (larger fish), the use of grass carp in Lake Limerick does have potential for large-scale application. Current constraints involve need for outlet structure modification and inlet screening to prevent grass carp escape, but allow salmonid migration. Also, the WFWD currently requires completion of a Lake Restoration Feasibility Assessment before planting triploid grass carp into waters with public access. While several diagnostic (limnological and watershed) studies have recently been conducted on the lake (See WATER, 1991b, 1992, 1993), a full blown Feasibility Study has not officially been performed. However, after review of the above-mentioned documents, WDFW has indicated that this requirement has been met for use of sterile grass carp Lake Limerick.

Physical Control Methods

Hand-Digging

Principle Hand-digging and removal of rooted, submersed plants is an intensive treatment option. This method involves digging out the entire plant (stem and roots) with a spade or long knife and disposing residue on shore. In shallow waters less than 3 feet, no specialized gear is required. In deeper waters, hand removal can best be accomplished by divers using Scuba® or snorkeling equipment and carrying collection bags for disposal of plants. The technique is most appropriately applied to **small areas** (e.g. < 5000 sq ft).

Control Effectiveness And Duration Efficacy of plant removal depends on sediment type, visibility, and thoroughness in removing the entire plant, particularly the roots. A high degree of control over more than one season is possible where complete removal has been achieved.

Advantages The technique results in immediate clearing of the water column of nuisance plants. The technique is very selective in that individual plants are removed. It is most useful in sensitive areas where disruption must be kept to a minimum. Because the technique is highly labor-intensive, it is most suitable for small-area, low plant density treatments. In these cases, the technique is very useful for aggressive control of sparse or small pockets of rooted Eurasian watermilfoil or Brazilian elodea. This method can also be useful for clearing pondweeds or *very small* patches of water lilies from areas around docks and beaches.

Drawbacks The technique is time-consuming and costly, especially where contract divers may be used. Diver visibility may become obscured by turbidity generated by swimming and digging activities. Also, it may be difficult for the laborer to see and dig out all plant roots. Environmental impacts are limited to mostly short-term and localized turbidity increases in the overlying water and some bottom disruption.

Costs Costs will vary depending on whether contract divers or laborers are used, or if removal activities are the result of volunteer efforts. In the case of contract divers and dive tenders, expenses can run upward of $500 to $2400/day with area covered dependent on density of plants.

Permits No permits are currently required for hand-digging aquatic plants. However, be sure to check with your local jurisdiction before beginning any activities.

Applicability to Lake Limerick Hand digging of plant stems and roots could be used for small-scale, intensive removal of nuisance rooted plants (pondweeds, Brazilian elodea) around private dock areas and short shoreline segments. If root systems are completely removed, this technique provides a more long-term means of control (as compared to hand-cutting described below).

Hand-Cutting

Principle This technique is also a manual method, but differs from hand-digging in that plants are cut below the water surface (roots generally not removed). Because roots are not removed, this is a less intensive removal technique. Implements used include scythes, rakes, or other specialized devices that can be pulled through the weed beds by boat or several people. Mechanized weed cutters are also available that can be operated from the surface for small-scale control.

Control Effectiveness and Duration Root systems and lower stems are often left intact. As a result, effectiveness is usually short-term as regrowth is possible from the uncut root masses. Duration of control is limited to the time it takes the plant to grow to the surface.

Advantages The technique results in immediate removal of nuisance submerged plant growth. Costs are minimal.

Drawbacks Like hand-pulling, the technique is time-consuming. Visibility may become obscured by turbidity generated by cutting activities. Also, since the entire plant is usually not removed, this technique does not result in long-term reductions in growth. Duration of control of rooted plants like Brazilian elodea would be minimal. Environmental impacts are limited to mostly short-term and localized turbidity increases in the overlying water and some bottom disruption. Cut plants must be removed from the water.

Costs Where volunteer efforts are employed, costs are mostly limited to purchase of a cutting implement. This can vary from under $100 for the Aqua Weed Cutter (Sunrise Corp.) to over $1000 for the mechanized Swordfish (Redwing Products).

Permits No permits are required for hand-cutting or raking of aquatic plants. Mechanical cutting (including battery-operated equipment) does require hydraulic approval by Department of Fisheries and Wildlife. Be sure to check with your local jurisdiction before beginning any activities.

Applicability to Lake Limerick Hand cutting of plant stems would be most appropriate for small-scale, short-term control of nuisance rooted plants around private dock areas and short shoreline segments.

Bottom Barrier Application (Sediment Covers)

Principle Barrier material is applied over the lake bottom to prevent plants from growing, leaving the water clear of rooted plants. Bottom covering materials such as sand-gravel, polyethylene, polypropylene, synthetic rubber, burlap, fiberglass screens, woven polyester, and nylon film have all been used with varying degrees of success. Applications can be made up to any depth, with divers often utilized for deeper water treatments. Usually bottom conditions (presence of rocks or debris) do not impede most barrier applications, although pre-treatment clearing of the site is often useful.

Control Effectiveness and Duration Bottom barriers can provide immediate removal of nuisance plant conditions upon placement. Duration of control is dependent on a variety of factors, including type of material used, application techniques, and sediment composition. Elimination of nuisance plant conditions for at least the season of application has been demonstrated by synthetic materials like Aquascreen and Texel. Where short-term control is desired for the least expense, burlap has been found to provide up to 2-3 years of relief from problematic growth before eventually decomposing (Truelson, 1985; 1989). After satisfactory control has been achieved (usually several months), some barrier materials can be relocated to other areas to increase benefits.

Advantages Bottom barriers can usually be easily applied to small, confined areas such as around docks, moorages or beaches. They are hidden from view and do not interfere with shoreline use. Bottom barriers do not result in significant production of plant fragments (critical for milfoil treatment). Bottom barriers are most appropriately used for localized, small-scale control where exclusion of all plants is desirable; where other control technologies cannot be used; and where intensive control is required regardless of cost.

Drawbacks Depending on the material, major drawbacks to the application of benthic barriers include some or all of the following: high materials cost, labor-intensive installation, limited material durability, possible suspension due to water movements or gas accumulation beneath covers, or regrowth of plants from above or below the material. Periodic maintenance of bottom barrier materials is required to remove accumulations of silt and any rooting fragments. In some situations, removal and relocation of barriers may not be possible (e.g., natural fiber burlap does decompose over time). Sediment covers can also produce localized depression in populations of bottom-dwelling organisms like aquatic insects.

Costs Costs vary from approximately $0.30/sq. ft (Texel) to $0.35/sq. ft (Aquascreen) for materials with an additional $0.25-0.50/sq. ft for installation. Locally, prices for rolled burlap material (available in fabric stores, outlets) average from $0.15 to $0.25/sq. ft for materials only.

Permits Bottom barrier applications require hydraulic approval from Washington Department of Fish and Wildlife (no charge). In addition, barriers costing more than $2500 may need a shoreline permit, so local Shoreline Master Plan should be checked for compliance; contact your local Planning Department for information.

Applicability to Lake Limerick Because most of the better screening materials are somewhat costly and proper applications can be labor-intensive, they are better suited for spot treatments. Thus, potential use in Lake Limerick would be limited to small areas where no rooted weed growth can be tolerated, such as swim beaches or around docks.

TABLE H-1.
SUMMARY OF AQUATIC PLANT MANAGEMENT TECHNIQUES AVAILABLE IN WASHINGTON STATE
(Adapted from Gibbons et. al., 1994)

Method	Appropriate Scale (area or extent)	Duration of Control	Intensity of Control	Cost	Advantages	Disadvantages	Permit(s) Required?
Physical							
Hand-pulling	Small-scale	Season or longer	Moderate to High (with complete removal)	$0 with volunteer labor $500 to $2400/day for contract divers	• Site specific • Species specific • Minimum impact on native plants • Use near obstructions	• Slow, labor intensive, expensive • short-term turbidity increase • Diver visibility can restrict effectiveness	Maybe
Hand-cutting	Small-scale	< One season	Moderate	$100 to $1000 for equipment + labor	• Immediate plant removal	• Slow • Fragments generated • Short-term increase in turbidity	Yes
Bottom Barriers	Small-scale	2 to 3 years	High	$0.15 to $0.75/sq. ft. for material $0.25 to $0.50/sq. ft. for installation	• Immediate plant removal • Materials reusable • Site specific • Useful around obstructions	• Not species specific • Benthic organism impacts • Material costs • Maintenance required	Yes
Drawdown	Large-scale	None	Low	Variable	• Useful for repair/ maintenance of shorelines and structures • May enhance growth of emergents (waterfowl habitat)	• Not species specific • May impact wetlands • Loss of recreation • Dissolved oxygen decrease • Benthic invertebrate impacts	Yes
Watershed Controls	Small-scale	None - long-term	Low	Low-mod	• Long-term improvement in water quality • May encourage rooted and discourage non-rooted species	• Does not address nutrient sources used by most aquatic plants • May encourage rooted/discourage non-rooted species • Sometimes difficult to implement	No

SUMMARY OF AQUATIC PLANT MANAGEMENT TECHNIQUES AVAILABLE IN WASHINGTON STATE (Continued)

Method	Appropriate Scale (area or extent)	Duration of Control	Intensity of Control	Cost	Advantages	Disadvantages	Permit(s) Required?
Water column dye	Weeks to months	Weeks to months	Low	$12.50/acre-ft.	• Non-toxic • No special equipment needed • Colors water blue	• Shallow, closed systems only • Repeat treatments through growing season required • Not effective when plants near surface • No use in potable, flowing, or chlorinated water • Some classified as herbicides	Yes/No (Those classified as herbicides require a permit)
Mechanical							
Harvesting	Large-scale	Less than one season	Low-Mod	$600/acre (May vary with transport costs)	• Immediate plant removal to cutting depth (4 to 8 ft.) • Minimal bottom disturbance • Materials may be composted • Reduces internal loading of nutrients	• Plant disposal • Fragments produced • Fish and invertebrate impacts • Slow • High initial capital $ • Operating depth limited • Operations depend on weather • Not species specific	Yes
Rotovation/ Cultivation	Large-scale	2 to 3 years	Mod-High	$1000 to $1700/acre (depends on plant density and area of treatment)	• Winter treatment minimizes summer season recreation impacts • May increase species diversity	• Bottom disturbance /increased turbidity • Long-term efficacy only on perennials • Bottom obstructions limit use • Not species specific	Yes
Hydraulic dredge	Large-scale	Potentially long	High	variable, average $2-$7/m3	• Removal of entire plant, including roots • Additional benefits of deepening lake, removal or enriched or toxic sediments	• Very costly • Temporary bottom disturbance and increased turbidity in water column • Not species specific, where mixed comm	Yes

SUMMARY OF AQUATIC PLANT MANAGEMENT TECHNIQUES AVAILABLE IN WASHINGTON (Continued)

Method	Appropriate Scale (area or extent)	Duration of Control	Intensity of Control	Cost	Advantages	Disadvantages	Permit (s) Required?
Diver-operated dredge	Small-scale	Potentially long (Depends on availability of propagules for recolonization)	Mod-High	$1100-2000/day (coverage depends on plant density)	• Site specific • Species specific • No depth constraints • Used near obstacles	• Labor intensive • Slow • Potential fragment production • Temporary bottom disturbance and increased turbidity	Yes
Biological							
Grass carp	Large-scale	Potentially long	Low-High	$50 to $200/acre (depending on stocking density)	• Low maintenance • Large area covered • Triploid fish are sterile	• Stocking densities not well established • Difficult to fine-tune control • Preference for native species over exotics • Containment structures required • Ecological impacts not fully known • Not site specific • Recapture problems • Susceptible to predation by wildlife or humans	Yes
Chemical							
Fluridone	Large-scale	> 1 year (depends on availability of propagules for recolonization)	High	$700 to $1000/acre	• Systemic herbicide • Some species specificity with correct application rates • Non-toxic	• Requires long contact time • Off-site movement possible • Nutrient release and dissolved oxygen	Yes
Glyphosate	Large-scale	> 1 year (depends on availability of propagules for recolonization)	High	$250/acre	• Systemic herbicide • Non-toxic • No label restrictions on swimming and fishing	• Non-selective herbicide • Emergent plants only	Yes
Endothall	Large-scale	Weeks to months	Moderate	$500 to $700/acre	• Short contact time required • Low toxicity • Low cost • Fast dissipation	• Contact herbicide • Temporary effect • Some label restrictions for swimming and domestic water use	Yes

Lake Limerick Aquatic Plant Control Intensity Zones
Step I

Extent of Aquatic Plant Problem in Lake Limerick

Two critical components of the integrated management approach involve assessing the **extent** of the problem and **intensity** of corrective action needed. Two types of weed species have been identified as targets for control in Lake Limerick: **Brazilian elodea and non-rooted, submersed forms, particularly bladderwort.** Brazilian elodea (*Egeria densa*) is classified by the State of Washington as a Class B Noxious Weed. For infestations of Brazilian elodea, any level of occupancy necessitates control action, given the considerable nuisance potential of the plant if growth is left unchecked. Furthermore, this is entirely consistent with Washington State objectives concerning noxious weed species, which gives high treatment priority to prevention, control and eradication of these invaders from state waters (WDOE, 1992). In order to achieve this end in a specific waterbody, more intensive, aggressive measures may be justified with the necessary precautions. Other major nuisance plants in Lake Limerick are species of bladderwort (*Utricularia)*, which are also not native to the Pacific Northwest region. Submersed, marginally-rooted plants like common elodea, (*Elodea canadensis*), also occur in localized dense beds around the lake littoral. Because of human safety and navigational problems associated with dense growth of these weeds around the shoreline, aggressive control measures are also appropriate for use against these macrophytes.

A critical part of IAPMP development is determining important plant zones in Lake Limerick and what degree of control should be applied to each of those zones. To reiterate, the ***goal of aquatic plant management is not to remove all vegetation from a waterbody, but to selectively eliminate harmful or noxious plant populations while adequately preserving native stands.*** As a result, macrophyte control decisions can range from leaving select high quality plant beds intact (*no control action)* to implementing aggressive removal measures against noxious or nuisance plant stands (*high level of control*), being careful to minimize impacts to beneficial native species. Development of a ***Control Intensity Map*** provides a useful aid for choosing appropriate treatment options for each area of the lake (See Step J).

Highest Intensity Control

Figure I-1 is a Control Intensity Map for Lake Limerick that clearly shows three different macrophyte control intensity zones. The highest priority zone is that area between the 1 and 4 m depth contours inhabited by the noxious, exotic weed Brazilian elodea. This "noxious weed" zone covers all of the lake littoral, including a small band between survey transects 11 and 3 (see Figure G-1) where Brazilian elodea colonization had not been recorded as of the July, 1995 survey date. Currently, Brazilian elodea beds in

Lake Limerick occur in moderate densities, but the growth habit is such that much of the plant biomass is concentrated in the upper water column. This situation creates a real physical obstacle to movement through the lake by means of rowing or motoring. The presence of this noxious weed in the lake justifies use of ***high intensity control*** efforts to remove plant populations.

Moderate to High Intensity

Stands of other submersed nuisance species, such as bladderwort and common elodea, also occupy the zone between shoreline and the 4 m depth, in many areas overlapping the Brazilian elodea zone. These species occur in mixed beds that, depending on location in the lake, necessitate moderate to high intensity control efforts. High levels of control involving maximal removal of plants can be applied to those areas where, for safety or navigation reasons, **minimal or no** surfacing plants can be tolerated. Potential areas would include shoreline adjacent to the state boat launch, popular swimming beaches, and dock areas. Other areas of the lake may be subjected to a lesser control effort, such as selective spot treatment in embayments (e.g., Cranberry Creek-Leprechaun Outlet and Beaver Creek bays).

No Control

Aquatic plant management recognizes the importance of maintaining a healthy, diverse plant community for human and wildlife utilization. As a result, beneficial native plant stands or special habitat areas in a lake are not targeted for any direct action, but are left untouched. In Lake Limerick, one area has been identified as a **no control zone**. This zone is the open water mid section of the lake, greater than 4.5 m (14.75 ft) in depth. The zone is primarily inhabited by sparse stands of pondweed (*Potamogeton* sp.) and macroalgae (*Nitella* spp.), the latter providing a source of competition to planktonic algae in the lake. Plant growth in this deeper region of the lake is not currently and is not expected to be problematic with implementation of a prudent macrophyte management plan.

Prudent application of the various control intensity strategies within Lake Limerick should ultimately result in selective removal of nuisance plant populations, while retaining diverse and abundant native plant stands throughout the lake.

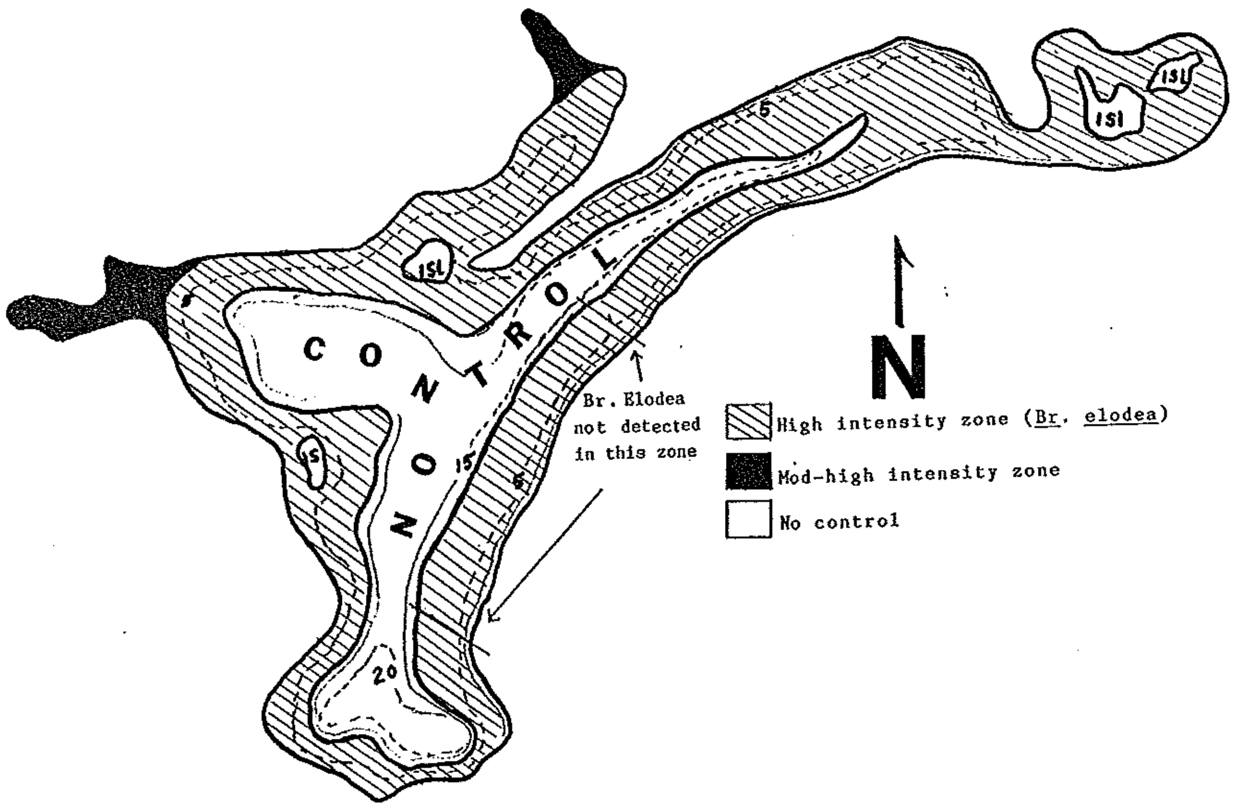

Figure I-1. Aquatic Plant Control Intensity Map for Lake Limerick. Depth Contours Shown in Meters.

Alternative Integrated Treatment Scenarios For Lake Limerick Step J

This section presents alternative in-lake treatment scenarios for management of nuisance aquatic plant populations in Lake Limerick At this point, it may be helpful to explain the various types of management strategies available as action alternatives, particularly with regard to Lake Limerick. Aquatic plant management strategies span the control spectrum, ranging from **aggressive removal (high intensity control)** of noxious plant populations from the waterbody (e.g., Brazilian elodea) to less intensive **maintenance (cosmetic)** techniques that aim to achieve short-term decreases in nuisance macrophyte growth. Bounded by these two endpoints, management strategies vary in intensity of treatment depending on types of problem plant(s), extent of infestation and program goals.

Management Strategies Span the Spectrum

A Balancing Act

It is important to note that benefits of any management program cannot be gained without some short-term adverse impacts. There is no ideal management alternative that is at the same time 100% effective against target species, absolutely environmentally safe, and cost-effective. The decision-making process regarding design of a specific aquatic plant management program necessitates weighing all factors and achieving a balance between acceptable environmental disruption and cost-effective treatment and a consensus among all affected parties on course of action.

Realistic Expectations Regarding Brazilian Elodea Removal

Effective treatment of Brazilian elodea populations, the main target, in Lake Limerick will require aggressive, lakewide action, using intensive techniques that kill or remove the entire Brazilian elodea plant, including roots and upper stems. In contrast, if less intensive control strategies were implemented or no action was taken at all, the lake would continue to support Brazilian elodea populations and remain a source of fragments that could be transported to other area lakes. To be sure, elimination of Brazilian elodea from a waterbody is an uncertain process, and is very dependent on age and extent of infestation and management "tools" available and permitted for use. Certainly, the chances for successful removal of this weed from a lake are greater and costs are less when the infestation is in a beginning, pioneering stage than when the plant becomes fairly established throughout a waterbody as it has in Lake Limerick. Given the present extent of Brazilian elodea growth throughout Lake Limerick, complete removal of this plant may be a difficult task to achieve at best and will require a continuous, intensive, long-term effort to approach this goal.

Other Management Issues

While the need to use intensive control techniques in Lake Limerick is clear, **choice** of methods and operational **logistics** are necessarily tied to Brazilian elodea beds and growth habit/patterns of other nuisance plants such as bladderwort, common elodea, and watershield in Lake Limerick. The band of Brazilian elodea growth in Lake Limerick at this time occurs primarily at depths of between 1 m to 4 m (3 to 14 ft). The fact that rooted Brazilian elodea occurs intermingled with other plants like rootless, non-native bladderwort, also targeted for control, could complicate choice of control strategy somewhat. Additionally, in-lake dilution and flow effects could become important issues due to the presence of several perennial tributaries that discharge into the lake, as well as continuous outflow through a regulated dam/fish ladder structure. Also, it will be important to maximize protection of wetland fringe plants at the eastern end of the lake. Management efforts must also provide for maintenance of the existing trout and migrant salmon fisheries in the lake. Thus, a combination of control alternatives will be necessary, differentially targeting Brazilian elodea and other problem plant areas both in time and space, perhaps resulting in some overlap of areas covered.

Options Narrowed

As described earlier, truly effective Brazilian elodea control alternatives must either kill the roots/shoots or physically remove the entire plant from the sediment. This requirement tends to narrow down prospective treatment options for Lake Limerick with Brazilian elodea as the prime target. Intensive control methods that can be effectively used against Brazilian elodea and other rooted problem plants in Washington State include **hydraulic dredging, application of systemic aquatic herbicides, or implantation of sterile grass carp all for large-scale application, and hand removal, diver dredging, and bottom barrier application for smaller areas.** However, because of the large bottom area currently occupied by Brazilian elodea, hydraulic dredging of sediments in Lake Limerick would be extremely costly and is not considered a feasible large-scale option at this time. Rootless or marginally rooted forms like bladderwort and common elodea, respectively, can be most effectively removed by mechanical means and certain herbicides. Of note is that none of the proposed options is without some potential damage to non-target aquatic organisms and plants. However, timely and careful use of such intensive control tactics should minimize impacts to non-target organisms in the long-term.

Proposed Treatment Scenarios for Lake Limerick

In Lake Limerick, an **integrated** aquatic plant management program using a **combination of in-lake chemical/physical, chemical/biological or biological/physical techniques** listed above will be more effective in meeting a management goal of aggressive removal of Brazilian elodea and nuisance areas of bladderwort/elodea/watershield. In other words, a long-term, integrated program extending over ***at least 5 years*** is highly recommended that incorporates a major chemical and/or biological treatment coupled with bottom barrier application and hand removal, a public education/exotic weed prevention program, a monitoring/evaluation component, as well as implementation of watershed best management practices.

In view of this multi-faceted objective, the following Brazilian elodea (prime target)/other (secondary) submersed problem plant treatment options for Lake Limerick are presented in descending order of intensity of treatment and effectiveness against target plants. Of note is that the most intensive actions may possibly have the greatest initial impacts on the ecosystem and require the greatest initial expense. Thus, the order in which the scenarios are presented does not represent a preferred ranking. All of the treatment scenarios are set up in terms of an integrated aquatic plant management program with review each year, utilizing a main, large-scale treatment option, supported by other smaller scale options (to cover nooks and crannies missed by large-scale treatment). Thus, the long-term, integrated Brazilian elodea management program is composed of a reactive treatment component, consisting of a combination of large-scale and small-scale methods, a proactive public awareness/preventative component, a program monitoring/ evaluation element, and implementation of watershed best management practices (e.g. septic system checks). For Lake Limerick, none of the recommended options is expected to have any detrimental impacts on human health, if treatments are performed properly. Table J-1 summarizes Proposed Management Options, including Integrated Treatment Scenario components and projected costs for a minimum 5-year program.

Treatment Scenario #1

In-lake Treatments

Whole-lake aquatic plant survey and biomass sampling
(Year 1) Major treatment using SONAR, one annual application along entire lake littoral
(Year 2)Major treatment using SONAR, one repeat application of lesser scale along lake littoral
(Year 5) Major treatment using SONAR, one annual application along entire lake littoral
(Year 2+)Minor treatments using aquatic algaecide, if needed
(Year 3+)Minor treatments using hand removal and bottom barrier

Other Program Elements

Environmental permits and assessment, if necessary
Use restrictions and/or modifications
Public Awareness-Noxious Weed Prevention Program

- Public meetings/posted signs on lake/ newsletters/media coverage
- Citizen watch for exotic weeds in lake
- Boat/Trailer Inspections-voluntary

Program Monitoring and Effectiveness Evaluation
Watershed Management Program
Implementation and funding plan

The major treatment component of this scenario consists of an intensive, chemical treatment using ***systemic herbicide, SONAR,*** that is actively absorbed by plant roots and shoots. In **year 1**, an initial survey of the lake littoral is conducted sometime in late spring (e.g., May-June) to map Brazilian elodea distribution, determine extent of coverage and biomass in lake. Upon completion of the survey, control elements can be initiated, ideally early in the Brazilian elodea growth season (June to mid-July). In this scenario a large-scale application of SONAR (fluridone) is made along the entire shoreline of Lake Limerick during the late-spring/early summer season following the survey to confirm extent of Brazilian elodea growth. Application would be made at the recommended label rates targeting lake area between 1 and 4 meter water depth (where *Egeria* growth was concentrated as of July 1995).

Year 2+: As in year 1, a pre-treatment aquatic plant survey/biomass sampling of the lake littoral is recommended. Depending on the effectiveness of Brazilian elodea removal in Lake Limerick following the first year SONAR treatment, another SONAR application may be necessary in the following year to hit regrowth. Large-scale applications of SONAR possibly covering up to 80 acres may be needed in year 2. Because at least two initial herbicide treatments are anticipated (assuming they are permitted), mitigation efforts (to revegetate any damaged downstream or shoreline areas) are delayed to year three to allow time for full effects to become obvious. Later in the season of year two, when evidence of kill effectiveness is more apparent (2-3 months later), cleanup treatment of unaffected Brazilian elodea plants by hand removal or bottom screening application may be necessary. In succeeding years, hand removal of small Brazilian elodea patches is recommended, as well as maintenance and reapplication of bottom barriers, if needed. Annual spot treatments with an aquatic algaecide may be necessary to control algal blooms. The prevention program (boat checks, public education) should be continued every year. Annual monitoring and evaluation of treatment effectiveness is highly recommended in order to make appropriate adjustments in succeeding year's management program. Watershed best management practices are also encouraged.

First Year Costs: Annual aquatic plant survey costs are estimated to be $3000. At an average cost for materials and application by private contractor of roughly $1000/acre, first year costs for an application of SONAR (80 acres) could be upwards of $80,000. It is anticipated that the prevention component would be mainly a volunteer effort, with negligible expenses. Permit/Environmental Assessment fees could cost up to $5000. Monitoring costs for a consulting limnologist/engineer to monitor carry-over effectiveness in the lake are estimated to be $3,000. Thus, **first year** program costs could be as much as **$103,000.**

Costs for Year 2+: The bulk of program costs for scenario 1 will most likely occur in year 1, although large costs may be incurred in years 2 and 5. This is because of a possible need for additional large-scale SONAR retreatment in both of these years, all depending on efficacy of the first year herbicide treatment. As in year 1, permit fees could cost upwards of $5000 in years 2 and 5.

Total annual costs for an herbicide-based program for Brazilian elodea control in Lake Limerick using SONAR and supported by physical removal methods should successively decline after the second year, approaching costs of $25000 or less in years 3 and 4. Mitigation efforts are delayed to the third year to allow time to estimate revegetation needs resulting from any herbicide damage to downstream native plants. Based on results of similar herbicide programs in Washington State, emergent plant revegetation cost should be minimal; for example, if 300 m^2 of shoreline area were affected, revegetation estimates would be about $5,000 relying largely on volunteer labor.

Ecological/human impacts: Detrimental impacts of SONAR on other vulnerable non-target in-lake plants are possible, but can be minimized by adjusting timing and rate of application to target Brazilian elodea at their most susceptible point. Because of potential for drift, SONAR may not stay within the treatment zone. The possibility does exist for some downstream effects of SONAR at the outlet end of the lake, but because of dilution effects, these impacts should be minimal. Also, delaying the SONAR treatment to late spring-early summer, when precipitation and outflow are usually on the decline, should further minimize out-of-system, downstream movement of the herbicide. Considering this potential for non-target plant effects, a plan for mitigation of shoreline and downstream plants may be necessary.

Fluridone has a very low order of toxicity to fish and wildlife, and at the extremely low concentrations expected to be used in Lake Limerick, should have negligible effect on trout and other warmwater fish in Lake Limerick, and any salmonids present downstream.

There are no expected risks to human health if Lake Limerick is treated with SONAR. A chemical review of SONAR literature was recently completed by Thurston County Public Health and Social Services Department with regard to usage in Long Lake, which found no significant long-term human health risks associated with the proper use of this herbicide (Thurston County Public Health and Social Services Department Memo, SONAR Review, March 27, 1990).

Water quality impacts of SONAR applications should be minimal. Toxicity effects of fluridone on vegetation are slow, taking up to 1-3 months to become visually evident. The process of plant death is slow, so potential nutrient releases and possible algal bloom should be correspondingly slowed too. If non-target plants are not substantially damaged by the SONAR treatment, unimpacted plants could continue to take up the extra nutrients, providing a mechanism for natural mitigation and perhaps staving off an artificially-induced algal bloom.

There may be some recreational impacts, affecting mostly swimming, which is discouraged during and immediately after treatment, although there is no label restriction for swimming (See

SONAR label, Appendix D). There are irrigation restrictions with SONAR use.

Permits/Special Requirements

Use of aquatic herbicides does require submitting an Aquatic Plant Management Permit Application for short-term modification to state water quality standards to Washington State Department of Ecology before initiation of treatment.

Hydraulic permit required for bottom screening in lake, obtainable (free of charge) from Washington State Department of Fish and Wildlife (WDFW).

Bottom barrier application and herbicide treatment may be subject to Shoreline Management Act and may need Shoreline permit for installation, dependent on scale and total cost of in-lake treatment.

Ideally, time required for state agencies to process a permit application is at least 45 days, but could be much longer if the permit application is not properly completed. If multiple permits from several local, county or state jurisdictions are required, the overall processing time period could be extended as well.

Treatment Scenario #2

In-lake Treatments

Whole-lake aquatic plant survey and biomass sampling
(Year 1)Major application of systemic herbicide SONAR
(Year 2)Major treatment involving planting of sterile grass carp
Outlet/inlet containment structure design and construction
(Year 2+)Minor treatments using aquatic algaecide, if needed
Minor treatments using hand removal and bottom barrier

Other Program Elements

Environmental permits and assessment, if necessary
Use restrictions and/or modifications
Mitigation of damaged native plants, if needed
Public Awareness-Noxious Weed Prevention Program.

- Public meetings/posted signs on lake/ newsletters/media coverage
- Citizen watch for exotic weeds in lake
- Boat/Trailer Inspections-voluntary

Program Monitoring and Effectiveness Evaluation
Water quality monitoring (N,P sampling)
Watershed Management Program
Implementation and funding plan

This scenario involves a combination of chemical/biological techniques as a major inlake treatment of nuisance aquatic plants, supported by small-scale physical/mechanical methods. Initially, a large-scale application of the systemic herbicide, SONAR, is made in **year 1** to effect major reductions in target Brazilian elodea beds. The idea of this scenario is to decrease reliance on use of large-scale chemical applications in Lake Limerick. This is followed in **year 2** by implantation of sterile grass carp as a potential technique for lake-wide, moderate-intensity control of submersed plants in Lake Limerick, particularly any residual

Brazilian elodea populations. Grass carp can control certain nuisance aquatic plants under the right circumstances, although the fish do demonstrate distinct food preferences. Brazilian elodea appears to be a preferred plant food species, and control (=removal) of this weed by grass carp has been demonstrated elsewhere in the Northwest (e.g., Silver Lake, Cowlitz County). However, control effects may be more slowly achieved with use of this biological agent than with other mechanical or chemical options listed above. Management studies in Washington waters indicate that substantial removal of vegetation by sterile grass carp may not become apparent until 3-5 years after introduction. Stocking rates are dependent on climate, water temperature, type and extent of plant species and other site-specific constraints. Use of this biocontrol method requires cautious evaluation and development of specific stocking rates for Lake Limerick. An environmental assessment specific to Lake Limerick may also be required prior to implementation. Since an escape barrier on the outlet is required to prevent movement of fish out of the system and avoid impacts on downstream non-target vegetation, the scenario requires design and modification of the fish ladder/outlet structure. Because of the presence of important habitat areas elsewhere around the lake, other barrier structures may be necessary at the Cranberry Creek inlet (that drains Cranberry Lake upstream), and at both Beaver Creek and the Islands inlet culvert at the east end as additional precautions. A second restocking of up to 30% of the initial fish quantity may be needed by year 5. The scenario provides a mitigation plan for downstream native vegetation affected by the initial SONAR application, as well as in-lake fish habitat enhancement with artificial structures to compensate for diminished cover (=destroyed Brazilian elodea). The scenario also includes small-scale bottom barrier applications in the lake to suppress nuisance weed growth, if necessary in years 4 and 5. Annual spot treatments with an aquatic algaecide may be necessary to control algal blooms.

Costs: Annual aquatic plant survey costs are estimated to be $3000. At an average cost for materials and application by private contractor of roughly $1000/acre, first year costs for a lakewide application of SONAR (80 acres) could be upwards of $80,000. It is anticipated that the prevention component would be mainly a volunteer effort, with negligible expenses. Monitoring costs for a consulting limnologist/engineer to evaluate carry-over effectiveness in the lake are projected to be $3,000. Overall **first-year program costs** for this scenario are estimated to be upwards **of $103,000, and** include stocking rate design, permitting and any required environmental assessment, as well as prevention and monitoring. The bulk of expenses for this scenario would most likely occur in the second year with design and construction of grass carp inlet/outlet barriers being a big expense item (total project expense ranging from $118,200-120,000). However, successive annual project costs are estimated to be **$20,000 or less for both years 3 and 4,** increasing to about **$35,000 in year 5** to cover fish restocking assessment, required permits, and replanting, if needed. Mitigation efforts are delayed to the third year to allow time to estimate revegetation needs resulting from any herbicide damage to downstream native plants; assuming maximal use of volunteer labor, mitigation costs are projected to be $5,000.

Ecological/human impacts: Detrimental impacts of SONAR on other vulnerable non-target in-lake plants are possible, but can be minimized by adjusting timing and rate of application to target Brazilian elodea at their most susceptible point. Because of potential for drift, SONAR may not stay within the treatment zone. The possibility does exist for some downstream effects of SONAR at the outlet end of the lake, but because of dilution effects, these impacts should be minimal. Also, delaying the SONAR treatment to late spring-early summer, when precipitation and outflow are usually on the decline, should further minimize downstream movement of the herbicide. Considering this potential for non-target plant effects, a plan for mitigation of shoreline and downstream plants may be necessary.

Fluridone has a very low order of toxicity to fish and wildlife, and at the extremely low concentrations expected to be used in Lake Limerick, should have negligible effect on trout and other warmwater fish in Lake Limerick, and any salmonids present downstream. Water quality impacts of SONAR applications should be minimal. Toxicity effects of fluridone on vegetation are slow, taking up to 1-3 months to become visually evident. The process of plant death is slow, so potential nutrient releases and possible algal bloom should be correspondingly slowed too. If non-target plants are not substantially damaged by the SONAR treatment, unimpacted plants could continue to take up the extra nutrients, providing a mechanism for natural mitigation and perhaps staving off an artificially-induced algal bloom.

There may be some recreational impacts, affecting mostly swimming, which is discouraged during and immediately after treatment, although there is no label restriction for swimming (See SONAR label, Appendix D). There are irrigation restrictions with SONAR use. There are no expected risks to human health if Lake Limerick is treated with SONAR.

Since herbivorous grass carp demonstrate distinct food preferences, removal of non-target native aquatic plants is possible. Impacts of grass carp introduction on human health should be negligible to non-existent.

Permits/Special Requirements

Use of aquatic herbicides does require submitting an Aquatic Plant Management Permit Application for short-term modification to state water quality standards to Washington State Department of Ecology before initiation of treatment.

Washington State Department of Fish and Wildlife (WDFW) requires a game fish planting permit prior to grass carp introduction to a water body. In addition, if outlet screening is necessary, hydraulic approval is required from the WDFW.. Washington Department of Natural Resources Natural Heritage Program must be contacted for assessment of threatened or endangered plant species. Bottom barrier application requires hydraulic approval from the WDFW, and may be subject to Shoreline Management Act and may need Shoreline permit for installation, dependent on scale and cost of barrier application.

Ideally, time required for State agencies to process a permit application is at least 45 days, but could be much longer if the permit application is not properly completed. If multiple permits from several local, county or state jurisdictions are required, the overall processing time period could be extended as well

Treatment Scenario #3

In-lake Treatments

Whole-lake aquatic plant survey and biomass sampling
(Year 1)Major application of herbicide Aquathol, one-time treatment, for immediate, short-term reduction of plant biomass
(Year 1)**Major treatment involving planting of sterile grass carp**
Outlet containment structure design and modification
(Year 2+)Minor treatments using aquatic algaecide, if needed
Minor treatments using hand removal and bottom barrier

Other Program Elements

Environmental permits and assessment, if necessary
Use restrictions and/or modifications
Public Awareness-Noxious Weed Prevention Program.

- Public meetings/posted signs on lake/ newsletters/media coverage
- Citizen watch for exotic weeds in lake
- Boat/Trailer Inspections-voluntary

Program Monitoring and Effectiveness Evaluation
Watershed Management Program
Implementation and funding plan

This scenario involves a combination of chemical/biological techniques as a major inlake treatment of nuisance aquatic plants, supported by small-scale physical/mechanical methods. Initially, a large-scale application of the contact herbicide, Aquathol, is made in Year 1 to effect immediate, short-term biomass reductions in target Brazilian elodea beds. This is followed later in **Year 1** by implantation of sterile grass carp for moderate-intensity, follow-up control of submersed plants in Lake Limerick, particularly Brazilian elodea populations remaining after Aquathol treatment. The idea of this scenario is to decrease reliance on use of large-scale chemical applications in Lake Limerick. Grass carp can control certain nuisance aquatic plants under the right circumstances, although the fish do demonstrate distinct food preferences. Brazilian elodea appears to be a preferred plant food species, and control (=removal) of this weed by grass carp has been demonstrated elsewhere in the Northwest (e.g., Silver Lake, Cowlitz County). However, control effects may be more slowly achieved with use of this biological agent than with other mechanical or chemical options listed above. Management studies in Washington waters indicate that substantial removal of vegetation by sterile grass carp may not become apparent until 3-5 years after introduction. Stocking rates are dependent on climate, water temperature, type and extent of plant species and other site-specific constraints. Thus, it will be necessary to develop specific stocking rates for Lake Limerick. An environmental assessment specific to Lake Limerick may also be required prior to implementation. Since an escape barrier on the outlet is required to prevent movement of fish out of the system and avoid impacts on downstream non-target vegetation, the scenario requires design and modification of the fish ladder/outlet structure. Because of the presence of important habitat areas elsewhere around the lake, other barrier structures may be necessary at the Cranberry Creek inlet (that drains Cranberry Lake upstream), and at both Beaver Creek and the Islands inlet culvert at the east end as additional precautions. A second restocking of up to 30% of the initial fish quantity may be needed by year 5. To compensate for physical reduction of cover (=removal of Brazilian elodea beds) for salmonid and spiny-ray fish, the scenario provides a plan for in-lake fish habitat enhancement with artificial structures. The scenario also includes small-scale bottom barrier applications in the lake to suppress nuisance weed growth, if necessary in years 4 and 5. Annual spot treatments with an aquatic algaecide may be necessary to control small-scale algal blooms.

Costs: Overall **first-year program costs** for this scenario include a large-scale Aquathol application, stocking rate design, outlet barrier design and construction, fish purchase and any required environmental assessment, as well as prevention and monitoring. The bulk of expenses for this scenario would occur in the **first year** and could total as much as **$161,800**. However, successive annual costs are estimated to be $15,000 or less for both years 2 and 3, increasing to about $30,000 in year 4 (if fish restocking is needed) and dropping back to approximately $20,000 in year 5.

Ecological/human impacts: Aquathol treatment is not species-specific and could result in removal of target Brazilian elodea as well as other non-target species intermingled with them. Currently, Washington State requires an 8 day swimming restriction following treatment with Aquathol. There are also label restrictions on fish consumption, food and non-food crop irrigation. Since herbivorous grass carp demonstrate distinct food preferences, removal of certain beneficial native aquatic plants are most likely. Impacts of grass carp introduction on human health should be negligible to non-existent.

Permits/Special Requirements

Use of aquatic herbicides does require submitting an Aquatic Plant Management Permit Application for short-term modification to state water quality standards to Washington State Department of Ecology before initiation of treatment.

Washington State Department of Fish and Wildlife (WDFW) requires a game fish planting permit prior to grass carp introduction to a water body. In addition, if outlet screening is necessary, hydraulic approval is required from the WDFW.. Washington Department of Natural Resources Natural Heritage Program must be contacted for assessment of threatened or endangered plant species. Bottom barrier application requires hydraulic approval from the WDFW, and may be subject to Shoreline Management Act and may need Shoreline permit for installation, dependent on scale and cost of barrier application.

Ideally, time required for State agencies to process a permit application is at least 45 days, but could be much longer if the permit application is not properly completed. If multiple permits from several local, county or state jurisdictions are required, the overall processing time period could be extended as well.

Treatment Scenario #4

In-lake Treatments

(Major treatments contracted out)
Major treatment involving annual large-scale Aquathol herbicide
(Year 2+)Minor treatments using aquatic algaecide, if needed
Minor treatments: small-scale bottom barrier application
Minor treatments: hand-removal of plant, including roots

Other Program Elements

Public Awareness-Prevention Program.

- Public meetings/posted signs on lake/ newsletters/media coverage
- Citizen watch for exotics weeds in lake
- Boat/Trailer Inspections-voluntary

Program Monitoring and Effectiveness Evaluation
Watershed Management Program
Implementation and funding plan

This scenario adds the element of annual large-scale application of the contact herbicide, Aquathol, used as a cosmetic tool to keep the water column clear in those areas of heavy weed infestation (e.g., the eastern arm of the lake, nearshore areas, especially boat launch). With this scenario, the primary, large-scale management goal is one of keeping high use areas free of nuisance, surfacing weeds. A small-scale goal would be as in previous scenarios to keep shallow, critical areas clear of weeds using more intensive methods such as bottom barrier applications or hand removal techniques. Annual spot treatments with an aquatic algaecide may also be necessary to control algal blooms. Implementation of watershed measures, annual aquatic plant survey, public awareness-prevention, and monitoring programs are included as in previous scenarios.

Costs: Annual aquatic plant survey costs are estimated to be $3000. At an average cost for materials and application by private contractor of roughly $700/acre, first year costs for an application of Aquathol (40 acres) could be upwards of $30,000. Costs for small-scale bottom barrier application would depend on target area and barrier material; for example, 1/4 acre treatment would be upwards of $10,000, including purchase of materials. Shoreline permit fees could cost as much as $5000, depending on acreage of bottom barrier applied. With a lake management plan involving large-scale contact herbicide treatment, small-scale bottom screening and hand removal, and inclusion of public awareness and monitoring elements, **first year costs** could run as high as **$53,000.** Annual expenses for this maintenance mode scenario should continue at approximately $54,000 or less (depending on scale of physical/mechanical removal required).

Ecological/human impacts: Aquathol treatment is not species-specific and could result in removal of target Brazilian elodea as well as other non-target species intermingled with them. Currently, Washington State requires an 8 day swimming restriction following treatment with Aquathol. There are also label restrictions on fish consumption, food and non-food crop irrigation.

Permits/Special Requirements

Use of aquatic herbicides does require submitting an Aquatic Plant Management Permit Application for short-term modification to state water quality standards to Washington State Department of Ecology before initiation of treatment.

Bottom barrier application requires hydraulic approval from the WDFW, and may be subject to Shoreline Management Act and may need Shoreline permit for installation, dependent on scale and cost of barrier application.

Ideally, time required for state agencies to process a permit application is at least 45 days, but could be much longer if the permit application is not properly completed. If multiple permits from several local, county or state jurisdictions are required, the overall processing time period could be extended as well.

TABLE J-1
ALTERNATIVE TREATMENT SCENARIOS FOR LAKE LIMERICK AQUATIC PLANT MANAGEMENT

Treatment Scenarios	*Treatment Elements	** Costs (est) First Year	** Costs (est) Second Year	** Costs (est) Third Year	** Costs (est) Fourth Year	** Costs (est) Fifth Year	Scenario Cost First 5 Years
Intensive Programs							
1 Systemic Herbicide	•*Macrophyte survey*	$3,000	$3,000	$3,000	$3,000	$3,000	
large-scale	•SONAR(fluridone) applic	$80,000 80 ac	$0-$80,000 0-80 ac	0	$0	$0-$80,000 0-80 ac	
	•*Algicide application, if nec*	$0	$1,200	$1,200	$1,200	$1,200	
w/intensive small-scale	•Mitigation +	$0	$0	$5,000 +volun	$0	$0	
treatments	•Downstream veg surv	volunteer	volunteer	volunteer	volunteer	volunteer	
	•*Permitting/(checklist)*	$5,000	$5,000	$0	$0	$5,000	
	•*Small-scale treatment (physical/mechanical)*	$10,000	$10,000	$10,000	$10,000	$10,000	
	•*Public Ed/Noxious Weed Prev*	$2000+volun	$2000+volun	$2000+volun	$2000+volun	$2000+volun	
+=replace damaged emergent native vegetation downstream	•*Program Monitor/Eval w/ Steering Committee*	$3000+volun	$3000+volun	$3000+volun	$3000+volun	$3000+volun	
	•*Septic System Checks****	-	-	-	-	-	
TOTALS		$103,000	$24,200 to $104,200	$24,200	$19,200	$24,200 to $104,200	$194,800 to $354,800
2 Systemic Herbicide	•*Macrophyte survey*	$3,000	$3,000	$3,000	$3,000	$3,000	
large-scale	•SONAR (fluridone) applic	$80,000 80 ac	$0	$0	$0	$0	
+ Grass Carp Plant	•Mitigation +	$0	$0	$5,000 +volun	$0	$0	
	•Stocking rate design/admin	$10,000	$0	$0	$0	$10,000	
w/ primary barrier (at outlet)	•Grass carp purch1 (rate deter in year of plant)	$0	$12,500 to $25,000	$0	$0	$0	
w/secondary barriers (at inlets)	•Grass carp purch2 (rate deter in year of plant)	$0	$0	$0	$0	$3,750 30% init to $7,500	
w/intensive small-scale treatments	•Outlet structure mod Inlet structures mod	$0	$80,000	$0	$0	$0	
	•Maintain screens/traps	$0	$1,500	$1,000	$1,000	$1,000	
	•*Algicide application, if nec*	$0	$1,200	$1,200	$1,200	$1,200	
	•*Permitting/(checklist)*	$5,000	$5,000	$0	$0	$5,000	
	•*Small-scale treatment (physical/mechanical)*	$0	$0	$5,000	$5,000	$5,000	
	•*Public Ed/Noxious Weed Prev*	$2000+volun	$2000+volun	$2000+volun	$2000+volun	$2000+volun	
+=replace damaged emergent native vegetation downstream	•*Program Monitor/Eval w/ Steering Committee*	$3000+volun	$3000+volun	$3000+volun	$3000+volun	$3000+volun	
	•*Septic System Checks****	-	-	-	-	-	
TOTALS		$103,000	$108,200 to $120,700	$20,200	$15,200	$33,950 to $37,700	$280,550 to $296,800

TABLE J-1 (Con't)

ALTERNATIVE TREATMENT SCENARIOS FOR LAKE LIMERICK AQUATIC PLANT MANAGEMENT (con't)

Treatment Scenarios	Treatment Elements	** Costs (est) First Year	** Costs (est) Second Year	** Costs (est) Third Year	** Costs (est) Fourth Year	** Costs (est) Fifth Year	Scenario Cost First 5 Years
Intensive Programs							
3 Contact Herbicide + Grass Carp Plant	•Macrophyte survey-lt May (before Aquathol applic)	$3,000	$3,000	$3,000	$3,000	$3,000	
	•Aquathol application	$30,000 40 ac?	$0	$0	$0	$0	
w/ primary barrier (at outlet)	*•Macrophyte survey -July (before carp plant)*	$2,300 1 day	$0		$0	$0	
w/secondary barriers (at inlets)	•Stocking rate design/admin	$10,000	$0	$0	$10,000	$0	
w/intensive small-scale treatments	•Grass carp purch1 (rate deter in year of plant)	$12,500 to $25,000	$0	$0	$0	$0	
	•Grass carp purch2 (rate deter in year of plant)	$0	$0	$0	$3,750 30% init to $7,500	$0	
	•Outlet structure mod & Inlet structures mod	$80,000	$0	$0	$0	$0	
	•Maintain screens/traps	$1,500	$1,000	$1,000	$1,000	$1,000	
	•Algicide application, if nec	$0	$1,200	$1,200	$1,200	$1,200	
	•Permitting/(checklist)	$5,000	$0	$0	$0	$5,000	
	•Small-scale treatment (physical/mechanical)	$0	$0	$5,000	$5,000	$5,000	
	•Public Ed/Noxious Weed Prev	$2000+volun	$2000+volun	$2000+volun	$2000+volun	$2000+volun	
	•Program Monitor/Eval w/ Steering Committee	$3000+volun	$3000+volun	$3000+volun	$3000+volun	$3000+volun	
	*•Septic System Checks****	-	-	-	-	-	
TOTALS		$149,300 to $161,800	$10,200	$15,200	$28,950 to $32,700	$20,200	$223,850 to $240,100
Maintenance Programs							
4 Contact Herbicide	*•Macrophyte survey*	$3,000	$3,000	$3,000	$3,000	$3,000	
w/intensive small-scale treatments	•Contact (Aquathol) applic	$30,000 40 ac?	$30,000 40 ac?	$30,000 40 ac?	$30,000 40 ac?	$30,000 40 ac?	
	•Algicide application, if nec	$0	$1,200	$1,200	$1,200	$1,200	
	•Permitting (checklist)	$5,000	$5,000	$5,000	$5,000	$5,000	
	•Small-scale treatment (physical/mechanical)	$10,000	$10,000	$10,000	$10,000	$10,000	
	•Public Ed/Noxious Weed Prev	$2000+volun	$2000+volun	$2000+volun	$2000+volun	$2000+volun	
	•Program Monitor/Eval w/ Steering Committee	$3000+volun	$3000+volun	$3000+volun	$3000+volun	$3000+volun	
	*•Septic System Checks****	-	-	-	-	-	
TOTALS		$53,000	$54,200	$54,200	$54,200	$54,200	$269,800

* Program elements common to all Scenarios are italicized

** Cost are projections based on contractors' current estimates.

*** Septic System Checks are part of auxiliary watershed control program tentatively planned to be implemented by Mason County by January, 1997.

Recommended Action Plan for Lake Limerick
Step K

Plan Formally Chosen at Public Meeting

In a formal vote of the Lake Limerick membership held in a Public Meeting in January, 1996 (See Appendix), Treatment Scenario Option #2 was overwhelmingly chosen as the heart of the recommended long-term action plan for the lake. The Lake Limerick IAPMP recommends aggressive treatment of in-lake noxious, nuisance weed populations, along with other lake and watershed management elements to maintain beneficial uses. While the immediate problem is an exotic weed infestation, the plan emphasizes the importance of watershed management in limiting inputs of nutrients and other contaminants to the lake. It must be stressed that aquatic plant management in Lake Limerick, particularly management of the exotic weed species, Brazilian elodea, will be an **on-going concern** and will take **long-term commitment**. Furthermore, the resulting Plan is **dynamic and flexible**, with checkpoints (Annual evaluations, Steering Committee Meetings) set along the way to allow for any changes in course direction or control tactics. Given the difficulty in routing established Brazilian elodea from a system, a five-year (minimum) program using the following elements is recommended.

Treatment Scenario #2

In-lake Treatments

Whole lake aquatic plant survey and biomass sampling
(Year 1)Major application of systemic herbicide SONAR
Outlet/inlet containment structure design and modification
(Year 2)Major treatment involving planting of sterile grass carp
(Year 2+)Minor treatments using aquatic algaecide, if needed
Minor treatments using hand removal and bottom barrier

Other Program Elements

Environmental permits and assessment, if necessary
Use restrictions or modifications
Mitigation of native plants downstream, if needed
Mitigation of fish habitat loss (use of artificial structures)
Public Outreach and Education Program
Noxious Weed Prevention Program
Program Monitoring and Effectiveness Evaluation

- aquatic plant surveys
- water quality monitoring (N,P sampling)
- regular meetings of Steering Committee

Watershed Management Program
Implementation and funding plan

The recommended alternative for aquatic plant management in Lake Limerick involves a combination of large-scale systemic herbicide/biological treatments in the first few years, followed in succeeding years by small-scale follow-up with hand removal and bottom barriers to prevent re-infestation. The plan also includes provisions for a public awareness program, and an annual monitoring program to evaluate effectiveness. In addition, to maximize benefits of exotic Brazilian elodea removal, it is critical to sustain a noxious weed prevention program so that any new outbreaks can be destroyed. Other program elements include permitting, use restrictions, watershed management , and securing and implementing funding. Components of the recommended treatment scenario and other short- and long-term program elements are described in more detail below.

In-lake Treatments

SONAR Application

The major treatment component of this scenario consists of use of a systemic herbicide in the **first year** to effect major reductions in target Brazilian elodea (*Egeria densa*) beds. Initially, an aquatic plant survey and biomass sampling is conducted in late spring (May-June) to document extent of *Egeria* coverage in the lake. This surveillance is followed (June-mid-July) by a large-scale application of the systemic herbicide, SONAR. With this herbicide, the active ingredient fluridone is absorbed by target plant roots and shoots and is potentially capable of killing the entire plant. The fluridone application is made targeting *Egeria* beds between 1 and 4 meter water depth (where growth was concentrated as of July 1995 survey and to be confirmed in 1996), approximately 60 acres. The appropriate formulation of SONAR will be used, with application made at the recommended label rate for Brazilian elodea. Since it is critical that exposure/contact time of the active ingredient be optimal for maximum kill effectiveness, fluridone concentrations may need to be maintained for up to 10 weeks. A sampling program will be necessary to collect water samples at regular intervals to monitor fluridone concentrations in the lake for the appropriate period.

Grass Carp Stocking Rate

The Plan considers use of sterile grass carp as a biocontrol method for Lake Limerick in terms of follow-on control to the SONAR treatment in year one. The Steering Committee will be working closely with WDFW during 1996 to develop a realistic fish stocking rate for possible use in 1997. An environmental assessment specific to Lake Limerick may also be required prior to grass carp implementation.

Outlet/inlet Barrier Design

An escape barrier on the outlet is required to prevent movement of sterile grass carp out of the system and avoid impacts on downstream non-target vegetation. As a result, the scenario requires design (in year one) and modification of the fish ladder/outlet structure (prior to implant in year two). Because of the presence of important habitat areas elsewhere around the lake, WDFW have determined that other barrier structures will be necessary at the Cranberry Creek inlet (that drains Cranberry Lake upstream), and at both Beaver Creek and the Islands inlet culvert at the east end as additional precautions (prior to implant in year two). At the same time provision must be made for adult salmon movement upstream at the outlet and possibly at the Cranberry Creek inlet. Initial conceptual design work and cost estimates for these carp containment structures have been developed by a consulting fisheries biologist in conjunction with WDFW (See Summary Report by KCM, Inc in Appendix). Fine-tuning of these conceptual designs will occur during spring-summer 1996, and actual construction and modification of the structures is scheduled by early 1997 three to six months prior to actual carp planting.

Sterile Grass Carp Planting

The idea of this scenario is to decrease reliance on use of large-scale chemical applications in Lake Limerick. In the **second year,** the plan recommends implantation of sterile grass carp as a supplementary technique for lake-wide, follow-on control of submersed plants in Lake Limerick, particularly any residual Brazilian elodea populations that may have survived first-year SONAR treatment. As in year one, a pre-treatment macrophyte survey of lake littoral is recommended in year two to document plant bed composition and extent. This survey is followed by implantation of sterile grass carp at the recommended stocking rate and fish size as approved by Washington State Department of Fish and Wildlife.

Barrier Inspections

Based on recent experience in northwest waters, the conceptual design study recommended mesh traps be installed on the upstream end of the primary inlets to the lake to prevent carp passage during salmon migration season. The trap would contain all fish passing upstream, until inspected and appropriate manual disposition be made. From year two on, regular annual inspection and maintenance of inlet barrier traps/outlet structure will be necessary.

Small-scale Weed Control

The IAPMP for Lake Limerick also recommends small-scale physical plant removal methods to suppress nuisance weed growth around the shoreline, if necessary in years 3 through 5. In year 3, when evidence of carryover effectiveness of SONAR/grass carp against Brazilian elodea and other nuisance species like bladderwort is more apparent, cleanup treatment of residual nuisance plants by hand removal (digging or raking) or bottom screening may be required. A variety of bottom barrier materials are available from local suppliers. Depending on material used, careful maintenance of bottom screens can result in removal and reuse of screens in other areas. Spot algaecide applications may be needed to control any occurrence of nuisance algal blooms in the lake.

Grass Carp Restocking

By year 5, the possibility of a second restocking of grass carp in Lake Limerick should be assessed by the Steering Committee in conjunction with the WDFW.

Other Program Elements

Environmental permits and assessment, if necessary
Use restrictions or modifications
Mitigation of damaged native downstream plants, if needed
Mitigation of fish habitat loss by introduction of artificial structures
Public Outreach and Education Program

Noxious Weed Prevention Program
Program Monitoring and Effectiveness Evaluation

- aquatic plant surveys
- water quality monitoring (N,P sampling)
- regular meetings of Steering Committee

Watershed Management Program
Implementation and funding plan

Permits/Assessment

Use of aquatic herbicides, such as SONAR, does require submitting an Aquatic Plant Management Permit Application for short-term modification to state water quality standards to Washington State Department of Ecology before initiation of treatment. Ideally, this permit application should be filed before the end of February, 1996 for a late spring-early summer, 1996 treatment.

Washington State Department of Fish and Wildlife (WDFW) requires a game fish planting permit prior to grass carp introduction to a water body. This permit should be filed by mid-year 1996. WDFW has made a preliminary determination that the Phase I Diagnostic Study requirement of the permit has been met in the previous limnological investigations conducted by the Plan consultant, WATER Environmental Services, Inc. In addition, if outlet screening is necessary, hydraulic approval is required from the WDFW. This permit should be filed well before modification activities occur, preferably after the engineering design plan is approved. Washington Department of Natural Resources Natural Heritage Program has already been contacted for assessment of threatened or endangered plant species in the Lake Limerick vicinity. If bottom screens are employed later in the Lake Limerick management program, their use may be subject to Shoreline Management Act. A shoreline permit may be required for installation, dependent on scale and cost of barrier application. Bottom barrier application also requires hydraulic approval from the WDFW. Both of these permits should be completed two to three months prior to planned treatment.

Use Restrictions and Modifications

There may be some recreational impacts with the use of SONAR, affecting mostly swimming, which is discouraged during and immediately after treatment, although there is no label restriction for swimming (See SONAR label, Appendix D). However, because SONAR treatments are most effectively made between May-July for Brazilian elodea control, recreational impacts can be kept to a minimum by early season application. There are irrigation restrictions with SONAR use. As a result, lake water cannot be used for irrigation of the golf course and grounds for the 10 week SONAR treatment period. However, a plan has been developed by the LLCC Water Committee to divert one existing well normally used for drinking water to golf course irrigation.

Mitigation of Native Plants

No or negligible impacts of fluridone (the active ingredient in SONAR) are anticipated on the wetland at the east end of the lake, since flow occurs through the wetland **into** the lake. SONAR may impact other non-target native plants in Lake Limerick and possibly in downstream reaches of Cranberry Creek. However, concerted efforts to employ a prudent application scheme should minimize impacts to emergent plants on the lakeshore perimeter of Lake Limerick. Also, delaying the SONAR treatment to late spring-early summer, when precipitation and outflow typically decline, should further minimize downstream movement of the herbicide. Such efforts as well as development of a mitigation plan for revegetation of damaged areas are expected to satisfy the Governor's Executive Order 11990, Protection of Wetlands. These actions should also satisfy the Washington Department of Fish and Wildlife's recommendation that a minimum of 25% of aquatic vegetation be preserved for wildlife habitat in lakes treated with herbicides.

Mitigation efforts (to revegetate any damaged native emergent plants along shoreline areas and downstream) are delayed to year three to allow time for full effects to become obvious of both the SONAR treatment/grass carp stocking. Mitigation need should be determined in year three by performing a similar basic survey of vegetation bordering shoreline of Lake Limerick and outflow channel to assess condition of emergent plants. Results in year three should be compared to aquatic vegetation data compiled on this same channel prior to 1996 SONAR treatment. If a database characterizing downstream vegetation does not exist, a pre-treatment survey of vegetation along Cranberry Creek should be performed by late spring 1996 prior to SONAR application.

Mitigation of Fish Habitat

Brazilian elodea, the primary target of aquatic plant control in Lake Limerick, currently accounts for a large portion of macrophyte biomass and areal coverage in Lake Limerick. If SONAR treatment and grass carp grazing prove to be as highly effective as expected against this weed species, macrophyte bed area could decrease considerably by year three. Annual macrophyte surveys with biomass sampling will provide a quantitative means of assessing status of plant beds in the lake at that time, and whether additional mitigation measures are needed. If mitigation of aquatic habitat is recommended, structures like logs and cement blockscan be strategically positioned along the lake bottom to provide artificial habitat/refuge for salmonids, trout and spiny-ray fish.

Public Outreach/Education

The Lake Limerick IAPMP also includes a multi-faceted public outreach/education element. Public outreach efforts are encouraged on a year-round basis to keep the larger community informed as to the status and progress of integrated management in Lake Limerick, particularly nuisance aquatic plant control. This will be accomplished by continuation of regular newsletters mailed to Lake Limerick Country Club members, conducting public and informal meetings, and posting lake information on local bulletin boards. Public Education efforts resulting from the Integrated Aquatic Plant Management Plan should complement existing lake and watershed management programs (See below).

Exotic Weed Prevention Program

The purpose of the exotic weed prevention element is to prevent reintroduction of Brazilian elodea, or other non-native invasive plants, to the lake and provide a quick response if new populations are sighted. While Brazilian elodea is presently the species of concern in Lake Limerick, it is important to prevent introduction of other exotic species, such as hydrilla (*Hydrilla verticillata*), Eurasian watermilfoil (*Myriophyllum spicatum*), parrotfeather (*M. aquaticum*), and fanwort (*Cabomba caroliniana*), all of which have documented, established populations in western Washington waters. While established, persistent populations have yet to be documented in Washington waters, it is also critical to be on the alert for other exotic nuisance species like water hyacinth (*Eichhornia crassipes*).

Since spread of exotic invaders like Brazilian elodea and milfoil fragments most commonly occurs as a result of transport on boating equipment (Newroth, 1990), efforts to halt spread through educational means and by visual inspection of boats entering/leaving the lake are recommended. A milfoil prevention sign developed by Washington Department of Ecology is currently posted at the Lake Limerick public boat launch. A boat checking operation could be undertaken at the two boat launches on the lake, staffed by volunteers from the community. Inspection efforts should be targeted for typical high-use periods, e.g., from April to July.

Regular patrolling of Lake Limerick should be conducted to check for outbreaks of Brazilian elodea or other non-native, invasive plants. At least six lake residents should be trained to look for Brazilian elodea as well as other dangerous exotic invasive plants. The Citizen's Manual for Developing Integrated Aquatic Vegetation Management Plans (Gibbons et. al., 1994) provides a description and line drawings of these and other exotic invasive plants. Surveillance should be made monthly from April to October, using an underwater viewer to see into the water, and pulling suspect plant samples with a rake for a surface check. Washington Department of Ecology can be consulted for expert identification of aquatic plants.

Program Monitoring and Evaluation

The monitoring/evaluation component consists of at least annual surveying and evaluating effectiveness of in-lake control activities and other program elements. By performing a periodic "checkup" of the lake, appropriate adjustments can be made in the succeeding year's management program to maximize program effectiveness. With so much time, effort and money behind the integrated aquatic plant management program, the importance of an annual program evaluation cannot be over-emphasized. Program results should be evaluated with respect to aquatic plant management objectives set for the lake, and produced into a written report. The following offers some guidelines for evaluating progress of the program in achieving major management goals.

Major Goal:

To enhance water quality and beneficial uses of the lake. This will be accomplished by appropriate use of nuisance macrophyte control actions and watershed management practices recommended in the Plan. Success in achieving this goal can be measured quantitatively by annual aquatic plant surveys and regular monitoring of water quality parameters (e.g., nitrogen and phosphorus levels, water transparency, dissolved oxygen, pH). These data can be compared to pre-existent data collected by limnologists in diagnostic studies (e.g., WATER Environmental Services) and by Ecology through the Citizen Monitoring Program. With the assistance of State and tribal fisheries scientists, the condition and health of salmonids and planted trout and spiny-ray species can be assessed in the lake. An additional measure of project success can be supplied through results of an annual opinion survey of lake residents regarding major program goals. Finally, continual tracking of project status and careful review of annual surveys and study results by the Steering Committee is crucial in the evaluation process.

Major Goal:

To aggressively remove noxious Brazilian elodea populations from all known locations in the lake. As discussed earlier, accomplishment of this goal will take aggressive, persistent, long-term efforts. To get a quantitative handle to measure progress on this goal, type and extent of aquatic plants need to be assessed from year to year. Aquatic plant mapping similar to the procedure performed during summer of 1995 should be continued for at least 5 years of the program. During the early summer season, community composition and areal estimates of aquatic plant beds should be made, as well as collection of plant biomass samples at pre-existing survey transects around the lake. These surveys should be supplemented with results of volunteer surveillance as described above. A detailed evaluation report should be prepared including this comparative data, particularly as it relates to the 1995 pre-treatment survey results. Costs for aquatic plant mapping and biomass measures are estimated to be about $3000/year.

Major Goal:

To keep priority areas, the boat launch and selected shoreline residential areas clear of plants for boating and swimming safety reasons. Nuisance growth of Brazilian elodea, bladderwort, common elodea, and big-leaf pondweed to a lesser extent, are the main concern in the shallow nearshore areas of Lake Limerick where swimming occurs. Brazilian elodea should be maximally affected by the year-one SONAR treatment and grass carp grazing. The other plants may be incidentally affected by SONAR application in year 1. Big-leaf pondweed beds may experience minimal to heavy grazing by grass carp, depending on location in lake and proximity to human activities. From year three on, small-scale treatments of shoreline beds of nuisance plants may be necessary, employing hand-pulling (limited) and placement of bottom barriers. Success of these measures can be evaluated quantitatively in terms of the annual aquatic plant mapping results described above. An additional measure of success can be supplied through results of an annual opinion survey of lake residents regarding degree of shoreline obstruction by aquatic plants.

Major Goal: **To maintain sufficient habitat for fish and wildlife.** While fluridone applications can be made in a way to maximize selectivity for Brazilian elodea, non-target plants may be variably affected. Also, although grass carp appear to graze Brazilian elodea well, the fish do exhibit preferential feeding and may affect other native plants in the lake. Thus, declines in plant bed area may be most apparent in year 3 (following year-one herbicide and year-two grass carp implant). Succeeding years should see nuisance plant populations replaced by native species, and continued maintenance of habitat for fish and wildlife. Additionally, the strategic positioning of structures like logs and cement blocks along the lake bottom will provide artificial habitat/refuge for salmonids, trout and spiny-ray fish. The annual macrophyte survey will provide plant community composition, areal coverage, and biomass estimates, generating a useful means to gage achievement of this goal.

Major Goal: **To complement concurrent watershed management program activities to reduce input of nutrients/contaminants to the lake.** This goal can be achieved through an active public outreach/education program on lake protection consisting of workshops, newsletters, or printed or videotaped educational materials made available to the lake community. Use of best management practices (BMP's) by lakeshore property owners, such as environmentally friendly fertilizers, vegetative shoreline buffers, compost bins set well back of shoreline are obvious indicators of a property-owner's dedication to lake protection.

Watershed Management

Although excessive nutrient loading is not considered a problem in Lake Limerick at this time, the Plan emphasizes watershed management to limit inputs of nutrients and other contaminants to the lake from activities on lakeshore properties. A comprehensive check of lakeshore septic systems is being planned with Mason County Public Health as part of the overall watershed protection program. Furthermore, informational meetings are planned dealing with the topics of septic system maintenance and property-owner best management practices. As it has done in the past, the LLCC newsletter will continue to carry special supplements on watershed management measures and lake protection.

Project Costs

At an average cost for materials and application by private contractor of roughly $1000/acre, first year costs for a large-scale application of SONAR (80 acres) could be upwards of $80,000. Annual aquatic plant survey costs are estimated to be $3000. Annual monitoring costs for a consulting limnologist/engineer to evaluate carry-over effectiveness in the lake are projected to be $3,000. It is anticipated that the prevention component would be mainly a volunteer effort, with negligible expenses. Overall **first-year program costs** for this scenario are estimated to be upwards of $103,000, including stocking rate design, permitting and any required environmental assessment. The bulk of expenses for this scenario would most likely occur in the second year with design and construction of grass carp inlet/outlet barriers being a big expense item (total year-two project expense ranging from $108,000-120,000). However, successive annual project costs are estimated to be $20,000 **in year three, including possible mitigation of damaged downstream/in-lake native plants, and approximately $15,000 in year four.** Program costs are projected to increase to about **$35,000 in year 5** to cover fish restocking assessment, required permits, and replanting, if needed.

Estimated Costs For Implementation of Lake Limerick IAPMP

SONAR/Grass Carp Scenario	Program Elements	1st Year Est Costs	2ndYear Est Costs	3rd Year Est Costs	4th Year Est Cost	5th Year Est Costs
Systemic herbicide applic followed by grass carp plant	Macrophyte Survey	$3000	$3000	$3000	$3000	$3000
	SONAR (fluridone) applic	$80,000	$0	$0	$0	$0
	Stocking rate design/admin	$10,000	$0	$0	$0	$10,000
w/ primary barrier (at outlet)	Grass carp purch1 (rate deter in year of plant)	$0	$12,500 to $25,000	$0	$0	$0
w/secondary barriers (at inlets)	Grass carp purch2 (rate deter in year of plant)	$0	$0	$0	$0	$3,750 to $7,500
	Outlet structure mod	$0	$80,000	$0	$0	$0
	Inlet structures mod	$0	$1,500	$1,000	$1,000	$1,000
	Maintain screens/traps	$0	$0	$5,000	$0	$0
	Mitigation of native plants	$0	$1,200	$1,200	$1,200	$1,200
w/intensive small-scale treatments	Algaecide application, if nec	$5,000	$5,000	$0	$0	$5,000
	Permitting/(checklist)					
	Small-scale treatment (physical/mechanical)	$0	$0	$5,000	$5,000	$5,000
	Public Ed/Nox. Weed *Prev*	$2000+vol	$2000+vol	$2000+vol	$2000+vol	$2000+vol
	Program Monitor/*Eval* w/ Steering Committee	$3000+vol	$3000+vol	$3000+vol	$3000+vol	$3000+vol
	*Septic System Checks****	-	-	-	-	-
TOTALS		**$103,000**	**$108,200 to $120,700**	**$20,200**	**$15,200**	**$33,950 to $37,700**

*** Septic system checks are part of an auxiliary watershed program tentatively planned to be implemented by Mason County by January 1997.

Plan Implementation and Funding

Financing IAPMP Plan Implementation

As indicated above, the recommended alternative for aquatic plant management in Lake Limerick involves a combination of (1) herbicide/biological treatments, (2) follow-up with hand removal and bottom barriers to prevent re-infestation, (3) public awareness/noxious weed prevention program, and (4) monitoring program to evaluate effectiveness, and (5) watershed management program. Costs for a minimum five-year integrated lake management program on Lake Limerick are projected to range from $280,550-$296,800. A combination of grant funding, loan procurement, and local revenue from Lake Limerick general funds is proposed to fund implementation of the Lake Limerick IAPMP over five years. In order for plan implementation to be successful, the Lake Limerick Country Club and Mason County Health Department will continue communicating throughout the plan implementation period with the Squaxin Island Tribe, the Washington State Department of Fish and Wildlife, the

Washington State Department of Ecology, other permitting agencies, the contracted businesses, and other interested parties.

Grant Funding

The Lake Limerick IAPMP was developed under an Aquatic Weeds Management Fund (AWMF) planning grant from the Washington State Department of Ecology (Ecology). The grant provided 75 percent of the funding; Mason County and Lake Limerick Country Club (LLCC) have provided the remaining 25 percent via cash, staff time and in-kind volunteer services respectively. A residual balance of approximately $60,000 remains in the current AWMF planning grant that will be applied toward expenses of the implementation phase commencing in 1996. With this grant residual amount and the community's general funds, Lake Limerick is prepared to carry out the first year (1996) of full project implementation.

Mason County will also apply for an AWMF implementation grant of $100,000 during the next grant application period (July, 1996). If the grant is awarded, plan implementation would continue in 1997 with LLCC contributing local matching funds and in-kind services. The grant would fund up to 75 percent of the costs of implementing the Lake Limerick IAPMP with the LLCC funding the remaining 25 percent.

State SRF Loan Funding

Loan funding is another financing avenue being pursued by the County/LLCC to be combined with existing and new AWMF moneys and dedicated community-generated revenue to permit full implementation of the longterm IAPMP. Mason County/LLCC have submitted an application for a no-interest loan for $125,000 through the State Revolving Fund (SRF) Program administered by Ecology.

Local Funding Commitment

LLCC is prepared to dedicate up to $25,000 annually from its general funds to cover successive annual costs of plan implementation, regardless of other financing. If the SRF loan is secured, the community is also prepared to repay an annual amount of $25,000 for the five years beginning tentatively in 1999. However, if LLCC winds up as the only funding source (no SRF loan or AWMF implementation grant), the integrated management program for Lake Limerick would continue, but in a significantly scaled back form, especially in year two, most likely jeopardizing long-term effectiveness.

Implementation Schedule

Full implementation of the Lake Limerick IAPMP is dependent on a number of financing factors including (1) success of SRF loan application and (2) success of AWMF implementation grant application. Listed below is a proposed IAPMP implementation schedule that assumes loan and grant funding are pursued and successful. The AWMF planning grant balance of $60,000 and annual community outlay of $25,000 are considered dedicated secured amounts.

Date	Action	Est. Cost	Funds Avail/Req	Cash Flow
Jan 96	LLCC IAPM Plan Approval		$ 60,000(currAWMF)	$ 60,000
Jan-Dec 96	Public Outreach/Education			$ 60,000
Feb 96	Apply for SRF loan		–	$ 60,000
Apr 96	Select Herbicide Contractor		–	$ 60,000
	Secure permits	$ 3,000	–	$ 57,000
	Steering Comm Mtg			$ 57,000
	Divert water well to golf irri	$ 2,000		$ 55,000
May 96	Plan Septic System Check Prog			$ 55,000
Jun-Jul 96	(SRF loan award)		($125,000)	$180,000
Jun/Aug 96	Herbicide (SONAR) treatmt	$ 80,000		$100,000
	Small-scale weed control	$0-10,000		$ 90,000
Jul 96	Apply for AWMF Imp-grant			$ 90,000
Aug 96	Complete Carp Conta Desig	$ 10,000	$ 25,000LLCC	$105,000
	Issue Carp Cont. Constr RFP			$105,000
Oct 96	Steering Comm Mtg			$105,000
	Restore well to Water Dept	$ 1,000		$104,000
Nov 96	Issue Carp Stock RFP			$104,000
	Award Contr Carp Contain			$104,000
Dec 96	Begin Septic System checks (tenta)		(Separate funding)	$104,000
	Steering Comm Review	$ 3,000		$101,000
Jan 97	Award Carp Stock Contrac			$101,000
Jan-Dec 97	Public Outreach/Education			$101,000
Mar 97	Compl Carp Contain Cont	$ 80,000		$ 21,000
	Steering Comm Mtg			$ 21,000
May-Jun 97	Aq Plant Survey	$ 2,000		$ 19,000
Jun 97	WDFW carp rate/permit	$ 6,000		$ 13,000
	Plant Carp	$15-25,000	$ 27,000LLCC	$ 15,000
Jul 97	Aq Plant Survey	$ 2,000		$ 13,000
Sep-Dec 97	Fish Trap/I&O Mainten	$ 1,000		$ 12,000
	Steering Comm Review	$ 3,000		$ 9,000
Dec 97	Complete Septic System checks(tenta)		Separate funding)	$ 12,000
Apr 98	Steering Comm Mtg			$ 12,000
Jun-Dec 98	Macro Surv,Small-scale weed contr			
	Mitigation, barrier maint,etc.	$0-12,000		$0

1999 on

Expenses
- Annual Aq Plant Surveys
- Maintenance Inlet/Outlet Screens
- Small-scale weed/algae control
- Annual Program Monitoring and Evaluation
- Twice yearly Steering Comm Mtgs
- Public Outreach/Education
- Watershed Management Program-BMP
- Repay SRF loan @$25,000/year, beginning in 1999
- Possible Restock Carp in 2001

1999 on

Revenue
- LLCC annual general funds ($25,000+)
- LLCC in-kind services
- Other sources

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Appendix A
Lake Limerick Workshop and Steering Committee Meeting Notes, Citizen Letters and Newsletters

LAKE LIMERICK COUNTRY CLUB, INC
E 790 ST. ANDREWS DRIVE
SHELTON, WA 98584
(206) 426-3581
FAX (206) 426-8922

The following organizations and individuals have been invited to participate in the Lake Limerick working group to plan the 1995 lake aquatic weed control program.

1.	WASH. STATE DEPT OF WILDLIFE 48 DEVONSHIRE RD MONTESANO, WA 98563	Contact: Phone FAX:	Bill Freeman 753-2600; 2601
2.	MASON COUNTY DEPT. OF HEALTH P.O. BOX 1666 SHELTON, WA 98584	Contact: Phone: FAX:	Wayne Clifford 427-9670 Ext 581
3.	SQUAXIN ISLAND TRIBE WEST 81 HIGHWAY 108 SHELTON, WA 98584	Contact: Phone: FAX:	Michelle Stevie 426-9783
4.	WATER ENVIRONMENTAL SERV. 9515 WINDSONG LOOP RD NE BAINBRIDGE ISLAND, WA 98110	Contact: Phone: FAX:	M V. Gibbons (206) 842-9382 Same
5.	LAKE LIMERICK COM. CLUB E 790 ST. ANDREWS DRIVE SHELTON, WA 98584	Contact: Phone: FAX:	Dan Robinson 426-7908 427-6451
6.	WASH. STATE DEPT OF ECOLOGY SOUTHWEST REGIONAL OFFICE P.O. Box 47775 OLYMPIA, WA 98504-7775	Contact: Phone: FAX:	Loree Randall 407-6294 407-6305
7.	WASH STATE DEPT OF ECOLOGY WATER QUALITY FINANCIAL ASSIST. P. O. BOX 47600 OLYMPIA, WA 98504-7600	Contact: Phone: FAX:	Kathy Hamel 407-6562
8.	DAHMAN SHELLFISH CO. S.E. DAHMAN ROAD SHELTON, WA 98584	Contact: Phone: FAX:	Ernie Dahman 426-2658

MEMORANDUM

TO: Dan Robinson, Lake Limerick Country Club

FROM: Maribeth Gibbons, WATER Environmental Services, Inc.

SUBJECT: Notes for April 12 Steering Committee Meeting, Lake Limerick IAPMP Project

DATE: May 10, 1995

The following are general notes on major topics discussed during the meeting.

The first Lake Limerick IAPMP Steering Committee Meeting was held on April 12 from 3:00 to 5:00 pm at the Mason County Commissioners Hearing Room. Those in attendance were:

- Kathy Hamel--Department of Ecology
- Bill Freeman--Department of Fish and Wildlife
- Wayne Clifford--Mason County Department of Health
- Dan Robinson--Lake Limerick Country Club
- Maribeth Gibbons--WATER Environmental Services, Inc.

The startup meeting went very well with great discussion on the in-progress IAPM Plan and surrounding issues. Dan reviewed background and current status of the project. Maribeth briefly reviewed each section (11 parts) of the draft IAPM Plan for Lake Limerick that she had completed up to the meeting day. The 11 plan elements are:

- Develop Problem Statement for Lake Limerick-mainly non-native invasive Brazilian Elodea
- Identify Management Goals
- Public Involvement
- Watershed/Lake Features--recent studies completed by WATER
- Identify Beneficial Use Areas of Lake Limerick-map
- Map Aquatic Plants-will conduct survey in July, 1995
- Characterize Aquatic Plants
- Investigate Control Alternatives
- Specify Control Intensity-areas around lake subject to high,mod, low or no control
- Choose Integrated Treatment Scenario
- Develop Final Action Plan

Since the Sqauxin Tribe is apparently concerned about seepage (bacterial/nutrient?) into the lake from septic drainfields, a dye tracing study of drainfields around the lakeshore may be a necessary part of the final plan. Wayne noted that the County does such investigations. Maribeth also produced a handout on 4 different treatment scenarios for general discussion. The dredging and harvesting-based alternatives were mostly ruled out due to

Lake Limerick IAPMP Project 1995
Possible Integrated Long-term Treatment Scenarios (5 years +)

Intensive Treatment Scenario #1

In-lake Treatments (treatments contracted out)
(Years 1+) Major treatment of Brazilian elodea beds using hydraulic dredging of substrate up to a depth of 1 m
Off-lake disposal of sediment/plant fragment spoils
(Years 1+)Minor treatment of undredged shallow shoreline using other physical means (hand pulling/bottom barrier application)
(Years 1+)Minor treatment of undredged shoreline floating leaf plant areas (problem) with systemic Rodeo, if necessary

Other Program Elements
Permit Application/Environmental Assessment, if necessary
Public Awareness-Brazilian elodea Prevention Program
- Public meetings/posted signs on lake/ Newsletters/media coverage
- Citizen watch for Br. elodea in lake
- Boat/Trailer Inspections-voluntary

Watershed best management practices
Program Monitoring and Effectiveness Evaluation

Major Advantage: Complete removal of nutrient-enriched sediments+rooted plants.
Major Disadvantages: Costs for treatment of large weed bed areas are prohibitively large; a very intensive method resulting in nontarget plant/ invertebrate impacts, degree depending on scale of treatment.

Intensive Treatment Scenario #2

In-lake Treatments
Whole-lake (littoral) surveillance for current Br. elodea
(Year 1)Major treatment using fluridone, one annual application to entire affected lake area
(Year 2)Possible retreatment in next year, but total area should be less than first year
(Years 1+)Minor treatment of problem floating-leaved plants using glyphosate, at selected areas along lake littoral, if needed
(Years 1+)Minor treatments using hand removal, bottom barrier application or diver-operated dredging

Other Program Elements
Public Awareness-Brazilian elodea Prevention Program.
- Public meetings/posted signs on lake/ newsletters/media coverage
- Citizen watch for Br. elodea in lake
- Boat/Trailer Inspections-voluntary

Watershed best management practices
Program Monitoring and Effectiveness Evaluation.

Major Advantage: At optimal dosage & exposure time, potential for long-term control effectiveness w/ fluridone can be high at a reasonable cost

Major Disadvantages: Long contact time needed at optimal concentrations of fluridone; high drift potential of herbicide out of treatment area; repeat treatment may be needed.

LAKE LIMERICK PLANT MANAGEMENT
STEERING COMMITTEE MEETING

10:00 am, November 14, 1995
Mason County Department of Health, 426 West Cedar, Shelton

AGENDA

PURPOSE: Convene the Steering Committee established by the Mason County Commissioners to review program status and develop plans to control invasive aquatic plants in Lake Limerick.

1. Introductions - D. Robinson
2. Review of 1995 Weed Control Efforts - D. Robinson
3. Biomass Survey Results and Analysis - M. Gibbons
4. Carp Containment Study Report - W. Daley
5. Current SONAR Application Experience - T. McNabb
6. Carp Introduction Feasibility - B. Freeman
7. Ecology Position on SONAR Treatment and Future Grant Possibilities - K. Hamel
8. Review of Proposed Five Year Plan - D. Robinson & M. Gibbons
9. Adjourn

Please contact Dan Robinson at (360) 426-7908 if you cannot attend.

LAKE LIMERICK PLANT MANAGEMENT
STEERING COMMITTEE MEETING
November 14, 1995

The steering committee members attending the meeting are the following:

Dan Robinson - Lake Limerick - AWM Grant project Manager
Wayne Clifford - Mason County Health Dept. - AWM Administrator
Bill Freymond - Dept of Fish & Wildlife - Cognizant Biologist
Mari Beth Gibbons - Water Environmental, Inc. - Lake Limerick Consult.
Kathy Hamel - Dept. of Ecology - Water Quality Financial Assistance

In addition, the following contributors were present:

Wayne Daley - KCM, Inc. - AWM Contractor - Grass Carp Containment
Terry McNabb - Resource Mgmt, Inc. - Herbicide Contractor
Carolyn Soehnlien - Lake Limerick - Deputy Grant Project Mgr.
Bill Buff - Lake Limerick - Lake/Dam Committee Chair

Steering Committee member not present:

Michelle Stevie - Squaxin Island Tribe
Loree Randall - Dept of Ecology - Herbicide Management

Dan Robinson reviewed the aquatic plant management activities conducted in Lake Limerick during 1995. No herbicide treatment was conducted. A very limited copper treatment for algae was accomplished in June, and a manual harvest of Bladderwort and pond weed was conducted during July and August at Lake Limerick expense.

Terry McNabb reported on current experience with fluridone (SONAR), a systemic herbicide that may have the capability to kill some portion of the Brazilian Elodea. To accomplish the destruction of these hardy plants, a concentration of 10 to 15 parts of fluridone per billion parts of water must be maintained over a period of 8 to 10 weeks. Even with this extensive treatment, we would not expect a complete eradication of the Elodea, necessitating follow-on treatments in 3 to 5 years. In response to questions about water flow adjacent to lake inlets, Terry indicated that a "drip system" technique exists that could eliminate or reduce this problem, although such a technique has not been approved for Washington lakes. He reported that the use of Aquathol, a contact herbicide for temporary control, is being reevaluated, and he expects the previous swimming restrictions associated with it will be removed. It was reaffirmed that use of lake water for irrigation during fluridone treatment and

An additional source of funds is a loan fund maintained by the State and available to us through Mason County. This is a low interest loan that can have flexible repayment options. Lake Limerick will investigate this fund.

Although Loree Randall was unable to attend the meeting, she has previously indicated that, although a 1996 fluridone (SONAR) herbicide treatment would probably be approved, it is unlikely that she will be able to approve repeated herbicide treatments in the future, in part because the Squaxin Island Tribe has expressed some concerns about such treatments. Lake Limerick will take action to review our option plans with the Tribe as soon as practical.

Dan Robinson reviewed a suggested 5 year plan, calling for a fluridone treatment in 1996, and a carp plant in 1997. In addition, this plan calls for annual biomass surveys, continued review by this steering committee, and an early application to Lake Limerick of the Mason County septic system maintenance program.

Mari Beth Gibbons reviewed four intensive treatment scenarios she has prepared for possible application to Lake Limerick. These scenarios include as large-scale alternative options: dredging, carp introduction, fluridone herbicide, and harvesting. Her comparative 5-year cost evaluations of these options range from more than $2.5 Million for dredging to $200,000 for fluridone herbicide.

The steering committee agreed that Lake Limerick Community now needs to decide on the preferred actions for 1996 as quickly as possible, to coordinate such decisions with this committee, (including those committee members not present), and to proceed with those actions.

The meeting was adjourned at 12:30 P.M.

Prepared by Dan Robinson

11/14/95

Lake Limerick Meeting Sign In

Wayne Clifford	Mason County	427-9670 X-581
WAYNE DALEY	KCM	206/443-3583
MARIBETH GIBBONS	WATER ENV. SVCS.	(206) 842-9382
Carolyn Soehnlein	LAKE LIMERICK	426-0703
Tony McNabb	Resource Management, In.	360-754-3460
Bill Buff	Lake Limerick	360-427-5356
DAN ROBINSON	LAKE LIMERICK	360 426-7908
Kathy Hamel	Ecology	360-407-6562
Bill Freymond	WDFW	360-753-2600 Ext. 225

LIMERICK

LAKE LIMERICK COUNTRY CLUB, INC
E 790 ST. ANDREWS DRIVE
SHELTON, WA 98584
(206) 426-3581
FAX (206) 426-8922

January 2, 1996

To: Lake Limerick Country Club Members

The purpose of this letter and the accompanying explanatory data is to bring you up to date on the Aquatic Plant Management Program for Lake Limerick, and to seek your help in deciding on the course of future actions. The work done by myself and others in the community over the past year has brought us through the "study" phase of the grant from the State Department of Ecology, and we are now ready to select the long term means of lake plant management under the terms of the grant. In conjunction with the involved State and County agencies, we have found three viable options for weed management, each of which we expect to fund from a combination of grants, no-interest loans, and the same level of community operating moneys we have allocated to Lake Management for the past several years. <u>We do not expect that any special assessments for this five year lake management program will be necessary!</u>

The options available to us are as follows:

1. Systemic Herbicide Application
   a. Apply Fluridone (*SONAR*) in June, 1996
   b. Possible Re-Application of the herbicide in 1997, and each 5 years
2. Grass Carp with One-Time Contact Herbicide Application
   a. Apply *AQUATHOL* in June, 1996
   b. Plant Grass Carp in August, 1996
3. Grass Carp with One-Time Systemic Herbicide Application
   a. Apply Fluridone (*SONAR*) in June, 1996
   b. Plant Grass Carp in July, 1997

Each of the above options, while viable for our lake, has its own pros and cons as described further in the attachment to this letter. It is the consensus of myself and the cognizant State Agencies that option 3 is the preferable course of action.

This letter also serves as an announcement of a special membership meeting on January 27, 1996 at 2:00 P.M. in the Great Hall of the Lake Limerick Inn to review the above alternatives and for the members to vote their preference (along with other subjects announced elsewhere). If you cannot attend, please complete the enclosed ballot and mail it directly to the Lake Limerick office. <u>Your vote is most important</u>.

Sincerely;

Daniel C. Robinson
President
Lake Limerick Country Club, Inc

January 2, 1995

Lake Limerick Country Club Members:

As you are aware from the reviews in both newsletters and Board of Trustee and Membership meetings, representatives of your club have been engaged in an evaluation of the various methods available for control of the plant growth in our lake. The Club was awarded a grant from the State Department of Ecology early in 1995 for this evaluation, as well as for the selection and execution of an appropriate control procedure. We have completed the evaluation phase, and are now at the point of selection of the methods we will execute.

The plant growth in our lake is dominated by Brazilian Elodea (Igeria Densa), which as of July, 1995, was estimated to cover approximately half of the total lakebed. This plant is classed as an invasive (non-native) noxious weed by Washington State, and Lake Limerick is one of a limited number of western Washington lakes known to harbor it. It is easily spread throughout the lake as well as among lakes, spread by birds, boat trailers, and inadvertent human-caused transplantation. This plant is the direct target of the initial control efforts, although we also intend to control the growth of all the plants in the lake. In addition, it is crucial to our long term plan that a vigorous program be implemented to reduce the weed-encouraging nutrients entering the lake from the surrounding watershed.

The evaluation activities, conducted over the last 10 months by Grant-funded consultants as well as community volunteers, addressed all known, and permissible, methods of aquatic plant control. We have considered doing nothing to control the weed growth, but the consequences of this approach would be a lake unusable for fishing, boating, or swimming in about three years. We considered continuing the relatively modest treatment with contact herbicide each year as we have been doing the past 4 years, but, in addition to facing mounting opposition from Community members and others having an interest in our lake, this approach would be the most expensive over the 5 year span of our control plan. Most other methods were eliminated as ineffective or exceedingly expensive, leaving two essentially equal options meeting our criteria for feasibility.

Throughout the evaluation, we have worked closely with and have been supported by representatives of County and State Agencies, the Squaxin Island Tribe, and our long-time consultant, Water Environmental, Inc. " This Steering Committee" has endorsed each of the options presented herein, and agrees that the Community members should select the course of action to be pursued henceforth.

In conclusion, I encourage each property owner to review the alternatives described herein, and to vote your preference for the long term control of our lake. Until this point, I have not indicated a preferred option, because there is no clear advantage of one over any over the others. However, I believe option 3 (1996 SONAR and 1997 grass carp plant) has a narrow advantage from the standpoint of logistics of accomplishment and of securing necessary funds. At the special membership meeting on January 27, 1996, I plan to provide a complete schedule and cost breakdown for those wishing more detail that we are able to include in this mailing. In the meantime, additional data and answers to your questions will be provided in response to written requests directed to the Club Office.

Dan Robinson
AWM Project Manager

LAKE LIMERICK COUNTRY CLUB

AQUATIC WEED MANAGEMENT PLAN

SECTION 3 OPTION SUMMARY FOR COMMUNITY DECISION JANUARY, 1996

ALL OPTIONS BASIC REQUIREMENTS

All funding provided by no-interest loans, grants, and LLCC general funds -- No special assessments!
Annual biomass surveys
County-supervised Septic System checks begin Dec 96
Active education program on use of "lake-friendly" fertilizers
Evaluation of localized plant growth control measures (bottom barriers, etc.)
Twice-annual Steering Committee reviews
State and local permitting activities and coordination with interested parties

OPTION 1 SYSTEMIC HERBICIDE (*SONAR*) APPLICATION

Apply Fluridone (*SONAR*) in June 96
Possible re-application of Fluridone required in 1997

Relative Advantages: Immediate extermination of a major portion of the invasive weeds; moderate 1996 expense covered by the grant; may have eradication guarantee from the Manufacturer

Relative Disadvantages: Probably will not completely eradicate all of the Elodea or any other Lake plant specie; surviving plants will flourish, requiring follow-on herbicide treatments; lake water cannot be used for irrigation of the golf course for 10 weeks during application, although a plan has been developed with the LLCC Water Committee to divert one existing well normally used for drinking water to golf course irrigation; may require mitigation of downstream plant growth extermination

Approximate costs: $215,000 for three years plus up to $16,000 per year
Fund sources: Existing Grant -- $60,000; State Low-Interest Loan -- $95,000; LLCC -- $60,000 from general funds
Septic tests -- Centennial Grant : $75,000; LLCC general funds -- $15,000

LAKE LIMERICK COUNTRY CLUB

AQUATIC WEED MANAGEMENT PLAN

SECTION 3 OPTION SUMMARY FOR COMMUNITY DECISION JANUARY, 1996

OPTION 3 GRASS CARP WITH ONE-TIME FLURIDONE APPL. TO ERADICATE BRAZILIAN ELODEA

Apply Fluridone (*SONAR*) in June 96
Grass carp stocking rate design by Dept of Fish and Wildlife April, 97
Design and construction of Carp containment screens at inlets and outlet May, 97
Install Grass carp July, 97
Maintenance installation of Carp June, 2001

Relative Advantages: Large scale extermination of Elodea and some other plant growth prior to carp installation; additional time to secure grant or loan funds for carp containment structures; additional experience in other lakes using carp for plant growth control

Relative disadvantages: High cost of both Fluridone application and carp containment; same uncertainties of number of carp permitted to actually control plant growth, containment structures, golf course irrigation, etc.; may require mitigation of downstream plant growth extermination

Approximate Costs: $235,000 for three years plus $11,000 per year thereafter.
Fund Sources: Existing Grant -- $60,000; State Low-Interest Loan -- $125,000; Lake Limerick -- $30,000 from general funds
Septic Checks: Centennial Grant -- $75,000; :Lake Limerick -- $15,000 from general funds

Lake Limerick Country Club, Inc.

Aquatic Weed Management Plan Option Selection   January 27, 1996

NOTIFICATION OF SPECIAL MEMBERSHIP MEETING

A SPECIAL MEMBERSHIP MEETING HAS BEEN APPROVED BY YOUR BOARD OF TRUSTEES AND IS HEREBY CALLED FOR JANUARY 27, 1996 AT 2:00 P.M. , TO BE HELD IN THE LAKE LIMERICK INN.

The purpose of the meeting is to review the available aquatic weed control options and to choose by ballot the option to be pursued by the Club.

BALLOT

SELECT ONE OPTION ONLY

OPTION 1	*SONAR* ONLY	/ /
OPTION 2	*AQUATHOL* PLUS GRASS CARP	/ /
OPTION 3	*SONAR* PLUS GRASS CARP	/ /

Please mail the marked ballot to the Lake Limerick office if you cannot attend the January 27, 1996 special membership meeting called for this purpose. All ballots, mailed or delivered in person, must be received at the Lake Limerick office no later than the voting recess at the January 27th meeting. One vote per member please!

December 19, 1995

Mason County Commissioners:

I am writing this letter in regard to the proposed ordinance establishing an operation and maintenance program for some of the county's many septic systems. The primary thrust of this program is toward shoreline-situated systems, most of which have been in operation for many years.

I urge you to resist the "naysayers" and retain the proposed schedule of mandatory checks of shoreline systems, and to put the plan into operation. Our waters, both salt and fresh, will eventually benefit from the increasingly stringent requirements on new septic systems throughout the county. But to allow older systems to continue to pollute these same waters is, in my opinion, an unconscionable disregard for the health, not only of our water bodies, but of our citizens who use them. In addition, to delay the operations plan would certainly be an insult to those shoreline residents who have been required to invest many thousands of their dollars in the newest generation of septic systems.

The pollution introduced into waterbodies by failed systems not only threatens the health of anyone using the water, but represents nutrients that contribute significantly to undesirable rates of aquatic plant growth. Many waterbodies in Mason County are being attacked by this plant growth, requiring the residents, with the support of the county, to expend uncounted thousands of dollars in the attempt to control the weeds.

As we all know, it is a small percentage of property owners who ignore not only their legal, but also their social, responsibility and allow their septic systems to deteriorate and pollute the waters belonging to all of us. It is because of these irresponsible owners that government must act to protect the interests of the many. My children and grandchildren have enjoyed the use of the waterbodies in this county over the years. Please don't ignore their right to healthy enjoyment of the water. Please resist the vocal opponents of "Government Intervention" and help us improve our water quality by approving the maintenance and operation ordinance as proposed.

Dan Robinson
Lake Limerick

LAKE LIMERICK/LEPRECHAUN FACTSHEET NUMBER THREE

In the last issue, we discussed alternative *household practices* that can be implemented by citizens of the watershed to reduce pollutant loading into a receiving waterbody and help protect its water quality. In this issue, we'll look at what you can do *outside your home* in your yard/garden to further reduce pollutant loading into streams and lakes.

Its Raining..Its Pouring..

The Puget Sound region has certainly received its fair share of rain this year, with the spring of 1993 being one of the soggiest in many years. The great volumes of water brought by recent storms not only causes flooding and streambank scouring, but also increases the washing of sediments and other pollutants from the land into nearby receiving waters. Indeed, one of the largest sources of nonpoint surface water pollution comes from stormwater water/urban runoff. (Remember that *nonpoint source pollution* comes from many different, hard to pin down sources, in contrast to *point* (piped) discharges.)

Much of the rain falling on forests and farmlands soaks gradually into the ground, draining into aquifers or to nearby surface waters. But, rain striking cleared surfaces associated with cities and suburbs results in more water running off than soaking into the ground. As rainwater splatters onto concrete, asphalt, lawns and construction sites, it picks up road oils, gasoline, metals, dirt, fallen leaves, lawn fertilizers, pet waste and other debris. Carried through dirty drains and gutters, rainwater laden with contaminants makes its way downward and untreated to the nearest body of water.

In residential areas, the biggest runoff problem is organic waste, such as lawn clippings, leaves, animal wastes, and garbage. When these wastes are carried into a lake, the decaying process consumes precious oxygen from the water, severely affecting aquatic life. Excess nutrients generated by decomposition of these organic inputs add to in-lake nutrient reserves and can trigger nuisance growth of algae. A little bit of waste from each yard can accumulate into a significant loading very quickly.

Backyard Best Management Practices

There are a number of yard practices the homeowner can implement to reduce pollutant runoff from his/her property to a receiving water.

- Mow your lawn properly. Correct mowing height maximizes root depth and grass blade density and determines degree of runoff. A healthy lawn retains water, filters silt and chemicals and requires less watering. Recommended mowing height for perennial ryegrass and fescues is 1.5 inches. No more than the upper third of the grass blade should be removed at a mowing.

- Periodically aerate and thatch your lawn to enhance water and air penetration. Water your lawn efficiently, at most once a week. Water during early morning or late evening to reduce evaporation losses.

- Dispose of excess grass clippings by composting. (Be sure to construct compost pile well away from the water's edge, if you have shoreline property.) Sweep grass clippings from sidewalks or driveways to prevent washing of clippings into storm drains or surface waters.

- Apply lawn fertilizer cautiously. Excess fertilizer is carried into receiving waters, only adding to existing nutrient supplies and fueling algae growth. Contact the local cooperative extension service for information on recommended fertilizing practices. WSU Cooperative Extension Service Agent for Mason County is Bob Simmons (427-9670).

STATEMENT FOR JULY FLYER

LAKE / DAM COMMITTEE -- CAROLYN SOEHNLEIN

The goals of the Lake / Dam committee shall be to maintain and enhance the recreational facilities directly related to Lakes Limerick and Leprechaun. In addition, we will work toward improving the water quality by limiting weed growth. We intend to accomplish this by implementing an aggressive Lake Management program. Part of this program involves rehabilitation of the Dam itself.

As most members are aware, the emergency drain valve at the dam failed this spring and through a notable effort by Jerry Soehnlein, Steve Morely, Scott Carey, Simpson Timber Company, and others, a disaster was avoided and a temporary plug was positioned to replace the failed valve. As a result of this failure, a critical inspection of the emergency drain tube under the dam was conducted by the State of Washington. The consequence of all this is that the State requires the replacement of the valve within the next year and a rehabilitation of the drain tube within the next 5 years.

A marine Engineering firm owned by Ken Martig has been retained to evaluate the alternatives available for rehabilitation of the valve and drain tube and to develop cost estimates for the various alternatives. We have entered into a $5,000 contract with Mr. Martig to prepare this plan for us. He has agreed to provide his evaluation of the alternatives and the attendant costs no later than the 10th of August. We expect he will propose the replacement of the valve this fall and that the rehabilitation of the drain tube will be significantly less expensive if done at the same time.

The total cost of all this is, of course, very speculative at this writing. It may well exceed $50,000, in which case a special assessment may be required to defray this cost.

Looking beyond the repair of the Dam, the goals of the Lake/Dam committee include the following;

a. Reconstruction of additional community docks.
b. Aquatic weed control as described below.
c. Monitoring of effectiveness of grass carp planting in Lake Leprechaun
d. Development of an operation and Maintenance Manual for the Dam.
e. Development of emergency action plan for the Dam.

5. Lake front property owners should remove and burn all weeds reachable by hand or with suitable hand tools.

6. Support your Lake Management organization in its efforts to control all forms of lake pollution

Over the years we have tried dredging the bottom of the lake and harvesting the aquatic weeds. We have recently planted Triploid (sterile) grass eating carp in Lake Leprechaun.
During the past three years, with limited funds, we have used the contact herbicide Aquathol to "knock down" the weeds, and a copper sulfate compound to control the algae. Approval of our application for the State grant would provide the funds to use the systemic herbicide SONAR to eradicate (kill roots and all) the Brazilian Elodea, while controlling other aquatic plants. We anticipate this new program would have several advantages:

1. A very low concentration of the systemic SONAR (30 parts per Billion for ten weeks) will be harmless to fauna with minimal restrictions, the worst being a 7 day irrigation suspension for each application.
2. Avoiding the accumulation of residual herbicides in the lake.
3. With near complete eradication of the non-native Elodea, we will invoke a long range plan that, though initially more expensive (for 1995), will have the greatest potential for controlling following year budget requirements to a reasonable level.

Although experience with SONAR applications to Brazilian Elodea is currently limited, we expect to have considerably more actual data from other lake systems by the end of this summer. We do know that excellent results have been achieved applying SONAR to the exotic Eurasian Mil foil throughout the United States, including lakes in Western Washington. We believe that the application of SONAR to our Brazilian Elodea will achieve comparable results.

This is your lake. We know you want it maintained as an asset to our rapidly growing community of nearly 1200 buildable lots. We welcome your interest and comments. You are encouraged to attend the monthly Lake/Dam Committee meetings (held at the Inn the Second Thursday at 5:30 p.m.) or drop a note in Chair-person Carolyn Soehnlein's folder at the Inn.

Appendix B
Washington Natural Heritage Program Database Search of Lake Limerick Watershed

WASHINGTON STATE DEPARTMENT OF

Natural Resources

JENNIFER M. BELCHER
Commissioner of Public Lands

KALEEN COTTINGHAM
Supervisor

July 13, 1995

Maribeth Gibbons
Water Environmental Services
9515 Windsong Loop NE
Bainbridge Island WA 98110

SUBJECT: Lake Limerick Watershed - Integrated Aquatic Plant Management Plan (T21N R03W S27)

We've searched the Natural Heritage Information System for information on rare plants, high quality native wetlands and high quality native plant communities in the vicinity of your project. A summary of this information is enclosed.

The Washington Natural Heritage Program is responsible for information on the state's endangered, threatened, and sensitive plants as well as high quality native plant communities and wetlands. The Department of Fish and Wildlife manages and interprets data on wildlife species of concern in the state. For information on animals of concern in the state, please contact the Priority Habitats and Species Program, Washington Department of Fish and Wildlife, 600 Capitol Way North, Olympia, WA 98501-1091, or by phone (360) 902-2543.

The Natural Heritage Information System is not a complete inventory of Washington's natural features. Many areas of the state have never been thoroughly surveyed. There may be significant natural features in your study area that we don't yet know about. This response should not be regarded as a final statement on the natural features of the areas being considered and doesn't eliminate the need or responsibility for detailed on-site surveys.

I hope you'll find this information helpful.

Sincerely,

Sandy Norwood

Sandy Norwood, Environmental Review Coordinator
Washington Natural Heritage Program
Division of Forest Resources
PO Box 47016
Olympia WA 98504-7016
(360) 902-1667

Enclosure

c: Wayne Clifford, Mason County Dept. of Health Services

WASHINGTON NATURAL HERITAGE INFORMATION SYSTEM
ENDANGERED, THREATENED AND SENSITIVE PLANTS
HIGH QUALITY NATIVE WETLANDS AND HIGH QUALITY NATIVE PLANT COMMUNITIES
IN THE VICINITY OF LAKE LIMERICK WATERSHED - AQUATIC PLANT MANAGEMENT PLAN
REQUESTED BY MASON COUNTY DEPT OF HEALTH / WATER ENVIRONMENTAL SERVICES

Data current as of July 1995

TOWNSHIP, RANGE AND SECTION	ELEMENT NAME	STATE STATUS	FEDERAL STATUS
T21N R03W S29 S30	low elevation sphagnum bog		
T21N R03W S29 S30	low elevation freshwater wetland		
T21N R03W S15 SWOFSW S21 NEOFNE S22 NWOFNW	low elevation freshwater wetland		

State of Washington
DEPARTMENT OF FISH AND WILDLIFE
Mailing Address: 600 Capitol Way N, Olympia, WA 98501-1091 · (360) 902-2200; TDD (360) 902-2207
Main Office Location: Natural Resources Building, 1111 Washington Street SE, Olympia, WA

Date: 6-22-95

Dear Data Requester:

Enclosed is the information you requested from the Priority Habitats and Species (PHS) Division of the Washington Department of Fish and Wildlife (WDFW). This package also contains documentation to help you understand and use these data.

This information only includes data that WDFW maintains in a centralized data system. It is not an attempt to provide you with an official agency response as to the impacts of your project on fish and wildlife. Nor is it designed to provide you with guidance on interpreting this information and determining how to proceed in consideration of fish and wildlife. This data only documents the location of important fish and wildlife resources to the best of our knowledge. It is important to note that *priority habitats or species* may occur on the ground in areas not currently known to WDFW biologists, or in areas for which comprehensive surveys have not been conducted. Site-specific surveys are frequently necessary to rule out the presence of *priority habitats or species*.

Your project may require further field inspection or you may need to contact our field biologists or others in WDFW to assist you in interpreting and applying these data. Refer to the enclosed directory and regional map for those contacts. Generally, contact the Regional Habitat Program Manager in the appropriate WDFW region for assistance on specific projects.

Please note that locational data for Spotted Owls is not routinely displayed on the standard maps. They are however, listed in the tabular reports that accompany the 1:24,000 scale maps.

WDFW periodically updates this information as additional data become available. Because fish and wildlife species are mobile and because *priority habitats and species* data is dynamic, project reviews for fish and wildlife should not rest solely on mapped information. Instead, they should also consider new data gained in current field investigations. Remember, PHS data can only show that a species or habitat type is present, they cannot show that a species or habitat type is not present. These data should not be used for future projects. Please obtain regular (6 months) updates rather than use outdated information.

Because of the high volume of requests for information that WDFW receives, we need to charge for these data to recover some of our costs. Enclosed is an invoice itemizing the costs for your data and instructions for submitting payment. There is a base cost of $20.00 for all data requests; this covers setup, shipping and handling. Above that, there is an incremental cost for each map or magnetic media. Costs are as follows:

06/21/95

WASHINGTON DEPT OF FISH AND WILDLIFE - PRIORITY HABITATS AND SPECIES
****** SENSITIVE DATA - MASON_COUNTY_HEALTH DATA RELEASE ******

This data release contains PHS maps or digital data considered sensitive information subject to WDFW's Sensitive Information MOU with MASON_COUNTY_HEALTH

COMMON NAME	SPECIE CODE	USE	DATA SOURCE	QUAD CODE	USGS QUAD NAME
Bald eagle	HALE	B	PHS	4712331	UNION

WASHINGTON DEPT OF WILDLIFE

PRIORITY HABITATS AND SPECIES
Tabular Data Report - General Information - DRAFT
06/21/1995

form: 902412 species/habitat: HALE species use: B season: WS F definition: 6 map accuracy: 1
sitename: EAGLE TERRITORY
general description: BALD EAGLE TERRITORY

date: 04 91 code: PROF
source: SCHIRATO, WDW
synopsis: TERRITORIES WERE DRAWN BASED ON OBSERVED AERIAL SURVEY OBSERVATIONS, LOCAL KNOWL
EDGE AND LITERATURE INFORMATION ON BASIC EAGLE BEHAVIOR.

form: 904451 species/habitat: WET species use: season: definition: 6 map accuracy: 1
sitename: REGION 6 SALTWATER WETLANDS
general description: COASTAL SALT MARSHES SALT MEADOWS AND BRACKISH MARSHES

date: 04 78 code: CZA
source: WASHINGTON STATE COASTAL ZONE ATLAS D.O.E., 1979
synopsis: D.O.E. SPONSORED MAPPING OF COASTAL FEATURES

form: 904464 species/habitat: PHVI species use: PA season: SU definition: 0 map accuracy: 1
sitename:
general description: HARBOR SEAL HAUL OUT SITE WHERE PUPPING OCCURS SEASONALLY

date: 91 code: PROF
source: STEVE JEFFRIES, WDW
synopsis: AERIAL SURVEYS

WASHINGTON DEPT OF WILDLIFE

PRIORITY HABITATS AND SPECIES
Tabular Data Report - General Information - DRAFT
06/21/1995

form: 904776 species/habitat: CLIFF species use: season: definition: 0 map accuracy: 1
sitename:
general description: BLUFF-COASTAL ZONE ATLAS OF WASHINGTON-NONVEGETATED STEEP TO MODERATE SLOPES OF VARYING SUBSTRATE. BLUFFS OFTEN SERVE AS BUFFER BETWEEN DEVELOPED UPLANDS AND WETLANDS AT THEIR BASE CREATING IMPORTANT STRIPS OF COASTAL HABITAT. CZA CODE 76.
source: COASTAL ZONE ATLAS OF WASHINGTON. STATE OF WASHINGTON DEPT OF ECOLOGY. date: 78 code: CZA
synopsis:

Washington Dept. of Fish and Wildlife - Wildlife Survey Data Management
Data Current as of June 21, 1995
Requested by MASON_COUNTY_HEALTH for quad 4712331

Name: BALD EAGLE SA Number: 463- 1
Indexcode: DF.416 State Status: ST Federal Status: FT
Precision: LOCATION SHOWN ACCURATE TO 1/4 MI RADIUS & CONFIRMED BY WDG.
Source of lead: MCMILLAN, ANITA - WDW P.210 IN '93 SURVEY
Name of Area:
Date of Sighting: 19930615
Number of Owners: . Site Name: UNION
Name of Owner:
Agency Subsection:
Protection Status: . Data Point #: 7
Criterion: B
TRS: T21N R03W S06 NWOFNE
Dtenter: 940720
Region: 6
Latlong: 472038N1230622W
Quadcode: 4712331
Quadname: UNION
County: MASON
Ownership Code: PVTUUU
Special Status Code:
General Description: BALD EAGLE NEST, LOCATED ON EDGE OF SMALL DRAW, NORTHERN-MOST NEST.

Name: BALD EAGLE SA Number: 463- 4
Indexcode: DF.416 State Status: ST Federal Status: FT
Precision: LOCATION SHOWN ACCURATE TO 1/4 MI RADIUS & CONFIRMED BY WDG.
Source of lead: MCMILLAN, ANITA - WDW P.210 IN '93 SURVEY.
Name of Area:
Date of Sighting: 19930615
Number of Owners: . Site Name: UNION
Name of Owner:
Agency Subsection:
Protection Status: . Data Point #: 22
Criterion: B
TRS: T21N R03W S06 SEOFNE
Dtenter: 940720
Region: 6
Latlong: 472028N1230625W
Quadcode: 4712331
Quadname: UNION
County: MASON
Ownership Code: PVTUUU
Special Status Code:
General Description: BALD EAGLE NEST, LOCATED S OF NEST #2 AND N OF NEST #3.

Name: BALD EAGLE SA Number: 463- 2
Indexcode: DF.416 State Status: ST Federal Status: FT
Precision: LOCATION SHOWN ACCURATE TO 1/4 MI RADIUS & CONFIRMED BY WDG.
Source of lead: AMENT, SHELLY
Name of Area:
Date of Sighting: 19940616
Number of Owners: . Site Name: UNION
Name of Owner:
Agency Subsection:
Protection Status: . Data Point #: 10
Criterion: B
TRS: T21N R03W S06 SWOFNE
Dtenter: 940720
Region: 6
Latlong: 472031N1230622W
Quadcode: 4712331
Quadname: UNION
County: MASON
Ownership Code: PVTUUU
Special Status Code:
General Description: BALD EAGLE NEST, LOCATED 10FT DOWN IN DEAD-TOP TREE ON EDGE OF SMALL DRAW. THIS WELL CONCEALED NEST IS ON N SIDE OF DRAW

Name: BALD EAGLE SA Number: 463- 3
Indexcode: DF.416 State Status: ST Federal Status: FT
Precision: LOCATION SHOWN ACCURATE TO 1/4 MI RADIUS & CONFIRMED BY WDG.
Source of lead: MCMILLAN, ANITA - WDW P.210 IN '93 SURVEY.
Name of Area:
Date of Sighting: 19930615
Number of Owners: . Site Name: UNION
Name of Owner:
Agency Subsection:
Protection Status: . Data Point #: 19
Criterion: B
TRS: T21N R03W S06 SWOFNE
Dtenter: 940720
Region: 6
Latlong: 472028N1230625W
Quadcode: 4712331
Quadname: UNION
County: MASON
Ownership Code: PVTUUU
Special Status Code:
General Description: BALD EAGLE NEST, LOCATED IN LIVE FIR ON S SIDE OF DRAW, S OF BEIGE A-FRAME.

Washington Dept. of Fish and Wildlife - Wildlife Survey Data Management
Data Current as of June 21, 1995
Requested by MASON_COUNTY_HEALTH for quad 4712331

Name: BALD EAGLE SA Number: 881- 1 Criterion: B
Indexcode: DF.416 State Status: ST Federal Status: FT TRS: T21N R03W S35 SWOFSE
Precision: LOCATION SHOWN ACCURATE TO 1/4 MI RADIUS & CONFIRMED BY WDG. Dtenter: 900401
Source of lead: AMENT, SHELLY Region: 6
Name of Area: Latlong: 471543N1230123W
Date of Sighting: 19940411 Quadcode: 4712331
Number of Owners: . Site Name: OAKLAND BAY Quadname: UNION 7.5
Name of Owner: County: MASON
Agency Subsection: Ownership Code: PVTUUU
Protection Status: . Data Point #: 11 Special Status Code:
General Description: OAKLAND BAY TERR, NEST IN DOMINANT FIR IN CLEARCUT AREA WEST OF THE NORTH END OF OAKLAND BAY.

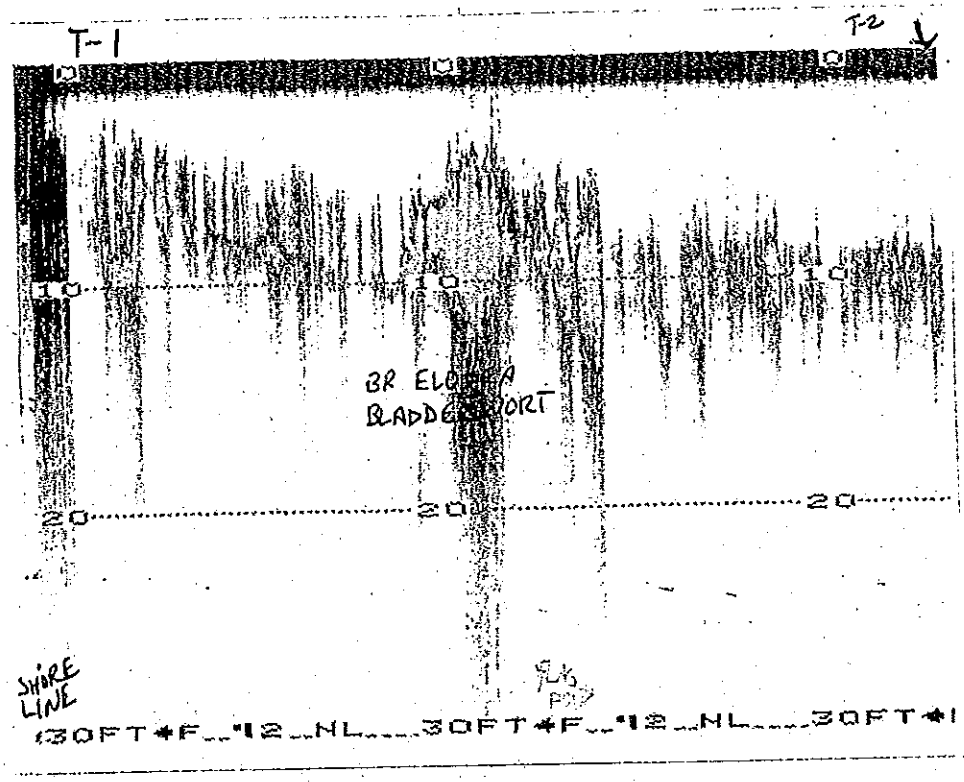
Name: PURPLE MARTIN SA Number: 35- 1 Criterion: B
Indexcode: EB.447 State Status: SC Federal Status: TRS: T21N R03W S36 SWOFSW
Precision: LOCATION SHOWN ACCURATE TO 1/4 MI RADIUS & CONFIRMED BY WDG. Dtenter: 871001
Source of lead: MERKER & OWENS WDW Region: 6
Name of Area: Latlong: 471532N1230036W
Date of Sighting: 19870803 Quadcode: 4712331
Number of Owners: . Site Name: Quadname: UNION 7.5
Name of Owner: County: MASON
Agency Subsection: Ownership Code: PVTUUU
Protection Status: . Data Point #: 18 Special Status Code:
General Description: PURPLE MARTIN NEST IN CAVITY OF PILING AT THE NE CORNER OF OAKLAND BAY.

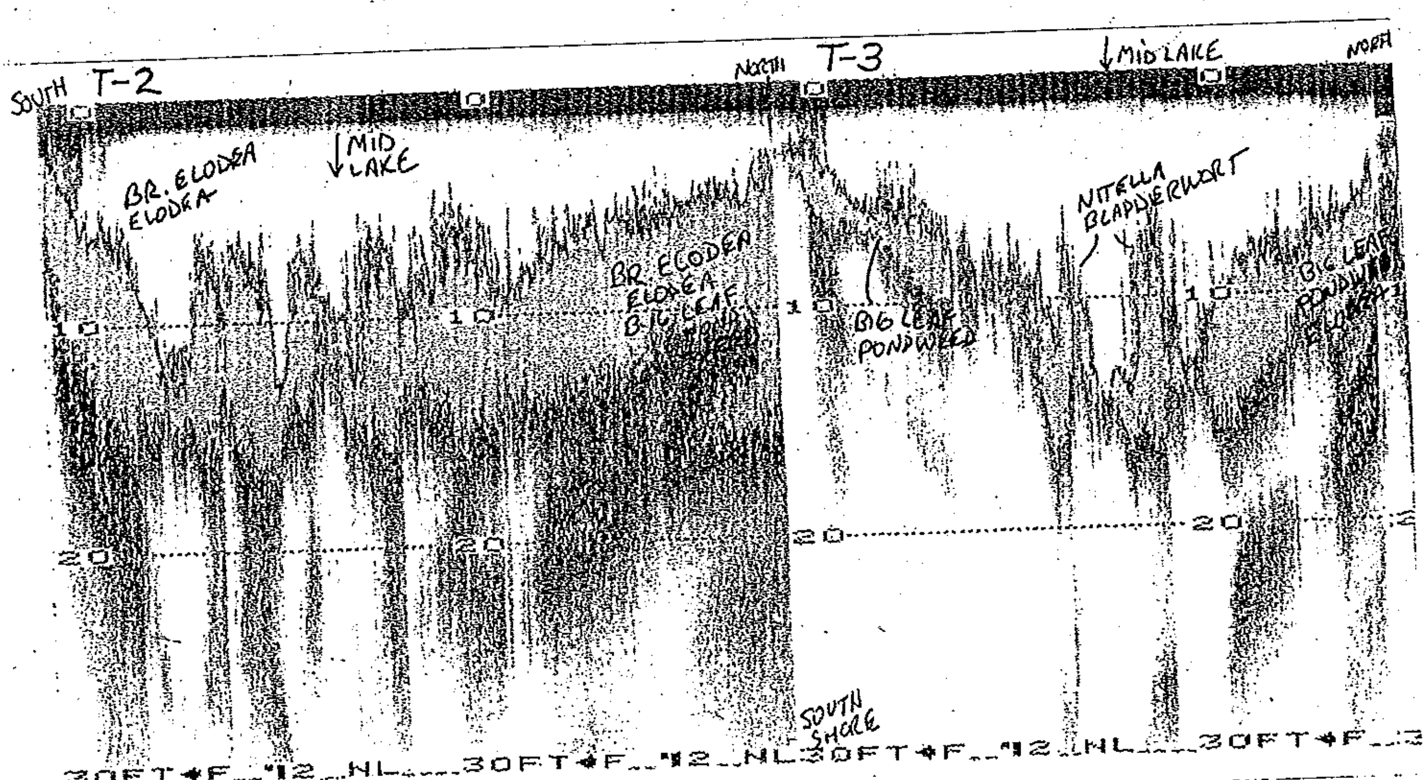
Name: OSPREY SA Number: 893- 1 Criterion: B
Indexcode: DF.435 State Status: SM Federal Status: TRS: T22N R03W S26 SWOFSW
Precision: LOCATION SHOWN ACCURATE TO 1/4 MI RADIUS & CONFIRMED BY WDG. Dtenter: 940323
Source of lead: NIXON, MATTHEW, WDW Region: 6
Name of Area: Latlong: 472143N1230159W
Date of Sighting: 19940224 Quadcode: 4712331
Number of Owners: . Site Name: SISTERS POINT Quadname: UNION
Name of Owner: County: MASON
Agency Subsection: Ownership Code: PVTUUU
Protection Status: . Data Point #: 23 Special Status Code:
General Description: OSPREY NEST.

Name: BALD EAGLE SA Number: 631- 2 Criterion: B
Indexcode: DF.416 State Status: ST Federal Status: FT TRS: T22N R03W S27
Precision: LOCATION SHOWN ACCURATE TO 1/4 MI RADIUS & CONFIRMED BY WDG. Dtenter: 941109
Source of lead: SHELLY AMENT, WDFW (PG 502 94 BE DATA BK) Region: 6
Name of Area: Latlong: 472201N1230246W
Date of Sighting: 19940616 Quadcode: 4712331
Number of Owners: . Site Name: TAHUYA Quadname: UNION
Name of Owner: County: MASON
Agency Subsection: Ownership Code: PVTUUU
Protection Status: . Data Point #: 33 Special Status Code:
General Description: BALD EAGLE NEST 50 FT EAST OF NEST TREE #1.

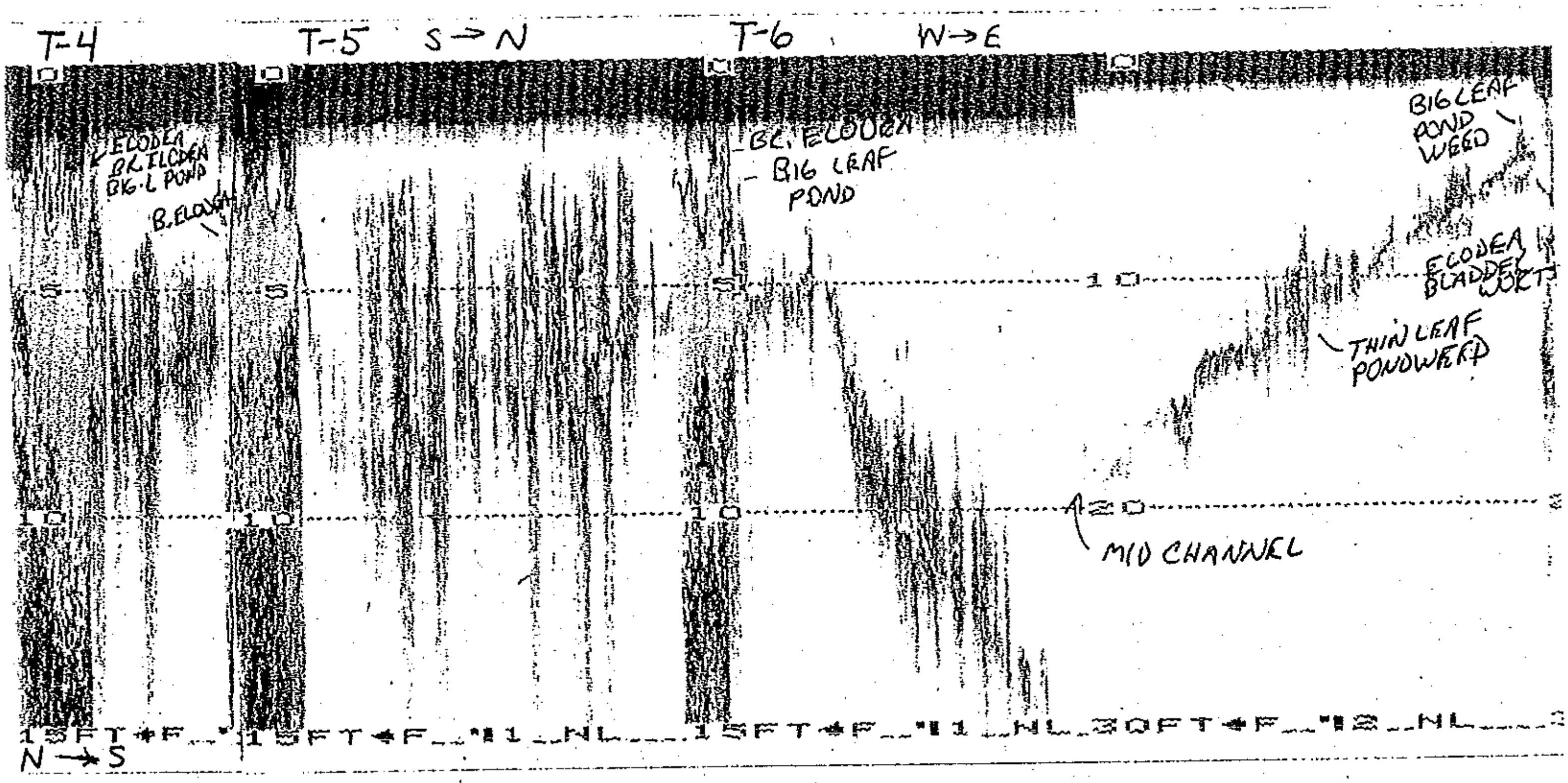
Appendix C
1995 Lake Limerick Aquatic Plant Survey
Fathometer Recordings

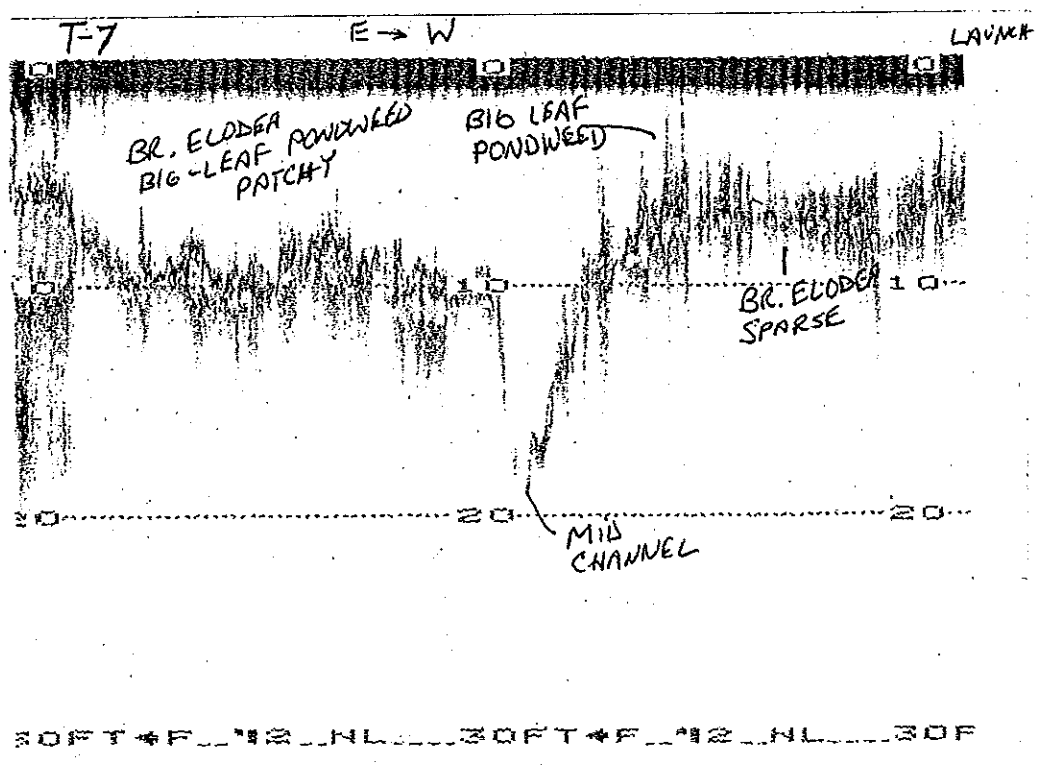
July, 1995 Lake Limerick Aquatic Plant Survey
Fathometer Recordings





July, 1995 Lake Limerick Aquatic Plant Survey
Fathometer Recordings





Appendix D
Manufacturer Labels
for SONAR®, AQUATHOL®, and RODEO®

This sample label is current as of February 15, 1995. The product descriptions and recommendations provided in this sample label are for background information only. Always refer to the label on the product before using Monsanto or any other agrichemical product.

RODEO®

EMERGED AQUATIC WEED AND BRUSH HERBICIDE

BY Monsanto

Complete Directions for Use In Aquatic and Other Noncrop Sites.

EPA Reg. No. 524-343

AVOID CONTACT WITH FOLIAGE, GREEN STEMS, EXPOSED NONWOODY ROOTS, OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, SINCE SEVERE INJURY OR DESTRUCTION MAY RESULT.

1995-1 21061T1-1/CG

Read the entire label before using this product.

Use only according to label instructions.

Read "LIMIT OF WARRANTY AND LIABILITY" before buying or using. If terms are not acceptable, return at once unopened.

REFORMULATION IS PROHIBITED. SEE INDIVIDUAL CONTAINER LABEL FOR REPACKAGING LIMITATIONS.

LIMIT OF WARRANTY AND LIABILITY

This Company warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes set forth in the Complete Directions for Use label booklet ("Directions") when used in accordance with those Directions under the conditions described therein. NO OTHER EXPRESS WARRANTY OR IMPLIED WARRANTY OF FITNESS FOR PARTICULAR PURPOSE OR MERCHANTABILITY OR ANY OTHER EXPRESS OR IMPLIED WARRANTY IS MADE. This warranty is also subject to the conditions and limitations stated herein.

Buyer and all users shall promptly notify this Company of any claims whether based in contract, negligence, strict liability, other tort or otherwise.

Buyer and all users are responsible for all loss or damage from use or handling which results from conditions beyond the control of this Company, including, but not limited to, incompatibility with products other than those set forth in the Directions, application to or contact with desirable vegetation, unusual weather, weather conditions which are outside the range considered normal at the application site and for the time period when the product is applied, as well as weather conditions which are outside the application ranges set forth in the Directions, application in any manner not explicitly set forth in the Directions, moisture conditions outside the moisture range specified in the Directions, or the presence of products other than those set forth in the Directions in or on the soil or treated vegetation.

THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE LIMIT OF THE LIABILITY OF THIS COMPANY OR ANY OTHER SELLER FOR ANY AND ALL LOSSES, INJURIES OR DAMAGES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT (INCLUDING CLAIMS BASED IN CONTRACT, NEGLIGENCE, STRICT LIABILITY, OTHER TORT OR OTHERWISE) SHALL BE THE PURCHASE PRICE PAID BY THE USER OR BUYER FOR THE QUANTITY OF THIS PRODUCT INVOLVED, OR, AT THE ELECTION OF THIS COMPANY OR ANY OTHER SELLER, THE REPLACEMENT OF SUCH QUANTITY, OR, IF NOT ACQUIRED BY PURCHASE, REPLACEMENT OF SUCH QUANTITY. IN NO EVENT SHALL THIS COMPANY OR ANY OTHER SELLER BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL, OR SPECIAL DAMAGES.

Buyer and all users are deemed to have accepted the terms of this LIMIT OF WARRANTY AND LIABILITY which may not be varied by any verbal or written agreement.

PRECAUTIONARY STATEMENTS

Hazards to Humans and Domestic Animals

Keep out of reach of children.

CAUTION!

HARMFUL IF INHALED

Avoid breathing vapors or spray mist.

Remove contaminated clothing and wash clothing before reuse.

Wash thoroughly with soap and water after handling.

FIRST AID: IF INHALED, remove individual to fresh air. Seek medical attention if breathing difficulty develops.

In case of an emergency involving this product, Call Collect, day or night, (314) 694-4000.

Environmental Hazards

Do not contaminate water when disposing of equipment washwaters. Treatment of aquatic weeds can result in oxygen depletion or loss due to decomposition of dead plants. This oxygen loss can cause fish suffocation.

In case of: SPILL or LEAK, soak up and remove to a landfill.

Physical or Chemical Hazards

Spray solutions of this product should be mixed, stored and applied using only stainless steel, aluminum, fiberglass, plastic and plastic-lined steel containers.

DO NOT MIX, STORE OR APPLY THIS PRODUCT OR SPRAY SOLUTIONS OF THIS PRODUCT IN GALVANIZED STEEL OR UNLINED STEEL (EXCEPT STAINLESS STEEL) CONTAINERS OR SPRAY TANKS. This product or spray solutions of this product react with such containers and tanks to produce hydrogen gas which may form a highly combustible gas mixture. This gas mixture could flash or explode, causing serious personal injury, if ignited by open flame, spark, welder's torch, lighted cigarette or other ignition source.

ACTIVE INGREDIENT:	
*Glyphosate, N-(phosphonomethyl)glycine, in the form of its isopropylamine salt	53.8%
INERT INGREDIENTS:	46.2%
	100.0%

*Contains 648 grams per litre or 5.4 pounds per U.S. gallon of the active ingredient, glyphosate, in the form of its isopropylamine salt. Equivalent to 480 grams per litre or 4 pounds per U.S. gallon of the acid, glyphosate.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in any manner inconsistent with its labeling.

For more product information, call toll-free 1-800-332-3111.

Storage and Disposal

Do not contaminate water, foodstuffs, feed or seed by storage or disposal.

See container label for STORAGE AND DISPOSAL instructions.

GENERAL INFORMATION

This product, a water-soluble liquid, mixes readily with water and nonionic surfactant to be applied as a foliar spray for the control or destruction of many herbaceous and woody plants.

This product moves through the plant from the point of foliage contact to and into the root system. Visible effects on most annual weeds occur within 2 to 4 days but on most perennial brush species may not occur for 7 days or more. Extremely cool or cloudy weather following treatment may slow the activity of this product and delay visual effects of control. Visible effects are a gradual wilting and yellowing of the plant which advances to complete browning of above-ground growth and deterioration of underground plant parts.

Unless otherwise directed on this label, delay application until vegetation has emerged and reached the stages described for control of such vegetation under the "Weeds Controlled" section of this label.

Unemerged plants arising from unattached underground rhizomes or root stocks of perennials or brush will not be affected by the spray and will continue to grow. For this reason best control of most perennial weeds or brush is obtained when treatment is made at late growth stages approaching maturity.

Always use the higher rate of this product per acre within the recommended range when vegetation is heavy or dense.

Prepare the desired volume of spray solution by mixing the amount of this product in water shown in the following table:

Spray Solution

	AMOUNT OF RODEO*					
DESIRED VOLUME	3/4%	1%	1¼%	1½%	5%	8%
1 gallon	1 oz.	1 oz.	1 oz.	2 oz.	6 oz.	10⅔ oz
25 gallons	1½ pt.	1 qt.	1¼ qt.	1½ qt.	5 qt.	2 gal.
100 gallons	3 qt.	1 gal	1¼ gal.	1½ gal.	5 gal	8 gal

2 tablespoons = 1 ounce

For use in knapsack sprayers it is suggested that the recommended amount of this product be mixed with water in a larger container. Fill sprayer with the mixed solution and add the correct amount of surfactant.

WEEDS CONTROLLED

ANNUAL WEEDS

Apply to actively growing annual grasses and broadleaf weeds.

Allow at least 3 days after application before disturbing treated vegetation. After this period the weeds may be mowed, tilled or burned. See "Directions for Use," "General Information" and "Mixing and Application Instructions" for labeled uses and specific application instructions.

Broadcast Application—Use 1 1/2 pints of this product per acre plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution if weeds are less than 6 inches tall. If weeds are greater than 6 inches tall, use 2 1/2 pints of this product per acre plus 2 or more quarts of an approved nonionic surfactant per 100 gallons of spray solution.

Hand-Held, High-Volume Application—Use a 3/4 percent solution of this product in water plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution and apply to foliage of vegetation to be controlled.

When applied as directed under the conditions described in this label, this product plus nonionic surfactant WILL CONTROL the following ANNUAL WEEDS:

Balsamapple**
Momordica charantia

Barley
Hordeum vulgare

Barnyardgrass
Echinochloa crus-galli

Bassia, fivehook
Bassia hyssopifolia

Bluegrass, annual
Poa annua

Bluegrass, bulbous
Poa bulbosa

Brome
Bromus spp.

Buttercup
Ranunculus spp.

Cheat
Bromus secalinus

Chickweed, mouseear
Cerastium vulgatum

Cocklebur
Xanthium strumarium

Corn, volunteer
Zea mays

Crabgrass
Digitaria spp

Dwarfdandelion
Krigia cespitosa

Falseflax, smallseed
Camelina microcarpa

Fiddleneck
Amsinckia spp.

Flaxleaf fleabane
Conyza bonariensis

Fleabane
Erigeron spp.

Foxtail
Setaria spp.

Foxtail, Carolina
Alopecurus carolinianus

Groundsel, common
Senecio vulgaris

Horseweed/Marestail
Conyza canadensis

Kochia
Kochia scoparia

Lambsquarters, common
Chenopodium album

Lettuce, prickly
Lactuca serriola

Morningglory
Ipomoea spp.

Mustard, blue
Chorispora tenella

Mustard, tansy
Descurainia pinnata

Mustard, tumble
Sisymbrium altissimum

Mustard, wild
Sinapis arvensis

Oats, wild
Avena fatua

Panicum
Panicum spp.

Pennycress, field
Thlaspi arvense

Pigweed, redroot
Amaranthus retroflexus

Pigweed, smooth
Amaranthus hybridus

Ragweed, common
Ambrosia artemisiifolia

Ragweed, giant
Ambrosia trifida

Rocket, London
Sisymbrium irio

Rye
Secale cereale

Ryegrass, Italian*
Lolium multiflorum

Sandbur, field
Cenchrus spp.

Shattercane
Sorghum bicolor

Shepherdspurse
Capsella bursa-pastoris

Signalgrass, broadleaf
Brachiaria platyphylla

Smartweed, Pennsylvania
Polygonum pensylvanicum

Sowthistle, annual
Sonchus oleraceus

Spanishneedles*
Bidens bipinnata

Stinkgrass
Eragrostis cilianensis

Sunflower
Helianthus annuus

Thistle, Russian
Salsola kali

Spurry, umbrella
Holosteum umbellatum

Velvetleaf
Abutilon theophrasti

Wheat
Triticum aestivum

Witchgrass
Panicum capillare

*Apply 3 pints of this product per acre.

**Apply with hand-held equipment only.

Annual weeds will generally continue to germinate from seed throughout the growing season. Repeat treatments will be necessary to control later germinating weeds.

PERENNIAL WEEDS

Apply this product as follows to control or destroy most vigorously growing perennial weeds. Unless otherwise directed, allow at least 7 days after application before disturbing vegetation.

Add 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution to the rates of this product given in this list. See the "General Information," "Directions for Use" and "Mixing and Application" sections in this label for specific uses and application instructions.

NOTE: If weeds have been mowed or tilled, do not treat until regrowth has reached the recommended stages. Fall treatments must be applied before a killing frost.

Repeat treatments may be necessary to control weeds regenerating from underground parts or seed.

When applied as recommended under the conditions described, this product plus surfactant WILL CONTROL the following PERENNIAL WEEDS:

Alfalfa
Medicago sativa

Alligatorweed*
Alternanthera philoxeroides

Anise/Fennel
Foeniculum vulgare

Artichoke, Jerusalem
Helianthus tuberosus

Bahiagrass
Paspalum notatum

Bermudagrass
Cynodon dactylon

Bindweed, field
Convolvulus arvensis

Bluegrass, Kentucky
Poa pratensis

Blueweed, Texas
Helianthus ciliaris

Brackenfern
Pteridium spp.

Bromegrass, smooth
Bromus inermis

Canarygrass, reed
Phalaris arundinacea

Cattail
Typha spp.

Clover, red
Trifolium pratense

Clover, white
Trifolium repens

Cogongrass
Imperata cylindrica

Cordgrass
Spartina spp.

Cutgrass, giant*
Zizaniopsis miliacea

Dallisgrass
Paspalum dilatatum

Dandelion
Taraxacum officinale

Dock, curly
Rumex crispus

Dogbane, hemp
Apocynum cannabinum

Fescue
Festuca spp

Fescue, tall
Festuca arundinacea

Guineagrass
Panicum maximum

Hemlock, poison
Conium maculatum

Horsenettle
Solanum carolinense

Horseradish
Armoracia rusticana

Ice Plant
Mesembryanthemum crystallinum

Johnsongrass
Sorghum halepense

Reed, giant/ice plant—For control of giant reed and ice plant, apply a 1 1/2 percent solution of this product with hand-held equipment when plants are actively growing. For giant reed, best results are obtained when applications are made in late summer to fall.

Spatterdock—Apply 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when most plants are in full bloom. For best results, apply during the summer or fall months.

Sweet potato, wild—Apply this product as a 1 1/2 percent solution using hand-held equipment. Apply to actively growing weeds that are at or beyond the bloom stage of growth. Repeat applications will be required. Allow the plant to reach the recommended stage of growth before retreatment.

Thistle: Canada, artichoke—Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment for Canada thistle. To control artichoke thistle, apply a 2 percent solution as a spray-to-wet application. Apply when target plants are actively growing and are at or beyond the bud stage of growth.

Torpedograss—Apply 6 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment to provide partial control of torpedograss. Use the lower rates under terrestrial conditions, and the higher rates under partially submerged or a floating mat condition. Repeat treatments will be required to maintain such control.

Tules, common—Apply this product as a 1 1/2 percent solution with hand-held equipment. Apply to actively growing plants at or beyond the seedhead stage of growth. After application, visual symptoms will be slow to appear and may not occur for 3 or more weeks.

Waterhyacinth—Apply 5 to 6 pints of this product per acre as a broadcast spray or apply a 3/4 to 1 percent solution with hand-held equipment. Apply when target plants are actively growing and at or beyond the early bloom stage of growth. After application, visual symptoms may require 3 or more weeks to appear with complete necrosis and decomposition usually occurring within 60 to 90 days. Use the higher rates when more rapid visual effects are desired.

Waterlettuce—For control, apply a 3/4 to 1 percent solution of this product with hand-held equipment to actively growing plants. Use higher rates where infestations are heavy. Best results are obtained from mid-summer through winter applications. Spring applications may require retreatment.

Waterprimrose—Apply this product as a 3/4 percent solution using hand-held equipment. Apply to plants that are actively growing at or beyond the bloom stage of growth, but before fall color changes occur. Thorough coverage is necessary for best control.

Other perennials listed on this label—Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached early head or early bud stage of growth.

WOODY BRUSH AND TREES

When applied as recommended under the conditions described, this product plus surfactant CONTROLS or PARTIALLY CONTROLS the following woody brush plants and trees:

Alder
Alnus spp.

Ash*
Fraxinus spp.

Aspen, quaking
Populus tremuloides

Bearclover, Bearmat
Chamaebatia foliolosa

Birch
Betula spp.

Blackberry
Rubus spp.

Broom:
French
Cytisus monspessulanus
Scotch
Cytisus scoparius

Buckwheat, California*
Eriogonum fasciculatum

Cascara*
Rhamnus purshiana

Catsclaw*
Acacia greggii

Ceanothus
Ceanothus spp.

Chamise
Adenostoma fasciculatum

Cherry:
Bitter
Prunus emarginata
Black
Prunus serotina
Pin
Prunus pensylvanica

Coyote brush
Baccharis consanguinea

Creeper, Virginia*
Parthenocissus quinquefolia

Dewberry
Rubus trivialis

Dogwood
Cornus spp.

Elderberry
Sambucus spp.

Elm*
Ulmus spp.

Eucalyptus, bluegum
Eucalyptus globulus

Hasardia*
Haplopappus squamosus

Hawthorn
Crataegus spp.

Hazel
Corylus spp.

Hickory
Carya spp.

Holly, Florida, Brazilian Peppertree
Schinus terebinthifolius

Honeysuckle
Lonicera spp.

Hornbeam, American
Carpinus caroliniana

Kudzu
Pueraria lobata

Locust, black*
Robinia pseudoacacia

Manzanita
Arctostaphylos spp.

Maple:
Red**
Acer rubrum
Sugar
Acer saccharum
Vine*
Acer circinatum

Monkey Flower*
Mimulus guttatus

Oak:
Black*
Quercus velutina
Northern pine
Quercus palustris
Post
Quercus stellata
Red
Quercus rubra
Southern red
Quercus falcata
White*
Quercus alba

Persimmon*
Diospyros spp.

Poison Ivy
Rhus radicans

Poison Oak
Rhus toxicodendron

Poplar, yellow*
Liriodendron tulipifera

Prunus
Prunus spp.

Raspberry
Rubus spp.

Redbud, eastern
Cercis canadensis

Rose, multiflora
Rosa multiflora

Russian-olive
Elaeagnus angustifolia

Sage: black, white
Salvia spp.

Sagebrush, California
Artemisia californica

Salmonberry
Rubus spectabilis

Salt cedar*
Tamarix spp.

Saltbush, Sea myrtle
Baccharis halimifolia

Sassafras
Sassafras albidum

Sourwood*
Oxydendrum arboreum

Sumac:
Poison*
Rhus vernix
Smooth*
Rhus glabra
Winged*
Rhus copallina

Sweet gum
Liquidambar styraciflua

Swordfern*
Polystichum munitum

Tallowtree, Chinese
Sapium sebiferum

Thimbleberry
Rubus parviflorus

Tobacco, tree*
Nicotiana glauca

Trumpetcreeper
Campsis radicans

Waxmyrtle, southern*
Myrica cerifera

Willow
Salix spp.

*Partial control

**See below for control or partial control instruction.

NOTE: If brush has been mowed or tilled or trees have been cut, do not treat until regrowth has reached the recommended stage of growth.

Apply the recommended rate of this product plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution when plants are actively growing and, unless otherwise directed, after full-leaf expansion. Use the higher rate for larger plants and/or dense areas of growth. On vines, use the higher rate for plants that have reached the woody stage of growth. Best results are obtained when application is made in late summer or fall after fruit formation.

In arid areas, best results are obtained when application is made in the spring or early summer when brush species are at high moisture content and are flowering. Ensure thorough coverage when using hand-held equipment. Symptoms may not appear prior to frost or senescence with fall treatments.

Allow 7 or more days after application before tillage, mowing or removal. Repeat treatments may be necessary to control plants regenerating from underground parts or seed. Some autumn colors on undesirable deciduous species are acceptable provided no major leaf drop has occurred. Reduced performance may result if fall treatments are made following a frost.

See the "Directions for Use" and "Mixing and Application Instructions" sections in this label for labeled use and specific application instructions.

Applied as a 5 to 8 percent solution as a directed application as described in the "HAND-HELD AND HIGH-VOLUME EQUIPMENT" section, this product will control or partially control all species listed in this section of this label. Use the higher rate of application for dense stands and larger woody brush and trees.

Wiper applications can be used to control or suppress annual and perennial weeds listed on this label. In heavy weed stands a double application in opposite directions may improve results. See the "Weeds Controlled" section in this label for recommended timing, growth stage and other instructions for achieving optimum results.

CUT STUMP APPLICATION

Woody vegetation may be controlled by treating freshly cut stumps of trees and resprouts with this product. Apply this product using suitable equipment to ensure coverage of the entire cambium. Cut vegetation close to the soil surface. **Apply a 50 to 100 percent solution of this product to freshly cut surface immediately after cutting.** Delay in applying this product may result in reduced performance. For best results, trees should be cut during periods of active growth and full leaf expansion.

When used according to directions for cut stump application this product will CONTROL, PARTIALLY CONTROL or SUPPRESS most woody brush and tree species, some of which are listed below:

Alder
Alnus spp.

Coyote brush*
Bacchans consanguinea

Dogwood*
Cornus spp.

Eucalyptus
Eucalyptus spp.

Hickory*
Carya spp.

Madrone
Arbutus menziesii

Maple*
Acer spp.

Oak
Quercus spp.

Poplar*
Populus spp.

Reed, giant
Arundo donax

Salt cedar
Tamarix spp.

Sweet gum*
Liquidambar styraciflua

Sycamore*
Platanus occidentalis

Tan oak
Lithocarpus densiflorus

Willow
Salix spp.

*This product is not approved for this use on these species in the state of California.

INJECTION AND FRILL APPLICATIONS

Woody vegetation may be controlled by injection or frill application of this product. Apply this product using suitable equipment which must penetrate into living tissue. Apply the equivalent of 1 ml of this product per 2 to 3 inches of trunk diameter. This is best achieved by applying 25 to 100 percent concentration of this product either to a continuous frill around the tree or as cuts evenly spaced around the tree below all branches. As tree diameter increases in size, better results are achieved by applying dilute material to a continuous frill or more closely spaced cuttings. Avoid application techniques that allow runoff to occur from frill or cut areas in species that exude sap freely after frills or cutting. In species such as these, make frill or cut at an oblique angle so as to produce a cupping effect and use undiluted material. For best results, applications should be made during periods of active growth and full leaf expansion.

This treatment WILL CONTROL the following woody species:

Oak
Quercus spp.

Poplar
Populus spp.

Sweet gum
Liquidambar styraciflua

Sycamore
Platanus occidentalis

This treatment WILL SUPPRESS the following woody species:

Black gum*
Nyssa sylvatica

Dogwood
Cornus spp.

Hickory
Carya spp.

Maple, red
Acer rubrum

*This product is not approved for this use on this species in the state of California.

RELEASE OF BERMUDAGRASS OR BAHIAGRASS ON NONCROP SITES

RELEASE OF DORMANT BERMUDAGRASS AND BAHIAGRASS

When applied as directed, this product will provide control or suppression of many winter annual weeds and tall fescue for effective release of dormant bermudagrass or bahiagrass. Make applications to dormant bermudagrass or bahiagrass.

For best results on winter annuals, treat when weeds are in an early growth stage (below 6 inches in height) after most have germinated. For best results on tall fescue, treat when fescue is in or beyond the 4 to 6-leaf stage.

WEEDS CONTROLLED

Rate recommendations for control or suppression of winter annuals and tall fescue are listed below.

Apply the recommended rates of this product in 10 to 25 gallons of water per acre plus 2 quarts nonionic surfactant per 100 gallons of total spray volume.

<u>WEEDS CONTROLLED OR SUPPRESSED*</u>

NOTE. C = Control
S = Suppression

WEED SPECIES	RODEO* FLUID OZ/ACRE 6	9	12	18	24	48
Barley, little *Hordeum pusillum*	S	C	C	C	C	C
Bedstraw, catchweed *Galium aparine*	S	C	C	C	C	C
Bluegrass, annual *Poa annua*	S	C	C	C	C	C
Chervil *Chaerophyllum tainturieri*	S	C	C	C	C	C
Chickweed, common *Stellaria media*	S	C	C	C	C	C
Clover, crimson *Trifolium incarnatum*	•	S	S	C	C	C
Clover, large hop *Trifolium campestre*	•	S	S	C	C	C
Speedwell, corn *Veronica arvensis*	S	C	C	C	C	C
Fescue, tall *Festuca arundinacea*	•	•	•	•	S	S
Geranium, Carolina *Geranium carolinianum*	•	•	S	S	C	C
Henbit *Lamium amplexicaule*	•	S	C	C	C	C
Ryegrass, Italian *Lolium multiflorum*	•	•	S	C	C	C
Vetch, common *Vicia sativa*	•	•	S	C	C	C

*These rates apply only to sites where an established competitive turf is present.

RELEASE OF ACTIVELY GROWING BERMUDAGRASS

NOTE: USE ONLY ON SITES WHERE BAHIAGRASS OR BERMUDAGRASS ARE DESIRED FOR GROUND COVER AND SOME TEMPORARY INJURY OR YELLOWING OF THE GRASSES CAN BE TOLERATED.

When applied as directed, this product will aid in the release of bermudagrass by providing control of annual species listed in the "Weeds Controlled" section in this label, and suppression or partial control of certain perennial weeds.

For control or suppression of those annual species listed in this label, use 3/4 to 2 1/4 pints of this product as a broadcast spray in 10 to 25 gallons of spray solution per acre, plus 2 quarts of a nonionic surfactant per 100 gallons of total spray volume. Use the lower rate when treating annual weeds below 6 inches in height (or length of runner in annual vines). Use the higher rate as size of plants increases or as they approach flower or seedhead formation.

Use the higher rate for partial control or longer-term suppression of the following perennial species. Use lower rates for shorter-term suppression of growth.

Bahiagrass
Dallisgrass
Fescue (tall)
Johnsongrass**
Trumpetcreeper*
Vaseygrass

*Suppression at the higher rate only.
**Johnsongrass is controlled at the higher rate.

Use only on well-established bermudagrass. Bermudagrass injury may result from the treatment but regrowth will occur under moist conditions. Repeat applications in the same season are not recommended, since severe injury may result.

BAHIAGRASS SEEDHEAD AND VEGETATIVE SUPPRESSION

When applied as directed in the "Noncrop Sites" section in this label, this product will provide significant inhibition of seedhead emergence and will suppress vegetative growth for a period of approximately 45 days with single applications and approximately 120 days with sequential applications.

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AQUATHOL® K

AQUATIC HERBICIDE

ACTIVE INGREDIENT	
Dipotassium salt of endothall*	40.3%
INERT INGREDIENTS	59.7%
TOTAL	100.0%

*7-oxabicyclo [2.2.1]heptane-2,3-dicarboxylic acid equivalent 28.6%
Contains per gallon 4.23 lb. dipotassium endothall
(equivalent to 3.0 lbs. endothal acid)

KEEP OUT OF REACH OF CHILDREN

DANGER POISON

STATEMENT OF PRACTICAL TREATMENT

IF SWALLOWED, drink promptly a large quantity of milk, egg whites, gelatin solution or if these are not available, drink large quantities of water. Avoid alcohol. Call a physician immediately.

IF ON SKIN, immediately flush with plenty of water for at least 15 minutes. Remove and wash contaminated clothing before reuse.

IF IN EYES, immediately flush with plenty of water for at least 15 minutes. Call a physician.

NOTE TO PHYSICIAN: Probable mucosal damage may contraindicate the use of gastric lavage. Measures against circulatory shock, respiratory depression and convulsion may be needed.

See Side Panel for Additional Precautionary Statements

NOTE: For GENERAL INFORMATION and DIRECTIONS FOR USE refer to accompanying brochure.

EPA Registration No. 4581-204 EPA Establishment No. 4581-TX-1

Net Contents ____ Gallons/____ Liters

ELF ATOCHEM NORTH AMERICA, INC.
Aghem Division
2000 Market Street, Philadelphia, PA 19103

GENERAL INFORMATION

AQUATHOL K is a liquid concentrate soluble in water which is effective against a broad range of aquatic plants with a margin of safety to fish.

Dosage rates indicated for the application of AQUATHOL K are measured in "Parts Per Million" (ppm) of dipotassium endothall. Only 0.5 to 5.0 ppm are generally required for aquatic weed control, whereas some fish species are tolerant to approximately 100 ppm or over.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

AQUATIC WEEDS CONTROLLED AND DOSAGE RATE CHARTS

AQUATHOL K is recommended for the control of the following aquatic weeds in irrigation and drainage canals, ponds and lakes at the rates indicated. Since the active ingredient is water soluble and tends to diffuse from the area treated, select the dosage rate applicable to the area to be treated. Use the lower rate in each range of rates where the growth is young and growing and/or where the weed stand is not heavy. Marginal treatments of large bodies of water require higher rates as indicated.

HOW TO APPLY:
AQUATHOL K is a contact killer; consequently, do not apply before weeds are present. Application as early as possible after weeds are present is recommended to permit use of lower application rates. However, for best results water temperature should be at 65°F or above. If an entire pond is treated at one time, or if the dissolved oxygen level is low at time of application, decay of weeds may remove enough oxygen from the water, causing fish to suffocate. Water containing very heavy vegetation should be treated in sections to prevent suffocation of fish. Sections should be treated 5-7 days apart. Carefully measure size and depth of area to be treated and determine amount of AQUATHOL K to apply from chart. For best results apply on a calm day where there is little wave action.

AQUATHOL K should be sprayed on the water or injected below the water surface and should be distributed as evenly as possible. It may be applied as it comes from the container or diluted with water depending on the equipment. Some dilution will give better distribution.

In instances where the nuisance to be controlled is an exposed surface problem (i.e., some of the broad-leaved pond weeds) it is important to get good contact coverage utilizing the highest concentration (least water dilution) compatible with the type of equipment used so that even distribution is achieved.

Necessary approval and/or permits should be obtained in states where required.

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AQUATHOL®

GRANULAR AQUATIC HERBICIDE

ACTIVE INGREDIENT	
Dipotassium salt of endothall*	10.1%
INERT INGREDIENTS	89.9%
TOTAL	100.0%

*7-oxabicyclo [2.2.1]heptane-2,3-dicarboxylic acid equivalent 7.2%

KEEP OUT OF REACH OF CHILDREN

DANGER

STATEMENT OF PRACTICAL TREATMENT

IF IN EYES, hold eyelids open and flush with a steady, gentle stream of water for 15 minutes. Call a physician.

IF SWALLOWED, drink promptly a large quantity of milk, egg whites, gelatin solution or if these are not available, drink large quantities of water. Avoid alcohol. Call a physician immediately.

IF ON SKIN, immediately flush with plenty of water for at least 15 minutes. Remove and wash contaminated clothing before reuse.

NOTE TO PHYSICIAN: Probable mucosal damage may contraindicate the use of gastric lavage. Measures against circulatory shock, respiratory depression and convulsion may be needed.

See Side Panel for Additional Precautionary Statements

EPA Registration No. 4581-201 EPA Establishment No. 228-IL-1

40 Lbs. Net Weight

ELF Atochem North America, Inc.
Agchem Division
Philadelphia, PA

Specimen Label

SePRO

Sonar* A.S.

Herbicide

A herbicide for management of aquatic vegetation in fresh water ponds, lakes, reservoirs, drainage canals and irrigation canals

Active Ingredient:
fluridone: 1-methyl-3-phenyl-5-[3-(trifluoromethyl)phenyl]-4(1*H*)-pyridinone 41.7%
Inert Ingredients 58.3%
Total 100.0%
Contains 4 pounds active ingredient per gallon.

EPA Reg. No. 67690-4

Precautionary Statements

Hazards to Humans and Domestic Animals

Keep Out of Reach of Children

CAUTION PRECAUCION

Precaucion al usuario: Si usted no lee inglés, no use este producto hasta que la etiqueta le haya sido explicada ampliamente.

Harmful If Swallowed, Absorbed Through Skin, Or If Inhaled

Avoid breathing of spray mist or contact with skin, eyes, or clothing. Wash thoroughly with soap and water after handling. Wash exposed clothing before reuse.

First Aid

If in eyes: Flush eyes or skin with plenty of water. Get medical attention if irritation persists.
If swallowed: Call a physician or poison control center, drink one or two glasses of water and induce vomiting by touching back of throat with finger. Do not induce vomiting or give anything by mouth to an unconscious person.
If inhaled: Remove victim to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. Get medical attention.

Environmental Hazards

Follow use directions carefully so as to minimize adverse effects on nontarget organisms. In order to avoid impact on threatened or endangered aquatic plant or animal species, users must consult their State Fish and Game Agency or the U.S. Fish and Wildlife Service before making applications.

Do not contaminate water when disposing of equipment washwaters. Trees and shrubs growing in water treated with Sonar A.S. herbicide may occasionally develop chlorosis. Do not apply in tidewater/brackish water.

Lowest rates should be used in shallow areas where the water depth is considerably less than the average depth of the entire treatment site, for example, shallow shoreline areas.

Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
Read all Directions for Use carefully before applying.
Shake well before using.

Storage and Disposal

Do not contaminate water, food, or feed by storage or disposal.
Storage: Store in original container only. Do not store near feed or foodstuffs. In case of leak or spill, use absorbent materials to contain liquids and dispose as waste.
Pesticide Disposal: Wastes resulting from use of this product may be used according to label directions or disposed of at an approved waste disposal facility.
Container Disposal: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

Sonar* A.S. Herbicide

*Trademark of SePRO Corporation

Mixing and Application Directions

The aquatic plants present in the treatment site should be identified prior to application to determine their susceptibility to Sonar A.S. It is important to determine the area (acres) to be treated and the average depth in order to select the proper application rate. Do not exceed the maximum labeled rate for a given treatment site per annual growth cycle.

Shake Sonar A.S. well before using. Add the recommended amount of Sonar A.S. to water in the spray tank during the filling operation. Agitate while filling and during spraying. Surface or subsurface application of the spray can be made with conventional spray equipment. Sonar A.S. can also be applied near the surface of the hydrosoil using weighted trailing hoses. A spray volume of 5 to 100 gallons per acre may be used. Sonar A.S. may also be diluted with water and the concentrated mix metered into the pumping system.

Application to Ponds

Sonar A.S. may be applied to the entire surface area of a pond. Rates may be selected to provide 0.06 to 0.09 ppm of active ingredient in the treated water. Application rates necessary to obtain these active ingredient concentrations in treated water are shown in the following table. When average water depth of the treatment site is greater than 5 feet, apply 1 to 1.5 quarts of Sonar A.S. per treated surface acre.

Average Water Depth of Treatment Site (feet)	Quarts of Sonar A.S. per Treated Surface Acre
1	0.16 - 0.25
2	0.33 - 0.50
3	0.50 - 0.75
4	0.65 - 1.00
5	0.80 - 1.25

Use the higher rate within the rate range where there is a dense weed mass or when treating more difficult to control species.

Application to Lakes and Reservoirs

For best results in lakes and reservoirs, Sonar A.S. treatment areas should be a minimum of 5 acres in size. Treatment of areas smaller than 5 acres or treatment of narrow strips such as boat lanes or shorelines may not produce satisfactory results due to dilution by untreated water. In lakes and reservoirs, do not apply Sonar A.S. within one-fourth mile (1320 feet) of any functioning potable water intake.

Rates may be selected to provide 0.075 to 0.15 ppm of active ingredient in the treated water. Application rates necessary to obtain these active ingredient concentrations in treated water are shown in the following table. When average water depth of the treatment site is greater than 10 feet, apply 3 to 4 quarts of Sonar A.S. per treated surface acre.

Average Water Depth of Treatment Site (feet)	Quarts of Sonar A.S. per Treated Surface Acre
1	0.2 - 0.4
2	0.4 - 0.8
3	0.6 - 1.2
4	0.8 - 1.6
5	1.0 - 2.0
6	1.2 - 2.4
7	1.4 - 2.8
8	1.6 - 3.2
9	1.8 - 3.6
10	2.0 - 4.0

Use the higher rate within the rate range where there is a dense weed mass or when treating more difficult to control species.

Use Rates for Control of Eurasian Watermilfoil in Whole Lake or Reservoir Treatments: The following application rates may be used for control of Eurasian watermilfoil when treating lakes or reservoirs where little dilution with untreated water is expected to occur. Under these conditions, Sonar may be applied to provide a concentration of 0.01 to 0.02 ppm (10 to 20 ppb) of active ingredient in treated water. Application rates necessary to achieve these active ingredient concentrations in treated water are shown in the following table. For optimum control, it is recommended that applications be made early in the growing season.

Average Water Depth of Treatment Site (feet)	Quarts of Sonar A.S. per Treated Surface Acre
1	0.027 - 0.05
2	0.05 - 0.11
3	0.08 - 0.16
4	0.11 - 0.22
5	0.14 - 0.27
6	0.16 - 0.32
7	0.19 - 0.38
8	0.22 - 0.43
9	0.24 - 0.49
10	0.27 - 0.54

When treated with these use rates, other less susceptible species listed under Aquatic Plants Controlled may exhibit only temporary injury or stunting followed by recovery and normal growth. These 0.01 to 0.02 ppm rates may be applied where functioning potable water intakes are present. Note: When applications for management of Eurasian watermilfoil are made to only portions of lakes or reservoirs such as bays or fingers of these water bodies, the higher rates and use directions listed on this label for Applications to Lakes and Reservoirs are recommended.

Application Rate Calculation - Ponds, Lakes and Reservoirs

The amount of Sonar A.S. to be applied to provide the desired ppm concentration of active ingredient in treated water may be calculated as follows:

Quarts of Sonar A.S. required per treated surface acre = Average water depth of treatment site (feet) x Desired ppm concentration of active ingredient x 2.7

For example, the quarts per acre of Sonar A.S. required to provide a concentration of 0.075 ppm of active ingredient in water with an average depth of 5 feet is calculated as follows:

5 x 0.075 x 2.7 = 1.0 quart per treated surface acre.

When measuring quantities of Sonar A.S., quarts may be converted to fluid ounces by multiplying quarts to be measured x 32. For example, 0.25 quarts x 32 = 8 fluid ounces.

Note: Calculated rates should not exceed the maximum allowable rate in quarts per treated surface acre for the water depth listed in the application rate table for the site to be treated.

Application to Drainage Canals and Irrigation Canals

In drainage and irrigation canals, Sonar A.S. should be applied at the rate of 2 quarts per treated surface acre. Where water retention is possible, the performance of Sonar A.S. will be enhanced by restricting water flow. In moving bodies of water, use an application pattern that will provide a uniform distribution and avoid concentration of the herbicide.

Supplemental Labeling

SePRO Corporation 11550 North Meridian St., Suite 200 Carmel, Indiana 46032 USA

Sonar* A.S. Herbicide (EPA Reg. No. 67690-4)

Sonar for Control of Eurasian Watermilfoil in Whole Lake or Reservoir Treatments

- It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
- **This labeling must be in the possession of the user at the time of application and is intended for use only by Federal, State or local public agency personnel, trained in aquatic weed control, or by licensed commercial applicators under contract to or supervised by the above agencies.**
- **Note to applicators (State and Local Coordination):** Before application under any project program, notification and approval of local and state authorities may be required, either by letter of agreement or issuance of special permits for such use.
- **All Directions for Use, General Information, Application Information, Precautions and Limitations on the Sonar A.S. label apply to this supplemental labeling.**

Use Rates for Control of Eurasian Watermilfoil in Whole Lake or Reservoir Treatments:
The following application rates may be used for control of Eurasian watermilfoil when treating lakes or reservoirs where little dilution with untreated water is expected to occur. Under these conditions, Sonar may be applied to provide a concentration of 0.01 to 0.02 ppm (10 to 20 ppb) of active ingredient in treated water. Application rates necessary to achieve these active ingredient concentrations in treated water are shown in the following table. For optimum control, it is recommended that applications be made early in the growing season.

Average Water Depth of Treatment Site (feet)	Quarts of Sonar A.S. per Treated Surface Area
1	0.027-0.05
2	0.05-0.11
3	0.08-0.16
4	0.11-0.22
5	0.14-0.27
6	0.16-0.32
7	0.19-0.38
8	0.22-0.43
9	0.24-0.49
10	0.27-0.54

When treated with these use rates, other less susceptible species listed under Aquatic Plants Controlled may exhibit only temporary injury or stunting followed by recovery and normal growth. These 0.01-0.02 ppm rates may be applied where functioning potable water intakes are present. Note: When applications for management of Eurasian watermilfoil are made to only portions of lakes or reservoirs such as bays or fingers of these water bodies, the higher rates and use directions listed on the label accompanying the product under Applications to Lakes and Reservoirs are recommended.

*Trademark of SePRO Corporation

Post-it™ Fax N

Approved 6/21/94

Appendix E
Conceptual Design for Grass Carp Containment Structures on Lake Limerick Outlet/Inlets
KCM, Inc.

ENGINEERS | ARCHITECTS | PLANNERS | APPLIED SCIENTISTS

KCM

Seattle
Portland
Kansas City
Juneau
Taiwan

November 2, 1995

Mr. Dan Robinson
Lake Limerick Country Club
East 790 St. Andrews Drive
Shelton, Washington 98584

Subject: Grass Carp Containment Structures on Lake Limerick

Dear Dan:

The following material is a draft summary of our findings for a system to contain grass carp in Lake Limerick. If there is additional material we need to include for our report to the State and the County on November 14, please give me a call, and we can discuss the issues before the meeting.

Sincerely,

KCM, INC.

Wayne J. Daley, C.F.S.
Sr. Fisheries Biologist

WJD:lo

c: *Harry Gibbons*
Lowell Warren
Central Files

2550022-001

KCM, Inc.
1917 First Avenue
Seattle, WA
98101-1027
Tel 206.443.5300
Fax 206.443.5372

DRAFT

INTRODUCTION

In May of 1995 KCM, Inc. was retained to evaluate the issue of containment structures for grass carp on Lake Limerick. The study was to evaluate and prepare a conceptual design for both the inlets and the outlet of the lake. In addition, this study was to develop cost estimates for the structures required to keep grass carp from leaving the lake. Cranberry Creek and two additional un-screened small inlets enter the lake under St. Andrews Drive by way of culverts. The outlet of the lake is an existing concrete structure which includes an adult fish passage for the returning coho.

DESIGN ISSUES

At the present time, weed growth in Lake Limerick has created a problem for people who are using the lake for recreation and for property owners with waterfront homes. The problems include interference with boat operation, swimming dead and decaying plant matter on the beaches and water quality issues associated with intense weed growth. One of the state-of-the-art methods for the removal of aquatic vegetation is the use of triploid grass carp. These animals have demonstrated the ability to remove aquatic vegetation. The genetic alteration, as triploids, prevents their breeding and reduces the potential for biological problems as an introduced (exotic) species; however, the State of Washington Department of Fish & Wildlife, as a measure of safety, requires that structures must confine the movement of the introduced fish to the receiving water.

The dam, which was built to create Lake Limerick, includes a concrete structure which includes the spillway and fish passage. The structure, required to prevent the grass carp from going downstream while allowing juvenile and adult salmon passage, is a simple structure and uses existing and proven technology; however, the structures to prevent upstream migration of the grass carp is not as simple a solution. Grass carp are, by nature, upstream swimmers. In addition, they are well known as jumpers when confined in ponds or nets. The problem with designing a structure to prevent the carp from moving upstream, while allowing adult salmon to migrate upstream, is the lack of technical data concerning the ability of the carp to jump over fish weirs.

In an effort to address this problem, we conducted a literature search through the technical services of The US Fish & Wildlife Service. We were unable to find any data to assist us in the design of upstream migration weirs which would preclude the use of the weirs by the carp. To further explore the swimming capability of the grass carp, we talked with the operators of two of the largest carp rearing facilities in the country. Both of these operators indicated that the carp would easily jump to heights of 3 feet. Although this height was not associated with water flowing over a weir, they were certain that the carp would jump over an 18 to 24-inch weir used for coho migration. With this information in hand, it not possible for us to guarantee a weir design to keep carp in the lake from moving upstream.

Based on our observation of the movement of grass carp out of Silver Lake in Cowlitz County, we feel there is a possible alternative to this problem. In the early period of use of carp in Silver Lake there was a hole in the downstream containment structure. An the Department of Fish & Wildlife consider a variance on the requirement for screens on the inlets to Lake Limerick.

COST ESTIMATES

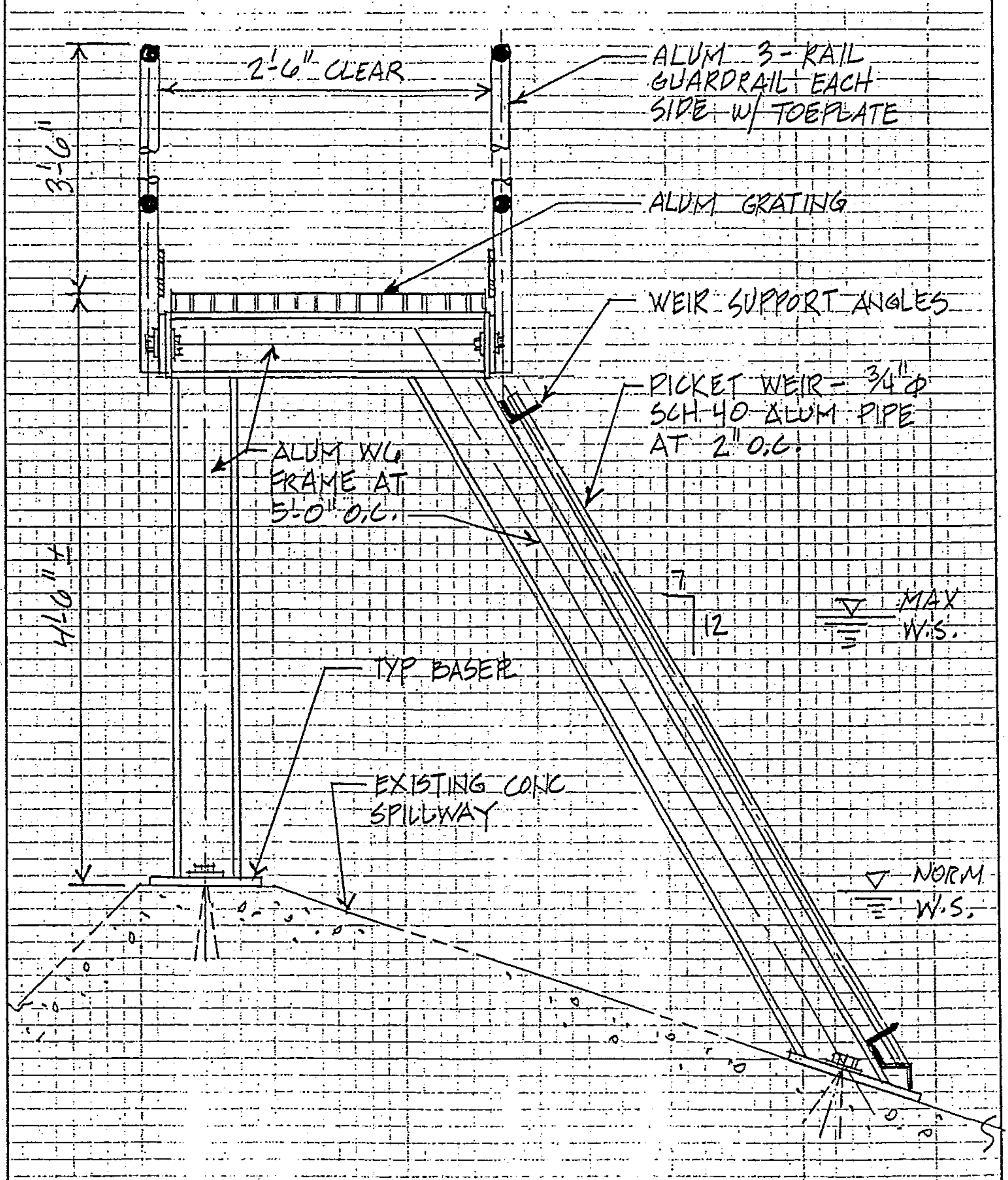
A summary of the costs for all of the structures is attached. Because this estimate is based on conceptual design, there is a 50% construction contingency. The contingency costs include consulting fees (geotechnical assistance, etc.) for permit submittals and support for public meetings and agency meetings.

All of the structures for this estimate are assumed to be fabricated from aluminum. The installed cost is based on a cost per pound of material and represents typical costs at present for aluminum structures.

CLIENT:

PROJECT:

SUBJECT:



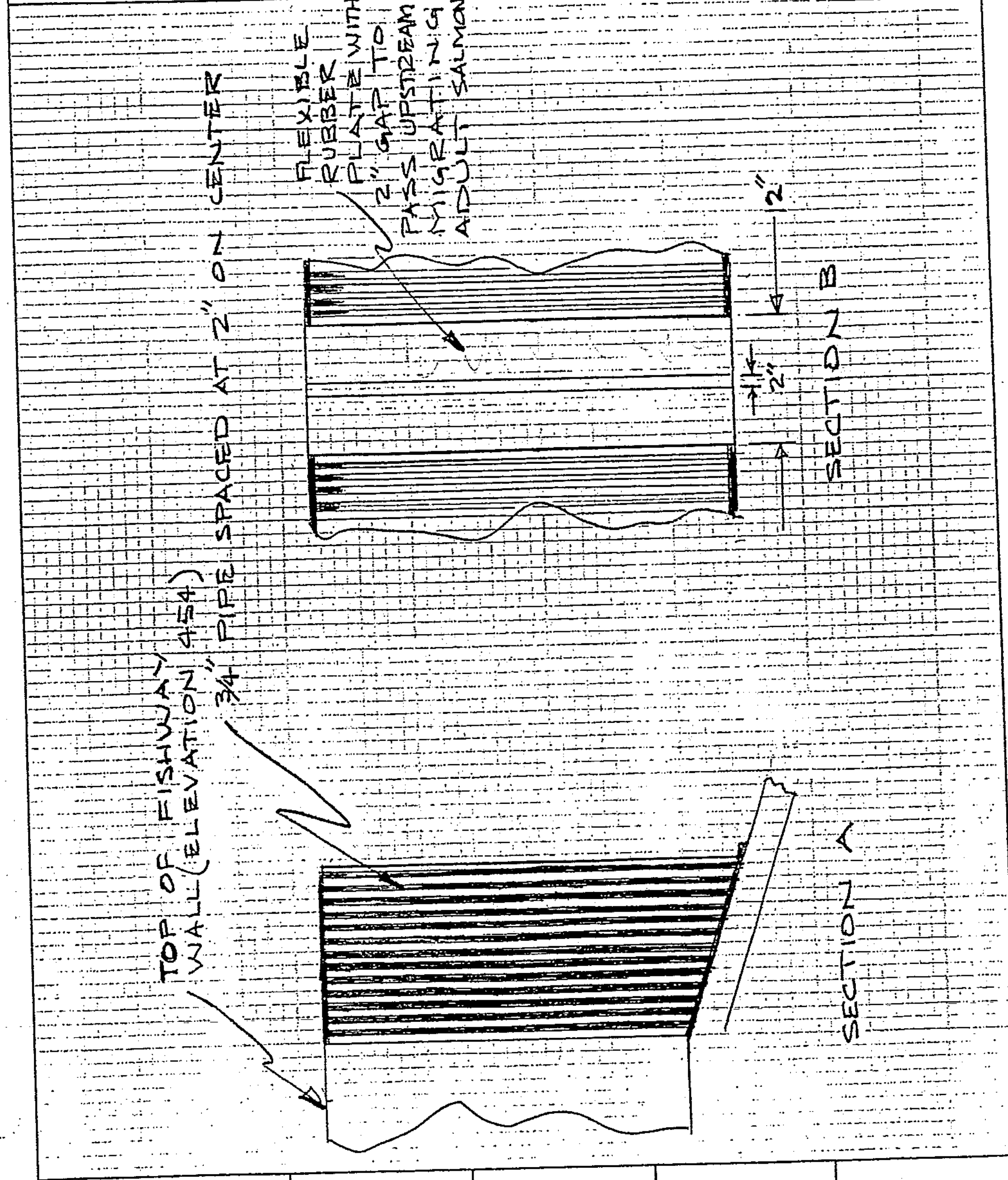
KCM

GB

CLIENT:

PROJECT: LAKE LIMERICK

SUBJECT: FISHWAY EXIT DETAILS FOR GRASS CARP CONTROL



KCM | WJD | 10/15/95 | FIGURE 4

TABLE 1

Construction Cost Estimate Detail Sheet

KCM, INC
1917 FIRST AVI
SEATTLE, WA

Project: LAKE LIMERICK GRASS CARP CONTAINMENT STRUCTURES
Subject:
CSI Section:
Location: LAKE LIMERICK
Base Location:

Level of Est.: CONCEPT
Project No.: 2550022

Sheet: 1 OF 1
Prepared by: WJD
Date: 11/1/1995
Revised by:
Date:

Item No.	Description	Quant.	Unit	Labor $	Material $	Unit Price $	Total $
	MOBILIZATION & DEMOB.	1	LS			2,500.00	2,500
	OUTLET STRUCTURE						
	PICKET WEIR (34FT.)	3,000	LB			8.00	24,000
	FISHWAY EXIT	750	LB			8.00	6,000
	SUBTOTAL						**32,500**
	CONSTRUCTION CONTIGENCY - 50%						**16,250**
	DESIGN FEE (outlet only)		LS				**4,500**
	CONST. ADMIN.		LS				**3,000**
	SUBTOTAL						**56,250**
	TYPICAL INLET STRUCTURE (3 REQUIRED)						
	PICKET WEIR (1900 LB EA)	6,000	LB			8.00	48,000
	FISHWAY EXIT (750 LB EA)	2,200	LB			8.00	17,600
	CONSTRUCTION CONTINGENCY - 50%						32,800
	DESIGN FEE (inlet only)		LS				**7,500**
	CONST. ADMIN.		LS				**4,500**
	SUBTOTAL						110,400
	TOTAL						**166,650**

Appendix F
Addendums to Original Lake Limerick IAPMP

LAKE LIMERICK/LAKE LEPRECHAUN 5-YEAR INTEGRATED MANAGEMENT PLAN (Current)

Single SONAR/ Mechanical-Physical Scenario B*	Program Elements	1st Year Act Costs 1996	2ndYear Act Costs 1997	3rd Year ActCosts 1998	4th Year Est Costs 1999	5th Year Est Costs 2000	6th Year Est Costs 2001
Large-scale systemic herbicide applic w/intensive small-scale physical/mechanical treatments	Annual Macrophyte Survey with biomass sampling	$3,000	$5,030	$3,600	$3,225(Act)	$3,384(Act)	$3,000
	SONAR (fluridone) applic phased over one year only	$85,000	$0	$0	$0	$0	$0
	Mitigation of native plants, if needed	$0	$0	$0	$0	$0	$0
	Engineering design-grass carp outlet modif feasibility	$4,000	$0	$0	$0	$0	$0
	IAPMP devel-1996 balance	$4,000	$0	$0	$0	$0	$0
	Addtl plan modif/data coll	$0	$650	$600	$300(act)	$300(enc)	$3,000
	Permitting/(checklist)	$0	$500	$500	$0	$0	$500
	Small-scale treatment						
	•bottom barrier-up to 2 ac	$0	$0	$0	$0	$0	$0
	•diver removal--2 acre	$0	$0	$0	$0	$0	$0
	•combo mech/phys method poss barrier replaceYr5	$0	$0	$0	$0	$0	$10,000
	SONAR applic-block	$0	$6,500	$0	$0	$0	$0
	•manual harvesting-5 acres	$0	$3,000	$0	$7,000	$3,500	$3,500
	•contact herbicide-spot treatmt-up to 10 acres	$0	$1,500	$0	$0	$0	$0
	Public Ed/Watershed Mnmt	$2000+vol	$2,000+vol	$2,000+vol	$2,000+vol	$2,000+vol	$2,000+vol
	Program Monitor/Eval w/Steering Committee	$4000+vol	$4000+vol	$2000+vol	$4000+vol	$4000+vol	$4000+vol
	Program Administration	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500
TOTALS		**$103,500 expended & paid**	**$24,680 expended & paid**	**$10,200**	**$18,025**	**$14,684**	**$27,500**

- 1997 AWMF Implementation Grant Application Program Year

LAKE LIMERICK/LAKE LEPRECHAUN 5-YEAR INTEGRATED MANAGEMENT PLAN DEC 1996

2-Phase SONAR/ Mechanical-Physical Scenario A	Program Elements	1st Year Act Costs 1996	2nd Year• Est Costs 1997	3rd Year Est Costs 1998	4th Year Est Costs 1999	5th Year Est Costs 2000	6th Year Est Costs 2001
Large-scale systemic herbicide applic	Annual Macrophyte Survey with biomass sampling	$3000	$3000	$3000	$3000	$3000	$3000
w/second-yr applic, if necessary	SONAR (fluridone) applic	$85,000	$30,000 to $50,000	$0	$0	$0	$0
w/intensive small-scale physical/mechanical treatments	Mitigation of native plants, if needed	$0	$0	$5,000	$0	$0	$0
	Engineering design-grass carp outlet modif feasibility	$4,000	$0	$0	$0	$0	$0
	IAPMP devel-1996 balance Addtl plan modif/data coll Permitting/(checklist)	$4,000 $0 $0	$0 $6,000 $500	$0 $6,000 $500	$0 $6,000 $500	$0 $6,000 $500	$0 $3,000 $500
	Small-scale treatment •bottom barrier-up to 2 ac •diver removal--2 acre •combo mech/phys method poss barrier replace Yr5 •manual harvesting-5 acres •contact herbicide-spot treatmt-up to 10 acres	$0 $0 $0 $0 $0	$0-$50,000 $0 $0 $7,000 $1,500	$,0 $10,000-20,000 $0 $7,000 $0	$0 $0 $13,000 $7,000 $4,000	$0 $0 $13,000 $7,000 $0	$0 $0 $10,000 $3,500 $0
	Public Ed/Watershed Mnmt	$2000+vol	$2,000+vol	$2,000+vol	$2,000+vol	$2,000+vol	$1,000+vol
	Program Monitor/Eval w/ Steering Committee	$4000+vol	$4000+vol	$4000+vol	$4000+vol	$4000+vol	$3000+vol
	Program Administration	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500
TOTALS		$103,500 already paid	$55,500 to $125,500	$39,000 to $49,000	$41,000	$37,000	$24,500

• 1997 AWMF Implementation Grant Application Program Year

LAKE LIMERICK/LAKE LEPRECHAUN 5-YEAR INTEGRATED MANAGEMENT PLAN DEC 1996

Single SONAR/ Mechanical-Physical Scenario B	Program Elements	1st Year Act Costs 1996	2nd Year Est Costs 1997	3rd Year Est Costs 1998	4th Year Est Costs 1999	5th Year Est Costs 2000	6th Year Est Costs 2001
Large-scale systemic herbicide applic	Annual Macrophyte Survey with biomass sampling	$3000	$3000	$3000	$3000	$3000	$2000
	SONAR (fluridone) applic	$85,000	$0	$0	$0	$0	$0
w/intensive small-scale physical/mechanical treatments	Mitigation of native plants, if needed	$0	$5,000	$0	$0	$0	$0
	Engineering design-grass carp outlet modif feasibility	$4,000	$0	$0	$0	$0	$0
	IAPMP devel-1996 balance	$4,000	$0	$0	$0	$0	$0
	Addtl plan modif/data coll	$0	$6,000	$6,000	$6,000	$6,000	$3,000
	Permitting/(checklist)	$0	$500	$500	$500	$500	$500
	Small-scale treatment •bottom barrier-up to 2 ac	$0	$0-$50,000	$,0	$0	$0	$0
	•diver removal--2 acre	$0	$10,000-20,000	$0	$0	$0	$0
	•combo mech/phys method poss barrier replaceYr5	$0	$0	$13,000	$13,000	$13,000	$10,000
	•manual harvesting-5 acres		$7,000	$7,000	$7,000	$7,000	$3,500
	•contact herbicide-spot treatmt-up to 10 acres	$0	$1,500	$0	$4,000	$0	$0
	Public Ed/Watershed Mnmt	$2000+vol	$2,000+vol	$2,000+vol	$2,000+vol	$2,000+vol	$1,000+vol
	Program Monitor/Eval w/ Steering Committee	$4000+vol	$4000+vol	$4000+vol	$4000+vol	$4000+vol	$3000+vol
	Program Administration	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500
TOTALS		**$103,500 already paid**	**$40,500 to $100,500**	**$37,000**	**$41,000**	**$37,000**	**$24,500**

• 1997 AWMF Implementation Grant Application Program Year

LAKE LIMERICK
INTEGRATED AQUATIC PLANT MANAGEMENT PLAN

Amended Action Plan for Lake Limerick For Year 2+

In a formal vote of the Lake Limerick membership held in a Public Meeting in January, 1996, Treatment Scenario #2 (involving phased large-scale herbicide/biological treatments) was overwhelmingly chosen as the heart of the recommended long-term action plan for the lake. A large-scale application of the systemic herbicide, SONAR, was successfully completed in Lake Limerick during the summer of 1996, meeting the recommended IAPM Plan objectives for Implementation Year One. However, since adoption of the original recommended plan and initiation of Year One Program elements, issues and concerns have arisen regarding possible use of sterile grass carp in Year Two (1997). Specific concerns involve required outlet/inlet barrier construction and maintenance costs (community), and ecological considerations of using sterile grass carp in salmonid-bearing waters of the Lake Limerick system (Wash. Dept. Fish & Wildlife, Squaxin Island Tribe). In keeping with the dynamic concept of an integrated aquatic plant management plan, these recent concerns have prompted re-evaluation of the elements of the original long-term IAPM Plan for Lake Limerick. At present, the original option of introducing sterile grass carp in Year Two of the minimum 5-year integrated plan for Lake Limerick does not appear to be feasible. Certainly, use of sterile grass carp in Lake Limerick may be a future possibility, but more discussion and evaluation of important issues surrounding this biocontrol technique is presently warranted before inclusion in the longterm plan .

As a result of these developments, an alternative management scenario is needed to replace the grass carp control element in the long-term integrated plan for Lake Limerick. Two amended options are proposed based on carryover effectiveness of the lakewide SONAR treatment that was conducted in Year One (1996) against target Brazilian elodea populations. Carryover effectiveness in the year after herbicide treatment will be assessed by performing a quantitative macrophyte survey and biomass sampling along transects previously established around the lake and using assessment techniques employed in pre-treatment surveys on Lake Limerick (see IAPMP). Treatment Scenario A is triggered by **lesser efficacy** of the 1996 SONAR application and thus, a larger residual area of Brazilian elodea found actively growing in the lake in Year Two (1997), requiring additional moderate-scale aggressive control. The only large-scale effective control technique appropriate to this objective and available for use is a followup treatment with the same herbicide, SONAR. Treatment Scenario B is recommended if herbicide carryover **effectiveness is substantial** in Year Two, with small areas of Brazilian elodea beds documented around the lake that can be further controlled by small-scale intensive measures (physical and mechanical). Beyond Year Two, both scenarios include small-scale follow-up treatments with hand removal and bottom barriers to prevent re-infestation of Brazilian elodea.

In addition to aggressive treatment of in-lake noxious, nuisance weed populations, the amended Lake Limerick IAPMP continues to recommend other lake and watershed management elements to maintain beneficial uses. While the immediate problem is an exotic weed infestation, the plan emphasizes the importance of watershed management in limiting inputs of nutrients and other contaminants to the two-lake system. The plan also includes provisions for a public awareness program, and an annual monitoring program to evaluate effectiveness. Furthermore, to maximize benefits of exotic Brazilian elodea removal, it is critical to sustain a noxious weed prevention program so that any new outbreaks can be destroyed. Additionally, the long-term plan contains provisions for continued monitoring and management of Lake Leprechaun, which drains into Lake Limerick. Other program elements include permitting, use restrictions, and securing and implementing funding. It must be stressed that aquatic plant management in Lake Limerick, particularly management of the exotic weed species, Brazilian elodea, will be an **on-going concern** and will take **long-term commitment**. Furthermore, the resulting Plan is

dynamic and flexible, with checkpoints (Annual evaluations, Steering Committee Meetings) set along the way to allow for any changes in course direction or control tactics. Given the difficulty in routing established Brazilian elodea from a system, a five-year (minimum) program using the following elements is still recommended. It is anticipated that with aggressive in-lake treatments against the noxious Brazilian elodea populations in the lake in the first two years, management efforts and costs should decline substantially to reasonable levels that can be sustained by the Lake Limerick community.

Long-term Management Scenario A
(Large regrowth area of Brazilian elodea in Year 2)

In-lake Treatments

Whole lake aquatic plant survey and biomass sampling in Spring

(Completed in 1996)-----------(Year 1)Large-scale application of systemic herbicide SONAR

(Year 2)Secondary application of systemic herbicide SONAR or equivalent herbicide, if regrowth of target Brazilian elodea exceeds 5-10 acres

(Year 2+)Minor treatments using aquatic algaecide, if needed

Minor treatments using hand removal and bottom barrier and/or mini suction dredge

Minor treatments–manual harvesting

Minor treatments–contact herbicide application

Other Program Elements

Environmental permits and assessment, if necessary
Use restrictions or modifications
Mitigation of native plants downstream, if needed
Public Outreach and Education Program
Noxious Weed Prevention Program
Program Monitoring and Effectiveness Evaluation

- aquatic plant surveys
- water quality monitoring
- regular meetings of Steering Committee

Watershed Management Program
Implementation and funding plan
Program administration costs

Long-term Management Scenario B
(Small regrowth area of Brazilian elodea in Year 2)

In-lake Treatments

Whole lake aquatic plant survey and biomass sampling in Spring

(Completed in 1996)-----------(Year 1)Large-scale application of systemic herbicide SONAR

(Year 2)Minor treatments using diver removal and/or bottom barrier placement if regrowth of target Brazilian elodea is less than 5 acres

(Year 2+)Minor treatments using aquatic algaecide, if needed

Minor treatments using hand removal and bottom barrier and/or mini suction dredge

Minor treatments–manual harvesting

Minor treatments-contact herbicide application

Other Program Elements

Environmental permits and assessment, if necessary
Use restrictions or modifications
Mitigation of native plants downstream, if needed
Public Outreach and Education Program
Noxious Weed Prevention Program

Program Monitoring and Effectiveness Evaluation

- aquatic plant surveys
- water quality monitoring
- regular meetings of Steering Committee

Watershed Management Program
Implementation and funding plan
Program administration costs