LAKE MANAGEMENT PLAN

FOR

LAKE CLEMENTIA, LAKE CALERO, LAKE CHESBRO, LAGUNA JOAQUIN AND BASS LAKE

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1.0 MISSION OF THE LAKE MANAGEMENT PLAN

Provide high water quality in a cost effective manner while maintaining the lakes' natural aquatic ecosystems, compatible with the recreational, aesthetic and water source uses of the lakes.

2.0 PROBLEM STATEMENT

Over time, the recreational, aesthetic and water supply uses of the lakes have been reduced on a seasonal basis due to aquatic plant growth. Each lake identified herein has unique uses and aquatic plant growth. The following are problem statements for each lake.

2.1 *Lake Clementia*

Currently the primary use of Clementia is for recreation. At full buildout, Clementia will be used as a water supply lake, and its recreational uses will be lessened.

Eurasian Milfoil has been a problem at the swimming area and around the shore up to the boat dock. A thick edge of tules grow on the east and north banks.

2.2 *Lake Calero*

Calero is the largest water supply lake and, as such, its recreational use is limited to fishing and no body contact.

Tule growth has increased sporadically along its banks, diminishing fishing access and may lead to water quality supply issues.

2.3 *Lake Chesbro*

Chesbro is the primary water supply lake feeding into the water treatment plant. Its recreational use is limited to fishing and no body contact.

Tule growth has increased sporadically along its banks, diminishing fishing access and may lead to water quality supply issues. In addition Eurasian Milfoil has grown outward from the tules hampering fishing.

2.4 *Laguna Joaquin*

Joaquin is the community's entry theme lake for the north development. Its primary uses are catch and release fishing and irrigation supply, while providing an aesthetic benefit to the entry landscaping.

2.5 *Bass Lake*

Bass Lake is the primary water storage lake for the north golf course. It receives reclaimed water and river water for irrigation on the golf course. Its uses are limited to irrigation and catch and release fishing with no body contact.

Tule growth has increased sporadically along its banks, diminishing fishing access and may lead to water quality supply issues. Eurasian Milfoil growth beyond the tule edges also limits fishing use and access and may lead to water quality supply issues. In the summer duckweed blankets the surface. In shallow areas near the golf course algae blooms matt the surface.

3.0 GOALS

These goals take into account the lakes, their characteristics and uses, the community, and associated costs. The goals are outlined as follows:

- Reduce and then maintain Eurasian Milfoil in Lake Clementia swimming and dock area, as is environmentally and economically feasible.
- Reduce overgrowth of tules in lakes Clementia, Calero and Chesbro, while maintaining a balanced wildlife habitat.
- Reduce and then maintain Eurasian Milfoil in Lake Chesbro as is environmentally and economically feasible, while not degrading its water supply nature.
- Reduce tule growth in Bass Lake. Reduce and then maintain Eurasian Milfoil without hampering irrigation practices and uses of the lake. Control algae in shallower areas of lake.
- Manage algae growth in Laguna Joaquin.
- Implement watershed management to reduce nutrients and silt in Laguna Joaquin.
- Develop and begin implementation of an educational plan that will reduce the algae growth in Laguna Joaquin.
- Seek a balanced approach for treatments. Take into consideration all beneficial uses, including the domestic water source, recreational use, the fishery, and wildlife habitat.

- Continue lake water quality monitoring and data collection for management information.

4.0 DEFINITION OF AQUATIC PLANTS

4.1 *Aquatic Plants and Algae*

Aquatic plants are large vascular plants that live in wet conditions. Aquatic plants (also called macrophytes) usually possess true roots, stems and leaves, and look like plants in your yard. They can be grouped into four types: emergent plants, rooted floating-leafed plants, submersed plants, and free-floating plants. **Emergent plants** have a large portion of stems and leaves growing above (emerging from) the water surface; they are found in shallow water (less than 2 feet deep) or along the shoreline.

Rooted floating-leafed plants have leaves that float on or just above the surface, but are connected to the bottom by long, tough stalks. **Submersed plants** have most of their leaves and stems below the water surface, often with flowering parts projecting above surface. They may be securely or loosely rooted in the bottom.

Free-floating plants float near the water surface, with root systems dangling in the water, but not connected to the sediment.

Algae are simple, primitive plants that do not have true roots, stems or leaves. Many algal species are microscopic forms that float in the water (called phytoplankton). Some appear as large, easily seen upright forms, and are called macro-algae. Certain types of green algae can form stringy colonies 3 feet or more in length. Nuisance algal growth commonly associated with nutrient problems often appears in the form of surface scum that are greenish or brownish in color.

Algae are an essential part of pond ecosystems. In fact, they provide the main source of oxygen for living things in ponds. However, when temperature and nutrient levels are just right, usually during the summer, algal growth can progress uncontrollably forming an "algae bloom." As with most things in excess, too much algae is a bad thing. Algae blooms are characterized by dense mats of green or red colored algae on the pond surface.

Typical aquatic plants encountered in the community's lakes are:

- Eurasian Milfoil
- Duckweed
- Tules
- Algae

Each lake is unique in its aquatic growth. Lake Calero has by far the least problems with aquatic plant intrusion. Bass Lake is known for excessive tule and Eurasian Milfoil growth.

5.0 AQUATIC PLANT CONTROLS

5.1 *Physical Control Methods*

Physical methods of aquatic plant control include:

- Hand-pulling
- Bottom barrier application (sediment covers/bottom screens)
- Water level drawdown
- Implementing watershed controls to reduce nutrient inputs
- Water column dyes

Each method will be briefly discussed in terms of mode of action, effectiveness and duration of control, advantages, drawbacks, costs, and required permits.

5.10 *Hand Pulling*

Principle: Hand-digging and removal of rooted, submerged 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.

Hand pulling also includes gathering algae growth on the surface, concentrating it in one location, and pulling it ashore and or into a boat.

<u>Control Effectiveness and Duration</u>: 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.

<u>Advantages</u>: 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 appropriate for small-area, low plant density treatments. In these cases, the technique is very useful for aggressive control of sparse or small pockets of Eurasian Milfoil.

<u>Drawbacks</u>: The technique is time-consuming and costly, especially where contract divers may be used. 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.

5.11 Hand Cutting

<u>Principle</u>: This technique is also a manual method, but differs from hand-pulling in that plants are cut below the water surface (roots generally not removed). 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.

<u>Control Effectiveness and Duration</u>: 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.

<u>Advantages</u>: The technique results in immediate removal of nuisance submerged plant growth. Costs are minimal.

<u>Drawbacks</u>: 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. 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.

5.12 *Bottom Barriers*

<u>Principle</u>: 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, nylon film, rock cobbles, and rip rap 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.

<u>Control Effectiveness and Duration</u>: 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. After satisfactory control has been achieved (usually several months), some barrier materials can be relocated to other areas to increase benefits.

<u>Advantages</u>: Bottom barriers can usually be easily applied to small, confined areas such as around docks 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.

<u>Drawbacks</u>: Depending on the material, major drawbacks to the application of 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. Cobble and rip rap bunkers tend to reduce shoreline access.

5.13 *Water Level Drawdown*

Principle: Water level drawdown used for management of aquatic plants involves exposing plants and root systems to prolonged freezing and drying, or hot, dry conditions to kill the plants. Drawdown for plant control is usually performed during winter months, although summertime drawdowns are sometimes conducted. Its use has been more common in management of reservoirs and ponds than in natural lakes.

Water drawdown also includes lowering lake levels and flushing out dirty water laden with weed growth and/or nutrients and replenishing with cleaner alternative water sources. Water drawdown can be used in conjunction with mechanical or hand pulling of weeds or tules.

Control Effectiveness and Duration: Aquatic plants vary in terms of susceptibility to drawdown. Some aquatic plants can be permanently damaged after sufficient exposure, while others are unaffected or even enhanced. For Eurasian Milfoil, effects have been variable, partly because of its ability to withstand low temperatures for short periods of time, as well as its resiliency and tenacity. The mild, wet winters typical may not provide adequate freezing/drying conditions to kill certain plants.

Flushing is seasonal and its benefits are determined more by the quantity and timing of nutrients and/or silt.

Advantages: In addition to controlling aquatic plant biomass, drawing down the water level makes it possible to use several other management procedures for restoration or improvement. For instance, it can be used for fish management, to repair structures, such as docks or dams. This technique can result in compaction of certain types of sediments, such as mucky substrates and, thus, improve shoreline use. Decreasing near shore vegetation through drawdown can reduce potential inputs of nutrients to the water from seasonal dying of aquatic plants.

Drawbacks: This technique is not species-selective; removal of beneficial plant species may occur. Wetlands adjacent to the water body can be exposed with possible negative impacts on both plant and associated animal communities. If summer or winter drawdown is implemented for plant control, sediments must become completely dry for a prolonged period of time to kill plant roots.

5.14 Watershed Controls

<u>Principle</u>: The principle involves reducing sources of external (outside) nutrient and sediment inputs by implementing watershed best management practices (BMPs). The idea is to shut off entry of growth-stimulating nutrients (phosphorus and nitrogen) to the water body by using prudent household and yard care practices, as well as employing construction and road maintenance practices that minimize pollutant loadings in the watershed. Common examples of homeowner BMP's include: using prudent lawn and garden fertilizing practices, and disposing of yard litter by shredding or composting well away from water's edge, and preventing silt laden runoff from construction activities.

Erosion protection for silt laden runoff can be prevented by using BMPs at construction sites.

<u>Control Effectiveness and Duration</u>: If it has been demonstrated that excessive rooted macrophyte growth is due to siltation and external nutrient inputs and not to historically-enriched sediments, then appropriate watershed controls could provide long-term control of nuisance aquatic plant growth. But it will take many years to achieve this because siltation has created suitable habitat for plants to flourish, with an adequate supply of nutrients already contained in sediments.

<u>Advantages</u>: Watershed best management practices are wide-ranging and usually easy to perform. Since the watershed and water body are interconnected, any reduction in contaminant loading to a water body as a result of BMPs can maintain or extend effectiveness of in-lake controls.

<u>Drawbacks</u>: Employing BMPs to correct nuisance aquatic plant growth will not result in immediate, substantial growth reduction because habitat has already been created that supports aquatic plant growth.

5.15 Water Column Dyes

<u>Principle</u>: The theory behind this technique is to suppress aquatic plant growth by shading the plants from sunlight needed for photosynthetic growth. Dark-colored dyes are applied to the water, which reduces the amount of light reaching the submersed plants.

Control Effectiveness And Duration: Aquashade is a commercial dye product available for applications in closed systems (water bodies with no outflow). According to the manufacturer, Aquashade is apparently effective against Eurasian Milfoil. These products are probably more effective in shallower water bodies where dye concentrations can be kept up and the loss of dye through dilution would be less. Best results are obtained when the product is used early in the growth season.

Advantages: Aquashade is reported to be non-toxic to humans, livestock, and aquatic organisms. No special equipment is needed for application; it can be poured into the water by hand from shoreline or boat. It imparts a blue color to the water.

Drawbacks: Its use is limited to shallow water bodies with no outflow. According to the manufacturer, Aquashade is less effective when aquatic plant growth is within 2 feet of the surface In this case other methods of removal are recommended prior to dye use. This can increase program costs considerably. Repeat dye treatments may be necessary throughout the growth season. Aquashade should not be used in drinking water supplies, in flowing waters, or in chlorinated waters.

5.2 *Mechanical Control Methods*

Mechanical methods for aquatic plant control include:

- Mechanical harvesting
- Aeration

5.21 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.

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, depending on water depth and the depth of cut.

Advantages: Harvesting is most appropriately used for large, open areas with few surface obstructions. There is usually little interference with the use of the 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: Cut plant material requires collection and removal from the water. Harvesting creates plant fragments. This is of great concern with Eurasian Milfoil, given its ability to rapidly disperse by fragmentation. Harvesting can be detrimental to non-target plants and animals, 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.

5.22 *Aeration*

Principle: Oxygen from the atmosphere is mixed into the water through diffusion. However, more oxygen is mixed into the water with the help of winds, rain, waves, and currents. The process of photosynthesis (underwater plants and algae) occurring in the water affects the number and kinds of animals found there.

Levels of dissolved oxygen below 4-5 milligrams per liter affect fish health and levels below 2 milligrams per liter can be lethal to fish. This assumes normal oxygen cycles during the day and night. Minimum oxygen levels should be above 2 to 3 milligrams per liter.

Dissolved oxygen is affected by weather, temperature, and even salinity. Cold, fresh water holds more oxygen than warm or salty water. When the weather conditions are dry and hot, the water temperature increases which may result in evaporation. Dissolved oxygen concentrations may decrease under these conditions.

Seasons will also have an impact on the oxygen concentrations in the water. When the water temperature increases during the day, the oxygen level decreases by late afternoon.

Algal photosynthesis, particularly during periods of high aquatic growth may increase the oxygen level during the day; however, algae is also responsible for oxygen depletions in the water. At night when photosynthesis can not occur, loss of oxygen usually occurs when the algae respires, as well as when the plants die and begin to degrade. Dissolved oxygen concentrations are typically lowest at dawn.

Control Effectiveness and Duration:
Emergency aeration is commonly practiced in larger isolated areas of 3 to 20 acres and involves the use of splash or spray type aerators, typically powered by tractors, or electric or fuel driven motors. This aeration is used only when dissolved oxygen drops to levels stressful to fish. Inherent in this approach is the need to frequently monitor oxygen in the pond to anticipate when crises may arise. To maximize the efficient use of emergency aeration equipment, it is desirable to only aerate during periods of low oxygen and to be able to move the aerators from area to area as needed. The more powerful the aerator, the more rapidly the oxygen may be raised to safe levels.

Maintenance aeration systems are intended to prevent critical low oxygen levels from occurring. Aeration systems of this type typically include a low-pressure high-volume blower, PVC and/or polyethylene distribution pipe, and air releasers. Often small bubble diffusers are used to maximize oxygen transfer from the air stream. Air is released near the pond bottom, aerating and mixing water as it rises to the surface.

Advantages: These systems are relatively energy efficient and, when operated continuously, create and sustain an improved environment for fish.

Disadvantages: Total operating costs may be higher for the maintenance systems, but labor cost of oxygen monitoring are reduced, risk due to low oxygen kills minimized, and higher production per acre is often realized. Oxygen maintenance systems usually entail higher purchase and installation costs, but again the benefits realized can offset the initial expense over a relatively short period of time. Also, power outages or mechanical breakdowns can shut down any unit.

6.0 BIOLOGICAL METHODS

6.1 *Grass Carp*

Currently, in Northern California, introduction of triploid (sterile) grass carp as a biological control method is strictly prohibited.

6.2 *Barley Straw*

Principle: Barley straw offers an environmentally acceptable and cost effective method of algae control. When barley straw is put into water, it starts to rot. During this process, a chemical is released that inhibits the growth of algae. The chemical released by the straw does not kill algal cells already present, but it prevents the growth of new cells.

In still waters, such as lakes, ponds and reservoirs, the minimum quantity of straw needed to control algae is 10g straw / sq yd of water surface. It is better to apply the straw in a loose form retained in some type of netting or cage, anchored in the desired location.

Control Effectiveness and Duration: Straw is best applied in the autumn, winter or very early spring, when the water temperature is low. Barley straw can be effective in controlling algae when used on its own or in combination with various chemicals.

Advantages: Barley straw is a natural means to control algae. It is very low cost and has a high public acceptance level.

Disadvantages: Barley straw may not be readily available on the west coast. Straw suppliers are typically located in Canada and the northeast US. Trucking costs may be high depending on the haul distance and load size.

7.0 CHEMICAL METHODS

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

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.

7.1 *Fluridone*

Principle: Fluridone is available as the EPA-registered herbicide SONAR for use in the management of aquatic plants in freshwater ponds, lakes, reservoirs, and irrigation canals. It is sprayed above or below surface, and in controlled release pellets on the water surface. SONAR is effectively absorbed and translocated by both plant roots and shoots.

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. 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. 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 extensive human health risk studies, it has been determined that use of fluridone according to label instructions does not pose any affect to human health. 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. DOHS has prohibited its use in water supply lakes.

7.2 *Glyphosate*

<u>Principle</u>: Glyphosate (N-(phosphonomethyl)glycine) is a non-selective, broad spectrum herbicide used primarily for control of emergent or floating-leafed plants like water lilies. 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 for aquatic application.

<u>Control Effectiveness And Duration</u>: Glyphosate is effective against many emergent and floating-leafed plants, such as water lilies and rooted growth such as tules. 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.

<u>Advantages</u>: 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.

<u>Drawbacks</u>: 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.

7.3 *<u>Copper Chelates</u>*

<u>Principle</u>: Copper is an essential element for plant growth. High concentrations of copper can lead to inhibition of photosynthesis and plant death. In order to maintain effective concentrations of the copper ion in solution, a number of chelated or complexed forms of copper have been developed. These complexed copper compounds are much more effective herbicides than copper sulfate.

Cutrine is a chelated (chemically locked-in) copper compound. This concentrated product provides a long contact (killing) time, contains no sulfates, prevents the build-up of toxic copper carbonate precipitates, and causes little harm to non-target aquatic organisms. Cutrine-Plus has worked effectively against several noxious weed species when combined with other chemicals or when used by itself.

Control Effectiveness and Duration: Its use is primarily limited to algae control. The effectiveness of complexed copper compounds is enhanced by warm temperatures and sunlight, conditions that stimulate copper uptake by sensitive plants. Depending on timing of the initial treatment and regrowth rates, a second treatment after about 12 weeks may be necessary for full season control.

Advantages: Costs of copper treatment are low relative to other herbicides for submersed plant control. There are no use restriction following treatment; complexed copper can even be used in potable water supplies.

Drawbacks: Copper is persistent in the environment. Applied copper eventually becomes bound to organic materials and clay particles and is deposited in the sediment. Yearly application of copper to lakes can result in elevated copper concentrations in sediments. Although the bioavailability and toxic effects of sediment-bound copper is unknown, the toxicity of the copper ion to fish is higher in soft than in hard water.

8.0 Control Alternatives Available for Rancho Murieta

A variety of methods are currently available for controlling nuisance aquatic plants. The following is a list of aquatic plant control alternatives currently available in Rancho Murieta:

Physical Methods:

- Hand-pulling/cutting
- Bottom barrier application/ sediment covers
- Water-level drawdown and flushing
- Water-level drawdown and mechanical removal
- Watershed controls

Mechanical Methods:

- Harvesting and cutting

- Aeration

Biological Methods:

- Barley straw

Chemical Methods:

- Copper compounds
- RODEO
- SONAR

9.0 RECOMMENDED CONTROL AND TREATMENT SCENARIO

Each lake is different and as a result each lake has a different treatment and control program. The program is dynamic. As conditions change seasonally, physically, and naturally over time, the recommended program will change also.

Lake management is a balancing act at times very proactive and later letting nature take its course in controlling plant growth. Plant growth is essential for healthy lakes and for wildlife habitat as well as recreational activities.

The following table presents the recommended control and treatment scenario for each lake with suggested timing.

Table 1

Treatment and Control Methods

Lake	Hand Pulling	Bottom Barrier	Water Drawdown	Harvesting	Aeration	Biological	Chemical	Watershed Controls
Clementia	Tule removal in Fall		Yearly due to usage				Sonar for Eurasian milfoil in May and June	
Calero	Tule removal in Fall		Yearly due to usage					
Chesbro	Tule removal in late Spring or early Fall.	Rock slopes or barrier fabric at selected locations, over time	Draw down with mechanical removal.	Barge harvesting of Eurasian milfoil in Spring as necessary		Barley straw		
Laguna Joaquin	Algae removal by pulling, as needed during summer	Rock slopes, as provided by RMA	Flushing flows during winter		As needed during summer	Barley straw	Copper sulfate for algae blooms during summer	Erosion protection at construction sites during winter Nutrient removal from lawns during spring thru fall
Bass Lake	Tule removal in Fall	Rock slopes and/or steeper slopes		Barge harvesting in Spring as necessary		Barley straw		Nutrient removal from course during spring thru fall

10.0 MONITORING AND SAMPLING PROGRAM

10.1 *Lake Characteristics That May Be Monitored*

<u>Transparency</u>: Water transparency is one of the oldest and easiest methods for describing a lake. Over the years the method of measuring transparency has been standardized to allow comparisons of measurements taken by different people in different lakes. The standard method utilizes a **Secchi disk** to measure transparency. A Secchi disk is a large diameter, black and white plate that can be lowered into the water on a rope. The depth at which the disk disappears from view (the Secchi depth) is related to the amount of materials (algae, sediment, and dissolved organic material) suspended in the water column. The Secchi depth has been correlated with a number of indices that indicate the overall productivity of the lake, including the maximum depth at which aquatic plants can grow.

<u>Temperature</u>: Temperature profiles are important descriptive information because of the effect of temperature on biological activity and water density. Most biochemical reactions occur more rapidly at higher temperatures. Water temperature is an important determinant of photosynthesis rate in plants and respiration rates of plants and animals. Temperature influences the rate of growth of aquatic plants, and triggers the onset of growth in the spring and the fall dieback. Temperature also influences the density of water. Surface warming can lead to thermal stratification, as mentioned above, which can have significant impacts on nutrient availability, distribution and concentrations in lakes. In addition, extensive shallow areas (which typically have high aquatic plant densities) may undergo larger night/day temperature fluctuations than deeper, off-shore waters, which can lead to onshore-offshore water currents that can shorten herbicide contact times and effectiveness.

<u>Dissolved Oxygen</u>: Measurement of dissolved oxygen profiles in the lake can provide much information about the overall functioning and productivity of the lake. All of the organisms that are commonly observed in lakes require oxygen to survive. In **stratified** lakes, oxygen in the cool, dark bottom waters can be used up by the bacteria that decay and decompose the dead algae cells that rain down from the warmer and more well-lit surface waters. Loss of dissolved oxygen in the bottom waters makes those waters inhospitable for fish and many other aquatic organisms. Loss of oxygen also causes chemical changes in the sediment that result in the release of nutrients that can fuel growth of algae and rootless aquatic plants.

Alkalinity: Alkalinity is a measure of the ability of water to resist changes in pH (a measure of acidity). Large fluctuations in pH can occur on a daily basis in lakes with low alkalinity and dense aquatic plant growth because of the chemical reactions of photosynthesis. Plant photosynthesis uses the energy of sunlight to convert the carbon in carbon dioxide and bicarbonate ions into plant tissue. The removal of carbon dioxide from the water causes pH to increase. During the night, respiration of plant tissues releases carbon dioxide into the water, causing pH to decrease. Extreme high and low pH can influence a number of chemical reactions that determine the availability of nutrients in the lake, and can lead to chemical toxicity problems for fish and insects.

Phosphorus: In many lakes, the concentration of phosphorus in the water determines the growth rate of algae. Therefore, measurement of the concentration of phosphorus in the water is an indication of the potential productivity of algae in the lake. Two forms of phosphorus are generally measured in lakes. Dissolved, inorganic phosphorus is readily available for plant and algae uptake. Total phosphorus includes dissolved phosphorus and the phosphorus that is associated with algae, zooplankton, and particles in the water.

Phosphorus concentrations can vary considerably with depth in stratified lakes. Low dissolved oxygen concentrations in bottom waters of stratified lakes can result in a chemical reaction that causes phosphorus to be released from the sediment to the water. As a consequence, bottom waters can have much higher phosphorus concentrations than surface waters.

Nitrogen: Nitrogen often limits aquatic plant growth and can occasionally limit algae growth. As with phosphorus, there are inorganic and organic forms of nitrogen. Inorganic nitrogen can exist in three forms in lakes: nitrite, nitrate, and ammonia. Nitrite is usually present in only very small amounts. As with many other chemical constituents, the distribution of inorganic nitrogen varies with depth in stratified lakes. Nitrate is generally most abundant in the surface waters, and ammonia dominates the bottom waters.

11.0 Sampling Frequency

11.1 *Minimum lake monitoring*

Spring, summer, fall (three sampling events)

11.1 More intensive sampling

A more detailed picture of the lake can be obtained through more intensive sampling schedule, emphasizing the spring-fall months (total of eight sampling events): Monthly May through October; two sampling events in winter months.