City of Vacaville
Adopted Lagoon Valley Lake
Management Plan

October 13, 1999

Prepared for:

City of Vacaville
Community Services Department
850 Merchant Street
Vacaville, CA 95688

Prepared by:

LSA Associates, Inc.
257 Park Place
Point Richmond, CA 94801
(510) 236-6810
LSA Project #COV831

City of Vacaville
Adopted Lagoon Valley Lake
Management Plan

October 13, 1999

Prepared for:

City of Vacaville
Community Services Department
850 Merchant Street
Vacaville, CA 95688

Prepared by:

LSA Associates, Inc.
257 Park Place
Point Richmond, CA 94801
(510) 236-6810
LSA Project #COV831

TABLE OF CONTENTS

PLAN SUMMARY v

1.0 INTRODUCTION 1
- 1.1 Setting 1
- 1.2 Need for Management Plan 6
- 1.3 Problematic Conditions in the Lagoon Valley Lake Watershed 6

2.0 EXISTING CONDITIONS 9
- 2.1 Physical Characteristics 9
- 2.2 Biological Characteristics 10

3.0 STUDY APPROACH AND DESIGN 12
- 3.1 Management Plan Process 12
- 3.2 Identification of Lagoon Valley Lake's Beneficial Uses 13
- 3.3 Specific Management Plan Goals 14
- 3.4 Technical Studies 16

4.0 STUDY RESULTS 19
- 4.1 Lake Seasonal Water Loss and Need for Supplemental Water 19
- 4.2 Watershed Management and 100 Year Storm Analysis 20
- 4.3 Lake Water Quality 28
- 4.4 Sedimentation, Water Depth, and Need for Lake Deepening 42
- 4.5 Shoreline Erosion 43
- 4.6 Fisheries 45
- 4.7 Waterfowl Studies; Special Status Species Observations 49

5.0 MANAGEMENT RECOMMENDATIONS 54
- 5.1 Upper Watershed Erosion Management 54
- 5.2 Lower Watershed Erosion Management 59
- 5.3 Lower Watershed Nutrient Management 61
- 5.4 Lake Nutrient and Bacterial Management 66
- 5.5 Weed Management 71
- 5.6 Lake Shoreline - Stabilization and Planting 72
- 5.7 Bypass Channel Enhancement and Management 76
- 5.8 Dam Berm Maintenance and Lagoon Drain Rehabilitation 78
- 5.9 Fisheries Management and Enhancement 79
- 5.10 Interpretive Enhancements 81
- 5.11 Recreational Enhancements 84
- 5.12 Summary of Possible Management Actions 86

6.0 COST ANALYSES AND FUNDING SOURCES 92
- 6.1 Cost Estimates 92
- 6.2 Potential Funding Sources 92

7.0 REGULATORY CONSIDERATIONS 102
- 7.1 Federal Agencies 102
- 7.2 State Agencies 103

7.3 Solano County 104

8.0 REFERENCES, PERSONS CONTACTED AND STUDY TEAM 109
8.1 References 109
8.2 Personal Communications 109
8.3 Study Team 110

APPENDIX A: Special Status Species Potentially Present, Lagoon Valley lake and Surroundings Habitats, Solano County, California

APPENDIX B: Summary of Investigations and Studies in Relation to Management Plan Goals

LIST OF FIGURES

Figure 1 Regional Location 2
Figure 2 Lagoon Valley Lake Site 3
Figure 3 Lower Lagoon Valley - Land Use Map....4
Figure 4 Wetland and Riparian Habitats - Lagoon Valley Lake 5
Figure 5 Watershed Map - Lagoon Valley Lake....21
Figure 6 Drainage System in the Vicinity of Hines Nursery 22
Figure 7 Location of Water Quality and Fish Sampling Sites 34
Figure 8 Nitrate Levels in Lagoon Valley Lake....35
Figure 9 Orthophosphate Levels in Lagoon Valley Lake....36
Figure 10 Nitrate Levels in the Perennial Tributary to Lagoon Valley Lake 37
Figure 11 Orthophosphate Levels in the Perennial Tributary of Lagoon Valley Lake 38
Figure 12 Nitrate Levels in the Intermittent Tributaries of Lagoon Valley Lake 39
Figure 13 Orthophosphate Levels in Intermittent Tributaries of Lagoon Valley Lake....40
Figure 14 Shoreline and Tributary Erosion Problem Areas....44
Figure 15 Sacramento Blackfish - Size Distribution....47
Figure 16 Sacramento Perch - Size Distribution....48
Figure 17 Upper Watershed Sediment Management Actions 55
Figure 18 Sediment Basin Conceptual Design 60
Figure 19 Lower Watershed Sediment Management Recommendations....59
Figure 20 Conceptual Design for Plunge Basin 62
Figure 21 Lower Watershed and Lake Nutrient Management Actions 65
Figure 22 Proposed Dredged Spoil Wetland Creation Area 68
Figure 23 Bypass Channel, Dam and Embankment Management Actions....77
Figure 23A Cross Section - Bypass Channel, Dam and Embankment Maintenance 77
Figure 24 Interpretive and Shoreline Recreation Enhancements....82

LIST OF TABLES

Table 1 - Hydrologic Parameters used in HEC-1 Analysis 26
Table 2 - Summary of 100-Year Peak Discharges 26
Table 3 - Lagoon Valley Lake 100-Year Peak Inflow Pre-Storm Lake Level at Spillway 27
Table 4 - Lagoon Valley Lake 100-Year Peak Inflow Pre-Storm Lake Level 1 Foot Below Spillway 27
Table 5 - Lagoon Valley Lake Water Quality Characteristics: Fall, Winter and Spring, 1997-1998 29
Table 6 - Lagoon Valley Lake Dissolved Oxygen and Coliform Bacteria Characteristics - Summer 1998 31
Table 7 - Lagoon Valley lake and Tributaries Nutrient Levels, January and February, 1999 33
Table 8 - Lagoon Valley Lake Stage Storage Relationship - 1980 43
Table 9 - Lagoon Valley Lake Stage Storage Relationship - 1997 43
Table 10 - Summary of Water Bird Survey Results 52
Table 11 - Suggested Native Erosion Control Seed Mix 59
Table 12 - Seasonal Wetland Seed Mix 74
Table 13 - Summary of Proposed Shoreline Plantings 75
Table 14 - Summary of Proposed Shoreline Erosion Control Treatments 76
Table 15 - Relationship of Possible Management Actions to Management Goals 88
Table 16 - Potential Sources of Funding for Capital Improvements 93
Table 17 - Summary of Agency Regulatory Approval and Review (other than CEQA) 105

PLAN SUMMARY

Purpose of this Plan

The City of Vacaville *Comprehensive Parks, Recreation and Open Space Master Plan* (City of Vacaville 1991) identified the potential for the Lagoon Valley Regional Park to provide improved opportunities for a variety of passive and active recreational opportunities, many of which are directly related to Lagoon Valley Lake. The City has prepared a master plan for the Lagoon Valley Regional Park to implement the recommended recreational improvements. However, successful implementation of the recreational improvements is dependent on development of a long-term lake management plan that will address a wide range of lake management concerns.

This proposed lake management plan will complement the City's regional park master plan by providing short and long-term options for enhancing and managing Lagoon Valley Lake. The overall goal of this plan is to ensure that the lake will remain a natural, scenic and recreational amenity for the people of Vacaville and the surrounding region. The options presented in this plan provide the basis for a program of capital improvements, operational techniques, and use policies that will create and maintain a healthy lake ecosystem, and facilitate public recreational use.

Background on Lagoon Valley Lake Site

Lagoon Valley Lake is located within a 670-acre area of contiguous open space and regional parkland owned by the City of Vacaville (see Figures 2 and 3). The site is situated at the southern (lower) end of Lagoon Valley, between the Vaca Mountains to the west and the Laguna Hills ridgeline to the east. The urbanized areas of the City of Vacaville lie to the east of the Laguna Hills. Adjacent land uses consist of a mix of open space grazing lands, a commercial nursery and other small scale commercial uses. Immediately to the north and east are the park's existing passive recreational areas. The Pena Adobe Community Park lies to the northeast of the lake.

The Lower Lagoon Valley drains to Laguna Creek which is a tributary of Alamo Creek, which is, in turn, a major tributary of the Ulatis Creek watershed in the northwestern portion of Solano County (see Figure 2). Lagoon Valley Lake was historically a natural seasonal lake and wetland. The present lake was created in the late 1970s as part of the Lagoon Valley Regional Park construction. An earthen dam (bermed embankment) forms almost the entire western and southern boundaries of the lake (see Figure 4). West of the dam is a bypass channel that diverts runoff from the southeast and west sides of the valley. The lake is 106 surface acres, with an average depth of 6 to 7 feet when full, and a maximum depth of 9 feet near the dam's spillway. The lake receives inflow from a perennial to near-perennial tributary that enters the lake at its southeast corner near the intersection of Lagoon Valley Road and the park road (see Figure 4). Several minor intermittent tributaries also flow to the lake.

Summary of Lake Management Problems

Existing conditions in the surrounding watershed are contributing to a range of lake management problems. These conditions can be categorized by whether they occur in

the upper or lower watershed areas. The proposed management plan takes a "start at the source" approach in solving these problems. Wherever feasible, problems are addressed first in the upper watershed, then in the lower watershed and finally in lake itself.

The upper watershed appears to be a major source of sedimentation to the lake. These sedimentation problems may be attributed to the following causes:

- erosion of upper watershed drainages possibly due to over-grazing by cattle;
- a lack of riparian vegetation that would help stabilize drainages, and
- possible erosion of recreational trails and fire roads.

The lower watershed contributes to a range of problems in the lake as follows:

- sedimentation problems from intermittent tributary erosion in the lower watershed, and
- high levels of nutrients that flow into the lake primarily from the perennial tributary, causing excessive summertime growths of aquatic weeds, depletion of dissolved oxygen in the lake, and unsuitable conditions for fishing.

Problems intrinsic to the lake itself include the following:

- a large population of Sacramento blackfish, which are conflicting with the ability to maintain a viable sportfishery; blackfish enter the lake when the lower lagoon drain backs-up, allowing backflows to enter the lake over the dam spillway;
- minor shoreline erosion caused by exposure to wind and wave action;
- shallow lake depths that allow light penetration all the way to the bottom, thereby promoting the growth of aquatic weeds that interfere with sailboarding and fishing opportunities;
- high bacterial levels in the lake probably due to runoff from resting and foraging areas that are heavily used by waterfowl, and
- Need for improved maintenance of the dam embankment and bypass channel to ensure that their water control functions are maintained in an optimal condition.

Lake Beneficial Uses and Management Goals

Lagoon Valley Lake potentially offers a wide range of recreational and non-recreational benefits. City of Vacaville staff suggested that a wide range of beneficial uses and specific management plan goals for Lagoon Valley Lake be investigated under this management plan. Project studies and investigations were directed toward evaluating and achieving these specific management plan goals. Beneficial uses and management goals are summarized on the next page.

1. Beneficial Use: Recreational Fishing

Goals:

A. Manage and control Sacramento blackfish populations

B. Re-introduce largemouth bass and redear sunfish populations

C. Maintain Sacramento perch nursery benefits

D. Improve recreational fishing accessibility

E. Reduce sedimentation

F. Reduce summer aquatic weed infestations

2. Beneficial Use: Small Motorless Craft Use of Lake

Goal:

A. Facilitate windsurfing usage of lake

3. Beneficial Use: Scenic Amenity that Encourages Passive Recreational Use

Goals:

A. Maintain I-80 corridor view of lake and valley

B. Enhance the visual quality of shoreline usage areas

4. Beneficial Use: Wildlife Habitat

Goals:

A. Establish shoreline wetland zones

B. Establish woody riparian vegetation zones along the lake shoreline

C. Enhance stabilized drainage corridors

5. Beneficial Use: Storm Water Management

Goals:

A. Maintain lake storage capacity

B. Properly maintain spillway and dam

6. Beneficial Use: Swimming & Shoreline Recreation

Goals:

A. Evaluate the potential for a controlled wading beach

B. Enhance interpretive values

C. Enhance shoreline passive recreational opportunities in conjunction with the park master plan

Summary of Study Results

The project team conducted a wide range of geotechnical, hydrological, water quality, fisheries, ornithological, and recreation/interpretive investigations and technical studies in support of the project management goals (see Section 3.4). Appendix B provides a summary of the relationship of the project team's investigations and technical studies to the management plan goals. A brief summary of key study results is provided below:

- ***Lake Water Supply*** - Lagoon Valley Lake is currently receiving an adequate supply of water, and under current conditions has the potential to supply approximately 977 acre-feet of water per year for other uses. No supplemental water inflow is currently needed. For the purposes of increasing lake depth and water surface area, the lake would have more than adequate water to accommodate increasing the height of the spillway by at least one foot.

- ***Storm Water Detention and Retention*** - Based on the elevations of its earthen berm and spillway, the lake is currently capable of adequately detaining water from a 100-year storm under conditions of both low and high pre-storm lake levels. However, in the absence of watershed erosion mitigation measures, a relatively high rate of sedimentation will likely continue in future years, causing the lake's storage capacity to decline.

- ***Lake Water Quality Problems*** - Excessive nutrient loading, in combination with much of the lake being less than 6-7 feet in depth, creates massive growths of aquatic plants and algae that cover most of the lake during the summer. These growths interfere with beneficial uses such as swimming, boating, fishing, and general aesthetics, and may lead to dissolved oxygen depletion and fish kills. Based on sampling results, the primary source of these nutrients is the perennial tributary that receives direct runoff from the Hines Nursery during the rainy season. Domestic waterfowl wastes also play a role in nutrient enrichment of the lake. The limited data available suggests that cattle grazing in the lake's watershed is not a significant contributor of nutrients to the lake. A second water quality problem is periodically high levels of fecal coliform bacteria. Domestic waterfowl are the most probable cause of this problem.

- ***Sedimentation Problems*** - Elevation-Storage relationships indicate that Lagoon Valley Lake has lost approximately 130 acre-feet (AF) of storage at elevation 208, 223 AF at elevation 210, and 349 AF at elevation 215 (storage capacity) in the past 17 years. This amounts to an average annual sedimentation rate of 20.5 AF/year. The main sources for this sediment is soil erosion associated with the contributing watersheds and channel bank erosion from channels, and headcuts that feed directly into the lake.

- ***Shoreline Erosion*** - In general, shoreline erosion to the lake itself does not appear to be a significant cause of lake sedimentation problems at this time. However, some segments of the lake's shoreline are experiencing some degree of bank failure or slumping of material into the lake. Most lake shoreline erosion problems

can be attributed to wind and wave action against the water's edge. Failure to take shoreline stabilization actions will likely cause these problems to get worse.

- ***Lake Fisheries*** - All attempts to establish a productive sport fishery in Lagoon Valley Lake have been adversely impacted by the presence of large numbers of Sacramento blackfish. Due to an apparent lack of predators, populations of desirable sport fish, such as Sacramento perch, appear to be too heavily skewed toward juveniles to provide much fishing opportunity. A key to creating a productive sport fishery in Lagoon Valley Lake is to eliminate or greatly reduce the numbers of Sacramento blackfish in the lake. Another impediment to recreational angling in the lake is the extensive growths of sago pondweed and filamentous algae that fills much of the lake each summer. There is very little open water that can be fished from shore, as only the deepest portions of the lake are free of pondweed.

- ***Waterfowl*** - Lagoon Valley Lake and the adjacent uplands provide significant resting and foraging seasonal habitat for migratory waterfowl, particularly geese, ducks and American coots. Foraging activities by both migratory, domesticated birds and gulls tends to be concentrated on the east shore picnic area. The concentration of birds in these areas corresponds to the limited coliform bacterial data that show high levels in the waters below the eastern shore.

Summary of Possible Management Actions - As described in detail in Section 5, the following Management Actions are proposed in this plan. In some instances, management actions represent options for achieving the same goals, while in other instances all the management actions are needed to achieve a particular goal. Table 15 in Section 5.12 summarizes optimal versus mandatory management actions.

UPPER WATERSHED EROSION MANAGEMENT - In order to control the sources of upper watershed sedimentation to the lake, several structural improvements and management options are proposed.

- **Management Action 1: Sediment Basins** – One or two upstream sediment basins could be installed to intercept and retain sediments generated largely from the upper watershed (see Figure 17).

- **Management Action 2: Diversion to Bypass Channel** -The perennial tributary currently discharges large volumes of sediments directly into the lake via several culverts (see Figure 17). Diversion structures could be constructed at or above the culvert discharge locations to divert sediment-laden flows away from the lake and into the bypass channel.

- **Management Action 3: Upper Watershed Management** - An integrated set of upper watershed management actions is proposed, including a grazing management plan, stabilization and revegetation of upper watershed drainages, and a program for trail/fire road assessment and maintenance.

LOWER WATERSHED EROSION MANAGEMENT - Sediment volumes derived from the lower watershed are less significant than from the upper watershed. Nevertheless, there are certain management options for the lower watershed that could have minor benefits for reducing sediment loads to the lake.

- **Management Action 4: Hines Nursery Ditch Stabilization** - The runoff collection ditch that borders the Hines Nursery has bank erosion problems that could be alleviated by stabilizing the entire channel bank with vegetation and/or geotextiles. This would need to be done with the permission and cooperation of Hines Nursery (see Figure 19).

- **Management Action 5: Localized Sediment Capture** - Under this option, a long narrow sediment basin could be constructed along the west property line of Hines Nursery adjacent to the existing ditch, or several smaller sediment capture basins could be created within the ditch (see Figure 19). This option would also need to be done with the permission and cooperation of Hines Nursery.

- **Management Action 6: Intermittent Drainage Channel Stabilization** - Three intermittent drainages that enter Lagoon Valley Lake (see Figure 14) could be stabilized within the park area.

LOWER WATERSHED NUTRIENT MANAGEMENT - A cooperative nutrient reduction planning program with Hines Nursery is proposed. Under this program, the City and Hines Nursery would work together to design changes to the storm water management system that would greatly reduce nutrient inflows from the perennial tributary, while ensuring that the nursery maintains its existing level of flood protection.

- **Management Action 7: Increase Hines Nursery Reservoir Storage Capacity** - The storage capacity of the nursery's irrigation recycling reservoir could be increased so that the need for bypass flows from the reservoir to the perennial tributary could be greatly reduced or entirely eliminated (see Figure 21).

- **Management Action 8: Off-Stream Water Quality Treatment Ponds** - One or more water quality treatment ponds could be placed downstream of the nursery bypass discharge (see Figure 21). The water quality pond(s) would be designed to treat the "first-flush" of storm water runoff which contains most pollutants.

- **Management Action 9: Diversion to Bypass Channel** - This would be approximately the same management action as No 2. However, the diversion structure would need to be designed so that first flush flows, as well as high flows (laden with sediments), are sent to the bypass channel.

- **Management Action 10: Waterfowl Waste Management/Turf Fertilizer Management** - To reduce nutrient and bacterial input from waterfowl waste, a program could be initiated to discourage waterfowl from their primary foraging and resting area along the eastern shore, west of the paved park road. This program would entail a combination of runoff management and treatment, educating the

public, enforcement and the trapping and removal of domestic waterfowl. The runoff treatment program could also be used to prevent park turf fertilizer inflows to the lake.

Lake Nutrient & Bacterial Management - In addition to watershed management actions that deal with the source of nutrients, there are a range of within-lake management actions that may reduce nutrient levels and thereby reduce annual aquatic weed growth.

- **Management Action 11: Treatment with Alum** - Applying alum (aluminum hydroxide) to the lake would precipitate suspended sediments and nutrients from the water column and seal the nutrients into lake bottom sediments under the precipitate.

- **Management Action 12: Flushing the Early Winter Runoff** - The first rains of the rainy season typically carry the greatest load of watershed derived nutrients to the lake. It may be possible to annually flush a portion of these nutrient laden waters out of the lake by partially draining the lake, following the first significant storm events of the rainy season.

- **Management Action 13A: Deepening the Lake; Off-site Disposal** - Deepening most of the lake to 10 feet in depth or greater would prohibit rooted aquatic plants from all but the shoreline perimeter of the lake (the slope transition into deeper water) and would remove nutrients accumulated in the lake sediments (see Figures 21 and 22 and b). However, disposal of the excavated material can be costly due to trucking costs. A suitable disposal site as close as possible to the lake would be desirable to minimize trucking costs. One possible option would be to investigate the suitability of the material for use by the Hines Nursery as a supplemental or direct potting medium.

- **Management Action 13B: Deepening the Lake; Create New Wetland Area** - Another possibility is to deepen 60-80 percent of the lake and deposit the excavated materials in the south end of the lake to create an emergent marsh in the vicinity shown in Figures 21 and 22a and b. The created marsh would greatly enhance the biological quality of the lake by providing a significant littoral area with habitat for fish, aquatic fauna, and waterbirds. It could also reduce nutrient loading from the perennial tributary, by routing flow through a meandering tributary channel in the created emergent marsh that would help strip nutrients. The created marsh may also serve as a potential wetland mitigation bank for City projects that require Section 404 Individual Permits or Nationwide Permit authorizations for unavoidable wetland impacts.

- **Management Action 14: Waterfowl Waste Management** - This is the same as Management Action 10 above.

- **Management Action 15: Water Quality Monitoring Program** - This would be a necessary component of whatever set of water quality enhancement options are ultimately chosen by the City. It would help document water quality changes in response to management actions, and allow modification of actions as needed.

Weed Management – Control of both aquatic and terrestrial weeds is proposed to improve habitat quality and to enhance recreational benefits.

- **Management Action 16: Aquatic Weed Control** - In the absence of the nutrient management actions proposed above, direct weed management approaches would be required in the lake. This would entail periodic mechanical harvesting and removal of rooted aquatic plants in combination with the chemical treatment of algae. This is a relatively expensive operation that must be conducted two or more times a year.

- **Management Action 17: Terrestrial Invasive Exotic Plant Control** - Both the upper and lower watersheds have significant growths of yellow star thistle, an invasive exotic plant that tends to exacerbate drainage problems and displaces more desirable native and naturalized plant species. Other invasive exotic pest species are also a problem. A watershed-wide exotic plant management program is proposed.

Lake Shoreline – Stabilization and Planting - In order to mitigate the effects of erosion along the shoreline, at the mouths of intermittent tributaries, and on the island, several treatment options are proposed.

- **Management Action 18: Regrading** - Where steep vertical cuts have developed, regrading to a more stable configuration is achievable. In most instances such regrading would entail minor re-sloping (7:1 grade or gentler) and compacting of banks.

- **Management Action 19: Geotextiles** - The are a large variety of geotextile fabrics on the market that are designed to hold seeds and soil in place until vegetation is established. Geotextiles are relatively inexpensive and offer a good solution for areas that have experienced recent slumping.

- **Management Action 20: Rock Riprap** - Rock riprap offers a permanent structural solution for areas that are experiencing severe erosion problems. The disadvantages are that construction costs are higher than installation of geotextile fabric and the end result is not as aesthetically pleasing.

- **Management Action 21: Tri-Lock Articulated Erosion Control System** - *Tri-Lock* is a flexible, permeable erosion control system that has the capacity to allow revegetation. This solution may be utilized as an option that would be of similar function to geotextiles.

- **Management Action 22: Island/Breakwater Device** - A breakwater device (or levee) off the island's shore would protect it from the full impact of wave action. Since erosion on the island is most severe on the north side, this would be the logical location to place such a device.

- **Management Action 23: Shoreline Planting** - Planting of shorelines with woody riparian species and seeding can be conducted in conjunction with or, in some cases, as an alternative to other shoreline erosion control treatments. Trees could also serve as a windbreak to reduce shoreline erosion.

Bypass Channel Enhancement and Management - The bypass channel on the west side of the lake (Figure 23) already provides well-established riparian habitat used by waterfowl and aquatic fauna, including western pond turtles, a state-listed Species of Special Concern. However, the woody riparian vegetation along the channel suffers from extensive beaver cutting damage.

- **Management Action 24: Beaver Trapping Program** - A state-licensed trapper should be retained by the City to remove beavers from the bypass channel and re-locate them to suitable habitat outside Lagoon Valley.

- **Management Action 25: Riparian Planting Program** - This would entail a riparian tree planting program for barren portions of the bypass channel shoreline.

- **Management Action 26: Bypass Channel Maintenance** - In order to ensure the maintenance of the bypass channel as a conduit for storm flow, riparian vegetation should be periodically trimmed back (once every 2-3 years) and dense stands of cattails should be managed

- **Management Action 27: Bypass Channel Dredging** - Channel bottom depths should be surveyed and a channel profile and storm flow capacity ascertained. Limited dredging of the central (deepest) portion may be needed.

- **Management Action 28: Tree Removal from Bypass Channel Ditch along Lagoon Valley Road** - This arm of the bypass channel, which parallels Lagoon Valley Road, is very narrow and shallow. Several mature cottonwood and willow trees have become established in the middle of the channel and need to be removed.

Dam Berm Maintenance and Lagoon Drain Rehabilitation - Several minor management actions are needed to help maintain the integrity of the dam and drain channel that flows from the dam spillway.

- **Management Action 29: Berm Vegetation Removal** - Woody vegetation needs to removed from the dam berm's western side to prevent undermining of the dam berm.

- **Management Action 30: Crest Trail Enhancement** - The dam may be over-topped during storm events in excess of the 100-year storm. The ability to withstand such events could be enhanced by construction of an impervious all-weather (asphalt) bike/hiking trail along the dam's crest. Thus would also serve to enhance the recreational utility of the dam.

- **Management Action 31: Lagoon Drain Rehabilitation** - An annual maintenance program for this drainage channel should also be implemented. Additionally, a shallow zone in the drain, near the Pena Adobe footbridge, needs to be dredged out.

Fisheries Management and Enhancement - The management actions proposed below are designed to directly improve and maintain the lake fishery, in association with, or as an alternative to, the other actions discussed above.

- **Management Action 32: Chemical Treatment to Eliminate Blackfish** - The lake could be treated with rotenone to kill all fish in the lake, then re-stocked with desirable species. However until the potential for backflows from the lake drain into the lake is resolved, blackfish will likely re-establish themselves in the lake during the first wet water year.

- **Management Action 33: Draining the Lake to Eliminate Blackfish** - The lake could be drained and pumped dry to eliminate blackfish from the lake and then re-stocked with desirable species. This would be a temporary solution unless the potential for blackfish re-introduction is eliminated.

- **Management Action 34: Controlling Blackfish Numbers through Seining** - Commercial fishermen could be contracted by the City to annually seine the entire lake and remove all blackfish captured. This approach would not eliminate blackfish from the lake, but it could reduce their numbers sufficiently to eliminate their impact to the fishery

- **Management Action 35: Add Riser to Dam Spillway** - The dam spillway elevation could be increase by about 1 foot to allow the lake to store more water and increase lake depth. This could potentially prevent blackfish re-introductions during period of downstream flooding problems.

- **Management Action 36: Lake Drainage in Conjunction with Lake Deepening** - Should the lake be deepened by first fully draining it prior to using earth moving equipment, the blackfish would be eliminated from the lake. This action should coincide with a correction to the downstream flooding problem, otherwise the blackfish will reappear in the lake following a wet year.

- **Management Action 37: Fish Stocking Program** - Assuming that the blackfish population can be adequately controlled, stocking of the lake with redear sunfish, largemouth bass, and channel catfish could be successful.

Interpretive Enhancements - There are an array of options for enhancing the public's understanding and appreciation of Lagoon Valley Lake's natural ecosystems.

- **Management Action 38: Establishment of a Protected Habitat Area in the Southeastern Portion of the Lake** - The southeast portion of the lake offers the

best wildlife habitat due to the diversity of habitats, and the separation from areas of intensive human use. If a new wetland complex is created in this area as a result of dredged spoil disposal, the natural value will increase further.

- **Management Action 39: Trail and Boardwalk** - A trail and boardwalk could be constructed through the protected habitat area (see Figure 24), crossing the perennial tributary delta area and linking with the trail atop the dam berm.

- **Management Action 40: Wildlife Viewing Platforms** - Wildlife viewing platforms could be constructed on the knoll south of the boat ramp to provide views of the island and much of the lake (Figure 24). If a marsh complex is created at the south end of the reservoir, a platform could be constructed on the island (with a removable floating access bridge), or at the southeast or southwest portion of the shoreline to provide a view into the marsh.

- **Management Action 41: Interpretive Signs and Pamphlets** - Interpretive signs and pamphlets could be placed along the berm crest trail and in the picnic areas.

- **Management Action 42: Development of Public Stewardships** - The City Parks Department could develop a program of stewardship in cooperation with local schools and civic organizations. Under this program, a classroom or organization would "adopt" a particular unit of the lake and surrounding watershed to help implement some of the management actions described herein.

- **Management Action 43: Marked Canoe Trail** - The bypass channel provides an excellent opportunity for a short interpretive canoe trail that could be opened for limited periods by the Parks Department (see Figure 24).

Recreational Enhancements - Many of the management actions described above will increase the utility of the lake for activities such as recreational fishing, sail boarding and nature study. The following additional recreational options may also be considered.

- **Management Action 44: Public Wading Beach** - Unless the bacterial and nutrient management actions are successfully designed and implemented, there is no realistic possibility of establishing a safe public wading area. It should also be noted that the goal of creating a wetland and protected habitat area in the southeast portion of the lake will likely encourage waterfowl usage and therefore may be counter to the goal creating a wading beach. Assuming these bacterial/nutrient management goals are met and the protected habitat area is not established, then it may be possible to establish a wading beach in the area of the eastern shoreline picnic grounds. This would require regrading of the area, establishment of a bacterial monitoring program by the Solano County Health Department, and an assessment of the entire wading beach proposal by the City Risk Manager.

- **Management Action 45: Fishing Piers** - There are many potential locations for fishing piers around the lake. Potential locations would be any shoreline other than

the proposed protected habitat area in the southeastern portion of the lake (if implemented). Optimal locations for fishing piers are shown in Figure 24. At least one pier should be handicapped accessible.

- **Management Action 46: Fishing Derbies** - City and or corporate sponsored fishing derbies can be an excellent means to enhance public awareness of Lagoon Valley Lake as a recreational resource, raise revenue for fishing management and stocking programs and to introduce children to fishing.

- **Management Action 47: Shade Tree and Windbreak Planting** - Planting of the lake's western shoreline could help reduce island and northern shoreline erosion by creating a windbreak and could also serve to enhance the recreational value of this area by creating shaded spots for picnicking and relaxing.

Regulatory Requirements

The draft management plan was sent for review and comment to all federal, state and local regulatory agencies with potential oversight or policy concerns with Lagoon Valley Lake. Numerous telephone and letter responses were received. Additionally, the project team and City staff met with the State Division of Safety of Dams, the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, and the U.S. Environmental Protection Agency to discuss plan management recommendations in more detail. Section 7.0 provides a summary of local, state and federal regulatory requirements that are likely to be applicable to the management actions contained in this plan.

Plan Review and Final Recommendations

City staff and various local, regional and state agencies reviewed the draft plan and provided comments in June-August, 1999. Additionally, a public workshop and subsequent Community Services Board public meetings were held in July and October, 1999, at which public comments were received. Based on the various city, agency and public comments, the draft plan's 47 possible management options were pared down and synthesized into 9 proposed capital improvement actions, which are described in this Executive Summary. Management options not included in the selected set of capital improvements were treated as follows:

- Some management options (*e.g.*, mechanical harvesting of lake weeds, establishment of a wading beach) were rejected as being too costly and/or impractical based on City budgetary and labor constraints, or were rejected in favor of options more consistent with the park master plan .

- Other management options (*e.g.*, off-stream water quality treatment ponds, dam crest trail enhancement) were placed in a "contingency" category of management actions that may be desirable to implement based on further study and budgetary considerations, or as part of the future operations and maintenance budget.

- Several management options (*e.g.*, fishing piers, shade tree planting) were directly incorporated into the design of the proposed regional park master plan

The remaining (selected) lake management options are being proposed as capital improvements under a 4-phase implementation process that will allow adequate time for developing and enhancing funding sources, conducting detailed engineering design studies and obtaining federal and state regulatory approval. These are discussed in the accompanying Executive Summary and are listed below.

Recommended 4-Phase Program of Capital Improvements:

- ***Phase 1 - Reduce the Sources of Sedimentation into the Lake; Improve Lake Spillway Drain***

  1-1: Upper Watershed Erosion Management
  1-2: Hines Nursery Ditch Stabilization
  1-3: Lagoon Drain Rehabilitation

- ***Phase 2 - Reduce Lower Watershed Sediments into the Lake***

  2-1: Construct Sediment Basins; Conduct Detailed Engineering Design & Analysis
  2-2: Intermittent Drainage Channel Stabilization

- ***Phase 3 - Improve Lake Water Quality through Deepening, Shoreline Stabilization and Possible Spillway Modifications***

  3-1: Deepen the Lake; Create New Wetland Area
  3-2: Lake Shoreline Stabilization and Planting
  3-3: Add Riser to Dam Spillway

- ***Phase 4 - Lake Fishery Improvements***

  4-1: Fish Stocking Program

Cost Estimates and Funding

The project team, in consultation with City staff, prepared rough cost estimates for the recommended proposed capital improvements. Costs are described in the accompanying Executive Summary and listed briefly below.

• Phase 1	$474,200
• Phase 2	$745,620
• Phase 3	$1,387,000
• Phase 4	$50,000
• Regulatory Approval	$100,000
• **Total**	**$2,756,820**

Annual Operations and Maintenance Costs for the recommended capital improvements were estimated to be $87,500.

Research was also completed on potential grant sources for the project (Table 16). Based on these grant sources, as well as funds currently or potentially available from the General Fund and Lagoon Valley Development Agreements, the following total funding revenue is projected:

• Current General Fund Allocation (1999/2000)	$200,000
• Grants (State/ Federal) & State Park Propositions	$750,000
• Lagoon Valley Development Agreements:[1]	
PHASE 1A	$100,000
PHASE 1B	$2,100,000
	$3,150,000

[1] This funding is contingent upon the private development schedule of Lagoon Valley. The timing of the proposed lake improvements could be spread out over a number of years, or in accordance with development agreement timelines.

1.0 INTRODUCTION

The overall purpose of this lake management plan is to provide a long-term blueprint for enhancing and managing the City of Vacaville's Lagoon Valley Lake so that it will remain a natural, scenic and recreational amenity for the people of Vacaville and the surrounding region. This plan provides options for short-term and long-term management and enhancement of the lake that should complement and fully integrate with the City's Lagoon Valley Regional Park Master Plan. The options presented in this plan will provide the basis for a program of capital improvements, operational techniques, and use policies that will create and maintain a healthy lake ecosystem, and facilitates public recreational use.

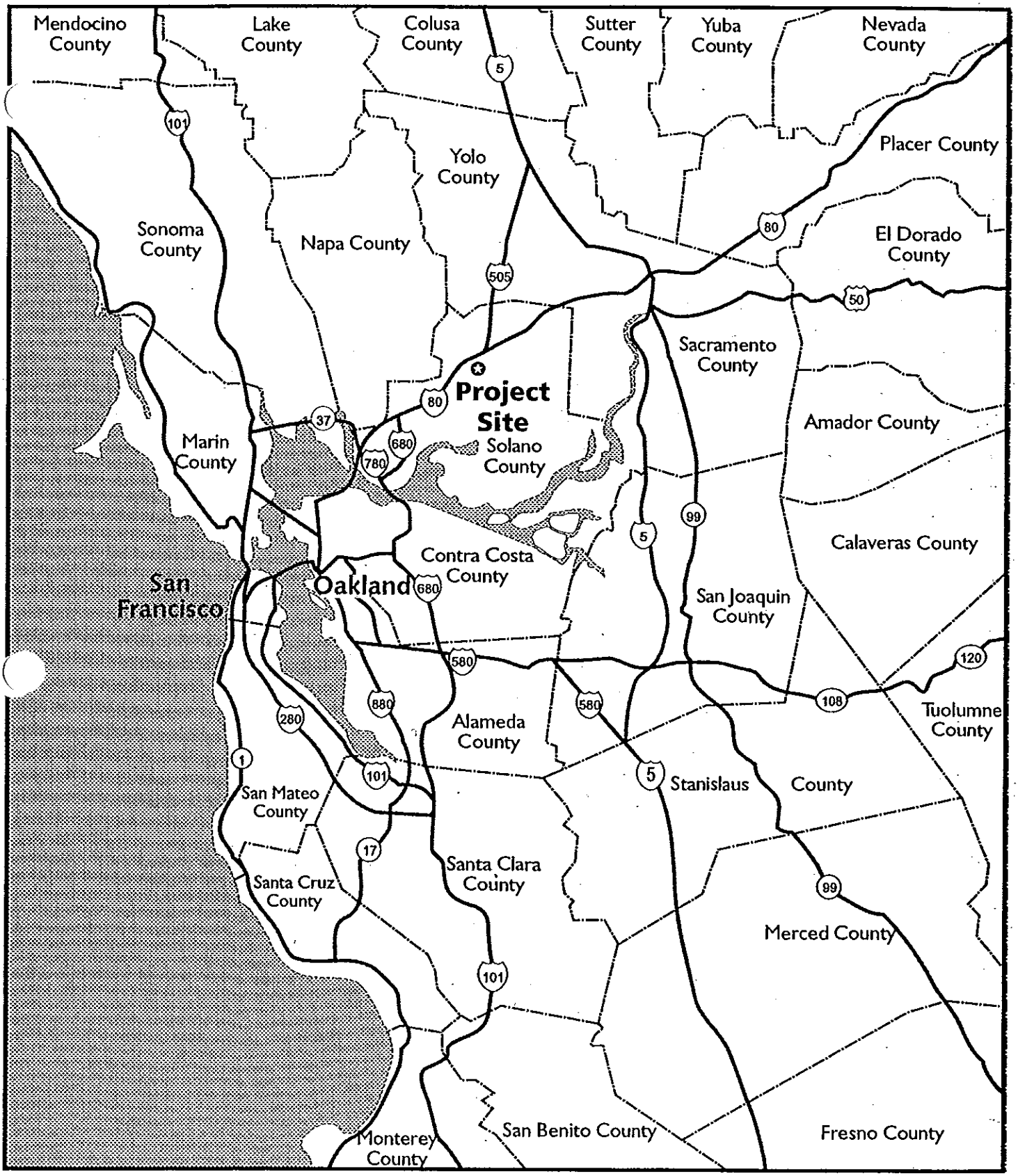
1.1 Setting

Lagoon Valley Lake is located in the City of Vacaville in Solano County within the 306-acre Lagoon Valley Regional Park, which is situated east of Interstate Highway 80, between the Cherry Glen and the Pena Adobe exits (Figures 1 and 2). The City of Vacaville owns approximately 370 acres of land surrounding the park as open space and community separator holdings (Figure 3). Another 330 acres of open space lands to the south are owned by the City, but separated from the park by private holdings. The regional park is situated at the southern (lower) end of Lagoon Valley, a narrow, north-south trending alluvial valley situated between the Vaca Mountains to the west and the Laguna Hills ridgeline to the east. The urbanized areas of the City of Vacaville lie to the east of the Laguna Hills.

Adjacent land uses consist of a mix of open space grazing lands, parkland, commercial and nursery uses (Figure 3). Immediately to the north and east are the existing passive recreational areas (*e.g.* exercise course, bike trails, picnic sites, small paved parking areas and drive) within lower-lying lands of the regional park. Further to the north and east lie the eastern slopes and ridgelines of the Laguna Hills, which consist largely of open grazing lands with regional hiking trails. The Pena Adobe Community Park lies to the northeast of the lake. The park contains the historic Pena Adobe homesite as well as gardens and recreational facilities. Adjacent to Pena Adobe is a small abandoned amusement park that contains "go-kart" and waterslide facilities. To the west and south lie fallow agricultural lands, an abandoned gliderport and some minor commercial land uses (motel/horse boarding facility, auto wrecking operation). The Hines Nursery lies to the southeast of Lagoon Valley Lake. This commercial facility raises containerized ornamental plants that are sold throughout the United States.

The Lower Lagoon Valley drains to Laguna Creek which is a tributary of Alamo Creek (Figure 2). Alamo Creek is a major tributary within the approximate 150-square mile Ulatis Creek watershed in the northwestern portion of Solano County. Lagoon Valley Lake was historically a natural, seasonal lake and wetland. The present lake was created in the late 1970s by Solano County as part of the Lagoon Valley Regional Park construction. An earthen dam (bermed embankment) forms almost the entire western and southern boundaries of the lake (Figure 4). The top of dam is at elevation 217.5 and the spillway crest is at elevation 213. West of the dam is a bypass channel that diverts runoff from the southeast and west sides of the valley.

Figure 1 – Regional location of lagoon Valley Lake



12-21-98(COV831Region2HP)

Figure 1

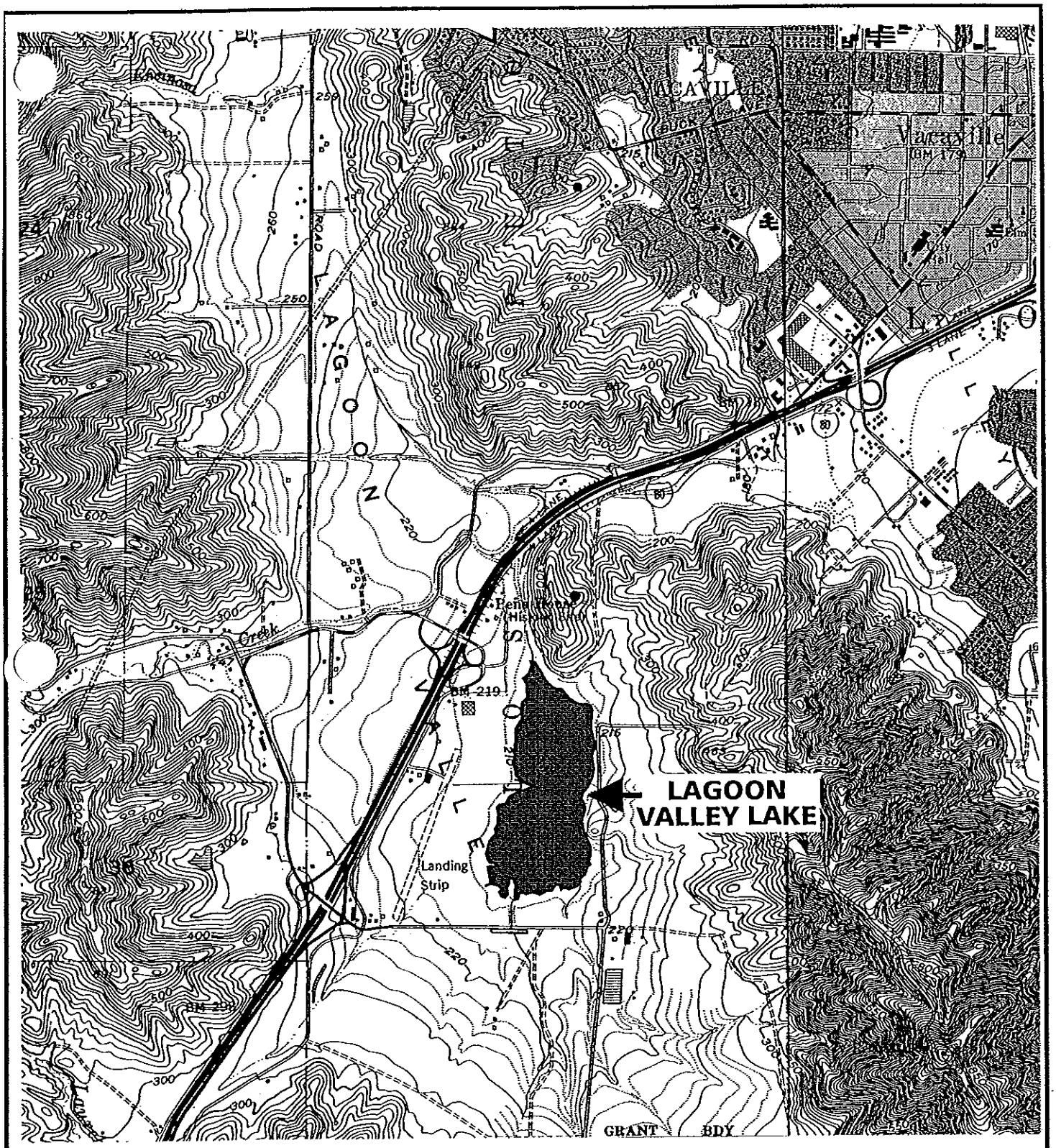
LSA

Scale in miles

0 20

Regional Location

Figure 2 – Lower Lagoon Valley topographic map with lake



Source of base: USGS 7.5' Elmira and Fairfield North quadrangle maps

12/ 8(COV831ProjLoca)

Figure 2

N

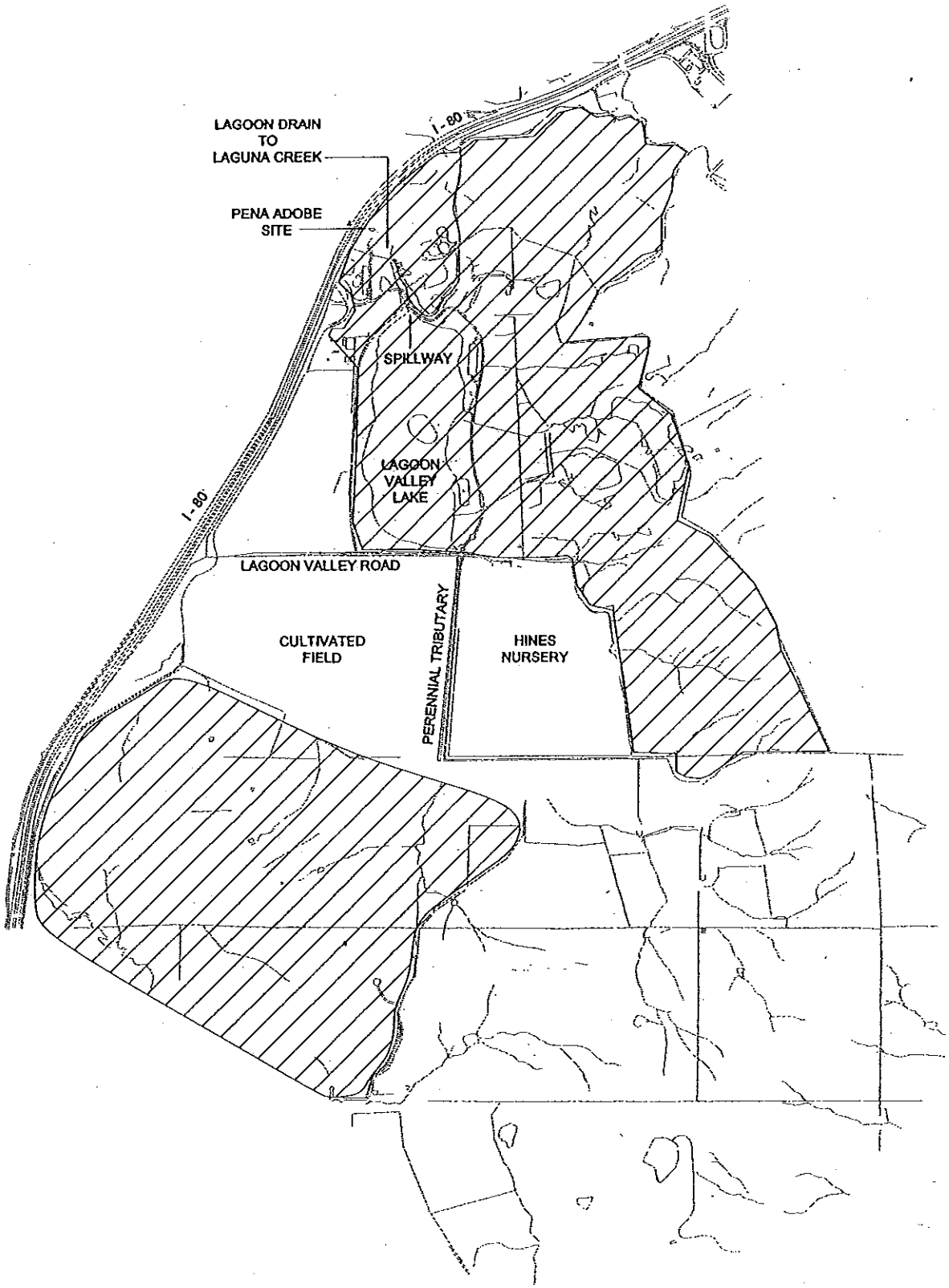
LSA

Scale in miles

0 20

Project Location

Figure 3



05-21-99(COV831LandUses)

Figure 3

N

LSA

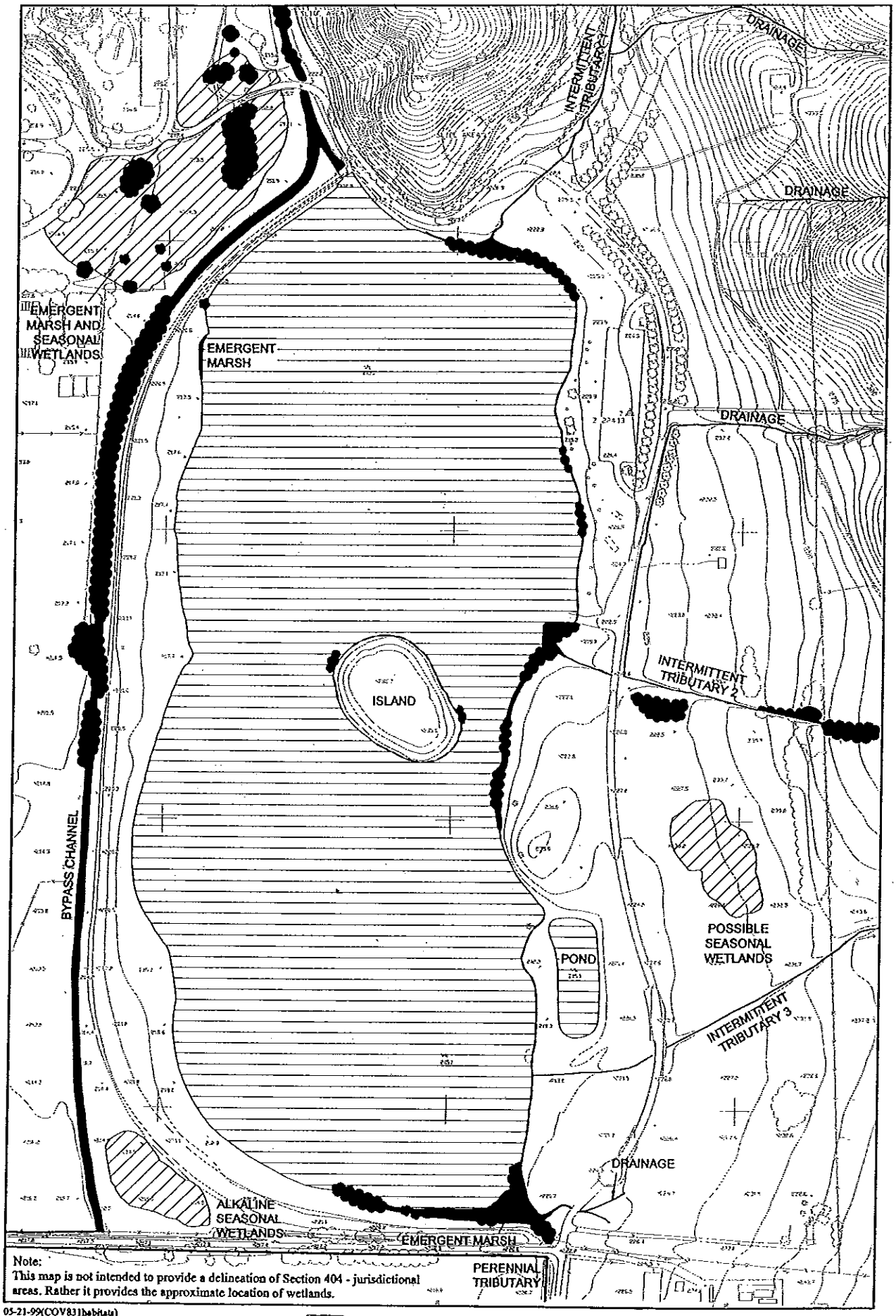
Scale in feet

0 1500

Park & Open Space Lands

Surrounding Land Uses

Figure 4



Note:
This map is not intended to provide a delineation of Section 404 - jurisdictional areas. Rather it provides the approximate location of wetlands.

05-21-99(COV831habitats)

N

LSA

Scale in feet
0 300

Ocassional Riparian Trees
Open Water
Woody and Channel Riparian Habitat

Figure 4

Wetland and Riparian Habitats - Lagoon Valley Lake

The lake is 106 surface acres, with an average depth of 6 to 7 feet, and a maximum depth of 9 feet near the dam's spillway. The land to the west and south of the lake is relatively flat, while that to the east and north is hilly with three intermittent tributaries that drain to the lake. Additionally, the lake receives inflow from a perennial to near-perennial drainage channel (hereafter referred to as the "perennial tributary") that enters the lake at its southeast corner near the intersection of Lagoon Valley Road and the park road. A small delta has formed in the lake at this inflow point.

Most of the hill and ridgelines surrounding the Lower Lagoon Valley are protected as open space and community separator lands under the City of Vacaville General Plan and the Lower Lagoon Valley Specific Plan (Figure 3). Those portions of the lower valley not protected as regional parklands are designated for a variety of future development under the Specific Plan. Approximately 333 acres lying southeast of the lake are designated as estate-style residential (1-2 units/acre) with an integrated golf course. Much of the remainder of the valley's private lands (70 acres) is reserved for commercial uses including an office park and a regional shopping center. In 1990, the Lower Lagoon Valley Specific Plan, which addressed these land uses, was adopted by the City. No developments under the Specific Plan have thus far been approved and the valley's private lands, not devoted to the Hines Nursery operation, remain largely undeveloped.

1.2 Need for Management Plan

The City of Vacaville *Comprehensive Parks, Recreation and Open Space Master Plan* (City of Vacaville 1991) identified the potential for the Lagoon Valley Regional Park to provide improved opportunities for a variety of passive and active recreational opportunities, many of which are directly related to the lake. These include fishing, non-motorized watercraft usage, and nature study. A variety of other recreational opportunities have also been proposed, including fair and festival events, ballfields, hiking trail expansion and expanded picnic facilities. Although these other recreational opportunities are not directly related to the lake, they nevertheless will benefit from the scenic amenity provided by the lake, and must be designed so that there are no adverse environmental impacts to the lake.

The City has prepared a master plan for the Lagoon Valley Regional Park to implement the proposed recreational improvements. However, successful implementation of recreational improvements is dependent on development of a long-term lake management plan that will address a wide range of lake management concerns. For example, improvement of lake water quality will enhance the potential for fishing and boating opportunities. Shoreline erosion control and enhancement of shoreline vegetation will improve opportunities for nature study and the lake's scenic quality. This lake management plan is therefore an integral component of the overall Lagoon Valley Regional Park master planning process.

1.3 Problematic Conditions in the Lagoon Valley Lake Watershed

Existing conditions in the surrounding watershed are contributing to a range of lake management problems. These conditions can be categorized by whether they occur in the upper or lower watershed areas. The proposed management plan takes a "start at the source" approach in solving these problems. Wherever feasible, problems are

addressed first in the upper watershed, then in the lower watershed and finally in lake itself.

Upper Watershed: The upper watershed comprises the zone between the base of the adjacent hills to the tops of the ridgelines (elevation range - approximately 300 feet to 800 feet NGVD). It consists of relatively steeply sloped terrain containing numerous drainages, gullies and small canyons. The upper watershed appears to be a major source of sedimentation to the lake. Many drainages are somewhat incised, have obvious headcut problems and lack stabilizing vegetation along channel slopes. Hillside slump areas are also found. Evidence of the degree of sedimentation flowing down the drainages is found in the upper storm drainage collection system above the Hines Nursery where large volumes of sediments collect on an annual basis and must be occasionally removed.

The entire upper watershed is under near continuous grazing by cattle, which may be one source of the erosion problems. According to the City of Vacaville Community Services Department, grazing densities are well within recommended per-acre guidelines. However, based on the grass heights and densities observed during the period of this investigation, it would appear that grasslands in the overall watershed do not get much annual relief from grazing. Based on the paucity of woody riparian vegetation and the heavily eroded banks of many drainages, there is probably a heavy concentration of cattle along these areas in the late dry season, when the drainages provide the only source of non-desiccated forage. This likely results in excessive trampling of bank vegetation, contributing to erosion problems, as well as preventing riparian vegetation from maturing.

Portions of the watershed area have become invaded by yellow star thistle, an exotic plant species that is toxic to horses and avoided by cattle due to its spiny inflorescences. This annual plant matures rapidly, attaining heights of up to 3 feet by late summer, and then dies-off, leaving dead "skeleton" plants. The "skeleton" plants are often concentrated in and along drainages, obstructing flow and contributing to erosion problems.

Another potential cause of sedimentation in the upper watershed may be the various recreational trails and fire roads that are used by mountain bikers and horseback riders. In the absence of proper annual maintenance and repair, long-term trail use may increase areas of trail erosion and wash-outs.

Lower Watershed: The lower watershed consists of the relatively flat lands between the base of the hills and Lagoon Valley Lake. It encompasses the various active land uses (*e.g.* Hines Nursery, motel, horse boarding facility and parks) as well as fallow agricultural lands and seasonal wetlands. The lower watershed contributes to sedimentation problems, nutrient enrichment, high bacterial levels and blackfish infestations in the lake. Other problems or potential problems in the lower watershed include invasive exotic vegetation and the potential impacts of future urban development.

Seasonal tributaries that enter the lake in the lower watershed tend to be moderately to deeply incised, suggesting that upper watershed erosion problems may be allowing excessively large and rapid flows to enter the lower watershed during large storm

events. These flows contribute to lower watershed channel downcutting and probably increase sediment volumes entering the lake.

As will be illustrated by the water quality analysis (see Section 4.3 below), the lower watershed is the source of excessive nutrients and bacterial inflow to the lake. High levels of nutrients flow into the lake during storm events from the perennial tributary. Nutrients may also enter the lake during storm events from intermittent channels that collect nutrients from the areas heavily used by waterfowl, and from other areas of the park. Finally, nutrients from upper watershed grazing lands may be a minor contributing factor. Bacterial contamination from the lower watershed is probably related to runoff from roosting and resting areas that are heavily used by waterfowl.

The lower watershed contains areas that are heavily infested by star thistle. This invasive exotic pest plant not only limits the utility of large areas for park visitors but also prevent the growth of more desirable native vegetation that would be more attractive to wildlife. Other invasive exotic pest plants known or likely to occur in the lower watershed include perennial pepperweed (*Lepidium latifolium*), broom (*Genista monspessulana*), eucalyptus (*Eucalyptus globulus*), giant reed (*Arundo donax*), salt cedar (*Tamarix ramosissima*) and Canada thistle (Cirsium arvense), bull thistle (C. vulgare) and milk thistle (*Silybum marianum*).

As discussed in Section 4.7, Sacramento blackfish have entered the lake when the lower lagoon drain (which flows to Laguna Creek - see Figure 2) becomes backed-up, allowing backflows to enter the lake over the dam spillway. Blackfish are major cause of the decline of the lake's sport fishery.

The growth of woody riparian vegetation along the bypass channel shoreline has been inhibited by beaver activity. Numerous willow and cottonwood trees have been felled by beavers in this area. If riparian vegetation were allowed to mature and expand along the bypass channel, its utility for migrating and resident songbirds, waterfowl, wading birds and other fauna would be enhanced.

Finally, the approved Lower Lagoon Valley Specific Plan would allow commercial, residential and golf course development in the lower watershed. Unless, such development includes a wide range of structural and maintenance best management practices (BMPs) to treat storm water quality (*e.g.* minimization of impervious areas, grassy swales, water quality ponds, detention ponds) before discharge to the lake, there will be a strong potential for further water quality degradation in the lake.

2.0 EXISTING CONDITIONS

2.1 Physical Characteristics

Topography – The lower Lagoon Valley consists of relatively flat alluvial lands ranging in elevation from approximately 210 feet NGVD at the lake shoreline to 300 feet NGVD at the base of the surrounding hills. There is a general north-northwest gradient (slopes 1-2 percent) toward Laguna Creek. The Vaca Mountains to the west of the valley have a north-south tending ridgeline with elevations up to 1,400 feet NGVD. The hills to the east and north of Lagoon Valley Lake are somewhat lower with a maximum elevation of approximately 960 feet (Figure 2). The hill systems surrounding the lake are characterized by numerous folds and ridges that have created many large and small canyon drainages and channels that flow toward the lake.

Soils - Soils in the lower lagoon Valley and surrounding hills are primarily clay to clay loam that were formed in alluvium derived from sedimentary rocks (NRCS 1977). They are generally characterized by poor percolation and zones of high alkalinity.

The eastern hillsides and slopes consist of a moderately deep clay loam formed from weathered sandstone. Lowland, flatter areas on the east side of the lake consist of Rincon clay loam. These soils and the Brentwood clay loam found in the western part of the valley extending to the I-80 corridor, are on alluvial fans and have moderate surface runoff properties. A pocket of Clear Lake clay occurs west of the lake. This soil type drains poorly. Small pockets of Pescadero clay loam occur along the lake's east and west shores, except for another small pocket of Dibble-Los Osos loams. The Pescadero clay loams drain poorly and have a saline alkali subsoil. The lake's south and southeast shores consist of clay loam and silty clay loam. Soils within the lake are of hydrologic soil groups C and D which have medium to high runoff potential.

2.2 Biological Characteristics

Upland Habitats - The majority of the undeveloped watershed, surrounding Lagoon Valley Lake, consists of heavily grazed annual grassland and ruderal (weedy) fallow fields. Grasslands are characterized by non-native grasses and forbs, including wild oats (*Avena barbata*), bromes (*Bromus diandrus*, *B. hordeaceus*), perennial ryegrass (*Lolium perenne*), mustards (*Brassica spp.*), vetch (*Vicia villosa*), filaree (*Erodium bortrys*) annual cranesbill (*Geranium molle*), and a range of other common grassland species. Ruderal fields are similar to non-native grasslands, except that they have a higher presence of weedy species and invasive exotic species, including yellow star thistle (*Centaurea solstitialis*), purple star thistle (C. *calcitrapa*), common ragweed (*Ambrosia artemisiifolia*), black mustard (*Brassica nigra*), bindweed (*Convolvulus arvensis*), fennel (*Foeniculum vulgare*), tarweed (*Hemizonia sp.*) and birdsfoot trefoil (*Lotus corniculatus*).

Valley oak woodland typically occurs in the upper watershed along canyons with north and east-facing slopes. The dominant species in this forest are valley oak (*Quercus lobata*), interior live oak (*Q. wislizenii*), coastal live oak (*Q. agrifolia*), California bay (*Umbellularia californica*), California buckeye (*Aesculus californica*), and poison oak (*Toxicodendron diversilobum*). Oak woodland also occurs along canyon floors where surface runoff and emerging groundwater allow for the development of relatively

mature trees. Individuals and small stands of coyote thistle (*Baccharis pilularis*) are also found. Various native and non-native trees have been planted for landscaping purposes along roadside and in picnic areas, including valley oak, pines, Australian pine, alder and Oregon ash.

Riparian Habitats - Riparian habitats occur in a few locations along the intermittent tributaries on the valley floor, along the lake bypass channel, and in various locations along the lake shoreline, particularly along the south shoreline near the outlet delta for the perennial tributary (Figure 4). Vegetation consists of mature and sapling willows (*Salix sp.*) and cottonwoods (*Populus fremontii*) as the dominant canopy cover.

The oak woodland and riparian areas likely support red-tailed hawk (*Buteo jamaicensis*) and the great horned owl (*Bubo virginianus*). Other avian species probably utilizing this community include black-headed grosbeak (*Pheucticus melanocephalus*), downy woodpecker (*Piciodes pubescens*), western scrub-jay (*Aphelocoma californica*), Stellar's jay (*Cyanocitta stelleri*), chestnut-backed chickadee (*Poecile rufescens*), black phoebe, dark-eyed junco (*Junco hyemalis*), song sparrow (*Melospiza melodia),* white-crowned sparrow (*Zonotrichia leucophrys),* and bushtit (*Psaltriparus minimus*). Mammals such as deer mouse (*Peromyscus maniculatus*), dusky-footed woodrat (*Neotoma fuscipes),* fox squirrel (*Sciurus niger*), raccoon (*Proycon lotor*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*) and black tail deer (*Odocoileus hemionus*) occur in the oak woodland community. Adult California newts spend the dry portion of the year in the oak woodland but move to the aquatic sites to breed during the rainy season. Other species, such as the California slender salamander (*Batrachoseps attenuatus*) and the ensatina (*Ensatina eschscholtzii*), spend their entire life in the woodland floor leaf litter.

The non-native annual grassland community provides potential habitat for several species of small mammals, including California meadow vole (*Microtus californicus*), western harvest mouse (*Reithrodontomys megalotis*), Botta's pocket gopher (*Thomomys bottae*), and California ground squirrel (*Spermophilus beecheyi).* Black-tailed deer utilize this community for forage during the spring. Red-tailed hawk, American kestrel (*Falco sparverius*), and the great horned owl also utilize this community as forage habitat. Other species observed utilizing this community include meadowlark (*Sturnella neglecta*), killdeer (*Charadrius vociferus),* white-tailed kite (*Elanus leucurus*), and loggerhead shrike (*Lanius ludovicianus*).

Wetlands and Aquatic Habitats - In addition to the open water aquatic habitat of the lake, several other wetland and aquatic habitat types occur within the Lagoon Valley watershed (Figure 4). These are described below:

- ***Emergent Marsh*** - This wetland habitat type occurs within the lake bypass channel as well as within segments of the intermittent tributary channels and banks. It also occurs along those portions of the lake shoreline where the slope is gentle enough to allow emergent vegetation to have become established. Dominant vegetation in deeper emergent marsh areas, where permanent inundation occurs, is cattails (*Typha spp.*), tule (*Scirpus acutus*), and willow. In shallower areas, subject to saturated soil conditions year round but annual recession of surface waters, spikerush (*Eleocharis sp.*), rushes *(Juncus spp.*) and sedges (*Carex spp.*) become dominant.

Bird species such as black phoebe (*Sayornis nigricans*) and cliff swallows (*Petrochelidon pyrrhonota*) forage for insects at these marshes, and red-winged blackbirds (*Agelaius phoeniceus*) may nest in the cattails. Emergent marsh also provides excellent foraging habitat and cover for waterfowl and wading birds, as well as habitat for reptiles such as the western pond turtle, amphibians such as California newt (*Taricha torosa*), bullfrog (*Rana cate*) and Pacific tree frog (*Pseudacris regilla*) and mammals such as muskrat and freshwater otter. Along the lake shore, this habitat provides protective cover and feeding areas for juvenile Sacramento perch and bass.

- ***Seasonal Wetlands*** – This habitat occurs within low-lying areas in the lower watershed where seasonal runoff accumulates, allowing for extended periods of soils saturation and shorter periods of inundation. Seasonal wetlands also occur along the banks of intermittent tributaries. To the south of the lake, seasonal wetlands reflect the alkaline nature of the natural soils in the valley. Dominant species include halophytes (salt tolerant plants) such as salt grass (*Distichlis spicata*) and pickleweed (*Salicornia viginica*), as well as ruderal hydrophytes (weedy plants tolerant of wet conditions) such as bristly oxtongue (*Picris echioides*), curly dock (*Rumex crispus*) and Mediterranean barley (*Hordeum marinum ssp. gussoneanum*).

  To the northwest of the lake, near the park entrance, lie several large patches of seasonal wetlands intermixed with emergent marsh. Dominant species within these seasonal wetlands include perennial ryegrass, Mediterranean barley, curly dock, Baltic rush (*Juncus balticus*), and teasel (*Dipsacus fullonum*). Along some drainages in the upper watershed hills, natural hillside seeps maintain sufficiently saturated soils to support small stands of seasonal wetlands and a few willow trees.

Special Status Species - Special status species are those listed as threatened or endangered or candidates for such listing under the federal and state endangered species acts, and other rare species afforded special protection or recognition by the state. During survey work, three special-status wildlife species were observed in the Lagoon Valley Regional Park: western pond turtle (*Clemmys marmorata*), white-tailed kite, and loggerhead shrike. A maximum of 25 western pond turtles were observed in the bypass channel west of the lake and two were observed in the small pond at the southeastern edge of the lake. Two white-tailed kites were observed in trees between Lagoon Valley Road and the lake and one loggerhead shrike was observed in the trees on the knoll south of the boat ramp. Both the white-tailed kite and loggerhead shrike could nest on-site. Appendix A provides a summary of special status species known to occur or potentially occurring within the surrounding Vacaville region, and their potential for occurrence within or around Lagoon Valley Lake.

Preliminary Cost Estimates Lagoon Valley Lake Management Plan
Capital Improvements

Proposed Capital Improvement	Planning and Design	Construction	City Review & Inspection	Total Item	Key Assumptions
Phase 1 Improvements					
1-1: Upper watershed management plan	$25,000	$250,000	$25,000	$300,000	Assumes full implementation of all watershed stabilization items; assumes 10+ heavily-eroded drainages. Assumes construction costs partially borne by grants and donor contributions. Assumes planting costs borne in part by volunteer stewardship program.
1-2: Hines Nursery ditch stabilization; Localized sediment capture system	$14,600	$73,000	$14,600	$102,200	Assumes 5 check dams, 8' wide and 15' deep with basins of 225 square feet; Assumes 1000 linear feet of ditch stabilization. NOTE: This alternative may reduce the size of the detention basin required on acquired land under Task 1B.
1-3: Lagoon drain rehabilitation	$6,000	$60,000	$6,000	$72,000	Removal of rock obstruction in channel; and removal of constricting aquatic vegetation.
				Phase 1 Subtotal	$474,200
Phase 2 Improvements					
2-1: Two sediment basins on public lands	$75,000	$535,000	$75,000	$685,000	Four-acre sediment basins with on-site disposal. Design includes basin and lake hyro and geotechnical study work.
2-2. Intermittent drainage channel stabilization	$8,660	$43,300	$8,660	$60,620	Lower watershed drainage channels only.
				Phase 2 Subtotal	$745,620
Phase 3 Improvements					
3-1: Lake deepening - create new wetlands	$100,000	$908,000	$70,000	$1,078,000	Deepen lake as above; 15 acre wetland area.
3-2: Lake shoreline stabilization	$30,000	$266,000	$0	$296,000	Assumes use of inmate labor. Range of options includes re-grading, geotextiles, rock riprap, Tri-Lock, island breakwater and shoreline planting. Planting costs could be reduced through volunteer stewardship program.
3-3: Riser on dam spillway	$10,000	$2,500	$500	$13,000	
				Phase 3 Subtotal	$1,387,000
Phase 4 Improvements					
4-1: Fish stocking program	$0	$50,000	$0	$50,000	Assumes 3 stockings over ten years; Cost may be covered by State fisheries program or other grants.
				Phase 4 Subtotal	$50,000
Regulatory Approval - Background studies, document and report preparation; fees.	$100,000				Total costs may be greater to lesser depending on the degree of Section 404 regulatory approval required, and degree of federal agency review.
				GRAND TOTAL	$2,766,820

NOTE: Cost estimates are *order-of-magnitude*.

(P:\cov831\capital4)

Preliminary Operations Maintenance Budget Estimates - Lagoon Valley Lake Capital Improvements

Operations & Maintenance Item	Annual Estimated Cost	Assumptions
Sediment basin clean-out	$30,000	Assumes clean-out once every 2 years and on-site disposal
Upper watershed maintenance	$6,000	Fence maintenance & repair; inspections of stabilized areas; minor repairs as needed.
Hines Nursery ditch & intermittent channel maintenance	$4,000	Assumes clean-out once every 2 years and on-site disposal; inspections and minor repairs as needed.
Flushing early winter runoff	$0	Involves opening spillway to flush nutrients from lake.
Stabilized shoreline and new wetland maintenance	$15,000	Inspect for excessive erosion; conduct repairs as needed. Conduct biological monitoring as needed.
Nuisance species relocation program	$4,500	Domesticated ducks and beavers
Blackfish seining	$3,000	Seining of entire lake under contract with commercial fishermen.
Annual water quality monitoring	$25,000	Sediment monitoring in watershed, tributaries and lake. Nutrient monitoring in tributaries and lake.
TOTAL ANNUAL MAINTENANCE BUDGET		$87,500

POTENTIAL REVENUE AND FUNDING SOURCES – LAGOON VALLEY LAKE MANAGEMENT PLAN CAPITAL IMPROVEMENTS

- CURRENT GENERAL FUND ALLOCATION (1999/2000) $200,000
- GRANTS (STATE/ FEDERAL) & STATE PARK PROPOSITIONS $750,000
- LAGOON VALLEY DEVELOPMENT AGREEMENTS:*

PHASE 1A	$100,000
PHASE 1B	$2,100,000
	$3,150,000

* This funding is contingent upon the private development schedule of Lagoon Valley. The timing of the proposed lake improvements could be spread out over a number of years, or in accordance with development agreement timelines.

3.0 STUDY APPROACH AND DESIGN

3.1 Management Plan Process

This management plan has been prepared and was reviewed in accordance with the following six phases:

Phase 1: Identify specific beneficial uses and management goals that will maintain and enhance Lagoon Valley lake.

The project team met with City staff and agency representatives to identify the public benefits provided by Lagoon Valley Lake (*i.e.* "beneficial uses") and to develop a preliminary set of specific management goals to achieve these beneficial uses (see Sections 3.2 and 3.3 below). These preliminary management goals were then related to key lake management problems to design the necessary technical studies and planning analyses (see Section 3.4 below).

The *Recreational Fishing* beneficial use provides a good example of how this overall planning process worked. To achieve an improvement in recreational fishing, the team identified *reduction in sedimentation* as a specific management goal, because excessive sediment influx to the lake interferes with maintaining sustainable native fish populations. The project team therefore identified various studies (*e.g.* sediment load studies, shoreline erosion studies) needed to identify sources of sedimentation and possible management solutions.

Phase 2: Conduct technical studies to evaluate management problems and the related specific management goals

Based on the results of Phase 1, the project team conducted hydrological, geotechnical, biological and water quality analyses to evaluate the above management problems and to determine the feasibility of the related specific management goals. Project team members included biologists, engineers, recreational planners, water quality and geotechnical experts (see "Study Team" Section 8.3). Specific study tasks undertaken by the team are identified in Section 3.4 below. Study results are provided in Section 4.

Phase 3: Recommend options for management, enhancement actions and capital improvements

Based on the results of the Phase 2 technical and planning studies, the project team proposed actions for achieving specific management goals. Recommendations include capital improvements, management actions and enhancement actions. Whenever feasible, multiple management options were provided, representing a range of "hard" (*e.g.* structural) and soft solutions (*e.g.* best management practices) as well as a range of cost options. The likely "pros" and "cons" of each management option were also identified so that the City and the public could make informed decisions about the final plan. Proposed management plan options are provided in Section 5.

Phase 4: Estimate implementation costs and options for funding

Order of magnitude costs for capital improvements and other management actions were provided to City staff. These included any one-time costs, such as stocking fish into the lake, as well as expected annual costs for required maintenance activities. The project team also prepared a summary of potential funding sources for capital improvements. Federal, state and local options for grants and cost sharing programs were investigated and evaluated, and details on application requirements provided. Funding options are provided in Section 6.

Phase 5: Obtain agency input and recommendations

Lagoon Valley Lake falls under the jurisdiction of a number of federal, state, and county agencies, including California Department of Fish and Game (CDFG), State Division of Safety of Dams (DSD), U.S. Army Corps of Engineers (Corps), U.S. Fish and Wildlife Service (USFWS), and Solano County Environmental Management Department. Each of these agencies have regulatory requirements and/or policy guidelines with which the lake management plan should comply. Moreover, certain agencies have direct interests in how the lake is managed. For example, CDFG uses Lagoon Valley Lake as a nursery for Sacramento perch for the re-introduction of this native centrarchid (sunfish family) to other California waters. The management plan needs to ensure that this public benefit is not adversely affected and potentially enhanced.

The project team contacted all the agencies listed above to obtain their preliminary comments and concerns, which have been taken into consideration in the preparation of this preliminary plan. Following distribution of this plan for agency comment, and subsequent meetings with the agencies, modifications were made to address agency concerns and to properly describe regulatory processes for plan implementation. Potential agency regulatory requirements are outlined in Section 7.

Phase 6: Obtain public input and recommendations

The lake management plan is ultimately intended to serve the people of Vacaville and surrounding areas. Development of a plan that has a public consensus is imperative. Three public meetings were held to provide an opportunity for public comment before a final version of the proposed plan was placed before the City Council for approval. This final proposed plan was modified based on public input from these meetings.

3.2 Identification of Lagoon Valley Lake's Beneficial Uses

Lagoon Valley Lake potentially offers a wide range of recreational and non-recreational benefits. The first task under the study approach was to identify the range of existing or potential public benefits ("beneficial uses") that currently exist and/or that may be created, enhanced and protected under this lake management plan. City of Vacaville staff suggested that the following beneficial uses for Lagoon Valley Lake be investigated under this management plan:

1. *Recreational fishing*
2. *Windsurfing and other small motorless craft use of lake*
3. *Scenic values that encourage passive recreational use of the lake*
4. *Wildlife habitat*
5. *Storm water management*
6. *Swimming*
7. *Non-aquatic recreation*

3.3 Specific Management Plan Goals

In order to promote and/or enhance Lagoon Valley Lake's beneficial uses, City staff and the project team identified the following specific management plan goals. Project studies and investigations were directed toward evaluating and achieving these specific management plan goals. Appendix B provides a summary of the relationship of the project team's investigations and technical studies to the management plan goals.

1. BENEFICIAL USE: RECREATIONAL FISHING

A. ***Manage and control Sacramento blackfish populations*** - Blackfish have caused the lake's sport fishery to decline. Blackfish reproduce in the lake at a much higher rate than bass or sunfish and out-compete bass. Until they are controlled, a successful sportfishery in the lake cannot be sustained.

B. ***Expand largemouth bass and redear sunfish populations*** - Healthy and sustainable populations of these species will promote a sustainable sport fishery in the lake, once blackfish are controlled.

C. ***Maintain Sacramento perch nursery benefits*** - Lagoon Valley lake provides an important source of this species for CDFG's stocking program in other water bodies. This benefit needs to be maintained.

D. ***Improve recreational fishing accessibility*** - Access for sport fishing is physically limited by inadequate facilities and by extensive summertime growths of aquatic weeds. The recreational utility of the lake could be increased through programs of improved access and weed control.

E. ***Reduce sedimentation*** - Sedimentation gradually reduces lake depth and increases turbidity by stirring-up the shallow lake bottom. Shallower lake depths also promote growth of algae and aquatic weeds.

F. ***Reduce summer aquatic weed infestations*** - Recreational angling is impeded by extensive growths of sago pondweed and filamentous algae that fill much of the lake each summer. There is very little open water that can be fished from shore, as only the deepest portions of the lake are free of

pondweed. Decaying plant materials deplete dissolved oxygen levels to below the levels sport fish can tolerate.

2. **BENEFICIAL USE: SMALL MOTORLESS CRAFT USE OF LAKE**

   A. ***Facilitate windsurfing usage of lake*** - Summer weed infestations inhibit the utility of the lake for windsurfing and canoeing. These non-motorized craft provide an environmentally-friendly recreational use of the lake that should be encouraged, provided that important habitat areas are kept off-limits.

3. **BENEFICIAL USE: SCENIC AMENITY THAT ENCOURAGES PASSIVE RECREATIONAL USE**

   A. ***Maintain I-80 corridor view of lake and valley*** - The view of the lake and lower Lagoon Valley is recognized as an important aesthetic feature along the I-80 entrance to Vacaville. There should be no changes to the park and lake that would disrupt this view.

   B. ***Enhance the visual quality of shoreline usage areas*** - The utility and aesthetic value of the shoreline area can be enhanced through a program of native tree planting and by controlling unsightly erosion problems.

4. **BENEFICIAL USE: WILDLIFE HABITAT**

   A. ***Establish shoreline wetland zones*** - Wetland areas can help stabilize shorelines, reducing sedimentation. Wetland zones can be important habitat features increasing the utility of the lake for aquatic and terrestrial species. Wetlands can also enhance water quality through nutrient uptake. The creation of additional wetlands with dredged bottom materials could create off-site mitigation opportunities for the city.

   B. ***Establish woody riparian vegetation zones along the lake shoreline*** - Woody riparian vegetation will also help stabilize the lake shoreline, providing additional cover for wildlife, roosting opportunities for birds, and will enhance the aesthetic quality of the shoreline.

   C. ***Enhance stabilized drainage corridors*** - Planting of woody riparian vegetation and seeding with wetland herbaceous species will help stabilize the intermittent tributaries and will provide new riparian habitat zones.

   D. ***Enhancement of lake bypass channel*** - The bypass channel provides a suitable location to expand and enhance riparian habitat while not interfering with water management functions. Wildlife using the lake could find excellent refuge within bypass channel riparian habitat.

5. **BENEFICIAL USE: STORM WATER MANAGEMENT**

   A. ***Maintain storage capacity*** - Lagoon Valley Lake provides significant storm water storage benefits to the surrounding lower valley. This function will

become more important if lower valley development proceeds as per the Specific Plan. The lake's storage capability must therefore be protected.

B. ***Spillway and dam maintenance*** - The drainage channel below the dam spillway is not fully functional due to blockage by vegetation and sediments. The entire dam embankment needs to be maintained in proper condition to avoid undermining or erosion problems.

6. BENEFICIAL USE: SWIMMING & SHORELINE RECREATION

A. ***Evaluate the Potential to Establish a controlled wading beach*** - A small area devoted to shallow wading could enhance the overall utility of the lake to the public. In conjunction with nearby picnic areas and ballfields, a diverse overall recreational experience could be provided.

B. ***Enhance interpretive values*** - There are numerous existing and new opportunities for public appreciation of the lake's natural values. Opportunities should be expanded for people to view wildlife in a non-intrusive manner and to provide educational and possibly stewardship experiences for Vacaville school children and civic organizations.

C. ***Enhance shoreline passive recreational opportunities in conjunction with the park master plan*** - Lagoon Valley Lake should be the aesthetic and recreational centerpiece of the Lagoon Valley Regional Park. Every opportunity should be used to integrate and coordinate the lake with overall park development plans, and to avoid conflicting uses.

3.4 Technical Studies

Under Phase 2, the project team conducted the following technical studies and evaluations:

- ***Evaluation of Lake Seasonal Water Loss and Need for Supplemental Water***

  In order to evaluate the lake's holding capacity, the project team examined historical inflow data and lake levels. This information was used to estimate expected inflow and lake levels for a typical year. Based on this data, and based on data relevant to other lakes in the area, the amount of water lost by evapotranspiration was estimated. The purpose of this investigation was to determine if there is any need for supplemental seasonal water to sustain the lake over the long term and to ensure that storm water detention needs are met.

- ***Evaluation of Watershed Management and 100 Year Storm Analysis***

  The project team researched and analyzed existing contributing watershed data and evaluated watershed effect on the lake. Upstream conditions, including flows from tributaries, adjacent agricultural properties, and impervious surfaces such as roads and hardscapes were evaluated to determine significant sources of sediment that might be controlled. The 100-year storm event was also evaluated. Using

selected pre-storm lake levels, existing mechanisms for water storage and outflow were examined. This information was used to determine conditions that could occur during a 100-year event (*i.e.* water flowing over the top of the dam and potential dam breaches).

- ***Evaluation of Lake Water Quality and Management Options***

  A primary lake management concern with regard to recreation is the lake's propensity for algal blooms and excessive aquatic plant growth during June through October. Not only do the algae and aquatic plants obstruct boating and fishing, but the decaying plant material creates an odor problem and lowers dissolved oxygen to levels that could cause fish kills. The project team conducted water quality sampling and analyzed past water quality data to:

  1) identify the reasons for the excessive growth of algae and aquatic plants;
  2) identify data gaps so that a long-term monitoring program can be designed to obtain needed data, and
  3) create a management program for restricting, removing, and/or chemically treating algae and aquatic plants that interfere with the beneficial uses of boating, fishing, wading, and general aesthetics.

  Water quality analysis included the following factors: temperature and thermal stratification; naturally occurring chemical impacts; dissolved oxygen levels; agricultural chemical impacts; pH; water clarity, nutrient sources and control; bacterial contamination sources and control; pondweed and algae formation and control; water depth and the slope of the lake bottom. The lake's gradation and water depth was also evaluated as a factor in contributing to the excessive growth of algae and aquatic plants.

  Water quality sampling was conducted at key locations in the lake and contributing streams before and during storm events. This data was supplemented by data previously collected by the City and by others (Will C. Wood H.S.).

- ***Evaluation of Grading Plans, Water Depth, and Options for Lake Deepening***

  The project team evaluated past grading plans in comparison to the current depth survey in order to evaluate impacts on the lake's current and future conditions. Quantity takeoffs and cost estimates were prepared in order to examine the potential for deepening the lake and determining the level of benefit that this would provide.

- ***Siltation and Erosion Control Evaluations***

  Problematic siltation from erosion of seasonal creeks and roadside ditches was evaluated. As discussed above, the project team worked to identify major sources contributing to siltation. In particular, those sources which can readily be controlled at minimal cost were examined in greater detail and suggestions made for implementation strategies.

- ***Evaluation of Shoreline Erosion***

  Most lake shoreline erosion problems can be attributed to wind and wave action against the water's edge. The project team examined the extent to which shoreline erosion has been occurring and suggested mitigation strategies to help reduce erosion.

- ***Fisheries Evaluation and Management Plan***

  To assess the existing lake fishery, the project team conducted fish netting studies and also conferred with a CDFG fisheries biologist (Dennis Lee), a retired CDFG fisheries biologist (Fred Meyer), a former Lagoon Valley park ranger (Duane Davis) and a commercial fisherman who regularly fishes the lake (Mark Meadows). The fish netting data and the information from these knowledgeable individuals were used to develop a fisheries management plan for the lake. The plan took into consideration water quality concerns, the habitat needs of existing fish populations, and possible recreational plans for the lake and park. The lake presently supports populations of Sacramento perch, Sacramento blackfish, and mosquitofish. Originally widely distributed in the Sacramento-San Joaquin rivers, Sacramento perch are now found in only scattered localities in the state. The lake is used by CDFG as a source of Sacramento perch for the re-introduction of this native centrarchid (sunfish family) to California waters. Because of the habitat importance of rooted emergent vegetation to this species, management of the lake's aquatic plants will need to maintain areas of pondweed to support Sacramento perch population. Also evaluated was the possibility of adding either bluegill or redear sunfish to the lake to serve as both an additional game fish and a prey species for the larger Sacramento perch.

- ***Evaluation of Waterfowl Impacts on the Lake***

  Because of its potential effect on aquatic plant and algae growth, nutrient contributions from waterfowl waste were examined as well as the impacts of waterfowl waste on water contact sports from a public health perspective (bacterial contamination). Options for controlling the waterfowl population and educating the public to discourage feeding waterfowl were evaluated along with bacterial control methods.

- ***Evaluation of Proposed Public Recreational Uses***

  Recreation planning must maintain the primary park feature, Lagoon Valley Lake, by providing for a limited recreation program, siting selected activities, designing improvements, and informing or educating the public. The project team worked with City staff to refine the preliminary recreation program objectives and locate recreation activities so that they do not impact the health of the lake.