AQUATIC PARK IMPROVEMENT PROGRAM
SUMMARY REPORT

Prepared for:

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INTRODUCTION

Aquatic Park is located in West Berkeley adjacent to Interstate 80 between Ashby and University Avenues and is the largest city park in Berkeley. The City of Berkeley has completed several planning efforts for Aquatic Park. In 1990 a Master Plan was prepared which identified enhancing natural resources and improving water quality as major goals. The Master Plan also recommended the southern end of the park become a bird sanctuary. In 2003 the City released a Natural Resource Management Study (NRMS). This study provided recommendations to improve water quality by increasing water circulation and increasing wetland habitat areas; however, a limited amount of hydrologic modeling and data collection was completed for the NRMS. In 2006 the City moved forward with the Aquatic Park Improvement Program (APIP) to prepare concept-level designs for the major recommendations in the NRMS. This report summarizes the studies and analyses for the APIP completed by a consulting team of Laurel Marcus & Associates (LMA) and Hydrologic Systems Inc. (HSI). The City will complete CEQA review and permit acquisition for the recommended alternative. The City is currently working with the State Coastal Conservancy on implementation funding.

PROGRAM PURPOSE

The goals of the APIP include:

- Improve water circulation and quality
- Restore and expand natural habitat to the extent feasible
- Balance protection of recreational uses with water quality and habitat restoration
- Improve park appearance
- Provide realistic and clear detailing of improvements to be made, equipment or materials to be used, phasing and monitoring and maintenance requirements
- Encourage increased on-going study and monitoring of conditions at the Park
- Encourage active pursuit of funding for those components of the APIP that can't be funded through the Coastal Conservancy/Proposition 50 funds.

BACKGROUND

Aquatic Park was created from intertidal and subtidal areas in the 1930s as part of the construction of the Bayside Freeway. Aquatic Park now has three lagoons: the Main Lagoon, the Model Yacht Basin, and the Radio Tower Pond. The largest lagoon is the Main Lagoon (ML) at 58.3 acres with the Model Yacht Basin (MYB) to the south at 5.0 acres. The Radio Tower Pond (RTP) of 4.7 acres is the southernmost lagoon and only partially owned by the City. The entire park is 102 acres and includes: 68.0 acres of aquatic habitat in the three lagoons, 0.7 acres of salt/brackish wetland, 1.1 acres of freshwater wetland, 11.0 acres of lawn, 7.0 acres of roads and trails, and 14.0 acres of buildings and uplands.

CONCEPT DESIGN DEVELOPMENT

The Aquatic Park Subcommittee of the Parks & Recreation Commission oversaw the development of the APIP. Four commissioners volunteered to be on the subcommittee. Fourteen publicly noticed meetings were held in 2006-2008. The consulting team of LMA and HSI attended the subcommittee meetings and over 11 meetings with city staff and various stakeholders. At these meetings, the consulting team presented technical information and addressed concerns raised by city staff and the public. On January 17, 2008 the Aquatic Park Subcommittee approved the preferred plan (Alternative 4B). On January 28, 2008 The Parks and Recreation Commission approved the recommended alternative with the amendment that no stormwater be allowed into the lagoons at the new Potter St. and Strawberry connections.

As part of the design development process, the consulting team collected and analyzed data on the existing hydrologic and habitat conditions in the park. The team completed surveys of site topography and elevations, dimensions and structural integrity of the tide tubes and stormdrains; monitored tidal cycles; digitally mapped salt/brackish wetlands, freshwater wetlands, and non-native invasive plants; delineated the watershed area of each stormdrain; and collected and reviewed data on water quality, fisheries, and water bird use of the park and nearby bay shallows. A use area/protection area analysis was then created for the park, and design guidelines were drafted for the APIP. A series of recommendations for hydrologic and habitat improvements were formulated. A detailed hydrologic and hydraulic model was used to analyze existing conditions and evaluate 14 alternatives for improved tidal circulation.

The consulting team identified a recommended alternative (4B) and prepared concept level designs for hydrologic improvements, shoreline revegetation, invasive plant removal, wetland creation and wildlife enhancement measures including improvements to Bird Island, tidal wetland creation at the Rowing Club site, and asphalt removal and revegetation on the western area of the park. Concept level cost estimates were also prepared for the components of the concept design. A detailed project description was prepared for use in CEQA and the permitting process. The team identified potential environmental impacts resulting from implementation of the concept design and recommended areas for further study in order to fully evaluate the environmental effects of the concept design.

Finally, the consulting team analyzed the ability to use the existing freshwater wetlands to serve as biofilters for inflowing stormwater. In addition to these tasks, HSI completed a flushing rate analysis to evaluate residence time of stormwater in the lagoons under existing conditions and under the recommended alternative. LMA completed an analysis of watershed BMPs and biofilter improvements to reduce urban stormwater contaminants from reaching the lagoons during rain storms.

EXISTING CONDITIONS

Aquatic Park has three lagoons and areas of turf and landscaping, roads, native vegetation, and various recreation areas. The park is used for active recreation such as waterskiing, rowing, kayaking, and bicycling as well as hiking and birdwatching. There is an established disc golf course along the east side of the park, and a children's playground. While park rules restrict off-leash dogs, they are frequent in the park and often chase wildlife from the lagoon shoreline. In general the western side of the park has less recreational use than the eastern side.

Hydrology

Aquatic Park receives both stormwater from the City of Berkeley and tidal water from the San Francisco Bay. The flow of water into and out of the lagoon system varies by season. During the summer months, water enters the lagoons from San Francisco Bay through a series of tide tubes that cross under Interstate 80. During the winter months, both tidal water and stormwater can enter the lagoon.

The lagoons receive tidal flushing from water entering the lagoon through a series of culverts or tide tubes. There are a total of nine culvert connections in the lagoon circulation system. The tidal infrastructure of Aquatic Park is deteriorating. The main tide tubes are falling apart on the bay side and failing riprap and parts of the pipes are occluding flows into several of the tide tubes. The Model Yacht Basin tide tube is buried in sand on the bay side. The Radio Tower Pond tide tube has collapsed under the frontage road and appears to have separated on the bay side.

Due to the small size of the tide tubes and their elevation, the average daily tidal range in the lagoons is very small (<0.1 ft.). The lowest tidal elevation acceptable in each lagoon is defined by the elevation of the tide tubes or stormdrain that drains the lagoon and, in the Main Lagoon, navigational hazards that would be exposed at low tide. In addition, each lagoon has shoreline buildings and roadways or other facilities which limit the allowable highest-tide elevation.

A large portion of the City of Berkeley drains towards Aquatic Park. The majority of this runoff drains into the Potter Street Stormdrain and the Strawberry Stormdrain. During high runoff periods, stormwater can enter the lagoons from these two drains. During large storm events most of the watershed immediately east of the park drains directly into the Main Lagoon through a set of seven stormdrains.

Habitat

The primary type of habitat in Aquatic Park is shallow subtidal aquatic habitat in the three lagoons (68 acres total). Aquatic Park is located in central San Francisco Bay which has the most ocean-like conditions of any area of the Bay. There are a number of schooling "bait" fish which are typically very abundant in the central bay and are found in lagoons similar to Aquatic Park, such as Lake Merritt and the tidal lagoon at the Oakland Airport. These small fish are a major food source to diving ducks such as scaups, buffleheads, surfscoters, and grebes which

over-winter in San Francisco Bay and Aquatic Park. Wading birds—egrets and herons, as well as pelicans, cormorants, mergansers, and other fish-eating birds—also feed on the small fish. Aquatic Park supports a variety of wintering water birds. These birds are mostly fish eaters who use the lagoons in winter when water temperatures are cool and small fish are likely to inhabit the lagoons. Data collected in June and September 2004 through the Regional Board's Surface Water Ambient Monitoring Program (SWAMP) show high water temperature and low dissolved oxygen levels, which likely limits fish survival. Large algal blooms and foul odors are also typical conditions in the lagoons in the summer and fall due to very low water circulation and poor water quality.

The three lagoons also have small areas of salt/brackish wetland (0.7 acres total). A natural tidal lagoon would have gently sloping edges and a larger tidal range creating the conditions for tidal wetlands. The lagoons of Aquatic Park have steep slopes and a very small average tidal range. These conditions limit the area for salt/brackish marsh to small pockets along the shoreline of the Main Lagoon and Model Yacht Basin. The Radio Tower Pond has the largest area of salt/brackish marsh along its western edge. At the outlets of the stormdrains on the eastern shoreline of the Main Lagoon, brackish marsh plants grow in pockets. In addition to these pockets, individual high marsh plants grow in the rock riprap of the lagoon shorelines, especially in the Main Lagoon. These wetlands in the Main Lagoon do not provide much wildlife habitat due to their small size and proximity to active recreation uses.

There are intertidal mudflats in several locations where inundation periods are too lengthy for salt marsh plant species to establish. The Main Lagoon has a non-vegetated intertidal flat adjacent to the Rowing Club and the Radio Tower Pond has a large intertidal flat.

Upland areas in Aquatic Park include lawn, pathways, roads, currently used and abandoned parking areas, non-wetland edges of the lagoons and both derelict and currently used buildings. These areas cover 25 acres of the park. The majority of recreation facilities are along the eastern side of the park. The western side of the Main Lagoon has an asphalt access road and a series of asphalt parking areas. The Waterski Club and Rowing Club have facilities on the western side of the Main Lagoon. Another upland area is Bird Island. Bird Island has a building on it which is used by the Waterskiing Club. The elevation of Bird Island is low and the island floods during large storms. The Model Yacht Basin and Radio Tower Pond are bordered by roads including an on-ramp to I-80, parking, and areas of ornamental plantings. At many locations in the upland areas there are homeless encampments. All three lagoons have Monterey cypress planted near the shoreline. These cypresses are used for roosting by various species of herons and egrets.

There are six small freshwater wetlands on the eastern border of the park adjacent to the railroad berm (1.1 acres total). Several have a small creeklet draining into the Main Lagoon. The freshwater wetlands have mostly saturated muddy soils with wetland plants. Most of the wetlands at Aquatic Park have dense cattails or tules due to the soggy soil conditions. Grass areas next to the freshwater wetlands are also often saturated. Many features of Aquatic Park's freshwater wetlands greatly reduce their value as wildlife habitat, such as immediately adjacent active recreation areas, homeless encampments, and significant infestations of invasive non-native plants.

MODELING AND ANALYSIS

Hydrology

A hydraulic model was developed to evaluate the pipe network that connects Aquatic Park with the bay. The United States Environmental Protection Agency Stormwater Management Model (SWMM) was used for the analysis because it is uniquely suited to the evaluation of networks of pipes and impoundments under unsteady tidal conditions. The model was run for the existing condition to determine the volume of water that is presently flowing into and out of the lagoons. Various project components were evaluated in an effort to determine the most effective modifications that could be made to the connections with the bay.

One or all of the following four components of the lagoon system were analyzed:
1) Increasing the capacity of the connection at the Strawberry Stormdrain.
2) Increasing the capacity of the Potter St. Stormdrain connection.
3) Improving the connection between the Model Yacht Basin and the Main Lagoon.
4) Opening up the Northern Tide Tube.

Each project component was modeled separately and in combination under three separate scenarios. The first scenario was to allow water only to flow through the lagoon system in a south to north direction. The second scenario allowed water only to flow through the lagoon system in a north to south direction. The third scenario allowed water to enter and exit the lagoon in any direction based on the hydraulics of the connection. The objective of the one-way scenarios was to force a positive circulation through the system. A one-way flow pattern would minimize stagnant areas in the lagoons and force a positive flushing action. However, the scenario allowing water to flow in and out of all connections had the greatest volume of water circulating daily through the system. For each of the three scenarios the four components of the lagoon system described above were analyzed. An additional scenario was added, which was an analysis of several of the components individually to determine their relative importance to circulation in the lagoons.

To determine the volume of stormwater entering the lagoon system, a watershed hydrologic model was developed to compute the flow in the Potter Street and Strawberry stormdrains. The watershed model simulated the rainfall to runoff processes for the 2-year through 100-year storm events over the Aquatic Park watershed. The results of this analysis provided flow rates for the Strawberry Stormdrain and the Potter Street Stormdrain. This flow was used as input to a hydraulic model to determine the volume of stormwater that flows into the lagoons on each storm event.

An evaluation of the results of the circulation model showed that Alternative 4B, which would enlarge the connection between the Potter Street Stormdrain and the Model Yacht Basin, construct a 20 ft. wide channel between the Model Yacht Basin from the Main Lagoon, modify the Strawberry Stormdrain connection to allow tidal flow to enter and exit the Main Lagoon, construct a new connection between the Radio Tower Pond and the Potter Street Stormdrain, and repair the Bay tide tubes, provides for a 420% increase in water exchange per tidal cycle compared to the existing condition. The volume of tidal water entering the Main Lagoon per

tidal cycle would increase form the current 22 acre-feet to 115 acre-feet. Based on the model analysis, Alternative 4B was selected as the preferred alternative.

The model was used to evaluate retention time of stormwater in the Main Lagoon from two different size storms under existing conditions and under the recommended alternative. Under the current conditions it takes 48.5 days to remove stormwater from the lagoons after a 100 year storm event. Under the preferred alterative it will only take 10.4 days to remove the stormwater following a 100 year storm event resulting in greatly improved aquatic habitat conditions.

The hydrologic analysis also determined the volume of discharge that enters the lagoon from the sub-basins immediately east of the park termed the "local" watershed. These sub-basins, made up of storm drains along Bancroft, Channing, Dwight, Parker, Carleton, Grayson and Heinz Streets, can drain directly into the Main Lagoon during large storm events. Watershed modeling showed that 30% of stormwater entering the lagoons originated not from the Potter and Strawberry stormdrains, but from stormdrains and urban runoff along the east side of the park.

The persistent urban stormwater contaminants that pose the greatest biological problems in the tidal lagoons of Aquatic Park as well as San Francisco Bay are transported on clay particles moving as suspended sediment in stormwater. Revising the water circulation in the lagoons to move stormwater out quickly will reduce the deposition of clay particles in the lagoons; however, these particles will still move into the bay. The most effective way to reduce pollutants is to treat stormwater in the watershed of Aquatic Park.

The urban streets, parking lots, and buildings of the local watershed could be retrofitted with stormwater biofiltration facilities. Biofiltration facilities provide treatment of stormwater as it flows along streets and through parking lots and before it enters the stormdrain system. Biofiltration facilities provide a medium which can rapidly and effectively filter out trash and a high percentage of the fine sediment particles, bacteria, and nutrients, and biologically treat these contaminants. Biofiltration facilities have been found to remove 80 percent or greater of the total suspended sediments (TSS) from stormwater and therefore a high percentage of the metals, nutrients, pesticides, coliform bacteria, oil and gas, and other contaminants. For the Aquatic Park local watershed, design of these facilities will need to take into account soil conditions, rainfall amounts, land uses, utility and pipe systems, land ownership, and overall redevelopment planning. Additional stormwater facilities that could be included in the Aquatic Park local watershed are stormwater detention facilities such as cisterns and rain barrels, as well as residential and even commercial use of porous pavement, rain gardens, and grassy swales. All of these measures will need to be retrofit into the Aquatic Park local watershed to effectively filter contaminants out before stormwater reaches the lagoon system. This watershed is ultra-urban: it contains no open land and is almost entirely paved over.

As an optional APIP component vortex filters could be installed on the storm pipes on the upslope/east side of the railroad berm at the Bancroft, Dwight, and Channing Street stormdrains and in the park to replace the oil/water separators on the Heinz, Grayson, Carleton, and Parker Street stormdrains. These filters would remove trash, large particulates, and oil and grease and would consist of a unit placed in the stormdrain as an in-line facility or next to the pipe as an off-

line unit. The vortex filters would not remove the small particulates which transport many of the persistent pollutants; thus, this type of filter would not take the place of the biofilters but could provide treatment while the biofilter improvements are installed.

Habitat

Open water habitat is the major type of wildlife habitat in Aquatic Park. A lack of water circulation and very small daily tidal volume are the main causes of poor aquatic habitat conditions. Revising water circulation and increasing the volume of tidal water entering and exiting the lagoon system daily could dramatically improve water quality and aquatic habitat. To achieve the greatest level of habitat improvement, Alternative 4B is recommended. Under this alternative, both winter and summer conditions for fish would be improved. After tidal improvements are made, monitoring can determine if conditions in the Main Lagoon will support additional enhancements of aquatic habitat, such as eelgrass and native oyster beds.

Salt/brackish wetlands are very limited in the Main Lagoon and Model Yacht Basin. Several shoreline areas were evaluated for excavation for wetland restoration. The Rowing Club site was selected as the salt/brackish wetland restoration site due to its larger size and lack of shoreline trees. There is also an intertidal flat and narrow strip of pickleweed marsh along the lagoon shoreline. Creating a salt/brackish wetland adjacent to an intertidal area will create a larger, more valuable wildlife area. Once the wetland site is excavated, some salt marsh plants would be planted and some would be expected to colonize. An upland berm would be constructed to reduce disturbance from dogs and park users.

The shoreline areas of the rest of the Main Lagoon and the other two lagoons offer an opportunity to eradicate invasive non-native plants and revegetate with high marsh/transition zone native plants. The mapped invasive plants were split into three stages of removal. Following invasives removal along the lagoon shoreline, native species could be planted along the lagoon shorelines.

Improvement of Bird Island and upland areas on the western side of the Main Lagoon are included in the APIP. These areas have a greater degree of isolation from recreational use and a higher potential for successful habitat restoration. The soil at the wetland restoration site would be tested for contaminants and if usable then several projects would be done to re-use the soil. Bird Island would have a ring of rock placed on its shoreline to allow the excavated soil to be placed on the island and build up elevations and allow plating of native trees and shrubs. Approximately two acres of upland areas can be improved using the soil excavated from the wetland restoration and channel between the Model Yacht Basin and the Main Lagoon. The abandoned parking lots and adjacent vegetated bulbout areas on the west side of the park could be enhanced as native upland habitats. The asphalt in the parking areas would be broken up and removed and soil placed in 2.5 foot tall mounds. A variety of native species would be planted and a drip irrigation system would be installed. Finally a small berm would be constructed around the radio transmitter building in the RTP to allow a greater level of tidal water circulation without causing flooding of the building.

Enhancement options for the freshwater wetlands are included as an optional component oft eh APIP. Change to the vegetation of the freshwater wetlands is unlikely to increase habitat values unless disturbance levels can be reduced. Two different options were evaluated for the freshwater wetlands: a pilot wetland restoration project and riparian revegetation. The proposed pilot project would reconfigure a one-acre area to create an open pond with a vegetated wetland border to isolate some habitat areas and produce a more attractive habitat for wetland birds. However, in order to have an adequate water level in the created pond, surface water from the local watershed will be needed in the summer from one of the stormdrains. The Regional Board has a policy which limits the use of existing wetlands for treatment of stormwater. The pilot wetland would incorporate an existing freshwater wetland but would mostly convert lawn to wetland, so it's not clear how this policy will apply to the project. If, due to Regional Water Quality Control Board concerns, additional water is not available from the stormdrains, then creation of the pilot wetland should not move forward. If the freshwater wetland cannot be adequately improved, then the saturated soils could be used to increase the riparian habitat in the area.

The greatest challenge to creating viable wildlife habitats at Aquatic Park is buffering habitat areas from the high level of human activity and unleashed dogs in the park. The eastern side of the park has the highest amount of human activity, but both the east and west sides of the park suffer from unleashed dogs disturbing birds and wildlife and sometimes chasing them into the lagoons. The west side is the primary focus for habitat improvements to take advantage of the lower level of recreation.

Adaptive management is an approach used in ecological restoration projects and involves changing management strategies as ecosystem monitoring and performance is evaluated. There are several types of management strategies at Aquatic Park that should use this approach. Prior to implementing the water circulation improvements, a water and sediment quality characterization of the Main Lagoon could be done. This study will establish the baseline conditions in the system and allow long-term comparison with post-project conditions. Another component of the baseline and on-going monitoring could be characterization of the benthic invertebrates which inhabit various areas of the lagoons. Once the project is built, monitoring of water levels and water quality is recommended. This detailed pre- and post-project monitoring can be used in evaluating the effects on the aquatic habitat of various settings of the gates on the tide connections.

For the upland habitat areas, adaptive management practices could be used in revising revegetation and replanting practices and/or species. A final level of adaptive management should review the success of first step efforts to control human and unleashed dog disturbance to habitat areas.

TABLE I SUMMARY OF CONSTRAINTS
Tidal Hydrology
The current connections to the San Francisco Bay limit tidal water from entering the lagoons.
The existing tide tubes date from the 1930s and are deteriorating and collapsing.
Installing new tide tubes under I-80 is expensive and infeasible.
Larger connections to the existing stormdrains, if not managed correctly, can allow more stormwater into the lagoon. The additional stormwater will temporarily reduce the salinity and may increase the amount of pollutants entering the lagoon.
Constructing new connections will be complicated because the existing openings should remain operational until the new connections are completed.
The presence of buildings and roads on the lagoon shoreline limits the elevation of high tide and the volume of additional bay water that can be let into the lagoon.
The recreational uses of the lagoon will limit the low-tide elevation and the volume of tidal water which can be exchanged with the bay.
Watershed Hydrology and Urban Stormwater
Stormwater flows into the Main Lagoon from the two major stormdrains under certain conditions: in Strawberry Stormdrain when flows overtop a weir and from the Potter St Stormdrain.
Stormwater flows into the Main Lagoon from localized stormdrains along the eastern edge of the park.
Stormwater flows directly into the lagoon from several adjacent streets.
Summer urban flows provide additional nutrients and likely increase the water quality problems in the Main Lagoon.
Urban stormwater varies in the concentrations of contaminants over the winter season. The first flush of runoff in the fall/winter typically carries the highest concentration of contaminants and is the most important to filter or treat.
There is limited water quality monitoring data for the lagoons and for stormwater in the Berkeley area.
There is limited area in the park to filter stormwater.
Regulations may restrict directing additional stormwater to freshwater wetlands for bio-treatment.
Maintenance is a requirement for stormwater filtration facilities.
Shallow Subtidal Aquatic Habitat and Water Quality
Very limited tidal inflows and water circulation in Main Lagoon and Radio Tower Pond.
Deteriorating tide tubes likely to further reduce inflows.
High water temperatures occur in summer and fall.
Algal and aquatic plant growth from warm stagnant conditions results in low dissolved oxygen in the lagoon. DO levels drop below RWQCB water quality standards in the summer and fall.
Stormwater inflows are retained in the lagoons for several weeks due to limited water circulation possibly allowing for contaminants to deposit out.
Salt/Brackish Wetland and Shoreline Habitats
The Main Lagoon has a very small average tidal range of .2 ft. and the Model Yacht Basin has an average tidal range of about 1.77 ft. This is in comparison to the average 6.16 ft. tidal range in the adjacent San Francisco Bay.
Most of the lagoon shorelines are rock-lined and relatively steep (>10%) or consist of rock terraces and will not support wetlands.
Wind-driven waves erode the eastern shorelines and could limit success of wetland creation.
Human recreational use is high along the Main Lagoon and Model Yacht Basin and includes unleashed dogs which run near the shoreline and into the water to chase birds.. Unleashed dogs also deter any nesting by resident ducks or shorebirds.

TABLE I SUMMARY OF CONSTRAINTS
Salt/Brackish Wetland and Shoreline Habitats
Invasive plants, such as ice plant, cover areas of the shoreline on and near existing and potential wetland sites.
Black-crowned night herons roost in the willows in the northeast corner of Radio Tower Pond and in the cypress along the western shoreline of the Main Lagoon.
Homeless encampments, trash dumping and other activities disturb and degrade shoreline areas, further limiting habitat values.
Upland and Bird Roosting Habitat
The upland areas support active recreation including biking, walking, leashed and unleashed dog walking, disc golf and boat launching.
There are limited wildlife species using the upland areas.
There are high levels of disturbance and human uses.
Homeless encampments, trash dumping and other activities that disturb habitat occur in upland areas.
There are invasive non-native plants in the upland areas.
There are a number of derelict and unused buildings in the park.
The road between the Model Yacht Basin and Radio Tower Pond is used by a large number of cars as a freeway on-ramp.
Freshwater Wetlands
The freshwater wetlands have shallow ponding and saturated soil encouraging the growth of dense cattails with little vegetative diversity or open water. Water flows are likely from groundwater seeps and aesthetics of wetlands are low. Water flows saturate lawn areas.
Water from the marshes flows through narrow channels into the lagoon. Changing the narrow deep channels to wide shallow channels would create more cattails and muddy areas.
Invasive ivy is killing some of the willow trees and other invasive plants also occur.
Areas next to freshwater wetlands are used for active recreation which involves people and unleashed dogs walking through the marshes, creating a very high level of disturbance and diminishing value for wildlife habitat.
There are homeless encampments in the wetlands which reduce habitat values.
Wetlands are not large enough, even if doubled in area, to adequately filter and treat winter stormwater from the stormdrains in the park. Wetlands could possibly filter and treat summer nuisance flows.
Regulations may restrict increasing urban runoff into the wetlands and changing their form.
It may be difficult to find funding for changes and improvements to the freshwater wetlands due to the negative effects of the high disturbance levels on habitat values and the small area of the marshes set in a recreational area.

TABLE II SUMMARY OF OPPORTUNITIES
Tidal Hydrology
The connections to two large stormdrains adjacent to the park could be modified to increase the amount of cooler and relatively unpolluted water coming into the lagoons from San Francisco Bay.
Putting better controls on the Potter Street Stormdrain connection and Strawberry Stormdrain connection will allow for selectively blocking out stormwater inflow. This is particularly important for blocking the first flush that occurs during fall and early winter.
Larger connections in the Potter Street and Strawberry stormdrains will allow for significantly faster removal of any stormwater that flows into the lagoon.
Repair and stabilization of the five main tide tubes will prevent them from totally collapsing and preventing bay water from entering the lagoon. This is essentially the only existing opening for bay water to enter the Main Lagoon.
Replacing the two 24-inch culverts between the Model Yacht Basin and the Main Lagoon with a larger channel opening will allow tide water from the Potter Street Stormdrain to enter the Main Lagoon. Presently very little of the tidal flow from Potter Street Stormdrain enters the Main Lagoon.
A new channel connection between the Main Lagoon and the Model Yacht Basin will require less maintenance to keep open. The existing culverts require continual maintenance to keep them from getting clogged up with marine growth. Presently they have less than half of their original flow capacity, and they were cleaned out two years ago.
Watershed Hydrology and Urban Stormwater
In the Park:
Control structures can be installed at Potter Street Stormdrain and Strawberry Stormdrain to limit stormwater inflows into the lagoons.
A bioswale could be installed along the road/lawn on the northern end of the park to filter stormwater flowing directly from streets into the park.
Increased water circulation in the lagoon system will remove stormwater at a much faster rate.
Outside the Park:
There are numerous locations in the urban area which could have biofiltration facilities installed on streets, parking lots and other locations.
The eastern edge of the railroad/western ends of streets could accommodate a series of large vortex filters to cleanse stormwater before entering the park.
The Aquatic Park area could be used as a regional demonstration project for integrated ultra urban stormwater treatment, habitat restoration, monitoring and adaptive management.
Shallow Subtidal Aquatic Habitat and Water Quality
There are two locations, Potter Street Stormdrain and Strawberry Stormdrain, which can be used to improve the volume of tidal exchange and water circulation in the lagoons.
Increasing tidal volume and circulation would reduce stagnant warm water conditions and increase cold water and dissolved oxygen, creating aquatic conditions more like the central bay habitats for fish.
Increased tidal circulation would remove stormwater from the lagoons at a much faster rate.
Summer/fall bird use includes mallard ducks, double-crested cormorants, Forster's terns, snowy egrets and shorebirds. According to the 2005 Bird Study these species forage in the Main Lagoon. October through March migratory diving ducks, including scaup and bufflehead, use the Main Lagoon as a foraging area. Year-round residents include great blue herons, black-crowned night herons and great egrets. Improved aquatic habitat would benefit these species.

TABLE II SUMMARY OF OPPORTUNITIES
Salt/Brackish Wetland and Shoreline Habitats
A wetland could be created by excavating material out of the shoreline in one of several locations. Filling the water area to create wetlands would reduce the tidal prism and reduce the volume of water circulating through the lagoon. The western shoreline of the Main Lagoon is not eroded by waves and could support a new wetland.
The western portion of the Main Lagoon has a lower level of recreational use. Dogs and people could be restricted through design of vegetative barriers, signs and some fencing.
Invasive plants are located on and near existing and potential wetland sites and will need to be eradicated.
Sites P2, P3 or the Rowing Club areas could be graded to create intertidal conditions. Excavated material could be used to create vegetated berms along the edge of a new wetland to restrict unleashed dogs and for other native plant re-vegetation areas (P-1, P-2 and P-3) along the western road, to create a berm around the Radio Transmitter Building in the Radio Tower Pond and to improve Bird Island.
Removal of the black-crowned night heron roosting areas in the northeast corner of the Radio Tower Pond and the cypress along the western shoreline of the Main Lagoon should be avoided.
Senescent and dead trees could be removed and replaced with cypress seedlings and native vegetation.
The northern portion of the eastern shoreline trail could be relocated and the shoreline could be revegetated while retaining the rock walls and riprap to protect against erosion.
Upland and Bird Roosting Habitat
Derelict buildings could be restored or removed.
Un-needed road pavement and parking areas on the western side of the park could be removed and revegetated.
Trails along the shoreline could be relocated to reduce disturbance and the shoreline area could be revegetated.
Some upland areas could be restored to tidal wetlands or freshwater wetlands.
Once the freeway on-ramp is closed much of the pavement could be removed, a trail could be created and revegetation completed.
Turf area on the northern end of the Main Lagoon along the eastside could be used as a bioswale to filter street stormwater runoff from directly entering the lagoon.
Invasive and dead plants could be removed and natives and non-invasive ornamentals planted.
Freshwater Wetlands
Wetlands could be deepened into ponds so that cattails will not dominate marshes allowing for greater water flow, vegetative diversity, aesthetic appeal, creation of water-isolated, less disturbed habitat areas and less maintenance.
Habitat for a wider diversity of bird species could be created if vegetation is changed and disturbance is significantly reduced.
Freshwater wetlands could be altered and expanded to filter summer nuisance flows and improve the quality of water entering the Main Lagoon. Currently summer flows either directly flow into the Main Lagoon or into the transit pipe and into Potter Street Stormdrain.
Several willow groves in the wetland area support songbirds and could be enhanced.
Removal of invasive plants should be an initial step in wetland improvements.
The disc golf course would need to be revised and integrated into any changes in the wetlands to reduce incursions and disturbance.
Signs, low fencing, and potentially some type of enforcement may be needed to keep dogs and people out of the freshwater wetlands.
Changes to the wetlands could reduce saturation of the lawn areas and trails and maintenance needs.

RECOMMENDATIONS

Hydrology Improvements

1. Aquatic habitat improvement is the highest priority action for park enhancement. Aquatic habitat is the primary habitat in Aquatic Park and suffers from poor water quality conditions in the summer and fall. A major increase in water circulation and tidal exchange is needed to improve habitat to support fish and other aquatic life.

2. Maximize the increase in tidal circulation and tidal volume. The current five tide tubes that provide tidal water to the Main Lagoon are falling apart. A new and improved tidal connection and water circulation system is needed. Alternative 4B would create larger connections at the Potter Street and Strawberry stormdrains, and would include excavation to create a new open channel between the Model Yacht Basin and the Main Lagoon, and a structure to protect the bay side of the five tide tubes. This alternative would increase the volume of tidal water entering the Main Lagoon from 22 acre-feet to 115 acre-feet per tidal cycle. Alternative 4B provides the largest tidal range and the greatest water quality improvement. Due to the low elevation of the Radio Transmitter Building, the tidal range at the Radio Tower Pond cannot be changed unless a berm is constructed around the building.

3. Block stormwater inflow volumes at new connections. Enlarging the connections at the Potter Street and Strawberry stormdrains could allow more urban runoff into the lagoon. Slide gates will be installed at the new connections. The gates will be able to block first flush flows which carry the largest concentrations of pollutants. The gates will also be used to block the maximum amount of stormwater. In addition, increasing tidal circulation will remove stormwater at a much faster rate than under current conditions and will reduce effects on aquatic life.

4. Consider installing a bioswale along the road/lawn on the northeastern end of the park to filter stormwater flowing directly from streets into the park.

5. Consider creating a demonstration area for ultra urban stormwater treatment using biofiltration facilities installed on streets, parking lots and other locations in the Aquatic Park watershed. These facilities will reduce the concentration of pollutants in stormwater which directly enters the Main Lagoon.

OPTIONAL ACTION

6. Consider as an optional action installation of in-line vortex filtration units on eastside stormdrains at the eastern edge of the railroad/western ends of Dwight, Channing, and Bancroft Streets. For the stormdrains at Parker, Carleton, Grayson, and Heinz Streets, vortex filter units can be installed in the park to replace the oil/water separators. The vortex filters would not remove the small particulates which transport many of the persistent pollutants, but would provide a treatment option while the biofiltration program is implemented.

Habitat Improvements

1. **Implement a salt/brackish wetland restoration on 1.3 acres at the Rowing Club site.** Excavate the site to the -1.5 ft. (Berkeley Datum) elevation to create salt marsh and high marsh transition areas. Install a berm along the road edge of the site to serve as a vegetated transition area and barrier to unleashed dogs.

2. **Reuse excavated material from wetland creation to restore additional areas, if feasible.** The Rowing Club site elevations are -1 to +4 ft. and will require excavation of 6,230 cubic yards of soil. If soils tests show the material is acceptable, the excavated material could be used for improving bird roosting habitat on Bird Island and native plant re-vegetation areas (P-1, P-2 and P-3).

3. **Remove invasive plants in all shoreline areas and all stem and seed-reproducing invasive plants in other areas of the park.** Invasive plants on and near existing wetlands, especially in the Radio Tower Pond and near the wetland restoration site, need to be eradicated to make the wetland restoration a success.

4. **Replant shoreline areas with native plants.** Remove dead trees on the shoreline and replant with cypress seedlings and native vegetation.

5. **Fill Bird Island with soil excavated from the wetland creation to create areas for tree planting for bird roosting habitat.**

6. **Install additional nearshore roosting structures** for birds made up of anchored floating platforms, rock or large wood

7. **Asphalt parking areas on the western side of the Main Lagoon (P1, P2, and P3) are no longer used and would be removed and covered with 2.5 feet of excavated soil and revegetated with native plants.**

8. **Eradicate ivy in freshwater wetlands and increase riparian habitat in FW-3 and FW-4 areas.**

9. **Monitor water quality and aquatic life.** Increasing the tidal volume and circulation will improve the habitat quality of the lagoons by reducing stagnant warm water conditions and increasing dissolved oxygen. As part of the implementation of tidal improvements, both water quality and aquatic life should be monitored. The results of the monitoring should be used to revise management methods and, if possible, implement additional subtidal habitat improvements such as eelgrass plantings, creation of oyster beds and placement of rocks for herring spawning.

10. **Post and enforce wildlife protection regulations, including leash laws, throughout the park**. Shoreline improvements recommended in the 2005 Bird Study include planting willow or other dense vegetation and fencing the shoreline to reduce disturbance from recreation and dogs. The fencing recommendation will conflict with other recreational uses. Posting and

enforcing rules against off-leash dogs and informing park visitors of how to behave to reduce negative effects on the birds should be tried prior to fencing the shoreline on new habitat areas.

11. **Address homeless encampments and evaluate the number and location of trash cans to reduce dumping and littering.**

OPTIONAL AND FUTURE ACTIONS

12. **Evaluate construction of a 1.0 acre pilot freshwater wetland incorporating FW 1 and the adjacent lawn**. Summer water from the stormdrain system would be needed for the wetland.

13. **Plan a tree replacement program.** Eucalyptus and Acacia make up the largest area of invasive non native plants in the park. As part of future efforts to remove these trees, a tree replacement planting program should be initiated to evaluate the locations and species for replacement trees well in advance of the removal of Acacia and Eucalyptus. As the outer railroad tracks are returned to active use there is high likelihood that the Eucalyptus will be trimmed or cut.

NEXT STEPS: ENVIRONMENTAL REVIEW AND PERMITTING

The next steps in the implementation of the Aquatic Park Improvement Program are to:

1) Complete several studies;
2) Complete a CEQA (California Environmental Quality Act) document on the project; The City of Berkeley will serve as the lead agency for the CEQA review
3) Complete a grant process with the Coastal Conservancy;
4) Complete the permit process.

Features of the recommended project that need additional analysis:

1. Soils in the salt/brackish wetland excavation area and Model Yacht Basin to Main Lagoon channel excavation area need to be tested. These tests would determine if there are any contaminant levels which would limit re-use of the soil for restoration projects on Bird Island and the P1, P2, and P3 upland sites.

Once CEQA is completed, the City can work with the California Coastal Conservancy to gain approval of the proposed $2.0 million in funding. This funding is expected to cover only parts of the APIP including hydrology improvements for aquatic habitat, salt/brackish wetland creation, shoreline invasives removal and revegetation, and enhancement of Bird Island and areas P1, P2, and P3.

Concurrent with the CEQA process, the City will need to apply for permits to implement the APIP from the Regional Water Quality Control Board, the Army Corps of Engineers and the California Department of Fish and Game for most of the project components, and the San Francisco Bay Conservation and Development Commission and the Army Corps of Engineers for the bay side structure to protect the five tide tubes.