Staff Report

MITIGATION:

AN ANALYSIS OF TIDELAND RESTORATION PROJECTS IN SAN FRANCISCO BAY

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San Francisco Bay Conservation and Development Commission

FOREWORD

Can San Francisco Bay resources lost as a result of authorized Bay fill be replaced or compensated through mitigation programs involving tideland restoration or enhancement? How successful have past tideland restoration projects been in mitigating the adverse impacts of Bay fill? Can regulatory agencies do a better job of assuring that Bay fill projects do not result in further degradation or loss of Bay resources? What factors are critical to the success of mitigation programs involving restoration of Bay resources? Such questions are increasingly being raised by scientists, regulatory agencies, environmentalists, and permit applicants alike, all concerned that mitigation programs which involve the re-creation of wetlands may fail to offset Bay resource values disrupted or lost as a result of fill projects.

The San Francisco Bay Conservation and Development Commission believes that the answers to these and similar questions are critical to the Commission's effective management of San Francisco Bay. For this reason, the Commission retained the firms of Demgen Aquatic Biology and Philip Williams and Associates, hydrologists, to conduct field investigations of several tideland restoration projects that the Commission has required as mitigation for Bay fill it has authorized under its law, the McAteer-Petris Act and the San Francisco Bay Plan, to determine whether these projects have successfully met the Commission's mitigation goals and requirements. Based on the consultants' field analysis of the mitigation projects and the Commission staff's review of each project's history, several recommendations have been developed for improving both tideland restoration efforts in general, and the

Commission's mitigation efforts in particular. This report summarizes those conclusions and recommendations. The consultant's lengthy and detailed field evaluations and analysis of each mitigation program are available for review at the Commission's office.

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EXECUTIVE SUMMARY

This report evaluates the success of 14 mitigation programs involving tideland restoration in San Francisco Bay. Each mitigation program was required by the San Francisco Bay Conservation and Development Commission as a condition of permit approval for a project involving Bay fill.

Ideally, the success of a tideland mitigation program would be measured by how well it replaced or offset the specific, adverse Bay-related impacts of the authorized Bay fill project. For a variety of reasons, it was not possible to measure success using this criterion because: (1) few of the evaluated permits and their associated environmental documents contain detailed information on the Bay resources lost or disturbed as a result of the authorized fill project; (2) early mitigation efforts appear to have been largely designed to create a desired habitat (in most cases, a cordgrass marsh) rather than replacing the specific resources lost as a result of authorized fill; and (3) there is no agreement regarding the relative value of various Bay resources (such as Bay surface area and volume and marshes and mudflats).

Because it was not possible to determine whether a mitigation program replaced or offset the specific Bay-related impacts of the Bay fill, this study evaluated success based on whether the completed mitigation project met the permit's specific mitigation requirements and whether the mitigation program either created or enhanced valuable Bay resources that are comparable to resources found in relatively undisturbed Bay tidelands.

The results of this detailed analysis of permit conditions, project histories, and field evaluations support the following conclusions and recommendations:

- **Mitigation programs can and, in most cases where work has been adequately performed, have successfully created and enhanced Bay resources,** ranging from increasing the Bay's tidal prism and surface area to creating diverse tidal plant and animal communities. This conclusion supports continued use of tideland restoration as mitigation for Bay fill projects, consistent with the Commission's Bay Plan policies.

- Despite these successes, **there is no certainty that any given tidal restoration program will fully meet all of its mitigation goals.** Tideland restoration and design contain an element of risk and uncertainty that is inherent in the nature of tidelands--scientists do not fully understand the life cycles of organisms or the hydrologic functions of tidal or estuarine systems. Possible storms, floods, and future colonization of sites by plants and animals are unpredictable. Thus, while many of the mitigation projects were successful, some well-designed projects have yet to create the desired resources. This points to the need to continue research on wetlands ecology and restoration techniques, and to widely disseminate the results of tideland programs to scientists in the field of restoration. In addition, the possibility that a given restoration effort may fail, or that it

may be several years before desired resources are established, leads to the recommendation that mitigation programs should involve restoring areas that are larger in size and greater in resource value than the area disturbed by the Bay fill project.

- **The primary reason some mitigation programs have not been successful in the past is that some portion of the required mitigation work was not performed.** This conclusion argues for increased attention to enforcing mitigation requirements.

- **The difficulty in identifying and acquiring suitable tidal restoration sites has delayed many tideland mitigation programs.** Five of the 14 projects experienced some delay in completing all or a portion of their mitigation requirements as a direct result of being unable to either find and/or acquire a suitable restoration site. Experience with recent permits suggests that it is becoming increasingly difficult to find appropriate mitigation sites. This conclusion leads to the recommendation that permittees be required to acquire a mitigation site, prepare a mitigation plan, and commence work on their required mitigation program prior to placing any authorized Bay fill. This conclusion also supports increased Commission involvement in promoting the acquisition of lands

suitable for tideland restoration around the Bay, and using these lands to establish mitigation banks.

- **Applications and permits contain little information on the Bay resources disturbed or lost as a result of the Bay fill project.** This lack of information makes it virtually impossible to craft a mitigation program that will offset the specific adverse impacts of a project. This conclusion suggests that the Commission's permit application form should be revised to require applicants to provide more information on Bay resources impacted by the fill, and that each permit requiring mitigation should clearly state what resources have been impacted by the authorized Bay fill.

- **Mitigation program goals are not clearly stated in Commission permits.** The lack of clear mitigation program goals contributes to the difficulty of determining whether a specific mitigation program will offset a Bay fill project's adverse impact on Bay resources. This conclusion leads to the recommendation that Commission permits should state clear mitigation program goals and require greater specificity in approved mitigation plans.

INTRODUCTION

Background

State law requires the San Francisco Bay Conservation and Development Commission to control the placement of fill in San Francisco Bay (See California Government Code Section 66632). The Commission's enabling legislation, the McAteer-Petris Act, and its San Francisco Bay Plan allow the Commission to approve Bay fill only for water-oriented projects[1/] or minor amounts of fill necessary to improve shoreline appearance or increase public access to the Bay. Under the McAteer-Petris Act, the Commission may authorize Bay fill only when there is no alternative upland location, and only when the fill is the minimum necessary to accomplish the project. Further, the Commission must find that the project's public benefits clearly outweigh the detriments caused by any Bay fill. This last requirement, in addition to the Commission's responsibilities under the California Environmental Quality Act (CEQA) and its role as an administrator of the public trust in San Francisco Bay, have led the Commission in certain instances to require mitigation to assure that the public benefits of a Bay fill project clearly exceed the project's adverse environmental impacts on the natural resources of the Bay.

1/ Section 66605(a) of the McAteer-Petris Act defines water-oriented uses as ports, water-related industry, airports, bridges, wildlife refuges, water-oriented recreation and public assembly, water intake and discharge lines for desalinization plants, and power generating plants requiring large amounts of water for cooling purposes.

Commission Mitigation Policy

Since 1974, pursuant to the authorities discussed above, the Commission has required that the unavoidable adverse environmental impacts of authorized fill projects be offset through mitigation. A statement reflecting this long-held policy was included in the Commission's San Francisco Bay Plan in 1985 (See Appendix A). In brief, the Commission's mitigation policy states that: (1) the benefits from the mitigation should be commensurate with the fill project's adverse impacts on Bay resources; (2) the mitigation should occur as close to the fill project site as possible; (3) the mitigation should be planned to assure its long-term success and permanence; (4) the mitigation should be provided concurrently with those parts of the project having adverse impacts; and (5) all affected local, state, and federal agencies should be involved in developing the mitigation program to assure that a single mitigation program satisfies the policies of all agencies involved.

The goal of the mitigation required by the Commission is to offset the specific adverse environmental impacts of a particular Bay fill project. Thus mitigation can take many forms, provided that it includes some action taken to avoid, reduce, or offset the unavoidable adverse environmental impacts from the fill that affects Bay resources such as fish and wildlife habitat, water quality, circulation, or volume, or Bay surface area. The case-by-case analysis and flexibility of the Commission's mitigation policy allow mitigation plans to be crafted to take into account a fill project's specific environmental impacts, current understanding of how various kinds of fill impact the Bay, and advances in the technology for offsetting specific environmental impacts. As a result, the Commission's mitigation practices have evolved as more knowledge has been gained about the impacts of Bay fill and the effectiveness of various mitigation measures.

However attractive a given mitigation program may be in terms of restoring Bay resources, mitigation by itself cannot make a fill project acceptable that otherwise does not meet all the McAteer-Petris Act requirements. The Commission can only authorize fill for specified water-related uses, and only when there is no alternative upland location for the proposed project. When fill is unavoidable (for example, some port terminals, recreational marinas, and flood protection projects cannot normally be built without some fill), the fill must be the minimum necessary to accomplish the project. Though such projects may provide substantial public benefits in and of themselves, they may also individually or cumulatively result in significant losses of critical Bay resources. In such instances, the Commission has often required mitigation programs involving tideland restoration to offset such losses of Bay resources.

Criticism of Past Mitigation Programs

The Commission has required many different kinds of mitigation to reduce a project's adverse impacts on Bay resources, including changing a project's design, limiting construction to certain seasons to avoid fish or waterfowl, and removing dilapidated structures and debris from the Bay. Typically, however, mitigation for most projects involving solid or earth fill in the Bay has involved either restoring former diked or filled baylands to tidal action, or enhancing existing tidal marshes by removing debris and constructing channels to improve water circulation and drainage. In most cases, the restorative work has been designed to support a permanent, productive tidal marsh at the mitigation site, thereby both increasing the Bay's tidal prism, surface area, and volume, and creating new productive habitat for Bay biota.

Since 1974, the Commission has authorized 68 permits in which the mitigation program involved wetland restoration.

In 1985, a respected biologist and observer of early Bay restoration programs, Dr. Margaret Race, published an article that questioned whether Bay mitigation programs involving wetland restoration had successfully mitigated the Bay resources lost as a result of authorized Bay fill (Race, 1985). Dr. Race's article was followed by a report prepared by Wendy Eliot of the California State Coastal Conservancy staff (Eliot, 1985) that also called into question the success of Bay mitigation projects in compensating for Bay resources adversely affected by authorized Bay fill. After investigating several wetland restoration mitigation programs required by the Commission and the U. S. Army Corps of Engineers, both Dr. Race and Ms. Eliot concluded that Bay mitigation programs have generally been unsuccessful, and that implementation of the Commission's mitigation policy has led to further dimunition of the Bay and its natural resources.

Shortly thereafter, two well respected biological scientists long associated with the Bay's ecology, Dr. H. Thomas Harvey and Dr. Michael Josselyn, took issue with Dr. Race's conclusions in a published response to Dr. Race's article (Harvey and Josselyn, 1986). Dr. Harvey and Dr. Josselyn specifically questioned Dr. Race's conclusion that San Francisco Bay wetland restoration projects have been substantially unsuccessful in creating new Bay wetland resources.

The criticism of past mitigation programs and the conflict between respected scientists and other observers on this matter naturally concerned agencies and individuals involved in the mitigation process and prompted the Commission to initiate an evaluation of its mitigation practices. This report

evaluates the performance of Commission-required tideland restoration projects as mitigation for authorized Bay fill. The report addresses: (1) whether Commission-required mitigation projects involving wetland restoration have been successful; (2) the lessons that have been learned from the performance of past mitigation programs that can be used to promote success in future mitigation projects; and (3) specific recommendations for improving the Commission's mitigation practices to ensure the success of future mitigation programs.

Report Organization

This report summarizes the findings and conclusions of the study jointly conducted by the Commission's staff and by Demgen Aquatic Biology and its subcontractor, Phillip Williams and Associates, hydrological engineers. Chapter I discusses the methods used to evaluate Commission-required mitigation programs. Chapter II provides a detailed analysis of 14 mitigation programs, describing the Bay resources lost as a result of the project, the mitigation program required by the Commission, the mitigation site as it existed in early 1987 when the consultants conducted their field evaluations, and an analysis of factors influencing the degree of project success. This chapter concludes by comparing the findings of this study with other studies of mitigation projects reported for San Francisco Bay. The next chapter presents the findings and conclusions of the report. Chapter IV presents recommendations for improving future Commission-required mitigation programs.

CHAPTER I. METHODS

Mitigation refers to a wide range of actions designed to reduce a project's adverse environmental impacts, including such diverse actions as converting dry land to new tidal marsh and limiting construction to certain times of the year to avoid fish or bird migrations. Funding and time limitations precluded evaluating every Commission permit in which mitigation was required. Therefore, the Commission's consultants, Demgen Aquatic Biology and Philip Williams and Associates, focused their evaluation on the most numerous and controversial class of mitigation programs authorized by the Commission--the restoration of tidal marshes, mudflats, or subtidal areas.

Sample Selection

The Commission's staff gathered information on all tideland restoration projects that the Commission has required as mitigation. Of the 68 permits in which some form of wetland restoration was required as mitigation, 18 were eliminated from review because the mitigation project either was under construction, had been delayed, or had been abandoned because the authorized fill project for which the mitigation was required had not been constructed. Of the remaining 50 permits, 16 involved no more than the removal of temporary fill and the restoration of the site to the condition that existed prior to site disturbance. Because of the similarity of these 16 projects, the consultants selected one of the larger of these projects for detailed analysis.

Of the remaining 34 Commission-required mitigation programs, the consultants selected a balanced, representative sample of 13 programs that reflected the wide range of tideland mitigation projects required by the

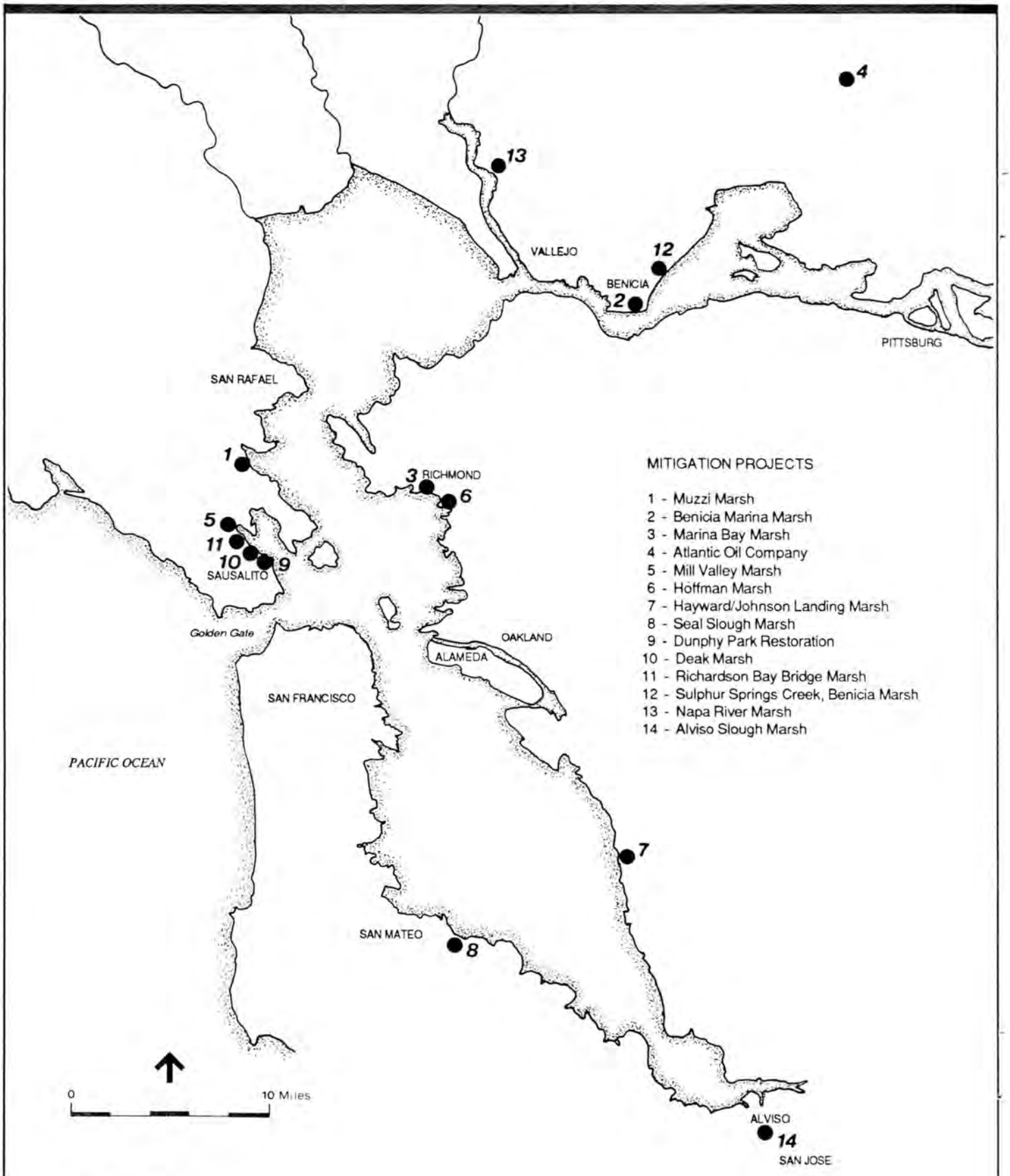

FIGURE 1

Mitigation Projects in San Francisco Bay

Commission in terms of size, location, number of growing seasons, desired resources, extent of site manipulations, etc. The selection of permits was as unbiased as possible as the principal consultant, Demgen Aquatic Biology, had little previous involvement or knowledge of any of the 34 mitigation programs (see Figure 1).

Criteria of Success

Ideally, the success of a tideland mitigation program would be measured by how well it replaced or offset the specific, adverse, Bay-related impacts of the authorized Bay fill project. For a variety of reasons, it was not possible to measure success using this criterion: (1) few of the evaluated permits and their associated environmental documents contain detailed information on the resources lost or disturbed as a result of the authorized fill project; (2) early mitigation efforts appear to have been largely designed to create a desired habitat (in most cases, a cordgrass marsh) rather than replacing resources lost as a result of authorized fill; (3) and there is no agreement regarding the relative value of various Bay resources.

Because it was not possible to determine whether a mitigation program had replaced or offset the specific Bay-related impacts of the Bay fill, this study evaluated success based on the two following criteria. The first criterion involved determining whether the mitigation project, as it existed at the time of the study, met the specific mitigation requirements of the permit authorized by the Commission. A mitigation program was judged a success under this criterion if all key permit mitigation requirements had been met. This measure of success is relatively straight-forward and objective. Clearly, one can measure whether "75 percent of the mitigation

area is inundated by the tide at least once daily", or whether the completed project includes "provisions to protect the marsh from intrusion by people, cats, and dogs."

The second criterion involved determining whether the mitigation program had either created or enhanced valuable Bay resources that were comparable to the resources found in similar natural, relatively undisturbed Bay tidelands. This measure of success is more subjective. Unless sophisticated measurements of productivity or biomass are performed, unless detailed measurements of plant and animal composition, diversity, and density at the mitigation site are compared with similar measurements of a nearby control site and unless detailed comparisons of the functional attributes (e.g. food chain support, nutrient cycling, hydrologic functioning, of restored or enhanced marshes are compared with the functional attributes of natural marshes, such an evaluation is necessarily subjective. Still, a trained and experienced biologist can obtain some meaningful sense of whether a restored wetland provides valuable habitat by (1) observing animal use of the mitigation site; (2) randomly sampling the density, size, and composition of the plant and animal community; (3) observing the formation of sloughs and channels; and (4) estimating the percentage of the site that is regularly inundated by the Bay. By comparing these observations with observations of similar, undisturbed wetlands, an experienced biologist can reach some general conclusions regarding the success of a restoration program.

Permit Review

For each of the 14 selected permits, the staff evaluated the mitigation conditions for clarity, completeness, and ease of enforcement. The staff also

reviewed the permit files for information on Bay resources impacted by the project, the history of the mitigation program and the goals of the mitigation plan, and any monitoring reports of the mitigation site.

Field Investigations

To determine whether the mitigation work performed met the permit requirements, the consulting biologist visited each project site from one to three times, evaluating such features as: (1) plant composition, diversity, and density; (2) percentage of the site flooded daily by tides; (3) number and size of water distribution channels; (4) bird species present; (5) condition of any water control structure(s) or levee(s); and (6) adjacent land uses. The consulting biologist also observed such features as: (1) water quality, color, and smell; (2) changes that could be expected at the site in the future; and (3) possible site modifications that would enable the mitigation program to better comply with the permit requirements. In addition, the consulting hydrologist visited the nine most hydrologically complex sites to evaluate such factors as: (1) restrictions to tidal action, (2) site elevations, (3) soil composition, and (4) contributing sources of water other than the Bay. Finally, nine of the sites were visited and analyzed by a team of biologists from the Commission, the California Department of Fish and Game, and an independent, consulting wetland biologist, as well as an individual from the Audubon Society.[2/] This team assessed the value of each mitigation

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[2/] The biological team consisted of the following individuals: Carl Wilcox, Department of Fish and Game (four sites); Jim Swanson, Department of Fish and Game (five sites); Phyllis Faber, biological consultant (nine sites); Bob Batha, San Francisco Bay Conservation and Development Commission (nine sites); and Barbara Salzman, Audubon Society (two sites).

site for broad categories of Bay-related aquatic plants and animals, both as the site existed in early 1987, and as it could be expected to appear in five years. The use of these experts helped assure that the site assessments presented in this study represent a broad cross-section of expertise, thereby reducing the subjectivity inherent in observation by one person or one type of specialist.

CHAPTER II.
MITIGATION PROGRAM ANALYSIS

- Of the mitigation programs analyzed, no two projects had similar impacts on Bay resources, and, as a result, no two mitigation conditions were alike, though there were many shared features. The mitigation sites also were quite distinct - some had been used as dredged material disposal sites; others had been filled with earth fill. Some already received limited tidal action; others had been dry for years. Some sites already supported some wetland vegetation; others were barren or vegetated with upland plants. And there were many differences among the mitigation programs themselves - some involved little more than breaching a dike or excavating a few water-distribution channels; others involved extensive earth movement and site grading. Some sought to create a diversity of wetland resources; others were designed to create a single wetland habitat or simply improve tidal circulation. Some had been completed several years ago; others had been completed within the last two years.

Given these differences, it is not suprising that the resources found on the mitigation sites in early 1987 were quite diverse.[3/] Such differences make it exceedingly difficult to group mitigation programs into convenient categories for comparison and analysis of their relative successes. However, the projects did seem to fall into three rough groups based on their relative

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3/The consultant's field notes and analysis of each mitigation site are available for review at the Commission's office.

degree of success in both meeting permit conditions and creating valuable Bay resources: (1) successful programs were those that had fully met the permit's mitigation requirements and had created valuable Bay resources; (2) partly successful programs were those projects that had achieved a portion of their required mitigation, and/or had partially succeeded in creating the desired Bay resources; and (3) unsuccessful programs were those where the required mitigation was either not carried out or had largely failed to create valuable Bay resources.

Successful Programs

Of the 14 mitigation programs evaluated, six (43 percent) were judged to have both achieved the Commission's permit requirements and successfully created valuable Bay resources. Each of the successful mitigation programs are discussed below.

1. Muzzi Marsh. Permit No. 22-73 for constructing the Larkspur Ferry Terminal and approach channel required the Golden Gate Bridge, Highway and Transportation District to acquire 530 acres for open space, wildlife habitat, and marsh creation. Of this total, the Commission required at least 390 acres to be existing tidal marsh and tidelands and 125 acres to be lands suitable for marsh restoration (the remaining 15 acres were levees around the mitigation site). The Environmental Impact Report indicated that approximately 31.7 acres of mudflat and 1.1 acres of pickleweed marsh would be dredged to construct the ship approach channel and turning basin for the Larkspur Ferry Terminal; the permit stated that approximately 1.9 acres of Bay would be covered with pile-supported platforms, riprap, and boarding floats.

This permit had the most detailed marsh restoration condition of all the permits reviewed; the two pages of specifications included: (a) a

description of the kinds of areas to be acquired and a requirement that they be reserved for open space and wildlife habitat in perpetuity; (b) a requirement that the permittee institute court proceedings to acquire a parcel that met the specified criteria prior to the commencement of construction; and (c) a requirement that the permittee develop a detailed tidal marsh restoration program that would create at least 125 acres of new tidal marsh with substantial stands of cordgrass and pickleweed. The marsh restoration program was to include: (a) marsh restoration and management experts that would develop the program; (b) a soils preparation and planting program; (c) a plan showing the areas that would be inundated by the tide during a normal tidal cycle; (d) a five-year monitoring and maintenance program; and (e) a work schedule and budget.

Prior to submitting any restoration plan for the mitigation site, the permittee, in 1976, breached the dike surrounding the mitigation site and planted cordgrass seeds at a few locations for test purposes. These experimental plantings were largely unsuccessful, although other plants, primarily pickleweed, began colonizing the site naturally shortly after tidal action was introduced to the site. Then, in February, 1978, the permittee submitted a restoration plan for the mitigation site which the Commission rejected, determining that it failed to satisfy the specified condition. In rejecting the plan, the Commission adopted a statement that gave the permittee even more specific guidance for developing the restoration program, including recommending that the program contain provisions for creating a water distribution channel network, excavating portions of the site to elevations suitable for cordgrass, and establishing a technical advisory committee to assist in the development and implementation of the program.

A subsequent restoration plan developed in accord with these provisions was approved by the Commission in December, 1978. Most of the channel excavation and grading specified in the approved marsh restoration program was completed in 1981, although the permittee was unable to complete all of the required excavation because of the difficulty of using heavy equipment on the soft, unconsolidated restoration site soils.

In 1987, the site was densely vegetated, primarily with pickleweed and cordgrass, and was heavily used by shorebirds and migratory waterfowl. The marsh is still evolving: tidal marsh plants continue to colonize the remaining large mudflat area on the site and the channels in the western, higher portion of the site are rapidly filling with sediment. The consultants judged that this project both met the requirements of the permit and had created valuable Bay resources.

Several factors contributed to the success of this tidal marsh restoration project: (a) the permittee was committed to meeting the restoration requirements despite the difficulties and expense involved; (b) the detailed permit conditions and subsequent Commission guidance gave the permittee very specific direction as to what was necessary to satisfy the mitigation condition; (c) experts in marsh restoration, including biologists and hydrologists, helped develop the restoration goals and plan, and helped supervise its implementation; (d) the site elevations and soil conditions were suitable for the desired marsh plants; (e) the newly excavated water distribution channels greatly improved tidal circulation throughout the marsh; (f) the site was located adjacent to large, vigorous Bay marshes, an undoubted ready source of colonizing plants and animals; and (g) sufficient time has elapsed since the dike was first breached (11 years) for plants to colonize

and become established, and to erase the tracks and scars of the heavy machinery used to create channels and appropriate land elevations.

2. Benicia Marina Marsh. In developing the Benicia Marina in accord with Permit No. 5-77, the City of Benicia proposed creating an 18.6-acre tidal marsh to improve marina water quality. Both the marsh and the 18-acre marina basin were to be created out of what the application described as a vacant, barren, upland area. The marina project involved dredging 120,000 cubic yards of material to provide an access channel to the newly excavated marina basin, and placing 3.4 acres of primarily floating and pile-supported fill for various marina facilities such as boat berths, boat sheds, breakwaters, a fishing pier and boardwalk within the excavated basin. The Commission found that the public benefit of increasing the Bay's surface area by 36.6 acres was sufficient to offset the "loss of organisms or habitat caused by the dredging and the increased human use of the project site." The Commission incorporated the City's marsh proposal in a permit condition requiring that the 18.6-acre man-made marsh be constructed in accord with an existing, City-prepared marsh restoration plan. The restoration work was to be completed prior to use of any boat berth.

The excavation required to create the 18.6 acre marsh was completed in 1977. This mitigation project has been called by Department of Fish and Game personnel "the nicest looking marsh in the Bay",[4/] supporting a diversity of habitats including an open water channel, and dense stands of

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4/ From Eliot (1985), p. 20

bulrushes, cattail, pickleweed, and salt grass. Its success can be attributed to the fact that the marsh was constructed in accord with a restoration plan specifying suitable elevations for marsh plants and providing daily tidal inundation. While the restoration plan provided for planting appropriate marsh vegetation, such planting was apparently never done. It is certainly not needed now as plants have vigourously colonized the site naturally.

3. Marina Bay Marsh. Pursuant to Permit 11-78, the City of Richmond created an approximately 4.4 acre tidal marsh as mitigation for approximately 3.05 acres of solid fill and 1.8 acres of floating fill associated with the Marina Bay redevelopment project. The permit did not describe the resources lost as a result of the authorized fill. Commission staff familiar with the project, however, indicated that the areas filled were former shipways, with a rocky, cobble substrate and little marsh vegetation. The mitigation condition also did not specify the restoration project goals beyond stating that the excavation should establish elevations sufficient to assure that "the marsh will be inundated by the tide at least twice daily and that new channels of a depth sufficient to flood, flush, and drain the new marsh will be created." The condition required that the restoration effort be completed prior to use of any commercial facility or boat berth and that restoration be performed in accordance with a Commission-approved restoration plan that included: (a) provisions for protecting the marsh from human disturbance; (b) a work schedule; and (c) a five-year monitoring program.

The mitigation marsh was created in 1980 or 1981 by excavating 23,000 cubic yards of earth material from an upland site. In the course of performing the excavation, the permittee unearthed a significant deposit of lead paint. The discovery of this toxic material has delayed full

implementation of the mitigation program as the City develops a plan for disposing of this hazardous waste. In 1987, the 4.38 acre mitigation marsh was fully tidal with good water circulation despite complete siltation in one of the two channels excavated to connect the restored area to the Bay. In 1987, the restored area supported a diversity of wetland habitats, including open water channels, mudflats, low and high salt marshes and a small upland island as called for in the approved mitigation plan. A comparison of quadrat samples from the restored area and a neigboring undisturbed marsh indicate that plant density and diversity in the restored marsh are similar to those found in the natural marsh.

This restoration project was judged successful even though discovery of toxic materials has delayed full implementation of the approved restoration plan, namely the planting of suitable marsh and upland vegetation, and submittal of a work schedule, budget, and monitoring program all of which appear unnecessary at this time. The success of this restoration effort can be attributed to: (a) the creation of suitable elevations for the desired vegetation; (b) the establishment of good water circulation throughout the restored area; and (c) the presence of a large, healthy marsh nearby that provided a ready seed source for colonizing the excavated area.

4. Atlantic Oil Company. Permit No. 37-79(M) authorized the Atlantic Oil Company (now ARCO) to place earth fill over 20,500 square feet (0.5 acre) of managed wetlands in the Suisun Marsh to construct an exploratory natural gas drilling pad. To offset the fill's adverse impacts, the permittee was required to remove all authorized fill material and reseed all disturbed areas with "appropriate California native plant seed, as approved by staff in consultation with the California Department of Fish and Game, within six

months of fill removal" if the drilling proved unsuccessful. The habitat lost as a result of fill placement was not described in the permit, but staff familiar with the project indicated that the drill pad site was a densely vegetated managed wetland. This mitigation program was selected as representative of the 16 programs where the sole mitigation requirement was to return the site to the condition that existed prior to project construction.

The exploratory drilling failed to find commercial deposits of natural gas so the fill for the drill pad was removed in 1981 and reseeded with natural vegetation sometime in the next 12 months. The site was located with difficulty in 1987 as it appeared virtually indistinguishable from neighboring managed wetlands. In 1987, the site supported a healthy diversity of native plants including alkali bulrush, salt grass, California bulrush, alkali heath, pickleweed, various rushes, cattail, and dock. The only apparent difference in the site from the surrounding wetlands was that there remained a few unvegetated spots and the vegetation was slightly lower in height than similar vegetation in adjoining areas.

This mitigation effort was successful because: (a) the site was returned to elevations suitable for the desired marsh plants, and (b) the mitigation site was surrounded by acres of marsh providing a ready seed source for colonizing the site. Planting appropriate native plants may also have contributed to the program's success, but without suitable controls, it is impossible to determine what contribution planting seeds made to the mature population of plants found on the site in 1987.

5. Mill Valley Marsh. Pursuant to Permit No. 21-80, the Sewerage Agency of Southern Marin created a 12,000-square foot (.27 acres) tidal marsh and enhanced an existing 5-acre primarily pickleweed marsh as mitigation for

placing fill on 6,400 square feet (.15 acres) of high-elevation salt grass and pickleweed tidal marsh to expand and improve an existing sewage treatment facility in Mill Valley. This was one of the few permits that described the Bay resources that would be lost as a result of project construction.

The permit specified that the mitigation was to be completed by July 1, 1983, and that a 12,000-square foot tidal marsh was to be constructed in accord with a marsh plan approved by or on behalf of the Commission. The marsh plan was to include: (a) a detailed description of the excavation and grading which would be undertaken to establish elevations and channels within the mitigation site to assure that 75 percent of the site would be inundated at least once daily; (b) provisions for excluding people, cats, and dogs from the restored areas; and (c) a work schedule and budget for completing the restoration work.

The mitigation work was completed in May 1984 in accord with an approved marsh restoration plan that designed the site primarily for cordgrass. A series of small channels excavated in a neighboring 5-acre existing pickleweed marsh greatly enhanced tidal circulation in the marsh and led to the enlargement of some existing channels and the creation of some new channels.

In 1987, both the 5-acre enhanced marsh and the new 12,000 square foot tidal marsh were thriving. Both areas are inundated daily and support dense stands of tidal marsh vegetation. A variety of benthic organisms, fish, insects, and waterfowl were observed using both the new and enhanced marshes.

The factors that contributed to success were: (a) careful preparation of a restoration plan in association with a tidal hydrologist; (b) establishment of site elevations suitable for the desired salt marsh

vegetation; (c) the presence of a large population of existing marsh vegetation nearby that provided a ready seed source for colonizing the restored areas; and (d) enhanced tidal circulation that improved water quality to both the enhanced and created marshes.

6. Hoffman Marsh. In accord with Permit No. 11-83, the California Department of Transportation improved tidal circulation to a 7.5-acre marsh in Richmond as mitigation for the construction of a 510-square foot pile-supported bridge in the Commission's jurisdiction, and for widening a roadway covering 0.8 acres of remnant marsh outside the Commission's jurisdiction. Although no description of the impacted resources was included in the permit, the Commission's staff recalls that the bridge covered a tidal open water channel bordered by cordgrass, pickleweed, and saltgrass. The permit required that the permittee improve tidal circulation to the 7.5-acre mitigation site prior to project construction.

The permit originally required the permittee to install two siphons or breaches through a low levee that protected a sewer line separating the 7.5-acre enhancement marsh from an adjoining, fully tidal, primarily pickleweed marsh. In addition, the permittee was required to dredge 100 cubic yards from existing marsh channels in the enhanced marsh to improve water circulation, and to dispose all dredged material outside the Commission's jurisdiction. However, when the permittee determined that the cost of installing the two siphons would be at least $130,000 and could undermine the old sewerline, and that the heavy equipment needed to remove the 100 cubic yards of dredged material from marsh channels would adversely impact the marsh, it requested that the permit be amended to postpone installation of the siphons for approximately 10 years (at which time the sewerline was expected

to be abandoned), and that it be permitted to spread the dredged material on the marsh. The requested amendment was granted, but the Commission imposed the additional requirement that the permittee keep the lone existing culvert beneath the sewerline clear of debris and sediment until such time that the levee was breached or the siphons installed. In addition, the permittee agreed to remove the dredged materials it had placed on approximately one acre of high marsh and transitional habitat, to lower the elevation of this one acre area so that it would be more frequently inundated, and to extend a channel through the newly excavated area to improve tidal circulation.

Under supervision of the Commission staff, the mitigation work was completed in October 1985. The marsh responded quickly to the improvements in water circulation. By 1987, pickleweed had already begun to cover the dredge spoils and had invaded both the former salt pans on the site as well as the one acre excavation area. While water circulation has noticeably improved, portions of the marsh still appear to be receiving insufficient tidal exchange as indicated by the stunted growth of the pickleweed in these areas. Overall, widening existing channels and excavating new channels improved habitat for fish and invertebrates and noticeably benefited the plant community.

The success of this enhancement project can be attributed to: (a) reliance on a tidal hydrologist's recommendations for improving tidal exchange throughout the marsh, (b) a permit condition requiring that such improvements be maintained; (c) establishing correct elevations for desired marsh plants; and (d) the presence of a large, nearby community of suitable plant and animals for colonizing the restored areas.

Partially Successful Projects

Five of the 14 mitigation projects evaluated by the consultants (37 percent) were determined to have been partially successful. By 1987, all five of these partly successful projects had succeeded in creating or enhancing Bay resources, but did not fully meet the specific requirements of the permit condition or the Commission-approved mitigation plan, usually because either: (a) a portion of the required mitigation program was not completed; (b) portions of the completed mitigation project had not been implemented in accord with the approved mitigation plan, or (c) the completed mitigation project had not fully realized the goals of the mitigation program. The five partly successful project were:

1. Hayward/Johnson Landing Marsh. In 1974, as mitigation for constructing the pile-supported Dumbarton Bridge covering 14.2 acres of Bay surface area, and to offset the loss of 70 acres of salt ponds and managed wetlands and 5.75 acres of tidal marsh to create the new bridge approaches, the Commission required the Division of Bay Toll Crossings (now the California Department of Transportation) to acquire and return to tidal action "an area or areas totaling not less than 200 acres...." Permit No. 20-73 specified that a mitigation plan be prepared jointly with the Commission prior to the commencement of any work, and that 200 acres be restored, preferably in the South Bay. Lands selected were to be "(1) not now subject to tidal action, (2) not now used for...salt production, and (3) diked off from the Bay prior to September 17, 1965". Nine hundred thousand dollars was to be set aside to prepare and carry out the mitigation plan; any funds remaining after acquiring a 200 acre parcel were to be used to acquire wetlands and salt ponds within the Commission's jurisdiction, preferably on the west side of the Bay but

outside the preliminary boundaries of the then proposed San Francisco Bay National Wildlife Refuge.

Approximately $550,000 of the funds were used for the East Bay Regional Park District's acquisition and development of the 220-acre Hayward Marsh. The Park District's mitigation plan was developed in close cooperation with biologists and hydrologists, and called for extensive grading to create a diverse tidal wetland including open water areas and channels, mudflats, both high and low elevation tidal marsh, and upland islands. The mitigation program was designed to create a diverse habitat supporting a rich variety of aquatic life and wildlife species. Excavation of the site was completed and the dike breached in May 1980.

Plant colonization of the site, particularly by cordgrass, has been much slower than anticipated. At this time only about 10 percent of the site is vegetated, primarily with pickleweed and some cordgrass; the remainder is mostly mudflat. Despite its apparent barrenness, however, the site supports large large populations of fish and benthic organisms and, as a result, attracts large bird populations to rest and feed. The project has satisfied the permit requirement of returning at least 200 acres to tidal action and has also increased the Bay's tidal prism and surface area while creating valuable wildlife resources. However, despite careful planning, only a fraction of the expected marsh vegetation has colonized the site. Various explanations have been advanced for the slow cordgrass colonization of this site, including: (a) the fact that a portion of the site was formerly used as a crystalizer pond in salt production may have resulted in some of the soils being too saline for plant establishment, a condition that should change over time as salts leach from the soil and new sediments are deposited; (b) some biologists

have noted that cordgrass, which requires less saline conditions for seed germination, does not generally propagate as well by seed in the south Bay compared to the north Bay, a fact some biologists attribute to the lack of freshwater inflow in the south Bay, (Josselyn, 1988, personal communication); (c) because of the long fetch, the mitigation site appears to be experiencing significant, wave-induced erosion that likely disrupts sedimentation and seedling establishment; and (d) soil compaction during excavation, and the fact that approximately 80 percent of the site was graded, probably significantly altered the soil characteristics of the site. Still, the successful establishment and vegetative propagation of experimental cordgrass plantings has led most observers to remain optimistic that more cordgrass will colonize the site in time.

The remaining $350,000 was to have been spent to acquire the Ravenswood Triangle in Menlo Park, a property identified by the Commission as an appropriate acquisition under the terms of the permit. To date, the acquisition has been mired in litigation brought by the owner of a neighboring parcel. The litigation has also led the Department of Transportation to keep the area pumped dry, thus reducing its value to Bay wildlife.

2. Seal Slough Marsh. The City of San Mateo enhanced forty-three acres of high tidal plain adjacent to Seal Slough in San Mateo as mitigation for constructing a pile-supported bridge and approaches covering 1.48 acres of Bay and 2.8 acres of diked wetlands largely outside of the Commission's jurisdiction. Permit No. 18-82 does not describe the Bay resources lost as a result of project construction, but the Environmental Impact Report (EIR) states that the bridge and highway project degraded "primarily brackish or freshwater ruderal [weedy] marsh [largely outside of the Commission's

jurisdiction], and a lesser amount of cordgrass and bay mudflat...used for feeding by the endangered California clapper rail." The permit and EIR describe the enhancement area as being high in elevation, infrequently inundated, and largely barren.

A permit condition required preparation of a marsh plan prior to the commencement of any work within the Commission's jurisdiction and the completion of the mitigation project prior to use of any authorized facilities. Eight acres of the enhancement area were to be improved primarily as a cordgrass marsh in accord with preliminary plans already prepared by the permittee in association with a hydrologist. These preliminary marsh plans called for excavating 47,000 cubic yards of earth material to create a large channel with gentle side slopes at elevations suitable for cordgrass. Tidal circulation in the remaining 35 acres of the enhanced marsh was to be improved by excavating a system of small water distribution channels throughout the area. Finally, to mitigate the loss of a 0.6 acre portion of a 1.6-acre brackish marsh in the Commission's shoreline band jurisdiction, the permittee was required to expand the remaining portion of the brackish marsh by 0.75 acres. The permittee was also supposed to prepare a planting program for all restored areas.

The required excavation was completed in 1983. The network of new channels has significantly enhanced the tidal prism and tidal circulation within the site. As a result, the enhancement area is rapidly evolving with new channels forming and new sediments accumulating. However, the excavation did not completely isolate the mitigation site from offroad vehicles, which apparently still ocasionally access portions of the site.

The City did not prepare a planting program, nor was any planting performed. The failure to initiate a planting program probably accounts for the scarcity of cordgrass on the eight-acres designed for cordgrass. This eight-acre area was primarily intertidal mudflat in 1987. However, vigorous stands of pickleweed and cordgrass have become naturally established evenly over most of the entire 35 acre enhanced area. Thousands of birds have been observed feeding and resting on the site.

Although the enhancement area is far from being a mature marsh, the consultants believe that the enhancement work has created valuable Bay resources, and that the site is well along the way to becoming a healthy, mature tidal marsh. The following factors contributed to the success of this enhancement project: (a) the permittee had identified the mitigation site and prepared a mitigation plan prior to submitting an application, reducing delays in implementing the plan; (b) the marsh plan was developed in accord with the recommendations of biologists, a hydrologist, and fish and wildlife agencies; and (c) the implemented plan greatly enhanced tidal circulation in the area, creating conditions favorable for marsh establishment.

This mitigation program was considered only partially successful because the eight-acre area designed for cordgrass is largely unvegetated, and because the required 0.75 acres of new diked brackish marsh has not yet been established. Possible explanations for the slow cordgrass colonization of the eight-acre area include changes to the soil structure as a result of the heavy equipment used to lower the sites elevations, and poor germination of cordgrass seeds in the south Bay (see Hayward Marsh discussion pgs. 28-30).

The other unsuccessful element of the required mitigation program, creation of a brackish marsh, was unsuccessful simply because it was never

completed. The permit authorized filling a 0.6 acre portion of a 1.6-acre brackish marsh existing within the Commission's shoreline band and offsetting this loss by excavating a 0.75 acre area adjacent to the one acre remaining portion of the marsh. The permittee did the required excavation, but shortly thereafter, the approach road was relocated, resulting in the loss of the entire brackish marsh and the newly excavated mitigation area. The permittee has tentatively selected a replacement site for the lost marsh, but has not yet prepared restoration plans for the site.

3. Dunphy Park Restoration. In 1981, as mitigation for constructing a 16,078 square foot (0.37 acre) pile-supported addition to an existing pile-supported sewage treatment facility built over the Bay in Sausalito, the Commission required the Sausalito-Marin City Sanitary District to return an equivalent-sized area to tidal action. A condition of Permit No. 24-80 required that a mitigation plan be prepared and approved by the Commission prior to any construction, and that the mitigation area be open to tidal action prior to completion of the authorized facilities.

After unsuccessfully attempting to locate an appropriate site, the permittee requested and received an amendment to allow it to satisfy its mitigation requirement by contributing $6,000 to be used to excavate upland areas and plant marsh vegetation as part of a proposed 0.5-acre improvement of Sausalito's Dunphy Park. The park improvements appear to have been primarily designed to improve shoreline appearance, small boat access to a small lagoon adjacent to the park, and water quality and circulation. In addition, wetland plants were to be planted along the shoreline for erosion control and wildlife habitat, but only a thin strip of land is shown on the plans at elevations suitable for marsh plants. The plans for the restoration project specify: (a)

cutting a channel through a small intertidal peninsula to improve tidal circulation and boat access to the lagoon adjacent to the park, and to create an island that would be isolated from land-based predators; (b) cleaning the shoreline of debris; (c) recontouring the shoreline edge to provide better tidal flushing of a stormwater outfall and to provide conditions suitable for establishing cordgrass and pickleweed along the shoreline, and (d) planting marsh vegetation at suitable locations throughout the project. The grading was completed in November of 1985 and the area planted spring of 1986.

Some of the project goals have been achieved. Much debris has been removed, although some debris remains on the site. The excavation and grading have increased both tidal circulation in the lagoon and Bay surface area and volume, although it is difficult to determine by exactly how much. But it is doubtful that there will ever be many wetland plants at the site, for the shoreline slopes are too steep to support more than a narrow band of marsh vegetation. And, the restoration site itself is very small and adjoins an urban park that is heavily used by humans and their pets. As a result, while the project created a more attractive shoreline, increased recreation opportunities, and improved tidal flushing, it has provided limited benefits to wildlife.

4. Deak Marsh. Deak Investment Corporation created a 0.36 acre mixed pickleweed and cordgrass marsh as mitigation for 560 square feet (0.01 acre) of solid fill and 0.48 acres of floating and pile-supported fill associated with a marina and office park development in Sausalito. Permit No. 32-78 does not contain information on the resources lost as a result of the project, but staff recalls that the site was formerly filled with debris, old pilings, and dilapidated boats. The Bay portion of the site was comprised primarily of

mudflat and subtidal areas, with some marsh vegetation along the shoreline edge. Mitigation was proposed on-site in an area that was primarily vegetated with grassland plants intermixed with wetland species.

The permit required that the entire 0.36-acre mitigation site be developed as a cordgrass marsh, and that restoration occur in accordance with a Commission-approved mitigation plan. The restoration was to be completed prior to the use of any authorized facility.

The restoration plan submitted by the permittee and approved by Commission staff differed from the permit requirement in that only half of the mitigation site was designed for cordgrass; the remaining half of the mitigation site was designed as a pickleweed and high elevation tidal marsh (e.g. gum plant, salt grass). In accordance with the approved plan, the site was dredged to lower its elevation and then graded to create a small island ringed by a tidal channel. Earth work was completed and the mitigation site was planted in late 1984 - early 1985.

Currently most of the site receives daily tidal action. The island and much of the shoreline fringe support a healthy, mixed community of pickleweed, gum plant, and salt grass. Similarly, vigorous stands of cordgrass have become established at many locations specified for cordgrass in the plan. However, neither the high or low elevation salt marsh communities occur at all locations that the plan specified for these plant communities. There is some evidence that the entire site may be slightly higher than called for in the mitigation plan, and thus the project may approximate but never achieve the exact mix of vegetation called for in the approved plan.

This project was largely successful in that Bay surface area and volume was increased and a healthy tidal marsh was established with good tidal

circulation. Though the entire 0.36 acres of cordgrass marsh specified in the permit did not result, Commission staff approved this modification and by 1987 implementation of the approved plan had resulted in a diverse wetland vegetation community that may have greater habitat value and be more visually interesting than a monoculture of cordgrass. Still, either insufficient excavation or unexpectedly rapid sedimentation appears to have resulted in portions of the site being slightly too high to support the vegetation mix required in the approved mitigation plan. For these reasons, the project was not considered a complete success.

5. Richardson Bay Bridge Marsh. In accord with Permit No. 35-79, Lincoln Property Company restored tidal action to three noncontiguous areas along the Richardson Bay shoreline totalling 3.00 acres as mitigation to offset the impacts of placing additional fill on a site that had been formerly filled, but had subsided to the point that it was occasionally inundated by the Bay. Photographs and a site description in the permit file indicate that the area to be filled was largely barren with little if any wetland characteristics and included a large area shaded by the Richardson Bay bridge, a junkyard, and a 9,250 square foot building.

The permit required preparation of a plan to create a "new tidal marsh" prior to any construction. The marsh plan was to include: (a) a description of the grading and excavation that would be undertaken to assure that the restored marsh would receive daily tidal inundation; (b) the excavation of new channels sufficient to assure good tidal circulation in restored areas; (c) provisions for excluding humans, cats, and dogs from the marsh; and (d) a work schedule. The marsh was to be completed prior to the occupancy of any of the authorized buildings.

Excavation and grading of the three new marsh areas was completed early in 1985. Approximately 40 percent of the 6,500-square foot (0.15 acre) easternmost restoration area was insufficiently excavated to assure daily tidal inundation. In 1987 this high area was largely barren and rocky, although high elevation salt marsh plants such as brass buttons, pickleweed, and sand spurrey, have become established over approximately 20 percent of the site. The remainder of this easternmost restoration area is at lower elevations and in 1987, had nearly completely revegetated with salt marsh vegetation including cordgrass, pickleweed, salt grass, marsh rosemary, alkali heath, and gum plant.

The middle portion of the restoration project involved removal of an earth and gravel road covering approximately 1,900 square feet (0.04 acre) of pickleweed marsh. The road area was not sufficiently excavated; it is still slightly higher than the surrounding marsh plain. Also, the substrate is quite rocky and devoid of vegetation. It is likely that the high elevation and inappropriate soils of the former roadway have thus far prevented the establishment of wetland vegetation.

The western 2.8-acre restoration area had also been previously filled, was also barren, and had also subsided so that it was occasionally inundated by the tides. Tidal circulation in this area was improved by excavating a channel and pond connecting the inner portions of the site to the Bay. Cordgrass was planted along the edge of the channel and pond. In 1987 many of the cordgrass sprigs had survived though they had not yet spread. Although the site was largely barren in 1987, it appears to have good potential for supporting marsh vegetation in the future because of improved tidal circulation and seemingly suitable soils.

This restoration project had both successful and unsuccessful elements. The successful portions of the restoration efforts established suitable elevations and soil conditions for the desired marsh plants, had good tidal circulation, and were bordered by existing marsh that could colonize the restored site. It is quite possible that the restored areas that are largely barren today will eventually support healthy stands of marsh vegetation, but much of these barren areas appear to be too high in elevation to be frequently inundated or to support most marsh plants. In addition, the soils in much of this barren area appear to be left over from the former fills placed on the site and appear unsuitable for the growth of most marsh plants.

Unsuccessful Projects

Three of the fourteen projects evaluated by the the consultants (21 percent) failed to meet the Commission's mitigation requirements and/or failed to create valuable Bay resources primiarly because either no work on the tideland restoration project had been performed or becuase some key aspect of the on-site improvements was never completed:

1. **Sulphur Springs Creek, Benicia Marsh.** As mitigation for constructing a 3,220-square foot (.07 acre) pile-supported bridge across a tidal channel and placing solid fill on 10.9 acres of diked seasonal wetlands, the Commission required Benicia Industries to return an 11.5-acre seasonal wetland to tidal action and dedicate a 6.3-acre existing tidal marsh as permanent wildlife habitat. Except for the bridge and the 6.3 acre existing tidal marsh, most of the project and the mitigation site were outside of the Commission's jurisdiction and had been formerly used as a dredged material disposal site.

Permit No. 4-80 required the 11.5-acre seasonal wetland to be returned to tidal action in accord with an approved plan that would provide "for the successful establishment and retention thereafter of marsh vegetation, such as alkali bulrush, in the restored areas." The plan was to include a planting program and all excavated material was to be removed from the mitigation site. A permit condition specified that plans for returning the area to tidal action were to be completed prior to any project construction, but failed to set a specific time for completing the mitigation project.

The approved mitigation plan indicated that a 20-foot wide, steep-sided, meandering tidal channel would be excavated to provide tidal action to the mitigation site. The new channel would connect to the Bay through two breaches cut in a levee bordering the mitigation site. The plan specified that the entire mitigation area was to be hydromulched with alkali heath. Elevations for approximately half the site were not indicated on the plan.

Excavation of the restoration site was completed in 1984 under the supervision of California Department of Fish and Game personnel who modified the restoration plan without consulting the Commission. Specifically, the Department recommended that the material excavated from the tidal channel be left on-site to create a high elevation refuge for the endangered salt marsh harvest mouse. A member of the Commission's staff visited the site in April 1985 and noted that the restoration site was then tidal and supported healthy vegetation and bird life. The staff member also contacted the State Department of Fish and Game, who confirmed that the restoration work had been satisfactorily completed. However, when the consultants visited the site two

years later in February 1987, the hydrologist found no evidence that the levee had ever been adequately breached and found tidal exchange within the mitigation site to be poor. Stagnant water that was iron-red in color and thick with filamentous green algae was noted.

In spite of the site's poor water quality, various shorebirds and waterfowl were observed on the site and portions of the site are densely vegetated with pickleweed and brass buttons. However, the density and branching of the pickleweed suggest that these are old plants which existed on the site prior to the restoration effort. The habitat islands constructed of excavated material remain bare, despite the presence of established upland plants nearby. The consultants believe that the restoration work has thus far provided little benefit to Bay resources.

Several factors likely contributed to the failure of this mitigation program: (a) the Commission did not specify clear restoration goals in the permit condition; (b) the restoration plan was approved even though it failed to show elevations for much of the site, proposed a planting program that bore little relationship to either existing site conditions or restoration goals, and failed to indicate how one of the two levee breaches would connect the mitigation channel to the Bay (this breach location, in fact, terminates in a high tidal marsh would that effectively preclude tidal action through the breach at all but the highest tides); (c) the restoration plan was further modified by the permittee without consulting the Commission or sufficiently investigating how such modification might affect the hydrodynamics of the site; (d) a hydrologist who would have provided expertise to design appropriate tidal circulation for the site was not used by the permittee; (e) site inspections after completion of the mitigation project

were apparently not thorough enough to identify potential problems and (f) the permit condition did not require the permittee to monitor or maintain the mitigation improvements to assure that the marsh improvements had in fact established a self-perpetuating marsh community as required by the Commission.

2. Napa River Marsh. Permit No. 7-74 required the City of Vallejo to return 63 acres of seasonal wetlands along the Napa River to tidal action as mitigation for approximately 11 acres of solid fill, 1.89 acres of pile-supported fill, and the dredging of an unspecified area of marsh and mudflat in the Napa River. To date, the 63 acres have not yet been improved or returned to tidal action, although a naturally occurring breach in an existing levee has allowed some tidal waters into a portion of the site. The history of this complex and much amended permit is instructive in revealing some of the problems with implementation of the Commission's required mitigation programs.

The original permit, dated August 1974, authorized 2.02 acres of pile-supported fill and extensive dredging that, according to the permit, resulted in the loss of 6.35 acres of marsh and 7.24 acres of mudflat. To mitigate these adverse environmental impacts, a condition of the permit required the permittee to prepare and implement a mitigation plan within one year of permit approval (by August 1975) that would "restore marsh and tidal habitat to at least 13 acres...that is not now subject to tidal action...." The permit also gave the permittee the option of requesting different mitigation measures if the cost of the required mitigation proved, in the permittee's judgment, to be too costly.

Amendment No. 3 to the permit authorized additional dredging and the installation of additional cofferdams in the Bay. The mitigation

condition was amended to specify that the required mitigation must be implemented before the improvements authorized by Amendment No. 3 could be used, or by June 1977. Because the permittee had made a good faith effort to identify a suitable site, but had not yet done so, this deadline was extended in Amendment No. 4. By the time the fifth amendment to the permit was issued, in August 1978, the permittee had identified but had not yet acquired a site that satisfied the Commission and the Department of Fish and Game.

Amendment No. 6 authorized significant new work at the project site and added additional mitigation requirements to the permit. Specifically, Amendment No. 6 authorized nearly 11 acres of solid fill, approximately 0.61 acres of pile-supported fill, and extensive additional dredging. As mitigation for the impacts of this additional fill, the City was required to obtain an additional 50 acres of land suitable for returning to tidal action and capable of supporting marsh and wildlife habitat, to excavate a 3,400 foot long tidal channel through the mitigation site, and to dispose all excavated material outside the Commission's jurisdiction or at approved locations within the mitigation site. The Commission required the City to complete the required mitigation site improvements by March 1984 and to transfer title of the mitigation site to the Department of Fish and Game by April 1984. To guarantee that the mitigation would occur by the specified date, the permittee was required to deposit $30,000 in an interest bearing account. The permit has been subsequently amended four more times but none of the subsequent amendments have affected the amount of fill or the required mitigation.

To date, the City has set aside the required $30,000, has acquired a 63-acre mitigation site, and has recently transferred title of the mitigation lands to the Department of Fish and Game. However, the required

restoration work has still not been performed, although natural forces appear to be returning portions of the site to tidal action. Currently much of the mitigation site is a healthy seasonal wetland, attracting many shorebirds and waterfowl to its ponds and marsh.

This mitigation project was judged a failure because the numerous delays in implementing the mitigation program has meant that Bay resources lost 13 years ago have not yet been replaced. Several factors contributed to this failure. First, the difficulty in identifying a suitable site delayed the first step of the mitigation process, acquisition, for several years.

Second, the permittee was allowed to complete the authorized project, as well as several significant additions to the project, without completing the required mitigation. The fill and dredging created a marine construction facility, one of the few water-related industrial projects built in the Bay in the last several years. The ability to put the facility on line quickly was essential to the success of the industrial project. The permit file indicates that the delay in implementing the required mitigation was much discussed between the Commission staff and the permittee, with the permittee continually persuading staff that completion of the mitigation project was imminent. The permit condition was never amended to require mitigation completion prior to construction or use of the authorized facilities, a requirement typical of the Commission's public access and most mitigation conditions. Such a requirement would have provided the permittee additional incentive to complete the mitigation in a timely manner but it may have jeopardized the underlying project.

Third, when a suitable site was finally acquired, restoring tidal action to the site raised a new problem. If the site was connected to the

Bay, other adjoining parcels would flood opening the way for possible litigation. This problem could have easily been foreseen had a tentative plan for site restoration been prepared by a competent team of biologists and hydrologists.

Finally, the mitigation policies of the various fish and wildlife agencies have changed substantially since the original permit was issued. Fish and wildlife agencies generally supported returning diked areas to tidal action when the permit was first issued in 1974, and when it was substantially amended in 1980. Currently, however, these agencies oppose mitigation projects that simply exchange one type of wetlands for another and have generally opposed returning diked seasonal wetlands to tidal action. Thus, the Bay may have suffered a permanent loss of tidal wetlands because of delays in implementing the mitigation program.

3. **Alviso Slough Marsh**. Permit No. 13-81 was issued as a result of Commission enforcement action and required Marshland Development Company, Inc. to create a quarter acre of new Bay surface area to offset the impacts of placing 6,000 square feet (0.14 acre) of solid fill in a tidal inlet along Alviso Slough in Santa Clara County. The application described the fill site as a small inlet with a large barge covering the inland end and marsh vegetation growing bayward of the barge. The permittee was to mitigate the impacts of the fill by excavating existing uplands to create new tidal areas with a gentle slope capable of supporting marsh vegetation.

Unfortunately, although the permit authorized fill removal, fill removal was not specifically required in a permit condition. As a result, the requirement to remove fill is more difficult to enforce, though the findings clearly indicate that the Commission intended for fill to be removed to offset the adverse impacts of the authorized fill.

A grading plan for filling the inlet and removing fill was approved in August 1983. Early in 1987, the permittee stated that the inlet was filled and that approximately half of the area indicated for fill removal had been excavated. However, a site inspection in 1987 found little evidence that any fill had been removed.

This project failed primarily because at least a portion of the work was never carried out. The fact that the permit did not require mitigation, but simply authorized it, and did not set a specific date for completing the mitigation, creates difficulties for the Commission in assuring that the restoration work will be completed.

Comparison With Past Studies of San Francisco Bay Mitigation Projects Involving Wetland Restoration

Other evaluations of San Francisco Bay mitigation and wetlands restoration programs have not always reached the same conclusions reported here. For example, Dr. Margaret Race (1985, p. 76) of the University of California, Berkeley, in a review of 11 experimental marsh plantings and five wetland restoration projects, concluded that such:

> [p]rojects have been plagued by multiple problems such as high soil salinities, incorrect slope, improper tidal elevations, incomplete vegetation establishment, channel erosion, sedimentation or poor tidal circulation. On the basis of these findings, it is debatable whether any sites in San Francisco Bay can be described as completed, active, or successful restoration sites at present.

Wendy Eliot (1985, p. 20) of the State Coastal Conservancy, in a review of 58 permits in which either the Commission or the U.S. Army Corps of Engineers had required tideland restoration to mitigate adverse project impacts concluded that:

> Current mitigation policies have been largely unsuccessful in San Francisco Bay. Institutional and scientific uncertainties impede the success of mitigation sites restored under present mitigation policies. Regulatory agencies mitigating for the adverse impacts of development proposals by requiring wetland restoration should assume that inadequate restoration of wetlands may ensue.

The findings of this study do not support such pessimistic conclusions. In most cases where some work has been carried out to fulfill permit mitigation requirements, significant Bay resources have been created, resources that range from mudflats supporting good populations of benthic invertebrates to densely vegetated, high-elevation salt marsh. There are several possible explanations for why this study reached different conclusions regarding the relative success of wetland restoration projects than Race and Eliot's studies:

1. Each Investigator Evaluated Different Projects. No study thus far has investigated all of the tideland mitigation projects required by the Commission in San Francisco Bay. Only two of the 16 mitigation projects evaluated by Race were wetland restoration projects required by the Commission as mitigation for Bay fill projects (the Hayward Marsh, Permit No. 20-73, and the Muzzi Marsh, Permit No. 22-73) and both were evaluated in this study. Of the 58 mitigation projects evaluated by Eliot, 21 were required by BCDC as mitigation for the adverse impacts of Bay fill[5/]. Of these 21 mitigation

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5/Eliot actually lists 26 Commission permits in her review of development projects that required mitigation, five more than are cited here. This difference is due to the fact that four of the 26 wetland restoration projects listed by Eliot were not required by the Commission as mitigation for fill in the Bay; one mitigation project was used as mitigation by two separately listed permits and was therefore counted as only one mitigation project in this study.

projects, 11 were analyzed here. It is obvious that both Race and Eliot base their conclusions in large part on projects that were not Commission-required mitigation programs and were therefore, not subject to this study. In fact, many of Race's conclusions appear to be drawn from the results of early experimental test plantings and not from mitigation projects at all. Though the results of such studies are clearly relevant to wetland restoration projects today, the goals of experimental test plantings are quite different from the goals of a mitigation project. As observed in an article publishedin 1986 by Dr. H. Thomas Harvey, professor emeritus of biology at San Jose State University, and Dr. Michael Josselyn, director of the Tiburon Center for Environmental Studies and professor of biology at San Francisco State University, and the Commission's consulting biologist, "experimental planting, in contrast to restoration, is the testing of planting techniques, or the testing of responses of plants to tidal heights or wave action" and can be considered successful even if they fail to establish marsh vegetation if they provide data which does or does not support the hypothesis being tested. Thus, one possible explanation for the different conclusions reported for the success of wetland mitigation projects is that each investigator reviewed a different pool of wetland restoration projects.

2. Each Investigator Used Different Criteria to Measure Success. In this study, a mitigation project was determined to have been successful if it both fully met the key mitigation requirements of the permit and had either created or enhanced valuable Bay resources that were comparable to the resources found in natural baylands that were at an equivalent successional stage. As Harvey and Josselyn (1986) point out, Race does not define her evaluation techniques, a criticism that could also be made of Eliot's review.

However, a comparison of the conclusions each investigator drew from observing the same project makes it quite apparent that each investigator was using a different measure of success. For example, Race (1985, p. 71) states that "it is debatable whether any sites in San Francisco Bay can be described as completed, active, or successful restoration projects at present." However, based on Race's own description of the Muzzi Marsh (Race, 1985) in which she states that "[s]ince the channel improvement project, vegetative cover has continued to increase, especially in areas with formerly restricted tidal flushing and high elevations. By 1982, percent cover of the dominant species, Salicornia virginica, was reported as high as 70 percent to 95 percent in many areas, and cordgrass areas were continuing to expand," and based on the results reported by Josselyn and Buchholz (1984) which found marsh plant productivity in Muzzi Marsh similar to other natural marshes and substantial use of the marsh by fish and wildlife, including endangered species, this study would have concluded in 1984, as it does in 1987, that the Muzzi Marsh was in fact a completed, active, and successful example of wetland mitigation. Similarly, one of the two projects that Eliot reports as successful in 1985, the Hayward Marsh (Permit No. 20-73), was determined in this study to have been only partly successful because not all of the money set aside for mitigation has been spent and because vegetation has not yet become established on the site in the densities expected after seven years of tidal action on the site.

3. Many of the Restoration Projects Evaluated By Other Investigators Were Too New to Adequately Assess the Success of the Restoration Effort. It is quite difficult to determine whether a recently constructed wetland restoration project will be successful because it usually takes at least three

years under ideal circumstances for vegetation to colonize an appreciable portion of the mitigation site, longer if the mitigation site is large, isolated from possible seed sources, subject to erosion, or has been significantly disturbed during restoration. Newly constructed wetland sites typically undergo rapid changes as the natural processes of erosion and sedimentation begin reconfiguring the site and marsh vegetation and benthic organisms (such as the hornsnail (Cerithedia californica, ribbed mussel, Ischadium demissum, and amphipods) begin colonizing areas where suitable soil conditions, elevations, and tidal regimes have been established. Thus it is quite likely that observations of a wetlands mitigation project made shortly after restoration would find very different conditions than observations made later. This clearly was a factor in some of the conclusions reached by Eliot (1985) regarding the Seal Slough marsh (Permit No. 18-82) which she visited in 1984, one year after project completion. The site is depicted in photographs and text as largely barren, with most of the site being too high to receive regular tidal inundation, and the remainder experiencing rapid erosion. Observations of this site made approximately three years later in 1987 found that the site was still experiencing rapid erosion associated with new channel formation, but also found that most of the site was receiving good tidal exchange, that cordgrass, pickleweed, and benthic organisms were rapidly invading most of the site, and that shorebirds and waterfowl used the site extensively. In fact, only one of the eleven projects reviewed both by Eliot and the Commission's consultants had been completed for more than two years at the time of Eliot's review; notably, the one project that had been completed for more than two years was a project Eliot cited as an example of successful restoration (the Hayward Marsh, Permit 20-73).

It is quite possible that some of the mitigation projects determined to have been only partially successful in this study may support healthy wetland communities in time. Three of the 12 wetland mitigation projects investigated here were judged to have been only partially successful, primarily because the sites were largely devoid of vegetation (Hayward Marsh, Permit No. 20-73; Dunphy Park Marsh, Permit No.24-80; and Richardson Bay Bridge Marsh, Permit No. 35-79). Yet all three of these projects may eventually support wetland plant communities once erosion and sedimentation have created conditions suitable for intertidal plant and animal communities to become established on these sites. Most restoration projects are designed to take advantage of the natural processes of channel formation, sedimentation, and plant colonization; processes that take several years.

CONCLUSIONS

There is no simple answer to the question of whether the Commission's past mitigation efforts have been successful, for the answer is determined in large part by the criteria used to measure success, and by how one characterizes each individual mitigation project. For example, should the Hayward Marsh (Permit No. 20-73) be considered a success because the completed mitigation project meets the Commission's stated permit requirement of returning at least 200 acres to tidal action, and has increased the Bay's tidal prism and surface area while creating valuable mudflats and marsh? Or should it be considered a failure because as of 1987, seven years after the site was returned to tidal action, the site supports only a fraction of the cordgrass it was designed for and $350,000 of the money set aside for mitigation remains unspent six years after the Dumbarton Bridge was completed?

Assessing the success of past mitigation projects is made more difficult by changes that occur naturally in all Bay wetlands over time, changes that can significantly alter both the appearance and functioning of a wetland. Natural tidal marshes are an exceedingly dynamic system and can change significantly in a single storm or flood. Even without major disturbances, tidal marshes change over time as marsh vegetation increases sedimentation within the marsh, and waves and currents erode the marsh edge. Thus it is difficult to know with any certainty if the conditions observed at a mitigation site are the result of natural processes, a poorly conceived mitigation plan, or poor implementation of a well-designed plan. For example, a site inspection of the Deak Marsh (Permit No. 32-78) sheds no light on

whether the site's elevations, which appear to be higher than specified in the approved plan, are the result of natural sedimentation or incomplete excavation of the mitigation site.

These examples illustrate the difficulties in both determining whether an individual mitigation program is successful, and in arriving at overall conclusions regarding the performance of Commission-required mitigation programs. Still, this study supports some general conclusions:

1. **Mitigation Projects Can Successfully Create and Enhance Bay Resources.** Eleven of the 12 mitigation programs that had performed some work in fulfillment of their permit mitigation requirements[6/] have successfully created or significantly enhanced valuable Bay resources by increasing the Bay's tidal prism and surface area or creating diverse wetland plant and animal communities. While it is relatively simple to increase the Bay's tidal prism and surface area by opening an area to tidal action, most of the projects had also successfully created conditions favorable to the establishment of a diverse and healthy salt marsh community, a far more difficult achievement. Even more encouraging, the existing plant distributions and diversity found in eight of these twelve projects closely approximate the design distributions and diversity shown in the mitigation plans, although few sites are as fully vegetated as healthy natural tidal marshes.

6/Because two of the 14 projects (Napa River Marsh, Permit No. 7-74 and Alviso Slough Marsh, Permit No. 13-81) had not completed any improvements to the mitigation site, they were not included in this analysis which evaluates only those mitigation programs or portions of programs where some work had been performed.

2. **There Is No Certainty That Any Given Tidal Restoration Program Will Totally Meet All Of Its Restoration Goals.** The results of this study suggest that the major factors limiting wetland plant communities are understood, and that it is possible to create suitable conditions for many wetland species in the field. (See the Commission's "Guidelines for Enhancement and Restoration of Diked Historic Baylands", February 1983 for a discussion of the critical elements of a successful tidal marsh restoration project). As encouraging as these results are, there inevitably will remain an element of uncertainty in the planning and design of wetland restoration projects. Biologists face the uncertainty of climatic events and their effect on biota, the vagaries of propagule dispersal and plant colonization, and imperfect knowledge about wetland organisms and their life cycles. Hydrologists face the uncertainity of future storm and flood magnitudes, lack of local water discharge data and sedimentation rates, and imperfect understanding of the hydraulics of wetlands an estuaries.

Planning and design of mitigation program must take into account the dynamic nature of wetlands processes, for both the biotic and abiotic components of wetland ecosystems are constantly changing. The design problems noted in this study (as opposed to implementation problems) often involved a failure to consider the dynamic nature of wetlands and estuaries. Problems included inadequate analysis of wave-induced erosion (the Hayward Shoreline Marsh, No. 20-73), sedimentation (Marina Bay Marsh, No. 11-78), and soil characteristics (the Richardson Bay Bridge Marsh, No. 35-79). It is possible that a more thorough analysis could have foreseen these problems, but tideland design will always contain an element of risk or uncertainty that is inherent in the nature of tidelands.

In addition, without detailed scientific analysis of the diversity, productivity, hydrologic functions and food chain support of restored marshes, there is no certainty that restored marshes fully duplicate the values of natural tidelands.

The fact that some of the evaluated restoration projects appear to be either progressing more slowly than restoration biologists expected (the Hayward Marsh, Permit No. 20-73), or have changed so rapidly that they no longer support the desired wetland habitats (Deak Marsh, Permit No. 32-78) indicates that gaps remain in the scientific community's knowledge of the factors limiting the growth and establishment of tidal marsh communities. For example, although most observers believe that the carefully planned Hayward Marsh will eventually support a diverse and vigorous tidal marsh community, only 10-15 percent of the site is vegetated seven years after tidal action was re-introduced on the site, a much lower percentage of plant coverage than was expected based on experience with similar restoration projects (e.g. the Muzzi Marsh, Permit No. 22-73). And although several plausible hypotheses have been advanced to explain the relative slow pace of plant colonization of the site, (see pgs. 28-30 of this report) these hypotheses have not been tested and scientists have not yet established what factor or combination of factors are responsible for the relative paucity of marsh vegetation on the site. On the other hand, the Hayward Marsh mitigation program has increased the Bay's tidal prism and created mudflats and open water channels that provide important habitat for many aquatic and wildlife species.

3. **The Primary Reason Some Mitigation Projects Have Failed In The Past Is That Some Portion of the Required Mitigation Has Not Been Performed.** Of the three mitigation projects that were judged failures, two had failed simply

because the required mitigation work was never performed (Alviso Slough, Permit No. 13-81; Napa River Marsh, Permit No. 7-74). The major reason that four of the five partially successful projects were judged to have not fully complied with the Commission's mitigation requirements was either because some portion of the required mitigation had not yet been performed (Hayward Marsh, Permit No. 20-73; Seal Slough Marsh, Permit No. 18-82), or because the required mitigation improvements appear to have been carried out incorrectly (Deak Marsh, Permit No. 32-78; Richardson Bay Marsh, Permit No. 35-79).

4. <u>The Difficulty in Identifying and Acquiring Suitable Restoration Sites Has Delayed Many Mitigation Projects Involving Tideland Restoration</u>. In five of the 14 projects reviewed by the consultants, there were delays in completing all or a portion of the required mitigation as a direct result of the permittee being unable to either find and/or acquire a suitable restoration site (Hayward Marsh, Permit No. 20-73; Napa River Marsh, Permit No. 7-74; Richardson Bay Bridge Marsh, Permit No. 35-79; Dunphy Park Marsh, Permit No. 24-80; and, Seal Slough Marsh, Permit No. 18-82). In three of these five projects, a portion of the required mitigation has still not been provided, although the authorized fill has been in place for some time. Experience with recent permits suggests that it has become even more difficult to find appropriate mitigation sites because so much of the shoreline of San Francisco Bay has either been developed, has development potential and is high-priced, or already supports valuable wildlife resources that other government agencies are charged with protecting. Scarcity of suitable mitigation sites frustrates permit applicants, regulatory agencies, and the public in their efforts to offset a project's adverse environmental impacts. It appears likely that difficulty in finding wetland mitigation sites may soon

force the Commission into the hard choice of either approving projects without mitigation, or turning down permits for projects that are otherwise in the public interest.

- 5. **Permits Contain Little Information on the Bay Resources Lost as a Result of Authorized Fill and Do Not Clearly State the Goals of the Mitigation Program.** Few permits state explicitly what Bay resources will be impacted by the fill. Thus, in evaluating the performance of individual mitigation programs, it is difficult to ascertain whether a project's specific adverse impacts on the Bay have been offset by its mitigation project.

The failure to clearly identify Bay resources lost as a result of authorized fill contributes to ambiguity on the part of the permittee, interested parties, and Commission staff as to what precisely needs to be done to satisfy the permit's mitigation requirements. This confusion is reflected in the fact that few permits provide clear mitigation goals. Several permits simply require returning a given site to tidal action or creation of a tidal marsh. Such conditions do not provide clear direction as to the resources that should be created through the mitigation project. For example, should an area that is to be returned to tidal action be a subtidal area, an intertidal mudflat, or a high elevation salt marsh?

The ambiguity of most mitigation requirements makes it exceedingly difficult to evaluate whether completed mitigation projects meet the Commission's mitigation objectives, for there is no clear mitigation goal by which performance can be measured.

6. **Monitoring of Completed Projects and Maintenance of Restoration Improvements Has Rarely Been Required.** The Commission has rarely required monitoring of mitigation programs. Of the 14 programs the consultants

evaluated, only three required the permittee to monitor the restoration project (only one of these three projects has actually performed the required monitoring); only two required the permittee to maintain the required improvements to assure that the restoration project functioned as designed (no maintenance has been needed on either of these two sites since the mitigation improvements were completed).

Without monitoring, problems at the mitigation site are unlikely to be detected or corrected. For example, both the Sulphur Springs Creek Marsh (Permit No. 4-80) and the western portion of the Benicia Marina Marsh (Permit No. 5-77) apparently developed problems shortly after the restoration project was completed. Had these problems been identified early, immediate action could have been taken to correct the problem, probably at less cost and certainly with less disturbance to the newly restored area than would be involved in correcting the problem today.

Monitoring also allows government agencies involved in wetland restoration to refine restoration techniques so that past mistakes can be avoided and needless requirements eliminated. For example, early mitigation projects involving wetland restoration typically required the permittee to plant the restored site with suitable marsh vegetation. However, experience with planting programs in San Francisco Bay suggests that such planting is often unnecessary, particularly for small restoration sites bordering large, existing marshes or for mitigation programs where pickleweed is the target plant. Thus, mitigation conditions have been modified so that planting is usually only required when the mitigation site is some distance from a natural

seed source, when cordgrass is a significant componet of the target habitat, or when plants have failed to colonize the site two to five years after completion of the restoration improvements.

- Finally, monitoring provides a convenient enforcement mechanism to assure satisfactory completion of a mitigation project. Annual reports on the condition of the mitigation site keep the Commission abreast of the progress the site has made toward achieving the mitigation goals, and increase the permittee's involvement with the restoration effort. If monitoring is coupled with a requirement to correct deficiencies in the marsh restoration effort, permittees are likely to make even greater efforts to assure that mitigation projects are thoughtfully planned and carefully carried out.

7. **Enforcement of Mitigation Requirements Has Not Been a Commission Priority.** The Commission has insufficient funds and staff to investigate all work performed in its jurisdiction, or to assure compliance with all permit requirements. For this reason, the staff has focused its enforcement activity on unauthorized fill projects rather than monitoring mitigation sites. This policy is reflected in a review of the files of the 14 evaluated permits which indicate that mitigation requirements are often loosely tracked by Commission staff. In addition, the enforcement staff does not have the scientific expertise to properly evaluate the performance of mitigation programs involving tideland restoration. Thus, the permit files often do not provide such critical information as: (a) when were the required mitigation improvements completed (the completion dates cited in this study often came from telephone conversations with the permittee), (b) has the permittee completed all of the required mitigation improvements; (c) was the mitigation completed "concurrently with those parts of the project causing adverse

impacts," as required by the Commission's mitigation policy; (d) what problems arose during implementation of the mitigation requirements; and (e) was the wetland restoration work completed in accord with the approved mitigation plan. Only occasionally was there any indication in the permit file that Commission staff had inspected the mitigation site for compliance with the permit mitigation conditions.

RECOMMENDATIONS

While various researchers have reached different conclusions regarding the relative success of past tideland mitigation projects, there has been general unanimity regarding measures that would improve regulatory agencies' implementation of mitigation programs involving tideland restoration and enhancement. Setting clear objectives for tideland mitigation programs, monitoring completed mitigation projects, conducting additional research on wetlands ecology and restoration techniques, and assuring widespread reporting of the results of mitigation programs and advances in restoration techniques has been recommended by Josselyn and Bucholz (1982), Zedler (1984), Race (1985), Eliot (1985), Harvey and Josselyn (1986), and Good (1987). Race (1985) further suggests that permits address how long it should take for desired habitats to become established at a mitigation site, and that permits set clear lines of responsibility for taking corrective action if a restoration project fails to meet specified restoration objectives. Race also questions the cost-effectiveness and habitat value of many small marsh establishment projects, a question also raised by Good (1987). Zedler (1984) and Good (1987) suggest that restoration goals be established for a region as a whole and that specific mitigation plans should capitalize on the attributes of the site and not necessarily attempt to fulfill all regional goals. The need to improve enforcement of wetland mitigation requirements is stressed by Eliot (1985), who also suggests that mitigation banks may be an effective means of meeting mitigation requirements where on-site mitigation is not possible.

The results of this study support all of these recommendations. Specifically, the results of this study indicate that the success of mitigation programs in San Francisco Bay can be improved by implementing the following measures:

1. Applications and Permits Should Provide Detailed Information on the Specific Bay Resources Impacted by An Authorized Fill Project. Applicants should provide and permits should clearly state how much and what kinds of tideland habitats (such as high elevation salt marsh, pickleweed marsh, cordgrass marsh, intertidal mudflats, and subtidal lands) will be lost or disturbed in constructing the project, and how the project will affect such resources as Bay tidal prism, surface area, and water circulation. Such information is critical in assuring that a project's specific environmental impacts are offset by its mitigation program. Without such information to guide the mitigation effort, there is no assurance that the mitigation program, even if successfully implemented, will offset the project's impacts on Bay resources. Moreover, the recent U. S. Supreme Court decision in Nollan vs. California Coastal Commission places a greater burden on the staff and the Commission to explain with supporting evidence what the precise adverse impacts of a given project are going to be or are likely to be, and then explain precisely how the particular mitigation condition or set of conditions will offset those anticipated impacts. Few of the 14 permits evaluated in this study contained any information on the resources impacted by the project.

The Commission could take several steps to improve both the sufficiency and accuracy of the information an applicant provides regarding a Bay fill project's adverse environmental impacts, including: (a) directing staff to request needed information in responding to all environmental

documents; (b) having the Commission's biological and hydrological consultants perform such evaluations, with applicants absorbing the cost; and (c) directing staff to perform such evaluations using either an existing resource evaluation technique (such as the U. S. Fish and Wildlife Service's Habitat Evaluation Procedure (HEP)) or one tailored to the Commission's regulatory needs to assure consistent evaluations.

2. **Permit Mitigation Conditions Should Set Clear Goals for the Mitigation Project.** Mitigation programs involving tideland restoration should be carefully planned and implemented to assure the creation of tidal regimes, site elevations, and soil conditions suitable for the establishment of the desired Bay resources. For this reason, tideland mitigation conditions should require preparation of a mitigation plan in association with a tidal hydrologist and a biologist experienced in estuarine wetland restoration that takes the specific attributes of the selected mitigation site into account. In most instances, the mitigation plan should include:

a. Precise elevations at one foot contour intervals that the biologist certifies are suitable for the desired plant and animal communities and that the hydrologist certifies will provide sufficient tidal prism and circulation to accommodate expected siltation;

b. An analysis of both on- and off-site constraints to tidal flow to the site, such as channel dimensions, and size of levee breaches or tidal control structures;

c. A soil analysis to determine whether the soils are suitable for establishment of target plant and animal communities;

d. A list of the Bay resources to be created by the mitigation program, with an indication of how much of the mitigation site is to be occupied by each habitat type;

e. A requirement that the contractor guarantee that the grading and excavation are in conformance with the approved plan;

f. A clear schedule for meeting each element of the mitigation program; and

g. A list of who will be responsible for planning and implementing each element of the mitigation program, such as preparation and review of mitigation plans, site improvements, and maintenance and monitoring programs.

3. **Mitigation Projects Should Involve Restoring Areas That Are Larger in Size and Greater in Habitat Value Than The Area Disturbed By The Project.** Though careful planning and implementation greatly increase the likelihood that a mitigation program will succeed in creating desired resources, there is no certainty that any given mitigation program will successfully create its target resources, or that the created resources will be as long-lived as the resources lost to fill activities. In addition, there is always an unknown period of time between completion of required mitigation improvements and the establishment of a complex wetland community of plants and animals, a lag time

that may be decades long in the case of large restoration projects. Finally, until detailed studies of the diversity, productivity, and functioning of restored tidelands are performed, we cannot be certain that restored tidelands fully duplicate all the environments and functions of natural tidelands. By requiring that mitigation programs involve restoration of larger areas having greater resource value than areas lost to fill, the risk is reduced that authorized fill projects and their associated mitigation programs will result in the continued diminution of tideland resource values.

The difficulty is in deciding how much larger the mitigation site should be, and how much greater the resource value. Any formula, while predictable, is also somewhat arbitrary. For example, how do we factor in the unknown number of years it will take for a mitigation site to fully replace resources lost or disturbed as a result of a fill project? Some coastal programs (e.g. New Jersey) have attempted to address such issues by requiring that disturbance or loss of wetlands "must be compensated for by the creation or restoration of an area of wetlands at least twice the size of the surface area disturbed, unless the applicant can prove...that by restoring or creating a lesser area, there will be no net loss in the environmental value of wetlands...." But this ratio may be too high, or too low. There simply isn't the knowledge at this time to set a ratio that will assure that mitigation programs will not result in the further loss of Bay resources, though it is obvious that the larger the ratio of mitigation resource values to resource values lost through authorized Bay fill, the greater the likelihood that a mitigation program will adequately offset a project's impacts.

4. The Need for and Contents of a Suitable Mitigation Program Should Be Identified Sufficiently Early That the Public Can Comment on Proposed Mitigation Programs. Applications for projects adversely impacting Bay resources should include a mitigation program to offset the project's adverse, Bay-related impacts. In such cases, staff should advise applicants as early as possible of the probable need for a mitigation program so that applicants can describe the location and contents of a proposed mitigation program in their applications. Staff should further advise applicants that a project adversely impacting Bay resources that does not provide an adequate mitigation program runs the risk of being denied by the Commission. (Conversely, it is possible that Bay fill projects with major public benefits may, under the Commission's law, be approved without mitigation if mitigation is not possible.)

This study found some evidence that applicants that have prepared a specific mitigation program early in project planning, and had mitigation programs available for public and agency review and comment during the public hearing process, have experienced less delay in both building the project and in implementing the mitigation program. This study also found some evidence that the lack of success of some restoration efforts likely arose because of poorly conceived mitigation programs. Public comment on mitigation programs conducted as part of the hearing on the project would tend to identify defects in mitigation programs and help applicants find solutions.

5. Approved Mitigation Programs Should Be Implemented Concurrently with Construction of the Project. This study found that implementation of nine of the fourteen evaluated mitigation projects was delayed because of problems in: (a) finding and acquiring a suitable mitigation site;

(b) developing an appropriate mitigation program for the selected site; and/or (c) unforeseen conditions at the mitigation site necessitating changes in the mitigation program. Such delays in implementing mitigation programs have, in some instances, resulted in the Bay suffering damage from a project for some time before the benefits of a mitigation program were realized. In a few cases, those benefits have still not been realized. To avoid recurrence of such problems, proposed mitigation programs should include a specific and enforceable schedule for implementation such that the benefits of the program will be, to the extent possible, concurrent with the environmental damage caused by the project. When exact concurrence cannot be achieved, greater mitigation should be included to offset environmental losses owing to the lapse in time between the damage inflicted by the project and the benefits provided by the mitigation program.

6. Completed Mitigation Projects Should be Monitored and Maintained.

Monitoring short-term changes following site restoration, coupled with a requirement to maintain mitigation improvements for a specified period of time, allows adjustments to be made to the mitigation program in response to the actual functioning of the newly created tidelands. Monitoring also allows the results of a mitigation program to aid the planning and implementation of future restoration projects, increases the permittee's commitment to the success of the mitigation program, and assists in the enforcement of mitigation requirements. In most instances, when a Commission permit requires tideland mitigation, the permits should require the permittee, through consultants approved by the Commission, to annually report to the Commission on the status of the mitigation effort. At a minimun, such reports should:

a. Identify any problems that may have arisen at the mitigation site, such as greater than anticipated sedimentation rates, constraints to tidal flow, failure of required plantings, accumulation of debris, etc.;

b. Evaluate how closely the resources actually occurring on the site compare with the resources shown in the approved mitigation plan, including an estimate of plant coverage; and

c. Report on whether restoration is proceeding in accord with the approved schedule.

7. Enforcement of Mitigation Requirements Should Be Improved. The two factors most often responsible for the failure of a mitigation program is that either some portion of the required mitigation was not implemented, or was carried out incorrectly. Thus, improved enforcement of Commission-required mitigation programs is an essential action that would improve performance of these mitigation projects. The Commission could improve the enforcement of mitigation conditions by: (a) directing staff to increase the priority given to monitoring mitigation programs (unfortunately, because of staff and funding limitations, this would probably be at the expense of other necessary enforcement activities); and (b) requiring submittal of annual monitoring reports of mitigation sites (see discussion under item 6, above). As most permittees lack the requisite expertise to evaluate the progress of a mitigation program, such monitoring should be performed by independent specialists hired by the permittee, and approved by the Commission.

8. Research on Tidelands Ecology and Restoration Techniques Should Be Promoted. Increased knowledge of how tidelands function and improvements in restoration techniques will increase both the success and the efficiency of mitigation programs involving tideland restoration. In particular, information is needed on: (a) whether the productivity, species diversity, density, food chain support, hydrologic functioning, nutrient cycling, etc. of restored tidelands are equivalent to natural tidelands; (b) whether restored tidelands are as long-lived as natural tidelands; (c) why some restoration projects fail, age rapidly, or are slow in recruiting plant and animal communities; (d) whether some resources can't be replaced (for example, efforts to establish eelgrass beds in San Francisco Bay have thus far been unsuccessful); (e) the relative habitat value and cost-effectiveness of small restoration projects in comparison to large restoration areas; and (f) whether certain restoration designs, site manipulations, and planting techniques are more effective than others in establishing a tideland community. Because restoration is a new and evolving science, it is important that the results of wetlands mitigation projects be disseminated to estuarine scientists, restoration professionals, regulatory agencies, and the public. Though the Commission itself has neither the expertise nor funds to perform or fund such original research, the Commission can promote such research by encouraging Bay area Universities and Colleges to include studies of Bay area estuarine systems in their research programs, and can support the grant applications of scientists undertaking research that will advance the science of restoration. The Commission could also make a valuable contribution to the science of restoration by preparing an annual or biennial report on the current status of Commission-required mitigation programs.

9. The Commission Should Promote Acquistion of Lands Suitable for Tidal Restoration Around the Bay. The Commission should promote an aggressive, comprehensive, and regional approach to enhancement of Bay resources, particularly the acquisition of suitable areas near the Bay which can be enhanced for Bay-related habitat. Mitigation programs should be integrated with this enhancement program. Such integration will reduce the burden on applicants in finding acceptable sites and designing appropriate mitigation programs. Because development has been proposed for many of the remaining undeveloped lands along the Bay's perimeter, and because the wetland policies of fish and wildlife agencies have changed so that they now generally oppose using diked seasonal wetlands as mitigation sites, mitigation sites will become increasingly difficult to locate and expensive to purchase.

The natural resources of the Bay can be enhanced more fully and economically if a large, regional, and enforceable enhancement program is available. Currently, there is no comprehensive and binding plan with restoration and management goals for San Francisco Bay's tidelands and associated wetlands. But much technical information needed for such a plan exists, particularly in the Commission's "Diked Historic Baylands Study," completed in October 1982, and in the U.S. Fish and Wildlife Service's report on the "Protection and Restoration of San Francisco Bay Fish and Wildlife Habitat."

All federal, state, and local agencies with expertise or permit authority for Bay activities should be included in developing and implementing a regionwide, Bay-related wetland enhancement program. Such a plan will streamline mitigation efforts, assure consistency of mitigation requirements, and better assure that the total regional resource values of the Bay estuarine

system are increased in the future. A comprehensive, professionally designed and managed, and regionwide enhancement program will be more likely to create the type and amount of new Bay-related resources that are needed, at less cost than a number of small, unrelated mitigation programs. Legislation may be required to assure that all agencies involved with mitigation programs and resource enhancement activities participate fully in and are bound by a comprehensive and regional program.

Finally, after acquiring and creating Bay tidelands and associated wetlands, the state should institute a program for recovering much of the money spent in acquiring, restoring, and managing such wetlands by subsequent application of developer fees to mitigate authorized tideland losses, thus creating a mitigation bank on a regionwide scale. Such a proposal would provide a mechanism for protecting lands suitable for restoration, as well as reserving areas that could be used as mitigation for needed and approvable water-related uses.

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APPENDIX A
CURRENT COMMISSION MITIGATION POLICY
(adopted in 1985)

Mitigation for the unavoidable adverse environmental impact of any Bay fill should be considered by the Commission in determining whether the public benefits of a fill project clearly exceed the public detriment from the loss of water areas due to the fill and whenever mitigation is necessary for the Commission to comply with the provisions of the California Environmental Quality Act. Whenever mitigation is needed, the mitigation program should be provided as part of the project. Mitigation should consist of measures to compensate for the adverse impacts of the fill to the natural resources of the Bay, such as to water surface, volume or circulation, fish and wildlife habitat or marshes or mudflats. Mitigation is not a substitute for meeting the other requirements of the McAteer-Petris Act concerning fill. When mitigation is necessary to offset the unavoidable adverse impacts of approvable fill, the mitigation program should assure:

(1) That benefits from the mitigation would be commensurate with the adverse impacts on the resources of the Bay and consist of providing area and enhancement resulting in characteristics and value similar to the characteristics and values adversely affected.

(2) That the mitigation would be at the fill project site, or if the Commission determines that on-site mitigation is not feasible as close as possible;

(3) That the mitigation measures would be carefully planned, reviewed, and approved by or on behalf of the Commission, and subject to reasonable controls to ensure success, permanence, and long-term maintenance;

(4) That the mitigation would, to the extent possible, be provided concurrently with those parts of the project causing adverse impacts; and

(5) That the mitigation measures are coordinated with all affected local, state, and federal agencies having jurisdiction or mitigation expertise to ensure, to the maximum practicable extent, a single mitigation program that satisfies the policies of all the affected agencies.

If more than one mitigation program is proposed that satisfies all five factors, above, the Commission should consider the cost of the alternative in determining the appropriate program.

To encourage cost effective and comprehensive mitigation program, the Commission should extend credit for certain fill removal and encourage land banking provided that any credit or land bank is recognized pursuant to written agreement executed by the Commission. In considering credit or land bank agreement, the Commission should assure that the five factors listed above will be met.