STAFF REPORT

SALT PONDS

October 2005

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION

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Aerial of salt ponds, Mark Bittner
White pelicans and gulls on levee, Judy Irving
Salt stack, Cargill Salt

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ADOPTED REVISIONS TO THE *SAN FRANCISCO BAY PLAN*
SALT PONDS FINDINGS AND POLICIES

The following amended findings and policies were adopted by the San Francisco Bay Conservation and Development Commission on August 18, 2005 and are the culmination of the *San Francisco Bay Plan* amendment process for revision of the salt ponds findings and policies. The staff background report, *Salt Ponds*, initially sent to the Commission and the public on June 3, 2005, provided the information foundation from which the following updated findings and policies emerged. The background report with staff's proposed recommendations was considered by the Commission at a public hearing on July 21, 2005.

The adopted revisions to the *San Francisco Bay Plan* included the separation of the "salt ponds and other managed wetlands" section into two sections, one on salt ponds and one on managed wetlands. The following findings and policies apply only to salt ponds. The findings and policies related to managed wetlands were not revised as part of this amendment process.

Findings

a. Natural salt pans (ponds), ranging in size from a few feet in diameter to more than 1,000 acres, once existed in the tidal marshes of the Bay. These ponds supported vegetation such as widgeongrass, providing an important food source for waterfowl and salt was harvested from these ponds by Native Americans and early Spanish and Mexican settlers. Beginning in the 1850s, shallow areas of the Bay and tidal marshes were diked to form ponds to commercially produce salt through solar evaporation. Solar salt production relies on natural conditions present in the Bay Area including adequate area for solar evaporation of salt water, a dry climate and prevailing summer winds to aid evaporation.

b. Since the 1960s the public has acquired roughly 90 percent of the over 41,000 acres of property used for production for the purpose of maintaining and restoring habitat, which will make the Bay larger and healthier. Currently, salt ponds total some 30,000 acres in the South Bay and more than 11,000 acres in the North Bay. The North Bay salt ponds are publicly owned and are being managed and restored for the benefit of fish, other aquatic organisms and wildlife. The South Bay consists of salt ponds that are: (1) publicly owned and being managed and restored for the benefit of fish, other aquatic organisms and wildlife (about 16,000 acres); (2) publicly owned and privately managed for salt production (about 8,000 acres); (3) privately owned and managed for solar salt production, particularly for harvest (about 4,400 acres); or (4) publicly or privately owned with an undetermined future use (about 1,400 acres).

c. Cargill Salt, a business unit of Cargill Incorporated, is the sole private owner of salt ponds and the only entity producing salt in San Francisco Bay through solar evaporation. Changes in the market for several varieties of salt products coupled with the achievement of greater production efficiencies in the salt pond system have enabled Cargill to meet current market demand for salt in an area reduced from that historically used for commercial salt production.

d. Salt production is an economically important and productive use of the waters of the Bay and salt is an important product. Multiple brand names representing a myriad of different salt products are produced in the Bay Area for food, pharmaceutical, agricultural and water softening uses. In addition, brine shrimp are commercially harvested from salt ponds for aquaculture research and tropical fish food.

e. The water surface area of the salt ponds supplements the water surface area of the Bay and thus helps to moderate the Bay Area climate and to prevent smog. Further, the salt ponds contribute to the open space character of the Bay and the levees surrounding the ponds, although not designed or maintained for flood control, help to protect adjacent low-lying areas from tidal flooding.

f. Salt is made by moving Bay water through a series of ponds that become progressively more saline as a result of evaporation. Beginning with an intake pond, where Bay water is taken into the salt pond system and salinity matches that of the Bay, brine (hypersaline water) is moved through evaporator ponds until saturated with sodium chloride. The brine, or pickle, is then moved to the final pond, called the pickle pond. The portion of the salt pond system where the salt is harvested include—in order of their stage in the salt production cycle—pickle ponds (which are used for storage),

crystallizers (where the salt precipitates on leveled and packed beds and is harvested using heavy equipment), bittern desalting ponds (where residual brine solution discharged from crystallizers prior to harvest is sent for removal of additional salt), bittern storage ponds (where bittern is stored prior to sale for dust suppressant and de-icing products or mixed with Bay water and sent back to crystallizers for harvest), and wash ponds (which receive Bay water that has been used to wash impurities from the crystallized salt).

g. For foraging waterbirds, the depth of a salt pond affects access to prey. In addition, the level of salinity in salt ponds affects the use of such areas by plants and animals. Species found in low-salinity salt ponds are similar to those found in the Bay and include plants, such as sea lettuce (a macroalgae); invertebrates, such as crabs; fish, such as bay pipefish; and waterbirds, such as American White pelicans, California least terns and numerous wintering waterfowl. Medium-salinity ponds are dominated by green algae, fed upon by brine shrimp and brine flies that are food for waterbirds, such as Northern Shovelers and avocets. In high-salinity salt ponds, no fish are able to survive, but abundant brine shrimp and brine flies support numerous waterbirds, including grebes, gulls, sandpipers and phalaropes. Ponds with extremely high salinity support very little aquatic life and, consequently, if used by birds are primarily used for roosting, not foraging. In addition, dry areas and levees and internal islands can provide breeding habitat for birds such as the Western snowy plover and American Avocet.

h. Salt ponds no longer needed for salt production offer a significant opportunity for the restoration of large areas of the former Bay to tidal action. Increased tidal influence associated with the removal or breaching of salt pond levees can: (1) support the establishment of new subtidal, tidal flat and tidal marsh habitat; (2) benefit Bay water quality; (3) improve the health of the Bay's aquatic food web by re-connecting existing subtidal areas to tidal marsh habitat, where much of the Bay's nutrient-rich plant life is located; and (4) increase resting, foraging and breeding opportunities for numerous fish, other aquatic organisms and wildlife species dependent upon subtidal, tidal flat and tidal marsh habitats (e.g., the Alameda song sparrow and salt marsh harvest mouse). In some cases, if salt ponds are opened to the Bay, new levees may have to be built on the landward side of the ponds to provide the flood control protection now being provided by the salt pond levees.

i. Maintaining some salt ponds no longer needed for salt production as managed pond habitat can benefit resident and migratory shorebirds and waterfowl by providing for a range of resting, foraging and breeding needs.

j. Salt ponds no longer needed for salt production offer an opportunity to increase public access to the Bay and shoreline in conjunction with restoration, enhancement or conversion of ponds to aquatic or wetland habitat.

Policies

1. The use and maintenance of salt ponds for salt production should be encouraged. Accordingly, property tax policy should assure that rising property taxes do not force conversion of the ponds and other wetlands to urban development. In addition, maintaining the integrity of the salt production system should be encouraged (i.e., public agencies should not take for other projects any pond or portion of a pond that is a vital part of the production system).

2. If the owner of any salt ponds withdraws any of the ponds from their present use~~s~~, the public should make every effort to buy these lands and restore, enhance or convert these areas to subtidal or wetland habitat. This type of purchase should have a high priority for any public funds available, because opening ponds to the Bay represents a substantial opportunity to enlarge the Bay and restoring, enhancing or converting ponds can benefit fish, other aquatic organisms and wildlife, and can increase public access to the Bay.

3. Any project for the restoration, enhancement or conversion of salt ponds to subtidal or wetland habitat should include clear and specific long-term and short-term biological and physical goals, success criteria, a monitoring program, and provisions for long-term maintenance and management needs. Design and evaluation of the project should include an analysis of:

a. The anticipated habitat type that would result from pond conversion or restoration, and the predicted effects on the diversity, abundance and distribution of fish, other aquatic organisms and wildlife;

b. Potential fill activities, including the use of fill material such as sediments dredged from the Bay and rock, to assist restoration objectives;

c. Flood management measures;

d. Mosquito abatement measures;

e. Measures to control non-native species;

f. The protection of the services provided by existing public facilities and utilities such as power lines and rail lines;

g. Siting, design and management of public access to maximize public access and recreational opportunities while avoiding significant adverse effects on wildlife; and

h. Water quality protection measures that include management of highly saline discharges into the Bay; monitoring and management of mercury methylation and sediments with contaminants; managing the release of copper and nickel to the Bay; and the minimization of sustained low dissolved oxygen levels in managed ponds.

4. If the public does not acquire for habitat restoration, enhancement or creation purposes all the salt ponds proposed for withdrawal from their use in salt production, and if some of the ponds are proposed to be developed or used for purposes other than salt production, consideration of the development should be guided by the following criteria:

   a. Recognizing the potential for salt ponds to contribute to the moderation of the Bay Area climate, the alleviation of air pollution and the open space character of the Bay, and to maximize potential habitat values, development of any of the salt ponds should provide for retaining the maximum amount of water surface area consistent with the project. Water surface area retained can include a variety of subtidal and wetland habitat types including diked ponds managed for wildlife or restoration of ponds to tidal action;

   b. Development should provide the maximum public access to the Bay consistent with the project while avoiding significant adverse effects on wildlife; and

   c. An appropriate means of permanent dedication of some of the retained water surface area should be required as part of any development.

5. To determine where and how much water surface area should be retained and how much public access should be provided consistent with any development proposal in a salt pond(s), a comprehensive planning process should be undertaken as part of the development project that integrates with regional and local habitat restoration and management objectives and plans, and provides opportunities for collaboration among local, state and federal agencies, landowners, other private interests, and the public. In addition, the planning process should incorporate:

   a. A baseline scientific assessment of existing and historical natural conditions and resource values of the pond(s);

   b. Natural resource conservation objectives that will protect and enhance onsite and adjacent habitat and species diversity;

   c. Provisions for public access and recreational opportunities appropriate to the land's use, size and existing and future habitat values; and

   d. Flood and mosquito management measures.

CONCLUSIONS AND RECOMMENDATIONS

Commercial solar salt production has been occurring for over 150 years in San Francisco Bay. The San Francisco Bay Conservation and Development Commission (Commission) has had enforceable policies pertaining to salt ponds in effect since 1970 when the California Legislature amended the McAteer-Petris Act and designated the Commission as the agency responsible for maintaining and carrying out the provisions of the McAteer-Petris Act and the *San Francisco Bay Plan* (Bay Plan), including regarding salt ponds. Minor revisions to the Bay Plan salt ponds findings and policies were approved in 1985, pertaining to commercial fishing opportunities.

The current Bay Plan findings and policies on salt ponds were developed nearly forty years ago when most of the ponds were in private ownership. The current findings and policies highlight the environmental values of the ponds, support continued use of the ponds for salt making and call for government acquisition of any ponds no longer needed for salt production. Since the inception of the Bay Plan salt pond findings and policies, there have been major changes in salt pond ownership and use, including the transfer of a vast acreage of salt ponds to public ownership for restoration and management for wildlife habitat. Also, there continue to exist some privately owned parcels that may no longer be needed for salt production purposes in the future.

In addition to changes in ownership since the creation of the salt ponds findings and policies, there has also been a significant increase in information on the habitat values of salt ponds, specifically on the range of unique habitats provided by salt ponds for a variety of plant and animal species and the particular importance of salt ponds for waterbirds. Furthermore, there is an ever increasing understanding of the specific opportunities and challenges of undertaking projects that either restore salt ponds to tidal habitat or retain ponds that are managed specifically for wildlife habitat.

Finally, the Bay Plan salt pond findings and policies are currently in a section that also includes findings and policies on managed wetlands (defined in part in the McAteer-Petris Act Section 66610 as "consisting of all areas which have been diked off from the bay and have been maintained…as a duck hunting preserve, game refuge or for agriculture"). Though there are some similarities between salt ponds and managed wetlands and some resulting similar policy considerations, revision of the Bay Plan section provides an opportunity to separate salt ponds and managed wetlands and develop individual findings and policies that better address the unique nature, use and status of salt ponds.

Accordingly, in its adopted 2003-2004 work program, the Commission included review of a staff background report and proposed revisions to the Bay Plan salt pond findings and policies. Consistent with this direction from the Commission, the staff applied for and secured a federal grant with the National Oceanic and Atmospheric Administration to carry out this work.

The following provides overall conclusions based on information presented in this background report, and offers general recommendations for improvements to the Commission's Bay Plan salt pond findings and policies where appropriate.

Conclusions

Salt Production in the San Francisco Bay Area. Natural salt ponds once existed along the Alameda shoreline in the vicinity of San Lorenzo Creek and Mount Eden Slough. Beginning in the 1850s, natural salt-crystallizing ponds, along with significant acreages of tidal marsh and tidal flat habitat, were converted in the northern and southern portions of San Francisco Bay for the commercial production of salt. San Francisco Bay possesses a variety of natural and economic features necessary for a viable solar salt production industry. These features include regional markets for salt, adequate land for solar evaporation of salty water, a climate absent of rain for most of the year and strong prevailing summer winds to aid evaporation.

The Bay's solar salt operation system has remained much the same over time, recovering salt from Bay water by moving brines through a series of evaporation ponds until salt is harvested at a plant site. Over time, the basic technique has been refined and improved to increase production efficiency and product quality.

Changes in Salt Pond Ownership. A shift in market demand from raw salt to refined salt, thereby reducing the total volume of salt sold, and an ability to produce salt more efficiently has resulted in a reduction in the amount of land needed to produce salt in the Bay Area. Since the 1970s, over 36,000 acres of salt ponds have been transferred to public ownership to be restored or managed as diked pond habitat. Most recently, in 2003, 16,500 acres of salt ponds (and adjacent tidal habitats) were purchased by the public, a monumental acquisition made possible by a consortium of government officials and private organizations. Currently, Cargill retains salt-making capacity on approximately 12,400 acres in the South Bay, of which Cargill owns only 4,500 acres outright. Of the 4,500 privately owned acres, 3,000 are in the east Bay and are known as the Newark Plant Site, and 1,400 acres are located in Redwood City and are known as the Redwood City Plant Site. The remaining 8,000 acres are owned by the United States Fish and Wildlife Service as part of the Don Edwards National Wildlife Refuge and are adjacent to the Newark Plant Site.

Values of Salt Ponds. Salt ponds provide a variety of aesthetic, economic and biological values. These values include the provision of salt to the marketplace, moderation of the Bay Area's climate, habitat for numerous shorebirds and waterfowl, open space values including recreation and public access opportunities, protection of adjacent low-lying areas from tidal flooding, and opportunities for habitat enhancement and restoration.

The range of salinities and pond depths found throughout the salt pond system provide a multiplicity of habitat types for micro-organisms, which in turn provide food for a variety of bird species. Salt ponds hold a significant value for shorebirds and waterfowl. For example, the salt ponds provide shallow and deep-water foraging habitat, while the levees surrounding the salt ponds and the islands within the salt ponds provide nesting and roosting (resting) habitat. Each year the Bay's salt ponds are used by hundreds of thousands of waterbirds, representing over 100 species. Ponds of extremely high salinities, such as crystallizers, support virtually no aquatic life and are harvested using heavy equipment, and therefore if used birds are used for roosting only.

Restoration Potential of Salt Ponds. Salt ponds no longer needed for salt production provide a significant opportunity to restore former areas of the Bay to various subtidal or wetland habitat types, or to maintain as ponds managed for wildlife.

In undertaking restoration of salt ponds to tidal habitat or retention and management of ponds as habitat for waterbirds, due to the scale and complexity of the endeavor, a number of issues need to be considered to ensure that the goals and objectives of a project are met without causing harm to the Bay or causing significant negative impacts such as flooding.

Determining which ponds should be restored to tidal action and which should be enhanced as managed ponds is a critical aspect of restoration planning as different kinds of species are dependent upon different kinds of habitats. The composition of the habitats restored and enhanced will directly affect the diversity, abundance and distribution of fish, other aquatic organisms and wildlife, and requires analysis on a regional scale.

Further, the restoration of a salt pond to tidal marsh depends on the ability of tidal marsh plants to colonize ponds open to the tide. Some of the salt ponds in the Bay are significantly subsided and improving a pond's tidal marsh restoration success rate entails an adequate supply of sediment to raise the elevation of the pond to a level where vegetation can grow. Similarly, the use of fill for restoration may need to be considered as an aid for rapid creation of high tidal marsh and upland transitional habitat.

Further, the levees associated with the salt pond operating system were not constructed to meet modern flood control engineering requirements nor are they maintained to provide flood protection for adjacent communities. However, salt pond levees act as de-facto flood control protection for the subsided Santa Clara Valley and other parts of the highly urbanized South Bay. Therefore, flood management will need to be addressed as part of the restoration of salt ponds, particularly in the South Bay.

Control of non-native species is another potential issue for salt pond restoration projects. Of particular concern for tidal restoration projects is the non-native smooth cordgrass, *Spartina alterniflora* that hybridizes with the native cordgrass and colonizes tidal mudflats, marsh pans, and small tidal creeks and ditches.

In addition, a number of water quality considerations exist in the planning process for the restoration of salt ponds. For example, of particular concern is the effect the restoration of salt ponds to tidal habitat

may have on the creation of methylmercury, an organic form of mercury. Although there are significant gaps in knowledge regarding mercury methylation and export of mercury to the Bay, there is the potential for the restored salt ponds to transform mercury into methylmercury. Additional water quality issues include managing discharge of hypersaline water into the Bay, as well as copper and nickel, and managing dissolved oxygen levels in managed ponds. Additionally, while the salt ponds used for salt production do not foster large mosquito populations, changes in water management regimes associated with habitat restoration may lead to a substantial increase if managed improperly.

Finally, salt pond restoration projects provide an opportunity for recreation and public access opportunities, including achieving important Bay Trail connections, increasing recreational boating opportunities, and providing educational and interpretive experiences. Maximizing the opportunities for recreation and public access need to be balanced with avoiding adverse effects on wildlife.

Commission Salt Pond Jurisdiction and Authority. McAteer-Petris Act Section 66610(c) defines the Commission's "salt pond" jurisdiction as "…all areas which have been diked off from the bay and have been maintained during the three years immediately preceding…1969…for the solar evaporation of bay water in the course of salt production." The Commission has the authority to require permits for: (1) the placement of fill in salt ponds; (2) the extraction of materials associated with salt production; and (3) substantial changes in use of salt ponds. In addition, McAteer-Petris Act Section 66610(c) defines the Commission's "salt pond" jurisdiction in such a way that the jurisdiction is retained even if an area is no longer used for salt production. In other words, once an area is defined as a salt pond, it remains within the Commission's "salt pond" jurisdiction, even if developed or opened to the Bay. The Bay Plan findings and policies on salt ponds therefore guide the regulation of different uses of salt ponds including: (1) salt ponds used for salt production; (2) salt ponds restored to tidal action or enhanced and managed for habitat; and (3) salt ponds proposed for development.

Alternate Uses of Privately Owned Salt Ponds. McAteer-Petris Act Section 66602.1 details the Commission's objectives regarding salt ponds in both their continued use in salt production and their possible change in use out of salt production. These objectives include: (1) recognizing the many values provided by retaining salt ponds in salt production; (2) seeking public purchase of areas proposed for development in order to preserve open water areas; and (3) providing tests which must be met if development is to occur in former salt ponds, including providing "maximum" public access and retaining "maximum" water surface area consistent with the proposed project.

Approximately 4,400 acres of salt ponds in salt production are owned in fee title by Cargill in San Francisco Bay. The Redwood City Plant Site consists of approximately 1,400 acres, while the Newark Plant Site consists of approximately 3,000 acres. It is possible that at some future point all or portions of these properties will be deemed surplus to the salt production system and the owner will pursue other uses for the properties.

A comprehensive planning process would be beneficial in helping to determine where and how much water surface area should be retained and where and how much public access should be provided as part of a proposal for development of a salt pond. Key elements of a successful planning process designed to maximize both the development potential and the natural resource values of the Bay include: a scientific assessment of the area; the establishment of goals and objectives for maximizing public access opportunities and resource values that are integrated with local and regional goals, and; collaboration with all interested parties, including local, state and federal agencies, land owners and the public.

General Recommendations

Based on the above conclusions, the staff has the following general recommendations:

1. The Bay Plan "salt pond and other managed wetlands" findings and policies should be split into two separate sections, one for salt ponds and one for managed wetlands. Accordingly, any reference to "managed wetlands" should be deleted and moved to a new section of the Bay Plan.
2. The Bay Plan salt pond policies should support ongoing salt production in San Francisco Bay by recognizing the values to the Bay provided by salt production.
3. The Bay Plan salt pond policies should be expanded to better describe salt ponds as a significant and regionally important habitat type in San Francisco Bay.

4. The Bay Plan salt pond policies should acknowledge the vast acreages of salt ponds transferred to public ownership and should continue to support the public acquisition and restoration or management for wildlife habitat of salt ponds no longer needed for salt production.
5. The Bay Plan salt pond findings and policies should be revised to acknowledge the opportunities for restoration of salt ponds to tidal habitat or management of ponds specifically for habitat and outline the major issues that should be considered in any restoration or enhancement proposal.
6. The Bay Plan salt ponds findings and policies should be updated to address in more detail the potential for alternate uses of privately owned salt ponds. Specifically, the existing policies should be revised to: bring the policies into consistency with language in the McAteer-Petris Act; expand existing policy language to allow for more flexibility in retaining benefits associated with salt ponds; delete language that is no longer applicable, confusing or is better covered elsewhere in the policies, and; update existing language to conform with the Commission's present practices and terminology. In addition, language should be added that describes the logical elements of a comprehensive planning process to guide the development of any salt pond.
7. The Bay Plan Maps and Plan Map Notes, Suggestions and Policies should be revised to reflect changes in ownership and to correct any errors regarding salt ponds.

CHAPTER 1

SOLAR SALT PRODUCTION AND LAND USE CHANGES IN SAN FRANCISCO BAY

The commercial production of salt in San Francisco Bay over the past 150 years has relied on unique economic and natural conditions. In particular, the solar evaporation of seawater to produce salt has occurred in the United States in only two locations—San Diego Bay and San Francisco Bay. The features necessary for a viable solar salt production industry include adequate land for solar evaporation, a source of salt water, a climate featuring wind, warm temperatures and low rainfall resulting in net evaporation, and of course, a market for salt. This chapter provides background information on: (1) the history of salt production in San Francisco Bay; (2) how salt is produced and salt markets; (3) changes in ownership of salt ponds; and (4) current salt production in the San Francisco Bay.

History of San Francisco Bay Solar Salt Production.[1] The vast tidal marshes that abutted the Bay included natural salt pans, where the sun and the prevailing northwesterly summer winds evaporated trapped bay water. Tidal waters would inundate these shallow impoundments or low spots only infrequently, usually at only the highest tidal ranges. When the tide receded, salty water would be trapped until the next high tide, often occurring some months into the future. The sun would evaporate the trapped water leaving behind mushy or solid salt deposits atop soft muds.

Prior to 1850, such natural salt ponds existed along the Alameda shoreline in the vicinity of San Lorenzo Creek and Mount Eden Slough. These natural salt ponds consisted of "large, shallow, hypersaline impoundments or depressions in tidal salt marsh systems which undergo a sequence of infrequent flooding with saline or brackish Bay water, evaporative concentration, and formation of strong hypersaline brines and deposits of gypsum, calcium carbonate, and crystalline salt."[2] The best known natural salt pond was the Crystal Pond complex, which was formed by a wave-constructed beach ridge. Comprising nearly 1,000 acres, the Crystal Pond complex was physically and ecologically similar to modern commercial salt ponds.[3]

The salt that collected in these natural salt ponds was harvested by Native Americans, Spaniards and Mexicans, but was of a poor quality and an uncertain quantity from season to season. However, small quantities of natural salt were brought to market beginning in the 1850s. At this time, most of the demand for salt in California was met largely through imports from Baja California, Peru, Asia and England.

Captain John Johnson, a San Francisco dockworker, is credited as the first person to increase the capacity and yield of salt from the natural salt ponds along the Alameda County shore by expanding and improving them with levees in 1854. The first commercial salt crop reportedly sold for $50 a ton, a price that stimulated other entrepreneurs to follow Johnson's example by diking tidal marsh and adjacent uplands and entering the salt production business. Today, no natural salt-crystallizing ponds remain in San Francisco Bay, although smaller saltpans and marsh ponds containing weak brine (hypersaline water) in summer and fall do occur.[4]

Salt production soon exceeded demand and prices fell to $2 a ton. But the discovery of the Comstock Lode in Nevada created a huge new market for salt, to be used in the process of treating silver ores. By 1862, salt from San Francisco Bay was selling in Virginia City, Nevada, for $150 a ton. Although discoveries of salt deposits in Nevada soon reduced the Comstock's reliance on salt from San Francisco Bay, metallurgy remained an important market for the Bay's salt throughout the nineteenth century.

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[1] Unless otherwise noted, this section is adapted from:
Ver Planck, William E. 1968. *Salt in California*. Bulletin 175. State of California Division of Mines. San Francisco.

[2] Baye, Peter R. *Plants of the San Francisco Bay Salt Ponds*. Goals Project. 2000. Baylands Ecosystem Species and Community Profiles: Life histories and environmental requirements of key plants, fish and wildlife. Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. P.R. Olofson, editor. San Francisco Bay Regional Water Quality Control Board, Oakland, Calif..

[3] Goals Project. 1999. Baylands Ecosystem Habitat Goals. A report of habitat recommendations prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. U.S. Environmental Protection Agency, San Francisco, Calif./S.F. Bay Regional Water Quality Control Board, Oakland, Calif.

[4] Baye. Goals Project, 2000.

The Bay's early salt plants were predominantly small, family enterprises, some as little as 20 acres and worked by a single person. Very early, these pioneer salt producers developed the method that is followed in principle today (described in greater detail in the following section). By the late 1860s, some producers were moving brines through a series of ponds producing salt that was 99.63 percent sodium chloride. The construction of crystallizers, ponds constructed specifically for the crystallization and harvest of salt, resulted in a marked quality increase and was a turning point for Bay salt producers. The high quality of the salt produced in San Francisco Bay and the increase in production soon led to a decline in salt imports. By 1880, crude salt from 17 different salt works in the Bay Area was being exported to Mexico, South America and Asia.

The early salt industry in San Francisco Bay suffered from chronic overproduction, a key factor leading to efforts to consolidate the various salt making operations around the Bay and stabilize prices. The first such effort took place in 1885 when the Union Pacific Salt Company agreed to lease other salt plants on San Francisco Bay. Although a number of smaller plants did not join in this agreement, Union Pacific succeeded in controlling most of the Bay's salt production until the late 1890s. In 1900, the Federal Salt Company succeeded in controlling the entire San Francisco Bay salt crop, but this monopoly lasted only until 1902.

Not until the Leslie Salt Company (Leslie) was formed in 1936, by the union of the Arden Salt Company and the Leslie-California Salt Company, was most of the Bay Area's salt production system consolidated under one owner. Moving forward, the Leslie Salt Company continued its consolidation efforts eventually becoming the sole producer of solar salt in the region. During this same period, Leslie Salt Company began production in the North Bay. Salt production in the North Bay did not begin to any appreciable degree until the 1950s, when Leslie established its Napa Plant on the eastern and western shores of the Napa River adjacent to San Pablo Bay. Salt ponds in Napa were converted to salt production from agricultural lands first reclaimed in the late 1800s and early 1900s.

To give a sense of the scope of production by Leslie Salt Company throughout consolidation, between 300,000 and 325,000 tons of salt were produced in 1936 over roughly 12,500 acres. By 1946, approximately 500,000 tons were harvested using a total of 25,000 acres, which increased to 750,000 tons four years later.[5] In 1959, production was up to one million tons with salt production encompassing roughly 30,000 acres in the South Bay and over 11,000 acres in the North Bay.

In 1978 the Leslie Salt Company's entire property in the North and South Bays, consisting of approximately 41,500 acres, was acquired by Cargill, Incorporated (Cargill or Cargill Salt). Cargill is a privately held, international provider of food, agricultural and risk management products and services that employs 101,000 people in 60 countries.[6] Cargill Salt currently employs more than 200 people in salt production in the Bay Area.[7] Cargill Salt operates vacuum-evaporated salt production facilities[8] in New York, Ohio, Michigan, Kansas, Louisiana and California. Rock salt mines are operated by Cargill in New York, Ohio and Louisiana, while solar evaporation facilities are owned in Oklahoma, Utah, San Francisco Bay, Venezuela and the Netherlands Antilles. In addition, Cargill Salt has numerous salt terminals and storage facilities located throughout the United States. Cargill is currently the sole producer of solar salt in the Bay Area.

Solar Salt Production Process. Sodium chloride, the substance commonly referred to as salt, is the principal mineral found in ocean water, and consequently San Francisco Bay water. Other salts such as magnesium chloride, magnesium sulfate and calcium sulfate are also present. In composition, ocean water is essentially 3.5 percent salt with nearly 77 percent of that salt being sodium chloride, or common salt. Bay water, due to freshwater inflow from surrounding tributaries, is less saline at approximately 2.0 to 3.0 percent salt.[9] Because magnesium salts have a bitter taste and both the magnesium and calcium salts tend

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[5] Siegel, S.W. and P.M. Bachand. 2002. Feasibility Analysis of South Bay Salt Pond Restoration, San Francisco Estuary, California. Wetlands and Water Resources, San Rafael, California. 228 pp.

[6] Ransom, Barbara. 2004. Personal interview with Environmental Manager of Cargill Salt.

[7] http://www.cargill.com/today/07_sustainable_envir.htm

[8] Vacuum evaporation is a process used by Cargill in San Francisco Bay and elsewhere to create the most refined salt for home use. (http://www.cargillsalt.com/sfbay/T_refine_home.html)

[9] Siegel and Bachand, 2002.

to attract water and stay wet,[10] the art of modern salt making involves keeping these minerals in solution (liquid phase) while sodium chloride precipitates (crystallizes and falls out of solution) into its pure white crystal form.[11]

In the solar evaporation salt production process, minor salts are removed and sodium chloride is produced by careful manipulation of increasingly concentrated brines through a series of evaporation ponds. Although the basic process for making salt has changed little from the early days of the Bay's salt industry, the technique has been refined and improved to increase production efficiency and product quality. Probably the first use of machinery in salt production was the use of windmill pumps to move brine between ponds. By 1916, gasoline and electric powered pumps began to replace the windmills. Machines were also developed for harvesting the salt from crystallizers, a task that prior to World War I had been accomplished by hand shoveling. The transport of salt from the crystallizers was also mechanized, with some of the larger salt plants employing tram cars on temporary tracks as early as 1880, although many of the smaller producers continued to use wheelbarrows into the 1920s. Contemporary movement of the brines in San Francisco Bay is controlled with the help of the tides, gravity and pumps, as well as other infrastructure such as pipelines between ponds and large trucks to transport salt from the crystallizers. In addition, each of the evaporator ponds is surrounded by levees made of Bay mud that hold the brines and separate the ponds from one another and the Bay. The compact, heavy clays of former tidal marsh and tidal flat soils form watertight pond bottoms and allow the pond system to function.[12] In the Bay, a dredge, the *Mallard II*, routinely scoops up mud from borrow ditches at the edges of the ponds to maintain the levees.

The Bay's solar salt operation is a system consisting of a series of evaporator ponds and other infrastructure which are represented as different stages in the salt production process, beginning with less saline ponds and ending at a "plant site" where the salt is harvested and refined. In terms of time, salt production takes three to five years from beginning to end and depends in large part on evaporation rates and rainfall variability. Ranges of salinities in the salt making system vary dependant on the time of year, weather patterns, types of water movements, operational demands and maintenance needs. However, the general process can be described as follows. The first stage of the salt production process consists of the intake pond, where Bay water is taken into the salt pond system in the dry months when Bay salinity is highest. Salinity within the intake pond matches that of the Bay at 2.5 percent salt or 25 parts per thousand (ppt). The next series of ponds are known as evaporator ponds. Each subsequent evaporation pond is more saline due to the closed nature of the system and natural evaporation. Within these ponds calcium carbonate and gypsum (calcium sulfate) may precipitate from the brine.

Brine remains in the evaporator ponds until it is close to being saturated with sodium chloride, at a salinity range in the mid to upper 200 ppt. Known as "pickle," because it is saturated with sodium chloride, the brine is moved within the plant site to the final pond for storage, called the pickle pond. Salinity in the pickle pond ranges from the high 200s ppt to low 300s ppt. The pickle pond, in turn, is the point of transfer for the highly concentrated pickle into the numerous crystallizers where sodium chloride precipitates from solution into the crystallized form of common salt. During harvest, the crystallizers are freshened with additional pickle to prevent the precipitation of bittern salts.[13] Salinity of the pickle in the crystallizers ranges from the high 200s ppt to low 300s ppt.

To facilitate the mechanical harvesting of salt, the crystallizers are leveled and packed to create flat, even bottoms.[14] Traditionally the salt harvest begins in the fall and concludes before the rainy season starts. During harvest the crystallizers are drained sequentially to minimize the time that each bed of salt is left uncovered. Residual brine solution transferred from the crystallizers prior to harvest, known as bittern and containing some residual sodium chloride as well as various other salts, is moved to bittern desalting ponds and then to storage ponds. Salinity in the bittern ponds can exceed 300 ppt.[15] Due to its potential toxicity bittern cannot be discharged into the Bay without prior approval from the San Francisco

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[10] State of California Division of Mines. 1958. *Salt in California*. Bulletin 175. By William E. Ver Planck. San Francisco.

[11] Cargill Salt, San Francisco Bay: The Outdoor Salt Plant. http://www.cargillsalt.com/sfbay/T_solar_evap.html

[12] Ver Planck, 1958.

[13] Magnesium sulfate, magnesium chloride, potassium chloride and magnesium bromide.

[14] Cargill Salt, San Francisco Bay: The Outdoor Salt Plant. http://www.cargillsalt.com/sfbay/T_solar_crystal.html

[15] Ransom, 2004.

Bay Regional Water Quality Control Board.[16] Instead, bittern is stored on-site, marketed as dust suppressant and de-icing products, or may be mixed with Bay water in the desalting ponds and sent back to the crystallizers for harvest, potentially leading to a reduction in bittern production and on-site storage.[17]

Prior to harvest, the exposed salt bed is five to eight inches deep. Harvesting entails the use of a mechanical harvester that breaks up the salt bed with a rotating "pickroll" and scrapes up the pieces with a blade that operates like a snowplow. Once on the harvester, conveyors lift the salt and place it into large trucks.[18] Immediately after harvesting, the salt is washed with saturated brine to remove any clay scraped up from the crystallizers. At this point the salt is 99.5 percent sodium chloride. More recently, a new approach to harvesting called "salt floor harvesting" has been adopted to increase efficiency. This approach entails leaving a few inches of salt on the crystallizer beds after harvest, thus eliminating the need to wash the crystallizers and the collected salt after harvest.[19] The washed salt is then dropped onto a massive conveyor that carries it to the top of a 90-foot-tall stack of salt. Exposed to weather, the salt stack forms a thin crust that sheds most rainwater.[20] In the early plants, salt received no washing except for that accomplished when the stacks of harvested salt were exposed to winter rains. Washing to remove traces of gypsum (calcium sulfate) and bittern began in the 1890's. Salt sold directly from the salt stack without refinement is known as raw or bulk salt.

Salt Refinement and Salt Markets. In the early 1970s, the five operating plant sites in the Bay Area were Redwood City, Baumberg, Newark #1 (largely north of the Dumbarton Bridge) and Newark #2 (largely south of the Dumbarton Bridge), Alviso and Napa.[21] In the late 1970s, the harvest of salt shifted to plant sites in Napa, Redwood City and Newark. In terms of production, the Napa Plant Site and the Redwood City Plant Site processed and distributed raw, bulk salt sold directly from the salt stack, while the Newark Plant Site focused on refined salt products, such as table salt. Changes in the business climate throughout the 1990s led to reduced demand for the bulk salt produced at the Napa and Redwood City Plant Sites.[22] Thus, Cargill determined that the "low-value business" in Redwood City supplying road salt should be shifted instead to high-value markets supplying refined salt for foods and pharmaceuticals.[23] As a result, the Redwood City Plant Site is now largely operated in support of the Newark Plant Site, across the Bay.

Refined salt is refined beyond the raw salt stage of 99.5 percent pure sodium chloride. For agricultural, industrial and water-conditioning uses, salt is refined in a manner known as the kiln-dried method.[24] Here the crude salt is taken from the salt stack, re-washed to remove dust, then dried in gas-fired-revolving kilns. Industrial uses of refined salt include the production of chemicals, such as chlorine and caustic soda, which in turn are used to produce plastics, glass, cleansers, adhesives, paints and pesticides.[25] For agricultural use, the kiln-dried salt is compacted by powerful hydraulic presses into various-sized livestock salt blocks.

The purest salt is marketed for human consumption and is 99.9 percent sodium chloride. This high-grade, high-value salt is refined through the vacuum evaporation process. In this process, tons of salt are first dissolved in tanks of pure drinking water to remove dust and traces of minerals that may have clung

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[16] The discharge of bittern and brines into Bay waters is regulated pursuant to the federal Clean Water Act and the state Porter-Cologne Water Quality Control Act.

[17] Siegel and Bachand, 2002.

[18] Historically, conveyers lifted the salt and placed into hopper cars that were pulled by diesel locomotives along temporary tracks laid on the floor of the crystallizer.

[19] Since the salt is harvested directly from a salt floor rather than scraped directly off of the clay of the crystallizers beds it is higher quality salt when it reaches the refining stage.

[20] Cargill Salt, San Francisco Bay: The Outdoor Salt Plant. http://www.cargillsalt.com/sfbay/T_solar_crystal.html & http://www.cargillsalt.com/sfbay/T_solar_harvest.html

[21] Siegel and Bachand, 2002.

[22] Douglass, Robert C. 2003. Letter from C.E. of Cargill to Andrea Gaut, Permit Analyst of San Francisco Bay Conservation and Development Commission. Westpoint Marina Project Permit File No. 2-02.

[23] Johnson, Lori. 2003. Personal Conversation with Cargill Salt Public Affairs Manager.

[24] Cargill Salt, San Francisco Bay: Salt Refinery. http://www.cargillsalt.com/sfbay/T_refine_ind.html

[25] Cargill Salt, San Francisco Bay: Industry. http://www.cargillsalt.com/sfbay/AAS_role_industry.html

to the salt crystals throughout the harvest. From the tanks, the brine is passed through vacuum evaporators that crystallize the salt. After the salt recrystallizes, it is dried, filtered and air-cooled. A series of vibrating screens allow Cargill to separate the crystals into various sizes for packaging.[26]

Overall, purified and refined Bay salt is marketed under multiple brands consisting of a myriad of salt products sold to retailers throughout the West Coast, including grocery stores.[27] These grades of salt include table salt, kosher salt, popcorn salt, pickling salt, canning salt, butter salt and rock salt. In particular, the California dairy industry relies upon salt produced in the Bay area for cheese production. The variety of salt blended into cheese is a highly refined microcrystalline salt. Each of these products is packaged and shipped via train or truck. Bulk salt may also be barged via ship. Whereas it may cost as much to ship a ton of bulk salt as it does to produce it, refined salt sold for food use may raise the value of a ton of salt from $25 to $600.[28]

Over time, there has been a shift from supplying low-value salt for road de-icing and chemical production toward high-value refined salt for food and pharmaceuticals; corresponding with a shift towards much smaller markets for San Francisco Bay solar salt. For example, in 2002 the chemical industry consumed 42 percent of total salt sales nationwide. Salt for highway de-icing accounted for 36 percent of U.S. demand. On the other hand, agricultural sales accounted for four percent, food use for three percent and water treatment for one percent of total salt sales.[29] Of tremendous importance was the chemical industry's demand for large volumes of salt to be used in the production of chlorine and sodium chlorate. When the chemical industry reduced the overall production of chlorine-related products, the need for large volumes of salt produced also declined substantially.[30] In addition, markets for road salt, in contrast to salt markets in general, are known to be unstable and to fluctuate widely.[31]

Other economic forces have also affected the economic viability of salt production in the Bay Area. These forces include the cost of electricity to refine salt and to pump brines throughout the solar salt system. For example, during the energy crisis in 2001 Cargill was charged 16 cents per kilowatt-hour in the Bay Area for electricity and only 2.9 cents per kilowatt-hour at its facilities in Utah.[32] In addition, the use of Cargill's property in the Bay Area is regulated by a number of parties in furtherance of state and federal laws regarding wetlands protection, water quality and endangered species recovery. Thus, the cost of producing solar salt in the Bay Area may be greater when compared to the cost of solar salt production at facilities owned in locations where environmental regulations may not be as comprehensive.[33] Further, the value of land in the Bay Area may be placing pressure on Cargill to sell its property, as other land uses may be more profitable than salt production.[34] For example, the price paid to Cargill for the recent sale of 16,500 acres to the state and federal government was $100 million. However, the appraised fair market value of the property was $243 million.[35]

Worth noting, however, is that Cargill's properties in the Bay Area are uniquely positioned to stay competitive and economically viable. For example, the market for high-value, refined salt used for food or pharmaceuticals grows in direct relationship to population. Thus, as the West Coast population continues to grow, so will the need for salt. In addition, it is unlikely that any other salt company would ever purchase property in the Bay Area to directly compete with Cargill, due to the high cost of

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[26] Cargill Salt, San Francisco Bay: Salt Refinery. http://www.cargillsalt.com/sfbay/T_refine_home.html

[27] Cargill Salt, San Francisco Bay: Salt, Salt, Salt. http://www.cargillsalt.com/sfbay/AAS_basics_kinds.html

[28] Werblow, Steve. 1999. Salt Harvest Sustains California Industry and Wildlife. *California Manufacturer; A Publication of the California Manufacturer's Association.*(February).

[29] Kostick, Dennis. 2002. United States Geological Survey, Mineral Commodities Summaries: Salt.

[30] Shamel, Roger. 2003. Personal interview with a chlor-alkali expert and member of the Consutling Resources Group; and Kostick. 2003 Personal interview with United States Geological Survey salt commodity specialist.

[31] Hanneman, Dick. 2004. Personal Interview with employee of the Salt Institute.

[32] Johnson, Lori. February 2002. Conservation Efforts at Salt Plant Free Up Electricity for Neighbors. *The Bay's Edge: A Cargill Salt Report*. vol. 13, no. 1.

[33] Kostick, 2002.

[34] Kostick, 2002.

[35] Johnson, Lori. July 2002. Historic Agreement Sets the Stage for the West's Largest Wetlands Restoration. *The Bay's Edge: A Cargill Salt Report*. vol. 13, no. 1.

waterfront property. Cargill's greatest potential competitor is located in Baja, Mexico, where a major salt-making operation produces about 20 percent of the total amount of salt produced by the United States salt industry, altogether.[36]

Reducing the Geographic Scope of the Salt Pond System. The reduction in the amount of land needed to produce salt in the Bay Area has occurred due to two primary forces acting in concert—a shift in market demand from raw salt to refined salt, thereby reducing the total volume of salt sold, and an ability to produce salt more efficiently. Therefore, the reduction in acres of salt production does not translate to a similar reduction in tons of harvested salt. Cargill's projected harvests for the next five years are approximately 500,000 to 550,000 tons.[37] Much of the impetus for Cargill to improve its salt production system came from the fact that its system was an amalgamation of properties from many historic salt producers that did not link coherently. Recently, plans were formulated to link the ponds in a more efficient manner to better utilize their capacity. In general, the two substantial engineering improvements are to: (1) move concentrated brine east from the Redwood City Plant to the Newark Plant for harvest and refining; and (2) transfer brine more efficiently within the system such that concentrated brine production remains at peek capacity.[38]

The increases in efficiency allow Cargill to improve the movement of brines throughout the system by analyzing brine salinity and assessing exactly where brines from each pond should be moved as the salt production cycle progresses. Such efficiency of movement was not possible in the past as the system was built in a manner that severely limited the movement between ponds. For example, pumps and new infrastructure on the Newark side of the trans-bay pipeline will enable brines of differing salinities from Redwood City to be directed to different parts of the salt pond system. Further, all ponds will be used to the greatest extent possible, minimizing recirculation and dilution of brines while speeding the movement of brines through the system. In addition, Cargill has developed techniques to recover more salt from bittern and has also adopted the more efficient "salt floor harvesting," described above, thereby increasing salt yields. While the geographic scope of the salt production system has changed, Cargill maintains that the general nature of the system and salt making has not. The larger and smaller systems contain evaporator ponds of increasing salinity in the same varying proportions and pond depths are still maintained in a manner that takes full advantage of evaporation.[39]

Changes In Salt Pond Ownership. The consolidated salt making system held by Leslie Salt consisted of salt making systems created by different owners at different times. As a result, much of the property needed considerable attention as the salt pond systems were never designed or engineered for the most efficient salt making. Moreover, Leslie had accumulated a system that could produce raw salt in excess of the foreseeable market demand in the western United States. For these reasons, changes to the consolidated salt making system have been undertaken, as described above. As a result, about 90 percent of the salt ponds in the Bay Area have come under public ownership since the 1970s.

In 1977 Congress created the Don Edwards San Francisco Bay National Wildlife Refuge with the federal government acquisition of approximately 12,000 acres of South Bay salt ponds. While fee title to this property transferred to the federal government, Leslie Salt retained the perpetual right to make salt on the vast majority of the property. The U.S. Fish and Wildlife Service (USFWS) took management responsibility for the Refuge while Leslie continued to manage the property for salt making purposes. In 1979 the USFWS signed an agreement with Leslie (now owned by Cargill) setting out the parties' mutual responsibilities over the property within the Refuge but operated by Leslie. The agreement sets out in detail Leslie's (now Cargill's) right to continue to operate the property for salt making in perpetuity.[40]

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[36] Hanneman, 2004.

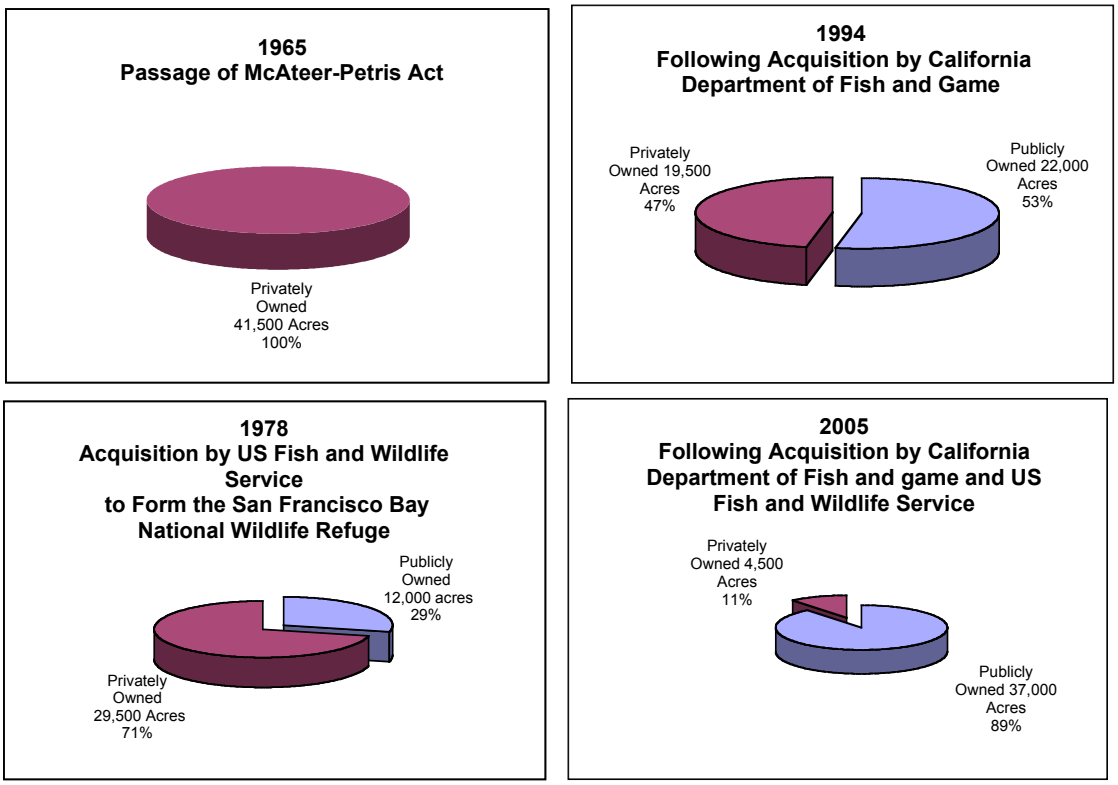
[37] Johnson, Lori. October 2000. Cargill Redesigns its Bay Area Salt Operations. *The Bay's Edge: A Cargill Salt Report*. vol. 11, no.1.

[38] Douglass, Robert. 2004. Personal interview with Real Property Manager of Cargill Salt.

[39] Ransom, Barbara. 2005. Personal communication with Environmental Manager of Cargill Salt.

[40] Siegel and Bachand, 2002.

Figure 1.
Ownership of Salt Ponds Over Time



In 1994, 9,850 acres of salt ponds located on the western shore of the Napa River were acquired by the California Department of Fish and Game (Fish and Game) from Cargill and included as part of the Napa-Sonoma Marshes Wildlife Area, Napa River Unit. Currently, the California Coastal Conservancy, the California Department of Fish and Game and the United States Army Corps of Engineers have prepared federal and state environmental documents outlining alternatives for the restoration of the ponds.[41] The Napa Plant Site on the eastern side of the Napa River, consisting of 1,400 acres, was retained by Cargill until 2003 as described below. In 1996, Cargill transferred another 850 acres to Fish and Game, located in the Baumberg area. The transaction involved the sale by Cargill of 814 acres with the donation of a second parcel encompassing roughly 40 acres. This property has become the Eden Landing Ecological Reserve.

The next pond to change ownership was Pond A4, consisting of 310 acres, in the Alviso area of San Jose. Pond A4 was purchased from Cargill by the Santa Clara Valley Water District in 2000 for future restoration and mitigation of impacts associated with the Lower Guadalupe River Flood Protection Project.[42]

The next public acquisition of salt ponds occurred in 2003 when 16,500 acres were purchased by the public, a monumental acquisition made possible by a consortium of government officials and private organizations. Ultimately the Federal government and the State of California, along with several notable charitable organizations, contributed $100 million to the sale.

In the South Bay, 15,100 acres of salt ponds (and some adjacent tidal habitats) in San Mateo, Santa Clara and Alameda Counties were acquired by the state and federal governments for restoration. Approximately 9,600 of the 15,100 acres in the South Bay were acquired by the United States as an

[41] http://www.napa-sonoma-marsh.org/overview.html

[42] Santa Clara Valley Water District. 2002. Final Environmental Impact Report for the Lower Guadalupe River Flood Protection Project.

addition to the Don Edwards San Francisco Bay National Wildlife Refuge. This acreage, located in Alameda, San Mateo and Santa Clara counties, is commonly referred to as the Alviso and Ravenswood evaporating ponds. The remaining 5,500 acres in the South Bay were acquired by the State of California for management by Fish and Game, known as the Eden Landing evaporating ponds in Alameda County. The Eden Landing ponds have been included in the Eden Landing Ecological Reserve. The Redwood City Plant site property was also offered to the public at this time, but the offer was declined due to the high cost of the property. In the North Bay, the 1,400 acre Napa Plant Site on the eastern side of the Napa River in Napa County was also acquired for management by the Fish and Game as part of the 2003 sale.[43] Of the total acreage purchased in the North and South Bays, 13,000 acres were conveyed in fee title while 3,500 acres consisted of Cargill's salt production rights. Comprehensive planning processes are underway for the restoration and enhancement of the North and South Bay salt ponds now in public ownership, described in more detail in Chapter Two.

Pond A18, also in Alviso, is currently under a contract for acquisition by the City of San Jose. The 856-acre evaporator pond provides the City of San Jose with a buffer between the San Jose/Santa Clara Water Pollution Control Plant and surrounding land uses, creates a land banking opportunity and provides the City the opportunity to participate in the salt pond restoration planning process being undertaken by the state and federal governments.[44]

Composition of the Current Salt Production System. Figures 2 and 3 show the current ownership of the San Francisco Bay salt ponds. Cargill currently retains salt-making capacity on approximately 12,500 acres in the South Bay. The 12,500 acres includes approximately 8,000 acres of evaporator ponds in the East Bay owned by the U.S. Fish and Wildlife Service and 4,400 acres owned outright by Cargill, a significant decline from the estimated 41,500 acres once owned by Leslie Salt Company. Of the 4,400 privately owned acres in salt production, 3,000 are in the East Bay and are known as the Newark Plant Site. The final 1,400 privately owned acres in salt production are located in Redwood City and are known as the Redwood City Plant Site. The 1,400-acre Redwood City Plant site was originally included in the 2003 proposed sale to the state and federal governments, but costs were prohibitive due to the development potential of the site. The Newark and Redwood City Plant Sites consist of pickle ponds, crystallizers, bittern desalting ponds, bittern storage ponds, and wash ponds. In addition, Cargill has retained Pond 3C (about 150 acres) in Eden Landing for alternative uses.

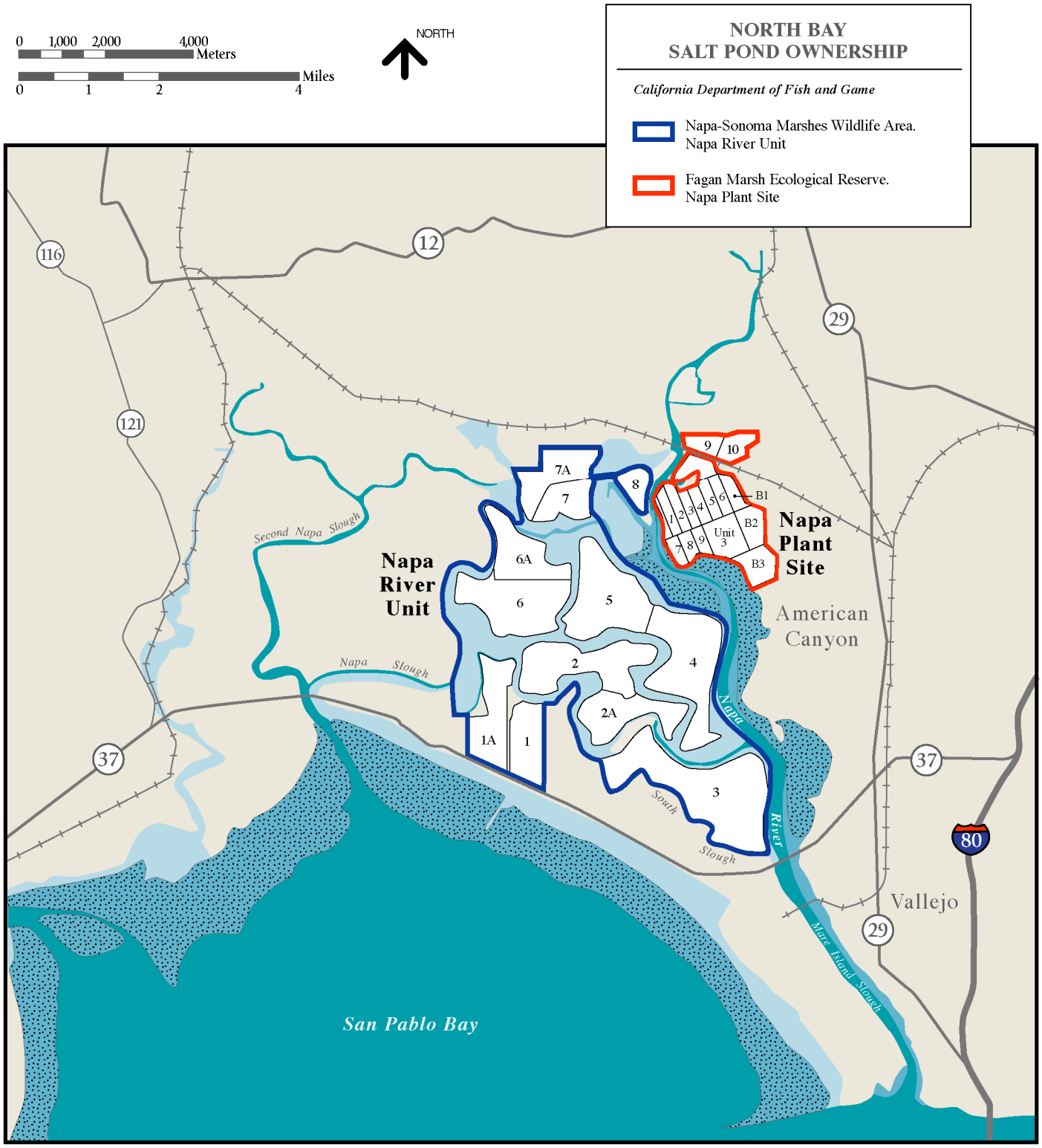
[43] Conveyance Agreement Summary. 2003. Cargill Salt Property, San Francisco Bay, California.

[44] City of San Jose. 2003. Memorandum for Council Agenda 5-2-03. To: Honorable Mayor and City Council. Regarding: Purchase Agreement with Cargill, Inc.

SOURCE: California Department of Fish and Game

Figure 2

Ownership of the North Bay Salt Ponds

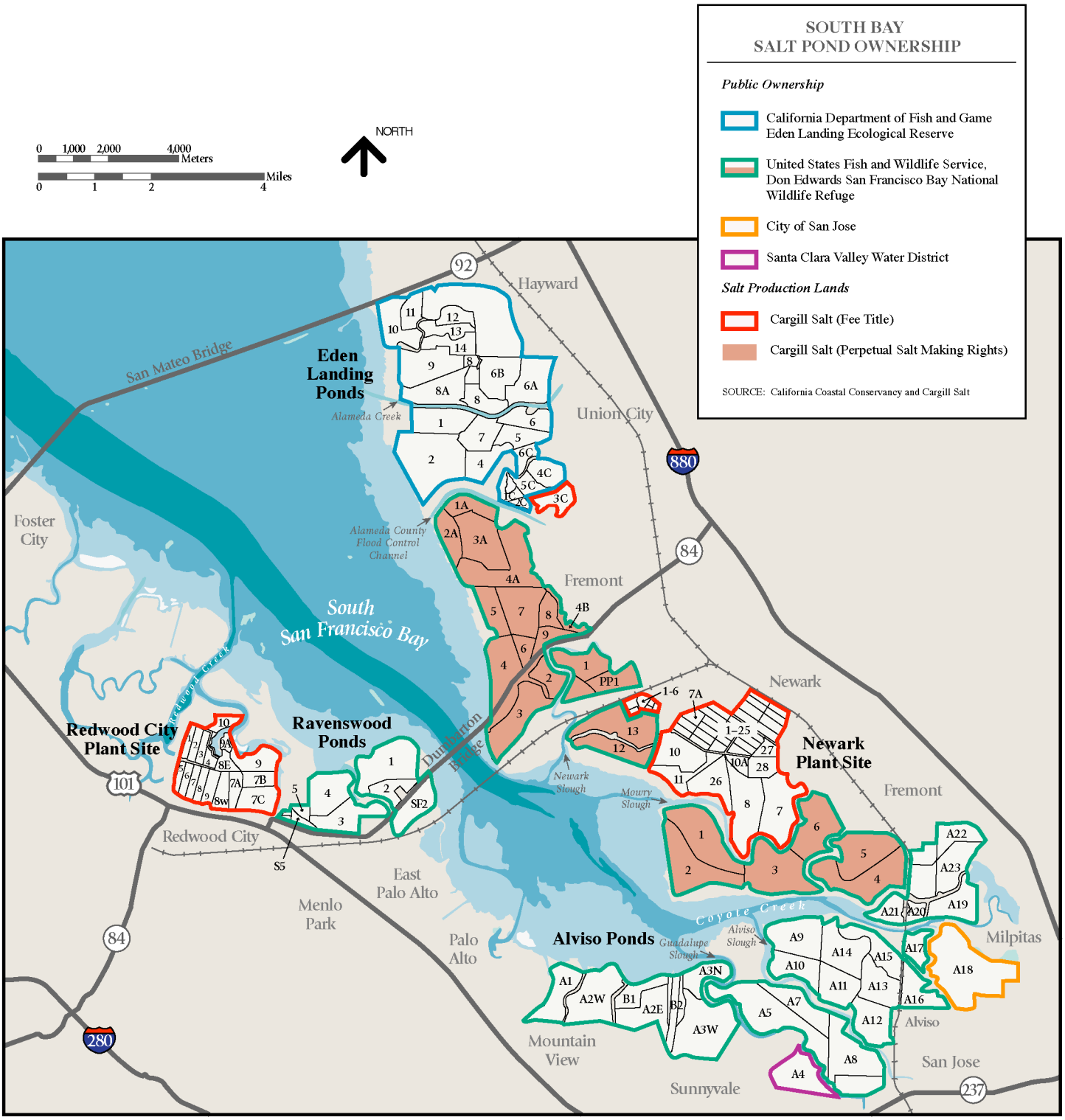


BACKSIDE

SOURCE: California Department of Fish and Game

Figure 3

Ownership of the South Bay Salt Ponds



BACKSIDE

CHAPTER 2

VALUES OF SALT PONDS

In addition to the provision of salt to the marketplace, salt ponds provide many other important amenities. Salt ponds provide open space values, such as visual respite from the highly urbanized Bay Area, and public access opportunities. Section 66602.1 of the McAteer-Petris Act describes salt ponds as important to the Bay Area because they "provide a wildlife habitat and a large water surface which, together with the surface of the bay, moderate the climate of the bay area and alleviate air pollution." Further, salt pond levees, though not constructed or maintained for flood purposes, help to provide needed tidal flood protection for low-lying areas of the South Bay. Salt ponds also provide an important habitat for shorebirds, waterfowl and other waterbirds, and provide opportunities for habitat enhancement and restoration by either removing levees and restoring the areas to historic tidal marsh and tidal flat habitat or by enhancing and managing them as ponds for shorebirds and waterfowl.

This chapter focuses primarily on the natural resource values of the salt ponds and explores their restoration and enhancement potential.

Changes in Historic Bay Habitats. Historically, tidal marsh habitat comprised nearly 190,000 acres in the San Francisco Bay region, including vast portions of the Suisun, San Pablo and San Francisco Bays. The arrival of European settlers brought about dramatic changes in the region, including impacts on habitat. Alteration of tidal marsh habitat took many forms, such as conversion through diking and filling for agriculture and development, as well as diking for salt production.[45] Figure 4 illustrates the extent of habitat alterations brought about by the diking of historic Bay habitats for salt production over the past 150 years.

In the South Bay, tidal marshes historically covered over 56,000 acres and in addition to extensive vegetated marsh plains, were also characterized by a band of shallow ponds (pans) along the backshore of the tidal marshes which "formed a nearly continuous string of shallow intertidal habitats" of which the natural salt ponds were part.[46] Further, the Santa Clara Valley, due to the water table being close to ground surface, had a number of persistent, non-tidal freshwater ponds and marshes adjacent to the edge of the Bay and its tidal marshes. Moist grasslands, vernal pools and large stands of willows were also found in the South Bay uplands and adjacent to tidal marshes. Salt production facilities in the South Bay accounted for almost half of the loss of tidal marshes in the South Bay.[47]

In the North Bay, salt ponds had replaced nearly one-fifth of the historic tidal marsh by the middle of the twentieth century.[48] This historic tidal marsh, which had been previously diked for agriculture and then used for salt production, was part of what was once one of the most extensive wetland systems in the San Francisco Bay Area—the Napa Marsh.[49] The Napa Marsh encompassed approximately 125 square miles. Historically, northern San Pablo Bay, into which Sonoma Creek, the Petaluma and Napa Rivers and the Sacramento-San Joaquin Delta drain, was bordered by extensive tidal marshes. Tidal marshes stretched upstream for several miles from the mouth of the Petaluma and Napa Rivers. Delta-like wetlands formed at the mouths of creeks along the Marin Bay front. Further inland, the low plains bordering the tidal marshes supported dispersed seasonal wetlands and were intersected by riparian habitat along the creeks.[50]

In addition to the direct loss of tidal marsh as a result of diking for salt production, the Bay's tidal prism (the volume of water that moves in and out of an area during a tidal cycle) has been greatly reduced. Though the results of the decrease in tidal prism are still not completely understood, studies in the South Bay show that due to the reduction in tidal volume (and therefore reduced tidal velocity), over time slough channels have been filled with sediment and are now much more narrow than they were

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[45] Goals Project, 1999.

[46] Goals Project, 1999.

[47] Goals Project, 1999.

[48] Goals Project, 1999.

[49] California Department of Fish and Game. 1977. *The Natural Resources of the Napa Marsh*.

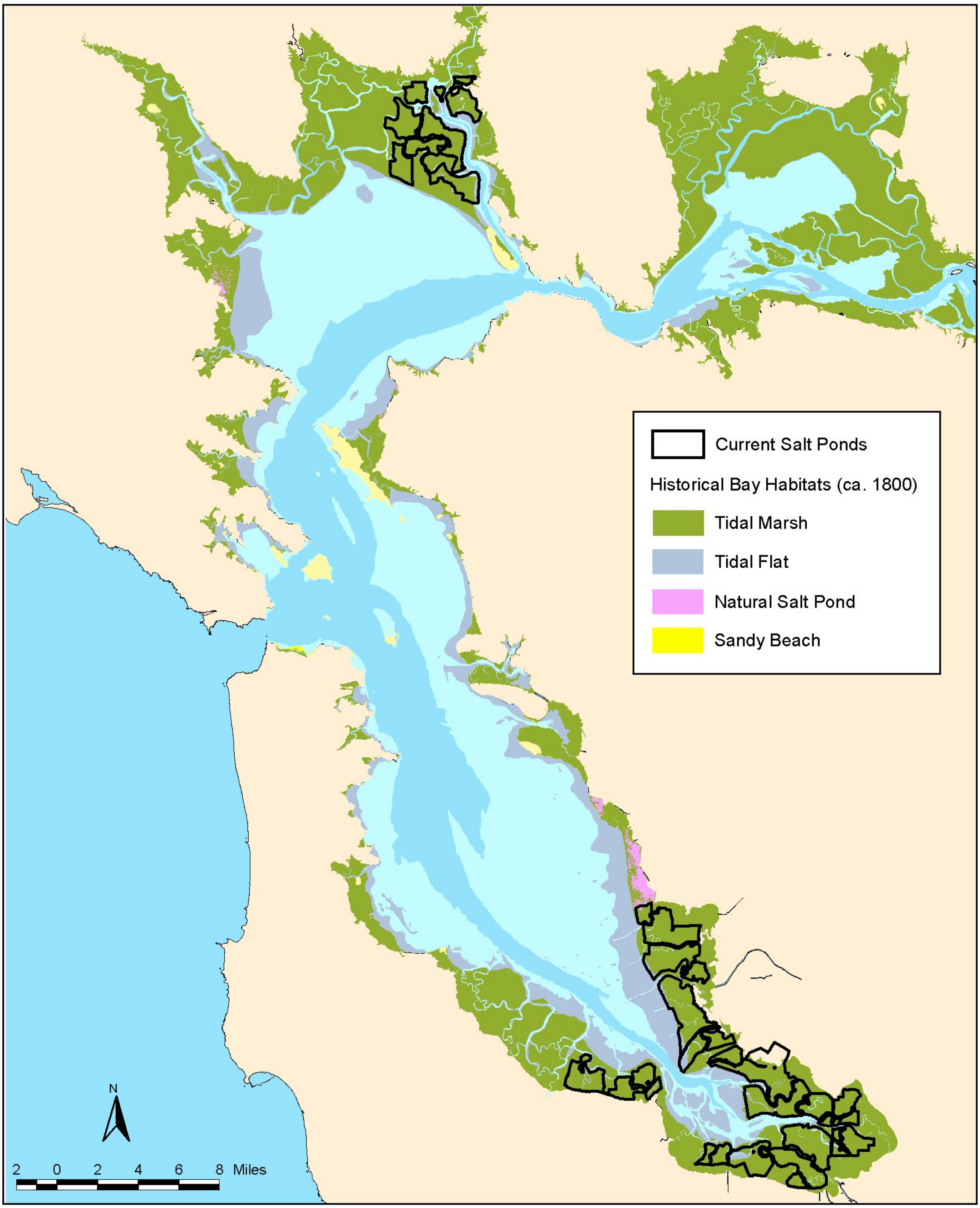
[50] San Francisco Bay Conservation and Development Commission. 1997. Revised Staff Report. *Wetlands in the North Bay Planning Area*.

historically. In addition, in some areas new narrow bands of tidal marsh have formed along the edges of the salt pond levees. These fairly young bands of tidal marsh have less plant species diversity and very little transitional habitat compared to the historic marshes, and therefore typically have lower habitat value.

Figure 4

SOURCE: Bay Area EcoAtlas, SFEI

Historical Habitat Alteration as a Result of Diking for Salt Production Over the Past 150 Years



Shorebird and Waterfowl Use of Salt Ponds. Though diking for salt production has resulting in the loss of historic tidal marsh in the San Francisco Bay, the salt ponds themselves are diverse and rich habitats and are of significance to shorebirds, waterfowl and other waterbirds such as gulls and terns.[51] The solar salt making process results in a wide range of salinities and depths of water (pond depth) throughout the salt pond system, providing many habitat types for micro-organisms. In turn, this diversity of micro-organisms supports a wide variety of bird species. A more detailed discussion of salt pond food webs associated with differing salinities and pond depths follows in the next section.

Salt ponds are particularly important habitat for resident and migrating shorebirds (Shorebirds are described as the "major group of birds that run, walk and wade along the water's edge").[52] San Francisco Bay has been recognized as a site of "hemispheric importance" for shorebirds by the Western Hemisphere Shorebird Reserve Network (WHSRN), the highest ranking distinction for a wetland included in the WHSRN, denoting that at least 500,000 shorebirds are known to use the site annually.[53] San Francisco Bay meets this standard by hosting over a million shorebirds annually during migration. This amount includes the largest population of wintering shorebirds along the Pacific Flyway.[54]

Within the Bay, salt ponds support shorebird populations by providing shallow and deep-water foraging (feeding) habitat. In addition, the levees surrounding the salt ponds and the islands within the salt ponds provide nesting and roosting (resting) habitat for many shorebird species.[55] In particular, about 10 percent of the Pacific Coast population of the Western snowy plover, which is listed as federally threatened under the Endangered Species Act, has been recorded breeding in the South Bay salt ponds.[56] Interestingly, the Western snowy plover, which nests on dried ponds, islands within ponds and levees, probably did not breed in the South Bay prior to the late 1800s when salt production began in earnest throughout the Bay. The American Avocet and the Black-necked Stilt also did not breed in the San Francisco Bay before the creation of salt ponds.

As an example of the large numbers of shorebirds that utilize the salt ponds, one study found that during peak migration more than 200,000 shorebirds may be found in a single salt evaporation pond.[57] Table 1 outlines many of the shorebird species that utilize the salt ponds of San Francisco Bay and for what purpose.

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[51] Takekawa et al, 2000. *Waterfowl and Shorebirds of the San Francisco Estuary*. Goals Project. 2000. Baylands Ecosystem Species and Community Profiles: Life Histories and environmental requirements of key plants, fish and wildlife. Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. P.R. Olofson, editor. San Francisco Bay Regional Water Quality Control Board, Oakland, Calif.

[52] Paulson, Dennis. 1993. *Shorebirds of the Pacific Northwest*. University of Washington Press. Seattle Audubon Society.

[53] Harrington, Brian and Edward Perry. 1995. *Important Shorebird Staging Sites Meeting Western Hemisphere Shorebird Reserve Network Criteria in the United States*. United States Department of the Interior, Fish and Wildlife Service.

[54] Page, Gary W., Lynne E. Stenzel and Janet E. Kjelmyr. 1999. Overview of Shorebird Abundance and Distribution in Wetlands of the Pacific Coast of the Contiguous United States. *The Condor* 101:461-471.

[55] Rintoul, Chris, Nils Warnock and Gary W. Page. 2003. Breeding Status and Habitat use of Black-Necked Stilts and American Avocets in South San Francisco Bay. *Western Birds* 34:2-14.

[56] Takekawa et al. Goals Project, 2000.

[57] Stenzel, Lynne E., Catherine M. Hickey, Janet E. Kjelmyr, and Gary W. Page. 2002. Abundance and Distribution of Shorebirds in the San Francisco Bay. Western Birds 33:69-98.

Table 1
Shorebird Use of San Francisco Bay Salt Ponds[58]

Feeding & Roosting	Mainly Roosting	Resident Breeders
Willet	Marbled Godwit	Black-necked Stilt
Greater Yellowlegs	Long-billed Curlew	American Avocet
Western Sandpiper	Whimbrel	Killdeer
Least Sandpiper	Long-billed Dowitcher	Snowy Plover
Dunlin	Short-billed Dowitcher	
Semipalmated Plover	Red Knot	
Wilson's Phalarope	Black-bellied Plover	
Red-Necked Phalarope		

The term "waterfowl" is used to describe ducks, swans and geese. Ducks as a category can be further broken down into dabbling ducks, which feed at the surface of the water or to the depth of their body lengths, and diving ducks, which forage for food underwater.[59] San Francisco Bay is one of 34 waterfowl habitat areas of major concern as defined by the North American Waterfowl Management Plan, due to its significance to waterfowl and the substantial declines in waterfowl populations that have occurred in this area.[60] Within the Bay, salt ponds support substantial amounts of waterfowl, upwards of 41 percent of the total amount using the Bay's habitats. In the former North Bay salt ponds, up to 14 percent of the Bay's total waterfowl population have been counted, while the South Bay salt ponds support up to 27 percent of the Bay's total waterfowl population. Species of diving ducks known to use the ponds in significant numbers include ruddy ducks, canvasbacks, and buffleheads. Species of dabbling ducks highly reliant upon salt ponds include northern pintail, mallards and northern shovelers. Worth noting is that 86 percent of the Bay's (excluding Suisun Marsh) total dabbling ducks, including 90 percent of the northern shovelers, rely upon South Bay salt ponds.[61] Also, 67 percent of ruddy ducks, a diving duck, are supported by South Bay salt ponds. Further, 59 percent of the canvasbacks, 38 percent of the bufflehead and 47 percent of the mallards using the Bay rely upon former North Bay salt ponds.[62]

Salt Pond Habitat Diversity. The range of salinities and pond depths found throughout the salt pond system provides a breadth of habitats used by a diversity of shorebirds, waterfowl and other waterbirds. For foraging waterbirds, the depth of a pond affects access to prey. In addition, salinity has been shown to be an important predictor of waterbird abundance and diversity, based primarily on prey abundance, though waterbird sensitivity to salinity may also be a factor.[63] Thus, a helpful tool used by a number of scientists to classify the biological components of salt ponds relies on the salinity ranges of the ponds from low to high.

1. **Low-Salinity Evaporation Ponds (15-60 ppt).** At the lower end of the salinity scale are the intake ponds where salinities match Bay waters at around 15-33 ppt. With evaporation, low salinity evaporation ponds increase in salinity to around 60 ppt. In terms of species composition in the low salinity ponds, diversity is high, although the density of organisms is low. This trend will reverse as salinity increases throughout the system. Invertebrate species diversity is high (around 20 species), with a number of the species found in the Bay also being found in the low salinity ponds. Examples include native and non-native mussels,

[58] Rintoul et al. 2003.
[59] Takekawa et al. Goals Project, 2000.
[60] United States Department of the Interior, Fish and Wildlife Service, SEMARNAP Mexico, and Environment Canada. 1998. Expanding the Vision, 1998 Update, North American Waterfowl Management Plan.
[61] Accurso, Louise. 1993. Distribution and abundance of wintering waterfowl on San Francisco Bay, 1988-1990. Unpubl. Mater's Thesis. Humboldt State University. Arcata, CA. 252pp.
[62] Takekawa et al. Goals Project, 2000.
[63] Warnock, N., G. W. Page, T.D. Ruhlen, N.Nur, J.Y. Takekawa, and J. Hanson. 2002. Management and conservation of San Francisco Bay salt ponds: effects of pond salinity, area, tide, and season on Pacific Flyway waterbirds. *Waterbirds*. 25:79-92.

clams, crabs, sea anemones, worms and salt-tolerant insects.[64] Dominant plant species include marine macroalgae, such as sea lettuce, and marine plankton.[65] About fifteen species of fish are associated with low salinity ponds, including yellowfin goby, threespine stickleback, staghorn sculpin, topsmelt, and longjaw mudsucker.[66] Birds associated with the low salinity ponds include white and brown pelicans, double-crested cormorant, snowy egrets, black-crowned night herons, Forster's terns, sandpipers and avocets, as well as numerous wintering waterfowl.[67] The low salinity ponds are particularly important to numerous fish-eating birds, as well as waterfowl reliant on aquatic plants and insects.

2. **Medium-Salinity Evaporation Ponds (60-180 ppt).** Medium-salinity evaporation ponds undergo a pronounced reduction in species diversity, since the number of species that are extremely salt tolerant is limited. However, overall species biomass[68] increases in relationship to salinity. At the base of the food chain are green algae, such as *Dunaliella*.[69] Fish species diversity declines with salinity, though some species have been found in ponds with salinities of up to 80 ppt. The most common fish species are the topsmelt and the mudsucker.[70] The decrease in fish species in medium-salinity ponds leads to a decrease in fish-eating birds. A shift in the invertebrate community occurs with the ponds becoming dominated by the Franciscan brine shrimp.[71] In fact, brine shrimp are so abundant in some ponds, they are commercially harvested (primarily to be sold as food for aquarium fish). Brine shrimp, Reticulate water boatman (an insect species) and brine fly are a significant food source for eared grebes, California gulls, Bonaparte's gulls, stilts, sandpipers and avocets, among other shorebird species, as well as some waterfowl species.[72]

3. **High-Salinity Evaporation Ponds (180 ppt and higher).** High-salinity evaporation ponds are defined by their red color. This red color arises when increased salinity causes the green algae, *Dunaliella*, to produce a red pigment. In addition, salt-tolerant bacteria contribute to the red and purplish-red hues of the high-salinity ponds.[73] At this stage in the salt production process, no fish are able to survive in the ponds. The dominant invertebrates are Reticulate water boatman, brine shrimp and brine flies. Species diversity is very low, but biomass is extremely high. Due to the tremendous availability of food, eared grebes and gulls forage for food in large flocks. Further, shorebirds, such as phalaropes, stilts, avocets, willets, and sandpipers may forage in high-salinity evaporation ponds.[74]

Pickle ponds, bittern storage ponds and crystallizers have very high salinities and in general provide lower habitat value for waterbirds. Crystallizers can have salinity levels that exceed 200 ppt when they are receiving pickle, but also often contain solid, crystallized salt. Above a salinity of 200 ppt, even brine shrimp cannot survive. With the exception of halophytic bacteria, the crystallizers support virtually no aquatic life. In addition, the crystallizers are physically different than the evaporator ponds as the beds have been engineered, compacted and graded, and heavy equipment is used to maintain the beds and harvest the salt. The high salinity of these areas as well as the high disturbance level makes the crystallizers less suitable as habitat. Thus the crystallizers have low foraging value for most species of

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[64] Lonzarich, D.J. 1989. Temporal and spatial variations in salt pond environments and implications for fish and invertebrates. M.A. Thesis. State University, San Jose, CA.

[65] Baye. Goals Project, 2000.

[66] Lonzarich, 1989.

[67] Takekawa et al. Goals Project, 2000.

[68] The total mass of all living organisms in the pond.

[69] Baye. Goals Project, 2000.

[70] Lonzarich, 1989.

[71] Lonzarich, 1989

[72] Anderson, W. 1970. A preliminary study of the relationship of saltponds and wildlife. *California Fish and Game* 56:240-252.

[73] Cargill Salt, San Francisco Bay: Spectacular Salt Pond Colors. http://www.cargillsalt.com/sfbay/EV_colors.html

[74] Stralberg, D., N. Warnock, N. Nur, H. Spautz, and G.W. Page. 2003. Predicting the effects of habitat change on South San Francisco Bay bird communities: and analysis of bird-habitat relationships and evaluation of potential restoration scenarios. Final report, California Coastal Conservancy, Oakland, CA.

shorebirds and waterfowl, though they may provide some roosting habitat when not disturbed by heavy equipment. For example, since the transfer to public ownership in 2003, the U.S. Geological Survey has been conducting surveys on the crystallizer ponds in the Napa Plant Site. The surveys of the unused crystallizer ponds have recorded some roosting behavior for various species of birds, including Black-bellied plover, Western sandpiper, and Ring-billed gull.[75] In addition, the federally threatened Western snowy plover and the Endangered California least tern nest on low, barren to sparsely vegetated salt pond levees, islands and abandoned structures, at pond edges, and on salt pan areas of dry ponds.[76] To this end, the crystallizers, when dry and not receiving pickle, may provide breeding and foraging habitat. The greatest concentration of snowy plovers in the San Francisco Bay Area has consistently occurred in the Eden Landing/Hayward area, with a high count during the breeding season in 2004 of about 130 in two evaporator ponds.[77] However, the San Francisco Bay Bird Observatory reported sightings of twelve snowy plovers in the Redwood City Plant Site in the summer of 2003.[78] In addition, the United States Fish and Wildlife Service's Draft Recovery Plan for the Western snowy plover reported the presence of nine Western snowy plovers in 2001 at the Redwood City Plant Site.[79]

As this discussion illustrates, the range of ponds comprising the salt production system are utilized by many estuarine fish, invertebrate and bird species. Due to losses of habitat elsewhere in the Bay, and as far afield as the Central Valley, salt ponds hold a particularly significant value for species of resident and migrating birds associated with wetland habitats. Because of the importance of the salt ponds to bird conservation, an array of scientific studies of salt pond bird populations has been undertaken. For example, studies by the United States Geological Survey found fifty-two species of waterbirds (defined as bird species dependent upon aquatic habitats to complete portions of their life cycles[80]) totaling 100,000 between January and October of 1999 in the North Bay salt ponds.[81] A 2002 study undertaken by scientists from the Point Reyes Bird Observatory and the United States Geological Survey concluded that the salt ponds are breeding habitat for a number of waterbirds including the threatened snowy plover, the black-necked stilt, the American avocet and a number of gull and tern species, and that over 70 species of waterbirds use the salt ponds (a later study by the Point Reyes Bird Observatory detected over 100 different bird species in salt ponds[82]). The study concluded that salt ponds with exposed moist soil and shallow water attract maximum numbers and diversity of migrating and wintering gulls and shorebirds and that deeper water ponds are important for many waterfowl species, especially diving ducks. The study also concluded that a range of salinities is important to provide food for fish-eating birds as well as to promote a high biomass of invertebrate prey important to a wide range of migrating and wintering shorebirds, waterfowl, gulls and terns. Finally, the study found that roosting waterbirds rely upon exposed islands in the middle of salt ponds.[83]

Napa River Salt Marsh Restoration Project. As discussed in Chapter 1, 9,850 acres of former salt ponds (evaporator ponds and a bittern storage pond), located on the west side of the Napa River, were sold to the state of California by Cargill in the early 1990s. Once purchased by the state, interim

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[75] Athearn, Nicole. 2005. Personal communication of Wildlife Biologist, U.S. Geological Survey, San Francisco Bay Estuary Field Station.

[76] Warnock, Nils. 2003. Personal interview of Wetlands Ecology Division Co-Director, Point Reyes Bird Observatory & San Francisco Bay Bird Observatory. San Francisco Bay Bird Observatory Western Snowy Plover Program. http://www.sfbbo.org/plover_b.htm.

[77] Strong, CM, N. Wilson, and J. Albertson. 2004. Western Snowy Plover numbers, nesting success, and avian predator surveys in the San Francisco Bay, 2004. Unpublished report. San Francisco Bay Bird Observatory.

[78] Strong, Cheryl. 2003. Personal interview with San Francisco Bay Bird Observatory biologist.

[79] U.S. Fish and Wildlife Service. 2001. Western Snowy Plover (*Charadrius alexandrinus nivosus)* Pacific Coast Population Draft Recovery Plan. Portland, Oregon. xix+630pp.

[80] Waterbird Conservation for the Americas. What Are Waterbirds? http://www.nacwcp.org/waterbirds

[81] Miles, Fregien, Takekawa, Martinelli, Schoellhamer, Duffy, Schlosser and Saiki. Science Support for Wetland Restoration in the Napa-Sonoma Salt Ponds. http://sfbay.wr.usgs.gov/access/saltponds/intro.html

[82] Stralberg et al, 2003.

[83] Warnock, Nils, Gary Page, Tamiko Ruhlen, Nadav Nur, John Takekawa, and Janet Hanson. 2002. Management and Conservation of San Francisco Bay Salt Ponds: Effects of Pond Salinity, Area, Tide, and Season on Pacific Flyway Waterbirds. Point Reyes Observatory Conservation Science. Stinson Beach, CA.

management of the ponds was undertaken by Fish and Game and the property became the Napa River Unit of the Napa-Sonoma Marshes Wildlife Area.

Planning for the restoration of the Napa ponds has been underway since 1997. Throughout the period of interim management by Fish and Game, lessons have been learned that are applicable to other salt pond restoration projects. Of greatest scope and resonance has been the lesson that inadequate funding for the operation and maintenance of the ponds can lead to significant problems. For example, an inability to manage the movement of water throughout the salt pond system has had detrimental impacts on the overall wildlife value of the ponds. More specifically, because of Fish and Game's inability to freshen the ponds sufficiently and manage pond depths by pumping adequate amounts of water throughout the salt pond system—due to deteriorating water control structures, increased operational and maintenance costs, such as the price of power, lack of discharge point, and an inadequate water supply—the Napa ponds have continued to become more and more saline. As a result, some ponds that once provided wildlife habitat throughout the year now dry out completely during the summer months, becoming salt flats, reducing or eliminating habitat in these higher salinity areas.

Also a symptom of a lack of funding for the operation and maintenance of the salt ponds is a decline in system-wide levee integrity. Because salt pond levees are made of soft Bay mud, erosion occurs over time. Thus, the levees are in need of: (1) topping with fresh dredged sediment; (2) discing and grading two to three years after topping; and (3) grading and constructing of chokers (small berms constructed on the levees to prevent dredged muds from slipping). To date, Fish and Game has not undertaken the extent of levee maintenance necessary, with the kinds of equipment required, to protect the salt pond system from unforeseen breaches.[84] For example, in January of 1995, the levee of Pond 2A was intentionally breached by Fish and Game as an emergency measure to reduce the risk of an uncontrolled levee failure in a more critical part of the system. In addition, Pond 3 was breached by unknown persons in 2002 and the breach grew to fourteen meters wide during the first rainy season. Thus, there is an ongoing risk of an unplanned release of concentrated salts both within the pond system and outside of the pond system (e.g. to the Napa River or associated sloughs). Worth noting is that levee failure has the potential to alter the ecology of the North Bay, due to significant impacts associated with the exposure of aquatic organisms, such as fish, to highly saline brines or bittern.[85]

In order to address the increasing deterioration of the Napa salt pond system, the California State Coastal Conservancy, U.S. Army Corps of Engineers, and Fish and Game are undertaking a salinity reduction, water delivery and habitat restoration project for the salt ponds on the west side of the Napa River. Known as the Napa River Salt Marsh Restoration Project (Napa Project), the Napa Project includes 11 former salt ponds, three of which are currently open to tidal influence, and eight which are closed to tidal circulation and need varying levels of salinity reduction before restoration is possible.[86] The project seeks, first, to reduce salinity then to provide for a mosaic of habitat types including retention of some areas as diked managed ponds and restoration of some areas to tidal habitat.

Throughout the planning process for the Napa River Salt Marsh Restoration Project, Fish and Game, the Coastal Conservancy and the U.S. Army Corps of Engineers have sought consistency with the Baylands Ecosystem Habitat Goals report's (Goals Report)[87] subregional restoration goals for the North Bay. These subregional goals include restoring large areas of tidal marsh and enhancing seasonal wetlands. Specifically, the Goals report recommends increasing tidal marsh from the existing 16,000 acres to about 38,000 acres, and creating about 17,000 acres of diked wetlands.

In addition, more specific habitat restoration goals for the project were developed by the project sponsors using recommendations from the Goals Report for the Napa River and Sonoma Creek areas. The site-specific habitat restoration goals guiding the project's design include:

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[84] Siegel and Bachand, 2002.

[85] U.S. Army Corps of Engineers, California Department of Fish and Game & California Coastal Conservancy. 2001. Summary Status Report: Napa River Salt Marsh Restoration; Napa, Sonoma, and Solano Counties.

[86] Notice of Availability of the Draft Feasibility Report and Draft Environmental Impact Report/Environmental Impact Statement (Draft EIR/EIS) and Request for Comments on the Draft EIR/EIS for the Napa River Salt Marsh Restoration Project. 2003.

[87] Goals Project, 1999.

1) In a phased approach, restore large patches of tidal marsh that support a wide variety of fish, wildlife and plants…
2) Ensure connections between the patches of tidal marsh (in the project site and with adjacent sites) to enable the movement of small mammals, marsh-dependent birds, and fish and aquatic species.
3) Restore tidal marsh in a band along the Napa River to maximize benefits for fish and other aquatic animals.
4) Manage water depths of ponds to maximize wildlife habitat diversity, with shallow-water areas for migratory and resident shorebirds and dabbling ducks and deepwater areas for diving benthivores (ducks).
5) Manage salinity levels in ponds to support a rich diversity of biota (life).
6) Break up unneeded levees to create refuges for roosting and nesting shorebirds.
7) Manage invasive plant species, as feasible.

Due to the large and unprecedented size of the Napa River Salt Marsh Restoration Project, the project proponents have designed the project in a manner that will help to ensure the project's long-term success. Important ongoing restoration design approaches to be included in the project are: (1) phasing; (2) monitoring and evaluation; (3) adaptive management; and (4) flexible project goals.[88] Phasing is a design approach in which the ponds are restored in stages, with those ponds that are the easiest to desalinate and establish habitat values undertaken first. Therefore, some of the restoration goals of the project can be achieved fairly quickly, with the more difficult to restore areas coming on-line later. In addition, phasing of the project allows for the coordination of various stages of the project with restoration projects occurring nearby, such as the restoration of Cullinan Ranch located north of San Pablo Bay. Phasing will also enable the adaptive management of the ponds by allowing decisions about project goals and the future habitat composition of individual ponds (e.g., managed ponds vs. tidal marsh) to be made throughout the project based on lessons learned. Further, monitoring of pond conditions, such as rates of salinity reduction or accretion of sediment, will ensure that corrective actions are taken when needed to ensure that project-wide habitat restoration goals are met. In other words, all of the design tools work together to ensure that the long-term success of the project is achieved. The aforementioned restoration design tools will not only guide the Napa salt pond project on its planned course, but the same tools also have the potential to inform the South Bay salt pond restoration project, discussed below.

South Bay Salt Ponds Restoration Project. Chapter 1 details the recent acquisition of 15,100 acres of salt ponds (all evaporation ponds) in the southern portion of the Bay[89] by the State of California and the federal government. Restoration of the South Bay salt ponds will also further the objectives of the Goals Report's habitat recommendations and represents a significant opportunity to make the Bay larger and healthier. Specific South Bay subregional goals for restoration in the Goals Report include "increasing the area of tidal marsh from about 9,000 acres to between 25,000 and 30,000 acres," as well as "managing for wildlife somewhere between 10,000 acres and 15,000 acres of salt pond habitat."[90]

Due to the complexity of restoring the South Bay salt ponds, a series of steps will be undertaken before the ponds are fully restored. The steps required to restore the ponds include: (1) the phase out of salt production by Cargill; (2) initial stewardship of the ponds by the United States Fish and Wildlife Service (Fish and Wildlife) and the California Department of Fish and Game (Fish and Game); and (3) the planning and implementation process for the long-term restoration of the ponds. Each of these is described in greater detail, below.[91] Currently, approximately 80% of the ponds have met the transfer

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[88] Philip Williams and Associates. 2002. Napa River Salt Marsh Restoration: Habitat Restoration Preliminary Design, Phase 2 Stage 2 of the Hydrology and Geomorphology Assessment in Support of the Feasibility Study, Final Report. Prepared for the California State Coastal Conservancy.

[89] An additional 1,400 acres of crystallizer ponds on the eastern side of the Napa River were also part of the 2003 sale.

[90] Goals Project, 1999.

[91] In addition, the ponds in the Napa Plant site on the eastern side of the Napa River are undergoing a separate process for the removal of salt by Cargill and the planning process for their eventual restoration by Fish and Game.

standard and are ready for restoration once the planning is complete. The remaining ponds may take as long as three to ten years, although some ponds may become available for restoration in one to two years.

1. **Phase Out of Salt Production.**[92] Based on a Phase Out Agreement between Cargill, the State of California and the federal government, Cargill has responsibility for the operation and maintenance of the salt pond properties recently acquired by the state and federal governments until specific water quality conditions are met. The water quality conditions, known as the "Transfer Standard," refer to the issuance of San Francisco Bay Regional Water Quality Control Board (Regional Board) permits for the discharge of brines from the ponds into the Bay. More specifically, once the brines found in each pond are deemed of a low enough salinity to be discharged to the Bay as established by the Regional Board's permit, responsibility for the operation and maintenance of the pond then transfers to Fish and Game or Fish and Wildlife. Thus, Cargill will play an active role in the salinity reduction of the ponds. However, because the ponds are very different in their salinity levels, the ponds will be transferred to the resource agencies at different times. For example, the low salinity ponds in Eden Landing, in Hayward, and most of the Alviso ponds will likely meet the Transfer Standard in one to two years (eighteen Alviso ponds were turned over to the Fish and Wildlife Service in March 2004), while the higher salinity ponds in the South Bay will likely take from three to six years. According to Cargill, during the phase out of salt production the saltiest brines will be transferred to the Newark Plant Site for harvest and salt production, while lower salinity brines are discharged directly to the Bay.[93]

2. **Initial Stewardship.**[94] The initial stewardship of the South Bay salt ponds begins as each pond is transferred by Cargill to Fish and Game and Fish and Wildlife and ends when a long-term restoration plan for the South Bay salt ponds is completed and can be implemented. Thus, the initial stewardship of the ponds coincides with the planning process for the long-term restoration of the ponds. Goals of the initial stewardship of the ponds are to: (1) cease net evaporation and the attendant salinity increase; (2) maintain the ponds in a restorable condition until long-term restoration can occur; (3) protect existing habitat values; (4) maintain existing levels of flood protection; and (5) meet all regulatory requirements, including water quality standards. The project is needed because: (1) without initial stewardship, the ponds would be subject to increasing salinity and decreasing ecological value; (2) deterioration of levees could lead to levee breaches and uncontrolled high salinity discharges and flooding of inland areas; (3) restoration costs would be increased with site deterioration; and (4) water levels would become unmanageable and, especially during the summer months, would result in drying of most of the ponds.[95] Management measures to achieve initial stewardship goals include installing new water control structures to circulate Bay waters through reconfigured pond systems—made up of smaller pond units—with some ponds taking water in from the Bay and others discharging water into the Bay. In particular, the three complexes (Alviso, Eden Landing and Ravenswood) historically managed as one system will each be subdivided into several systems within which water will circulate. Further, a limited number of ponds will be managed as seasonal ponds—ponds allowed to fill with rainwater in the winter and to dry down in the summer—to reduce management costs and optimize habitat for migratory and resident waterbirds, including the federally threatened Western snowy plover. Also, different summer and winter water levels will be maintained in a small number of ponds to reduce management costs and optimize habitat for resident and migratory waterbirds. In addition, the restoration of a limited number of ponds to muted tidal or full tidal influence will occur. Also, a few ponds in the Alviso system will be managed as higher salinity

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[92] Phase Out Agreement by and between Cargill, Incorporated, A Delaware Corporation, United States of America, acting by and through the Secretary of the Interior or her authorized representatives, including United States Fish and Wildlife Service, and State of California, acting by and through its Department of Fish and Game (http://www.resources.ca.gov).

[93] Johnson, Lori. July 2002. The First Step: How Do You Stop Making Salt? *The Bay's Edge: A Cargill Salt Report*. Vol. 13, no. 2.

[94] Notice of Intent to Prepare a Joint Environmental Impact Statement/Environmental Impact Report for the South Bay Salt Ponds Initial Stewardship Project (http://www.southbayrestoration.org/NOI.htm).

[95] Draft Environmental Impact Report/Environmental Impact Statement for the South Bay Salt Pond Initial Stewardship Plan (http://www.southbayrestoration.org)

batch ponds where salinity levels will be allowed to rise in order to support specific wildlife populations, such as brine flies and brine shrimp, phalaropes and eared grebes.[96]

3. **Long-Term Restoration.** Planning for the long-term restoration of the South Bay salt ponds is underway and coincides with the phase out of salt production by Cargill and the initial stewardship of the ponds. The long-term restoration planning process is being facilitated by the California Coastal Conservancy (Conservancy), in partnership with Fish and Wildlife and Fish and Game, with implementation of the plan scheduled to begin in the year 2008. The goal of the long-term restoration is defined as "…the restoration and enhancement of wetlands in the South San Francisco Bay while providing for flood management and wildlife-oriented public access and recreation."[97]

   The Conservancy has defined an overall planning structure and is engaging trustee and regulatory agencies, local governments, non-governmental organizations, and the public to produce a scientifically sound, widely supported plan for implementation. Key elements of the project management structure include an Executive Leadership Group, a Project Management Team, a Science Team, a National Science Panel, A Regulatory Agency Group, a Local Government Forum, a Stakeholder Forum, and Work Groups dedicated to the detailed analysis of specific restoration issues such as recreation and public access, habitat restoration and flood management.[98]

   Because of the tremendous size of the restoration, a large-scale, landscape-level approach will be undertaken which accounts for the biological, physical and chemical health of the Bay.[99] To this end, planning for the restoration of the ponds will incorporate consideration of the needs of native species that depend on healthy tidal marsh and tidal flat habitat, as well as the needs of species that depend on salt ponds, such as migratory bird species. To assist with the flood management planning, the Santa Clara Valley Water District, Alameda County and the U.S. Army Corps of Engineers sit on the Project Management Team and are active partners in the project planning process.

The Commission is an active partner in the restoration of the ponds, both through permitting and planning processes. In terms of planning, the Commission's staff participates at various levels of the long-term planning process, including sitting on the Public Access and Habitat Work Groups, as well as the Regulatory Agency Group which will meet over the next several years to help Fish and Game, Fish and Wildlife and the Coastal Conservancy navigate the range of regulatory issues they will need to consider for the management and long-term restoration of the ponds. In terms of permits, the Commission has transferred responsibility for portions of the current salt pond maintenance permit, due to changes in land ownership, to Fish and Game and Fish and Wildlife for their respective, newly acquired properties. Cargill will maintain its portion of the maintenance permit for those ponds within the Don Edwards San Francisco Bay National Wildlife Refuge on which it holds the rights to continue to produce salt. In addition, Fish and Game has received a permit for the interim management of the ponds and will need a future permit for the long-term restoration. Similarly, a Consistency Determination has been issued to Fish and Wildlife for the interim management of its ponds, and will also be required for the long-term restoration of the ponds.

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[96] Johnson, Lori. April 2003. Interim Management Team Takes First Steps Toward Wetlands Restoration. *The Bay's Edge: A Cargill Salt Report.* Vol. 14, no. 1. & Draft Environmental Impact Report/Environmental Impact Statement for the South Bay Salt Pond Initial Stewardship Plan (http://www.southbayrestoration.org).

[97] South Bay Salt Pond Long Term Restoration Plan Mission, Goals, Guiding Principles and Objectives. February 19, 2004. Final Version.

[98] South Bay Salt Pond Restoration Project. Decision Making Structure.(http://www.southbayrestoration.org/Structure.html)

[99] South Bay Salt Pond Restoration Project. Project Description. (http://www.southbayrestoration.org/Project_Description.htm#Background)

Restoration Issues Relevant to the Bay Plan Salt Pond Policies. In undertaking the restoration[100] of salt ponds, due to the scale and complexity of the endeavor, a number of issues need to be considered to ensure that the goals and objectives of the project are met without causing harm to the Bay or causing significant negative impacts such as flooding. Many of the restoration issues of relevance are considered in the following discussion. While the following discussion often utilizes the South Bay Salt Pond Restoration Project for elucidation, each of the following issues are important to consider for any salt pond restoration project.

1. **Habitat Composition Tradeoffs.** Determining which ponds should be restored to subtidal or wetland habitat and which should be enhanced as managed ponds is a critical aspect of the planning process for the restoration of the Bay's salt ponds. Because different kinds of species are dependent upon different kinds of habitats, the composition of the habitats restored and enhanced in the South Bay will directly affect the diversity, abundance and distribution of fish, other aquatic organisms and wildlife. For example, restoration of ponds to tidal habitat will benefit some bird species, including the federally-listed endangered California Clapper Rail and the Tidal Marsh Song Sparrow, a California Species of Special Concern, as well as the federally-listed salt marsh harvest mouse. In addition, salt ponds are primarily a closed system, meaning virtually no export of nutrients or energy to the Bay. However, the loss of ponded areas may adversely affect the number of waterbirds in the south bay, such as diving ducks and shorebirds, as well as the federally-listed Snowy Plover.

   The Point Reyes Bird Observatory (PRBO) recently completed the first phase of a long-term effort to evaluate the potential effects of the South Bay salt pond restoration project on birds in San Francisco Bay. Using bird survey data from salt pond and tidal marsh habitat, PRBO developed models to predict outcomes of specific restoration scenarios. Based on the outcomes of the models, PRBO put forth some preliminary conclusions that can help frame the discussion of habitat composition of the restoration project including:[101]

   1) A mix of tidal marsh and managed pond habitats can offer the best overall results, in terms of minimizing waterbird habitat losses while maximizing landbird habitat gains, though the most optimal mix varies for different bird species;
   2) Waterbird use of tidal marsh habitat is positively affected by the existence of large channels and ponded areas;
   3) Managing retained ponds for a mix of salinity levels would benefit a large number of species;
   4) Increasing the amount of tidal marsh and tidal flats in the South Bay may help increase species diversity and bird numbers, in both salt pond and tidal marsh habitats, and;
   5) Trade-offs should be evaluated in the context of long-term population viability, rather than absolute bird numbers.

   In addition, documents necessary to consider when determining regional restoration strategies for the South Bay and the North Bay salt ponds will include recovery plans for species federally listed as threatened or endangered. Recovery plans are mandated under Section 4 of the federal Endangered Species Act for the purpose of addressing the recovery needs of listed species. While most recovery plans focus on the protection and improvement of specific species, newer plans have begun to address ecosystem level protections, which cover more than one listed species. Two plans relevant to the restoration of the salt ponds are the "Western Snowy Plover (*Charadrius alexandrinus nivosus*) Pacific Coast Population Recovery Plan" and the "Tidal Marsh Ecosystem Recovery Plan." Each of these recovery plans will form the foundation for the United States Fish and Wildlife Service's regulatory review of the long-term restoration plan for the South Bay salt ponds.

   Further, in looking at the regional needs of fish, other aquatic organisms and wildlife associated with the South Bay, it is critical to consider the habitat opportunities presented not only by the

[100] The term "restoration" here includes both restoration to subtidal or wetland habitat and the management of diked ponds for wildlife habitat.
[101] Stralberg et al, 2003.

publicly-acquired salt ponds, but also to understand the habitat values of the ponds under continued management and ownership by Cargill. For example, as some of the publicly acquired salt ponds are restored to tidal influence, the remaining privately managed ponds may be of even greater importance to species that utilize salt pond environments.[102]

Restoration planning should also address the need to increase and improve the quality of transition zones[103] between wetland habitats and upland habitats, wherever feasible.[104] In turn, improved habitat connectivity and subsequent, larger bands of contiguous habitat will support more viable populations of sensitive species through increased breeding opportunities and access to territory.[105] In addition, the habitat needs of fish and other aquatic organisms should be considered an integral part of the salt pond restoration planning process.

Further implications of decisions regarding types and amounts of habitat to restore are covered in the following detailed discussion of restoration issues.

2. **Salt Pond Bathymetry and Sediment Supply.**[106] The successful restoration of a salt pond to a tidal marsh depends on the ability of tidal marsh plants to colonize ponds opened to the tide. Because tidal marsh plants only grow in specific "zones," the elevation of the bottom of a pond, once the surrounding levee is breached, in relationship to the height of incoming tidal waters is critical to the successful colonization of a pond by vegetation. More specifically, low marsh vegetation, such as Pacific cordgrass, grows from mean tide level (MTL) to mean high water (MHW), while high marsh vegetation, such as pickleweed, grows from MHW to mean higher high water (MHHW).

   A review of the elevations of the South Bay's salt ponds[107] shows that most South Bay salt pond bottom elevations lie between MTL and MHW (about 61 percent of the salt ponds), at the elevation where tidal marsh habitat forms. In these ponds, colonization by low marsh species should occur during restoration with relative rapidity. On the other hand, ponds spanning from Mountain View east to San Jose are significantly subsided, due to groundwater withdrawal and aquifer overdraft in Santa Clara County between 1912 and 1969. For this reason, most of the ponds in this region are between mean low water (MLW) and MTL (about 22 percent of the salt ponds). In terms of feet, these ponds are anywhere from six to eight feet below tidal marsh elevation. Thus, existing elevations in each of these ponds are too low to support the colonization of tidal marsh vegetation. The restoration feasibility of salt ponds in the South Bay, therefore, will depend on the approach taken to raise the elevations of each of the ponds to achieve successful tidal marsh formation.

   To a great extent, improving a pond's tidal marsh restoration success rate entails an adequate supply of sediment to raise the elevation of the pond to a level where vegetation can grow. Simply opening the ponds to tidal influence poses potential harm to the South Bay's tidal flats, as the subsided ponds may act as sediment sinks where sediment taken from surrounding tidal flats by the tides will be deposited. In addition, a restoration project on the scale of that proposed in the South Bay has the potential to significantly affect the sediment dynamics of the Bay as a whole. In particular, scientists are coming to understand that the sediment that is delivered to the Bay from the Delta and surrounding watersheds is a limited resource, especially in light of increasing restoration projects that trap sediment and the effects of relative sea level rise. Additional research on sediment dynamics is needed including a better understanding of: (1) Bay-wide sediment dynamics and the sediment budget for the South Bay; (2) the potential role of the

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[102] Siegel and Bachand, 2002.

[103] A transition zone is a habitat type where a gradual change from wetland to upland occurs. Transition zones contain a rich mixture of vegetation types and are an especially important habitat for aquatic and terrestrial wildlife.

[104] Siegel and Bachand, 2002 & LaRiviere, Florence. 2003. Personal Interview with Chairperson of Citizens Committee to Complete the Refuge.

[105] Siegel and Bachand, 2002.

[106] This section is adapted from Siegel and Bachand, 2002.

[107] This characterization of the elevation of the salt ponds in the South Bay does not include ponds owned by Cargill in Newark as no information is available.

restoration of the salt ponds on the South Bay sediment budget and Bay-wide sediment dynamics;[108] and (3) the potential effects of changing tidal flats on wildlife.

3. **Existing Infrastructure.**[109] The presence of infrastructure, including storm drain systems, roads and rail, petroleum pipelines, fiber optic cables, electrical transmission lines, natural gas pipelines, historic structures, and sewer structures may also prove to be a challenge to restoration efforts. For example, below-ground pipelines may lie at elevations that would partially or wholly block tidal exchange into a pond proposed for restoration. Furthermore, there may be a need to provide access for maintenance of existing facilities. In addition, regional airports, such as the Napa County Airport near the Napa Plant Site, may pose restoration constraints due to potential increases in bird strikes associated with habitat improvements.[110] For this reason, adequate mapping, planning and coordination with those entities responsible for the infrastructure must occur throughout the restoration of the salt ponds.

4. **Use of Fill for Restoration.** Restoration planners view the use of clean dredged sediment as a potentially beneficial tool to speed up the salt pond restoration process, while also ensuring the protection of ecologically valuable South Bay tidal flat habitats.[111] Specifically, dredged sediment may be helpful in aiding the rapid creation of high tidal marsh and transitional habitat in a restored salt pond. Without the placement of dredged material, under a natural sedimentation approach, high tidal marsh habitat can take many more years to restore naturally because the rate of sedimentation in a tidal marsh decreases as elevation increases and transitional habitat will not form. However, important considerations arise in planning for the use of clean dredged sediment for habitat restoration. One critical consideration, in particular, is the Commission's authority to permit fill in salt ponds. In 1990, the Attorney General's office for the state of California determined in part that "…the Commission has the authority to require permits for fill placed in salt ponds, even when the only purpose of the fill is to enhance salt pond production."[112] Thus, the Commission does have the authority to consider the placement of fill in salt ponds. To be determined is the amount of fill that is permissible based on the Commission's law, the McAteer-Petris Act, and Bay Plan policies. The foundation of the Commission's analysis determining the appropriate placement of fill in salt ponds for restoration purposes should be consistency with McAteer-Petris Act Section 66605(c)-(g) which states:

> …(c) That the water area authorized to be filled should be the minimum amount necessary to achieve the purpose of the fill;
>
> (d) That the nature, location and extent of any fill should be such that it will minimize harmful effects to the bay area, such as the reduction or impairment of the volume surface area or circulation of water, water quality, fertility of marshes or fish and wildlife resources, or other conditions impacting the environments, as defined in Section 21060.5 of the Public Resources Code[113];
>
> (e) That public health, safety, and welfare require that the fill be constructed in accordance with sound safety standards which will afford

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[108] For more information on Bay sediment and the relationship to restoration projects see Philip B. Williams article entitled "Is There Enough Sediment" in *Science and Strategies for Restoration,* a compilation of proceedings from the October 2001, State of the Estuary. Published by the San Francisco Estuary Project and Calfed.

[109] This section is adapted from Siegel and Bachand, 2002.

[110] San Francisco Bay Area Wetlands Restoration Program, Design Review Group. September 15, 2003. Draft Meeting Summary.

[111] South Bay Salt Pond: Frequently Asked Questions. (http://www.southbayrestoration.org/sbsp_faq.html)

[112] Barbieri, Joseph. 1990. Deputy Attorney General to Alan Pendleton, Executive Director of BCDC.. Informal Opinion Regarding the "Regulation of the Placement of Fill in the Salt Ponds." July 9, 1990

[113] Public Resources Code Section 21060.5., "Environment," means "the physical conditions which exist within the area which will be affected by a proposed project, including land, air, water, minerals, flora, fauna, noise, objects of historic or aesthetic significance."

> reasonable protections to persons and property against the hazards of unstable geologic or soil conditions or of flood or storm waters;
>
> (f) That fill should be authorized when the filling would, to the maximum extent feasible, establish a permanent shoreline;
>
> (g) That fill should be authorized when the applicant has such valid title to the properties in question that he or she may fill them in the manner and for the uses to be approved.

Further, in other valuable natural resource areas, such as tidal marshes, tidal flats and wildlife refuges, the Commission has determined and specified in the Bay Plan that the placement of a minor amount of fill for enhancement or restoration is permissible. For example, Bay Plan Tidal Marshes and Tidal Flats Policy 8 states that:

> [b]ased on scientific ecological analysis and consultation with the relevant federal and state resource agencies, a minor amount of fill may be authorized to enhance or restore fish, other aquatic organisms or wildlife habitat if the Commission finds that no other method of enhancement or restoration except filling is feasible.

A similar determination regarding the value of the placement of fill for the restoration or enhancement of salt ponds should also occur. Other restoration considerations pertaining to the reuse of dredged sediment include cost, determining how to get the dredged material from the dredging area into the target salt pond with the least amount of environmental impact, and planning for offloading and sediment placement within the ponds. Regarding ecological concerns, effort should be made to protect the structure and form of historic tidal channels located throughout the salt ponds when placing dredged material.

5. **Flood Protection.** Unlike publicly maintained flood control levees, the levees associated with the salt pond facilities were not constructed for flood protection of the surrounding communities, and therefore do not meet modern flood control engineering requirements. In addition, much of the Santa Clara Valley is subsided, thereby exacerbating the risk of flooding. Indeed, the United States Army Corps of Engineers (Corps) in a San Francisco Bay shoreline study undertaken in the 1980s described the privately maintained Cargill salt pond levees as "substandard levees" but that because the salt ponds themselves provided a buffer between the bayfront levees and urban areas and because no salt pond levee failures has occurred in over 20 years, the Corps concluded that there was no federal interest in dedicating federal funds to improving the levees in the South Bay.[114] More specifically, in the 1980s the Corps undertook a study to evaluate the economic feasibility of providing federal protection to the low-lying areas of the South Bay, including San Mateo, Alameda and Santa Clara Counties, in danger of being flooded by the tide. In 1990, the Corps concluded that the potential incidence of levee failure and potential damage in the study area were low and, therefore, not of federal interest.[115] The study was then suspended until sufficient economic benefits could be demonstrated.[116] Currently, the Corps and the Santa Clara Valley Water District recognize that the flood protection needs of the South Bay will change significantly with alterations in the Bay's hydrology associated with opening many of the publicly owned ponds to tidal influence.[117] In particular, as tidal influence is introduced to the

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[114] U.S. Army Corps of Engineers. 1988. Office Report: Southern Alameda and Santa Clara Counties Interim San Francisco Bay Shoreline Study & U.S. Army Corps of Engineers. 1989. Office Report: San Mateo and Northern Alameda Counties Interim San Francisco Bay Shoreline Study

[115] The study determined that the most likely mode of tidal flooding was overtopping of a levee, rather than erosion or levee failure and because levees have historically withstood overtopping the study estimated that few benefits could arise from levee improvements. The Santa Clara Valley Water District's position, as a proponent of federal investment in the improvement of the South Bay's levees, is that the low incidence of levee failure is due only to luck and diligent efforts by public and private maintenance efforts.

[116] Santa Clara Valley Water District. 2003. Status Report: Federal Projects for Santa Clara County, California and Federal Appropriation Statements of Support, Fiscal Year 2004.

[117] Kendall, Thomas. 2003. Personal Interview with Chief, Planning Branch, U.S. Army Corps of Engineers.

ponds through levee breaches, flood control efforts will likely shift from bayward levees to inland levees. Therefore, substantial engineering improvements to inland levees and ongoing maintenance would be required to protect the South Bay from tidal flooding associated with restoration. To this end, the Corps and the Santa Clara Valley Water District support a re-examination of the results of the original "San Francisco Bay Shoreline Study" to "…determine whether modifications to the recommendations contained therein are advisable at the present time in the interest of tidal and fluvial flood damage reduction, environmental restoration and protection and related purposes along the South San Francisco Bay shoreline for the counties of San Mateo, Santa Clara and Alameda, California."[118] Congress authorized funding to begin a re-examination of the original study's results in 2004.

Other important flood control measures that should be integrated into the restoration planning process include accounting for increased relative sea level rise associated with climate change when determining the height of new or modified levees. In other words, the height of levees surrounding salt ponds or adjacent to restored areas can be built or modified in accordance with predicted increases in sea level.[119] In addition, flood control improvements associated with salt ponds can increase the surface area and volume of the Bay by removing those levees deemed unnecessary for flood control and wildlife habitat, and focusing flood control improvements in areas closest to the shore. In addition, levees can be built in a manner that improves their integration into the surrounding landscape. For example, instead of the use of steep levee slopes built with rock or concrete rubble rip-rap, more natural options may include the use of native vegetation for erosion control and the creation of gentler slopes. Importantly, as part of the long-term planning process for the South Bay salt ponds, a work group has been formed to provide more detailed analysis of flood management issues associated with restoration.

6. **Adaptive Management.** Because ecosystems are complex and dynamic, and there is much uncertainty in the science of restoration, adaptive management is a process whereby natural resource managers "learn by doing" by incorporating information learned into subsequent decisions regarding management activities, such as habitat restoration. More specifically, adaptive management can be defined as:

> …a formal, systematic, and rigorous approach to learning from the outcomes of management actions, accommodating change and improving management. It involves synthesizing existing knowledge, exploring alternative actions and making explicit forecasts about their outcomes. Management actions and monitoring programs are carefully designed to generate reliable feedback and clarify the reasons underlying outcomes.[120]

To date, adaptive management has been used to solve problems in large, complex natural systems, such as the restoration of the Everglades and the recovery of salmon in the Columbia River. Primarily, adaptive management seeks to:

> …address uncertainty directly by using management as a tool to gain critical knowledge. The result is that, rather than managing for a single, optimal state, we manage within a range of acceptable outcomes while avoiding catastrophes and irreversible negative effects.[121]

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[118] U.S. House of Representatives: Committee on Transportation and Infrastructure. 2002. Resolution on South San Francisco Bay Shoreline, California. Docket 2697.

[119] The Commission's 1988 study entitled "Sea Level Rise: Predictions and Implications for San Francisco Bay" estimated the relative future sea level rise in the year 2007 to be 2.78 feet at highly subsided Alviso Slough at Coyote Creek and .73 feet at the Dumbarton Bridge.

[120] Forest Practices Branch for British Columbia, Canada. Ministry of Forests: An Introductory Guide to Adaptive Management. (http://www.for.gov.bc.ca/hfp/amhome/INTROGD/preface.htm)

[121] Johnson, B.L. 1999. The role of adaptive management as an operational approach for resource management agencies. *Conservation Ecology*. 3(2): 8. [online] http://www.consecol.org/vol3/iss2/art8

Due to adaptive management's strength in helping to solve complex and large scale natural resource dilemmas it is a beneficial approach to use for large scale salt pond restoration projects. As part of the plan for the restoration of the South Bay salt ponds the Science Team is developing a plan for adaptive management that will serve as the methodology for acting on the information gained through monitoring and studies undertaken during the planning phase, as well as through future phases of the restoration project.

7. **Non-Native Species.** Those species not historically found in the Bay and known as non-native or invasive species are currently considered a primary threat to the Bay's biological diversity (biodiversity). Over 175 non-native species now inhabit the Bay.[122] These species can crowd out native species, prey upon them, and disturb their habitats. All of the Bay's habitats have been affected by invasive species. For example, invasive species are now strongly contributing to the further demise of endangered birds and mammals. Some native Bay species have been displaced by non-natives altogether (for example, the native mudsnail *Cerithidea* has been displaced in some areas by introduced mudsnails). Other native wetland species, such as the endangered clapper rail, are preyed upon by the invaders (such as Norway rats or red fox). In some cases, the invading species have changed the very structure of the habitat, to the detriment of some native inhabitants.

   One non-native plant species, in particular, has the potential to significantly affect salt pond restoration efforts. Smooth cordgrass, known as *Spartina alterniflora,* is native to Atlantic coast tidal marshes. In the early 1970s, smooth cordgrass was deliberately introduced to the South Bay with unforeseen effects.[123] Unlike the native cordgrass species, *Spartina foliosa*, smooth cordgrass colonizes tidal mudflats, marsh pans, and the banks of small tidal creeks and ditches.[124] This colonization in previously unvegetated areas eliminates the "sinuous, branched sloughs and mosaics of pans" which uniquely define native San Francisco Bay tidal marshes from the more homogeneous "poorly-drained extensive marsh plains" of Atlantic coast salt marshes.[125] Also, smooth cordgrass grows on the same tidal mudflats, which, in their unvegetated state, provide foraging habitat for over one million migratory shorebirds passing through the estuary annually. Smooth cordgrass is highly invasive because it easily spreads from area to area on the tides and also can breed with native cordgrass, resulting in invasive hybrids.

   The Bay region containing the greatest amount of non-native smooth cordgrass, approximately 75 percent of the estuary's total, is in the South Bay between the San Mateo Bridge and the Dumbarton Bridge, totaling 350 acres. Thus, non-native smooth cordgrass has the potential to profoundly affect salt pond restoration goals and objectives, especially in the South Bay, due to possible colonization of areas opened to the tides and the restoration of salt ponds close to existing stands of smooth cordgrass will need to be undertaken cautiously.[126] In addition, the long term restoration of the salt ponds should be done in coordination with the Coastal Conservancy's Spartina Control Program, which is initiating efforts to control non-native cordgrass species throughout the Bay.

8. **Water Quality.** A number of water quality considerations exist in the planning process for the restoration of the salt ponds. Those water quality issues of greatest concern include: (1) hypersalinity in managed ponds; (2) dissolved oxygen; (3) mercury methylation; (4) copper and nickel; and (5) bittern management.

   a. **Hypersalinity in Managed Ponds.** The salinity of the Bay can range widely from 15-35 ppt, due to freshwater inflow from the Delta and other sources and tidal influence from

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[122] Cohen, A.N., and J.T. Carlton. 1998. Accelerating invasion rate in a highly invaded estuary. Science 279:555-558.

[123] Coastal Conservancy, San Francisco Estuary Invasive Spartina Project . 2001. Map of Distribution of Invasive Spartina Populations by Species, 2000-2001 Survey.

[124] San Francisco Estuary Invasive Spartina Project: Invasion Impacts. (http://www.spartina.org/invasion.htm#6)

[125] Baye, Peter. 2002. *Plant Species in Decline in the S.F. Bay Estuary*. San Francisco Estuary Project and Calfed. State of the Estuary Proceedings, October 2001.

[126] Baye, 2002.; and San Francisco Estuary Invasive Spartina Project: Invasion Impacts. (http://www.spartina.org/invasion.htm#6)

the Pacific Ocean.[127] Above 35 ppt, salinity becomes toxic to some organisms. Proposals to maintain managed saline ponds to simulate habitat currently provided by salt ponds can lead to retention of hypersaline waters in the South Bay ecosystem leading to issues of saline discharges into the Bay. Consequently, planning for the salinity reduction of brines (hypersaline water) in the salt pond system has been a primary focus of the restoration effort.

In March 2004, the Regional Board set maximum discharge salinity limits for initial release of salt ponds waters at 135 ppt for the Initial Stewardship Plan and discharges are limited to March and April due to various aquatic life constraints. The Regional Board also set a maximum salinity limit of 44 ppt for continuous circulation discharges, where Bay water is taken into and discharged from pond systems of the Initial Stewardship Plan.[128] At about 146 ppt, gypsum (calcium sulfate) precipitates, and changes the ion balance of the pond waters, making them more potentially toxic. The limit of 135 ppt for gypsum was set to include a margin of safety. In the Initial Stewardship Plan, Fish and Wildlife has proposed a batch pond system (Ponds A12, A13 and A15) to maintain hypersaline conditions that support brine shrimp and brine flies. Contents of these ponds will be released slowly to Pond A16, which will serve as a mixing chamber prior to discharge to the Bay below 44 ppt. Studies and monitoring conducted near discharge outfalls will assist the Regional Board in evaluating whether the 44 ppt limit is sufficient.

b. **Dissolved Oxygen**. Dissolved oxygen is oxygen gas molecules that are dissolved in water. While the atmosphere is about 20 percent oxygen, or 200,000 parts per million (ppm), only a small amount of oxygen, typically 7-14 ppm, can be dissolved in water. Oxygen easily dissolves from the atmosphere to water until it reaches a point of saturation and cannot hold anymore of the gas. The oxygen begins to diffuse slowly once it is in the water by currents that are created by wind. Oxygen also can enter the water after it is produced by photosynthesis from aquatic plants and algae. The amount of oxygen that can be held in the water is determined by factors such as temperature, salinity levels, and atmospheric pressure. When dissolved oxygen dips below 5 milligrams per liter (mg/l) for sustained periods of time, aquatic organisms suffer negative impacts on growth, reproduction, physiology, and behavior.[129] In the salt ponds, dissolved oxygen is controlled by the diurnal cycle, with maximum levels in the afternoon due to photosynthesis and minimum levels at dawn due to algal respiration. Excess nutrients in ponds, especially in late summer, could lead to accelerated algal growth that could upset the balance of dissolved oxygen and lead to fish kills and odors.

Low salinity ponds are more likely conducive to algal growth because (a) more algal species can tolerate salinities in this range, and (b) they tend to have elevated nitrogen and phosphorus concentrations, warm temperatures, and sunlight can penetrate to the bottom.[130] Higher temperatures make also dissolved oxygen management more challenging. Oxygen is less soluble at higher temperatures, and algal productivity and nighttime oxygen consumption increases with temperature. Due to shallow water depths, water temperature in the salt ponds is elevated relative to the Bay and varies widely throughout the day.

The key to controlling dissolved oxygen will be to maintain adequate flows in the system, and lowest possible water residence times. Some measures are available to keep

[127] Siegel and Bachand, 2002.

[128] California Regional Water Quality Control Board, San Francisco Bay Region, 2004. Waste Discharge Requirements for U.S. Fish and Wildlife Service and California Department of Fish and Game South San Francisco Bay Low Salinity Salt Ponds. Order No. R2-2004-0018.

[129] U.S. EPA, 1986. Ambient Water Quality Criteria for Dissolved Oxygen. EPA 440/5-86-003.

[130] Siegel and Bachand, 2002.

dissolved oxygen at levels that protect aquatic life, such as allowing high tide waters to enter ponds through one-way tidegates, or solar-powered aerators.[131]

c. **Mercury.** Mercury is a naturally occurring heavy metal found throughout the Coast Range of California in an elemental form known as cinnabar. In fact, the California Coast Range contains one of the world's greatest geologic deposits of mercury. Mercury was mined extensively from the Coast Range during the late 1800s and early 1900s and used to supply Gold Rush era gold miners in the Sierra Nevada with material needed for the gold extraction process.[132] The legacy of mining left piles of waster rock, surface soils and sediment contaminated with mercury, which flow from watersheds into the Bay, causing elevated mercury levels in Bay sediments and in some salt ponds.[133]

Of great concern with plans to restore many of the salt ponds to tidal marsh is the effect that this restoration process will have on the creation of methylmercury, an organic form of mercury. Mercury can undergo biological and chemical reactions that cause it to change form and alter its solubility, toxicity and bioavailability. More specifically, the transformation of inorganic mercury to organic methylmercury is powered largely by sulfate-reducing bacteria active at the interface of water high in oxygen and water low in oxygen, and in sediment and wetlands. Methylmercury is the most toxic form of mercury to animals and humans because when taken in, stays in an organism for long periods and accumulates in muscle tissues. In addition, methylmercury transfers between organisms through the food web and magnifies in concentration due to the increasing volume of food ingested.[134] Thus, as methylmercury moves from the water, to algae, to invertebrates to fish, birds and humans, the amount of methylmercury in the organisms highest up in the food chain is substantial.[135] Bird species reliant on fish and other aquatic organisms for their diet are highly susceptible to methylmercury contamination. Methylmercury is most damaging to the developing embryos of affected birds, resulting in possible behavioral changes in young birds and egg hatch failure.[136] For example, in the Bay the highest methylmercury levels were found in the eggs of those birds that nest in the salt ponds near Alviso Slough. Species impacted in the South Bay include black-necked stilts, avocets, snowy plovers, Caspian terns, black-crowned night herons and California clapper rails. In fact, "[m]ercury toxicity to clapper rail embryos appears to be one of the primary causes of mortality in the population of this endangered species."[137] Scientists also worry that fish hatchlings are at risk of being killed.[138] In addition, the consumption of fish is a primary pathway for exposure to mercury by humans.

In an aquatic environment, the methylation of mercury can occur in the sediment and the water column. Because wetlands are methylating environments, data suggest that methylmercury production may be significant in brackish environments, such as tidal

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[131] California Regional Water Quality Control Board, San Francisco Bay Region, 2004. Waste Discharge Requirements for U.S. Fish & Wildlife Service and California Department of Fish & Game South San Francisco Bay Low Salinity Salt Ponds. Order No. R2-2004-0018.

[132] Jones, Alan B. and Darrell G. Slotten. 1996. *Mercury Effects, Sources, and Control Measures*. San Francisco Estuary Institute, Regional Monitoring Program Contribution #20. (http://www.sfei.org/rmp/reports/mercury/mercury.html)

[133] Moore, Steve. 2003. Planning Section Leader of the San Francisco Bay Regional Water Quality Control Board. Letter to Al Wright of the California Department of Fish and Game Wildlife Conservation Board. "Review of Data from Cargill Salt Ponds, South San Francisco Bay."

[134] Calfed Bay-Delta Program. 2000. Water Quality Program Plan: *Mercury*.

[135] Presentation by James G. Wiener, University of Wisconsin-La Crosse, at U.S.EPA. 2003.

[136] California Regional Water Quality Control Board San Francisco Bay Region, 2003.

[137] Jay A. Davis, Donald Yee, Joshua N. Collins, Steven E. Schwarzbach, and Samuel N. Luoma. 2003. *Potential for Increased Mercury Accumulation in the Estuary Food Web* In: Larry R. Brown, editor. Issues in San Francisco Estuary Tidal Wetlands Restoration. San Francisco Estuary and Watershed Science. Vol. 1, Issue 1, Article 4.

[138] Kay, 2002.

marshes and sloughs, though methylmercury may also occur in diked managed ponds.[139] Factors that facilitate the methylation of mercury include the presence of organic matter, low-oxygen sediment, high microbial activity, and water level fluctuations.[140] In addition, scientists hypothesize that some areas within a tidal marsh are more conducive to the creation of methylmercury than other areas. In particular, the smallest channels and marsh ponds (pans) are areas that may have conditions most favorable to mercury methylation. These parts of a tidal marsh are highly utilized by fish, other aquatic organisms and wildlife for foraging for food. Also, methylmercury created in a tidal marsh environment can be exported on the tides to other parts of the Bay.[141] In particular, "[l]arge scale tidal wetlands restoration could have regional effects on mercury levels; however, any deleterious effects might be minimized or avoided by careful project design."[142]

Regulatory efforts are underway to address mercury in the Bay. Section 303(d) of the federal Clean Water Act requires states to compile a list of "impaired" water bodies that do not meet water quality standards for specific contaminants, such as mercury. Further, under the Clean Water Act the Regional Board is required to develop plans with numerical goals designed to attain and maintain water quality standards for specific contaminants, known as Total Maximum Daily Loads (TMDLs). All of San Francisco Bay is deemed to be impaired by mercury because it adversely impacts established beneficial uses, including sport fishing, preservation of rare and endangered species, and wildlife habitat.[143] Accordingly, the Regional Board completed a draft Total Maximum Daily Load project report in June 2003 for mercury. Key provisions of the final report will be formally incorporated into the Regional Board's Basin Plan.[144] A separate TMDL effort has been initiated by the Regional Board and the Santa Clara Valley Water District for addressing mercury in the Guadalupe River watershed.[145] Currently, seven percent of the Bay's total mercury inputs, or approximately 92 kg/year, are estimated to enter the Bay from the Guadalupe River watershed. Once implemented, the TMDL for the Guadalupe River watershed will decrease permissible loads of mercury into the Bay through identified implementation actions.[146]

In terms of salt pond restoration, "Regional Board staff believes that the mercury levels in the salt ponds warrant attention in how these ponds are managed during the restoration phase of the project."[147] The Regional Board staff also emphasizes the need to define Best Management Practices for the restoration of the salt ponds in order to prevent methylation of mercury when the ponds are opened to tidal influence in the highly contaminated South Bay.[148] More specifically, "[a]lternatives for careful management of Alviso Ponds near Alviso Slough must be characterized to minimize the concentration of

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[139] California Regional Water Quality Control Board San Francisco Bay Region, 2000 & Presentation by James G. Wiener, University of Wisconsin-La Crosse, at U.S.EPA. 2003.

[140] California Regional Water Quality Control Board San Francisco Bay Region, 2003.

[141] Wiener, James G. 2003. University of Wisconsin-La Crosse. Presentation at U.S.EPA.

[142] Davis, Yee, Collins, Schwarzbach, and Luoma, 2003.

[143] California Regional Water Quality Control Board San Francisco Bay Region, 2003.

[144] The Basin Plan is the master policy document that contains descriptions of the legal, technical, and programmatic bases of water quality regulation in the San Francisco Bay region. [California Regional Water Quality Control Board, San Francisco Bay Region. 1995. Water Quality Control Plan, San Francisco Basin.]

[145] Fiedler, Jim. 2003. Personal interview with the Chief of the Watershed Management Division at the Santa Clara Valley Water District.

[146] California Regional Water Quality Control Board San Francisco Bay Region, 2003.

[147] Letter from Steve Moore of the San Francisco Bay Regional Water Quality Control Board to Al Wright of the California Department of Fish and Game Wildlife Conservation Board. January 9, 2003. "Review of Data from Cargill Salt Ponds, South San Francisco Bay."

[148] Moore, Steve. 2003. Personal interview with Planning Section Leader of the San Francisco Bay Regional Water Quality Control Board.

mercury in the Bay's food chain."[149] In other words, it is important to relate wetland design and management practices to methylmercury production rates where feasible. Physical factors that can be manipulated during restoration as a means to reduce the production of methylmercury in the Bay's wetlands include: (1) degree of inundation; (2) salinity; (3) vegetation; and (4) source sediment.[150] However, additional studies are needed to determine potential methylmercury management strategies and their effectiveness, and pre- and post-project monitoring will be important.

d. **Copper and Nickel.** The process of making salt through the solar evaporation of Bay water concentrates Bay pollutants (e.g. copper and nickel) in the ponds proportionately with salinity. Therefore, higher salinity ponds (above 50 ppt) contain levels of pollutants in excess of water quality objectives for the Bay. As a result, the Regional Board will likely have to limit the discharge of brines from salt ponds to the Bay to a salinity of 50 ppt and lower—possibly nearer ocean salinity of 35 ppt—during the restoration process.[151] In sum, the restoration of the salt ponds will need to proceed in a manner which assures the appropriate dilution of brines before release to the Bay, so as not to exceed water quality objectives for copper and nickel.

e. **Bittern Management.** Bittern is the residual brine transferred from crystallizers after the harvesting of sodium chloride (common salt). Initially a liquid, bittern is composed of dissolved salts, primarily magnesium, potassium, bromide and chloride. Because of evaporation, bittern continues to concentrate after transfer and separates into a solid and liquid phase.[152] In addition, as brine moves through the salt production process, various ions[153] are removed from solution creating what is termed an "ionic imbalance." The combination of hypersalinity and an ionic imbalance makes bittern toxic to aquatic organisms. Thus, the Regional Board has not allowed direct discharge of bittern (without dilution) into San Francisco Bay. As a result, approximately 19-20 million tons of liquid and solid bittern are estimated to be stored in Cargill-owned ponds in Redwood City and refuge-owned Ponds 12 and 13 in Newark.[154] Cargill has undertaken concerted efforts to market products derived from bittern liquid, such as "Dust-Off," "Hydro-Melt" and ClearLane."[155] Each of these products assists with keeping roads dust free or ice free. Further, Cargill opened a salt recovery pilot plant in Newark related to different utilizations of bittern and is currently researching marketable uses for solid bittern.[156]

Overall, it is important to consider various water quality issues when determining the mix between restoring salt ponds to tidal habitats and managing ponds to provide habitat for specific species. For example, restoring salt ponds to managed ponds infers a permanent necessity to monitor the movement of water through the ponds in such a way that stagnation and the production of algae blooms is avoided.[157] On the other hand, tidal marshes and tidal flats have the capacity to improve water quality, rather than potentially exacerbate water quality problems.

In addition, tidal marshes serve an important function of assimilating nutrients such as nitrate and phosphate, particularly from land-based sources. While nutrients are essential for aquatic life, excessive nutrient enrichment can result in eutrophication, the process of nutrient enrichment

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[149] Letter from Steve Moore of the San Francisco Bay Regional Water Quality Control Board to Al Wright of the California Department of Fish and Game Wildlife Conservation Board. January 9, 2003. "Review of Data from Cargill Salt Ponds, South San Francisco Bay."

[150] California Regional Water Quality Control Board San Francisco Bay Region, 2000.

[151] Moore, 2003.

[152] Siegel and Bachand, 2002.

[153] An "ion" is an atom or group of atoms that has acquired an electric charge by losing or gaining one or more electrons.

[154] Siegel and Bachand, 2002.

[155] Johnson, Lori. April 2001. Cargill Research Opens Up Sweet Opportunities for Bittern Utilization. *The Bay's Edge: A Cargill Salt Report.* Vol. 12, no. 1.

[156] Douglass, Robert C. 2001.

[157] Moore, 2003.

such that the productivity of the system ceases to be limited by the availability of nutrients. Eutrophication leads to algal blooms. Bacterial decomposition of the excess algae can result in the depletion of dissolved oxygen. Restoration of salt ponds to tidal marsh, on the other hand, would increase assimilation of nutrients.

Also, tidal marshes and tidal flats provide a vital connection to the Bay's aquatic food web. For example, when tidal marsh plants die back in the fall and winter, up to 70 percent of the plant material is broken down into small particles and released into the Bay on the tides. Once in the Bay, this plant material provides a wealth of food to estuarine fish and other aquatic organisms. The South Bay's most important source of primary productivity[158] is the annual spring phytoplankton bloom[159] in the water column.[160] On the East Coast, tidal marsh and tidal flats are the most significant source of primary productivity, rivaling that of the world's most productive ecosystem, tropical forest.[161] In San Francisco Bay, the decrease in tidal flat and tidal marsh area may explain why the spring bloom is today's most important food source to Bay organisms. Restoration of tidal habitats could restore the importance of the Baylands for primary productivity and therefore increase populations of some Bay species.

9. **Mosquito Abatement.** While the salt ponds used for salt production do not foster large mosquito populations, changes in water management regimes associated with habitat restoration may lead to a substantial increase if managed improperly. A variety of species of mosquitoes is associated with the tidal and seasonal wetlands of the Bay, including the California salt marsh mosquito and the black salt marsh mosquito.[162] Because mosquitoes are vectors for disease, including West Nile Virus, the restoration of the salt ponds will need to proceed in a manner that incorporates plans for mosquito abatement. The primary goals of mosquito abatement are to keep mosquito populations below threshold levels for disease transmission to humans and to reduce nuisance problems that can impact recreational, economic and agricultural activities, as well as create public distress.[163] A critical component of adequate abatement is ensuring that the restoration of the salt ponds incorporates input from local mosquito abatement districts on the design of wetland restoration and enhancement projects. In particular, tidal action is a good deterrent to increases in mosquito populations because water movement hinders mosquito reproduction. Further, appropriate design elements may include: (1) exposing an area to regular tidal action; (2) creating open water with little or no vegetation; (3) permanently flooding areas to provide habitat for mosquito predators; and (4) establishing a long fetch for the creation of wind waves.[164]

10. **Public Access.** In an effort to seek a balance between the need to provide public access to the Bay, while recognizing potential impacts on the Bay's natural environment associated with public access, in particular impacts to wildlife, the Commission initiated a study and adopted new Bay Plan findings and policies pertaining to public access and wildlife compatibility in 2001. In considering future siting, design and management of public access in salt pond areas proposed for restoration, the following Bay Plan Public Access policies are of particular relevance to the Commission in considering salt pond restoration plans:

> Policy 4. Public access should be sited, designed and managed to prevent significant adverse effects on wildlife. To the extent necessary to

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[158] Amount of organic material, primarily plant material, available in an ecosystem as a food source for organisms higher up the food chain.

[159] Tiny plants, such as algae, which float in the Bay's waters and provide food to fish and other aquatic organisms.

[160] National Oceanic and Atmospheric Administration. 2003. Report of the Independent Scientific Peer Review Panel on Predicted Changes in Hydrodynamics, Sediment Transport, Water Quality, and Aquatic Biotic Communities Associated with San Francisco International Airport Runway Configuration Alternatives. November 2003. pp. 16-19.

[161] Schlesinger, W.H. 1977. Carbon Balance in Terrestrial Detritus. Annual Review of Ecology and Systematics. Volume 8, pp. 51-81.

[162] Contra Costa Mosquito & Vector Control District: Comparative Biology of Twenty-One Prevalent California Mosquito Species. (http://www.ccmvcd.dst.ca.us/california_mosquito_species.htm)

[163] Goals Project, 1999.

[164] Goals Project, 1999.

> understand the potential effects of public access on wildlife, information on the species and habitats of a proposed project site should be provided, and the likely human use of the access area analyzed. In determining the potential for significant adverse effects (such as impacts on endangered species, impacts on breeding and foraging areas, or fragmentation of wildlife corridors), site specific information provided by the project applicant, the best available scientific evidence, and expert advice should be used. Siting, design and management strategies should be employed to avoid or minimize adverse effects on wildlife…
>
> Policy 12. Public access should be integrated early in the planning and design of Bay habitat restoration projects to maximize public access opportunities and to avoid significant effects on wildlife.

As defined previously, the goal of the South Bay salt pond restoration process includes providing for "wildlife-oriented public access and recreation." Similarly, the North Bay restoration process will also include a public access component. Further, both land management agencies involved in the acquisition and restoration of the salt ponds—Fish and Game and Fish and Wildlife—recognize the importance of providing public access compatible with the protection of wildlife. For example, the Don Edwards San Francisco Bay National Wildlife Refuge was established by Fish and Wildlife to "…preserve and enhance significant wildlife habitat in South San Francisco Bay; protect migratory birds and other wildlife, including threatened and endangered species, and to provide opportunities for wildlife-oriented recreation and nature study."[165]

Similarly, Fish and Game's Mission Statement is to both maintain "native fish, wildlife, plant species and natural communities for their intrinsic and ecological value and their benefits to people," while providing for "the diversified use of fish and wildlife including recreational, commercial, scientific and educational uses."[166] To this end, both Fish and Game and Fish and Wildlife support the need to, "[p]rovide public access and recreational opportunities compatible with wildlife and habitat goals," as a long term restoration objective for the salt ponds.[167]

Planning for the public access component of the long term restoration phase of the South Bay salt ponds will occur over the next five years with substantial scientific and public input. The Commission's staff is an active partner in the public access planning process for the long-term restoration of the South Bay salt ponds and is actively participating in the Public Access and Recreation Work Group. Overall, the Commission's role in the planning process for the siting, design, and management of public access associated with the restoration of salt ponds will include promoting the objectives of the McAteer-Petris Act and the Bay Plan, including avoiding significant adverse effects on wildlife. Additional, more specific, public access objectives for salt pond restoration projects include the following:

a. **Plan for Permanence.** Many changes to the configuration of levees where public access could be sited will be occurring in the upcoming years as salt ponds are restored to tidal marsh. However, levees necessary to provide flood protection or to enhance specific salt ponds as managed ponds will likely have more permanence. Thus, flood control and managed pond levees may be considered more appropriate for the siting of public access, due to their longevity, than levees that may be breached in the future.

b. **Create a Conceptual Plan for the Bay Trail.** Early in the restoration planning process, a conceptual plan for the siting of the Bay Trail spine (such as along the inland edge of the salt ponds) should be created. The establishment of a vision for public access along the inland edge of the Bay would be valuable because it would: (1) be focused in a location

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[165] U.S. Fish and Wildlife Service—Pacific Region: Don Edwards San Francisco Bay National Wildlife Refuge, Mission Statements. (http://desfbay.fws.gov/mission.htm).

[166] California Department of Fish and Game: Mission Statement. (http://www.dfg.ca.gov/html/dfgmiss.html).

[167] Napa Plant Site Restoration Plan, Mission, Goals, Guiding Principles, and Objectives. May 1, 2003. Draft. & South Bay Salt Pond Long Term Restoration Plan, Mission, Goals, Guiding Principles, and Objectives. June 4, 2003. Draft.

that is less likely to change throughout the restoration process; and (2) provide a starting point for interested parties to work together on a public access plan. Further, as restoration plans are solidified, the planning for spur trails moving from the shore towards the Bay can be considered in an effort to bring people closer to the Bay.

c. **Recreational Boating.** Recreational boating opportunities, such as kayaking and canoeing, could be vastly improved throughout the Bay. At the same time possible adverse impacts to marine mammals, such as harbor seals, must be avoided to the greatest extent possible consistent with the Marine Mammal Protection Act. An example of a possible adverse effect could include kayaking too close to a haul-out site and causing harbor seals to flush into the water. In addition, while larger creeks and sloughs may be the most appropriate location for recreational boating, due to depth and ease of access, seasonal closures may be necessary to avoid potential impacts on sensitive wildlife. Further, some creeks and sloughs may not be appropriate for recreational boating, regardless of size, due to the presence of sensitive wildlife.

d. **Education/Interpretation.** Salt pond restoration projects provide unique and significant opportunities for educational and interpretive experiences for the public. Education and interpretive planning can provide the public with quality experiences while also promoting resource protection. In addition, salt ponds provide an opportunity for the public to understand and experience unique historical and cultural features, including the historical salt making industry.

CHAPTER 3
COMMISSION SALT POND JURISDICTION AND AUTHORITY

This chapter discusses the Commission's jurisdiction and authority over salt ponds in San Francisco Bay, including a discussion of how Cargill and the Commission differ in their interpretations of the Commission's jurisdiction and authority.

Much of this chapter is based on informal written advice issued by the Office of the California Attorney General. Informal written advice is meant to assist the Commission on questions of law and is generally undertaken by Deputy Attorneys General familiar with the Commission's law and policies. However, such written advice is informal and, as such, does not hold the same weight as formal legal opinions regarding questions of law issued by the Attorney General, the chief law officer of the state. In contrast to informal written advice, formal legal opinions are reviewed by the Opinion Unit of the Office of the Attorney General and are given great respect by the courts, although they are non-binding on a court's ultimate decision in a case. In addition, formal legal opinions are published in a Monthly Opinion Report and a Yearly Index.[168] Informal written advice, however, does provide the Commission with valuable insight regarding legal questions, such as the Commission's jurisdiction over salt ponds.

Commission "Salt Pond" Jurisdiction. Government Code Section 66610(c) defines the Commission's "salt pond" jurisdiction as:

> [s]alt ponds consisting of all areas which have been diked off from the bay and have been maintained during the three years immediately preceding the effective date of the amendment of this section during the 1969 Regular Session of the Legislature for the solar evaporation of bay water in the course of salt production.

The Office of the California Attorney General has advised the Commission that all types of ponds in the salt production cycle are part of the Commission's "salt pond" jurisdiction.[169] Thus, according to the Office of the Attorney General, the Commission's "salt pond" jurisdiction includes evaporator ponds, pickle ponds, crystallizer ponds, bittern ponds and wash ponds. Cargill disputes this conclusion and contends that only evaporator (concentrating) ponds are part of the Commission's "salt pond" jurisdiction because the solar evaporation process occurs in the evaporators and not in the pickle ponds, crystallizers, bittern ponds and wash ponds. As the final stage in the evaporative process, the role of pickle ponds is to hold saturated brines before they are distributed to the crystallizers, and Cargill contends further evaporation is undesirable. In addition, Cargill contends that because the other types of ponds are not used for solar evaporation, are highly industrialized (and thus do not foster the habitat values associated with salt ponds) and are dry for parts of the year they should not be included in the Commission's "salt pond" jurisdiction. Based on this premise, Cargill believes that its privately owned Newark and Redwood City Plant sites are not within the Commission's jurisdiction because these areas consist primarily of crystallizers, bittern ponds and wash ponds. Historically, however, the Commission has asserted its authority over the entire salt pond system. For example, BCDC Permit No. 4-93 issued to Cargill authorizes maintenance activities throughout the entirety of Cargill's salt production system (though Cargill reserved its right to argue that such authorization was not needed). The Commission has not, however, asserted jurisdiction over the refining and processing facilities located upland of the salt ponds because these areas were not "diked off from the bay…for the solar evaporation of bay water in the course of salt production."[170] It should also be noted that Cargill, as successor to Leslie Salt, has claimed total exemption from BCDC's jurisdiction as delineated in Case 74-1. However, BCDC has agreed to hold this claim in abeyance and the parties have agreed to disagree on the legitimacy of the exemption.

The Attorney General's office reached its conclusion that BCDC has jurisdiction over each of the salt pond types based on the following determinations:

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[168] For more information please see (http://caag.state.ca.us/opinions/index.htm)

[169] Masouredis, Linus. 1986. Deputy Attorney General. Letter to Alan Pendleton, Executive Director of BCDC. "Request for an Informal Opinion Regarding BCDC Salt Pond Jurisdiction." July 3, 1986.

[170] Government Code Section 66610(c).

(1) while the majority of evaporation does occur in the evaporator ponds, solar evaporation also occurs in the other types of ponds;[171]

(2) while the ponds in the salt production cycle may have different names, the brines moving through each of the ponds "consist of, or are derived from, seawater;"[172]

(3) "all of the ponds are integral and essential components of the salt production system;"[173]

(4) no language in Section 66610(c) indicates that certain types of ponds should be excluded from the definition of "salt ponds;"[174]

(5) the "legislative objectives underlying salt pond jurisdiction [e.g., maintaining open space and water surface area, as well as protecting the integrity of the salt production system and associated habitat values] are provided not only by concentrators, but also by the other types of salt ponds in the salt production system;"[175]

(6) "[i]f 'salt ponds' were deemed to include only concentrators, then other ponds—which are essential to the continued operation of the system—could be more easily converted to other uses, which would impair the viability of the overall system…"[176] and

(7) because it is not difficult to convert salt ponds from one type to another, if the Commission's "salt pond jurisdiction was construed as being limited to only one type of pond (for example, concentrators) then certain areas might pass in and out of BCDC's jurisdiction depending upon the fortuitous production patterns of the salt-making company."[177]

Three other conclusions reached by the Attorney General's office in 1986 regarding the Commission's salt pond jurisdiction include:

(1) "the dikes creating salt ponds are included as part of a 'salt pond' as that term is used in Government Code Section 66610(c);"[178]

(2) salt pond levees are not within the Commission's "shoreline band" jurisdiction, rather "the levees that create and surround salt ponds are part of the salt ponds and fall within BCDC's salt pond jurisdiction…;"[179] and

(3) "salt pond jurisdiction includes ponds that may have been excavated from uplands and that were not historically part of the Bay."[180]

In regards to the first determination regarding the inclusion of dikes surrounding salt ponds within the Commission's "salt pond" jurisdiction, the Attorney General's opinion concludes that the language of McAteer-Petris Act Section 66610(c) defining the Commission's "salt pond" jurisdiction "is broad enough to include the protective works or dikes without which there would be no salt pond at all."[181] In addition, because it is an important objective of the Legislature to "preserve and maintain a viable functioning salt pond system, it is reasonable to conclude that the Legislature intended that the

[171] Masouredis, 1986: 4.
[172] Masouredis, 1986: 4.
[173] Masouredis, 1986: 4.
[174] Masouredis, 1986: 5.
[175] Masouredis, 1986: 9-10.
[176] Masouredis, 1986: 11.
[177] Masouredis, 1986: 13.
[178] Masouredis, 1986: 14.
[179] Masouredis, 1986: 15.
[180] Masouredis, 1986: 16-19.
[181] Masouredis, 1986: 14.

dikes—which are an essential requirement for maintaining that system—should also be subject to BCDC salt pond regulation."[182]

In regards to the second determination regarding the exclusion of salt pond levees from "shoreline band" jurisdiction, the Attorney General's informal opinion expresses that "[i]nsofar as such levees are within BCDC's salt pond jurisdiction, they cannot also be within BCDC's shoreline band jurisdiction" due to the specific provisions of McAteer-Petris Act Section 66610(b) which excludes salt ponds from having "shoreline band" jurisdiction.[183] In regards to the third conclusion that "salt pond" jurisdiction includes ponds that were not formerly part of the Bay prior to their excavation for salt production, the Attorney General opines that "to construe BCDC jurisdiction as limited to only those salt pond areas that are within the historic Bay margin would lead to bizarre and anomalous consequences."[184] For example:

> …if a salt pond was partly within and partly outside the historic Bay margin, and if BCDC jurisdiction included only that portion within the historic Bay margin, then BCDC jurisdiction would extend in a crazy quilt fashion over portions of the pond even though both portions of the pond provide the same wildlife, climatic, air quality, and open space benefits which are the very reasons for salt pond jurisdiction."[185]

Permit Authority. The Commission has the authority to require permits for: (1) the placement of fill in salt ponds; (2) the extraction of materials associated with salt production; and (3) substantial changes in use of salt ponds because salt ponds are within the Commission's jurisdiction. The Commission's salt pond authority derives from Section 66632(a) of the McAteer-Petris Act which states that "[a]ny person or governmental agency wishing to place fill, to extract materials, or to make any substantial change in use of any water, land or structure, within the area of the commission's jurisdiction shall secure a permit from the Commission."

Further, all projects within the Commission's "salt pond" jurisdiction should be consistent with BCDC's law, the McAteer-Petris Act, and its Bay Plan policies.

1. **Fill.** In regards to the placement of fill in salt ponds, the Attorney General's office in 1990, determined that:

> …the Commission may evaluate fill projects in its salt pond jurisdiction for their consistency with the policies contained in subsections (c) through (g) of section 66605 because these policies are applicable throughout the Commission's jurisdiction.[186]

Relevant provisions of Section 66605 that pertain to the placement of fill in salt ponds include:

> …(c) That the water area authorized to be filled should be the minimum amount necessary to achieve the purpose of the fill;
>
> (d) That the nature, location and extent of any fill should be such that it will minimize harmful effects to the bay area, such as the reduction or impairment of the volume surface area or circulation of water, water quality, fertility of marshes or fish and wildlife resources, or other conditions impacting the environments, as defined in Section 21060.5 of the Public Resources Code[187];

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[182] Masouredis, 1986: 14.

[183] Masouredis, 1986: 15.

[184] Masouredis, 1986: 19.

[185] Masouredis, 1986: 19.

[186] Barbieri, Joseph. 1990. Deputy Attorney General. Letter to Alan Pendleton, Executive Director of BCDC. "Regulation of the Placement of Fill in the Salt Ponds." July 9, 1990.

[187] Public Resources Code Section 21060.5., "Environment," means "the physical conditions which exist within the area which will be affected by a proposed project, including land, air, water, minerals, flora, fauna, noise, objects of historic or aesthetic significance."

> (e) That public health, safety, and welfare require that the fill be constructed in accordance with sound safety standards which will afford reasonable protections to persons and property against the hazards of unstable geologic or soil conditions or of flood or storm waters;
>
> (f) That fill should be authorized when the filling would, to the maximum extent feasible, establish a permanent shoreline;
>
> (g) That fill should be authorized when the applicant has such valid title to the properties in question that he or she may fill them in the manner and for the uses to be approved.

2. **Extraction of Materials.** The Commission has the authority to review the proposed extraction of materials (e.g., dredging) associated with salt production. Some of the dredging activities approved by Commission Permit No. 4-93 for the maintenance of the salt ponds include authorizing Cargill to: (1) "[p]erform periodic maintenance dredging of the Redwood City and Napa dock area, and the Newark barge canals…;" (2) "[d]ispose salt pond dredged material along the inside and top of salt pond levees to maintain levee configuration; and (3) "[p]lace dredged material into existing stockpile areas…or on the levees, to the maximum extent feasible." Dredging activities associated with the restoration of the publicly-acquired ponds are also within the purview of the Commission. For example, the Commission authorized the dredging of a barge access channel by Cargill so salt could be harvested and shipped out of the Napa Plant Site crystallizers purchased by the State of California for restoration in 2003.

3. **Substantial Change in Use.** A substantial change in use of a salt pond is defined by Government Code Section 10125 of the Commission's regulations as:

> …any change in use including abandonment which, for the purposes of this section, shall include any draining of water except temporary draining for a short period of time in accordance with routine operating practice…

Therefore, the Commission's regulations define the abandonment of a salt pond as a change in use that results in the discontinuation of salt production, rather than a change in ownership. For example, for Fish and Game and Fish and Wildlife to stop producing salt, once the phase-out of salt production is complete, and active restoration begins, both Fish and Game and Fish and Wildlife will need authorization from the Commission to "abandon" salt making.

"Salt Pond" Jurisdiction For Ponds No longer Used to Produce Salt. McAteer-Petris Act Section 66610(c) defines the Commission's "salt pond" jurisdiction in such a way that the jurisdiction is retained even if an area is no longer used for salt production. This is due to the fact that the state legislature, in writing the McAteer-Petris Act, defined "salt ponds" as those areas "used during the three years immediately preceding the effective date of the amendment of this section during the 1969 Regular Session of the Legislature" for salt production. Thus, once an area is defined as a salt pond, it remains within the Commission's "salt pond" jurisdiction. Such a determination results in an interesting outcome when a salt pond is opened to the tides. In this instance, the area would have simultaneous "bay" and "salt pond" jurisdiction because the "salt pond" jurisdiction is not extinguished when the tide enters the site.[188] "Bay" jurisdiction is defined by McAteer-Petris Act Section 66610(a) as:

> San Francisco Bay, being all areas that are subject to tidal action…including all sloughs, and specifically, the marshlands lying between mean high tide and five feet above mean sea level; tidelands

[188] This conclusion is based upon informal consultation with Deputy Attorney General Joel Jacobs. To date, no court has addressed this question. Nothing in the McAteer-Petris Act, however, specifies that an area may come within only one type of Commission jurisdiction even if it satisfies the requirements of only one. In addition, the Commission has implemented this opinion in one permit, No. 2-02, which authorized a marina and a boatyard in a former salt pond and included a finding that the parcel falls within both the Commission's "bay" and "salt pond" jurisdiction. However, it is important to note that the Commission would not gain "shoreline band" jurisdiction under this dual jurisdiction scenario, due to conflict with Section 66610(b) which specifically excludes salt ponds from having "shoreline band" jurisdiction.

(land lying between mean high tide and mean low tide); and submerged lands (land lying below mean low tide).

As many of the salt ponds are proposed for restoration, former salt ponds restored to tidal marsh, tidal flat or open water would still be considered jurisdictional "salt ponds" while also being considered jurisdictional "bay." In addition, restored areas would also continue to be mapped on the Bay Plan Maps as salt ponds, shown in gray. Further, ponds no longer used for salt production, but instead managed under a muted tidal regime[189] for shorebirds and waterfowl, would also continue to be considered jurisdictional "salt ponds" even though no salt is produced by the ponds. These areas operating under a muted tidal regime would also continue to be mapped as gray on the Plan Maps. Though the graphic depiction of salt ponds restored to tidal action or managed as diked pond habitat on the Plan Maps as salt ponds may cause some confusion as to the true physical nature of an area, it is important to acknowledge the Plan Maps' function as a tool for the Commission and the public in determining jurisdictional authority, rather than a description of the physical properties of the Bay. To that end, retaining jurisdictional salt ponds as gray on the Plan Maps will assist the Commission and staff in determining what sections of the McAteer-Petris Act and the Bay Plan to apply to a proposed project.

In conclusion it is important that revised Bay Plan salt pond findings and policies guide the regulation of different uses of the salt ponds, including: (1) salt ponds used for salt production; (2) salt ponds proposed for development; and (3) salt ponds restored to tidal action or managed for shorebirds and waterfowl.

[189] Under a muted tidal regime, full tidal action (the tide) is dampened and controlled by tide gates or other barriers.

CHAPTER 4

CHARACTERISTICS AND ALTERNATE USES OF THE PRIVATELY OWNED SALT PONDS

Due to a consolidation of Cargill's operations and market changes, the roughly 41,500 acres of salt ponds once used by Cargill to manufacture salt in the North and South Bays has been reduced to about 12,400 acres in the South Bay only (of which only 4,400 acres are owned in fee title by Cargill). Public entities have purchased over 36,000 acres since the early 1990s, an outcome consistent with McAteer-Petris Act and the Bay Plan. Today, the majority of the salt ponds operated by Cargill are publicly owned as part of Don Edwards San Francisco Bay National Wildlife Refuge, although Cargill retains perpetual salt making rights on these ponds. By and large the only salt ponds remaining in private ownership are two large tracts (the Redwood City Plant Site and the Newark Plant Site) on either side of the South Bay that are part of the larger salt production system.

Both of these privately owned areas are discussed in this chapter in terms of their physical characteristics, role in the salt production cycle, and values, as well as their context in relationship to adjacent land uses. In addition, an important component of this discussion is how the Commission evaluates proposed alternate uses of these areas if continued salt production ceases and public purchase for restoration does not occur.

In addition to the two plant sites, Cargill owns a pond of about 150 acres in size that is no longer used for salt production, the future use of which is currently undetermined. Finally, there are about 1,100 acres of ponds currently owned by public agencies (the City of San Jose and the Santa Clara Valley Water District) with undetermined future uses. Though it is likely that these 1,100 acres will be restored or managed for habitat, it is certainly possible that development may be proposed for these areas. However, given that any ponds other than those within Cargill's two plant sites would be proposed for development is relatively unlikely, this chapter focuses primarily on the two plant sites, though any resulting revisions to the Bay Plan salt pond findings and policies to address alternate uses would apply to any jurisdictional salt pond, regardless of ownership.

Description of Plant Sites. As discussed in Chapter 1, Cargill owns approximately 4,400 acres of Bay Area salt ponds in fee title. The Redwood City Plant Site consists of approximately 1,400 acres while the Newark Plant Site consists of approximately 3,000 acres. Figure 2 illustrates the location of the Newark and Redwood City Plant Sites. While historically the Redwood City Plant Site operated independently as a site where salt was harvested and shipped to market, the lands in Redwood City are currently being operated in support of solar salt operations at the Newark Plant Site across the Bay[190] as the result of changes in infrastructure allowing brines and other liquids to be transported back and forth between the Newark and Redwood City Plant Sites.

The Newark Plant Site is the focus of Cargill's current system, but the Redwood City Plant Site continues to have a role in the system. Speaking of that role and the future of the Redwood City Plant site, Robert Douglass, Manager of Real Property for Cargill, noted, "we cannot predict what future market conditions in salt may bring so we cannot know how long it will be profitable to utilize Redwood City facilities for salt making purposes."[191]

Cargill also has the ability to ship bittern from Cargill's former marine terminal in Redwood City (now owned by Abbott Laboratories but leased by Cargill). Bittern operations are scheduled to be phased out at this location by 2010 when the lease ends.[192] Worth noting is that bittern, as a product of salt production, is deemed a profitable and marketable product by Cargill. For example, Cargill has established a pilot plant at the Newark Plant Site for the production of low sulfate bittern. Thus, less storage is occurring in bittern storage ponds and more bittern is being refined for commercial sales. Efficiency in re-use of bittern may have an effect on the amount of land which Cargill needs for salt

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[190] Douglas, 2003.

[191] Douglas, 2003.

[192] City of Redwood City Planning Services. 2003. Draft Environmental Impact Report for Abbott Laboratories West Coast Research Center. Prepared by Environmental Science Associates.

production, potentially freeing up bittern ponds for alternate uses after stored bittern has been processed and sold.

As discussed in Chapter 2, the two plant sites are where the salt is harvested. The types of ponds found at each plant site include—in order of its stage in the salt production cycle—pickle ponds (which store the feedstock brine for the crystallizers), crystallizers (where salt precipitates on engineered beds and is mechanically harvested), bittern desalting ponds (used to remove additional salt and make the bittern more concentrated), bittern storage ponds (where bittern is stockpiled, processed and eventually marketed or mixed with Bay water and sent back to crystallizers for harvest), and wash ponds (which receive Bay water that has been used to wash impurities from the crystallized salt). The plant sites represent the termination of the salt production cycle and the types of ponds in the plant sites distinguish the areas from the evaporator ponds found earlier in the salt production cycle. Thus, the ponds closest to and within the plant sites are highest in salinity.[193]

Habitat Values of Plant Sites. The habitat values of salt ponds in general, and of the types of ponds found in plant sites in particular, are discussed in great detail in Chapter 2. Overall, the management regime of a pond largely determines the value of a pond to shorebirds and waterfowl. For example, in general, as the salinity increases, waterbird abundance and diversity in ponds decreases. In addition, the depth of the water in a pond matters. Shallow water ponds are good habitat for shorebirds, while many waterfowl species prefer deeper water ponds. In general, bittern ponds and pickle ponds do not have high resource values because they are too high in salinity. Similarly, crystallizer ponds have low habitat values for most species of shorebirds and waterfowl, although they may be used as roosting sites.[194] Also, the federally threatened Pacific coast population of the Western snowy plover utilizes dried and drying ponds and adjacent levees of any type.[195] However, due to the operational requirements necessary to move the brines, harvest the salt, etc. plant sites have a degree of ongoing industrial activity that may limit habitat opportunities. Worth noting is that neither the Redwood City Plant Site nor the Newark Plant Site has been surveyed from the ground, so no definitive conclusions can be drawn as to the habitat values of the area.

Salt ponds also may provide water surface area, which is important for climate moderation and air quality. Though it seems reasonable to assume that not all the areas of the plant sites contain water surface area, some of the various ponds within a plant site would seem to provide some water surface area, including pickle ponds, wash ponds, bittern desalting ponds, and to a much more limited extent, even crystallizers.

Finally, all salt ponds provide a significant opportunity for restoration to tidal action or management for wildlife, though clearly some types of ponds may be easier to restore or manage than others. However, history has shown that even crystallizers can be successfully restored to tidal action. LaRiviere Marsh, part of the Don Edwards San Francisco Bay National Wildlife Refuge, is the site of 100 acres of former crystallizers that was successfully restored to tidal marsh in the mid 1980s. In addition, Fish and Game anticipates the successful restoration or management of the Napa Plant Site they acquired in 2003.

Historic Habitat Composition of Plant Sites.[196] While it is difficult to discern the exact historic conditions of the plant sites, some generalizations can be made based on what is known. Prior to being diked for salt production, the Redwood City Plant Site (not including the upland portions) consisted of tidal marsh habitat with large, well-developed channels and adjacent associated slough systems. Outboard of the tidal marshes in this area of the Bay were oyster shell beaches, large expanses of tidal flats and oyster beds. To the west of the present day Redwood City Plant Site was moist grassland habitat characterized by seasonal wetlands. Similarly, with the exception of the crystallizers, the majority of the Newark Plant Site consisted of tidal marsh habitat. Tidal marshes in this area supported extensive channel systems and numerous tidal marsh pans, including backshore pans along the tidal marsh and upland

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[193] Siegel and Bachand, 2002.

[194] Warnock, Nils. 2003. Personal interview of Wetlands Ecology Division Co-Director, Point Reyes Bird Observatory.

[195] San Francisco Bay Bird Observatory.San Francisco Bay Bird Observatory Western Snowy Plover Program. http://www.sfbbo.org/plover_b.htm

[196] Goals Project, 1999.

habitat ecotone.[197] The area where the Newark crystallizer ponds are located was once upland grassland habitat strongly associated with the adjacent tidal habitats by extensive transition zones. The tidal flats outboard of the tidal marshes, adjacent to the present day Newark Plant Site, were moderate in size with channel and shallow bay habitat more abundant than today.

Habitat Goals Restoration Recommendations for the South Bay.[198] The *Baylands Ecosystem Habitat Goals* report (discussed in more detail in Chapter 2) specifies detailed restoration opportunities and recommendations for each region of the Bay. It is important to consider the recommendations in the Goals Report for the South Bay within the context of the acreage acquired from Cargill that are currently undergoing plans for habitat restoration and management. The Goals Report's overall goal for the South Bay is to restore large areas of tidal marsh (an increase of about 15,000 to 20,000 acres) and to manage an additional 10,000 to 15,000 acres of salt pond habitat specifically for wildlife, for a total of 25,000-35,000 acres of restored and converted habitat. Clearly, the transfer to public ownership for restoration purposes of over 15,000 acres of salt ponds in the South Bay in 2003 significantly advances the Goals Report objectives for the South Bay.

The Goals Report also contains specific opportunities and recommendations in the region of the Redwood City Plant Site[199] including: (1) the opportunity to maintain and enhance shorebird and waterfowl habitat at the Redwood City crystallizers and associated salt ponds in close proximity to the large tidal flats that are so important for foraging shorebirds; (2) the opportunity to provide nesting habitat for the snowy plover by creating salt pan habitat; (3) the recommendation to restore large areas of tidal marsh by providing a continuous band along the waterfront; and (4) the recommendation to restore tidal marsh along Westpoint Slough and Redwood Creek, but modify the Redwood City salt crystallizers adjacent to Redwood Creek as salt pond habitat managed for shorebirds and waterfowl.

Opportunities and recommendations in the region of the Newark Plant Site include: (1) the potential for modifying and managing salt ponds for the benefit of large numbers of shorebird species that forage on nearby tidal flats; (2) the opportunity to restore historic tidal marsh/upland transitional habitat and associated vernal pool habitat at the upper ends of Newark, Plummer, Mowry and Albrae sloughs; (3) the recommendation to modify and manage for shorebirds and waterfowl a complex of salt ponds adjacent to and including the crystallizer complex between Mowry Slough and Newark Slough; and (4) the recommendation to protect and enhance the tidal marsh/upland transition at the upper end of Mowry Slough.

Local Government Land Use Designations. In terms of understanding the interests of the local governments in terms of development of the plant sites, it is useful to review the general Plans and zoning ordinances that identify and define the use of land that should occur in a local government's jurisdiction. It is important to understand, however, that these designations can be changed through plan amendments and zoning changes.

To date, both the Newark and Redwood City Plant Sites are largely restricted to agricultural and open space uses. The City of Redwood City's General Plan designation for the eastern portion of the Redwood City Plant Site is "Open Space," defined as an area that is "unimproved and is devoted to the preservation of natural resources, the managed production of resources, outdoor recreation, or public health and safety." The western portion of the property is designated as "Urban Reserve," defined as an area "to be preserved for future use to expand the limits of the urbanized area of the City" and that "[e]xact land use designations are to be withheld pending review of development plans and their environmental consequences." In terms of zoning, the majority of the Redwood City Plant Site is zoned "Tidal Plain District" with "General Industrial District" zoning in a very small portion of the property.[200] The purpose of the "Tidal Plain District" is:

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[197] An ecotone is a transition zone between two different habitats that is typically characterized by a great diversity of plant and animal species.

[198] Goals Project, 1999.

[199] The Redwood City plant site was offered to the public in 2003 but was not purchased.

[200] City of Redwood City. 1990. Strategic General Plan. Adopted January 22, 1990. http://www.redwoodcity.org/cds/planning/generalplan.

> [t]o create a district for the marsh lands adjacent to San Francisco Bay and to permit certain types of development therein of a relatively temporary nature which can ultimately be replaced by permanent development under another more appropriate zoning district.[201]

The purpose of the "General Industrial District" is:

> [t]o provide a district exclusively for sound industrial development wherein manufacturing and other industries can locate and operate away from the restricting influences on non-industrial uses….[202]

Acceptable "Tidal Plain District" land uses include agriculture, mineral extraction by natural evaporation from seawater, and public parks and recreation areas or facilities.[203]

The City of Newark's General Plan designation for the Newark Plant Site is "Agricultural and Resource Protection—Open Space." The entire plant site area is zoned as an "Agricultural District."[204]

Adjacent Land Uses. The Redwood City Plant Site, located within the City of Redwood City, is bounded on the northwest by Pacific Shores office park and the Westpoint Slough Marina and the north by Westpoint Slough. North of Westpoint Slough lies Greco Island, part of the Don Edwards San Francisco Bay National Wildlife Refuge. On the east the Plant Site is bounded by Flood Slough, with a park and some light industry beyond the Slough. To the South, it is bounded by industrial uses and mobile-home parks, and on the west the Plant Site is bounded by Seaport Boulevard, the Union Pacific Railroad, and mixed industrial and commercial uses. Examples of facilities in the urbanized corridor to the west include the Port of Redwood City, the Seaport Center business park, and Granite Rock, a regional supplier of concrete and gravel-related construction materials. Each of these facilities relies on access to Seaport Boulevard, which runs along the western perimeter of the Redwood City Plant Site and links with Highway 101 to the south.

The majority of land use adjacent to the Newark Plant Site, with the exception of salt evaporator ponds to the south and southwest, is industrial and commercial development, including some high-tech business parks.

Both the Redwood City and the Newark Plant Sites were identified by Congress in 1990 as potential additions to the Don Edwards San Francisco Bay National Wildlife Refuge.

Policy Approach to Alternate Uses of Salt Ponds. Chapters 1 and 2 express in great detail the role of salt making in the Bay Area and the value of salt ponds in general to the Bay Region as a whole. The Legislature, in adopting the McAteer-Petris Act, recognized the value of salt ponds to the Bay region. Section 66602.1 states that:

> [t]he Legislature further finds and declares that areas diked off from the bay and used as salt ponds…are important to the bay area in that, among other things, such areas provide a wildlife habitat and a large water surface which, together with the surface of the bay moderate the climate of the bay area and alleviate air pollution….

And further,

> …it is in the public interest to encourage continued maintenance and operation of the salt ponds….

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[201] Article 20 TP (Tidal Plain) District.
http://bpcnet.com/codes/redwoodci_zoning/_DATA/TITLE20/20_1_Purpose_.html
[202] Article 19 GI (General Industrial) District.
http://bpcnet.com/codes/redwoodci_zoning/_DATA/TITLE19/19_1_Purpose_.html
[203] Article 20 TP (Tidal Plain) District.
http://bpcnet.com/codes/redwoodci_zoning/_DATA/TITLE20/20_2_Permitted_Uses_.html
[204] "Plan Diagram: General Plan Update, City of Newark" & "Official Zoning Map, City of Newark."

In addition,

> …if development is proposed for these areas, dedication or public purchase of some of these lands should be encouraged in order to preserve water areas….

And,

> …if any such areas are authorized to be developed and used for other purposes, the development should provide the maximum public access to the Bay consistent with the proposed project and should retain the maximum amount of water surface area consistent with the proposed project….

Section 66602.1 is important to the Commission's understanding and regulation of salt ponds because it defines the values of salt ponds, the public interest in retaining the salt ponds in salt production, as well as the Commission's role in the proposed development of salt ponds. In regards to terminology, three terms in need of greater discussion are: (1) "development" (2) "maximum" and (3) "water surface area." Discussion of these terms will help clarify the McAteer-Petris Act and provide guidance for revising the Bay Plan salt pond findings and policies.

1. **Development.** The term "development," as found in both Section 66602.1 and other sections of the McAteer-Petris Act (e.g., 66605.1 and 666651), refers to kinds of development that are general in nature, in other words, neither specifically water-oriented or non-water-oriented. Thus, Section 66602.1 likely refers to any kind of development, water-oriented or not, in salt ponds used for purposes other than salt production and not purchased by the public for restoration. Thus, a salt pond might be developed for residential uses, a business park, a marina, or any other number of uses.

2. **Maximum.** As it relates to the "maximum amount of water surface area" retained consistent with any proposed development of a salt pond, the term "maximum" can be defined as: (1) the greatest or best possible;[205] (2) the greatest in quantity or highest in degree attainable;[206] or (3) being the largest amount or number allowed or possible.[207] Thus, the most acreage possible, consistent with the proposed project, should be retained as water surface area when any salt pond is proposed for development.

3. **Water Surface Area.** The term "water surface area" relates to the development of the salt ponds and the need to retain areas in some phase of un-developed water coverage. Relating the term back to the values listed, "among others" in the Act (i.e., wildlife habitat, moderation of climate and alleviation of air pollution), a logical interpretation of "water surface area" today would mean both diked ponds managed for shorebirds and waterfowl as well as types of open water habitats, specifically tidal marsh, tidal flat and subtidal areas. This more inclusive interpretation the Act is based on improved scientific understanding of the wildlife use of the Bay in general and the salt ponds in particular, including the notion that some sort of combination of various habitat types is the best for the Bay's wildlife. Some flexibility in the determination of water surface area type to be retained as part of any development of a salt pond is critical to ensuring that site specific and regional restoration goals can be considered as part of any development project.

It's important to note that the current Bay Plan salt pond policies contain similar, though not identical language. The current Bay Plan salt pond policies state in part "Development of the ponds…should provide for retaining **substantial** amounts of open water [and] should provide for **substantial** public access to the Bay" (emphasis added). The word "substantial" is defined somewhat differently than "maximum." A dictionary definition of "substantial" includes "considerable in quantity" or "significantly great"[208]– standards arguably less than those described by the word "maximum."

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[205] http://www.cogsci.princeton.edu/cgi-bin/webwn.

[206] Merrian-Webster's Dictionary Tenth Edition.

[207] Cambridge Dictionary.

[208] Merrian-Webster's Dictionary Tenth Edition.

In interpreting the Bay Plan policies in the past, the Commission's staff stated in a letter in specific reference to Cargill's 1,400 acre Redwood City Property that "if about half of the 1,400-acre property is retained in open water, dedicated to the public and restored to tidal circulation, our staff would recommend that the Commission find that this action would meet the test of being 'substantial' and, thus, in accord with the salt pond policies…."[209] However, the letter also noted that "the precise level of development permissible cannot be determined" and that "environmental studies may identify biological or physical constraints that would have to be accommodated" and finally that "it will be our Commission, not our staff, which will determine how the Bay Plan policies should be applied." Worth noting, is that in the year following the above referenced staff letter, in permitting a marina and boatyard in a portion of a historic salt pond (Pond 10 in Redwood City) the Commission agreed with staff's recommended determination of "substantial open water" not as a percentage of the project, but in both quantitative and qualitative terms.[210] Furthermore, it is important to acknowledge that any project must be found consistent with the language of the McAteer-Petris Act. In this instance, regardless of whether or not a project is found consistent with the language of the Bay Plan regarding "substantial open water" it must still provide for "maximum amount of water surface area."

Given that the McAteer-Petris Act is the foundation for the Commission's policies, the inconsistencies between the McAteer-Petris Act's requirement for "maximum" and the Bay Plan's requirement for "substantial," and the fact that any revisions to the Bay Plan must be consistent with the findings and declarations of policy in the McAteer-Petris Act, an amendment of the Bay Plan should reflect the terminology used in the McAteer-Petris Act. Specifically, the Bay Plan salt pond policies should be revised to replace "substantial" with "maximum" for both open water and public access requirements. Furthermore, it would be beneficial to refine the Bay Plan policies to facilitate a qualitative planning approach to achieving the "maximum" as it is applied to open water and to public access consistent with the project (discussed in more detail in the following section).

In conclusion, an amendment to the Bay Plan salt pond policies provides an important opportunity to support and further clarify the McAteer-Petris Act findings and declarations regarding salt ponds found in Section 66602.1.

Planning Process for Development. The McAteer-Petris Act provides the basic requirements for proposed development of any salt ponds, that such development should provide the maximum public access to the bay consistent with the project, and should retain the maximum amount of water surface area consistent with the project. However, the determination of maximum water surface area and public access entails both a qualitative and quantitative assessment based on maintaining the values of salt ponds to the Bay. Accordingly, a formal comprehensive planning process would be beneficial in helping to determine what portions of a site should be developed and what portions should be restored to the Bay or enhanced as managed ponds, as well as how to achieve maximum public access. For the Redwood City and the Newark Plant sites in particular, both are located in the midst of large areas proposed for restoration or currently managed for the benefit of fish, other aquatic organisms and wildlife. Thus, a tremendous opportunity exists to link existing or potential habitat values found at the plant sites with habitat values found nearby. For example, the Redwood City Plant Site is bordered by Greco Island, Bair Island and the Ravenswood evaporation ponds, which are all part of the Don Edwards San Francisco Bay National Wildlife Refuge. Similarly, the Newark Plant Site is bordered on more than one side by the Don Edwards San Francisco Bay National Wildlife Refuge. In addition, a number of citizen groups and local governments have a strong interest in helping to determine the future of Cargill's lands, if they are no longer needed for salt production, including providing for both wildlife habitat as well for as recreation and public access opportunities.

In terms of the kinds of planning approaches that could be undertaken, one possible approach is for the Commission to define in Bay Plan policy language the range of issues that should be addressed if any planning process is undertaken and then allow the local government and the land owner to meet those planning objectives. Another approach would be to define in the Bay Plan policies that a proposed project must be consistent with a comprehensive special area plan for the geographic vicinity, a special area plan that the Commission has determined to be consistent with the policies of the Bay Plan. Advantages of the

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[209] Travis, Will. 2002. Executive Director, San Francisco Bay Conservation and Development Commission. Letter to William C. Britt, Vice President, Cargill, Incorporated. March 15, 2002.

[210] San Francisco Bay Conservation and Development Commission. July 3, 2003. Application Summary for Permit Application No. 2-02.

Commission undertaking a formal special area planning process would be that the Commission would have the authority to ensure that the process: (1) adequately includes the public; and (2) sufficiently addresses the policies of the McAteer-Petris Act and the Bay Plan within the planning process.

On the other hand, a great deal of staff and Commissioner time would have to be dedicated to a special area planning process for the privately-owned salt ponds. Thus, even if the Commission is not formally involved, at the minimum, specific Bay Plan policies could define the range of considerations to be addressed by the land owner and relevant local governments as part of a well-defined planning process, if a salt pond or ponds is proposed for development.

Conservation Development Models. Several successful models exist for developing large properties while still protecting a substantial amount of the site's natural resource values. Another way to describe such an undertaking is "conservation development." Conservation developments are "planned communities that have land conservation as a central organizing principle underlying their design."[211]

Examples of conservation developments include the Otay Ranch in San Diego, California and Playa Vista in Los Angeles, California. More specifically, the Otay Ranch is a 5,300-acre residential community, in which half of the land has been set aside in its natural state in perpetuity. Similarly, Playa Vista is a 1,087-acre planned development that includes housing, commercial, retail and recreation uses, but nearly half of the site is protected open space. A large portion of the protected open space consists of wetlands totaling 340 acres.

A more formal regulatory process that has been enacted by the State of California to plan for the development and protection of private properties where endangered species are located is known as the Natural Community Conservation Planning Act (NCCP Act). While the NCCP Act may not be directly applicable to a proposal to develop the salt ponds, it provides an important example of how biological and economic objectives can be met on large, privately owned properties with endangered species and natural resource protection concerns. The scope of any planning effort undertaken under the authority of the NCCP Act must be regional. Further, it must be based on a scientific and procedural framework that can address cumulative impact concerns and integrate them with multi-jurisdictional planning efforts. In addition, the focus of any natural community conservation plan must be ecosystem conservation. In other words, the plan must promote wildlife diversity through the conservation of habitat on an ecosystem level. Further, any natural community conservation plan must provide a conservation strategy for species of concern on the property that is based on recognized principles of conservation biology.

Other important aspects of the NCCP Act planning process is that the plan promotes coordination and cooperation among public agencies, landowners, other private interests, and members of the public. In addition, the plan allows for compatible economic activity, including resource utilization and development.[212] In sum, the NCCP Act planning process is meant to identify and provide for the regional or area wide protection and perpetuation of plants, animals and their habitats while allowing compatible land use and economic activity. In addition, any NCCP Act plan must establish measurable goals, such as a monitoring program and an adaptive management plan.

An example of an NCCP Act planning effort and lessons learned that could be applied to the privately-owned salt ponds is the development of Rancho Mission Viejo in Orange County, California. Rancho Mission Viejo consists of a 23,000-acre ranch property that was developed for homes, schools, parks, as well as other amenities, while maintaining nearly 75 percent of the original ranch in its natural state.

Important components of the NCCP Act planning effort included: (1) the creation of a good science database about the property; (2) the establishment of broad goals agreed upon by all interested parties and tied to implementation criteria; and (3) early consensus regarding the areas to be preserved. Also, in the case of Rancho Mission Viejo, an integrated conservation plan was created that addressed water quality, wildlife migration, and habitat preservation, among other concerns.[213]

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[211] Urban Land Institute. 2002. The Practice of Conservation Development: Lessons in Success.

[212] http://resources.ca.gov/NCCP/genproc3.htm.

[213] http://www.ranchomissionviejo.com/quality/index.php.

In conclusion, existing conservation development models provide useful guidance for defining the essential elements of a successful planning process designed to maximize the values provided by salt ponds to the Bay. Specifically, a comprehensive planning process, undertaken by the landowner with any applicable public agencies should include: a scientific assessment of the resource values of the area; the establishment of goals and objectives for maximizing public access opportunities and resource values that are integrated with local and regional goals; and collaboration with all interested parties, including local, state and federal agencies, land owners and the public.