Part V.
Conclusions

Chapter 15.
Conclusions and Recommendations

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The Cargill Salt Corporation produces about 1 million tons of common salt annually from its 26,190-acre South San Francisco Bay salt pond complex. Cargill owns 14,760 acres (56%) of these salt ponds. The Don Edwards San Francisco Bay National Wildlife Refuge owns the remaining 11,430 acres (44%), which it acquired in the 1970s (see Map 2). As part of that sale, Cargill (then Leslie Salt) retained the mineral rights for salt production on all these lands.

Nearly the entire South Bay salt pond complex (97% total area) consists of former tidal marshlands diked for decades. Only about 670 acres (3%), representing about three quarters of the Newark crystallizer ponds (see Map 5), were built outside the tidal marshlands on the adjacent grassland/vernal pool complexes. The historical condition affects the extent of current federal regulatory jurisdiction under the Clean Water Act and Rivers and Harbors Act. Jurisdiction, in turn, can affect the property value of the salt ponds through its restrictions on development and thus acquisition negotiations.

A long-established and worthy goal of the regional resource management community has been to acquire the entire South Bay salt pond complex and restore it to its pre-existing tidal marsh condition. Two actions have taken place in the past few years that may bring this goal to fruition and which serve as the impetus for this Feasibility Analysis. First, the San Francisco International Airport has been evaluating salt pond restoration (in part or in whole) as mitigation for its proposed runway extension project. Second, in 2000 Cargill formally offered to sell about 16,000 acres plus 600 acres of South Bay tidelands and another 1,400 acres along the Napa River to the state and federal governments for $300 million. Those 16,000 acres include 12,000 acres Cargill owns and mineral rights on 4,000 acres the Refuge owns. Negotiations have been ongoing since 2000, and a smaller deal for $100 million representing 13,000 to 15,000 acres may soon be reached that may or may not involve SFO mitigation funds.

In negotiating with Cargill and other entities, resource managers will need to understand not only the short-term goals of acquiring property but also the long-term goal of sustainable restoration and management. Restoration, especially along the scale of the South Bay salt ponds, is a process and not an event. The complexity of this process crosses many scales. Most basically, each restoration site must undergo a number of changes to transform from the current salt pond condition to the ultimate goal for that site whether it be tidal marsh, ponds, pannes or some combination. Some of the important issues and challenges facing resource managers and planners that will affect the rate at which salt ponds can be restored to tidal marsh include: proximity to colonizing plants and animals, initial site elevations creating sediment deficits, sediment supply and dredged sediment availability, bittern and hypersaline brine removal and pond desalination, restoration and ongoing operations and maintenance costs, containing invasive species, protecting existing biological resources, and decreasing survival pressures on the many special status species that utilize tidal marsh and salt ponds. These issues have implications on a broad spatial scale and a long temporal scale, one of the most significant of which is resolving the sediment deficit with scouring ecologically important South Bay mudflats. Restoration does not mean that today it is a salt pond and the day after breaching a levee we have a vegetated, natural marsh.

This Feasibility Analysis examined the suite of issues relevant to restoring tidal marsh on the entire 26,000-acre South Bay salt pond complex as well as the smaller 16,000-acre Cargill proposed sale area. The analysis integrates all the information obtained into a pond-by-pond restoration feasibility determination and a set of overall recommendations. This conclusion chapter summarizes the seven key conclusions that we believe affect the acquisition and restoration planning most strongly (Section 15.1) and it describes a variety of other pertinent considerations (Section 15.2).

15.1 Seven Key Conclusions Summarized

From all the material we evaluated and people we talked with in preparing this Feasibility Analysis, we have identified seven key conclusions that we believe are the most salient to negotiating a purchase and planning the restoration of all or a portion of the South Bay salt pond complex. Although we support acquisition and restoration fully, addressing the challenges summarized in these seven key conclusions will require careful planning and thoughtful action to achieve the desired environmental and ecological benefits in a cost effective manner. The important message from these analyses is that a long-term commitment will be required to realize the benefits of salt pond purchase and restoration.

15.1.1 Mix Tidal Marsh Restoration and Shallow Open Water Management

Promoting recovery of federally listed species and species of concern should be a primary consideration in restoration planning and implementation. To accommodate conflicting ecological requirement between many of these species, an overall restoration plan should include about one-third of the salt ponds retained as managed shallow open water areas and two-thirds restored to tidal marsh. Tidal marsh represents the historical condition for nearly all the salt ponds and their loss is directly responsible for declines in numerous plant, fish and wildlife species around which a broad consensus exists for their recovery. Shallow open water, historically less common in the South Bay and currently provided almost entirely by the salt ponds, supports a thriving bird community around which a broad consensus also exists for its protection. Several threatened and endangered species depend on and/or utilize both ecosystem types. Reconciling these competing goals translates into retaining about one-third of the South Bay salt ponds as managed shallow open water habitats and restoring the remainder to tidal marsh. This approach is consistent with recommendations originally put forth by the Goals Project as well as goals to promote recovery of special status species as stated in the two draft U.S. Fish and Wildlife recovery plans applicable to the South Bay (Western Snowy Plover and Tidal Marsh Ecosystems). How these goals are accomplished in the context of ongoing Cargill operations presents a complex challenge for restoration planners. Though based clearly in conservation needs, permanently maintaining one-third of the salt ponds as shallow open water habitats will require a long-term O&M funding commitment that would not be necessary were all ponds restored to tidal marsh. Thus, the resource management community must understand and accept the permanent costs associated with meeting its conservation goals as well as the consequences of failing to meet those funding needs (see Key Conclusion #4 in Section 15.1.4).

15.1.2 Resolve Sediment Deficit with Phased Restoration and/or Dredged Sediment Reuse

A very large sediment deficit exists for restoring tidal marsh elevations on subsided salt ponds that will require restoration phasing over many decades and/or dredged sediment reuse in order to protect South Bay mudflats. Subsidence is a common feature of San Francisco Estuary diked baylands. Most of the salt ponds from Mountain View to San Jose (the "Alviso Plant") have subsided from 6 to 8 feet below marsh height due to groundwater pumping ongoing through the 1960s. Surrounding uplands in the South Bay have subsided even more, up to 13 feet in some places. Most of the remaining salt ponds have subsided from 1 to 4 feet below marsh height.

We estimate this subsidence to represent a sediment deficit of about 108 million cubic yards (MCY) to restore tidal marsh elevations for the entire 26,000-acre South Bay salt pond complex and about 89 MCY for the 16,000-acre Cargill proposed sale area. The actual deficit will be less according to how many and which ponds are retained as managed shallow open water (or retained for salt production). Meeting this sediment deficit *without scouring the ecologically important South Bay mudflats* will require one of two approaches: (1) phase restoration over many decades to match sediment demand with the rate at which sediment naturally enters the South Bay (estimated by others at about 0.9 MCY per year), or (2) partially fill ponds with clean dredged sediment. We estimate the first option would require about 120 years to restore two-thirds of the entire South Bay salt pond complex and 99 years for two-thirds of the smaller Cargill proposed sale area. Dredged sediment reuse can reduce these time frames to as short as 56 years and 39 years for the full complex and Cargill proposed sale area, respectively, depending on the rate of dredged sediment availability. These time periods could be reduced further if greater quantities of dredged sediment could be made available more rapidly. Dredged sediment, however, has economic consequences that must be considered; these are discussed next.

15.1.3 Dredged Sediment Reuse May Be Desirable and Economically Competitive

Our cost estimate ranges for "natural sedimentation" and "dredged sediment reuse" restoration approaches overlap considerably, suggesting that dredged sediment may be economically competitive. Further, dredged sediment reuse can speed the overall period of restoration, thereby achieving ecological goals decades sooner. A fundamental aspect of salt pond restoration is that the sediment supply to offset the sediment deficit (see Section 15.1.2 above) cannot, as a matter of natural resource protection, come at the expense of South Bay mudflats. Our estimates indicate that the "mudflat-sustainable" natural sedimentation restoration approach will require on the order of 120 years to restore two-thirds of the total salt pond complex to tidal marsh and 100 years for two-thirds of the smaller Cargill proposed sale area ponds. The dredged sediment reuse options we evaluated reduced that time frame to 56-72 years and 39-51 years for the total salt pond complex and the Cargill proposed sale area, respectively. The range in years reflects different amounts of dredged sediment reuse that could be considered. These time periods could be shortened further if suitable dredged sediment were available more rapidly than we assumed for our analyses. Because total restoration costs include interim and ongoing O&M costs, more rapid restoration shortens the duration of the more costly interim O&M and thus reduces costs further. Additionally, accelerated restoration efforts, if well planned, will also achieve the environmental and ecological benefits sooner. These benefits have not been estimated though their consideration is critical in developing any accurate cost-benefit analyses that considers using dredged sediment.

Our rough cost estimate for the "mudflat-sustainable" natural sedimentation approach consists entirely of interim and permanent O&M and comes in at $621 million to $1.49 billion for restoring two-thirds of the total South Bay salt pond complex (or about 18,000 acres). For the 16,000-acre Cargill proposed sale area, those costs span a range of $315 to $764 million. For dredged sediment reuse, we considered three scenarios reflecting variable quantities of dredged sediment. Though dredged sediment reuse has considerable up-front costs, it gains a vital economic benefit – it reduces the time period over which costly interim O&M is necessary. To calculate these costs, we used a suite of assumptions including that restoration sponsors would be responsible only for the incremental costs of dredged sediment reuse not normally paid for by dredging projects. Dredged sediment reuse cost estimates range from $457 to $1.48 billion for the full salt pond complex and $222 to $899 million for the Cargill proposed sale area. In other words, dredged sediment has the potential to be a very effective and economically competitive approach to restoring the South Bay salt ponds. In practice, the single greatest issue is dredged sediment availability, as competition now exists for reusing dredged sediment for wetland restoration (e.g., Montezuma and Hamilton-Bel Marin Keys).

15.1.4 Account for All the Bittern and Hypersaline Brine in the Short and Long Term

The current acquisition negotiations need to include requirement for full bittern and hypersaline brine removal from the Redwood City ponds included in the Cargill proposed sale area and a formulation of a binding plan for Cargill's long-term disposition of bittern and

hypersaline brines stored in Newark. Bittern is the hypersaline byproduct of solar salt production. Bittern occurs in both a liquid and solid state and consists of naturally occurring minerals in bay water minus the commercially harvested common salt and some other salts that solidify within the pond system as part of evaporation (mainly gypsum). Bittern is thus distinguished from bay water by a salinity level over ten times higher and by its ionic imbalance, both of which make it toxic to aquatic organisms. Hypersaline brines are the concentrated bay waters that arise from salt production prior to salt harvesting and from any efforts to "clean" bittern and other high-salinity ponds during pond decommissioning. Three specific issues require incorporation into current acquisition negotiations.

Bittern Definition Must Include All Components of Bittern in Acquisition Negotiations

Considerably different estimates of the ongoing bittern production rates exist that we believe stem in part from varying definitions of bittern. Cargill currently estimates it produces 0.15 million tons of bittern annually. Leslie Salt, Cargill's predecessor, estimated 1 million tons annually. Resolving this disparity is critical to ensure that bittern in all its forms are properly removed from Redwood City as part of acquisition so that the public does not take on this costly liability as it did with the North Bay salt ponds in the 1990s. **Bittern is defined as the total liquid bittern, including dissolved ions and salts and the water in which they are dissolved, plus the precipitated bittern salts that have deposited on bittern pond bottoms.** Using this definition and assuming that Cargill stores bittern at the highest salinity possible in the region (dictated by rainfall and solar evaporation), our new mass balance analysis estimates an annual bittern production rate of about 0.6 million tons. We believe that Cargill's estimate of 0.15 million tons is too low to account for all forms of bittern regardless of storage salinity and liquid or solid phase and that Leslie's estimate of 1 million tons is too high because it failed to account for evaporative concentration in the bittern storage ponds.

Acquisition Should Provide Plan for Hypersaline Brines

Hypersaline brines are the concentrated bay waters that arise from salt production prior to salt harvesting and from post-acquisition efforts to "clean" (i.e., desalinate) bittern and other high-salinity ponds. Hypersaline brines pose similar toxicity issues to that of bittern, though at reduced levels of significance since their ionic imbalance is less than bittern. Negotiations should clearly define responsibilities, terms and conditions for the disposition of these brines. The volume produced will depend upon the desalination method and the initial salinity level of ponds being desalinated and could be an additional one to two volumes in addition to what is currently within a pond. Because of its very large volume, transferring brine into Cargill's salt production stream at a rate that is economically and logistically feasible while meeting state and federal restoration goals will require close coordination between Cargill and the resource management agencies.

Provide a Long-Term Plan for Existing Stockpiled Bittern Disposition

In the early 1970s, the federal Clean Water Act and the state Porter-Cologne Water Quality Act ended unregulated bittern discharge to the Bay. Since that time, the available market for bittern has been relatively minor. Consequently, Cargill has stockpiled roughly 30 years of bittern at Redwood City and Newark. We have estimated that stockpile to be about 19-20 million tons of bittern. It is our understanding that all the bittern stockpiled in Redwood City will be transferred to Newark. Most of Cargill's Newark-stored bittern is located in Ponds 12 and 13 in Newark Plant #2; these ponds are owned by the Refuge. Transfer of the Redwood City bittern to Newark may require converting additional ponds to bittern storage, and whether these additional ponds would be on Cargill or Refuge property is to be determined as part of the acquisition.

The 1979 operating agreement under which Cargill exercises it mineral rights on Refuge-owned salt ponds places Cargill under no obligation to clean up bittern or any other problems it has created on these publicly-owned lands. Solar salt production in the highly urbanized San Francisco Estuary may not be an economical operation in the long-term as suggested by Cargill's current efforts to reduce local salt production and increase production efficiencies. Over the anticipated period for sustainable restoration, it seems likely that Cargill will cease salt production altogether. **Thus, current acquisition negotiations are the forum to establish clear Cargill responsibility for long-term disposition of all bittern, including the existing stockpiles and all future bittern production.** The State of California has learned the hard way from the Napa River salt ponds just how difficult and costly bittern remediation can be. Cargill has currently undertaken efforts to reduce bittern volumes through reprocessing bittern in the salt production process and creating and enlarging commercial markets for bittern.

15.1.5 Commit to Immediate and Long-Term Operations, Maintenance and Monitoring

Immediate and long-term ongoing operations, maintenance and monitoring funds are essential to achieve ecological goals and protect against levee failures that could flood locally large segments of the South Bay. These funds represent a need for long-term political and fiscal commitment by local, state and federal agencies. Securing these funds may be more important and difficult than the initial purchasing of the property. Beyond the first step in restoration (acquisition), it will be essential to maintain hundreds of water control structures and some significant portion of the 234 miles of levees enclosing the salt ponds. Adaptive management will provide the best approach for ensuring a successful restoration program that will take decades to complete. Monitoring data are the essential information resource for adaptive management and therefore monitoring should be adequately funded throughout the restoration effort.

Water Control Structures Provide the Means for Wildlife Management in Retained Ponds

Pond water levels, salinity and water quality are all essential elements for wildlife management in the salt ponds. These parameters are governed largely by the amount and rate of water exchange between ponds and the South Bay. Numerous pumps, pipes, gates, and related infrastructure are necessary to carry out any water management. Therefore, inadequately maintaining water control structures could compromise ecological goals and provide the potential for water quality problems (i.e., unintended "salt production" leading to hypersaline brines and gypsum deposition).

Flood Protection Levees Protect Subsided South Bay Uplands

Cargill currently maintains a total of 21 miles of levees that separate salt ponds from adjacent upland land uses and another 180 miles bayward of these levees, some of which provide flood control protection remotely. Public agencies maintain another 17 miles of levees enclosing the salt ponds. Inadequate levee maintenance could lead to failures potentially flooding extensive areas of the South Bay that lie below sea level.

Estimated Operations and Maintenance Activities and Costs

O&M activities will vary according to the phase of overall restoration and the target ecosystem types being managed. We have divided the restoration effort into three phases: initial planning and design, interim management of ponds targeted for tidal marsh restoration, and permanent management of ponds retained as shallow open water habitats. The full range of O&M activities that will required for most of these phases includes water management, levee maintenance, water control structure maintenance, and meeting regulatory act requirements. We estimate annual O&M costs (in 2001 dollars) for all these activities to range between $284 and $686 per acre. These costs translate to $4.5 to $11 million total annually for the 16,000-acre Cargill proposed sale area (a slightly reduced version of which is currently being negotiated) and $7.4 to $17.8 million total annually for the entire salt pond complex. Annual costs will decline over time as described next. All O&M funds would need to go to the Don Edwards San Francisco Bay National Wildlife Refuge, the entity expected to own and be responsible for all the acquired salt ponds. Actual O&M costs will depend also on which ponds are restored to tidal marsh and which are retained as open water, as levee maintenance costs will vary depending on the nature of individual levees.

Initial planning and design period. During the initial planning and design period, which we assume last five years, we expect that full O&M activities and funds will be required for all purchased properties. For the 16,000-acre Cargill proposed sale area, initial O&M will cost somewhere between $23 and $55 million total. For the entire 26,000-acre South Bay salt pond complex, these costs would be $37 to $89 million.

Interim management of ponds restored to tidal marsh. During the extended period over which two-thirds of the pond acreage would be restored to tidal marsh, O&M activities and costs will gradually decline. At the outset, the full range of O&M activities would be required. Once a pond is restored to tidal marsh, only levee maintenance would be required and we assume that ends once marsh vegetation becomes well established for levee erosion protection. For two-thirds of the Cargill proposed sale area, these O&M costs will be somewhere between $156 and $357 million for the longer implementation time required by the natural sedimentation approach and $62 to $151 million for a shorter period associated with dredged sediment reuse.

Permanent management of ponds retained as shallow open water habitats. The one-third of pond acreage retained as shallow open water habitat will require the full range of O&M activities and costs in perpetuity. For the Cargill proposed sale area, these costs will be between $1.4 and $3.4 million annually. These costs would be $2.3 to $5.5 million annually for the entire salt pond complex.

Monitoring

Monitoring funds will also be required and are likely necessary shortly after acquisition. We estimate that monitoring will cost $1.5 to $3.0 million dollars annually for the 16,000-acre Cargill proposed sale area and will extend over a 40-year period and perhaps longer. We would anticipate that actual monitoring costs will rise and fall from one year to the next, so this 40-year estimate should approximate those total costs. Total costs over those 40 years would range between $60 and $120 million, in 2001 dollars.

15.1.6 Restoration Planning Needs to Consider the Many Pressures on Biological Resources

During the restoration process, many environmental and economic pressures will threaten existing biological resources and thus are important considerations in acquisition and restoration planning. We have identified three topics of particular concern: increased importance to wildlife of remaining salt production ponds, dynamics of wildlife use of South Bay salt ponds, and the invasive eastern cordgrass, Spartina alterniflora.

Increased Importance of Remaining Salt Production Ponds

Converting two-thirds of salt ponds to tidal marsh (regardless whether of the entire salt pond complex or the smaller Cargill proposed sale area) will increase the importance of the remaining salt ponds for species that rely on shallow open water environments. The situation becomes more complex in the context of Cargill retaining salt production on a reduced area consisting of Newark #1 and #2 plants, which comprise about 10,000 acres. Cargill recently began a series of modifications to those plants intended to increase production efficiency by about 25% in anticipation of public acquisition. Historically, conflicts exist between salt production and wildlife management on existing Refuge-owned ponds in Newark #1 and #2 plants. Although these conflicts have diminished in recent years, Cargill's higher salt production expectations and the inherent need to optimize the salt production process could lead to less flexibility for pond operations in an ecologically friendly manner. Some of these modifications have, however, improved wildlife conditions by providing more ponding in certain areas that were previously difficult to keep flooded adequately.

Dynamic Ecological Resources

Wildlife resource use of the South Bay salt ponds is best characterized by its dynamics. Variability in pond environmental conditions occur from interannual climate differences as well as Cargill operations. Wildlife continually adjust their use of any particular salt pond in response to these varying conditions. Therefore, throughout the restoration planning and implementation effort, it will be important for restoration planners to have current information. These information needs emphasize the role of ongoing monitoring, within an Adaptive Management framework, to provide data on species recovery and decline that can be used to adjust restoration planning and goals as the process moves forward.

Spartina alterniflora

The invasive *Spartina alterniflora*, an aggressive eastern cordgrass, diminishes marsh habitat functions relative to the native cordgrass, S. foliosa. No current controls effectively prevent *S. alterniflora* spread once it has become established. It is particularly problematic in the East Bay between the San Mateo and Dumbarton bridges. Restoring ponds close to existing stands of *S. alterniflora* should be undertaken cautiously until more research into and demonstration of its control has been completed.

15.1.7 Buyer Beware of Differential Restoration Feasibility

Not all ponds can be restored with equal ease. The current Cargill proposed sale area contains many of the most difficult and costly to restore ponds while retaining most of the easiest and least costly to restore ponds under Cargill control. Restoration costs for a given pond depend upon many factors but are most impacted by the degree of subsidence. The feasibility of restoring any given salt pond to tidal marsh varies according to a variety of site-specific factors as well as how surrounding ponds are treated. Thus, which ponds the public buys and which ponds Cargill retains in salt production have tremendous economic and ecological ramifications for all parties. Using a suite of biological, physical, and chemical criteria, we reached the following conclusions about restoration feasibility: 2,690 acres (10 percent total area) are high feasibility, 13,240 acres (51 percent total area) are medium feasibility, 8,430 acres (32 percent total area) are low feasibility, and 1,830 acres (7 percent total area) we had insufficient data to make a determination. Without dredged sediment reuse, we estimate per-acre restoration costs to be approximately $1,500 versus $5,000 for high and low feasibility ponds, respectively.

Most of the "high feasibility" ponds are not part of the Cargill proposed sale area. As it currently stands, Cargill is selling the public the most costly ponds to manage and restore, especially the deeply subsided Alviso ponds, and retaining the most easily restored ponds. Of the 108 MCY estimated sediment deficit for the total salt pond complex, those ponds Cargill has offered for public acquisition represent 89 MCY or 82% of that total deficit. Further, under the range of possible dredged sediment reuse options we evaluated, virtually all that sediment is needed only in the ponds Cargill is currently offering the public. Only under the maximum reuse scenario would ponds currently not part of the proposed acquisition be considered for dredged sediment reuse, and those ponds account for only 4 MCY of 58 MCY under that scenario.

In addition to these economic ramifications, this arrangement has ecological consequences. Most of the "high feasibility" ponds are represented by just three salt ponds – Mowry 1, 2 and 3 in Alameda County. These three ponds have long been targeted for restoration because of their particular suitability to yield tremendous ecological recovery benefits. Because they are easily restored and have undergone minimal subsidence, those benefits could be reached with a minimum of cost and in comparatively short time periods. Their exclusion from the acquisition poses an important constraint on achieving ecological recovery goals for the San Francisco Estuary.

15.2 Other Considerations and Recommendations

Along with the key findings presented in the previous section, we have identified numerous other issues that warrant highlighting here. These other issues have fewer and more manageable implications than the key findings. We have divided these into four areas:

- Ecological Considerations (Section 15.2.1)
- Physical Considerations (Section 15.2.2)
- Environmental Chemistry Considerations (Section 15.2.3)
- Economic and Logistical Considerations (Section 15.2.4)

15.2.1 Ecological Considerations

- **Salt ponds to be operated in perpetuity as open water habitat should have a salinity level less than 140 ppt to optimize habitat for shorebirds and preclude additional gypsum precipitation.** Salinity levels in ponds should be varied to promote different biotic communities and increase wildlife diversity. Maintaining salt ponds at variable salinity levels below 140 ppt will provide ecological benefits by providing good habitat conditions for a variety of invertebrates that have different optimum salinity requirements. Invertebrates provide an important dietary component of migrating shorebirds and waterfowl.
- **Levees represent artificial boundaries and should not constrain restoration planning.** There is no magic to the location of the existing pond boundaries. Levees were constructed decades ago based on ownership boundaries, ease of construction, and solar salt production needs. They do not bind us in the location of future restoration areas. Moving boundaries increases costs, but ecological benefits can outweigh costs. In some cases, it may be imperative to adjust boundaries. The draft USFWS Tidal Marsh Ecosystem Recovery Plan considers these boundaries adjustable.
- **Tidal marsh and managed shallow open water should be dispersed geographically throughout the South Bay salt ponds.** Species that utilize each of these ecosystem types occur throughout the South Bay and the optimal recovery strategy is to disperse these habitats spatially. The challenge for restoration planners in the context of ongoing Cargill salt production in Newark Plants #1 and #2 is to integrate the ecological functions of those ongoing production ponds into a regional restoration strategy.
- **Salt panne habitat for western snowy plover roosting and breeding is most easily achieved on crystallizer ponds.** These seasonally ponded areas are unvegetated, flat, hypersaline, and ideal for snowy plover habitat. Restoring panne habitat from salt ponds requires far more effort and expense.

15.2.2 Physical Considerations

- **Gypsum layers will hinder tidal marsh establishment on one 310-acre pond in Baumberg and could hinder establishment on another 2,140 acres elsewhere throughout the South Bay salt pond complex.** Gypsum is present on about 6300 acres of salt ponds at an estimated thickness of nearly 2 inches. Gypsum forms a hard, cement-like coating that can impede plant colonization and tidal slough channel formation. At lower elevations, gypsum is not expected to be a problem but in higher elevation ponds it could interfere with marsh establishment.
- **Ease of providing a tidal connection should be considered in determining whether ponds are restored to tidal marsh or retained as shallow open water habitats.** Restoring tidal action or managing pond levels with tidal exchange requires a physical link to the bay, either directly or through adjacent ponds. Many ponds are enclosed entirely by other salt ponds

or are far upstream small tidal sloughs from the bay. These constraints on tidal exchange will need to be considered carefully in restoration planning. In addition to possible direct connections, Cargill has a variety of gates and pipes that link salt ponds together and this plumbing system should be exploited to the maximum extent practicable.

- **Further research should be undertaken to define the sediment deficit problem more precisely.** We have been able to estimate the sediment deficit magnitude from recent yet fairly generalized salt pond topographic data and place that deficit in context of current knowledge about South Bay sediment dynamics. We have predicted that too rapid of salt pond restoration to tidal action is likely to scour sediment from the South Bay mudflats, which would cause significant adverse environmental impacts to wildlife resources that utilize those mudflats. It will be essential for restoration planning to define these issues far more quantitatively. There are three topics that we believe would aid such a planning effort: (1) improve our understanding of South Bay sediment dynamics and budgets, (2) generate accurate bathymetric maps of the South Bay to provide a baseline against which to evaluate future changes, and (3) improve our numerical modeling capabilities to provide more accurate predictions at resolutions important biologically in an intertidal environment. Organizations such as the USGS and Stanford University have made progress in these areas, but a concerted, well-funded research program is warranted.

15.2.3 Environmental Chemistry Considerations

- **Maintaining ponds during an interim period in a low salinity condition may increase nuisance algae and odor problems.** Nuisance alga and hydrogen sulfide production has historically been a problem in low salinity pond. During the interim restoration period when ponds are flushed and lower salinity levels are maintained, nuisance algae could become a greater problem given that ponds are relatively shallow, warm and have good light attenuation, conditions that favor algae blooms.
- **Salt ponds sediments should have few contaminants. Most water quality differences between salt ponds and adjacent bay waters will be transitory once tidal flow resumes.** Salt pond sediments are likely to have lower concentrations of PCBs, DDT, chlordanes, mercury and trace elements than nearby tidal marshes because of severely muted tidal flows and very low sedimentation rates. Any water quality differences such as salinity, nutrients, water temperature, DO and pH are likely to be transitory, disappearing once tidal flows resume.

15.2.4 Economic and Logistical Considerations

- **It may be advantageous for all parties to retain salt production on some ponds for an interim period following public acquisition.** The public presumably becomes responsible for pond operations and maintenance costs following acquisition and decommissioning from salt production. Many factors will limit the time at which any given pond can be restored to tidal marsh, most notably the sediment deficit constraint. Consequently, a comprehensive plan should be formulated whereby Cargill continues salt production on some ponds following acquisition while other acquired ponds are converted wholly to interim or permanent management as shallow open water habitats. Such an approach maintains higher salt production levels for Cargill and reduces public expenditures for O&M.
- **Negotiations with Cargill to acquire more ponds should be continued.** Cargill should be encouraged to consider selling additional ponds, as it considered with its preliminary 1999 proposal. One year prior to the current proposal being negotiated, Cargill considered releasing nearly 7,000 acres more for restoration, including all of Newark #1 Plant and roughly half of Newark #2 Plant. The USFWS Tidal Marsh Ecosystem Recovery Plan targets Newark #2 Plant ponds 1, 2 and 3 between Mowry Slough and Coyote Creek as the highest priority ponds for tidal marsh restoration in the entire South Bay. These ponds are not optimal intake ponds for Cargill's salt production system because they are far south where salinities are lower and more pumping is required. In all cases, the economics to both the government and Cargill should be considered in the rate ponds are released for restoration. Releasing ponds at a rate that exceeds realistic restoration efforts will burden the government with unnecessary long-term O&M expenditures and reduce Cargill efficiencies.
- **Cargill will have roughly 240 acres of excess crystallizer capacity in Newark once salt production drops to its post-sale and post-desalination levels.** Cargill has always maintained that these areas are not subject to federal wetlands jurisdiction and therefore they can be developed. At current real estate prices, these crystallizers could be worth more than $1 million per acre. Conversely, the crystallizers are targeted by regional ecological recovery efforts as prime salt panne habitat easily managed and restored for Snowy Plover nesting, least tern foraging, and seasonal shorebird use.

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