DRAFT

South Bay Salt Pond Restoration Project

Major Decisions, Specific Decisions, and Key Questions

April 7, 2003

California Coastal Conservancy,
U.S. Fish and Wildlife Service,
California Department of Fish and Game

I. MAJOR DECISIONS

Major decisions are defined as those that will guide the overall restoration planning effort. The following major decisions will have to be made as part of the planning effort.

1) Overall restoration design. Determine the overall design that maximizes benefits to wildlife, including the appropriate mix of habitats and their placement on the landscape. Factors/ considerations in this decision include the following:
   a) Are the Habitat Goals Report recommendations for the South Bay still valid? (25-30,000 acres of tidal marsh, 10-15,000 acres of saline ponds, and 15,000 acres of tidal flats)
   b) Which portions of the Goals Project recommendations should the South Bay Salt Ponds Restoration Project accomplish within its 15,000 acres? (e.g., 10,000 acres of tidal marsh (including brackish marsh) and 5,000 acres of saline ponds)
   c) How should external constraints (such as flooding, subsidence, sediment availability and quality, management costs, etc.) be taken into consideration?
   d) How do we phase tidal restoration and what are the associated Adaptive Management and Monitoring Plans?
   e) How do we maximize habitat functions of managed ponds/managed pond complexes (mix of depths and salinities, locations, water management, etc.)?
   f) How can tidal restoration and saline pond management be designed to minimize impacts from mercury methylation?

2) Flood management requirements, and areas where flood management and restoration design will be integrated

3) Appropriate wildlife-oriented public access and recreation opportunities. Associated considerations include:
   a) What types of access/recreation are acceptable/will be included?
   b) How do we provide wildlife-oriented public access and recreation that does not negatively impact at-risk species?
   c) Where will access/recreation be located?

4) The most cost-effective restoration implementation and management (related to phasing, mix of ponds, flood management, dredge material reuse) process

5) Phasing of Restoration –key drivers (restoration or other concerns, such as flood management, funding, etc.)

IV. SPECIFIC DECISIONS AND ASSOCIATED KEY QUESTIONS

The specific decisions associated with each major decision are provided below. Each specific question is followed by relevant key questions. Specific decisions pertaining to fish and wildlife and other biological factors are described first, followed by specific decisions pertaining to physical process, and finally specific decisions pertaining to contaminants and water quality. Frequently, specific decisions and key questions will encompass some aspects of more than one general category. In these cases, the specific decision/key question has been assigned to the category that is most significant for that particular decision/question. Specific decisions that will also have to be made to complete the planning effort, but that are not being addressed at the data gaps workshop, are presented at the end of this section.

IV.1 FISH AND WILDLIFE AND OTHER BIOLOGICAL FACTORS

Seven specific decisions have been identified pertaining to fish and wildlife and other biological factors.

4.1.1 Specific Decision 1: Determine the specific restoration recommendation for each pond (managed pond, tidal pond, seasonal wetland, panne habitat, etc.) and the optimal design features.

- What design features that can be included in the construction of a site template for tidal marsh restoration would benefit the broad range of ecological goals for tidal marshlands (levee lowering, borrow ditch blocks, channel excavation, edge and interior high tide escape, ecologically functional flood control levees, etc.)?

- What engineering design and construction approaches have proven effective at restoring the several structural components of tidal marshlands, their slough channel networks, and adjacent upland transitions? What approaches promote natural processes that provide such structural attributes? What time frames of ecological output can be anticipated under different approaches?

- How will estuarine and anadromous fisheries resources benefit from tidal marsh restoration? How can tidal marsh restoration maximize estuarine fisheries species habitat?

- What water quality, depth, and salinity conditions are suitable in managed ponds to support the target forage resources (e.g., total invertebrate biomass, species composition, seasonal timing) and general wildlife communities of interest and how do these conditions vary seasonally and interannually?

- What are the feasible water depths and salinity ranges for each of the ponds that may be retained as managed ponds to support target wildlife resources, avoid flood hazards, and meet economic constraints?

- What conditions make pannes, isolated levees, islands, and edges suitable for breeding?

- How much of the pannes, isolated levees, islands, and edges are necessary to support target population sizes?

- What are the spatial distribution needs of target species for pannes, isolated levees, islands, and edges, incorporating slopes, distance from public access, predator protection, habitat elements, and adjacent land uses?

- Given that some (if not all) tidal marsh restoration design alternatives will result in interim intertidal mudflats and subtidal habitats, how can their specific attributes (i.e., amount, location, inundation regimes, and duration) be incorporated into the overall restoration strategy to best serve avian and fisheries resources?

- To what extent are existing (antecedent) channel networks in the ponds sufficient to recreate suitable tidal sloughs in restored ponds?

- What measures might be required to address borrow ditch hydrologic capture to promote recreation of naturalistic slough channel networks and their associated ecological functions?

- How can water and sediment exchange with the South Bay be achieved where outboard marsh and mudflats and tributary sloughs are present?

- What is the geomorphology of South Bay sloughs along which salt ponds are located?

- What are the goals for restoration and the states that will be measured to assess the success of restoration efforts?

- How might restoration be integrated with restoration work planned for adjacent properties, such as the Knapp property, Eden Landing, Pond A4, Pond A18, Bair Island, and Moffett Field?

- How can overall productivity be optimized?

- What adjacent land uses (e.g., industry, housing, marinas) may impede restoration and/or management?

- Has any new information developed since 1999 that would alter the Habitat Goals recommendation of habitat mixes in the South Bay?

- Should the ponds be grouped into management units for planning purposes, and what are the appropriate divisions/units?

- How should the overall habitat mix be achieved? Should each management unit/geographic area contain approximately equal mixes of habitat, or should the South Bay system be considered as one unit?

- What are the specific constraints on tidal restoration and pond management for each pond?

4.1.2 Specific Decision 2: Determine the types of species, population numbers, population viability, and habitat uses that need to be accommodated in the South Bay.

- To what extent do a broad range of waterfowl, shorebirds, and other birds utilize tidal marsh in the South Bay and, therefore, to what extent will tidal marsh restoration, both as interim mudflats and as long-term vegetated marsh, provide ecological support for this broad range of species?

- What factors (e.g., habitat and landscape features, adjacent land uses, contaminants, predators) affect the following attributes of bird use of tidal marshes in the South Bay: reproductive success, dispersal and territory acquisition, over-winter survivorship, habitat use versus availability, behavioral responses to habitat changes, and diets.

- What is the relative use by salt marsh harvest mice and other small mammals of tidal marsh interior (primarily gum plant and marsh baccharis along channel margins) versus edge high tide escape cover?

- What are the functions of existing fringing marsh/strip marshes to endangered species, including salt marsh harvest mice?

- What are the food resources of target species and how do these resources depend upon primary, secondary, and higher trophic level production?

- What are the primary functions of managed ponds for target wildlife species – e.g., foraging, high tide roosting, storm shelter?

- What are the spatial distribution needs of target avian species for managed ponds, incorporating the following factors: pond size, variable salinity, suitable water quality, habitat elements, and adjacent land uses?

- How do South Bay salt ponds currently fit into larger-scale habitat resources for migratory waterfowl of the Pacific flyway and how might pond alteration affect these populations?

- What are the seasonal needs of the target avian species for managed ponds?

- Do target species depend upon juxtaposition and/or size of managed pond features, such as proximity to edge or pond size, which could be modified through restoration designs?

- What factors (e.g., habitat and landscape features, adjacent land uses, contaminants, predators) affect the following attributes of bird use of open water ponds in the South Bay: reproductive success, dispersal and territory acquisition, over-winter survivorship, habitat use versus availability, behavioral responses to habitat changes, and diets?

- What affects the waterfowl carrying capacity of the salt ponds and are the ponds currently at their carrying capacity?

- How does shorebird use of shallow water areas in the ponds differ from shorebird use of shallow water areas outside of the ponds?

- What factors (e.g., habitat and landscape features, adjacent land uses, contaminants, predators) affect the following attributes of bird use of pannes, isolated levees, islands, and pond edges in the South Bay: reproductive success, dispersal and territory acquisition, over-winter survivorship, habitat use versus availability, behavioral responses to habitat changes, and diets.

- What is the current use of intertidal/subtidal habitat by the avian and fisheries resources?

- To what extent do existing outboard fringe marshes serve important ecological roles for tidal-marsh dependent species (e.g., salt marsh harvest mouse), what attributes of these fringe marshes do and do not provide suitable functions,

- What is the current bird and fisheries use of riparian zones?

- What estuarine and anadromous fish species are found in the South Bay, where are they located, and in what manners do they interact with tidal marsh, watersheds, and salt ponds?

4.1.3 Specific Decision 3: Determine how to minimize short-term and long-term impacts of restoration on wildlife.

- What impacts will water management in the managed open water pond habitat have upon estuarine and anadromous fisheries resources and how can these impacts be minimized?

- How will the amounts and inundation regimes of mudflats within restored ponds as they transition to tidal marsh compare to the amounts and inundation regimes of existing mudflats that may be lost temporarily or permanently from sediment scour?

- Will interim mudflats provide the same level of ecological support as existing mudflats, including primary and secondary production, fisheries use, and bird use?

- What are the potential impacts of restoration to avian and fisheries resources that utilize the intertidal and shallow subtidal habitats of the South Bay?

- How might the existing ecological functions of outboard fringe marsh be altered with tidal marsh restoration and pond management (to the extent that fringe marshes are temporarily scoured as ponds are breached)?

- How might current bird and fisheries use of riparian zones be altered, beneficially or adversely, by the hydrodynamic and sediment regime changes that will occur from tidal marsh restoration and increased Bay water exchange with managed ponds?

- How might restoration induced changes to South Bay tidal prism, sediment dynamics, and salinity regime affect the estuarine food web?

- What specific measures will be necessary to avoid adverse impacts to the large variety of open water-dependent bird species?

- What specific measures will be necessary to avoid adverse impacts to panne/isolated levee/island-dependent bird species?

- How might fish entrainment increase with increased water fluxes generated by pond management and might these entrainments adversely affect special status fish species?

- How will altering water flow and accretion in retained ponds and restored marshes affect existing islands utilized by colonial nesting birds for breeding?

- How will the proposed restoration and pond management efforts affect estuarine food web support in the South Bay especially with regards to phytoplankton production?

- What species or habitats are most sensitive to public access, which are least sensitive, and what are the effects of various types of public access and recreation on wildlife?

- How do we measure/quantify the impacts on wildlife? What types of analyses are appropriate?

4.1.4 Specific Decision 4: Determine the management approach to minimize impacts of introduced species, especially Spartina alterniflora, on restoration.

- What is the likelihood that *Spartina alterniflora* will be successfully controlled or eradicated over the next decade?

- What may be the effect on tidal marsh ecosystem functions of *Spartina alterniflora* colonization in restoration sites?

- What invasive invertebrate species are present in the South Bay that may interfere with restoration and management efforts, including levee-burrowing species, water column filter feeders, etc.?

4.1.5 Specific Decision 5: Determine the management strategy for predators, especially with respect to at-risk species.

- How will new boardwalks to existing PG&E towers affect predator access to restored marsh interior?

- How will predator populations be affected by the restoration effort? How can the restoration design minimize predator access/populations?

4.1.6 Specific Decision 6: Determine how to consider the short-term and long-term habitat functions of the remaining Cargill salt ponds be considered in the restoration design.

- How should the remaining (active) Cargill ponds be integrated into the overall restoration design?

- Will the salt ponds retained by Cargill and managed for increased salt production efficiency meet the ecological goals for shallow water habitat? If so, how will the habitat quality in those ponds be controlled?

- Are the salt ponds retained by Cargill ultimately better suited for shallow water habitat, tidal marsh, or a combination of the two?

- Since there is a possibility that Cargill will cease all South Bay salt production during long-term restoration implementation, how should those additional 10,000 acres be addressed during the restoration planning effort?

4.1.7 Specific Decision 7: Determine required project modifications, if any, to minimize mosquito populations and potential for disease outbreaks.

- What current features promote mosquito production, and how can the restoration effort address these concerns?
- Will any proposed restoration features increase the current level of mosquito production?
- Are the risks to human health related to mosquitoes increasing over time?

4.1.8 Specific Decision 8: Determine how to minimize short-term and long-term impacts of public use (access and recreation) on wildlife.

4.1.9 Specific Decision 9: Determine how to account for water discharges in the South Bay in the restoration design process.

IV.2 PHYSICAL PROCESSES

Seven specific decisions have been identified pertaining to physical processes.

4.2.1 Specific Decision 10: In an iterative manner, 1) determine if there is a sediment deficit by determining the sediment supply in the South Bay (taking into account sea level rise, sediment supply and dynamics, subsidence, and other projects in Bay); 2) determine how much sediment is needed for each restoration alternative in order to meet the project goals and objectives (habitat evolution, mix of tidal habitats), and 3) determine the need for imported sediment for tidal restoration areas, if any. Determine potential sources and feasibility of importing sediment, if required. Conduct a cost-benefit analysis of speed of restoration (evolution rates to tidal marsh of individual ponds and phasing of tidal restoration over entire project area) versus costs of importing sediment, also taking into account the cost of on-going pond management versus sediment import.

- What is the bathymetry of each pond in the acquisition area, including average and variation in elevation?
- What is the sediment deficit of each pond, assuming restoration to tidal marsh?
- What levels of ongoing subsidence and internal compaction may occur that would increase the sediment demand of any restored pond? Has South Bay subsidence stopped or is it ongoing?
- What is the total sediment supply to the South Bay, what are the relative sources from local watersheds versus the northern estuary, and what are the long-term projections of change for these resources? Are existing monitoring data sufficient to support numerical modeling?
- What are the possible dredged sediment supply options over the next several decades and what is the projected quality of that sediment?
- What will be the demand on sediment supply to account for projected sea level rise to maintain marshes, mudflats, and restored tidal marsh?
- What is the range of projections in sea level rise over the next 100 years?
- What is the relative contribution to net elevation accretion in restored ponds from external suspended sediment, internally generated organic matter, subsidence, and internal compaction and over what time scale do these different processes operate to evolve restored ponds toward tidal marsh?
- What is the impact of wind-wave resuspension on sediment accretion rates for predicting marsh evolution and of wind waves on levee erosion? What are the wind speeds and potential water depths and lengths of fetch?
- What design features could improve sediment accretion rates in areas restored to tidal action?

- How is sediment transported in South Bay sloughs and what are the hydrodynamics of these sloughs?

- What are the anticipated sediment accretion rates and how might these rates vary around the South Bay?

- What are the technical considerations of importing and distributing dredged sediment to the subsided Alviso ponds?

4.2.2 Specific Decision 11: Determine the impacts of tidal restoration on hydrodynamics, geomorphology, and water quality of San Francisco Bay (including potential loss of mudflats, impacts on sediment budget, impacts to other projects in the Bay, increased velocity and scour, changes to currents and tides, impacts on navigation, impacts on infrastructure, increased residence time), and how adverse impacts can be minimized.

- To what extent will large-scale tidal marsh restoration and managed pond Bay water exchange increase the South Bay tidal prism, especially in the extreme south? How will changes in tidal prism alter sediment resuspension, transport, and deposition throughout the South Bay? How will these changes affect the existing mudflats? How will changes in tidal prism affect circulation patterns that flush pollutants from the wastewater treatment plants (San Jose, Sunnyvale, Palo Alto)?

- How will the hydrodynamics, sediment dynamics, and salinity regimes of the lower reaches of South Bay tributary streams and rivers be affected by the increased tidal prism, altered circulation patterns (including pollutant flushing), and altered sediment regime induced by tidal marsh restoration and managed pond Bay water exchange?

- What historically-deposited contaminants might be exposed if intertidal and/or subtidal mudflats scour following opening of ponds to tidal action?

- Will methyl mercury concentrations in restored wetlands increase over those found in existing tidal marshlands of the South Bay?

- Will tidal marsh restoration increase trapping, bioavailability, and adverse ecological impacts from PCBs that are known to exist in bay sediments in the Guadalupe area?

4.2.3 Specific Decision 12: Determine how enhanced ponds will be managed to meet project goals and objectives for managed pond habitat, including the engineering requirements of managed ponds, and how water will be circulated through managed ponds.

4.2.4 Specific Decision 13: To evaluate Specific Decisions 8, 9, and 10 (and other specific decisions), determine the modeling framework or protocol that will be used to evaluate alternatives for pond management and tidal restoration (and associated hydrodynamic and geomorphologic changes to the Bay) and establish an ongoing/iterative approach to modeling in connection with decision-making. Determine the goals and objectives for modeling over the planning, construction, and monitoring and adaptive management period, the decisions that will be addressed by modeling, and the required accuracy and breadth of modeling (such as processes and grid sizes) required at various decision points.

Determine how physical models will be integrated with other models, such as habitat models.

- What are the exchanges between salt ponds and how do these exchanges affect pond water budgets and consequent salinity, water quality, and environmental conditions?
- Are current South Bay bathymetric data sufficient to support numerical modeling?
- Are current South Bay tidal water level and suspended sediment concentration monitoring data sufficient to support numerical modeling?

4.2.5 Specific Decision 14: Determine which levees will need improvements, whether and where new levees are required, and whether and where other new infrastructure, such as water control structures, are required, in order to manage ponds and protect South Bay communities from tidal flooding.

- Which interior levees separating salt ponds from adjacent upland land uses currently function as flood control levees, which levees may be used for flood control in the future, and which levees may require reconstruction to meet flood control needs?
- Is ongoing subsidence occurring on a regional basis? Will subsidence affect flood protection functions of existing and planned levees?
- Which and to what extent are interior salt pond/adjacent land use separator levees experiencing ongoing subsidence and are subject to seismic instability?
- What minimum levee freeboard heights are necessary to protect against flood hazards from project-related activities such as altering managed water levels in ponds?
- What seismic safety concerns do the existing inland levees pose?

4.2.5 Specific Decision 15: Determine how the project will be integrated with flood management plans for creeks and rivers in the South Bay to achieve win-win situations.

- How might salt pond restoration be integrated with plans for improving the capacity of the Alameda Flood Control Channel, the planned Guadalupe River flood control efforts, and other flood control efforts?
- How can flood management and tidal marsh restoration be integrated so that they are mutually beneficial?

4.2.7 Specific Decision 16: Determine infrastructure constraints, and how these constraints will be addressed.

- How will new boardwalks to existing PG&E towers affect predator access to restored marsh interior?

- What underground utilities and pipelines exist at and within 1,000 ft of every pond? (Utilities and pipelines include electrical, petroleum, fiber optic, storm water, waste water, natural gas, etc.)

- What transportation corridors (roads, rail) are located near salt ponds and might these corridors require flood protection and/or modifications to allow increased water movement?

- What is the inventory and condition of existing pond operational infrastructure, including siphons, pipes, valves, gates, pumps, etc.?

- How will infrastructure modifications for interim management be incorporated into the long-term restoration planning?

IV.3 CONTAMINANTS AND WATER QUALITY

Two specific decisions have been identified pertaining to contaminants and water quality.

4.3.1 Specific Decision 17: Determine steps to be implemented to minimize mercury methylation and its effects on wildlife and humans. Identify the areas, if any, that require design adaptations due to elevated mercury levels.

- What has been the history of each pond in the salt pond complex and how might that history inform contaminant potential?
- What is the soil/sediment chemistry in the salt ponds and adjoining levees?
- Will methyl mercury export from tidal wetlands into the South Bay increase and, if so, will this increase be detectable elsewhere in the South Bay?
- What is the effect of the Almaden Quicksilver Mine on historic and modern mercury loads of sediments entering the salt ponds and which ponds are most likely to contain these inflows?
- What historically-deposited contaminants might be exposed if intertidal and/or subtidal mudflats scour following opening of ponds to tidal action? Are there specific hot spots in the South Bay mudflats, marshes, and salt ponds?
- What is the potential to foster environmental conditions suitable for mercury methylation and how might identified adverse impacts be mitigated? What are the present methylation rates and how might these rates accelerate in restored wetlands? Will methyl mercury concentrations in restored wetlands increase over those found in existing tidal marshlands of the South Bay?

4.3.2 Specific Decision 18: Determine how other contaminants (in water and sediment) will be addressed.

- To what extent will nuisance algae be a problem in managed ponds?
- To what extent would use of recycled wastewater to maintain water in managed ponds contribute to algae production?
- What is the potential to increase sulfide-reducing bacteria with addition of freshwater, either from bay-discharged treatment effluent or direct reuse of treated wastewater (especially City of San Jose)?
- What conditions promote eutrophication and anoxia in ponds, which can adversely affect wildlife resource functions?
- How will changes in tidal prism affect circulation patterns that flush pollutants from the wastewater treatment plants (San Jose, Sunnyvale, Palo Alto)?
- Will there be an increase in freshwater input from wastewater treatment plants due to population growth? If there is an increase, would it create more freshwater marsh than currently exists?

- What has been the history of each pond in the salt pond complex and how might that history inform contaminant potential?

- What is the soil/sediment chemistry in the salt ponds and adjoining levees?

- How, if at all, will new NPDES permit requirements (currently under development between the Regional Water Quality Control Board and the City of San Jose for its wastewater treatment plant discharge) alter contaminant loading and freshwater influence?

- What historically-deposited contaminants might be exposed if intertidal and/or subtidal mudflats scour following opening of ponds to tidal action? Are there specific hot spots in the South Bay mudflats, marshes, and salt ponds?

- Will contaminant exchange and trapping change as a result of tidal marsh restoration and pond management shifting to routine Bay water exchange?

- Will tidal marsh restoration increase trapping, bioavailability, and adverse ecological impacts from PCBs that are known to exist in bay sediments in the Guadalupe area?

4.3.3 Specific Decision #19. Determine the effects of nutrients, nutrient loads, and nutrient cycling on the restoration effort (in both managed ponds and tidal areas), and define approaches to minimize risks of eutrophication.

4.3.4 Specific Decision #20. Determine the effects of salinity on other contaminants and water quality parameters, and how salinity ranges should be defined to optimize water quality in the project area.

IV.4 OTHER SPECIFIC DECISIONS (NOT ADDRESSED IN DATA GAPS WORKSHOP)

The following three specific decisions will also be required, but will not be addressed as part of the data gaps workshop.

4.4.1 Specific Decision 21: Determine the types of wildlife-oriented recreational uses and public access that will be allowed, and the appropriate locations for those recreational uses and access.

- What is the existing extent of public access and recreation within the acquisition area and on adjacent properties?
- What are the existing public uses and who are the existing users within the acquisition area and on adjacent properties?
- What are the needs in the South Bay for public access and recreation (demographics, interests, existing opportunities and demands)?
- What are the range of public access and recreation opportunities that could be offered on CDFG and USFWS properties?
- What are the identified Bay Trail alignments through the acquisition area?

4.4.2 Specific Decision 22: Determine the overall cost of the project, and the appropriate trade-offs that can be made to manage both capital and long-term operation costs.

- What are the relative costs of implementing different design and construction approaches?
- What are the costs to maintain existing inland levees as a function of levee height above pond/inland ground surface elevations for ponds that may be retained as open water areas?
- What are the present worth costs for capital and O&M expenses for maintaining shallow water habitat as opposed to restoring areas to tidal marsh and what factors most affect those costs?
- What are realistic long-term O&M funding expenditures expected from the State and federal government and, if willing, major foundation sources?
- What are the economic considerations of importing and distributing dredged sediment to the subsided Alviso ponds?
- What are the implementation and long-term maintenance costs of public access and recreation?

4.4.3 Specific Decision 23: Determine the amount of funding that will be required for the project, and when will it be required.

- For ponds restored to tidal action, at what point following restoration can interim O&M activities (levee maintenance, water management) cease?

- What are the implementation and long-term maintenance costs of public access and recreation?

IV.5 General Research Questions (Not Addressed in Data Gaps Workshop)

The following key questions identified by Wetlands and Water Resources will not be discussed at the data gaps workshop because they pertain to larger-scale issues than the restoration planning effort. These questions are considered general research questions.

- What are the minimum marsh sizes and structural attributes necessary to support viable, self-sustaining populations of the target species such that no species faces adverse consequences of catastrophic events (floods, disease, etc.)?

- What are the minimum marsh sizes and structural attributes necessary to support the required genetic diversity of the target species?

- What constitutes appropriate minimum connections (size, structural attributes, vegetative cover, high tide escape, extend of tidal action, etc.) between large, diverse tidal marsh patches, accounting for differing needs across target species? How can these connections be restored and maintained to support viable, self-sustaining populations? Is a "margin of safety" beyond the minimum requirement required to compensate for other environmental stressors? How can connections be designed to minimize predator effects?

- At the large spatial scale, what landscape composition and vegetation associations of mudflat, low marsh, high marsh, upland transitions, and channel networks are necessary to support target species, food web support, and other tidal marsh functions? How can these needs be incorporated into site selection, especially when trying to recreate upland transitions? What level of engineering intervention is appropriate?

- What long-term changes in sediment sources (watershed and estuarine), sediment sinks (sea level rise, restoration projects, dredging, proposed new runways), and bay bathymetry can be expected during the course of salt pond restoration? How are the multiple sources, sinks, and exchange mechanisms linked and how might those linkages change with salt pond restoration, increased tidal prism, other projects such as new runways? Can these sources, sinks, and exchange mechanisms be managed to any degree through restoration engineering design?

- How will construction of new SFO runways, if approved and built, affect hydrodynamics and sediment supply in the South Bay and will such changes affect salt pond restoration and Bay-wide effects of salt pond restoration?

- What modifications to overhead electrical transmission lines will be necessary to maintain minimum sag line clearances, and to protect tower footings?

ATTACHMENT A

KEY QUESTIONS FRAMEWORK

The key questions provide additional information on potential data needs and issues associated with each of the specific decisions. Due to the complexity of the project and planning effort, a framework was developed to identify key questions by topic area. The framework has two major areas: (1) ecological goals and (2) opportunities and constraints. Ecological goals help identify the key ecological, physical, and chemical questions about restoring and managing target ecosystem functions. Opportunities and constraints help determine viable options for achieving ecological goals. Table 1 presents this framework. Abbreviations for the categories are shown in parantheses.

Table 1. Key Questions Framework

Ecological Goals	Opportunities and Constraints
Ecological, physical, and chemical questions about restoring and managing target ecosystem functions	Defines opportunities and constraints to restoration and management
1) Tidal marshlands, sloughs, and upland transitions	**1) Hydrogeomorphic considerations**
2) Managed open water ponds	**2) Sediment supply and hydrodynamics**
3) Pannes, isolated levees/islands/edges	**3) Restoration impacts on hydrology and geomorphology of bay**
4) Intertidal mudflats and subtidal habitats	**4) Contaminants**
	5) Biological resource protection
Conservation biology principles: • Patch size, distribution, connectedness, shape, heterogeneity • Landscape setting (e.g., adjacent land uses, regional context)	**6) Flood protection** **7) Infrastructure**
Habitat suitability considerations, e.g., • Minimum areas • High tide/storm refugia • Proximity to forage resources • Predator avoidance • Ecosystem heterogeneity/structure • Resilience from disease, invasions • Juvenile dispersal	**8) Economics and logistics** **9) Public access and recreation** **10) Cultural resources**

CONSIDERATIONS FOR FRAMEWORK QUESTION CATEGORIES

Tidal Marshlands, Sloughs and Upland Transitions

This section presents key questions pertaining to the ecological goals of restoring tidal marshlands, their associated slough channel networks, and the upland transitions in and along the edges of former salt production ponds. It is important to recognize that tidal marshes and their slough channel networks will take time to develop following restoration implementation, with the duration dependent upon a variety of factors. Their intermediate stages as intertidal and subtidal mudflats are addressed separately below. Upland transitions within and adjacent to tidal marshes provide critical refuge during extreme high tides and storms for tidal marsh species such as the salt marsh harvest mouse and they provide habitats for rare plant species. These areas can consist of tall, shrub vegetation in narrow bands along channel margins as well as narrow and broad bands at the upland edge of restored marshes.

Tidal marshland ecosystems, including their slough channel networks and upland transitions, support a wide variety of target species and they contribute to food web production, flood stage reduction, sediment entrapment, and water quality filtering (the non-biological issues are addressed in the contaminants and sediment/hydrodynamics sections). The key questions pertain to all these functions. The species known or expected to utilize tidal marshlands and their sloughs and upland transitions include but are not limited to the following:

- Special status species that utilize tidal marshes, their sloughs, and the upland transition: California clapper rail, long-billed curlew, short-eared owl, saltmarsh common yellowthroat, Alameda song sparrow, salt marsh wandering shrew, salt marsh harvest mouse, Pt. Reyes bird's beak, California sea blite

- Other avian species that utilize tidal marshes, their sloughs, and the upland transition: great egret, great blue heron, snowy egret, black-crowned night heron, willet, marbled godwit, sanderling, red knot, western sandpiper, least sandpiper, dunlin, short-billed dowitcher, long-billed dowitcher, marsh wren, and savannah sparrow

- Other species that utilize tidal marshes, their sloughs, and the upland transition: Salmonids and other fish, Pacific harbor seals

Managed Open Water Ponds

Managed open water ponds are salt ponds with the management shifting from one-way evaporative concentration of Bay waters for salt production to two-way salt exchange with the Bay for supporting a variety of prey resources suitable for numerous important bird species. These ponds include open water of variable depths and salinities along with perimeter levees and in some cases isolated levees and interior islands that are addressed separately below. The open water serves as forage and roosting grounds for a variety of waterfowl and seabirds that feed upon secondary and higher food web production:

- Special status species: American white pelican, California least tern, elegant tern

- Other avian species that utilize open water: northern pintail, canvasback, ruddy duck, eared grebe, northern shoveler, American wigeon, Bonaparte's gull, mew gull, ring-billed gull, herring gull, glaucous-winged gull, western gull, Forster's tern, Caspian tern

Pannes, Isolated Levees, Islands, and Pond Edges

Seasonally or perennially emergent lands within the overall complex of ponds and tidal marsh provide significant nesting, roosting, and escape cover habitats for numerous wildlife species. Such areas include the following features: (1) part or all of former salt ponds that dry seasonally, (2) portions of remnant internal salt pond levees be they contiguous or islands, (3) other high ground within ponds, and (4) the edges of salt ponds. The most critical aspects of these ecosystems are their isolation from disturbance (especially predators such as red fox and Norway rats and including humans), lack of vegetation, and their not being inundated during nesting periods. A sample of the species that these areas support includes:

- Special status species: Western snowy plover, California gull, black skimmer, California least tern, California horned lark, salt marsh harvest mouse

- Other species that utilize pannes, isolated levees, islands, and edges: black-bellied plover, black-necked stilt, American avocet, sanderling, red knot, western sandpiper, least sandpiper, dunlin, short-billed dowitcher, long-billed dowitcher, Wilson's phalarope, red-necked phalarope, salt marsh wandering shrew

Intertidal Mudflats and Subtidal Habitats

The process of transformation from salt ponds to tidal marsh involves ponds shifting from open, unvegetated areas to a vegetated marsh. Intertidal mudflats and/or subtidal habitats, which provide important ecological functions, will characterize this transitional post-restoration period. The duration of the transition period in any given pond depends on many factors and is expected to last from a few years to many decades. Intertidal mudflats and shallow subtidal areas may persist in the project area after restoration has been completed, but at a smaller scale. The ecological functions of mudflats are well established in the San Francisco Estuary and include the following uses:

- Shorebirds that utilize mudflats: black-bellied plover, black-necked stilt, American avocet, sanderling, red knot, western sandpiper, least sandpiper, dunlin, short-billed dowitcher, long-billed dowitcher, Wilson's phalarope, red-necked phalarope

- Food web support through primary, secondary, and higher trophic level production of phytoplankton, zooplankton, and benthic invertebrates

- Fisheries relying upon the benthic and aquatic food web: bat ray, leopard shark, Pacific herring, northern anchovy, Chinook salmon, steelhead, longfin smelt, jacksmelt, topsmelt, threespine stickleback, brown rockfish, Pacific staghorn sculpin, white croaker, shiner perch, arrow goby, bay goby, longjaw mudsucker, California halibut, and starry flounder

Hydrogeomorphic and Environmental Considerations for Restoration

Achieving ecological goals of restoration and management will require application of the latest understandings of physical processes of marsh restoration, tidal marsh interactions with the open estuarine waters, and related environmental considerations.

Sediment Supply and Hydrodynamics

Sediment issues (e.g., sediment budget, supply and methods to mitigate for sediment deficits) and hydrodynamic issues (e.g., flow capacities of sloughs, creeks, and rivers bordering the salt ponds, tidal prism, and overall South Bay circulation) have two implications for restoration planning. First, these issues are the most important factors governing the rate restoration can occur without adversely impacting South Bay mudflats or other important resources. The time period for restoration will govern the funding and political commitments necessary for restoration as well as be an important criterion for the public to consider when evaluating the success of this restoration effort. Second, these issues are important in evaluating the extent to which such large-scale wetland restoration and pond management may alter South Bay physical processes intricately linked to estuarine ecological productivity as well as human use of the South Bay. Several key questions below relate to the first issue; the second issue is addressed separately under the Impacts discussion.

Impacts of Restoration on Hydrology and Geomorphology of San Francisco Bay

Examining the opportunities and constraints on restoring and managing salt ponds includes the potential adverse effects such actions may have on the hydrology and geomorphology of the South Bay, outside of the restored or managed salt ponds.

Contaminants

The San Francisco Estuary has a long history and ongoing concerns of anthropogenic contaminant inputs. Historical contaminant loading may be present in salt pond and bay sediments that could become available with tidal marsh restoration. Abandoned mines are located within the watershed and can be a source of ongoing contaminant loading. Wastewater and industrial point sources and storm drains numbering in the hundreds or more continue to discharge to the Bay routinely.

Biological Resource Protection and Interferences

The South Bay contains two essential ecosystem types that support a wide array of fish and wildlife species and that could be adversely impacted by large-scale tidal marsh restoration. Existing salt ponds provide important shallow open water habitats for numerous waterfowl and some seabird species. Intertidal and subtidal mudflats provide important habitat for waterfowl, shorebirds, and fisheries. In addition, biological interferences such as the invasive *Spartina alterniflora* could impede progress toward ecological goals and could constrain restoration efforts.

Flood Protection

Bayfront salt pond levees provide flood protection to extensive areas of the South Bay, with the corridor from Mountain View to San Jose being most critical due to regional subsidence conditions. As bayfront levees are breached to restore tidal action, these flood management functions transfer to interior and inland levees and the suitability of those levees for flood management becomes a fundamental issue. Maintaining levees presents high maintenance costs and stability concerns.

Infrastructure

Infrastructure constraints are plentiful in an area as urbanized as the San Francisco Estuary. Infrastructure includes underground and overhead utilities and pipeline corridors, nearby land uses such as marinas and ports, roads, bridges, etc. Ultimately, a thorough inventory on a pond-by-pond basis will be essential for planning purposes along with general and specific strategies for addressing common types of infrastructure constraints so that decisions can be made regarding target ecosystem types for each pond as well as general restoration strategies.

Economics and Logistics

To accommodate conflicting ecological requirements, the Goals Report (Goals Project 1999) recommends retention of about one-third of the salt ponds as managed shallow open water and restoration of about two-thirds to tidal marsh. There are several key questions relevant to this goal, which will have long-term economic, ecological and environmental consequences and are driving issues in the restoration process. Essentially, management of open water will require long-term O&M commitments and the magnitude of those commitments will depend upon which ponds are maintained as shallow aquatic habitat. For the purpose of planning for restoration and understanding the long-term financial commitments, these issues need to be carefully addressed early in the process in order to make educated decisions and plans. Restoring and maintaining the salt pond complex will require a large political and financial commitment from the public; maximizing the return on that investment would benefit the process.

Public Access

One objective of the restoration project is to provide public access and recreation in the South Bay. Public access will have to be planned to minimize impacts to wildlife and various forms of public access and recreation will have to be coordinated to reduce conflicts between users.

Cultural Resources

The acquisition area has a long history of uses by people, from Native American use of the marshes for food to the creation of salt ponds. Ultimately, a thorough inventory of cultural resources, within the area that will be affected by the restoration, will be essential in order to document the resources and determine if any are significant.