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The National Heritage Institute (NHI) is a nonprofit organization of lawyers, scientists and economists dedicated to improving the laws and institutions that manage natural resources in the United States. NHI's practice encompasses advocacy in judicial and administrative forums and negotiations and environmental policy development in the areas of biological diversity, land use and water resources. In the severely altered aquatic environments of California, NHI has taken a leading role in negotiating and implementing the bay-delta standards for more than a decade. We are restoring damaged habitats in many watersheds, including the Trinity River in Northern California, the San Joaquin River in the great Central Valley, the delta formed by the two major drainage systems of California, and the Mono Lake tributaries on the east side of the Sierra.

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INTRODUCTION

The CALFED Bay Delta Program is an unprecedented undertaking. Never before have the full constellation of state and federal agencies invested with managerial and regulatory responsibilities joined together with the resource conservation and utilization stakeholders to attempt to forge a long-term management plan for a landscape scale biohydrologic resource. The motive force behind this bold experiment is not the implementation of outstanding legal requirements. These are captured in current programs — the baseline beyond which the CALFED Program is designed to progress. Rather, the motive force is the common interest in exploring opportunities for conjoint problem solving predicated on the realization that the status quo is woefully suboptimal from the standpoint of all communities. The common bond that launched the CALFED program is the potential for innovations that will mutually advance the core interests of the core constituencies together-not necessarily at the same time, but in an inter-linked, progressive fashion. The most tangible manifestation of this common vision is the joint enterprise of the stakeholders and public agencies in securing authorization for some $1.5 billion in "earnest money" funding for the ecosystem restoration component of the emerging plan, on the understanding that it is impossible to make progress on any of the other goals of the program until there is confidence that the ecological crisis resulting from an oversubscribed water system can and will be ameliorated.

In our view, CALFED cannot be allowed to fail . . . If it did not exist, the stakeholders would have to invent it.

In our view, CALFED cannot be allowed to fail, simply because there is nothing better on the horizon. That is why NHI has contributed staffing to the process and continues to be one of its most avid supporters. If it did not exist, the stakeholders would have to invent it—as, indeed, they did. To succeed, the CALFED program must serve as a framework for high-confidence technical analysis that will lead the stakeholders beyond their defensive preconceptions and ideologies and into a process of mutual problem solving.

Unfortunately, this grand conception has fallen short of its potential for a number of reasons. The most obvious is that CALFED has not invested in high-confidence technical analysis. Rather, it has relied almost exclusively upon state agency personnel who have simply brought their institutional perspectives into a new arena. Rather than liberating planning from the preconceptions that have defeated it in the past, these have simply been imported into the CALFED Program. Thus, water supply planning oblivious to the economics of water use continues to bedevil the CALFED process. The remarkable and dangerous reticence to squarely face the inherent instability of a water delivery and aquatic ecosystem dependent upon hundred of miles of dikes to keep the ocean “at bay” perpetuates the risk of catastrophic failure. The tendency to equate water supply augmentation with the conventional large-dam paradigm continues to defeat serious analysis of an array of faster, cheaper and more environmentally acceptable alternatives. The instinct of existing agencies to police the perimeters of their turf has forestalled serious consideration of the potential benefits and architecture of a new delta ecosystem management model based on rights and entitlements rather than rules and regulations.

In sum, instead of technical illumination, what the CALFED process has provided is yet another forum for political positioning. It has been dominated by a Bay Delta Advisory Committee and a plethora of working subgroups populated by purported representatives of particular constituent interests rather than by experts appointed for their technical competence. The process has been conducted as if the final outcome was to be a compromise of claims and positions in a grand settlement. However, no perceptible movement in that direction has occurred, nor will it occur until options for mutual gains are developed that do not also require mutual concessions. Herein lies the stalemate: the stakeholders are not yet willing to “give” in order to “get”. In the face of these realities, the CALFED solution will not be found through "horse-trading" — the instinct toward "mutual assured destruction” is still too strong. Rather, the solution will lie in initiatives that provide tangible benefits to all sides without appreciable sacrifices by any.

This "Environmentally Optimal Alternative" is therefore oriented toward describing approaches that should be mutually supportable by all sectors. That is not to say that there will not be winners and losers in this alternative. Any departure from the current (precarious) equilibrium will advantage some vested interests at the expense of others. Rather, our claim is that the combination of initiatives in this alternative will provide sufficiently large **net benefits** to each sector in the aggregate that it should be possible to adjust the internal equities in a manner that brings everyone out better under this alternative than they are today. Net benefits do not mean that there will be no adverse consequences felt by any farmer, urban water user or stream reach, but that these will be far outweighed by the benefits to the sector as a whole. That is as good as it gets in the real world of resource allocation—be it water or funds. There never has been the prospect of a CALFED solution that meets the needs of any one sector without meeting the legitimate core goals of the other significant sectors. As the late water philosopher Nat Bingham was fond of saying: “Everyone has to be able to envision a future”.

This Environmentally Optimal Alternative envisions a future in which:

- Natural processes are sufficiently restored to sustain native aquatic species indefinitely and with minimal maintenance.

- The San Joaquin River flows again from Friant to the Mendota Pool while the Friant water contractors receive a substitute supply of water via the California aqueduct.

- The hydrologic security of water supplies — for all sectors — is improved by augmented interannual groundwater storage.

- The biological security of water supplies — for all sectors — is improved by recovery of flow-dependent species.

- The delta islands are restored slowly but consistently to sea level-- where and to the extent feasible — to reduce the vulnerability of current and future land uses and the water conveyance system to catastrophic failure.

- The delta levee system is progressively restored to tidal marsh — where and to the extent agreeable to the local landowners-- to create a sustainable mosaic of wetlands and aquatic habitats co-existing with productive farmland.

- Farm profits are maintained with reduced water consumption through cost-justified improvements in the application and conveyance of irrigation water and through revenues from the marketing of the conserved water.

- Environmental water needs are met through participation in a state-wide water market that includes sufficient reliable sources of funds to assure competitive access.

- Urban water reliability is improved through a combination of efficiency improvements in all consumptive sectors, storage of conserved water in conjunctive use facilities and transfer of conserved water through market mechanisms.

- All water facility improvements are predicated upon net improvements accruing to aquatic ecosystems as well as water consumers.

- Urban water quality is improved at the source through improved diversion facilities that also sharply reduce adverse impacts on fish and other biota.

- Agricultural water use in the delta is maintained through salinity repulsion including maintenance of the western island levee system and sufficient freshwater inflows, particularly from the San Joaquin side of the delta.

- A new delta ecosystem management entity emerges which can perform all of the enumerated functions envisioned in this Alternative in a manner superior to the uncoordinated constellation of current agencies, including proactively improving the fundamental understanding of this complex hydro-biological system and adapting the management provisions accordingly.

The Environmentally Optimal Alternative does not merely posit this vision, it describes in detail how the mix of initiatives can be operationalized in practice. In this respect, it goes considerably beyond the draft plans that have emerged from the CALFED process, particularly with respect to the non-structural components. This alternative is superior to the CALFED drafts not only with respect to the ecosystem restoration goal, but also against the other three CALFED program goals. It will provide

> ***This Alternative will provide considerably greater water supply reliability, because its storage component is faster cheaper and more environmentally acceptable than CALFED's surface storage approach.***

considerably greater water supply reliability because its storage component is faster, cheaper and more environmentally acceptable than CALFED's surface storage approach and because it includes a diagnosis and prescription for addressing the barriers to water transfers. It is far superior in reducing levee system vulnerability because it does not pretend that the levee system can be made invulnerable to failure from seismic and flood events—which it simply cannot. Rather, this alternative describes a coherent and less-expensive strategy for reversing subsidence and rendering the levee structures unnecessary over the long-term, to the maximum feasible extent. And, it would improve source water quality for both agricultural and urban water diverters — irrespective of the delta diversion facility ultimately chosen — by rewatering the San Joaquin River and thereby improving southern delta inflows. For the Bay-Delta ecosystem, this alternative would lead to a more extensive habitat restoration program — in a manner more acceptable to, indeed, created by the delta landowners themselves — and an approach to restoring ecosystem processes and functions that is driven by the best science, as it progresses, rather than by static preconceptions.

Of course, no proposal is above criticism, and lying in wait for something to attack has become the standard stakeholder posture in the CALFED process. This alternative may fare no better. We recognize better than most the herculean efforts of the CALFED staff who tried to sail an uncharted course against unprecedented pressures and expectations. Rather than criticize, this paper takes to heart the exhortations of the CALFED policy agencies in rolling out the Draft Environmental Impact Report to provide affirmative suggestions for improvement. This document is a work in progress and will remain so while the CALFED Program continues. We hope that others genuinely interested in finding workable solutions will join in and help us improve this effort to articulate workable approaches.

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EXECUTIVE SUMMARY

I. DEVELOPMENT OF SHORT- AND LONG-TERM PROGRAMS TO PROTECT AND RESTORE THE DELTA AND MAKE IT SUSTAINABLE

The current lack of understanding of both long-term land owner preferences and biophysical constraints suggest that the plan for the Delta's future should include a near-term component consisting of immediate, low-conflict restoration opportunities nested with a longer term process that emphasizes local control, learning by doing, and actions that secure the future of the Delta irrespective of future land use decisions. There is too much uncertainty to specify the ultimate targets for types, locations or magnitudes of habitat restoration, but there is sufficient certainty and consensus to move ahead with the immediate opportunities on which the interested parties already agree. Rather than argue about the extent and magnitude of a long-term plan, Delta stakeholders should work together to immediately implement this more modest set of low-conflict restoration projects. Lessons learned from implementation of these projects coupled with additional time for further analysis will help illuminate and foster consensus on the next steps to take on the path toward a broader restoration program and a sustainable future for the Delta.

A. Long-term Program for Making the Delta Sustainable

1. Introduction

NHI proposes a gradual conversion of much of the Delta lands back to a vast mosaic of high quality aquatic, wetland, and terrestrial habitats, co-existing with agriculture, waterfowl forage crops, managed wetlands, and shallow and deep water recreation. *The only way to restore the Delta is incrementally and progressively over time***.** Thus, the CALFED restoration program must not consist merely of an initial list of projects that can be implemented in a short period of time. Rather, the restoration plan must include principles, processes and the means to guide a long-range effort.

2. Problem statement

> ***Probabilistic analyses conclude that it is only a matter of time before an earthquake causes levee failure and greater or lesser areas of the Delta become inundated.***

Before it was developed into agricultural lands, the Delta was a vast brackish tidal marsh with upland areas defined by natural stream meanders. However, agriculture on peat soil leads inevitably to land subsidence as a result of oxidation. Current land uses in the Delta can only be maintained artificially through levees that are costly to maintain and are susceptible to failure by natural events. The Delta islands are situated several feet below sea level, protected from inundation by hundreds of miles of levees constructed on soils prone to liquefaction under seismic forces. Probabilistic analyses conclude that it is only a matter of time before an earthquake causes levee failure and greater or lesser areas of the Delta become inundated. Loss of the islands could be devastating to the farmland owners, the water supply system, and the aquatic environment.

3. Developing a solution

Restoring the Delta island surface elevations, particularly in the western Delta, to at or near sea levels is critical to assure the sustainable protection and improvement of ecosystem values, and agricultural and drinking water quality. Several technologies for halting and reversing subsidence are reviewed in this Alternative. Field experiments suggest that tule cultivation in combination with layers of sediment captured from deposition sites within the Delta or acquired from nearby terrestrial sources could—within a few decades--raise the majority of subsided lands to elevations that could support either shallow water habitat, subtidal marsh, tidal marsh, or sustainable agriculture.

At a minimum, CALFED should develop a program to control and reverse subsidence on lands most prone to future subsidence or catastrophic levee failure.

At a minimum, CALFED should develop a program to control and reverse subsidence on lands most prone to future subsidence or catastrophic levee failure. A recent seismic hazard study funded by CALFED determined that the western Delta islands, particularly Sherman Island, are by far the most vulnerable to failure and inundation in an earthquake. Inundation of these islands would have the greatest impact on Delta water quality.

A major subsidence reversal program could be implemented in the western Delta without displacing existing Delta agriculture or private landowners. Most of the western Delta islands are currently either in public ownership, slated for uses as in-Delta reservoirs and habitat, or not in cultivation.

This Environmentally Optimal Alternative is based upon replacing unsustainable land uses in the Delta with restored tidal marsh and other habitats, thereby reaping large financial savings and environmental benefits over time. Indeed, this restoration program, including voluntary land acquisition and restoration, might actually reduce overall costs in the long run as unsustainable land uses are replaced with sustainable land use.

B. Defining Principles and Process for Developing a Long-Term Restoration Program

Efforts to develop a long-term restoration plan should focus on a process for advancing restoration rather than on the extent and location of restoration actions. CALFED's emphasis on restoration targets in the Delta, particularly arbitrary targets, is premature and creates conflict rather than promoting incremental progress. There is too much scientific uncertainty to legitimately develop long-term targets for Delta restoration. The Delta is too large, the issues too complex, the level of distrust too high, and the stakes too great to achieve adequate consensus around a comprehensive plan for the future of the Delta. Rather, CALFED should focus its efforts on establishing a fair and well reasoned set of principles and an inclusive decisional process for pursuing the Delta restoration goal incrementally over at least the next five decades.

Based on our discussions with local Delta stakeholders, this Alternative describes a set of principles that should guide any long-term restoration process in the Delta.

1. Local control of restoration on private lands
2. Create options for landowners while banking capital for restoration
3. Maintain a strong local economy
4. Empower local people to plan, implement, and manage ecosystem restoration
5. Promulgate "Good Neighbor" policies for government land managers
6. Subsidence reversal for all land uses
7. Protect agricultural water quality through interim prevention of levee failure and by reconnecting the mainstem San Joaquin River to the southern Delta
8. Focus on improving quality of habitat
9. Prevent irreversible land use changes in the Delta
10. Reduce flood peaks in the Delta
11. Regulate harmful effects of recreational boating

C. Near-Term Program for Protection and Restoration of the Delta's Ecological Resource

The near term program of Delta restoration is comprised of immediate, low-conflict opportunities around which a substantial consensus already exists. NHI has worked with in – Delta interests to identify and map these low-conflict opportunities. These targets fit within the longer-term program guided by the set of principles enumerated above. The most immediate efforts to advance the long-term conservation and restoration goals in the Delta should be focused on three elements:

1. Developing consensus with Delta landowners and residents regarding additional low-conflict restoration opportunities that can be feasibly implemented in the next five years. Figure 11 depicts ecosystem restoration sites and opportunities that Delta landowners and agencies have already proposed as low-conflict opportunities for CALFED restoration projects in the Delta.

2. Developing "learning laboratories" to advance our understanding of the restoration techniques that can be more widely propagated to achieve broad-scale conservation and restoration in the Delta.

3. Preventing urbanization and other irreversible changes to the Delta that will preclude or inhibit the protection and restoration of Delta resources.

II. AN ADAPTIVE MANAGEMENT PROGRAM

Adaptive Management is a strategy for managing uncertainty and reducing the risks associated with decision making in the face of scientific uncertainty that involves the following steps:

- Articulating measurable goals and objectives.
- Explicitly disclosing the assumptions regarding how the biophysical system will respond to hypothetical management interventions
- Testing these assumptions against actual results achieved through a directed program of data collection and interpretation
- Determining whether monitoring results warrant changes in the management or restoration strategy and adjusting accordingly.

III. CREATION OF A DELTA ECOSYSTEM RESTORATION AUTHORITY

Virtually every stakeholder group involved in CALFED now supports the creation of a new, non regulatory management and restoration authority for the Delta, because the restoration program emerging from the CALFED process calls for more than just better coordination among the agencies with existing managerial authority—it calls for new functions not now within the aegis or experience of any of these agencies. These novel functions include exercising property rights in water and lands, adaptive management (as described in the next section) and, potentially, administration of an assurances package that might include a program of regulatory indemnity, as also described later in this paper.

For ease of reference, we refer to that entity as the "Delta Ecosystem Restoration Authority" ("DERA"). Form should follow function in designing this entity. Structurally, governance should be commensurate with responsibility. Two models are possible in this regard. Under the first, DERA is a facilitative entity with the ultimate responsibility for meeting environmental standards (arising under the Clean Water Act or the Endangered Species Act, for example) and/or achieving the ecosystem restoration goals emanating from the CALFED Program resting with the stakeholders and/or public agencies. Under that model, all stakeholders and cognizant public agencies would have a seat on the board of governance of DERA.

Under an alternative model, DERA would assume the ultimate responsibility for achieving the ecosystem restoration program emanating from the CALFED Program and acting as surety for the achievement of environmental standards. Under this model, governance of DERA would be restricted to governmental and non-governmental entities whose mission and expertise is solely natural resource conservation and protection.

In either case, DERA would be capitalized with a limited but ample endowment of water, storage, conveyance, pumping and property rights and an assured income stream, insulated from the political process. DERA would use, trade, sell, and acquire property rights to maximize environmental benefits. As a result, the institution would have a strong incentive to invest its resources in highly effective strategies and to avoid or withdraw from activities that were not effective. It would seek restoration through non-regulatory means. As a result, it would: (1) face reduced resistance to implementation; (2) be able to modify its programs quickly in response to new scientific understanding; and (3) be able to take advantage of key market opportunities. DERA itself could be constituted as either a creature of government (through a joint-powers arrangement, for example), or as a non-governmental, private non-profit corporation. The latter option may have the advantage of insulating it from the politics associated with annual appropriations of funds from the legislature and/or the Congress.

IV. REVISING DELTA EXPORT OPERATIONS

The export pumps are a major cause of fish declines in the Bay-Delta ecosystem. Under the Endangered Species Act and the Clean Water Acts, a regulatory regime governing exports has been established to reduce the number of fish entrained. While these rules have been effective in slowing fishery declines, their command and control quality does not allow the flexibility necessary to optimize environmental and water supply benefits in real time operations. The ideal set of export rules should:

1. Be protective
2. Be predictable
3. Be compatible with real-time management
4. Be compatible with market transfers
5. Promote cooperation between the environmental manager and the export projects
6. Share the benefits of future changes

The current regime for controlling exports violates all of these criteria to a degree. Fortunately, there are a number of possible ways to improve the export rules. The Environmentally Optimal Alternative proposes an approach that is based upon explicit environmental control over pumping, conveyance, storage, and water rights. Environmental managers would achieve improved operations by bartering these rights with the managers of the state and federal projects. This approach does not require significant changes to existing export standards. However, improving the climate for water transfers probably does require modifications of existing prescriptions to more performance-based standards.

V. ESTABLISHING PRIORITIES FOR ECOSYSTEM RESTORATION

A. The ecosystem restoration component of the Delta system is both the most complex and the most foundational in the sense that all other components depend upon its success. Below, we offer criteria for selection of restoration projects~~.~~

Learning potential: Projects should be designed specifically to address critical knowledge gaps pertinent to broader application of restoration techniques.

Fungibility: The restoration program should invest in ecosystem assets (land, water) that can be exchanged as priorities evolve.

Reversibility/Conservation: Projects that prevent relatively irreversible changes to the landscape such as urbanization, fragmentation, exotic species invasions, or conversion to perennial crops should be prioritized.

Comparative Cost Effectiveness: Projects should yield the greatest benefits per unit of investment in achieving the restoration goals and objectives.

Restorability: Restorability: Projects that truly restore or protect natural process, functions or character, or come close should be favored.
Feasibility/Ripeness: Projects that can be achieved in the near term without countervailing adverse consequences should be favored.

Sustainability: Projects that are self-sustaining should be preferred over those that require significant maintenance.

Leverage: Projects that have the potential to leverage an initial public investment into a larger effort for ecosystem benefits are desired.

B. Risk/Certainty: Projects with low risk or high certainty of success should be prioritized.

C. Based upon these criteria, the Alternative proposes the following sets of actions:

1. Remove Dams and Rewater Rivers to Expand the Range of Anadromous Salmonids

- Remove Dams and Barriers on Battle Creek.
- Rewater the Upper San Joaquin (the most important anadromous fishery restoration opportunity in the entire Central Valley, as explained below).
- Remove Englebright Dam on the Yuba River.
- Remove Nimbus Dam.

2. Acquire Floodways, Restore Floods and Floodplain Habitat

- Acquire floodway corridors.
- Create Levee setbacks and flood bypasses.
- Modify dam operations to increase peak flows.

3. Eliminate Channel Clearing and Dredging Practices

CALFED and other restoration managers could save both time and expense by halting chronic disturbance associated with flood control activities and allowing stream channels to restore themselves instead of making large investments in riparian plantings and habitat construction.

<u>4. Control Exotic Species to:</u>

- Halt introductions by ballast water by the year 2010.
- Form an exotic species emergency response team.

<u>5. A special program to restore flow and habitat on the San Joaquin River</u>

The dewatering of the San Joaquin River below Friant dam in the 1940's extirpated spring and fall runs of Chinook salmon, steelhead, and other native fish from the San Joaquin river upstream of the Merced River. Today, it is possible to serve water users dependent on Friant diversions with Delta water via the California aqueduct in exchange for increased stream releases from Friant Dam. This plan would not only restore the most degraded river in the Bay-Delta watershed, but it would also improve water quality in the lower San Joaquin and south Delta, improve water supply reliability, and potentially increase overall water supply yield.

VI. IMPROVING WATER SUPPLY RELIABILITY WITH A NEW WATER MANAGEMENT PARADIGM

A. Integrating Markets, Conservation, and Groundwater Storage

Water conservation, conjunctive use, and water markets (transfers) are all components of an integrated water management strategy to increase the availability of water in drier years for all the benefit of all sectors, including the aquatic environment. It is a mistake to consider these components as discrete and unrelated, as the CALFED program has tended to do. Dry year supplies are inadequate to meet existing demands because the system fails to capture flood releases and store them underground for dry year use, and because surface supplies are lost to deep percolation and transpiration by low value crops during these dry years. Considerable empirical research shows clearly that water is routinely applied in excess of root moisture requirements in California agriculture because it is not economically worthwhile to invest in more water conserving technologies and techniques. While this is not a problem in most areas during wetter years, excess applications cannot be justified in times of scarcity. This same research also shows that the best way to make larger investments worthwhile is to provide market incentives. If water is worth more in the market than a farmer pays for it, he has a larger incentive to use it sparingly. However, there is not much market incentive in wetter years because the market price of water is low. If, however, a farmer could salvage water in wetter years for sale in drier years, much larger market incentives would be created. This can be done if the saved water can be stored in groundwater basins.

If water is worth more in the market than a farmer pays for it, he has a larger incentive to use it sparingly.

B. The Central Role of Economics: Create financial incentives for water use efficiency improvements in agriculture

1. Defining Water Use Efficiency

The definition of agricultural water use efficiency that we have found to be consonant with the perspective of growers themselves is increasing the profitability of agriculture per unit of water consumed (or, conversely, minimizing the amount of irrigation water needed to maintain current levels of profit). Allowing farmers an alternative way to profit from water than applying it to crops achieves this goal. Market transfers provides that alternative.

2. Why Market Incentives Work Better than Regulations

> ***Financial incentives are likely to outperform best management practice (BMP) regulations.***

Planning mandates and "best management practices" prescriptions do not induce much actual water conservation in a state like California because, as the growers themselves often proclaim, irrigation is about as efficient as is currently cost-justified. To require more would be to economically irrational from the standpoint of these growers who are, after all, good businesspersons, adept at cost minimization. Moreover, irrigation system investments are influenced by a number of individual and environmental conditions beyond the control of regulators. For this reason, that dictate on-farm water management practices.

The answer, then, is to increase the value (not necessarily the cost) of water applied in irrigation to the point where it is worth investing more in water conserving techniques and technologies. That is measured in terms of irrigation technology adoption, reduced conveyance losses, shifting to higher value crops and dry-year or permanent fallowing of marginal lands (where the value of the production is less than the value of the water). The best way to increase the value of water in agriculture without increasing its cost to agriculture is through water markets. Tiered and volumetric rate designs can also be efficacious, but are often harder to administer successfully. In sum, financial incentives are likely to outperform the best management practice regulations that dictate on-farm water use.

C. Remove institutional barriers to water markets

1. Current Impediments to Transfers in California

Water transfers are subject to many checkpoints, rules, criteria and inertial influences. Successful transfers across district boundaries are relatively rare; multi-year transfers even rarer. Recent efforts to reform the state laws governing the market transfer of water have foundered by attempting a comprehensive set of reforms, suggesting that incremental progress may be the prudent course.

2. Key reforms necessary to facilitate water transfers

- *Create incentives for water and irrigation districts to facilitate water transfers.* A key to voluntary water transfers in a state like California, where local water districts are the central feature of the distribution system, is to encourage these districts to play a mediating and facilitative role. Where they do so, water transfers are relatively easy to accomplish.

- *Confront the consumptive use limitation.* The easiest and most acceptable agricultural water conservation opportunities are technologies and techniques to line canals and laterals and eliminate over-application of irrigation water. However, federal water conserved in those ways is not transferable (except in the drainage-problem areas). That removes the incentive to conserve. Where the water is imported into CVP or SWP service areas, recaptured return flows or deep percolation should be considered transferable water. This imported water exception to the consumptive use limitation is recognized in state water transfer rules but not in the federal rules.

- *Protect groundwater resources.* To protect groundwater tables from additional depletion, liberalized surface water transfer rules must assure that out-of-basin surface water transfers do not result in groundwater substitution.

- *Expedite approvals of transfers.* The water code should be amended to authorize the State Board to exercise its rulemaking authority to develop a fast-track approval process for benign categories of transfers, under criteria codified by the statute.

- *Compensate for third party economic impacts.* Rather than freezing agricultural water use into its existing pattern, it would be far preferable to provide an impact compensation scheme.

- *Expedite transfers of water to instream uses*. Protection of voluntary dedications to instream flow would be greatly enhanced by establishing an "instream flow registry." This computer database would be established and maintained by the State Water Resources Control Board. It would track all voluntary dedications and regulatory reservations applicable to a given stream segment in a cumulative manner.

D. A Maximal Groundwater Banking Program

Conjunctive use is a standard tool of many local water supply agencies that have access to groundwater. What is new in the proposal in this Alternative is that much larger system-wide benefits would accrue from a maximal scale, centrally-orchestrated, actively recharged program that provides yield benefits to all sectors in the entire, integrated Central Valley water system to the same extent as would additional surface storage. The use of groundwater storage to provide benefits for areas remote from the storage site is relatively rare in the Central Valley. *NHI proposes a program in which groundwater storage services would be procured from overlying landowners in a manner that permits the program to store and retrieve the water with only positive consequences to correlative groundwater users*. This program would also be wholly (or largely) self-financing and could be implemented with no (or minor) changes in existing law.

Groundwater development fits well with adaptive management and phasing because it can be pursued and improved incrementally. Yet, the CALFED DEIR proposes increasing groundwater storage in the Central Valley by only 750,000 acre feet which translates into approximately 100,000 acre feet of yield. Considering the promise of groundwater banking, a more ambitious program is warranted.

Our preliminary investigations indicate that, given liberal assumptions about: 1) the existence of infrastructure; 2) the ability to reduce surface storage levels below current patterns; and 3) the availability of suitable land, the amount that could be captured through the pre-delivery of water is approximately 1.4 MAF of additional <u>yield</u> per year on average.

<u>1. Potential Groundwater Banking Sites</u>

A preliminary feasibility study has generated the following array of candidate sites with a combined storage capacity of over 10 maf: (1) The Butte Basins Area; (2) Cache Creek-Yolo Area; (3) East Stockton-Stanislaus River Area; (4) Westside San Joaquin; (5) Kern County; (6) Greater Los Angeles; (7) Imperial Valley; and (8) Gravelly Ford/Madera Ranch. We are now evaluating these sites with the Water Evaluation and Planning model (WEAP) that was enhanced for this purpose.

<u>2. Legal and Institutional Constraints and Implications for Design of a Maximal Groundwater Banking Program</u>

Several legal and institutional issues constrain the development and implementation but our analysis indicates that major progress could be made without new laws. In the body of the document, we offer design guidelines for developing conjunctive use opportunities around these legal and institutional constraints.

E. Reoperation of existing facilities to maximize efficiency

<u>1. Flood Reservation Storage</u>

The true flood reservation associated with any reservoir is the sum of the vacated storage behind the dam <u>and</u> the amount of water that can be released from the dam in a given period of high run-off, such as three days. On many rivers, the amount of controlled flow that can be released from the dam is limited because of downstream flooding damage to crops and structures. If those releases can be increased, annual carryover storage is effectively increased. Such reoperations are also consistent with CALFED's ecosystem plan to restore ecological processes associated with high flows, flooding, and floodplains. This can be accomplished through combination of flood easements on agricultural lands, acquisition and removal of structures where they are relatively scant, and localized ring levees.

VII. FRAMEWORK FOR EVALUATING THE NEED FOR AN ISOLATED CONVEYANCE SYSTEM

Arguments in favor of and against an isolated transfer facility revolve around the relative performance of the isolated facility with respect to fish entrainment, drinking water quality, and seismic stability, and assurability of operations, given the existence of high levels of scientific uncertainty.

A. Entrainment

It is certain that the impacts of the pumps on the environment are negative. However, it is not clear just how much of the declines in populations are caused by the pumps and how much is caused by other factors. If pumping in the south Delta is a major problem for fish, then there are a number of possible solutions. They fall into five categories.

1. Change pumping patterns to kill fewer fish.
2. Reduce overall diversions from the Delta.
3. Screen out fish more effectively.
4. Move the location of the intakes.
5. Grow more fish.

All of these approaches have technical merit. Moving the location of the intakes (e.g., an isolated facility) has the greatest likelihood of success. Reducing overall diversions is technically possible but an unlikely candidate for the type of political consensus on which a CALFED plan must rest. In Stage 1 of the CALFED Phased Program, it will be testing whether a combination of changed pumping patterns, better screens, and habitat improvements will be capable of overcoming the problems of continued diversions from the south Delta. This is reasonable, provided that CALFED is prepared to move the location of the intakes, should entrainment be determined to be the limiting factor in achieving the ecological restoration goals of the Program.

B. Water Quality

The south Delta is both the sump of the Central Valley water system and the gateway to the Pacific Ocean. Anything that is put in the river from the high Sierras down to the Delta will show up in the pumps. Similarly, salt water from the Pacific Ocean makes its way upstream with the tides and is pulled into the pumps. Alternative approaches to dealing with water quality are as follows:

1. Source control, salinity intrusion reduction.
2. Treatment.
3. Reoperation and agricultural/urban segregation.
4. Shift the location of the intake.

All these approaches have merit. However, it is questionable whether efforts to reduce contaminant inputs at their source or to reduce salinity intrusion can make a major difference to drinking water quality. Treatment is more promising. New technologies may allow treatment of Delta water while still meeting future EPA standards. However, those technologies have yet to be tested on a large scale and the cost could be substantial. Moreover, low quality raw water carries risks that are not fully dealt with by regulatory standards. Agricultural/urban supply segregation could provide some benefits (e.g., splitting the California Aqueduct south of San Luis Reservoir), but the cost, feasibility, and potential benefits have yet to be analyzed. Shifting the location of the intake would provide highly certain improvements in raw water quality and probably, but not certainly would allow for lower cost treatment technologies. In Stage 1, CALFED will not shift the intake location, but will observe the trajectory of water quality standards and water treatment technologies. This is reasonable, provided that CALFED makes invests in the research and development of advanced treatment technologies and is willing to move the urban intakes, if such new technology capable of meeting future EPA standards does not become available at a cost comparable to shifting the intakes.

C. Security of Delta Levees

Over time, one probable future for the Delta is a large earthquake, resulting in the simultaneous flooding of many Delta islands. Since the volume of the Delta islands which is below sea level is on the order of 5 maf -- far /more water than Central Valley rivers could provide in a short time -- a large failure would necessarily pull in salt water from San Francisco Bay and force a shutdown of the export pumps until the salt could be flushed out. The shutdown might last for months or years or even become permanent. But if the islands were permanently inundated, more salt water would routinely intrude into the Delta from the ocean, exacerbating the long-term water quality problems caused by salinity in the South Delta. Moreover, the environment would lose enormous amounts of usable habitat. In order to resolve this problem, the following approaches are possible:

1. Backup storage.
2. Shift the location of the intakes.
3. Levee Upgrades.
4. Subsidence Reversal.

The only long-term solution to seismic instability is restoration of island elevations.

Of these, backup storage and shifting the location of the intakes could protect export interests, but would do little or nothing to protect the Delta landforms themselves. Levee upgrades might provide some small measure of protection to the levees in the event of earthquake, but no amount of levee upgrades can eliminate the problem of liquefaction. The only long-term solution to seismic instability is restoration of island elevations. Unfortunately, CALFED's program largely ignores the problem and seems more concerned with preserving the status quo than dealing with long-term issues.

D. Assurances

The south Delta export location forces export interests to care about the integrity of the Delta levees and the quality of Delta water. This is the common pool principle. Shifting the diversion point to a point upstream of the Delta would reduce or eliminate this shared interest in levees and Delta water quality.

The common pool principle is widely misunderstood. The principle is more an expression of the interests of Delta agriculture than of the environment. Generally speaking, Delta agriculture is benefited by the current location of the export pumps. Exporters have joined Delta interests to support the provision of massive public subsidies to protect Delta levees for agriculture. Moreover, exporters pull in huge amounts of salt from the south Delta and this helps to freshen the water for Delta agriculture.

The utility of the common pool principle for the environment is highly questionable. The premise of the common pool principle is that, even if exporters are able to overcome existing regulatory obstacles that constrain their operations, the physical existence of the common pool will force them to operate in ways that protect Delta agriculture and the environment. This assumption is, generally speaking, wrong. In fact, the major obstacles to unlimited exports are regulatory, not physical. The forces which might lead to violation of standards after construction of an isolated facility already exist with existing facilities.

A more legitimate concern is that southern California's interest in continued funding of levee maintenance and subsidence reversal might wane after construction of an isolated facility. Therefore, assurances of continue payment into levee and Delta subsidence funds may ultimately be more important than new types of operational assurances, if an isolated facility is built.

E. Conclusions

Despite high levels of uncertainty, a few conclusions are possible:

A small (5-10,000 cfs) isolated system will provide environmental, water quality, and security benefits with high probability. The probability of major downsides (compared to current conditions) is low. However, the actual size of the benefits is somewhat uncertain. The conclusions we draw as to the probable technical superiority of the isolated facility option are also consonant with the judgments drawn by the CALFED staff in the Phase II Interim Report, the CALFED Diversion Effects Fisheries Team, and the U.S. Fish and Wildlife Service, and the all of which also acknowledge the considerable degree of uncertainty yet to be resolved as to that conclusion.

Other approaches may also provide significant levels of benefits. However, in order to provide the same environmental, water quality, and security benefits (whatever they may be) equal to a small isolated facility a large number of actions would need to be undertaken (discussed above), and all of them would need to have positive outcomes. The likelihood that all of these highly uncertain actions would provide hoped for benefits is low. Therefore, if a final decision had to be made today, it seems to us that the correct technical and economic choice would be an isolated system.

However, the final decision need not be made today. Planning for any large piece of infrastructure will take many years. Given the high degree of controversy surrounding the isolated facility, it is worth testing 1) whether or not alternatives to the facility are viable and 2) whether the benefits of the isolated system are as valuable as currently believed, while planning for the isolated facility goes forward. If it turns out that that alternatives exist to an isolated facility or that the benefits of isolation have been overstated, then there is no need to expend money on the facility.

While NHI agrees that the final decision on whether or not to construct an isolated facility can be delayed for some years, the decision cannot be delayed forever. There is a substantial chance that the alternatives to isolation will fail and that the canal will be needed. We urge all participants in the CALFED process to put aside ideology. Fish, Delta habitats, and human health are all too important to play games with. They deserve the best solution we can devise.

I. DEVELOPMENT OF SHORT- AND LONG-TERM PROGRAMS TO PROTECT THE DELTA AND MAKE IT SUSTAINABLE

1. Problem statement

The Delta formed by the confluence of the two great river systems of the Central Valley is one of the defining environmental assets of the nation. The entire San Francisco Bay Area community is enriched by its fish, wildlife, and native plant habitats, as well as its exceptional economic, recreation and aesthetic qualities. But the Delta has been tragically compromised over the past century and a half by progressive land transformations and hydrologic modifications. Altogether, over 95% of its tidal wetlands have been diked, filled, and transformed into farmland (Figures 1 and 2). This aquatic system is critical habitat for several runs of Chinook salmon and a suite of endangered fish species. In the midst of this habitat, the federal and state governments have constructed the world's largest water export pumps, capable of diverting 15,000 cubic feet per second, equivalent to the flow of a large river. These pumps are then connected via canals to some 20 million urban water users in southern California, and to a $14 billion per year irrigated agriculture industry in the Central Valley, the most productive farmland in the world. The high stakes of this potential "train wreck" eclipse other fabled western resource conflicts such as the spotted owl vs. timber harvest controversy in the Pacific Northwest.

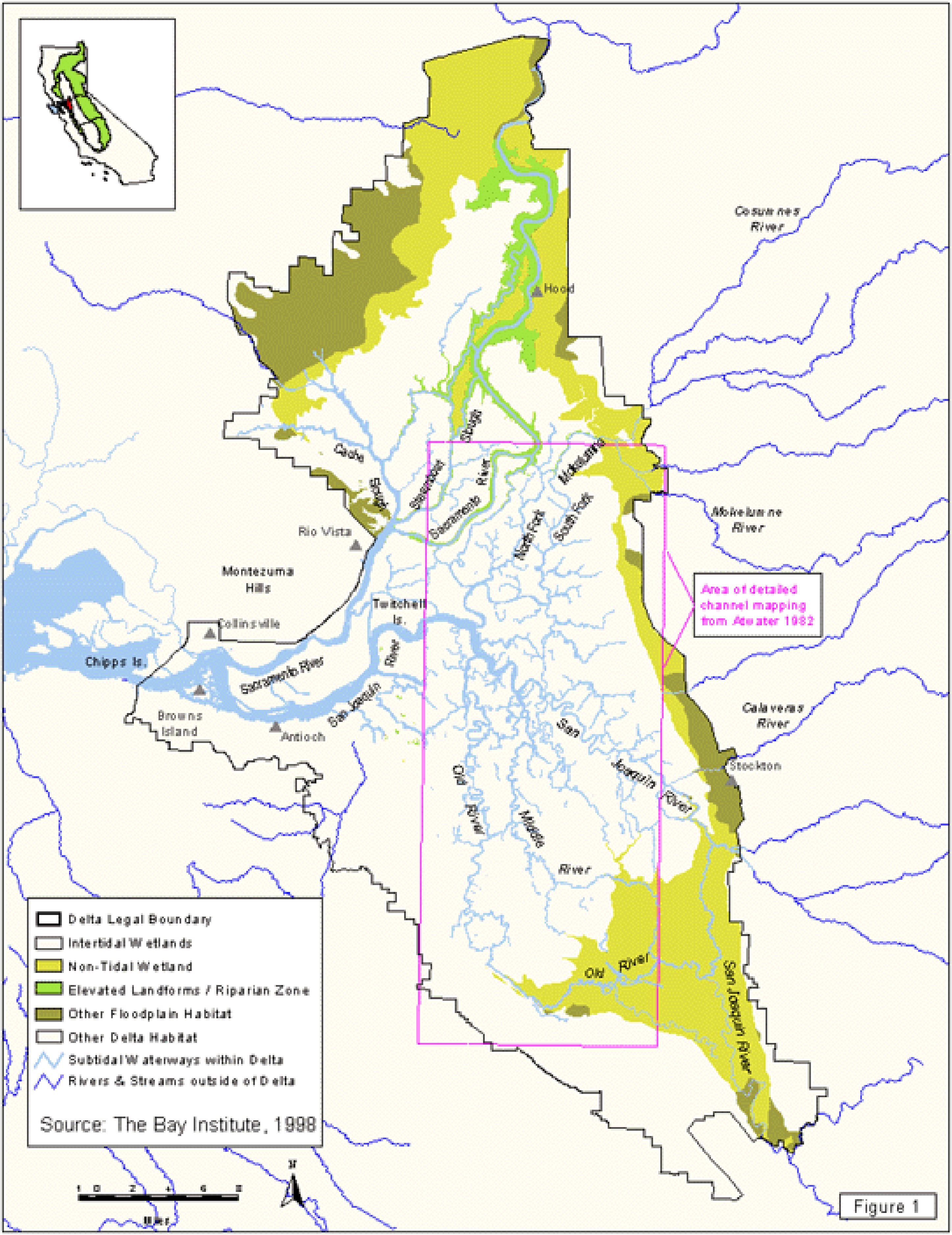
These alterations have exacted a large toll in both environmental and economic costs and risks. A preliminary assessment of the economic costs is provided in appendix 1. The biological costs are listed below:

Loss of habitat: Between 1860 and 1930, 97% of the Delta's 450,000 acres of freshwater wetlands were diked and planted with crops. Very little of the predisturbance wetland habitat now exists within the Delta, reducing or altogether eliminating the wildlife species dependent on this resource. Wetlands provide vital spawning and nursery grounds for fish and important sheltering, feeding, and nesting areas for many species of birds, some of which are endangered. Wetlands can also improve water quality by trapping sediments and by removing nutrients and some chemical contaminants.

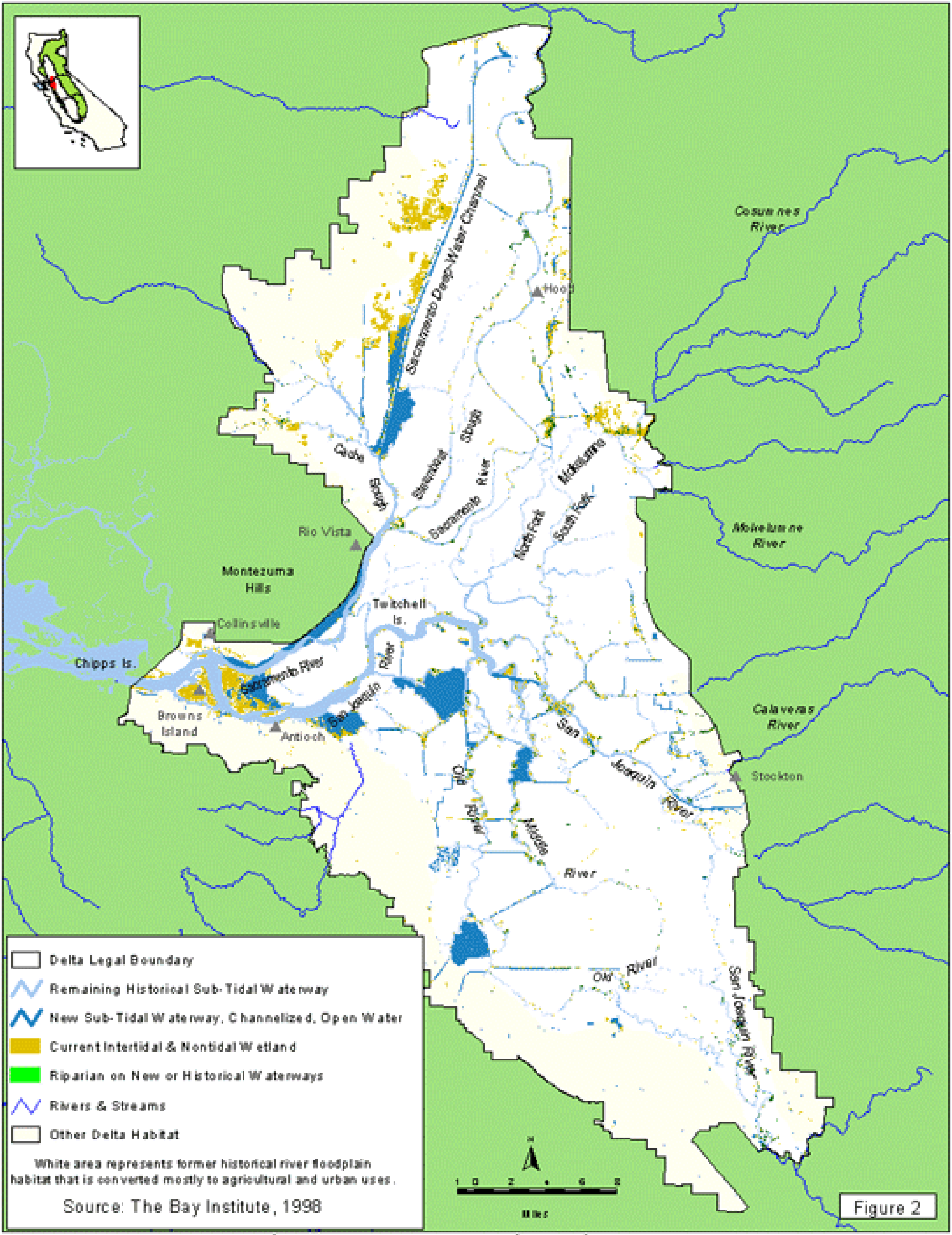
Diversions: The peak diversion season in the Delta coincides with the months when large numbers of young Chinook salmon, Delta smelt, other native fish, and striped bass are present in the system. There are about 1900 unscreened diversions in the Delta, pulling in large numbers of fish, eggs, and larvae. Some rough estimates indicate that the losses of young striped bass (generally less than 16 mm in length) is on the order of several hundred million and the loss of juvenile Chinook salmon may be in the range of a few hundred thousand.[1]

Drainage: The application of fertilizer and pesticides on Delta farmlands can be problematic not only for local wildlife, but for inhabitants of (and visitors to) the downstream estuary.

[1] DWR report, "Screening Agricultural Diversions in the Sacramento-San Joaquin Delta."



The Historical Aquatic Delta Ecosystem



The Current Aquatic Delta Ecosystem

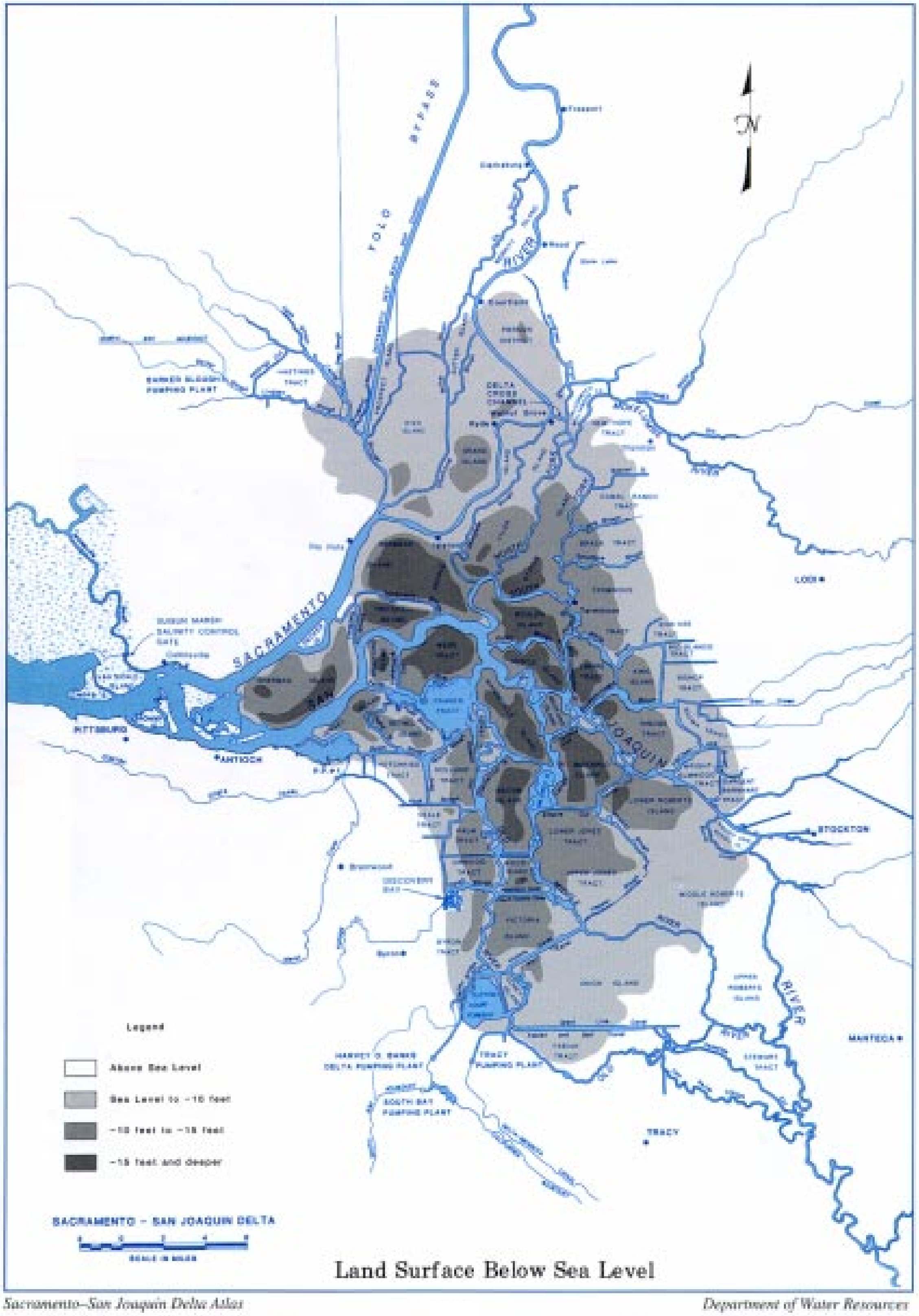


Figure 3: Land Surface Elevation and Subsidence in the Delta
(source: California Department of Water Resources, Delta Atlas 1995)

Crops rarely absorb more than half of the nutrients in fertilizers; as a result, ammonia (toxic to fish) and nitrate (which in excess can cause rapid, oxygen-depleting growth of algae) leach into agricultural drainage water. While some pesticides decompose quickly, most are more resistant to chemical breakdown and leach into drainage water unaltered. Some studies indicate pesticides to have been a significant factor in reducing population levels of striped bass in the estuary during the 1973-1986 period.

Subsidence: Before it was developed into agricultural lands, the Delta was a vast brackish tidal marsh with upland areas defined by natural stream meanders (Figure 1). Even 100 years ago, Delta agricultural land was at sea level and sat behind minor artificial levees. However, agriculture on peat soil leads inevitably to land subsidence primarily as a result of oxidation. The elevation of subsided lands is quite variable within the Delta, ranging from near sea-level at the eastern, southern and northern fringes and increasing in the interior and western sectors as much as 25 feet below sea level in parts of the central and western Delta (Figure 3). Constructed of unconsolidated clays, muds, or silts, the levees were never meant to withstand the increase hydrostatic loads resulting from island subsidence.

Probabilistic analyses conclude that it is only a matter of time before greater or lesser areas of the Delta become inundated.

Of greatest concern is the vulnerability of the islands to earthquake. According to a report by DWR, there is a 50% chance that the levees in the western half of the Delta will sustain significant damage in an earthquake within 30 years.[2] More recently, a panel of seismologists and engineers convened by CALFED determined that the risk of five to ten levee breaches during a single event was greater than 50% in the next 50 years. More alarming, they concluded that CALFED's proposal to spend over one billion dollars to improve Delta levees would do little to reduce the risk of failure in a seismic event because the mineral soil underlying the levee is the most susceptible to failure. [3]

Figures 4 and 5 describe the probability of levee breaches occurring in seismic events.[4] Figure 4 describes the probability of a seismic event causing any number of levee breaches during any one year period. According to Figure 4, each year the probability of an event causing 5 levee breaks is one percent. Figure 5 describes the probability of multiple levee breaches from a seismic event over multiple exposure periods ranging from 30 years to 380 years. According to Figure 5, over a 30 year time frame, there is a 25% chance of a single seismic event causing 5 levee breaches. Over a 130 year exposure period, there is a 50% chance of ten levee breaches occurring in a single event.

[2] This estimate represents a middle range between the large uncertainties associated with whether peat soils amplify or attenuate seismic shocks. DWR, "Review of Seismic Stability Issues for Sacramento-San Joaquin Delta Levees", July 1993.

[3] Seed, 1998.

[4] Figures 3 and 4 were prepared by a NHI consultant on the basis of a presentation of Dr. Raymond Seed to the CALFED Bay-Delta Advisory Committee on July, 16 1998 and therefore may no be precise. CALFED has yet to release a written report, making it impossible to properly characterize their results.

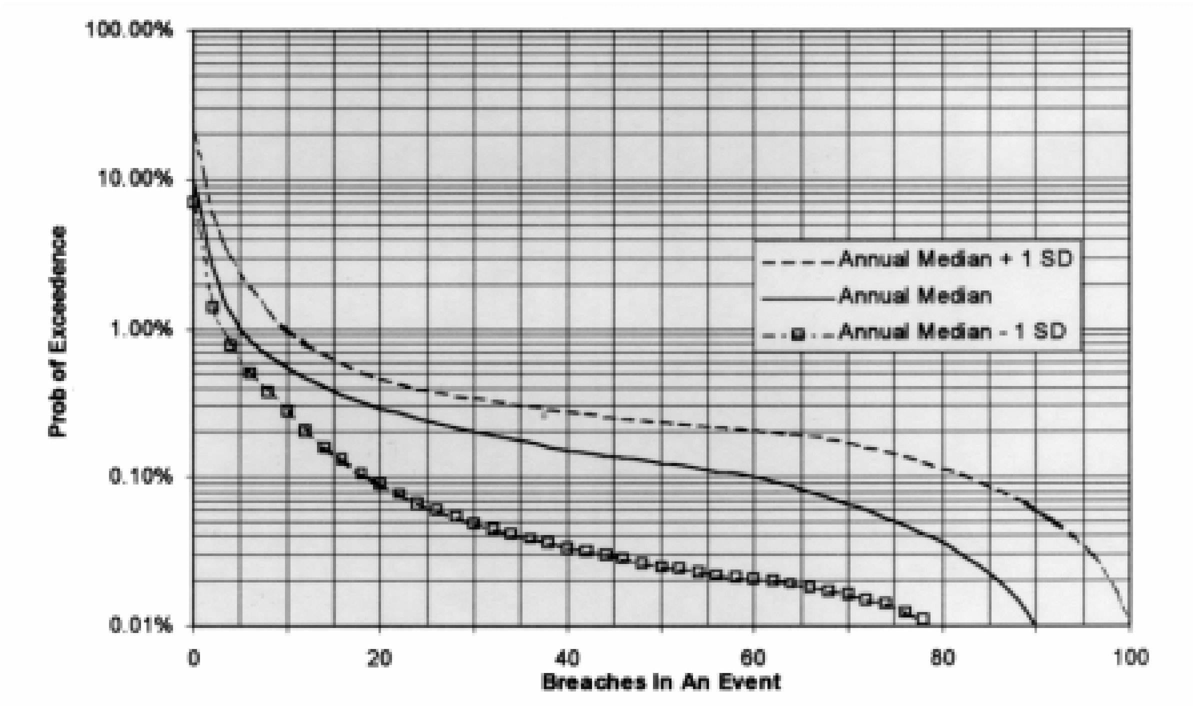


Figure 4: Annual Probability of Exceedence for Levee Breaches during a Seismic Event

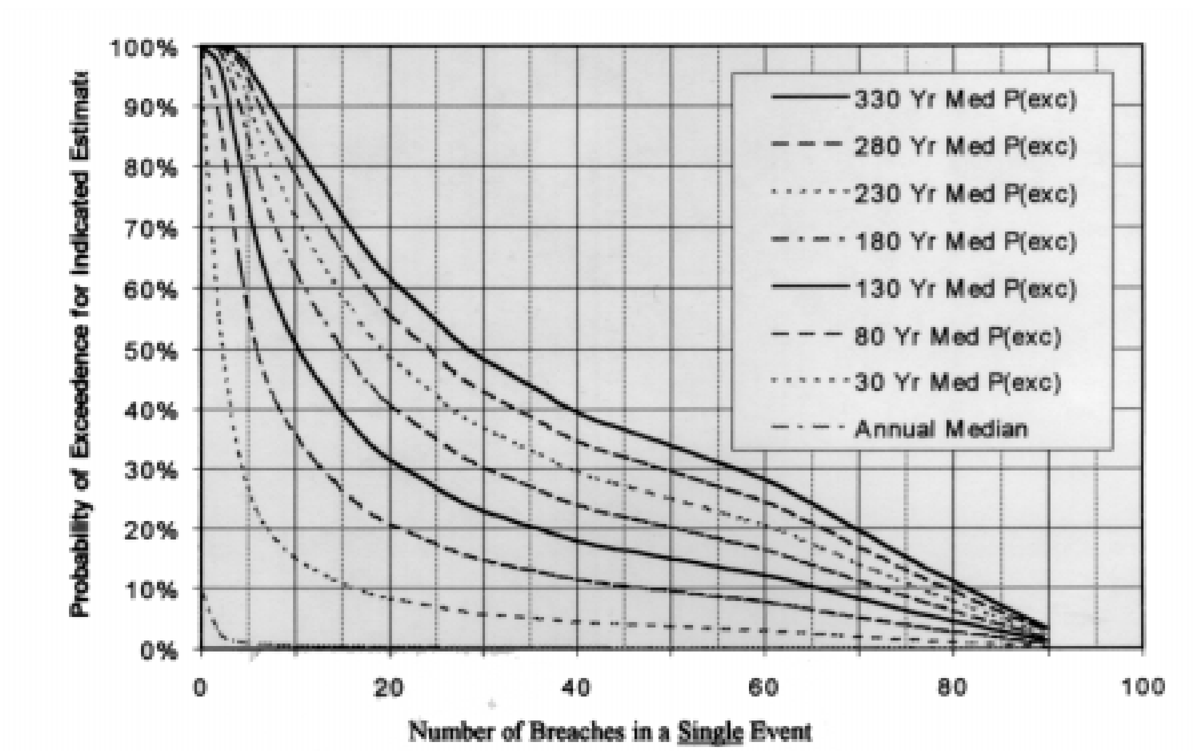
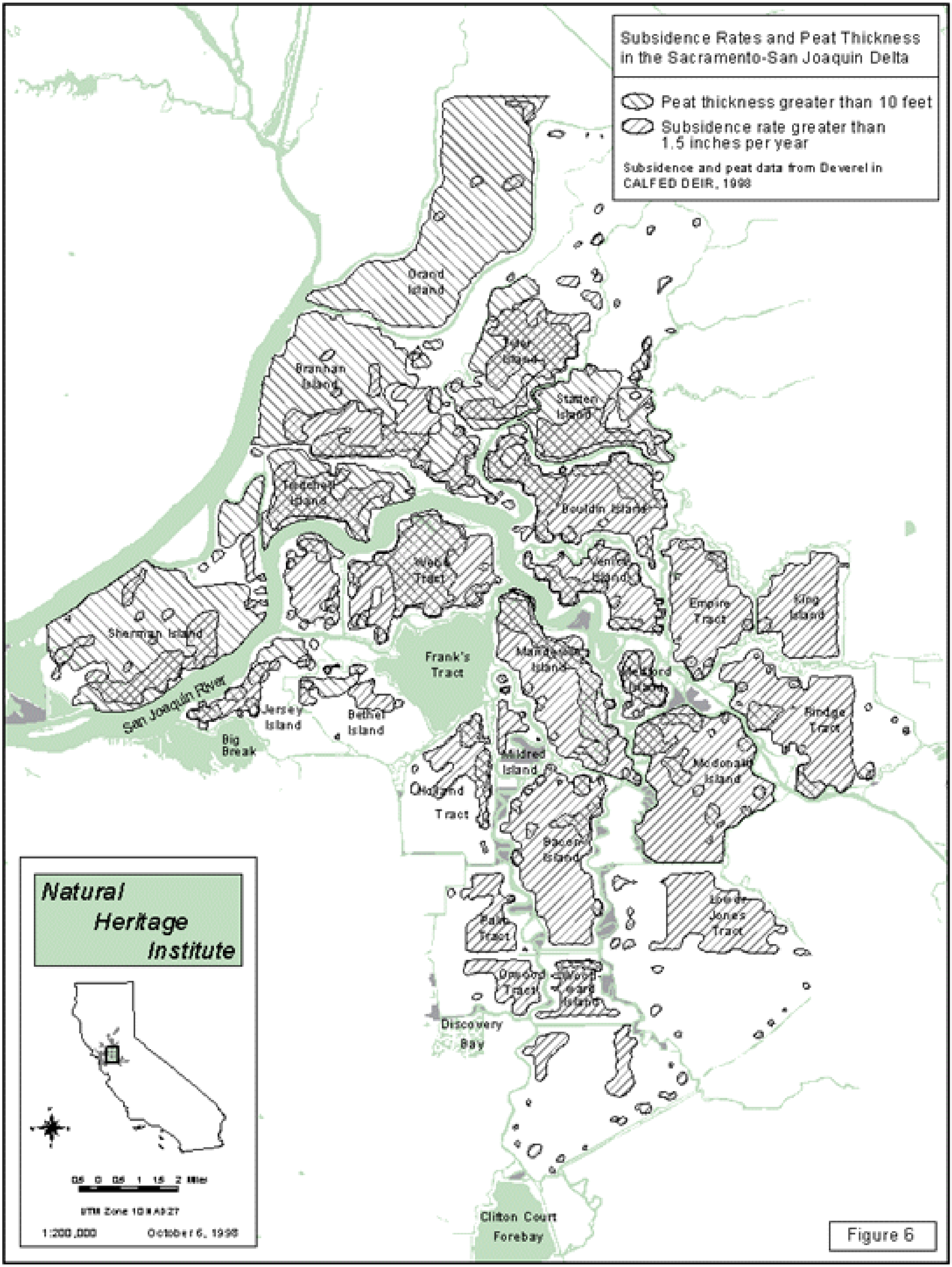


Figure 5: Probability of Exceedence Curves for Levee Breaches from a Single Seismic Event during Various Exposure Periods



Subsidence Rates and Peat Thickness in the Sacramento-San Joaquin Delta
Peat thickness greater than 10 feet
Subsidence rate greater than 1.5 inches per year
Subsidence and peat data from Deverel in CALFED DEIR, 1998
Grand Island
Brannan Island
Tyler Island
Staten Island
Twitchell Island
Bouldin Island
Webb Tract
Venice Island
Empire Tract
King Island
Sherman Island
Frank's Tract
Mandeville Island
Medford Island
San Joaquin River
Jersey Island
Bethel Island
Big Break
Mildred Island
Holland Tract
McDonald Island
Rindge Tract
Bacon Island
Palm Tract
Lower Jones Tract
Orwood Tract
Woodward Island
Discovery Bay
Clifton Court Forebay
Natural Heritage Institute
1:200,000
October 6, 1998

Figure 6

The economic and ecological consequences of permanent and unplanned levee failures would be severe. Levee breaches could easily exceed 1,000 feet in width and create 30 to 40-foot deep scour holes. If multiple islands were lost simultaneously to earthquake, it is unclear whether the islands could be repaired before wave action caused major damage to the interiors of the levees. In this scenario, hundreds of thousands of acres of Delta land might be permanently abandoned. There would, in fact, be few offsetting environmental benefits for many decades. Land levels have subsided to such a depth that many islands, if flooded without prior modification, would become deep-water habitat with little or no value for native species. Valuable agricultural wetlands and other habitat on subsided islands would be lost. The environmental costs of repairing levee failures would also be significant. Large amounts of dredged material would probably be hurriedly excavated and deposited on the levee breaches without regard to environmental laws.

Most importantly, loss of the islands would lead to salt water intrusion, which could degrade aquatic habitat and would jeopardize the agricultural and drinking water supply for over 20 million people. According to a 1993 DWR study, failure and long-term inundation of Sherman Island would degrade water quality at Clifton Court by 41%. Long-term inundation of Jersey, Web or Twitchell would result in a 40%, 24% or 19% degradation in water quality respectively. [5] Simultaneous failure of more than one of these islands would have even greater water quality impacts. Construction of a large isolated facility would significantly reduce the adverse impacts of such a failure on export water quality, but the impacts to the ecosystem and agricultural water quality in the Delta would remain. Under a levee failure scenario with a large isolated facility, water exporters may be tempted to abandon commitments to maintain water quality throughout the Delta. The continual risk that the Delta levees pose to the state economy will create persistent pressure for construction of an isolated facility. Indeed, a state-wide water crisis precipitated by a major levee failure could lead to the emergency construction of an isolated facility without consideration of the ecological and water quality impacts. By contrast, an aggressive subsidence reversal program in the western Delta, particularly on Sherman and Jersey Islands would provide assurance that whatever decision CALFED makes on a Delta conveyance facility would be durable.

In sum, current land uses in the Delta can only be maintained artificially through levees that are costly to maintain and are susceptible to failure by natural events. Probabilistic analyses conclude that it is only a matter of time before greater or lesser areas of the Delta become inundated. If this occurs in a planned and phased manner, the result could be large areas of productive habitat; if it occurs in an unplanned and sudden manner, the loss could be devastating to the farmland owners, the water supply system, and the aquatic environment.

[5] Enright, presentation 1998. This study assumed an extended drought and that prolonged inundation 50% of peripheral levees.

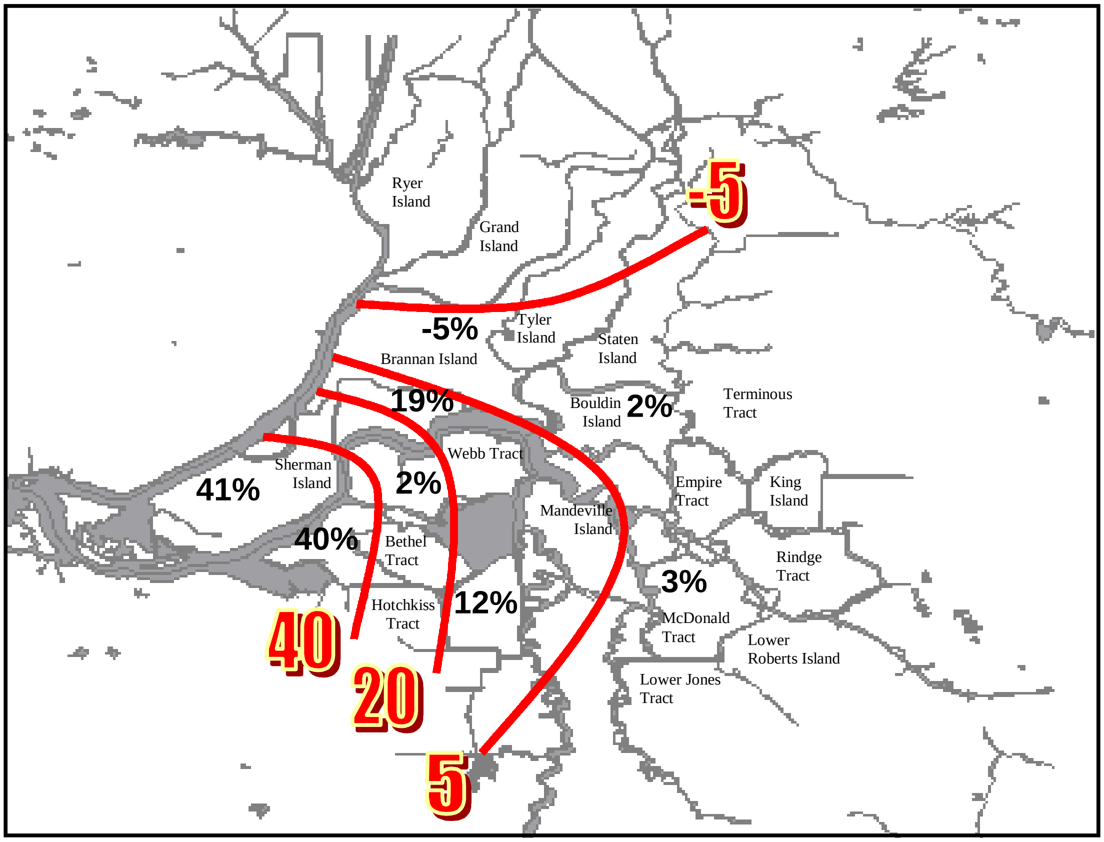


Figure 7: Map of Water Quality Degradation from Levee Failure. Assumes levees failure during a drought period and that up to 50% of levee is eroded from prolonged inundation.

2. <u>Developing a solution</u>

> ***Progress toward all CALFED objectives will be at risk until CALFED adequately addresses the underlying problem of land subsidence on Delta islands.***

The centerpiece of a Bay-Delta solution has to be the Delta itself, and yet the physical threats and solutions to a sustainable future for the Delta and its residents have not yet received the prominence that they warrant in the CALFED planning process. Restoring the Delta island surface elevations, particularly in the western Delta, to at or near sea levels is critical to <u>assure</u> the sustainable protection and improvement of ecosystem values and agricultural and drinking water quality. Progress toward all CALFED objectives will be at risk until CALFED adequately addresses the underlying problem of land subsidence on Delta islands. Although the CALFED levee program includes a subsidence control element, it is limited to subsidence that directly weakens Delta levees and does nothing to resolve the larger problem of subsidence in the interior of the islands. As long as the western Delta islands are more than a few feet below sea level, CALFED will be plagued by the dilemma of either spending millions of dollars a year on environmentally harmful levee maintenance or accepting the risk of catastrophic levee failure that would severely undermine all progress toward CALFED goals. Despite the fact that the Category III program has allocated $3.6 million for testing and improving subsidence reversal technologies, CALFED's draft plan ignores the need and opportunity to raise the landforms in the Delta, where feasible, over the next several decades to the point where they will no longer be dependent upon the maintenance of the levee system. Instead, CALFED has assumed that the only feasible option for the Delta is repair and reinforcement of the levees in perpetuity. This vision of the future of the Delta would leave it vulnerable to risks that cannot be controlled, entail high maintenance costs indefinitely, and severely limit the potential for restoring the natural functions and habitats that existed before development.

Instead, CALFED has assumed that the only feasible option for the Delta is repair and reinforcement of the levees in perpetuity.

Really, the issue is not whether a less risky, more sustainable future for the Delta is possible. Rather, the salient issues are:

- where is the Delta most vulnerable?
- what is the best mix of subsidence reversal techniques to pursue?
- where are the most promising sites to capture sediment in the Delta and acquire it outside of the Delta?
- where are the most promising sites to use this sediment and pursue other subsidence reversal techniques?
- how long will these techniques take to raise these landforms to near the low tidal elevations?
- what will this cost?
- what is the maximal extent and location of rebuilding the landforms in the Delta that can be accomplished at manageable cost? and,
- as the Delta landforms are rebuilt, how should habitat restoration opportunities be incorporated in a manner consistent with the owners and residents of these lands?

Virtually no progress has been made within CALFED in addressing these questions. Yet, without answers to these technical, economic and process questions—or, more accurately, a method to get the answers--it will be difficult to generate consensus among Delta residents and other stakeholders around either a near term or a long term Delta restoration plan. Equally obviously, until there are at least reconnaissance level answers to these questions, it is imprudent to close the book on the potential for permanently reducing the vulnerability of the Delta system to natural disasters.

The current uncertainties regarding physical constraints on restoration or the availability of sites suggest that it is impractical to attempt to describe a long-range ecosystem restoration plan for the Delta. A better approach is to identify and immediately implement the near-term opportunities for restoration that are sufficiently low-conflict that a working consensus with the in-Delta interests can be forged, and nest this within a longer-range agreement regarding the principles and processes that will guide the further restoration efforts over the next several decades. Lessons learned from implementation of the low-conflict projects coupled with a proactive effort to test promising restoration techniques will help illuminate and foster consensus on the next steps to take on the path toward a broader restoration program and a sustainable future for the Delta.

But CALFED has not done its job if it stalls out at the near-term restoration opportunities. A sustainable future requires a long-range vision that will take decades to accomplish. (Since the Delta has been subsiding for over 100 years, a 50 year program to rebuild it does not seem too much to expect). The sooner we start, the sooner we can arrive. While CALFED does not have the knowledge to write the long-term plan, it does have the knowledge and the mission to set forth the principles and processes that will guide and govern progress toward that plan. Our work with the in-Delta interests confirms that agreement on these principles and processes is possible. That long-range vision enables strategic planning regarding the pursuit of opportunities to both restore and learn how to restore.

Below, NHI outlines both a long-range vision and a short-range plan for Delta restoration. The short-range plan focuses on immediate, low-conflict restoration opportunities. Our long-range strategy outlines a process through which the restoration program can evolve as knowledge progresses and conditions change.

A. Long-Term Program for Making the Delta Sustainable

1. Introduction

> ***The only way to restore the Delta is incrementally and progressively over time.***

This Environmentally Optimal Alternative articulates a long-term vision of a gradual, yet cumulatively dramatic, conversion of much of the historic Delta lands now below sea level back to a vast mosaic of high quality aquatic, wetland, and terrestrial habitats, co-existing with agriculture, waterfowl forage crops, managed wetlands, and shallow and deepwater recreation. We recognize, however, that a gradual, incremental process is the only realistic approach to achieve this vision.

Although abrupt on the geologic time scale, the transformation of the Delta from a natural system in the 1850s to a highly engineered system of levees, channels, and islands was gradual and continues to occur today even as CALFED contemplates restoration of tens of thousands of acres. Although “reclamation” (diking) of Delta islands began in the 1860s, the current configuration of Delta islands was not completed until the late 1920s. Over 30% of the Delta's tidal marsh still existed in 1906 nearly 50 years after reclamation efforts began.[6] Over time, as reclaimed islands subsided and levees eroded under the force of great floods, engineers built the levees thicker, taller, and stronger. After World War II flood control agencies, aided by herbicides, began a concerted effort to clear vegetation from levees. More recently, they have resorted to spreading millions of tons of rock along Delta levees to prevent erosion. Old timers recall wetland margins around many Delta islands as recently as the 1960's, but these have mostly been eliminated by erosion and dredging. Numerous other incremental actions, including the construction and expansion of large water projects over the last 60 years, have and continue to inexorably transform the Delta landscape from its native state to its current, artificial condition.

As the Delta ecosystem was gradually transformed over decades, so its restoration will take decades to complete. Just as its development was not driven by a pre-existing master plan, so no master plan for its restoration can be constructed at the outset. Rather, each project will suggest another until the mosaic is complete. The only way to restore the Delta is incrementally and progressively over time. Thus, the CALFED restoration program must not consist merely of an initial list of projects that can be implemented in a short period of time. Rather, the restoration plan must include principles, processes and the means to drive a long-range effort which recognize that the pace and extent of restoration will remain under the control of the Delta landowners and residents.

Subsidence Reversal Technologies

Numerous technologies for halting and reversing subsidence are available.

Numerous technologies for halting and reversing subsidence are available. NHI, DWR, USGS, and three private consultants have been funded by CALFED to test and improve the three most promising island surface building techniques on Twitchell Island in the western Delta. These techniques include: 1) cultivating tules and other wetland vegetation to accelerate peat formation, 2) reusing clean dredge materials from Delta channels, and 3) capturing and depositing natural sediment loads passing through the Delta. These large scale field experiments are scheduled to begin soon and are expected to yield useful results within the next three years.
Figure 8 depicts how subsided island surfaces could be restored to productive tidal marsh and riparian habitat over time.

Previous field experiments by USGS and DWR have determined that tule cultivation could accrete up to 2-3 inches of organic material a year.[7] Combined with a program to spread fine layers of sediments on top of these tules to stabilize these organic soil accretions, it may be possible to accelerate or at least sustain this rate of tule growth over the long term. Within 50 years, this would amount to an average accretion rate of over 10 feet--enough to raise the vast majority of subsided lands to elevations that could support either shallow water habitat, subtidal marsh, tidal marsh, or sustainable agriculture.

[6] CALFED ERP, 1998.
[7] Curt Schmutte, DWR personel, pers. com 1998.

Although accreting peat soils through tule cultivation is comparatively slow, it probably will become a central part of all subsidence reversal work for several reasons. First, it is consistent with permanent inundation of peat soils. Oxidation of peat soil is the predominant cause of subsidence and oxidation is best halted through inundation.[8] Seasonal inundation, which makes for better migratory bird habitat, will not halt subsidence and may even accelerate it. Another potential but limited method of halting subsidence is capping peat soils with a layer of mineral soils.

Second, tule cultivation does not rely upon external sources for fill material. Building surface elevations with dredge spoils or river sediments will be a locally important subsidence reversal strategy, but there is not enough dredged spoils and probably not enough river sediment to apply this method broadly throughout the Delta.[9] Moreover, even if enough mineral soil were available to rebuild island surface elevations, the weight of mineral soil on underlying peat soils would cause compaction and further subsidence that would partially offset any surface elevation gained. The deformation of underlying peat soils under such a scenario could cause levee rotation and failure. Nevertheless utilization of mineral soils to reverse subsidence could have very important local and strategic applications and would be important to augment peat accretion efforts with tule cultivation.

At a minimum, CALFED should develop a program to control and reverse subsidence on lands most prone to future subsidence or catastrophic levee failure. DWR and CALFED have determined that approximately 60,000 acres, primarily in the central and western Delta are priority areas for subsidence control in the Delta (Figure 13).[10] Furthermore, a recent seismic hazard study funded by CALFED determined that the western Delta islands, particularly Sherman Island, are by far the most vulnerable to failure and inundation in an earthquake.[11] Inundation of these islands would have the greatest impact on Delta water quality (Figure 7).

A major subsidence reversal program could be implemented in the western Delta without displacing existing Delta agriculture or private landowners. Most of the western Delta islands are currently either in public ownership, slated for uses as in-Delta reservoirs and habitat, or not in cultivation. If CALFED can demonstrate the viability of restoring elevations on public lands, they may be able to entice private landowners on other subsided lands to implement similar programs. Over the long term, a subsidence reversal program could create future agricultural opportunities that would not exist if the current unsustainable practices were continued.

A major subsidence reversal program could be implemented in the western Delta without displacing existing Delta agriculture or private landowners.

[8] Deverel and Rojstaczer, 1996.

[9] Numerous sources (Krone, 1979, 1996; Beeman 1992; DWR 1955; Shultz 1965) estimate amount of sediment deposited in the Delta between 1.5 – 3 million cubic yards per year. At this rate it would take over 100 years to fill Sherman Island alone. The average annual Delta dredging to upland disposal is 500,000 cubic yards per year a sub-set of the total annual sediment deposition estimate cited above (AHI and PWA 1990).

[10] Deverel, 1998 in CALFED.

[11] Seed, 1998.

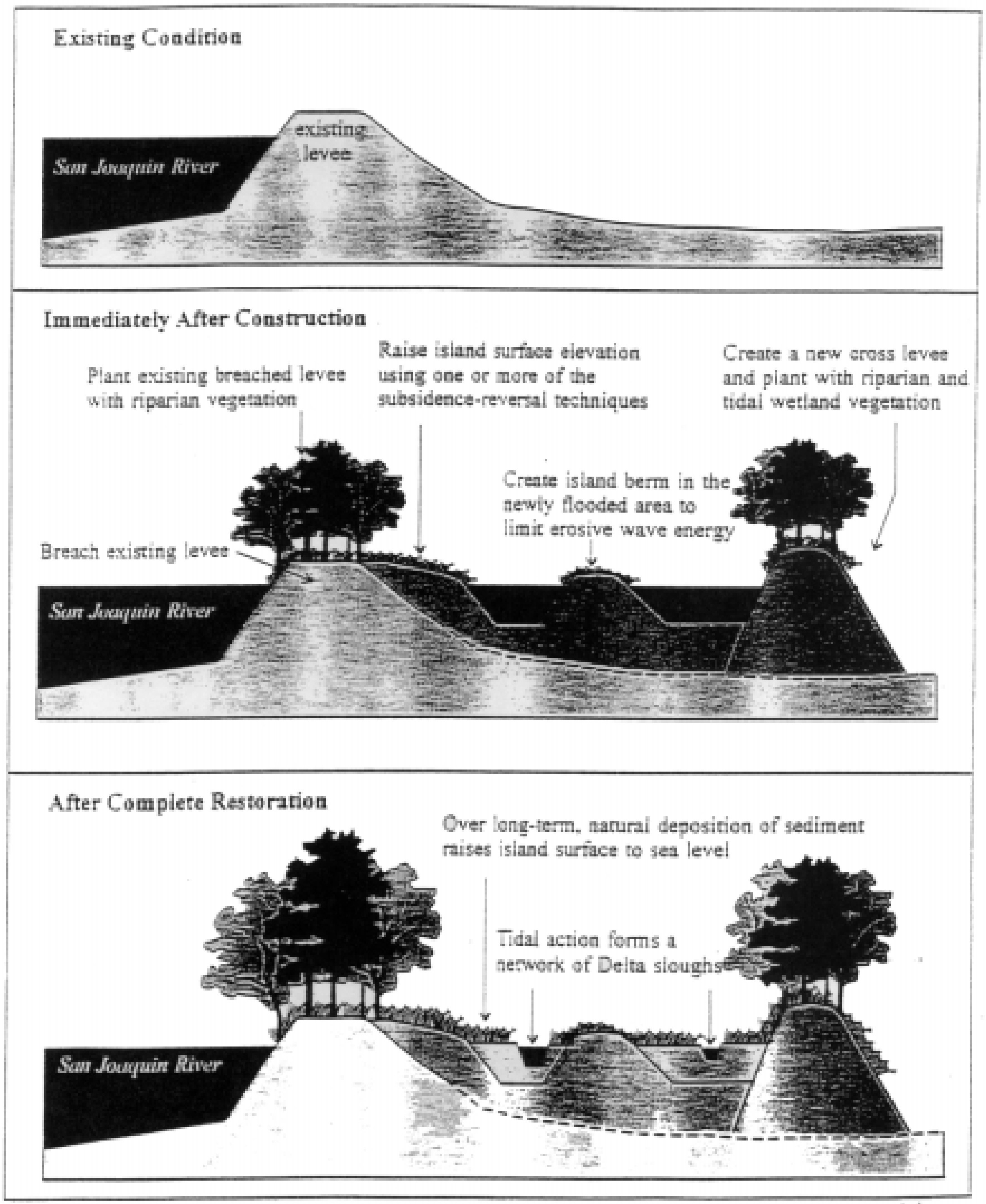


Figure 8: General Subsidence Reversal and Habitat Restoration Schematic

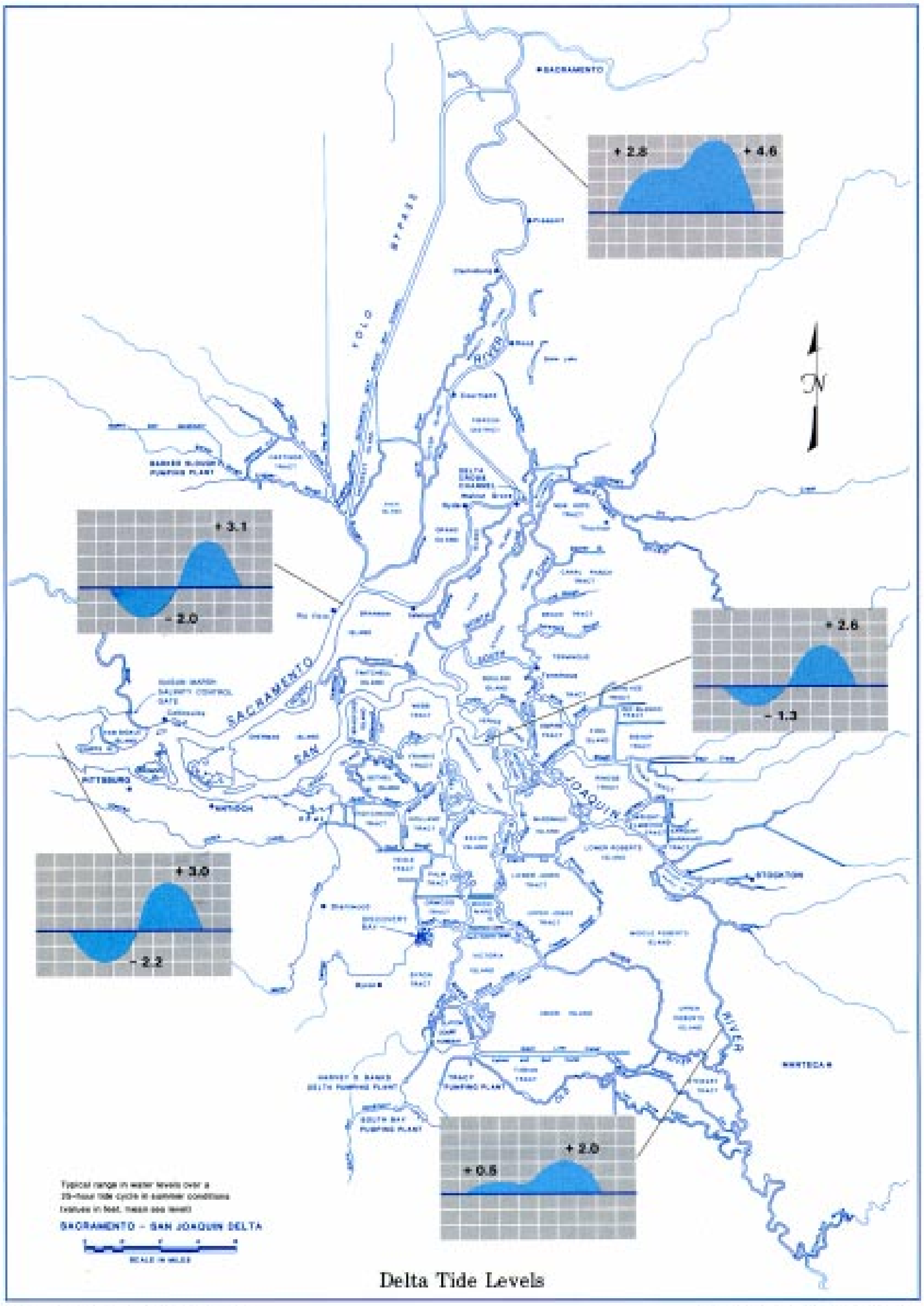
Restoring subsided Delta islands to sea level in the western Delta *would not* adversely affect Delta agriculture. To the contrary, minimizing reliance on inherently unstable levees would benefit agriculture. Many Delta landowners and officials are amenable to conversion of the western Delta from agriculture to habitat or subsidence reversal projects on the condition that the rest of the Delta remains fresh to satisfy agricultural water quality requirements. This makes sense from both sides of the negotiating table. We would not expect Delta agriculture to concede degradations in water quality that might drive them out of business, and a deep water embayment and resulting higher salinities would almost certainly be harmful to an array of fishery resources. In short, there is a mutual interest in maintaining the levees on the islands for the immediate future, with the prospect of breaching them and restoring tidal marsh when and where island surface elevations have been restored. Within a planning horizon of perhaps 50 years, we appear to have no insurmountable differences with the Delta representatives on how to approach broad scale restoration of the western Delta lands to tidal marsh.

Not only would the investment of subsidence reversal be significantly lower than levee maintenance over the next 100 years, but it will result in a far more sustainable and valuable end product. Most importantly, it would reduce the risks and costs to Delta farmers and the environment of catastrophic levee failures over time. In contrast, these risks and costs would increase over time as island surfaces continue to subside under the status quo.[12] In the interim, subsidence reversal efforts could be managed to reduce the impacts of local Delta diversions on the aquatic environment. If restored island surfaces were eventually restored to tidal marsh, they would increase the yield of commercial and recreational fisheries; significantly improve populations of endangered fish species (and attendant reductions in the constraints on water project operations); and increase local revenue from recreational activities. If restored island surface elevations were ultimately utilized for agriculture, the large operating costs associated with exiting levee maintenance and drainage would be significantly reduced.

2. Restoring tidal marsh

Reversing subsidence benefits all current and potential land uses in the Delta. For restoration of high-quality tidal marsh habitat, it is indispensable. This alternative envisions a long-range and broad-scale program of restoring native Delta habitats, particularly fresh water tidal marsh. The actual extent and location of the habitat conversion would be constrained by the willingness of the current landowners to transfer the necessary interests in the land, the elevation of available land, the relative value of the land in its current uses, the vulnerability of the levee system to failure, and the relative ease of filling the subsided lands to sea level. NHI has worked with Delta landowners and agencies to identify and map areas where landowners may be amenable to restoration activities. This map and process are described in section I-C of this document. NHI is currently conducting a GIS assisted, spatial analysis to determine where other controlling parameters overlap.

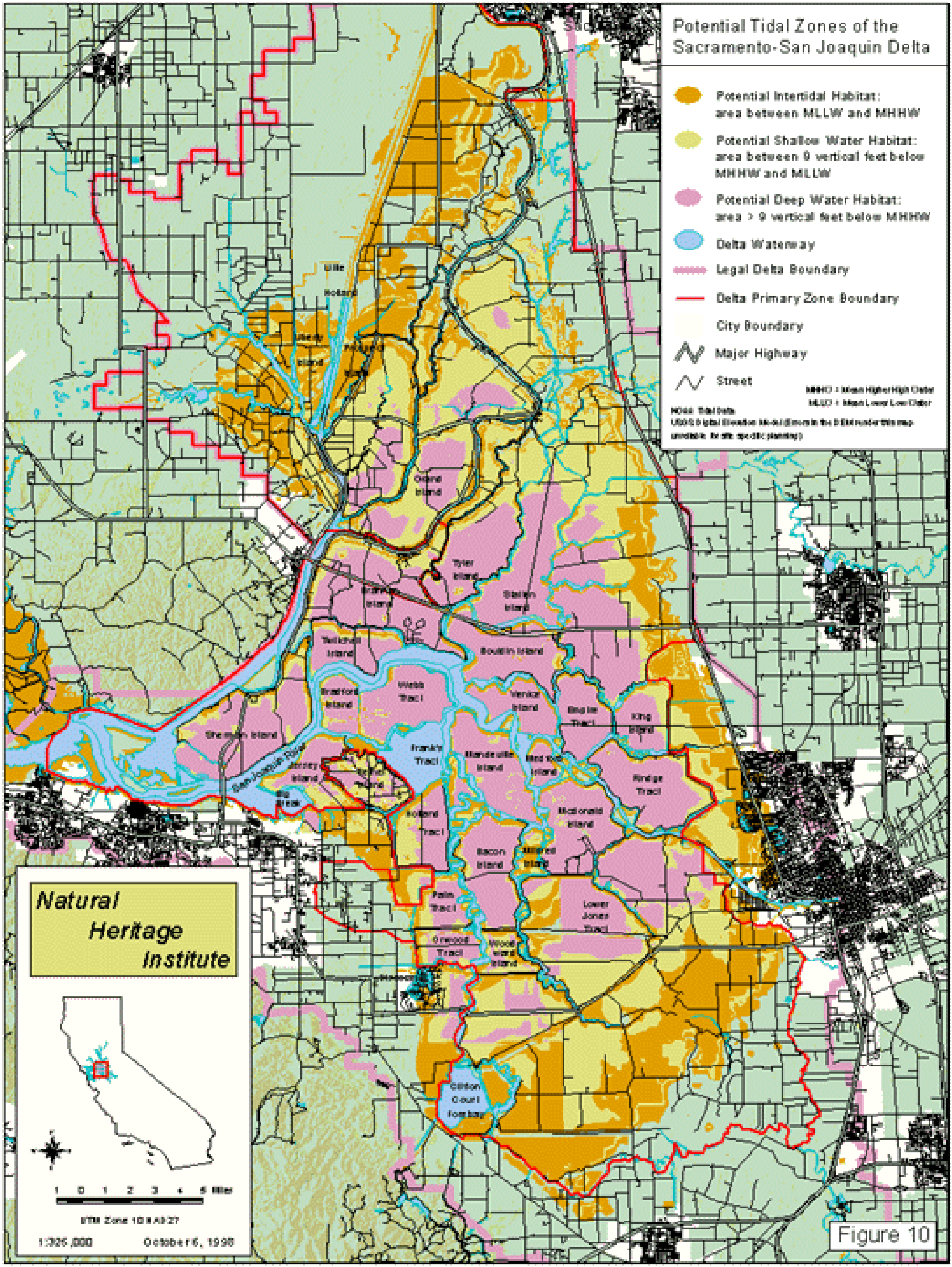
[12] The consequence and costs of levee failure is much higher on deeply subsided Islands. The deeper the subsidence, the greater the scour hole that forms during a levee breach, and the more material and effort necessary to repair the breach and scour hole.



Delta Tide Levels

Sacramento–San Joaquin Delta Atlas *Department of Water Resources*

Figure 9: Tidal Elevations throughout the Delta
(source: California Department of Water Resources, Delta Atlas 1995)


Potential Tidal Zones of the Sacramento-San Joaquin Delta
Potential Intertidal Habitat: area between MLLW and MHHW
Potential Shallow Water Habitat: area between 9 vertical feet below MHHW and MLLW
Potential Deep Water Habitat: area > 9 vertical feet below MHHW
Delta Waterway
Legal Delta Boundary
Delta Primary Zone Boundary
City Boundary
Major Highway
Street
Grand Island
Tyler Island
Staten Island
Brannan Island
Twitchell Island
Bouldin Island
Webb Tract
Bradford Island
Venice Island
Empire Tract
King Island
Sherman Island
Franks Tract
Mandeville Island
Rindge Tract
Mcdonald Island
Holland Tract
Bacon Island
Palm Tract
Lower Jones Tract
Orwood Tract
Woodward Island
Clifton Court Forebay
San Joaquin River
Natural Heritage Institute
1:325,000
October 6, 1998
Figure 10

Landuse & Crop Cover Types in the Sacramento-San Joaquin Delta

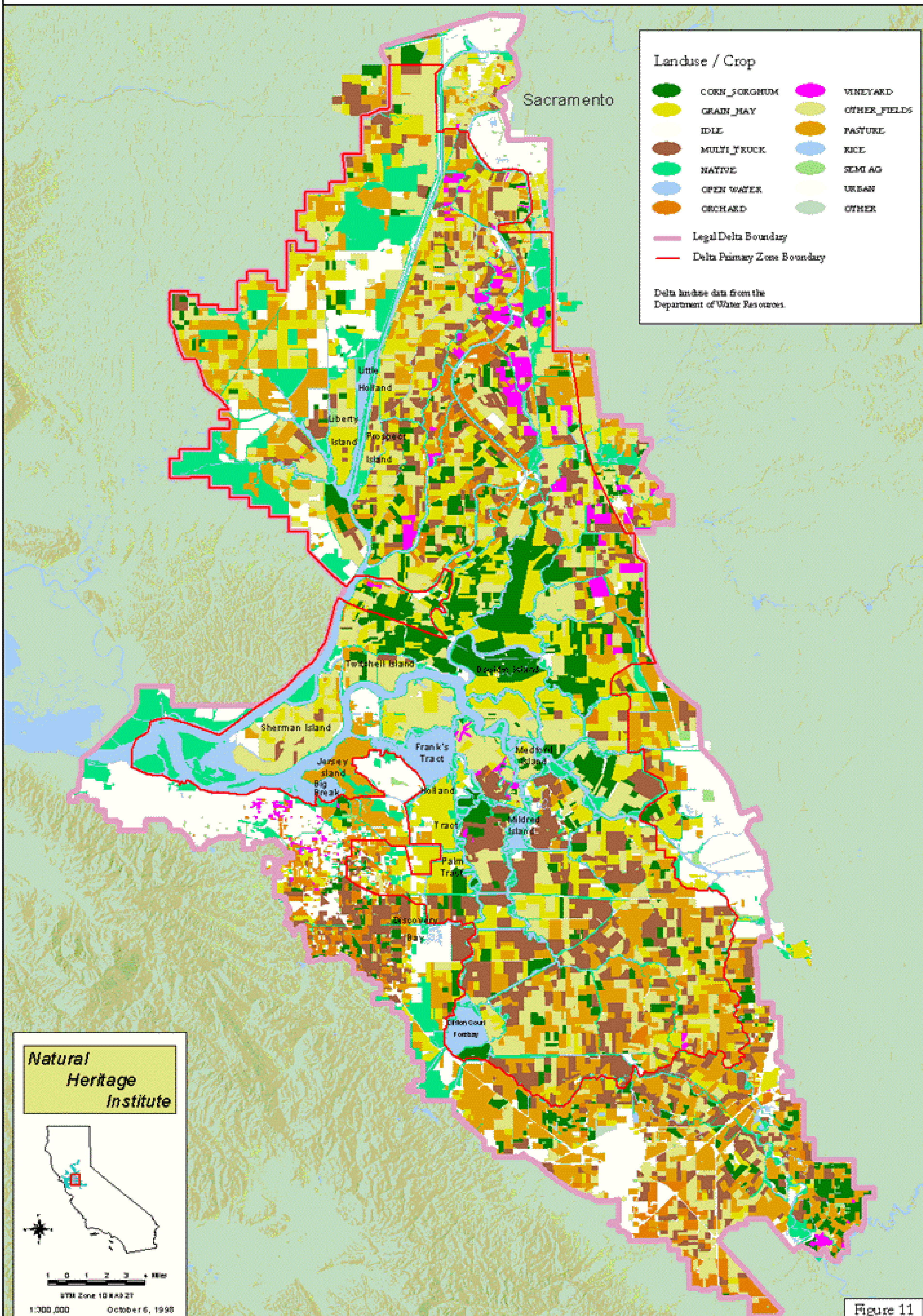


Figure 11

Ecosystem Management and Restoration Opportunities in the Sacramento-San Joaquin Delta

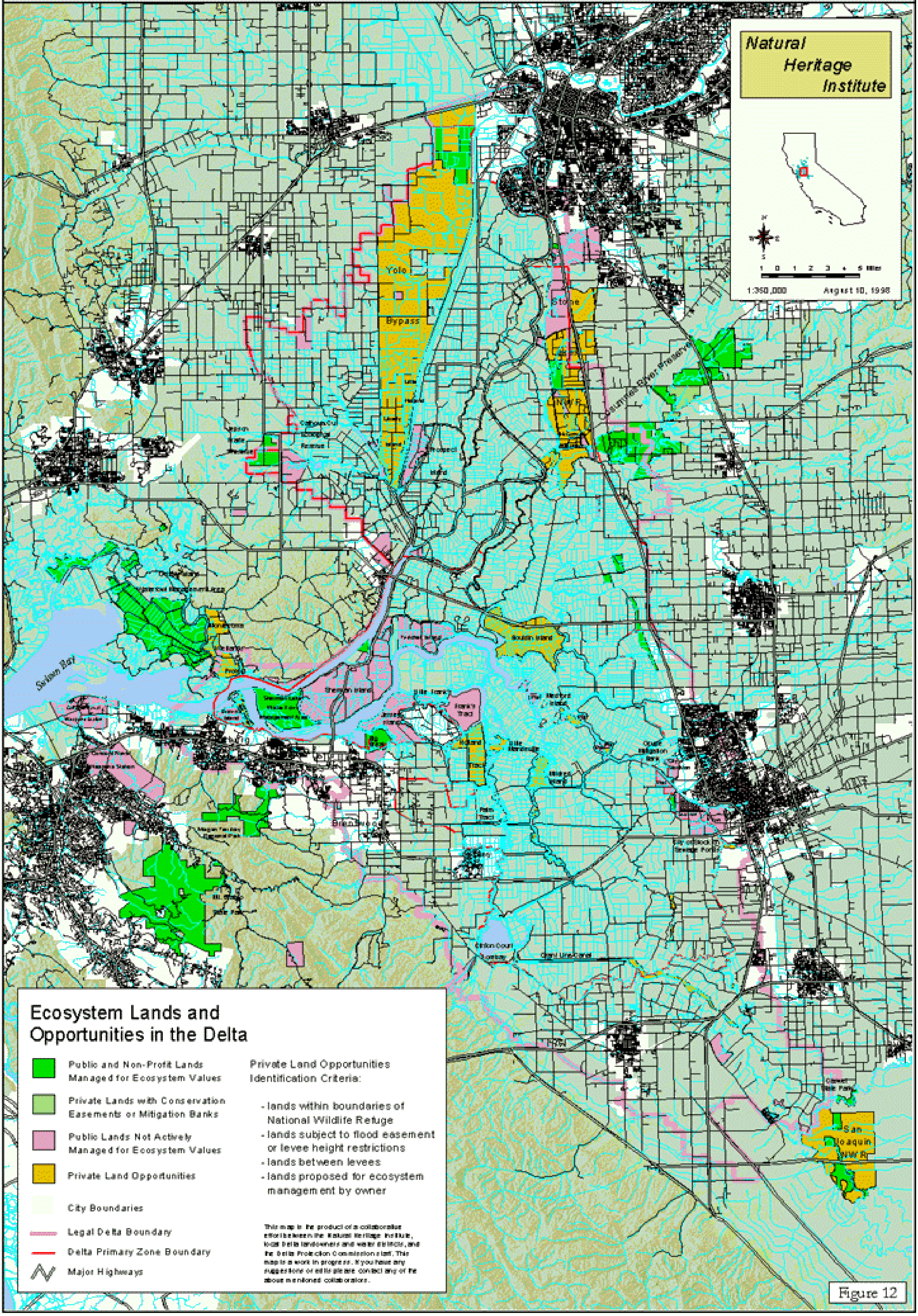


Figure 12

CALFED has identified tidal marsh and shallow water habitat as target habitats for restoration, but the maximum potential extent of these habitats is limited by the extent of land at or near mean sea level. Because regional mean sea level varies (mean tides) significantly in the Delta (Figure 9), the area of land amenable to tidal marsh restoration can not be estimated by simply identifying lands within 0' NGVD on USGS maps. Rather the area suitable for tidal marsh restoration is dependent on local tidal conditions. Using data from USGS digital elevation models, a network of NOAA tidal stations, and Thieson Polygon analysis; NHI estimated mean tidal elevations and calculated the maximum potential extent of tidal marsh and shallow water habitat.[13] Based on the elevation criteria alone, 100,500 acres of the Delta are suitable for shallow water habitat, and 118,000 are suitable for tidal marsh development. These areas are depicted in Figure 10.

This analysis is useful for estimating Delta wide potential for restoration but is not sufficiently accurate for site specific planning because of errors in the USGS digital elevation model[14], and because it assumes that tidal elevations will remain constant as the tidal prism increases. Nevertheless, Figure 10 indicates that opportunities for tidal marsh and shallow water habitat restoration are distributed mostly along the margins of the Delta. There are very few opportunities for immediate restoration in the western and central Delta and relatively abundant opportunities in the southern and northern Delta. The CALFED ecosystem restoration plan and many agency biologists hypothesize that restoring shallow water and tidal marsh habitat in the south Delta with existing export facilities would be harmful to native fish, because it would attract them to the vicinity of the Delta pumps where they are likely to be entrained. This hypothesis should be tested sooner than latter because, if true, it would limit tidal marsh restoration to the north Delta and small areas in the east and west Delta.

NHI is currently conducting a land use and economic analysis. Figure 11 is a map of land use cover types assembled from DWR spatial data sets. Although our analysis is preliminary, Figure 11 shows large areas of idle land on Bradford Island in the Western Delta; and south of Lindsey Slough, west of Hastings cut, and throughout the Yolo bypass in the north west Delta. Areas of "native" lands are concentrated west of Sherman Island, throughout the Yolo bypass, in the Stone Lakes Refuge, and the Cosumnes River Preserve. Based on this data, economic input/output data prepared for the legal Delta by University of California Agricultural Extension service, and crop report data prepared by county agricultural commissioners, NHI is currently evaluating the economic importance of various areas and land uses.

Evaluating the vulnerability of the levee system to failure and the relative ease of filling the subsided lands to sea level. We are still waiting for CALFED to release the seismic hazard report for Delta levees, but preliminary presentations of the report indicate that the western

[13] Mean higher high water (MHHW) and mean lower low water (MLLW) delineate the upper and lower extent of the maximum intertidal zone (tidal marsh habitat). Areas within 9 vertical feet of MHHW were classified as shallow water habitat.

[14] The USGS digital elevation model shows some areas of tidal marsh such as Sherman Lake as above mean higher high water while it show some areas near sea level such as the southern shore of Big Break as being several feet below sea level.

Delta islands, particularly Sherman Island are most vulnerable to levee failure during and earthquake. Based on the seismic report and CALFED's recently released estimates for improving Delta levees, NHI will attempt to characterize the relative vulnerability of Delta islands. We need far more information regarding the relative efficacy of various subsidence reversal techniques to properly characterize the level of effort necessary to raise most subsided lands, but it is possible to identify some areas that could be relatively easily raised to elevations suitable for tidal marsh or shallow water habitat restoration. In particular, Delta island peninsulas characterized by a low levee length to area ratio such as the western tip of Jersey Island, are prime candidates for levee setbacks and habitat restoration. NHI plans to identify other similar opportunities with the use of levee data, digital elevation models, and soils data.

CALFED, the Nature Conservancy, NHI, and other groups have already identified numerous opportunities for tidal marsh restoration, particularly in the Northern Delta. In our view, the most promising opportunities are: along Cache and Lindsey sloughs; McCormack Williamson Tract on the Mokelumne; the southern edge of Big Break; and mid-channel islands in the San Joaquin River between Stockton and Venice Island.

There are well-founded concerns regarding the impact of large-scale wetland restoration on the quantity of dissolved carbons in Delta water. There is no data to determine whether restored tidal marsh or tule cultivation under various management regimes would increase or decrease dissolved carbon loads. The NHI subsidence reversal project with DWR and USGS will investigate this issue in detail over the next three years. Dissolved carbons are not a problem for the ecosystem, if anything they would boost aquatic productivity. They are, however, a problem in water exported from the south Delta for drinking water. An isolated facility would moot this issue.

<u>3. Progress towards NHI's vision</u>

Ambitious as NHI's long-term vision for the Delta seems, we have achieved significant progress already. The extent of the tidally influenced Delta that can feasibly be reconverted to wetlands depends predominately upon three constraints:

1) The extent of cooperation of the existing land and water rights holders.
2) The availability of funding for acquisition and restoration.
3) The amount of land near sea level or our ability to rebuild subsided land surface elevations.

We have already taken the first indispensable steps of :

1) <u>engaging</u> the Delta landowners in a process for developing a joint Delta restoration plan for integration into the CALFED Program and
2) <u>generating</u> sources of public financing to implement these restoration opportunities.
3) <u>initiating</u> a $3.5 million project to field test techniques for restoring subsided lands.

B. Defining Principles and Process for Developing a Long-Term Restoration Program

Efforts to develop a long-term restoration plan should focus on a process for advancing restoration rather than on the extent and location of restoration actions. CALFED's emphasis on restoration targets in the Delta, particularly arbitrary targets, is premature and creates conflict rather than promoting incremental progress. There is too much scientific uncertainty to legitimately develop long-term targets for Delta restoration. The Delta is too large, the issues too complex, the level of distrust too high, and the stakes too great to achieve adequate consensus around a comprehensive plan for the future of the Delta. Rather, CALFED should focus its efforts on establishing a fair and well reasoned set of principles and an inclusive decision making process for pursuing the Delta restoration goal incrementally over at least the next five decades.

Based on our discussions with local Delta stakeholders, NHI has developed a set of principles that we propose guide any long-term restoration process in the Delta.[15] We believe that adherence to these principles will insure that progress toward a restored Delta will not unduly harm Delta stakeholders. Failure to heed these or similar principles will increase the risk that a Delta restoration effort will become hopelessly entangled in a bitter and counterproductive controversy.

1. Local control of restoration on private lands

Delta landowners and their elected officials must control the pace and extent of conversions of private lands to habitat. The CALFED restoration program should be set up to provide new options--not compulsions--to Delta landowners. Restoration projects by the local landowners or conveyance of interests in land to enable public agencies to undertake restoration projects should be voluntary and compensated. The purpose of a strong preference for adhering to a "willing seller only" process, is to not simply give local landowners the ability to control the pace of restoration, but more importantly, to allow local communities to control their social and economic future.

In some cases, the power of eminent domain will be necessary to give the local Delta community the ability to shape their own future. Some parcels of land valuable for ecosystem restoration may lay idle and be owned by absentee landowners or a public entity such as a port district. Situations may arise where "hold-outs" seek to prevent the rest of the landowners on a particular island from entering into habitat restoration arrangements. Even here local control is important. Local democratic institutions, such as the Delta Protection Commission, should have the power to approve the exercise of eminent domain.

2. Create options for landowners while banking capital for restoration

The restoration program will not know in advance just where it will want to do restoration work or when. These decisions will evolve as the program evolves. But, the program should not wait until these decisions are made to acquire interests in land from willing sellers.

[15] We are currently working with Delta Landowners to achieve consensus around this set of principles.

Rather, the program should promptly set up an acquisition program that will be available to any landowners in the Delta who may prefer to sell an option or other interest in land to the restoration program, rather than to some other land use. This will provide an economic option to landowners on an ongoing basis. It will also create land capital for the restoration program to use for restoration projects, or an asset to bank for eventual sale or to trade for other more suitable restoration parcels. Early acquisitions as they become available will likely be most cost-effective and will prevent irreversible land use changes that could limit the potential for restoration. Lands in the bank would continue to be farmed under option or lease-back arrangements to minimize impacts on the local agricultural economy.

3. Maintain a strong local economy

Agriculture and recreation will continue to be primary elements of the local economy although the mix may shift over time as restoration projects go forward. Gradual land conversions should minimize third party economic impacts. In the event of more rapid land use changes, the CALFED program may need to take appropriate actions to mitigate negative impacts of ecosystem restoration on the Delta's regional economy.

4. Empower local people to plan, implement, and manage ecosystem restoration

The CALFED restoration program will be incremental, as we have stated. These incremental restoration projects should be developed with the active participation of the local Delta agencies, landowners, and residents, not imposed from without.. Agriculture is and will continue to be an important part of the Delta economy, but increasingly state and national interests are looking toward the Delta to provide products and services necessary for maintaining reliable water supplies and protecting biological diversity. Wherever qualified and competitive, Delta farmers and communities should be contracted to provide these services. CALFED should identify desired services and pay Delta farmers to provide them. To the extent practicable, the restoration actions should maintain property in private ownership or management. Agency management of public lands is often expensive and inefficient.

5. Promulgate "Good Neighbor" policies for government land managers

Public entities that acquire rights in land for restoration purposes should pay their fair share of infrastructure maintenance costs, such as levees or other flood control works, and make payments in lieu of taxes to local governments. Public land acquisition within local reclamation districts often increases the burden of financing district functions to neighboring private landowners within the district, because public agencies often fail to consistently pay their share of assessments imposed by the local district. To ensure that the CALFED Program does not weaken the financial integrity of local reclamation and drainage districts, it may be necessary for CALFED to require that restoration projects pay in perpetuity all assessments and charges at a rate equal to that paid by private landowners as a condition to receiving any CALFED funding.

Pesticide application agreements and “Safe Harbor” agreements with local farmers may be warranted to avoid conflicts over application techniques and endangered species respectively.

6. Subsidence reversal for all land uses

Subsidence is an inexorable process that will ultimately compromise the viability of Delta agriculture in parts of the Delta, and increase the economic, water supply, and ecological costs of unplanned levee failure. Subsidence management and reversal programs, particularly in the western Delta, will benefit all land and water uses of the Delta irrespective of CALFED’s preferred alternative. Thus, subsidence reversal should occur where ever the physical conditions are suitable and the landowner is willing, regardless of the current or future land use. Subsidence reversal is a time intensive process that will take several decades. CALFED should commit to funding such a long-term program in the interest of gradually increasing the durability of the ultimate CALFED solution.

Subsidence reversal programs will take decades to restore land surface elevations to sea level. In the interim, significant investments in levee infrastructure are necessary to protect beneficial uses of the Delta.

Islands most vulnerable to seismic events should receive priority for subsidence reversal. This entails ongoing improvements in the seismic risk data as a key part of a Delta restoration program.

7. Protect agricultural water quality through interim prevention of levee failure and by reconnecting the mainstem San Joaquin River to the southern Delta

Until landforms are rebuilt, levee failure will significantly harm all beneficial uses of the Delta. Maintaining the western island levees as salinity barriers is essential to the water quality of the central delta for irrigation. A long-term restoration program therefore needs to include a plan to minimize the risk of levee failure and a commitment to reclaim islands inundated by an unplanned levee failure regardless of the ultimate CALFED alternative selected.

The CALFED program should also take steps to decrease the load of salts from agricultural drainage in the San Joaquin basin upstream of the Delta. Poor water quality in the southern Delta has long been a problem for Delta farmers. One of the major factors contributing to poor water quality is the lack of flows from the mainstem San Joaquin River. For both ecosystem and water quality purposes, the CALFED program should increase releases from Friant Dam to augment flows in the lower San Joaquin River. In a later section, this Environmental Optimal Alternative suggests a set of initiatives to accomplish just that.

8. Focus on improving quality of habitat

CALFED’s should create quality habitat by learning from initial implementation efforts through an adaptive management program. An early focus should be on high quality habitat development linking core habitat areas with corridors. Core habitat restoration areas are Yolo

Bypass/Cache Slough, Cosumnes River/McCormick Williamson, Suisun Marsh/Sherman Lake, and the San Joaquin National Wildlife Refuge.

9. Prevent irreversible land use changes in the Delta

If CALFED is serious about broadscale, long-term habitat restoration in the Delta, it is imperative that steps be taken immediately to prevent land use activities that irreversibly preclude or discourage restoration. Urbanization is such an irreversible use; conversion to capital-intensive permanent crops such as orchards or vineyards diminishes the availability of these lands for habitat restoration by substantially increasing the purchase price. The conversion of row crops and grains to vineyards and other perennial crops has also reduced habitat for Swainson's hawk and other bird and terrestrial species.

The Delta Protection Commission currently has limited jurisdiction over proposed developments in the Delta primary zone, but the secondary zone of the Delta is still extremely vulnerable to harmful urban development. Urbanization of the secondary zone and other periphery areas could transform the Delta primary zone into a marginal "island" of agriculture. CALFED should acquire agricultural land easements and employ other strategies to prevent further urbanization of the secondary zone and to prevent conversion to permanent crops.

10. Reduce flood peaks in the Delta

Actively dissipate flood peaks upstream of the Delta rather than convey them through the Delta. Aside from the upstream dams, the present upstream flood control system exasperates flood control and levee vulnerability in the Delta by funneling flood flows to the Delta via the upstream levee system. Even the upstream dams do not significantly reduce the peak of the very largest floods. As a result, the Delta levees are subjected to unnecessarily high peak flow events, which erode levees and tidal marsh, and increase the risk of levee failure. CALFED should attempt to attenuate flood peaks in the Delta by slowing and spreading water upstream of the Delta with set back levees, channel roughness features, flood bypasses, and flood basins.

11. Regulate harmful effects of recreational boating

The degradation and erosion of tidal marsh habitats and levees is caused, in part, by the erosive wakes of motorized watercraft. Since the erosion of both tidal marsh and levees are issues central to the CALFED problem, CALFED should pro-actively develop a plan to minimize the harmful effects of motorized watercraft. Although boaters have rights to use the Delta channels for navigation, the public has a right to regulate the speed, location and type of craft to protect other essential public trust values, such as water supply, fish, and wildlife.

C. Near-Term Program for Protection and Ecological Restoration of the Delta

To reiterate, the near term program of Delta restoration is comprised of immediate, low-conflict opportunities around which a substantial consensus already exists. These near-term opportunities are actual sites and projects. These fit within the longer-term program which, by contrast, is defined as a set of principles and processes for restoration actions over the next five decades. We suggest that the near-term efforts to advance the long-term conservation and restoration goals in the Delta should be focused on three elements.

- Developing consensus with Delta landowners and residents regarding low-conflict restoration opportunities that can be feasibly implemented in the next five years
- Developing "learning laboratories" to advance our understanding of the restoration techniques that can be more widely propagated to achieve broad-scale conservation and restoration in the Delta
- Preventing urbanization and other irreversible changes to the Delta that will preclude or inhibit the protection and restoration of Delta resources

<u>1. Working with Delta landowners to identify restoration opportunities</u>

The Delta is a shared resource. While its potential environmental values are incomparable, the leveed lands are, in fact, owned and controlled largely by private parties and these lands support a longstanding and locally cherished farming culture and economy. There is no realistic prospect of a forced sale of these lands. Thus, the key to habitat restoration is a voluntary program of compensated conversion of the lands possessing the highest potential as habitat potential and the least value in their current usage.

In recognition of this reality, NHI has taken the initiative to engage the Delta landowners and other collaborators in a process to articulate a common vision for the Delta's future which will include the preservation of those agricultural land uses that are sustainable while dramatically expanding the extent of fish and wildlife habitats. The first step in this collaboration has been to inventory candidates for ecosystem restoration in the Delta and develop a map of ecosystem lands and opportunities in the Delta. Figure 12 depicts ecosystem lands and opportunities that Delta landowners and agencies have proposed as low-conflict opportunities for CALFED restoration projects in the Delta. Figure 12 was developed by NHI staff, Delta landowners and water districts, and the staff of the Delta Protection Commission. All collaborators on the mapping project agree that it is a work in progress that will evolve over time as we learn more about the Delta. In conjunction with NHI, Delta landowners and water agencies also developed written plans for a wildlife-friendly agriculture program and a riverine habitat corridor plan. NHI will continue to work with Delta landowners to refine and improve these programs.

2. Developing "learning laboratories"

Pilot projects must be identified and designed in the near term that can simultaneously advance restoration objectives and increase knowledge about how the Delta ecosystem works and how best to reverse adverse trends such as land subsidence and restore its natural processes and functions. Early learning about how to restore is essential to a successful and efficient longer-term program. CALFED has been inhibited in defining a restoration program by the significant knowledge gaps about how to do it. The answer is not to limit the restoration program to what is well understood, but to set up the program to expand the range of knowledge and apply the lessons to open up new possibilities progressively. Thus, the first priority for use of restoration funds should be projects that are specifically designed to answer critical research questions. NHI calls these types of projects "learning laboratories". Several have been launched by NHI and its collaborators during the past two years with Category III funds. Several more are being designed. These are described in some detail in Appendix 2 to this Alternative.

3. Preventing urbanization

As noted in the discussion of the principles for long-term restoration in the Delta, the greatest threat of irreversible land use changes that will limit opportunities in the Delta is urban sprawl. Northeast Contra Costa County is particularly vulnerable to urbanization. The city of Brentwood and the unincorporated area of Oakley are among the fastest growing communities in the United States. Figure 13 depicts urbanization encroaching on the south shore of Big Break[16], just north of Oakley. Although the undeveloped land in this photo is suitable for tidal marsh restoration, it is currently slatted for subdivision development. A developer in the southern Delta has proposed plans for a mega-development and amusement park on Stewart Island along the southern Delta.

The inexorable pressure for "ranchette" development within the primary zone will fragment the highest value orchards and vineyards and reduce production on these lands. Urbanization of the Delta will also be harmful to the environment. Drainage from urban areas will degrade Delta water quality. Increased boating and other recreation will further reduce already limited habitats for wildlife. Feral and exotic pets that escape from newly created suburbs will create an unabated source of exotic species that disrupt the existing ecology. Increased population on flood prone areas will necessitate the construction of larger levees potentially degrading existing channel habitat. Finally, urbanization of lands near sea level will preclude unique opportunities for tidal marsh restoration and increase resistance to converting agricultural land to habitat. Delta farmers are understandably concerned about removing land from agricultural production. Each acre removed for urbanization will make it more difficult to retire land for ecological restoration.

The CALFED plan should include strategies in conjunction with local jurisdictions to limit and constrain urban sprawl into agricultural lands throughout the legal Delta. The Delta

[16] Big Break is one of the few large shallow water habitat areas in the Delta and provides habitat for large numbers of native Delta fish.

Protection Commission currently has limited jurisdiction over proposed developments in the Delta primary zone, but the secondary zone of the Delta is still extremely vulnerable to harmful urban development. One element of such a strategy should be acquisition of agricultural land easements.

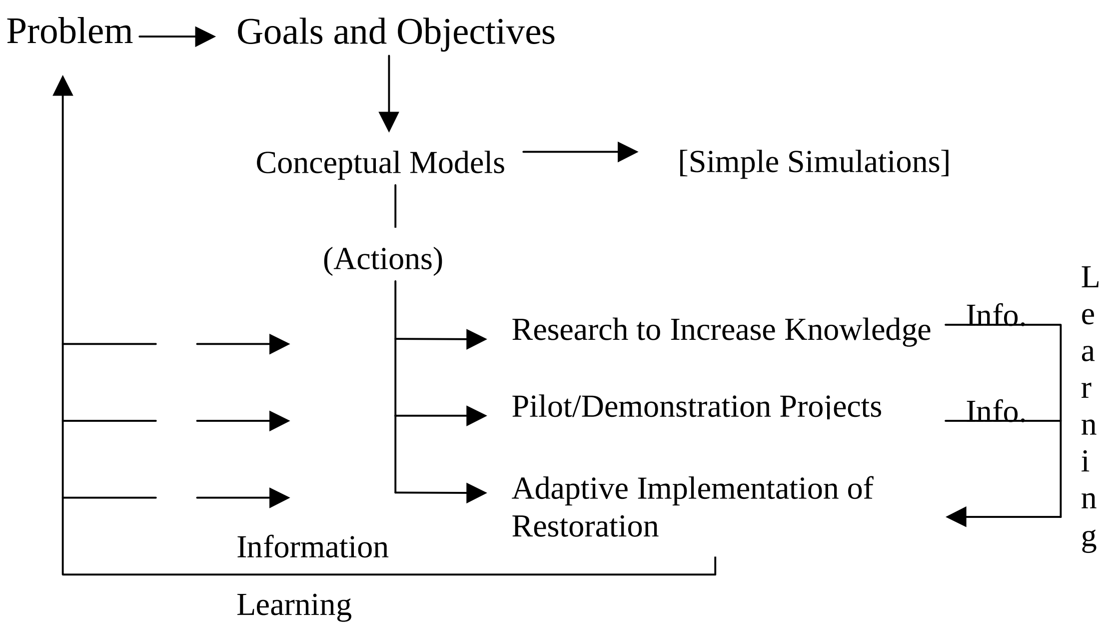
Figure 13: Aerial Photograph of Urbanization along the Southern Edge of Big Break (source: UC Berkeley Digital Library)

II. AN ADAPTIVE MANAGEMENT PROGRAM

A. The Adaptive Management Method

Adaptive Management is a strategy for managing uncertainty and reducing the risks associated with decision making in the face of scientific uncertainty. Among the decisions that need to be "adaptively managed" are those regarding the *expenditure* of *scarce resources on restoration actions of uncertain efficacy.* The "core team" of scientists working on the strategic plan have developed the graphic in Figure 14 to depict the adaptive management process and method.

Figure 14: Framework for Adaptive Management Planning**.**



Both the core team and the independent scientific review panel that reviewed CALFED's ecosystem restoration plan emphasized the importance of adaptive management and described the process. Although the adaptive management process is simple and logical, this simplicity has sometimes been obscured by the scientific jargon used to describe the process - conceptual models, testable hypothesis, numerical simulations, etc. Decision makers can not afford to remain confused about the adaptive management process because it is essential to the success of the restoration program and must be embedded into the culture of the agency that will eventually implement ecosystem restoration.

In lay terms, the adaptive management process entails:

- Articulating measurable goals and objectives.
- Explicitly disclosing the assumptions regarding how the biophysical system will respond to hypothetical management interventions.
- Testing these assumptions against actual results achieved through a directed program of data collection and interpretation.
- Determining whether monitoring results warrant changes in the management or restoration strategy and adjusting accordingly.

Articulating explicit, measurable, and attainable goals is an obvious and essential first step that CALFED has too often failed to observe. In the context of adaptive management, the worst kind of uncertainty is uncertainty about what you are trying to achieve. Resources expended to achieve vague goals are likely to be wasted.

Everybody makes assumptions about how the world works. In the adaptive management lexicon, these assumptions are referred to as conceptual models and hypotheses. Failure to explicitly disclose these assumptions results in confusion and uncertainty that will overwhelm the restoration program before it gets started. Disclosing these assumptions forces managers to think more clearly about how the system works and specifies the type and nature of the data that will need to be collected to confirm or refute the management hypothesis.

Shifting management direction as new information is gleaned from the adaptive management process will require a flexible, technically proficient institution specifically designed to manage adaptively.

Interpreting data from management experiments will involve retaining a higher level of scientific expertise than currently exists in the agencies and will most likely require collaboration with university scientists. Finally, shifting management direction as new information is gleaned from the adaptive management process will require a flexible, technically proficient institution specifically designed to manage adaptively. *We describe such an institution in the next chapter of this document.*

B. Managing Risk in the Ecosystem Program

In the ecosystem restoration context, one risk that adaptive management can address is the risk of irretrievably expending scarce resources on ineffective treatments or harmful treatments. Analogies to the financial sector may be helpful here. The financial sector has developed elaborate tools and strategies for managing risk, such as portfolio diversification and hedging, that can be employed in ecosystem management as well. These risk-averse investment strategies should guide the ecosystem restoration program emanating from CALFED with respect to decisions on how best to spend the funds that will be appropriated.

In the restoration context, adaptive management should be conducted as counseled in an article in *Science* magazine.[17]

> Most principles of decision-making under uncertainty are common sense. We must consider a variety of plausible hypotheses about the world; consider a variety of possible strategies; favor actions that are robust to uncertainties, ***hedge***; favor actions that are informative; probe and experiment; monitor results; update assessments and modify policy accordingly; and ***favor actions that are reversible.*** (italics added)

Experimentation rather than commitment of resources to a fixed list of actions is essential. The notion of favoring reversible actions may be the most important step for insuring the success of an adaptive management program. Adaptive management is predicated on the notion that management decisions can and should be modified periodically if they are determined to be misdirected. It is easier for a manager to change course if the resources previously expended can be redirected into a new action. Thus, the ERP independent scientific review panel emphasized the value of land and water acquisitions as a strategy for dealing with uncertainty. It also recognized the importance of protecting existing resources as a "strategy to increase certainty."[18]

Favor actions that are reversible.

Land and water acquisitions comprise a low risk investment, because land and water are fungible assets that appreciate over time and can be exchanged for other assets that may become more useful in light of the evolution in management approach that adaptive management fosters. If the adaptive manager buys land or water in the wrong place, it can resell it for land and water in the right place. If it buys too much land or water relative to other actions such as installing fish screens, it can sell those assets and invest the proceeds in fish screens. In contrast, if the adaptive manager spends too much on fish screens, this is a sunk investment.

[17] Ludwig, et al. 1993.

[18] "The most cost-effective way to protect systems is to prevent impacts. Preventing damage is much easier than repairing it. The ERP should more explicitly embrace an anti-degradation philosophy. Ecosystem components that are in good shape should be kept intact. . . . The ERP should emphasize preventing places that are fair from becoming poor." From report of the Independent Scientific Review Panel, Dec. 1997.

III. CREATION OF A NEW ADAPTIVE MANAGEMENT INSTITUTION FUNDED TO RESTORE THE ECOSYSTEM

> ***Where there is no accountability, there is little incentive to spend limited resources where they will do the most good.***

Today, the entire cluster of CALFED sponsoring agencies share responsibilities for the fate of the Delta, but none of them jointly or severally have a legal mandate, or the operating experience, to restore its ecological functions and processes. What a single agency cannot now do, a consortium is even less likely to achieve. Since many agencies are responsible for various aspects of the Delta environment, *none are accountable for the success or failure of the CALFED ecosystem restoration program as a whole.* Where there is no accountability, there is little incentive to spend limited resources where they will do the most good. Rather, agencies have an incentive to expend resources in areas where they have existing programs and authority and in areas that are politically popular. Finally, existing institutions generally cannot shift directions quickly in response to new scientific information. An adaptive manager of the Delta will need to possess a very different orientation and set of capabilities.

Virtually every stakeholder group involved in CALFED now supports the creation of a new, non regulatory management and restoration authority for the Delta because the restoration program emerging from the CALFED process calls for more than just better coordination among the agencies with existing managerial authority—it calls for new functions not now within the aegis or experience of any of these agencies. These novel functions include exercising property rights in water and lands, adaptive management (as described in the previous section) and, potentially, administration of an assurances package that might include a program of regulatory indemnity, as also described later in this paper.

A. Activities

For ease of reference, we refer to that entity as the “Delta Ecosystem Restoration Authority” (“DERA”). Form should follow function in designing this entity. DERA's fundamental purpose is to implement the Ecosystem Restoration Plan (ERP) as effectively and efficiently as possible. Toward this end, DERA should engage in the following activities:

a. Ecosystem Restoration Program Manager

DERA should be responsible for implementing the Ecosystem Restoration Program, including planning, execution, monitoring, and analysis. More specifically:

- Undertake physical habitat restoration projects with emphasis on those that address knowledge gaps or deficiencies regarding restoration techniques that have the potential for widespread application within the geographic scope of the CALFED Bay Delta Program;

- On its own initiative or on behalf of public agencies, enter into agreements for the purchase, sale, transfer, exchange, or donation of interests in land, water, water rights, and/or water storage or conveyance facilities including groundwater banks for enhancement of aquatic ecosystems within the geographic scope of the CALFED Bay Delta Program;

- Undertake fish and wildlife restoration activities authorized by the Central Valley Project Improvement Act of 1992, including acting as a recipient of federal appropriations for this purpose, and projects selected under "Category III" of the Bay Delta Accord;

- Perform monitoring and data analysis of bio-physical processes and functions and the biological responses to restoration efforts;

- Enter into arrangements alone or jointly with other entities to construct water conservation, storage, transfer or conveyance facilities for environmental restoration purposes, or where a net environmental improvement would accrue;

b. Real Time Operations

DERA should have some degree of influence over water project operations to assure that diversion patterns have minimum possible impact.

DERA should have some degree of influence over water project operations to assure that diversion patterns have minimum possible impact. For instance, the following chapter describes a proposal that would enable DERA to barter export pumping rights in an effort to minimize the environmental impacts of the Delta pumps.

c. Feed back loop for the CALFED implementation superstructure

DERA should coordinate the implementation of the ERP with other CALFED program components.

d. Administer an Assurances Program

DERA could assume responsibility for compliance with the Delta inflow-dependent requirements of the federal and state water quality, endangered species, and other environmental regulations which would otherwise fall upon the consumptive water users. This would increase the likelihood of compliance while providing a significant "water supply reliability" premium. The legal liabilities that arise under these laws would not be altered. Instead, DERA would *indemnify*, in some degree, these parties against the risk of loss of water associated with compliance with these programs out of a risk pool created through "premiums" paid by the water users.

B. Powers and Functions

To do this job, DERA will need to be endowed with ample funding, and with the following powers and functions:

- Apply for, obtain, hold or become party to all necessary or useful regulatory permits or licenses, on its own behalf or on behalf of restoration partners, including preparation of habitat conservation plans, candidate conservation agreements, and safe harbor agreements under the Federal Endangered Species Act, or any state counterpart documents under the California Endangered Species Act;

- Facilitate, administer or assist in the design and implementation of adaptive management and regulatory assurances mechanisms that may emanate out of the CALFED Bay Delta Plan, including, for example and without limitation, a restoration contingency or indemnity fund;

- Enter into contracts for technical, scientific and other professional services and expertise in the conduct of all of the above functions, with the objective of deploying the best independent science available;

- On its own behalf, and not on behalf of any of its members or any other entities, initiate or engage in regulatory proceedings involving or affecting environmental resources of the Sacramento and San Joaquin Delta and River Systems;

C. What Resources and Tools Would A DERA Need To Do Its Jobs?

- DERA would start with an initial endowment of water, storage, conveyance, pumping and property rights, or, more likely, the funds to acquire these working assets. The water endowment would build upon the baseline flows already available under regulatory programs. DERA must be able to manage and protect its water like any other water agency. Current law provides for such protection for instream flows by permitting changes in place and type of use for existing water rights. Additional legislation may be needed to account for environmental water flows as additive to instream flows that would otherwise be available.

- DERA would have an assured income stream, insulated from the political process.

- DERA would use its property rights and income to implement the CALFED Ecosystem Restoration Program. Where necessary it would trade, sell, and acquire property rights to maximize environmental benefits.

- DERA would not exercise or supplant existing regulatory authorities under the Endangered Species Act, the Clean Water Act, their state law counterparts, or any other environmental compliance mandate. It would have no regulatory authority. In fact, in its role as a project manager, it would be subject to regulation under these laws like other governmental agencies or private corporations (depending on the form it takes).

DERA would trade, sell, and acquire property rights to maximize environmental benefits.

D. Creation: How Would DERA be Formed

The Delta Restoration Authority could be created either by special legislation at the state or federal level or through a joint powers authority or as a private, non-profit corporation. Private corporate status would also insulate DERA from the vagaries of the annual appropriation processes. If it were incorporated as a tax-exempt entity, it could receive taxable deductible gifts of Delta farmlands or of water rights. This would expedite and lower the costs of the acquisition program. In any case, with an expert staff, its single mission should be environmental restoration and management.

E. Governance: How Would DERA Be Governed?

Structurally, governance should be commensurate with responsibility. Two models are possible in this regard. Under the first, DERA is a facilitative entity with the ultimate responsibility for meeting environmental standards (arising under the Clean Water Act or the Endangered Species Act, for example) and/or achieving the ecosystem restoration goals emanating from the CALFED Program resting with the stakeholders and/or public agencies. Under that model, all stakeholders and cognizant public agencies would have a seat on the board of governance of DERA.

Under an alternative model, DERA would assume the ultimate responsibility for achieving the ecosystem restoration program emanating from the CALFED Program and acting as surety for the achievement of environmental standards. Under this model, governance of DERA would be restricted to governmental and non-governmental entities whose mission and expertise is solely natural resource conservation and protection.

IV. REVISING DELTA EXPORT OPERATIONS TO OPTIMIZE WATER SUPPLY AND ENVIRONMENTAL BENEFITS

The water exports pumps in the south Delta are the largest such facilities in the world. Their influence, including but not limited to entrainment, is one of the major causes of fish declines in the Bay-Delta ecosystem. Under the Endangered Species Act and the Clean Water Acts, a regulatory regime governing exports has been established to reduce the number of fish entrained. While these rules have been effective in slowing fishery declines, their command and control quality does not allow the flexibility necessary to optimize environmental and water supply benefits in real time operations. And, these types of regulations are limited to preventing actions; they cannot compel habitat restoration actions such as increasing the frequency of inundation of the Yolo By-Pass to improve shallow water habitat conditions for a suite of Delta-dependent species.

The current rules governing exports, based primarily upon an export/inflow ratio, are underprotective, constrain water transfers, and promote conflict between water users and the environment. This chapter describes a better approach that utilizes water markets to produce a more favorable export regime. We discuss the criteria that export rules should meet, critique the existing rules, and then propose an approach to improve the export rules.

A. Criteria for Workable Operations

The ideal set of export rules should meet a number of criteria:

> Protection: The rules should be intrinsically protective of the environment (even without real time management).
>
> Predictability: For given hydrological conditions and infrastructure, allowable water exports should be highly predictable. Allowable diversions should rise in wet years and fall in dry ones and should increase as a result of new infrastructure and to allow water transfers. The rules should allow for at least partial recovery during favorable conditions of water losses occasioned by regulatory restrictions during unfavorable conditions. Predictability of dry season supplies is also explicitly desirable.
>
> Compatibility with real-time management: The rules should allow for adjustment of export pumping according to real-time biological conditions with a sharing of the benefits of flexible operations between the environment and water users.
>
> Compatibility with water transfers: The rules should allow for predictable market transfer of water across the Delta and should not require water taxes significantly greater than the damage caused by the transfer.
>
> Cooperation between the environmental manager and the export projects: The project operators and DERA should each have behavioral incentives to act in ways that promote the interests of the other side.
>
> Share the benefits of future changes: The rules should share the benefits of future infrastructure improvements between the environment and the projects.

The current set of operational controls violates all these criteria to some degree:

> Standards are not intrinsically protective. Because of operator discretion, the project may be operated in a fish-friendly, or fish-unfriendly manner at the discretion of the operators.
>
> Benefits are unpredictable. The "no net loss" provisions of the Accord help increase export predictability, but only for new ESA take restrictions. The lack of assured payback for existing take limits and for voluntary pumping reductions makes export levels relatively unpredictable.
>
> Real-time management is the exception, not the rule. Real time management can happen when regulatory agencies have the authority to force ir (e.g., under the ESA). It rarely happens without compulsion if there are risks involved to the exporters.

Market transfers are controversial. Transfers either require no environmental mitigation in the Delta, or very high levels of mitigation. This is not a stable foundation for a market regime.

The interests of environmental interests and water interests are misaligned. The water projects and environmental interests have incentives to attack each other's benefits. The environment gains by seeking pumping reductions without a commitment to payback. Export users gain by pumping at maximum allowed rates until demand is met and storage is full, whatever the biological impacts.

There is no mechanism to automatically share the benefits of new infrastructure. Instead, proposals for new infrastructure have led to controversy over operational rules.

B. Possible Approaches

Any solution will involve making decisions on several levels:

- What are the baseline export rules? That is, if no affirmative action is taken, what parameters control exports? Under current rules, exports are controlled explicitly by Delta inflow during most months and by San Joaquin inflow during the April-May pulse period. Exports may be limited implicitly by Delta salinity standards. These rules could be altered. First, environmental health is better correlated with Delta outflow than Delta inflow. Moreover, Delta inflow can become relatively meaningless during the summer since Delta island pumping is not within the standard. Second, as discussed above, the E/I standard causes problems with the transfer market. Third, it may be possible to incorporate real-time biological information into the standards. For example, the standards might require reductions in export pumping when entrainment per acre-foot of pumping rises above certain levels. Conversely, the standards might allow increased pumping when entrainment per acre-foot is below certain thresholds. Thus, an export standard which is a non-linear function of outflow with pumping adders and subtractors based upon entrainment in real-time could probably be developed. Such a standard could provide intrinsic protection to the ecosystem (and would effectively internalize real-time operations into the baseline standards), provide more reliable supplies to exporters, and reduce environmental transfer taxes in the Delta. The standard could also be written so as to automatically respond to the construction of new infrastructure. We probably have enough information to revise baseline standards to be more biologically protective and to reduce the water transfer problems caused by the current standards. NHI is working on such a standard based upon the logistic equation. However, the state of biological information is rudimentary enough that a program of real-time management is needed beyond any set of baseline standards for the foreseeable future.

- Who has discretion to alter the baseline export rules in real-time? With the current rules, project operators have the discretion to reduce pumping in real time. Also, the ESA agencies – NMFS and USFWS – have exercised discretion by imposing certain take restrictions on the projects. The Operations Group, made up of all the CALFED agencies has the discretion (but not the requirement) to allow variances to the export standards in order to provide makeup water to the projects, subject to approval by the SWRCB. As discussed above, this distribution of discretion is problematic in that the water projects have little incentive to make voluntary reductions in pumping when payback is uncertain. A better approach would be to grant some pumping rights to DERA, then allow DERA to use those rights to make agreements with the water projects to provide for real-time pumping shifts. DERA could allow the export projects to use some of its pumping rights when entrainment of fish appeared to be low. In return, DERA would be able to require reduced pumping later in the season when impacts were high. Thus, in this example, the discretion to allow pumping from the baseline would be granted to DERA (subject to SWRCB veto). The relationship between the projects and DERA remains to be worked out. However, it should be possible to structure a set of rules that provides for improved export reliability (and even increased exports), reduced entrainment, incentives for cooperation between the projects and DERA, and an automatic sharing of benefits as new infrastructure is constructed.

- Accounting, risk and reliability. This topic is closely related to the discretion topic above. How do we balance the books when we make real-time modifications? Who is at risk if paying back reduced exports may have significant environmental impacts – the environmental or the water exporters? Who will capture the benefits of real-time management? The answers fall on a continuum. With the current system, operators retain significant discretion and they tend to retain the risk if payback would cause environmental problems. For this reason, real-time operations are not happening very frequently. Another problem with the current system is the difficulty with accounting. The existing standards do not represent a firm operational baseline for accounting purposes so we are left with the problem of hypothesizing what operators would have done if they had not made a real-time shift. This ambiguity causes enormous accounting problems and will be a source of conflict. At the other end of the spectrum, we could guarantee that water exports will reach certain levels each year as a function of annual hydrology, but give considerable discretion about when that water will be delivered to DERA. In that case, DERA gets the freedom to do unfettered real-time management, but now has the responsibility of taking care of the exporters, whatever the impacts on fish. To put it another way, with current standards, the environment is a constraint on the discretion of the project operators. At the other end of the spectrum, export deliveries would be a constraint on the discretion of DERA. Responsibility for meeting constraints carries risk, but also offers great opportunities. NHI would be inclined to accept that risk in the expectation of major rewards. Others will be more cautious. In any case, the ultimate solution is probably some sort of shared risk and shared discretion regime.

C. A Specific Proposal

The transition to a new export regime that fully meets the criteria set forth at the beginning of the section will take considerable time and effort. In the interim, it should be possible to put into place a modified export regime that (1) promotes real-time water management; (2) promotes cooperation between environmental and water users; and (3) allows sharing of the benefits of changes in export infrastructure and rules. As an example, DERA might be granted the following tools to advance real-time management of export operations during Stage 1:

- Automatic rights to ½ the water pumped under the proposed Joint Point of Diversion, new South Delta facilities, and other new facilities or operational rules. This water could be stored in San Luis Reservoir or other storage site.

- The right to increase SWP and CVP export pumping above projected levels in order to build up credits or to pay off debts to the projects. This right extends to granting variances to the Export/Import ratio, provided that the variance is not vetoed by the SWRCB. This water is lowest priority water within the projects.

- Purchase of export water credits and storage rights. The environment will be allowed spend money on the purchase of export area storage rights or to purchase water from the export contractors.

- Access to San Luis storage. The default would be that environmental water would spill as San Luis fills. However, DERA could make arrangements with the projects to gain higher priority in storage.

- Access to additional storage. DERA would get rights to ½ of new south-of-Delta storage developed by CALFED and could acquire additional storage using environmental funds.

- The environment may use its credits at any time to limit export pumping, provided that the credits can be converted into real water for the affected project in a timely manner so that the projects are left whole.

- An account of incremental pumping costs will be maintained and the environment will be responsible for paying any net increases in costs.

- The environment could also use its credits to shift pumping between Tracy and Banks (e.g., it could drop Tracy, while increasing Banks, using its positive credits from Banks to pay off its debt to Tracy).

- The environment could only force the projects to reduce pumping to the extent that it had credits built up. However, voluntary arrangements would be possible.

Such an approach would allow for the acquisition of credits on the order of several hundred thousand acre-feet of water, enough for significant real-time operations within years. In the future, the environment might be able to acquire significantly larger amounts of storage. With 1 MAF or more of storage, the environment could significantly reduce project pumping during dry years.

V. ESTABLISHING PRIORITIES FOR ECOSYSTEM RESTORATION

The ecosystem restoration component of the Delta system is both the most complex and the most foundational in the sense that all other components depend upon its success. Developing, implementing, and refining an ecosystem plan through adaptive management will require consulting the best expertise that can be marshaled.

A. Criteria for Prioritizing and Selecting Stage 1 Restoration Actions

CALFED is currently working to develop a list of stage 1 restoration actions that will be implemented in the next 7 years. To ensure that projects are consistent with the ecosystem program goals and the adaptive management approach, all stage 1 restoration actions should be selected on the basis of pre-defined criteria. NHI suggests the following criteria.

Learning potential: Projects should be designed specifically to address critical knowledge gaps pertinent to broader application of restoration techniques.

Fungibility: The restoration program should invest in ecosystem assets (land, water) that can be exchanged as priorities evolve.

Reversibility/Conservation: Projects that prevent relatively irreversible changes to the landscape such as urbanization, fragmentation, exotic species invasions, or conversion to perennial crops should be prioritized.

Comparative Cost Effectiveness: Projects should yield the greatest benefits per unit of investment in achieving the restoration goals and objectives.

Restorability: Projects that truly restore or protect natural process, functions or character, or come close should be favored.

Feasibility/Ripeness: Projects that can be achieved in the near term without countervailing adverse consequences should be favored. Many worthwhile projects will involve small environmental impacts. The criteria is not avoidance of all such impacts but tangible net ecosystem benefits.

Sustainability: Projects that are self-sustaining should be preferred over those that require significant maintenance.

Leverage: Projects that have the potential to leverage an initial public investment into a larger effort for ecosystem benefits are desired.

Risk/Certainty: Projects with low risk or high certainty of success should be prioritized.

Based upon these criteria, NHI proposes the following sets of actions:

B. Removing Dams and Rewatering Rivers to Expand the Range of Anadromous Salmonids

Over 82% of the spawning and holding habitat of salmon and steelhead has been blocked by dams, and the remainder has been degraded by a series of human perturbations.[19] Expanding the range and available spawning habitat is the most promising strategy for recovering these endangered salmonids, but this will require removing dams and rewatering desiccated rivers. Dam removal has become feasible because there are a surprising number of dams that are no longer needed or useful for water supply or flood control purposes or that now have marginal economic value as hydro-power sources. Such dams can be removed without any significant impact on the local or regional economy.

Removal of such dams can have profound environmental benefits by restoring access to upstream habitat and by restoring the natural flow of water, sediment and nutrients along the stream continuum. These processes shape the aquatic ecosystems in numerous ways that are not yet fully understood.

1. Remove Dams and Barriers on Battle Creek

Removal of dams and fish passage barriers on Battle Creek is the single most important restoration action for assuring the survival of winter run and spring-run salmon. Winter-run spawners have been blocked by PG&E hydro dams and by barriers at the USFWS Coleman fish hatchery. The reduction of their range to a single reach of the Sacramento renders them very vulnerable to extinction in a catastrophic event. As long as winter run habitat is confined to one small segment of the Sacramento River, the operations of Shasta Dam, both for water supply and ecosystem restoration will be severely constrained. The Battle Creek working group has developed a promising and affordable plan to open up approximately 42 miles of river to anadromous salmonids and result in a ten fold increase in amount of winter-run spawning habitat by removing or re-operating several small, economically marginal hydropower dams.

The CALFED ERP merely calls for a study to evaluate the opportunities for removing barriers on Battle Creek. The August 5 Draft Preferred Program Alternative has a list of stage one ERP actions that does not include any actions on Battle Creek.[20] This omission must be rectified.

2. Rewater the Upper San Joaquin

Restoring the upper San Joaquin River is the single biggest restoration opportunity in the entire valley. We describe a couple of low conflict restoration scenarios for the San Joaquin

[19] Yoshiyama, et. al. 1996.

[20] Battle Creek was ostensibly omitted from the list because the USFWS is purportedly going to do something on Battle Creek. Isn't USFWS a CALFED agency? The USFWS has had decades to do something on Battle Creek but instead they have blocked migration of endangered salmonids with their own fish barrier while they have simultaneously imposed stiff regulations on other parties whose actions effect endangered salmonids.

River later in this chapter and describe the conjunctive use benefits of these scenarios in the water supply chapter.

3. Remove Englebright Dam on the Yuba River

Removal of Englebright Dam is another opportunity for expanding the range of spring run Chinook salmon, steelhead, and other native fish. Englebright does not currently serve any significant water supply function and thus removal would not diminish the water supply. Removal of the dam would result in less than $1 million dollars of foregone hydro-power revenues and would restore over 60 miles of spring-run Chinook and steelhead habitat. Removal of Englebright would also restore more natural sediment and flow regimes to the Yuba and lower Feather rivers. There may be an opportunity to utilize the Yuba Goldfields as a flood bypass and groundwater recharge area.

4. Removal of Nimbus Dam

Removal of Nimbus Dam would restore approximately 8 miles of salmon and steelhead spawning habitat without affecting water supply or flood control. This would approximately double the amount of spawning habitat on the American River. Power operations of Folsom Dam could be shifted from peaking load to base load operations or a new re-regulation dam could be built closer to Folsom Dam.

5. Rewater the Calaveras River

Salmon have historically spawned in the Calaveras River below New Hogan Reservoir, but reservoir operations combined with irrigation diversion have dewatered the river during the salmon migration period. Properly timed releases from New Hogan could simultaneously restore an annual salmon run and recharge the depleted regional aquifer. Water users currently dependent on diversions from the Calaveras could be augmented by water from New Melones or an isolated facility. Because the Calaveras is one of the few rivers that flows directly into the Delta, rewatering it could create unique biological benefits in the Delta. Numerous anomalous records of a winter run on the Calaveras during the nineteen seventies exist. Although these reports have been dismissed by knowledgeable biologists,[21] it is possible that water temperature conditions are suitable for winter run. The canyon reach below New Hogan is fed by cool spring water.[22] In the spirit of adaptive management, this issue should be investigated fully.

6. Rewater Cache Creek

Cache Creek is one of the few large Central Valley Rivers without a terminal reservoir and thus retains a relatively natural sediment and peak flow regime. Presently the entire summer and fall flow is diverted at the inflatable Capay dam. Increased releases below the dam could restore a continuous stream of water to the Delta allowing for the consistent annual migration

[21] Yoshiyama, et. al. 1996.
[22] Nick Villa, DFG biologist; personal communication 1997.

of salmon and steelhead into the upper reaches of Cache Creek. To be successful, such a plan would need to address barriers in the Cache settling Basin. Water released from Capay dam would recharge the regional aquifer and could be replaced with water from an expanded Tehama Colusa canal.

C. Acquire Floodways, Restore Floods and Floodplain Habitat

The ERP properly emphasizes the restoration of natural process associated with peak flows, flooding, and floodplain habitat. Life stages of many species of native fishes are dependent on inundated floodplain habitat. To emulate peak flow events, dams must be operated to release overbank flows rather than preventing them. This is a radical departure from conventional flood control operations. It would requires change in land use patterns in the floodplains and changes in operations by the Army Corps of Engineers, multiple dam operators, and a host of local reclamation districts. The optimal restoration program for the Central Valley watershed should not shy away from this important restoration strategy, but we should also not underestimate the magnitude of this task.

Because of the volume of water that would be required, restoring the natural frequency and extent of inundated floodplain will be impossible. Nevertheless, several actions can be taken to create floodplain habitat with moderate flow volumes or to optimize flooded habitat conditions when large flows occur. These include acquisition of floodway corridors, levee setbacks, modification of dam operations, and elimination of channel clearing and dredging practices.

1. Acquisition of floodway corridors

It will not be practical or feasible to release peak, over bank flows until or unless a floodway corridor is secured. On many tributaries, the frequency of overbank flows is limited not by the availability of water, but rather by Army Corps flood control regulations that specifically limit overbank flows to protect property or structures from inundation or damage. In most cases this will require acquisition of flood easements or fee title along the entire course of a stream

Development of floodway corridors would be beneficial not only for the ecosystem, but also for reducing flood damage, increasing carryover storage in existing reservoirs, and recreation. In section VI of this document, NHI describes how expansion of floodway corridors and reductions in flood reservoir storage can actually increase annual carryover storage at existing reservoirs.

2. Levee setbacks and Flood Bypasses

The CALFED objectives of Delta levee system integrity and ecological quality will be difficult to attain unless upstream levees are setback and flood bypasses and basins are utilized. Simply planting trees and creating habitat on levees will not solve the problems levees create. Levees eliminate the ecologically important connectivity between the river and its floodplain. They also increase peak flood flows which causes erosion of the channel, thereby decreasing the complexity and diversity of channel habitat and fauna over time. The increase in peak flows to the Delta risks levee failure, necessitating expensive and ecologically destructive levee maintenance.

3. Modifying Dam Operations (without necessarily releasing more water)

Once floodways have been secured and levees have been set back where necessary, it will be possible to release ecologically beneficial flood flows. It will be economically infeasible[23] to approximate the duration (quantity) of peak flows, but it may be possible to mimic the frequency, timing, and magnitude of peak flow events without increasing the total amount of water released. Dams are currently operated to prevent over bank flows. To control for floods, a dam may release bankful discharges for weeks. If flood easements were acquired along the floodplain, the alternative would be to release overbank flows for a shorter period of time. Another way to increase peak flows without increasing total flows is to meet Delta water quality standards with peak flow release from one tributary rather than with moderate flows from multiple upstream tributaries. For example, the San Joaquin River and its tributaries could be managed to maximize annual peak flows on each tributary without exceeding the out flow standards at Vernalis.

4. Elimination of channel clearing and dredging practices

If left alone and provided an adequate flow regime, most rivers would restore themselves rather quickly. Unfortunately, most degraded rivers in the Central valley have been repeatedly disturbed by flood control activities designed to improve channel conveyance. Channel conveyance improvements generally entail eliminating the complexity of channel habitat features such as vegetation, bars, woody debris, and meanders. More complex channels support a greater diversity of habitat and bio-diversity. "Improved channels" convey water better, but support less habitats and species. Over time, flows, particularly flood flows will reshape "improved channels" into more complex natural channels. CALFED and other restoration managers could save both time and expense by halting chronic disturbance associated with flood control activities and allowing stream channels to restore themselves instead of making large investments in riparian plantings and habitat construction.

D. Controlling Exotic Species

A single invasive species can undo millions of dollars of restoration efforts. The estuarine ecosystem is changing profoundly and rapidly in response to new invasions. A restoration program for the Delta cannot succeed unless these invasions are stopped.

Ballast water is a major source of invading exotic species, but other sources need to be addressed as well: unauthorized deliberate introductions (e.g., northern pike, white bass),

[23] The natural dominant discharge, or channel forming flow, on most rivers in the watershed exceeds 10,000 c.f.s. or 20,000 acre feet per day. At $100 an acre foot, a 3 day peak flows, not including ramping flows, would cost $2,000,000 for a single tributary every 1 to 2 years.

releases from bait buckets, releases from aquaria, and releases from aquaculture operations. The latter three are related to commercial industries in California that are not currently held responsible for the ecological costs that escaping organisms can cause. Better education and better controls are needed. In addition to the actions suggested in the CALFED ERP, we suggest:

- Introductions by ballast water should be halted by adopting state and federal regulations as rigorous as those that apply to the discharge of ballast water in the Great Lakes. The shipping industry needs to be forced to take responsibility for solving this problem; voluntary efforts have not worked.

- An Exotic Species Emergency Response Team should be formed, with authorization, training, and funds to treat outbreaks of new, potentially harmful species. Perhaps it could be connected to the oil spill emergency response team.

E. A special program to restore flow and habitat on the San Joaquin River

A fundamental limit to doubling natural production of anadromous fish is the virtual dewatering of the mainstem San Joaquin River by the diversion of 95% of the flow at Friant Dam. The San Joaquin River below Friant dam once supported very large runs of chinook salmon. But, the dewatering of the San Joaquin in the 1940's and 50's extirpated spring and fall runs of chinook salmon, steelhead, and other native fish from the San Joaquin river upstream of the Merced. It also caused the loss or degradation of thousands of acres of riparian forest and wetlands between Friant Dam and the Merced River including the remarkable *natural* wetlands of the San Luis National Wildlife Refuge complex and the Grasslands Ecological Reserve. Today, in dry and average hydrologic years, no water from the upper San Joaquin reaches the Delta.

The decision to sacrifice the San Joaquin River to irrigated agriculture has been marked by over five decades of acrimony and litigation. In July 1998, a three judge panel of the federal 9th District Court of Appeals ruled unanimously that the decision to dewater the San Joaquin River at Friant Dam should be revisited to comply with the Endangered Species Act and the State Fish and Game Code. The latter requires dams—even federally operated dams—to release sufficient flows to maintain downstream fisheries.

A plan is described below to significantly improve mainstem San Joaquin flows *without loss of irrigation water*. This plan would also improve water quality in the lower San Joaquin and south Delta, improve water supply reliability, and potentially increase overall water supply yield. We also describe options for augmenting this plan with relatively small additional flows necessary for salmon restoration.

This plan would also improve water quality in the lower San Joaquin and south Delta, improve water supply reliability, and potentially increase overall water supply yield.

1. Hydrologic Background

Nearly all of the San Joaquin River is diverted at Friant Dam for use in the Friant water users service area. A small amount of water flows for approximately 35 miles below the dam to meet riparian water rights below Friant Dam. Further downstream, for a 20 mile reach between Gravelly Ford and Mendota Pool, the channel is totally dry except during the wettest years. At Mendota Pool, water is delivered from the Delta via Delta Mendota Canal to supply agricultural water users who once relied on San Joaquin River water before the river was diverted at Friant Dam. These farmers are known as exchange contractors because they gave water from the San Joaquin in exchange for water delivered from the Delta.

When Friant Dam was built and the San Joaquin diverted south to the Friant Service area, it was impossible to serve the Friant Service area with water diverted from the Delta. Today it is physically possible to deliver water to the southern Friant Service area via the cross valley canal. Below, we analyze several scenarios for rewatering the San Joaquin and directly or indirectly meeting Friant water user demands with deliveries from the California Aqueduct in exchange for increased flow releases from Friant Dam.

2. Replumbing the CVP for the Environment

This plan for rewatering the San Joaquin is based on the simple concept of supplying the San Joaquin river exchange contractors with San Joaquin water released from Friant Dam instead of Delta water diverted via the Delta-Mendota Canal. Friant Dam was built to divert San Joaquin River water upstream of the Friant service area, because there was then no way to connect it to the rest of the Central Valley Project (CVP) system. Today it is physically possible to deliver Delta water to that area via the California Aqueduct and the Cross Valley Canal. Instead of relying solely on Delta water via the Delta-Mendota Canal, the exchange contractors would rely, at least in part, on water released from Friant Dam. Some Delta water currently delivered to the exchange contractors would be redirected to the Friant water users in the Tulare Basin via the California Aqueduct. **Figure 15** is a map depicting how this replumbing scheme would work.

Once the water is conveyed to the Tulare Basin, it can be "delivered" to the Friant Service area customers in two ways: 1) directly via the existing or an expanded cross valley canal or via a new mid-valley canal; or 2) indirectly through an exchange with Kings or Kern River water users. The Cross Valley Canal delivers water from the California aqueduct across the Tulare Basin to a point near the terminus of the Friant-Kern Canal in Kern County. Many areas supplied by the Friant-Kern Canal can thus also be supplied by the Cross Valley Canal. The Cross Valley Canal is limited in conveyance capacity, however, so it may have to be expanded or supplemented by a new mid-valley canal to significantly increase the amount of water moved across the valley.

The second way to deliver water across the valley is legally more complex but would require less infrastructure. The California Aqueduct traverses the west side of the Tulare Basin several feet above and adjacent to the bed of Tulare Lake. The lake bed is now irrigated with water from the Kings River. California aqueduct water could be "transferred" across the valley to the Friant Service area by using it to irrigate the Tulare Lake bed in exchange for redirecting an equal amount of Kings River water into the Friant-Kern Canal. Conveniently, the Kings River flows across the Friant-Kern Canal. A similar arrangement might also be accommodated by utilizing California Aqueduct water to irrigate the Buena Vista Lake Bed in exchange for redirecting an equal amount of Kern River water to the Friant service area.

In theory, rewatering the San Joaquin could be done by simply rerouting existing diversions without affecting any water rights or increasing diversions from the Delta. In reality, however, significant carriage losses, particularly to groundwater seepage at Gravelly Ford could be problematic. For years, the high losses of Gravelly Ford have been cited as an argument against rewatering the San Joaquin River. In an era of increased interest in conjunctive use of surface and groundwater resources, however, NHI views it as an opportunity rather than a liability. Water percolated at Gravelly Ford in wet and average hydrologic years could be pumped in dry years and delivered to the San Joaquin River exchange contractors in exchange for reduced deliveries from the Delta Mendota Canal. If additional conveyance infrastructure were developed, groundwater pumped from Gravelly Ford could be delivered to water users in the Tulare Basin including Friant Contractors. In chapter V-D2 on groundwater storage, we describe a plan for utilizing the high percolation rates and abundant aquifer space at Gravelly Ford as a groundwater storage opportunity.

Despite the carriage losses at Gravelly Ford, rewatering the San Joaquin and meeting a portion of exchange contractors' demands with Friant water would have significant ecological and water quality benefits. Flows below Gravelly Ford would restore riparian vegetation and aquatic habitats to a 20-mile stretch of river between Gravelly Ford and Mendota Pool. Higher quality water from Friant would improve water quality in the San Joaquin below Mendota Pool. If enough water (30 – 40 TAF) was released from Friant, a continuous stream of water would flow between Friant Dam and Sac Dam (below Mendota Pool). Depending on flows below Mendota Dam this may be enough to allow salmon passage to their spawning grounds below Friant in most years.

3. Restoring Salmon to the San Joaquin River

Studies have estimated that a minimum average annual release of approximately 200,000 acre feet from Friant Dam would be sufficient for restoring and maintaining a salmon run in the upper San Joaquin River between Gravelly Ford and Friant Dam[24]. 200,000 acre feet is approximately 12% of the average annual inflow into Millerton Reservoir (Friant Dam). The inflow into Millerton, however, is highly variable ranging from 360,000 acre feet in 1977 to as much as 4,640,000 acre feet in 1982.[25]

In the event that this plan to increase releases from Friant with an equal increase in Delta water deliveries to the Friant Service area via the California Aqueduct is not sufficient to restore and maintain runs of Chinook salmon, there are a number of opportunities for

[24] (Fry 1957, Cain 1997)
[25] (Friant water users Authority, 1988).

supplementing San Joaquin River flows with water transferred from other parts of the state. Several of those options are outlined below:

- Reduce diversions from the San Joaquin River in exchange for water transferred from a north Delta isolated facility

  In the event that the CALFED program results in selection of an isolated delta facility, it may be feasible to increase diversions from the Sacramento River at Hood by 200 – 300 TAF (5% of critical dry year Delta outflow and about 1.5% of average outflow) in

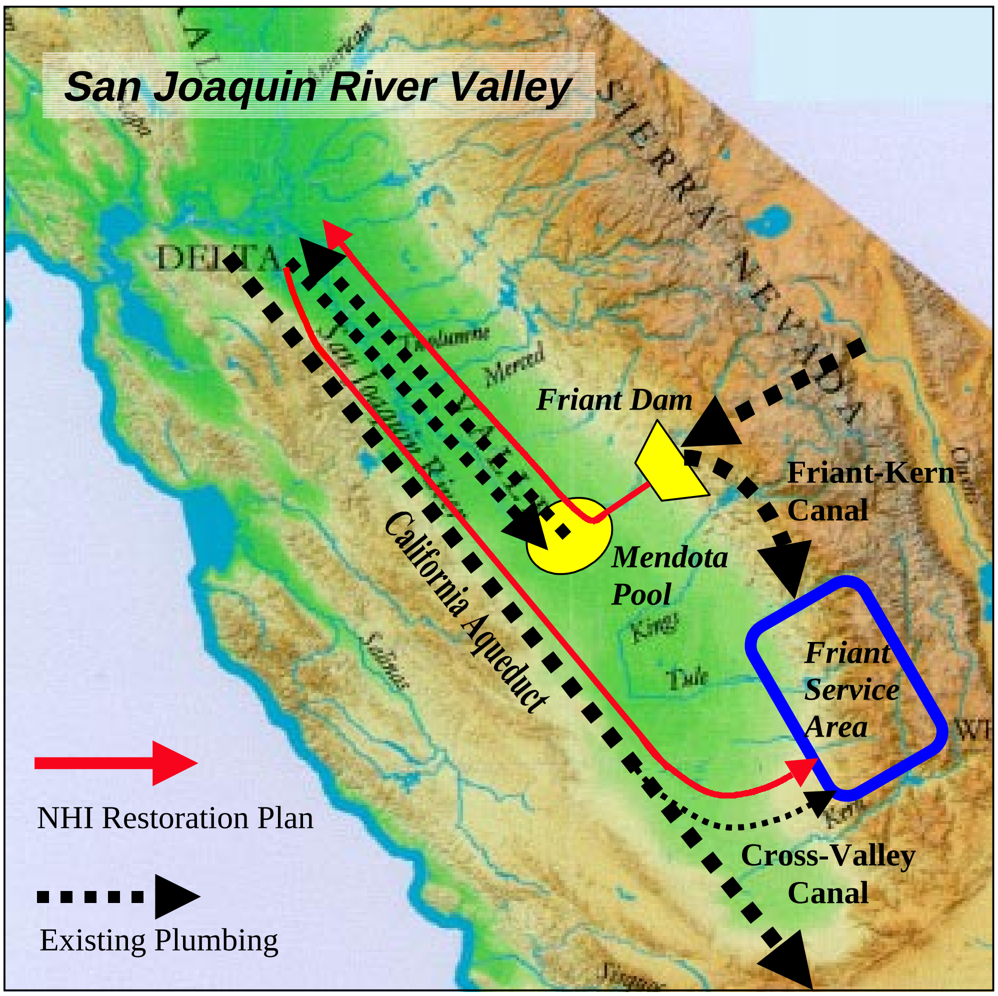


Figure 15: San Joaquin River Flow Restoration Plan

exchange for releasing 200 – 300 TAF from Friant Dam. Most of the increased releases would be allowed to flow down the San Joaquin and through the Golden Gate. Some portion (30 – 100 TAF) would be percolated into the groundwater at Gravelly Ford and stored for dry years.

This alternative would significantly increase the ratio of San Joaquin inflow to south Delta pumping, improving flow from the south Delta to the west Delta without significantly diminishing flow in the Sacramento from the north Delta to the west Delta. This alternative could be constrained so as to not increase Delta pumping.

- Retire agricultural lands with drainage problems and transfer water saved to the Friant Service Area

  Many lands on the west side of the San Joaquin Valley and Tulare Basin have drainage problems. Since Westlands currently drains into the San Joaquin River, retiring these lands would also improve water quality in the San Joaquin River. Water saved by retiring lands in the Westlands could be delivered to the Friant Service Area via the existing Cross Valley Canal or an expanded Cross Valley Canal. Water from the Westlands area could also be transferred to the Friant Service Area Drainage problem lands through an exchange for Kings River water currently used to irrigate the Tulare Lake bed.

  Drainage problem lands in the Tulare Basin are served by a combination of Kings River water and the California Aqueduct. Kings River water used to irrigate these lands could then be transferred into the Friant-Kern Canal in exchange for increased releases from Friant Dam.

- Purchase Water from the Friant Service Area and Sell it to Delta Exporters

  A fully functioning water market would allow properly endowed environmental managers to simply purchase water from the Friant water users, release it down the river, and sell it to Delta water exporters. At $100 an acre foot, the entire 200,000 acre feet necessary for Salmon restoration could be acquired for $20 million per year. This water would improve ecological and water quality conditions along the entire river.

- Reducing Water Diversions to the Friant Service Area

  The litigation brought by the Natural Resources Defense Council and other groups may result in the Friant Unit of the CVP releasing sufficient water to keep the downstream fishery healthy. That would obviously contribute to the rewatering of the River in a manner consistent with this plan.

VI. ACHIEVING WATER SUPPLY RELIABILITY WITH A NEW WATER MANAGEMENT PARADIGM

A. Integrating Markets, Conservation, and Groundwater Storage

Water conservation, conjunctive use, and water markets (transfers) are all components of an integrated water management strategy to increase the availability of water in drier years for all the benefit of all sectors, including the aquatic environment. It is a mistake to consider these components as discrete and unrelated, as the CALFED program has tended to do. The water supply problem today (for all sectors) is not that there is not enough water, but that there is not enough water during extended dry periods. If more water can be conserved and more runoff can be captured during wetter periods for use in drier periods without additional dams, all interests would be served, including the environment. While the natural hydrologic variability in the Central Valley water system produced the very species diversity that we now price and are at pains to rescue, the fact is that the natural flow patterns and volumes have now been so fundamentally altered that the biota have lost their resilience to extended periods of drought, as the ecological emergencies that attended the last such episode attest. Today, environmental water storage is a necessary part of an ecosystem restoration scenario.

Dry year supplies are inadequate to meet existing demands because the system fails to capture flood releases and store them underground for dry year use, and because surface supplies are lost to deep percolation and transpiration by low value crops during these dry years. Considerable empirical research shows clearly that water is routinely applied in excess of root moisture requirements in California agriculture because it is not economically worthwhile to invest in more water conserving technologies and techniques at the current prices that farmers and districts pay for water. While excess application of irrigation water is not a problem in most areas during wetter years, it cannot be justified in times of surface water scarcity. This same research also shows that the best way to make larger investments in water conservation techniques and technologies worthwhile is to increase the value of water in agriculture—in all years (without necessarily increasing its cost to agriculture). If water is worth more in the market than a farmer pays for it, he has a larger incentive to use it sparingly. There is not much market incentive in wetter years because the market price of water is low. If, however, a farmer could salvage water in wetter years for sale in drier years, much larger market incentives would be created. This can be done if the saved water can be stored in groundwater basins.

That is the meaning of conjunctive use. In simplified form, this illustrates a system in which water conservation, transfers and conjunctive use work synergistically to provide water management benefits far larger than accrue otherwise. Collateral benefits would include retirement of economically marginal agricultural lands (e.g., the drainage impacted lands), less reliance by agriculture on exogenous storage services (e.g., the federal and state projects), much reduced dry year water deficiencies in agriculture as well as the environment, a shift of water from lower value to higher value crops while keeping profitability of California agriculture constant or better, and less pressure for new surface storage facilities. This is clearly a much better future than yet envisioned by the CALFED draft plans.

1. A Conceptual Model for Achieving Water Supply Reliability

Figure 16 and Figure 17 depict a conceptual model for achieving the goal of water supply reliability through an integrated program of transfers, water use efficiency, and conjunctive use. Figure 16 and Figure 17 were developed from a hypothetical modeling exercise[26] that assumes a base demand, annual fluctuating surface supply, and variable levels of future demand, transfers, and groundwater storage. The model predicts shortages under various management regimes. Figure 16 predicts shortages and groundwater overdraft with an assumed surface water supply and no transfers, demand reduction, or groundwater banking. Figure 16 predicts relatively little shortages with a moderate demand reduction, transfers, and a groundwater banking program.

This conceptual model improves basin wide efficiency as well as on farm efficiency, because it lowers demand by all water users in dry years irregardless of percolation to the aquifer in wet and normal years. Skeptics of water conservation programs have argued that on farm efficiency improvements often do not translate into basin wide efficiency improvements because water applied inefficiently on the farm is not lost, but rather percolated to the aquifer where it is used at a later date. Although NHI agrees that this criticism applies in wet and normal years, it does not apply in dry years when shortages and water supply reliability is most problematic. We argue that the environmental and economic costs of allowing farmers to over apply and percolate surface water during dry years when surface supplies are in short supply cannot be justified. By lowering demand for water in dry years, on farm efficiency improvements significantly improve reliability by reducing shortages in dry years when they are most likely to occur. But efficiency incentives must apply in years of abundance as well as years of scarcity to induce the type of investments in conservation technology and techniques that pay off only over several years. The ability to carryover water saved in wetter years for sale in drier years when the price is higher creates these interannual incentives. Reducing applied water in dry years, through more efficient technology and conveyance systems, does not prelude recharging the aquifer in wet and normal years through intensive or extensive groundwater recharge programs. To the contrary, this model proposes a concerted groundwater banking in wet and normal years that has the advantage of not wasting scarce surface water to percolation in dry years.

[26] The model assumes a base demand of 1,000 units that increases at approximately 1% per year, and an annual surface water supply that fluctuates between 700 and 1,200 units per year. Figure 17 assumes a demand reduction of 5% of base demand, a transfer market of 5% of base demand, and a maximal groundwater banking program where conserved water and surplus transferred water is banked during wet and normal years for use during dry years. Transferred water is used directly in dry years.

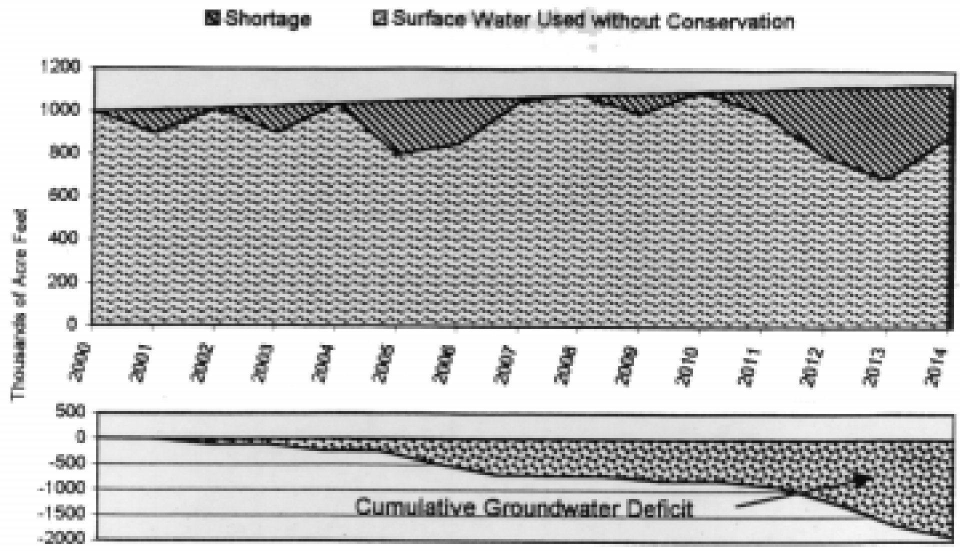


Figure 16: Hypothetical Reliable Yield and Groundwater Deficit without Conservation and Groundwater Banking of Conserved and Transferred Water.

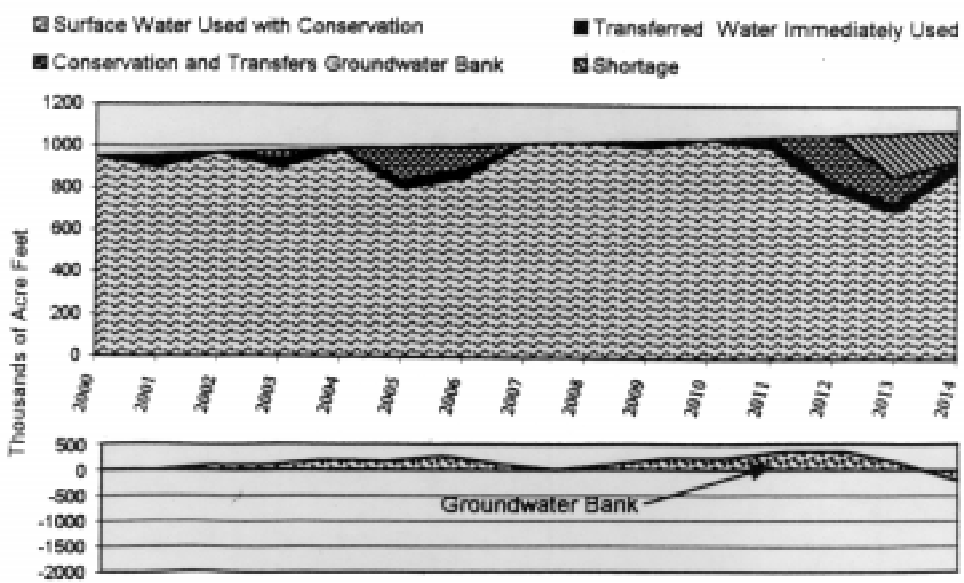


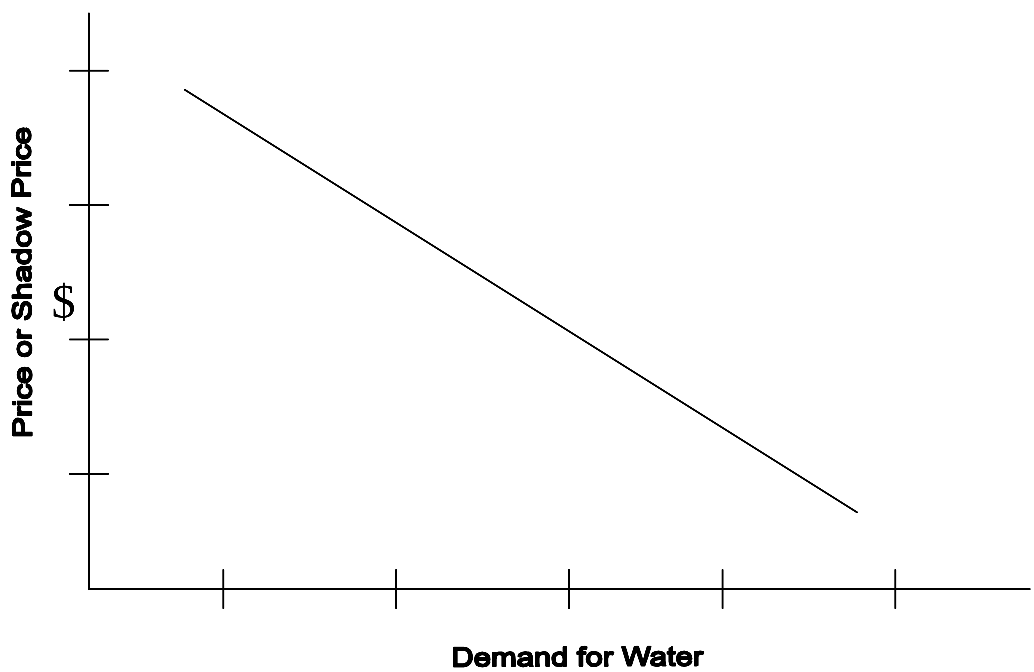
Figure 17: Hypothetical Reliable Yield and Groundwater Storage with Conservation and Groundwater Banking of Conserved and Transferred Water

B. The Central Role of Economics: Create financial incentives for water use efficiency improvements in agriculture

1. A Conceptual Model for Improving Water Use Efficiency.

Figure 18, the supply and demand curve is a depiction of a conceptual model for addressing the CALFED objective of "reducing the mismatch" between water supply and demand. Economics; not regulation, BMP's, land retirement, or new reservoirs will be the engine that drives water-use efficiency improvements eventually balancing supply and demand, without reducing overall profitability in the urban and agricultural sectors. In our vision, an active water transfers market will increase the shadow price (not necessarily the price) of water allowing a gradual reallocation of water to higher value uses such as more profitable crops. Despite our well-documented conclusion that water transfers are the best (probably the only) methods to achieve CALFED's water use efficiency and water supply reliability objectives, NHI recognizes that there are many legal and institutional obstacles to a well-functioning water transfer market. Below we address these obstacles and outline strategies for surmounting them.

Figure 18: A conceptual model for improving water use efficiency.



2. Defining Water Use Efficiency

Water use efficiency is typically defined as reducing water applied to produce a given crop output. We adopt an alternative formulation, namely maximizing the value produced with a given amount of water. Of course, these definitions are not inconsistent, but are rather inverses of each other. Our Challenge Grant work with the University of California has demonstrated that the latter definition has more resonance within agriculture, while producing an identical result.

Our Challenge Grant research has demonstrated that farmers respond vigorously to changes in water price but that the actual response is often dependent on a complex combination of environmental and economic factors. Farmers have several potential responses to changes in water price: fallowing, technology adoption, crop shifiting and more intensive management. Generally, fallowing and other management decisions that do not require significant up-fron outlays are adopted in the short-run. Crop shifting and irrigation technology investment are longer-term responses.

Financial incentives are likely to outperform best management practice (BMP) regulations.

Furthermore, our research indicates that irrigation system investments are conditioned by a number of individual and environmental conditions beyond the control of regulators such as soil quality and weather conditions. As a result, financial incentives are likely to outperform best management practice (BMP) regulations that dictate on-farm water management practices. Individual farm investments are most often tailored to specific circumstances about which regulators may not have complete information, whereas BMPs often have a one size fits all character that is inimical to the goal of conservation.

3. Water trading within districts

Water trading among growers serves many of the same functions as increasing the price paid to the district. Water trading can increase the marginal price of water; significantly, it also avoids the revenue neutrality requirements that hamstring most district-implemented conservation measures such as tiered pricing and buybacks. There are three basic conclusions of the Challenge Grant work on trading within Westlands Water District: 1) there is extensive participation in the internal market, 2) the water market helps growers cope with surface supply fluctuations and 3) water trading has especially important benefits to small landowners. Detailed analysis of the data and its design implications is provided in the Challenge Grant's annual reports.

4. Volumetric Pricing

In the spring of 1995, Arvin Edison Water Storage District (AEWSD) altered its rate structure from contracted water allotments to use-based allocation. Historically each grower had been contracted a given allotment of water per acre. If growers needed more they would either pump ground water or purchase additional water from the AEWSD, if it was available.

With the change in the rate structure growers are no longer limited to a specific quantity of water and the variable portion of the charge has been increased to discourage excessive water use. One of the specific goals of this policy change was to target some water uses that the AEWSD thought were wasteful, especially pre-irrigation and other year end irrigation activities.

The problem was that when growers had water left over at the end of the year under the water contract rate structure they would typically use it on low value cover crops, such as hay, or use it for pre-irrigation. This typically was not an efficient use of water, but the grower perceived the water as already being paid for since it was specified in the contract. These changes have removed the perception that the water is already paid for and increased year-end flexibility.

To date, the data look promising; for example, there was a 1,200-acre reduction in hay and a 900-acre reduction in small grains, both of which tend to be low-value cover crops. There was also an 800-acre increase in potatoes, a 400-acre increase in onions and a 500-acre increase in miscellaneous truck crops, all of which are considered medium- to high-value crops. The end result of the change in the rate structure is a slight increase in water use per acre (which is achieved with a reduction in the total number of acres farmed and a reduction in potentially uneconomic practices such as pre-irrigation and double-cropping), and a dramatic increase in the value per acre-foot of water applied.

C. Remove institutional barriers to water markets

1. Current Impediments to Transfers in California

The state's limited water supply is, for all intents and purposes, fully appropriated, and yet there are substantial unmet needs in all sectors in drier years. While these needs are fixed in the environmental and agricultural sectors, they are growing exponentially in the urban sector. A well-functioning water market has the unique potential to reallocate these scarce supplies to maximize their social value in a manner that is efficient and acceptable to the current rights holders. Yet, California is a state where transfers are more debated than consummated.

Transfers are more difficult in California than in other jurisdictions due to a number of rather unique circumstances:

- The developed water system in California is dominated by the two large public projects, the federal Central Valley Project (CVP) and the State Water Project (SWP); the water stored by these projects is distributed largely though local water district contractors;

- Surface applications of this project water constitutes the largest source of groundwater recharge in many parts of the project service areas and, in California, this groundwater comprises a larger fraction of irrigator supply than in any other western reclamation state;

- Water transfers often require approval at three levels: the local district, the Bureau of Reclamation or the Department of Water Resources, and the State Water Resources Control Board.

Thus, water transfers are subject to many checkpoints, rules, criteria and inertial influences. Successful transfers across district boundaries are rare; multi-year transfers even rarer.[27] Recent efforts to reform the state laws governing the market transfer of water have foundered by attempting a comprehensive set of reforms, suggesting that incremental progress may be the prudent course. Yet, some rather fundamental issues are presented if water transfers are to achieve their full potential as a mechanism for expanding the beneficial use and reallocating the limited supply of water. In the California context, it is difficult to view state water law in isolation from the federal water storage and distribution system, the Central Valley Project. Indeed, federal reclamation law and the incentives that drive local and private initiatives are as important as state law in devising an optimal water transfer system.

Ideally, proposals to reform state water transfer laws should be derived from a comprehensive analysis of the critical constraints and disincentives, viewed from the vantage point of the actors at the critical decisional nodes: those who own or control the already allocated supply, those who want access to that supply, those who are at risk when water rights are transferred, and those in the approval loop. Proceeding from such a global vantage point, it is easier to discern where the state rules need to be tuned up to make a comprehensive approach work. It is also easier to see where the federal rules are the critical constraint, and where the voluntary initiatives may need to be fostered. These insights would permit the proposed state law reforms to include incentives for private initiative in furtherance of transfers; it would also provide a source of advice to the U.S. Congress and the partisans in the current debate over reforms to reclamation law regarding how the federal transfer rules could be fashioned to produce an optimal state-federal transfer framework.

It is from this vantage point that this paper addresses some of the more fundamental issues that must eventually be confronted in developing a framework for widespread water transfers in California. The first two have been utterly neglected by previous water transfer reform proposals at both the state and federal levels.

2. Key reforms necessary to facilitate water transfers

a. creating incentives for water and irrigation districts to facilitate water transfers

A key to voluntary water transfers in a state like California, where local water districts are the central feature of the distribution system, is to encourage these districts to play a mediating and facilitative role. A fundamental impediment to progress in devising a water market framework has been the stalemate over whether a member of the district holds an

[27] For a more detailed explanation of the local, state, and federal regimes which govern market reallocations of water in California, see Brian E. Gray, *The Modern Era in California Water Law*, 45 Hastings L. J. 249 (1994). For a more detailed explanation of the institutional barriers which have historically inhibited a more prolific California water market, see Barton H. Thompson, Jr., Institutional Perspectives on Water Policy and Markets, 81 Calif. L. Rev. 673 (1993).

individual water right unencumbered by any collective rights. This has led to endless and ultimately unproductive debates over the extent to which members of water districts enjoy a transferable interest in the water allotted to them and the extent to which other members, or the district itself, can or should be able to constrain or veto member initiated transfers. Under current state law, district members have a legal right to transfer their allotment outside the district if it is surplus to the in-district needs. In the view of many district managers and members, however, water supplied by a district is like a common property resource in that any allotment not used by one district member reverts to the common pool and becomes available for other members to use.

NHI has proposed that incentives be provided to encourage districts to establish water buyback programs in which the districts would offer to purchase water back from its members at prices, in amounts, and at times that respond to offers to buy received from outside of the district. Any member's decision to release water back to its district would be wholly voluntary. Ideally, the offers to buy and sell would be posted on a state-wide electronic bulletin board which might be referred to as the California Water Exchange (CWE).[28] A software package for this has already been developed for NHI's water conservation project with water districts under a grant from the U.S. Bureau of Reclamation. Because all transfers of CVP water under the CVPIA require the approval of the Bureau of

[28] The CWE might be conferred the following structure and powers:

The CWE could be set up without authorizing legislation by simply creating a private, non-profit corporation. Its board of governance might include potential buyers and sellers of water (including environmental water purchasers), representatives of water districts such as the Association of California Water Agencies, and agencies that own or control the conveyance systems. It might be funded through modest service charges paid by parties to water transfers.

CWE would develop a computerized water transfer data base that will match potential buyers with potential sellers. It will be accessible by modem to permit computerized trading.

The CWE might enter into options with buyers and sellers to lock in prices and quantities of both offers to buy and offers to sell. It might also enter into options for conveyance capacity for water transfers and make this available to facilitate consummated deals on a cost-reimbursable basis. All these transactions would be subject to a modest surcharge to defray the CWE's operating costs.

CWE will facilitate transfers, but will not "occupy the field." That is to say, parties will deal with CWE on a voluntary basis only. Any buyer or seller would remain free to deal separately.

It may act as an escrow agent for transfers.

It may receive environmental mitigation payments provided by parties to a transfer. Such payments may make that transfer eligible for fast-track treatment by the State Water Resources Control Board (• State Board•), as described below. CWE would expend the mitigation funds as intended by the source or as instructed by the State Board. For instance, it might contribute the funds to the Central Valley Project Improvement Act (• CVPIA•) Restoration Fund, or use the funds to purchase instream flows pursuant to recommendations by the U.S. Fish and Wildlife Service or the California Department of Fish and Game.

If requested by the parties to a transaction (and if costs are defrayed by those parties), CWE may represent the transaction in the State Board• s approval process. If approval by the Bureau of Reclamation (• Bureau•) is required, it may also represent the parties in that proceeding. CWE would issue annual reports on transactions consummated and their economic effects.

CWE might also study and report on constraints and barriers to transfers and make recommendations on how to remove them.

Reclamation,[29] it would be highly desirable to have a centralized entity to deal with the Bureau for these approvals. In fact, routine approvals could also be conducted electronically. To assure that in-district needs would be met before water left the district, the buyback programs should include a right of first refusal exercisable by any district member at the bid price plus a pro rata share of the costs incurred by the district in administering the program[30]. The remaining buyback water would be available to satisfy purchase offers from outside of the district (i.e. from the CWE). Notably, all of this can be accomplished under existing law, including the buyback programs and the electronic bulletin board.[31]

The buyback water could be generated through any of the techniques that constitute "conserved water", including on-farm efficiency improvements, crop shifting or land fallowing. The district would also generate water for transfer (or use within the district) by reducing losses in its water delivery system (e.g., lining canals). Some of the buyback water would be purchased by other growers or agricultural districts and would remain in the agricultural economy. However, some buyback water would be purchased by municipal districts or for environmental purposes. With respect to this fraction, the only potential adverse effect on the local economy would be from reduced agricultural production as a result of fallowing land. Other means of generating buyback water would not reduce agricultural production.

All of this is theoretically achievable, but sufficient incentives for the districts to undertake this facilitative role are currently lacking. NHI has proposed that districts which develop buyback programs or other facilitative mechanisms that are approved by an appropriate regulatory body should be eligible for certain rewards or privileges. For instance, certain

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[29] See Central Valley Project Improvement Act ("CVPIA"), Pub. L. No. 102-575, section 3405(a)(1) and (2), 106 Stat. 4600 (1992).

[30] However, there is an issue whether the right of first refusal should not apply to environmental water transfers which confer a broad public benefit that should not be subject to pre-emption by water users interested in purchasing the same water.

[31] Recent additions to state and federal water transfer law seek to encourage an active water market, and many of the more important legislative reforms necessary to carry this forward have already been accomplished. See generally Gray, *The Modern Era in California Water Law,* supra at n. 1. CVPIA Section 3405(a) specifically encourages user-initiated transfers by significantly reducing the plenary power of CVP water agency contractors to block extrajurisdictional transfers. Moreover, Section 3405(a) provides for transfers to private nonprofit organizations such as the CWE for any purpose recognized as beneficial under applicable state law; and section 3405(a)(1)(F) gives project users a preemptive right of first refusal over all transfers of project water for uses outside the CVP service area.

Cal. Water Code Sections 109(a) and (b) declare it State policy to facilitate the voluntary transfer of water and water rights where consistent with the public welfare of the place of export and place of import, and direct all appropriate State agencies to provide technical assistance and identify conservation measures that will make additional water available. Section 481 requires DWR to create and maintain a list of entities seeking to enter into water transfer arrangements, as well as a list of the physical facilities which may be available to carry out water supply transfers. Section 382 authorizes local water agencies to sell, lease, exchange, or transfer water that is surplus to the needs of the agency• s users, and Sections 1810-1814 prohibit State and local agencies from denying a bona fide transferor of water the use of unused capacity in a water conveyance facility.

requirements of federal reclamation law might be regarded as satisfied in the case of approved programs.[32] Similar consideration should be given to benefits that might accrue under state law. Creating such an "enabling environment" for water transfers may ultimately prove to be more important for facilitating water transfers than legal reforms.

b. confronting the consumptive use limitation

California agriculture is heavily reliant on groundwater, which comprises some 40% of water for this sector.[33] This is more than in any other western state.[34] In the CVP service area south of the Delta, deep percolation from surface water allocation contributes more to groundwater recharge than does natural runoff.[35] CVPIA transfer rules confine transferable water to that fraction irretrievably lost to subsequent beneficial use[36] and thus render this incidental recharge water ineligible for transfer (except in areas where the groundwater is too saline for reuse, e.g., in the most severely-impacted of the drainage-problem areas on the westside of the San Joaquin River)[37]. There is also a state law presumption that only consumptive use is

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[32] As examples:

< Such programs would automatically satisfy the water conservation mandates of the CVPIA and the Reclamation Reform Act.

< Districts with approved programs would be entitled to have their determinations of "unreasonable impact" under Section 3405 (a) (1) (k) of the CVPIA treated either as conclusive, with substantial deference, or with a rebuttable presumption of correctness in the Bureau's approval process.

< Member of districts with approved plans would not have to pay the M & I surcharge that the Bureau otherwise exacts under the CVPIA when they exercise a right of first refusal (provided the restoration fund is otherwise made whole through, for instance, an excess profit recapture policy as described elsewhere in this article.

The degree of latitude and discretion accorded to the district in the transfer approval process should obviously depend upon how exacting the criteria are for approving district water transfer programs. If the criteria assure that the district will not use the "unreasonableness" determination to thwart transactions that are consistent with the intent of the CVPIA, districts with approved programs can be given broad latitude to manage and approve the transfer of water out of and into the district.

[33] Cal. Department of Water Resources ("DWR"), *California Water Plan Update,* Bulletin 160-93, Chpt. 4, p.79.

[34] United States Geological Survey, *National Water Summary 1987 - Water Supply and Use*, Table 19 (Summary by State of freshwater withdrawals by source and category of use).

[35] DWR, Bulletin 160-93, supra n.11, at Chpt. 4, p. 82.

[36] CVPIA section 3405(a)(1)(I).

[37] See *A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside of the San Joaquin Valley*, Final Report of the San Joaquin Valley Drainage Program, Sept. 1990 (a comprehensive study of agricultural drainage and drainage-related problems affecting the westside of the San Joaquin Valley).

subject to transfer.[38] Such rules to protect this fraction of irrigation water applications from transfer in effect confer upon the groundwater users a vested right to this recharge water. Yet, groundwater recharge is nowhere specified as an authorized purpose of the CVP or the SWP.[39] This consumptive use limitation implicates the fundamental issue of water transfer reform which has heretofore been given scant attention in the debate. Yet, it defies finesse.

The rule that transferable water is limited to the fraction consumptively used makes sense where the water originates within the same hydrologic basin in which it is used. Within a hydrologic unit, surface and groundwater are unitary. Water percolating into the groundwater can be recovered and applied once again to the surface. But in California the state and federal projects, which dominate the water supply system, are designed to move water out of "basins of origin" to service areas which are in hydrologically disconnected basins (e.g., from the Sacramento to the San Joaquin basin; from the San Joaquin basin to Kern County; and from the Trinity River basin to the Sacramento basin). Where the water is imported into CVP or SWP service areas, the consumptive use limitation arguably should not apply to the transfer of this water to other users within or outside of that service area.

The perverse effects of limiting transfers to water that does not return to beneficial use are twofold. First, this criterion places a large fraction of the developed water supply outside of the market. This is most unfortunate in that the primary advantage of the water markets is that it “unlocks” the water supply from the shackles of the prior appropriation doctrine which allocates water on the basis of sequential acquisition in contrast to its highest economic or social value. Second, this rule would often exclude from transfer the very water that is most easily salvaged without deleterious effects on existing uses: water liberated through efficiency improvements such as lining canals or improving water application techniques or technologies on the farm.[40] In short, the very strategies that have been the focus of most water conservation successes in the state give rise to water that may not be eligible for

[38] Cal. Water Code section 1725, which applies to temporary changes in the point of diversion, place of use, or purpose of use, requires that transfers for a period of one year or less involve only the amount of water that would have been consumptively used or stored in the absence of the proposed temporary change. The statute defines “consumptive use” as the amount of water consumed through use by evapotranspiration, underground percolation, or otherwise removed from use in the downstream water supply as a result of direct diversion. While no similar limitation applies to long-term transfers under Sections 1735 and 1736, these transfers are not subject to a CEQA exemption, and this in conjunction with application of the “no injury rule” (section 1702) has effectively limited transferable water in California to that consumptively used.

[39] A 1937 Act authorized the Central Valley Project under the Reclamation Act to be used • first, for river regulation, improvement of navigation, and flood control; second, for irrigation and domestic uses; and, third, for power. Section 2, 50 Stat. 850 (1937); see also CVPIA Section 3402 for a list of specific Act "purposes". See Cal. Water Code Section 10000 et. seq. for SWP authorizing legislation.

[40] The consumptive use limitation confines transfers to water that would otherwise be lost to evaporation, transpiration, or flows to saline sinks. The universe of conservation techniques that would generate transferable water is accordingly limited to land fallowing, crop substitution, or techniques to reduce evaporation, such as replacing sprinklers with drip irrigation systems.

transfer.[41] This limitation on transferability is a serious deterrent to water transfers in California.

The impetus for the consumptive use limitation is the intention to protect the sequential uses of return flow and deep percolation. Sequential "users" of excess irrigation applications also includes the environment. Wetlands and springs systems sometimes depend upon excessive irrigation applications.[42] Also, in some districts, such as Arvin Edison, surface water deliveries are intended to benefit the members who use groundwater as well, and these members pay for that recharge water.[43]

Protecting these uses while avoiding the rigidities associated with recognizing a universe of subsidiary water rights is the challenge. A partial solution may lie in distinguishing between the rights that can accrue to subsidiary users of native waters as opposed to imported waters, and to distinguish between secondary users who pay for this water and those who do not. The former distinction is already recognized in existing law, but needs to be reaffirmed and carried forward into water transfer law. The California rule appears to be that an importer of surface water does not relinquish control of the return flow; that is, the importer can recover the return flow irrespective of whether others are making use of it.[44]

The fundamental question is whether the return flow and deep percolation of imported water can also be salvaged for transfer in cases where the secondary users do not pay a share of the cost of importation. Stated another way, should water transfer policy recognize a distinction between the transferability of salvaged surface water depending on whether it is native or imported and, if imported, whether the secondary user pays part of the cost of importation? Under this distinction, where a local water agency or grower takes steps to reduce the deep percolation or return flow of imported water, that salvaged water would be transferable irrespective of the effect on "free-rider" secondary users. The transferability would depend only on a showing that surface water applications or conveyance losses were reduced through measures implemented by the transferor and that the source of the imported water is hydrologically disconnected from the groundwater basin.

NHI recommends that the law create a rebuttable presumption to that effect where the water is supplied by the state and federal water projects and where district members pay the district nothing for groundwater recharge. We would further recommend that all surface water

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[41] See discussion of this case at pp. 30-31, Thomas, "Conserving Aquatic Biodiversity: A Critical Comparison of Legal Tools for Augmenting Stream Flows in California", 15 *Stanford Environmental Law Journal* 3 (1996).

[42] DWR, Bulletin 160-93, supra n. 11, at Chpt. 8, pp. 221-222. See also, *A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside of the San Joaquin Valley*, Final Report, supra n. 15, p.21.

[43] Arvin-Edison Water Storage District, The Arvin-Edison Water Storage District Water Resources Management Program, May, 1993.

[44] See *City of San Fernando*, 14 Cal. 3d 199, 260-261 (1975).

applied in the area declared by the San Joaquin Valley Drainage Program to be a "drainage impacted area" enjoy a presumption that deep percolation does not return to usable groundwater, thus also allowing water efficiency improvements to generate transferable water.

Notably, this approach would not deprive "free-rider" groundwater users of the recharge water on which they have historically relied, but it would require them to pay for it in market transactions instead of receiving it as a free good. This change would benefit the growers and urban users who can afford to pay market rates for water; it would disadvantage farmers who rely exclusively on groundwater within the CVP service area. The net effect would be to make much more water available for transfer than under the Model Act (or the current regime) and therefore would significantly lower the price. This is a net social benefit, particularly when combined with the next policy proposal.

We hasten to add, however, that secondary environmental uses of imported water may have to be treated differently than secondary consumptive uses. Whereas it is reasonable to require profit-generating uses, such as farms, to pay for their secondary use of imported water (which they now receive for free), the same does not hold for the environment. Whatever incidental benefit aquatic environments may receive in the import area has usually been paid for at a high environmental cost in the export area.

c. protecting groundwater resources

Whether or not recharge water is made eligible for transfer, it is important that surface water transfers not be allowed to contribute to groundwater depletion. Where irrigators have access to both ground and surface water, substitution between them is automatic, routine and widespread.[45] To protect groundwater tables from additional depletion, liberalized surface water transfer rules must assure that out-of-basin surface water transfers do not result in groundwater substitution. This is particularly important if recharge water originating from the CVP and SWP is made eligible for transfer (as it should be). With this limitation, liberalized transfers would not contribute to net groundwater depletion.

Therefore, surface water transfers in areas of critical overdraft should not be permitted if the transferred surface water is replaced with groundwater, except in specified circumstances.[46] This principle should be broad enough to cover all overdrafted aquifers so that transfers do not exacerbate groundwater depletion. However, groundwater substitution must not be prohibited when it occurs within a conjunctive use program that is operated to ensure no long term net depletion of groundwater.

[45] Pers. comm. to Gregory A. Thomas, Westlands Water District staff.

[46] Section 208.

d. expediting approvals of transfers

Perhaps the greatest encumbrance on a functioning water market is the multiple approval checkpoints under California and federal reclamation law. These particularly bedevil the very types of transfers with the greatest potential to resolve the most serious water reallocation needs of the state, that is, long-term or permanent transfers across district boundaries for new uses. Often, these are subject to at least three approval processes: by the district of origin, by the State Water Resources Control Board and by the Bureau of Reclamation.[47] If water transfers are to fulfill their potential for improving the social benefits derivable from a limited water supply, water transfer reforms must include an expedited approval process for those categories of transfers that pose no appreciable potential for adverse impacts on other water users or the environment.

NHI suggests that the water code be amended to command the State Board to exercise its rulemaking authority to develop a fast-track approval process, under criteria codified by the statute.[48] The State Board would determine which categories of transfers are sufficiently innocuous from the standpoint of protected legal interests (including the environment) to be eligible for expedited approvals, including exemption from CEQA. NHI suggests that the statutory criteria confine expedited transfers to environmental water transfers under section 1707 of the Water Code and transfers that confer a net benefit on the aquatic environment. This could be accomplished through an environmental restoration or mitigation fee that would allow the net environmental benefits to be achieved through the operation of the water market. For instance, water might be purchased for areas with inadequate streamflows through an impact compensation fund, described more fully below.

The Board rules would also prescribe the "fast-track" approval process for those eligible categories of transfers. The Board will determine what type of hearing, if any, to conduct for

[47] CVPIA Section 3405(a) states that, • All transfers to Central Valley Project water authorized by this subsection shall be subject to review and approval by the Secretary under the conditions specified in this subsection. Transfers involving more than 20 percent of the Central Valley Project water subject to long-term contract within any contracting district or agency shall also be subject to review and approval by such district or agency under the conditions specified in this subsection:...•

Cal. Water Code Section 1727 requires that the State Board, upon receipt of notification of a proposed temporary change in point of diversion, place of use, or purpose of use, make an evaluation sufficient to determine that the proposed change would not injure any legal user of the water, and that it would not unreasonably affect fish, wildlife, or other instream beneficial uses. A similar requirement is mandated by Section 1736, upon petitions for long-term transfers. Notably, State law under Water Code Sections 1726 and 173 also requires that the Department of Fish and Game be notified of a proposed change for both temporary or long-term water transfers. This frequently will add yet a fourth layer of administrative review to the approval process.

[48] We assume that by conferring fast track approval authority, the Water Code would not change or enlarge the jurisdiction of the State Board over, for example, pre-1914 or (adjudicated) riparian water rights. However, transfers by such water rights holders may be authorized to avail themselves of the CEQA exemption if the proposed transaction otherwise satisfied fast track approval requirements.

these transfers, what kind of environmental documentation will be required, what the protest opportunities will be, and how to allocate burdens of proof.

e. third party economic impacts

It is clear the water that should move out of agriculture to meet other needs is the water that is being used least productively in that sector. Fully 20% of the water used in agriculture produces less than 5% of its profits.[49] This 20% would more than meet anticipated urban and environmental needs, such as the Delta inflow standards.[50] NHI's research shows that if this water is tapped, the economic costs of meeting the new Delta standards would be *an order of magnitude* less than if the water is taken *pro rata* out of existing agricultural uses. There are other areas where land retirement may be very desirable on environmental grounds, including the drainage impacted area on the west side of the San Joaquin and Delta agriculture. These low productivity crops are largely found in particular pockets in California. In short, uneven impacts on local agriculture are both a likely and desirable result of a functioning water market.

The problem with meeting unmet water needs is that the water is already tied up in a vested rights system. The solution is to encourage water to move from existing beneficiaries to new ones, not to create additional rigidities. Granting local economies something in the nature of a vested right to retain water now used there is the opposite of the direction we should go. Rather than freezing agricultural water use into its existing pattern, it would be far preferable to provide an impact compensation scheme.

NHI favors creating an impact compensation fund by "recapturing" the excess profits when and where they accrue in water transfers. Profits may be regarded as excessive when the differential between the cost of water (including the cost of conserving or salvaging it) to the seller and the sales price less the "transaction costs" exceeds the level necessary to motivate the transfer. This can be ascertained by analyzing the value of that same block of water in other applications. The potential for excessive profits in water transfers is substantial in light of the fact that water is appropriated without payment to its original owner (the people of the state), that it is delivered at often highly subsidized rates, and that there are large unmet needs for water within the state. If these excess profits were recaptured progressively (i.e., the percentage recaptured increases as the profit increases above a specified threshold), marginally profitable transfers would not be encumbered by a security assessment. Yet, the potential fund that could be created for impact mitigation and environmental restoration might be quite appreciable over time.

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[49] Sunding, Zilberman, Dinar & MacDougall, "The Costs of Reallocating Water from Agriculture", a research paper prepared under a cooperative agreement with the U.S. Environmental Protection Agency, July, 1994 at p. 6.

[50] The water supply impacts of the 1995 water quality control plan were estimated in the environmental impact report at approximately 400,000 acre feet as an annual average and up to 1.1 million acre feet in critically dry years. See analysis at Chapter VII of State Water Resources Control Board, Environmental Report, Appendix I to Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary, May 1995.

Environmental water transfers should not be subject to the profit recapture because this use of water does not lead to environmental impacts that need to be mitigated and is not revenue generating. The profits recaptured should be remitted to a non-governmental custodian to avoid the possibility of being diverted to the general fund by the legislature through its appropriation processes.

The impact mitigation fund should provide transitional aid with the objective of moving the effected people into more viable regions and sectors of the economy; it should not be used to create an artificial economy or long-term dependency in the area of impact. This is an important point because the anticipated effect of a more vigorous State-wide water market is that water will move from uses that provide lower economic value to uses that provide higher economic value. That means that areas now growing low value crops will either shift to higher value agriculture or go fallow. Either way, significant segments of the local agricutlure-dependent economy may get stranded. These effects will not be uniformly distributed throughout the Central Valley, but will tend to be concentrated in areas with highly marketable water. We think it would be a mistake to either arrest this process, which increases the aggregate benefits of water use in the State, or to respond by artifically maintaining economic activity that is no longer viable through subsidies. Rather, the impact assistance funds should be used for transitional assistance such as job retraining and relocating the affected families to locations where those skills are in demand.

f. transfers of water to instream uses

As with other transfers, it is important to assure that instream flow dedications will result in an increase in flows and not merely serve to alleviate the pre-existing instream flow obligations of other water users.[51] Without such a provision, the incentive to transfer water to instream flow is greatly reduced. Protection of voluntary dedications to instream flow would be greatly enhanced by establishing an "instream flow registry." This computer database would be established and maintained by the State Water Resources Control Board. It would track all voluntary dedications and regulatory reservations applicable to a given stream segment in a cumulative manner, unless the parties to a particular transfer agreement expressly state their intention to use the transferred water to satisfy pre-existing regulatory obligations. The registry would thus ensure that environmental water transfers are truly additive to flows otherwise required by regulatory actions. In addition, the registry would make all instream flow reservations and dedications transparent, so that all affected interests would know how much water is required to flow past particular diversion points and measuring stations at a given time.[52] The net effect of this arrangement will be to encourage voluntary water transfers to instream flow. A system to recapture excess profits generated in

[51] Thomas, "Conserving Aquatic Biodiversity: A Critical Comparison of Legal Tools for Augmenting Stream Flows in California", 15 *Stanford Environmental Law Journal* 3 at pp. 48-50 (1996).

[52] For the past three years, NHI has sponsored legislation to codify the instream flow registry concept, which has been co-sponsored by the Metropolitan Water District and the Association of California Water Agencies. This bill could serve as a template.

water transfers could finance purchases of instream flow dedications and, in this manner, provide an alternative to regulatory reallocations of water to meet environmental water needs.

D. Augmenting Water Supplies for all Sectors Through a Maximal-Scale, Central Valley Basin-Wide Groundwater Banking Program

Groundwater can be stored in the ground directly, through intentional percolation of surface water into the ground (either at special percolation facilities or through extra irrigation application) or through "in lieu" techniques (in which surface water is substituted for groundwater in areas which have historically relied either solely upon groundwater or on a combination of groundwater and surface water sources). It can involve the delivery of water during the summer, with later increased capture of flood flows by surface storage reservoirs, or the direct capture and storage of flood flows in the ground.

Groundwater banking is practiced throughout the Central Valley. However, with few exceptions, water in groundwater storage is not treated like surface storage, with specific user rights. Rather, it is treated as a community resource, available to all overlying landowners. As a result, the use of groundwater storage to provide benefits for areas remote from the storage site is relatively rare in the Central Valley. NHI proposes establishing arrangements with landowners and water users so that entities that store water at a site can secure it at a latter date when it is needed.

Groundwater development is a perfect fit with adaptive management and phasing because it can be pursued and improved incrementally. Unlike new surface water storage, groundwater banking does not require hundreds of millions of dollars in investment before any benefits accrue. To be sure, many groundwater banking opportunities require large capital outlays for recharge, pumping, and conveyance facilities; but many opportunities to enhance groundwater storage require nothing more than institutional initiative.

Groundwater development is a perfect fit with adaptive management and phasing because it can be pursued and improved incrementally.

The CALFED DEIR proposes increasing groundwater storage in the Central Valley by 750,000 acre feet. This storage is likely to produce average yields on the order of 100,000 – 200,000 acre-feet per year (groundwater yield is generally far lower than storage volume used because water is not put into or withdrawn from storage every year, and because deposit and withdrawal rates are frequently so low that it may take several years to fill and draw down a large storage account).

Considering the tremendous promise of groundwater banking, this is an unfortunately low target. To put it into perspective of the real groundwater storage opportunities, the total estimated fresh water with in the upper 1,000 feet of the greater Central Valley aquifer is 830 million acre feet, three orders of magnitude greater than CALFED's groundwater storage target. Table 1 shows the estimates of groundwater storage developed by CALFED's staff, but even this underestimates groundwater storage opportunities because it fails to consider several opportunities in the Tulare Basin and South of the Tehachapi Mountains.

Table 1: CALFED Estimates of Groundwater Storage.

North of Delta Storage	Potential Storage	South of Delta Storage	Potential Storage
Butte Basin	470 TAF	Folsom S. Canal (east S.J. county)	860 TAF
Cache Creek Fan (Cache-Putah)	450 TAF	Kern River Fan	930 TAF
Colusa County	320 TAF	Madera Ranch	350 TAF
Eastern Sutter County	470 TAF	Medota Pool (Westside)	900 TAF
Sacramento County	260 TAF	Mojave River	200 TAF
Stony Creek Fan	640 TAF	Semitropic WSD	1000 TAF
Sutter County	1180 TAF	Tuolumne/Merced Basin	1250 TAF
Thomes Creek Fan	220 TAF		
Yuba County	540 TAF		
Total North of Delta	**4,550 TAF**	**Total South of Delta**	**5,490 TAF**
TOTAL ESTIMATED GROUNDWATER STORAGE 10, 040 TAF			

The storage opportunities listed in table 1 compare favorably to the expected storage benefits from proposed new dams described in table 2. Considering that table 1 does not include many large groundwater storage opportunities in southern California, opportunities for groundwater storage exceed those for surface storage and with a fraction of the environmental and economic costs. According to a recent review of yield enhancement opportunities undertaken under the CVPIA[53] the cost of groundwater ranges from $60/af to $120/af of yield at source greatly below the $300-$2920/af source cost of new surface storage.

Table 2: Estimates of Storage from New and Enlarged Reservoirs

New Facilities	Storage (MAF)	Cost (AF yield)	Facility Enlargement	Storage (MAF)	Cost (AF yield)
Cottonwood	1.60	480	Shasta	1.40	430
Auburn	2.30	420	Folsom	1.34	1080
Marysville	1.05	1,240	Friant	1.40	2920
LosBanos Grandes	1.73	660	Pardee	0.36	1640
			Farmington	0.16	300
			Berryessa	1.3	610
Total New	**6.68 MAF**		**Total Enlargement**	**5.96 MAF**	
TOTAL RESERVOIR STORAGE 12.64 MAF					

[53] USDOI, USBR et al., 1995

Critics have dismissed the potential to increase water system yield with groundwater banking with the argument that it is impossible to develop the recharge capacity to capture a significant amount of unused flood flows. This argument is based on the erroneous assumption that the only way to increase system yield is to build large new conveyance and storage infrastructure that can capture surging flood flows. Such infrastructure would have to handle very large volumes of water in short periods of time and would be clearly unfeasible. NHI proposes a different, nonstructural method of increasing system yield that involves delivering water from surface reservoirs, directly or indirectly, to groundwater reservoirs in summer and fall (or through out the year) thereby freeing up space in existing reservoirs to capture a larger fraction of large flood flows when they do occur.

The majority of increased yield benefits accrue from the pre-delivery method rather than the direct diversion of water during flood periods.

1. A Conjunctive Use Program (CUP)

NHI conducted a study that examined two separate physical methods for converting "surplus" flows into yield:

- Direct diversion of water during periods of surplus flow. For example, during high winter flows, water could be diverted out of rivers and either delivered directly to percolation ponds or to short term storage sites for later percolation.

- Pre-delivery of water. In this method, water would be delivered for storage in the ground during the summer and fall. This water would either be directly transferred into the ground through percolation or injection wells or would be delivered indirectly, by being applied to farmland which would otherwise have relied upon groundwater pumping. This pre-delivery of water will cause reservoir levels to drop. Provided that the winter is wet and the reservoir spills in any case, then the reduced storage is recovered and yield is gained. If the winter is dry and reservoir levels drop below certain control levels, then the groundwater delivered is recovered and substituted for surface water demands, effectively boosting reservoir storage.

The majority of increased yield benefits accrue from the pre-delivery method rather than the direct diversion of water during flood periods.

To estimate the availability of water for conjunctive use, NHI developed the Conjunctive Use Potential model (CUP). Our preliminary investigations using CUP indicate that, given liberal assumptions about: 1) the existence of infrastructure; 2) the ability to reduce surface storage levels below current patterns; and 3) the availability of suitable land, the amount that could be captured through the pre-delivery of water is approximately 1.4 maf per year on average (Table 3).

Tributary	Projected Average Annual Yield (TAF)
American	**100**
Calaveras	**30**
Feather	**300**
Merced	**150**
Mokelumne	**80**
Sacramento	**360**
San Joaquin	**10**
Stanislaus	**140**
Tuolumne	**120**
Yuba	**140**
Total	**1430**

Table 3: Average Yield with CUP Model

This number probably overestimates the true amount of water that could be captured in this way. In reality, infrastructure to move the water from where it is available to where suitable storage sites exist does not always exist. Moreover, concerns over environmental protection, hydropower production or lake recreation will limit the degree to which reservoir storage levels can be manipulated.

Constraints on reservoir fluctuations resulting from the need to maintain thermal stratification were reanalyzed by revising the initial version of the CUP model. The minimum carryover and carryover target parameters in the revised version of CUP were established based on analysis of the physical juxtaposition of warm water in the Central Valley reservoirs and the release works on the impounding dams. When the carryover parameters are constrained accordingly, the total projected average annual yield decreases to approximately 900 TAF as depicted in Table 4. The estimate generated in this simulation reflects a limited capacity to tap water stored upstream of the major foothill reservoirs when the re-operated storage falls below the minimum carryover level. If this capacity is expanded to the maximum possible extent, the estimated average annual yield increases to nearly 1 maf. Both these estimates are based on conservative estimates of the storage needed to conserve sufficient cold water in the reservoirs.

As a point of comparison for evaluation of these estimates, a CH2MHill study that focussed on the direct capture of storm water for groundwater storage came up with an estimate of approximately 1 maf per year. Considering that at least some fraction of the projected yield in the CH2MHill study is additive to these results, the total theoretical potential for conjunctive use would appear to be in excess of estimates presented in Tables 3 and 4.

Tributary	Projected Averge Annual Yield (TAF)
American	**80.4**
Calaveras	**25.3**
Feather	**126.9**
Merced	**108.2**
Mokelumne	**69.3**
Sacramento	**196.8**
Stanislaus	**65.0**
Tuolumne	**77.9**
Yuba	**144.6**
Total	**894.4**

Table 4: Revised Average Yield with CUP Model

Table 4 assumes that infrastructure institutional flexibility exist to move water from where it is available to a suitable groundwater storage site. NHI is currently identifying feasible distribution networks as well as the specific rules governing the operation of these networks, and will this information to model the routing and ultimate recovery of this water for off-site and overlying correlative benefit and environmental enhancement.

Constraints imposed by infrastructure and institutional arrangements are significant, but since canals can be rerouted, new canals built, and contractual arrangements for resource transfer can be negotiated, these constraints need not be considered permanent limitations on the potential for groundwater banking in California.

2. Potential Groundwater Banking Sites

Figure 19 is a map of groundwater storage sites identified by both CALFED and NHI. Although extensive data collection and analysis have not yet been completed, our preliminary feasibility study has generated the following array of candidate sites to be examined further and rated for their relative compatibility with possible sources of surface water:[54]

- The Butte Basins Area: This area was chosen because of highly favorable hydrologic characteristics, and, because it is located upstream from many water service areas, its conjunctive use could offer multiple opportunities for downstream water users, both in terms of water deliveries foregone and water transfers made possible.
- Cache-Putah Aquifer[55]: Cache and Putah Creeks are significant west side tributaries that historicaly recharged much of Yolo County. The area is overdrafted, but unused aquifer

[54] Tocay Dudley of the DWR Central District has been directing studies of groundwater storage opportunities in Yuba, East Placer, Yolo, and Sacramento counties. These may be supplement the preliminary list outlined here.

[55] Jenkins. Mimi, September 1992, "Yolo County, California's Water Supply System: Conjunctive Use Without Management," M.S. Thesis, Department of Civil Engineering, University of California, Davis.

space could be used to bank new surface water brought into the area through extension of the Tehama-Colusa Canal. In exchange for such introduced water, the Yolo water users would continue to allow use of the Yolo County groundwater reservoir for the California Drought Water Bank--a valuable function it performed during the heart of the 1987-92 drought.

- East Stockton-Stanislaus River Area. Two associated groundwater basins in this area are overdrafted and the northernmost basin, which is used directly for water supply by the city of Stockton, is experiencing intrusion of brackish water from the Sacramento-San Joaquin Delta. This aquifer could be recharged with water from a completed Folsom South Canal, improved conjunctive use of New Don Pedro or New Hogan reservoirs, or even with surface water from an isolated facility. A consulting firm, Hydrologic Consultants, Inc., and local water districts[56] have looked at the structural modifications that would be needed to facilitate large-scale conjunctive use in this area.

- Westside San Joaquin. The intensive studies of the San Joaquin Valley Drainage Program (SJVDP)[57] recommended increased reliance on groundwater supplies in the region of agricultural drainage problems in order to lower shallow surface water tables--thereby precluding the generation of toxic drainage water. Groundwater pumped from deeper aquifers and water freed through retirement of selenium-contaminated lands were to be used in lieu of surface waters, which would be freed for agricultural or environmental purposes.

- Kern County. The earliest records of intentional recharge and its research are in Kern County.[58] The Kern Water Bank (KWB) is presently being developed to add operational flexibility and augment water supplies for the State Water Project (SWP). There are eight potential elements to the KWB; seven will be sponsored by local water districts and the eighth is DWR's Kern Fan Element (KFE). Initial studies indicate the KFE may store as much as 1.0 maf and contribute as much as 140,000 af per year to the SWP in drought years. The seven local elements together have the potential to provide over 2.0 maf of ground water storage and a capacity to store and extract approximately 370,000 af annually. The largest of the seven local elements is the Semitropic Local Element, with a groundwater storage capacity greater than 900,000 af and a proposed annual recharge capacity of approximately 114,000 af. Recent demonstration programs between DWR

[56] California Department of Water Resources, 1990, "Stanislaus and Calaveras Conjunctive Use Program," unpublished paper by Don Fisher, Senior Engineer, Sacrament, California.

[57]Gilliom, R.J., and others, 1989, "Preliminary Assessment of Sources, Distribution and Mobility of Selenium in the San Joaquin Valley, California": U.S. Geological Survey Water-Resources Investigations Report No.88-4186; San Joaquin Valley Drainage Program, September, 1990, A Management Plan For Agricultural and Subsurface Drainage and Related Problems on the Westside San Joaquin Valley": Sacramento, California.

[58]Artificial Recharge of Ground Water in the San Joaquin-Central Coastal Area. DWR San Joaquin District. May 1977. p16.

and MWD with the Semitropic Water Storage District have illustrated the opportunities available to exchange SWP water with this element.[59]

Other districts in Kern County that are not members of the KCWA have also adopted conjunctive use programs to stabilize their water supplies. The Arvin Edison Water Storage District has utilized its underlying ground water basin for storage during wet years. They are also developing a cooperative water banking project with MWD. Given the extent of inter-regional cooperative efforts, the developed infrastructure available to move water, favorable natural recharge areas, and the wealth of information accumulated on the ground water basin, the Kern County area is a strong candidate for participation in a state-wide conjunctive use scheme.

- Greater Los Angeles. There are currently over 70 recharge facilities being used to replenish groundwater basins in southern California.[60] Many are concentrated in the adjudicated basins in Orange County, Los Angeles County and adjacent areas. Metropolitan Water District (MWD) cooperates with a range of many of the local water districts in the operation of conjunctive use programs in which imported and reclaimed water supplies are used to replenish groundwater basins. In other cases water supplies are enhanced via in-lieu arrangements. MWD has quantified storage available in many of these basins.[61] Some are known to have substantial storage opportunities. The Raymond Basin, for example, has roughly 700,000 af of storage available.[62] Similarly, the Los Posas basin has roughly 300,000 af of operating storage.[63] In many of the greater Los Angeles region basins, an expanded conjunctive use program could operate by pre-delivering water to meet local needs as some of the MWD programs are already doing.

- Imperial Valley: Through exchange arrangements, the Imperial Valley can be readily tied to the rest of California. MWD's need for Delta water, via the California aqueduct, can be reduced by the amount of Colorado River water the Imperial Irrigation District can free for use Los Angeles, through reductions canal seepage financed by MWD. Investigations by private consultants[64] and a number of agencies using information developed by the USGS and the Imperial Irrigation District, suggest that ground water pumping might produce the double benefit of freeing up new water while lowering shallow ground water

[59]DWR Bulletin 160-93. California Water Plan Update: Volume 1. October 1994. pp 104, 292-295.

[60]The Metropolitan Water District of Southern California, Regional Urban Water Management Plan, Draft, April 25, 1995, p. 92.

[61]Presentation by Debra Mann at ACWA Conjunctive Use Mini-Conference, June 8, 1995

[62]Presentation by Don Evanson of Montgomery-Watson, ACWA conference, June 8, 1995.

[63]Wiley Horne, Deputy General Manager, MWD, presentation at ACWA mini-conference on Conjunctive Use, June 8, 1995.

[64]Salton Sea Authority, January, 1994, "Salton Sea Symposium," compiled by the Imperial Irrigation District, Imperial, CA 92251.

levels below agricultural drains to resolve a selenium load problem in those drains. Such a project could be financed with the proceeds of sales of Colorado River Water, for which groundwater had been substituted.

- Gravelly Ford/Madera Ranch. The aquifer underlying the Gravely Ford area of the San Joaquin River west of Mendota is an unutilized conjunctive use opportunity. Because of surface water diversions at Friant Dam, this area has experienced one of the largest groundwater declines in the entire Central Valley. Except during floods, the entire flow of the San Joaquin is diverted upstream of Gravelly Ford. As a result, a once navigable river has been transformed into a dry, desert wash preventing the migration of tens of thousands of Chinook salmon and obliterating all riparian forests along the river. In Chapter V, NHI has advanced a complementary proposal to restore flows to the San Joaquin and simultaneously recharge the aquifer underlying Gravelly Ford.

  The soil and aquifer along the channel at Gravelly Ford are characterized by very high infiltration and conductivity rates[65] that have been used as an argument against rewatering the channel. . Furthermore, the unutilized aquifer space beneath Gravelly Ford is the single largest cone of groundwater depression in the entire Central Valley (Figure 20 and 21). Although others have viewed the high percolation losses at Gravelly Ford as a problem justifying the dewatering of a major river, NHI views the percolation losses as an unparalleled opportunity for simultaneously increasing groundwater storage and restoring a riverine ecosystem

  One of the remarkable features of this groundwater recharge opportunity is that it could be implemented with no new conveyance infrastructure. Water necessary to recharge the aquifer underlying Gravelly Ford would come from increased releases at Friant Dam. Groundwater recharged in wet and normal years could be extracted by well fields paralleling the river course and delivered via the river channel to Mendota Pool where the San Joaquin River exchange contractors could utilize it.

  In 1980, DWR proposed a groundwater recharge facility at Gravelly Ford that would utilize water release from Friant Dam to recharge groundwater in wet periods for use in dry areas. The proposal called for developing canals from well fields near Gravelly Ford to Mendota Pool or the Tulare Basin for exchange with surface water users. A consortium of private interests is currently promoting a groundwater recharge facility at Madera Ranch some ten miles north of Gravelly Ford. This facility would rely on wet year releases from Friant Dam and a new two-way canal from Mendota Pool to recharge and exploit the groundwater resource.

[65] USGS Professional Paper 1401-D. Ground-Water Flow in the Central Valley, California: Regional Aquifer-System Analysis. 1989. Mark Reisner, per. com. April 1998.

3. Legal and Institutional Constraints to a Maximal Groundwater Banking Program

a. Institutional Analysis

The incentives to induce land owners and water users to participate in a groundwater bank would be as follows: Landowners overlying the recharge site would agree to store and retrieve the water as orchestrated by the program in exchange for a portion of the "new water" or for a cash payment. The water is regarded as "new water" if it would otherwise have been released for flood control purposes, was imported to the basin, or accrued through investment in irrigation efficiency. If the landowners are members of a CVP or SWP contracting district, the water would be treated as a predelivery of next season's irrigation entitlement.

Well monitoring may be necessary in selected areas to prevent increased pumping by overlying and adjacent landowners in storage areas, who could be tempted to irrigate new lands, avoid higher surface water costs, and/or to compensate for unrelated market transfers of surface water rights. Opportunities may exist to incorporate these schemes as a part of AB 3030 groundwater management plans for districts throughout the state, helping satisfy CVPIA requirements as well for CVP contractors.

Urban water supply agencies would be invited to participate in the arrangement under agreements that would give them the option to purchase a specified amount of the "new water" in drier years. The funds would be used to defray the costs of the program, which are expected to be mostly the costs of electricity costs for pumping the stored water. These would be minimized by selecting for storage those groundwater basins that already have a relatively high water table.

A preliminary analysis of California groundwater law has been conducted to explore how a conjunctive use program could be set up so that the rights to the "program water" stored in groundwater basins would be protected against other claimants. This research discloses certain implications for the design of a conjunctive use program that are summarized below.

4. Design Implications for Maximal Conjunctive Use Program

The “Feasibility Study of a Maximal Conjunctive Water Use Program for California” investigate two program designs: conjunctive use through import and active recharge and conjunctive use through in-lieu storage. These two designs are predicated on different legal entitlements to extract and use the stored groundwater. Both designs would tap flood control releases that otherwise escape beneficial use. Thereafter the program designs diverge.

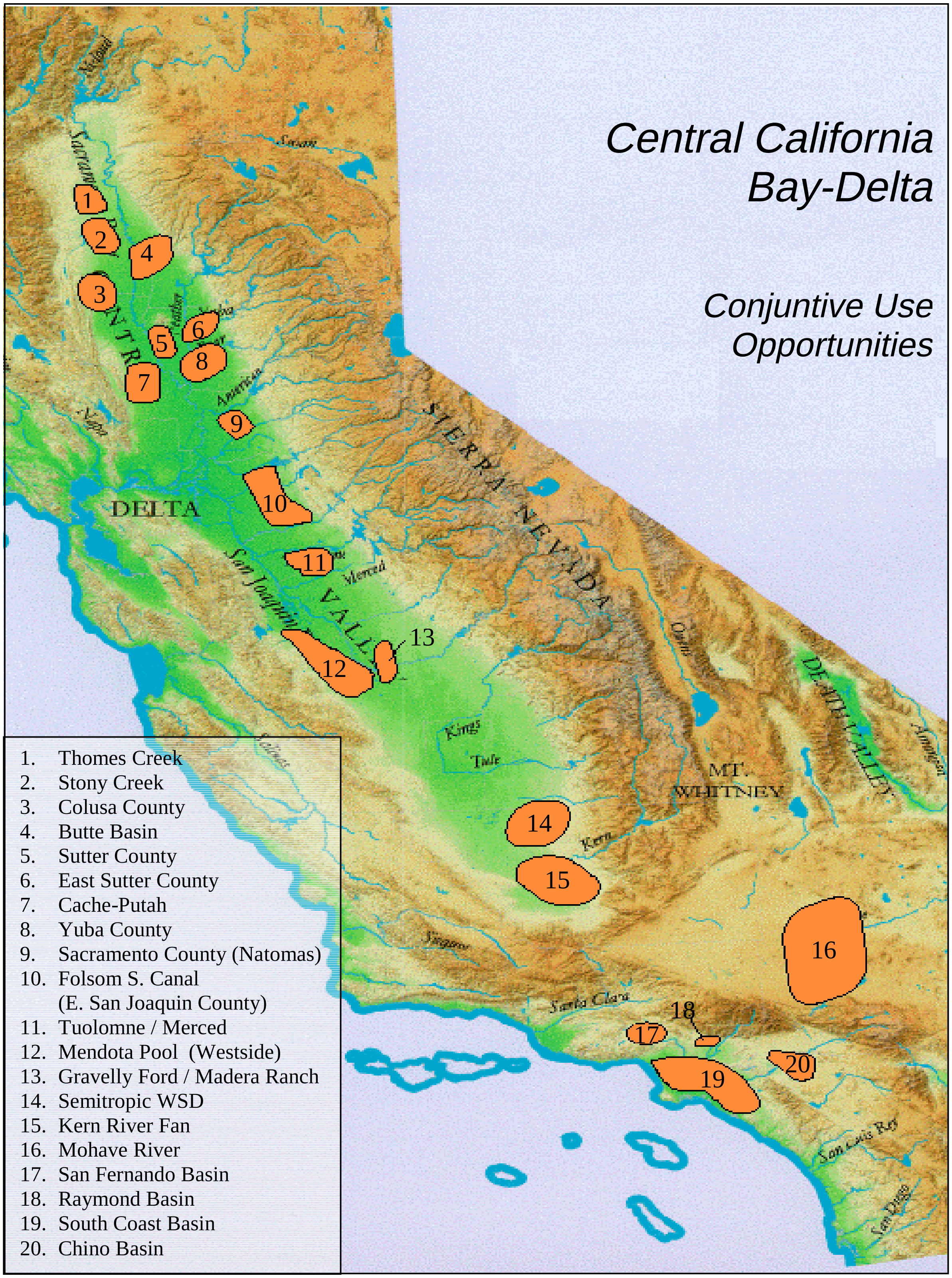

Figure 19: Map of Conjunctive Use Opportunities

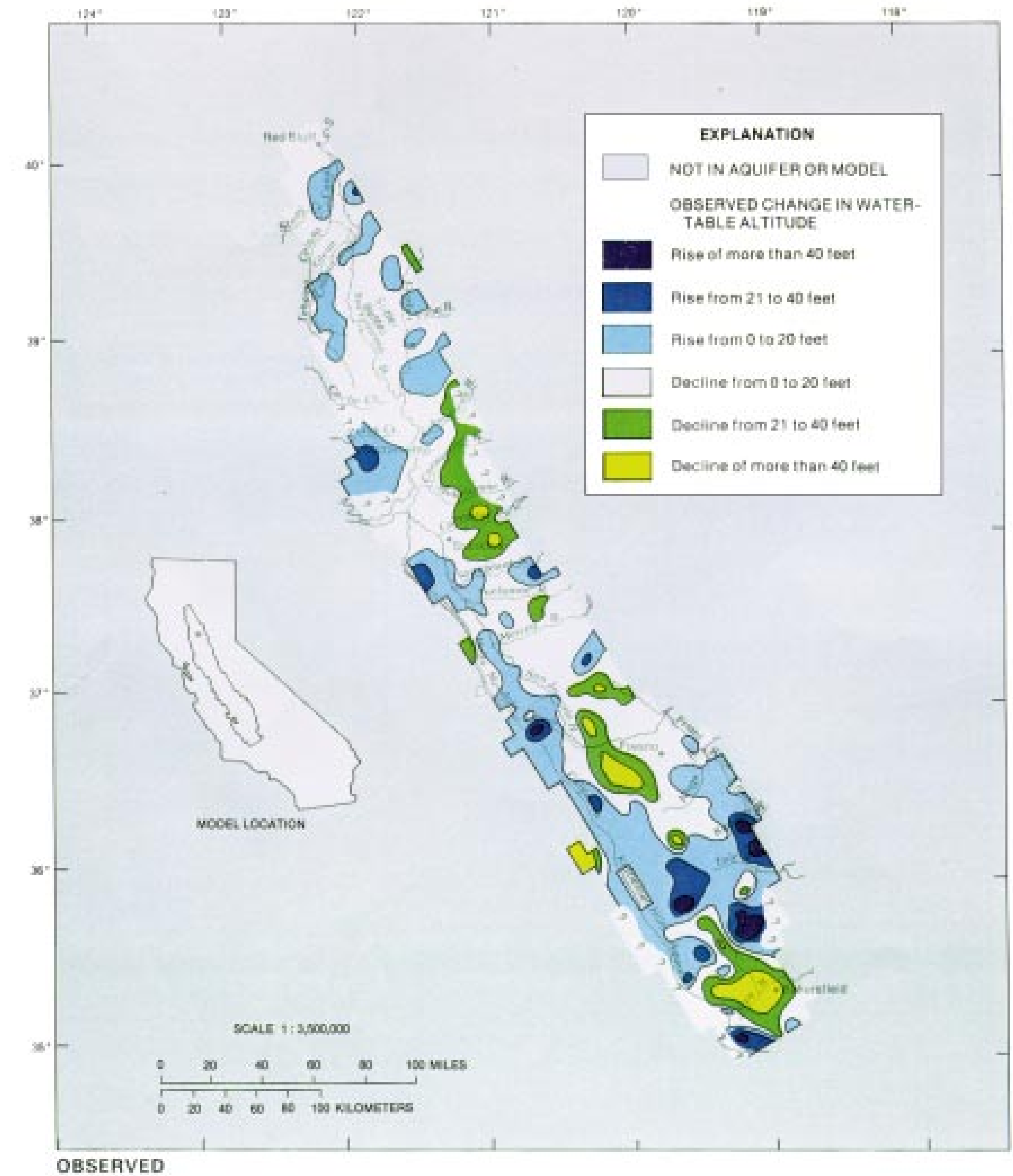

Figure 20: Observed Change in Water-Table Altitude, Spring 1961 to Spring 1976 (source: USGS Professional Paper 1401-D, 1989)

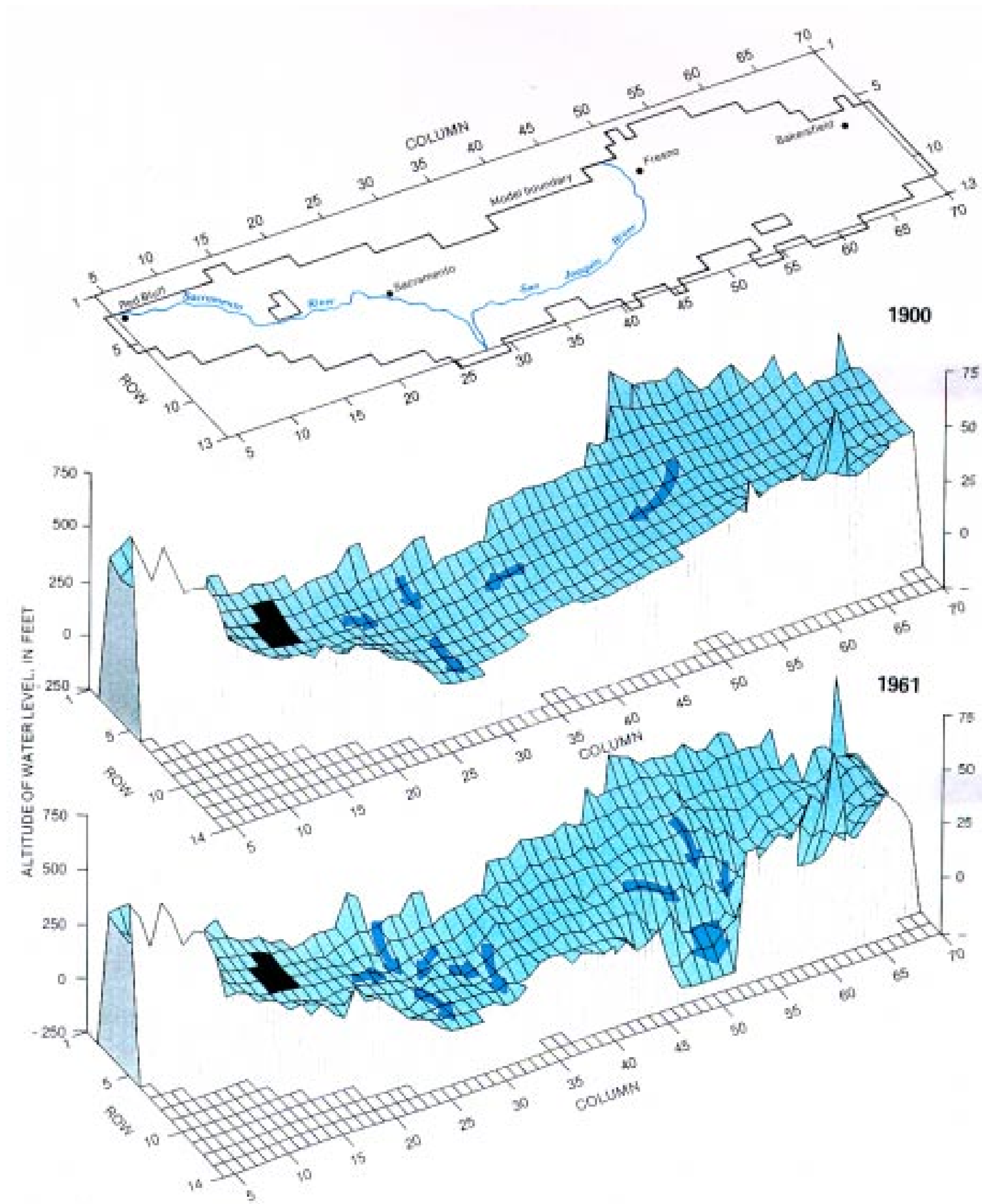

Figure 21: Modeled Change in Water Level and Direction of Flow in the Lower Pumped Zone, 1900-1961, due to Groundwater Pumpage
(source: USGS Professional Paper 1401-D, 1989)

a. Conjunctive use through import and active recharge.

i. What rights does the program want:?

The organizer of the conjunctive use program will enjoy the best legal position to extract the groundwater that it has stored if it is a public agency, if the recharge water is imported, and if the area of origin statutes do not apply. Under these circumstances, the right to extract the stored groundwater enjoys a high priority. Such a right prevails over all rights except in the following circumstances:

- It is inferior to the state-held public trust interest of the people of California, as are all usufructory rights;

- It is of equal priority with pueblo rights, but, since pueblo rights apply only to native water, disputes between the two result in apportionment to the importer of the quantity of groundwater attributable to imports;[66]

- It is of equal priority with other public and private importers in the watershed of destination and use, but disputes between these parties are also resolved by apportioning to each importer "the amounts attributable to the import deliveries of each."[67]

An importer's right to recapture imported recharge water is established by manifesting such intent prior to importation.[68] A conjunctive use program is predicated upon such an intent. Under the conjunctive use arrangements NHI is currently exploring, however, water might be introduced into a groundwater basin at one location and extracted at another some distance away. This raises the question of the hydrologic interconnections that must be maintained between the imported recharge water and the extracted water in order to preserve the importer's preference right. "Imported water" is "foreign water imported from a different watershed."[69] The advantage of obtaining the rights of an importer is that California law gives high priority to these rights in order "to credit the importer with the fruits of his expenditures and endeavors in bringing into the basin water that would not otherwise be there."[70] Under this rationale, it would appear that the area of recharge must be hydrologically connected to the area of discharge such that the program is pumping groundwater that "would not otherwise be there" but for the recharge. In other words, the two

[66]City of Los Angeles v. City of San Fernando, 537 P.2d 1250, ____, 14 Cal.3d at 288 (Cal. 1975).

[67]City of Los Angeles v. City of San Fernando, 537 P.2d 1250, ____, 14 Cal.3d at 260-62 (Cal. 1975).

[68]City of Los Angeles v. City of Glendale, 142 P.2d 289, ___, 23 Cal.2d at 78 (Cal. 1943); City of Los Angeles v. City of San Fernando, 537 P.2d 1250, ____, 14 Cal.3d at 257-58 (Cal.1975).

[69]City of Los Angeles v. City of San Fernando, 537 P.2d 1250, ____, 14 Cal.3d at 261 n.55 (Cal. 1975).

[70]City of Los Angeles v. City of San Fernando, 537 P.2d 1250, ____, 14 Cal.3d at 261 (Cal. 1975).

areas must be sufficiently proximate and interconnected so that the recharge water would be expected to replenish the area of discharge within the timeframe of the two events.[71]

The advantage of the program organizer being a public entity is that that status precludes the potential for adverse rights attaching to the program's stored groundwater through prescription. WHILE CAL. CIVIL CODE 1007 (West 1982) literally protects "any public entity" from prescription, the courts have been reluctant to afford the statute its broadest application[72] and may try to limit the definition of "public entity" to exclude some marginal parties. Therefore, care should be exercised in choosing or establishing the program organizer. Further research is needed regarding the outer bounds of the "public entity" definition. For instance, it would be useful to know whether a conjunctive use program organizer that was the creature of a memorandum of understanding between the state and federal government might qualify.

The areas-of-origin protections confer a preference right for local water uses in opposition to export uses. To perfect the right, local users must demonstrate an economic need for the water. NHI's preliminary research has revealed no instances where areas-of-origin rights have been exercised in California to cut off export rights.

ii. What type of groundwater does the program want rights to?

The organizer of the conjunctive use program should seek to obtain rights to groundwater that is percolating, used off-tract, imported to the watershed of use, and required for reasonable beneficial use. The universe of parties with potential claims to such water includes: the people of California through the public trust, and importers, prescribers and appropriators--both private and public.

The public trust is omnipresent. No disadvantage is incurred by using water of this type, since no type of water escapes the reach of the trust.

Prescribers, overlying users, and other importers are not of concern, if water of this type is used. If the organizer of the conjunctive use program is a public entity, as described above, prescribers are eliminated from competition for water imported by the organizer. The only colorable claim of overlying groundwater users to water of type 5 would result if the importer abandoned the imported water once it was in the ground. Neither spreading nor

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[71]One of the cases holds that it is possible to establish a right to imported water by making deliveries and withdrawals within one's own reservoir and alleging in a complaint that one intended to capture return flow from waters imported into the basin. City of Los Angeles v. City of Glendale, 142 P.2d 289, ___, 23 Cal.2d at 78 (Cal. 1943); City of Los Angeles v. City of San Fernando, 537 P.2d 1250, ____, 14 Cal.3d at 257-58 (Cal.1975). The issue, then, is whether the conjunctive use program would be viewed as delivering and withdrawing water from within the same underground reservoir.

[72]*See* City of Los Angeles v. City of San Fernando, 537 P.2d 1250, ____, 14 Cal.3d at 272, 274, 276 (Cal. 1975).

delivery for surface use constitutes such abandonment.[73] Other importers, as noted above, can claim only rights to a quantity of water attributable to their own imports--a situation that does not threaten the operation of a conjunctive use program. Thus, a public importer of water of this type need only be concerned about being displaced by appropriators.

Appropriators have a superior claim to water of this type only if the importer fails to require the water for reasonable beneficial use--that is, if the water is considered "surplus." The burden of proof would be on the would-be appropriator to show that such water was, in fact, surplus.[74] Storage of groundwater for domestic, irrigation, and municipal purposes is typically considered a reasonable beneficial use.[75] Storage of groundwater is a beneficial use if the water is later applied to the beneficial purposes for which the water was first appropriated on the surface.[76] Thus, it is important that, in addition to manifesting an intent to recapture imported waters stored in the ground, the organizer of the conjunctive use program demonstrate that such waters are being stored for later application to reasonable beneficial uses. In this way, the storage itself will be considered beneficial.

Thus, if the organizer of the conjunctive use program holds rights of this type to water of type 5, the program should be able to deposit water in the ground and, by right, withdraw it again.

iii. From what source(s) should the program obtain the water?

One consideration in selecting a source of program water is the fixed capital requirements of the program. If the program requires appreciable new physical infrastructure, the costs of those capital investments will presumably have to amortized by the project itself over a period of time. In that circumstance, the program will require a reliable source of water over that same time horizon. If, by contrast, the program does not require capital investment, the program water can be intermittent or less reliable. Should precipitation, geohydrology, or legal considerations render a once-viable source troublesome, the program can move on to a new source or even take a hiatus. Therefore, an early question to be resolved is whether the program can be based on an interruptible source of water, or does it require a durable source?

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[73] City of Los Angeles v. City of Glendale, 142 P.2d 289, ___, 23 Cal.2d at 76-78 (Cal. 1943).

[74] Miller v. Bay Cities Water Co., 107 P. 115, ___ (Cal. 1910); Allen v. California Water & Tel. Co., 176 P.2d 8, ___ (Cal. 1947) (burden on appropriator to show existence of surplus); Monolith Portland Cement Co. v. Mojave Public Utilities Dist., 316 P.2d 713, ___ (Cal. Ct. App. 1957) (burden on off-tract user to show existence of surplus); 62 Cal. Jur. 3d, Water • 410 (1981).

[75] Rank v. Krug, 142 F.Supp. 1, 111-12, 113-14 (S.D. Cal. 1956), *affirmed in part and reversed in part*, California v. Rank, 293 F.2d 340 (9th Cir. 1961), *modified upon rehearing*, 307 F.2d 96 (9th Cir. 1962), *affirmed in part*, City of Fresno v. California, 372 U.S. 627 (1963), *overruled*, California v. FERC, 495 U.S. 490 (1990).

[76] CAL. WATER CODE • 1242 (West 1971).

For instance, if an intermittent supply is sufficient, the preference right conferred by the area-of-origin statutes would be of less importance.

iv. Where should the program put the water?

To simplify the legal situation, the groundwater storage basin should be composed of percolating strata and be isolated from surface waters, such as streams or the underflow of streams. This would minimize the interplay of various legal doctrines, avoid factual disputes, and make the legal outcomes more predictable. As a result, the participants in the program will feel more secure about their rights.

Many California cases determining groundwater rights turn on geohydrologic characteristics of the groundwater aquifers. In addition to locating a storage site that is factually simple, it would be useful to locate one that is scientifically well-studied; ideally, one where the pertinent scientific facts have been determined in prior adjudications. Such prior judicial fact finding may not be binding on parties to any future suit but would at least serve as an advance indicator of what the program might expect from future litigation.

v. What parties should be involved?

The program organizer should seek contractual arrangements with parties owning land overlying groundwater since they may possess both spreading grounds and a right to extract groundwater. Their participation and cooperation may be secured by sharing the benefits of the program with them.

b. Conjunctive use through in-lieu storage

A program of conjunctive use involving in-lieu storage outside of southern California would be more difficult to achieve. Under an in lieu system, the program would enter into arrangements with overlying landowners who already have access to both groundwater and surface water sources. During periods when the program desires to recharge groundwater, the landowners would forego pumping and accept a substitute surface delivery from the program instead. Then, when the program desires to withdraw groundwater, the landowner would curtail its surface water use and substitute groundwater pumping.

The basic problem with such an arrangement is that the program will not be withdrawing groundwater that it has put into the aquifer through an active recharge program. Instead, it will cause groundwater rights holders to forego pumping water that they are otherwise legally entitled to extract in some years, and offset that forbearance by drawing more heavily on the aquifer in other years. The problem is that the contracting landowners have no better right to the underlying groundwater than do all of the other landowners overlying that same aquifer. The rights are "correlative", that is, of equal stature and limited by the principle of mutual avoidance of harm. Thus, in years of forbearance, the other pumpers would be entitled to extract the water that the program intended to store. In years of extraction, the contracting landowner's rates of withdrawal may impair the rights of the correlative pumpers.

Recognizing in the organizer a superior right to groundwater stored when surface water is used in-lieu, would involve upsetting an established set of property rights and investment-backed expectations, something courts are typically loathe to do.

This problem may be avoided where groundwater basins have been adjudicated such that the particular extraction rights have been quantified. This is the situation with a number of groundwater basins in southern California.

The technique of in-lieu storage can be used outside southern California, but special arrangements will be necessary. There are several potential approaches:

- The correlative rights problem can be avoided by bringing all of the correlative rights holders into the contractual arrangement, or mitigated by bringing most of them into it. The ability of any one rights holder to upset the program by withholding consent remains, however.

- The program could be operated in a manner that would presumptively avoid injury to correlative rights holders by foregoing pumping for a period sufficient to assure that when accelerated pumping occurred, it would not disadvantage the correlative rights holders compared to the status quo. That might mean designing the program so that the number of sequential years of accelerated pumping was limited.

- Special legislation might be enacted to preclude suits against the program by non-contracting landowners where the groundwater that the program causes to be extracted in any one year was limited to amounts that could have been extracted in any previous year but for the forbearance imposed by the program. This would be a legislative interpretation of the "no harm" rule as applied in the narrow context of an in lieu conjunctive use program. While a general groundwater management regime may be beyond reasonable legislative expectations, a modest enactment of this sort may be realistic.

5. Environmental Considerations of Maximal Groundwater Banking

A maximal groundwater banking program could cause negative environmental impacts. Like dams and reservoirs, maximizing groundwater banking ultimately involves capturing water that would otherwise flow to the ocean in a flood event. Floods and peak flows are important for maintaining and restoring fisheries and riparian and channel habitats. If not properly managed, a maximal groundwater banking program could degrade valuable habitats. On the hand, increased groundwater storage could make it possible for dam operators to intentionally release channel maintenance flows with less economic hardship.

Furthermore, as discussed above, pre-releases form reservoirs to groundwater recharge sites could cause increased water temperatures and decreased streamflows during droughts. NHI attempted to take these issues into consideration when developing estimates of groundwater yield in table 4. Never the less, more analysis is necessary to evaluate the potentially harmful effects of a maximal groundwater banking program. Specifically, this analysis should consider:

- The degree to which likely reductions in peak flow volumes and frequency could affect stream and habitat characteristics. What roles do small to intermediate peak flows play in maintaining the stream characteristics critical to fish and wildlife and would proposed operations alter these peaks sufficiently to affect critical characteristics?

- The impact changes in reservoir operating procedures needed for conjunctive management could have on water availability and temperature during droughts. Can criteria be developed to ensure that non-environmental users are shifted to banked groundwater at the beginning of droughts sufficiently early to guarantee environmental water availability; and what institutional guarantees are required to ensure environmental needs are not violated when intense droughts intensify competition?

E. Reoperation of existing facilities to maximize efficiency

1. Flood Reservation Storage

All major reservoirs are required to be drawn down to a certain level by November 1st each year in order to prevent downstream flooding and avoid dangerous uncontrolled spill over dams. The reservoir capacity set aside for flood control each is referred to as the flood reservation. This flood reservation, in effect, reduces annual carryover storage by the amount of the flood reservation behind the dam. The total flood reservation, however, is more than the extra flood control storage in the reservoir. In actuality, it is the sum of the vacated storage behind the dam and the amount of water that can be released from the dam in a given period of high run-off, such as three days. On many rivers, the amount of controlled flow that can be released from the dam is limited because of downstream flooding damage to crops and structures. Therefore, to prevent catastrophic (or reduce the frequency of) uncontrolled spills over the dam, the reservoir operator must maintain a large flood reservation behind the dam, even though the dam doesn't spill in most years. NHI's proposal is to increase the allowable controlled release from the dam thereby reducing the amount of reservation necessary behind the dam and effectively increasing annual carryover storage. This would increase the size of moderate sized floods, but not effect the size or frequency of catastrophic large floods. Table 5 below shows how releases and flood reservation storage could be adjusted at Friant Dam to increase annual carryover storage.

Table 5: Changes in Annual Carryover Storage from Increased Flood Releases

Physical Storage (1,000 a/f)	Flood release (c.f.s.)	Release to canals (c.f.s.)	Total Volume of 3-day release (acre feet)	Necessary Flood Reservation behind Dam to Maintain Current Flood Protection (acre feet)	Total Flood Reservation (behind dam + release) (1,000 a/f)	Allowable Annual Carryover Storage (1,000 a/f)	Change in Annual Carryover Storage (1,000 a/f)	Percent increase in carryover storage
655	8,000	4,800	76,032	170,000	246,032	485,000	0	0%
655	12,000	4,800	99,792	146,240	246,032	508,760	23,760	5%
655	15,000	4,800	117,612	128,420	246,032	526,580	41,580	8%
655	17,000	4,800	129,492	116,540	246,032	538,460	53,460	10%

The Bureau of Reclamation is required by the U.S. Army Corps of Engineers to create a flood reservation behind Friant Dam (and upstream reservoirs) of 170,000 af by November 1 of each year. Furthermore, USACE guidelines limit controlled releases from Friant Dam to 8,000 cfs. Assuming that the Bureau had a three day period to release flood flows before and during a major storm to prevent uncontrolled spills over the dam, their total flood reservation (storage behind dam + amount of water released during a three day period) is 217,500 af. By increasing the magnitude of flood releases the dam operator can decrease flood reservation behind the dam without decreasing total flood protection. This effectively increase total annual carryover storage. Table 5 shows how increases in the allowable flood control release effects annual carryover storage.

This approach to increasing annual carryover storage through increasing the size of releases from the dam is entirely compatible with CALFED's ecosystem plan to restore ecological processes associated with high flows, flooding, and floodplains. Any meaningful plan to increase the frequency and peak of high flows, flooding as well as the area of floodplains, will require an expansion in the size of flood ways and bypasses. Although this approach to increase storage does not effect the size or frequency of the very large floods, it would by definition increase the size of and extent of moderate floods and therefore also require expanding the size of downstream floodways and bypasses. The 1997 floods, much greater than the controlled releases called for in this approach, dictate that we reconsider flood management options particularly the development of expanded floodways and bypasses regardless of CALFED's ecosystem program or this storage maximization strategy.

VII. FRAMEWORK FOR EVALUATING THE NEED FOR AN ISOLATED CONVEYANCE SYSTEM

In the south of the Delta lie two large pumps, Tracy and Banks. These two pumping plants are capable of extracting over 15 kcfs of water out of the Delta. This is enough water to fill a football field 6 miles high each day. The average amount of water extracted is somewhat less--about 8 kcfs--but still enough water to fill that football field three miles high each and every day of the year.

The location and operation of these pumps is linked to a number of critical problems and controversies for California. We know that the current location and pumping patterns are bad. But none of the proposed solutions are without controversy. One camp supports retaining the south Delta location and reducing the associated problems through various means. The other camp argues that the isolated facility is the only credible solution to several key problems – entrainment, drinking water quality, and security.

Complicating matters are the issues of uncertainty and assurances. The relationship between actions under the control of CALFED – habitat restoration, facilities, operational rules, etc. – and ecosystem health are very cloudy. Given existing information, it is impossible to demonstrate conclusively whether an isolated facility is or is not absolutely needed if the Bay-Delta ecosystem is be substantially restored to health. Similarly, we cannot say for certain whether or not an earthquake will destroy the Delta islands and cause a water supply and ecological crisis. We do not know whether the discovery of new toxics in Delta water will force urban agencies to seek higher quality sources. Similarly, we do not know whether future advances in water treatment technology will render the quality of source water irrelevant. Thus, advocates on both sides of the debate have access to plenty of ammunition to bolster their arguments.

The assurance issue is also complex. We find little merit in the “Delta choke point” principle which suggests that the Delta represents a physical constraint on water diversions and that forcing water users to export water from the South Delta forces exporters to protect Delta outflows. In fact, there is little to stop Delta exporters from diverting nearly all Delta inflow other than laws and regulations. This is true with or without an isolated facility. Of greater concern is the linkage between an isolated facility and funding to protect Delta levees. Delta farmers and environmentalists can be legitimately concerned that exporter enthusiasm for protection of the levees would decline after construction of an isolated facility.

In the following discussion, we examine several of these issues, then attempt to draw some conclusions about appropriate policy toward the isolated facility.

A. Entrainment

- The pumps sit right next to where the San Joaquin River enters the Delta. As a result, virtually all the water coming down the San Joaquin and its tributaries is diverted into the pumps. Many young salmon migrating down through the San Joaquin River never make it into the ocean, but end up in the pumps.

- The pumps sit in the middle of the largest estuary on the western shore of North or South America. Large numbers of fish and other species make this estuary their home. Many are lost in the pumps.
- Natural flow patterns in the Delta are significantly affected by the pumps. Almost none of the San Joaquin River makes it through the Delta and a sizeable amount of the Sacramento river flows from north to south across the Delta rather than down the Sacramento.
- In looking at habitat restoration opportunities, most biologists write off the south Delta under current conditions, since any fish attracted by the new habitat would end up in the pumps. Yet the south Delta contains some of the most readily restorable lands in the Delta.

It is certain that the impacts of the pumps on the environment are negative. However, it is not clear just how much of the declines in populations is caused by the pumps and how much is caused by other factors. It may be that the effects of the pumps are so great that fish populations will never recover without major changes in how water is diverted. Alternatively, it may be that losses into the pumps are a minor drag on populations and can be mitigated for in various ways. Perhaps the answer is different for different species.

If pumping in the south Delta is a major problem for fish, then there are a number of possible solutions. They fall into five categories. These alternative approaches are not generally mutually exclusive.

1. Change pumping patterns to kill fewer fish.
2. Reduce overall diversions from the Delta.
3. Screen out fish more effectively
4. Move the location of the intakes
5. Grow more fish

All of these approaches appear to have technical merit.

The hypothesis behind **changing pumping patterns** is that the impacts of export pumping vary significantly over time. If true, then exports can be better attuned to the biology, allowing for reduced entrainment of fish without an impact on overall export levels. Existing export limits already are an attempt to match exports to the biological realities. Allowable exports are lower from February to June for a given level of Delta inflow. The VAMP experiment will drop exports even lower for a month in April and May. ESA take restrictions also give the projects incentives to shift exports away from periods of high take of listed species. Moreover, just as we may wish to vary pumping levels over the course of a year, we may also wish to vary pumping levels across years, allowing greater pumping in wet years and less in dry years.

Salvage data make a very strong case that most of the take of several fish species of concern takes place over perhaps a few dozen days over the course of a year. These data tend to support operational approaches based less upon fixed export standards and more upon real-time data on the location of fish in the Delta. When fish are in the vicinity of the pumps, the pumps should be largely shut down. Then pumping can resume after the fish have moved away from the pumps. Using real-time management of diversions, entrainment might be reduced while maintaining and even increasing overall export levels.

Our ability to operate the export pumps in real-time is limited by two factors: (1) monitoring data and (2) infrastructure. It might be possible to operate the export pumps based upon how many fish are taken in the pumps – when take starts to rise, pumping is reduced. However, it would be preferable to get a few days warning before fish show up at the pumps, both to give project operators some warning and to avoid drawing fish into the vicinity of the pumps in the first place. This requires monitoring some miles away from the export pumps – sort of a distant early warning line for fish. Infrastructure is a greater problem. If exports are to be reduced on short notice according to the location of fish in the Delta, then storage will be needed to buffer these abrupt shifts in pumping patterns. Ideally, a large regulating forebay could be attached to the export facilities. Bacon Island is already proposed as a storage site by Delta Wetlands and could serve this purpose admirably. Shifts away from dry year pumping to wet year pumping are even more problematic and will require either a very large amount of storage dedicated to environmental purposes south of the Delta (e.g., in groundwater) or a large system of dry year option contracts on behalf of the environment.

Reducing overall diversions from the Delta is technically, perhaps even economically feasible. However, the political costs may be high and the distributional effects problematic. The idea is to reduce the level of diversions to the point that losses in the pumps become less of an issue. Since we do not have a good handle on just how much of a problem diversions from the south Delta really are, it is difficult to determine how far exports need to be throttled back to have an effect. Note, however, that as diversion levels are reduced, the ability to shift pumping timing to reduce fish losses still further (discussed above) is enhanced. Thus, there are synergistic effects.

As a rough rule of thumb, many people have assumed that cutting export levels in half might lead to major fishery benefits. This would require cutting exports by about 3 maf per year and might be roughly comparable to the smallest isolated facility under consideration. How would this be done? Unless California is willing to impose growth controls or very stringent urban conservation requirements (e.g., elimination of grass), most of the long-term savings would need to come from agriculture. The reason is that the savings generated by aggressive urban water conservation and water reclamation programs will be eaten up by future urban growth. Urban areas probably are capable of feeding new urban growth using conservation and reclamation for several decades to come. They are unlikely to be a source of sustainable reductions in export demand.

Therefore, we are left with export agriculture as the source of the demand reductions. Total agricultural use in the export areas is on the order of 10-15 MAF per year (including exports, groundwater pumping, and supplies from other sources, such as the Friant-Kern Canal.). Therefore, we need a reduction of 20 – 30 %. This is a very tall order. In certain areas of the west San Joaquin Valley, classic water conservation is possible (e.g., Westlands Water District) because water wasted is water lost for future use (it is contaminated by salty groundwater). However, these areas are already among the most efficient agricultural areas in the world because of drainage problems and chronic water shortages. Elsewhere in the export areas, classic water conservation is not possible on a large scale because water wasted will, with some exceptions, go to replenish the groundwater table. Therefore, if conservation is coupled to reduced supplies (as it would need to be in order to benefit the Delta), all that has really been done is to increase groundwater overdraft. Therefore, the only way to gain large amounts of reduced demand in export agriculture is to reduce evaporation or transpiration--the amount of water consumed by crops as they grow.[77] Transpiration might be reduced through, crop shifting and land fallowing (whether permanent or temporary). In order to achieve an average saving of 3 maf of savings per year, about 1 million acres of agricultural land in the export areas would need to come out of production. Alternatively, cropping shifts would be necessary on a much larger area of land. Reductions in evaporation are likely possible, but we have not seen any evidence that enough water can be saved at a reasonable price to make a major difference in water use.

The ability to achieve fishery benefits through reductions in evapotranspiration in the export areas is complicated by interannual variability of supply. Many farmers in the export areas experience supply reductions during dry years--the very time when additional reductions in exports are probably most needed. This may increase the actual acreage needed to achieve fishery targets. On the other hand, increased use of groundwater storage and more sophisticated buying schemes might reduce the impact of this variability. For example, the fallowing program could be linked to groundwater storage so that water saved in wet years could be stored for use in dry years.

NHI believes that the social, economic, and political repercussions of an explicit state program to shift this much agricultural land use make such a policy infeasible. Such shifts could happen gradually over time as a result of market forces, however.

Of course, it may be that 3 maf of export reductions is more than is really needed to reduce pumping impacts to acceptable levels. If only 1 maf per year of permanent savings is needed, the political and economic feasibility increases dramatically. However, the lower the reduction in export demand, the lower the likelihood of actually getting any major biological benefits.

Improved screening and salvage technology may provide some benefits. In particular, fish losses associated with Clifton Court Forebay are very high and might be reduced through improved screens placed on the <u>outside</u> of Clifton Court.

There are three issues with screening at Clifton Court: a) the loss of fish before they reach the screen, primarily through predation by other species such as striped bass; b) losses in the screens; and c) losses during handling and when the fish are reintroduced to the Delta.

a) Most fish never make it to the Clifton Court screens. A large population of predators inhabits Clifton Court forebay and eats most small fish that are pulled in. Thus, improvements in screening technology alone will not have a major impact on overall

[77]Some savings are possible through reduced evaporation, but nothing like 20-30%.

survival rates. Possible responses are programs to eliminate predators (tried without success in the past) and moving the screens to locations less favorable to predators. For example, moving the screens to the front of Clifton Court (i.e., screening fish before they got into Clifton Court) would probably reduce the problem of predation. Similarly, an isolated system would probably not have a major problem with losses in front of the screens because it would take water directly from the Sacramento River.

b) Not all fish that reach the screens are actually captured by the screens. Smaller fish, and eggs and larvae generally, are screened imperfectly if at all. Only fish above a certain size can reliably be picked up in the screens. Improved screens might reduce these losses.

c) Screening is a very traumatic experience for fish even under the best of circumstances. Fish are "processed"--transported out of the screens and eventually back into the Delta. The processing of screened fish is particularly problematic in the south Delta. The south Delta is a backwater--a tidally dominated area miles from any significant river. Any fish released in the vicinity of the pumps would simply be pulled back into the pumps again. For this reason, fish are placed in tanker trucks, driven back into the Delta and dumped back into the channels at a number of locations. Predators eagerly await each shipment of screened fish. Losses vary by species but are significant. With the south Delta pumping location, it is difficult to see how handling losses can be significantly reduced. Another intake location that does not require trucking of salvaged fish might reduce mortality, however.

It is clear that the problem of fish losses associated with the pumps must be treated as a unit. Moving the screens to the outside of Clifton Court Forebay might reduce predation significantly. However, as long as handling losses are high, the overall reductions in mortality may be fairly small.

Move the Location of the Intakes. The south Delta diversion location is problematic because the density of fish in the vicinity of the pumps is high and losses associated with screening and salvage are high and the presence of the pumps forecloses nearby restoration opportunities. Rather than trying to ameliorate these problems, one alternative is to move the intakes somewhere else. The isolated facility is only the most prominent proposal for shifting the diversion point. The through-Delta alternative also relies upon this approach to some extent. In the through-Delta alternative, water is screened on the Sacramento River, just as with the isolated facility, but is then reinjected into the Central Delta. The benefit is that more Sacramento salmon stay in the Sacramento River compared to present circumstances. However: 1) Sacramento salmon can still end up at the pumps by swimming through channels farther down the river; 2) salmon swimming upstream may be blocked by the screen; and 3) pumping continues at current levels in the south Delta. Another option would be to construct several widely dispersed screened intakes in the Delta, then use real-time monitoring to select the intake with the lowest biological impact at any given time. However, considering that all of the intakes would remain within the Delta, it is unclear that the impacts of the diversions would be significantly reduced in this way.

The isolated system is not a panacea for screening by any means. Delta fish do swim in the vicinity of the pumps, albeit at lower densities. For part of the year, large numbers of striped bass eggs and larvae (which cannot be screened) would pass in front of the screens. If the intakes are not closed, losses at the intakes will be high. Finally, Sacramento salmon, which now receive some level of protection simply because their major migration route is geographically distant from the export pumps, would have to swim directly past the intakes. Fish that are taken into the screens would still need to be processed. However, the fish would not need to be trucked. Instead they could be piped to a location downstream. However, predators would presumably discover where the fish are piped back into the Delta and would attempt to eat the fish before they could disperse. The net effect is probably positive, with large benefits to San Joaquin fish species and relatively small damage to Sacramento salmon.

Finally, shifting the intakes to north of the Delta allows the diversion to be taken out of a river, not the tidally dominated southern Delta. Once fish are below the intake, they are out of the zone of greatest danger. Therefore, the south Delta can now be restored for fish, while much of the north Delta continues to be attractive for restoration.

It may also be possible to simply overwhelm the entrainment impacts of the south Delta pumping location by **growing more fish.** That is, CALFED could emphasize improving other possible factors limiting fish populations such as habitat, toxics, screening of other intakes, and the elimination of upstream barriers to migration. If entrainment is not, in fact the dominant factor in controlling fish populations, then improving fish populations may, in fact, be compatible with the continued use of the south Delta pumping location. The answer may differ by species.

B. Water Quality

The south Delta is both the sump of the Central Valley water system and the gateway to the Pacific Ocean. Anything that is put in the river from the high Sierras down to the Delta will show up in the pumps. Similarly, salt water from the Pacific Ocean makes its way upstream with the tides and is pulled into the pumps.

Low water quality is a problem for both agriculture and for drinking water. Millions of tons of salt are put onto agricultural lands in export areas each year. The salt forces the use of additional water for leaching. Much of the salt finds its way either into the groundwater, thus degrading this resource, or back into the San Joaquin River, whence it is pumped yet again.

Delta water is particularly problematic for urban drinking water. Technical fixes exist for almost any water quality problem in isolation. The difficulty is that urban areas are being squeezed from several directions simultaneously. They must simultaneously disinfect to kill bacteria and pathogens, retain disinfection in their treatment system, while avoiding the creation of byproducts formed as a result of disinfection.

If south Delta water quality is a problem for export agriculture and for human health, there are a number of ways to deal with the problem. As in the case of biological responses, these techniques will frequently be used in tandem.

1. Source control, salinity intrusion reduction.
2. Treatment.
3. Reoperation and agricultural/ urban segregation.
4. Shift the location of the intake.

There is potential for **reducing discharges** of pollutants from upstream and **for reducing salinity intrusion** from San Francisco Bay. Mine drainage can be sealed or treated. Pesticides, herbicides and organics can be kept out of the rivers through changed farming and irrigation practices. Discharges of salinity in the San Joaquin River can be reduced through land purchases, or timed to coincide with flood flows. Delta island discharges could be treated or the timing managed. Increases in Delta outflow would push the salt-freshwater interface farther downstream and would lead to reduced salinity at the export locations.

The salient question is whether an affordable source control program would improve water quality enough to justify the cost of the programs. The export pumps are at the base of an enormous watershed. Urban growth within that watershed is proceeding at a fast pace. Within decades, there may be a solid urban band from Sacramento in the north all the way to Tracy in the south. With several notable exceptions, sources of pollution are very diffuse. As a result, source control programs would need to be carried out on a very large scale. Finally, evidence is emerging that tidal wetland habitat in the Delta introduces significantly more organics of concern into the water than does agriculture. Source control is impossible for tidal wetlands. Thus, the goals of major ecosystem restoration may be in conflict with a goal of retaining a south Delta export location.

Increased flow can push salts back toward the ocean. However, the amount of water needed to significantly reduce salinity is very high. Moreover, in dry years, when salinity is particularly problematic, the water to push salinity downstream simply does not exist. Moreover, to the extent that Delta outflows are increased in dry years for salinity control, we greatly increase the chances that we will lose the ability to supply cold water to spawning areas just below the foothill dams.

Even if raw water quality is degraded, it may be possible to improve the quality of drinking water to acceptable levels through sophisticated **treatment**. Urban water treatment is a multidimensional problem. The agencies are required to kill bacteria and parasites at the treatment plants and to leave a residual disinfectant in the water to protect the water as it moves through the distribution system. They are also required to keep the chemical byproducts (particularly THMs) of disinfection below specified levels. These byproducts are caused when organics (from upstream) or bromides (from the ocean) react with the disinfectant to form THMs and bromate. The standards for disinfection byproducts will tighten next year and again in 2002. Future tightenings are probable if history is any guide. The problem with urban treatment is not bacteria or parasites or organics or bromide in isolation. The problem is when urban agencies are hit with all of these problems simultaneously. Chlorine disinfection doesn’t kill all parasites and creates THMs, but it doesn’t react with bromide to create bromate. Ozone kills bacteria and parasites and doesn’t create organic THMs at high levels, but reacts with bromide to create bromate.

Thus, if source water contains parasites, organics, and bromides at high levels, urban agencies will have a difficult time meeting future standards unless new treatment technologies can be demonstrated to be reliable. One possibility is more sophisticated filtration techniques. These techniques would remove parasites and organics from the water, reducing the need for disinfection and reducing the problem of THM and bromate formation. On the other side, there are a number of disinfection byproducts that have never been studied which might be controlled in the future and there are many potential toxics in the water that have yet to be studied and which cannot be filtered out. Finally, treatment capable of meeting all water quality standards may be very expensive – perhaps more expensive than the entire CALFED program.

For agriculture the main problem is salinity. Treatment to remove salinity is not cost effective for agricultural areas.

Reoperation and replumbing of the existing system. Water quality in the south Delta is not constant over the course of the year. Sometimes water quality is very high (e.g., during some periods of high flow) and sometimes it is relatively low (e.g., in the fall). If the high quality water could be reserved for urban uses, then urban water quality needs might be easier to meet without source control, without an isolated facility, and with lower treatment cost.

The problem is very complex because the export plumbing system is relatively inflexible. Two canals carry water from the Delta as far as San Luis Reservoir. But only one canal carries water south of San Luis. Moreover, because agriculture water use is highly seasonal, significant amounts of storage are required to meet agricultural needs. This means that San Luis Reservoir must be dedicated to agricultural purposes in the summer.

Two solutions that have been proposed are:

- Increase diversions during periods of high quality and run the water directly from the Delta to southern California (usually the winter) and store it there.

- Build a second storage reservoir south of the Delta for urban use. Put water into storage when quality is high. Then run water into southern California when agricultural demand is low.

Analysis of these options has shown that the benefits are rather small because mixing with lower quality water occurs and because some of the higher quality water must be sent to agriculture, even during the winter months. Also, it may be difficult for southern California to operate its system if deliveries of water come in large slugs.

Another idea would be to bifurcate the California Aqueduct south of San Luis Reservoir. A floating, hinged barrier could be constructed inside the existing canal to effectively divide the canal into two pieces. With such an arrangement, water taken from the Delta during periods of high quality could be completely segregated from lower quality water taken at other periods. Bifurcation of the canal would also allow urban water quality needs to be met with an isolated system much smaller than previously proposed. A canal as small as 2,000 cfs could meet all export urban needs.

Another possibility would be to send high quality water from the Friant-Kern Canal to southern California in exchange for water from the Delta. This option would require significant new infrastructure to allow for the exchange to take place, would increase salinity loading within agriculture in the San Joaquin Valley, and would not deal with water quality problems in Santa Clara and Alameda Counties, but it is worth consideration as a partial solution.

Shift the location of the intake. If water quality at an intake location is low, one possible response is to move the intake to where the quality is higher. This is what San Francisco and EBMUD have done with their Sierra intakes. The main option for intake shifting within the CALFED Program is shifting the intakes to north of the Delta with an isolated facility. This shift would put the intakes farther from the ocean, segregate the intakes from the San Joaquin River (which is very polluted because a high percentage of its flows come from agricultural runoff), and put the intakes above the organic discharges from the Delta islands. If the isolated facility were moved as far north as Freeport (a few miles south of Sacramento), then the intake could be placed above the Sacramento sewer outfall. Of course, water quality problems would still exist as a result of discharges above the intake point in the Sacramento Valley. This might argue for retaining the option of moving the intake even higher up on the Sacramento River in the future.

C. Security of Delta Ecosystem and Water Supply System

Delta "islands" are actually "holes" on the order of 20 feet below sea level. These holes are protected by fragile levees, built up over the last century, from peat soils. One possible future for the Delta is a large earthquake, resulting in the simultaneous flooding of many Delta islands.

Since the volume of the Delta islands which is below sea level is on the order of 5 maf -- far more water than Central Valley rivers could provide in a short time -- a large failure would necessarily pull in salt water from San Francisco Bay and force a shutdown of the export pumps until the salt could be flushed out. The shutdown might last for months or years, depending upon the level of the damage, the intensity of the response, and the how wet the year was. Moreover, given that some levees might be exposed to wave action from the inside for a considerable time, the feasibility of recovering all of the damaged islands is in doubt. But if the islands are permanently inundated, more salt water would routinely intrude into the Delta from the ocean, exacerbating the long-term water quality problems caused by salinity in the South Delta. Moreover, the environment would lose enormous amounts of usable habitat.

There are many uncertainties involved in assessing this scenario: the likelihood of a severe earthquake; the response of the levees to an earthquake; the feasibility of recovering islands once flooded; the length of time the pumps are shut down; and the economic repercussions of a pumping shutdown. Despite the uncertainties, given the possible economic repercussions of a disaster scenario in the Delta, the risk cannot simply be ignored.

In order to resolve this problem, the following approaches are possible:

1. Backup storage
2. Shift the location of the intakes
3. Levee Upgrades
4. Subsidence Reversal

Backup storage: If Delta diversion could be knocked off-line for a period of many months, one immediate fix would be to make sure that enough water was always in storage south of the Delta to supply water while the Delta is being flushed of salt. Storage already exists south of the Delta and this storage could be used for this purpose. However, existing storage is limited. Moreover, existing storage levels vary greatly over the course of a year. If a Delta outage took place at the wrong time, existing storage might be too low to provide a good buffer. More storage could be built. But to be effective, the storage would need to be kept full at all times. Considering that an outage might not occur for decades, the storage would rarely be used and thus represents a very expensive solution. Finally, storage does not address the problem of a long-term failure in the Delta. That is, if the islands cannot be recovered after an earthquake, salinity levels at the south Delta may remain permanently elevated. Storage cannot resolve this problem.

Shift the location of the intakes: A large isolated facility would allow export deliveries to continue, even during and after a major failure of islands in the Delta. Thus, the isolated facility would solve both the short and long-term water supply problems associated with major failures within the Delta. The main caveat is that an isolated facility itself might be damaged by an earthquake. However, the facility could probably be repaired relatively quickly. A small isolated facility constructed mainly for water quality purposes, would largely solve urban water supply problems associate with levee failure, but would not be adequate to deliver south of Delta agricultural deliveries.

However, an isolated facility would not protect Delta agricultural water quality or the Delta ecosystem from levee failure.

Levee Upgrades: Levees can be protected against flooding during storms. However, as discussed elsewhere in this document, levees sit atop unstable soils. No amount of strengthening can improve this basic foundation. No matter how much money is spent on levee upgrades, they will remain vulnerable to earthquake. One possible response would be to engineer the inside of the levees to hold water without major damage. This would involve reducing the interior slopes so that wave action would not degrade the levees as quickly. This would increase the chances that the levees could be repaired before major damage is sustained. However, this improvement would be very expensive and would take up significant amounts of existing agricultural land.

Subsidence Reversal. Subsidence reversal is discussed elsewhere in this document. It effectively eliminates the problem and is the only certain way to simultaneously protect export water supplies, habitat, agricultural land, and water quality within the Delta.

D. Assurances

The south Delta export location forces export interests to care about the integrity of the Delta levees and the quality of Delta water. This is the common pool principle. Shifting the diversion point to a point upstream of the Delta would reduce or eliminate this shared interest in levees and Delta water quality. The south Delta location forces exporters to:

- Support funding for subsidence reversal programs
- Support funding for levee protection.
- Allow certain minimum levels of water to flow out of the Delta to keep salt levels down at the intakes.
- Support pollutant source control efforts on the San Joaquin River.
- Pull salts concentrated in the south Delta into the export pumps (thereby improving Delta water quality).

Another perceived advantage (from an environmental perspective) of the south Delta location is that the Delta is an export bottleneck so that a south Delta export location protects areas upstream of the Delta from water development.

The common pool principle is widely misunderstood. The principle is primarily an expression of the interests of Delta agriculture, not the environment. Generally speaking, Delta agriculture is benefited by the current location of the export pumps. Exporters have joined Delta interests to support the provision of massive public subsidies to protect Delta levees for agriculture. Moreover, exporters pull in huge amounts of salt from the south Delta and this helps to freshen water for Delta agriculture.

The environment receives some level of protection from the common pool. Exporters must assure that some amount of water (perhaps 3,000 cfs) flows out of the Delta in order to protect the salinity of exports. Moreover, regulatory restrictions on south Delta diversions do limit the cost-effectiveness of new water development upstream of the Delta. Nevertheless, the utility of the common pool principle for the environment is highly questionable. The premise of the common pool principle is that, even if exporters are able to overcome existing regulatory obstacles that constrain their operations, the physical existence of the common pool will force them to operate in ways that protect Delta agriculture and the environment. What kind of protection does this really offer?

- The 3,000 cfs that exporters are required to release for Delta outflow in their own interest is only a small fraction of what the ecosystem actually needs.
- The Delta does not represent a physical limit on exports. Provided that the projects release about 3,000 cfs for outflow, they could physically export as much water as they could choke down.

- The south Delta location has never led to strong exporter support for source control efforts in the San Joaquin River.
- Subsidies for Delta levee protection have allowed Delta agriculture to continue the very land management practices that have created the subsidence problem. Thus, the problem of subsidence gets ever worse and the likelihood that much of the Delta will be lost permanently to the ecosystem increases.

That is, the common pool provides only limited protection for the ecosystem. Protection for the environment comes primarily from laws, regulations, and actions taken to improve habitat and reduce mortality.

A small isolated facility would not change this basic reality. As long as some exports must be made from the south Delta, then exporters would have incentives to provide Delta outflows and to maintain levees (albeit somewhat reduced incentives). The isolated facility would tend to be full most of the time so that increases in pumping could only take place at the south Delta, the same as now.

A very large isolated facility may pose additional environmental risks. If a facility is sized large enough that all export needs could be met through an isolated facility, then exporters would have greatly reduced incentives for helping to protect Delta levees and for providing Delta outflows. Moreover, surface water storage in the Sacramento Valley might become more cost effective. Thus, the burden of providing assurances for an isolated facility grows as the size of the facility grows.

E. Certainty

The existence of high levels of uncertainty greatly complicates the decision-making process. We do not know with certainty whether the key to ecosystem restoration is creation of new habitat, reduction in entrainment, reductions in toxics, reductions in commercial fishing, or some other factor. Obviously, all of these factors have some impact, but we do not know which are more important than others and what kind of synergies may exist.

Similarly, we do not know what kind of water quality standards may be put in place in the future. We do not know when the next major earthquake will occur in the Delta or what damage might result. We do not know whether sea levels may rise in the future and how much they may rise. We do not know whether historical weather patterns will exist in the future or whether patterns will shift.

There are also uncertainties surrounding the performance of parts of the solution. For example, there is uncertainty about the effectiveness of screens, levee upgrades, and water treatment. The effectiveness of the through Delta alternative is highly uncertain for fish.

On the other hand, we can predict some benefits with relatively high confidence, at least in a qualitative sense. For example, we can be confident that, all else being equal, an isolated system will improve raw water quality for exports, reduce earthquake risks, and improve San

Joaquin fisheries. Storage can improve our ability to manage water for the ecosystem and water users.

In general, it is easier to predict outcomes when we are building infrastructure than when we are working with non-structural approaches. This is expected, in that we have the freedom to tweak proposed structural fixes until they perform as we wish and because infrastructure increases system flexibility. This does not necessarily mean that we must build more infrastructure, only that we can be more confident of getting a good return on our investment with infrastructure.

However, another characteristic of infrastructure is that it takes a long time to design and build. This time delay provides the opportunity to test out non-structural approaches first. By doing so, we are able to reduce uncertainty and increase the chances of making the correct planning decisions.

F. Conclusions

Despite high levels of uncertainty, a few conclusions are possible:

A small (5-10,000 cfs) isolated system will provide environmental, water quality, and security benefits with high probability. The probability of major downsides (compared to current conditions) is low. However, the actual size of the benefits is somewhat uncertain. The conclusions we draw as to the probable technical superiority of the isolated facility option are also consonant with the judgments drawn by the CALFED staff in the Phase II Interim Report, the CALFED Diversion Effects Fisheries Team, and the U.S. Fish and Wildlife Service, and the all of which also acknowledge the considerable degree of uncertainty yet to be resolved as to that conclusion.

Other approaches may also provide significant levels of benefits. However, in order to provide the same environmental, water quality, and security benefits (whatever they may be) equal to a small isolated facility a large number of actions would need to be undertaken (discussed above), and all of them would need to have positive outcomes. The likelihood that all of these highly uncertain actions would provide hoped for benefits is low. Therefore, if a final decision had to be made today, it seems to us that the correct technical and economic choice would be an isolated system. This was also the conclusion of CALFED’s March 1998 Programmatic EIR/EIS and of CALFED’s DEFT report.

However, the final decision need not be made today. Planning for any large piece of infrastructure will take many years. Given the high degree of controversy surrounding the isolated facility, it is worth testing 1) whether or not alternatives to the facility are viable and 2) whether the benefits of the isolated system are as valuable as currently believe, while planning for the isolated facility goes forward. If it turns out that that alternatives exist to an isolated facility or that the benefits of isolation have been overstated, then there is no need to expend money on the facility.

While NHI agrees that the final decision on whether or not to construct an isolated facility can be delayed for some years, the decision cannot be delayed forever. There is a substantial chance that the alternatives to isolation will fail and that the canal will be needed. We urge all participants in the CALFED process to put aside ideology. Fish, Delta habitats, and human health are all too important to play games with. They deserve the best solution we can devise.

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Appendix I: Preliminary Analysis of the Public Costs Associated with Delta Agriculture

The sustainability of Delta agriculture from an economic perspective depends upon the profits and costs of doing business and the level at which society is willing to subsidize agriculture. Farmers themselves absorb the lost agricultural production associated with temporary and permanent flooding. But there are larger costs associated with Delta agriculture behind failure-prone levees that are defrayed largely by the public. These include:

i. the cost of levee maintenance, levee repair, and island rehabilitation after flooding events;

ii. the economic costs associated with allowing diversions to be unscreened (such as reduced commercial salmon catch) and the costs of screening them;

iii. the economic costs associated with treating Delta agricultural discharges for drinking water;

iv. the contribution of Delta agriculture to endangered species problems; and

v. the social costs associated with reduced habitat, impaired ecosystem function, reduced fish populations, and the probable loss of substantial amounts of terrestrial habitat in the future once the islands fail.

Information exists for the costs of only a few of these impacts--levees, screening, and drinking water treatment.

Levee subsidies: From 1980-1986 (the last date for which we have information as of yet), emergency subsidies for levees cost the state and federal governments over $90 million or about $15 million per year. State subsidies for routine maintenance and repair of non-project levees have recently been running between $2 million and $5 million annually. In addition, the state has spent $27 million since 1989 for a special Flood Protection Program for eight Delta islands and two Delta communities (with a total commitment of $35 million through 1997). These costs will only increase in the future as islands continue to subside.

Screening: Virtually none of the approximately 1,900 diversions in the Delta are screened. Current screening policies may be changing, however. The Department of Fish and Game (DFG) has recently written "Plan of Action for Screening Diversions," and there is some indication that the U.S. Fish and Wildlife Service is advocating a more rigorous screening policy in the Delta. If DFG were to order diversions in the Delta screened, it would wind up bearing most of the costs.[78] The potential costs for installing screening are roughly estimated

II. [78] Under the Fish and Game Code, DFG is responsible for installation and maintenance costs for diversions installed prior to 1972, and smaller than 250 cfs--which includes most Delta diversions) at $3,000 - $5,000 per cfs at each siphon type intake (where average maximum flow for Delta diversions is about 10-15 cfs); it is estimated that screening the multitude of Delta diversions would cost more than $100 million. Operation and maintenance costs would also be significant.

Drinking water treatment: The incremental cost for drinking water treatment caused by Delta island discharges may be as high as several hundred million dollars per year in the future.

APPENDIX 2: Learning Laboratories

a. Twitchell Island subsidence reversal learning laboratory

Subsided island surface elevations are the single largest constraint to large-scale restoration in the Delta. NHI, USGS, DWR, and private consultants have joined in a major initiative to establish a large scale learning laboratory for reversing subsidence of Delta islands. This subsidence reversal learning laboratory will test the three most promising subsidence reversal techniques currently known: reusing dredged materials, cultivating wetland vegetation to accelerate peat formation, and capturing natural sediment loads currently being transported through the Delta. Over the long term, the Twitchell Island project will not only develop information necessary to create a Delta restoration plan, but it will also result in over 1,500 acres of tidal marsh habitat in the western Delta and benefit several endangered species, including Delta smelt, Sacramento splittail, and Chinook salmon. Figure 6 depicts how subsided lands will evolve over time under the subsidence reversal program.

b. The Big Break shallow water habitat restoration learning laboratory

CALFED has adopted shallow water and tidal marsh restoration as the centerpiece of its restoration program, yet biologist disagree about the value of these habitats to native fishes and some even argue that creation of shallow water and tidal marsh would harbor exotic predators harmful to native fish. This issue is so fundamental to the future of restoration in the Delta and must be resolved as soon as possible. NHI is collaborating with the Delta Science Center at Big Break in a project designed to simultaneous restore shallow water habitat, learn about the impacts and benefits of shallow water habitat, and educate the public about the promise of restoration in the Delta.

The Big Break restoration site at the Mouth of Marsh Creek is uniquely suited to test the value of shallow water habitat because it can be implemented fairly quickly with few engineering problems and third party impacts. It is one of the few areas in the western Delta that can be restored to tidal marsh offering lessons that can no be learned from restoring tidal marsh on the perimeter of the Delta. Finally, the diversity of elevations and potential microhabitats at Big Break provide an excellent opportunity to study the relative benefits and impacts of different types of shallow water habitat.

c. Sacramento Splittail restoration in the Yolo Bypass

Fish biologists hypothesize that inundated floodplain habitat is very desirable for a variety of native fishes, but this hypothesis is very difficult to test in the field because of the diffuse nature of flood plains and the unpredictable frequency of flood events. The Yolo bypass is an ideal place to test this hypothesis because 1) all fish utilizing the bypass must leave through one point, and 2) the bypass can be operated to flood in a predictable fashion.

NHI has organized a group of scientists, and government land and water managers to restore the frequency of inundated floodplain habitat in the Yolo Bypass as part of a carefully designed experiment to understand impacts and benefits of floodplain habitat. The project will focus on changes in conditions for the Sacramento splittail, a rapidly declining native fish, but will also evaluate the effects on several other species including Chinook salmon. The Sacramento splittail is currently proposed for listing under the Endangered Species Act by the U.S. Fish and Wildlife Service, and listing could result in curtailment of the operation of the south Delta export pumps with significant adverse effects on water supply reliability. Yet, these curtailments would do little to recover the species. What is needed to recover the species the ESA probably cannot compel, namely the creation of shallow water habitat during low flow years to enhance spawning success. The best prospect is to increase the frequency of years in which the Yolo By-Pass is inundated. This will almost certainly have collateral benefits for some additional fish species including, most importantly, several runs of Chinook salmon.

d. watershed science program

Watershed management and river restoration are hot buzzwords, but far too often, well-intended efforts to restore or improve creeks and their watersheds are not based on a scientifically sound understanding of the system, resulting in misguided efforts that are, at best, a misallocation of public resources. In watersheds throughout California, citizens are bursting with energy to implement restoration actions but are lacking the data and knowledge necessary to make informed decisions.

In an effort to productively harness this local enthusiasm for watershed restoration, NHI is working to implement the Watershed Science Program in small watersheds throughout the larger Bay-Delta watershed. The Watershed Science Program can be summarized into the following three basic steps: develop an understanding of the environmental past and how it has changed into the present; based upon the understanding of change, develop quantitative resource objectives for the future; and monitor progress toward the objectives, including the risk factors that may prevent the objectives from being achieved.

NHI is currently launching a watershed science study in Carmen Creek on the North Fork of the Feather River and has submitted a proposal for a similar study on Marsh Creek which drains the backside of Mt. Diablo into the western Delta. These two vastly different watersheds are learning laboratories for increasing our knowledge about the opportunities and problems confronting small watersheds throughout the greater Bay/Delta watershed. Carmen Creek watershed is a degraded upper watershed. Among other things, our study will investigate and quantify opportunities for increasing late season water yield through land management practices and restoration of incised meadow systems. Marsh Creek is a rapidly urbanizing watershed that drains directly into the important western Delta. Our proposed study would evaluate the threats to the Marsh Creek system and the Delta from human activities in the watershed and advance objectives for preserving and restoring the watershed.

APPENDIX 3: Legal Analysis of Groundwater Banking and Retrieval

a. Conjunctive use through import and active recharge.

i. What rights does the program want?

The organizer of the conjunctive use program will enjoy the best legal position to extract the groundwater that it has stored if it is a public agency, if the recharge water is imported, and if the area of origin statutes do not apply. Under these circumstances, the right to extract the stored groundwater enjoys a high priority. Such a right prevails over all rights except in the following circumstances:

- It is inferior to the state-held public trust interest of the people of California, as are all usufructory rights;

- It is of equal priority with pueblo rights, but, since pueblo rights apply only to native water, disputes between the two result in apportionment to the importer of the quantity of groundwater attributable to imports;[79]

- It is of equal priority with other public and private importers in the watershed of destination and use, but disputes between these parties are also resolved by apportioning to each importer "the amounts attributable to the import deliveries of each."[80]

An importer's right to recapture imported recharge water is established by manifesting such intent prior to importation.[81] A conjunctive use program is predicated upon such an intent. Under the conjunctive use arrangements NHI is currently exploring, however, water might be introduced into a groundwater basin at one location and extracted at another some distance away. This raises the question of the hydrologic interconnections that must be maintained between the imported recharge water and the extracted water in order to preserve the importer's preference right. "Imported water" is "foreign water imported from a different watershed."[82] The advantage of obtaining the rights of an importer is that California law gives high priority to these rights in order "to credit the importer with the fruits of his expenditures and endeavors in bringing into the basin water that would not otherwise be there."[83] Under this rationale, it would appear that the area of recharge must be hydrologically connected to the area of discharge such that the program is pumping

[79]. City of Los Angeles v. City of San Fernando, 537 P.2d 1250, ____, 14 Cal.3d at 288 (Cal. 1975).

[80]. City of Los Angeles v. City of San Fernando, 537 P.2d 1250, ____, 14 Cal.3d at 260-62 (Cal. 1975).

[81]. City of Los Angeles v. City of Glendale, 142 P.2d 289, ___, 23 Cal.2d at 78 (Cal. 1943); City of Los Angeles v. City of San Fernando, 537 P.2d 1250, ____, 14 Cal.3d at 257-58 (Cal.1975).

[82]. City of Los Angeles v. City of San Fernando, 537 P.2d 1250, ____, 14 Cal.3d at 261 n.55 (Cal. 1975).

[83]. City of Los Angeles v. City of San Fernando, 537 P.2d 1250, ____, 14 Cal.3d at 261 (Cal. 1975).

groundwater that "would not otherwise be there" but for the recharge. In other words, the two areas must be sufficiently proximate and interconnected so that the recharge water would be expected to replenish the area of discharge within the timeframe of the two events.[84]

The advantage of the program organizer being a public entity is that that status precludes the potential for adverse rights attaching to the program's stored groundwater through prescription. WHILE CAL. CIVIL CODE 1007 (West 1982) literally protects "any public entity" from prescription, the courts have been reluctant to afford the statute its broadest application[85] and may try to limit the definition of "public entity" to exclude some marginal parties. Therefore, care should be exercised in choosing or establishing the program organizer. Further research is needed regarding the outer bounds of the "public entity" definition. For instance, it would be useful to know whether a conjunctive use program organizer that was the creature of a memorandum of understanding between the state and federal government might qualify.

The areas-of-origin protections confer a preference right for local water uses in opposition to export uses. To perfect the right, local users must demonstrate an economic need for the water. NHI's preliminary research has revealed no instances where areas-of-origin rights have been exercised in California to cut off export rights.

ii. What type of groundwater does the program want rights to?

The organizer of the conjunctive use program should seek to obtain rights to groundwater that is percolating, used off-tract, imported to the watershed of use, and required for reasonable beneficial use. The universe of parties with potential claims to such water includes: the people of California through the public trust, and importers, prescribers and appropriators--both private and public.

The public trust is omnipresent. No disadvantage is incurred by using water of this type, since no type of water escapes the reach of the trust.

Prescribers, overlying users, and other importers are not of concern, if water of this type is used. If the organizer of the conjunctive use program is a public entity, as described above, prescribers are eliminated from competition for water imported by the organizer. The only colorable claim of overlying groundwater users to water of type 5 would result if the importer abandoned the imported water once it was in the ground. Neither spreading nor

84. One of the cases holds that it is possible to establish a right to imported water by making deliveries and withdrawals within one's own reservoir and alleging in a complaint that one intended to capture return flow from waters imported into the basin. City of Los Angeles v. City of Glendale, 142 P.2d 289, ___, 23 Cal.2d at 78 (Cal. 1943); City of Los Angeles v. City of San Fernando, 537 P.2d 1250, ____, 14 Cal.3d at 257-58 (Cal.1975). The issue, then, is whether the conjunctive use program would be viewed as delivering and withdrawing water from within the same underground reservoir.

85. *See* City of Los Angeles v. City of San Fernando, 537 P.2d 1250, ____, 14 Cal.3d at 272, 274, 276 (Cal. 1975).

delivery for surface use constitutes such abandonment.[86] Other importers, as noted above, can claim only rights to a quantity of water attributable to their own imports--a situation that does not threaten the operation of a conjunctive use program. Thus, a public importer of water of this type need only be concerned about being displaced by appropriators.

Appropriators have a superior claim to water of this type only if the importer fails to require the water for reasonable beneficial use--that is, if the water is considered "surplus." The burden of proof would be on the would-be appropriator to show that such water was, in fact, surplus.[87] Storage of groundwater for domestic, irrigation, and municipal purposes is typically considered a reasonable beneficial use.[88] Storage of groundwater is a beneficial use if the water is later applied to the beneficial purposes for which the water was first appropriated on the surface.[89] Thus, it is important that, in addition to manifesting an intent to recapture imported waters stored in the ground, the organizer of the conjunctive use program demonstrate that such waters are being stored for later application to reasonable beneficial uses. In this way, the storage itself will be considered beneficial.

Thus, if the organizer of the conjunctive use program holds rights of this type to water of type 5, the program should be able to deposit water in the ground and, by right, withdraw it again.

iii. From what source(s) should the program obtain the water?

One consideration in selecting a source of program water is the fixed capital requirements of the program. If the program requires appreciable new physical infrastructure, the costs of those capital investments will presumably have to amortized by the project itself over a period of time. In that circumstance, the program will require a reliable source of water over that same time horizon. If, by contrast, the program does not require capital investment, the program water can be intermittent or less reliable. Should precipitation, geohydrology, or legal considerations render a once-viable source troublesome, the program can move on to a new source or even take a hiatus. Therefore, an early question to be resolved is whether the program can be based on an interruptible source of water, or does it require a durable source? For instance, if an intermittent supply is sufficient, the preference right conferred by the area-of-origin statutes would be of less importance.

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[86]. City of Los Angeles v. City of Glendale, 142 P.2d 289, ___, 23 Cal.2d at 76-78 (Cal. 1943).

[87]. Miller v. Bay Cities Water Co., 107 P. 115, ___ (Cal. 1910); Allen v. California Water & Tel. Co., 176 P.2d 8, ___ (Cal. 1947) (burden on appropriator to show existence of surplus); Monolith Portland Cement Co. v. Mojave Public Utilities Dist., 316 P.2d 713, ___ (Cal. Ct. App. 1957) (burden on off-tract user to show existence of surplus); 62 Cal. Jur. 3d, Water э 410 (1981).

[88]. Rank v. Krug, 142 F.Supp. 1, 111-12, 113-14 (S.D. Cal. 1956), *affirmed in part and reversed in part*, California v. Rank, 293 F.2d 340 (9th Cir. 1961), *modified upon rehearing*, 307 F.2d 96 (9th Cir. 1962), *affirmed in part*, City of Fresno v. California, 372 U.S. 627 (1963), *overruled*, California v. FERC, 495 U.S. 490 (1990).

[89]. CAL. WATER CODE э 1242 (West 1971).

iv. Where should the program put the water?

To simplify the legal situation, the groundwater storage basin should be composed of percolating strata and be isolated from surface waters, such as streams or the underflow of streams. This would minimize the interplay of various legal doctrines, avoid factual disputes, and make the legal outcomes more predictable. As a result, the participants in the program will feel more secure about their rights.

Many California cases determining groundwater rights turn on geohydrologic characteristics of the groundwater aquifers. In addition to locating a storage site that is factually simple, it would be useful to locate one that is scientifically well-studied; ideally, one where the pertinent scientific facts have been determined in prior adjudications. Such prior judicial fact finding may not be binding on parties to any future suit but would at least serve as an advance indicator of what the program might expect from future litigation.

v. What parties should be involved?

The program organizer should seek contractual arrangements with parties owning land overlying groundwater since they may possess both spreading grounds and a right to extract groundwater. Their participation and cooperation may be secured by sharing the benefits of the program with them.

b. Conjunctive use through in-lieu storage

A program of conjunctive use involving in-lieu storage outside of southern California would be more difficult to achieve. Under an in lieu system, the program would enter into arrangements with overlying landowners who already have access to both groundwater and surface water sources. During periods when the program desires to recharge groundwater, the landowners would forego pumping and accept a substitute surface delivery from the program instead. Then, when the program desires to withdraw groundwater, the landowner would curtail its surface water use and substitute groundwater pumping.

The basic problem with such an arrangement is that the program will not be withdrawing groundwater that it has put into the aquifer through an active recharge program. Instead, it will cause groundwater rights holders to forego pumping water that they are otherwise legally entitled to extract in some years, and offset that forbearance by drawing more heavily on the aquifer in other years. The problem is that the contracting landowners have no better right to the underlying groundwater than do all of the other landowners overlying that same aquifer. The rights are "correlative", that is, of equal stature and limited by the principle of mutual avoidance of harm. Thus, in years of forbearance, the other pumpers would be entitled to extract the water that the program intended to store. In years of extraction, the contracting landowner's rates of withdrawal may impair the rights of the correlative pumpers. Recognizing in the organizer a superior right to groundwater stored when surface water is used in-lieu, would involve upsetting an established set of property rights and investment-backed expectations, something courts are typically loathe to do.

This problem may be avoided where groundwater basins have been adjudicated such that the particular extraction rights have been quantified. This is the situation with a number of groundwater basins in southern California.

The technique of in-lieu storage can be used outside southern California, but special arrangements will be necessary. There are several potential approaches:

- The correlative rights problem can be avoided by bringing <u>all</u> of the correlative rights holders into the contractual arrangement, or mitigated by bringing most of them into it. The ability of any one rights holder to upset the program by withholding consent remains, however.

- The program could be operated in a manner that would presumptively avoid injury to correlative rights holders by foregoing pumping for a period sufficient to assure that when accelerated pumping occurred, it would not disadvantage the correlative rights holders compared to the status quo. That might mean designing the program so that the number of sequential years of accelerated pumping was limited.

- Special legislation might be enacted to preclude suits against the program by non-contracting landowners where the groundwater that the program causes to be extracted in any one year was limited to amounts that could have been extracted in any previous year but for the forbearance imposed by the program. This would be a legislative interpretation of the "no harm" rule as applied in the narrow context of an in lieu conjunctive use program. While a general groundwater management regime may be beyond reasonable legislative expectations, a modest enactment of this sort may be realistic.