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A Self-Regulating, Inclusive and Sustainable Solution for the Sacramento San Joaquin Delta

December 17, 2012, Updated May 17, 2013

The Delta

The Sacramento San Joaquin Delta is a remarkable place of enormous environmental, economic and cultural significance. In multiple ways it is the crossroads of California.

It is the location where the waters of two once-mighty rivers originating in the Sierra Nevada meet the salt waters of the Pacific Ocean that enter through San Francisco Bay. This estuarine environment is the heart of a food web that supports both aquatic species that live in the Delta and the salmonids that pass through the Delta on their journeys to the sea and back again to spawn upstream.

Because the junction of the rivers takes place on the inland side of the Coast Ranges, an inland delta with thick deposits of peat was formed over the last 10,000 years as sea level rose tens of feet. The peat marshes and tortuous waterways that resulted formed an environment that was extremely hospitable to many terrestrial as well as aquatic species. But, after the discovery of gold in the foothills of the Sierras, these impenetrable marshes, which were inhospitable to European settlers, gave way to the shipping trade routes that supplied the original forty-niners. Then, the combined efforts of the state and federal governments led to the draining of the swamps and the creation of dredged channels, a system of levees and prime agricultural lands.

Land subsidence, which resulted from early farming operations, led to some islands and tracts with land surfaces below sea level. Today, ocean-going vessels pass on a water surface that is elevated above fields of corn, alfalfa, asparagus, blueberries and tomatoes. The economic output of Delta agriculture is approximately $5 billion and the Ports of Stockton and West Sacramento are vital to the economies of those cities and to the Central Valley. In addition to the two shipping routes, the Delta is bordered by three interstate highways and crossed by three state highways and the BNSF railroad.

Natural gas from as far away as Canada and from local gas production fields within the Delta is stored under McDonald Island for distribution to the surrounding metropolitan areas. Twenty percent of California's natural gas-powered electricity is generated in the Delta region. Electric power from Washington State is carried to the northern outskirts of Los Angeles by the WAPA power lines. Numerous other electric power lines cross the

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Delta. Liquid fuel pipelines crossing the Delta also supply large portions of Northern California and Nevada

Fifty marinas and campgrounds provide recreational opportunities for the surrounding metropolitan areas of the San Francisco Bay Area, Sacramento and Stockton. The Delta receives three times as many visitor days per year than Yosemite National Park. While presently modest in scale, the patchwork quilt of fields and the meandering waterways, the migrating wildfowl, the ebb and flow of the tides, the sunsets over Mt Diablo and the legacy communities of the Delta, offer great potential for additional tourism, including eco-tourism, that is consistent with the lifestyle that Delta residents currently enjoy.

For better or worse, the Delta is also the crossroads of water supply in California with "surplus" water in the Sacramento River being drawn across the Delta by the pumping plants in the South Delta for export to the South Bay, the San Joaquin Valley, and over the Tehachapi Mountains to Southern California. The East Bay Municipal Utility District and the San Francisco PUC divert water upstream of the Delta and EBMUD's Mokelumne Aqueduct crosses the Delta. The pumping plants of the Contra Costa Water District, the East Contra Costa Irrigation District and other Delta agricultural water districts take water directly from the Delta.

The geography of the Delta was changed forever by reclamation. However, a relatively stable modified ecosystem was created in which, for instance, salmon and striped bass co-existed for many years. But that modified ecosystem is now threatened by multiple stressors at the same time that water exporters are seeking to maintain exports at a higher level than was the case prior to the turn of the century. So, we are at another kind of crossroads with two opposing caravans, neither of which wants to yield the right-of-way.

Hydrological Background

What are now known as the State Water Project (SWP) and the Central Valley Project (CVP) were created in response to a six-year drought in California from 1928-1934. In more recent times we have come close to having two additional six-year droughts although in each case a single wet year or wet month staved off disaster - and this was before the last housing boom and the conversion of large swaths of the Central Valley to permanent crops. The other side of the coin is that it started raining on Christmas Eve in 1861 and the rain continued virtually unabated for 43 days. An estimated one-quarter of California's cattle perished in a vast inland sea and Sacramento was flooded to a depth of 10 feet. Recent geologic studies suggest that such storms have occurred about once every two or three centuries over the last millennium.

The pattern in California precipitation of bunches of wet years and bunches of dry years, or droughts, is illustrated in Figure 1, which was developed for the Delta Vision effort.

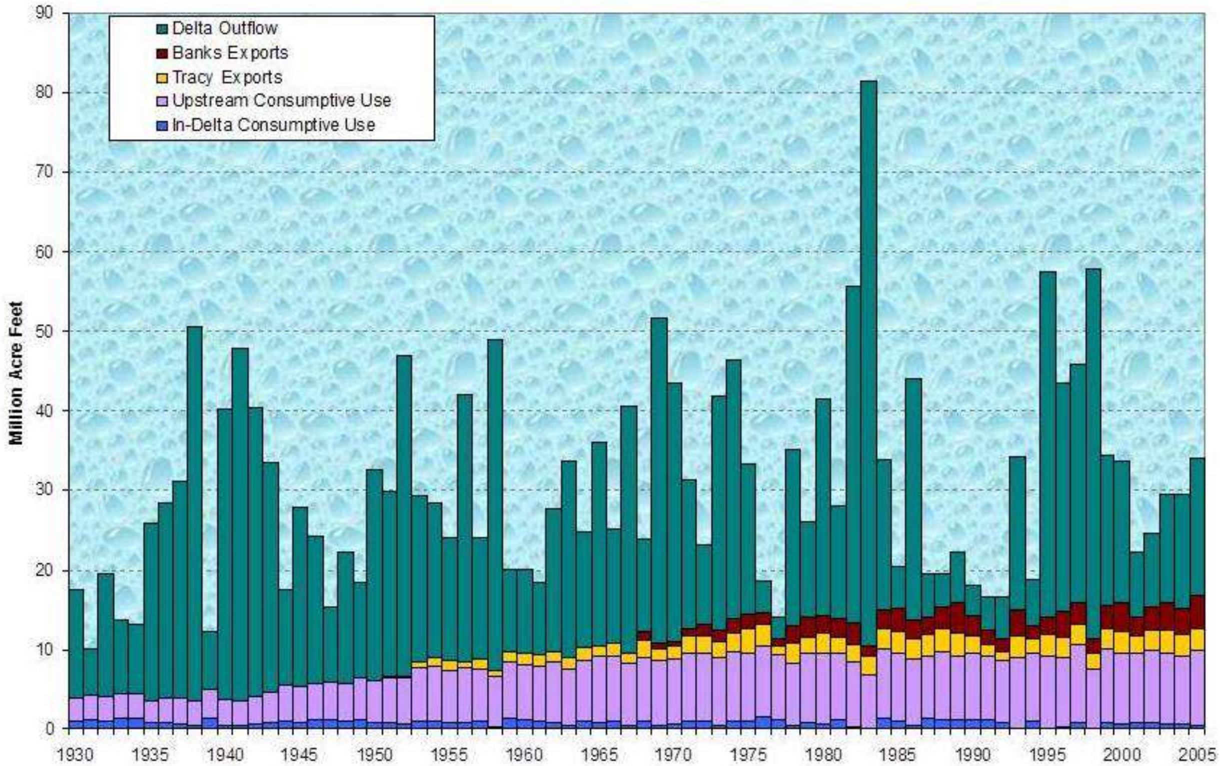

Figure 1 – Sacramento – San Joaquin Rivers Flow and Usage

It can be seen in Figure 1 that the combination of upstream diversions and in-Delta use was only a fraction of the total flow in the rivers, even in drought years, for the first half of the last century. It is only in the second half of the last century, when the CVP and the SWP start operating in earnest, that the total diversions grow to well over half the natural flow in the rivers and approach the entire natural flow in the worst years. The State Water Board has opined that, based on worldwide observations, the ecosystem is damaged if any more than 25 percent of the natural flow is taken out of a river but you do not have to be a highly trained ecologist to conclude that the pattern shown in Figure 1 is alarming. Clearly there is not enough water to go around in dry years.

So, while it is often said that the dominant feature of water supply and use in California is that the supply is in the north of the state while the greater part of the demand is in the south of the state, the fact that the supply is extremely variable is equally important.

An oddity that can be observed in Figure 1 is that in very wet years, such as 1983 or 1998, the total diversions are smaller than usual. That occurs for the obvious reason that in those years there is water, water everywhere, but isn't that when greater volumes of water should be diverted and placed in storage?

A final observation that can be made about Figure 1 is that there are three big bumps in precipitation and river flows in the late sixties through the early seventies, the late seventies and the early eighties, and the late nineties. These all correspond to periods of much higher salmon runs. While it is true both that there are multiple stressors impacting the river-Delta-Bay ecosystem and that ocean conditions for salmon might also have been better during those same periods, the conclusion that more water is good for fish is inescapable. The corollary of that is that efforts to create improved habitat and food supply for fish without increased flows are unlikely to be successful.

Historical Background

The state legislature passed the Central Valley Project Act in 1933. The act authorized the sale of revenue bonds to construct the project, but during the Great Depression, the bonds didn't sell. With the Rivers and Harbors Act of 1935, the federal government assumed control of the project and its initial features were authorized for construction by the U.S. Army Corps of Engineers. Funds for construction of the initial features of the Central Valley Project were provided by the Emergency Relief Appropriation Act of 1935. The project was authorized by a finding of feasibility by the Secretary of the Interior and approved by the President on December 2, 1935, for construction by the Bureau of Reclamation. When the Rivers and Harbors Act was reauthorized in 1937, Reclamation took over CVP construction and operation.

The "peripheral canal" of some sort has been included in discussion of California water transfers since at least the 1940s. For instance, the Bureau of Reclamation proposed a Folsom-Newman Canal that would divert water from the American River near Folsom Dam, and a "Hood-Clay Pump Canal" would divert Sacramento River water in the north Delta to the Folsom-Newman Canal. This water would then flow by gravity south to a point on the Delta Mendota Canal near San Luis Reservoir.

A peripheral canal was not included in the initial features of the State Water Resources Development System, subsequently called the State Water Project, as defined by the Burns-Porter Act which was approved by the voters on November 8, 1960. However, by 1964 an Interagency Delta Committee had recommended “the transfer of water for export through a new hydraulically isolated channel around the Delta, with the present level of salinity control accomplished by a continuation of moderate releases from upstream storage reservoirs. Irrigation water of adequate quality would be provided for the Delta by a combination of controlled freshwater releases from the canal and overland water facilities in the western Delta.” The Committee’s “Plan of Development for the Sacramento-San Joaquin Delta” provided for local water supply, flood control, salinity protection, fish and wildlife, recreation, and navigation in the Delta, as well as water conservation and transfer of water across the Delta for state and federal export.

The plan centered on the peripheral canal concept but also included several other components to fulfill all of the planning objectives. This peripheral canal was subsequently adopted as the Delta Water Facility of the State Water Project.

However, it is critically important to note this plan assumed increased diversions from the north coast sources, as described in Department of Water Resources Bulletin No. 76, Delta Water Facilities, December, 1960. This Bulletin preceded the work of the Interagency Delta Committee, examined alternatives for Delta Water Facilities which included a semi-isolated conveyance along the North Fork of the Mokelumne River and a master levee system, but not a peripheral canal as such. Page 11 of the Bulletin explains the need for water from north coastal sources and has a chart showing the projects and the timing of need which is reproduced as Figure 2.

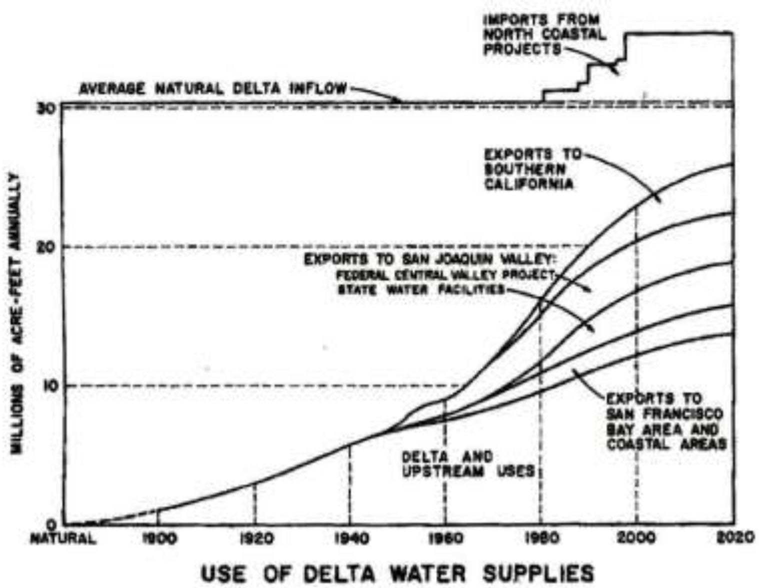

Figure 2 – 1980 Projection of Average Delta Inflow and Usage

Bulletin No. 76 explained that "full demands on the State Water Resources Development System can be met until 1981 from surplus water in and tributary to the Delta with regulation by the proposed Oroville and San Luis Reservoirs. However, upstream depletions will reduce the available surplus supplies and water will have to be imported from north coast sources after that year" and "economic development of water supplies will necessitate importation of about 5,000,000 acre-feet of water seasonally to the Delta from north coastal streams to areas of deficiency." It also notes that "in 1959 the State Legislature directed that water shall not be diverted from the Delta for use elsewhere unless adequate supplies for the Delta are first provided."

It is interesting that Bulletin No. 76 placed equal emphasis on water supply, Delta water quality, fishery resources, flood and seepage control and transportation and recreation.

And, although the impact on the overall ecosystem was not considered in the same way that it would be today, it was recognized that diversions from north coast sources were required to maintain some semblance of natural flow through the Bay-Delta estuary. In effect, exports would be supplied by these north coast sources rather than by the precipitation in the Sacramento and San Joaquin basins.

Of course this plan would have decimated the ecosystems of the northern rivers, thus, then-Governor Jerry Brown, acting on the advice of DWR Deputy Director Jerry Meral, did the right thing back in 1980 by renouncing those diversions forever and lobbying for the inclusion of the northern rivers in the federal Wild and Scenic Rivers Act. At the same time they shot themselves in the foot relative to "the Canal" and a referendum on the legislature's authorization of a peripheral canal in AB 200 was defeated in June 1982 by a vote of 63 to 37 percent of the electorate.

In summary, the peripheral canal idea of the 1960's included two really important considerations that are no longer included in the Bay Delta Conservation Plan (BDCP), which is the current attempt to construct an isolated conveyance and to obtain 50-year incidental take permits under the state and federal Endangered Species Acts. The 1960's plan included the diversions from north coast sources to maintain flows through the estuary and it provided for intermediate release facilities to maintain water quality in the Delta.

The Current Status

In the absence of the once planned diversions from the Northern Rivers, too much water is extracted from the Delta in dry years. Coupled with increased contamination from urban and agricultural waste water and poor ocean conditions, this led to a precipitous decline in some aquatic species, known as the Pelagic Organism Decline (the POD), in the first decade of this century. But there is also the fundamental flaw that the export pumps are simply in the wrong place because the north–south water transfer crosses the east-west salmon passage and because the pumps are located at the dead-end of intake canals from which fish have no escape. While something like 15 million fish are "salvaged" at the existing fish salvage facilities each year, many of the salvaged fish do not survive their transport by truck back to the Western Delta and some fish still pass through these facilities and are sucked into the pumps. Even construction of modern fish screens may not help very much as long as the incoming current is perpendicular to the screens.

However, the POD did trigger an appropriate general response first from the then-Governor who established the Delta Vision Blue Ribbon Task Force and then from the

State Legislature, which enacted the Sacramento-San Joaquin Delta Reform Act of 2009. While typically vague with respect to details, the Delta Reform Act did put into law the concept developed by Delta Vision that the goals of providing a more reliable water supply for California and protecting, restoring and enhancing the Delta ecosystem were co-equal. Further, the Delta Reform Act says that the co-equal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place. And the Delta Reform Act states rather clearly that "the policy of the State of California is to reduce reliance on the Delta in meeting California's future water supply needs through a statewide strategy of investing in improved regional supplies, conservation, and water use efficiency."

The federal Central Valley Project Improvement Act of 1992 had also amended previous authorizations of the Central Valley Project to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic uses. That Act also established fish and wildlife enhancement as a project purpose equal to power generation, although progress on implementing these new provisions has been slow.

Thus, the overall framework for a twenty-first century solution is clear, but the goals are not quantified and there is no physical plan to accomplish the stated goals.

The Way Forward

Given the pattern of precipitation and history described above, it would seem that there are two keys things that should be recognized with respect to addressing the problems that the Delta is facing. These are the facts that:

1. Manmade alteration of the Delta in combination with larger export flows has turned the Delta from an estuarine environment into a more lacustrine environment which favors invasive species over native species; and

2. Precipitation in California is extremely variable and not just the past variability, but also future variability, which many climate scientists predict might be greater, must be addressed in any sustainable water management plan.

There are six principles that should be incorporated in any detailed solution:

1. That natural flows through the Delta should be restored to the maximum practical extent, both in terms of quantity and the pattern of flow;

2. That much less, or zero, water should be extracted at periods of low flows, and only water available during periods of higher flow that is surplus to the needs of Delta farmers and the Delta ecosystem should be exported;

3. That additional South of Delta storage should be constructed in order to bank the greater than average amounts of water that could be extracted in wet years;

4. Project operations should be self-regulating and not rely on complicated legal assurances or guarantees which are difficult to enforce;

5. The Project should be relatively simple to design, permit and construct.

6. The Project should not have physical facilities which intrude on the character of the Delta

Adherence to these principles, with appropriate pumping and temporary storage facilities, will allow simultaneous recovery of the Delta ecosystem and sustainable exports at existing levels.

Does the BDCP Solve the Problem?

The apparent preferred conveyance alternative that is currently included in the BDCP consists of three 3,000 cfs intakes located along the Sacramento River between Freeport and Courtland, a large forebay near Hood, and 37-mile long twin tunnels that will take water by gravity flow to the vicinity of the existing South Delta pumping plants. The intakes will be provided with modern fish screens but the design of these fish screens is yet to be finalized and tested. Because use of the Sacramento River intakes will be limited by stringent bypass flow requirements, significant export flows will still be drawn across the Delta to the South Delta pumps but the BDCP includes no provision for channel or levee improvements.

Does this conveyance alternative help solve the overall problems of the Delta or even the problem of providing more reliable exports? The short answer is no. It provides some guarantee of better water quality, which is of particular importance to urban water users or wholesalers like the Metropolitan Water District of Southern California because it helps keep treatment costs down and helps maintain agency competitiveness relative to other sources of supply, but it does little else. Extracting significant amounts of water from the North Delta will not contribute to restoring more natural flows through the Delta. Lower flows in the Delta rivers and channels is not an improvement over the current cross flows. And the BDCP includes no mechanism for extracting more water in wet years to make up for extracting less water in dry years. To the contrary, the BDCP potential preferred alternative of February 2012 relied on reducing Delta flows during drier months to meet export water supply demands[1]. Also, the current situation wherein fish get sucked towards or even into the South Delta pumps would be somewhat improved by the BDCP if the South Delta pumps are in fact operated less frequently, but would not be eliminated. BDCP modeling suggests that during certain periods all of the exports would continue to be "through Delta" and none would be diverted via the new isolated facility.

A Concept that Does Solve the Problem

A concept known as the Western Delta Intakes Concept (WDIC) that would solve the current problem is illustrated in Figure 3. It contains six physical elements:

1. Restoration of floodplains on the Sacramento and San Joaquin Rivers and their tributaries in order to provide flood storage and stretch out the flood hydrograph in addition to providing significant flood management benefits; the only specific restoration candidate at present is the proposed Lower San Joaquin Bypass, which is now included in the BDCP and is worthy of support.

2. Location of new intake facilities somewhere in the Western Delta to allow flows to pass through the Delta in a natural way before surplus flows are extracted; the specific proposal is to use much of Sherman Island as an intake forebay; the peat underlying the forebay would be removed by hydraulic dredging and used to create tidal and subtidal habitat on the western end of Sherman island and in the vicinity of the submerged portion of Sherman Island; the peat removal is driven by drinking water quality considerations but would also allow natural infiltration of water into the Sherman Island forebay from the adjacent rivers. In order to provide an inflow capacity of up to 15,000 cfs, the levees along the Sacramento and San Joaquin Rivers would be replaced by permeable embankments; the approach velocities to these permeable embankments would be 100 times slower than the maximum approach velocities used in the current design of fish screens; in normal conditions with relatively low flows in the San Joaquin River, water would be extracted only at Sherman Island; no water would be extracted at Sherman island if Delta outflows drop below the level needed to keep X2 well west of Sherman Island ensuring that chloride and bromide levels in the exported water are kept below acceptable levels; the Delta Cross Channel gates would be

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[1] See Table C.A.-34 on page C.A-110:
http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/BDCP_Effects_Analysis_-_Appendix_5_C_Attachment_C_A_-_CALSIM_and_DSM2_Results_4-13-12.sflb.ashx

converted into to a boat lock in order to prevent Sacramento River salmon being diverted into the Delta.

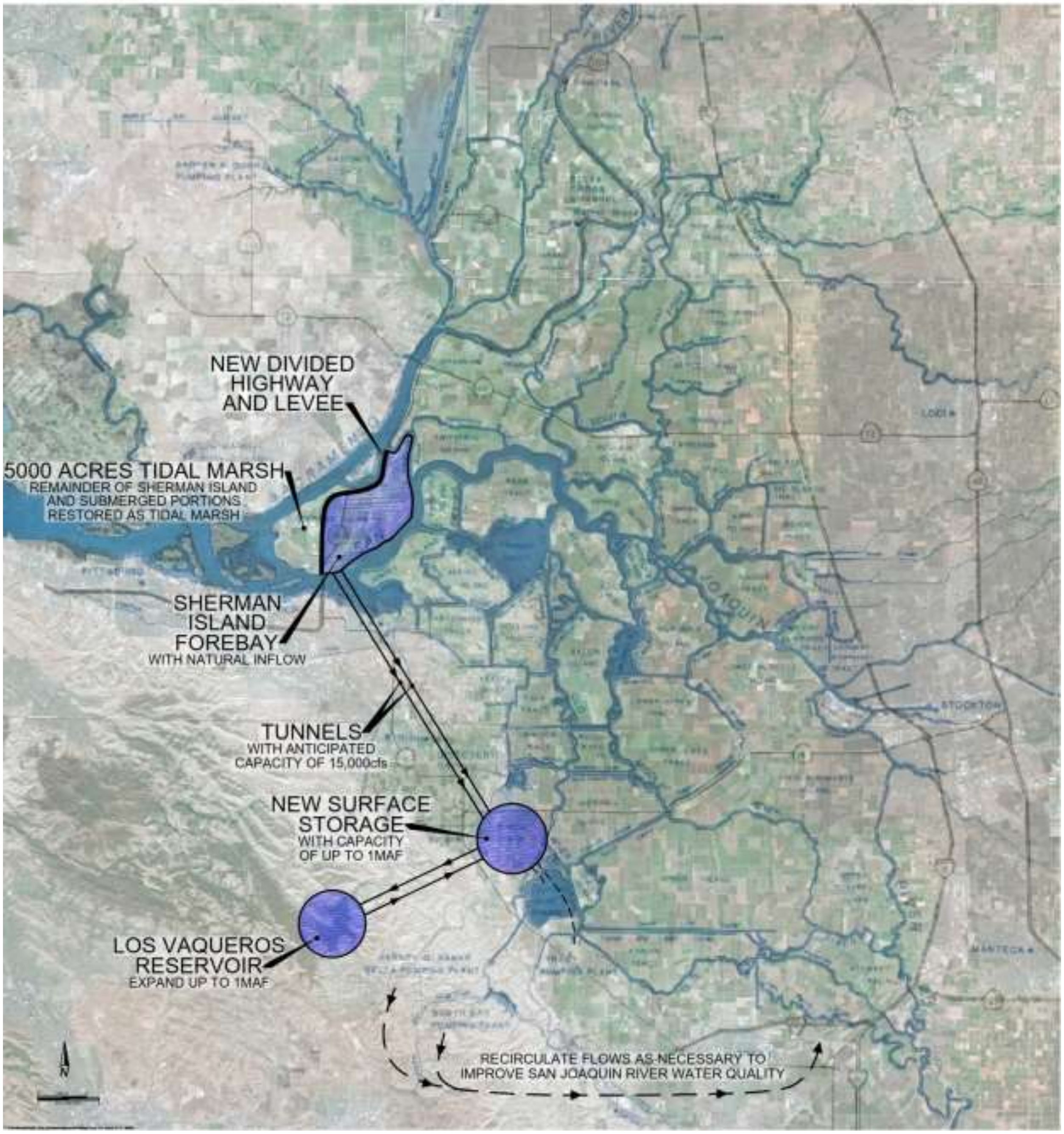

Figure 3 – The Western Delta Intakes Concept

3. Construction of a pumping station and one or more tunnels to extract water from Sherman Island and move it to new forebays for the existing South Pumps and

new storage facilities that would be located adjacent to the existing Clifton Court Forebay; these storage facilities would likely consist of a new Brushy Creek reservoir and a further enlargement of the existing Los Vaqueros reservoir; a pumped storage hydro-electric facility could be constructed between these two reservoirs so that the project could be energy neutral or positive.

4. During periods of very high flow in the San Joaquin River, the new intakes and the existing South Delta pumping plants with new screened intakes along the Old River would be used simultaneously; with the Banks and Jones pumping plants in the South Delta operating at their full capacity of 15,000 cfs, which they have never done in the past because of restrictions on operation of the Banks pumping plant, the combined rate of extraction could then be as much as 30,000 cfs; when the Banks and Jones pumping plans extract water from the South Delta, water extracted at Sherman Island would be stored in the Brushy Creek and Los Vaqueros reservoirs as necessary until Banks and Jones pumping capacity becomes available to move this stored water south.

5. Additional south-of-Delta storage would be constructed in order to store the surplus water that would be extracted in wet years, mostly in currently drawn-down groundwater basins but also perhaps including new Westside surface storage.

6. In order to maintain South and Central Delta water quality, a lined canal would be constructed to allow freshwater to be recirculated from the state and federal aqueducts into the San Joaquin River above Vernalis as necessary.

Environmental Restoration Elements

The WDIC includes the following environmental restoration elements:

1. Restores a more natural flow regime through the Delta.

2. Extracts surplus flows only after they have passed through the Delta.

3. Ensures that a greater flow and fresher water enters the Delta from the San Joaquin River.

4. Creates new tidal and sub-tidal habitat at the western end of Sherman Island.

5. Adds 10 miles plus of shaded riparian habitat.

6. Funds a world-class biological and water quality monitoring system throughout the Delta.

The WDIC is also intended to be complementary with renewed dredging of Delta channels, restoration of the mid-channel berms and a comprehensive program to further upgrade Delta levees that includes the development of semi-continuous shaded riparian habitat.

The concept does not directly include but would be supportive of other restoration measures, such as those at the lower end of the Yolo Bypass in the vicinity of Liberty and Prospect islands, which are already planned by others, construction of the Lower San Joaquin Bypass, and restoration of Franks Tract.

Rather than seeking incidental take permits using analyses that are not validated and verified, the WDIC would comply with the state and federal endangered species acts by simply not taking endangered species.

Additional Considerations

The WDIC can stand on its own but it is nonetheless intended to be part of a comprehensive solution to California's water supply challenges that includes greater regional self-sufficiency that might involve and further conservation and water use efficiency measures, recycling of waste water, reclaiming of storm water and desalinization of both brackish and seawater.

The WDIC is also intended to be compatible with longer-term strategies for flood risk management including the addressing of further sea level rise and to be compatible with future transportation needs and land-use in the Delta. In other words, it is consistent with a sustainable long-term vision for the Delta and California.

The WDIC does not rely on unsupported expectations that new habitat in the Delta will benefit fish in the absence of suitable flows or vague promises of adaptive management, but its operations can be fined tuned as a result of long-term observations obtained from the monitoring system. The WDIC is compatible with our best understanding of environmental science, engineering and economics but, more than anything-else, it is driven by commonsense.

By retaining the ability to operate the South Delta pumps, the WDIC does not put all the eggs in one basket but allows temporary flexibility of operations should unexpected conditions arise.

Comparison of Alternatives

It is not possible to do a complete comparison of the WDIC and the BDCP in this relatively brief paper, but their features can be compared in a general way, as shown in Table 1.

	WDIC	BDCP	DESP
Cost	Middling	Highest	Lowest
Protects Delta from salt water intrusion	Yes	No	Yes
Provides more sustainable export water supply	Allows sustained average exports in the order of 6 maf per year on average	Lower exports, maybe 4.7 maf, and no provision for a six-year drought	Even lower exports, maybe 4.2 maf, and no provision for a six year drought
Restores more natural flow through the Delta	Yes	No	No
Takes little or no water in periods of low flow	Yes	No	No
Maintains both export and Delta water quality	Yes	Marginal	Marginal
Creates new habitat	Yes	Yes	Yes
Self-regulating	Yes	No	No
Simple to design, permit and construct	Yes	No	Yes
Negative impacts on the Delta as a Place	No	Yes	No
Negative impacts on Delta agriculture	No	Yes	No
Includes flood control benefits	Yes	No	Yes
Contributes to improved transportation	Yes	No	No

Table 1 – Comparison of Alternatives

The colored backgrounds in each cell indicate the relative success of each alternative with regard to the issues listed in the left-hand column, green indicating more success and red indicating less success or that the issue is ignored. The relative importance of the various issues could be indicated by varying the height of each row although that has not been done in this presentation. But, if that were done, cost in particular should likely be given more weight.

Table 1 also includes a loosely-defined alternative that is labeled the DESP. This is an alternative that is minimally intrusive to the Delta as a Place. It is based on the recommendations of the Economic Sustainability Plan developed by the Delta Protection Commission[2]. The DESP alternative includes full implementation of the levee upgrades that are recommended in the Economic Sustainability Plan and habitat improvements that are compatible with existing farming operations. The DESP addresses head on the major reasons often cited in the media as justification for an isolated conveyance such as that proposed under the BDCP, which is that the Delta levees might explode or dissolve in a large earthquake leading to saltwater intrusion that might interrupt water exports for as long as three years. That scenario is hyperbole and is not supported by recent DWR studies of the consequences of even a worse than worst case levee failure scenario. However, the peer-reviewed Economic Sustainability Plan pointed out that a further-improved levee system would not only address the hazards to water exports posed by earthquakes but also would provide improved flood protection, would allow planting on the water side of levees to create shaded riparian habitat, and could be constructed for between $2-4 billion. While the Economic Sustainability Plan, which is directed solely to economic sustainability of the Delta, does not address all current problems of the Delta, it is a far cheaper and less intrusive solution to the perceived earthquake problem than constructing twin tunnels under the Delta for $14 billion and it is far more cost-effective because levee improvements serve multiple purposes.

Even without more detailed scoring and weighting, it is clear that the BDCP comes in third among these three alternatives on both positive rather than negative impacts and benefit-cost. More detailed studies would be required to determine whether the WDIC or the DESP wins on benefit-cost.

The DESP can in fact be viewed as a "no regrets" first stage of the WDIC. The DESP components can and should be funded for immediate construction while the water exporters figure out whether they can afford the additional cost of the full WDIC. Regardless, the WDIC offers greater benefits at a lower cost than the emerging BDCP preferred alternative. The WDIC therefore must be considered in any evaluation of alternatives that is required under NEPA or CEQA and in any comparative benefit-cost analyses undertaken as part of the BDCP development.

[2] http://forecast.pacific.edu/desp.html

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Addendum to "A Self-Regulating, Inclusive and Sustainable Solution for the Sacramento San Joaquin Delta", December 17, 2012

February 24, 2013, Updated May 8, 2013

The referenced 14-page white paper outlines a comprehensive solution to the current problems of the Sacramento - San Joaquin Delta called the Western Delta Intakes Concept (WDIC). The white paper introduced the concept that in normal to dry years, water would be extracted from the Delta only through a new forebay constructed on the eastern two-thirds of Sherman Island into which water would be drawn during periods of extraction through "permeable embankments that would replace the existing levees along the Sacramento and San Joaquin Rivers; the approach velocities to these permeable embankments would be 100 times slower than the maximum approach velocities used in the current design of fish screens". While the intent to make extraction of water as invisible as possible to migrating fish, including both salmonids and Delta smelt, was clear, this language failed to explain two other important considerations, one involving the fact that the existing levees would be left in place, both to provide added protection to the new embankments and to create new riparian habitat, and the other involving the small proportion of total flow at Sherman Island that would be extracted.

Details of Permeable Embankments

The general layout of the WDIC is shown in Figure 1. More detail of the proposed permeable embankments and levees is shown in this figure than in Figure 3 of the white paper. New permeable embankments would be constructed inside the existing levees along approximately 22,000 feet of the Sacramento River and 31,000 feet of the San Joaquin River and would constitute the world's largest and finest fish screens. The permeable embankment on the Sacramento River side would have a crest width of 100 feet in order to allow the improvement of State Highway 160 to a dual carriageway with 2 lanes in each direction. A new levee with a crest width of 100 feet would connect the western end of this embankment to the Antioch Bridge. The existing levee along 3-Mile Slough at the eastern end of Sherman Island would be improved to the "fat levee" standard with a crest width of 50 feet as suggested in the Delta Protection Commission's Economic Sustainability Plan. The permeable embankment on the San Joaquin River side would have a matching crest width of 50 feet. The existing levees would be intermittently breached to allow flow of water to and through the new permeable embankments.

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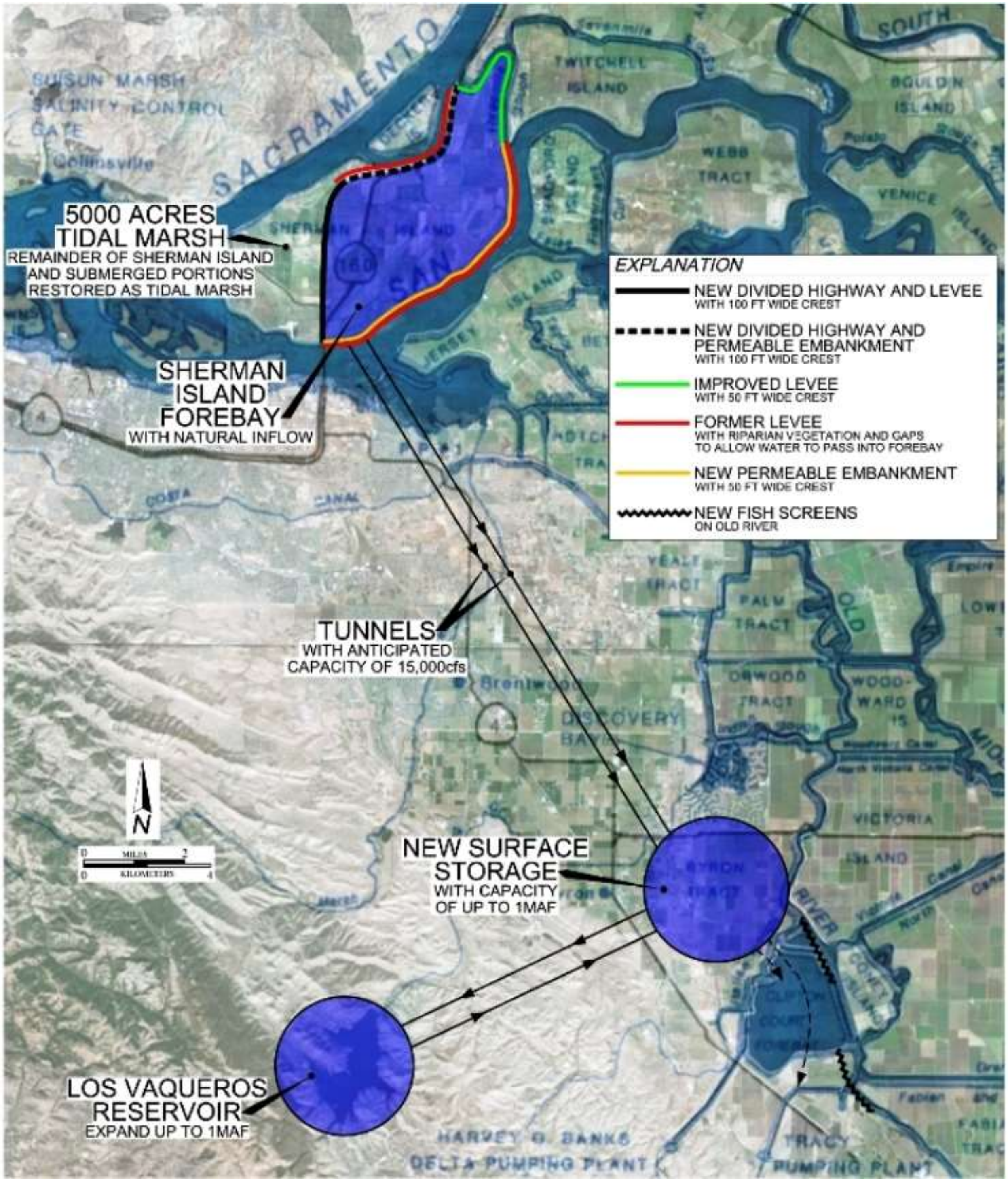

Figure 1 – The Western Delta Intakes Concept

The former levees would then be reconfigured as necessary and planted with appropriate vegetation to provide both erosion protection and riparian habitat. A schematic cross-section through the new permeable embankments and the former levee is shown as Figure 2.

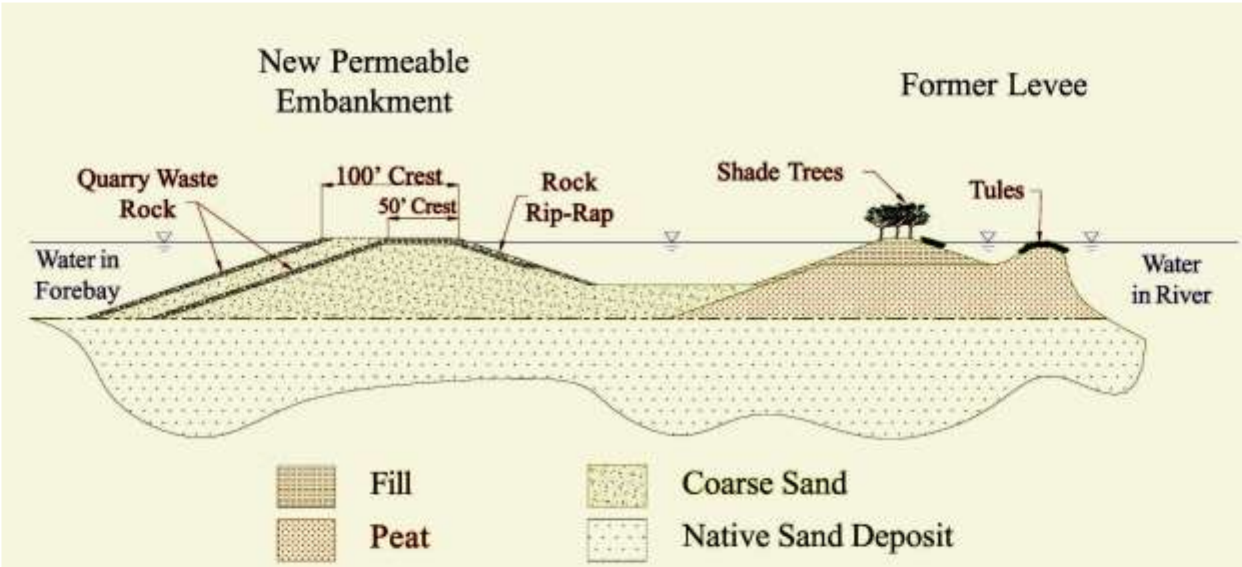

Figure 2 – Cross Section through Permeable Embankment

Of the three materials required for construction of the permeable embankment, only the quarry-waste rockfill needs to be imported. The heavier rock rip-rap would be salvaged from the existing levees and the coarse sand would be obtained from the interior of Sherman Island. The peat inside the forebay would be removed using hydraulic dredging techniques prior to the construction of the new embankments and would be used to create up to 5,000 acres of tidal marsh to the west of the forebay. The coarse sand would also be placed using hydraulic techniques and compacted as necessary in order to make it highly resistant to liquefaction. The maximum pore size in this material would be less than 1 mm, smaller than even Delta smelt eggs and much smaller than the juvenile Delta smelt that was downstream to the mixing zone in Suisun Bay following spawning upstream. Figure 3, from Bennett (2005)[1], shows schematically the size of Delta smelt at various stages during their short life. Thus not even migrating Delta smelt would be at risk of being sucked into these embankments. In fact it can be said zero fish will be taken with this arrangement, as opposed to the up to 15 million fish a year that are sucked into the South Delta salvage facilities.

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[1] Bennett, William A., Critical assessment of the delta smelt population in the San Francisco Estuary, California. Journal Issue:San Francisco Estuary and Watershed Science, 3(2) http://escholarship.ucop.edu/uc/item/0725n5vk

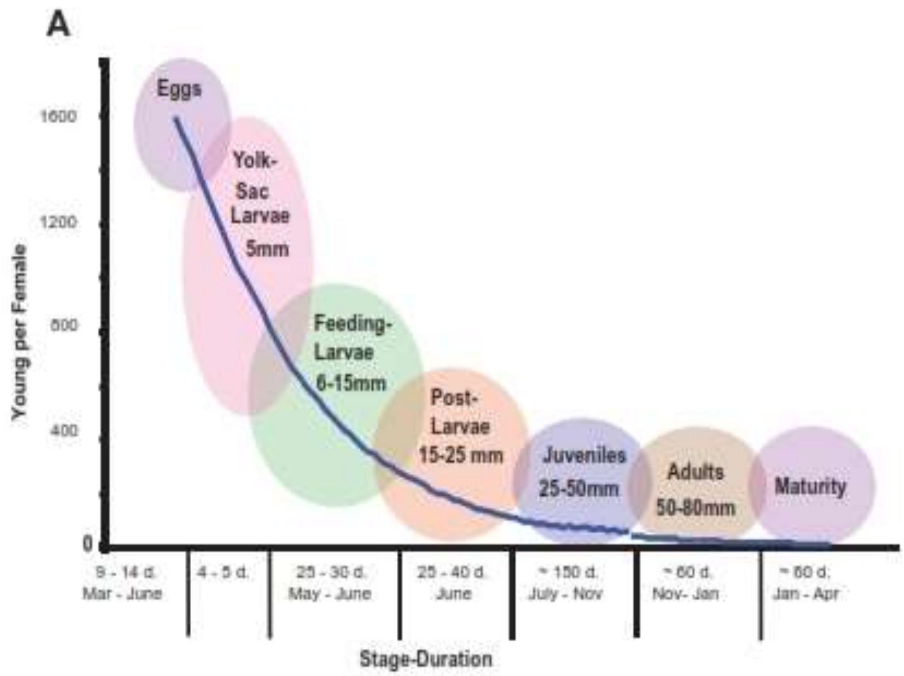

Figure 3 – Sizes of Delta Smelt

Magnitude of Flows at Sherman Island

In order to illustrate the second of the additional considerations noted above, flows measured in March 2011 in the San Joaquin River at Jersey Point, across the river from Sherman Island, are shown in Figure 3. . Even with relatively high flows in the San Joaquin River, the natural flow in the river is dwarfed by the tidal flows. At periods such as this, when under the WDIC 15,000 cfs might be extracted both from the Old River and at Sherman Island, the half of the 15,000 cfs drawn into Sherman Island on the San Joaquin River side would be only a small fraction of the total flow passing Sherman Island.

In addition to the fact that the approach velocities of water drawn through the permeable embankments would be very small, for much of the day there would also be good “sweeping velocities” as a result of the tidal and river flows being parallel to the permeable embankments. Moreover, because of the dominance of the tidal flows, these sweeping velocities are not uni-directional but are reversing.

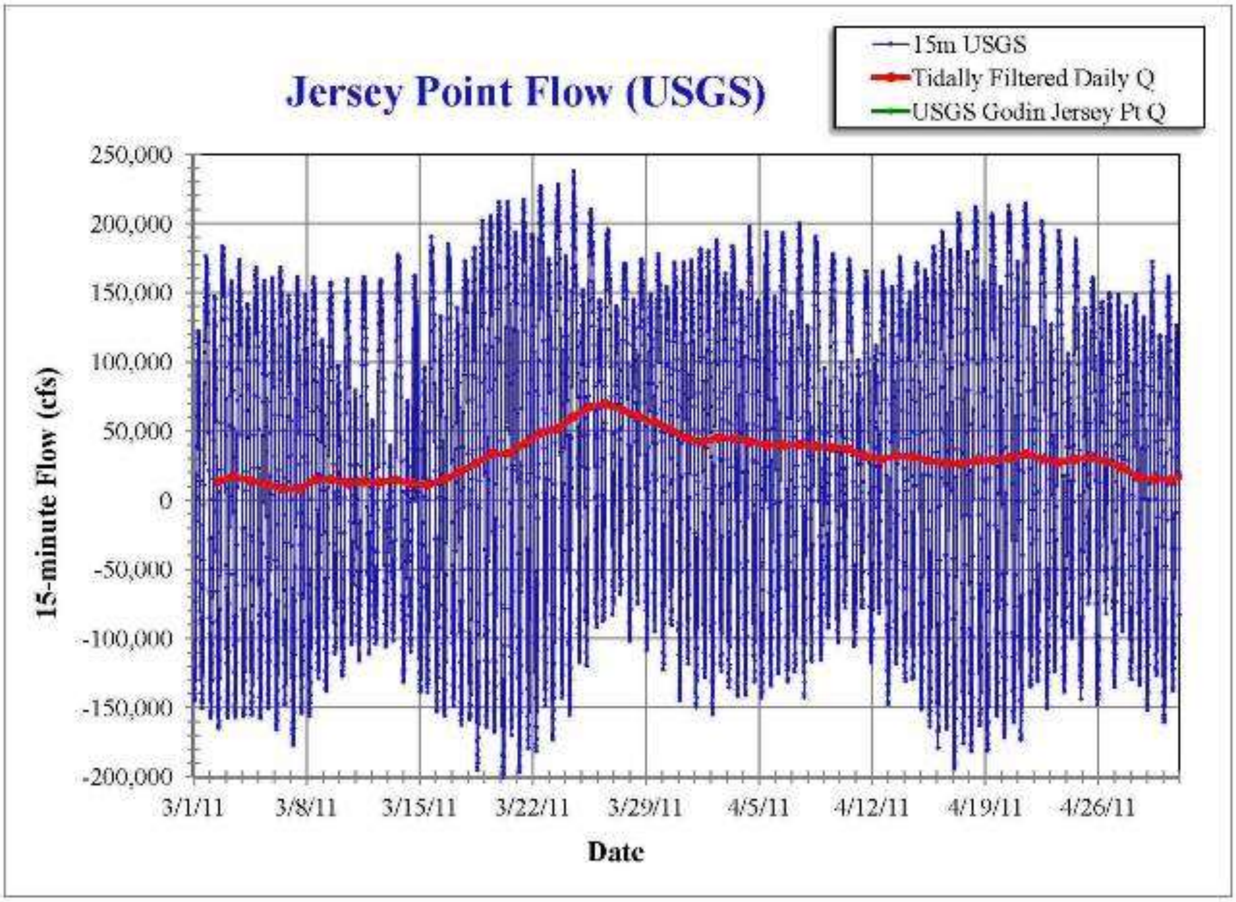

Figure 4 – Flows at Jersey Point

Other Concerns:

Possible clogging of the permeable embankments. It is possible over time that the permeable embankments might clog, reducing the amount of water that can be drawn in through the embankments, but this can be mitigated in three ways: (1) the embankments will be designed to initially have greater flow capacity than required; (2) the outer slopes of the embankments will be maintained and can be replaced as necessary; and (3) the pumps that extract water from Sherman Island could be designed so that the flow can be reversed and water stored in the proposed Brushy Creek reservoir used to raise the water level in Sherman Island so that the embankments are back-flushed. The kind of routine maintenance described under item (2) would typically be instigated after an initial period of, say, five years, and then perhaps a mile or two of the outer surface of the embankment would be replaced each year.

Possible salt water intrusion. While the intent of the WDIC is to maintain X2 well west of Sherman Island, it is possible that in the event of a prolonged drought that, even in the absence of extraction of water from the Delta for export, brackish water might come back as far as Sherman Island and enter the forebay. However, before the resumption of normal operations any brackish water can be pumped out drawing in fresh water to flush out the forebay. The brackish water would either be dumped to the west of the forebay during ebb tides or would be treated in a nearby brackish water desalination plant.

Impact of future sea level rise. The risk that X2 will move significantly inland as a result of sea-level rise can be managed to the point of it being negligible. As sea level rises the current position of X2 can be managed by raising the Delta levee system, restricting the channels of the Sacramento and San Joaquin Rivers, which are broader than they need to be adjacent to Sherman Island, the Sacramento in particular having been dredged out by the California Debris Commission in order to eliminate mining waste, and putting gates on the deepwater ship channels if necessary. If the Delta pool is raised with freshwater to balance the rise in the oceans, the salt water / fresh water transition does not have to move. It would help, and is a good idea otherwise, to have more tidal marshes around San Francisco, San Pablo and Suisun Bays to absorb tidal energy, Sea level rise is a much bigger problem for communities around San Francisco and San Pablo Bays than it is for the Delta.

Summary

The proposed intake forebay is located on Sherman Island in order to fulfill two of the main goals of the WDIC, to help restore natural flows through the Delta and to make the overall scheme self-regulating. That raises other issues including the possible impacts on migrating fish, but these issues can all be managed.

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