Review of Economic Benefits and Costs in the January 2014 Draft Upper San Joaquin River Storage Investigation Feasibility Report

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The Draft Upper San Joaquin River Storage Investigation Feasibility Report was released in January 2014, and concludes that constructing the Temperance Flat dam is economically justified and financially feasible. However, the study's conclusions depend on exaggerated estimates of the study's benefits. In particular, the categories of benefits with the largest economic benefits in the study, ecosystem benefits and emergency water supply benefits, are extremely exaggerated and Temperance Flat will actually provide little to no economic benefits in these categories. The agricultural water supply benefits are also unusually large given the modest water yields of the project. This review focuses on these three key areas of benefits. It is clear from the study that the proposed dam is not justified without including enormous ecosystem benefits that the technical appendix accompanying the feasibility report admits that the valuation of the benefits is highly uncertain and based on many tenuous assumptions. When reasonable adjustments are also made to the exaggerated emergency water supply and agricultural water supply benefits, it is clear that the economic costs of Temperance Flat dam are at least twice as high as its benefits.

Ecosystem Benefits

The study finds ecosystem benefits are the largest category of economic benefits, and the project does not have benefits that exceed costs without large ecosystem benefits. The study equates the ecosystem benefits of the project with projected changes in salmon populations in the San Joaquin River. The economic valuation of these ecosystem benefits is deeply flawed, and reasonable adjustments to this one category of benefits would result in a benefit-cost ratio is less than one. As discussed below, **the maximum plausible value for ecosystem benefits is $7 million annually, and a strong case can be made for zero benefits.**

The study ignores the ecosystem loss from permanently inundating habitat with the new dam. This area includes habitat for endangered and threatened species, and accounting for the destruction of this ecosystem by the proposed project could completely offset the claimed benefits to salmon from the project.

The benefits to salmon abundance may not be scientifically justified. While biology is not part of this review, it is important to note that this critical benefit category falls to zero if the dam does not provide benefits for salmon. Many scientists disagree with the conclusion that the dam benefits salmon, and their concerns will be expressed in other comments.

The salmon benefits of the project should be valued as the costs of reasonable alternatives that would achieve comparable increases in salmon abundance and/or reductions in water temperatures in the San Joaquin River in the absence of the new dam. Using this straightforward approach, the maximum *benefit to salmon from the project is $7 million annually.* There are an abundance of management actions that could be taken to enhance salmon populations in the absence of constructing Temperance Flat Dam. These include habitat restoration or additional water releases from the dam. However, the most straight-forward comparable project is the installation of a temperature control device (TCD) on Friant Dam. The feasibility study states that the TCD was not a necessary addition to the project if Temperance Flat dam were constructed, especially alternative 4 that includes a selective level intake structure (SLIS). However, a TCD on Friant is a straightforward approach to lowering temperatures for salmon in the San Joaquin River if Temperance Flat is not constructed, and thus the cost of a TCD represents the most valid and simple approach to establishing the maximum ecosystem benefits from reduced temperatures that would result from constructing Temperance Flat Dam. The 2008 Feasibility Study for this project estimated the cost of a TCD at $155million in 2006 which is $179m in the 2013 dollars used in this study. Assuming the 100 year amortization and 3.75% discount rate used in the feasibility study, the annualized cost of a TCD at Friant is slightly less than $7 million. Thus, the economic benefit from the ecological benefits to salmon habitat from Temperance Flat Dam is no more than $7 million annually, which represents the avoided cost of the TCD that would achieve the same ecological gain in the absence of the project. This approach is not only preferable to the benefits transfer analysis in the feasibility study, but it is also consistent with the approach used to value other benefits in the study. For example, the cost of lost recreation in the area of upstream of Millerton Lake that would be inundated by the new dam is accounted for in the study as the cost of constructing new facilities to relocate the existing recreational activity. Another example in the feasibility study is the benefit of water supplies being measured as the avoided cost of alternative supplies.

The benefits transfer approach used for valuing ecological benefits overstates benefits by choosing a single study of a non-comparable scenario and incorrectly scaling the benefits to cold water benefits from Temperance Flat. While best practice in benefits transfer is to use multiple studies through an equation or meta-analysis to establish transfer values, this report transfers a single value taken from a single study of salmon benefits from dam removal on the Klamath River.[1] In addition, best practice in benefits transfer requires the policy scenarios to be similar in the study used for transfer and the study case. While the Klamath study is superficially similar in that it is a recent study involving salmon in the State of California, the policy actions being valued are polar opposites. The main policy action in the Klamath study is the removal of 4 dams, an action with high-credibility and high-impact for salmon restoration and broadly supported by fisheries experts and environmental groups. In contrast, the policy action in this study is not tearing down a dam for salmon, but erecting a massive new dam that might provide a marginal benefit for a yet to be established salmon population, an action that does not have strong credibility or support from the environmental community. In fact, the survey instrument for the Klamath study describes the resource in detail and states that the policy action they are valuing has been negotiated and agreed upon by a large and diverse group of stakeholders, including farmers and environmentalists, so that respondents can be seen as not just expressing the value of the resource but of a collaborative process for a remedy with broad support. No such statements could be made about

[1] Klamath River Basin Nonuse Value Survey.
http://klamathrestoration.gov/sites/klamathrestoration.gov/files/DDDDD.Printable.Klamath%20Nonuse%20Survey%20Final%20Report%202012%5B1%5D.pdf

building Temperance Flat dam. It might be reasonable to use the Klamath study for benefits transfer for the San Joaquin River Restoration Program, but it is not valid to use it to measure the benefits of building Temperance Flat dam. The assumption in the feasibility studies' benefits transfer analysis that the public would value salmon restoration benefits from tearing down Klamath River dams as in anyway comparable to building Temperance Flat is incorrect.

Another critical factor in benefits transfer analysis is that the baseline and extent of change in the resource should be similar. Again, this is not the case for these two studies. The baseline for the Klamath River is an existing population that survey respondents were told was 100,000 to 200,000 fish per year. Respondents were presented policy scenarios where the number of returning salmon would increase by 30,000 (30% of a baseline of 100,000) and 100,000 fish annually (100%). In contrast, the modeling for the low SAR scenario for Temperance Flat indicates a change in salmon population of -5 to 20 on a baseline of 727 fish. The high SAR scenario for Temperance Flat estimates an increase of between 26 and 202 salmon over a baseline of 4,148 fish. Thus, the baseline in the Klamath is 24-137 times larger, and the change in salmon abundance is at least 150 times higher. The transfer of benefits in the study is based on the percentage change in salmon population in each case, an inaccurate technique strongly affected by the non-comparable baselines, rather than the actual change in abundance of salmon. If the results of the Klamath study are transferred on a per fish basis, the value is much lower. Dividing the $49.10 annual per household valuation in the Klamath study by the estimated 30,000 increase in the fish population, yield a household value of $0.00164 per salmon. If this value is applied to the range of salmon abundance increase in the Temperance Flat study, -5 to 202 fish, the range of values per household is from 0 to 33 cents. Applying this modified WTP to the projected number of households as in the study would yield a California level ecosystem benefit ranging from $0 to $5.6 million annually. Thus, even if one accepts the validity of transferring salmon restoration benefits from the Klamath to Temperance Flat, the ecosystem benefits are overstated by at least a factor of 10 due to this scaling issue. Furthermore, the projection of population growth and households is exaggerated and uses out-of-date projections from before the Great Recession and Census 2010. Using current population projections from DOF would decrease the ecosystem valuation by another 10% or more.

Emergency Water Supply Benefits:

Emergency water supply benefits are the second largest category of benefits after ecosystem benefits. Similar to the assessment of ecosystem benefits, these emergency benefits are grossly overstated and a strong argument can be made that these benefits are zero due to other actions that are likely to be taken to reduce this risk. Simply scaling the estimated value of the emergency water supply to be proportional to recent BDCP assessments would reduce this benefit by 90%, from roughly $25 billion to less than $4 million annually. **Thus, the maximum plausible value for this benefit is $4 million annually.**

The no-action scenario incorrectly ignores hundreds of millions of dollars in levee improvements that have already been constructed, as well as likely future actions to improve levees or build tunnel conveyance under the Delta to reduce the risk. There has been significant investment in Delta levees that has reduced the risk of flooding, and such investments will continue in the future. The Delta Stewardship Council and other state agencies support formation of an assessment district for Delta levees that would increase funding for improvements from beneficiaries. Finally, the proposed BDCP would build water conveyance tunnels under the Delta that would provide substantial protection from this risk.

Recent BDCP studies[2] *of the emergency water supply benefits of the proposed Delta tunnels in BDCP show much smaller benefits.* The BDCP has studied identical economic risk-reduction benefits that would arise from constructing the Delta tunnels. According to the BDCP's analysis, the proposed tunnels would provide over 3 maf of emergency water supplies in the event of a seismic-induced Delta flood, about six times higher than the highest emergency water supplies that would be provided by Temperance Flat dam according to the Economic Analysis appendix. Chapter 9 of the BDCP values this emergency water supply benefit at a discounted present value of $364million to $470million for the 50 year period from 2025 to 2074 using a 3% discount rate. This corresponds to an annualized benefit of between $18 million and $24 million dollars per year in 2012 dollars. Since the tunnels would provide at least six times more emergency water supplies than Temperance Flat, the maximum reasonable emergency water supply benefit from Temperance Flat dam is $3-4 million per year.

DRMS data on levees is outdated and inaccurate, and the flood probabilities predicted by DRMS have been repeatedly criticized as overstated. The DRMS study used as the source for levee failure probabilities did not collect any data on the state of Delta levees before modeling failure probabilities based on theoretical calculations and historical failure rates. The result were some ridiculous predictions, and the DRMS study warns on its first page that the researchers did not have time or resources to collect data. For example, the DRMS report predicts that Brookside, the most expensive neighborhood in the City of Stockton, has a 7% annual flood probability – the fourth highest in the Delta. The levees in this area received massive upgrades when it was developed in the 1980s, and it is considered to have over 200-year flood protection. However, the DRMS report does not appear to include any data on levee improvements made since the 1980s, after the vast majority improvements have been made with state financial assistance. In 2012, both the Department of Water Resources and the Delta Protection Commission Economic Sustainability Plan released up to date assessments of Delta levees and reported much stronger conditions than the DRMS report. These assessments found that there were only 300-350 miles of Delta levees that remained short of the PL 84-99 standard, about half the number in DRMS and reports based upon it.

Costs Allocated to Emergency Water Supply Benefits Should Be Allocated to Water Users, Not the State. To the extent these benefits exist, and they are grossly overstated in the feasibility study, the costs of providing this benefit should be 100% allocated to the water users, not the State of California as proposed in the feasibility study cost allocation. While the expenditure might be allowed under state law, it is unreasonable to expect that the state would allocate money for the purposes of protecting the

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[2] See Chapter 9, Appendix A of the BDCP.
http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/Public_Draft_BDCP_Appendix_9A_-_Economic_Benefits_of_the_BDCP_and_Take_Alternatives.sflb.ashx

state from a Delta flood emergency to building Temperance Flat reservoir. This is for two reasons. First, proposals that would provide similar emergency benefits, such as the proposed Delta tunnels, are completely paid by water users. Second, the state has alternative investment options to protect against this hazard, such as the strengthening of Delta levees, that provide a much larger and broader array of benefits – including saving lives and protection of transportation and energy infrastructure in the Delta.

The opportunity cost of using the water for emergency purposes does not appear to be accounted for in the study. In the event of an emergency, the water that is released to users is not available to provide the other benefits measured in this study in normal conditions. While it is presumably more valuable in emergency use, only the incremental value of the water in emergency use over and above its normal use should be valued.

Agricultural Water Supply Reliability:

Although the agricultural water supply values are derived from the SWAP model which has been extensively used in similar studies of California agriculture, the modeling done for this study is poorly documented in both the feasibility report itself and the technical appendix. The explanation and results displayed in the technical appendix are surprisingly short, and it is difficult to understand exactly how the summary results tables should be interpreted. Very little information is given about the groundwater model that drives the majority of the results, so it is difficult to discern whether these results make sense. For example, there is no equation given for the groundwater pumping cost function, so a reader is unable to determine the estimated cost to pump an acre foot of water from a given depth or how pumping a given quantity of groundwater affects depth in the aquifer and increases pumping costs for other users.

The lack of more detailed results and explanations is especially problematic, because the estimated value of agricultural water supply is very high given the modest agricultural water yields of the project. For example, alternative 1 produces $18.6 million in benefits on 30,000 af of agricultural water supplies, $620 af, and alternative 4 results in $18.9 million in benefits from 41,000 af or $461 af. In most studies including those conducted with the SWAP model in recent years, agricultural water supplies are valued at $100-150 per acre foot[3], so the agricultural water valuations in the feasibility study are as much as five times higher than normally expected.

Another lens with which to view the oddly high value of attributed to agricultural water is to compare the valuation of agricultural water benefits to the increases in direct agricultural output (gross receipts) and direct personal income from the Regional Economic Analysis chapter of the feasibility study. These results come from the same SWAP model runs, and normally the net change in income from agricultural will be substantially lower than output (gross receipts) or direct personal income (which includes wages

[3] For example, a recent report by the Public Policy Institute of California using the SWAP model estimated the value of agricultural water in a scenario of a 5% cut in supply in this region at $75 to $149 per acre foot. See page 95 of the 2011 PPIC publication Managing California Water: From Conflict to Reconciliation. http://www.ppic.org/content/pubs/report/R_211EHR.pdf

paid to employees in addition to income or profit accruing to the farm owner). The table below shows the reported values for these key indicators from the feasibility study.[4]

	Alternative 1	Alternatives 2&3	Alternative 4
Agricultural Water Supply Reliability Benefits ($millions annually)	18.6	20.8	18.9
Statewide Agricultural Production Industry Output ($millions annually)	16.7	15.2	14.3
Statewide Agricultural Production Personal Income ($ millions annually)	3.3	3.1	2.9

The result that agricultural water supply benefits as measured by a change in net income could exceed the change in gross revenues seems implausible. However, the Economics Appendix contains an interesting explanation, the vast majority of the NED benefits are not the result of increased crop production but are the result of decreased groundwater pumping costs.[5] Thus, the net income from additional crop production supported by the new surface water supplies is in line with normal results but is only a small portion of the estimated agricultural water supply reliability benefits. More than 80% of the water supply reliability benefits are from reduced groundwater pumping charges and it appears that the model predicts that over half of the new agricultural water supplies are used as a substitute for groundwater. Thus, the model suggests that water generates far more value offsetting groundwater use than it does growing crops. The policy implication of this finding is profound, as it suggests that regulations to reduce groundwater pumping would actually increase net farming income across the region, even if the pumping reductions resulted in fewer crops.

While the result is a strong argument that California is suffering from a “tragedy of the commons” in groundwater and the state needs to take control of groundwater management, it isn’t clear that it is appropriate to assign large values from reduced groundwater overdraft to the increased surface water supply from the dam in a policy study. This result from the SWAP model is untested and the groundwater costs are poorly documented, so the amount of groundwater substitution and pumping cost savings are highly uncertain. The result is based on a theoretical model, and is not supported by empirical evidence of the extent that increasing the long-run average amount of surface-water supplies reduces the long-run average amount of groundwater pumping by farmers. Even more important for valuing the groundwater benefits, there are more straight-forward and highly likely policy actions that would provide this identical benefit at far lower cost. If groundwater pumping in this region is regulated in the future, as seems likely given the direction of state policy, the regulations would set the permissible levels of groundwater pumping in various water year types, and the level of groundwater pumping would be largely independent of changes in surface water supplies, including new surface water supply development at Temperance Flat.

[4] Values for direct output and direct personal income come from Tables 12-4 through 12-9 in the Economics Appendix, and the value of agricultural water supply reliability benefits is from Table ES-3.
[5] The Feasibility Study itself does not mention that the majority of agricultural benefits are from reduced groundwater pumping. This is a critical detail that should not be buried in a technical appendix.

In other words, the No Action Alternative should include the reasonable assumption that there will be effective groundwater policies in the Central Valley by the time Temperance Flat is constructed. In this No Action Alternative, groundwater pumping levels in the Valley would be determined by the regulations – and once those regulations were imposed on the SWAP model, the individual profit-maximizing decisions of farmers in the model would have little to no effect on the overall level of groundwater pumping or its cost. In this case, the agricultural water supplies that result from Temperance Flat dam could be valued with a simple and straightforward method of the net income from additional crop production.

Alternatively, the groundwater benefits could be modeled as a separate benefit category from increased agricultural production. The groundwater benefits could then be valued by the "Cost of Likely Alternative" method. The likely alternative to producing groundwater benefits from building a dam would be regulation of groundwater, an action that could provide equivalent benefits to the aquifer at zero cost, and in fact could have a negative cost if the regulation prevented groundwater extraction where the societal cost from overdrafting the aquifer exceeds the private gain to the farmer. The SWAP modeling results in the feasibility study clearly implies that the NED benefit from reducing groundwater pumping exceeds the NED value of the crops that would be grown with that water if it were pumped. It simply does not make economic sense to spend billions on an enormous dam as an inferior substitute for inexpensive and sensible regulation of the groundwater resource.

In short, the feasibility study is using an unconventional approach to valuing agricultural water supply benefits that greatly inflates the value of agricultural water and is at odds with other studies that value agricultural water supply reliability with the same models. It makes more sense to value agricultural water supplies with a simple and straight-forward approach that applies commonly accepted values per acre foot of irrigation water supply. Following this method would result in agricultural water supply benefits from Temperance Flat in a range of $4-8 million annually, less than half the roughly $20 million in benefits in the feasibility study.

Other Comments

The feasibility study greatly exaggerates the purpose and need for Temperance Flat dam by relying on outdated and exaggerated predictions of water supply shortages from the 2005 California Water Plan Update. Population growth, water demand, and updated projections for population growth are all much lower than originally projected. As discussed in the 2011 PPIC Report, Managing California Water, and other sources, water demand in California has been declining even as population grows. And with population growing slower than anticipated, California water demand is trending closest to the "Slow and Strategic Growth" scenario shown in Table 2-3 where water demand declines by 2030. Recent state policy changes such as SB 375 and the 2009 Delta Reform Act add important policy support to this trend. In terms of the quantitative estimates in the feasibility study, the outdated growth projections inflate several benefit values, including the value of municipal water supply and the ecosystem benefits attributed to California households.

In addition to the three major areas of benefits described above, the feasibility study also values benefits associated with Municipal and Industrial Water Supply and Quality, Hydropower Benefits, Recreation Benefits, and Flood Damage Reduction Benefits. In general, these benefit categories are valued significantly lower than the ecosystem, emergency, and agricultural water supply benefits that are the focus of this review. The benefit estimates for these categories are of plausible magnitude, and they are small enough that they do not significantly effect of the study conclusions. Thus, I have not reviewed them in detail. Similarly, the construction and operating cost estimates are not covered in this review, and are assumed to be reasonable.

Finally, the combination of a 100 year life span for benefits and a relatively low 3.75% discount rate are generous assumptions that support building the dam. It is important to note that discount rates reflect not just the opportunity cost of capital, but also the uncertainty related with the project. There is considerable uncertainty surrounding all of these benefits which would make a higher discount rate appropriate. It is also worth noting that the study is transferring benefits from a study of dam removal, a clear example that dams may not have as long as a useful life as engineers assume when they are built.

Conclusion

From making reasonable adjustments to just a few categories of benefits, it is clear that constructing Temperance Flat dam has a benefit-cost ratio below one and is not economically justified. The table below compares the benefit-cost results for Alternative 4, the Alternative with the highest benefit-cost ratio in the feasibility study after three categories are benefits are adjusted to the maximum reasonable values identified in this review. After adjusting these 3 benefit categories to their maximum reasonable values, the benefits of Temperance Flat dam drops from $141-$157 million annually to $52.5 million annually, and the benefit cost ratio drops from 1.21-1.35 to 0.45. The results would be even worse if the considerable ecosystem costs to the flooded area were included.

Annual Benefits ($ millions)	Alt 4 Feasibility Study Values	Adjusted Values
Agricultural Water Supply	18.9	6.2
M&I Water Supply	22.3	22.3 (no change)
Emergency Water Supply	25.9	4
Net Hydropower	1.6	1.6 (no change)
Recreation	7.4	7.4 (no change)
Flood Damage Reduction	4.0	4.0 (no change)
Ecosystem Benefits (California)	59.5 to 75.6	7.0
Total Benefits	140.8 to 156.9	52.5
Total Costs	115.9	115.9
Benefit-Cost Ratio	1.21-1.35	0.45

Author Biographical Sketch

Dr. Jeffrey Michael is Associate Professor in the Eberhardt School of Business and Director of the Business Forecasting Center at the University of the Pacific in Stockton, CA. Jeff's areas of expertise include regional economic forecasting and environmental economics including work on water resources, the Endangered Species Act, climate change, and regulation on land use, property values and employment growth. His research has been published extensively in scholarly journals, books, and policy reports such as the *Journal of Law and Economics, Energy Policy,* and *Ecological Economics,* and he has been a principal investigator on over $2 million in grants and contracts.

Jeff is well recognized as an expert in the Central Valley Economy, and is cited over 200 times per year in the local and national press including the *Wall Street Journal, New York Times, San Francisco Chronicle, Los Angeles Times, NBC, NPR,* and *PBS.* He speaks frequently about the economic outlook and policy issues to diverse audiences. Before coming to Pacific, he was faculty, Associate Dean, and Director of the Center for Applied Business and Economic Research at Towson University in Maryland. Jeff received his Ph.D. in Economics from North Carolina State University, M.S. in Natural Resource Economics and Policy from the University of Maine, and a B.A. with honors in Economics and Biology minor from Hamilton College in Clinton, NY.