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March 2, 2011

Attn: National Research Council Committee Members via emailed pdf to RSO David Policansky
Project: Sustainable Water and Environmental Management in the California Bay-Delta
PIN: DELS-WSTB-09-09
Attn: Delta Stewardship Council via emailed pdf to Ms. Terry Macaulay
<deltaplanscoping@deltacouncil.ca.gov >
Re: Delta Plan EIR Notice of Preparation, V. Jigour comments submitted January 28, 2011

Subject: Conversion corrections re Dec. 9, 2010 memo: BDCP vs. central valley groundwater overdrafts identified through GRACE

This memo serves to correct erroneous conversion calculations included in my December 9, 2010 memo submitted to the NRC committee, which was subsequently attached to my comments on the Delta Plan NOP, submitted January 28, 2011, along with my July 30, 2010 summary submitted to NRC. I realize that since the NOP comment deadline has passed, the Delta Stewardship Council need not take these comments into account, but I provide them for the convenience of all. The conversions corrected in the following excerpt from my draft doctoral dissertation appear in yellow highlights; I refined the associated text accordingly. The numbers, which differ significantly from my earlier erroneous conversions, are nevertheless of great concern. However, they are closer in scale to what I estimate may be achieved through the baseflow augmentation through watershed restoration strategy I propose to address water resource issues related to the Bay-Delta. If anyone read my December 9, 2010 memo, perhaps they revisited those calculations themselves. But for the record and for general ease of comparison with the metrics used to assess water resource issues concerning the Bay-Delta, I submit the following corrected excerpt.

Again, I am in the process of developing the www.BaseflowAugmentation.net site, along with my own consulting services web site, so neither are operative as I submit this.

Respectfully,

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2.4.3.1.2. Need for Regional or Statewide Regulatory Oversight

Existing hydraulic models applied to surface waters differ mathematically from those applied to groundwater and this difference is among the reasons systemic, or integrative approaches addressing their interrelationships, have been lacking. But an intriguing application of satellite technology to study changes in the gravimetric weight of water among the components of large hydrologic systems has offered the first startling evidence of systemic overdrafts from the watersheds feeding the Sacramento/San Joaquin Rivers Delta, including especially large groundwater overdrafts from the San Joaquin River basin.

University of California Irvine, NASA and other institutional collaborators reported their initial findings from the GRACE (Gravity Recovery and Climate Experiment) twin satellite mission at the fall 2009 meeting of the American Geophysical Union in San Francisco. The abstracts for "Total water storage change over the San Joaquin and Sacramento River Basins comparing GRACE and observational data" (Ho and others 2009) and "Water storage change in the Sacramento and San Joaquin River Basins since 2003, including Central Valley groundwater depletion" (Bethune and others 2009) are available from the AGU web site. A ScienceDaily article, "California's troubled waters: satellite-based findings reveal significant groundwater loss in Central Valley" (University of California Irvine 2009) offers additional detail.

> GRACE monitors tiny month-to-month differences in Earth's gravity field primarily caused by the movement of water in the planet's land, ocean, ice and atmosphere. Its ability to "weigh" changes in water content provides new insights into how climate change is affecting Earth's water cycle.
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> Combined, California's Sacramento and San Joaquin drainage basins have shed more than 30 cubic kilometers of water since late 2003, said Jay Famiglietti, UCI Earth system science professor and director of the UC Center for Hydrologic Modeling. A cubic kilometer is about 264.2 billion gallons, enough to fill 400,000 Olympic-size pools. The bulk of the loss occurred in the state's agricultural Central Valley. The Central Valley depends on irrigation from both groundwater wells and diverted surface water.
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> "GRACE data reveal groundwater in these basins is being pumped for irrigation at rates that are not sustainable if current trends continue," Famiglietti said. "This is leading to declining water tables, water shortages, decreasing crop sizes and continued land subsidence. The findings have major implications for the U.S. economy, as California's Central Valley is home to one-sixth of all U.S. irrigated land and the state leads the nation in agricultural production and exports."
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> "By providing data on large-scale groundwater depletion rates, GRACE can help California water managers make informed decisions about allocating water resources," said project scientist Michael Watkins of NASA's Jet Propulsion Laboratory.
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> Preliminary studies show most of the water loss is coming from the more southerly

located San Joaquin basin, which gets less precipitation than the Sacramento River basin farther north. Initial results indicate the Sacramento River basin is losing about 2 cubic kilometers of water a year. Surface water losses account for half of this, while groundwater losses in the northern Central Valley add another 0.6 cubic kilometers annually. The San Joaquin basin is losing 3.5 cubic kilometers a year. More than 75 percent of this is due to groundwater pumping in the southern Central Valley, primarily to irrigate crops.

Famiglietti said recent California legislation decreasing the allocation of surface water to the San Joaquin basin is likely to further increase the region's reliance on groundwater for irrigation. "This suggests the decreasing groundwater storage trends seen by GRACE will continue for the foreseeable future," he said. …

(University of California Irvine 2009)

Our results show that the Sacramento river basin is losing 30 mm of water a year, half of which is lost from surface water, while an additional 8 mm/yr are lost from groundwater. The San Joaquin basin is losing 42 mm/yr, over 75% of which (32 mm/yr) we calculate to be lost from groundwater.

(Bethune and others 2009)

Converting these figures into the traditional water resource denomination of acre-feet used herein, the total loss of 30 cubic kilometers among the two basins since 2003 corresponds to 24,321,386 acre-feet. The annual loss of 3.5 cubic kilometers from the San Joaquin basin corresponds to a loss of 2,837,496 acre-feet per year. That amount is comparable to the potential estimated benefits of watershed restoration discussed herein. The application of GRACE to regional water balance analysis appears an exciting step toward more systemic approaches that may better accommodate the role of vadose zone hydrology than was previously possible.

Especially in the case of multiple watersheds feeding a single ecosystem, like that of the San Francisco Bay-Delta ecosystem, it seems that ultimately, the applicable laws will have to evolve to accommodate our 21st century, systemic understandings of the nonlinear path of water—through atmospheric flows, through our watersheds, including vadose zone and groundwater flows, through the oceans' flows, and back again. Considering how the interests of those with the most money can easily dominate over the best interests of the greater public in local agency CEQA and other regulatory processes, it does appear that some regional or statewide regulatory oversight is needed to ensure implementation of watershed restoration for baseflow augmentation.