STOCKHOLM ENVIRONMENT INSTITUTE

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California State Water Resources Control Board
Joe Serna, Jr.-Cal/EPA Building
1001 I Street
Sacramento, CA 95814

To whom it may concern:

Please accept these comments submitted in advance of your workshop entitled *Analytical Tools for Evaluating Water Supply, Hydrodynamic and Hydropower Effects*, scheduled for November 13 and 14, 2012 in Sacramento California. I am the Leader of the U.S. Water Group of the Stockholm Environment Institute, working from SEI's office in Davis, California and I am writing to suggest that our modeling platform, the Water Evaluation and Planning, or WEAP, system might be a useful analytical tool for your efforts to consider potential changes to the 2006 Water Quality Control Plan for the San Francisco/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan) as part of the State Water Resources Control Board's (State Water Board) Phase II comprehensive review of the Bay-Delta Plan.

We have been developing WEAP (www.weap21.org) within SEI for nearly 20 years, and it has emerged as one of the leading water system modeling tools in the world, with nearly 10,000 registered users located in over 170 countries. Currently WEAP is downloaded from the SEI website approximately 10 times per day, with a substantial user community existing in California. What has driven much of the interest in WEAP is the integrated nature of its representation of a water system, including internal routines that can be configured to represent:

- Snow accumulation/melt
- Rainfall/runoff processes
- Evapotranspiration from both natural and cropped landscapes
- Soil moisture storage
- Groundwater dynamics, including stream aquifer interactions
- Hydraulic system operation reflecting physical capacities and operating rules
- Urban water demand
- Water rights and water allocation priorities, including instream flow requirements
- Surface water quality
- Financial accounting of water system costs and benefits.

All of this functionally is found within a modern, user friendly, extendable software environment that has been constructed to facilitate scenario analysis whereby key aspects of the system can change over time. The inherent power, and accessibility, of WEAP has contributed to the growth of this is as a tool to

support water management planning and decision making in California (see Attachment 1 for a current list of California WEAP applications and peer reviewed journal articles that have been produced using the tool).

In terms of the current State Board processes, the most important application is one that has been developed to support the California State Water Plan Update Process managed by the Department of Water Resources and the Central Valley Project Integrated Resources Plan managed by the U.S. Bureau of Reclamation, and which will play a part in the analysis under the upcoming Sacramento-San Joaquin Basin Study. The application (see schematic in Attachment 2) covers the Sacramento, San Joaquin, and Tulare Lake Hydrologic Regions, with representations of the demands driving exports to the Bay Area and the South Coast.

Many WEAP applications in California take advantage for the internal climate driven hydrologic routines to simulate the potential impacts of climate change, and potential management responses. The Central Valley application, for example, has been run using multiple future climate scenarios to investigate the potential performance of strategies such as urban and agricultural water conservation, wastewater recycling and reuse, groundwater banking and conjunctive use, and new surface water storage and conveyance. Changes in management regimes related to modified environmental flow requirements and/or allocation priorities have also been modeled. It is also possible to model potential changes in land use to investigate how thes can impact hydrology, water demand and ultimately system operations.

The challenge before the State Board as it considers changse to the management of the Bay-Delta system and associated tributaries is complex and multi-faceted. I am of the opinion that this challenge is best met by deploying tools that represent these multiple dimensions in a seamlessly integrated fashion, as opposed to the Rube Goldberg modeling tools that have often been cobbled together using a series of single purposed modeling platform. If the State Board is interested in using WEAP, SEI stands ready to support the effort. The actual use of the software itself would be free of charge based on an agreement made between SEI and DWR as part of the Water Plan collaboration whereby all public entities in California are entitled to a complimentary WEAP license.

I look forward to interacting more with key actors in the Bay-Delta process about the potential utility of WEAP.

Sincerely,

David R. Purkey, Ph.D.
U.S. Water Group Leader

Attachment 1: California WEAP Applications

- **Sacramento Valley**, in addition to developing the WEAP application as proposed under the 2001 EPA grant, SEI modified the model to support analysis of climate change implications in the agricultural sector as part of the 2006 Governor's Report on Climate Change.
  - J. Sieber, D. Yates, A. Huber Lee, and D. Purkey, 2005. *WEAP a demand, priority, and preference driven water planning model: Part 1, model characteristics*. Water International. Vol. 30, No. 4. pp. 487-500
  - Yates, D., D. Purkey, H. Galbraith, A. Huber-Lee, and J. Sieber, 2005. *WEAP a demand, priority, and preference driven water planning model: Part 2, Evaluating freshwater ecosystem services*. Water International. Vol. 30, No. 4. pp. 501-512
  - Purkey, D**.**, A. Huber-Lee, D. Yates, M. Hanemann. 2007. *Integrating a climate change assessment tool into stakeholder-driven water management decision-making processes in California*. Water Resources Management. Vol 21. pp. 315-329.
  - Purkey, D., B. Joyce, S. Vicuna, M. Hanemann, L. Dale, D. Yates and J. Dracup. 2008. *Robust analysis of future climate change impacts on water for agriculture and other sectors: a case study in the Sacramento Valley*. Climatic Change. Vol 87, Supplement 1.
  - Yates, D., D. Purkey, J. Sieber, A. Huber-Lee, H. Galbraith, J. West, S. Herrod-Julius, C. Young, B. Joyce and M. Rayej (2009). *Climate driven water resources model of the Sacramento Basin, California*. Journal of Water Resources Planning and Management, 135 (5): 303-31 **(winner *2010 Environmental and Water Resources Institute Best Practice Paper)***
- **Santa Clara Valley**, Recognizing that the legacy FORTRAN planning model that had been developed over the years was becoming obsolete, the Santa Clara Valley Water District selected WEAP as a platform to which their planning model efforts could be ported.
- **South Fork American River**, in collaboration with the El Dorado Irrigation District (EID), SEI developed a WEAP application of the EID system that has been used to support various planning efforts undertaken by the district, including a drought plan, an Urdan Water Management Plan, and water supply portfolio assessment.
  - Purkey, D**.,** A. Huber-Lee. 2006. *A DSS for long-term water utility planning.* Southwest Hydrology. Vol. 4. pp. 18-31.
  - Yates, D., D. Purkey, M. Gunter, E. Mansfield. 2006. *Implications of climate warming on local water management in the South Fork American River, California*. Water Resources Impact, Vol. 4, No. 5. pp. 18-21.
- **San Gregorio Creek**, as part of a State Water Board sanctioned watershed planning effort comprised of various stakeholders, a WEAP application was develop to explore management options to respond to Coho salmon recovery goals for the system.
- **East Bay Area**, in order to implement its 2040 Water Master Planning process, the East Bay Municipal Utility District selected WEAP as a platform on which to simulate various in-district water management options which was dynamically linked to an existing reservoir operations model of the District's Mokelumne system.
- **Western Sierra Nevada**, in partnership with the Center for Watershed Sciences, under funding from RLFF, SEI develop WEAP applications to simulate the hydrology of 10 river systems draining the western Sierra under different climate projections.
  - Young, C.A., M.I. Escobar-Arias, M. Fernandes, B. Joyce, M. Kiparsky, J.F. Mount, V.K. Mehta, D. Purkey, J.H. Viers and D. Yates. 2009. *Modeling the hydrology of climate change in California's Sierra Nevada for subwatershed scale adaptation*. Journal of the American Water Resource Association. 45 (6): 1409-1423.

- **Cosumnes, American, Bear, and Yuba Basins**, based on a recommendation from EID, a partner in the CABY IRWMP process, a WEAP application was developed to support integrated planning across the EID, Placer County Water Agency, and Nevada Irrigation District service areas, including upper basin hydropower systems.

  Mehta, V., D. Rheinheimer, D. Yates, D. Purkey, J. Viers, C. Young, J. Mount. 2011. *Potential impacts on hydrology and hydropower production under climate warming in the Sierra Nevada*. J. of Water and Climate Change. 2(1), pp 29-43.
- **Inland Empire**, WEAP was applied to the Inland Empire Utilities Agency system as part of a Robust Decision Making evaluation of various options proposed as part of the District's Urban Water Management Plan.

  Groves, D., D. Yates and C. Tebaldi. 2008. *Developing and applying uncertain global climate change projections for regional water management planning*. Water Resources Research, Vol 44.

  Lempert, R., D. Groves. 2010. *Identifying and evaluating robust adaptive policy responses to climate change for water management agencies in the American west.* Technological Forecasting and Social Change, Vol. 77, No. 6, Pp 960-974
- **Butte Creek**, under funding from the EPA Science to Achieve Results (STAR) program, SEI worked in collaboration with colleagues at UC Davis to develop a WEAP application that captured climate change, hydrologic change, hydropower operations, and salmon life cycle modeling to investigate strategies to manage the singular spring run Chinook salmon population in the system.

  Thompson, L., M. Escobar, C, Mosser, D. Purkey, D. Yates, P. Moyle. 2011. *Water management adaptations to prevent loss of spring-run Chinook salmon in California under climate change*. J. Water Resour. Plann. Manage., 10.1061/(ASCE)WR.1943-5452.000019.
- **Sacramento-San Joaquin System**, as part of a collaboration with DWR to introduce new tools to support scenario based planning under the California Water Plan Update process, SEI expanded the existing Sacramento Valley WEAP application to include the San Joaquin Hydrologic Region. The model was also used to provide analytical support to the 2009 Governors Report on Climate Change.

  Joyce, B., V. Mehta, D. Purkey, L. Dale,M. Hanemann. 2012. Modifying agricultural water management to adapt to climate change in California's central valley. Climatic Change. Vol. 109, No. 1, pp 299-316.
- **Central Valley,** based on the success of WEAP in supporting the DRW California Water Plan Update process, the U.S. Bureau of Reclamation (USBR) expanded the existing Sacramento/San Joaquin WEAP application to include the Tulare Lake Hydrologic Region as part of the ongoing implementation of the Central Valley Project Integrated Resource Plan. As part of this expansion the USBR has also supported an effort to link WEAP to the Statewide Agricultural Production (SWAP) model developed by Dr. Richard Howitt at the UC Davis.
- **Cache Creek**, as part of an integrated assessment of potential climate change impacts in Yolo County being conducted by researchers at UC Davis, SEI collaborated with the Yolo County Flood Control and Water Conservation District to develop the first ever planning model of the entire Clear Lake, Indian Valley Reservoir, lower Cache Creek system.

Attachment 2: Central Valley WEAP Application Schematic