EXHIBIT ARWA-801

hydraulics | design | hydrology | field services | geomorphology

Chris Hammersmark, Director

Education
Ph.D., 2008, Hydrologic Sciences, University of California, Center for Watershed Sciences, Davis, CA,

M.S., 2003, Hydrologic Sciences, University of California, Center for Watershed Sciences, Davis, CA,

B.S., 1996, Civil and Environmental Engineering, Forestry minor, University of California, Berkeley, CA.

Professional Registration
2003, Professional Civil Engineer, CA, # C66595.

Professional Experience
2009-Present, Director
cbec, inc., eco-engineering, Sacramento, CA.
Providing environmental consulting services to the water resources industry.

2000–2008, Independent Hydrologist

2008, Post-Doctoral Researcher
University of California, Center for Watershed Sciences, Davis, CA.

2000–2007, Research & Teaching Assistant
University of California, Center for Watershed Sciences, Davis, CA

2003, Post-Graduate Researcher
Dept. of Civil and Environmental Engineering, University of California, Davis, CA

2000–2002, Research Assistant
Dept. of Civil and Environmental Engineering, University of California, Davis, CA

Dr. Hammersmark is a registered civil engineer specializing in hydraulics, hydrology, geomorphology, ecology, and ecosystem rehabilitation/restoration. He has over 17 years of experience on a diverse array of projects involving stream, meadow and floodplain restoration, fish passage, sediment transport and water quality, flood inundation and water supply. The environmental settings for these projects range from natural to urban, from headwater streams and adjacent meadows and forests through lowland alluvial rivers to tidally influenced coastal rivers and estuaries. While a majority of Dr. Hammersmark's experience is gained from projects within California, he has also participated in interdisciplinary projects in Alaska, Arizona, Utah, Washington, British Colombia, and Scotland.

Dr. Hammersmark has extensive experience in the design and evaluation of estuarine, stream and river restoration/rehabilitation projects. Facets of this experience include the assessment of hydrologic, hydraulic, geomorphic and ecological effects of a variety of restoration and rehabilitation efforts (e.g., levee breaching, channel and floodplain reconfiguration, bank stabilization, dam removal, structure placement, and vegetation planting/removal). Assessments have included the collection and comparison of before and after physical and biological data, in addition to the utilization of hydraulic, hydrologic and statistical species prediction models to predict the potential outcome of proposed designs, as well as retrospectively evaluate the benefits gained.

Dr. Hammersmark's technical experience includes a blend of computation analyses with a variety of field methods. Examples of skills and tools typically utilized include numerical hydraulic and hydrologic modeling (e.g., HEC, USGS, USBR and DHI models), water temperature modeling, habitat suitability modeling, terrain modeling, GIS and a variety of types of field investigations including sediment characterization and sediment transport measurements, habitat characterization and mapping, vegetation sampling, topographic and bathymetric surveys, water quality sampling, flow gaging, groundwater sampling, water table measurement, soil infiltration and compaction monitoring.

Dr. Hammersmark has been involved in interdisciplinary research regarding environmental restoration and water resources for more than 13 years, with a focus placed on identifying physical drivers of ecological processes. He has published a number of peer-review articles in scientific journals (e.g., River Research and Applications, Restoration Ecology, Wetlands, Ecological Engineering, Natural Hazards Review, and Hydrogeology Journal), and has presented at a variety of professional conferences and meetings. Dr. Hammersmark has taught, or assisted in teaching several field and classroom based university courses (e.g., Fluvial Geomorphology, Ecogeomorphology of Rivers and Streams), as well as university extension short courses (e.g., Understanding Riparian Processes, Geomorphic and Ecological Fundamentals of River and Stream Restoration, Streambank Assessment and Restoration).

Drawing from his diverse academic and consulting background, Dr. Hammersmark seeks innovative and sustainable process-based solutions to complex multi-objective water resource and ecosystem restoration challenges, while operating within the specific constraints of each project. He is committed to the conservation, preservation and rehabilitation of aquatic, wetland and terrestrial ecosystems.

Selected Projects

American River – Spawning/Rearing Habitat - Gravel Augmentation Design. *Rancho Cordova, CA. 2010-present. For the Water Forum, USBR & USFWS.* Project manager for a multi-year gravel placement and side channel creation effort to improve spawning and rearing habitat for Chinook salmon and steelhead. Activities include field surveys, data collection, 2D hydraulic modeling, habitat suitability modeling, preparation of construction drawings and Basis of Design reports, and performance evaluation of past projects. To date six separate projects have been designed and constructed.

Folsom Reservoir and American River Temperature Monitoring and Modeling. *Sacramento, CA. 2009–present. For the Water Forum*. Project manager for a multifaceted hydrodynamic and water temperature modeling project encompassing Folsom Reservoir, Lake Natoma and the lower

American River. Aspects of the project include temperature and stage monitoring, bathymetric surveys, the development and application of a HEC-RAS hydrodynamic and water quality model, modernization and improvement of the existing Coldwater Pool Management Model (iCPMM), and application of CEQUAL-W2 water temperature models for Folsom Reservoir and Lake Natomas. The HEC-RAS and CEQUAL-W2 models are used to evaluate reservoir and river conditions for a variety of scenarios reflecting 82 years of historic hydrology as simulated CALSIM II a water supply optimization model. This effort has required the development of disaggregation techniques to post-process monthly CALSIM model outputs into, daily or hourly time series for use and boundary conditions for the HEC-RAS and CEQUAL-W2 models.

Hallwood Side Channel and Floodplain Restoration Project, Lower Yuba River. *Hallwood, CA. 2012-present. For USFWS.* Project director for the development of restoration designs for a ~2 mile side channel complex and ~140 acres of floodplain adjacent to the Yuba River. The primary focus is on increasing/improving rearing habitat available to salmonids in a sustainable way, and providing an appropriate physical environment for woody riparian vegetation to recruit and thrive. Activities include field surveys, pre-project physical and biological monitoring, 2D hydraulic modeling, alternative development and assessment, development of construction documents and drawings, and stakeholder outreach.

American River – Spawning/Rearing Habitat - Gravel Augmentation Design. *Rancho Cordova, CA. 2010-present. For the Water Forum, USBR & USFWS.* Project manager for a multi-year gravel placement and side channel creation effort to improve spawning and rearing habitat for Chinook salmon and steelhead. Activities include field surveys, data collection, 2D hydraulic modeling, habitat suitability modeling, preparation of construction drawings and Basis of Design reports, and performance evaluation of past projects. To date six separate projects have been designed and constructed.

Lower American River - Redd Dewatering Assessment. *Sacramento, CA. 2013-2014. For USFWS.* Project manager for the assessment of the redd dewatering potential at highly utilized spawning sites in the American River. Activities included: collection of topographic and bathymetric data, development, calibration and application of 2D hydraulic models to assess water level changes due to various proposed flow reductions, GIS analysis of redd locations and dewatering potential, assessment of number of observed redds that would be dewatered at different flow rates, development of a database of water elevation surfaces that can be queried to understand the magnitude of water level change for future dewatering assessments.

American River - Sunrise Side Channel Monitoring and Evaluation. *Rancho Cordova, CA. 2009-present. For the Water Forum*. Project manager for a post-project monitoring and evaluation study of the recently completed Sunrise Side Channel Enhancement Project. Activities include topographic surveys, water level and velocity measurements, 2D hydraulic modeling and habitat evaluations.

Hydrologic and Geomorphic Analysis to Support Rehabilitation Planning for the Lower Yuba River. *Marysville, CA. 2013. For South Yuba River Citizens League and USFWS*. Project manager for or a study developing potential rehabilitation actions and projects for the lower Yuba River between Parks Bar and Marysville, with a focus on increasing/improving rearing habitat available to salmonids. Activities included an analysis detailing the historical geomorphic evolution, development of an estimated depth to water table map, an ecologically significant flow frequency analysis, development of potential enhancement actions and identification of potential sites for rehabilitation projects.

American River – Development of a Structured Decision Making Model. *Rancho Cordova, CA. 2011-present. For the Water Forum, USBR & USFWS.* In order to provide a framework for decision making regarding aquatic habitat enhancement actions for Chinook salmon and Steelhead trout, a Structured Decision Making Model is under development. This model will guide future actions by determining the type and location of future rehabilitation/enhancement actions that will result in the largest benefit to recovering populations of native fishes. Project entails data collection, as well as hydraulic and habitat suitability modeling of potential gravel placement (to create better spawning habitat) and excavation (to create floodplain or side channels).

Lower Yuba River Rehabilitation Concepts Design and Analysis. *Marysville, CA. 2009-2013. For South Yuba River Citizens League and USFWS*. Project manager and lead analyst for a study developing rehabilitation concepts/projects for a ~4 mile reach of the Yuba River, with a focus on increasing/improving rearing habitat available to salmonids. Activities include field reconnaissance and data collection, water level monitoring, topographic surveys, vegetation surveys, water table depth modeling and concept design development. A second phase of the project includes the development, design and implementation of a pilot riparian planting project, which was completed in 2013.

Reservoir and Riverine Water Temperature Modeling to Assess Various Configurations of the EID Intake Structure. *Folsom, CA. 2014–2015. For Eldorado Irrigation District*. Project manager for a temperature modeling project focused on Folsom Reservoir and the lower American River. Aspects of the project include modification and application of Coldwater Pool Management Model (iCPMM) to assess temperature benefits resulting for various configurations of the intake structure under various annual extraction volumes.

Folsom Dam Temperature Control Device - Water Temperature Modeling and Benefits Assessment. *Folsom, CA. 2013–2014. For Sacramento Water Forum*. Project manager for a temperature modeling project focused on various potential configurations of a temperature control device at Folsom Dam. Aspects of the project included modification and application of Coldwater Pool Management Model (iCPMM) to assess temperature benefits, and participation in a multi-agency value planning workshop.

Folsom Dam Water Control Manual Update - Technical Assistance. *Folsom, CA. 2014-2015. For the US Army Corps of Engineers as a sub-consultant to HDR Engineering.* Project manager for a project that provides technical assistance and guidance to HDR as they modify and apply various water temperature models to assess fisheries impacts related to various alternatives regarding the modification of the infrastructure and management of

Folsom Dam and Reservoir.

CVPIA - Science Integration Team. *Sacramento, CA. 2014-present. For Sacramento Water Forum and USFWS.* Member of a team of scientists charged with developing and applying a decision support tool to evaluated and prioritize a variety of management actions aimed at enhancing salmonid fisheries in the Central Valley.

American River - Drought Year Analytical Support. *Sacramento, CA. 2014-present. For the Water Forum*. Project manager for a project that provided technical support regarding management of the lower American River during the extreme drought years of 2013-2015. Technical tasks included hydraulic modeling to determine at what flow rate water supply extraction intakes would no longer be able to function properly, modeled estimates of the number of Chinook salmon and Steelhead redds would be dewatered or stranded due to flow reductions, temperature modeling for various potential release scenarios, installation of instrumentation to monitor water levels at various locations along the river, and data collection and analysis to determine potential Folsom inflow volumes and patterns.

Selected Publications

Hammersmark C. T., M. C. Rains, and J. F. Mount. 2008. Quantifying the hydrological effects of stream restoration in a montane meadow, northern California, USA. River Research and Applications 24:735-753.

Hammersmark C. T., S. Z. Dobrowski, M. C. Rains, and J. F. Mount. 2010. Simulated effects of stream restoration on the distribution of wet-meadow vegetation. Restoration Ecology 18:882-893.

Hammersmark C. T., A. C. Wickland, M. C. Rains, and J. F. Mount. 2009. Vegetation – water-table relationships in a hydrologically-restored riparian meadow. Wetlands 29:785-797.

Loheide, S. P., R. S. Deitchman, D. J. Cooper, E. C. Wolf, **C. T. Hammersmark,** and J. D. Lunquist. 2009. A framework for understanding the hydroecology of impacted wet meadows in the Sierra Nevada and Cascade Ranges, California, USA. Hydrogeology Journal 17:229-246.

Hammersmark C., S. Lorenzato, T. Griggs, and C. Bowles. 2012. Integrative floodplain design. Ecesis 22:1-5.

Florsheim J. L., J. F. Mount, **C. Hammersmark,** W. E. Fleenor, and G. S. Schladow. 2008. Geomorphic influence on flood hazards in a lowland fluvial-tidal transition area, Central Valley, California. Natural Hazards Review 3:116-124.

Hammersmark C. T., W. E. Fleenor & S. G. Schladow. 2005. Simulation of flood impact and habitat extent for a tidal freshwater marsh restoration. Ecological Engineering 25:137-152.