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# Chris Campbell, Director

**Education**
M.S., 2003, Biological and Agricultural Engineering, University of Idaho, Moscow, Idaho, USA.
B.S., 1998, Agricultural Engineering (*summa cum laude)*, University of Idaho, Moscow, Idaho, USA.

**Professional Registration**
1999, Engineer-in-Training, Idaho, #4896

**Professional Experience**
2008-Present, Director
cbec, inc., eco-engineering, Sacramento, CA.
Providing environmental consulting services to the water resources industry.

2001–2008 - Hydrologist to Senior Associate Philip Williams & Associates (PWA), Ltd., Sacramento, CA.

Chris Campbell has more than fifteen years of engineering and project management experience with an emphasis in ecohydraulics and ecohydrology. He specializes in hydrodynamics, physical hydrology, sediment transport, geomorphology, water resources, and ecosystem restoration. As technical director, at cbec, Chris applies his technical experience in numerical modeling and field studies to projects ranging from seasonal wetlands to lowland alluvial rivers to tidally influenced rivers and estuaries. Chris directs and provides quality control for 1D, 2D, and 3D numerical modeling using a range of public and proprietary software packages (e.g., HEC-RAS, MIKE 11/21, TUFLOW, Delft3D, FLOW-3D, FEFLOW). Chris also directs and performs a range of field studies to include topographic and bathymetric surveying, water quality monitoring, climate monitoring, flow gauging, sediment characterization, and sediment transport sampling. Chris Campbell has worked on a range of ecosystem restoration projects with an emphasis on vernal pool restoration in the Sacramento Valley and tidal wetland and floodplain habitat restoration in the Yolo Bypass, Cache Slough Complex, and North Delta. Chris has been the principal investigator of a vernal pool research project since 2008 to understand the potential hydrologic impacts of constructed pools on natural pools to inform design standards for vernal pool creation. This has involved four years of monitoring and subsequent 3D vadose zone modeling. Chris has also been working in the Yolo Bypass for more than a decade on various data collection, restoration, and mitigation projects. These include field data collection efforts to support hydrodynamic model development; hydrodynamic model development, calibration, and alternatives evaluation for the USBR/DWR Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project EIS/EIR; realignment of Putah Creek through the Yolo Bypass Wildlife Area; tidal restoration projects in the southern Yolo Bypass such as Lower Yolo, Prospect Island, and Yolo Flyway Farms; hydrodynamic modeling and design support of various mitigation banking projects throughout the Yolo Bypass to include Fremont Landing Conservation Bank (constructed), Capital Conservation and Mitigation Bank, Liberty Island Conservation Bank (constructed), and North Delta Fish Conservation Bank; identification and prioritization of drainage and infrastructure issues within the Yolo Bypass; and contributions to land management plans for the Yolo Bypass Wildlife Area and the Liberty Island Ecological Reserve.

**Selected Projects**

*Fluvial Projects*

**McCormack-Williamson Tract Levee Modification and Habitat Development Project.** *Sacramento County, CA, 2015 - present. For The Nature Conservancy and Reclamation District 2110.* As a key component of the North Delta Flood Control and Ecosystem Restoration Project with the Final Environmental Impact Report approved by DWR in 2010, this project aims to provide flood protection benefits by modifying levees (both enhancing and degrading) and creating habitat restoration opportunities (both tidal and fluvial) by reconnecting the floodplain to the Mokelumne River. Working with AECOM and West Yost Associates, cbec is preparing the hydrodynamic, particle tracking, and sediment transport modeling and the habitat grading design for the island interior. The modeling will be used to refine the restoration design to maximize onsite habitat benefits while minimizing offsite flood and geomorphic impacts. As project manager, Chris directed the modeling and physical components of the habitat restoration design.

**Wallace Weir Improvement and Fish Exclusion Project.** *Yolo County, CA, 2015 - present. For Reclamation District 108.* This project aims to improve the operations of Wallace Weir as well as include a fish trapping facility to prevent adult salmon entry into the Colusa Basin Drain. Working with KSN, Inc., cbec prepared hydraulic analyses to support the 408 Certification and Central Valley Flood Protection Board Permit by modifying and calibrating the Central Valley Floodplain Evaluation and Delineation Program HEC-RAS model in the vicinity of Wallace Weir to assess project performance over a range of flow conditions. As project manager, Chris directed the hydraulic analyses and coordination with the US Army Corps of Engineers.

**Knights Landing Outfall Gate Fish Exclusion Project.** *Yolo County, CA, 2014 - 2015. For Reclamation District 108.* This project aims to retrofit the existing outfall gates by constructing a positive fish barrier (Alaskan Weir) on the downstream side of existing structure to prevent adult salmon entry into the Colusa Basin Drain as well as repair an erosion site on the right bank of the drain on the downstream side of the outfall gates. Working with KSN, Inc., cbec prepared hydraulic analyses to support the 408 Certification and Central Valley Flood Protection Board Permit by modifying and

calibrating the Central Valley Floodplain Evaluation and Delineation Program HEC-RAS model at the outfall gates to assess project performance over a range of water years. As project manager, Chris directed the hydraulic analyses and coordination with the US Army Corps of Engineers.

**Upper Yolo Bypass Locally Developed Plan.** *Yolo and Solano Counties, 2014 - present. For the Sacramento Area Flood Control Agency.* This project aims to prepare a locally developed plan or alternative that meets the salmonid habitat and fish passage goals for the Yolo Bypass Project while being sensitive to other Yolo Bypass land uses. Conceptualization of the plan elements has occurred with substantial support from stakeholders and local agencies. The alternative includes managed floodplain inundation to amplify rearing habitat benefits and provide opportunities for food web production and export to the Delta based on the basic elements of a passive intake channel at Fremont Weir, operable weirs within Tule Canal to manage water levels within each management unit, and enhanced agricultural berms to control water levels within each management unit. As project manager for cbec, Chris prepared the concept design for the plan based on stakeholder input and directed the application of the Yolo Bypass TUFLOW model to evaluate the performance of the plan (ongoing).

**Oroville Wildlife Area Flood Stage Reduction Project.** *Butte County, CA, 2014. For the Sutter Butte Flood Control Agency*. This Project consists of weir improvements and associated ecosystem restoration in order to improve the connectivity of the Feather River to its historic floodway and reduce stages within the main channel. cbec conducted a reconnaissance level geomorphic assessment along 8 miles of the Feather River corridor in the vicinity of the Oroville Wildlife Area D-Unit with the goal to develop a better understanding of potential project related impacts to the local sediment regime and water quality within the study reach. Chris was the project director for this effort.

**Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project.** *Yolo and Solano Counties, CA, 2013 - present.* In support of the US Bureau of Reclamation and California Department of Water Resources Environmental Impact Statement and Environmental Impact Report, this project aims to develop a preferred alternative to meet the Reasonable and Prudent Alternative actions set forth in the National Marine Fisheries Service's Biological Opinion for creating floodplain habitat for juvenile salmonids and improving fish passage within the Yolo Bypass. Working with HDR Engineering to evaluate the alternatives, a detailed 1D/2D hydrodynamic model based on the TUFLOW platform was developed, calibrated, and applied. The efficacy of multiple alternatives were evaluated over 16-year simulation period based on the hydrodynamic outcomes that were also used to inform subsequent agricultural economic impact and fish benefits analyses. As project manager for cbec, and using his extensive knowledge of the Yolo Bypass, Chris directed the detailed TUFLOW model development and calibration, developed the long-term hydrology, collected missing bathymetric data, prepared preliminary gate designs for the alternatives, and supported the team by presenting the alternative outcomes (ongoing).

**Dry Creek Habitat Enhancement Project**. *Sonoma County, CA, 2013 - present*. *For the Sonoma County Water Agency.* This project will enhance up to 6 miles of Dry Creek below Warm Springs Dam through creation of in-channel and off-channel habitats to improve summer rearing and winter high-flow refuge for coho salmon and steelhead trout. Design elements include alcoves and side channels, in-channel riffle enhancement, large wood structures, biotechnical stabilization measures, and native revegetation. Working with Inter-Fluve, Inc., cbec supported the development of channel designs by performing detailed field surveys of the low flow channel and conducting 2D hydrodynamic model development and calibration using TUFLOW to evaluate the performance of the design features from low flows through the 100-year flood. Chris directed the surveys and hydrodynamic modeling.

**Ardenwood Creek Restoration and Flood Control Project**. *Alameda County, CA, 2013 - present*. *For the Alameda County Flood Control and Water Conservation District*. The goal of this project is to improve flood protection to urban areas adjacent to Ardenwood Creek as well as enhance the habitat function of the creek in the urban areas and through the Coyote Hills Regional Park. Working with NewFields, cbec developed a 1D/2D hydrodynamic model of Ardenwood Creek and the Alameda County Flood Control Channel based on the MIKE FLOOD platform to evaluate the performance of the preferred channel design. Chris was the project manager for this effort.

**Moosa Creek Mitigation Bank Concept Design.** *San Diego County, CA, 2013 - present*. *For San Lius Rey Downs Enterprises, LLC.* CA plans to develop a mitigation bank at a former golf course to rehabilitate and re-establish wetlands, riparian floodplain, and upland buffer along the San Luis Rey River and Moosa Creek as well as provide mitigation for federally and state listed species, including the coastal California gnatcatcher, least Bell's vireo, southwestern willow flycatcher, and arroyo toad. Construction activities will include grading and removal of topsoil and native revegetation of riparian and upland areas. Working with WRA, Inc., cbec prepared the geomorphic and hydraulic basis of design developed a 2D hydrodynamic model based on the MIKE 21FM platform to inform the design using the state of the science for vegetation roughness and evaluate flood impacts, prepared the grading plans inclusive of biotechnical bank stabilization and erosion control measures, and supported the preparation of permits. As project director, Chris prepared the basis of design, led the hydrodynamic modeling, and provided input into the design documentation.

**Lower Putah Creek Restoration Project.** *Yolo County, CA, 2012 - present. For the Yolo Basin Foundation and funded by the California Department of Fish and Wildlife.* This project aims to improve passage, rearing, and emigration of adult and juvenile salmonids on Putah Creek, enhance habitats for salmonids and other Delta native fish and wildlife within a realigned Putah Creek channel on the Yolo Bypass Wildlife Area, and enhance ecological functions of the recently restored tidal habitat on the Wildlife Area. Working with Environmental Science Associates and Stillwater Sciences, the project team has collected engineering design field data and prepared engineering and hydraulic modeling analyses to inform the restoration design of the realigned channel that meets ecological goals in the context of ongoing agricultural operations, Wildlife Area uses and benefits, and flood protection. Not unlike other restoration efforts planned in the Delta, implementation of this action presents considerable challenges related to

reconciling the goals of restoration of habitats and ecological functions that support native species with the realities of working within a highly managed Delta system. As project manager for cbec, Chris directed the flow monitoring, developed the restoration design hydrology and design channel geometry, and directed the hydrodynamic model calibration and long-term simulations using the Yolo Bypass TUFLOW model to assess project performance.

**Triangle Rock Stable Channel Design.** *Sacramento, CA. 2010. For Triangle Rock Products and Buada Associates.* Mr. Campbell was the Project Manager while cbec performed a Stable Channel Design evaluation on Laguna Creek. The evaluation involved hydraulically modeling the existing condition and proposed design to evaluate the geomorphic stability of the channel using shear stress (an indicator of erosive forces) for the proposed design under the 2-year flood event. The design was modified and iterated until a channel dimension and slope could be identified that yields shear values that correspond to a geomorphically stable design for the project reach. Channel shear values were compared to the critical shear values (those minimum shear values where erosion begins to occur in the channel) to determine if the shear values are less than the shear values that will typically erode the bed and banks up to the 2-yr storm event. The duration and frequency of inundation for both the lower and upper terraces of cbec's proposed design under 2-year, 5-year and 10-year storm events were also be examined to determine that the requirements for seasonal wetlands and riparian vegetation are met and are sustainable given Laguna Creek's ephemeral hydrology.

**Central Valley Flood Protection Plan - Identification and Prioritization of Potential Restoration Sites.** *Sacramento County, CA. 2010. For California Department of Water Resources.* cbec is currently assisting DWR through a sub-contract with AECOM, to identify and prioritize potential restoration sites for the CVFPP. The project involves sophisticated GIS techniques and HEC-Ecosystems Function Model (EFM).

**Suisun Valley Floodplain Modeling.** *Solano County, CA 2009 - 2010. For MTCo/Nolte Joint Venture on behalf of Solano Transportation Authority.* Chris was project manager for a two-phase project to develop a two-dimensional model for the Suisun Valley, which includes Suisun, Ledgewood and Dan Wilson creeks. The Suisun Valley Floodplain Modeling project was conceived, following a decade of creek specific hydrologic and hydraulic studies, to evaluate valley-wide flood impacts to existing infrastructure and formulate practicable alternatives to alleviate these impacts.

**Crest Marin Creek Diversion**. *2005. For Marin County FC&WCD*. The purpose of this project was to develop revised flood discharges to be used in the design of a diversion to minimize flooding to homes along Crest Marin Creek. Responsibilities as project manager included modifying the Coyote Creek hydrologic model (HEC-HMS) to develop design flows for the proposed diversion and assessing the impacts of the diversion on the flood channel (HEC-RAS).

**Feather River Levee Setback Project**. *Yuba County, CA, 2005 - 2007. For the Three Rivers Levee Improvement Authority*. Project hydrologist for this levee setback project on the Feather River, responsible for the geomorphic assessment of the proposed levee setback and the physical process elements of the environmental enhancement of the setback area.

**Bear River Levee Setback Project.** *Yuba County, CA, 2005 – 2007. For the Three Rivers Levee Improvement Authority.* Project hydrologist for this levee setback project on the Bear River, responsible for the geomorphic assessment of the proposed levee setback and the physical process elements of the environmental enhancement of the setback area.

**Various Yolo Bypass Studies.** *Yolo County, CA, 2008 - present.* cbec has and is assisting multiple agencies (Yolo County, California Department of Fish and Wildlife, Yolo Basin Foundation, Metropolitan Water District) in the collection of new field data to support various modeling efforts like the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project. Field efforts include collection of Tule Canal low flows, Tule Canal bathymetry, and Yolo Bypass air photo acquisition, all to support model calibration. cbec has also performed a study to improve the availability and quality of data for planning drainage and water infrastructure improvements that benefit wetlands and agriculture in the Yolo Bypass, which will assist Yolo County and the Yolo Basin Foundation in securing future funding for projects or feasibility studies to benefit agriculture and wetland operations. Chris managed these efforts.

**Demonstration Decision Support Modeling for the Sacramento Valley.** *Sacramento Valley, CA, 2012 - 2014. For the California Department of Water Resources and the Resources Legacy Fund.* This project resulted in the development and calibration of a planning level 2D hydrodynamic model for the whole of the Sacramento River Valley flood control system (from Hamilton City to Rio Vista) built on the GPU-based Jflow+ model platform. The model is part of a decision support tool, was used to evaluate the efficacy of multi-objective floodplain management alternatives, and can be used to support ongoing conservation strategies and feasibility studies. As project manager, Chris directed model development, calibration, and the alternatives evaluation.

**Santa Ynez River.** *Santa Barbara County, CA, 2011 - 2013. For the National Marine Fisheries Service.* Mr. Campbell was the acting project manager and led an effort that developed a two-dimensional flow model to model the Santa Ynez River hydraulics. The model was calibrated using the measured field data. The existing conditions and additional scenarios were modeled to assess the habitat of the upstream reach of the Santa Ynez River.

**San Joaquin Hydraulic Model Development**. San Joaquin Valley, CA, *2010 - 2011. For FishBIO.* Mr. Campbell was the acting project manager for this large and technical model. cbec conducted a baseline hydraulic survey (ADCP, RTK GPS) which quantified a stage and discharge relationship for a

range of flows for over 60 miles of the San Joaquin River. This data was used to develop a fully calibrated 1D hydraulic model (HEC GeoRAS) for 60 miles of the San Joaquin River to establish relationships between flow and floodplain habitat within the modeled reach.

**Stream Sewer Creek Crossing Assessment for Sacramento County,** *Sacramento County, CA, 2008 - 2014. For Sacramento Area Sanitation District.* cbec is currently undertaking the geomorphic assessment of 41 creeks and streams within Sacramento County for Sacramento Area Sanitation District. Mr. Campbell is overseeing the fieldwork and analysis component of this project to assess the bank and bed stability in the reaches where existing sewer crossings exist. cbec is using rapid geomorphic assessment techniques in conjunction with hydrodynamic and sediment transport analysis to provide recommendations on suggested biotechnical bank stabilization methods.

**Bay Delta Conservation Plan Effects Analysis.** *Yolo County, CA. 2010 – Present.* cbec is currently assisting DWR through a subcontract with SAIC to understand the effects of various inundation scenarios in the Yolo Bypass. The project involves 2D hydrodynamic modeling from Fremont Weir to Liberty Island using the MIKE 21FM platform.

**American River Sunrise Side Channel**. *Sacramento, CA. 2005–2008. For Water Forum and SAFCA.* The project objective is to reintroduce more frequent flows to a side channel on the American River to enhance steelhead spawning habitat. Responsibilities as PM include collecting baseline hydraulic data, calibrating a 2D (MIKE 21) hydrodynamic model, and assessing the geomorphic performance and sustainability of the conceptual alternatives using the calibrated hydraulic model.

**Santa Clara River Parkway**. *2009 - 2012. For California State Coastal Conservancy.* Mr. Campbell was the acting project manager for developing a 2D hydrodynamic model using MIKE FLOOD for approximately 40 miles of the Santa Clara River from the Los Angeles County Line to the Ocean. The model was validated against the January 2005 flood event and was used to assess the flood attenuation benefits of multiple levee setback scenarios incrementally and in aggregate for Q25 and Q100 under existing and future climatic conditions.

**Stanislaus River Honolulu Bar Restoration**. *Oakdale, CA. 2008–present. For FISHBIO.* As project manager on this salmonid habitat restoration project, Mr. Campbell designed and implemented a monitoring plan to support model calibration and supervised the development and application of a 2D model called SRH-2D to model a 7.5 mile reach from Knights Ferry to Orange Blossom bridge with the goal of designing a rearing habitat restoration project for the gravel bar.

**Putah Creek Flow Restoration and Flood Conveyance**. *Solano County. 2004–2008. For Solano County Water Agency.* The project objective was to identify potential management measures downstream of the Putah Diversion Dam on Lower Putah Creek to reduce tailwater elevations to more closely match design conditions and to accurately model the flood conveyance of Lower Putah Creek to determine where the creek has restricted flow capacity and may pose a flood threat. Responsibilities as PM included modeling in HEC-RAS to identify management measures and modeling in MIKE 21C to identify flood conveyance hazards.

**Fremont Landing Conservation Bank**. *Yolo County, CA. 2007–present. For Wildlands, Inc.* The project objective was to enhance site conditions at Fremont Landing to serve as a conservation bank to improve the aquatic and shaded riverine habitats for special-status anadromous salmonids. Project hydrologist responsibilities included development of a 2D curvilinear hydrodynamic model in MIKE 21C for Fremont Landing within the SAFCP (to include the Sacramento River, Sutter Bypass, Feather River, Yolo Bypass, and Natomas Cross Canal) and evaluation of the components and phasing of the preferred concept leading to a restoration approach that showed no significant impact relative to the Sacramento River design water surface and Yolo Bypass flow split.

**Napa River Sediment Reduction and Habitat Enhancement Plan**. *Napa, CA. 2006–2008. For California Land Stewardship Institute.* The project objective was to develop a sediment reduction and habitat enhancement plan for 9 miles of the Napa River between Oak Knoll Ave and Oakville Cross Road. Responsibilities as PM for the hydrodynamics include technical supervision and quality assurance of the modeling. The hydrodynamic model MIKE FLOOD (1D and 2D dynamically coupled models) will be used to evaluate the preliminary alternatives with respect to flood reduction and habitat benefits, and to select a preferred alternative.

**Sonoma Creek & Tributaries Feasibility Study**. *Sonoma, CA. 2006–2008. For Southern Sonoma County RCD.* The project objective was to identify restoration components and feasible designs for flood control for Sonoma Creek in the vicinity of Schellville. Responsibilities as PM under Phase II of the Work Program included technical supervision and quality assurance of the hydrodynamic modeling. The hydrodynamic model MIKE FLOOD was used to characterize existing conditions, test project alternatives and components, and to evaluate the preferred alternative with respect to flood hazard reductions and geomorphic stability.

**Sediment Transport on the Pajaro River**. *Santa Cruz County, CA. 2005. For Pajaro River Watershed Flood Prevention Authority.* The Pajaro River is the subject of a proposed flood plan that is threatened by potential difficulties in obtaining permits for sediment removal. Responsibilities as lead modeler included 2D sediment transport in MIKE 21C to identify the effects of redesigning the flood project to better manage sediment.

**Coyote Creek OM Analysis**. *Marin County. 2004–2008. For Marin County Flood Control and Water Conservation District (FC&WCD).* The project objective was to reassess the maintenance regime of the flood control channel and develop a design for a self-maintaining channel with ecological

benefits. Responsibilities as PM included review of existing information, hydrologic model development and calibration, hydraulic model (HEC-RAS) development, estimation of equilibrium channel dimensions, and development of conceptual alternatives to reduce channel maintenance requirements.

**Restoration of Clifton's Drain in Geothe Park**. *Sacramento County, CA, 2006–2007. For Sacramento County Regional Parks and SAFCA.* The purpose of this project is to develop a multi-objective restoration design for the site, to the satisfaction of all stakeholders, which considers channel restoration, elderberry bush mitigation, and organic farming. Responsibilities as PM to date include preliminary hydraulic modeling using MIKE 11 and a soils analysis.

**Pleasant Grove Creek Corridor Enhancement**. *Roseville, CA, 2006–2007. For Blue Oaks Property Owners and City of Roseville.* The purpose of this project is to identify concepts through the proposed Creekview and Panhandle developments that integrate flood conveyance and habitat enhancement and that maintain or enhance the entitled capacity of the City's proposed Reason Farms retention basin. Responsibilities as PM include hydrodynamic model development and supervision. The hydrodynamic model MIKE 11 is being used to evaluate each concept.

*Tidal and Estuarine Projects*

**Decker Island Habitat Restoration Project.** *Solano County, CA, 2015 - present. For California Department of Water Resources.* Located on the Lower Sacramento River downstream of Rio Vista, this project aims to restore functional tidal wetlands and seasonal wetlands on 140 acres of the island that was historically farmed along Horseshoe Bend as part of satisfying the 8,000 acre tidal wetland target required by the USFWS Delta Smelt BiOp. Working with Stillwater Sciences, cbec is preparing the hydrodynamic modeling to evaluate the performance of a suite of alternatives, as prepared by DWR, leading to the selection and refinement of a preferred alternative that maximizes habitat benefits. As project director, Chris is directing and reviewing the hydrodynamic modeling.

**Crane / Domeyer / Willow Bar Feasibility Analysis and Initial Designs.** *Sauvie Island, OR, 2015 - present*. *For the Columbia River Estuary Task Force.* The goal of this project is to restore estuary habitat critical to the recovery of threatened and endangered salmon species utilizing the Columbia River Estuary, with habitat restoration actions targeted to benefit juvenile salmonids at three impaired sites on the island. Working with Wolf Water Resources, cbec collected topographic and bathymetric field data and developed a 2D hydrodynamic model of the river system from St Helens to Vancouver / Portland based on the SRH-2D platform. This data and modeling was used to better understand existing hydrodynamics and inform the initial restoration designs at each site. Chris was the technical lead for the data collection and hydrodynamic modeling.

**Yolo Flyway Farms Restoration Project.** *Yolo County, CA, 2014 - present. For Reynier Fund, LLC.* This project in the southern Yolo Bypass will restore tidal interaction to 360 acres and preserve agricultural in the remaining 80 acres. The tidal restoration will enhance and create habitat for special status fish with the objectives to enhance regional food web productivity in support of delta smelt recovery; provide rearing habitats for out-migrating salmonids; supporting a broad range of other aquatic and wetland-dependent species; and provide ecosystem functions associated with the combination of Delta habitats that existed historically. Based on input from a scientific advisory committee, cbec designed the 360-acre tidal marsh restoration with a combination of swale and wetland terrace excavation and selective agricultural berm leveling to enhance tidal marsh habitat via conversion from managed grasslands. Chris directed the 2D hydrodynamic modeling and development of the concept, design plans, and cost opinions.

**Liberty Island Ecological Reserve Land Management Plan.** *Solano and Yolo Counties, CA, 2013 - 2015. For the California Department of Fish and Wildlife*. Working with AECOM, a draft land management plan has been prepared to guide adaptive management activities, provide an overview of planned operation and maintenance activities, serve as a guide for public use, and be a descriptive inventory of plant and animal species found at the ecological reserve. cbec developed the hydrology, geomorphology, water quality and climate sections for the Liberty Island Land Management Plan based on extensive literature review as well as assessments of tidal discharges, flood hydraulics and inundation due to sea level rise derived from earlier 2D hydrodynamic modeling by cbec and others within the Yolo Bypass and Cache Slough Complex. Chris directed this effort.

**Selby Slag Site Environmental Impact Report.** *Contra Costa County, CA, 2012-present. For the Department of Toxic Substances Control.* An EIR is being prepared for the reclamation of a former smelting facility along Carquinez Strait on former tidal areas to improve capping of hazardous slag and smelting wastes to minimize contamination via tidal action along the shoreline and groundwater leaching. Working with Ascent Environmental, cbec has refined the 3D hydrodynamic model prepared and calibrated by AECOM based on the Delft3D platform, which AECOM will use for design purposes. cbec will use this model to assess environmental impacts of the preferred design. As lead modeler, Chris performed the independent review and refinement of the Delft3D model and will direct the application of the model to assess environmental impacts due to changes in sedimentation patterns (ongoing).

**NAVFAC Bangor P990 Mitigation Survey and Modeling.** *Puget Sound, WA, 2011*. *For Naval Facilities Engineering Command Northwest.* Manager of the project, which included field data collection and model development for tidal estuary and riverine restoration projects in the Puget Sound, Washington. The project entailed collection of surface sediment samples representative of fluvial and deltaic morphological units and statistical tidal analyses for modeled water level calibration in the Puget Sound and Hood Canal, and 2D hydrodynamic (Delft3D modeling software, Deltares) simulations of tidal currents and riverine-floodplain interaction at the Big Beef Estuary and Big Quilcene River. The model was also calibrated and validated the 2D model of the Hood Canal inlet system based on measured water levels, tidal constituents and measured velocity.

**Shine Tidelands State Park Tidal Lagoon Restoration Feasibility.** *Puget Sound, WA, 2011 - 2012. For Naval Facilities Engineering Command Northwest.* Project manager for developing a two-dimensional hydrodynamic model of tidal and nearshore processes at the Shine Tidelands State Park proposed restoration site by using Delft3D modeling system of Delft Hydraulics. The Shine Tidelands model is being developed to simulate two-dimensional flow, tides and waves and their interactions.

**Big Beef Estuary Restoration Feasibility,** *Puget Sound, WA, 2011 - 2012. For Naval Facilities Engineering Command Northwest.* Project manager for development of a two-dimensional hydrodynamic and sediment transport model for tidal and riverine Big Beef estuary by using Delft3D modeling system of Delft Hydraulics. The Big Beef Estuary model extends from the fluvially dominated reach to the estuary surface and into the greater Hood Canal inlet system and was used to simulate a two-dimensional flow, sediment transport and morphology, and waves and the interactions between these processes.

**Northern Liberty Island Fisheries Enhancement Project Assessment.** *2011. For Wildlands, Inc.* Mr. Campbell was as the acting project manager overseeing the application and refinement of a 2D hydrodynamic model using MIKE 21FM. The MIKE 21FM model developed by cbec encompasses a complex network of tidal channels (both natural and manmande) within the Yolo Bypass-Liberty Island-Cache Slough Complex. The main goal of the Northern Liberty Island Fisheries Enhancement Project was to assess the feasibility, sustainability, and regional benefits of implementing various proposed enhancements (e.g., levee breaches, ditch plugs, pilot channels, etc.) within Stair Steps 1 and 2 in northern Liberty Island under tidal and flood regimes. These proposed enhancements are intended to create and enhance delta smelt and salmonid habitat in the project area.

**Prospect Island Tidal Restoration Project.** *Solano County, CA, 2011 - present. For the California Department of Water Resources and the California Department of Fish and Wildlife Fish Restoration Program Agreement.* This project aims to restore the property to freshwater tidal wetland and subtidal habitats to benefit native fish and improve aquatic ecosystem functions. Restoration will entail interior grading, vegetation management, clean fill import for subsidence reversal, weir installation, breaching of exterior levees, and addressing various property considerations. Monitoring will take place as part of a science- based adaptive management plan. The design of future restoration projects will incorporate knowledge gained through the implementation and monitoring of this project. Working with Wetland and Water Resources and Stillwater Sciences, cbec developed and calibrated a MIKE 21FM model to evaluate dissolved organic carbon impacts at the North Bay Aqueduct for multiple alternatives and assessed overall flood impacts by modifying the US Army Corps of Engineers RMA2 model. As project manager for cbec, Chris directed the MIKE 21FM and RMA2 modeling efforts to evaluate the performance of the alternatives and preferred project (ongoing).

**Lower Yolo Ranch Tidal Restoration Project.** *Solano County, CA. 2008 – to present*. Mr. Campbell is the project hydrologist for the largest restoration project in the Yolo Basin of California, for the State and Federal Water Contractors Agency. The project is being completed in partial fulfillment of the contractors' requirement to provide mitigation restoration for the endangered Delta Smelt.

**Solano County Water Agency North Delta Hydrodynamic and Water Quality Modeling and Monitoring**. *Yolo County, C,. 2008–present. For Solano County Water Agency.* As project manager on these multi-stakeholder, multi-objective studies, Mr. Campbell designed, installed, collected, and QC'd the monitoring data; supervised and QC'd the bathymetric data collection; created the bathymetric surface model; directed and QC'd the development and calibration of a MIKE 21FM hydrodynamic model for the Yolo Bypass–Liberty Island–Cache Slough complex; and continues to oversee the development and application of the model. The model is currently being used to support ongoing WQ and restoration studies.

*Wetland Projects*

**Calero County Park Pond and Wetland Restoration Project**. *Santa Clara County, CA, 2015 - present*. *For the Santa Clara Valley Habitat Agency*. To meet the goals of their Habitat Plan, this project aims to enhance habitat for California Red-Legged Frog and California Tiger Salamander at an existing stock pond and wetland seep. Working with H.T. Harvey & Associates, cbec is preparing the hydrologic assessment to inform pond / wetland design through topographic data collection, water budget calculations as well as preparing the grading plans. Chris is the project director responsible for the hydrologic assessment, to include a detailed monitoring and seep investigation, and developing the enhancement design plans.

**California Red-Legged Frog Pond Creation and Enhancement Opportunities and Constraints at Stanford University's Upper Quarry Site**, *Santa Clara County, CA, 2015 - present*. *For Stanford University.*To meet the needs of the Stanford University Habitat Conservation Plan, the goal of this project is to prepare a feasibility assessment to evaluate opportunities to both enhance the existing pond and construct at least two new ponds for California Red-Legged Frog breeding with the Matadero/Deer Creek Basin. Working with H.T. Harvey & Associates, cbec is preparing the hydrologic assessment to inform site selection and pond design through field reconnaissance, water budget calculations, and shallow groundwater monitoring. Chris is the project manager responsible for conducting the hydrologic assessment.

**Suisun Creek Preserve Mitigation Wetland.** *Solano County, CA, 2015. For the Solano Transportation Authority.* This project includes design of seasonal freshwater wetlands and riparian corridor enhancements along a section of Peltier Creek as mitigation for habitat being impacted by the I-80/I-680/SR12 Interchange Phase 1 Project. The main project objective is to create a wetland and riparian corridor complex that re-establishes lost functions and values within this restored creek channel and wetland system. cbec performed an independent review the hydrologic basis of design. Chris provided the expert review for this effort.

**Study of Hardpan Vernal Pools to Support Restoration Design**, *Butte and Placer Counties, CA 2008 - present*. *For University of Idaho.* Per research grants agreement between cbec and the US Fish and Wildlife Service and the US Bureau of Reclamation, this project will provide important design information for the restoration, enhancement, or creation of vernal pools on lands containing existing pools. The hydrologic regime of existing and created vernal pools was monitored for a period of four years at two mitigation sites, to include a combination of groundwater monitoring, climate monitoring, topographic surveys, and ground penetrating radar surveys. This data is currently being used to develop and calibrate a 3D vadose zone model called FEFLOW that will be used to simulate the potential hydrologic impacts to existing pools associated with restoration actions or land use alterations. Chris is the principal investigator for this research project.

**Urrutia Pond Restoration.** *Sacramento, CA, April 2008–present. For Sacramento Area Flood Control Agency (SAFCA) and City of Sacramento.* Worked as a project hydrologist as part of a team preparing the Surface Mining and Reclamation Act (SMARA) reclamation and restoration plan for the Urrutia Pond in the Lower American River Parkway.

**Lake Merritt Channel 7th and 10th Street Reconstructions**. *Oakland, CA. 2006–2008. For Rajappan & Meyer Consulting Engineers, Inc. and City of Oakland.* The project objective was to improve circulation in Lake Merritt and connectivity between the Lake and the Oakland Estuary for recreational users. Responsibilities as lead hydrologist/modeler included updating the MIKE 11 model, testing the hydraulic performance of various project and non-project elements, and optimizing the performance of the flood conveyance channel.

**Redwing Preserve Habitat Conservation and Enhancement Plan.** *Placer County, CA, 2006–2007. For Del Webb Corp.* The purpose of this project is to mitigate for the loss of vernal pool habitat associated with a future housing development. The Preserve will conserve and enhance existing vernal pool habitats and construct new vernal pool habitats. Responsibilities as PM include applying a GIS-based hydrologic model to the HCEP to evaluate the potential hydrologic impacts of constructed pools on existing pools. The hydrologic model is the first of its kind to be applied to vernal pools at the landscape scale.

**Butte County Highway Improvement Vernal Pool Preserve Habitat Conservation and Enhancement Plan (HCEP).** *Butte County, CA. 2005–2008. For Butte County Association of Governments and Caltrans.* The project objective was to mitigate for the loss of vernal pool habitat associated with improvements along four Butte County highways. The Preserve will conserve and enhance existing vernal pool habitats and create new vernal pool habitats. Responsibilities as PM include development of a GIS-based hydrologic model for vernal pool landscapes and application of the model to the HCEP to evaluate the potential hydrologic impacts of constructed pools on existing pools. The hydrologic model developed in-house is the first of its kind to be applied to vernal pools at the landscape scale.

**EGUSD Stonehouse Road Elementary School Mitigation and Monitoring Plan.** *Elk Grove, CA*, 2*005–2007. For Elk Grove Unified School District.* The purpose of this project is to mitigate for the loss of vernal swale and pool habitats associated with the construction of a new school near Rancho Murieta. Responsibilities as PM include developing an offsite conceptual design to recreate the form and function of the vernal swale and pool habitats using hydrologic and geomorphic techniques.

**NCSD Well TH-2 Water Facilities Project Mitigation and Monitoring Plan**. *Truckee, CA, 2005–2006. For Northstar Community Services District. The* purpose of this project is to mitigate for the loss of jurisdictional seasonal wet meadow associated with the development of an artesian well. Responsibilities as PM include evaluating the hydrologic function of the site, refining the conceptual mitigation plan, and develop grading plans for the preferred mitigation plan.

**Napa Sonoma Marsh Restoration.** *Napa/Sonoma County. 2001–2002*. Project hydrologist responsible for hydraulic modeling of one-dimensional sloughs and two-dimensional salt ponds under existing and project conditions to address salinity reduction alternatives, cohesive sediment transport, and restoration alternatives using MIKE FLOOD.

*Hydromodification Projects*

**Alder Creek Hydromodification Impacts Assessment.** *Sacramento County, CA, 2010 - 2012. For GenCorp Realty Investments.* Mr. Campbell was project manager for assessing hydromodification impacts of the planned Glenborough at Easton development on Alder Creek. Modified Draft Sacramento Stormwater Quality Partnership (SSQP) Hydromodification Management Plan (HMP) performance criteria were applied to hydraulic model results from long-term continuous simulations developed for existing and project conditions. Per the criteria, the hydromodification assessment for Glenborough at Easton demonstrated that erosion potential (EP) criteria were met when planned water quality (WQ) basins were modified and additional upslope basins were added to minimize potential hydromodification effects along Alder Creek's entire length below Prairie City Road to Lake Natoma.

**Elverta Specific Plan Hydrodynamic Modeling**. *Elverta, CA, 2010-2013. For Elverta Owners Group.* Mr. Campbell was project manager for a hydromodification impacts assessment of the Elverta Specific Plan (SP) on the receiving waters within and downstream of the SP area. The assessment was developed to inform the overall design of the planned multi-function open space corridors traversing the Project. cbec staff created a 1D hydraulic model to perform a long-term simulation analysis to determine hydromodification effects. cbec staff created a surface model of improvements to the waterway and incorporated it in a 2D model (SRH2D) that was evaluated to establish inundation patterns and habitat regions in the multi-purpose drainage corridor. Multi-function open space corridors are designed to provide drainage conveyance, flood control, water

quality treatment, natural resources habitat, recreational opportunities, and aesthetic appeal. The primary mechanism for attenuating urbanized runoff from the developed areas was through the integration of flood control measures into the design of the corridors, with the potential to also provide some flow duration control for hydromodification mitigation purposes. The proposed flood control measures included a series of in-line cross channel berms spanning the width of the corridors with notches of varying dimensions. Furthermore, major road crossings over the corridors were designed to provide additional in-corridor peak flow attenuation.

**Cordova Hills Geomorphic and Hydromodification Assessment.** *Sacramento, CA, 2009 – present. For Mackay & Somps Civil Engineers.* Mr. Campbell was project manager for assisting Mackay & Somps Civil Engineers with the stormwater drainage master planning for the Cordova Hills Specific Plan. Hydromodification mitigation was theoretically undertaken using LID and flow duration control approaches to match pre and post-project hydrology. cbec assisted with concept designs for multi-purpose flow duration control-water quality-storm detention basins. These technical studies were completed in anticipation of imminent stormwater requirements of the Regional Water Quality Control Board (RWQCB), including a Hydromodification Management Plan (HMP) to assess and mitigate for the effects of urbanization on the frequently occurring flow events passing to receiving waters.

**Sacramento County Hydromodification Management.** *Sacramento County, CA, 2009 - 2013. For Sacramento County.* Mr. Campbell participated in a project with the County's Department of Water Resources to investigate new and innovative tools to assess the impacts of hydromodification and propose potential mitigation strategies. Hydromodification refers to the impacts of urbanization on the frequently occurring flow events (typically between the 2- and 10-year events) that primarily affect the geomorphology of receiving waters. cbec was recently selected to assist the Sacramento Stormwater Quality Partnership (SSQP) with the preparation of the HMP as part of their NPDES MS4 Stormwater Permit Renewal process.

**Sun Creek Hydromodification Planning.** *Sacramento, CA, 2007 - 2008. For City of Rancho Cordova.* Mr. Campbell was project manager for performing hydromodification planning for the Sun Creek Stormwater Master Plan in the Laguna Creek watershed. Hydromodification mitigation was theoretically undertaken using LID and flow duration control approaches to match pre- and post-project hydrology. cbec assisted with concept designs for multi-purpose flow duration control-water quality-storm detention basins. Of particular concern, the designs are addressing the infiltration and evapotranspiration of summer irrigation runoff flows.