INDEPENDENT EXTERNAL PEER REVIEW PANEL

for the

LOWER SANTA CRUZ RIVER, AZ
FLOOD RISK MANAGEMENT FEASIBILITY STUDY

The U.S. Army Corps of Engineers submits the following information per requirements in the Water Resources Reform and Development Act of 2014, Section 1044(c)(4)(B).

Entity Conducting the Review	
Outside Eligible Organization:	Battelle 505 King Avenue Columbia, OH 43201
Dates of Review	
Review Initiation:	25 June 2019
Type I IEPR Final Report Submittal:	13 September 2019
Reviewer Names and Qualifications	
Don Ator	**Plan Formulation/Economics**

Mr. Ator is an independent consultant and serves as Research Associate, Professor, and Undergraduate Advisor in the Department of Agriculture Economics and Agribusiness at Louisiana State University. He earned his M.S. in economics and agriculture economics and his M.B.A. with a concentration in finance and accounting from Louisiana State University. Mr. Ator's current research is in financial resiliency analysis and planning for local governments in Louisiana, Texas, Alabama, Mississippi, Florida, Georgia, Kentucky, and Nebraska. He has 40 years of experience working for 28 USACE districts, first as a full-time employee with the Vicksburg District, then with a not-for-profit research institute, and later at three architect-engineer firms. He has demonstrated experience in flood risk management evaluating and conducting complex multiobjective public works projects with high public and interagency interest. A few examples of the more than 500 flood risk management projects Mr. Ator has conducted include Sensitivity Analysis of Benefit and Cost Evaluation Criteria to Risk and Uncertainty Associated with Study Parameters, Flood Damage Reduction Feasibility Study, Passaic River Basin, New York and New Jersey, USACE New York District; Rancho Palos Verdes, Rolling Hills Shoreline Erosion and Storm Damage Reduction Reconnaissance Study, Los Angeles, California, USACE Los Angeles District; Reconnaissance Study and Report for Flood Damage Prevention, St. Croix, U.S. Virgin Islands, USACE Jacksonville District; Reconnaissance Study and Report for Flood Damage Prevention, Sandusky River Basin, Ohio, USACE Buffalo District; Section 905(b) Flood Damage Reduction Reconnaissance Report, Lower Sabine River, Texas and Louisiana, USACE Galveston District; Section 205 Flood Damage Reduction Study, High School Branch, Newton County, Missouri, USACE Little Rock District; and Flood Damage Reduction Feasibility Study, Sweetwater Creek, Austell and Lithia Springs, Georgia, USACE Mobile District. He has worked extensively with USACE conducting flood risk management analysis, performing economic calculations using the Hydrologic Engineering Center's (HEC) Flood Damage Assessment software (HEC-FDA 1.4.2). He has expertise in methodologies for estimating life loss via the use of HEC's LifeSim software (HEC-LifeSim 1.0) and/or Flood Impact Analysis software (HEC-FIA 3.0). Mr. Ator has extensive experience directly dealing with the USACE six-step planning process governed by ER 1105-2-100, Planning Guidance Notebook. He developed and field tested a template for preparing Project Management Plans (PMPs) for Feasibility Studies for USACE Regional Planning and Environment Division South. He served as a team leader while embedded in the Plan Formulation Branch USACE New Orleans District, directing plan formulation activities of three plan formulators, providing project oversight and review to ensure compliance with USACE guidelines. Mr. Ator is actively involved in related professional engineering and scientific societies, including the Society of American Military Engineers and the American Society of Civil Engineers.

Kay Crouch	**Environmental Law Compliance/Cultural Resources**

Ms. Crouch is an independent environmental consultant and is the founder of Crouch Environmental Services, Inc. of Houston, Texas. She specializes in National Environmental Policy Act (NEPA) analysis, environmental site assessment, permitting, wetlands delineation, and natural resource mitigation for projects with high public and interagency interests. Her experience is particularly related to flood damage reduction. She earned her M.S. in biology/ecology in 1978 from Stephen F. Austin State University and has received additional academic training in the NEPA process from the Duke University Nicholas School of Environmental and Earth Sciences (2004-2005). Ms. Crouch has more than 40 years of nationwide experience conducting environmental site assessments and NEPA impact assessments for complex multi-objective public works projects with competing trade-offs. Her experience includes performing wetlands delineations, endangered species surveys, and environmental site assessments in California. She has also recently performed an IEPR review for an eco-restoration project in Southern California. Ms. Crouch has assessed NEPA impacts for large flood damage reduction projects in urban areas as well as remote locations and has evaluated related ecosystems, species, and habitats. She has done extensive work in the coastal marsh habitats that span the Gulf Coast and in a wide variety of habitat types throughout the nation. She has experience in inland wetlands as well as high and low tidal marsh restoration and evaluation. In the mid-1990s, Crouch Environmental Services designed and constructed the Baytown Nature Center, in Baytown, Texas. For that large, several hundred-acre coastal marsh creation project, the company received the 1998 Award of Excellence from the National Association of Landscape Architects. She also has experience restoring upland habitats such as forests and coastal prairies. Ms. Crouch is familiar with USACE calculations of environmental benefits and routinely performs cumulative effects analyses on high-visibility public works projects as part of her extensive NEPA practice. She is also familiar with several types of habitat models used nationwide. Habitat modeling has been required on every flood damage reduction and ecosystem restoration project she has worked on relating to USACE, including the Bayport Container Terminal, the Clear Creek Flood Damage Reduction Project, and the Addicks and Barker Dams and Reservoirs in Harris County, Texas. Other nationwide NEPA projects have consisted of flood damage reduction projects, dams, ports, parks, offshore activities, linear transportation corridors, power plants, and other types of projects involving Federal funding. Ms. Crouch has extensive knowledge of endangered species surveys and impact analysis. She has completed numerous projects that involve compliance with the Endangered Species Act. The evaluation of the presence or absence of listed species has been required for almost every project in which she has been involved, including USACE 404 permit applications requiring field investigations for listed species in numerous states, including California. She also has completed the Section 7 consultation process for several species. In addition, almost every project Ms. Crouch has worked on has involved investigating and evaluating cultural resource issues. She is intimately familiar with the record search step as well as field survey techniques for cultural resources. She also has supervisory experience related to USACE 404 permits and NEPA documentation and Section 106 experience for the analysis of historical issues. She has demonstrated experience conducting biological assessments, including wetlands delineations, compilation of biological assessments for Section 404 permitting, and NEPA documentation.

Ms. Crouch's skills include knowledge of the USACE planning process, SMART planning, and calculation and application of environmental impacts and benefits. She is well versed in various modeling types and in the performance of ICA. She has experience reviewing the application of Wetland Value Assessment (WVA) methodology and has calculated the environmental losses and benefits of USACE projects using the hydrogeomorphic (HGM) approach, habitat evaluation procedures (HEPs), and WVA, as well as other models. Most recently, she performed a WVA analysis for the Addicks and Barker Dams environmental assessment in Harris County, Texas (USACE, Galveston District). In 2001, Ms. Crouch was selected to receive a Telly Award for a video presentation she produced for the USACE Galveston District that describes, via interviews with staff and the use of sophisticated graphics, the USACE planning process. In 2010, Ms. Crouch and her staff were recognized as the "National Best Practice Standard" for the USACE for public engagement work performed for the Addicks and Barker Dams and Reservoirs dam safety project. Ms. Crouch has performed IEPR reviews for numerous USACE projects for the New Orleans District, including the Mississippi River Gulf Outlet (MRGO) (2011); Southwest Louisiana (2013 and 2015); Louisiana West Bank (2014); Morganza (2012); New Orleans to Venice (2011); and Barataria Basin (2011). She is a standing member of the Louisiana Water Resources Council. She has also performed IEPR reviews for projects in Tennessee (Center Hill Dam, 2013); Missouri (Alton to Gale Levees, 2010, and East St. Louis Levees, 2010); Princeville, North Carolina (2014); Norfolk (2018); and the Brazos River Floodgates (2018).

Jennifer Guohong Duan	**Hydrology and Hydraulic (H&H) Engineering**

Dr. Duan is an independent consultant and P.E. in the state of Arizona. She received her Ph.D. in Computational Hydroscience and Engineering from the University of Mississippi in 1998, and an M.S. in Hydraulic Engineering from Tsinghua University, China in 1992. She is currently a Professor of Hydraulics and Water Resource Engineering at the University of Arizona in the Department of Civil and Architectural Engineering and Engineering Mechanics. Dr. Duan is a Professional Engineer in Arizona and Nevada, and is a Diplomat of the American Academy of Water Resource Engineers. Dr. Duan is familiar with the Lower Santa Cruz River, having worked on a sediment transport model for erosion analysis in the LSCR in Pima County as well as co-designing the Sunset Bridge crossing the Santa Cruz River at Sunset Road. She conducted the scour analysis around the piers and abutments for different designs, and provided hydraulic parameters for geotechnical and structural engineering designs. She also evaluated sediment transport models for the Rillito River, Tucson for the Pima County Regional Flood Control District, Tucson, Arizona. The project involved three sediment transport models commonly used in erosion analysis of alluvial rivers. Her research results have helped the development of Pima County Technical Policy 17 for erosion and sedimentation analysis. For the Maricopa Regional Flood Control District in Phoenix, Arizona, she conducted a computational simulation of river morphodynamic processes for a reach of Salt River in Phoenix, Arizona using the EnSed2D model in 2004. The study aims for designing stream restorations to mitigate erosion. In 2011-2012, she upgraded an experimental flume for hydraulic engineering education and research using the funding from the U.S. Army Research Office. The flume has been used for studying flow and sediment transport in vegetated dryland rivers, and bridge scour in a complex pier system. The National Science Foundations (NSF) funded her as a co-principal investigator on a collaborative research project looking at climate and population change and thresholds of peak ecological water: integrated synthesis for dryland rivers. Her research has incorporated the impacts of climate change on the flood magnitude and frequency relation for the Upper Santa Cruz River.

Douglas Spaulding	**Civil Engineering**

Mr. Spaulding is a Principal and geotechnical/civil engineer with Spaulding Consultants, LLC, responsible for dam, levee, and floodwall design and inspection. He earned his M.S. in geotechnical engineering from Purdue University, and is a registered professional engineer in Wisconsin, Minnesota, and Michigan. He has 50 years of experience in the design, evaluation, and inspection of water-retaining structures. During his long career, he has provided geotechnical design and evaluation services for flood control levees, embankments, and hydroelectric projects in a 23-state area. His experience includes 10 years with USACE, where he served as Chief of the Levee and Channel Design Section for the St. Paul District. In that capacity, he managed the design of the Pembina levee project in North Dakota and provided geotechnical/civil design services for over $200 million worth of local flood protection projects in Wisconsin, Minnesota, and North Dakota. The Pembina project and the Mankato and Winona flood control projects in Minnesota all included extensive sections of floodwall (both I-wall and T-wall configurations). In addition, for the Winona project, Mr. Spaulding supervised the evaluation of underseepage using a drainage trench. He also served as the Program Manager for the National Dam Safety Program in Wisconsin and Minnesota. He has experience with lock structures in Minnesota and Michigan and served on the design team for the rehabilitation of Lock and Dams No.1 and No.2 on the Mississippi River and managed the design of several hydroelectric projects at dams on the Mississippi and Red River in Louisiana. Mr. Spaulding's geotechnical background includes evaluating the stability of levee sections founded on soft clay foundations. His experience also encompasses geotechnical design of bridge foundations, cellular sheet pile structures, sheet pile tieback walls, conventional gravity walls, and pump stations founded on sand and soft clay deposits. He has provided design services for embankments using preload fills to strengthen underlying foundation deposits. He recently served as a consultant to evaluate the instability caused by a sanitary landfill founded on more than 100 feet of soft lacustrine clay. All the local flood control projects for which Mr. Spaulding has provided design services have involved at least several gatewells to accommodate gravity drainage. As part of his experience, he applied USACE risk-informed approaches to the evaluation of safety issues at USACE navigation, flood control, and hydroelectric projects. From 1988 to 2010 Mr. Spaulding also provided dam safety training for USACE operations personnel at navigation and flood control projects. Over the last 10 years, Mr. Spaulding has participated in more than 75 Potential Failure Mode Analysis (PFMA) evaluations of dams and hydroelectric projects. As a facilitator of PFMA evaluations authorized by the Federal Energy Regulatory Commission (FERC), Mr. Spaulding has directed more than 50 evaluations for embankment dams, concrete gravity structures, and arch dam structures. In addition, Mr. Spaulding has served as a civil/geotechnical member of IEPR review panels dealing with local flood protection projects such as levees, channels and floodwalls, dam remediation, dam replacement, and seepage control system upgrades. This experience has given him with extensive background in USACE's Safety Assurance Review (SAR) requirements. Mr. Spaulding has provided peer review services on two reaches of hurricane protection projects in the New Orleans area. In 2008, he peer-reviewed the geotechnical design of the New Orleans Group 1 to Group 3 pump stations. In 2010, Mr. Spaulding also served on the IEPR team reviewing the Olmsted

Lock and Dam structure on the Ohio River. In 2014 he served on the IEPR evaluation team for the Pine Creek dam remediation in Oklahoma, assessing proposed methods to control internal embankment seepage around an existing conduit that had created large internal voids in the 50-year-old dam. In addition, Mr. Spaulding currently serves on two FERC-appointed Boards of Consultants reviewing the design of two major hydroelectric projects and was appointed to the Department of Energy (DOE) Peer Review panel to evaluate ongoing DOE-sponsored research related to dams and hydroelectric generation. He recently served on a Bureau of Reclamation review panel for the Folsom Dam spillway addition. Mr. Spaulding is a lifetime member of the American Society of Civil Engineers. He is also a member of the Minnesota Geotechnical Society, the National Hydropower Association, and the Construction Panel for the Minneapolis section of the American Arbitration Association.

Abdul Shakoor	**Geotechnical/Soils Engineering**

Dr. Shakoor is an emeritus professor of engineering geology at Kent State University and an independent consultant. He earned a Ph.D. in engineering geology from Purdue University in 1982. He is a registered professional geologist (P.G.) in Pennsylvania and a certified professional geologist (CPG) by the American Institute of Professional Geologists. He has more than 45 years of academic and practical experience in physical geology, engineering geology, environmental geology, soil mechanics (including sampling and laboratory testing), rock mechanics, rock slope stability, foundation engineering, hydrogeology, and remote sensing. Dr. Shakoor's research is broad-based, covering, but not limited to, the engineering behavior of weak rocks (shales, claystones, mudstones, etc.), stability of slopes in both soils and rocks, evaluation of construction materials, influence of geologic characteristics on engineering properties/behavior of soils and rocks, and environmental hazards such as lakeshore erosion, mine subsidence, and structural damage due to expansive soils and blasting operations. His research in these areas involves extensive field and laboratory studies with a number of his research projects regularly conducted in collaboration with local engineering firms or government organizations, such as the Ohio Department of Transportation, state geological surveys, the National Park Service, and the U.S. Environmental Protection Agency. Since his advanced engineering geology course focuses on rock mass classification systems, dams, tunnels, and ground subsidence, he is very familiar with dam hydraulics, failure mode analysis, risk assessment, risk reduction measures, empirical methods for evaluating erodibility of soils and rocks, drilling and logging techniques, pressure testing, and ground fissures produced by fluid withdrawal. Dr. Shakoor is familiar with all applicable USACE guidance criteria, including USACE dam safety guidance and procedures. He is familiar with the probability-based analysis currently used by USACE and has working knowledge of all applicable USACE design criteria and related documents. Having served as an engineering geology expert on multiple IEPR panels, he has gained considerable experience in failure mode analysis (both the embankment and the foundation), seepage and uplift pressure analyses, riverbank erosion and stability, risk assessment of spillway, risk assessment for embankment dams and levees, and the evaluation of risk reduction measures for dam safety projects including flood management studies (Bluestone Dam, WV; Zoar Levee, OH; Lake Isabella Dam, CA; Westminster, East Garden Grove Flood Management Study, CA).