ABSTRACTS AND BIOGRAPHIES
# AGENDA

Hyatt Regency Columbus  
350 North High Street, Columbus, Ohio 43215  

## Monday, August 27, 2018  
8:00am – 5:00pm  

- **TRB AFB-65 Summer Meeting** – Open to Public – Delaware Room A  
- **TRB AFB-60 Summer Meeting** – Open to Public – Delaware Room B  
- **AASHTO TCHH Annual Committee Meeting** – Invitation only – Delaware Room C  
- **FHWA Meeting** – Invitation only – Delaware Room D  

## Tuesday, August 28, 2018  
8:00am–11:30am  
Conference Registration/Sponsor Set Up – Delaware Foyer  

**Workshop A** – *Two-dimensional Modeling Best Practices for Transportation Hydraulics*  
Scott Hogan, Alan Zundel, and Yong Lai  
Delaware Room A-B  

**Workshop B** – *NCHRP 14-26 Culvert and Storm Drain System Inspection Manual*  
Jesse Beaver  
Delaware Room C-D  

1:00pm-4:40pm  
General Session – Delaware Room A-D  

1:00pm-1:20pm – *Opening Remarks* – Shad Sargand, Russ Professor and Associate Director of ORITE  
1:20pm-1:30pm – *Welcome* – Dr. M. Duane Nellis, President of Ohio University  
1:30pm-2:20pm – *Keynote Speech* – Dave Slatzer, Deputy Director of Ohio Department of Transportation  
2:20pm-3:00pm – *Stan Davis Tribute/Mark Miles Award*  
3:00pm-3:20pm – Break – Delaware Foyer  
3:20pm-3:40pm – *FHWA Update* – Joe Krolak, HIBS-20 Team Leader and Principal Bridge Engineer – Hydraulics  
3:40pm-4:00pm – *AASHTO Update* – Nick Wark, Vermont DOT  
4:00pm-4:40pm – *Transportation Research Board Committee Updates* – Bea Hunt (AFB-60) and Scott Taylor (AFB-65)  

5:30pm-7:00pm – *Ice Breaker/Poster Session* – Peppercorn Room (First floor)
## Wednesday, August 29, 2018

6:45am-7:45am – Breakfast (provided) – Hayes Room, first floor

8:00am-10:05am

### Moderated by: Mike Hogan

<table>
<thead>
<tr>
<th>Session Topic/Title</th>
<th>Room/Presenter</th>
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<tbody>
<tr>
<td><strong>Culvert Hydraulics – The Practical and Innovative</strong></td>
<td>Delaware Room A-B</td>
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<tr>
<td><strong>Why Bigger is Not Always Better: Culvert Hydraulics</strong></td>
<td>Matthew Johnson</td>
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<tr>
<td><strong>Culvert Hydraulics and Testing Diffuser Outlet Efficiency: Methods for Demonstrating Increased Capacity</strong></td>
<td>Alex Mann</td>
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<tr>
<td><strong>Web-based Tool for Evaluating Sedimentation at Multi-Box Culverts</strong></td>
<td>Dave Claman</td>
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<tr>
<td><strong>Fish Passage Barrier Correction at State Highways in Washington State</strong></td>
<td>Julie Heilman and Dave Minner</td>
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<tr>
<td><strong>Million Dollar Culvert Rehabilitation Summary</strong></td>
<td>Timothy Mallette</td>
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### Moderated by: Brian Beucler

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<tr>
<th>Session Topic/Title</th>
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<tr>
<td><strong>Coastal Hydraulics – Resiliency for Extreme Events and Changing Seas</strong></td>
<td>Delaware Room C-D</td>
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<tr>
<td><strong>An Assessment of Hydraulic Damages in Northeast Florida from Hurricane Irma</strong></td>
<td>Raphael Crowley</td>
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<tr>
<td><strong>Fast Tracked Shore Protection along Lake Michigan – A Case Study</strong></td>
<td>Saied Saiedi</td>
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<tr>
<td><strong>NCDOT Bridge Superstructure Level III Wave Vulnerability Study Report and GIS Database</strong></td>
<td>Jerry Snead and Ken Ashe</td>
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<tr>
<td><strong>Development of a Physics-Based Model for Predicting Loading on Bridges During Water Wave Attack</strong></td>
<td>Christian Matemu</td>
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<tr>
<td><strong>New Coastal Guidance Development</strong></td>
<td>Scott Douglass</td>
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10:05am-10:25am – Break – Delaware Foyer

10:25am-12:05pm

### Moderated by: Brian Campbell

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<tr>
<th>Session Topic/Title</th>
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<tr>
<td><strong>Improving Roadway Hydraulic Design Through Innovation and Advanced Tools</strong></td>
<td>Delaware Room A-B</td>
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<tr>
<td><strong>Assessment of HEC-22 Equations for the Design of Curb-opening Inlets</strong></td>
<td>Muhammad Ashraf</td>
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<tr>
<td><strong>Errors in HEC-22 for Long Curb Inlets and the Challenges for Implementation of Revised Designs</strong></td>
<td>Saul Nuccitelli</td>
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<tr>
<td><strong>Computation of Hydraulic Jump’s Sequent Depth in Sloped Circular Water Pipe</strong></td>
<td>Kenneth Edwards</td>
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<tr>
<td><strong>3D CFD Analysis of Hydroplaning Risk and Grate Hydraulic Efficiency</strong></td>
<td>Marta Sitek</td>
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### Moderated by: Cynthia Nurmi

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<tr>
<th>Session Topic/Title</th>
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<tbody>
<tr>
<td><strong>Streamlining, Adaptation, and State of the Art Tools for Floodplains</strong></td>
<td>Delaware Room C-D</td>
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<tr>
<td><strong>NCDOT’s Partnership With NC Floodplain Mapping Program to Streamline FEMA Compliance</strong></td>
<td>Jerry Snead</td>
</tr>
<tr>
<td><strong>The Cannon Drive Levee – Coupling Roadway Improvements and Flood Protection at the Ohio State University</strong></td>
<td>Miles Hebert</td>
</tr>
<tr>
<td><strong>State-of-the-art FEMA Map Update With a HEC-RAS 1D/2D Hybrid Model and Validated With TUFLOW</strong></td>
<td>Rachel L. Tereska</td>
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<tr>
<td><strong>New Methods for Floodplain and Floodway Determination Using 2D Models</strong></td>
<td>Scott Hogan</td>
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12:05pm-1:05pm – Lunch (provided) – Hayes Room, first floor
### Wednesday, August 29, 2018

#### 1:05pm-2:45pm

<table>
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<tr>
<th>Session Topic/Title</th>
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<tbody>
<tr>
<td>Innovation Through New Scour Methodology</td>
<td>Delaware Room A-B</td>
<td>Advancing Resilient Design With Improved Data and Tools</td>
<td>Delaware Room C-D</td>
</tr>
<tr>
<td>NCHRP Project 24-47: Revised Clear-Water and Live-Bed Contraction Scour Analysis</td>
<td>Paul Clopper</td>
<td>HY8 and Toolbox Updates</td>
<td>Eric Jones</td>
</tr>
<tr>
<td>The Observation Method for Bridge Scour: Case Histories</td>
<td>Jean-Louis Briaud</td>
<td>U.S. Geological Streamgage Data and Their Applications</td>
<td>Thomas Harris</td>
</tr>
<tr>
<td>Implementation of the Scour Evaluation Model (SEM)</td>
<td>John Schuring</td>
<td>Web Service Resources for Hydrologic and Hydraulic Modeling</td>
<td>Chris Smemoe</td>
</tr>
<tr>
<td><strong>FHWA – Scour Depth Equilibrium State Design Approach</strong></td>
<td>Kornel Kerenyi</td>
<td>ESRI Culvert Collector</td>
<td>Matt Retta and Michael Weakley</td>
</tr>
</tbody>
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1:05pm-5:10pm – **Field Trip A – OSU Cannon Drive Floodwall Project**

2:45pm-3:05pm – Break – Delaware Foyer

#### 3:05pm-5:10pm

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<tr>
<th>Session Topic/Title</th>
<th>Room/Presenter</th>
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</thead>
<tbody>
<tr>
<td>Bridge Resiliency Through Scour Countermeasures</td>
<td>Delaware Room A-B</td>
<td>Consideration of Extreme Weather Events in Resilient Design</td>
<td>Delaware Room C-D</td>
</tr>
<tr>
<td>Scour Monitoring: Innovative Tool – Case Histories</td>
<td>Joe Scannell, Dave Claman, Mike Hogan, Wesley Peck</td>
<td>Detection and attribution of flood change across the United States</td>
<td>Stacey Archfield</td>
</tr>
<tr>
<td>Drone Based Riprap Imaging and Gradation Measurement</td>
<td>LeAndra Nelson</td>
<td>Confidence Bounds on Freeboard at Stream Crossings for Evaluating Overtopping Risk</td>
<td>Tim Stephens</td>
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<tr>
<td>An Icebreaker Under Troubled Waters (and Ice Bergs)</td>
<td>Michael Knapp</td>
<td>Discussing the Known and Unknown of Anthropogenic Climate Change and Precipitation Extremes for Resilient Design</td>
<td>Jared Bowden</td>
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<tr>
<td>Low-Cost Scour-Preventing Fairings for Bridges – Permanent Solution for Foundation Rock Scour</td>
<td>Roger Simpson</td>
<td>Adapting Global Climate Model Precipitation Projections to Hydrologic Design</td>
<td>Roger Kilgore</td>
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<tr>
<td>Underwater Installation of Filter Systems for Scour and Other Erosion Control Measures</td>
<td>Pete Lagasse</td>
<td>Panel Discussion</td>
<td>Presenters</td>
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#### 5:30pm-7:30pm

TRB AFB-65, TRB AFB-60, and AASHTO TCHH Combined Meeting – Open to Public – Delaware Room A-B
<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
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<tbody>
<tr>
<td>6:45am-7:45am</td>
<td>Breakfast (provided) – Hayes Room, first floor</td>
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<tr>
<td>8:00am-10:05am</td>
<td>Session Topic/TITLE Room/Presenter</td>
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<tr>
<td>Rethinking the Methodology for Stream Stability</td>
<td>Delaware Room A-B/Brinton Swift</td>
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<tr>
<td>Right Sizing Stream Stability</td>
<td>Hayes Room A-B/Brinton Swift</td>
</tr>
<tr>
<td>Practical Approaches to Sediment Transport at Stream Crossings</td>
<td>Delaware Room C-D/Holly Yaryan Hall</td>
</tr>
<tr>
<td>Advances in 3D CFD Modeling of Scour with Sediment Transport and in Analysis of Stream Instability and Channel Migration</td>
<td>Delaware Room C-D/Steven Lottes</td>
</tr>
<tr>
<td>Applying Temporal Bed Shear and Flow Duration Data to Determine Bankfull Width and Stream Stability</td>
<td>Delaware Room C-D/Kornel Kerenyi</td>
</tr>
<tr>
<td>10:05am-10:25am</td>
<td>Break – Delaware Foyer</td>
</tr>
<tr>
<td>10:25am-12:05pm</td>
<td>Session Topic/TITLE Room/Presenter</td>
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<tr>
<td>Ensuring Resiliency Through Stream Stability Countermeasures</td>
<td>Delaware Room A-B/Veronica Ghelardi and Marta Sitek</td>
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<tr>
<td>Rockeries in the River Environment</td>
<td>Delaware Room C-D/Charles Hebson</td>
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<tr>
<td>Engineering Log-Jams and Dolosse for Streambank Protection</td>
<td>Delaware Room C-D/Oscar Suaznabar and Sven Leon</td>
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<tr>
<td>Implementation of Bankfull Channels, Vanes, and Weir Structures at Bridge Openings as Alternatives to Traditional Maintenance Practices</td>
<td>Delaware Room C-D/Jon Witter</td>
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<tr>
<td>Integrating Nature-Based Resiliency for Levee Wave Wash Protection</td>
<td>Delaware Room C-D/Sachin Mandavkar and Jon Witter</td>
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<tr>
<td>12:05pm-1:05pm</td>
<td>Lunch (provided) – Hayes Room, first floor</td>
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**Description:**

Bulletin 17C, *Guidelines for Determining Flood Flow Frequency*, was recently published by the U.S. Geological Survey (USGS), as an update to Bulletin 17B. Bulletin 17C uses the Log Pearson Type III frequency distribution applied to stream gage data. Enhancements include the ability to use flow intervals for flood events, better utilization of historical information for events outside the gage record (historic floods), an improved method for determining confidence limits, and improved identification of multiple low flood events. The USGS PeakFQ program includes the new methods in 17C and will be demonstrated in the workshop.
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<tr>
<th>Time</th>
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<tbody>
<tr>
<td>1:05pm-2:45pm</td>
<td>Using Innovative Tools and Methods for Improved Design</td>
<td>Delaware Room A-B</td>
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<td>Truckee River Bridge Scour – Unique Structure and New Methods</td>
<td>Brad Hartman</td>
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<td>Using Computational Fluid Dynamics (CFD) as a Tool to Gain Insights Into Challenging Scour Situations</td>
<td>Kevin Flora</td>
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<td>In-Situ Scour Testing Device for Determining Soil Erosion Resistance</td>
<td>Haoyin Shan</td>
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<td>Advancements in Bridge Hydraulic and Scour Analyses with Two-Dimensional Hydraulic Modeling</td>
<td>Scott Hogan</td>
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<td>2:45pm-3:05pm</td>
<td>Stormwater Management 2</td>
<td>Delaware Room C-D</td>
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<td>SMS and Permitting</td>
<td>Megan Frye</td>
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<td>FDOT’s Approach Toward Integrated Water Resource Planning</td>
<td>Carlton Spirio</td>
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<td>NCDOT’s Stormwater Research Program – What We’re Doing and Where We’re Heading</td>
<td>Andrew McDaniel</td>
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<td>TMDL Alternatives: A Non-regulatory Approach Success Story in North Carolina</td>
<td>Andrew McDaniel</td>
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<tr>
<td>3:05pm-5:10pm</td>
<td>Culvert Durability and Rehabilitation for Resiliency</td>
<td>Delaware Room A-B</td>
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<td>Basics of Culvert Durability</td>
<td>Kevin White</td>
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<td>Re-rounding of Thermoplastic Conduit Under State Route 150 in Jefferson County, Ohio</td>
<td>Shad Sargand</td>
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<td>Structural Rehabilitation of Invert-Deteriorated Metal Culverts Through Field Concrete Paving</td>
<td>Teruhisa Masada</td>
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<td>Structural Design Methodology for Spray Applied Pipe Liners in Gravity Storm Water Conveyance Conduits</td>
<td>Mohammad Najafi</td>
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<td>Laboratory Testing and Analysis of Geopolymer Pipe-lining Technology for Rehabilitation of Stormwater Conduits</td>
<td>Joe Royer</td>
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<td></td>
<td>Evaluating Runoff Controls for Stormwater Pollution Prevention Plans</td>
<td>Wesley Zech</td>
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<td>Design, Construction, and Calibration of an Apparatus for Large-Scale Testing of Catch Basin Inserts (CBIs)</td>
<td>Wesley Zech</td>
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<td>Characterizing Particle Size Distribution and Trash in Stormwater Runoff from Ohio Roads</td>
<td>Ryan Winston</td>
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<td>Use of Two-Dimensional Hydraulics Modelling for Design of Erosion Countermeasures</td>
<td>Daniel Hoffman</td>
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<td>Effects of Changing Precipitation Patterns on Sediment Dynamics, Nutrient Concentrations, and Biofilm Communities in an Acid Mine Drainage Stream, Hewett Fork, Ohio</td>
<td>Jennie Brancho</td>
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<tr>
<td>2:45pm-3:05pm</td>
<td>Break – Delaware Foyer</td>
<td>Field Trip B – FHWA ISTD Soil Erosion Resistance Demonstration</td>
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<tr>
<td>Time</td>
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<tr>
<td>6:45am-7:45am</td>
<td>Breakfast (provided)</td>
<td>Hayes Room, first floor</td>
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<td>8:00am-12:00 noon</td>
<td><strong>Advanced Hydraulic Modelling</strong></td>
<td>Delaware Room A-D</td>
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<td><em>Two-Dimensional Hydraulic Modelling with Tidal Boundary Conditions</em></td>
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<td><em>Right Sizing The I-69 Bridge over the Ohio River at Evansville, Indiana</em></td>
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<td><em>Hydraulic Design and Permitting of a 5,000-ft Long Crossing of the Illinois River Utilizing 1D (HEC-RAS) and 2D (SRH-2D) Modelling</em></td>
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<td><em>Phase II Scour Evaluation Comparison of SRH-2D &amp; HEC-RAS</em></td>
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<td>10:00am-10:20am</td>
<td>Break</td>
<td>Delaware Foyer</td>
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<td></td>
<td><strong>NCDOT Realizing the Benefits and Challenges of Adopting 2D Modelling</strong></td>
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<td><strong>Utilizing SRH-2D to Improve Cost Efficiencies and Design Process for the Colorado DOT</strong></td>
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<td><strong>The Role of Large Scale Roughness in 2D Hydraulic Model Development</strong></td>
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<td><strong>SAMPLE: A 3D Flow Modeling Procedure for Hydraulic Engineers</strong></td>
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<td><strong>Closing Remarks</strong></td>
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ABSTRACTS
And
BIOGRAPHIES
ABSTRACT:
The Federal Highway Administration (FHWA) has been actively promoting the use two-dimensional (2D) hydraulic modeling for transportation hydraulics through the FHWA Every Day Counts program that helps promote underutilized and emerging technology. The hydraulic initiative in this program has been labeled CHANGE, which stands for Collaborative Hydraulics: Advancing to the Next Generation of Engineering. More than 40 states have been actively engaged in CHANGE; taking the NHI 135095 2D hydraulic modeling training course, using 2D modeling on their projects, comparing results to previous 1D models and other models, using the new visualization tools to communicate with stakeholders, and integrating 2D hydraulic modeling guidance into their state policies and procedures.

With more than 500 new 2D hydraulic modeling users participating in CHANGE related activities, many questions have been raised regarding best practices for mesh development (element size and type, model limits, adequate representation of terrain, etc.), and the application of boundary conditions and model parameters (time step, initial conditions, duration, types of inflow/outflows, and hydraulic structures). These topics will be thoroughly addressed during the workshop by the author of SRH-2D (Dr. Yong Lai) and the developer of SMS (Dr. Alan Zundel). An exercise is included in the workshop to give users hands-on experience with the topics presented. Previous modeling experience is not required for this workshop. Some computers will be provided, but participants are encouraged to bring their own laptops with the software loaded and registered. Links to download the software will be provided prior to the conference, along with any necessary software licenses.

In addition to best practices questions, numerous users have inquired about reviewing models and what key elements need to be examined to verify that the results are acceptable. Mr. Hogan, Senior Engineer from the FHWA Resource Center and Team Lead for the EDC CHANGE initiative, will present guidelines for reviewing and troubleshooting SRH-2D models and provide a recommended checklist/procedure for states or other reviewers to use.
BIOGRAPHY:

Scott Hogan –
Mr. Hogan has spent his entire 25-year career working in the field of hydraulics and river engineering. He is currently a Senior Hydraulic Engineer with the FHWA Resource Center in Fort Collins, CO, and has previously served as the Hydraulics Team Lead for the Central Federal Lands Highway Division for 7 years, and 15 years in consulting engineering prior to that. Mr. Hogan specializes in bridge hydraulic modeling and design, scour analyses, sediment transport, countermeasure design, and floodplain analysis. For more than 20 years he has been an instructor for several hydraulics training courses through FHWA National Highway Institute (NHI), including 1D modeling with HEC-RAS, 2D modeling with SRH-2D, Hydraulic Design of Culverts, Hydraulic Bridge Design, and Countermeasure Design. He has a sincere passion for hydraulic engineering and advancing the state of our practice.

Alan Zundel –
Dr. Zundel leads Aquaveo and was the original manager of the SMS under contract to the U.S. Army Corps of Engineers. Dr. Zundel has a long history of model development and application for several 1D and 2D hydraulic and sediment transport models including SRH, TUFLOW, ADH, RMA2, FESWMS, and others. He has also been involved with hydraulic modeling projects for the past twenty years. Dr. Zundel has taught university level courses and has also instructed numerous training courses in the US and internationally and for all of the models included in the SMS package.

Yong Lai –
Yong Lai is a specialist hydraulic engineer at the Technical Service Center, U.S. Bureau of Reclamation, Denver, Colorado. Dr. Lai obtained his Ph.D. in 1990 from Arizona State University and has since been involved in a wide range of research and development activities and engineering projects. His employer includes a private company, a research institute, the University of Iowa, and now the federal government. Dr. Lai has published more than 50 international journal papers and over 80 conference papers in diverse engineering areas. He is the lead author of the widely used SRH-2D model. Dr. Lai currently serves as an associate editor of the ASCE Journal of Hydraulic Engineering, a member of the International Scientific Advisory Board for several conferences, and a regular journal reviewer and session organizer. He regularly provides short courses on hydraulic modeling.
**ABSTRACT:**
Presentation of the new AASHTO Guide for Inspection of Culvert and Storm Drain Systems. This workshop will present components of the new guide, introduce the new component-level condition rating system, and walk attendees through direct application of the guide. The guide includes a description of design and performance characteristics, the inspection procedure, the condition rating system, and a new catalog of distressed conditions that can be used as a visual comparator to help different inspectors arrive at the same numerical condition rating.

**BIOGRAPHY:**
Mr. Jesse L. Beaver is a senior leader with Simpson Gumpertz & Heger’s Engineering Mechanics and Infrastructure Division in Massachusetts. Jesse provides expert consulting in the areas of buried structures (soil-structure interaction), structural materials, and construction. He has conducted numerous studies using the finite element method to analyze and design buried structures, investigated structure distress and construction issues to support litigation, authored standards and specifications for related industries, and conducted materials and field testing. Jesse is a registered professional engineer in 20 states and 4 Canadian provinces.

Prior to joining SGH, Jesse served as Assistant State Construction Engineer with the Washington State Department of Transportation, overseeing highway structures construction for contracts totaling over $1 billion annually. Jesse is Chairman of Transportation Research Board Committee AFF70 on Culverts and Hydraulic Structures and Chairman of ASTM International Subcommittee F17.65 on Land Drainage for plastic pipe systems. Jesse is instructor for the American Society of Civil Engineers Seminar on Design of Buried Pipes. He is also a veteran of the United States Army. Jesse was Principal Investigator for National Cooperative Highway Research Program (NCHRP) Project 14-26 to develop the new Guide for Inspection of Culverts and Storm Drains that will be discussed today.
Session: General

Opening Remarks

Shad Sargand
Russ Professor of Civil Engineering and Associate Director of the
Ohio Research Institute for Transportation and the Environment
Ohio University
Athens, OH 45701-2979
Office Phone: 740.593.1467
Email: sargand@ohio.edu

ABSTRACT:
Dr. Sargand will provide a brief welcome to the 2018 NHEC. Dr. Sargand will share the innovative hydraulic research being conducted at Ohio University.

BIOGRAPHY:
Dr. Sargand earned his PhD in civil engineering from Virginia Tech in 1981. He subsequently joined the civil engineering department of Ohio University’s Russ College of Engineering and Technology, and was named Russ Professor in 1990. He has authored over 290 journal articles, conference papers, and technical reports. He is the Associate Director of the Ohio Research Institute for Transportation and the Environment. His areas of research interest and expertise include geotechnical engineering, drainage structures, thermoplastic pipes, steel and concrete conduit, flexible and rigid pavements, nondestructive infrastructure test methods, quality assurance/quality control, and finite element modeling. He has received several nationally recognized awards and honors for his research, including the D.R. Harting Award of the Society of Experimental Mechanics in 1992 and 1999. Professor Sargand’s studies have delivered substantial value to industry and government sponsors.

Dr. Sargand’s projects on pipes and drainage include a long-term study of the performance of deeply buried thermoplastic pipes, which has continued for two decades. He developed a method for inspecting and evaluating the condition of pipes and culverts in the field for the Ohio Department of Transportation. He also contributed laboratory test results and finite element modeling of thermoplastic pipes with recycled content for NCHRP Project 04-39, and is investigating the performance of concrete pipe reinforced with synthetic fibers.
Welcome

Dr. M. Duane Nellis
President
Ohio University
Athens, Ohio 45701
Office Phone: (740) 593-1000
Email: president@ohio.edu

ABSTRACT:
Dr. Nellis will greet the 2018 NHEC on behalf of the Ohio University.

BIOGRAPHY:
Dr. M. Duane Nellis was named the 21st president of Ohio University on February 22, 2017. As an internationally recognized scholar and national higher education leader, Dr. Nellis brings nearly four decades of experience in academia as a president, provost, dean and professor to Ohio University.

Prior to arriving at OHIO, Dr. Nellis was president of Texas Tech University from 2013 to 2016. While at Texas Tech, Dr. Nellis was committed to enhancing the University’s presence as a top tier national public research university. He led Texas Tech to designation as Carnegie ‘highest’ research activity national research university. The institution was also designated nationally as an Innovative and Economic Prosperity University and received special recognition for university engagement during Nellis’ tenure.

Prior to his time at Texas Tech, Dr. Nellis was president of the University of Idaho (2009-2013) where he led the university toward record enrollments and record levels of fund raising. He also served as provost and senior vice president at Kansas State University from 2004 to 2009 and dean of the Eberly College of Arts and Sciences at West Virginia University, the institution’s largest academic college, from 1997 to 2004.

He is recognized nationally and internationally for his research that utilizes satellite data and geographic information systems to analyze various dimensions of the Earth's land surface. This research has been funded by more than 50 sources, such as NASA, the National Geographic Society, the U.S. Agency for International Development, and the U.S. Department of Agriculture. His research has led to more than 160 articles and reports in a wide range of professional journals, and over 20 books and book chapters, and his selection as a Fellow of the prestigious American Association for the Advancement of Science.

Dr. Nellis received his bachelor’s degree in earth sciences/geography at Montana State University in 1976. He received his master’s and doctoral degrees in geography from Oregon State University in 1977 and 1980, respectively.
Keynote Speech

Dave Slatzer
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ABSTRACT:
Mr. Slatzer will share the Ohio Department of Transportation’s work in innovative technologies.

BIOGRAPHY:
Dave Slatzer currently serves as the deputy director of the Ohio Department of Transportation's Division of Engineering, which is responsible for policy implementation and technical support for the following ODOT Offices: CADD and Mapping Services, Consultant Services, Geotechnical Engineering, Hydraulic Engineering, Pavement Engineering, Real Estate, Roadway Engineering, and Structural Engineering.

Previously, Dave served as the district design engineer in the ODOT District 5 office, where he was responsible for the delivery of in-house design as well as consultant projects ranging from simple to complex highway projects.

He also served as the planning and engineering administrator for ODOT District 5, where he was privileged to lead a talented team of individuals responsible for all activities related to project development and delivery. He received his B.S. in civil engineering in 2000 from The Ohio State University.
FHWA Update

Joe Krolak
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ABSTRACT:
Mr. Krolak will provide an update of Federal Highway Administration’s Hydraulic Research, Technology and Guidance.

BIOGRAPHY:
As FHWA’s Team Lead and Principal Bridge Engineer in the Hydraulics Section, Joe Krolak directs the national hydraulic program, develops policy and guidance, and provides technical and management leadership. Mr. Krolak also serves as the DOT liaison in interagency efforts with FEMA and the Coast Guard. Prior to his current position, Mr. Krolak served as the Senior Bridge Engineer in the FHWA Office of Bridge Technology and a Hydraulic Engineer in the FHWA Resource Center.

Mr. Krolak has worked at the Federal Highway Administration since 2000. Prior to working at FHWA, Mr. Krolak worked as a Hydraulic Engineer in the Water Resources and Environmental Division of Greenhorne and O’Mara. Mr. Krolak also worked at GKY Associates.

Mr. Krolak earned a Bachelor’s of Science in Civil Engineering at the University of Maryland.
AASHTO Update

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ABSTRACT:
Mr. Wark will provide a summary of the AASHTO Technical Committee on Hydrology and Hydraulics activities.

BIOGRAPHY:
Nick Wark is the State Hydraulic Engineer at Vermont Agency of Transportation. He serves as the Chair of the AASHTO Technical Committee on Hydrology and Hydraulics.

Mr. Wark earned his Bachelor of Science Degree in Civil Engineering from Clarkson University.
Transportation Research Board Committee Updates

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ABSTRACT:
Ms. Hunt will present an update of TRB AFB-60 Subcommittee on Hydrology and Hydraulics activities.

BIOGRAPHY:
Beatrice Hunt has over 30 years of civil engineering experience which includes bridge structures, hydraulics and scour engineering and project management. Her expertise includes hydrologic, hydraulic, scour and stream stability analyses for new and existing bridges over rivers and tidal waterways; hydraulic bridge design; bridge and culvert scour evaluations including screening, prioritization and management programs; bank stabilization and protection; river training; and the evaluation, development, and implementation of scour countermeasures and monitoring programs. Ms. Hunt is experienced in the development of Plans of Action (POAs); forensic investigations; special studies on bridge scour; and hydraulic vulnerability assessments. Since 1998 she has lectured and taught short courses on bridge scour nationally and internationally, authored, contributed to, and edited books on bridge scour, and contributed articles on the subject to numerous publications.

Beatrice Hunt has been a leader in the development and implementation of bridge scour monitoring programs using fixed instrumentation on projects for NCHRP, FHWA, NYS DOT, NYCDOT, MSHA, VDOT, TxDOT, RIDOT and REFER in Portugal. She is the principal investigator for the NCHRP Synthesis 396 “Monitoring Scour Critical Bridges” (2009). She is a technical contributor for the 2009 update to FHWA Hydraulic Engineering Circular 23 (HEC-23) on scour countermeasures, the FHWA Plan of Action template (2006) and the NHI course “Plan of Action for Scour Critical Bridges” (2007). Ms. Hunt was responsible for an innovative 2002 ACEC national award-winning scour monitoring program on Long Island, NY.

She is currently the chair of TRB Committee AFB60, Hydrology and Hydraulics. She co-chaired the ASCE/ISSMGE Fifth International on Scour & Erosion, is former chair of the ASCE Task Committee on Bridge Scour, and past president of the ASCE Metropolitan Section.

A registered professional engineer in New York, Ms. Hunt studied engineering mechanics at Columbia University, where she earned Bachelor of Science and Master of Science degrees.
ABSTRACT:
Mr. Taylor will provide an update of the TRB AFB65 Subcommittee on Stormwater.

BIOGRAPHY:
Mr. Taylor is a nationally and internationally recognized speaker and practitioner with extensive expertise in the area of surface water quality. He has over 30 years of experience in flood control engineering and surface water quality and has taught undergraduate courses in hydrology and hydraulic design at the University of California at Irvine and California State University at Long Beach. He serves as the course coordinator and an instructor for a Professional Engineer’s (PE) License review course. Mr. Taylor has served as an instructor for ASCE continuing education for courses in BMP design. Mr. Taylor is past Chair of the California Stormwater Quality Association (CASQA). He has presented technical papers on the subjects of flood control and BMP effectiveness at domestic and international conferences and has consulted to the Government of Hong Kong relative to stormwater quality. He has moderated webcasts, served as a plenary session speaker and provided testimony before the California Little Hoover Commission.

Mr. Taylor earned a BSCE from California State Polytechnic University at Pomona, and an MSCE from California State University at Long Beach. He is an ASCE Fellow and a Diplomate in Water Resources Engineering. Mr. Taylor is a registered professional engineer in eight states, including California. Mr. Taylor is a member of the Transportation Research Board Committee AFB 60 on Hydrology, Hydraulics and Water Quality, and chairs the Water Quality subcommittee.
Ice Breaker/Poster Session

Alex Mann (Maine DOT) – Diffuser Outlet Efficiency: Methods for Demonstrating Increased Capacity

Patrick Grover (BGC Engineering) – Flood Forecasting with Machine Learning Models for Small Watersheds

Devan Fitzpatrick (University of Georgia) – Hydraulic Effects of Temporary Bridge Construction Structures

Sven Leon (FHWA Western Federal Lands Hydraulic Team) – Developing Practical Monitoring Metrics for Successful Aquatic Organism Passage (AOP) and AOP Culvert Database

FHWA Western Federal Lands Hydraulic Team – Silvio O. Conte National Fish & Wildlife Refuge Drainage Improvements

FHWA Western Federal Lands Hydraulic Team – Fort Pulaski Entrance Bridge

FHWA Western Federal Lands Hydraulic Team – Old US 60 Bridge Replacement

FHWA Western Federal Lands Hydraulic Team – Catwalk Reconstruction

FHWA Western Federal Lands Hydraulic Team – Gardiner Gateway Drainage Improvements

FHWA Western Federal Lands Hydraulic Team – Upper Hogan Creek Drainage

Mike McColeman and Matt Retta (Ohio DOT) – ODOT’s Hydraulic Inspection Vehicle Explorer (HIVE)
Why Bigger is Not Always Better: Culvert Hydraulics

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ABSTRACT:
Across the United States we rely on culverts to convey stormwater and channel flows underneath roadway embankments. Eventually the design life of these culverts ends, a roadway improvement project necessitates the replacement of these structures, or a failure occurs. Frequently, when a replacement is required, the size of the culverts are increased. Many times this is associated with advancements and updates in hydrology, updated design criteria, or changing flow patterns.

When an existing culvert is undersized it often causes backwater and changes to the channel characteristics upstream and downstream. This can be realized by widened floodplains which can cause increased riparian and wetland areas due to the stored water. These changes to channel morphology may be beneficial for stream health, but can be detrimental to the flood conveyance capacity of the channel and culvert crossing.

As engineers designing culvert crossings for the safety of the travelling public we often think bigger is better! But, sometimes overlooked, increases to culvert size results in changes to the channel system upstream and downstream of the crossing. These changes are not always beneficial. Many times erosion can occur within the channel as a result of the increased conveyance of the crossing structure causing increased velocities. A channel meander may be removed to better align with the culvert, which shortens the channel length and results in steeper slopes and higher velocities. This presentation focuses on a few example cases of culvert increases within channels and how they affected the adjacent channel morphology. This presentation serves as a reminder to practitioners and policy makers to consider more than just the culvert erosion, but also the overall channel stability of the system, when upsizing culverts. We will seek to challenge the common belief that bigger is better.

BIOGRAPHY:
Matthew Johnson has six years of experience in hydrologic and hydraulic analysis and design. This experience includes both 1D and 2D hydraulic modeling, scour analysis, scour & erosion countermeasure design, and stream stabilization. He is experienced in major drainage analysis including FEMA Floodplain modeling and mapping.
ABSTRACT:
The ability of a diffuser outlet to increase the flow rate by decreasing outlet losses in a culvert can be demonstrated by two methods. First, using a laboratory flume, the relative performance of a projecting pipe, a pipe with an improved flared inlet, a pipe with a diffuser outlet, and a pipe with both an improved inlet and a diffuser outlet can be compared at a constant flow rate. This is accomplished by noting the changes in water level with the addition of the inlet, the diffuser, and both together. In this laboratory situation, this method gave a 6 to 9% improvement in capacity with just the improved inlet, an 11 to 20% improvement with just the diffuser, and a 25 to 32% improvement with both the improved inlet and diffuser outlet. Performance curves can be generated by collecting data at different flow rates.

Second, a drawdown technique was developed to determine the instantaneous flow rate of a pipe system through a continuous range of inlet water levels. This technique can be applied in a laboratory, as well as in field settings, where pretesting the pipe system is advantageous. Additionally, observing and monitoring the flow conditions during a field drawdown provides significant information on the performance and operation of a culvert system during a simulated high flow event.

The laboratory results demonstrate the efficacy of diffuser outlets in increasing flow rates under controlled ideal conditions. When used in the field, the drawdown technique provides an accurate way of measuring the actual flow rate and observing flow conditions. This can be accomplished at a safe and convenient time, independent of weather conditions.

BIOGRAPHY:
Alex graduated from Penn State with a BS in Geosciences in 1983. He was employed as a field geophysicist for the Maine Geological Survey, then for Weston Geophysics, and finally for the Maine DOT. In 1995, he transitioned from Geophysics into Surface Water Hydrology within the DOT. Alex worked in collaboration with the USGS to produce papers on:

Alex created a research project through the Maine Department of Transportation with Federal Highways support to study an outlet diffuser’s ability to increase a culvert’s capacity. He proceeded to design, build and test the outlet diffuser. The final report “Outlet Diffusers to Increase Culvert Capacity” was completed in June 2016 and published as Technical Report 14-17 through the Maine DOT Research Section. The drawdown analysis technique was developed in conjunction with this research.

Alex has had a long-term interest in hydraulics. During his childhood he built dams at every opportunity, a practice he continued with his son. While doing geologic field work in Iceland, he was introduced to Micro-hydropower, and to the concept of using flared outlet diffusers to recover energy. Intrigued by this concept, he created an independent study course at the University of Maine with Dr Bryan Pearce to study the effects of diffusers on pipe capacity using CFD (Star-CCM+) at the FHWA sponsored TRACC Computer at Argonne National Lab. He continued this work by comparing David Yarnell’s physical models with CFD models. In September, 2015, the first diffuser prototype was installed. Its performance has been monitored over the last 3 years. The flows calculated through the use of the drawdown technique produced an essentially identical dimensionless performance curve to that obtained using Yarnell’s diffuser data.
Web-based Tool for Evaluating Sedimentation at Multi-Box Culverts

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ABSTRACT:  
A significant percentage of multi-box culverts in Iowa become completely or partially filled with sediment deposits due to erosive soils in Iowa. The sediment can considerably reduce the capacity of the culvert for large flood events potentially causing roadway overtopping or increasing impacts on upstream properties. The process that causes sedimentation in culverts is complex and is a function of the stream and culvert geometry as well as the watershed and stream characteristics in the basin.

The Iowa Department of Transportation in cooperation with the University of Iowa has analyzed the causes and potential mitigation alternatives for sedimentation in multi-barrel culverts under Iowa Highway Research Board projects TR-596 & TR-619. These research projects have enhanced our knowledge of the processes that can cause sedimentation and developed mitigation alternatives to reduce the potential for sediment accumulation. Based on flume studies, field implementation of these mitigation measures have been constructed at several multi-box sites in Iowa.

Under research project TR-665, the University of Iowa has developed a web-based tool that analyzes the relationship between the culvert and stream geometry along with the basin characteristics, soil loss parameters, stream slope and other factors to predict the potential for sedimentation at multi-box locations. The establishment of the functional relationship for predicting sedimentation is made through the use of analytic techniques and prediction applications through the web-based tool. The presentation will show the use of this platform and its capabilities for the storage and query of culvert and drainage area characteristics, monitoring of sedimentation at culverts using in-situ or remote sending technologies, analysis of sedimentation at culverts and support of culvert design by forecasting the sedimentation potential for existing or proposed multi-box culvert sites.

BIOGRAPHY:  
Dave Claman is the Transportation Manager for the Preliminary Bridge Section at the Iowa Department of Transportation and has 34 years of experience in the hydrology and hydraulics engineering field. Dave’s primary responsibility is to insure the State’s highway structures are cost-effective and appropriately sized/designed in accordance with Iowa DOT guidelines and policies. He is also the DOT’s expert regarding drainage disputes, bridge scour, stream geomorphology, 2-D hydraulic analysis and FEMA/floodplain management issues. Prior to working for the Iowa DOT, Dave worked for the Iowa Department of Natural Resources where he was responsible for the administration and enforcement of the State’s floodplain management program.

Dave has been involved in many advisory committees on the local, state and national level regarding climate change, flood mitigation, water resources and bridge scour. He has also been involved in many research projects as technical advisor or co-investigator for various issues involving the prediction and monitoring of bridge scour (NCHRP 24-20), the reduction of sedimentation accumulation in multi-barrel culverts (IHRB TR-665) and other hydraulic or stream migration/degradation issues facing the civil engineer profession in Iowa.
Fish Passage Barrier Correction at State Highways in Washington State

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ABSTRACT:
The Washington State Department of Transportation (WSDOT) has been working for many years to correct fish passage barriers under state highways to improve fish passage and restore access to prime spawning and rearing habitat, ultimately protecting and restoring fish populations. The Washington Department of Fish and Wildlife (WDFW) estimates that there are approximately 30,000 fish passage barriers statewide are in need of correction. Approximately 1,977 culverts on the statewide highway systems are currently classified as barriers to fish passage, of which 1,513 have more than 200 meters of upstream habitat.

In March of 2013, a federal court injunction required Washington State to significantly increase the effort for removing state-owned culverts that block habitat for salmon and steelhead by 2030. More than 800 of WSDOT’s culverts are subject to the injunction. As of 2017, WSDOT has completed 319 projects across the state, resulting in the restoration of fish passage to 1,032 miles of upstream habitat.

This presentation will focus on WSDOT’s fish passage program, summarizing the program history, goals and progress to date, along with the process WSDOT has put into place for managing and implementing the program. Currently, WSDOT is in the second year of a six-year long-range project delivery plan, anticipating to spend $97.5 million during the 2017-19 biennium. This presentation will detail the typical fish passage barrier correction design process, including stakeholder coordination, collection of field data, hydraulic modeling and preliminary/final design, construction and lessons learned. The typical design process will be illustrated using recently constructed fish passage projects including crossings that were designed using both stream simulation and bridge methodologies.

BIOGRAPHY:
Julie Heilman -
Julie Heilman has over 18 years of engineering experience in transportation, hydraulics, construction, and construction management; all of which she has obtained through her career with the Washington State Department of Transportation. Currently, as the State Hydraulics Engineer, she manages programs to serve as support statewide in Stormwater, Fish Passage, Hydraulics, and Hydrology. She leads the Fish Passage Program within the hydraulic section, reviewing fish passage projects, hydraulic structures and stream restoration. She performs and reviews appropriate design analyses to predict scour depths at bridges and assists in determining intermediate pier locations and bridge span lengths in support of the WSDOT Bridge Office and develops and establishes statewide design criteria for roadway drainage, stormwater quality treatment, and stormwater quantity control. She has extensive experience working with inter- transportation
designers, water resource specialists, biologists, geomorphologists, geotechnical experts, structural specialists and as an emergency response team member.

Ms. Heilman earned a Bachelor’s of Science in Civil Engineering from Washington State University in 2000. Ms. Heilman is a member of the American Association of State Highway and Transportation (AASHTO) Technical Committee on Hydraulics and Hydrology (TCHH) and the following working groups: Climate Change, Research, Water Quality, and Coastal Design.

Dave Minner
Dave Minner is a Water Resources Engineer at HDR in Des Moines, Iowa and has over 10-years of experience working on a wide array of H&H projects with emphasis on 1D/2D hydraulic analysis and fish passage design. His previous fish passage work includes culvert and bridge replacements, fish passage around dams, stream restoration and collection of field measurements on a floating fish collector. In the last four years, Dave has worked with the Washington State Department of Transportation (WSDOT) to replace over 10 fish passage barriers. Dave received his undergraduate degree from the University of Minnesota.
Million Dollar Culvert Rehabilitation Summary

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ABSTRACT:
The hydraulic controls and challenges for lining a multi-size arch culvert at Crawford Notch under Route 302 in Carroll NH will be discussed. The original culvert was constructed in 1958. The culvert is made of three continuous sections in series (Upper 325 ft. 137 x 87 structural plate arch with 0.4% slope, middle 103 x 71 arch with 4% slope, and 103 x 71 lower arch with 10% slope). In 1961 the upper arch section was up sized, and a concrete transition chamber was constructed. An external energy dissipator was constructed at the outlet, and the inlet was redesigned.

The hydraulic analysis and the final design alternative that was ultimately selected will be presented. HEC RAS & HY8 analysis will be compared, and the design process pertaining to the hydraulic decisions will be shared. Runoff estimates will be discussed for the distinctive aspects of the headwater watershed with its extreme slopes, Saco Lake Dam, and wetlands.

The site constraints include a narrow work area between a mountain pass (Elephant Head) and a railroad. Road closure was not an option because of tourism, and the long detour. Alternating one way traffic will be used for rock scaling on the eastern side of US Route 302 in May 2018. Staging and culvert lining will start in June and be completed by mid-August 2018. All work will be done underground.

The hydraulic system controls of slope and area in the upper section, the custom concrete transition chamber, and the middle arch performance will be explained. The system cross section area is less in the lower sections, because the slope is increased. The design of a unique external energy dissipator constructed in 1961 will be discussed. Why different liner technologies were used for upper and lower sections will be shared. The unique 1000 ft. long culvert system is shown on the attached plans.

BIOGRAPHY:
Mr. Mallette has served the NH Department of Transportation as an hydraulic engineer since 2007. He is chairing a group of eleven NH “champions” for the CHANGE Initiative (Collaborative Hydraulics Advancing the Next Generation of Engineering). He is the President of the New Hampshire Land Surveyors Association. Mr. Mallette is a member of the inter-agency Silver Jackets team under the direction of the ACOE. He directed a recent Nature-based Resilience pilot study in NH for Coastal Highways by partnering with Maine DOT, UNH, & GEI, Inc.
An Assessment of Hydraulic Damages in Northeast Florida from Hurricane Irma

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ABSTRACT:
Hurricane Irma caused extensive damage to the state of Florida. After the storm, two teams from the Geotechnical Extreme Events Reconnaissance (GEER) Association supported by the National Science Foundation were deployed to investigate storm damage. This presentation provides an overview of the damages in the northeastern parts of the state. Damage consisted of erosion and scour around residential structures, bridges, and retaining walls; damage from overwash and washover including the opening of a breach along a barrier island; and failure of a concrete-covered earthen dam. The presentation will conclude with a “lessons learned” section that discusses which damage protection measures functioned as designed and which measures failed to provide adequate protection during the storm.

BIOGRAPHY:
Dr. Crowley has been an assistant professor at the University of North Florida since August of 2013. His area of expertise is coastal structural performance during worst-case loading conditions such as hurricanes or low-frequency storms. Since Hurricane Matthew and Hurricane Irma struck the northeast Florida coast in 2016 and 2017, much of his work has been associated with assessing damage from these storms and analyzing methods in which coastal hurricane protection can be improved. Dr. Crowley is a registered Professional Engineer (PE) in Florida with his BS from Bucknell University in Civil and Environmental Engineering (2004), his MS from the University of Florida (UF) in Coastal and Oceanographic Engineering (2008), his Ph.D. from the University of Florida in Civil Engineering (2010), and a stint as a postdoc at UF from 2010 – 2013.
Fast Tracked Shore Protection along Lake Michigan – A Case Study

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ABSTRACT:
Fast tracked design, permitting, contractor procurement, and construction for a project on shore protection against wave action in Lake Michigan are summarized and lessons learned are presented.

A combination of water level rise and series of large storms over the last few years led to serious damages to the existing beach protection structures and began to scour the bluff supporting a class-I railroad in St. Joseph, Michigan. Engineering services necessary to repair the slope failure and damages to the shoreline steel bulkheads and rock revetment had to be fast tracked to enable construction of the rehabilitation prior to the pending winter storm season in 2017. Given the existing infrastructure and topography, the only reasonable access to the site was with a barge while the contractor would not be able to perform major works when the lake is iced over in winter.

Field investigations including shore bathymetry surveying were accomplished. High level comparison of repair alternative that could meet the necessary construction schedule was performed. In-depth analysis of local and historic data was completed to obtain design parameters for waves and water levels. The limits of the stone revetment and the size of the units were determined based on coastal engineering principles and rock availability. It was decided to embed parts of the remaining steel bulkheads into the armor units. The buried steel bulkhead helped interlocking of the rock units, acted as an internal barrier, and thereby provided for some stability redundancy.

Permitting applications were prepared for a joint Michigan Department of Environmental Quality / US Army Corps of Engineers permit. An additional soil quality permit was secured from the respective county. The design, permitting, and contractor procurement process was completed within two months of the Notice to Proceed and the construction was completed within the following three months.

A few lessons learned from the design, permitting, construction administration services, and monitoring of the construction progress are discussed.

BIOGRAPHY:
Dr. Saiedi is a civil engineer with 30 years of engineering and academic experience in Iran, Australia, Malaysia, Canada, and US. His hydrotechnical interests cover a wide range: Coastal structures and processes, free surface flow (hydraulic structures, sediment transport, hydropower dams, river engineering, etc.), floating offshore structures, navigation waterways, hydrodynamics (cavitation, gates, etc.), surface hydrology and flood studies, and dam safety review. He has developed, managed, and reviewed several numerical and physical modeling works. He also shares his hydrotechnical experience with professional engineers by development and teaching of several applied short-courses in the US and Canada.
ABSTRACT:
A report was prepared in 2012 which summarizes the work performed by Ocean Engineering International, PLLC (now Intera, Inc.) for North Carolina Department of Transportation (NCDOT) on the vulnerability of selected NCDOT coastal bridges to design storm surge and wave loads. From the report’s abstract: “In this study, the bridge is considered to be vulnerable if the surge/wave forces and moments (with the appropriate load factors) exceed the resistive forces and moments created by the dead weight of the superstructure for any of the spans. A Level III storm surge/wave analysis was performed to provide the design water level and wave parameters needed to compute the loads. This analysis entailed 1) the hindcasting of 62 of the most severe tropical storms and hurricanes that have impacted North Carolina coastal waters over the past 160 years, and 2) performing extreme value analyses on water elevation, wave heights, and depth averaged current velocities throughout the area covered by the model to obtain 100-year design conditions. To increase the data set for the extreme value analyses, the hindcasted storm paths were shifted to the right and left of the actual path and the modified-path storms hindcasted. This resulted in a total of 186 hindcasts being performed. The results from the extreme value analyses are presented in a GIS database for ease of access and use. The information in the GIS database has many uses beyond that of providing the conditions needed for computation of surge/wave loads on the bridge superstructures.” Subsequent to the initial report, which only studied the 100-year return event, Intera, Inc. was contracted to further provide GIS data for additional recurrence intervals including the 5-, 10-, 25-, and 50-year recurrence intervals as well.

It is anticipated that this data can be widely used for many of NCDOT’s coastal bridge hydraulics and scour analyses required for NCDOT project delivery without having to repeatedly enter into as many contracts for expensive and time-consuming coastal hydraulic two-dimensional modeling services as have been required in the past. NCDOT is in the process of converting this GIS data to a format that can readily be served via GIS web services for public consumption and reference. This presentation will discuss how NCDOT has been using this data and how it will be maintained and used to streamline future project delivery and promote efforts toward asset risk management, resilience, and sustainability.

BIOGRAPHY:
Jerry Snead –
Jerry Snead, PE, CFM has a BSCE degree and over 25 years of experience in the NCDOT Hydraulics Unit. He is currently the manager of the unit’s statewide Highway Floodplain Program which was established to ensure compliance with FEMA’s National Flood Insurance Program regulations for NCDOT projects. He also has been involved in the development and maintenance of NCDOT’s Guidelines for Drainage Studies and Hydraulic Design manual and related web resources, including a GIS database for a Level III Wave Vulnerability Study of NCDOT’s coastal bridges.
Ken Ashe –
Mr. Ashe has over 20 years of experience in FEMA floodplain map development, CLOMR and LOMR development and no-rise analyses. He is a Project Management Professional and has managed small and large projects, including concurrently managing over $55 million in H&H and floodplain mapping projects in 9 river basins. His experience is specialized in floodplain and stormwater management and includes more than 30,000 miles of hydrologic & hydraulic studies and he has served as a Subject Matter Expert for FEMA’s Technical Mapping Advisory Council (TMAC), FEMA’s Climate Change and Coastal Studies Project: Primary Frontal Dune and Coastal A Zones, and the National Research Council of the National Academies Mapping the Zone. He is currently supports the NCDOT Hydraulics Unit and is leading hydrologic and hydraulic studies in 20 NC Counties, is the lead engineer for H&H studies in 12 MO Counties and is leading 2D modelling for watershed master planning in Cutler Bay FL and Folly Beach SC.

Mr. Ashe has managed or taken part in multiple disciplines of water resources, including stream restoration, FEMA no-rise, CLOMR/LOMR submittals, community and FEMA flood studies, Hazard Mitigation Plan updates, mobile application development, grant management, flood warning program and website development, and policy and regulation review and development. As the former Assistant Director of the NC Floodplain Mapping Program (NCFMP), he managed the NCFMP’s hydrologic and hydraulic studies, FEMA Flood Study Production, the NC LOMC delegation, the NCDOT-NCFMP MOA, the NC Floodwarning Program, the NC NFIP Program, outreach staff and served as the Risk Management Deputy Section Chief during Disaster Activations.

Ken has a BS in Environmental Engineering and a MS in Water Resources Engineering from the University of Central Florida.
Development of a Physics-Based Model for Predicting Loading on Bridges During Water Wave Attack

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ABSTRACT:
Recent failures of bridges due to wave attack during hurricanes has exposed a lack of understanding of wave forcing mechanisms on bridge superstructures. This deficiency has spurred extensive research, specifically through experimentation and computational fluid dynamics (CFD). However, application of these techniques usually requires significant computing power and/or specialized laboratory/computational equipment and skills. In addition, results from these approaches may not properly scale. Hence, development of a computationally inexpensive and accurate physics-based model (PBM) would be beneficial. During this study, a previously-developed diffraction model was combined with a previously-developed trapped air model to compute wave loading on bridges under worst-case vertical uplift wave conditions (i.e. when the water surface was at the same elevation as the bottom bridge chord elevation). The governing equations were solved using a finite difference algorithm in MATLAB for the case where the bridge was attacked by a single wave in two dimensions. Resultant inertial and drag water forces were computed by integrating water pressure contacting the bridge superstructure in the horizontal and vertical direction, while resultant trapped air forces (high-frequency oscillatory forces or sometimes called “slamming forces” in the literature) were computed by integrating air pressure along the bottom of the bridge deck in the vertical direction. The trapped air model was also used to compute the buoyancy force on the bridge due to trapped water. Results were compared with data from experiments that were conducted at the University of Florida in 2009. Results were in good agreement when a length-scale coefficient associated with the trapped air model was properly calibrated. Computational time associated with the model was only approximately one hour per bridge configuration, which would appear to be a significant improvement when compared with other computational techniques.

BIOGRAPHY:
Mr. Matemu is a graduate student who works with Dr. Raphael Crowley at the University of North Florida. Previously, he was a structural engineer at Advanced Engineering Solutions Limited in Tanzania. Christian’s primary research interests include bridge responses under dynamic loading, soil-stability improvement, and underwater pile driving noise. His current research focuses on fluid-structure interaction, mainly on water wave loading on bridge decks. As a graduate student, he developed a simplified physics-based model to predict water wave loading on bridge superstructures by combining diffraction and trapped air models. Christian modeled the problem in MATLAB to compute wave forces under worst-case vertical uplift wave conditions (i.e. when the water surface was at the same elevation as the bottom bridge chord elevation). Christian is a registered graduate engineer in Tanzania with BS from University of Dar es Salaam in Civil Engineering.
New Coastal Guidance Development
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ABSTRACT:
Several ongoing guidance development efforts focused on coastal highways will be summarized in this presentation:

1. FHWA’s revision of HEC-25, Highways in the Coastal Environment. This revision will merge the two existing documents, HEC-25 (2nd ed. 2008) and HEC-25: Volume 2: Assessing Extreme Events (2014), into one complete document to be called HEC-25 (3rd ed.). This revision will update all the topics in this manual (waves, water levels, sand transport, coastal geology, coastal revetments, approaches to roads along receding shores, overwashing roads, wave loads and scour at coastal bridges, etc.) as well as the development of new content on coastal nuisance flooding and nature-based solutions.

2. An Implementation Guide for Nature-Based Solutions for Coastal Highways. This effort is a new FHWA research and development project in an exciting, evolving field that is becoming more important on all US coasts. Nature-based solutions mimic characteristics of natural features; such as beaches, dunes, wetlands, and reefs including those habitats; but are created by human design, engineering, and construction. When designed well they serve as alternatives to, or ecological enhancements of, traditional shoreline stabilization and infrastructure protection techniques. This effort is also currently underway and a White Paper was published in February 2018 and a series of four regional peer exchanges were held this Spring. A written Implementation Guide will be developed.

3. Preliminary explanation of coastal engineering aspects of NCHRP 15-61 including sea level rise projections for engineering design based on the latest climate science and federal guidance.

The schedules of these efforts, as well as the relationship between them and other coastal guidance efforts will be explained. Significant time will be left at the end of the presentation to solicit input from the NHEC audience into the HEC-25 revisions.

BIOGRAPHY:
Scott Douglass is a co-developer of many of the FHWA’s primary guidance documents for coastal engineering including HEC-25 Highways in the Coastal Environment. Mr. Douglass is also an author of the book Saving America’s Beaches: The Causes of and Solutions to Beach Erosion.

Mr. Douglass’ training and background are from Virginia Tech, Mississippi State, and Drexel University. He has more than 38 years of experience in government, academia, and consulting focused on coastal engineering.

Mr. Douglass is the founder and President of South Coast Engineers, a coastal engineering and science consulting firm in Fairhope Alabama, and an Emeritus Professor in the Department of Civil, Coastal and Environmental Engineering at the University of South Alabama.
Assessment of HEC-22 Equations for the Design of Curb-opening Inlets

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ABSTRACT:
The Hydraulic Engineering Circular No. 22 (HEC-22) contains the FHWA’s guidelines and recommended design procedures, which are widely used in design of roadway drainage. HEC-22 proposes a set of equations for the design of curb inlets; however, it does not mention the source or the assumptions behind these equations. In this study, the theoretical basis of these equations is presented and the underlying assumptions were critically examined. In the case of undepressed inlets, data from previous studies showed that HEC-22 accurately predicts the 100% interception for flat cross-sectional slopes and underestimates the inlet’s performance for steep cross-sectional slopes. For depressed inlets, full-scale tests showed that HEC-22 significantly overestimates the interception capacity of long inlets (>5 ft). Modifications are proposed to HEC-22, which show good agreement with results from earlier studies. Finally, full interception of incoming flow is seldom achieved for depressed and undepressed inlets on a road with both a steep grade (>3%) and a flat cross-sectional slope (<3%). Designers are advised to use a different type of storm drain inlet for this condition or take into account the substantial degradation in the performance of the curb inlet.

BIOGRAPHY:
Muhammad Ashraf received his BS in Civil Engineering and MS in Water Resources Systems from Cairo University, Egypt. He was a research assistant at the Hydraulic Research Institute of the Egyptian National Water Research Center, where he studied the hydraulics of dam failure and power plant cooling systems as part of the institute’s physical modeling department. Muhammad is currently a PhD candidate and research assistant at the University of Texas at Austin. His research focus is urban stormwater drainage by investigating the performance of curb-opening inlets as part of a research project funded by TxDOT. This research won the $1,000 1st prize in the student paper competition at the Texas Water Conference, sponsored by the AWWA.
Errors in HEC-22 for Long Curb Inlets and the Challenges for Implementation of Revised Designs

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ABSTRACT:
Recent studies with full-scale laboratory models of 10 ft and 15 ft curb inlets have shown that the HEC-22 design equations significantly over-predict the interception capacity of long inlets at full capture. Such long inlets are often desirable to reduce the overall number of inlets required along a stretch of road, and are common in areas where convective thunderstorms routinely cause high rainfall rates. Unfortunately, the typical curb inlet spacing at design conditions will not achieve full capture at the design ponded width, but instead will result in significant unintended bypass and/or greater ponded width that can lead to additional vehicle hydroplaning. A modified set of equations for long inlets has been developed, but there are challenges to implementing these changes for new construction and retrofitting existing systems. For new construction, designers will need to look carefully at how the inlet length affects bypass and the number of inlets required to capture design flow. For retrofitting, some effort is needed to determine whether this issue is the culprit for areas with known drainage problems. Also, software with HEC-22 equations built-in will need to be modified to incorporate these new equations.

BIOGRAPHY:
Saul Nuccitelli joined TxDOT as the department’s Chief Hydraulics Engineer in 2017. In this role, he is responsible for maintaining TxDOT’s statewide policies on stormwater, including the Hydraulic Design Manual, drainage software, standards and specs, and research or special initiatives with universities and other state/federal agencies. He has over 25 years of civil engineering experience having worked in both public and private agencies. His experience includes many years assisting FEMA at the Regional and National levels managing their floodplain mapping and map change processes. He is also currently serving on AASHTO’s technical committee on Hydrology & Hydraulics.
Computation of Hydraulic Jump's Sequent Depth in Sloped Circular Water Pipe

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ABSTRACT:
For pipeline design over long distances (order of miles) and large elevation drops (hundreds of feet), pipelines are likely designed to flow as open channels, not pressurized. Due to changes in topography, the pipeline might have both steep and mild slopes. Steep slopes are classified as having supercritical flow through the pipe while mild slopes have subcritical flow through the pipe. A supercritical flow is one with a Froude number greater than one, while a subcritical flow has Froude number less than one. The Froude number is commonly used to classify open channel flow regimes and is essentially a ratio of inertial to gravitational effects.

If the topography dictates that a steep slope is followed by a mild slope, then a hydraulic jump will occur in the pipeline upstream of the transition. The sequent (aka. conjugate) depth is the water depth in the pipeline at the downstream end of the hydraulic jump. Since it is generally undesirable to have a pressurized situation in a pipe designed for open channel flow, it is important to compute the sequent depth to make sure that the pipeline is sized sufficiently to accommodate this water depth.

Many resources present the sequent depth computation in horizontal circular pipes. To the authors’ knowledge, there are no published methodologies, equations, tables, or figures for computing sequent depth in a sloped circular pipe. This presentation will present flow diagrams, force vectors, conservation of momentum analysis, methodology, and examples for computing the sequent depth resulting from a hydraulic jump in a sloped circular pipe.

BIOGRAPHY:
Ken Edwards is a Professional Engineer in Ohio and holds a Ph.D. from Iowa State University in civil engineering. He and his wife, Debbie, who is also an author of this paper, are co-owners of LMNO Engineering, Research, and Software. LMNO Engineering is a consulting and software development company in Athens, Ohio, focusing on fluid dynamics, hydraulics, and hydrology. Prior to forming LMNO Engineering in 1998, Ken was a faculty member in civil engineering at Ohio University in Athens.
ABSTRACT:
The High Performance Computing resources available at Argonne National Laboratory’s Transportation Research and Analysis Computing Center were used to perform three-dimensional computational fluid dynamics (CFD) analyses of hydroplaning risk on highways and hydraulic efficiency of a grate as a part of the Hydraulics Research Program at the Turner-Fairbank Highway Research Center, through an Interagency Agreement between DOT and DOE.

Hydroplaning occurs when a water film exists on a road and vehicles are traveling at a speed that does not provide sufficient time for the tires to push the water film out of the tire path, allowing the tire to maintain in contact with the road. The water film thickness is a primary parameter used in evaluating the hydroplaning risk. The present CFD study takes into account various factors that influence the development of the water film on modern many lane roadways, such as: geometry of a roadway: road width, cross slope, longitudinal slope, as well as type of drainage, at varying rainfall rates.

Proper design of surface drainage of rural/urban highways is essential to minimize flooding and to provide for traffic safety. Inlets collect the excess storm water from a roadway and discharge it to storm drains. Knowing the performance of inlets, defined as the percentage of intercepted flow to the total street flow, is necessary in the design of inlet spacing. A hydraulic performance assessment of a CB25 type of catch basin with an inlet grate, was performed using 3D CFD analysis with a goal to yield the following results: (a) efficiency curves as function of the spread or volume flow rate, the longitudinal slope, and the shoulder width, (b) the flow spread along the roadway in the vicinity the catch basin inlet, and (c) drainage area curves used for designing the spacing between drains.

BIOGRAPHY:
Dr. Sitek has been working as a member of the computational mechanics team at Argonne National Laboratory’s Transportation Research and Analysis Computing Center since 2014. She started at TRACC as a Postdoctoral Appointee and in April 2017 she became an Argonne staff member. Previously, she worked at Warsaw University of Technology Faculty of Civil Engineering as an assistant professor. In 2012-2013 she was a Visiting Researcher at the University of Michigan Civil and Environmental Engineering Department. She participated in various projects that covered development and correctness assessment of new finite element formulations, as well as FEM modeling of structures. During her time at Argonne, she gained extensive experience and expertise in CFD modeling of hydraulic engineering problems and the response of structures to storms and other dynamic loadings. She also has eight years of experience in teaching mechanics of structures and FEM courses.
Session: Streamlining, Adaptation, and State of the Art Tools for Floodplains

NCDOT’s Partnership With NC Floodplain Mapping Program to Streamline FEMA Compliance

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ABSTRACT:
The mission of North Carolina Department of Transportation (NCDOT) is connecting people, products and places safely and efficiently with customer focus, accountability and environmental sensitivity to enhance the economy and vitality of North Carolina. In keeping with this mission relative to the location and hydraulic design of highway facilities which involve encroachments in floodplains, NCDOT has implemented a Highway Floodplain Program to support compliance with various federal and state regulations which encourage a broad and unified effort to prevent uneconomic, hazardous, or incompatible use and development of floodplains. The primary driver of this program was the establishment in 2008 of a state Memorandum of Agreement (MOA) between NCDOT and the North Carolina Floodplain Mapping Program (NCFMP) in the Division of Emergency Management within the North Carolina Department of Public Safety.

Prior to this, in September 2000, FEMA designated North Carolina as a Cooperating Technical Partner (CTP) and thereby delegated the responsibility to NCFMP to update and maintain the state’s Special Flood Hazard Areas (SFHAs), Digital Flood Insurance Rate Maps (DFIRMs), and processing of all Letters of Map Changes (LOMC) in North Carolina to ensure compliance with FEMA’s National Flood Insurance Program (NFIP) regulations.

In August 2006, the FHWA Resource Center and North Carolina Division, FEMA Region IV, the NCDOT Hydraulics Unit and the NCFMP staff met in Raleigh, North Carolina to discuss the compliance requirements for the NFIP. Both NCDOT and the NCFMP recognized the need to function as cooperative partnership in order to effectively deliver NCDOT’s multi-modal transportation programs, including road improvements, bridge and culvert construction or repair, maintenance facilities operations, ferry operations, greenways, railways, etc. This led to the 2008 signing of the MOA, which allows for efficient use of both agencies’ resources and has been developed in a manner to streamline project FEMA approval reviews and maintain construction schedules in a cost-effective way. This interagency cooperation has been hailed by some as a model for other state DOTs with respect to how to efficiently manage FEMA NFIP compliance.

This presentation will discuss how the MOA between NCDOT and NCFMP has served to mutually benefit both state agencies in fulfilling their respective missions and goals over the past ten years. Discussion will include a summary of past successes, lessons learned, and future goals for the continuation of this MOA between the two state agencies.

BIOGRAPHY:
Jerry Snead, PE, CFM has a BSCE degree and over 25 years of experience in the NCDOT Hydraulics Unit. He is currently the manager of the unit’s statewide Highway Floodplain Program which was established to ensure compliance with FEMA’s National Flood Insurance Program regulations for NCDOT projects. He also has been involved in the development and maintenance of NCDOT’s Guidelines for Drainage Studies and Hydraulic Design manual and related web resources, including a GIS database for a Level III Wave Vulnerability Study of NCDOT’s coastal bridges.
The Cannon Drive Levee – Coupling Roadway Improvements and Flood Protection at the Ohio State University

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ABSTRACT:
A significant portion of Ohio State's campus is impacted by the 100-year (1% annual chance) and 500-year (0.2% annual chance) floodplain of the Olentangy River. In 1923 an earthen embankment was constructed along the river as flood protection; however, it is not sufficient to be recognized as a certified levee. Beside the typical risks associated with having buildings and other infrastructure located within a flood zone, the university's risk insurance carrier currently provides only limited coverage for the potential flood damages.

Ohio State implemented a major infrastructure project to alleviate the potential for flood damages up to a 500-year event. The key elements of the project are the realignment of Cannon Drive to become a certified flood levee, providing green space along the Olentangy River, creating a north-south connection through campus and opening up 12 acres of land to allow for future development to support the university and its medical center. The levee will be coupled with the new roadway embankment, and two stormwater pump stations to discharge local runoff from within the campus area when the river is at or near flood stage. The project was conceived under the university’s Framework 2.0 Plan, a long-term guiding vision for development to support teaching, learning and research.

The project needed to meet all of the design and regulatory standards which would allow it to be permitted through the State of Ohio and eventually recognized by the Federal Emergency Management Agency (FEMA) as providing flood protection. The preliminary and final design process overcame numerous design challenges associated with major underground utilities, landscaping requirements, and the development of a very complex interior drainage system to protect the university's assets from river flooding events.

The university’s goal is to have the line of flood protection complete in 2020. At that point, billions of dollars of critical infrastructure and related assets will be flood protected.

BIOGRAPHY:
Miles Hebert is a Registered Professional Engineer and the Director of Water Resources Engineering for EMH&T. Miles is a 1988 graduate of The Ohio State University, with a Bachelors of Science in Civil Engineering. Miles oversees projects related to watershed planning, ecosystem restoration and flood protection. In this role, he interacts with municipalities, conservancy districts, regulatory agencies and watershed stakeholders to develop sustainable solutions. Miles also assists in the development of capital improvement programs for stormwater management projects to protect public infrastructure and improve water quality. Miles served as a project manager on the Cannon Drive project specific to the development, design and permitting of the integrated flood protection measures.
State-of-the-art FEMA Map Update With a HEC-RAS 1D/2D Hybrid Model and Validated With TUFLOW

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ABSTRACT:
An updated hydraulic analysis was performed for Mud Swamp Creek in Luzerne County, PA to revise the regulatory FEMA maps. The FEMA study was performed in the 1970s and the FEMA floodplain encapsulated a residential area that has never flooded. While the FEMA model indicated flood flows would be contained along Mud Swamp Creek, LiDAR mapping showed the southern floodplain as a wide, flat area that would not encapsulate the flow.

The FEMA HEC-2 model was updated with a HEC-RAS 5.0 1D/2D hybrid analysis. The 1D model represented the channel of Mud Swamp Creek and the northern floodplain, and a 2D area was used for the expansive southern floodplain. A lateral weir connected the 1D and 2D modeling components and allowed for flow to leave the channel as flood elevations exceeded natural high ground. A separate TUFLOW model was created to validate the 1D/2D results and to calibrate the lateral weir coefficient in HEC-RAS.

The HEC-RAS 1D/2D model was run as an unsteady analysis with an HEC-HMS hydrograph at the upstream limit of Mud Swamp Creek. Not only was the updated hydrology necessary to update the regulatory peak flows, but the hydrograph approach was also advantageous to represent the volume of water in the small watershed. The updated HEC-HMS peak flows were less than half the FEMA regulatory flows, and the unsteady model more accurately accounted for the storage within the floodplain.

The 1D/2D results were coordinated extensively with FEMA and used to prepare a LOMR. The HEC-RAS mapper was used to plot areas with average depths of 1 foot or more to distinguish between flood insurance zones. The 1D/2D model indicated that a significant portion of the flow diverted through the southern floodplain and drastically reduced the floodplain limits in the residential area along Mud Swamp Creek.

BIOGRAPHY:
Ms. Rachel Tereska is a Principal of NTM Engineering, Inc., a women-owned business that specializes in water resources, GIS, transportation and bridge engineering, and technical course development and instruction. Ms. Tereska earned her B.S. and M.S. in Civil Engineering from The Pennsylvania State University and holds Professional Engineering licenses in Pennsylvania and Delaware. She has 17 years of experience performing hydrologic and hydraulic modeling, bridge scour analysis, waterway permitting, and floodplain studies. She is a lead instructor for five H&H-related courses that NTM developed for PennDOT. Ms. Tereska conducted PennDOT’s first two-dimensional (2D) hydraulic analysis using the Surface-water Modeling System (SMS) and is currently using various 2D software like HEC-RAS 5.0, SRH-2D, and TUFLOW for hydraulic studies in PA and MD. Ms. Tereska has presented on 2D modeling applications to the American Society of Highway Engineers (ASHE), Floodplain Management Association (FMA), National Association of State Floodplain Managers (ASFPM), and PennDOT. She is also leading the EDC-4 CHANGE initiative for PennDOT.
New Methods for Floodplain and Floodway Determination Using 2D Models

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ABSTRACT:
The Federal Highway Administration (FHWA) has promoted the use of two-dimensional (2D) modeling for floodplain and bridge hydraulic analysis for many years, and in recent years adopted the US Bureau of Reclamation (USBR) SRH-2D model, due to its advanced modeling capabilities for transportation related hydraulics. Several new hydraulic structure features have been incorporated into the model for evaluating hydraulics at culverts, bridges in pressure flow, and many other cases. FHWA also sponsored the development of a custom graphical user interface in the SMS software package, which has a free community version available. The SRH-2D model and custom interface provide a powerful tool for analyzing complex hydraulics and clearly communicating results to others.

Most recently FHWA has been focusing on the use of SRH-2D for accurate floodplain and floodway delineation and improved capabilities to support floodplain analyses and submittals (i.e. no-rise, CLOMR/LOMR). New tools have been developed in the SMS interface to support these features. This presentation will provide an overview of these tools along with some of key differences between 1D and 2D floodway evaluation that need to be considered as we move forward with 2D modeling.

BIOGRAPHY:
Scott Hogan –
Mr. Hogan has spent his entire 25-year career working in the field of hydraulics and river engineering. He is currently a Senior Hydraulic Engineer with the FHWA Resource Center in Fort Collins, CO, and has previously served as the Hydraulics Team Lead for the Central Federal Lands Highway Division for 7 years, and 15 years in consulting engineering prior to that. Mr. Hogan specializes in bridge hydraulic modeling and design, scour analyses, sediment transport, counter measure design, and floodplain analysis. For more than 20 years he has been an instructor for several hydraulics training courses through FHWA National Highway Institute (NHI), including 1D modeling with HEC-RAS, 2D modeling with SRH-2D, Hydraulic Design of Culverts, Hydraulic Bridge Design, and Countermeasure Design. He has a sincere passion for hydraulic engineering and advancing the state of our practice.

Alan Zundel –
Dr. Zundel leads Aquaveo and was the original manager of the SMS under contract to the U.S. Army Corps of Engineers. Dr. Zundel has a long history of model development and application for several 1D and 2D hydraulic and sediment transport models including SRH, TUFLOW, ADH, RMA2, FESWMS, and others. He has also been involved with hydraulic modeling projects for the past twenty years. Dr. Zundel has taught university level courses and has also instructed numerous training courses in the US and internationally and for all of the models included in the SMS package.
Session: Innovation Through New Scour Methodology

**NCHRP Project 24-47: Revised Clear-Water and Live-Bed Contraction Scour Analysis**

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**ABSTRACT:**  
Current guidance in Hydraulic Engineering Circular No. 18, “Evaluating Scour at Bridges,” (Arneson et al. 2012) includes equations for estimating contraction scour in bridge waterways. A previous NCHRP project, Project 24-34, found that the existing clear-water and live-bed contraction scour equations exhibited a surprisingly low reliability index when compared to predictive equations for other scour components (i.e., pier scour and abutment scour).

NCHRP Project 24-47 has the objectives of: 1) examining the assumptions and limitations of existing guidance for estimating contraction scour in bridge waterways; 2) conducting physical and numerical model studies of contraction scour for both clear-water and live-bed conditions; and 3) developing revised scour equations and/or modifying existing guidance for estimating contraction scour.

This presentation provides an overview of contraction scour processes and a description of the experimental approaches to be taken during the course of the investigation. A critical component of the study is to accurately define the flow field before, during, and after scour occurs in the contracted section for various geometries and flow rates.

**BIOGRAPHY:**  
Paul Clopper is the Director of Applied Technology in the Fort Collins, Colorado office of Ayres Associates. His training and experience are in the fields of surface water and ground water hydrology and hydraulics, river mechanics, bridge scour, and erosion/sediment control. He has 34 years of experience in consulting engineering, joining Ayres Associates in 1992.

Paul is responsible for planning, coordination, technical conduct, and management of a variety of projects involving hydrologic and hydraulic data collection and analysis, water resource assessment and characterization, and engineering design. Typical projects have included:

- Bridge scour and stream stability countermeasure performance, selection, and design
- Applied research in erosion control product performance
- Development of adult learning materials, including course curricula and web-based training.
- Surface water and groundwater monitoring networks
- Levee and roadway overtopping protection – applied research
- Levee foundation seepage analysis

Since 2007, Paul has been an active member of Transportation Research Board (TRB) Committee AFB60, “Hydrology and Hydraulics.” He served as the Chairman of the Hydraulics Subcommittee of AFB60.
The Observation Method for Bridge Scour: Case Histories

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ABSTRACTS:
Bridge scour is the number one cause of bridge collapse in the USA yet the existing guidelines are felt to be excessively conservative. These apparently conflicting statements are due to the fact that most bridge foundations designed before 1987 did not consider scour as part of the design. The Observation Method for Scour (OMS) was developed to address the conservatism inherent in the current procedures by relying significantly on past observations at the bridge. The OMS works in four steps. Step 1 consists of collecting the maximum observed scour depth at the bridge, Zmo. Step 2 consists of finding out what is the biggest flood velocity Vmo that the bridge has been subjected to since its construction. Step 3 answers, by using an extrapolation function, the question: what will be the scour depth Zfut if the bridge is subjected to a major flood velocity Vfut. Step 4 is a comparison between Zfut and the allowable scour depth Zall for the foundation.

Eleven bridge scour case histories in Texas and in Massachusetts are presented where the OMS was applied and the results are used to compare predicted and measured values of Zfut for both the OMS and the current FHWA guidelines. The advantages and drawbacks of the OMS are outlined in a final section.

BIOGRAPHY:
Professor Jean-Louis Briaud is University Distinguished Professor and Holder of the Spencer J. Buchanan Chair in the Zachry Department of Civil Engineering at Texas A&M University, a distinguished member of ASCE and a registered Professional Engineer. He received his Bachelor degree from the Ecole Speciale des Travaux Publics in France in 1972 and his Ph.D. degree from the University of Ottawa in Canada in 1978. His expertise is in foundation engineering and more generally geotechnical engineering. He has served as President of the Association of Geotechnical Engineering Professors in the USA, President of the Geo-Institute of the American Society of Civil Engineers, is President of the International Society for Soil Mechanics and Geotechnical Engineering and is the current President of the Federation of International Geoengineering Societies. Among other awards, he has received the ASCE Ralph Peck Award, the CGS Geoffrey Meyerhof Foundation Engineering Award, the ASTM Hogentogler Award, the ASCE Huber Research Prize, and the ASCE Martin Kapp Award. Over the last 35 years, Dr. Briaud has conducted about 10 million dollars of research most of which was on foundations and retaining walls. He has supervised 50 PhD students and 90 Master students. He is the author of the book: “Geotechnical Engineering: Unsaturated and Saturated soils” of the book “The Pressuremeter” and has published about 300 articles and reports in geotechnical engineering.
Implementation of the Scour Evaluation Model (SEM)

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ABSTRACT:
This presentation describes the results of a recent implementation and field assessment of the Scour Evaluation Model (SEM) for existing, non-tidal bridges. Developed under research funding from the New Jersey Department of Transportation (NJDOT) and the Federal Highway Administration (FHWA), the SEM method offers some new analysis procedures, while still retaining the applicable parts of FHWA HEC-18. The risk-based method evaluates eight key geotechnical, hydrologic, and hydraulic factors, in addition to a structure’s importance. Improved protocols are also provided for erosion classification of sediments and determination of maximum historic stream flow. The end product of a SEM analysis is a scour priority rating for the bridge (1 through 4), along with specific recommended actions for repair or delisting form the Scour Critical List.

In 2017, the SEM method was approved by FHWA and NJDOT for application to bridges throughout New Jersey. The approval followed a year-long implementation and field assessment of the model during which 19 scour critical bridges were fully evaluated. Test bridges were located in all four of New Jersey’s physiographic provinces, and they featured a wide variety of characteristics, including age, structure type, number of spans, drainage basin size, and flooding history. Three New Jersey consulting firms participated in the project for the purposes of technology transfer. In keeping with the versatility of SEM method, the field assessments yielded a range of results, including:
• High risk bridges that were recommended for priority repairs or replacement;
• Medium risk bridges that were recommended for minor repair or continued monitoring; and
• Low risk bridges that were recommended for delisting and removal from the Scour Critical List.

The overall goal of the SEM method is to provide NJDOT with a rational tool to manage bridges on the Scour Critical List, and the Department is currently moving ahead with additional bridge evaluations. While the SEM method is currently calibrated for the geology and hydrology of New Jersey, it can also be adapted for use in other states to help them manage their scour critical bridges.

BIOGRAPHY:
JOHN R. SCHURING, Ph.D., P.E. is Professor Emeritus in the Department of Civil and Environmental Engineering at New Jersey Institute of Technology. Dr. Schuring has more than 40 years’ experience in both the academic sector and professional practice. He teaches courses in engineering geology, hydraulics, and hydrogeology.

Dr. Schuring’s research interests have included bridge scour, ground water remediation, and engineering geomorphology. He holds several United States patents for a novel soil treatment known as “pneumatic fracturing” that has been used to decontaminate many hundreds of industrial and government sites in the U.S. and abroad. His research has been sponsored by the National Science Foundation, Federal Highway Administration, New Jersey Department of Transportation, and the U.S. Environmental Protection Agency, in addition to corporate clients such as AT&T, BP America, and Union Carbide. Dr. Schuring has also provided consultation on many bridge and infrastructure projects for transportation agencies, including the New Jersey Department of Transportation, New York State Thruway Authority, Maine Turnpike Authority, and the Triboro Bridge and Tunnel Authority in New York City.

Dr. Schuring is a registered professional engineer and a Fellow of the American Society of Civil Engineers. Recently, he moved to part-time “emeritus” status at NJIT and is now working as a Senior Technical Adviser with HNTB Corporation in Parsippany, NJ.
**ABSTRACT:**
The scour estimating equations and methods described in the current 5th edition of HEC 18 are based on measurements and laboratory experiments conducted in one uniform, homogeneous layer of soil. This implies that a single critical shear stress value can be used to describe the erosion resistance of the soil throughout the full scour depth. This is true for experiments conducted in both non-cohesive (sands) and cohesive soils (manufactured clays).

In nature, it is quite rare that a single homogeneous soil type and associated critical shear stress would be required or available to support bridge foundations, especially deep foundations. Typically, the subsurface soils are comprised of multiple layers of variable type, thickness, and erosion resistance. Therefore, to generate the best scour estimate possible, it is incumbent upon the engineer to account for the impact of variable soil erosion resistance on scour depth. This could be attempted through a trial and error procedure using the recommended equations and the critical shear stress applicable to each subsurface soil layer. However, such a procedure would be quite tedious, with the results being only approximate. A better alternative is to describe the decrease in hydraulic shear stress that occurs within the scour hole, as scour deepens, and use this measure, along with the vertical profile of soil erosion resistance, to determine the equilibrium of scour.

The reduction of hydraulic shear stress as scour forms is referred to as Shear Decay, which is primarily a function of the scour hole depth and shape. The procedure for determining the scour depth using the soil erosion resistance profile and the appropriate shear decay function is referred to herein as the Scour Depth Equilibrium State design approach. The determination of soil resistance with depth, the development of applicable shear decay functions, and the scour depth equilibrium state analysis procedure will be presented.

**BIOGRAPHY:**
Kornel Kerenyi is a hydraulics research engineer in the Federal Highway Administration's (FHWA’s) Office of Infrastructure Research and Development. He coordinates hydraulic and hydrological research activities with State and local agencies, academia, and various partners and customers, and manages the FHWA Turner-Fairbank Highway Research Center (TFHRC) J. Sterling Jones Hydraulics Research Laboratory. He was previously a research engineer at a private company and supervised support staff in the laboratory. Dr. Kerenyi holds a Ph.D. in fluid mechanics and hydraulic steel structures from the Vienna University of Technology in Austria.
ABSTRACT:
The HY-8 culvert hydraulic analysis program has been used by engineers for decades to design new culvert crossings and analyze existing culvert crossings. HY-8 uses the methods described in FHWA's HDS-5 manual. HY-8 performs 1-D Hydraulic analysis on culvert crossings with multiple culvert barrels. HY-8 determines if an hydraulic jump occurs and if it does, the location of the jump. HY-8 can analyze broken back culverts as well as horizontal and adversely sloped culverts. It is also used to design energy dissipation structures using methods described in FHWA’s HEC-14 manual and design for Aquatic Organism Passage as described in FHWA’s HEC-26 manual. HY-8 can be downloaded free of charge from the following FHWA Hydraulic Engineering website: http://www.fhwa.dot.gov/engineering/hydraulics/software/hy8/

The Hydraulic Toolbox is an intuitive computer program containing a suite of calculators that perform many of the routine hydrologic and hydraulic computations needed by highway hydraulic engineers and roadway designers. The following calculators are included in the previous version of the Toolbox: roadway hydrology, open channel flow, weir flow, pavement drainage, inlet capture/bypass, ditch inlet capture/bypass, detention basin routing, channel lining design (vegetation, rolled erosion control products, and rock), multiple riprap sizing applications (channel bank revetments; bridge piers, abutments, and guide banks; spur dikes; embankment overtopping; culvert outlets; open-bottom culverts; and wave attack), riprap filter design, gradation analyses via pebble count or digital image, ditch inlet capture/bypass calculator, culvert assessment tool, Bridge Scour calculator, and Horizontal Grade Inlet Calculator.

Each of the calculators has the following support functions available:
- Plotting capabilities with printing and export options
- A Notes module for documenting information sources and/or input parameter qualifications
- A Report module for documenting all input and output data for any one or combination of calculators

Hydraulic Toolbox also incorporates a profile system that allows the user to define their own riprap classification system and culvert assessment profiles.

This presentation will demonstrate the latest bug fixes and commonly found mistakes and misunderstandings of HY-8. This presentation will demonstrate using Aquaveo’s Surface Water Modeling System (SMS) to populate the most common fields of the Bridge Scour Calculator in Hydraulic Toolbox.

Hydraulic Toolbox can be downloaded free from the following FHWA Hydraulics Engineering Software website: https://www.fhwa.dot.gov/engineering/hydraulics/software.cfm

BIOGRAPHY:
Eric is the lead developer for the Federal Highway Administration software HY-8, Hydraulic Toolbox, and HY-12 at Aquaveo, LLC. He also works on the development of the Watershed Modeling System (WMS) software at Aquaveo. He has received his B.S. and M.S. from Brigham Young University in Civil and Environmental Engineering. He has received his B.S. and M.S. from Brigham Young University in Civil and Environmental Engineering.
**U.S. Geological Streamgage Data and Their Applications**

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**ABSTRACT:**  
Streamgages are critical for flood prediction, determination of flood and low-flow frequency characteristics, engineering design, recreational interest and water management. The U.S. Geological Survey (USGS) currently operates over 8200 streamflow gages nationwide. In Ohio, the USGS, in cooperation with about 50 Federal, state and local cooperators operates over 300 streamgages (215 with streamflow) and 23 lake-level gages. This presentation will outline several useful USGS applications developed around USGS streamgage data including WaterAlert, Water Dashboard, Streamstats, and the Flood Inundation Mapping Program, as well as other data features and how to access them.

**BIOGRAPHY:**  
Thomas Harris is with the U.S. Geological Survey in Columbus, Ohio, where he is currently serving as the Data Chief of the Ohio-Kentucky-Indiana Water Science Center. He started with the U.S. Geological Survey in March 1993 in the Independence, Missouri Field Office as a hydrologic technician. He became a supervisory hydrologist and Field Office Chief in January 2005 in the Lee’s Summit, Missouri Field Office. Tom transferred to the Columbus Ohio office of the Ohio-Kentucky-Indiana Water Science Center in September 2014. During his career with the U.S. Geological Survey, Tom worked the Great Midwest Floods during the summer of 1993 and in the late 1990’s spearheaded the movement to measure discharges using acoustic Doppler current profilers in the Missouri Water Science Center in Independence, Missouri. Tom co-authored the report entitled “Water Quality and Ecological Condition of Urban Streams in Independence, Missouri, June 2005 through December 2008,” and is a co-author on several USGS flood reports. Tom holds a Bachelor of Science degree in Meteorology from Lyndon State College, Lyndonville Vermont and a Master of Science degree in Civil Engineering from the University of Kansas. Prior to working with the USGS, Tom was an active duty U.S. Air Force meteorologist from 1986 to 1992, serving in various assignments ranging from weather forecaster for Military Airlift Command at Scott Air Base, Illinois to A-10 Wing Weather Officer during Desert Storm 1 and Officer-in-Charge of the 39th Special Operations weather team at Royal Air Force base in Alconbury, United Kingdom. Tom then joined the Air Force Reserves in 1994 and after 20 years, retired from the Air Force Reserves in July 2014 as a Lieutenant Colonel, after having worked at the National Air and Space Intelligence Center at Wright-Patterson AFB, Ohio as a weather intelligence officer.

Tom is married and has two sons. His oldest son is a propulsion engineer with General Atomics and is living in San Diego, California. His youngest son is a junior at University of Missouri Kansas City and majoring in business and marketing. In his free time he enjoys working out, tending to the plants and animals on his farm, taking day trips with his wife and playing guitar.
ABSTRACT:
Web services are GIS-based web sites that have the capability of instantly trimming and transmitting raster or vector GIS data to a user’s computer. There are several web services that can be useful for hydrologic and hydraulic modeling and that have become available over the last few years. These web services allow users to download and use elevation data, aerial photography, topographic maps, land use data, FEMA flood data, and other types of data in hydrologic and hydraulic models. Web services that are useful for hydrologic and hydraulic modeling will be discussed. Tools for using these web services in hydrologic and hydraulic modeling projects will be demonstrated.

BIOGRAPHY:
Mr. Smemoe is the WMS Development Team Leader for Aquaveo. He has been a lead player in the development of WMS since 2007 and worked as a WMS software manager since 1997. Mr. Smemoe graduated from Brigham Young University with a BS, MS, PhD, Civil and Environmental Engineering-Hydrology.
ABSTRACT:
The ESRI Collector is an asset management application used to collect data for various assets around Ohio such as culverts, BMPs, underdrain outlets, etc. ODOT culvert inspectors utilize iPads to collect the state inventory and inspection data. This has led to higher quality data, particularly when syncing geospatial information recorded automatically with any smart device. The objective is to have a platform to store and manage accurate records. Over time, the data will lead to informed decisions and will result in cost savings by utilizing an optimized preventive maintenance approach. The application allows an inspector to quickly locate the culvert and begin their inspection through an easy to operate and streamlined user interface. ODOT has a dedicated support team for customizing the app for the business need of culverts and many other asset user groups. A member of the support team will help present and answer questions about the implementation.

BIOGRAPHY:
Matt Retta -
Matt Retta is a Hydraulic Engineer for the Ohio Department of Transportation in the Office of Hydraulic Engineering. He has served in this role since May 2015. Matt helps run the Culvert Management Program, including training, database and GIS solutions. Prior to this position, Matt interned in ODOT’s Office of Technical Services and completed ODOT’s engineer-in-training program in District 5. He is a graduate of Ohio State University with a Bachelor of Science in Civil Engineering and registered EIT in the State of Ohio.

Michael Weakley -
Michael Weakley is a GIS Analyst in the Office of Asset Inventory & Systems Integration at the Ohio Department of Transportation. He has been with ODOT for two years and has eight years of experience in the GIS industry. At ODOT, Michael is involved with the Collector Program, Transportation Asset Management Audit Group, and Asset Management Leadership Team. He earned his BA in Geography with a minor in City and Regional Planning from Ohio State University.
Session: Bridge Resiliency Through Scour Countermeasures

Scour Monitoring: Innovative Tool – Case Histories

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ABSTRACT:
The proposed presentation would include a short overview of the BridgeWatch web-based platform including some statistics on how many structures nationally are monitored using the system, updates since last presented to the hydraulic engineering community, and customizations made for individual state agencies.

Several State DOT clients have expressed interest in sharing their use of BridgeWatch with the national audience. Respectively, each state would provide a 5-7 minute overview of how BridgeWatch fits into their bridge safety/ asset...
management programs. Iowa DOT’s, Dave Claman would like to share their use of BridgeWatch with monitoring roadway overtopping as part of a Federally funded research project. Tennessee DOT’s Wesley Peck will present how TDOT averted potential disaster when BridgeWatch alerted regional engineers to inspect and close a bridge during a major flood event. The Connecticut DOT’s Mike Hogan will discuss how BridgeWatch is being used to monitor scour devices on the historic Mystic River bridge and share a success story where BridgeWatch alerted engineers to a state bridge that later failed due to scour. These last two are excellent success stories where engineers used their scour related thresholds and plans of action to protect the traveling public.

BridgeWatch is configured by each State DOT to identify the occurrence of environmental hazards and collect relevant structure information, several sources of real-time meteorological data, hydrologic data, seismologic data and any monitoring device data available.

BIOGRAPHY:
Joe Scannell –
Joseph Scannell is the President, CEO, and co-founder of USES Corp. Mr. Scannell is a graduate of the University of Rhode Island with a B.S. in Civil Engineering. Mr. Scannell is a former engineer with the Connecticut Department of Transportation (CTDOT). Mr. Scannell received a “25 Top Newsmakers” award by the editors of McGraw-Hill Company’s Engineering News Record magazine. Mr. Scannell is the primary author of a United States Patent for monitoring structural instabilities due to environmental processes. Mr. Scannell lives in Connecticut with his wife Christine and their three daughters.

Dave Claman –
Dave Claman is the Transportation Manager for the Preliminary Bridge Section at the Iowa Department of Transportation and has 34 years of experience in the hydrology and hydraulics engineering field. Dave’s primary responsibility is to insure the State’s highway structures are cost-effective and appropriately sized/designed in accordance with Iowa DOT guidelines and policies. He is also the DOT’s expert regarding drainage disputes, bridge scour, stream geomorphology, 2-D hydraulic analysis and FEMA/floodplain management issues. Prior to working for the Iowa DOT, Dave worked for the Iowa Department of Natural Resources where he was responsible for the administration and enforcement of the State’s floodplain management program.

Dave has been involved in many advisory committees on the local, state and national level regarding climate change, flood mitigation, water resources and bridge scour. He has also been involved in many research projects as technical advisor or co-investigator for various issues involving the prediction and monitoring of bridge scour (NCHRP 24-20), the reduction of sedimentation accumulation in multi-barrel culverts (IHRB TR 665) and other hydraulic or stream migration/degradation issues facing the civil engineer profession in Iowa.

Mike Hogan –
Michael E. Hogan, P.E. is a Supervising Engineer in Connecticut DOT’s Hydraulics & Drainage Section. Mr. Hogan has more than thirty (30) years of experience in hydrologic and hydraulic analysis/modeling and design for numerous projects involving bridges, culverts, stream channels, coastal and riverine floodplains, bridge scour and stream instability countermeasures, storm water drainage and regulatory permitting and certifications for CTDOT. He is a member of the American Association of State Highway and Transportation Officials (AASHTO), Committee on Design (COD), Technical Committee on Hydrology and Hydraulics.

Wesley Peck –
Wesley Peck received a BSCE from Tennessee Technological University and a MS in Environmental Engineering from the University of Tennessee at Knoxville. He is a licensed professional engineer in the state of Tennessee. Wesley has 22 years of experience with the Tennessee DOT and currently manages the Hydraulic Design Section of the Structures Division.
Drone Based Riprap Imaging and Gradation Measurement

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ABSTRACT:
Validation of installed properties of riprap is a key quality control step in the acceptance of newly constructed revetments. While the physical properties of rock can be determined using well established testing methods, the measurement of key gradation properties is much more difficult. Most often the acceptance of installed riprap is based simply on visual assessment or proxy methods such as a Wolman count. Direct measurement by weighing individual stones can be performed but is time consuming and is limited to only a few locations. In this presentation, we discuss the protocol developed by Kiewit for the use of drone based imaging for the determination of riprap gradation. Use of drone imagery solves two basic logistical problems associated with the use of imaging for gradation analysis. First, it allows images to be acquired from the best vantage point to observe the riprap installation; and second, it permits images to be acquired during the best lighting conditions. Drone imaging allows gradation to be determined at the source prior to loading, at reference sites within the project after transport, and after installation. Drone images of a revetment consist of multiple frames taken along a stream bank, which allows the gradation to be documented for the entire installation. Image processing steps consist of capturing and combining multiple high-resolution, geo-located photogrammetry images, adding CAD information for identifying location on the project, and editing the mesh to enhance the accuracy of measurements. Gradation documentation is then logged into Kiewit’s inspection record system, KieTrac, for the riprap installation. The US-34 permanent flood repair project in Big Thompson Canyon, Colorado is used as a case study. This project required the placement of over 100,000 cubic yards of riprap.

BIOGRAPHY:
LeAndra Nelson is a Hydraulic Engineer with Kiewit Infrastructure Engineers in Englewood, CO. Ms. Nelson has a Bachelor’s and Master’s Degree in Civil & Environmental Engineering from the University of Nevada, Las Vegas. Go Rebels! She has been coordinating with Kiewit Construction to obtain project information and drone images from the US-34 Flood Recovery Project in Colorado. LeAndra is an avid sports fan and traveler.
An Icebreaker Under Troubled Waters (and Ice Bergs)

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ABSTRACT:  
One of Alaska’s historic structural gems, the “Million Dollar Bridge”, spans the famed Copper River and is protected by two 108 year-old ice breakers. Unfortunately, one of those ice breakers was displaced by an ice berg during a recent spring breakup. My presentation will highlight interesting facts associated with the construction of the Million Dollar Bridge and its ice breakers, including the harrowing completion of the bridge ahead of the 1910 breakup, and it will cover our efforts (through assistance by the USGS) to monitor changes at the ice breaker. I will discuss DOT&PF’s present thoughts on what might be done with an aging ice breaker protecting an aging bridge on a segment of road we cannot easily access.

BIOGRAPHY:  
Michael Knapp has been with the Alaska DOT&PF for 14 years and has been the Statewide Hydraulics Engineer the past 10 years. His primary role is to support the Bridge Section with its design and inspection responsibilities. He lives in Juneau but his statewide role involves travel to all corners of the state, wherever public bridges are located. Michael earned a B.S. in Civil Engineering and an M.S. in Water Resources Engineering from Oregon State University.
Low-Cost Scour-Preventing Fairings for Bridges – Permanent Solution for Foundation Rock Scour

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ABSTRACT:
A heavily used large bridge is downstream of a bend in a river and has the most severe scour under the pier seals of any relatively new bridge in this state. Swirling flow brings the highest velocity surface water down to the river bottom. The limestone under the base seals of the piers has been partially scoured away, not the concrete seals. These base seals do not have pilings, so there is no other support for the bridge but the limestone. One pier has lost 29% of its load-bearing strength and 60% of its moment-bearing strength. The loss of this bridge would devastate the local rural economy. One year without this bridge would cost the economy more than the cost of the proposed project.

The permanent solution to this problem is to prevent the swirling flow from reaching the limestone under the seal. Traditional scour countermeasures do not do this. Based on many years of research experience, streamlined fairing designs for piers and underwater structures with vortex generators that counteract the swirling vortex have been developed, tested, and proven under National Cooperative Highway Research Program (NCHRP) sponsorship to permanently prevent pier scour and debris buildup. Flume model tests showed similar scour results for this bridge base seals to those obtained from underwater inspections. When streamlined fairing designs with vortex generators were added to the seals, there was no scour. This project will obtain up-to-date information on the current state of these pier seals which do not have pilings, restore the strength of these piers using accepted methods, and fabricate and install scouring-flow-altering stainless steel streamlined fairing designs with vortex generators that permanently prevent future scour. This permanent solution is far less expensive and more cost effective over the life of this relatively new bridge than commonly used current scour countermeasures.

BIOGRAPHY:
Dr. Roger L. Simpson, P.E., M.ASCE is President, AUR, Inc. (www.aurinc.com) and is an internationally recognized fluid dynamics researcher, inventor, and author on vortex-producing “juncture flows”, such as those that occur around wing/fuselage junctions on aircraft, appendage/hull junctions on submarines, and in bodies of water around hydraulic structures such as bridge piers and abutments. He is Past President and Fellow AIAA and Fellow ASME. Currently he is a consultant to NASA on reducing adverse aspects of “juncture flows” between airplane wings and a fuselage. For over 30 years his sponsored research at Virginia Tech, where he was the Jack E. Cowling Professor of Aerospace and Ocean Engineering, provided much data on separated flows, the prevention of acoustic noise producing vortices on submarines (Seawolf and Virginia Class), surface roughness effects on flow, and other turbulent flow problems. This work resulted in over 300 publications. Over the last years, he has applied this fluid dynamics background to designing and testing the scouring-vortex-preventing streamlined fairings scAURTM for bridge piers and abutments and the novel tetrahedral vortex generators VorGAURTM that create counter-rotating vortices that oppose the effects of scouring vortices and prevent debris collection.
Underwater Installation of Filter Systems for Scour and Other Erosion Control Measures

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ABSTRACT:
NCHRP Project 24-42 had the objective of developing guidance for design, construction, and maintenance personnel on the function of filters and techniques for installing both granular and geotextile filters underwater as an essential component of bridge scour and other erosion control countermeasures. Experience and a survey of practitioners indicated that few countermeasures in water include a filter as shown on design plans and as recommended in applicable technical guidance publications (e.g., HEC-23). The most common reasons given include constructability issues and environmental concerns.

This research resulted in a synthesis of the state-of-practice, internationally, for installing filter systems underwater. Recommended selection and design procedures, specifications, material testing requirements, installation alternatives, and quality checklist items are provided.

This research included prototype scale proof-of-concept laboratory testing of diver-assisted installation of both granular and geotextile filters. While the installation of granular filters in flowing water is problematic in most cases, the use of self-sinking geotextile composite fabrics is a common practice in Europe. Geotextile filters can also be installed as geotextile containers filled with sand or gravel. These can be filled prior to placement and dropped through the water column, or empty geobags can be placed underwater by divers and filled with a flexible tremie hose. These are commonly used in Europe, but are relatively unknown in the U.S. Wider use of the self-sinking geotextile mat or geobag approaches would constitute a significant advance in the state-of-practice for placing filters in flowing water in the U.S. Using innovative techniques such as these, there should be very few instances where a filter cannot be placed underwater as an integral part of a properly designed and installed scour or erosion control countermeasure.

BIOGRAPHY:
Dr. Lagasse has served as Principal Investigator (PI) or Co-PI for over $4M in applied research for the National Academy of Science, Transportation Research Board’s National Cooperative Highway Research Program (NCHRP). Research topics have included: countermeasures to protect bridge piers from scour, predicting stream meander migration, riprap design criteria, effects of debris on bridge pier scour, risk-based approach for bridge scour prediction, environmentally sensitive stream bank protection measures, and, more recently, guidance for underwater installation of filter systems.
Session: Consideration of Extreme Weather Events in Resilient Design

Detection and Attribution of Flood Change Across the United States

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ABSTRACT:
In the United States, there have been an increasing number of studies quantifying trends in the annual maximum flood; yet, few studies examine trends in floods that may occur more than once in a given year and even fewer assess trends in floods on rivers that have undergone substantial changes due to urbanization, land-cover change, and agricultural drainage practices. Previous research has shown that, for streamgages having minimal direct human intervention, trends in the peak magnitude, frequency, duration and volume of frequent floods (floods occurring at an average of two events per year relative to a base period) across the United States show large changes; however, few trends are found to be statistically significant. Current research is extending previous work to provide a comprehensive assessment of flood change across the United States that includes rivers that have experienced confounding alterations to streamflow in addition to the more commonly-used datasets of rivers that have only experienced limited catchment alteration.

BIOGRAPHY:
Stacey is currently a research hydrologist in the Water Mission Area of the US Geological Survey and has worked at the USGS since 1998. Stacey started her career as a Hydrologic Technician in the Massachusetts Water Science Center and continued working for the USGS while earning a M.S. in Geosystems from the Massachusetts Institute of Technology and a Ph.D. in Civil and Environmental Engineering from Tufts University. Stacey also holds a B.S. in Geology from Northeastern University.
Confidence Bounds on Freeboard at Stream Crossings for Evaluating Overtopping Risk

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ABSTRACT:
Changing precipitation, rapid urbanization, and the dynamic behavior of river channels interact to create unprecedented challenges for flood mitigation and management. In addition, our nation depends on a functioning transportation network for economic and societal prosperity emphasizing the need to identify stream crossings with an elevated or hidden risk of flash flooding. Standard methods for quantifying flood hazards and evaluating risk are hindered by approaches that do not sufficiently account for the compounding effects of changing precipitation, land-use, and river channels on flood hazards. This presentation describes novel techniques for quantifying the confidence bounds on freeboard at stream crossings during design floods using HEC-RAS hydraulic modeling. Confidence bounds are quantified through Monte-Carlo analyses of model inputs and parameters under current and future scenarios of precipitation, urbanization, and potential channel aggradation. The resulting distribution of modeled freeboard at stream crossings is compared with standard estimates of freeboard reported as a single value representing a binary description of flood hazard at that structure. Further, we describe rapid approaches to quantifying the range of possible water surface elevations and freeboard, and how this information can be utilized to identify stream crossings with an elevated or hidden risk of structure overtopping. The practical techniques described in this study can be utilized by practitioners and decision makers for evaluating and mitigating flash flooding at stream crossings.

BIOGRAPHY:
Tim is a Ph.D. student in the Institute for Resilient Infrastructure Systems at the University of Georgia. He has a Bachelor’s degree from the University of Tennessee and a Master’s degree from Colorado State University in Civil and Environmental Engineering. He has also spent several years working as consultant in stream restoration design. Currently, Tim conducts research in hydrology and hydraulics focusing on their relationship with resilient infrastructure, biodiversity, and enhancing human well-being under a changing climate, urbanization, and population growth.
ABSTRACT:
The frequency of extreme weather events such as floods and droughts are expected to increase in response to anthropogenic climate change. It is important for resilient design to understand the data that support conclusions about projected changes in extreme precipitation events and the assumptions, caveats, and unknowns regarding these changes. We provide an overview of observed and projected changes of extreme precipitation within the Contiguous United States and discuss some important changes in extreme precipitation responsible for flooding, such as hurricanes. For the projected changes, we will further provide an overview of the models and techniques and some knowns and unknowns when considering changes in the intensity, duration, and frequency of precipitation extremes for resilient design.

BIOGRAPHY:
Mr. Bowden’s technical background is in the area of climate dynamics with a specific focus on the use and development of limited area numerical atmospheric models (regional climate models) to generate high-resolution regional climate change data. Mr. Bowden conducts research in the field of atmospheric science and climate modeling, focusing on the area of applied climatology and modeling in a changing environment. Since 2017, Mr. Bowden has worked as the Senior Research Scholar in the Department of Applied Ecology at the North Carolina State University in Raleigh, North Carolina. Previously, Mr. Bowden served as at the University of Florida, Gainesville, the University of North Carolina Chapel Hill, North Carolina, the Oak Ridge Institute for Science and Education and the National Research Academies.
Adapting Global Climate Model Precipitation Projections to Hydrologic Design

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ABSTRACT:
Increasingly, engineers must make estimates of discharge associated with a particular risk (or set of risks) to design a hydraulic structure or stormwater management facility considering potential climate change. As part of a National Cooperative Highway Research Program (NCHRP) study “Applying Climate Change Information to Hydrologic and Hydraulic Design of Transportation Infrastructure” the authors examine issues and propose strategies for adapting Global Climate Model (GCM) precipitation output as inputs to rainfall/runoff models used in hydrologic design. This paper offers a preview of the recommendations anticipated from this project.

The use of hydrologic rainfall/runoff models requires precipitation inputs on a daily time step in some situations and in other situations, the engineer requires the data at a more temporally disaggregated sub-daily level of detail. Engineers have relied on the assumption of nonstationarity to apply historical information to future periods during which the transportation infrastructure will serve its intended purpose. However, with projections of a changing climate, transportation agencies and policy makers are asking engineers to consider future scenarios without relying on nonstationarity. To accomplish this, engineers using rainfall/runoff models need estimates of future daily and sub-daily precipitation as inputs at watershed-level spatial scales. As discussed in this paper, suitable Global Climate Model (GCM) output is limited at a daily time scale and is even more limited at a sub-daily time scale. GCM output is also generally available on a spatial scale larger than required to model smaller watersheds.

This paper addresses the research project findings and focuses on two primary challenges faced by the climate science and engineering communities in providing engineers with estimates of future sub-daily and daily precipitation data and offers recommendations for actionable guidance in these areas. The first challenge addressed is the identification, development, and application of sub-daily precipitation estimates from GCMs. The second challenge is adapting the spatial scales of GCM output to watershed scales that engineers require for both daily and sub-daily precipitation data.

BIOGRAPHY:
Mr. Kilgore is a Professional Engineer based in Denver Colorado with 30 years of experience in hydrology and hydraulics, stormwater management, water quality, and flood mitigation. He has written several design manuals for the Federal Highway Administration including Highways in the River Environment- Floodplains, Extreme Events, Risk, and Resilience (HEC-17) and Highway Hydrology (HDS 2). He is currently the Principal Investigator of an NCHRP applied research project addressing how engineers can incorporate projected climate change into hydrologic design.
Session: Rethinking the Methodology for Stream Stability

*Right Sizing Stream Stability*

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**ABSTRACT:**
Stream stability is a huge issue in the United States as communities continue to grow, weather patterns change, and sediment supplies in systems evolve. Changes in channel geometry, addition of man-made structures, or natural channel developments can also create stream instabilities. It is especially critical to understand the impacts from new transportation crossing structures and adjacent facilities on stream stability. Understanding stream stability is critical to understanding risks to adjacent infrastructure, habitat, downstream water quality, and beneficial uses.

The mechanics of hydrology, hydraulics, and sediment transport associated with stream stability are extremely complex and generally require significant experience to fully analyze. It has become increasingly important for engineers and scientists to complete stream stability analyses with efficient methods to better support comparison of multiple project alternatives. Often development of full calibrated and validated sediment transport models for evaluation of a large number of project alternatives is not practical. In these instances unique approaches and analyses have been developed with success.

This presentation will discuss the range of challenges faced with various stream stability assessment approaches and will provide an example project to illustrate creative analyses methods. Stream stability analyses of the American River downstream of Folsom Dam were completed for multiple dam operational criteria for the US Army Corps of Engineers. Unsteady hydraulic models were used to determine and compare periods of channel instability specific to channel reaches instead of developing full sediment transport models. These simplified stream stability analyses were completed to compare operational criteria impacts to horizontal stability, vertical stability, and specific habitat features. Attendees will come away from the presentation with a general understanding of stream stability considerations and some unique approaches to simplifying comparison of stream stability impacts from large projects.

**BIOGRAPHY:**
Brinton Swift is a Senior Drainage Engineer working at Kiewit Infrastructure Engineers located in the Denver office. Mr. Swift has over 12 years of experience in the private and public sectors with a focus on hydraulic analysis, sediment transport, river mechanics, and drainage system design and analysis for development and civil design projects. Mr. Swift has significant experience with hydraulic modeling and sediment transport modeling; as well as scour analysis and general geomorphic analysis and assessment. He just welcomed a second son into the family in June and when he is not working is busy changing diapers.
Practical Approaches to Sediment Transport at Stream Crossings

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ABSTRACT:
Significant resources are applied by transportation agencies to design, construct, and maintain stable roadway crossings of streams. In addition to flooding, common maintenance problems include channel alignments, waterway openings, pier and abutment scour, and debris and sediment accumulation. NCHRP Research Report 853 presents the results of a study focused on developing scientifically supported methods for defining design hydrology and promoting channel stability at stream crossings. Several decision support and analysis tools were developed during the project to improve and facilitate design hydrology analyses. The tools include: (1) a decision tree with web-based hydrologic analysis tools for generating design hydrology metrics under existing and future land use scenarios, (2) a tool for relating channel response potential to an appropriate level of design analysis, (3) guidance on selection of analog reaches (also referred to as reference reaches) and performing rapid geomorphic assessments of channel instability in the field, and (4) a spreadsheet tool for computing analytical channel designs that account for the full spectrum of sediment transporting events. In addition, recent studies indicate that longitudinal stream power is a useful predictor of channel changes and threats to bridges, and current advances in hydraulic analysis techniques can improve transport continuity of sediment and debris through bridge openings. This presentation will focus on hydraulic concepts and case studies for engineers and decision-makers interested in designing roadway crossings to reduce flooding and maintenance, and leveraging asset management systems by using stream geomorphic analysis to identify and prioritize bridges and culverts vulnerable to channel instability. Updated versions of the NCHRP 853 channel design and analysis tools will also be introduced.

BIOGRAPHY:
Holly Yaryan Hall is a registered professional engineer. She is pursuing a Ph.D. at the University of Georgia, where her research focuses on applied fluvial geomorphology: stream stability, sediment transport, and aquatic ecosystem restoration. Prior to UGA, Holly served 4 years as a senior member of the Water Resources Engineering team at EMH&T, where she consulted on a variety of stream restoration, floodplain, transportation, and stormwater projects. She also has 9 years of experience with the Ohio Department of Transportation, including district in-house design, statewide policy, and transportation research. Holly holds bachelor’s and master’s degrees in civil engineering from Princeton University and Colorado State University, respectively, and a master’s degree in teaching from the University of South Carolina. She has completed Levels I, II, and III of Rosgen training.
Advances in 3D CFD Modeling of Scour with Sediment Transport and in Analysis of Stream Instability and Channel Migration

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ABSTRACT:
Argonne National Laboratory’s Transportation Research and Analysis Computing Center (TRACC) is working with the Turner-Fairbank Highway Research Center in developing methods of applying 3D computational fluid dynamics (CFD) on high performance computer clusters to hydraulic problems of concern to the Federal Highway Administration (FHWA). A major focus of the work is assessment of scour at bridge foundations during flood events. Significant progress has been made in the development of 3D transient scour simulation with the addition of sediment transport.

The scour model calculation yields local erosion rates on river beds from the computed bed shear stress and turbulent kinetic energy. This type of analysis has also been applied to determining rates of bank erosion for a range of flow rates for a reach of the Maple river in western Iowa, and a new procedure for estimating bank migration has been developed. The scour model overcomes two challenges in simulating scour. The first is the moving riverbed, and the second is the large difference in the flow and scour time scales. While current CFD software has the capability to handle a variety of moving and deforming boundaries, in practice using these capabilities for scour simulation where large bed displacements occur and periodic remeshing is needed often leads to failures that require frequent human intervention to repair the computational mesh. These problems are avoided by deforming the bed as a consequence of sediment entrainment and deposition using an external Python program at intervals that correspond to a time step at the scour time scale. The presentation will include an overview of the major components and functions of the methodology and a number of examples of scour simulations with comparison to flume scour experiments.

BIOGRAPHY:
Dr. Steven Lottes is an Argonne theorist specializing in Computational Fluid Dynamics (CFD) of multiphase and reacting flows. He is currently the CFD simulation, modeling, and analysis lead at Argonne’s Transportation Research and Analysis Computing Center. He plans and coordinates CFD research on transportation applications, provides technical support to the center’s user community, develops training materials, and conducts training and technology transfer events to advance the use of CFD in solving aerodynamic and hydraulic problems that arise in maintaining and building transportation infrastructure. Dr. Lottes has extensive experience in the modeling and analysis of a variety of multiphase, reacting, and other complex flow systems. He is the author/co-author of 4 copyrighted CFD software codes including Argonne’s Glass Furnace Model that received an R&D100 Award in 2004. Dr. Lottes received a Master’s degree from Purdue University in Computer Science and a Master’s and PhD degree in Mechanical Engineering from the University of Illinois at Chicago.
Applying Temporal Bed Shear and Flow Duration Data to Determine Bankfull Width and Stream Stability

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ABSTRACT:
In order to better evaluate stream stability and the channel-forming process, the FHWA Hydraulics Research Program has developed a Computational Fluid Dynamics (CFD) modeling approach that computes shear stresses (erosion forces) on channel beds from various discharge rates. The CFD shear stress predictions are calibrated experimentally with the direct shear measuring devices in the testing apparatuses at the FHWA Hydraulics Laboratory. Applying the predicted shear stress and field erosion-rate data of the channel materials, the erosion volume from a select channel reach produced by a given hydrograph or flow duration curve can be determined. The presentation describes this concept and its applications in determining the channel forming flow. The result can be used for the prediction of bankfull width or the assessment of channel migration for stream stability related issues. Several field cases are discussed to demonstrate the capability of obtaining the temporal exceedance probabilities of “factored” bankfull widths. These reference widths can offer a better scientific basis in designing Aquatic Organism Passage in culverts by quantitatively limit the amount of time in the aquatic organisms’ life cycle that the culvert imposes an obstruction to their migration needs.

BIOGRAPHY:
Kornel Kerenyi is a hydraulics research engineer in the Federal Highway Administration's (FHWA’s) Office of Infrastructure Research and Development. He coordinates hydraulic and hydrological research activities with State and local agencies, academia, and various partners and customers, and manages the FHWA Turner-Fairbank Highway Research Center (TFHRC) J. Sterling Jones Hydraulics Research Laboratory. He was previously a research engineer at a private company and supervised support staff in the laboratory. Dr. Kerenyi holds a Ph.D. in fluid mechanics and hydraulic steel structures from the Vienna University of Technology in Austria.
Workshop C – Bulletin 17C / PeakFQ Workshop

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ABSTRACT:
Uniform and consistent techniques for estimating the magnitude and frequency of floods are needed for several purposes such as the economic design of bridges, culverts, roadways, dams and levees and for developing consistent floodplain maps to inform long-term land use planning. Considerable resources and effort have been expended over the years by Federal agencies in the United States to develop uniform national guidelines for estimating flood flow frequency including Bulletin 15 in December 1967, Bulletin 17 in March 1976, Bulletin 17A in June 1977 and Bulletin 17B in March 1982. Recently a work group of the Subcommittee on Hydrology of the Advisory Committee on Water Information developed new flood frequency guidelines, Bulletin 17C, Guidelines for Determining Flood Flow Frequency, an update of Bulletin 17B. The U.S. Geological Survey (USGS) published Bulletin 17C in March 2018 as USGS Techniques and Methods 4-B5. Although published by USGS, Bulletin 17C is an interagency report and all Federal agencies are requested to use these guidelines in planning activities involving water and land related resources. State, local, and private organizations are encouraged to use these guidelines.

Bulletin 17C continues the use of the Pearson Type III frequency distribution fitted to the logarithms of the annual maximum instantaneous peak discharge using the method of moments but major updates based on improvement in statistical procedures include:

- adoption of a generalized representation of flood data that allows for interval and censored data types,
- a new method called the Expected Moments Algorithm (EMA) that extends the method-of-moments approach for fitting the Pearson Type III distribution to interval and censored data,
- a generalized approach for identifying multiple low floods in the data set (Multiple Grubbs-Beck Test (MGBT)), and
- an improved method for computing confidence limits.

The workshop is intended to describe the new computational procedures in Bulletin 17C and demonstrate examples from Appendix 10 of Bulletin 17C using the USGS PeakFQ program (https://water.usgs.gov/software/PeakFQ/). The workshop will include:

- A brief overview of at-site flood frequency analysis – moments, quantiles, confidence intervals
- New computational procedures and concepts – flow intervals and perception thresholds, trend detection, EMA, MGBT, improvements in estimating confidence intervals and regional skew and extending flood records in time (MOVE.3)
- Examples of applying the new guidelines – illustration of perception thresholds, censoring of low floods, inclusion of historical information, estimation of regional skew
- Future work on flood frequency – the need for developing new procedures for analyzing nonstationary data

Bulletin 17C does not include procedures for analyzing nonstationary flood data due to possible changes in land use or climate. The time varying mean approach as described in FHWA Hydraulic Engineering Circular No. 17, 2nd Edition, will be described as an example of future work needed in flood frequency analysis.

The workshop could be 2, 3 or 4 hours in duration. For a 2- or 3-hour workshop, the above topics will be discussed with more detail provided in the 3-hour version. Only a couple examples of applying Bulletin 17C will be illustrated by the presenter with no computational exercises for the attendees. For the 4-hour workshop, the attendees can follow along using software on their computers. This workshop will be more interactive with a more detailed discussion of the examples and application of Bulletin 17C.
BIOGRAPHY:
Mr. Thomas is a Senior Technical Consultant with Michael Baker International in Cary, North Carolina. He reviews and performs hydrologic analyses for flood insurance studies and participates in special projects related to flood frequency sponsored by FEMA and other clients such as the Maryland State Highway Administration, the Federal Highway Administration and the Pennsylvania Department of Transportation. Mr. Thomas worked for the U.S. Geological Survey for 30 years and has worked for Michael Baker International since April 1995.

Mr. Thomas is a registered professional hydrologist with over 50 years of specialized experience in conducting water resources projects and analyzing water resources data. Mr. Thomas is the author of more than 80 papers and abstracts on a variety of surface water hydrologic topics. As an U.S. Geological Survey (USGS) employee, Mr. Thomas participated in the development of Bulletin 17B, Guidelines for Determining Flood Flow Frequency, published in March 1982 for flood frequency analysis for gaged streams. Mr. Thomas was the chair of the Hydrologic Frequency Analysis Work Group (http://acwi.gov/hydrology/Frequency/) that recently published Bulletin 17C for revised flood frequency guidelines that is an update to Bulletin 17B. The new Bulletin 17C, Guidelines for Determining Flood Flow Frequency, was published in March 2018 as an USGS Techniques Manual and is available at https://pubs.er.usgs.gov/publication/tm4B5.

Mr. Thomas received a Bachelor of Science degree in Mathematics from the University of Maryland and a Master of Science degree in Statistics from the University of Illinois.
Session: Ensuring Resiliency Through Stream Stability Countermeasures

**Rockeries in the River Environment**

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**ABSTRACT:**  
Colorado experienced an extreme flooding event in September of 2013 that ravaged canyon roadways southeast of Estes Park, CO. Central Federal Lands was asked to rebuild SH 34 and CO 43 after the floods. To minimize river encroachments in narrow canyons, roadway fill embankments must be over steepened. Using a rockery to stabilize the roadway embankment rather than traditional vertical, concrete structures was the solution; however, no analytical techniques were available for evaluating the hydraulic stability of such structures. Argonne National Laboratory was employed to estimate the hydrodynamic and contact forces by using advanced, computational fluid dynamics.

**BIOGRAPHY:**  
Veronica Ghelardi -  
Veronica Ghelardi is a registered Professional Engineer in Colorado and has 19 years of experience in hydrology and hydraulics with a MS in Water Resources from the University of Maryland. Ms. Ghelardi currently works for the Federal Highway Administration’s (FHWA) Resource Center Hydraulics Technical Service Team as a senior hydraulic engineer. She is involved in numerous activities including technology deployment, technical assistance to State DOTs, and training. Prior to this position, Ms. Ghelardi served as the Central Federal Land’s (CFL) Hydraulics Team Lead and the Federal Lands Hydraulics Discipline Champion. In her six years with CFL, Ms. Ghelardi worked in 14 western states performing hydrology, 1-dimensional and 2-dimensional hydraulic analysis for bridges, culverts, low water crossings and other hydraulic structures. Ms. Ghelardi started her hydraulics engineering career with Maryland State Highway Administration in the Structural Hydraulics Unit.

Marta Sitek -  
Dr. Sitek has been working as a member of the computational mechanics team at Argonne National Laboratory’s Transportation Research and Analysis Computing Center since 2014. She started at TRACC as a Postdoctoral Appointee and in April 2017 she became an Argonne staff member. Previously, she worked at Warsaw University of Technology Faculty of Civil Engineering as an assistant professor. In 2012-2013 she was a Visiting Researcher at the University of Michigan Civil and Environmental Engineering Department. She participated in various projects that covered development and correctness assessment of new finite element formulations, as well as FEM modeling of structures. During her time at Argonne, she gained extensive experience and expertise in CFD modeling of hydraulic engineering problems and the response of structures to storms and other dynamic loadings. She also has eight years of experience in teaching mechanics of structures and FEM courses.
**ABSTRACT:**
The Federal Highway Administration (FHWA) Western Federal Lands engineers are installing long-term stream bank protection solutions that would not only protect the highway infrastructure, but also would minimize environmental impacts. An emerging technology called "engineered logjams" (ELJs) with dolosse is used for the stream bank protection. These manmade logjams mimic those found in nature. In a natural river system, logjams typically form when a large tree falls into the water and becomes embedded in the river bottom, creating a snag that captures additional logs and debris moving downstream. Such logjams are capable of redirecting the channel and slowing the water's destructive forces. As an additional benefit, the logs and debris can create or enhance fish habitat. Dolosse concrete blocks with complex geometric shapes weighing up to 8 tons are used in great numbers to stabilize ELJ structures from stream erosive and drag forces. Experiments and Computational Fluid Dynamics (CFD) modeling conducted in the FHWA Hydraulics Laboratory investigated proposed ELJ/Dolosse installations for stream bank protection and developed design recommendations for practitioners. The paper summarizes research results and experimental and numerical modeling techniques used for this study.

**BIOGRAPHY:**
Oscar Suaznabar is a Hydraulics Research Engineer at Genex Systems with base at the FHWA Turner-Fairbank Highway Research Center (TFHRC) J. Sterling Jones Hydraulics Research Laboratory in McLean, VA. His training and experience are in the fields of bridge hydraulics, river mechanics, and bridge scour and sediment transport. He has 10 years of experience in physical and numerical modelling of bridge scour processes, bridge scour countermeasures, and stream stability problems. Mr. Suaznabar holds a M.Sc. in Water Resources Engineering and Management from the University of Stuttgart, Germany.
Implementation of Bankfull Channels, Vanes, and Weir Structures at Bridge Openings as Alternatives to Traditional Maintenance Practices

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ABSTRACT:
Scour and aggradation at bridge openings often requires maintenance to resolve issues that impact the structural integrity and capacity of the bridge. Traditional maintenance practices include grade control, armoring, and mechanical removal of sediment and debris accumulations. Current maintenance approaches can be costly and often provide only temporary resolution to the maintenance problem. As a result, ODOT sought out research to identify new practices that are: 1) more sustainable (i.e. reduce long-term maintenance frequency), 2) environmentally sensitive, 3) economical, and 4) readily implementable by county maintenance crews. A survey of problematic sites in multiple districts was conducted to better understand and categorize typical maintenance problems and identify potential sites for implementation of pilot projects. The research team worked with ODOT staff to identify alternative practices and develop plans for pilot projects through an iterative design process. In total, fifteen pilot projects were implemented including vanes and cross vane structures to improve stream channel alignment with the bridge opening, bankfull channel designs and level weir culvert retrofits to enhance sediment transport and mitigate aggradation, and a w-weir was implemented to reduce debris accumulation on a mid-channel pier. Additional research is being undertaken to monitor the sites and better understand the impact of these structures on channel hydraulics through modeling of hypothetical scenarios and numerous pilot project case studies.

BIOGRAPHY:
Jon Witter is an Assistant Professor at Ohio State Agricultural Technical Institute in Wooster, OH. His background includes education and experience in land surveying, GIS and remote sensing, and agricultural engineering with a focus on soil and water engineering. He previously worked as an applied researcher in the Department of Food, Agricultural and Biological Engineering at The Ohio State University with a focus on developing practical solutions to restore and enhance streams and agricultural drainage ditches.
ABSTRACT:
After 117 years of recordkeeping, the Ohio River watershed recorded its wettest season on record in the spring of 2011. Flooding began in portions of the basin as early as February and extended through May. During this flood event, Evansville levee incurred approximately 3000 feet of wave wash erosion along most of the riverfront of the Knight Township. To repair the eroded area, the original proposal was to excavate a foot below the wave wash zone bench, and re-compact using low permeability soils to reestablish the as-built levee to a 3.0H:1.0V slope in the lower portion of the levee. USACE requested alternate technical proposals using unconventional products to permanently repair the levee and extend this protection to within two feet of the top of the levee and either reduce, or maybe even eliminate, the riprap in the current contract. The project design engineers and USACE selected a solution using reinforced TRM that could provide an effective cost-benefit and conditions for re-establishing vegetation on the riverside levee slope. MacMat R, a reinforced TRM is made from a three-dimensional matrix of UV stabilized synthetic fibers, heat bonded at the junction, and extruded on a high tensile strength hexagonal double-twisted wire mesh. The three-dimensional polymer matrix of MacMat R helped protect the soil, seed and root system from rain splash, and hydraulically induced shear stresses while encouraging the seed germination and plant growth. Also, the steel wire mesh reinforced the slope fascia and protect against shallow surficial slope failure. As the result of this erosion mitigation solution which integrated nature-based resilience from the vegetation, the levee riverside bank has reestablished its natural look and complete recovery of the levee slope. This paper will highlight the design details of the proposed solution and discuss how overall design met the project design requirements.

BIOGRAPHY:
Sachin Mandavkar joined Maccaferri in 2005 after completing his master’s in geotechnical engineering. Mandavkar leads a team of engineering professionals and manages geosynthetic projects. He works regionally and nationally on mechanically stabilized earth structures and geosynthetics. He is a member of the American Society of Civil Engineers (ASCE), American Society for Testing Materials (ASTM International), and the Transportation Research Board’s (TRB) Earthworks Committee. Mandavkar is a registered professional engineer in Maryland.
Effective Management of Roadside Water

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ABSTRACT:
A Domestic SCAN project was recently completed on the topic of “Leading Landscape Design Practices for Cost-Effective Management of Roadside Water”. The SCAN was motivated by the state of Green Infrastructure (GI) practice in managing highway stormwater runoff. GI methods are well developed, widely documented, required in many regulatory settings, and generally encouraged by Federal Highway Administration, and yet they have not achieved a place in the designer’s toolbox of regular practice for managing highway runoff. The SCAN invited teams of non-DOT and state DOT practitioners who are successfully using GI to share their experiences. The huge variety of geographic and individual settings make it difficult, though not impossible, to provide guidance generally suitable for all DOT’s. Regional and local efforts seemed to display the greatest success in encouraging and applying GI. Based on what was learned, challenges and obstacles to more widespread adoption of GI were flagged and key elements of successful GI programs have been identified.

BIOGRAPHY:
Charles Hebson is Manager of the Surface Water Resources Division in the MaineDOT Environmental Office. He holds a PhD in Hydrology/Water Resources (Civil Engineering) from Princeton University and a ScB (Civil Engineering) from Brown University. His responsibilities include hydrology and hydraulics for transportation design with a special emphasis on field evaluations and design for fish passage as well as projects with significant water-related environmental issues. Charlie also provides technical support to ongoing policy development related to hydraulic design and fish passage as well as development of technical guidance materials for hydrology, hydraulics, and fish passage design. The Surface Water Resources Division consists of 2 engineers, 2 hydrologists, 1 program regulatory specialist, and 2 construction environmental compliance specialists.
If You Can Fit a Ditch, You Can Fit Bioretention

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ABSTRACT:
Providing post construction treatment to address both pollutant removal and volume reduction for stream stability on transportation projects can be a daunting task. Extended detention can sometimes lead to safety concerns due to footprint and standing water and many project sites do not have soil characteristics sufficient to support infiltration. Traditional bioretention cells have been designed in a basin configuration. However, ODOT has incorporated linear bioretention cells into its design guidance as well as into the design of various upcoming roadway projects. Linear bioretention cells take advantage of the ample length available on many roadway projects while maintaining a narrow footprint. Therefore, they can fit into most roadway projects that already have space for a grass ditch. This presentation will highlight the benefits of linear bioretention on roadway projects for permit compliance as well as to meet other potential environmental goals. The presentation will also discuss key design, construction, and maintenance considerations of linear bioretention near roads.

BIOGRAPHY:
Jon Prier has been working as an environmental engineer in Columbus for 12 years. He specializes in stormwater management planning, modeling, BMPs, and permit compliance and has experience working with facilities across the country. Jon works for the Ohio Department of Transportation focusing on off-site mitigation and stormwater permit requirements as well as coordinating with Ohio EPA.
**ABSTRACT:**
The NCDOT’s NPDES Stormwater Permit requires it to have a Best Management Practice (BMP) Retrofit Program, implementing a minimum of 70 stormwater BMP retrofits per 5-year permit term to provide stormwater treatment of existing impervious facilities.

NCDOT’s implementation of stormwater control measures on steeper slopes represents a challenge. A trending BMP within the stormwater profession in these scenarios is the use of regenerative riffle, step-pool conveyance systems, or as NCDOT titles them, biofiltration conveyance systems (BFC). Traditionally, construction of BFCs has involved placement of smaller stone in riffle areas, and placement of larger boulders along steeper pool slopes to prevent erosion of the system. The sourcing, selection, and placement of appropriately sized boulders has proven to be an expensive challenge during construction of these devices.

This presentation will discuss the implementation of an alternative BFC system near Patterson Creek in Olin, NC. Within the median of Interstate 77, NCDOT identified an opportunity to provide treatment of the northbound and southbound lanes of the Interstate. The existing drainage system conveyed runoff through a concrete lined channel, traversing grades exceeding 6%. Engineers from WSP and NCDOT analyzed several scenarios for implementation of stormwater control measures including more traditional detention facilities and BFCs with large boulders. To achieve the desired level of treatment, a significant amount of earthwork would have been necessary. The team developed an innovative BFC concept utilizing articulated concrete block mattresses (ACBM) in place of stone. The ACBM, in combination with an expanded slate, bioengineered soil underneath the pools provided a stable, riffle-pool sequence with internal water storage zones beneath the pools to promote infiltration into the in-situ soils and groundwater recharge. In comparison with facilities utilizing boulders, this innovative BMP required less excavation and time to install, resulting in a quick establishment time and less risk exposure.

**BIOGRAPHY:**
Everett Gupton is a Lead Water Resources Engineer in WSP’s Raleigh, North Carolina office and a credentialed project management professional who manages stormwater projects with the North Carolina Department of Transportation as well as local municipalities. Everett’s background is in green stormwater infrastructure and watershed management.
Early Returns on Statewide SCM Inspections

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ABSTRACT:
Stormwater control measure (SCM) inspections are proving to be more than a checkmark on the ever-expanding regulatory compliance checklist – they are paying dividends. The Pennsylvania Department of Transportation began a statewide program of inspecting its SCMs in the fall of 2017 with the goal of standardizing the inspection process across the state to save costs and meet regulatory requirements. The program includes new policies (e.g., inspection frequencies, procedures, and forms) and face-to-face training incorporating a mixture of classroom and field instruction. Engineering Districts are currently tasked with completing a visual screening inspection for each of the approximately 2,000 Department SCMs by the summer of 2018. As this initial wave of inspections are completed, the data collected has revealed relationships and trends for both program implementation and SCM types. Program highlights include the pronounced effect of training on the ability of inspectors to identify problems, enhancements to planning and the utilization of limited resources, and the importance of a commitment to SCM maintenance moving forward. The SCM problem types found encompassed every category from accumulations of sediment and other materials, erosion, vegetation issues, to design and structural problems. Specifically, the prolonged function of infiltration practices was wildly variable and somewhat unpredictable, dry basins from certain eras were not actually dry due to the design parameters of the time, and bioretention required the least intensive maintenance responses overall. While some of the findings may seem obvious, the data provided by the inspections helps to reiterate these points to those outside of the stormwater management orbit. Ultimately all this valuable information is being shared with the District offices and consultant engineers to improve upon future designs, construction oversight, and maintenance.

BIOGRAPHY:
Jeff MacKay is a Principal of NTM Engineering, Inc., a women-owned business headquartered in Pennsylvania that specializes in water resources, highway and bridge engineering, and technical training. Mr. MacKay earned his B.S. and M.S. in Civil Engineering from Drexel University and holds Professional Engineering licenses in Pennsylvania and Maryland. He has 17 years of experience in stormwater design, permitting, planning, and research. He is a lead instructor for three stormwater-related courses that NTM developed for PennDOT and is the lead water resources instructor for the School of PETM. Mr. MacKay developed PennDOT’s first stormwater design guidelines and policies and first manual of operation and maintenance of stormwater control measures. He is also the project manager for PennDOT’s statewide MS4 engineering support contract. Mr. MacKay became a member of Transportation Research Board’s Standing Committee on Stormwater (AFB 65) in 2017, its inaugural year. Prior to that, he was a member of the Standing Committee on Hydrology, Hydraulics, and Water quality (AFB 60).
Session: Using Innovative Tools and Methods for Improved Design

Truckee River Bridge Scour – Unique Structure and New Methods

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ABSTRACT:
Extensive roadway, bridge, and trail improvements are being made by FHWA Central Federal Lands Highway Division to Highway 89/28 in Tahoe City, California. In addition to a new bridge crossing the Truckee River, the existing Fanny Bridge, located directly downstream of the dam impounding the pristine waters of Lake Tahoe, was modified to accommodate new highway improvements. The project also included an extensive drainage system that had to balance functionality with sensitive environmental requirements. Other stakeholders included Caltrans, the Tahoe City Public Utility District, Placer County, and the Tahoe Regional Planning Agency. The new bridge crossing the Truckee River is being constructed currently and employs a unique cellular abutment design that includes shallow foundations, no piers, and two recreational bike trails that modified the grading, geometry, and hydraulics of the area. However, no adverse impact in terms of 1% water surface elevation was required. Eleven different discharges rates were evaluated. Although scour countermeasures were designed to protect bridge abutments, agencies required that the bridge footings be stable for design scour events. Bridge abutment scour was originally estimated using the more traditional HIRE and Froehlich methods. CFL requested that the relatively new NCHRP 24-20 method be employed instead. This presentation will include the nuances of the scour method and the challenges and solutions that were encountered, including the non-traditional bridge structure, unpublished HEC-18 procedures, pressure flow situations that had not yet been vetted with the NCHRP method, the realities of old bathymetric/late calibration data, and design standards from multiple agencies that were incomplete or contradictory. Through continuous coordination with CFL and stakeholder parties, bridge scour was estimated for multiple discharges and the design was approved and completed. This project received FHWA’s Corporate Award for implementing innovative solutions. Impressive static and video renderings will be shared as part of this presentation.

BIOGRAPHY:
Mr. Hartman completed his undergraduate and graduate work in Civil Engineering at Brigham Young University in 2001. He is a Certified Floodplain Manager and a registered professional engineer in several US States and Canadian Provinces. Most of his 17 years of experience has been providing quality solutions to match client needs throughout the world in drainage, flood control, hydrology, and hydraulics (including 1-D and 2-D numerical modeling), with a current focus on highway/bridge, rail, aviation, and mining projects. For the past 10 years, Mr. Hartman has worked as a Senior Technologist and technical mentor in the Salt Lake City, Utah office of CH2M, which is now Jacobs.

Personally, Brad has been an avid SCUBA diver, cyclist, backpacker, camper, and animal lover. He has traveled to many wonderful places in the world and has even learned a little Chinese. He recently got sucked into the world of Smart Home Automation and now everything in his house is controlled on his phone (for better or worse). Most importantly, Brad is a husband to Christine and father to three children.
ABSTRACT:
Estimating scour often involves assessing situations that fall outside of the standard limits under which scour prediction equations or design guidelines are developed. Typically, engineers are faced with the dilemma of (1) “forcing” the unique situation into the prescriptive equations, which can sometimes lead to unrealistic or misleading results, or (2) applying “engineering judgement” to modify the results without quantitative support. In an attempt to provide a physics based answer to these types of problems, Caltrans has an ongoing project with Stony Brook University to apply a Computational Fluid Dynamic (CFD) code, the so-called VFS-Geophysics model, to real-world scour problems. VFS-Geophysics model is an open-source and numerically robust code capable of three-dimensional hydraulic modeling of turbulence around structures with arbitrarily complex shape and simulating sediment transport processes in natural rivers. A model with such capabilities can be a valuable tool for engineers to gain a highly detailed understanding of both the turbulent flow and scour past bridge foundations. So far, this model has been used to estimate the flow characteristics and associated scour in open-channel flows at a number of real-world rivers and streams with installed bridge piers of complex geometry. The objectives of the past studies with the code include, among others: (1) , to study of the hydraulic influence of adjacent bridges piers, (2) to assess the impact of debris loading on bridge piers, and (3) to investigate highly transient, flash-flood flows in desert washes. In addition to improved scour prediction, the CFD results are also being used to provide insights to improve the design of scour countermeasures for real-world and practical applications.

BIOGRAPHY:
Kevin Flora has worked from the California Department of Transportation since graduating from Cal Poly, San Luis Obispo in 1988. He obtained a Master’s degree in Water Resource Engineering from UC Davis in 2003. For the past 23 years, he has directed the Caltrans Bridge Scour program for all state-owned bridges in California. With special interest in advanced computer modeling, Kevin has been involved with Computational Fluid Dynamic simulations for riverine flows for the past 15 years.
In-Situ Scour Testing Device for Determining Soil Erosion Resistance

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ABSTRACT:
Determining the erodibility of soils around bridge foundations is crucial to the safety of bridges over waterways. Direct measurement of erodibility of streambed material in situ would provide invaluable information for determining adequacy and efficiency of bridge foundation design. In-situ scour testing devices have inherent advantages attributed to their direct application to undisturbed soils that can avoid potential property change and time consumption caused by excavation and transportation of samples for laboratory testing. The FHWA has been developing the In-situ Scour Testing Device (ISTD) to determine the erodibility of soils under a well-controlled condition. The ISTD is comprised of an innovative erosion head, measuring sensors, pumps, and piping that enable flowing water to erode soil in situ. The device is placed within a standard geotechnical soil casing (pipe), which in turn, resides inside a hollow-stem auger. Both casing and auger are driven into the ground by a conventional geotechnical drill rig. Care is taken so that the casing does not disturb the soil to be tested. Water circulated through ISTD produces a high-speed horizontal flow over the exposed soil surface inside the casing at any designated depth and erode the soil in the casing. As erosion proceeds, the ISTD is automatically lowered to maintain a constant gap between the erosion head and the soil surface. The speed of the descending erosion head represents the soil erosion rate. The flow rate and the constant gap are translated into a shear stress by calibrating the ISTD with a fine-tuned standard laboratory erosion device. In a field erosion test, several pairs of erosion rate and shear stress data are collected by ISTD for each depth of interest. The critical shear stress is then determined by extrapolating a curve fit to these data pairs (minimum of 4 pairs, preferably 5 or more) to a ‘zero’ erosion rate. The ISTD can thereby define the erosion resistance of all soil strata within the scour zone (cohesive and non-cohesive). This information can be used with the decay function of hydraulic shear to determine the scour depth. This is the basis of FHWA’s Scour Depth Equilibrium State design approach which will greatly improve the accuracy of bridge scour estimates. About a dozen field tests have been conducted to validate the technology. The ISTD was successfully demonstrated to a panel consisting of hydraulic, geotechnical, and structural engineers in Virginia, United States in November 2017. A continuous deployment and demonstration phase of the ISTD is planned for the next two years. The ISTD is expected to become a convenient tool for bridge foundation design.

BIOGRAPHY:
Dr. Haoyin Shan is the ISTD Project Manager at Genex Systems and is based out of the Hydraulics Laboratory of FHWA Turner-Fairbank Highway Research Center (TFHRC) in McLean, VA. He specializes in bridge hydraulics, scour, sediment transport and soil geotechnical testing. His current work includes demonstrating the In situ Scour Testing Device (ISTD) across 20 U.S. states and conducting erosion tests of cohesive soils using the Ex situ Scour Testing Device (ESTD). He is a registered Professional Engineer in VA and holds a Ph.D. degree in Civil Engineering from the University of Nebraska-Lincoln.
ABSTRACT:
The Federal Highway Administration (FHWA) has promoted the use of two-dimensional (2D) modeling for floodplain and bridge hydraulic analysis for many years, and in recent years adopted the US Bureau of Reclamation (USBR) SRH-2D model, due to its advanced modeling capabilities. Several new hydraulic structure features have been incorporated into the model for evaluating hydraulics at culverts, bridges in pressure flow, and many other cases. FHWA also sponsored the development of a custom graphical user interface in the SMS software package, which has a free community version available. The SRH-2D model and custom interface provide a powerful tool for analyzing complex hydraulics and clearly communicating results to others.

SRH-2D ‘stands-out’ in comparison to other 2D models in several key areas. It uses a hybrid irregular-mesh that accommodates arbitrarily shaped cells. A combination of quadrilateral and triangular elements may be used with varying densities to obtain the desired detail and solution accuracy in specific areas of interest without compromising computing time. It uses an implicit numerical solution scheme that is impressively robust and stable, and it models shallow flow and trans-critical flow transitions with ease. In addition to bridge modeling capabilities, SRH-2D can also model 2D sediment transport. These capabilities make SRH-2D the model of choice for projects that require detailed 2D results at in-stream structures and accurate flow distribution in the overbanks. FHWA recommends SRH-2D as one of the tools in every engineer’s toolbox for modeling detailed hydraulics around bridges and other structures.

This presentation will provide an overview of the benefits of modeling complex bridge hydraulics with SRH-2D and the latest developments for evaluating bridge scour and assessing floodplain and floodway limits.

BIOGRAPHY:
Mr. Hogan has spent his entire 25-year career working in the field of hydraulics and river engineering. He is currently a Senior Hydraulic Engineer with the FHWA Resource Center in Fort Collins, CO, and has previously served as the Hydraulics Team Lead for the Central Federal Lands Highway Division for 7 years, and 15 years in consulting engineering prior to that. Mr. Hogan specializes in bridge hydraulic modeling and design, scour analyses, sediment transport, counter measure design, and floodplain analysis. For more than 20 years he has been an instructor for several hydraulics training courses through FHWA National Highway Institute (NHI), including 1D modeling with HEC-RAS, 2D modeling with SRH-2D, Hydraulic Design of Culverts, Hydraulic Bridge Design, and Countermeasure Design. He has a sincere passion for hydraulic engineering and advancing the state of our practice.
**Session: Stormwater Management II**

**SMS and Permitting**

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**ABSTRACT:**
The transition from 1D modeling to 2D modeling with SMS-SRH2D has greatly improved the graphics and visualization of the hydraulic parameters in design. The visualization tools in SMS allow CFLHD to create descriptive figures for project permits that better communicate the impacts of a proposed project and help streamline the permitting process as a whole. This presentation will show the differences in 1D and 2D visualization as it relates to permitting and will show examples/testimonials from past projects identifying the benefit of 2D visualization in the permitting process.

**BIOGRAPHY:**
Ms. Frye is a Hydraulic Engineer with the Central Federal Lands Highway Division in Lakewood, CO. Megan has over six years of experience working as a Hydraulic Engineer for both with Central and Western Federal Lands. In this position, she provides hydraulic design recommendations on highway and bridge projects through and accessing some of the most iconic Federal Lands in the Western U.S. Megan is registered as a Professional Engineer in Washington, has a Master’s of Science in Water Resource Engineering from the University of Minnesota, and a Bachelor’s in Civil Engineering from Carroll College (Montana).
FDOT’s Approach Toward Integrated Water Resource Planning

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ABSTRACT:
In the past, little if any, consideration was given to watershed and wetland restoration efforts that are managed through local municipalities and environmental permitting agencies. The FDOT has typically pursued costly land purchases to construct stormwater management and floodplain compensation sites to mitigate for large roadway expansion projects. This approach has been successful in addressing the presumptive stormwater management criteria; however, the proposed solution often overlooks and ignores the overall resource needs within the associated watershed. More recently, the FDOT has been approached by other agencies to assist with more worthwhile restoration initiatives that expand the benefits of the stormwater management facilities to include larger areas as opposed to only serving the roadway right-of-way. The FDOT has partnered with various Water Management Districts (WMDs) and Local Municipalities to seek more innovative stormwater management strategies that address more diverse needs and concerns, both now and in the future. This coordination has produced several cooperative partnerships to address regional watershed solutions related to the following initiatives: wetland and habitat restoration/preservation, flood control, future water supply needs, water re-use and harvesting and creative coastal stormwater management systems to serve as barriers against saltwater intrusion from sea level rise throughout Florida.

BIOGRAPHY:
Mr. Spirio currently serves as the State Drainage Engineer for the Florida Department of Transportation. He has 30-years of overall work experience, 16-years with FDOT and 14-years in the Private Industry. Additionally, Mr. Spirio serves on AASHTO’s Technical Committee on Hydrology and Hydraulics, which consists of 24 States and representatives from FHWA and AASHTO. This Committee identifies research needs and develops design guidance to improve the current practices within the drainage industry.
**ABSTRACT:**
NCDOT’s NPDES stormwater permit requires the Department to develop and implement a research plan with support from state universities and other independent institutions for the purposes of improving the treatment and management of stormwater runoff. Over the past 15 years NCDOT has sponsored over $10M in stormwater-related research to better understand pollutant loading from its transportation facilities and how to best to manage it. This presentation will provide a high level overview of a wide variety of NCDOT’s construction and post-construction stormwater research projects and how the findings are being used to improve project delivery. The presentation will also include a discussion of NCDOT’s recent research data contributions to the National Highway Runoff Database and a sneak peek into NCDOT’s plans to integrate the FHWA/USGS Stochastic Empirical Loading and Dilution Model (SELDM) into the project development process.

**BIOGRAPHY:**
Andy McDaniel is the manager of NCDOT’s Highway Stormwater Program which was created in 1998 to coordinate compliance activities for the Department’s statewide NPDES Phase I permit. Andy oversees the work of the program’s staff and consultants who implement a diverse array of management measures ranging from BMP retrofits, stormwater research, TMDL compliance, and post-construction stormwater management policy. Andy participates on a number of advisory committees at the national and state level including the TRB Standing Committee on Stormwater (AFB65), AASHTO’s Stormwater Management Community of Practice, the NC Nutrient Scientific Advisory Board and the NC Nutrient Criteria Implementation Committee. Before joining the NCDOT in 2004 Andy worked in private consulting specializing in watershed-based planning, and prior to that with the NC Division of Water Quality in the Modeling and TMDL Unit. Andy is a registered professional engineer in NC.
TMDL Alternatives: A Non-regulatory Approach Success Story in North Carolina
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ABSTRACT:
In 2011 EPA Region IV was on the verge of approving the third impervious cover limitation TMDL in North Carolina. The draft TMDL proposed using impervious cover as a surrogate for the unknown stormwater-related pollutants believed to be impairing water quality in Little Alamance Creek. The draft TMDL would cap impervious cover at 10% throughout the 16 square mile watershed. Local municipalities and NCDOT were concerned that this regulatory approach, enforceable through NPDES stormwater permits, could jeopardize future development and transportation projects in the area. A TMDL alternative was needed which would facilitate a holistic approach to watershed management and allow for planned economic development as well as water quality restoration. Recognizing a collaborative effort was needed, NCDOT formed a partnership with the City of Burlington and the City of Graham with the goal of developing and implementing an alternative approach to the proposed TMDL. This partnership, known as the ‘Little Alamance Creek Healthy Streams Cooperative’, used EPA guidance to develop a Category 4b Demonstration Plan for the watershed. The Plan demonstrates that a coordinated, non-regulatory approach for restoring water quality standards in Little Alamance Creek can be used as an alternative to the TMDL. The Plan was reviewed and approved by the NC Department of Environmental Quality and EPA Region IV in 2015 with the EPA commenting: “This collaborative effort by the Cities and DOT is a good example of how locals can effectively address priority waters and we support development of similar 4b demonstrations as alternatives to TMDLs in North Carolina.” This presentation will provide an overview of how NCDOT approached the developed of a successful, non-regulatory alternative to a TMDL and will highlight the unique outreach and reporting website that is maintained by the project partners at www.littlealamancecreek.com.

BIOGRAPHY:
Andy McDaniel is the manager of NCDOT’s Highway Stormwater Program which was created in 1998 to coordinate compliance activities for the Department’s statewide NPDES Phase I permit. Andy oversees the work of the program’s staff and consultants who implement a diverse array of management measures ranging from BMP retrofits, stormwater research, TMDL compliance, and post-construction stormwater management policy. Andy participates on a number of advisory committees at the national and state level including the TRB Standing Committee on Stormwater (AFB65), AASHTO’s Stormwater Management Community of Practice, the NC Nutrient Scientific Advisory Board and the NC Nutrient Criteria Implementation Committee. Before joining the NCDOT in 2004 Andy worked in private consulting specializing in watershed-based planning, and prior to that with the NC Division of Water Quality in the Modeling and TMDL Unit. Andy is a registered professional engineer in NC.
Session: Culvert Durability and Rehabilitation for Resiliency

_Basics of Culvert Durability_

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_ABSTRACT:_
Understanding the corrosion and environmental degradation processes for installed culverts is necessary for the selection of culvert materials and protective coating to ensure installed culverts meet specified design service life requirements. This paper presents an overview of important factors for assessing the durability of installed culverts. Degradation mechanisms will be discussed, as will products developed to retard these degradation mechanisms.

_BIOGRAPHY:_
Kevin White is the water resources group manager for E.L. Robinson Engineering. He has spent his entire 26-year career working in the fields of hydraulics, hydrology, water quality and pipe mechanics which included 10 years with Ohio DOT. He has a master of science degree in civil engineering and is currently pursuing his PhD at Ohio University. He is an emeritus member of TRB committee AFS40 on Subsurface Soil-Structure Interaction.
Re-rounding of Thermoplastic Conduit Under State Route 150 in Jefferson County, Ohio

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ABSTRACT:
Re-rounding is a rehabilitation method applied to newly installed flexible thermoplastic conduits with significant deflection (>7.5%) and no structural defects such as cracks or buckling. Re-rounding involves the internal vibration of the conduit while applying pressure against the conduit internal wall. Contractors claim re-rounding consolidates backfill and restores the round shape to the conduit. Re-rounding is utilized by Contractors due to the implementation of Ohio Department of Transportation (ODOT) Construction and Materials Specification 611, a performance-based conduit installation specification permitting conduit repair to ensure the vertical deflection is less than the maximum allowable value of 7.5%.

A severely deflected 36 in (91 cm) nominal diameter thermoplastic pipe buried 12 ft (3.6 m) under State Route 150 in Jefferson County, Ohio, was measured before and after re-rounding in Winter and Spring 2016. The vertical diameter after installation and before re-rounding was 29.5 in (75 cm), indicating a deflection of -18.06%, a magnitude exceeding the Ohio Department of Transportation criterion for severe deflection (7.5%) by a factor of 2.4. After re-rounding, the deflection was reduced to -1.25%, a decrease in magnitude of 93.08% from the initial deflection and now only 16.67% of the severe deflection criterion. Other deflection measures also showed substantial improvement. In addition, cone penetrometer test soundings were recorded before and after re-rounding at locations directly above and on either side of the pipe. A comparison of the soil profiles showed some rearrangement and homogenizing of the soil layers. Profilometer readings were used to measure the pipe circumference at selected locations through the pipe after re-rounding.

BIOGRAPHY:
Professor Sargand earned his PhD in civil engineering from Virginia Tech in 1981. He subsequently joined the civil engineering department of Ohio University’s Russ College of Engineering and Technology, and was named Russ Professor in 1990. He has authored over 290 journal articles, conference papers, and technical reports. He is the Associate Director of the Ohio Research Institute for Transportation and the Environment. His areas of research interest and expertise include geotechnical engineering, drainage structures, thermoplastic pipes, steel and concrete conduit, flexible and rigid pavements, nondestructive infrastructure test methods, quality assurance/quality control, and finite element modeling. He has received several nationally recognized awards and honors for his research, including the D.R. Harting Award of the Society of Experimental Mechanics in 1992 and 1999. Professor Sargand’s studies have delivered substantial value to industry and government sponsors.

Dr. Sargand’s projects on pipes and drainage include a long-term study of the performance of deeply buried thermoplastic pipes, which has continued for two decades. He developed a method for inspecting and evaluating the condition of pipes and culverts in the field for the Ohio Department of Transportation. He also contributed laboratory test results and finite element modeling of thermoplastic pipes with recycled content for NCHRP Project 04-39, and is investigating the performance of concrete pipe reinforced with synthetic fibers.
Structural Rehabilitation of Invert-Deteriorated Metal Culverts Through Field Concrete Paving

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ABSTRACT:
Across many areas of the U.S., the invert regions of metal culverts are deteriorating due to chemistry and abrasiveness of the drainage flow. Field invert concrete paving has been used over the years by state DOTs to repair these metal culverts when total replacement is not an option. Through this culvert rehabilitation method, the hydraulic function of the drainage structure is restored, but its benefit to the culvert is often unknown to the engineers from the structural standpoint.

A comprehensive study was completed recently by the authors for Ohio Department of Transportation (ODOT). The main goal of the study was to examine how the field concrete paving can rehabilitate the invert-deteriorated metal culverts structurally. To meet this goal, the authors carried out a series of full-scale field load tests. The test data gathered showed clearly and repeatedly that invert paving can restore the weakened metal culverts structurally. In the study, the authors also examined the current AASHTO LRFD design methods and proposed a design procedure that can be used to analyze invert-deteriorated metal culverts and specify how much steel reinforcement may be needed for field invert paving.

BIOGRAPHY:
Dr. Masada is a professor of Civil Engineering at Ohio University. Prior to attaining his doctoral degree, he had three years of industry experience at a consulting firm in Dayton, Ohio. Over the past 25+ years, he conducted several culvert-related research projects for Ohio DOT. Dr. Masada has published nearly fifty (50) professional journal papers, over twenty (20) technical reports, and over thirty (30) technical conference papers. Dr. Masada has been serving the ASCE Journal ‘Pipeline Systems Engineering & Practice’ as Associate Editor for several years.
ABSTRACT:
Drainage infrastructure systems (culverts, storm sewers, outfall and related drainage elements) represent an integral portion of Department of Transportations’ (DOTs) assets that routinely require inspection, maintenance, repair and renewal. These systems are buried and often out of public view unlike other assets such as pavement or bridges. Failure of these systems is costly due to unbudgeted expenses for infrastructure repair or replacement often resulting in an emergency project that is more costly than a planned and budgeted project. Impacts to the travelling public contain a cost due to lost time and in some cases fatalities have been experienced. Therefore drainage infrastructure systems are in need of special attention in terms of proactive/preventive asset management strategy. Asset management strategies for drainage infrastructure is being developed and implemented by DOTs in an effort to reduce emergency projects and impacts to the travelling public. While these efforts contain asset inventory and condition assessment, they also contain cost effective rehabilitative methods to extend asset service life. This presentation will include a status update of this unique two-year research, started in December 2017, with primary objective of developing design equations for structural renewal of gravity storm water conveyance culverts using spray applied pipe liners (SPAL) for both cementitious and resin-based materials and for circular and arch shapes. These design equations will use loading as detailed in the AASHTO LRFD Bridge Design Specifications and will be applicable for round, elliptical, egg, and box shapes. All parameters of the host culvert that may impact the design thickness such as vertical or horizontal deflections, unsymmetrical racking, section loss, cracks, material geometry (corrugations), or protrusions such as bolts and flanges will be considered. Additionally, practical limitations on the use of these design equations will be included.

BIOGRAPHY:
Dr. Mohammad Najafi, P.E., F. ASCE, is Director of the Construction Engineering and Management Area and Director of the Center for Underground Infrastructure Research and Education (CUIRE) at the Department of Civil Engineering at The University of Texas at Arlington. He completed his Ph.D. in Civil Engineering from Louisiana Tech University and M.S. and B.S. both in Civil Engineering from Purdue University and Texas Tech University respectively. From 1976 to 1987, he worked with several construction companies on multi-million dollar projects. From 1990 to 1993, he was Program Manager of the Trenchless Technology Center (TTC) at Louisiana Tech University. From 2002 to 2006, he was Assistant Professor of Construction Management, Adjunct Professor of Civil Engineering and Director of the CUIRE at Michigan State University. He is founder and Editor-in-Chief of ASCE Journal of Pipeline Systems. His interest area is in infrastructure asset management and innovative technologies for underground infrastructure construction and renewal. He is active with American Society of Civil Engineers (ASCE) in developing several manuals of practices and guidelines specifications. Dr. Najafi is author of the several books and has published more than 100 papers, and several manuals on various aspects of trenchless technology and has held short courses and engineering and inspection schools, and made presentations at major conferences. He currently serves as the past chair of the Executive Committee of the Pipeline Division, American Society of Civil Engineers (ASCE). He is an officer of the Utilities and Asset Management Committee (F-36) of the American Society for Testing Materials (ASTM), member of the AFB70 (Utility Committee) and Expert Task Group for SHRP 2 Projects R01-B&C of the Transportation Research Board, an academic member of the Construction Industry Institute (CII) at the University of Texas at Austin, a faculty advisor and board member of Underground Construction Technology Association (UCTA), and a No-Dig Program Committee member of the North American Society for Trenchless Technology (NASTT). He is a member of American Water Works Association (AWWA), Deep Foundations Institute, Water Environment Federation (WEF), NACE International, and a founding member and currently Vice Chair of the International Society for Underground Freight Transportation (ISUFT).
ABSTRACT:
According to ASCE, capital investment needs for the nation’s wastewater and storm water systems are estimated to total $298 billion over the next twenty years. Specifically, there is growing recognition that many of the hundreds-of-thousands of corrugated metal culverts used to convey storm water across embankments and roadways will be approaching the end of their useful service life over the next 20 years. Asset owners and engineers around the world are in search of cost-effective and environmentally friendly solutions that solve these infrastructure challenges. This paper reviews a geopolymer mortar system that has been used internationally since 2011 for trenchless rehabilitation of storm and wastewater conveyance infrastructure. The system is spray cast either by rotary nozzle or via traditional shotcrete delivery systems placed inside the existing structures to create a new structure. This paper will report observations made during an extensive laboratory testing program, consisting of geopolymer-mortar lined CMP and RCP host pipes specimens. The test specimens featured various liner thicknesses, pipe diameters and pre-loading conditions. The observed test data was compared with design predictions made using published engineering models.

BIOGRAPHY:
Joe Royer is currently the Research & Development Manager for all of Milliken Infrastructure Solutions Product lines. Joe has been with Milliken for 16 years in various technical and leadership roles.

Joe holds degrees a B.S. in Chemical Engineering from the University of Notre Dame (’95) and a Ph. D. in Chemical Engineering from North Carolina State University (’00).

Joe has written numerous papers and presented design details for structural pipe rehabilitation systems using geopolymer mortars. In addition to this structural knowledge, he has supervised installations in the U.S., Hong Kong, Bolivia, Canada and Eastern Europe.
Session: Stormwater Management 3

Evaluating Runoff Controls for Stormwater Pollution Prevention Plans

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ABSTRACT:
Runoff control practices (i.e., ditch checks, inlet protection practices, and silt fence) have long since been key components for controlling construction site stormwater runoff; nonetheless, many fail to perform in the field as intended. Runoff controls are temporary stormwater control measures used to convey and slow stormwater, retain captured sediment on-site, and discharge stormwater runoff at a controlled rate. The effectiveness of a runoff controls depend on many factors (i.e., design storm, site topography, material properties, and longevity requirements), all of which need to be considered when developing, implementing, and maintaining a stormwater pollution prevention plan. This presentation will cover on-going research efforts being performed at the Auburn University – Erosion and Sediment Control Testing Facility (AU-ESCTF). The AU-ESCTF was designed and constructed through a research collaboration with the Alabama Department of Transportation (ALDOT). Over the years, the facility assisted ALDOT and other state departments of transportation with research, product evaluation, and training associated with erosion and sediment control practices commonly used in construction. The AU-ESCTF is a 2.5-acre facility that is dedicated to large-scale, performance based testing of ditch checks, inlet protection practices, sediment basins, and sediment barriers. The focus of this presentation will provide an overview of research performed on runoff control practices commonly employed on construction sites.

BIOGRAPHY:
Wesley C. Zech is the Brasfield and Gorrie Professor of Construction Engineering and Management at Auburn University. He earned a B.S. (1999), M.E. (2000), and a Ph.D. (2004) from the University at Buffalo. He has been at Auburn University since 2004 and has conducted external research in collaboration with the Alabama Department of Transportation (ALDOT) that led to the development of the Auburn University Erosion and Sediment Control Testing Facility (AU-ESCTF). The AU-ESCTF has the capability of assisting ALDOT and other state departments of transportation with research, product evaluation, and training associated with erosion and sediment control practices commonly used in construction.

His research has focused on the evaluation of silt fence tieback practices; the use of polyacrylamide as an erosion and sediment control measure; the performance evaluation of various hydromulches, ditch checks, inlet protection measures, perimeter controls, and sediment basins; and assessing the in-field performance characteristics of sediment basins. Many of the research results from these efforts have been adopted as standard erosion and sediment control practices used on highway construction projects in the state of Alabama.
Design, Construction, and Calibration of an Apparatus for Large-Scale Testing of Catch Basin Inserts (CBIs)

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ABSTRACT:
As stormwater runoff flows over impervious surfaces, it suspends and transports various pollutants (i.e., fertilizer, oils and gas, soil, etc.) from their original location and conveys them into municipal separate storm sewer systems (MS4s) that will eventually discharge into lakes, rivers, and other bodies of water. Pollutants harm waterways and are known as nonpoint source (NPS) pollutants, or pollutants that come from many diffuse sources (EPA 2016). Since NPS pollutants threaten our national waterways, the Environmental Protection Agency (EPA) regulates effluent runoff conveyed by municipalities to ensure that it meets acceptable water quality standards before being discharged back into the surrounding environment. Most municipalities have developed stormwater management guidelines to ensure compliance with these EPA standards, including allowable methods and practices to remove pollutants from stormwater influent flowing into MS4s and prior to discharge.

Catch basin inserts (CBIs) have become an increasingly popular option for pollutant removal from stormwater because they are cost effective and can be manufactured to fit into existing systems for easy installation. However, limited data is available to demonstrate the actual, in-field performance of various CBIs to ensure that these practices meet the pollutant removal standards set forth by the EPA. This study, conducted in collaboration with the Ohio Department of Transportation covers the design, construction, and calibration of a large-scale testing apparatus to evaluation CBI performance. The purpose of the testing apparatus is to provide a means of collecting realistic CBI performance data that is used to validate the ability of a product to reduce sediment concentrations to a level consistent with EPA regulations before stormwater runoff enters the MS4. CBIs are tested and evaluated for pollutant removal efficiency and TSS reduction.

BIOGRAPHY:
Wesley C. Zech is the Brasfield and Gorrie Professor of Construction Engineering and Management at Auburn University. He earned a B.S. (1999), M.E. (2000), and a Ph.D. (2004) from the University at Buffalo. He has been at Auburn University since 2004 and has conducted external research in collaboration with the Alabama Department of Transportation (ALDOT) that led to the development of the Auburn University Erosion and Sediment Control Testing Facility (AU-ESCTF). The AU-ESCTF has the capability of assisting ALDOT and other state departments of transportation with research, product evaluation, and training associated with erosion and sediment control practices commonly used in construction.

His research has focused on the evaluation of silt fence tieback practices; the use of polyacrylamide as an erosion and sediment control measure; the performance evaluation of various hydromulches, ditch checks, inlet protection measures, perimeter controls, and sediment basins; and assessing the in-field performance characteristics of sediment basins. Many of the research results from these efforts have been adopted as standard erosion and sediment control practices used on highway construction projects in the state of Alabama.
**Characterizing Particle Size Distribution and Trash in Stormwater Runoff from Ohio Roads**

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**ABSTRACT:**  
Ohio Department of Transportation (ODOT) is required through its National Pollutant Discharge Elimination System permit to utilize post-construction best management practices (BMPs) which provide a minimum of 80% total suspended solids (TSS) removal. However, without knowledge of the particle size distribution (PSD; or the full range of sand, silt, and clay particle sizes) in untreated stormwater, it is impossible to predict sediment trapping within these BMPs. Gross solids, or trash and debris greater than 0.25 inches in diameter, are also important since they often clog BMPs or provide refuge for disease vectors.

To quantify runoff PSD and trash, 12 urban road sites were selected for stormwater runoff sampling. Between twelve and eighteen storm events were sampled at each site using automated samplers to collect flow-proportional, composite runoff samples. Samples were analyzed for TSS and PSD using a Beckman-Coulter 13-320 laser diffraction particle size analyzer. Trash samples were collected approximately weekly in purpose-built metal baskets inserted into catch basins. Results of field sampling for PSD and TSS will be discussed in the presentation. The PSDs will be compared against standard laboratory testing procedures, including the New Jersey Department of Environmental Protection’s procedures for assessment of hydrodynamic separators, which require a test sediment median particle diameter of 75 μm. TSS concentrations for the twelve sites were low compared to past research on road runoff. Natural vegetation made up the vast majority of the weight and volume of the gross solids. Cigarettes, plastic, wood, paper, and gravel were relatively minor contributors (that is <10% apiece) to the overall gross solids volume. This project will inform ODOT’s BMP selection to meet 80% TSS removal in space-constrained right-of-way sites.

**BIOGRAPHY:**  
Dr. Ryan Winston is a Research Assistant Professor in the Department of Food, Agricultural, and Biological Engineering at the Ohio State University. For the past decade, his research has focused on hydrologic and water quality improvements provided by Low Impact Development (LID) strategies, with particular interests in bioretention, permeable pavement, and highway runoff management. The project he will be discussing today identified the size of particulate matter in stormwater runoff and determined trash loads to ODOT-owned sewers. The goal is to use the data to properly size stormwater control measures.
ABSTRACT:
Bank erosion is often the result of hydraulic phenomena which cannot be reproduced in a one-dimensional (1D) numerical models such as HEC-RAS. Historically, the results of 1D hydraulic modeling results or hand calculations have been used in conjunction with equations or rules of thumb to approximate the erosive forces applied around bends or piers. The use of small scale two-dimensional (2D) hydraulic modeling can provide more accurate insight into the root cause of erosion and provide a useful tool for evaluating alternative designs. This presentation follows a case study in which 2D modeling was used to evaluate and design a solution to a rapidly eroding bank along the Great Miami River which was undermining an industrial process water outfall. Conventional erosion protection measures such as gabions had not been successful and were actively failing. Instead, a range of alternative strategies were considered for protecting the outfall, including sheet pile walls, bank stabilization with bendway weirs and relocation of the outfall. The 2D model was used to determine the effectiveness of the preferred alternative and refine the optimal geometry to create a stable and cost efficient solution which has remained stable since its construction. The presentation will also include other project examples of the integrated use of 2D modeling in design.

BIOGRAPHY:
Daniel Hoffman obtained his BS and MS in Civil Engineering from the University of Cincinnati in 2007 and 2009. He has worked as a Professional Engineer at Stantec Consulting in Cincinnati, Ohio for the past 9 years. Mr. Hoffman has experience in a wide range of water resource engineering projects, but has developed an expertise in hydrologic and hydraulic analysis using 1D and 2D modeling software.
ABSTRACT:
Climate change predictions for Ohio include increased storm and drought frequencies and intensities, which may significantly alter the physical and chemical characteristics of acid mine drainage (AMD) systems. However, the effects of climate change on AMD streams are not well documented, limiting resource managers in their ability to design treatment systems able to handle future AMD flows. Storms may affect AMD generation by increasing sulfide mineral dissolution rates or altering oxygen availability, and these changes ultimately increase or decrease, respectively, the concentration of contaminants in the stream. Eventually, acidity may be diluted to allow the pH to recover to near-neutral conditions, causing iron hydroxide to precipitate onto the substrate. Nutrients, particularly phosphate, may become immobilized by sorption to or complexation with precipitating metal hydroxides. These processes impair biofilms, the primary autotrophic component of AMD systems, through habitat degradation, smothering, and scouring. This study investigates the potential effects of climate change on an AMD-impaired stream, Hewitt Fork, by measuring sediment, nutrient, and biofilm dynamics during normal, storm, and drought conditions. Because of the Carbondale Doser active calcium oxide treatment system, Hewitt Fork has a water quality gradient ranging from impaired to recovered. Seven sampling sites across this gradient will show how the stream responds to storm and drought events. Nutrient concentrations are measured as nitrate, sulfate, and total reactive phosphorus. Sediment transport is measured by quantifying sediment deposition and total suspended solids. The biological response to these conditions is measured by comparing suspended and benthic biofilm abundance, quantified as chlorophyll a concentrations. Coupled with long-term meteorological, discharge, and chemistry data, the results of this study will be analyzed using time-series and multiple regression analyses. The results of this study can be used to prioritize restoration projects and facilitate efficient, cost-effective treatment design with hydrologic climate change.

BIOGRAPHY:
Jennie Brancho is currently a second-year Master of Science student in the Environmental Studies Program at the Voinovich School of Leadership and Public Affairs at Ohio University. Jennie received her Bachelors of Science in Environmental and Conservation Biology from Kent State University. Her research interests focus on water quality and water resource management. For the past few years, Jennie has worked in nonprofit watershed management, currently serving as a Research Assistant with the Voinovich School and Raccoon Creek Partnership.
Session: Advanced Hydraulic Modelling

Two-Dimensional Hydraulic Modelling with Tidal Boundary Conditions

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ABSTRACT:
Hoyle, Tanner & Associates, Inc. (Hoyle, Tanner) has prepared a Two-Dimensional (2D) Tidal Case Study for Bridge #2183 carrying US 1 over the Cousins River in Yarmouth and Freeport, Maine. Hoyle, Tanner developed a base hydraulic model for this bridge under a separate contract with the Maine Department of Transportation for preliminary engineering services to evaluate bridge replacement alternatives. The purpose of the Case Study was to summarize the relevant findings of the two-dimensional analysis prepared for this project as it pertains to Every Day Counts, Round 4 (EDC-4) and the Collaborative Hydraulics: Advancing to the Next Generation of Engineering (CHANGE) initiative.

The Cousin’s River Bridge is a tidal influenced crossing that rarely experiences wave-action. Within 200-feet upstream of the Cousins River Bridge crossing a confluence and two interstate bridges are found which would be challenging to accurately represent utilizing one-dimensional modelling. Therefore, an existing and proposed conditions steady and unsteady state two-dimensional model was developed using the US Bureau of Reclamation (USBR), SRH-2D (Sediment and River Hydraulics, Two-Dimensional) numerical model. Aquaveo’s Surface-water Modeling System (SMS) version 12.2 was utilized to develop the hybrid mesh and parameters (boundary conditions, manning’s n, etc.) needed to run the SRH-2D models. The existing conditions SRH-2D model was calibrated based on field measurements taken on October 10, 2017. The measurements included velocity and water surface elevations at the Cousins River Bridge. The downstream tidal boundary condition utilized NOAA’s Portland, ME station which was adjusted to account for the geoid. The calibrated existing model domain included the Pratt Brook, Cousins-Pratt confluence, multiple tidal tributaries, Royal River, and Cousins-Royal confluence. The calibrated existing conditions model was utilized to develop the proposed conditions models to determine; the low chord elevation, scour depths, changes in water surface elevations (if any) during a typical tide, and counter measure design.

This presentation will provide attendees with a summary of developing a SRH-2D model that has tidal-influenced boundary conditions, what may need to be considered during model development, how to calibrate a 2D model with regards to mesh density, time step, and manning’s roughness, and discuss the benefits of 2D modelling.

BIOGRAPHY:
Jeff DeGraff is a Hydraulic/Structural Engineer with Hoyle, Tanner & Associates. He has a BS and MS in civil engineering from Clarkson University. Jeff’s graduate work focused on researching, programming and modeling 3D hydrodynamic dispersion and physicochemical processes of naturally occurring and accidental underwater gas (CO2 & CH4) releases in the ocean. His design and work experience includes developing steady/unsteady one- and two-dimensional riverine models to size culverts and bridges, two-dimensional sediment transport models, designing energy dissipaters, and performing scour analyses and countermeasure sizing for new and existing bridges. He is a registered professional in Vermont but also has experience in New Hampshire, Maine, and Massachusetts.
Right Sizing The I-69 Bridge over the Ohio River at Evansville, Indiana

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ABSTRACT:
The Kentucky Department of Transportation and the Indiana Department of Transportation is improving I-69 at Evansville Indiana which includes a new bridge crossing of the Ohio River. The Ohio River at this location is 0.5-mile wide with a floodplain that expands to 3-miles with an extensive meander within the reach. One of the considered I-69 alignments has a curvilinear configuration that is not perpendicular to flow. To further complicate the bridge opening selection, Indiana allows a maximum backwater of only 0.15-feet without obtaining flood easements while Kentucky allows 1-foot of flooding. Locating bridges in the overbank areas to limit backwater to 0.14-feet is expensive but so are easements to allow a 1-foot backwater. The challenge was to find a bridge configuration to optimize the cost of the project.

The project team used SMS’s SRH2D to supplement the extensive HEC-RAS modeling that has been conducted on the Ohio River in a 10-mile reach centered on Evansville, Indiana. The HEC-RAS model was then adjusted to match the SRH2D flow splits and approximate water surface elevations for each alternative to determine the extent of flooding.

During model development, the hydraulic impacts were causing significant impacts as shown in the SRH2D and resulted in reconfiguration of the interchange. The impacts went 20 miles upstream. GIS data was used to identify and quantify the area and number of parcels impacted for each alternative so structural and ROW costs of the various bridge configurations could be evaluated.

Additionally, the main bridge over the Ohio River needs to accommodate barge traffic so bridge pier spacing is a major concern. Pier locations were tested in an advanced barge training simulator by several captains. An SRH2D model was developed to provide velocity vector data for the river where the captains can use computationally accurate data to simulate river conditions.

BIOGRAPHY:
Corinna Goodwin is a senior hydraulics and hydrology engineer for Parsons with more than 17 years of experience involving drainage in transportation design. Corinna’s assignments have included designing freeways, interchanges, railroads, storm water facilities, and pumping stations; providing construction supervision; cost estimating; and writing specifications. Corinna has managed engineering designs for drainage facilities and bridge hydraulic analyses for several large design-build projects.

Corinna has extensive experience involving drainage engineering. Her experience in conduction drainage design for transportation facilities includes hydrology studies using rational methods, HEC-1 software, and the Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS), and performing hydraulic analyses using the HEC-River Analysis System (HEC-RAS), and 2D hydraulic programs using the surface-water modeling system (SMS), watershed modeling system (WMS), Civilstorm and StormCAD software, and InRoads storm and sanitary programs, as well as other hydraulic analysis methods. Her drainage designs have included urban, rural, and mountain locations. Corinna’s bridge hydraulic designs have ranged from simple hydraulic analyses for small 100 ft. spans to very complex tidal analyses for large suspension bridges.

Corinna is a registered professional engineer in Arizona and Texas.
Hydraulic Design and Permitting of a 5,000-ft Long Crossing of the Illinois River Utilizing 1D (HEC-RAS) and 2D (SRH-2D) Modelling

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ABSTRACT:
Hanson is the lead Phase I design engineer for the new eastbound McClugage Bridge, which carries US 150 over the Illinois River in Peoria, IL. Phase I includes the preliminary design, hydraulic modeling and permitting for the new 5,000-ft long, 23-span bridge, which includes a 652-ft wide tied-arch navigation span. US 150 currently crosses the Illinois River on two bridges, eastbound on the downstream side and westbound on the upstream side. IDOT is proposing to remove the structurally deficient eastbound bridge and replace it on a new alignment only 100-ft downstream. The existing structure was designed as a steel cantilever structure in 1939 but not completed until 1948 due to World War II. In the 1980s, traffic demands warranted the construction of a second bridge separating eastbound and westbound. Starting in 2014, alternatives were developed to replace the existing truss structure which included a tied-arch and a true-arch navigation span. As with most new or replacement bridge along a major river system defined as a public body of water where flood control levees are present, and in accordance with Illinois floodway construction rules, the design goal was to provide an effective hydraulic opening that would meet a “zero-rise” design criteria. This presentation focuses on the complex river hydraulics associated with this unique river crossing location where the main channel rapidly diverges from a narrow river section to a wide pool section controlled by a series of USACE locks for navigation. We will discuss how the SRH-2D model was used to design the bridge and how the 2-D model results compared to the 1-D results with respect to key hydraulic parameters such as flow depth, velocity and angle-of-attack. We will also discuss how the existing bridge, which will remain through construction, impacted the design of proposed bridge elements.

BIOGRAPHY:
Mr. Comerio graduated from the University of Illinois and has worked in the field of water resource engineering for more than 20-years. He has been responsible for the analysis, design and permitting for numerous water resource projects throughout the U.S. and abroad. His expertise involves performing hydraulic design and permitting for bridges, levees, dams and other flow control structures for industrial clients as well as municipal, state and federal clients. Mr. Comerio previously held a position at the Illinois DNR - Office of Water Resources where his primary task was the planning and design of urban flood control projects and is currently the Chief Water Resources Engineer at Hanson Professional Services, Inc. headquartered in Springfield, IL.
**Phase II Scour Evaluation Comparison of SRH-2D & HEC-RAS**

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ABSTRACT:  
The State Route crossing of the Leaf River at Taylorsville, MS was the subject of a FHWA scour study in 1978 showing a successful counter-measure design. The infrastructure is now over 40 years old, and in need of repair. This study looks at a Phase II hydraulic and scour evaluation utilizing both a 1D HEC-RAS model and a SRH-2D model. This presentation will focus on NCHRP Abutment Scour, Pier Scour, and Contraction Scour with both the existing scenario and a scenario if the bank protection structure failed. The presentation will also discuss data acquisition for scour with each model.

BIOGRAPHY:  
Don is a Hydraulic Engineer with Garver. He obtained his BSC in Civil Engineering with emphases in Environmental and Coastal and MSC in Coastal Engineering from Jackson State University. He worked with the Dept. of Homeland Security, Coastal Hazards Center of Excellence, where he evaluated hurricane surge protection though modeling with ADCIRC and STWAVE. He was employed by the Mississippi DOT for 3 years in the Hydraulics Division. He has served as the Vice-President of the Board for Friends of the Mississippi River Basin Model since its inception in 2016. He is a life-long Mississippian, who has been married for 14 years and has 4 children, a dog, and a cat.
NCDOT Realizing the Benefits and Challenges of Adopting 2D Modelling

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ABSTRACT:
NCDOT joined the FHWA Every Day Counts Innovation partnership Collaborative Hydraulics: Advancing the Next Generation of Engineering (CHANGE) with FHWA in early 2017. NCDOT identified with FHWA four implementation plan activities that included training, model development process, evaluation of 2D capabilities and the development of design standards. This presentation will discuss the four implementation plan activities through project examples. NCDOT has used 2D in design, construction management, and risk-based resilience planning. In addition, NCDOT is exploring the use of both SRH2D and HEC-RAS2D through project comparison. The presentation will conclude with NCDOT’s plan of action for 2D and the next steps to be taken in the adoption of 2D as a hydraulics tool.

BIOGRAPHY:
Matt Lauffer –
Matthew (Matt) Lauffer is an Assistant State Hydraulics Engineer for North Carolina Department of Transportation Hydraulics Unit and has been with the Department for 19 years. The Hydraulics Unit supports Design, Operations and manages the Department’s compliance for Stormwater and the National Flood Insurance Program. Matt manages the Hydraulics design and operations for western North Carolina and chairs the Department’s Research Environment and Hydraulics Subcommittee. Matt is a member of the Transportation Research Board Committee on Hydrology, Hydraulics and Water Quality and is a member of the AASHTO Technical Committee on Hydrology and Hydraulics. Matt holds a Bachelor of Science in Civil Engineering from The Ohio State University. Matt is a registered professional engineer in North Carolina.

Ken Ashe -
Mr. Ashe has over 20 years of experience in FEMA floodplain map development, CLOMR and LOMR development and no-rise analyses. He is a Project Management Professional and has managed small and large projects. He has served as a Subject Matter Expert for FEMA’s Technical Mapping Advisory Council (TMAC), FEMA’s Climate Change and Coastal Studies Project: Primary Frontal Dune and Coastal A Zones, and the National Research Council of the National Academies Mapping the Zone. He is currently supports the NCDOT Hydraulics Unit and is leading hydrologic and hydraulic studies in 20 NC Counties, is the lead engineer for H&H studies in 12 MO Counties and is leading 2D modelling for watershed master planning in Cutler Bay FL and Folly Beach SC.

As the former Assistant Director of the NC Floodplain Mapping Program (NCFMP), he managed the NCFMP’s hydrologic and hydraulic studies, FEMA Flood Study Production, the NC LOMC delegation, the NCDOT-NCFMP MOA, the NC Flood Warning Program, the NC NFIP Program, outreach staff and served as the Risk Management Deputy Section Chief during Disaster Activations.

Ken has a BS in Environmental Engineering and a MS in Water Resources Engineering from the University of Central Florida.
Utilizing SRH-2D to Improve Cost Efficiencies and Design Process for the Colorado DOT

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ABSTRACT:
The Colorado Department of Transportation has enthusiastically embraced the EDC campaign and the SRH-2D / SMS two-dimensional modeling software developed by the United States Bureau of Reclamation, Aquaveo, and FHWA. Starting in 2015, CDOT Region 4 Hydraulics began to experiment with and implement 2D hydraulic design. The goals of this experimentation were to improve the determination of hydraulic variables throughout the design process as well as to obtain a more thorough understanding of the hydraulic system relating to highway infrastructure. This presentation will briefly sketch some of the project-specific outcomes of this ongoing 2D initiative within CDOT Region 4, with case studies and lessons learned which we believe will be applicable to all State DOTs as a part of day-to-day design practices. We will demonstrate how SRH-2D revealed that a replacement bridge design could be built with a shorter span (and thus a cost-savings) while maintaining hydraulic performance, and why future bridge replacement projects within the Region will benefit from a pre-scoping effort utilizing 2D modeling to attempt to identify these kinds of cost-saving opportunities as early as possible (as a process improvement). We will use another case study to illustrate the use of SRH-2D’s data calculator in channel revetment design – another process improvement which saved CDOT in both rock size (reducing a 24” d50 design to a 12” d50) as well as rock quantity. We will conclude our presentation, alongside other brief examples of cost savings and process improvements discovered using SRH-2D, with examples of post-processed exhibits for use in presenting these results to upper management, elected officials, and other non-technical stakeholders to achieve enthusiastic buy-in for these methods.

BIOGRAPHY:
Steven Griffin currently serves as a Region Hydraulic Engineer with the Colorado Department of Transportation, serving Region 4 in northeastern Colorado. He has worked extensively on hydraulic design of bridges and scour revetment design, including for the post-flood repair work from the 2013 flooding throughout the South Platte Basin, and was an initial responder to that flooding as well as the 2012 High Park Fire. He holds an MS in Civil Engineering from Colorado State University, and has previous work experience as a hydraulic engineer with the Wyoming DOT as well as Muller Engineering providing consultant design services.
ABSTRACT:
Many proposed highway and bridge projects require development of a 2D hydraulic model to prove design concepts and demonstrate that the design meets regulatory hydraulic criteria. A fundamental question in developing 2D models in large rivers such as the Mississippi River is how to best spend model development time. Balancing the time spent in mesh development, bathymetric and topographic processing, and incorporating in-river features is necessary to keep modeling projects on schedule and on budget. Large scale roughness features such as wing dams, spur dikes, and cut-offs play a very important role in determining near field hydraulic features (vortices and velocity profiles), but their impact on reach scale hydraulic characteristics (water surface, reach slope, and flow distribution) may not be as important. This study looks at the impact of incorporating wing dams on calibration and reach scale hydraulic characteristics in the context of the hydraulic model for a railroad bridge replacement across the Mississippi River. Roughness feature impacts to water surface elevations are quantified for a range of flood frequencies from the 2-year (50% annual exceedance probability) discharge to the 100-year (1% annual exceedance probability) discharge. Two different codes – TUFLOW FV and SRH-2D – and different approaches for representing the large scale roughness features in the model geometry are also reviewed.

BIOGRAPHY:
Brice Stafne has been a water resources engineer with HDR in Des Moines, Iowa for the past five years. While at HDR, Brice has applied 1D and 2D hydraulic models to help solve a variety of riverine and stormwater management problems. The Mississippi River model he will be presenting at NHEC builds on his graduate research at the University of Iowa, which included the development and application of an SRH-2D model of Pool 8 in its pre-impoundment state.
SAMPLE: A 3D Flow Modeling Procedure for Hydraulic Engineers

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ABSTRACT:
Numerical modeling of flow hydrodynamics in streams and reservoirs has been carried out for a wide range of applications. 1D cross-section averaged models have been in wide use for many years; 2D depth-averaged models are being adopted and will become the dominant modeling practice in the next decade. The same, however, cannot be said of the 3D computational fluid dynamics (CFD) modeling. A major obstacle of applying 3D models is that they are too difficult to use and have been limited mostly to CFD experts.

In this presentation, described is a new 3D flow modeling procedure named SAMPLE: Semi-Automatic Modeling Procedure for Lay Engineers. SAMPLE consists of five modeling steps: (1) generate a 2D mesh for the stream; (2) obtain the water surface elevation of the stream; (3) acquire the geometry of in-stream structures if they exist; (4) create a 3D mesh using a semi-automated tool; and (5) perform the 3D flow modeling. Four of the five above steps, except for the in-stream structure geometry, may be carried out using tools at the Bureau of Reclamation. These tools are simple to use and can be carried out by lay engineers. In the talk, the SMAPLE procedure is described and the development progress is reported. Demonstration cases are shown to illustrate the use of the procedure.

BIOGRAPHY:
Yong Lai is a specialist hydraulic engineer at the Technical Service Center, U.S. Bureau of Reclamation, Denver, Colorado. Dr. Lai obtained his Ph.D. in 1990 from Arizona State University and has since been involved in a wide range of research and development activities and engineering projects. His employer includes a private company, a research institute, the University of Iowa, and now the federal government. Dr. Lai has published more than 50 international journal papers and over 80 conference papers in diverse engineering areas. He is the lead author of the widely used SRH-2D model. Dr. Lai currently serves as an associate editor of the ASCE Journal of Hydraulic Engineering, a member of the International Scientific Advisory Board for several conferences, and a regular journal reviewer and session organizer. He regularly provides short courses on hydraulic modeling.
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FIELD TRIP A — OSU CANNON DRIVE FLOODWALL PROJECT

Wednesday August 29, 1:05 -5:10 p.m.

DESCRIPTION:
A significant portion of The Ohio State University’s (Ohio State) main campus in Columbus, Ohio, is impacted by the 100-year (1 percent annual chance) and 500-year (0.2 percent annual chance) floodplain of the Olentangy River. At some point in the past, an earthen embankment was constructed along the river's edge as flood protection for the university; however, the embankment is not sufficient to be recognized as a certified levee. In addition to the typical risks associated with having buildings and other infrastructure located within a flood zone, the university’s risk insurance carrier currently provides only limited coverage for the potential flood damages. In order to address the flood risk concerns, Ohio State chose to implement a project that would alleviate the potential for flood damages from a 500-year event. The key elements of the project are the realignment of Cannon Drive to become a certified flood levee, enhance green space along the Olentangy River, create a north-south connection through campus, and open up 12 acres of developable land to allow for future development to support the university and its medical center. The levee will be coupled with the new roadway embankment and two stormwater pump stations to collect and discharge local runoff from within the campus area when the river is at or near flood stage. The project was originally conceived as part of the university’s Framework 2.0 Plan, a long-term guiding vision for development to support teaching, learning, and research. The Cannon Drive project was later refined during schematic design and planning with Ohio State’s Wexner Medical Center, which brought in stakeholders from the university’s faculty, as well as planners, engineers, and community leaders.

FIELD TRIP B — FHWA ISTD SOIL EROSION RESISTANCE DEMONSTRATION

Thursday August 30, 3:05 -5:10 p.m.

DESCRIPTION:
The In Situ Scour Testing Device (ISTD) will help engineers better understand and improve the evaluation of scour depths by accounting for the erosion resistance of different soil types and comparing them to the erosion forces. This helps reduce uncertainty and inefficiency in design by incorporating site-specific geotechnical information in the analysis, which may reduce the depth of estimated scour and the cost of bridge foundations. Join us for a demonstration of the device in operation.
• 24/7 asset management and environmental conditions monitoring
• 24/7 secure web-based access through an intuitive interface that provides geographical and situational awareness
• Alerts personnel of potentially destructive events
• Emergency preparedness, simulation, and exercise tool
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