Letter from the Technical Committee on Hydrology & Hydraulics Chair
Nick Wark, Vermont Agency of Transportation and TCHH Chair

Welcome to the 15th Edition of Hydrolink, published by AASHTO's Technical Committee on Hydrology and Hydraulics (TCHH). I believe this is an exciting time to be part of the TCHH as sixteen new members have joined in the last five years. While we will certainly miss the experience and camaraderie of past members; new members bring innovative ideas, fresh viewpoints and renewed ambition to the group.

The Hydraulics Unit here at VTrans has gone through similar changes. Our division went from 40+ years of combined experience to less than 5 years. It took nearly two years to find the right applicants. Hydrology and hydraulics is a niche field that is not for everyone, but those of us in it find the work extremely rewarding. What other profession can you spend the morning walking down a stream measuring bank width and the afternoon at your desk working in sophisticated computer software? This is a balance that I love and what I believe keeps people in the field for so long.

Wherever you might be reading this, I hope you are enjoying spring and look forward to connecting.

EDC-4 CHANGE Innovation Update
J.R. Taylor, Montana DOT

In Issue 14 Matt O’Connor (Illinois DOT & TCHH) provided a follow-up to the Issue 13 discussion on the EDC-4 Innovation CHANGE; Collaborative Hydraulics: Advancing to the Next Generation of Engineering. Matt discussed the innovation's plans to provide support for 2-D hydraulic modeling around the nation, and the planned EDC-4 Regional Summits in the Fall of 2016.

Over the last three months of the 2016 year the CHANGE Innovation team presented at the Every Day Counts (EDC) summits across the nation. The purpose of the 7 Regional EDC Summits was to introduce the 11 innovations included in EDC-4 to the states DOTs (including Washington D.C. Virgin Islands, & Puerto Rico), the Federal Lands Highway (FLH) Offices, and state FHWA divisions. At the end of each summit all attending states had the chance to discuss which innovations they were tentatively considering. Following the completion of the last summit in December states were tasked with determining which innovations they would actually pursue. After the state’s submittals in the spring of 2017 it was determined that 42 states, all 3 FLH Offices, Washington D.C. and the Virgin Islands had selected the CHANGE innovation. That is a total of 46 CHANGE participants which was more than any other EDC-4 innovation.
The success of the CHANGE innovation highlights the excitement within the hydraulics engineering community with regards to 2-Dimensional Hydraulic Modeling and the possibilities it opens. Over the next 2 years the CHANGE innovation Team will be providing CHANGE participants numerous opportunities and advances with respect to 2-D modeling, including:

- Free version of FHWA-supported full software for state DOT and other reviewing agencies.
- Free Community version of software.
- Many training opportunities around the nation.
- Development of technical guidance documents with respect to;
  - Building 2-D hydraulic models and best-practice modeling techniques
  - Developing reports for 2-D hydraulic analyses and floodplain permits
  - Reviewing 2-D hydraulic models
- Creation of a 2-D hydraulic modeling blog for peer exchange.
- Holding Bi-Monthly Webinars to discuss the current advances and changes in 2-D modeling.
- Providing technical guidance on a limited number of design projects.

The CHANGE Innovation kickoff meeting was held on April 5th, 2017 to give states a better idea of what to expect from the CHANGE Team and what the CHANGE Team expects from the states and their Champions. The following figure illustrates advancement goals for each CHANGE participant.
Innovative Solution for Mitigating Sedimentation in Multi-Barrel Culverts

An innovative solution for mitigating sedimentation in multi-barrel culverts was developed at the Iowa Institute of Hydraulic Research (IIHR) - Hydroscience & Engineering, University of Iowa in cooperation with the Iowa Highway Research Board (IHRB). The concept behind the new solution relies on the use of stream hydraulic power for passing downstream of the culvert the sediment load carried by the streams during storms. The solution does not affect the current culvert design protocols, rather it streamlines the culvert vicinity, therefore can be applied before or after culvert construction. The self-cleaning culvert concept was designed and extensively tested in laboratory conditions at IIHR. The concept was implemented at a culvert located on HWY 1 in Iowa City, Iowa. Since its implementation in January 2013, the self-cleaning culvert operates efficiently in high and low flows as illustrated in the post-construction photos provided below.

The self-cleaning culvert concept was highlighted in various statewide conferences and was presented at the 2014 National Hydraulic Engineering Conference (NHEC) in Iowa City. The research has attracted interest from Iowa DOT District Offices and County/City Engineers. As a consequence, there have been multiple requests on guidance to translate this innovation into practice for new or existing culvert sites throughout the state.

Current efforts are focused on implementing the self-cleaning culvert technology as standard practice throughout the State of Iowa through a comprehensive implementation plan. The implementation plan includes as series of dissemination workshops to be delivered this summer. The workshops will also introduce a web-based tool developed for assessing the potential for sedimentation of multi-box culverts at any location within the State. The assessment is based on field observations, correlated with existing culvert information, potential sediment losses in the basin, stream to culvert width ratios and the drainage area upstream of the culvert. The tool will provide designer's additional information to assess the sediment potential and use of multi-box culverts at a specific location.

The lack of design specifications to mitigate the sedimentation problem at multi-barrel boxes leaves no other practical alternative than the costly mechanical means of cleaning out the culverts. Typically, this method will result in the re-accumulation of sediment within a short period of time. The Iowa solution has the potential to mitigate sedimentation on long-term or even completely remove it. The Iowa DOT is looking for partners in a Transportation Pooled Fund (TPF) to combine resources to support and explore the benefit of transferring this technology and practice to other States. For more information please contact Dave Claman at david.claman@iowadot.us or Marian Muste at marian-muste@uiowa.edu.

Bio-sorption Activated Media (BAM) in Roadside Swales

The Florida Department of Transportation (FDOT) and the Suwanee River Water Management District (SRWMD) have partnered to research the benefits of a bio-sorption activated media (BAM) in roadside swales to remediate nutrient-laden groundwater and highway stormwater runoff. This study compares two different media mixtures in the swale: a BAM mixture and woodchip mixture. The BAM mixture contains...
natural clay, tire crumb and sand, while the woodchip mixture contains sawdust and small wood chips or shavings. The function of these materials is to increase sorption capacity (important for phosphorus removal) and soil moisture retention (important for nitrogen removal) while providing sufficient infiltration capacity for flood management. Through this research, FDOT plans to develop design guidance for use of BAM in roadside swales. Otherwise, larger ponds, and the associated acquisition costs, would be required to properly address the water quality requirements imposed by the environmental agencies.

Nutrients, particularly nitrate, are a rising concern in groundwater aquifers and springs throughout different areas in Florida. The nitrate-nitrogen concentration in many of Florida’s aquifer springs has risen above 1 mg∙L⁻¹ in recent years. Environmental issues such as waterbody eutrophication (lakes, rivers, and springs), degradation of groundwater quality and quantity, and public health problems, have gained both the public and government’s attention. This trend of increasing nutrient concentrations can be attributed to agricultural and urban land-use practices near groundwater recharge zones.

The nitrogen removal process is a contribution from microorganisms in the nitrogen cycle or transformation process and includes ammonia oxidation, nitrification and denitrification processes. Different bacteria species form biofilm layers and are attached and reproduce on the surface of the media. When sufficient oxygen is present, the nitrification process will convert ammonia or ammonium into nitrite and then nitrate, nitrification usually happens at the beginning of infiltration when the dissolved oxygen concentration is higher (aerobic). Anammox with nitrate convert nitrogen directly to a nitrogen gas. Anaerobic or at least anoxic conditions are necessary for the denitrification process, during this reaction multiple nitrogen species such as nitrate, nitrite, nitric oxide, and nitrous oxide can be transferred into nitrogen gas. With the cycle of ammonia oxidation, nitrification and denitrification all based on different bacteria species, nitrogen removal can be achieved.
A prime example of this rising concern is the Fanning Springs springshed, located in Central Florida. State Road 26 was selected due to the land-use impacts within the springshed. A groundwater extraction well collected background samples at the site location to confirm the presence of nutrient rich groundwater. As noted above, two BAM media mixtures will be installed in the bottom of a 700-ft section of the existing roadside swale. During non-storm periods, groundwater with elevated nutrient levels will be pumped into the retrofitted roadside swale for remediation. During storm events, groundwater extraction will be stopped temporarily allowing for treatment of stormwater only. The thickness of the media mixture layers will vary along the length of the trench to compare efficiencies of differing contact times with the media. Lysimeters will be used to collect the samples from the bottom of the trench. Full construction of the swale test site is scheduled to begin in May 2017 and sampling will occur for a 12-month period.

---

Our Favorite Webinars and Training Videos of the Year  
Andrea Hendrickson, MnDOT

We recently were discussing all of the great training opportunities, webinars and forums that are available. Having a list of sources of technical information is becoming even more important as experienced people leave, new people are hired and strained budgets limit availability to training. Dave Hedstrom (MTDOT), Ann-Marie Kirsch (WiDOT), Brian Beucler (FHWA) and I provided a list of our favorites for the year. Hope you find some of these sources helpful.

**Two-Dimensional Hydraulic Modeling User’s Forum**
[https://connectdot.connectsolutions.com/sr500bmodelingusersforum/?launcher=false](https://connectdot.connectsolutions.com/sr500bmodelingusersforum/?launcher=false)
This link provides access to webinars that are hosted every couple of months by Scott Hogan of FHWA. (Contact Scott at scotthogan@dot.gov.) The topics include various elements, features, and resources associated with the SMS / SRH-2D two-dimensional hydraulic modeling software.

The meeting room is always open and recordings of past webinars and presentations and other resource information are available to view and download. You’ll have to enter your name to enter the meeting room but otherwise not additional login information is required.

**Highway Hydrology – Basic Concepts and Methods**
[https://www.nhi.fhwa.dot.gov/training/course_search.aspx?tab=0&key=135092&typ=3&cat=7&sf=0&course_no=135092](https://www.nhi.fhwa.dot.gov/training/course_search.aspx?tab=0&key=135092&typ=3&cat=7&sf=0&course_no=135092)

This is a free web-based course from the National Highway Institute (NHI). The course provides training on basic hydrologic concepts that will enable users to determine peak flow for transportation hydraulic structures.
Gasketed Joints by Alan Siebenthaler (Hamilton Kent)
Last year Alan Siebenthaler from Hamilton Kent did an excellent webinar on “Thinking Outside the Box (Culvert)”. If you ever wished to learn more about gaskets I’d highly recommend this learning opportunity. You can listen to a recording of the live webinar, hosted by Alan Siebenthaler. Alan discusses different ways gasketed box sections are proving to be cost-efficient, easy-to-install, high-performance solutions and highlights several project profiles where installations were successful!

Highlights include:
- Precast box sections fundamentals
- Joint testing discussion
- Four case studies

A recording of the webinar was created to re-watch or share.

They’ve also created a PDF of the webinar.

Culvert Hydraulic Analysis and Design Program (HY8)
https://www.nhi.fhwa.dot.gov/training/course_search.aspx?tab=0&typ=3&cat=7&sf=0&course_no=135094

This is also a free web-based course from the National Highway Institute (NHI). This course provides training on the use of the Federal Highway Administration’s (FHWA) HY-8 computer program to complete culvert analysis and design calculations.

FHWA Flume Videos
The Federal Highway Administration (FHWA) has posted a new educational video series on their You Tube site. The videos use a portable flume designed by Ayres Associates and FHWA in 1994 to illustrate a variety of hydraulic concepts and design issues relevant to roadway drainage design. The videos are based on National Highway Institute (NHI) Introduction to Highway Hydraulics and Culvert Design courses that Ayres has been leading for over 20 years. FHWA funded this project with the desire to reach a wider audience with the flume demonstrations that have proven so valuable in these training courses.

You can read about it and find a link to the videos here:
http://www.ayresassociates.com/fhwa-hydraulic-videos-train-engineers/

Figure 7; Photo from FHWA Hydraulic Video

FHWA has recently published a second edition of HEC 17 Highways in the River Environment: Extreme Events, Risk and Resilience. The updated circular is a major and significant update that provides technical guidance and methods for assessing the nexus of riverine and transportation as it relates to floods, floodplain policies, extreme events, climate change, risks, and resilience.

Specifically, HEC-17 describes and discusses:
- FHWA and other floodplain policies and guidance
- Uncertainty associated with hydrologic models
- Nonstationarity and two drivers: climate change and land use/land cover changes
• Several tools for identifying and adjusting for trends in the historical record
• Techniques for projecting floods
• Global/regional climate models, downscaling techniques, and emissions scenarios
• Risk and resilience and the probabilistic nature of flood events

Recognizing that all plans and projects do not merit the same attention, HEC 17 also provides a five level analysis framework and specific guidance for addressing non-stationarity, including climate change. Finally, the manual provides case studies to illustrate several of the concepts.

FHWA held three webinars to provide an overview of HEC 17:
• HEC 17 Webinar 1: Introduction, Floodplains, Riverine Flood Events, Non-Stationarity (Chapters 1-4)
• HEC 17 Webinar 2: Climate Modeling and Risk and Resilience (Chapters 5 and 6)
• HEC 17 Webinar 3: Analysis Framework and Case Studies (Chapters 7 and 8)

Presentation recordings and slide sets can be found at: [https://www.fhwa.dot.gov/engineering/hydraulics/media.cfm](https://www.fhwa.dot.gov/engineering/hydraulics/media.cfm)

To download the new HEC 17, please refer to the following link: [http://www.fhwa.dot.gov/engineering/hydraulics/pubs/hif16018.pdf](http://www.fhwa.dot.gov/engineering/hydraulics/pubs/hif16018.pdf)

For more information about HEC 17 and the webinars, please contact Brian Beucler at Brian.Beucler@dot.gov.

**Stormwater Technology Testing Center**

Geo-Environmental Services (GES) has taken the lead in developing a Stormwater Technology Testing Center (STTC) at the ODOT East Portland Maintenance Yard. In addition to testing new and innovative stormwater technologies, the facility can determine the failure rates and maintenance costs of stormwater technologies. The facility, once operational will also be a Washington State approved Technology Assessment Protocol – Ecology (TAPE) testing facility.

The Clean Water Act, supported by the National Pollutant Discharge Elimination System permitting, requires municipalities and private businesses to adhere to increasingly stringent stormwater quality standards. Stormwater treatment devices assist owners and operators in meeting those standards. Regulatory agencies have been expressing concern as to whether stormwater treatment devices installed in the field are actually treating water quality as required. This concern, coupled with the challenges with cleaning and replacing stormwater treatment devices, sparked our desire to assess how devices currently on the market are being tested. In 2009 a group of stormwater professionals representing ODOT and several local agencies in Oregon convened to discuss the challenges and ways to improve the management of large stormwater programs.

Figure 8; STTC Location - yellow outline shows the area of contributing stormwater
They found that the Washington Department of Ecology (WDOE) and several other agencies had facilities or protocols established for the evaluation of the pollution removal effectiveness of newly installed devices. Unfortunately, none of the existing facilities or protocols had testing capability to quantify a stormwater treatment device’s ability to treat water over the long-term, how much maintenance is required for that device, how much it costs to conduct that maintenance, and at what point in the service life of the device would the product need replacement. The STTC will assist in developing a credible qualified products list, improving overall environmental protection and providing data for local, state, and federal transportation resources to make better informed selections of stormwater treatment technologies.

Discussions with WDOE and other stakeholders yielded the concept of the STTC. A business plan and protocols for evaluating stormwater technology maintenance requirements and life-cycle costs was developed with assistance from Herrera Environmental Consultants, Inc. A site was selected and the center was designed by ODOT Region 1 Tech Center and constructed in Portland, Oregon. A board of directors has been established with representatives from the ODOT and several local, state, and federal agencies (FHWA, Wash DOT, Oregon DEQ, WDOE, City of Portland, City of Gresham, City of Lake Oswego, City of Eugene, Clean Water Services, and the Port of Portland and more) to oversee the operation of the STTC. Construction is substantially complete and calibration and preliminary testing will be conducted throughout the winter of 2016/2017. These activities will result in further refining the testing protocols prior to full operation and technology testing beginning.

The STTC is equipped to evaluate 3 technologies simultaneously in accordance with the TAPE in addition to the maintainability protocols created by this project. The center can be operated utilizing gravity or pumped flow. The remotely-operated computer control center is fed information from three weather stations installed throughout the 1,000 acre mixed-urban watershed. The computer controls positive displacement pumps and refrigerated samplers. The site is expected to be a convenient location for technology testing because it is easily accessed from I-205 and local roads. The STTC will provide a new standard of technology testing and is expected to assist owners and operators of all facility sizes when choosing or requiring stormwater treatment technologies. The STTC Board will share maintenance data on each of the technologies with member agencies across the United States.

Dedication of the facility is scheduled during the calibration period. Interested parties will be invited to attend. A written summary of facility design and the thought process behind the design will be developed so owners of technologies and stormwater systems can review our facility features.

Once open for testing, the STTC will quantify the maintainability performance characteristics and costs for commercially-ready stormwater treatment technologies that have the potential to improve and protect water quality and the environment. The STTC could serve as a national laboratory for the professional stormwater community and will provide designers, owners, and permittees of stormwater treatment technologies with an independent assessment of the technology they select or permit. The STTC is being developed as a self-sufficient facility primarily supported by testing fees; however, financial support by member agencies who manage stormwater systems will ensure continued operation of the facility and the ability for the Board of Directors to possibly expand the facility to include additional testing bays and testing parameters (e.g. dosing with bacteria or nitrates) in the future.
The STTC Facility was designed to allow the staff that operates the facility to do three things:

1. **Sample a representative “slice” of the stormwater** that is flowing in a *7 foot diameter pipe* (that drains 1,000 acres of highway and urban streets) and deliver that representative slice to each of the three **Test Bays** at the STTC. The slice must contain a proportionate amount of all the solid and soluble components in the stormwater including:
   a. Pollutants
   b. Oils
   c. Sand
   d. Plastic
   e. Leaves
   f. Soil

The delivery must be done with precise control of the flow rate by the Programmable Logic Controller (**PLC**) and recorded by the **SCADA** system. The exact dosage volume and flow rate of stormwater and pollutants must be managed so the each of the three **Test Bays** receives nearly exact doses of stormwater so that as the facility is operated through the years, it will not matter which test bay is used to test a treatment technology, each of the three will deliver the same test dose during any given rainfall event.
2. **TAPE Testing:** Sampling the raw influent stormwater and the treated effluent from the technology being tested will be done with precision so that a detailed laboratory analysis of the pollutants in the raw stormwater and remaining pollutants in the effluent, from each Test Bay, will show the removal efficiency of the technology.

3. **Maintainability Testing:** Following the steps needed to check the condition of the treatment technology and the steps needed to change-out the treatment system when it becomes too clogged to be effective, will be done by maintenance staff to determine the costs and techniques needed to handle the technology components and get the system operating again.

At the STTC site the pumps, pipes, air compressor, sensors and computers each has a role to play in accomplishing these three tasks. For example, the stormwater is diverted from the 7 foot drainage pipe to a large manhole called the **Feed Wet Well**. Pump #0 recirculates the stormwater and the debris in the **Feed Wet Well** so that all the suction pipes pull in an equal and representative sample of the pollutants in the stormwater. The diameter of the suction pipes is varied from 2” to 4” depending on the pumping flow rate so that the velocity of flow in the pipes is fast enough to move sand and other debris along and carry it to the test bays. Clear PVC pipe and clear hose is used so that the STTC staff can monitor the flow in the pipes. There are certain times of the year when many more leaves and sand are flowing in the storm drains. The system was designed for easy monitoring and ease of repair when required. In general the system was designed to convey all the pollutants and debris to the test bays so that the treatment technologies can be dosed with pollutants and debris that is representative of the contents of stormwater in Pacific Northwest urban runoff.

**Vacuum Samplers** are able to pull samples of the raw stormwater with high velocity into sample-jars to be sent to a laboratory for analysis. The high velocity is necessary to suspend and carry sand particles to the sample-jars. Laboratory analysis of the pollutant levels from the influent and effluent tells the operators what the removal efficiency of the technology in the test bay is.

The **PLC** performs two key tasks:

1. It controls **Pneumatic Valves** in order to match the suction pipe diameter to the pump speed that will produce the required velocity in the pipes and keep the sand moving.

2. It also monitors the water surface in the **Feed Wet Well** and test bays with **Guided-Wave Level Sensors** to determine whether too much water is being sent to the test system. If the water level is rising and is about to bypass some of the raw stormwater, the PLC slows the dosing flow rate to prevent bypass.
By performing the above two tasks the **PLC** manages the dose of stormwater and tracks the flow-rate capacity of the technology-system in each test bay. The **PLC** sends data of all the tasks it performs and all the water surface data and pump flow rate data to the **SCADA** program on the workstation (computer) for archiving and later analysis.

Figure 16: 2”, 3” and 4” Suction Pipe System to manage velocity of flow in the pipes so that sand is moved to the test bays

### Calendar of Events

More information on the Joint Meeting of SCOE and SCOD in Des Moines can be found at this link: [http://www.cvent.com/events/joint-meeting-of-the-aashto-scoe-and-scod-2017/event-summary-f49d22c42e0342eb9219c9ab60ef241c.aspx](http://www.cvent.com/events/joint-meeting-of-the-aashto-scoe-and-scod-2017/event-summary-f49d22c42e0342eb9219c9ab60ef241c.aspx)

---

**2017 TCHH Annual Meeting**  
July 17-20  
Des Moines, IA

The Annual TCHH Meeting will be held in conjunction with the Joint Meeting of SCOE and SCOD. Additional information can be found on the TCHH page using the link on the right.

For more information on the Technical Committee on Hydrology and Hydraulics and to view previous Hydrolink issues, see: [http://design.transportation.org/Pages/HydrologyandHydraulics.aspx](http://design.transportation.org/Pages/HydrologyandHydraulics.aspx)