Unsteady Flow Analysis Using HEC-RAS (Prospect # 188)

May 9-13, 2022

Objectives

This course is intended to provide participants with the knowledge to effectively utilize the HEC-RAS software to analyze hydraulic conditions that require one-dimensional unsteady flow modeling.

Topics include: River mechanics and the unsteady flow equations; overview of unsteady flow modeling; data requirements for unsteady flow model geometries; boundary and initial conditions; overview of model output; modeling bridges and culverts; modeling inline and lateral hydraulic structures; modeling storage areas and storage area connections; model calibration; model stability, accuracy, and sensitivity; trouble shooting; modeling urban areas; and advanced features for unsteady flow (mixed flow regime, pump stations, dam and levee breaching).

Prerequisites

Participants must have a good background in open channel hydraulics and be familiar with the HEC-RAS software. Basic HEC-RAS model development and input and output data requirements **will not** be covered in this class. It will be assumed that you already know how to use the software for performing a steady flow analysis. Familiarity with the unsteady flow equations and numerical solution techniques is desirable. Participants should be in positions requiring them to perform complex hydraulic analysis.

Instructors:

Eric Tichansky (Course Coordinator)

Cameron Ackerman

Stanford Gibson

Mark Jensen

Alex Sanchez

Alex Kennedy

Day 1 (May 9th)

Time		Topic	Objective	Instructor
0800-0900	**L0**	**Introductions and Pre-Course Activities**	Welcome and discussion of class expectations	Tichansky
0900-945	**L1.1**	**Overview of Unsteady Flow Modeling**	Description of unsteady flow applications (why would you use it). Distinction between steady and unsteady flow and hydrologic/hydraulic routing. Demonstration of unsteady flow.	Gibson
945-1015	**W1.2**	**Guided Demonstration**	Guided exploration of example unsteady applications	Gibson
1015-1030		**Break**		
1030-1130	**L1.3**	**River Mechanics and Intro to Unsteady Flow Equations**	Introduction to the unsteady flow equations and solution techniques and a description of the computational differences between steady and unsteady flow.	Jensen
1130-1230		**Lunch**		
1230-1330	**L1.4**	**Data Requirements for 1D Unsteady Geometry**	Types of data required, sources and availability. Limitations and flexibility of HEC-RAS with regard to data. Focus on preparing geometric data (cross sections) and processing that data with the HEC-RAS Pre-Processor (HTAB).	Ackerman
1330-1445	**W1.5**	**Pre-Processing Geometric Data**	This workshop will guide students to set cross-sectional table properties; pre-process the cross sections into tables of elevation versus conveyance, area, and storage; and to review and interpret the results from the pre-processor.	Ackerman, Jensen
1500-1515		**Break**		
1515-1545		**Review**		Ackerman
1545-1700	**L1.6**	**Boundaries and Initial Conditions**	Description of the various types of unsteady flow boundary conditions needed and available within HEC-RAS. Discussion of initial conditions and how to establish them.	Sanchez

Day 2 (May 10th)

Time		Topic	Objective	Instructor
0800-0845	**L2.1**	**Overview of Model Output**	Overview of available output from unsteady flow modeling. Discussions of optional output and how to obtain it.	Tichansky
0845-0930	**L2.2**	**HEC-RAS Mapper Introduction**	RAS Mapper Introduction with focus on reviewing results 1D	Kennedy
0915-0930		**Break**		
0930-1115	**W2.3**	**Basic Unsteady Flow Modeling and Reviewing Results**	Students will learn how enter the necessary data; run the pre-processor, perform the unsteady flow calculations, review the results of an unsteady flow model, and explore RAS Mapper capabilities.	Sanchez, Tichansky
1115-1145		**Review**		Sanchez
1145-1245		**Lunch**		
1245-1345	**L2.4**	**Modeling Bridges and Culverts**	Overview of input data for bridges and culverts. Entering hydraulic table parameters for bridges and culverts. Reviewing pre-processor output and unsteady flow output for bridges and culverts.	Ackerman
1345-1545	**W2.5**	**Modeling Bridges**		Ackerman, Jensen
1545-1600		**Break**		
1600-1630		**Review**		Ackerman

Day 3 (May 11th)

Time		Topic	Objective	Instructor
0800-0900	**L3.1**	**Inline and Lateral Structures**	Discussions of modeling inline and lateral hydraulic structures. Entering spillway and weir data, lateral culverts, and rating curves. Connecting lateral structures to storage areas and other reaches. Controlling gate settings. Reviewing output for inline and lateral structures.	Tichansky
0900-0945	**L3.2**	**Storage Areas and Storage Area Connections**	The purpose of storage areas and how to model with them. Connecting storage areas to other storage areas using storage area connections. Input and output for storage areas and storage area connections.	Sanchez
0945-1000		**Break**		
1000-1130	**W3.3**	**Lateral Structures, Storage Areas and Storage Area Connections**	Students will learn how to create and use lateral structures, storage areas. and storage area connections to model off-channel storage in the overbanks. Students will learn how to connect storage areas to river reaches and other storage areas using Storage Area Connections	Sanchez, Tichansky
1130-1230		**Lunch**		
1230-1300	**W3.3**	**Lateral Structures, Storage Areas and Storage Area Connections (continued)**		Sanchez, Tichansky
1300-1330		**Review**		Sanchez
1330-1430	**L3.4**	**Calibration of Unsteady Flow Models**	Interpretation, use, and reliability of field data. Which parameters to calibrate and adjust, problems and solutions. Calibration for large alluvial streams	Jensen
1430-1445		**Break**		
1445-1630	**W3.5**	**Calibration of the Mississippi - Ohio Confluence**	Students will learn how to adjust model parameters to replicate water surface elevations, discharges, and travel times.	Jensen, Tichansky

Day 4 (May 12th)

Time		Topic	Objective	Instructor
0800-0830		**Review**		Jensen
0830-0945	**L4.1**	**Common Model Stability Problems**	Cross-section spacing. Selection of model computational time step. Controlling iterations, tolerances, and other model stability factors. Understanding model sensitivity and the parameters that are most significant.	Jensen
0945-1000		**Break**		
1000-1045	**L4.2**	**Detecting and Fixing Stability Problems**	Detecting stability problems. Discussions will include how to turn on and review detailed log output from the unsteady flow model run.	Jensen
1045-1145	**W4.3**	**Troubleshooting Workshop**	Students will learn to detect and resolve several types of model instability problems.	Jensen, Ackerman
1145-1245		**Lunch**		
1245-1415	**W4.3**	**Troubleshooting Workshop (continued)**		Jensen, Ackerman
1415-1430		**Break**		
1430-1445	**L4.4a**	**Pumps and Pipes**	Pump stations and Pressurized Pipe Modeling.	Gibson
1430-1530	**L4.4b**	**Dam and Levee Breach**	Dam and levee breach modeling.	Gibson
1530-1700	**W4.4**	**Dam and Levee Breach Workshop**	Students will learn how to use HEC-RAS to perform a dam breaching analysis, as well as a levee breaching analysis.	Gibson, Tichansky

Day 5 (May 13th)

Time		Topic	Objective	Instructor
0800-0830		**Review**		Gibson
0830-0900	**L5.1**	**Introduction to the Rules Editor**	This lecture will introduce students to using the rules editor for controlling gates at Inline and lateral structures, as well as storage area connections. Other uses for the rules editor will also be introduced.	Gibson
0900-0915		**Break**		
0915-1030	**W5.2**	**Rules Editor Demonstration**	A student interactive demonstration of the use of rules will be given.	Gibson
1030-1130		**Post Test, Course Critique**		Tichansky