Steady Flow Water Surface Profile Computation
Using HEC-RAS
June 3-7, 2019

Objectives

The objective of the course is to enable the participants to perform water surface profile computations using computer program HEC-RAS in a sound and effective manner.

Topics will include concepts of open channel flow, data requirements, basic input requirements, output analysis, application of bridge and culvert routines, and floodway determination. Participants will have an opportunity to prepare input and analyze output during workshops.

Instructors:
Cameron Ackerman
Gary Brunner
Stanford Gibson
Mark Jensen
Alex Sánchez ((Course Coordinator)

Monday: **Modeling River Hydraulics with HEC-RAS**

8:00 – 9:00 a.m. **INTRODUCTION** (Sánchez)

9:00 – 10:00 a.m. 1.1 Lecture: **WATER SURFACE PROFILE CALCULATION** (Brunner)

Classifications of open channel flow; velocity distribution in a channel; energy principles; cross section subdivision for conveyance calculations; friction loss equations; contraction and expansion losses; computational procedure; critical depth determination; and applications of the momentum equation.

10:00 – 10:15 a.m. Break

10:15 - 11:15 a.m. 1.2 Lecture: **GEOMETRIC DATA REQUIREMENTS FOR WATER SURFACE PROFILE CALCULATIONS** (Ackerman)

Study limit determination; defining the river system schematic; cross section geometry and locations; optional cross section properties: ineffective flow areas, levees, and blocked obstructions; defining the reach lengths between sections; energy loss coefficients; stream junction data.

11:15 – 12:00 p.m. 1.3 Lecture: **RESISTANCE TO FLOW** (Gibson)

Discussions about Manning's equation; uniform flow equations; methods for computing n values: tables, pictures, and equations; examples of calibrated n values for various streams.

12:00 – 1:00 p.m. **LUNCH**

1:00 - 2:00 p.m. 1.4 Lecture: **STEPS IN DEVELOPING A HYDRAULIC MODEL WITH HEC-RAS** (Ackerman)

Starting HEC-RAS; steps in developing a hydraulic model: starting a new project, entering geometric data, entering steady flow data, performing the computations, viewing and printing results; getting and using help.

2:00 – 2:15 p.m. Break

2:15 - 3:15 p.m. 1.5 Lecture **GEOMETRIC DATA DEVELOPMENT WITH RAS MAPPER** (Ackerman)

This lecture will go through developing an HEC-RAS terrain model, river network, and entering and editing data tools in RAS Mapper.

3:15 - 4:15 p.m. 1.6 Workshop: **DEVELOPING HEC-RAS GEOMETRY WORKSHOP** (Ackerman, Gibson)

Students will create a new HEC-RAS terrain layer, layout the model schematic and cross sections.

4:15 – 4:45 p.m. **REVIEW WORKSHOP 1.6** (Ackerman)

Tuesday: **Developing a Model and HEC-RAS Bridge Analysis**

8:00 - 9:00 a.m. 2.1 Lecture **STEADY FLOW DATA REQUIREMENTS** (Sánchez)

Discussions about flow regime; boundary conditions; discharge information.

9:00 - 9:15 a.m. Break

9:15 - 10:15 a.m. 2.2 Lecture: **VIEWING RESULTS** (Jensen)

Viewing results; cross section plots; profile plot; X-Y-Z plot; summary tables; errors, warnings, and notes, and flood plain maps in RAS Mapper.

10:15 - 11:45 a.m. 2.3 Workshop: **CALCULATION OF WATER SURFACE PROFILES** (Ackerman, Gibson)

Students will learn to enter data into HEC-RAS; perform the hydraulic computations; and view results.

11:45 –12:45 p.m. **LUNCH**

12:45 - 1:15 p.m. **REVIEW** **WORKSHOP 2.3** (Ackerman)

1:15 - 2:30 p.m. 2.4 Lecture: **HYDRAULICS OF BRIDGE WATERWAYS** (Brunner)

Nature of flow through bridges; components of bridge losses; cross-section locations; defining ineffective flow areas; contraction and expansion losses.

2:30 - 2:45 p.m. Break

2:45 – 3:45 p.m. 2.5 Lecture: **BRIDGE MODELING APPROACHES IN HEC-RAS** (Brunner)

Available approaches to bridge loss computations within HEC-RAS; selecting the appropriate bridge modeling approach for various situations of low flow bridge hydraulics; selecting the appropriate bridge modeling approach for various situations under high flow bridge hydraulics.

3:45 - 4:00 p.m. Break

4:00 – 5:00 p.m. 2.6 Lecture **APPLICATION OF HEC-RAS TO BRIDGE HYDRAULICS** (Ackerman)

Demonstration of how to enter and edit bridge data; defining a bridge modeling approach; bridge modeling options; pertinent bridge output.

Wednesday: **HEC-RAS Bridge and Culvert Hydraulics**

8:00 - 10:00 a.m.	3.1 Workshop:	**BRIDGE COMPUTATIONS** (Brunner, Ackerman)
	Students will learn to enter and edit bridge data; perform bridge hydraulic computations; and review pertinent results.	
10:00 - 10:45 a.m.	**REVIEW:** Workshop 3.1 (Brunner)	
10:45 - 11:00 a.m.	Break	
11:00 -12:00 a.m.	3.2 Lecture:	**OVERVIEW OF CULVERT HYDRAULICS** (Brunner)
	Definition of terms; input requirements: cross section locations, ineffective flow areas, expansion and contraction coefficients; inlet control; outlet control; solution logic.	
12:00 -1:00 p.m.	**Lunch**	
1:00 – 2:00 p.m.	3.3 Lecture:	**APPLICATION OF HEC-RAS TO CULVERT HYDRAULICS** (Gibson)
	Demonstration of how to enter and edit culvert data; culvert modeling options; review of culvert output.	
2:00 - 2:15 p.m.	Break	
2:15 - 4:15 p.m.	3.4 Workshop	**CULVERT ANALYSIS** (Gibson, Brunner)
	Students will learn how to enter and edit culvert data, perform culvert hydraulic computations; and review pertinent output.	
4:15 - 4:45 p.m.	**REVIEW**: Workshop 3.4 (Gibson)	

Thursday: **Model Calibration, Optional Capabilities and Floodway Determination**

8:00 – 9:15 a.m.	4.1 Lecture:	**CALIBRATING A STEADY FLOW HYDRAULICS MODEL** (Gibson)
	Students will learn what data is required for model calibration and how to modify Manning's n values to calibrate the model to observed data.	
9:15 - 9:30 a.m.	Break	
9:30– 11:00 a.m.	4.2 Workshop:	**MODEL CALIBRATION** (Gibson, Sánchez)
	Students will learn how to modify Manning's n values to calibrate the model to observed data.	
11:00 – 11:30 a.m.	**REVIEW:** Workshop 4.2 (Gibson)	
11:30 -12:30 p.m.	Lunch	
12:30 - 1:30pa.m.	4.3 Lecture:	**OVERVIEW OF OPTIONAL CAPABILITIES** (Sánchez)
	Cross section interpolation; mixed flow regime calculations; flow distribution calculations; Inline Weirs and Gated Spillways.	
1:30 – 1:45 p.m.	Break	
1:45 - 2:45 p.m.	4.4 Lecture:	**FLOODPLAIN AND FLOODWAY DETERMINATION** (Jensen)
	Floodway definitions; general guidelines; computer procedures; program input requirements for floodway calculations; available output.	
2:45 – 4:30 p.m.	4.5 Workshop:	**FLOODWAY DETERMINATION** (Jensen, Gibson)
	Students will learn how to enter and edit encroachment data and perform a floodway analysis.	
4:30 - 5:00 p.m.	**REVIEW:** Workshops 4.5 (Jensen)	

Friday: **HEC-RAS Trouble Shooting and Output Analysis**

8:00 – 8:45 a.m.	5.1 Lecture:	**TROUBLE SHOOTING WITH HEC-RAS** (Jensen)
		This lecture will provide students with information on how to interpret HEC-RAS output messages (errors, warnings, and notes); diagnose common data input mistakes; and how to use the HEC-RAS Log File to understand more about the computations and possible problems.
8:45 – 9:00 a.m.	Break	
9:00 -10:30 a.m.	5.2 Workshop	**OUTPUT ANALYSIS** (Jensen, Sánchez)
		This workshop will teach students how to analyze the HEC-RAS output in order to detect common hydraulic modeling problems.
10:30 -11:00 a.m.	**POST-COURSE ASSESMENT** (Sánchez)	
11:00 –11:30 a.m.	**ORAL CRITIQUE AND COURSE COMPLETION** (Sánchez et al.)	