

## **ADVANCED STEADY FLOW ANALYSIS WITH HEC-RAS**

### Objectives

This course is intended to provide participants with the knowledge to effectively utilize the HEC-RAS software to analyze difficult hydraulic conditions in natural and constructed channels.

Topics include: Advanced input and output; supercritical and mixed flow regime water surface profiles, interfacing HEC-RAS with GIS systems for data import and export of results, performing channel modifications, modeling gated spillways weirs and drop structures, split flow and divided flow problems, advanced bridge and culvert hydraulics, and interfacing with HEC-DSS.

Monday

**Modeling River Hydraulics with HEC-RAS**

8:00 - 8:30 a.m.	<b>INTRODUCTION</b>
8:30 - 9:45 a.m.	1.1 Lecture: <b>WATER SURFACE PROFILE CALCULATION</b>  Classifications of open channel flow; velocity distribution in a channel; energy principles; cross section subdivision for conveyance calculations; computational procedure; vertical n-values; critical depth determination; applications of the momentum equation; cross section spacing; and limitations of 1D models.
9:45 - 10:00 a.m.	Break
10:00 - 11:00 a.m.	1.2 Lecture: <b>ADVANCED DATA ENTRY AND EDITING</b>  Various methods for entering data (manual entry; cut, copy and paste; importing data); summary table editors; graphical cross section editor; working with the model schematic; reversing cross section stationing; and cross section point reduction.
11:00 – 11:45 a.m.	1.3 Lecture: <b>ADVANCED OUTPUT FOR GENERATING STUDY REPORTS</b>  Discussions will include sending output to the Windows clipboard, controlling printing, scaling plots, user defined output tables, plotting variables in profile, plotting one variable versus another, graphics options, table options, and using the report generator.
11:45 - 1:15 p.m.	<b>ICE BREAKER LUNCH</b>
1:15 - 2:15 p.m.	1.4 Lecture: <b>SUPERCritical AND MIXED FLOW REGIME WATER SURFACE PROFILES</b>  Discussions about flow regime, draw down profiles, hydraulic jumps, boundary conditions, cross section spacing, Manning' s n values, contraction and expansion coefficients; junction hydraulics.
2:15 - 2:30 p.m.	Break
2:30 – 4:30 p.m.	1.5 Workshop: <b>MIXED FLOW REGIME WATER SURFACE PROFILES</b>
4:30 – 5:00 p.m.	<b>REVIEW</b> Workshop 1.5

Tuesday

**Using GIS Data and Channel Modifications**

8:00 - 8:45 a.m.	2.1 Lecture: <b>USING GIS TO DEVELOP GEOMETRIC DATA FOR HEC-RAS</b>
	Using GIS to extract cross section data and other cross section properties from terrain models.
8:45 – 9:30 a.m.	2.2 Lecture: <b>IMPORTING GIS DATA INTO HEC-RAS AND EXPORTING RESULTS TO GIS FOR FLOODPLAIN MAPPING</b>
	Importing cross section data from a GIS, completing the geometry data, performing the computations, and exporting the results to the GIS exchange file.
9:30 - 9:45 a.m.	Break
9:45 – 10:15 a.m.	2.3 Lecture: <b>IMPORTING HEC-RAS RESULTS AND DEVELOPING FLOOD INUNDATION MAPS IN THE GIS</b>
	Importing HEC-RAS computed water surface profiles and bounding polygons. Developing flood inundation maps and depth grids for display in the GIS.
10:15 –11:30 a.m.	2.4 Workshop: <b>USING GIS DATA FOR WATER SURFACE PROFILE CALCULATIONS</b>
	HEC-GeoRAS (ArcView version) will be used to extract cross section data, and then export the information to a GIS exchange file. The data will be imported into HEC-RAS, and water surface profiles will be computed. The HEC-RAS results will be exported to the GIS for floodplain mapping.
11:30 –12:30 p.m.	<b>LUNCH</b>
12:30 – 1:45 p.m.	2.4 Workshop: Workshop Continued
1:45 - 2:45 p.m.	2.5 Lecture: <b>PERFORMING CHANNEL MODIFICATIONS</b>
	Discussion on hydraulic design of channels. How to use HEC-RAS to perform a channel modification analysis.
2:45 – 3:00 p.m.	Break
3:00 - 4:30 p.m.	2.6 Workshop: <b>CHANNEL MODIFICATIONS</b>
	Students will learn how to use the channel modification option in HEC-RAS. Existing and modified conditions will be compared.
4:30 - 5:00 p.m.	<b>REVIEW</b> Workshop 2.6

Wednesday

**Bridges and Culverts**

8:00 - 9:15 a.m.	3.1 Lecture: <b>ADVANCED BRIDGE HYDRAULICS</b>
	Discussions will include modeling unique bridges, bridges on a skew, modeling debris, and multiple opening bridges.
9:15 - 9:30 a.m.	Break
9:30 - 11:15 a.m.	3.2 Workshop: <b>BRIDGE HYDRAULICS</b>
11:15 - 12:00 a.m.	<b>REVIEW:</b> Workshop 3.2
12:00 - 1:00 p.m.	<b>LUNCH</b>
1:00 - 2:00 p.m.	3.3 Lecture: <b>EVALUATING BRIDGE SCOUR</b>
	Concepts of contract scour, pier scour, and abutment scour will be presented, along with how to use HEC-RAS to compute the scour.
2:00 - 2:15 p.m.	Break
2:15 - 3:15 p.m.	3.4 Lecture: <b>ADVANCED CULVERT HYDRAULICS</b>
	Modeling unique culvert problems: culverts that change shape or slope; long culverts; buried culverts; multiple n-values in the barrel; drop inlets; bend losses and other minor losses.
3:15 - 5:00 p.m.	3.5 Workshop: <b>CULVERT HYDRAULICS</b>

Thursday

**Modeling Gated Spillways, Drop Structures, and Split Flow**

8:00 - 8:30 a.m.	<b>REVIEW:</b> Workshop 3.5
8:30 - 8:45 a.m.	Break
8:45 - 9:45 a.m.	4.1 Lecture: <b>MODELING GATED SPILLWAYS AND WEIRS</b>  Modeling gated spillways will include sluice gates, radial gates, weir flow through gates, and fully submerged gate flow. Overflow weirs will also be discussed.
9:45 -10:45 a.m.	4.2 Workshop: <b>GATED SPILLWAYS AND WEIRS</b>  Students will learn how to enter data for radial and sluice gates, as well as weir information. The model will be run and results for flow through the gates will be evaluated.
10:45 - 11:15 a.m.	<b>REVIEW:</b> Workshop 4.2
11:15 - 12:00 p.m.	4.3 Lecture: <b>MODELING DROP STRUCTURES</b>  Discussions will include the purpose of drop structures, how to model drop structures within HEC-RAS, and evaluating model output.
12:00 -1:00 p.m.	<b>LUNCH</b>
1:00 - 2:00 p.m.	4.4 Workshop: <b>DROP STRUCTURES</b>  Students will model a drop structure by two different methods and compare the results.
2:00 - 2:15 p.m.	Break
2:15 - 3:15 p.m.	4.5 Lecture: <b>MODELING SPLIT FLOW AND DIVIDED FLOW</b>  Discussions will focus on lateral weirs and gates, flow around islands, and optimizing the flow split.
3:15 - 5:00 p.m.	4.6 Workshop: <b>SPLIT FLOW AND DIVIDED FLOW</b>  Students will enter data for a lateral weir and perform a flow split optimization.

Friday

**HEC-DSS and Unsteady Flow Routing**

8:00 - 9:00 a.m.      **REVIEW:** Workshops 4.4 and 4.6

9:00 - 9:15 a.m.      Break

9:15 - 10:00 a.m.      5.1 Lecture:      **USING HEC-DSS WITH HEC-RAS**

Importing hydrographs from DSS; exporting HEC-RAS results to DSS; and plotting and tabulating data in a DSS file from HEC-RAS.

10:00 -11:00 a.m.      5.2 Lecture:      **UNSTEADY FLOW ROUTING IN HEC-RAS (Version 3.1)**

Demonstration and discussion of unsteady flow routing capabilities being implemented in HEC-RAS for version 3.1 release.

11:00 - 11:30 a.m.      **COURSE CRITIQUE AND CLOSING REMARKS**