

5th HEC-RAS:5.0.3 Water Modelling Training - Brisbane 2017



Day 1

HEC-RAS 1-D Training

Rob Keller and Mark Forest

Introductions and Course Objectives (8:00 am to 8:15 am)

Introductions: Class and Content

Module 1 – Open Channel Hydraulics (8:15 am to 9:45 am)

Lecture Topics (Introduction to Basic Principles and Methods):

- Fundamental Equations
- Flow resistance
- Uniform and non-uniform flow
- Flow regime – subcritical and supercritical flow
- The computational heart of HEC-RAS 1D
- Introduction to HEC-RAS 1D – philosophy, structure, and program capabilities

Break (9:45 am to 10:00 am)

Module 2 – Basic HEC-RAS Case Studies (10:00 am to 12:00 pm)

Lecture Topics:

- Introduction to Basic Case Studies
- Purpose and Scope

Module 2 Workshop 1:

- Case Study 1 – Unicorn River
- Obtain practice at running HEC-RAS, handling input and output options, and investigating the influence of varying river characteristics, such as roughnesses, boundary conditions etc., on water surface profile properties.

Lunch (12:00 pm to 1:00 pm)

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Module 2 - Basic HEC-RAS Case Studies (continued) (1:00 to 2:00 pm)

Module 2 Workshop 2:

- Case Study 2 – Humboldt River
- The purpose of this case study is to provide practice in developing a HEC-RAS project file and calibrating the model against known flow data and water surface elevations

Module 3 – Continue Case Study 2 as necessary and Important Aspects of Basic HEC-RAS (2:00 pm to 3:15 pm)

Lecture Topics:

- Cross-section locations and slope-averaging options

Break (3:15 to 3:30 pm)

Module 3 – Important Aspects of Basic HEC-RAS (continued) (3:30 pm to 4:15 pm)

Lecture Topics:

- One-dimensional flow profiles in context

Module 4 – Discussion and Wrap up of Day 1 (4:15 to 5:00 pm)

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Day 2

HEC-RAS 1-D Training

Rob Keller and Mark Forest

Module 5 – Bridge Analysis (8:00 to 8:45 am)

Lecture Topics:

- Bridge analysis with HEC-RAS
- Scour at bridge sites and treatment in HEC-RAS
- Introduction to Case Studies

Module 6 – Bridge analysis Case Study (8:45 to 10:00 am)

Module 6 Workshop 3:

- Case Study 3 – Humboldt River
- The study makes use of the same river geometry as was used for the Basic Course Case Study.
- Bridge data for two bridges need to be input and their influence on flood levels assessed.
- The effect of temporary staging works is then investigated

Module 7 – Bridge Scour Case Study (11:00 am to 12:00 pm)

Module 7 Workshop 4:

- Case Study 4 – Humboldt River
- The study makes use of the same river geometry as was developed for Case Study 3
- The case study is designed to give you practice at determining the scour associated with bridge sites

Lunch (12:00 pm to 1:00 pm)

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Module 8 – Advanced Floodplain Modelling: Junctions and Split Flow (1:00 to 2:00 pm)

Lecture Topics:

- Junction flow modelling
- Split flow modelling

Module 9 – Junction Modelling Case Study (2:00 to 3:00 pm)

Module 9 Workshop 5:

- Case Study 5 – Unicorn River
- The study makes use of the same river geometry as was used for Case Study 1
- The case study is designed to give you practice at developing a junction in HECRAS, inputting all of the required data, and observing the effect of modeling the junction on flow characteristics in the main river.

Break (3:00 to 3:15 pm)

Module 10 – Culvert Modelling (3:15 to 4:15)

Lecture Topics:

- Hydraulics of culverts
- Modelling culverts in HEC-RAS

Module 11 – Discussion and Wrap up of Day 2 (4:15 to 5:00 pm)

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Day 3

Mark Forest and Krey Price

Introductions and Course Objectives (8:00 am to 8:15 am)

Introductions

Module 12 – Overview of HEC-RAS 2D (8:15 am to 9:45 am)

Lecture Topics:

- 1D and 2D equations
- Unsteady v. Steady Flow Solution Differences
- Unsteady modeling with RAS
- When to use 1D v. 2D
- Overview of RAS 2D
- RAS 2D Computational Differences with other 2D models
- Diffusion Wave and Full Dynamic Solutions
- HEC-RAS 5.0 File Structure
- File Sizes and Data Management

Break (9:45 am to 10:00 am)

Module 13 – Terrain Development and Review (10:00 am to 12:00 pm)

Lecture Topics:

- Types of Source Data
 - DEM
 - LiDAR or Photogrammetry Point Clouds
 - Green and Red LiDAR Sensors
 - Photon LiDAR
 - Point and Breakline Data
 - Survey Data
 - Bathymetric Data
 - Building Footprint Data
- Triangulated Irregular Network (TIN)
- Reviewing Terrains/Identification of Terrain Deficiencies
- RAS Mapper Layers and Tools
- Coordinate System and Projection Files
- Terrain Data Requirements and Processing Options
 - Allowable Formats; Floating Point Grids (*.flt), GEO TIFF, ESRI Grid, DEM and others
 - Layering Terrains
 - HEC-RAS Terrain Considerations
- Background Data Layers
- Web Imagery

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Module 13 Workshop:

- Creating a RAS project
- Defining Projection
- Creating a HEC-RAS Terrain Surface
- Use of Hierarchical Terrain Data Files
- Terrain associations
- Adding map data layers
- Web Imagery

Lunch (12:00 pm to 1:00 pm)

Module 14 - Development of an Interpolation Terrain Feature (1:00 to 2:00 pm)

Lecture Topics:

- Potential Applications
- Fundamentals and Considerations

Module 14 Workshop:

- 1D model setup
- Creation of interpolation terrain
- Merging interpolated terrain into base terrain

Module 15 – 2D Flow Area Mesh Development and Editing (2:00 pm to 3:15 pm)

Lecture Topics:

- Mesh Fundamentals
- Selection of Domain Boundary Fundamentals
- Impacts of Domains that are too small or too large
- Considerations for cell size
- Use of the breakline tool for grid refinement
- Manual edits of mesh

Module 15 Workshop:

- Mesh Creation
- Breakline development and application
- Editing Mesh
- Identification and correction of errors
- Terrain Associations

Break (3:00 to 3:15 pm)

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Module 16 – 2D Boundary Conditions (3:30 pm to 4:15 pm)

Lecture Topics:

- Downstream boundary condition definition
- Type of downstream boundary condition (stage hydrograph, normal depth, rating curve)
- How the downstream boundary condition is used in HEC-RAS
- Importance of location for downstream boundary condition on hydraulic analysis
- Impact of inaccurate downstream boundary condition
- Upstream (inflow) boundary condition definition
- Type of upstream boundary condition (flow hydrograph, stage hydrograph, precipitation)
- How flow is transferred to the 2D grid elements from upstream boundary
- Importance of upstream boundary location
- Impact of inaccurate upstream boundary condition
- Internal boundary conditions (weirs, roads, culverts)

Module 16 Workshop:

- Creation of Boundary Conditions
- Selection of boundary condition type
- Editing boundary conditions
- Reading hydrograph data from DSS

Module 17 – 2D Computational Options (4:15 to 5:00 pm)

Lecture Topics:

- Selection of time step and the Courant Condition
- Selection of appropriate computational solution
- Computational tolerances options
- Continuity (does your model conserve volume?)

Module 17 Workshop – Computations and Viewing Results:

- Computations
- Reviewing Results
- Reviewing continuity results
- Identification of errors and debugging

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Day 4

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Module 18 – Land Use Data for Manning’s Roughness (8:00 to 8:45 am)

Lecture Topics:

- How land use data is used in RAS
- Finding, creating and editing land use data
- Site specific modification of n values for calibration

Module 18 Workshop:

- Associating a Land Use File
- Editing roughness values
- Default values

Module 19 – Internal 2D Connections (8:45 to 10:00 am)

Lecture Topics:

- When separate 2D and storage areas are needed
- Hydraulics of connections
- Incorporation of culverts and gates in a connection
- Importance of mesh size and alignment adjacent to connections
- How to review the connection results
- Linkage to DSS and viewing results in DSS

Module 19 Workshop:

- Adding internal boundary condition
- Creating 2D connections
- Adding culverts or gates to 2D connections
- Defining and editing overtopping section
- Fixing channel data at culverts

Module 20 – Dam Breach Modeling with HEC-RAS (11:00 am to 12:00 pm)

Lecture Topics:

- Breach formation fundamentals
- 1D v 2D breach flow routing fundamentals and differences
- Evolution of dam breach tools
- Prediction Regression Equations

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- Parametric Regression Equations
 - Using the breach parameter calculator
- Physical Breach Methods
- Simulation of reservoir response (Storage areas, 1D or 2D)
- Dynamic routing of breach hydrograph
- Defining consequence mapping objectives and accuracy requirements
- Consequence mapping options

Lunch (12:00 pm to 1:00 pm)

Module 21 – 2D Modeling Advanced Topics (1:00 to 2:00 pm)

Lecture Topics:

- Initial conditions and restart files
- Recognition of unique hydrodynamics that warrant special consideration
- Grid size optimization
- Adjustment of computational tolerances and computational methods for combined 1D/2D
 - Use of Eddy Viscosity Term
 - Use of Coriolis Effect
 - Theta Weighting Factor
- Identification and resolution of model instabilities
- Importance of inertial terms in solution
- Quantification of super-elevation on bends
 - Mesh considerations
 - Limitations with depth averaged solution

Module 22 – Incorporating Precipitation (2:00 to 3:00 pm)

Lecture Topics:

- Fundamentals of rainfall excess estimation
- Incorporating Precipitation
 - When to incorporate rainfall
 - Data input requirements for precipitation data
 - How to determine rainfall excess inputs
 - Potential use for watershed analysis
- Considerations
- Buildings
- Depth impacts on roughness estimates
- Verification of results
 - Comparison to observed events
 - Comparison to alternative methods

Module 22 Workshop:

- Precipitation workshop

Break (3:00 to 3:15 pm)

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Module 23 – Linking 1D and 2D (3:15 to 5:00 pm)

Lecture Topics (Mitch):

- Advantages and disadvantages of 1D v. 2D solutions
- Connecting 1D reach to 2D domain
- Connection 2D domain to 1D reach
- Lateral connections (incorporation, editing, coefficient selection)
- Culverts and Gates
- Stability considerations

Module 23 Workshop:

- Linking 1D and 2D elements

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Day 5

HEC-RAS 2D Training

Mark Forest and Krey Price

Module 24 – RAS Mapper Output (8:00 to 9:30 am)

Lecture Topics:

- RAS Mapper Output Options
 - Dynamic Mapping
 - Static Mapping
 - Standard and optional output options
- Flux Line
- Property tables
- Cell level time series data
- Profiles
- View windows
- 2D Output and input HDF files

Module 24 Workshop:

- Viewing 2D Results
- Adding map layers

Module 25 – Future HEC-RAS 5.1 Enhancements (9:30 to 10:00 am)

Lecture Topics:

- Known bugs and limitations
- Computational Enhancements
- RAS Mapper Enhancements

Break (10:00 to 10:15 am)

Module 26 – Reviewing a RAS 2D model (10:15 am to 12:00 pm)

Interactive Lecture and Workshop:

- HEC-RAS 2D Review Checklist
- Reviewing behaviors using animations
- Reviewing model warnings, errors, and computational log files
- Reviewing Geometry (2D)
- Reviewing Inputs
- Reviewing boundary conditions
- Reviewing Options and Tolerances
- Reviewing grid level data

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Lunch (12:00 pm to 1:00 pm)

1-2 pm Module 26 Workshop – Computations and Viewing Results (All)

- Practical Test of an example model
- How to Recognize Model Errors

2-3 pm Module 27 Benchmarking HEC-RAS vs. other 2D models

Break (3:00 to 3:15)

3:15-4:30 pm - Creating a 2D model from scratch

Close of 5th HEC-RAS Workshops