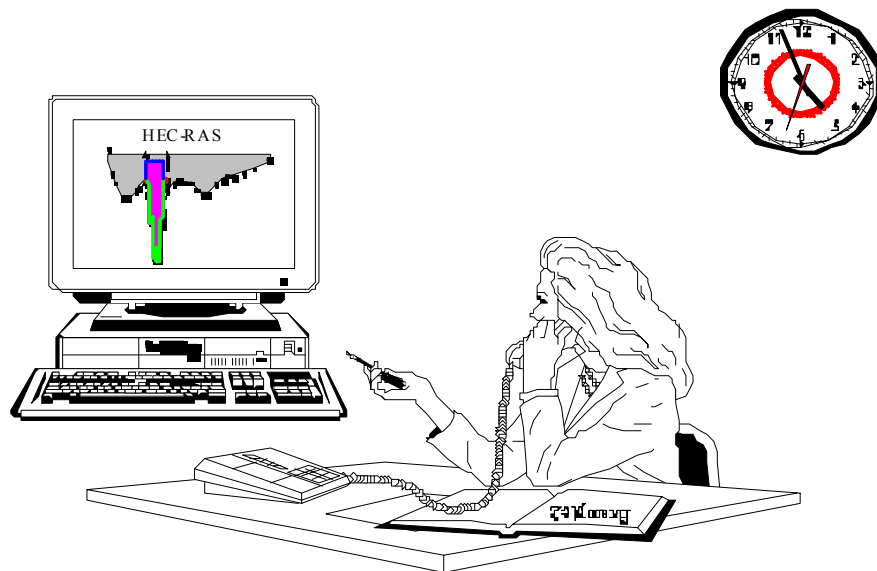




**US Army Corps  
of Engineers**  
Hydrologic Engineering Center

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# HEC-RAS



## River Analysis System

### Applications Guide

Version 3.0  
January 2001

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### **Applications Guide**

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US Army Corps of Engineers  
Institute for Water Resources  
Hydrologic Engineering Center  
609 Second Street  
Davis, CA 95616

(530) 756-1104  
(530) 756-8250 FAX  
[www.hec.usace.army.mil](http://www.hec.usace.army.mil)



# Table of Contents

<b>Foreword</b> .....	xi
<b>Introduction</b> .....	xii
<b>Example 1 Critical Creek</b> .....	1-1
Purpose.....	1-1
Subcritical Flow Analysis .....	1-1
Geometric Data.....	1-1
Flow Data .....	1-3
Steady Flow Analysis .....	1-4
Subcritical Flow Output Review.....	1-5
Mixed Flow Analysis .....	1-11
Modification of Existing Geometry .....	1-11
Flow Data .....	1-13
Mixed Flow Analysis.....	1-13
Review of Mixed Flow Output.....	1-14
Summary ..	1-16
<b>Example 2 Beaver Creek - Single Bridge</b> .....	2-1
Purpose.....	2-1
Pressure/Weir Flow Analysis .....	2-1
River System Schematic .....	2-2
Cross Section Geometric Data.....	2-3
X-Y Coordinates .....	2-3
Reach Lengths .....	2-4
Manning's n Values.....	2-6
Levees .....	2-6
Contraction/Expansion Coefficients.....	2-7
Bridge Geometry Data.....	2-8
Bridge Deck and Roadway Geometry .....	2-8
Bridge Pier Geometry.....	2-10
Ineffective Flow Areas .....	2-13
Bridge Modeling Approach .....	2-14
Low Flow Methods .....	2-14
High Flow Methods.....	2-16
Steady Flow Data.....	2-17
Pressure/Weir Flow Simulation .....	2-19
Review of Pressure/Weir Flow Output.....	2-20
First and Second Flow Profiles .....	2-21
Third Flow Profile.....	2-22
Energy Method Analysis.....	2-22
Energy Method Data and Simulation.....	2-22
Review of Energy Method Output.....	2-23
Evaluation of Cross Section Locations .....	2-23
Expansion Reach Length .....	2-23

Contraction Reach Length .....	2-26
Expansion Coefficient .....	2-27
Contraction Coefficient .....	2-28
Model Calibration .....	2-29
Comparison of Energy and Pressure/Weir Flow Methods to Observed Data.....	2-31
Summary .....	2-33
<b>Example 3 Single Culvert (Multiple Identical Barrels) .....</b>	<b>3-1</b>
Purpose.....	3-1
Geometric Data .....	3-1
River System Schematic .....	3-2
Cross Section Geometry .....	3-3
Cross Section Placement.....	3-4
First Cross Section .....	3-6
Second Cross Section .....	3-8
Third Cross Section .....	3-8
Fourth Cross Section .....	3-8
Culvert Data.....	3-9
Deck/Roadway Data.....	3-9
Culvert Geometric Data.....	3-11
Steady Flow Data .....	3-16
Flow Data .....	3-16
Boundary Conditions.....	3-16
Steady Flow Analysis.....	3-18
Output Analysis.....	3-19
Expansion and Contraction Reach Length Evaluations.....	3-19
Expansion Reach Length.....	3-19
Contraction Reach Length.....	3-20
Channel Contraction and Expansion Coefficients .....	3-21
Expansion Coefficient .....	3-21
Contraction Coefficient .....	3-22
Water Surface Profiles.....	3-22
Summary ..	3-28
<b>Example 4 Multiple Culverts .....</b>	<b>4-1</b>
Purpose.....	4-1
Geometric Data .....	4-1
River System Schematic .....	4-2
Cross Section Geometry .....	4-2
Expansion and Contraction Reach Lengths .....	4-3
Culvert Data.....	4-3
Deck/Roadway Data.....	4-3
Culvert Geometric Data.....	4-3
Ineffective Flow Areas .....	4-8
Steady Flow Data .....	4-9
Steady Flow Analysis.....	4-9
Output Analysis.....	4-9

Expansion and Contraction Reach Lengths .....	4-10
Expansion Reach Length.....	4-10
Contraction Reach Length.....	4-11
Channel Contraction and Expansion Coefficients .....	4-12
Expansion Coefficient .....	4-12
Contraction Coefficient .....	4-12
Water Surface Profiles.....	4-13
Summary .. .....	4-16
 <b>Example 5 Multiple Openings</b> .....	5-1
Purpose.....	5-1
River System Geometric Data.....	5-2
River System Schematic.....	5-2
Cross Section Geometry .....	5-3
Placement of the Cross Sections.....	5-3
Bridge Geometry.....	5-3
Deck/Roadway Data .....	5-3
Piers and Abutments.....	5-5
Bridge Modeling Approach .....	5-5
Culvert Geometry.....	5-6
Multiple Openings.....	5-7
Stagnation Limits.....	5-8
Ineffective Flow Areas .....	5-10
Manning's n Values .....	5-11
Cross Section Locations.....	5-11
Expansion Reach Length .....	5-11
Contraction Reach Length .....	5-13
Coefficients of Expansion and Contraction.....	5-13
Steady Flow Analysis.....	5-14
Multiple Opening Output Analysis .....	5-15
Cross Section Placement Evaluation .....	5-15
Water Surface Profiles.....	5-15
Multiple Opening Profile Table.....	5-16
Summary .. .....	5-20
 <b>Example 6 Floodway Determination</b> .....	6-1
Purpose.....	6-1
Floodplain Encroachment Analysis Procedure .....	6-2
Base Flood Profile .....	6-4
Method 5 Optimization Procedure .....	6-4
Method 5 Steady Flow Data .....	6-4
Method 5 Encroachment Data .....	6-5
Method 5 Output Review .....	6-7
Method 4 Encroachment Analysis - Trial 1 .....	6-8
Method 4 Steady Flow Data - Trial 1 .....	6-9
Method 4 Encroachment Data - Trial 1 .....	6-10
Method 4 Output - Trial 1 .....	6-11
Method 4 Encroachment Analysis - Trial 2 .....	6-13

Method 4 Steady Flow Data - Trial 2 .....	6-13
Method 4 Encroachment Data - Trial 2 .....	6-14
Method 4 Output - Trial 2 .....	6-15
Method 4 Encroachment Analysis - Trial 3 .....	6-18
Method 1 Encroachment Analysis .....	6-19
Method 1 Steady Flow Data .....	6-19
Method 1 Encroachment Data .....	6-20
Method 1 Output .....	6-20
Summary ..	6-21
 <b>Example 7 Multiple Plans</b> .....	7-1
Purpose.....	7-1
Elements of a Project .....	7-1
Elements of a Plan.....	7-2
Existing Conditions Analysis .....	7-3
Existing Conditions Geometry.....	7-3
Steady Flow Data.....	7-5
Existing Conditions Plan .....	7-6
Existing Conditions Output .....	7-7
Proposed Conditions Analysis .....	7-8
Proposed Conditions Geometric Data .....	7-8
Steady Flow Data.....	7-9
Proposed Conditions Plan.....	7-9
Proposed Conditions Output.....	7-10
Comparison of Existing and Proposed Plans .....	7-10
Profile Plot.....	7-10
Cross Section Plots .....	7-12
Standard Table.....	7-13
Bridge Only Table .....	7-14
X-Y-Z Perspective Plot .....	7-15
Summary ..	7-16
 <b>Example 8 Looped Network</b> .....	8-1
Purpose.....	8-1
Geometric Data .....	8-1
River System Schematic .....	8-1
Cross Section Data .....	8-2
Stream Junction Data.....	8-3
Steady Flow Data .....	8-4
Profile Data.....	8-4
Boundary Conditions.....	8-5
Steady Flow Analysis.....	8-6
Analysis of Results for Initial Flow Distribution .....	8-7
Steady Flow Analysis with New Flow Distribution.....	8-8
Analysis of Results for Final Flow Distribution.....	8-9
Summary ..	8-9



<b>Example 9 Mixed Flow Analysis</b> .....	9-1
Purpose.....	9-1
Geometric Data .....	9-1
River System Schematic .....	9-1
Cross Section Data .....	9-2
Location of the Cross Sections .....	9-2
Bridge Data.....	9-4
Deck/Roadway Data.....	9-4
Pier Data.....	9-5
Bridge Modeling Approach.....	9-6
Steady Flow Data .....	9-7
Profile Data.....	9-7
Boundary Conditions.....	9-8
Steady Flow Analysis.....	9-9
Review of Output for Energy Analysis .....	9-10
Water Surface Profile .....	9-10
Water Surface Profiles for Subcritical and Supercritical Flow Analyses .....	9-13
Profile Table - Bridge Comparison.....	9-15
Cross Section Table - Bridge.....	9-15
Pressure/Weir Analysis .....	9-17
Review of Output for Pressure/Weir Analysis .....	9-19
Water Surface Profile .....	9-19
Expansion and Contraction Reach Lengths .....	9-20
Expansion Reach Length.....	9-20
Contraction Reach Length.....	9-20
Bridge Comparison Table.....	9-21
Bridge Detailed Output Table.....	9-22
X-Y-Z Perspective Plot .....	9-23
Summary ..	9-24
 <b>Example 10 Stream Junction</b> .....	10-1
Purpose.....	10-1
Geometric Data .....	10-1
River System Schematic .....	10-1
Cross Section Placement.....	10-3
Cross Section Data .....	10-4
Stream Junction Data - Energy Method.....	10-5
Steady Flow Data .....	10-6
Steady Flow Analysis (Stream Junction Energy Method).....	10-8
Review of Output for Stream Junction Energy Analysis .....	10-9
Water Surface Profile .....	10-9
Standard Table 2.....	10-10
Steady Flow Analysis (Stream Junction Momentum Method).....	10-11
Review of Output for Stream Junction Momentum Analysis .....	10-13
Water Surface Profile .....	10-13
Standard Table 2.....	10-14
Comparison of Energy and Momentum Results .....	10-15

Summary ..	10-17
<b>Example 11 Bridge Scour</b> .....	11-1
Purpose.....	11-1
Geometric Data .....	11-2
Steady Flow Data .....	11-3
Steady Flow Analysis.....	11-4
Hydraulic Design - Bridge Scour .....	11-5
Contraction Scour .....	11-6
Pier Scour .....	11-8
Abutment Scour.....	11-9
Total Bridge Scour .....	11-10
Summary ..	11-12
<b>Example 12 Inline Weir and Gated Spillway</b> .....	12-1
Purpose.....	12-1
Geometric Data .....	12-1
Cross Section Data .....	12-2
Inline Weir .....	12-2
Gated Spillway .....	12-5
Ineffective Flow Areas .....	12-7
Cross Section Placement.....	12-8
Steady Flow Data .....	12-9
Flow Profiles .....	12-9
Boundary Conditions.....	12-10
Gate Openings .....	12-11
Steady Flow Analysis.....	12-13
Output Analysis.....	12-13
Water Surface Profiles.....	12-13
Inline Weir Detailed Output Table .....	12-14
Inline Weir Profile Summary Table.....	12-17
Summary ..	12-18
<b>Example 13 Bogue Chitto - Single Bridge (WSPRO)</b> .....	13-1
Purpose.....	13-1
Geometric Data .....	13-2
River System Schematic .....	13-2
Cross Section Geometric Data.....	13-3
Cross Section Placement.....	13-4
Bridge Geometry Data.....	13-7
Bridge Deck and Roadway Geometry .....	13-7
Bridge Pier Geometry.....	13-9
Sloping Abutments .....	13-10
Ineffective Flow Areas .....	13-11
Bridge Modeling Approach .....	13-14
Low Flow Methods .....	13-14
High Flow Methods.....	13-17
Steady Flow Data .....	13-18

Steady Flow Analysis.....	13-20
Review of Output.....	13-21
Water Surface Profiles.....	13-21
Profile Tables.....	13-23
Detailed Output Tables.....	13-26
Evaluation of Cross Section Locations .....	13-26
Expansion Reach Length .....	13-27
Contraction Reach Length .....	13-28
Expansion and Contraction Coefficients .....	13-29
Summary .....	13-29
 <b>Example 14 Ice-Covered River .....</b>	 14-1
Purpose .....	14-1
Open Water Analysis .....	14-2
Open Water Geometry.....	14-2
Steady Flow Data.....	14-2
Open Water Plan.....	14-3
Open Water Output.....	14-3
Ice Cover Analysis .....	14-3
Ice Cover Geometry.....	14-3
Steady Flow Data.....	14-4
Ice Cover Plan .....	14-4
Ice Cover Output .....	14-4
Ice Jam Analysis .....	14-5
Ice Jam Geometry.....	14-5
Steady Flow Data.....	14-6
Ice Jam Plan.....	14-6
Ice Jam Output.....	14-6
Comparison of Open Water, Ice Cover, and Ice Jam Results .....	14-7
Profile Plot.....	14-7
Ice Table .....	14-9
 <b>Example 15 Split Flow Junction With Lateral Weir/Spillway .....</b>	 15-1
Purpose .....	15-1
Geometric Data .....	15-1
Stream Junction Data.....	15-2
Cross Section Data .....	15-3
Lateral Weir.....	15-4
Gated Spillway .....	15-6
Steady Flow Data .....	15-8
Flow Profiles .....	15-8
Boundary Conditions.....	15-9
Gate Openings .....	15-10
Steady Flow Analysis.....	15-11
Output Analysis.....	15-13
Water Surface Profiles.....	15-13
Lateral Weir Detailed Output Table .....	15-14
Lateral Weir Profile Summary Table.....	15-15

Junction Profile Summary Table .....	15-16
Standard Profile Summary Table.....	15-17
Additional Adjustments .....	15-18
Junction Flow Splits .....	15-18
Lateral Weir Splits.....	15-18
Summary .....	15-19
 <b>Example 16 Channel Modification .....</b>	 16-1
Purpose .....	16-1
Geometric Data .....	16-1
Channel Modification Data.....	16-1
Performing The Channel Modifications .....	16-4
Saving The Channel Modifications .....	16-4
Steady Flow Analysis.....	16-5
Comparing Existing and Modified Conditions .....	16-5
Steady Flow Analysis .....	16-5
Water Surface Profiles.....	16-6
Cross Section Plots .....	16-7
X-Y-Z Perspective Plot .....	16-8
Standard Table.....	16-9
Summary .....	16-10
 <b>Example 17 Unsteady Flow Application .....</b>	 17-1
Purpose .....	17-1
Geometric Data .....	17-1
General Description.....	17-1
Creating Storage Areas .....	17-3
Entering Data for a Storage Area.....	17-5
Lateral Weir Connected to a Storage Area .....	17-6
Hydraulic Connections .....	17-8
Parameters for Hydraulic Tables .....	17-9
Cross Section Table Parameters .....	17-10
Unsteady Flow Data.....	17-11
Boundary Conditions.....	17-11
Upstream Boundary Condition .....	17-12
Downstream Boundary Condition .....	17-14
Initial Conditions .....	17-14
Unsteady Flow Analysis.....	17-16
Simulation Time Window.....	17-16
Computation Settings .....	17-17
Location of Stage and Flow Hydrographs .....	17-17
Unsteady Flow Simulation .....	17-18
Geometric Pre-Processor (HTAB).....	17-18
Unsteady Flow Simulation and Post-Processor .....	17-20
Summary .....	17-24
 <b>Appendix A References .....</b>	 A-1

## Foreword

The U.S. Army Corps of Engineers' River Analysis System (HEC-RAS) is software that allows you to perform one-dimensional steady and unsteady flow river hydraulics calculations. The HEC-RAS software supersedes the HEC-2 river hydraulics package, which was a one-dimensional, steady flow water surface profiles program. The HEC-RAS software is a significant advancement over HEC-2 in terms of both hydraulic engineering and computer science. This software is a product of the Corps' Civil Works Hydrologic Engineering Research and Development Program.

The first version of HEC-RAS (version 1.0) was released in July of 1995. Since that time there have been several releases of this software package, including versions: 1.1; 1.2; 2.0; 2.1; 2.2; 2.21; and now version 3.0 in January of 2001.

Version 3.0 of HEC-RAS is a major advancement over the previous 2.21 version. This new version (3.0) includes unsteady flow routing, as well as split flow optimization for steady flow modeling.

The HEC-RAS software was developed at the Hydrologic Engineering Center (HEC), which is a division of the Institute for Water Resources (IWR), U.S. Army Corps of Engineers. The software was designed by Mr. Gary W. Brunner, leader of the HEC-RAS development team. The user interface and graphics were programmed by Mr. Mark R. Jensen. The steady flow water surface profiles module was programmed by Mr. Steven S. Piper. The unsteady flow equation solver was developed by Dr. Robert L. Barkau. The routines that import HEC-2 and UNET data were developed by Ms. Joan Klipsch. The cross section interpolation routines were developed by Mr. Alfredo Montalvo. The routines for modeling ice cover and wide river ice jams were developed by Mr. Steven F. Daly of the Cold Regions Research and Engineering Laboratory (CRREL).

Many of the HEC staff made contributions in the development of this software, including: Vern R. Bonner, Richard Hayes, John Peters, and Michael Gee. Mr. Darryl Davis was the director during the development of this software.

This manual was written by John C. Warner, Gary W. Brunner, Brent C. Wolfe, and Steven S. Piper.

# Introduction

Welcome to the Hydrologic Engineering Center's River Analysis System (HEC-RAS). This software allows you to perform one-dimensional steady flow, unsteady flow, and sediment transport calculations (The current version of HEC-RAS can only perform steady flow calculations. Unsteady flow and sediment transport will be added in future versions).

The HEC-RAS modeling system was developed as a part of the Hydrologic Engineering Center's "Next Generation" (NexGen) of hydrologic engineering software. The NexGen project encompasses several aspects of hydrologic engineering, including: rainfall-runoff analysis; river hydraulics; reservoir system simulation; flood damage analysis; and real-time river forecasting for reservoir operations.

This introduction discusses the documentation for HEC-RAS and provides an overview of this manual.

## **Contents**

- HEC-RAS Documentation
- Overview of this Manual

## HEC-RAS Documentation

The HEC-RAS package includes several documents. Each document is designed to help the user learn to use a particular aspect of the modeling system. The documentation is arranged in the following three categories:

Documentation	Description
<i>User's Manual</i>	This manual is a guide to using HEC-RAS. The manual provides an introduction and overview of the modeling system, installation instructions, how to get started, simple examples, detailed descriptions of each of the major modeling components, and how to view graphical and tabular output.
<i>Hydraulic Reference Manual</i>	This manual describes the theory and data requirements for the hydraulic calculations performed by HEC-RAS. Equations are presented along with the assumptions used in their derivation. Discussions are provided on how to estimate model parameters, as well as guidelines on various modeling approaches.
<i>Applications Guide</i>	This document contains examples that demonstrate various aspects of HEC-RAS. Each example consists of a problem statement, data requirements, general outline of solution steps, displays of key input and output screens, and discussions of important modeling aspects.

## Overview of this Manual

This **Applications Guide** contains written descriptions of 17 examples that demonstrate the main features of the HEC-RAS program. The project data files for the examples are contained on the HEC-RAS program distribution diskettes, and will be written to the HEC\RAS\STEADY and HEC\RAS\UNSTEADY directories when the program is installed. The discussions in this manual contain detailed descriptions for the data input and analysis of the output for each example. The examples display and describe the input and output screens used to enter the data and view the output. The user can activate the projects within the HEC-RAS program when reviewing the descriptions for the examples in this manual. All of the projects have been computed, and the user can review the input and output screens that are discussed as they appear in this manual. The user can use the zoom features and options selections (plans, profiles, variables, reaches, etc.) to obtain clearer views of the graphics, as well as viewing additional data screens that may be referenced to in the discussions. The examples are intended as a guide for performing similar analyses. This manual is organized as follows:

- **Example 1, Critical Creek**, demonstrates the procedure to perform a basic flow analysis on a single river reach. This river reach is situated on a steep slope, and the analysis was performed in a mixed flow regime to obtain solutions in both subcritical and supercritical flows. Additionally, the example describes the procedure for cross section interpolation.
- **Example 2, Beaver Creek - Single Bridge**, illustrates an analysis of a single river reach that contains a bridge crossing. The data entry for the bridge and determination for the placement of the cross sections are shown in detail. The hydraulic calculations are performed with both the energy and pressure/weir flow methods for the high flow events. Additionally, the model is calibrated with observed high flow data.
- **Example 3, Single Culvert (Multiple Identical Barrels)**, describes the data entry and review of output for a single culvert with two identical barrels. Additionally, a review for the locations of the cross sections in relation to the culvert is presented.
- **Example 4, Multiple Culverts**, is a continuation of Example 3, with the addition of a second culvert at the same cross section. The second culvert also contains two identical barrels, and this example describes the review of the output for multiple culverts.
- **Example 5, Multiple Openings**, presents the analysis of a river reach that contains a culvert opening (single culvert with multiple identical barrels), a main bridge opening, and a relief bridge opening all occurring at the same cross section. The user should be familiar with individual bridge and culvert analyses before reviewing this example.
- **Example 6, Floodway Determination**, illustrates several of the methods for floodplain encroachment analysis. An example procedure for the floodplain encroachment analysis is performed. The user should be aware of the site specific guidelines for a floodplain encroachment analysis to determine which methods and the appropriate procedures to perform.
- **Example 7, Multiple Plans**, describes the file management system used by the HEC-RAS program. The concepts of working with projects and plans to organize geometry, flow, and other files are described. Then, an application is performed to show a typical procedure for organizing a project that contains multiple plans.
- **Example 8, Looped Network**, demonstrates the analysis of a river system that contains a loop. The loop is a split in the main channel that forms two streams which join back together. The example focuses on the procedure for balancing of the flows around the loop.
- **Example 9, Mixed Flow Analysis**, describes the use of a mixed flow regime to analyze a river reach containing a bridge crossing. The bridge crossing



constricts the main channel supercritical flow, creating a subcritical backwater effect, requiring the use of the mixed flow regime for the analysis. Results by subcritical and supercritical flow regime analyses are presented to show inconsistencies that developed, and to provide guidance when to perform a mixed flow analysis.

- **Example 10, Stream Junction**, demonstrates the analysis of a river system that contains a junction. This example illustrates a flow combining of two subcritical streams, and both the energy and momentum methods are used for two separate analyses.
- **Example 11, Bridge Scour**, presents the determination of a bridge scour analysis. The user should be familiar with the procedures for modeling bridges before reviewing this example. The scour equations and procedures are based upon the methods outlined in Hydraulic Engineering Circular No. 18 (FHWA 1995).
- **Example 12, Inline Weir and Gated Spillway**, demonstrates the analysis of a river reach that contains an inline weir and a gated spillway. Procedures for entering the data to provide flexibility for the flow analysis are provided.
- **Example 13, Bogue Chitto - Single Bridge (WSPRO)**, performs an analysis of a river reach that contains a bridge crossing. The example is similar to Example 2, however, all of the water surface profiles are low flow and are computed using the WSPRO (FHWA, 1990) routines that have been adapted to the HEC-RAS methodology of cross section locations around and through a bridge.
- **Example 14, Ice-Covered River**, is an example of how to model an ice covered river as well as a river ice-jam.
- **Example 15, Split Flow Junction With Lateral Weir and Spillway**, is an example of how to perform a split flow optimization with the steady flow analysis portion of the software. This example has a split of flow at a junction, as well as a lateral weir.
- **Example 16, Channel Modification**. This example demonstrates how to use the channel modification feature within the HEC-RAS Geometric Data Editor. Channel modifications are performed, and existing and modified conditions geometry and output are compared.
- **Example 17, Unsteady Flow Application**. This example demonstrates how to perform an unsteady flow analysis with HEC-RAS. Discussions include: entering storage area information; hydraulic connections; unsteady flow data (boundary conditions and initial conditions); performing the computations; and reviewing the unsteady flow results.
- **Appendix A** contains a list of references.