Chapter 1
Introduction

1-1. Purpose

This manual presents the techniques and procedures that are used to investigate and resolve river engineering and analysis issues and the associated data requirements. It also provides guidance for the selection of appropriate methods to be used for planning and conducting the studies. Documented herein are past experiences that provide valuable information for detecting and avoiding problems in planning, performing, and reporting future studies. The resolution of river hydraulics issues always requires prediction of one or more flow parameters; be it stage (i.e., water surface elevation), velocity, or rate of sediment transport. This manual presents pragmatic methods for obtaining data and performing the necessary computations; it also provides guidance for determining the components of various types of studies.

1-2. Scope

Procedures for conducting river hydraulic investigations are presented herein with minimal theory. Details of the theoretical principles of river hydraulics can be found in standard textbooks and publications that are referenced throughout this manual. Each chapter provides general information and guidance to assist and support decisions regarding choice of the most appropriate analytical and/or modeling methods and data acquisition for specific circumstances.

1-3. Applicability

This guidance applies to HQUSACE elements, major subordinate commands, laboratories, and field operating activities having civil works responsibilities.

1-4. References

References are listed in Appendix A.

1-5. Needs for River Hydraulics Studies

Missions of the Corps of Engineers include the development and maintenance of flood control and navigation systems. It is the policy of the Corps of Engineers to plan, design, construct, and provide for the maintenance of safe, functional, cost-effective projects. River hydraulic analyses are an essential component of most riverine projects, and the results from these analyses are often critical to project formulation, design, construction, and operation throughout the project's life. River hydraulics includes the evaluation of flow characteristics and geomorphic (physical) behavior of rivers and changes in these due to natural or man-made conditions.

As examples, determination of the elevations of dams, spillways, levees, and floodwalls requires both hydrologic and hydraulic computations. A major component of studies related to floodplain information, flood control channel design, navigation, water quality assessment, environmental impact and enhancement analysis, is the prediction of stage, discharge, and velocity as functions of time anywhere on a river. Environmental aspects of river engineering often require the prediction of stage, velocity distributions, sediment transport rates, and water quality characteristics, to evaluate the impacts of proposed actions on future river characteristics. Study of any type of river project requires a thorough evaluation of the possible impacts that it may have, both upstream and downstream from the location of the project itself. Prediction of the operation, maintenance, and repair or replacement requirements of existing and proposed projects is another role that river hydraulics studies play in the Corps' planning and design processes.

1-6. General Methods

Reliable assessment and resolution of river hydraulics issues depend on the engineer's ability to understand and describe, in both written and mathematical forms, the physical processes that govern a river system. Provided herein are background information and technical procedures necessary to perform river hydraulics engineering studies. This manual provides river engineers at all levels of experience with a wide range of practical field examples, diagnostic advice, and guidance for performing river hydraulics investigations. Three categories of methods for predicting river hydraulic conditions were identified by Rouse (1959). The first and oldest uses engineering experience acquired from previous practice by an individual. The second utilizes laboratory scale models (physical models) to replicate river hydraulic situations at a specific site or for general types of structures. Laboratory modeling has been in extensive and successful use for at least the past 60 years. The third category is application of analytical (mathematical) procedures and numerical modeling. Recent use of physical and numerical modeling in combination, guided by engineering experience, is termed "hybrid modeling" and has been very successful.

a. Field experience. Field experience is an extremely valuable asset for an engineer, yet planning and design based only on experience may not yield a defensible and reproducible product. Design by experience alone may result in inefficient trial-and-error procedures. Furthermore, the rationale for the design may be lost if the person with the experience becomes unavailable.

b. Physical models. Application of physical models has evolved into a dependable and reproducible procedure for analyzing river hydraulics. Physical modeling techniques are documented by the U.S. Department of the Interior (1980), Petersen (1986), and ASCE (1942). These references provide guidance for planning and conducting river hydraulics studies using physical models.

c. Analytical procedures. Application of analytical (mathematical) procedures and numerical modeling have become accepted methods for analyzing river hydraulics and are the focus of this manual.

d. River behavior. The most thorough contemporary strategy for analyzing and predicting river behavior and response to imposed changes combines all three of the methods mentioned above; this is known as hybrid modeling.

1-7. Organization

Seven chapters, followed by four appendixes, detailing guidelines, data requirements, and computational procedures are presented. The chapters are: Introduction, Introduction to River Hydraulics, Formulating Hydraulic Studies, Multidimensional Flow Analysis, Unsteady Flow, Steady Flow - Water Surface Profiles, and Water Surface Profiles With Movable Boundaries. Guidance for selecting appropriate study and design procedures is given in each chapter along with examples. The order of the technical chapters (4, 5, 6, and 7) is intended to show how each successive approach derives from the prior approach. References are in Appendix A. Appendix B provides definitions of the technical terms used throughout this document. Appendix C overviews reporting requirements and the development of a study work plan. Appendix D gives guidance on the preparation of geometric data and selection of energy loss coefficients based upon past experience. This information is generally applicable to all the methods presented in this manual; therefore, Appendix D should be consulted prior to embarking on any river hydraulics study. This manual is not intended to be read straight through; there is, therefore, some redundancy among Chapters 4, 5, 6, 7, and Appendix D with regard to such items as calibration procedures and parameter selection.