

WATER MEASUREMENT MANUAL

**3rd
Revised
Edition**

*A Guide to Effective Water Measurement
Practices for Better Water Management*

A WATER RESOURCES TECHNICAL PUBLICATION



*U. S. Department of the Interior
Bureau of Reclamation*

Water Measurement Manual

Third Revised Edition

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PREFACE

The mission of many public and private water resources organizations is to manage and conserve existing water supplies. These management efforts involve making sound technical and economic decisions concerning new and existing water needs, while respecting the environment by sustaining or restoring the aquatic ecosystems which may be affected. One key to better management practices, including water conservation, is reliable and accurate water measurement. The term "water measurement" as used in this manual refers to the measurement of flow (unit volume per unit time). Major advances in measurement technology along with a continued demand for the *Water Measurement Manual* are responsible for initiating this revision.

The first edition of the *Water Measurement Manual* (1953) had a distribution of 11,000 copies and was compiled from the Bureau of Reclamation (Reclamation) publication *Manual for Measurement of Irrigation Water* (1946). This previous manual had five earlier editions beginning in 1913 and extending to 1940. The continual demand for the *Water Measurement Manual* and the need for updating resulted in the second edition (1967). From 1967 to 1984, two revised reprints plus five reprints of the second edition were published. The demand and need for the second edition has continued because of conservation pressure and increased user competition for water; therefore, this third edition was prepared to supplement and update information contained in the second edition.

Modern trends of technical practice, along with the developments in personal computers, have resulted in increased emphasis on using custom-fitted, long-throated measurement structures that can be designed to measure flow and are simpler to fabricate. Consequently, fewer short-form flumes are being considered for new installations. Thus, information on Parshall flumes has been reduced and incorporated in the more general "Flumes" chapter, which recommends long-throated flumes for new installation in preference to Parshall flumes.

The main Parshall flume information retained in this edition relates to maintenance and operation needs of existing flumes, including flume dimensions, free flow measurement, submerged flow measurement, and head losses. The sections on size selection and setting crest elevation for Parshall flumes have been deleted or reduced in this edition. Where Parshall flumes may be desired or required by State law, examples in the previous editions of the manual can be referred to for size selection and setting the crest elevation.

New chapters and sections were added to make the third edition more current technologically and more useful to other government organizations. The new chapters added are:

- Basic Concepts Related to Flowing Water and Measurement
- Selection of Water Measuring Devices
- Measurement Accuracy
- Inspection of Water Measurement Systems
- Acoustic Flow Measurement
- Discharge Measurement Using Tracers

Russ Dodge was the primary author/editor for the revisions in this third edition. Reclamation especially appreciates the efforts of John Replogle and Albert Clemmens (from the U.S. Water Conservation Laboratory) of the Agricultural Research Service for writing major portions of chapters or separate sections relating to selection of devices, long-throated flumes, overshot weirs, and other devices, as well as for reviewing revisions of the entire manual.

Reclamation is also indebted to the U.S. Natural Resources Conservation Service, formerly the Soil Conservation Service, for contribution of material and reviews by Leland Hardy and Thomas Spofford. In addition to personnel from outside organizations, several Reclamation personnel contributed to revisions of new sections and chapters. Warren Frizell revised the chapter on measuring and recording water stage or head and conducted a peer review of the manual. Tracy Vermeyen wrote the chapter on acoustic flow measurements. Brent Mefford wrote much of the chapter on selection of water measurement devices. Dave Rogers wrote the section on radial gate flow measurements and the use of the RADGAT computer program. Tony Wahl compiled the tables in appendix A. Cliff Pugh coordinated the assembly, reviews, and publication. Jerry Fitzwater assembled and modified many of the drawings and figures. Tom Hovland was the primary technical editor in charge of publication editing and organization, and Teri Manross did the desktop publishing and copy editing. Jim Higgs created the online version of the manual, which is available at www.usbr.gov/pmts/hydraulics_lab/pubs/wmm/

Certain trade names appear in the manual. Mention of such names should not be construed as an endorsement or recommendation of a product by the Bureau of Reclamation, Agricultural Research Service, or Natural Resource Conservation Service.

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