Common problems in actual weir installations are insufficient pool upstream (often from sediment accumulation), non-level crest, and the use of 2-inch boards instead of sharp edges for the crest.

FLUMES

Parshall (Fig. 2) and other types of flumes have advantages of lower head loss and of passing the sediment on through but are more costly to fabricate and install. Non-level flumes and improper installation (insufficient crest height) are the most common problems. Cutthroat flumes (developed at USU) are simpler to construct than Parshalls and can operate as free flow conditions at a higher degree of submergence. The long-throated ramp flume (also known as a broad-crested-weir) has strong advantages in flat ditches or canals as free flow conditions can be maintained at 90% submergence and above.

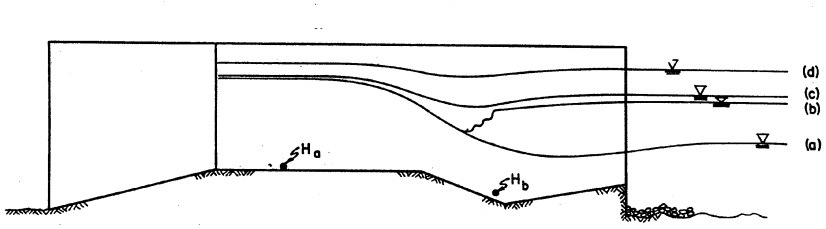

Figure 2. Illustration of fre flow and submerged flow in a Parshall flume. Figure a,b-freeflow; c-transition; and d-submerged.

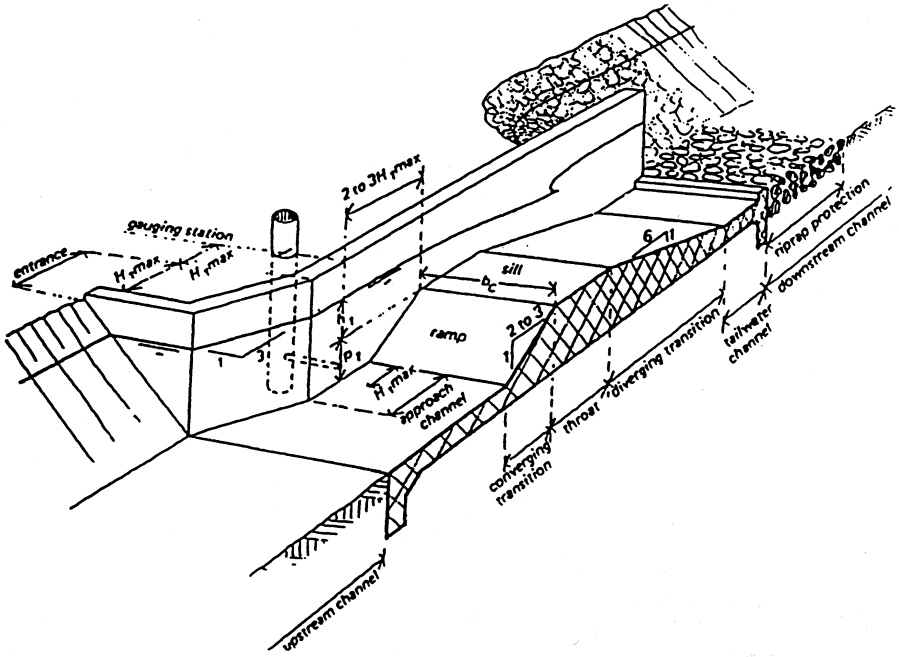

Figure 3. Ramp flume measurement structure for earthen channel with a rectangular control section.

CLOSED CONDUIT-PIPELINE

In-line propeller or turbine meters and impeller (small paddle wheel) transducer velocity meters are most commonly used to measure pipeline flow rates. Proper installation is critical for each, as is a rigorous maintenance program. Usually, most of the problems can be traced to partially full pipes, debris or chemical deposits and lack of peventative maintenance. While some still have mechanical readout of flowrate and accumulated volume, many are electronically operated.

WATER LEVEL RECORDING DEVICES

Three types of currently available water level recording devices are: mechanical chart recorder with a float; digital (electronic) recorder with mechanical float, and digital recorder with an electronic water level sensor. Electronic recording devices are being used instead of the usual strip chart to provide accurate stage height records with much less manual effort and time in many areas of the Western U.S. Electronic recorders have the advantage of allowing digital data transfer directly to a computer. This greatly simplifies data entry and analysis and allows the use of spreadsheet software for preparing water use reports.

Mechanical chart recorders, with float and pulley, produce a continuous paper graph of water level (or stage) and time. Some can be interfaced to digital recorders in addition to the chart.

Electronic data logging equipment can be interfaced to various types of water level detecting devices and are available from several companies. The most economical is a single input datalogger which connects to a mechanical float and pulley assembly. Water level is sampled at a user specified interval and recorded on a solid state storage module. The data can be retrieved manually in the field with a laptop portable PC or the storage module can be removed and connected to a desktop computer for data transfer.

Electronic water level sensors include pressure transducers and ultrasonic depth sensors. The ultrasonic depth sensors are an accurate non-contact sensor that can be mounted above any liquid surface.

WHERE TO FIND HELP

A list of possible sources of water measurement instrumentation and devices is on page 4 herein. Many suppliers provide on-site assistance with installation and operation. The local NRCS (formerly SCS) office can also be a source of technical assistance. For more information and/or technical assistance with your water measurement needs, contact your county Cooperative Extension Agent or the University Extension Irrigation Specialist.

County Extension offices can obtain pocket booklets (i.e. Wyoming. 583R) with standard tables of stage and discharge for weirs and flumes.

TYPICAL PRICES FOR VARIOUS INSTRUMENTATION AND DEVICES

Prices shown are approximate list prices from recent vendor literature for single unit purchases. Optional accessory configurations may account for considerable price variations.

Current Meters, Flow Meters, and Velocity Meters

* Current Meter with Rod, Price AA type	$1300
Mini (pygmy)	$1150
(add about $1,000 for digital readout)	

* Propeller Type Hand held Velocity Meter $700 - $800
(Global Flow Probe)

* Magnetic Field Portable Velocity Meter $3500
(no moving parts)

* Ultrasonic Flow Meters (portable)
Doppler $2000 - $3000 or more
Transit Time $4000 - $13,000

Pipeline

* Impeller Transducer Flow Meters with Electronic Readout $600 plus
(Grain land, Flow Research, Data Industrial, etc.)

* Venturi shunt meter (10" dia) $650

* In-line propeller or turbine with mechanical readout

8" dia flange tube	$ 700 - $1300	12" dia flange tube	$ 800 - $1900
8" dia saddle	$ 650	12" dia saddle	$ 720

Flumes

Parshall, Cutthroat, Trapezoidal, Ramp

Cost varies considerable depending on whether unit was purchased prefabricated ready to install, preformed (needs assembly prior to installation), or fabricated locally (by self or metal shop, etc.)

***** Preformed Galvanized 2' Parshall (needs assembly) $1200

* Prefabricated Fiberglass 4' ramp flume $1600 - $2400 or more
(make your own out of concrete or steel for $800 - $1200)

Water Level Recorders

* Mechanical Chart $1300 - $2600 (adds $1400 + for digital output)

*Electronic

Sensors:		Dataloggers:	
Float and Pulley Assembly	$350 - $400	single input	$ 500
Pressure Transducer	$500 - $1500+	3 sensor input	$1100
Interface equipment accessories	$500 - $1200	multiple input (10-16 sensor)	$1200 - $2500

Note: The use of brand names (shown in italics) is illustrative only and does not imply endorsement.

POSSIBLE SOURCES OF INSTRUMENTATION AND EQUIPMENT

WATER MEASUREMENT FLUMES:

CONTECH CONSTRUCTION
1935 North 900 West
Salt Lake City, UT 84115
Phone: (801) 487-7741
(800) 452-1457
FAX: (801)487-4517

FIBERGLASS STRUCTURE INC.
119 Washington Avenue
Laurel, MT 59044
Phone: (406) 628-8208

HINDE ENGINEERING
P.O. Box 737
Aromas, CA 95004-0737
Phone: (408) 726-2644

PLASTIFAB
P.O. Box 100
Tualatin, OR 97062
Phone: (503-692-5460

POWLUS MANUFACTURING
269 ½ Addison Avenue, West
Twin Falls, ID 83301
Phone: (208) 734-2060

WATERWORKS EQUIPMENT
801 West 12th Street
Ogden, UT 84233-5124
Phone: (800) 233-5124

Note: Also check with local sheet metal shops, etc. Adherence to standard dimensions **are a must!**

STAFF GAGES:

PORCELAIN ENAMEL
FINISHERS, INC.
3221 West 30th Street
Chicago, IL 60623
Phone: (312) 247-3221

WATER CONTROL GATES:

FRESNO VALVES & CASTINGS
(Formerly ARMCO)
7736 East Springfield Avenue
Selma, CA 93662
Phone: 834-2511

WATERMAN INDUSTRIES
SALES
6466 Supply Way
Boise, ID 83705
Phone: (208) 343-5478

FLOW/VELOCITY METERS:

MARSH-MCBIRNEY
4539 Metropolitan Court
Frederick, MD 21701
Phone: (800) 368-2723
FAX: (310) 874-2172

WATER MEASUREMENT AND OTHER INSTRUMENTATION, FLOWMETERS AND FLUMES

COOL EQUIPMENT COMPANY
353 West 3880 South3500 South Main
Salt Lake City, UT 84115
Phone: (801) 487-7741
FAX: (801) 487-4517

GOBLE, SAMPSON ASSOC., INC.
S3500 South Main Street, Suite 200
Salt Lake City, UT 84115
Phone: (801) 268-8790

INTERMOUNTAIN ENVIRONMENTAL
Suite B
601 West 1700 South
Logan, UT 84321
Phone: (435) 755-0774
FAX: (435) 755-0794

TRIMMER ENGINEERING
800 NW Starker Ave., #34
Corvallis, OR 97330
Phone: (503) 754-2819
FAX: (503) 754-0301

IRRIGATION AND WATER MEASUREMENT EQUIPMENT:

BULLENS, INC.
1427 North Main
Logan, UT 84321
Phone: (801) 752-7301

HADFIELD SPRINKLER & SUPPLY
50 South 1350 East
Lehi, UT 84043
Phone: (801) 768-3551

HARWARD IRRIGATION SYSTEMS INC.
1350 North Main
Spanish Fork, UT 84663
(800) 451-3201

MAIL ORDER CATALOGS FOR A VARIETY OF INSTRUMENTATION, FLOW METERS, WEATHER INSTRUMENTATION, ETC.:

BEN MEADOWS COMPANY
P.O. Box 80549
Atlanta (Chamblee), GA 30366
Phone: (800) 241-6401

FORESTRY SUPPLIERS, INC.
205 West Rankin Street
P.O. Box 8397
Jackson, MS 39284-8397
Phone: (800) 360-7788

NOVALYNX CORPORATION
P.O. Box 240
Grass Valley, CA 95945-0240
Phone: (916) 477-5226

WATER LEVEL RECORDING DEVICES AND ELECTRONIC DATA LOGGERS:

CAMPBELL SCIENTIFIC, INC.
P.O. Box 551
Logan, UT 84321
Phone: (435) 753-2342

LEUPOLD & STEVENS, INC.
P.O. Box 688
Beaverton, OR 97075-0688
Phone: (503) 656-9171

INTERMOUNTAIN ENVIRONMENTAL
601 W 1700 S
Logan, UT 84321
Phone: (435) 753-7300
FAX: (435) 755-0794

LUNDAHL INSTRUMENTS
4295 South Main
Logan, UT 84321
Phone: (435) 753-7300

Note: The generalized categories of vendors shown herein is not meant to imply any limits in available products or services. Several companies listed are dealers for a variety of instrumentation and devices.

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Israelsen, Orson W. and Vaughn E. Hansen. Irrigation Principles. 3rd ed. New York: John Wiley and Sons, Inc., 1962.

Skogerboe, Gaylord V., M. Leon Hyatt, J.D. England and J.R. Johnson. Design and Calibration of Submerged Open Channel Flow Measurement Structures, Part 2 - Parshall Flumes. Utah Water Research Laboratory, College of Engineering, Utah State University, 1967.

Water Measurement Manual. 3rd ed. U.S. Department of the Interior, Bureau of Reclamation. Denver, Co: U.S. Government Printing Office, 1997.

GLOSSARY - WATER MEASUREMENT TERMS

Acre Foot - A volume equal to one acre uniformly covered by water one foot deep. Equivalent to 12 acre inches. Also equal to 43,560 cubic feet, or about 325,850 gallons.

Acre Inch - A volume equal to one acre uniformly covered by water one inch deep.

CFS - See flowrate.

Continuity Equation - The notion that the same flowrate of water comes out of a system as went in; Qout = Qin, in a steady state. A steady state condition exists when there is no variation with time.

Flowrate - The product of cross-sectional area multiplied by average velocity of water moving through the cross-section, Q = AV. Typically expressed as cubic feet per second (cfs, also called second-feet); Q = ft^2 x ft per second or ft^3/sec.

Head - Depth of water above a reference point or datum, as in, "There is 10.1 feet of head on that pipe."

Staff Gage - A "ruler" used for measuring water depth or head. Usually, a porcelain coated flat steel strip with graduations marking feet, tenths and hundredths.

qt = ad One of the most important equations in irrigation engineering:

flowrate x time = area x depth.

In English units: cfs x hour ≅ acre x inch.

Exact equations are:

$$\frac{q(cfs) \times Hours}{1.0083} = Acres \times Inches$$

$$\frac{q(qpm) \times Hours}{452.54} = Acres \times Inches$$