Research Note

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FLOW METER FOR MEASURING GROUND WATER SEEPAGE FROM ROAD CUTS

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ABSTRACT

A flow meter, consisting of a small Parshall flume and an attached water level recorder, has been developed to continuously record ground water seepage from road cut banks. For low flow rates, inserts in the flume throat convert the Parshall flume to an orifice-type flow meter. The flow meter can easily register changes in ground water discharge caused by evapotranspiration.

INTRODUCTION

Roads constructed in steep mountainous terrain necessarily expose large areas of cut banks. If located in a high-precipitation zone, such as the Engelmann spruce-alpine fir forest in Idaho, the exposed cut banks may drain a considerable volume of ground water.[1]

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[1] Burroughs, E. R., Jr., and P. E. Packer. The effects of logging roads and timber cutting on the soil mantle hydrology of a spruce-fir forest. 1961. (Unpublished study plan on file at the Intermountain Forest and Range Experiment Station.)

In the systematic study of soil mantle hydrology, a metering device was needed to record cut bank seepage flow. The flow meter had to satisfy the following specifications:

1. Accurate over a wide range of flow rates.

2. Able to handle debris-laden water.

3. Able to operate for periods up to 1 week without maintenance.

4. Compact in design, allowing installation on the inside of the road, without interfering with vehicular traffic.

A small Parshall flume appeared to best fulfill the specifications. Plans developed by Robinson[2] at Colorado State University give dimensions for Parshall flumes with throat widths of 1, 2, and 3 inches. Both 1- and 2-inch flumes were installed for this study.

INSTALLATION

A typical installation, located at the lower end of a galvanized sheet metal trough, collects seepage from 100 feet of road cut bank (figs. 1 and 2). Between the collection trough and the flume is an 8- by 10- by 48-inch metal stilling section with wooden baffles in the bottom to trap sediment from earthslides and to reduce the approach velocity of water from the trough. For accurate measurements, the flume floor in the converging section must be level. This is best accomplished by inserting shims between the horizontal angle irons and the top of the flume walls (fig. 1). A short piece of $\frac{1}{2}$-inch copper tubing is soldered into the flume wall, and another into the stilling well; the flume and well are then connected by plastic hose one-half inch in inside diameter.

A section of culvert pipe 2 feet in diameter and 3 feet long forms the stilling well. Its concrete bottom, sealed against leakage, is bolted to a 24- by 15- by 10-inch concrete base with two 9- by 3/8-inch bolts. A 1- by 1- by 1/8-inch angle iron superstructure is mounted in the concrete base, to which a 3/4-inch exterior grade plywood deck is bolted. The water level recorder is positioned on the deck with the float pulley directly over the stilling well (fig. 2). The recorder clock weight operates in a length of capped galvanized stovepipe that prevents earthslides from interfering with the fall of the weight.

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[2] Robinson, A. R. Parshall measuring flumes of small sizes. Colorado State Univ. Tech. Bull. 61, 12 pp. 1957.

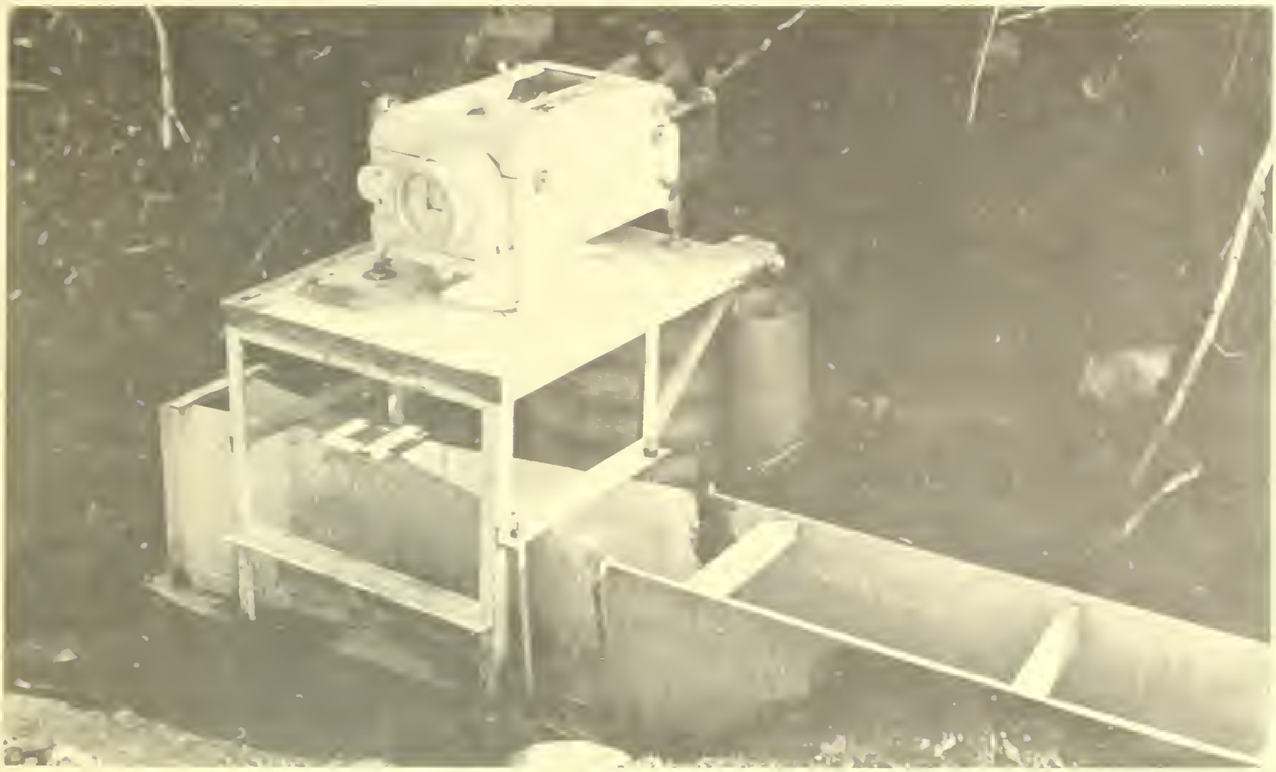
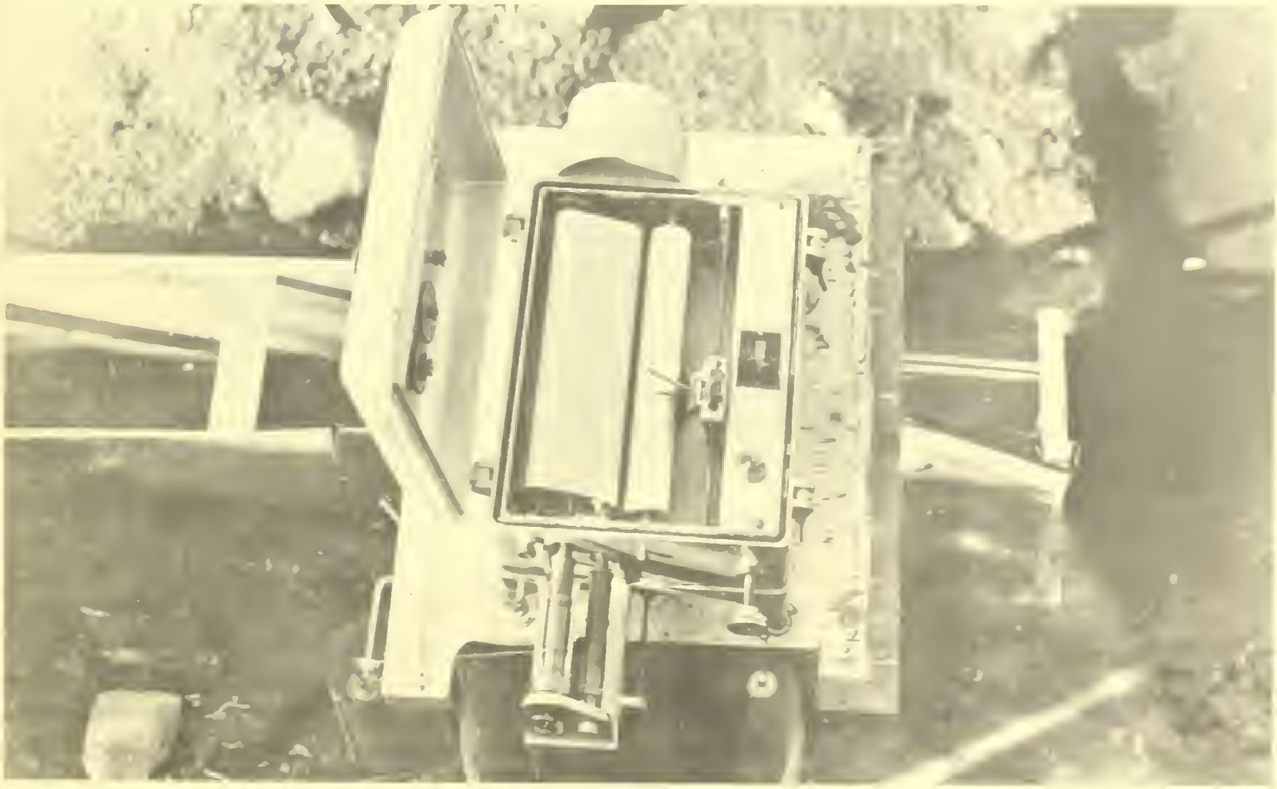


Figure 1.--General view of flow meter installation.
Note metal stilling section preceding the flume.
Figure 2.--Vertical view of flow meter installation.



OPERATION AND CALIBRATION

Two seasons' experience with this installation has demonstrated that when the head on the Parshall flume drops to 1 inch, its throat must be modified to permit continued accurate measurement of seepage flow. To modify the flume, its throat is reduced by using a graduated series of orifices, made in sheet aluminum inserts. The center of each orifice must be at least 1 inch above the bottom of the flume. An 8- by 8-inch piece of aluminum window screen in the flume's conveying section prevents submerged debris from plugging the orifice.

Head-discharge tables are given in Robinson's Technical Bulletin 61; however, small changes in dimensions, unavoidable during manufacture, make it advisable to field calibrate the flume. Careful field calibration of each orifice insert is an absolute necessity for accurate measurements. A series of volumetric flow measurements, taken as ground water discharge decreases, and corresponding head readings for each orifice will serve to define the head-discharge curve. Once head-discharge relations are known, templates can be made that, when laid on the recorder roll chart, will permit direct reading of discharge rates.

MAINTENANCE

Periodic maintenance on the installation is quickly and easily performed. The wooden baffles in the stilling section may be removed as required and accumulated sediment flushed through the flume. The hose connecting the stilling well and flume is large enough to pass silt and sand without causing erroneous readings. As a precaution, the float can be raised and lowered in the well to surge water through the hose and flush out sediment. This is done routinely whenever the recorder clock is rewound. Moreover, the head recorded on the roll chart can be checked at that time against head measured at the flume end of the hose connection.

A galvanized metal cover protects the recorder from weather. Plywood covers are placed over the stilling well and clock well openings when the installation is closed for the winter. The recorder can be sealed and left in place under its metal cover over winter, if logs are placed alongside the metal cover to bear the weight of snow. The roll chart should always be removed during the winter to prevent damage by condensation. The winterized installation can quickly be made operable for measurements of spring snowmelt.

CONCLUSION

This flow meter for measuring ground water seepage from road cut banks is easily built, operated, calibrated, and maintained. It measures small seepage flows continuously and accurately. For example, the flow meter records (1) slight increases in discharge caused by rainfall in the collecting trough and (2) definite diurnal fluctuations in seepage flow, from which a researcher can estimate evapotranspiration for the tributary area.