IMPLEMENTATION UPDATE

Drop-box weir for measuring flow rates under extreme flow conditions

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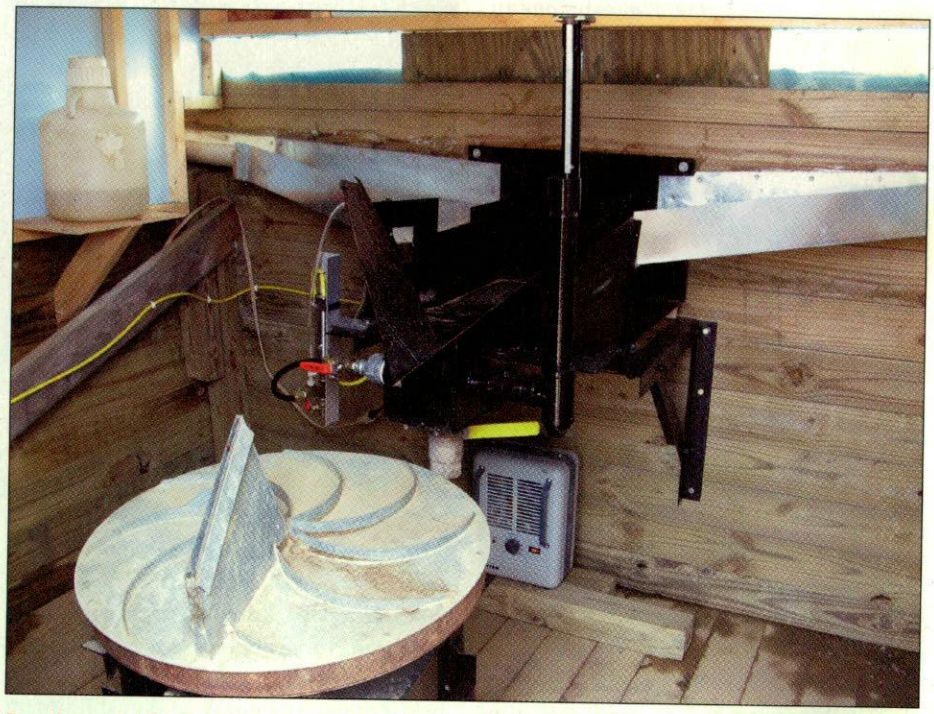
Measuring discharge rates in stream flows laden with sediment using precalibrated flow structures, such as flumes and weirs, is difficult and flow measurements can quickly become inaccurate. This is because large particles ranging from sand-sized particles to rocks easily clog the structures, changing the approach velocities and flow directions during a runoff event. These conditions often occur during extreme runoff events when there is sufficient transport capacity in the flows, causing deposition. Furthermore, assumptions are often made for individual structures regarding the approach conditions in a stream channel, such as a minimum channel slope and direction of flow. The drop-box weir is one of two flow-measuring devices (the other is the critical-depth flume) that can be used to monitor under these conditions and give accurate flow measurements.



Drop-box weir with Coshocton wheel installed on runoff plot used for a study of manure application on frozen ground.

The operating principle of the drop-box weir is to maximize the turbulence in stream flows to suspend large sediment particles. This is accomplished by forcing two water streams to flow into each other from opposite sides of a box, after falling into the box. The box is located upstream from a V-measuring section. At low flow rates, the water streams enter the box toward the front near the V section. At increasingly larger flows, the water streams enter over side weirs as water is concentrated in flows farther in the back of the box. For the drop-box configuration on runoff plots (see figure), runoff is precluded from overtopping the back wall of the box, but turbulence continues. However, for a watershed application, at extremely large flows water overtops the back wall of the box. Water depth is measured in the V section and converted to flows using a known rating curve.

The drop-box weir was invented in the 1960s for use in ranglenad studies at the Northwest Watershed Research Center, USDA Agricultural Research Service, in Boise, Idaho. The drop-box weir has been used successfully from small to large watersheds since its original development but has not seen widespread use due to inadequate documentation and lack of a universal low-flow rating curve.

Recent hydraulic studies at the North Appalachian Experimental Watershed, USDA Agricultural Research Service, have expanded the utility of the drop-box weir from large watershed flows to smaller flows from erosion plots (see figure), and additionally the low-flow rating curve has been developed. Furthermore, two composite samplers have been developed or adapted for use with the drop-box weir: a diverter sampler and a modified Coshocton wheel sampler (see figure). Recent research has also improved the design presentation.

Recent implementation of the drop-box weir includes at the outlets of 12- to 16-ha (30- to 40-ac) watersheds in Ohio in which the entire watershed was disturbed due to coal mining, causing significant transport of large rocks; erosion plots in surface mines in Ohio; rainfall-simulator plots in a study of western US rangeland erosion and infiltration; natural-precipitation erosion plots by the USDA Agricultural Research Service in Oregon; small watersheds operated by the National Soil Erosion Laboratory, USDA Agricultural Research Service, West Lafayette, Indiana; two watersheds that are being used in an urbanization study at Coshocton, Ohio; and in a watershed where copper was mined in California. The combined Coshocton wheel sampler and drop-box weir are now being used at Coshocton on large runoff plots (12 × 122 m [40 × 400 ft]) in a study of manure application on frozen ground.

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