

Use of Dye Tracing in Water-Resources Investigations in Wyoming, 1967-94

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Abstract

The U.S. Geological Survey has used dye tracing during many water-resources investigations in Wyoming. When mixed with flowing water, fluorescent dye can be traced to determine velocity (time of travel), dilution capacity, dispersion, and other information. This report describes results of all such investigations between 1967 and 1994, some of which previously were unpublished.

Time of travel and dispersion were measured in eight streams. A 113-mile reach of the Wind/Bighorn River below Boysen Dam was measured during 1971. Measurements were made during 1975 and 1977 in a 117-mile reach of the Green River upstream from Fontenelle Reservoir, in a 70-mile reach downstream, and in parts of four tributaries: East Fork River, Big Sandy River, Horse Creek, and Blacks Fork. A 75-mile reach of the Little Snake River along the Wyoming-Colorado State line was measured during 1976-77. The North Platte River downstream from Casper was measured during 1978 (36 miles) and twice during 1985 (95 and 94 miles).

Reaeration data were collected concurrently with the October 1985 time-of-travel measurements in the North Platte River. Propane gas and dye were traced through a 40-mile reach, starting at Casper. Reaeration coefficients, used as a measure of the capacity of the river to assimilate organic waste, were calculated for three subreaches.

Seventy dye-dilution measurements of stream discharge were made at 23 different sites. Five measurements, four using various antifreeze additives in the injection solution, were made in February 1967 under total ice cover in the Laramie River at Laramie as part of research to develop field procedures; four of the five were within 2 percent of a current-meter measurement made the same day. The accuracy of discharge-rating curves for streamflow-gaging stations on North and South Brush Creeks near Saratoga were verified with a series of 17 measurements during 1967-68. Similar results were obtained with eight measurements at the station on South Piney Creek near Story during 1971-78. A total of 25 discharge measurements were made during 1975-78 at 11 additional stations at remote sites on steep, rough mountain streams crossing outcrops of the Madison Limestone of Mississippian age in northeastern Wyoming. The largest discharge measured by dye tracing was 2,300

cubic feet per second at a station on the Tongue River. Most of the dye measurements were considered to be sufficiently accurate for use in defining the stage-discharge relation. Fifteen additional discharge measurements were made at eight other sites during 1971-82.

Four losing streams and one sinking stream in karst terrane were studied using dye tracing. In November 1970, dye injected into a sinkhole in the channel of the North Fork Powder River below Dullknife Reservoir was detected 16 hours later in a spring 5.8 miles downstream from the reservoir. In September 1974, dye injected into North Fork Crazy Woman Creek above zones of flow loss appeared as three separate peaks below springs about 1.3 miles downstream; 73 percent of the amount injected was accounted for by sampling. In October 1974, 35 percent of the dye injected into the Little Tongue River upstream from a losing reach was accounted for 2.6 miles to the north, in a stream in Tongue River Cave. This water eventually reaches the Tongue River, so at least part of the water lost in the Little Tongue does not represent recharge to the limestone aquifer. A dye test at Sinks Canyon State Park during August 1983 verified the connection of the Sinks (Sinks of Lander Cave) to the Rise, on the Middle Popo Agie River. The entire flow disappears into the cave, and surface flow resumes in large springs 3,500 feet downstream. The dye arrived 2 hours after injection, and 84 percent of the injected dye was accounted for by sampling. Dye was used in September 1991 to evaluate water loss in sinks between two stations on Smith Creek near Casper. A weak dye trace appeared at the downstream station about 20 hours after injection at the upstream station, indicating a hydraulic connection between the sinks and flow at the downstream station.

The versatility of dye tracing was demonstrated in four other investigations. Dye was used to tag water in Pass Creek near Wyoming Highway 130 for current-meter measurements at a series of downstream sites; to track flow through glacial deposits of Quaternary age in Yellowstone National Park; as a passive test for leakage of runoff through pavement cracks in Interstate Highway 25 near Wheatland; and as an active test for leaks in a retention pond at FE. Warren Air Force Base adjacent to Cheyenne.