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SEEPAGE STUDY OF THE VIRGIN RIVER FROM ASH CREEK TO HARRISBURG DOME, WASHINGTON COUNTY, UTAH

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Prepared by the
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CONVERSION FACTORS

Multiply	By	To obtain
foot	0.3048	meter
mile	1.609	kilometer
cubic foot per second	0.02832	cubic meter per second

Degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) by using the following equation:

$$°F = 9/5(°C)+32.$$

Degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) by using the following equation:

$$°C = 5/9(°F-32).$$

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ABSTRACT

A study was done during 1994 on selected reaches of the Virgin River from Ash Creek to Harrisburg Dome in the central Virgin River area, Washington County, Utah, to determine gain or loss of flow in the river from seepage. There was a net gain of 10.7 cubic feet per second in the selected 14-mile section of the Virgin River near Hurricane, Utah. The two upstream reaches of this section of the river had a gain of 7.2 cubic feet per second, the two middle reaches had a gain of 3.5 cubic feet per second, and the two downstream reaches had no substantial gain or loss.

INTRODUCTION

Information on seepage gains and losses is needed by water managers for reallocating irrigation water. Detailed investigation of a river system can aid in determining the gaining and losing sections of the system. This study (twelfth in a series) is part of the statewide water-resources program conducted by the U.S. Geological Survey in cooperation with the Utah Department of Natural Resources, Division of Water Rights; this study also was done in cooperation with Washington County Water Conservancy District. This report describes the results of a seepage study done on selected reaches along 14.07 miles of the Virgin River from below the confluence of Ash Creek near La Verkin to the St. George and Washington Canal south of Harrisburg Dome in the central Virgin River area, Utah.

Methods of Investigation

A reconnaissance of the river was completed in the fall of 1994. The section of river selected for the study was examined for (1) location of controls, turnouts, or other diversion structures, and the availability of river access; (2) general condition of the river; and (3) areas of natural and irrigation-return flow to the river.

By using the information from the reconnaissance, the selected section of the river was divided into reaches, and measuring sites were selected within each reach. Water-stage recorders were operated at selected sites, mainly at the upstream and downstream end of each reach.

Three sets of seepage runs were made from November 8-10, 1994, at nine sites along the selected section of the Virgin River near Hurricane, Utah. For the purpose of this report, a seepage run includes 10 discharge measurements on the river, and from about 8 to 15 discharge measurements and estimates at return-flow points to the river. Estimates were made in one location where measurements were not possible. Sites where a discharge measurement (or estimate) was made at least once are shown in figure 1.

Discharge measurements were made with a current meter, using standard methods of the U.S. Geological Survey (Buchanan and Somers, 1969). Each person making discharge measurements was assigned a reach in which the required number of measurements could be completed in a day. In each reach, discharge measurements were made at all selected measuring sites, including the upstream and downstream end of the reach, and all return-flow points. For each main-channel discharge measurement, the date and time of each measurement, discharge, specific conductance, and temperature of the water are listed in table 1. For return-flow points, the date and discharge are listed in table 1.

The numbers used for the return-flow points in figure 1 (for example, R1) were assigned in a downstream order to those return-flow points that had discharge during at least one set of measurements. Continuous water-stage records that were obtained are shown in figure 2.

Procedure Used in Computing Seepage Gains and Losses

Average seepage gain or loss determined from discharge measurements for Virgin River reaches is reported in table 2. The procedure used to obtain these results is described in the following pages.

Discharge that would be expected at each main river-measuring site was computed assuming no gain or loss from seepage. Beginning with the discharge at the upstream end of each reach and proceeding downstream, all return-flow discharges were added.

The computed value was subtracted from the measured value to determine the seepage gain or loss from the upstream measuring site to the downstream measuring site. The gain or loss was plotted as a function of distance downstream from the start of the reach. This was done for each set of measurements at each main river measuring site. The data obtained from the water-stage recorders showed that adjustments for fluctuations in flow were not necessary.

In some instances, depending on the rate of gain or loss or the scatter of plotted points, the river was segmented into reaches that include three main river measurement sites instead of two. Data for each of the newly defined reaches were then plotted (fig. 3) with the gain or loss at each main river measuring site plotted as a function of distance from the upstream measuring site of the reach. A dashed line was fitted to the plotted points for each reach (fig. 3), and the quantity and rate of gain or loss were estimated from this line and are listed in table 2.

Within a given reach, the seepage gain or loss varied in each set of discharge measurements and among the several sets of discharge measurements. This variation is shown by the scatter of the plotted points in figure 3. The scatter is attributed to one or more of the following: (1) difficult measuring conditions, (2) changes in the rate of seepage loss from the river, (3) changes in the rate of seepage return to the river from ground water and unconsumed irrigation water, (4) the inability to adjust completely for fluctuation in the amount of discharge within a given reach, and (5) the possibility that a water user changed the discharge rate in his turnouts or return-flow points during the time of discharge measurements.

EVALUATION OF THE VIRGIN RIVER SYSTEM

Three sets of seepage runs were made at nine sites on the Virgin River from below the confluence of Ash Creek near La Verkin, Utah, to above the diversion for the St. George and Washington Canal south of Harrisburg Dome, Utah (fig. 1). This section of the Virgin River was divided into six reaches. Measurements indicated seepage gains for four reaches and seepage losses for two reaches. The entire section had a net gain of about 10.7 cubic feet per second, with a gain of about 7.2 cubic feet per second in the two upstream reaches, a gain of about 3.5 cubic feet per second in the two middle reaches, and no substantial net gain or loss for the two downstream reaches. Following is a brief description of each reach studied and the calculated changes in discharge (fig. 3 and table 2).

Reach VR1-VR2.—Site VR1 is a temporary gage where a water-stage recorder was operated to monitor changes in stages of the river, downstream from the confluence of Ash Creek, about 1 mile west of La Verkin, Utah. Site VR2 is about 1.7 miles west of VR1 in NW 1/4 of section 28, Township 41 South, Range 12 West. The plot of discharge measurements for this reach had some scatter and showed a net gain of 4.6 cubic feet per second or about 2.0 cubic feet per second per mile.

Reach VR2-VR4.—Site VR4 is about 5 miles west of La Verkin in NW 1/4 of section 29, Township 41 South, Range 12 West. The plot of discharge measurements for this reach had some scatter and showed a net gain of 2.6 cubic feet per second or about 0.6 cubic foot per second per mile.

Reach VR4-VR5.—Site VR5 is a U.S. Geological Survey station about 5.0 miles west of Hurricane, Utah. The plot of discharge measurements for this reach had considerable scatter and showed a net loss of 0.7 cubic foot per second, or about 0.4 cubic foot per second per mile.

Reach VR5-VR7.—Site VR7 is about 2.6 miles southeast of Harrisburg Junction, Utah, in SE 1/4 of section 10, Township 42 South, Range 13 West. The plot of discharge measurements for this reach had some scatter and showed a net gain of 4.2 cubic feet per second or 1.5 cubic feet per second per mile.

Reach VR7-VR8.—Site VR8 is about 3.0 miles southeast of Harrisburg Junction, Utah, in SE 1/4 of section 16, Township 42 South, Range 13 West. The plot of discharge measurements for this reach had little scatter and showed a net loss of 3.2 cubic feet per second or 2.2 cubic feet per second per mile.

Reach VR8-VR9.—Site VR9 is about 3.8 miles southeast of Harrisburg Junction, Utah, in SW 1/4 of section 21, Township 42 South, Range 13 West. The plot of discharge measurements for this reach had some scatter and showed a net gain of 3.2 cubic feet per second or 2.2 cubic feet per second per mile.

SUMMARY

The net gain from seepage of the Virgin River from below the confluence of Ash Creek near La Verkin, Utah, to above the diversion for St. George and Washington Canal near Harrisburg Junction in a study done during 1994 was 10.7 cubic feet per second. The two upstream reaches had the largest gain, 7.2 cubic feet per second, the two middle reaches had a gain of 3.5 cubic feet per second, and the two downstream reaches had no substantial gain or loss.

REFERENCE CITED

Buchanan, T.J., and Somers, W.P., 1969, Discharge measurements at gaging stations: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A8, 66 p.

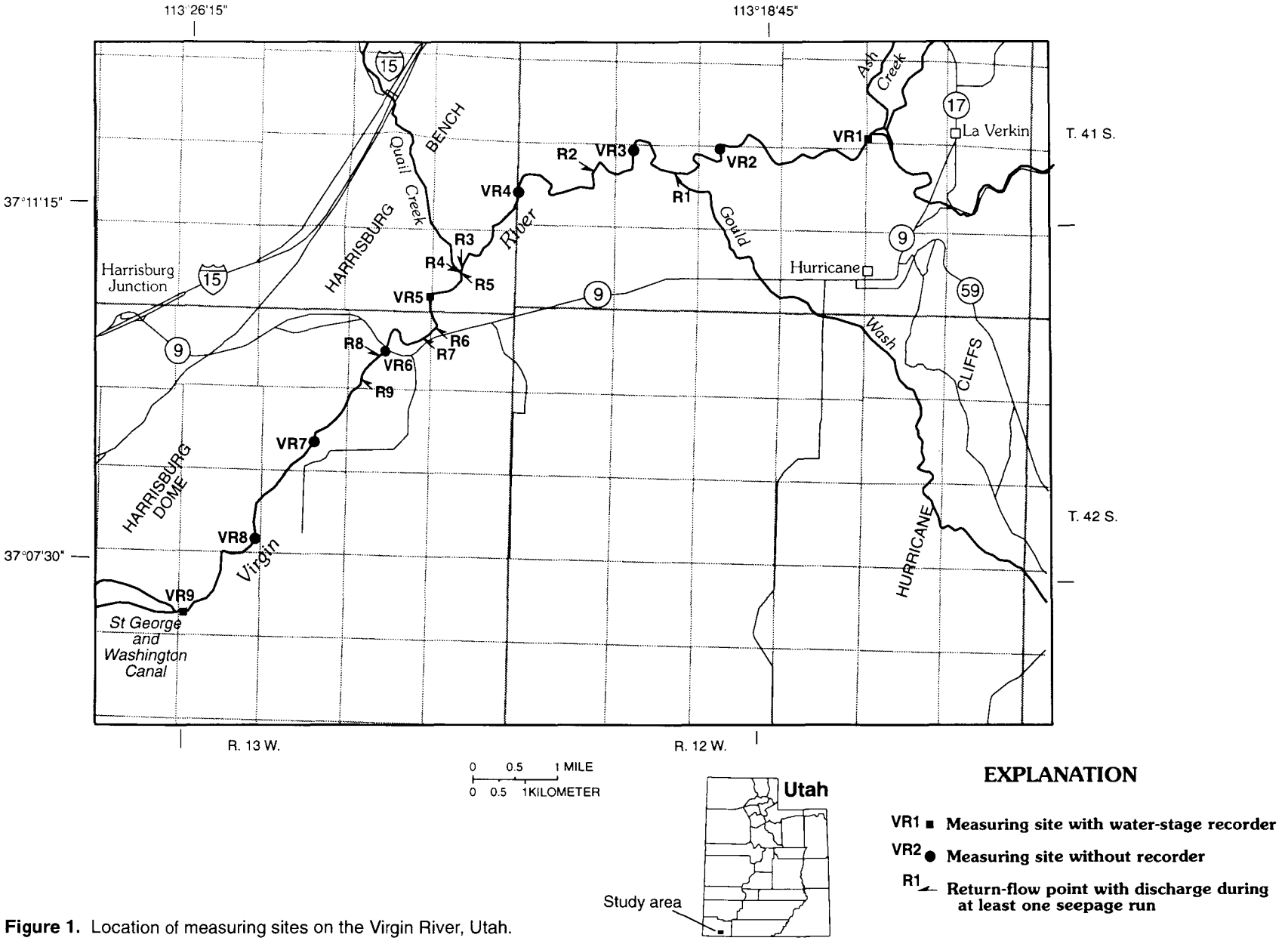

Figure 1. Location of measuring sites on the Virgin River, Utah.

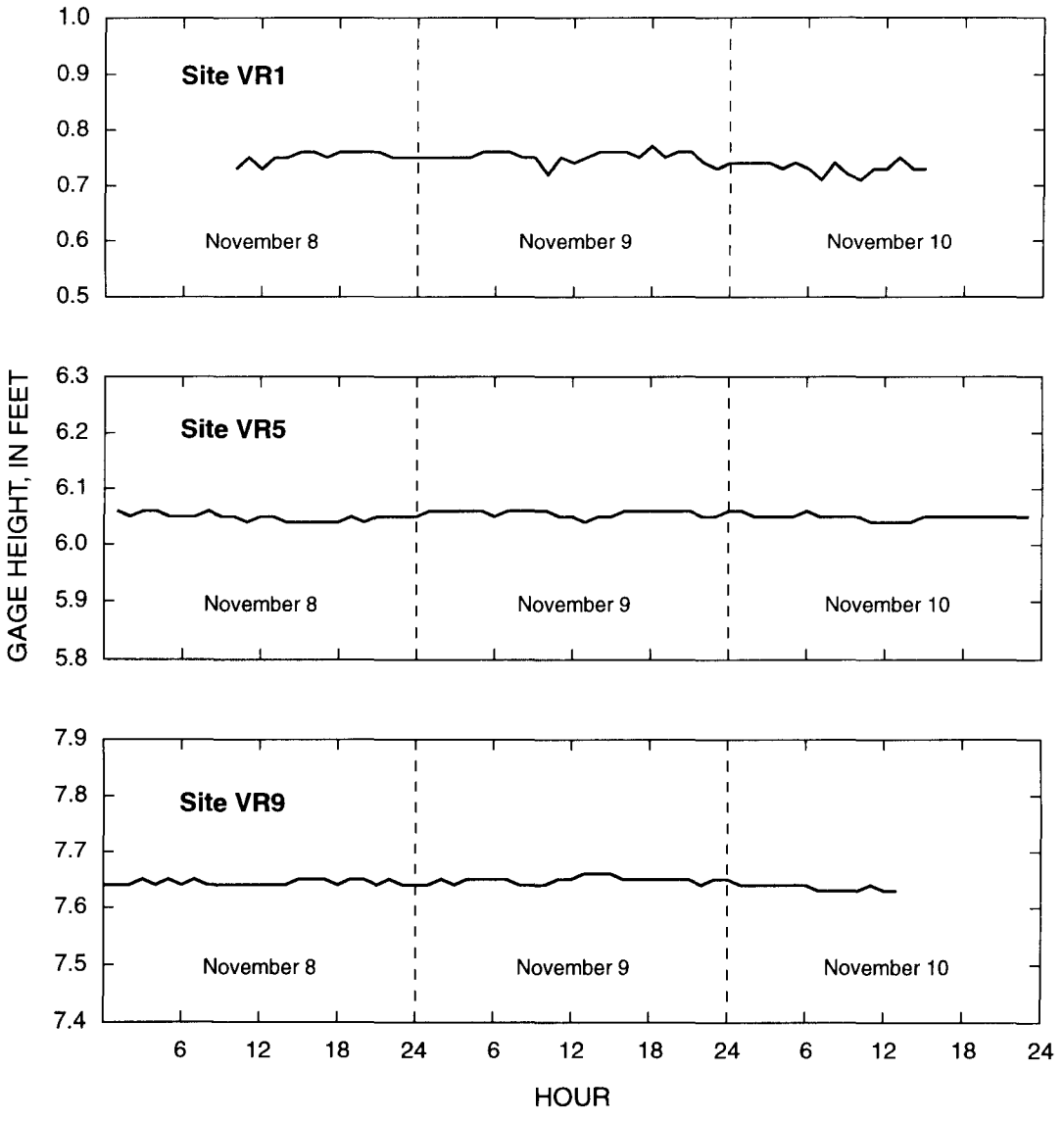

Figure 2. Gage height at water-stage recorder sites on the Virgin River, Utah, 1994.

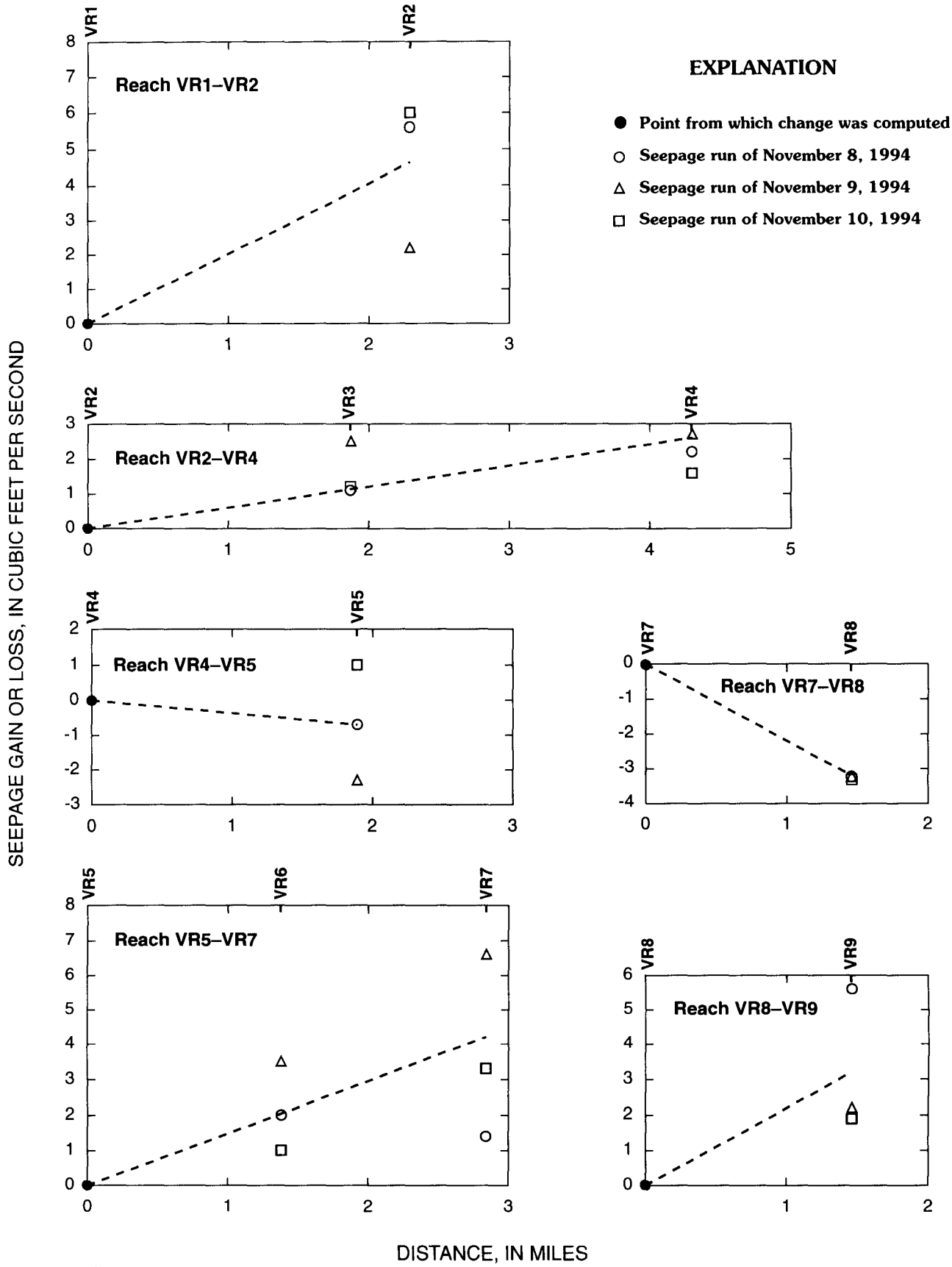

Figure 3. Estimated average seepage gain or loss for reaches of the Virgin River, Utah, 1994.

Table 1. Discharge, specific-conductance, and water-temperature measurements made on the Virgin River, Utah

Site: See figure 1 for location of site; VR, river; R, return flow point.

Time: —, no data.

Discharge: e, estimated.

Site	Time (24-hour)	Discharge (cubic feet per second)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Water temperature (degrees Celsius)
		MEASUREMENTS MADE ON NOVEMBER 8, 1994		
VR1	0935	49.6	3,330	14.0
VR2	1130	55.2	3,430	15.0
R1	—	.0		
VR3	1325	56.3	3,240	15.5
R2	—	.0		
VR4	1450	57.4	3,040	15.5
R3	—	2.0		
R4	—	2.9		
R5	—	2.0		
VR5	1555	63.4	3,090	15.0
VR5	0835	63.9	3,060	10.5
R6	—	.8		
R7	—	.1		
VR6	0935	66.5	3,090	11.0
R8	—	1.5		
R9	—	.7 e		
VR7	1040	68.1	3,020	11.0
VR8	1145	64.9	3,020	12.0
VR9	1300	70.5	3,000	13.0
		MEASUREMENTS MADE ON NOVEMBER 9, 1994		
VR1	1000	53.3	3,550	13.5
VR2	1145	55.5	3,320	14.5
R1	—	1.3		
VR3	1310	59.3	3,220	15.0
R2	—	.1		
VR4	1430	59.6	3,060	15.5
R3	—	1.4		
R4	—	3.0		
R5	—	1.7		
VR5	1525	64.9	3,010	15.5
VR5	0835	62.0	3,020	10
R6	—	.8		
R7	—	.2		
VR6	0940	67.9	3,060	10.5
R8	—	1.5		
R9	—	.7e		
VR7	1045	73.2	3,000	11.0
VR8	1150	70.0	3,000	12.0
VR9	1300	72.2	2,990	13.5

Table 1. Discharge, specific-conductance, and water-temperature measurements made on the Virgin River, Utah—Continued

Site	Time (24-hour)	Discharge (cubic feet per second)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Water temperature (degrees Celsius)
		MEASUREMENTS MADE ON NOVEMBER 10, 1994		
VR1	0850	48.0	3,670	14.0
VR2	1020	54.0	3,380	14.0
R1	—	.8		
VR3	1145	56.0	3,240	15.0
R2	—	.1		
VR4	1250	56.5	3,250	15.0
R3	—	1.6		
R4	—	3.0		
R5	—	1.2		
VR5	1400	65.0	2,940	15.0
VR5	0835	61.6	3,050	10.5
R6	—	.8		
R7	—	.2		
VR6	1010	65.3		
R8	—	1.5		
R9	—	.7 e		
VR7	1110	69.8	3,010	11.5
VR8	1215	66.5	3,020	12.5
VR9	1315	68.4	3,000	13.5

Table 2. Average seepage gain or loss determined from discharge measurements for six reaches of the Virgin River, Utah

Reach	Length (miles)	Graphic average gain (+) or loss (-)	
		Cubic feet per second	Cubic feet per second per mile
VR1-VR2	2.29	+4.6	+2.0
VR2-VR4	4.13	+2.6	+0.6
VR4-VR5	1.89	-0.7	-0.4
VR5-VR7	2.84	+4.2	+1.5
VR7-VR8	1.46	-3.2	-2.2
VR8-VR9	1.46	+3.2	+2.2
TOTAL	14.07	+10.7	