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SEEPAGE STUDY OF THE SEVIER VALLEY-PIUTE CANAL, SEVIER COUNTY, UTAH

by

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the United States Geological Survey
in cooperation with
the Utah Department of Natural Resources
Division of Water Rights

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ENGLISH-TO-METRIC CONVERSION FACTORS

Most numbers are given in this report in English units followed by metric units. The conversion factors are shown to four significant figures. In the text, however, the metric equivalents are shown only to the number of significant figures consistent with the accuracy of the number in English units.

English			Metric	
Units (Multiply)	Abbreviation	(by)	Units (to obtain)	Abbreviation
Cubic feet per second	ft^3/s	0.02832	Cubic meters per second	m^3/s
Cubic feet per second per mile	$(ft^3/s)/mi$	.01760	Cubic meters per second per kilometer	$(m^3/s)/km$
Feet	ft	.3048	Meters	m
Miles	mi	1.609	Kilometers	km

Water temperature is given in degrees Celsius (°C), which can be converted to degrees Fahrenheit (°F) by the following equation:

$$°F = 1.8(°C) + 32$$

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ABSTRACT

A study of the gains or losses of the Sevier Valley-Piute Canal from near Joseph to near Aurora, Sevier County, Utah, was made to aid in water allocation for the canal system. Four sets of seepage measurements were made in 1976, with the three most representative being used in the analysis. Adjustments for fluctuations in flow in the canals were made from information obtained from water-stage recorders operated at selected locations along the canal during the time of each seepage run.

The study showed a net loss of 13 cubic feet per second (0.37 cubic meter per second). During the seepage runs, an average of 198 cubic feet per second (5.6 cubic meters per second) entered the canal, thus the net loss was 6.6 percent of the available water.

INTRODUCTION

This report gives the results of the third of a series of canal-seepage studies in Utah. The study 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. Information on individual canal gains or losses by seepage is needed particularly by the Division of Water Rights when allocating water along canal systems. It is desirable also to know the sections of the canal where water is lost or gained, and this information is best obtained by detailed gaging of canals.

This report describes the study of the Sevier Valley-Piute Canal from near Joseph to near Aurora, Sevier County, Utah. The total length of canal studied is 29.6 mi (47.6 km). The Sevier Valley Canal (fig. 1) diverts from the left bank of the Sevier River about 2 mi (3.2 km) south of Joseph and has a capacity of about 350 ft^3/s (9.9 m^3/s) at the head. At site M21, about 4 mi (6.4 km) north of Richfield, the name of the canal changes to Piute Canal.

METHODS OF INVESTIGATION

A reconnaissance was made in the fall of 1975. The entire length of the canal was examined for: (1) the locations of main canal controls, drops, turnouts, or other diversion structures and bridges crossing the canal; (2) the general condition of the canal (for example, whether the canal had been recently cleaned or other maintenance had been performed); and (3) the locations of areas of natural and irrigation return flow to the canal.

Using the information from the reconnaissance and the geology of the area as described by Young and Carpenter (1965), the canal was divided into reaches and measuring sites were located within each reach. Water-stage recorders were installed at both ends of the canal and at the dividing point between each reach. A total of seven water-stage recorders were installed. Because of the size of the canal it was necessary to locate measuring sites at existing bridges or to construct measuring bridges.

Four sets of seepage measurements were made on the canal during 1976, covering the periods May 12 and 13, June 22 and 23, July 27 and 28, and September 14 and 15. The number of measuring sites on the canal was restricted because the depth of water prohibited wading measurements.

Prior to starting each set of seepage measurements, all personnel made calibration measurements with the current meters they were to use. Each person was assigned a reach for each day in which he could complete the required number of measurements. In each reach, measurements were made at all selected measuring sites, including both ends of the reach, all turnouts, and all inflow points. Figure 1 shows the sites where a measurement (or estimate) was made during at least one set of seepage measurements. The date, time of measurement, discharge at each measuring site, and the temperature and specific conductance of the water are shown in table 2.

The numbers used for the turnouts in figure 1 (for example, T10 or T10A) were taken from numbers marked on the headgate of the turnout. For a site without a marked number on the headgate, a designation such as T(I) was used. There is a duplication of turnout numbers because the turnouts were numbered beginning with site M1 in a downstream direction to site M21. Then, because the canal name changes at site M21, the turnouts were again numbered beginning with 1 in a downstream direction.

Continuous water-stage records were obtained at the head and tail of each reach, with the exception of site M30 where they were only obtained during the May measurements; the gage site was destroyed after the May measurements were made. The records of gage heights at recorders for the period of the May, June, and July measurements are shown in figure 2.

SEEPAGE MEASUREMENTS

The results of the seepage measurements, expressed in gain or loss along the canals, are given in table 1. The procedures used to obtain these results are described in the following pages.

A computation was made of the flow that would be expected at each main canal-measuring site, assuming no losses or gains. Beginning with the flow at the head of each reach and proceeding in a downstream sequence, all turnout flows were subtracted and all measured inflows were added. The computed value at each site was then adjusted for fluctuations in canal flow which originated above the reach being analyzed. Information required to make this adjustment is the change in flow with time at the head of the reach, the time of measurements at the head of the reach and the downstream measuring site, and the time required for passage of water from the head of the reach to the downstream site.

The change in flow with time at the head of the reach was determined from the recorded gage heights and the discharge measurements at the head of each reach. The times of the two measurements are available from table 2, and the time of travel between the two points was determined from the stage recorders at the ends of each reach.

As an example, assume that the measurement at the head of the reach was 200 ft^3/s (5.66 m^3/s) at 0800 hours, the measurement at the downstream measuring site was made at 1000 hours, the time required for flow to travel between the two sites is 1 hour, and the discharge at the head of the canal was dropping at the rate of 5 ft^3/s (0.142 m^3/s) per hour. To make the adjustment, the travel time is subtracted from the time of the downstream measurement (1000 hours - 1 hour = 0900 hours) to give a comparable time for flow at the head of the canal. From the gage-height records and the measurements available for the head of the canal, the flow at 0900 hours was calculated as 195 ft^3/s (5.52 m^3/s), or an adjustment of -5 ft^3/s (0.142 m^3/s). This adjustment was then applied to the computed value of the downstream measuring site.

The computed value was then subtracted from the measured value to determine the amount of gain or loss between the head of the canal and the downstream measuring site. The amount of gain or loss was then plotted as a function of distance downstream from the canal head. This was done for each main canal-measuring site for each set of measurements.

In some instances, depending on the rate of gain or loss shown on these plots, or if the plotted points showed large amounts of scatter, the canal was segmented into shorter reaches. The data for each of the newly defined reaches were then plotted in figure 3, with the gain or loss at each main canal-measuring site plotted as a function of distance from the head of the reach. A straight line was fitted through the plotted points for each reach, and the amount and rate of gain or loss from the reach were determined from this line. The amount and rate of gain or loss by reach are shown in table 1.

Within a given reach, the amount of gain or loss varied in each set of seepage measurements and among the several sets of 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: poor measuring conditions, changes in the rate of seepage loss from the canal, changes in the rate of seepage return to the canal of ground and irrigation water, the inability to adjust completely for fluctuations in the amount of flow within a given reach, and the possibility that a water user changed the flow in his turnouts during the time of the measurements.

The results presented are based on only the seepage measurements made during May, June, and July. Because of a shortage of water, the flow in the canal was reduced earlier than anticipated, and it was only about 40 ft^3/s (1.1 m^3/s) on September 14 and about 20 ft^3/s (0.6 m^3/s) on September 15. Plots of the data from the September measurements indicated undetectable gains or losses. A check of the previous 5 years of flow records for this canal indicated that on 80 percent of the days of flow, the flow was greater than 50 ft^3/s (1.4 m^3/s). Therefore, it was decided to omit the September measurements from the final analysis.

EVALUATION OF THE CANAL SYSTEM

Most reaches that were studied had small to moderate gains or losses. The study showed a net loss of 13 ft^3/s (0.37 m^3/s) (table 1). During the seepage runs an average of 198 ft^3/s (5.6 m^3/s) entered the canal, thus the net loss was 6.6 percent of the available water. Following is a brief description of each reach studied and its calculated gain or loss. The geological descriptions are from Young and Carpenter (1965).

Reach M1-M2.--Site M1 is about 0.5 mi (0.8 km) below where the canal diverts from the Sevier River. Reach M1-M2 is constructed in alluvium composed of poorly to well sorted clay, silt, sand, gravel, and boulders; the upper half of the reach is only a few feet above the adjacent flood plain. This reach had a calculated gain of 1 ft^3/s (0.03 m^3/s).

Reach M2-M5.--Reach M2-M5 is constructed in alluvium composed of poorly to well sorted clay, silt, sand, gravel, and boulders. It runs through the town of Joseph and through several farms. This reach had a calculated loss of 4 ft^3/s (0.11 m^3/s).

Reach M5-M6.--Reach M5-M6 is constructed for the most part in alluvium composed of poorly to well sorted clay, silt, sand, gravel, and boulders. The lower part of the reach is constructed in fanglomerate deposits consisting of silt, sand, gravel, cobbles, and boulders derived from adjacent highlands. This reach had a calculated gain of 1 ft^3/s (0.03 m^3/s).

Reach M6-M9.--Reach M6-M9 for a short distance below site M6 is constructed in fanglomerate deposits. The rest of the reach, which runs along the Elsinore fault, is constructed primarly along the contact of volcanic rocks (above the canal) and alluvium (below the canal). The lower end of the reach runs above the town of Elsinore, and it is lined with a considerable number of trees. This reach had a calculated loss of 5 ft^3/s (0.14 m^3/s).

Reach M9-M10.--Reach M9-M10 is constructed in alluvium. The area above the canal includes several irrigated fields. This reach had a calculated gain of 5 ft^3/s (0.14 m^3/s).

Reach M10-M11.--Reach M10-M11 is constructed in alluvium; some irrigated fields lie above the canal at the upper end of the reach, and considerable vegetation grows along the lower end of the reach. Site M11 turned out to be a poor measuring site; thus, the results for this reach (little or no net gain or loss) are considered to be poor.

Reach M11-M16.--Reach M11-M16 is constructed along the Elsinore fault, primarily along the contact of volcanic rocks (above the canal) and alluvium (below the canal). The lower end of this reach runs adjacent to the city of Richfield. There was no calculated net gain or loss for this reach.

Reach M16-M21.--Reach M16-M21 is constructed, for the most part, in alluvium; but it crosses the Elsinore fault in two places, and for about 0.75 mi (1.2 km) near site M19 it is underlain by the Flagstaff Limestone. This reach had a calculated loss of 10 ft^3/s (0.28 m^3/s), or 2.3 $(ft^3/s)/mi$ [0.04 $(m^3/s)/km$], which was the highest loss rate of any reach studied.

Reach M21-M26.--Reach M21-M26 is constructed in alluvium. Site M21 marks the beginning of the Piute Canal. There was no calculated net gain or loss for this reach.

Reach M26-M28.--Reach M26-M28 is constructed in alluvium. This reach had a calculated loss of 1 ft^3/s (0.03 m^3/s).

Reach M28-M30.--Reach M28-M30 is constructed in alluvium. There was no calculated net gain or loss for this reach.

SUMMARY

A study of 29.6 mi (47.6 km) of the Sevier Valley-Piute Canal showed that seepage gains or losses were small to moderate. The average flow at the head of the canal during the seepage runs was 198 ft^3/s (5.6 m^3/s). The study showed a net loss of 13 ft^3/s (0.37 m^3/s), which was 6.6 percent of the available water.

REFERENCE CITED

Young, R. A., and Carpenter, C. H., 1965, Ground-water conditions and storage in the central Sevier Valley, Utah: U.S. Geol. Survey Water-Supply Paper 1787.

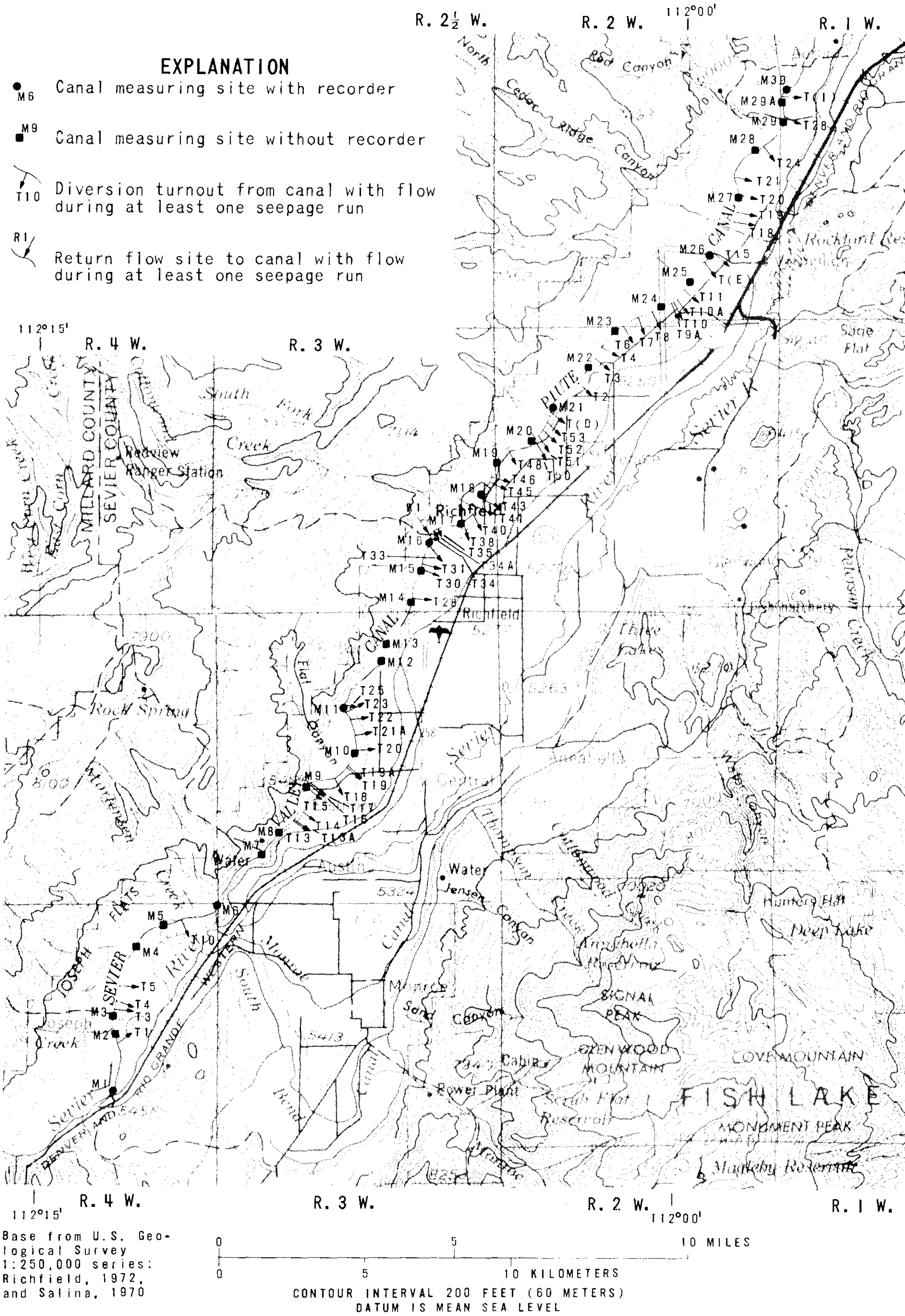


Figure 1.—Map of the Sevier Valley-Piute Canal showing measuring sites.

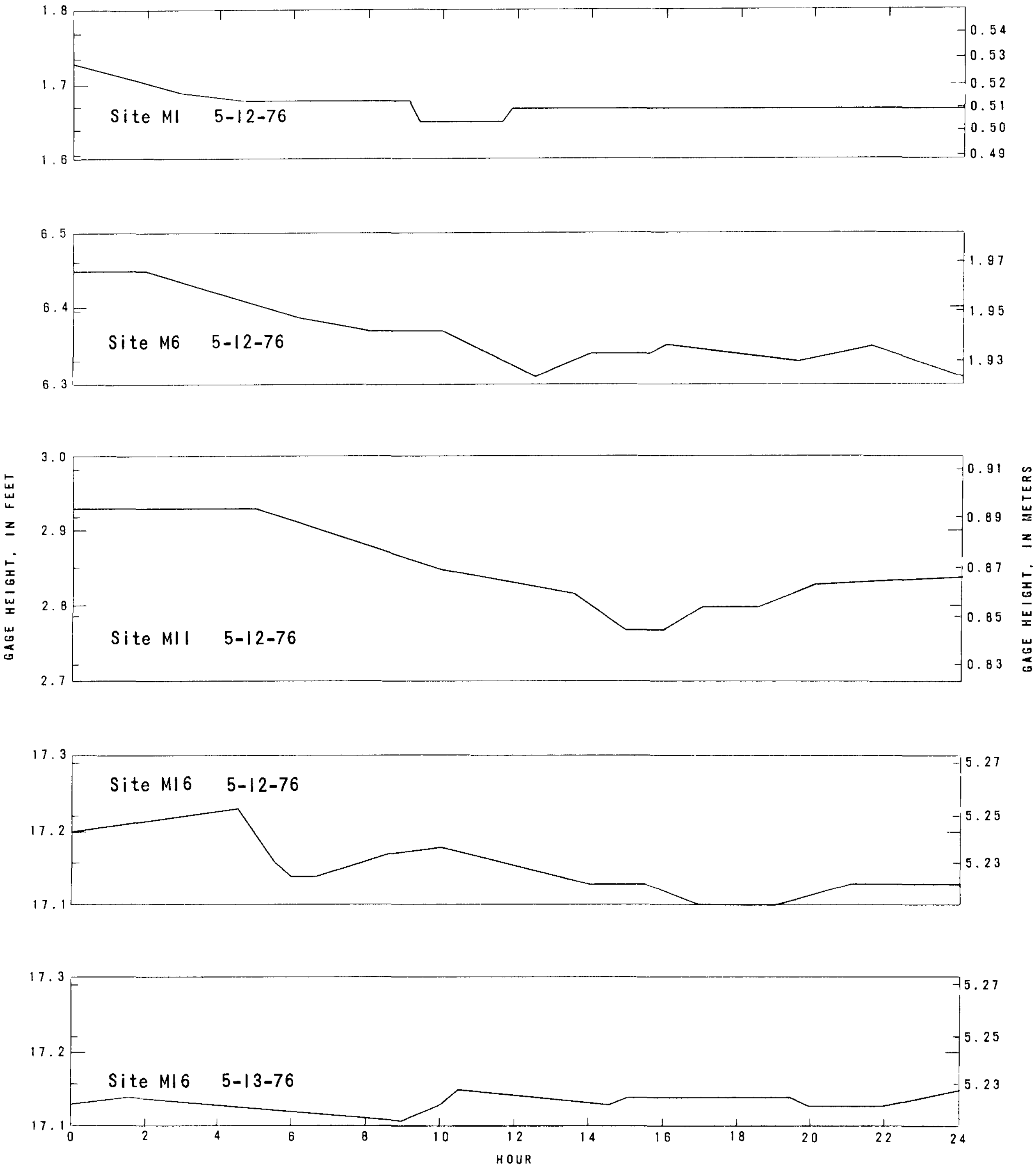
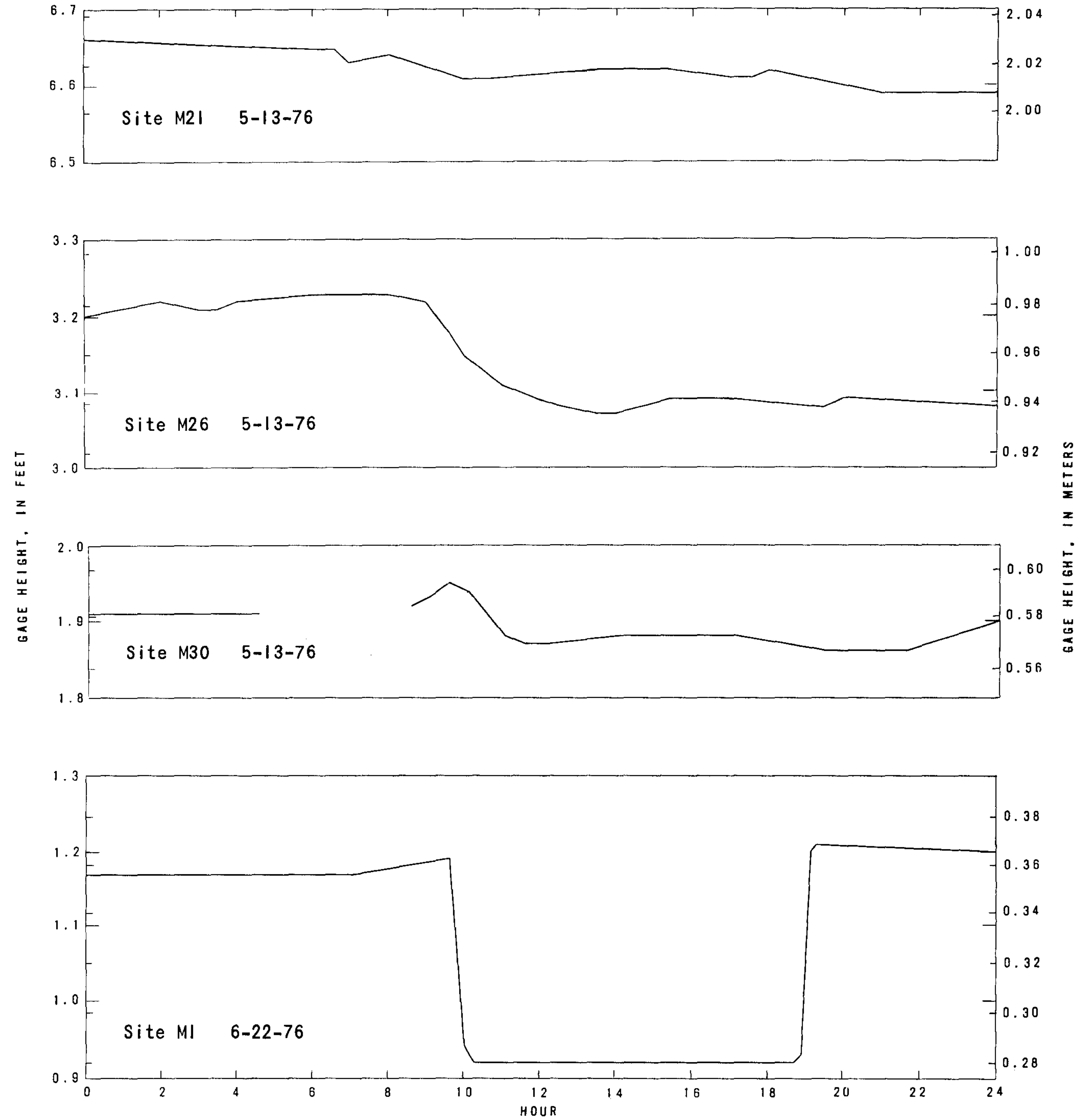


Figure 2.— Gage heights at recorders during seepage runs.



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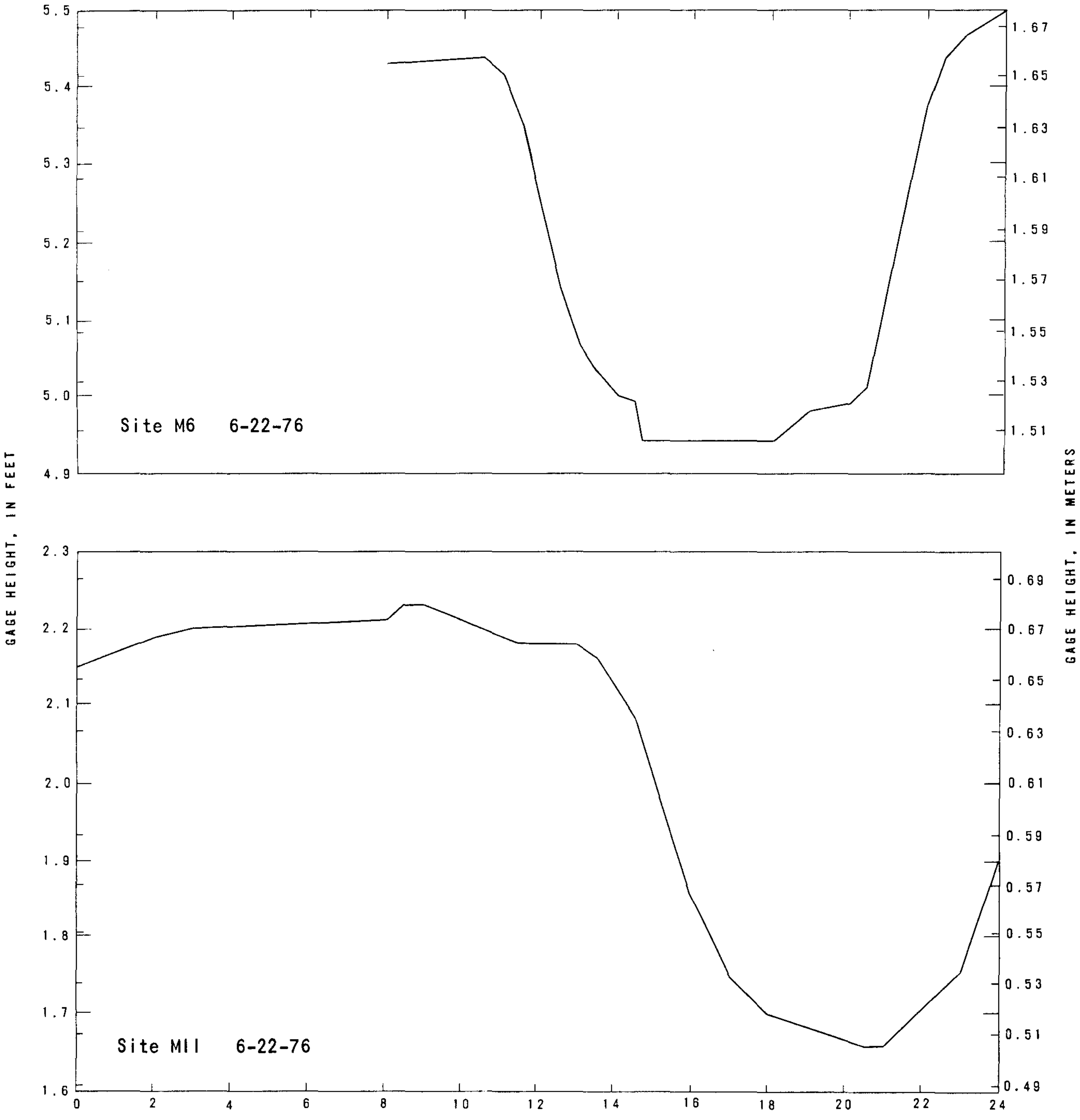

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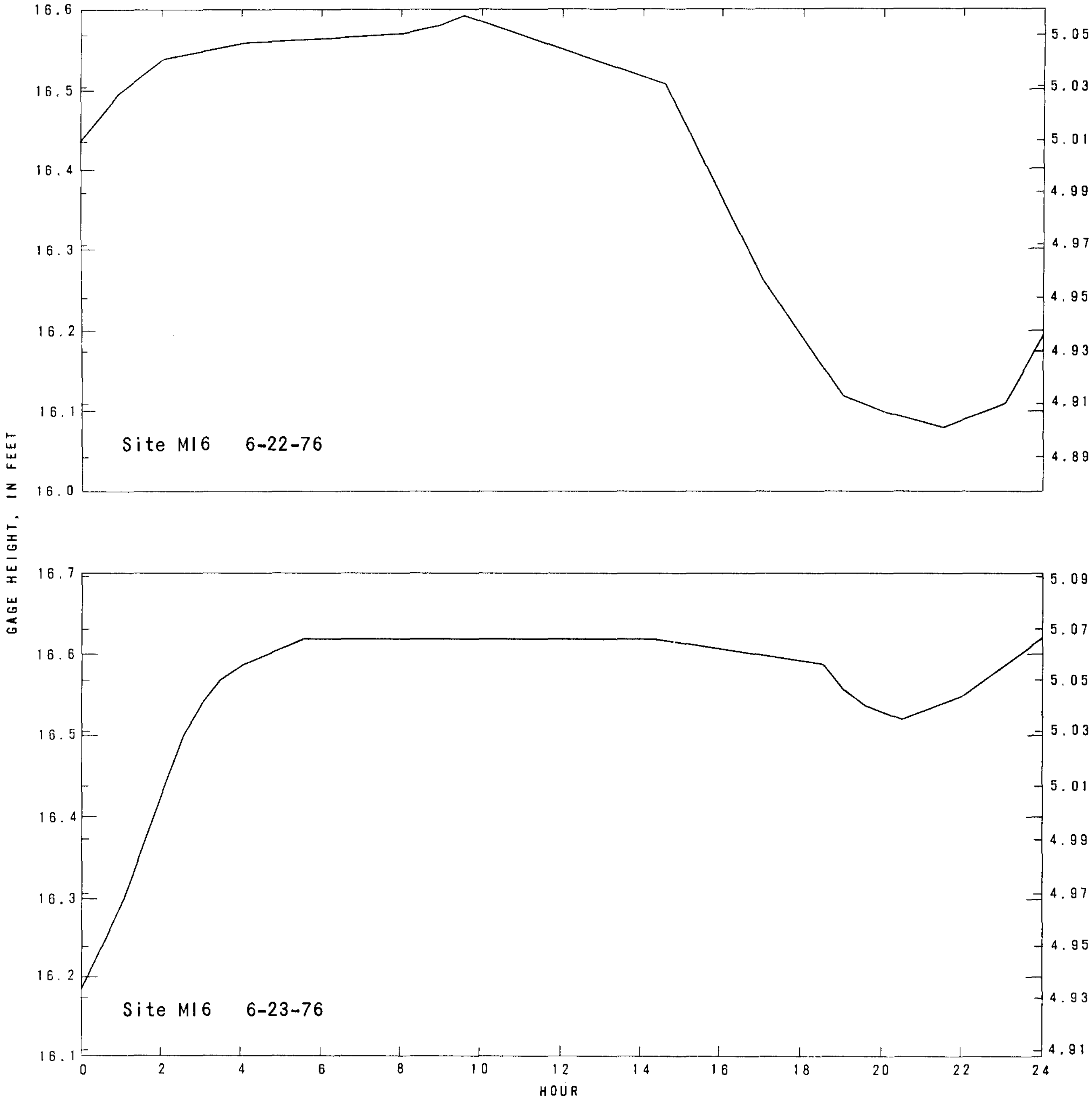

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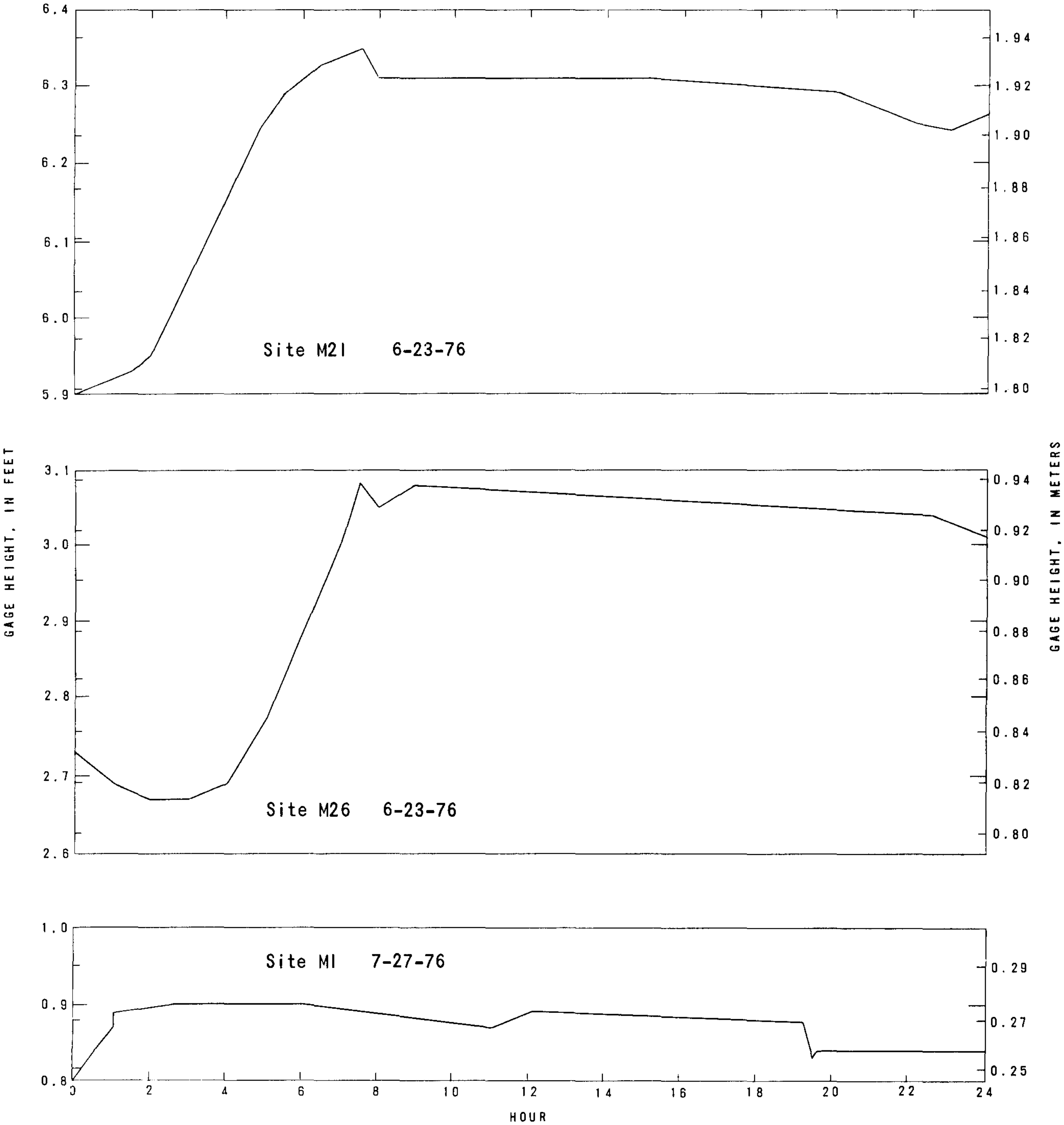

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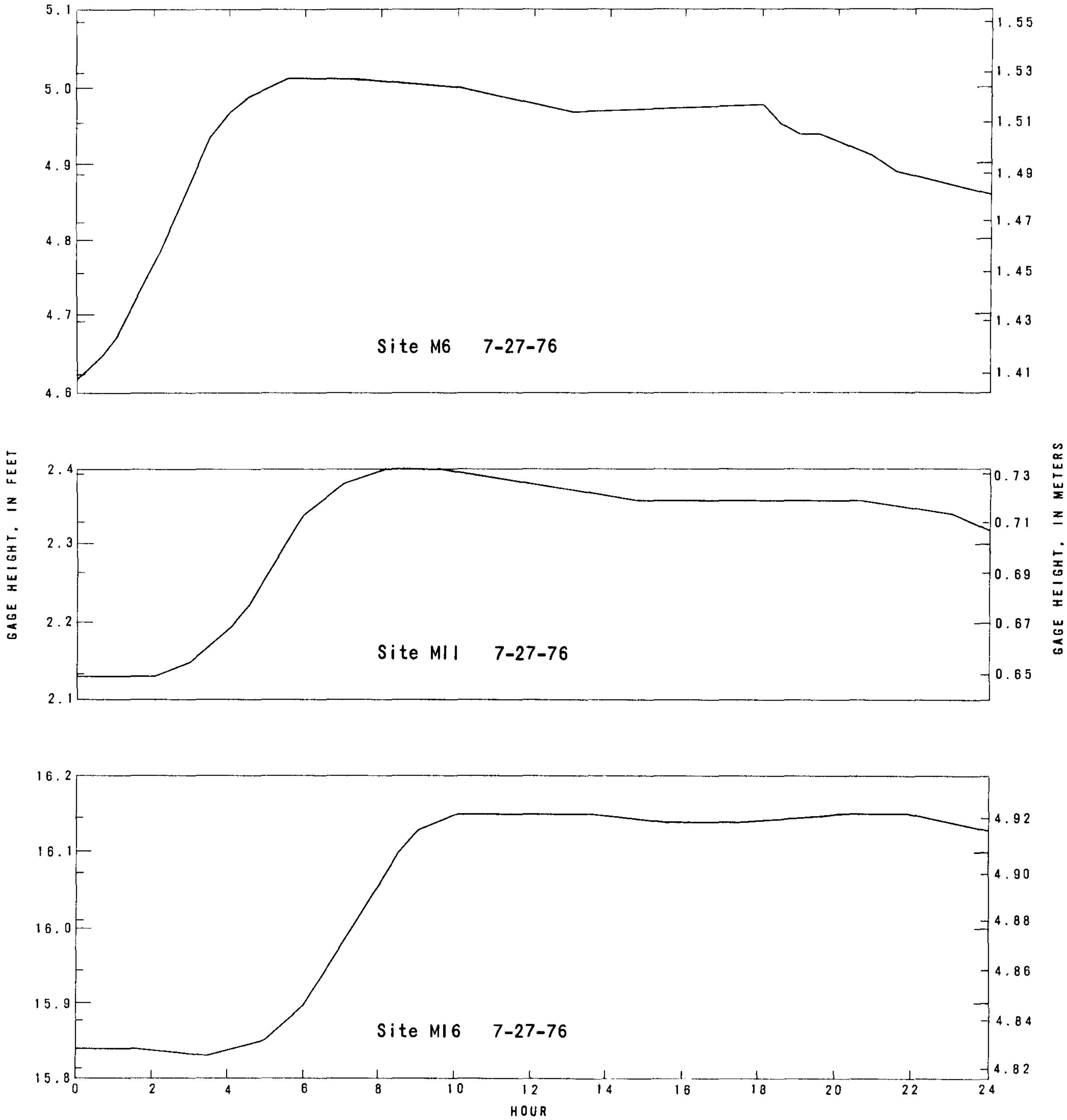

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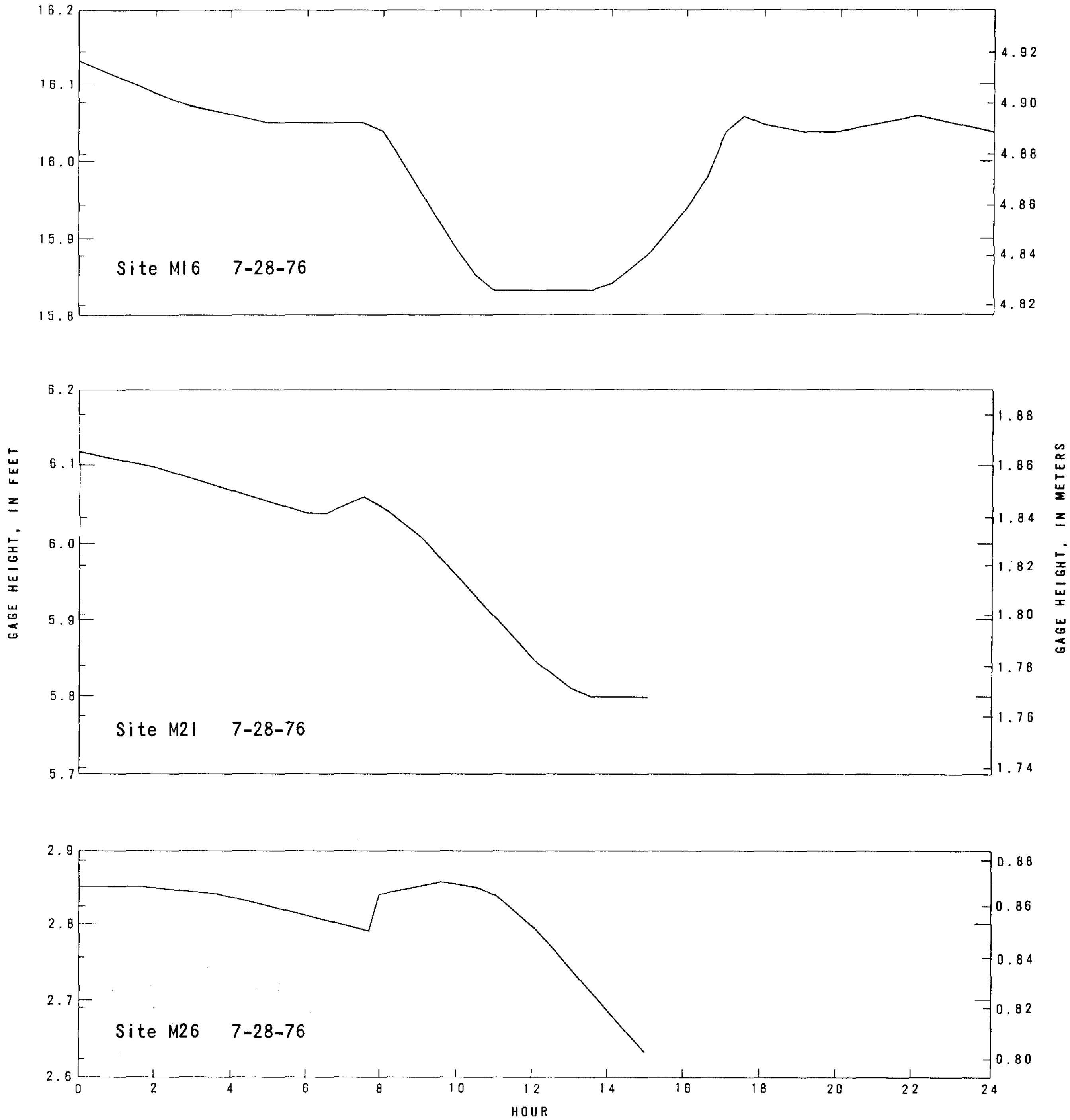

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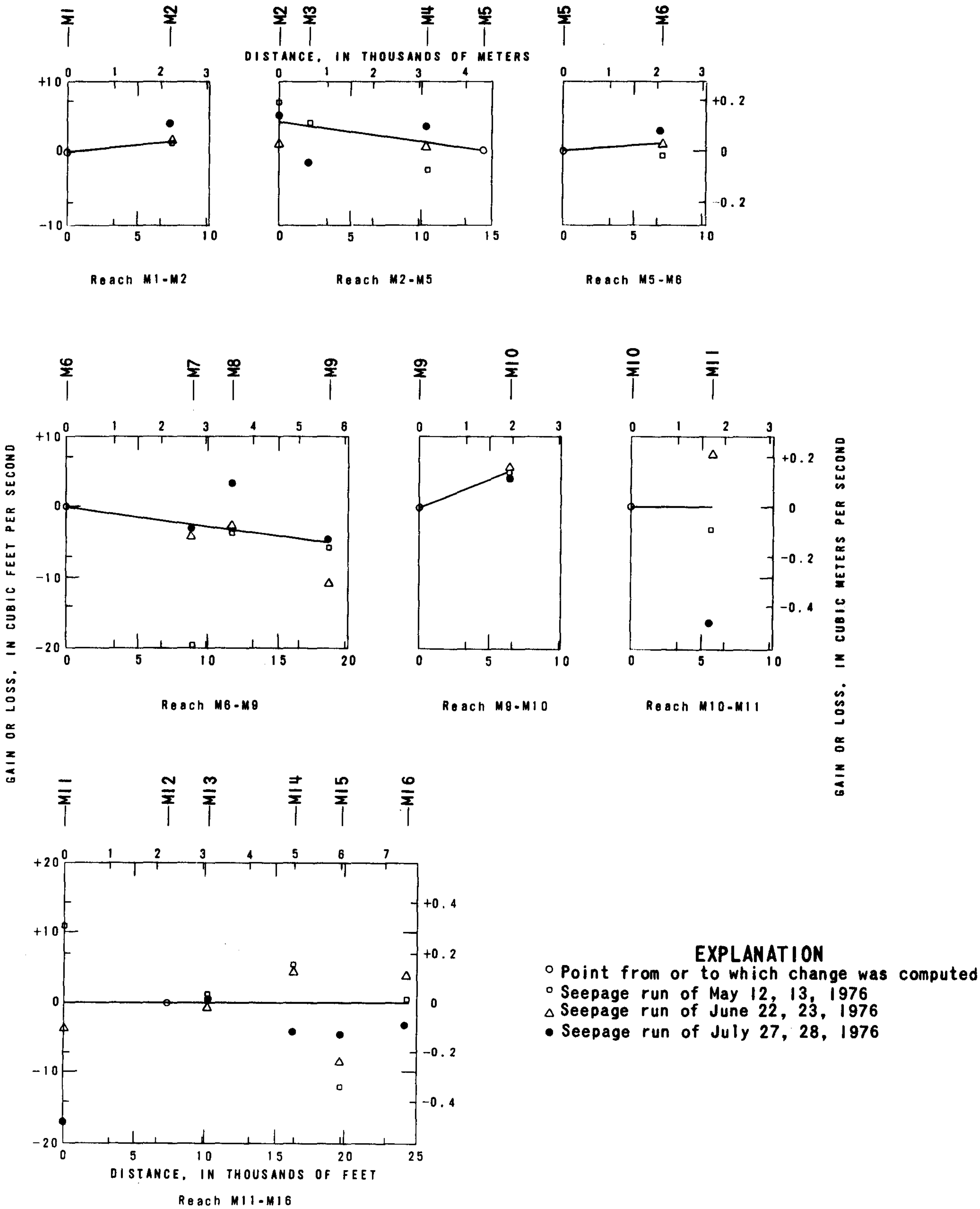

Figure 3.— Gain or loss for reaches of the canal.

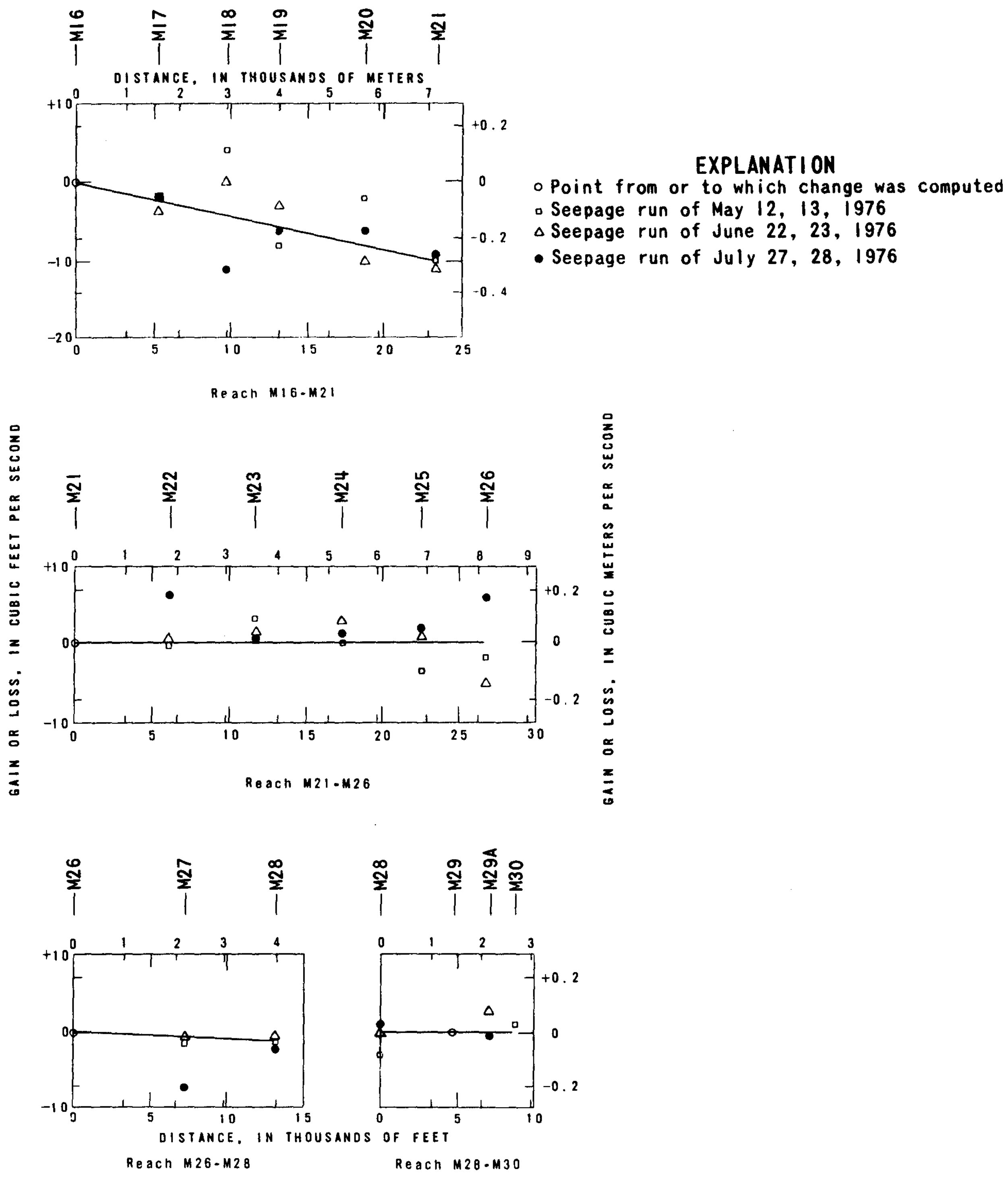

Figure 3.— Continued.

Table 1.--Gain or loss determined from seepage measurements for reaches of the canal

Reach	Length (ft)	Graphic average (from fig. 3) Gain(+) or loss(-) ft^3/s	$(ft^3/s)mi$
M1-M2	7,250	+1	+0.7
M2-M5	14,330	-4	-1.5
M5-M6	7,500	+1	+.7
M6-M9	18,580	-5	-1.4
M9-M10	6,400	+5	+4.1
M10-M11	5,580	0	0
M11-M16	24,310	0	0
M16-M21	23,450	-10	-2.3
M21-M26	26,820	0	0
M26-M28	13,470	-1	-.4
M28-M30	8,720	0	0
Total	156,410	-13	

Table 2.--Measurements made on the canal

Site: M, main canal; R, inflow; T, diversion.
Discharge: e, estimated.

Site	Date	Time	Discharge (ft^3/s)	Water temper-ature (°C)	Specific conductance (micromhos per cm at 25°C)
	1976				
M1	May 12	0940	275.1	12.0	440
M2		1100	276.1	13.5	405
M3		1225	273.0	14.0	405
T4		1335	6.33	-	-
T5		1305	2.08	-	-
M4		1530	262.7	15.5	420
M5		1650	265.2	15.5	405
M6		1810	264.4	15.5	420
M6		0855	265.4	9.5	390
M7		1010	245.9	11.5	405
M8		1110	261.0	12.5	420
M9		1230	257.5	12.0	410
T16		1320	3.16	-	-
T17		1340	4.98	-	-
T18		1410	10.1	-	-
T19		1435	3.21	-	-
T19A		1500	3.48	-	-
M10		1540	235.4	14.0	420
T20		1620	3.71	-	-
T21A		1650	.37	-	-
T22		1710	4.86	-	-
T23		1730	5.39	-	-
M11		1810	219.1	15.0	410
M11		0900	236.5	12.0	420
T25		0950	3.10	-	-
M12		1050	220.3	12.0	435
M13		1240	218.1	12.5	405
M14		1530	220.5	14.0	420
T28		1615	4.16	-	-
M15		1730	195.0	14.5	400
T30		1820	3.85	-	-
M16		1935	207.2	14.0	420
M16	May 13	0830	203.8	10.0	405
T34		0900	.7e	-	-
T34A		0920	.97	-	-
M17		1010	200.9	13.0	415

Table 2.--Measurements made on the canal--Continued

Site	Date	Time	Discharge (ft^3/s)	Water temper-ature (°C)	Specific conductance (micromhos per cm at 25°C)
	1976				
T38	May 13	1050	0.68	-	-
T40		1110	1.37	-	-
T41		1130	4.06	-	-
M18		1215	203.5	13.0	410
T45		1250	5.62	-	-
T46		1320	3.99	-	-
M19		1350	179.7	15.0	400
M20		1450	185.7	14.0	395
T50		1540	3.12	-	-
T52		1600	2.08	-	-
T53		1620	4.61	-	-
T(D)		1645	4.87	-	-
M21		1750	163.8	15.0	400
M21		0900	157.3	14.0	440
T2		1000	4.28	-	-
M22		1050	151.5	14.5	410
T3		1130	4.71	-	-
T4		1150	3.94	-	-
M23		1230	147.6	16.0	410
T6		1330	2.62	-	-
T7		1340	.01e	-	-
T8		1400	3.02	-	-
M24		1440	138.7	16.5	420
T9A		1520	3.20	-	-
T10		1600	3.62	-	-
T10A		1630	4.24	-	-
T11		1655	4.24	-	-
M25		1730	118.3	18.0	415
M26		1840	120.2	18.0	410
M26		0915	135.7	12.0	405
T15		1000	9.01	-	-
T18		1030	4.27	-	-
M27		1135	111.0	12.0	410
T21		1205	.01e	-	-
M28		1250	109.1	12.5	415
M29		1430	110.1	15.0	410
T(I)		1515	1.46	-	-
M30		1620	111.6	16.0	420
M1	June 22	0910	178.7	17.0	410

Table 2.--Measurements made on the canal--Continued

Site	Date	Time	Discharge (ft^3/s)	Water temper- ature (°C)	Specific conductance (micromhos per cm at 25°C)
	1976				
M2	June 22	1015	181.5	17.5	440
M3		1120	151.0	18.5	415
T4		1200	.04	-	-
M4		1310	137.4	18.5	410
M5		1430	137.3	18.5	410
T10		1520	3.81	-	-
M6		1615	134.5	19.0	400
M6		0850	179.6	15.5	450
M7		0945	176.2	16.0	455
M8		1040	178.1	16.5	450
T13		1110	.83	16.0	-
T13A		1120	.88	-	-
T14		1140	1.12	17.0	-
M9		1210	166.5	17.5	450
T15		1240	1.29	-	-
T19A		1300	2.26	18.0	-
M10		1340	159.4	17.0	450
T20		1415	.01	-	-
T21A		1415	.01	-	-
T22		1425	3.56	17.0	-
M11		1530	139.9	19.0	450
M11		0845	165.7	16.0	450
M12		1030	167.4	17.5	455
M13		1200	163.6	18.0	425
M14		1330	169.0	19.0	455
M15		1500	154.1	18.0	450
T30		1550	3.12	-	-
M16		1720	141.4	18.0	455
M16	June 23	0900	156.4	14.5	455
T34A		0940	.74	-	-
M17		1015	152.1	14.5	455
T41		1100	3.43	-	-
T43		1110	.11	-	-
M18		1140	152.3	15.0	455
T45		1210	4.28	-	-
M19		1240	144.9	16.0	460
T48		1315	3.29	-	-
M20		1400	134.4	18.0	450
T51		1445	4.34	-	-

Table 2.--Measurements made on the canal--Continued

Site	Date	Time	Discharge (ft^3/s)	Water temperature (°C)	Specific conductance (micromhos per cm at 25°C)
	1976				
T(D)	June 23	1510	1.97	-	-
M21		1600	126.4	18.0	460
M21		0900	128.4	17.0	440
T2		0940	2.74	-	-
M22		1010	126.0	16.5	445
T4		1040	.06	-	-
M23		1110	126.6	17.0	430
M24		1220	124.5	18.0	465
T10A		1300	4.10	-	-
M25		1340	119.7	18.5	455
T(E)		1420	2.65	-	-
M26		1500	113.8	19.0	415
M26		0900	125.3	16.0	425
T19		1000	2.32	-	-
M27		1045	122.2	17.0	435
T20		1120	5.92	-	-
M28		1215	116.2	17.0	430
T24		1255	2.98	-	-
M29		1345	112.6	18.0	435
M29A		1550	114.3	19.0	420
T(I)		1440	1.60	-	-
M1	July 27	0810	139.7	20.5	495
T1		0825	.01	-	-
M2		0940	143.5	21.0	495
M3		1055	135.2	21.0	485
M4		1210	140.6	22.0	490
M5		1345	136.9	23.0	490
T10		1140	.10	-	-
M6		1515	142.5	28.5	490
M6		0830	140.3	19.0	495
M7		0920	137.3	19.0	500
M8		1020	143.1	20.0	500
T13		1050	.62	-	-
T13A		1110	.47	-	-
M9		1140	133.9	20.0	500
T17		1210	2.84	-	-
M10		1300	134.9	21.0	505
M11		1435	117.3	22.0	495
M11		0900	124.9	19.0	485

Table 2.--Measurements made on the canal--Continued

Site	Date	Time	Discharge (ft^3/s)	Water temper-ature (°C)	Specific conductance (micromhos per cm at 25°C)
	1976				
M12	July 27	1030	142.0	19.0	495
M13		1215	140.6	20.0	495
M14		1400	134.9	20.0	495
M15		1510	134.5	19.0	485
T31		1550	7.00	-	-
T33		1755	.25	-	-
M16		1720	131.6	21.0	500
M16	July 28	0830	109.0	19.0	490
M17		0930	102.3	19.5	490
T41		1010	1.65	-	-
M18		1040	86.2	21.0	485
M19		1135	89.2	20.0	490
M20		1240	88.2	21.0	490
T(D)		1310	.06	-	-
M21		1350	85.0	21.5	495
M21		0740	104.0	20.0	470
M22		0900	108.6	23.0	490
M23		1000	99.8	23.0	485
M24		1100	98.5	23.5	475
M25		1215	95.1	24.0	480
M26		1320	97.3	25.0	485
M26		0845	115.8	20.0	485
M27		1000	108.3	20.0	490
T20		1035	3.42	-	-
M28		1130	109.4	21.0	485
M29		1230	107.1	21.0	490
T28		1310	3.27	-	-
M29A		1345	99.2	22.0	490
M1	Sept. 14	0900	40.6	16.0	505
M2		0955	39.5	16.5	500
M3		1040	39.8	17.0	500
T3		1100	.08	-	-
M4		1125	37.8	18.0	500
M5		1210	36.8	19.0	500
M6		1255	37.9	19.5	515
M6		0840	35.5	14.0	500
M7		0940	34.9	14.0	505
M8		1025	34.8	14.5	500
M9		1125	34.8	16.0	500

Table 2.--Measurements made on the canal--Continued

Site	Date	Time	Discharge (ft^3/s)	Water temperature (°C)	Specific conductance (micromhos per cm at 25°C)
	1976				
M10	Sept. 14	1230	35.2	16.0	485
M11		1340	35.0	17.0	475
M11		0920	38.5	15.0	490
M12		1040	36.6	15.0	495
M13		1150	38.3	15.0	490
M14		1330	36.1	16.0	495
M15		1430	38.3	17.0	485
M16		1545	36.1	18.0	490
M16	Sept. 15	0830	20.3	15.0	510
R1		0910	.70	-	-
M17		0940	18.7	16.0	510
M18		1020	19.1	16.0	515
M19		1105	18.6	16.0	530
M20		1150	18.4	16.0	535
T(D)		1220	.85	-	-
M21		1300	15.1	16.0	555
M21		0850	24.4	18.0	-
M22		0935	24.1	18.5	515
M23		1020	24.1	18.5	500
M24		1110	23.3	18.5	500
M25		1200	23.4	19.0	500
M26		1250	21.6	21.0	500
M26		0855	26.6	15.0	490
M27		1000	25.5	16.0	490
M28		1100	26.1	16.0	490
M29		1200	26.2	16.0	485
T(I)		1230	1.70	-	-
M30		1315	24.3	17.0	495

PUBLICATIONS OF THE UTAH DEPARTMENT OF NATURAL RESOURCES, DIVISION OF WATER RIGHTS

(*)-Out of Print

TECHNICAL PUBLICATIONS

*No. 1. Underground leakage from artesian wells in the Flowell area, near Fillmore, Utah, by Penn Livingston and G. B. Maxey, U.S. Geological Survey, 1944.

No. 2. The Ogden Valley artesian reservoir, Weber County, Utah, by H. E. Thomas, U.S. Geological Survey, 1945.

*No. 3. Ground water in Pavant Valley, Millard County, Utah, by P. E. Dennis, G. B. Maxey and H. E. Thomas, U.S. Geological Survey, 1946.

*No. 4. Ground water in Tooele Valley, Tooele County, Utah, by H. E. Thomas, U.S. Geological Survey, in Utah State Eng. 25th Bienn. Rept., p. 91-238, pls. 1-6, 1946.

*No. 5. Ground water in the East Shore area, Utah: Part I, Bountiful District, Davis County, Utah, by H. E. Thomas and W. B. Nelson, U.S. Geological Survey, in Utah State Eng. 26th Bienn. Rept., p. 53-206, pls. 1-2, 1948.

*No. 6. Ground water in the Escalante Valley, Beaver, Iron, and Washington Counties, Utah, by P. F. Fix, W. B. Nelson, B. E. Lofgren, and R. G. Butler, U.S. Geological Survey, in Utah State Eng. 27th Bienn. Rept., p. 107-210, pls. 1-10, 1950.

No. 7. Status of development of selected ground-water basins in Utah, by H. E. Thomas, W. B. Nelson, B. E. Lofgren, and R. G. Butler, U.S. Geological Survey, 1952.

*No. 8. Consumptive use of water and irrigation requirements of crops in Utah, by C. O. Roskelly and W. D. Criddle, 1952.

No. 8. (Revised) Consumptive use and water requirements for Utah, by W. D. Criddle, Karl Harris, and L. S. Willardson, 1962.

No. 9. Progress report on selected ground water basins in Utah, by H. A. Waite, W. B. Nelson, and others, U.S. Geological Survey, 1954.

*No. 10. A compilation of chemical quality data for ground and surface waters in Utah, by J. G. Connor, C. G. Mitchell, and others, U.S. Geological Survey, 1958.

*No. 11. Ground water in northern Utah Valley, Utah: A progress report for the period 1948-63, by R. M. Cordova and Seymour Subitzky, U.S. Geological Survey, 1965.

*No. 12. Reevaluation of the ground-water resources of Tooele Valley, Utah, by J. S. Gates, U.S. Geological Survey, 1965.

*No. 13. Ground-water resources of selected basins in southwestern Utah, by G. W. Sandberg, U.S. Geological Survey, 1966.

*No. 14. Water-resources appraisal of the Snake Valley area, Utah and Nevada, by J. W. Hood and F. E. Rush, U.S. Geological Survey, 1966.

*No. 15. Water from bedrock in the Colorado Plateau of Utah, by R. D. Feltis, U.S. Geological Survey, 1966.

*No. 16. Ground-water conditions in Cedar Valley, Utah County, Utah, by R. D. Feltis, U.S. Geological Survey, 1967.

*No. 17. Ground-water resources of northern Juab Valley, Utah, by L. J. Bjorklund, U.S. Geological Survey, 1968.

No. 18. Hydrologic reconnaissance of Skull Valley, Tooele County, Utah, by J. W. Hood and K. M. Waddell, U.S. Geological Survey, 1968.

No. 19. An appraisal of the quality of surface water in the Sevier Lake basin, Utah, by D. C. Hahl and J. C. Mundorff, U.S. Geological Survey, 1968.

No. 20. Extensions of streamflow records in Utah, by J. K. Reid, L. E. Carroon, and G. E. Pyper, U.S. Geological Survey, 1969.

No. 21. Summary of maximum discharges in Utah streams, by G. L. Whitaker, U.S. Geological Survey, 1969.

No. 22. Reconnaissance of the ground-water resources of the upper Fremont River valley, Wayne County, Utah, by L. J. Bjorklund, U.S. Geological Survey, 1969.

No. 23. Hydrologic reconnaissance of Rush Valley, Tooele County, Utah, by J. W. Hood, Don Price, and K. M. Waddell, U.S. Geological Survey, 1969.

No. 24. Hydrologic reconnaissance of Deep Creek valley, Tooele and Juab Counties, Utah, and Elko and White Pine Counties, Nevada, by J. W. Hood and K. M. Waddell, U.S. Geological Survey, 1969.

No. 25. Hydrologic reconnaissance of Curlew Valley, Utah and Idaho, by E. L. Bolke and Don Price, U.S. Geological Survey, 1969.

No. 26. Hydrologic reconnaissance of the Sink Valley area, Tooele and Box Elder Counties, Utah, by Don Price and E. L. Bolke, U.S. Geological Survey, 1969.

No. 27. Water resources of the Heber-Kamas-Park City area, north-central Utah, by C. H. Baker, Jr., U.S. Geological Survey, 1970.

No. 28. Ground-water conditions in southern Utah Valley and Goshen Valley, Utah, by R. M. Cordova, U.S. Geological Survey, 1970.

No. 29. Hydrologic reconnaissance of Grouse Creek valley, Box Elder County, Utah, by J. W. Hood and Don Price, U.S. Geological Survey, 1970.

No. 30. Hydrologic reconnaissance of the Park Valley area, Box Elder County, Utah, by J. W. Hood, U.S. Geological Survey, 1971.

No. 31. Water resources of Salt Lake County, Utah, by A. G. Hely, R. W. Mower, and C. A. Harr, U.S. Geological Survey, 1971.

No. 32. Geology and water resources of the Spanish Valley area, Grand and San Juan Counties, Utah, by C. T. Sumsion, U.S. Geological Survey, 1971.

No. 33. Hydrologic reconnaissance of Hansel Valley and northern Rozel Flat, Box Elder County, Utah, by J. W. Hood, U.S. Geological Survey, 1971.

No. 34. Summary of water resources of Salt Lake County, Utah, by A. G. Hely, R. W. Mower, and C. A. Harr, U.S. Geological Survey, 1971.

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No. 36. Ground-water resources of Cache Valley, Utah and Idaho, by L. J. Bjorklund and L. J. McGreevy, U.S. Geological Survey, 1971.

No. 37. Hydrologic reconnaissance of the Blue Creek Valley area, Box Elder County, Utah, by E. L. Bolke and Don Price, U.S. Geological Survey, 1972.

No. 38. Hydrologic reconnaissance of the Promontory Mountains area, Box Elder County, Utah, by J. W. Hood, U.S. Geological Survey, 1972.

No. 39. Reconnaissance of chemical quality of surface water and fluvial sediment in the Price River Basin, Utah, by J. C. Mundorff, U.S. Geological Survey, 1972.

No. 40. Ground-water conditions in the central Virgin River basin, Utah, by R. M. Cordova, G. W. Sandberg, and Wilson McConkie, U.S. Geological Survey, 1972.

No. 41. Hydrologic reconnaissance of Pilot Valley, Utah and Nevada, by J. C. Stephens and J. W. Hood, U.S. Geological Survey, 1973.

No. 42. Hydrologic reconnaissance of the northern Great Salt Lake Desert and summary hydrologic reconnaissance of northwestern Utah, by J. C. Stephens, U.S. Geological Survey, 1973.

No. 43. Water resources of the Milford area, Utah, with emphasis on ground water, by R. W. Mower and R. M. Cordova, U.S. Geological Survey, 1974.

No. 44. Ground-water resources of the lower Bear River drainage basin, Box Elder County, Utah, by L. J. Bjorklund and L. J. McGreevy, U.S. Geological Survey, 1974.

No. 45. Water resources of the Curlew Valley drainage basin, Utah and Idaho, by C. H. Baker, Jr., U.S. Geological Survey, 1974.

No. 46. Water-quality reconnaissance of surface inflow to Utah Lake, by J. C. Mundorff, U.S. Geological Survey, 1974.

No. 47. Hydrologic reconnaissance of the Wah Wah Valley drainage basin, Millard and Beaver Counties, Utah, by J. C. Stephens, U.S. Geological Survey, 1974.

No. 48. Estimating mean streamflow in the Duchesne River Basin, Utah, by R. W. Cruff, U.S. Geological Survey, 1974.

No. 49. Hydrologic reconnaissance of the southern Uinta Basin, Utah and Colorado, by Don Price and L. L. Miller, U.S. Geological Survey, 1975.

No. 50. Seepage study of the Rocky Point Canal and the Grey Mountain -Pleasant Valley Canal systems, Duchesne County, Utah, by R. W. Cruff and J. W. Hood, U.S. Geological Survey, 1976.

No. 51. Hydrologic reconnaissance of the Pine Valley drainage basin, Millard, Beaver, and Iron Counties, Utah, by J. C. Stephens, U.S. Geological Survey, 1976.

No. 52. Seepage study of canals in Beaver Valley, Beaver County, Utah, by R. W. Cruff and R. W. Mower, U.S. Geological Survey, 1976.

No. 53. Characteristics of aquifers in the northern Uinta Basin area, Utah and Colorado, by J. W. Hood, U.S. Geological Survey, 1976.

No. 54. Hydrologic evaluation of Ashley Valley, northern Uinta Basin area, Utah, by J. W. Hood, U.S. Geological Survey, 1977.

No. 55. Reconnaissance of water quality in the Duchesne River basin and some adjacent drainage areas, Utah, by J. C. Mundorff, U.S. Geological Survey, 1977.

No. 56. Hydrologic reconnaissance of the Tule Valley drainage basin, Juab and Millard Counties, Utah, by J. C. Stephens, U.S. Geological Survey, 1977.

No. 57. Hydrologic evaluation of the upper Duchesne River valley, northern Uinta Basin area, Utah, by J. W. Hood, U.S. Geological Survey, 1977.

WATER CIRCULARS

No. 1. Ground water in the Jordan Valley, Salt Lake County, Utah, by Ted Arnow, U.S. Geological Survey, 1965.

No. 2. Ground water in Tooele Valley, Utah, by J. S. Gates and O. A. Keller, U.S. Geological Survey, 1970.

BASIC-DATA REPORTS

*No. 1. Records and water-level measurements of selected wells and chemical analyses of ground water, East Shore area, Davis, Weber, and Box Elder Counties, Utah, by R. E. Smith, U.S. Geological Survey, 1961.

No. 2. Records of selected wells and springs, selected drillers' logs of wells, and chemical analyses of ground and surface waters, northern Utah Valley, Utah County, Utah, by Seymour Subitzky, U.S. Geological Survey, 1962.

No. 3. Ground-water data, central Sevier Valley, parts of Sanpete, Sevier, and Piute Counties, Utah, by C. H. Carpenter and R. A. Young, U.S. Geological Survey, 1963.

*No. 4. Selected hydrologic data, Jordan Valley, Salt Lake County, Utah, by I. W. Marine and Don Price, U.S. Geological Survey, 1963.

*No. 5. Selected hydrologic data, Pavant Valley, Millard County, Utah, by R. W. Mower, U.S. Geological Survey, 1963.

*No. 6. Ground-water data, parts of Washington, Iron, Beaver, and Millard Counties, Utah, by G. W. Sandberg, U.S. Geological Survey, 1963.

No. 7. Selected hydrologic data, Tooele Valley, Tooele County, Utah, by J. S. Gates, U.S. Geological Survey, 1963.

No. 8. Selected hydrologic data, upper Sevier River basin, Utah, by C. H. Carpenter, G. B. Robinson, Jr., and L. J. Bjorklund, U.S. Geological Survey, 1964.

*No. 9. Ground-water data, Sevier Desert, Utah, by R. W. Mower and R. D. Feltis, U.S. Geological Survey, 1964.

No. 10. Quality of surface water in the Sevier Lake basin, Utah, by D. C. Hahl and R. E. Cabell, U.S. Geological Survey, 1965.

*No. 11. Hydrologic and climatologic data, collected through 1964, Salt Lake County, Utah, by W. V. Iorns, R. W. Mower, and C. A. Horr, U.S. Geological Survey, 1966.

No. 12. Hydrologic and climatologic data, 1965, Salt Lake County, Utah, by W. V. Iorns, R. W. Mower, and C. A. Horr, U.S. Geological Survey, 1966.

No. 13. Hydrologic and climatologic data, 1966, Salt Lake County, Utah, by A. G. Hely, R. W. Mower, and C. A. Horr, U.S. Geological Survey, 1967.

No. 14. Selected hydrologic data, San Pitch River drainage basin, Utah, by G. B. Robinson, Jr., U.S. Geological Survey, 1968.

No. 15. Hydrologic and climatologic data, 1967, Salt Lake County, Utah, by A. G. Hely, R. W. Mower, and C. A. Horr, U.S. Geological Survey, 1968.

No. 16. Selected hydrologic data, southern Utah and Goshen Valleys, Utah, by R. M. Cordova, U.S. Geological Survey, 1969.

No. 17. Hydrologic and climatologic data, 1968, Salt Lake County, Utah, by A. G. Hely, R. W. Mower, and C. A. Horr, U.S. Geological Survey, 1969.

No. 18. Quality of surface water in the Bear River basin, Utah, Wyoming, and Idaho, by K. M. Waddell, U.S. Geological Survey, 1970.

No. 19. Daily water-temperature records for Utah streams, 1944-68, by G. L. Whitaker, U.S. Geological Survey, 1970.

No. 20. Water-quality data for the Flaming Gorge area, Utah and Wyoming, by R. J. Madison, U.S. Geological Survey, 1970.

No. 21. Selected hydrologic data, Cache Valley, Utah and Idaho, by L. J. McGreevy and L. J. Bjorklund, U.S. Geological Survey, 1970.

No. 22. Periodic water- and air-temperature records for Utah streams, 1966-70, by G. L. Whitaker, U.S. Geological Survey, 1971.

No. 23. Selected hydrologic data, lower Bear River drainage basin, Box Elder County, Utah, by L. J. Bjorklund and L. J. McGreevy, U.S. Geological Survey, 1973.

No. 24. Water-quality data for the Flaming Gorge Reservoir area, Utah and Wyoming, 1969-72, by E. L. Bolke and K. M. Waddell, U.S. Geological Survey, 1972.

No. 25. Streamflow characteristics in northeastern Utah and adjacent areas, by F. K. Fields, U.S. Geological Survey, 1975.

No. 26. Selected hydrologic data, Uinta Basin area, Utah and Colorado, by J. W. Hood, J. C. Mundorff, and Don Price, U.S. Geological Survey, 1976.

No. 27. Chemical and physical data for the Flaming Gorge Reservoir area, Utah and Wyoming, by E. L. Bolke, U.S. Geological Survey, 1976.

INFORMATION BULLETINS

*No. 1. Plan of work for the Sevier River Basin (Sec. 6, P. L. 566), U.S. Department of Agriculture, 1960.

*No. 2. Water production from oil wells in Utah, by Jerry Tuttle, Utah State Engineer's Office, 1960.

*No. 3. Ground-water areas and well logs, central Sevier Valley, Utah, by R. A. Young, U.S. Geological Survey, 1960.

*No. 4. Ground-water investigations in Utah in 1960 and reports published by the U.S. Geological Survey or the Utah State Engineer prior to 1960, by H. D. Goode, U.S. Geological Survey, 1960.

*No. 5. Developing ground water in the central Sevier Valley, Utah, by R. A. Young and C. H. Carpenter, U.S. Geological Survey, 1961.

*No. 6. Work outline and report outline for Sevier River basin survey, (Sec. 6, P. L. 566), U.S. Department of Agriculture, 1961.

*No. 7. Relation of the deep and shallow artesian aquifers near Lynndyl, Utah, by R. W. Mower, U.S. Geological Survey, 1961.

*No. 8. Projected 1975 municipal water-use requirements, Davis County, Utah, by Utah State Engineer's Office, 1962.

No. 9. Projected 1975 municipal water-use requirements, Weber County, Utah, by Utah State Engineer's Office, 1962.

*No. 10. Effects on the shallow artesian aquifer of withdrawing water from the deep artesian aquifer near Sugarville, Millard County, Utah, by R. W. Mower, U.S. Geological Survey, 1963.

*No. 11. Amendments to plan of work and work outline for the Sevier River basin (Sec. 6, P. L. 566), U.S. Department of Agriculture, 1964.

*No. 12. Test drilling in the upper Sevier River drainage basin, Garfield and Piute Counties, Utah, by R. D. Feltis and G. B. Robinson, Jr., U.S. Geological Survey, 1963.

*No. 13. Water requirements of lower Jordan River, Utah, by Karl Harris, Irrigation Engineer, Agricultural Research Service, Phoenix, Arizona, prepared under informal cooperation approved by Mr. W. W. Donnan, Chief, Southwest Branch (Riverside, California) Soil and Water Conservation Research Division, Agricultural Research Service, U.S.D.A., and by W. D. Criddle, State Engineer, State of Utah, Salt Lake City, Utah, 1964.

*No. 14. Consumptive use of water by native vegetation and irrigated crops in the Virgin River area of Utah, by W. D. Criddle, J. M. Bagley, R. K. Higginson, and D. W. Hendricks, through cooperation of Utah Agricultural Experiment Station, Agricultural Research Service, Soil and Water Conservation Branch, Western Soil and Water Management Section, Utah Water and Power Board, and Utah State Engineer, Salt Lake City, Utah, 1964.

*No. 15. Ground-water conditions and related water-administration problems in Cedar City Valley, Iron County, Utah, February, 1966, by J. A. Barnett and F. T. Mayo, Utah State Engineer's Office.

*No. 16. Summary of water well drilling activities in Utah, 1960 through 1965, compiled by Utah State Engineer's Office, 1966.

*No. 17. Bibliography of U.S. Geological Survey water-resources reports for Utah, compiled by O. A. Keller, U.S. Geological Survey, 1966.

*No. 18. The effect of pumping large-discharge wells on the ground-water reservoir in southern Utah Valley, Utah County, Utah, by R. M. Cordova and R. W. Mower, U.S. Geological Survey, 1967.

No. 19. Ground-water hydrology of southern Cache Valley, Utah, by L. P. Beer, 1967.

*No. 20. Fluvial sediment in Utah, 1905-65, A data compilation by J. C. Mundorff, U.S. Geological Survey, 1968.

*No. 21. Hydrogeology of the eastern portion of the south slopes of the Uinta Mountains, Utah, by L. G. Moore and D. A. Barker, U.S. Bureau of Reclamation, and J. D. Maxwell and R. L. Bridges, Soil Conservation Service, 1971.

*No. 22. Bibliography of U.S. Geological Survey water-resources reports for Utah, compiled by B. A. LaPray, U.S. Geological Survey, 1972.

No. 23. Bibliography of U.S. Geological Survey water-resources reports for Utah, compiled by B. A. LaPray, U.S. Geological Survey, 1975.