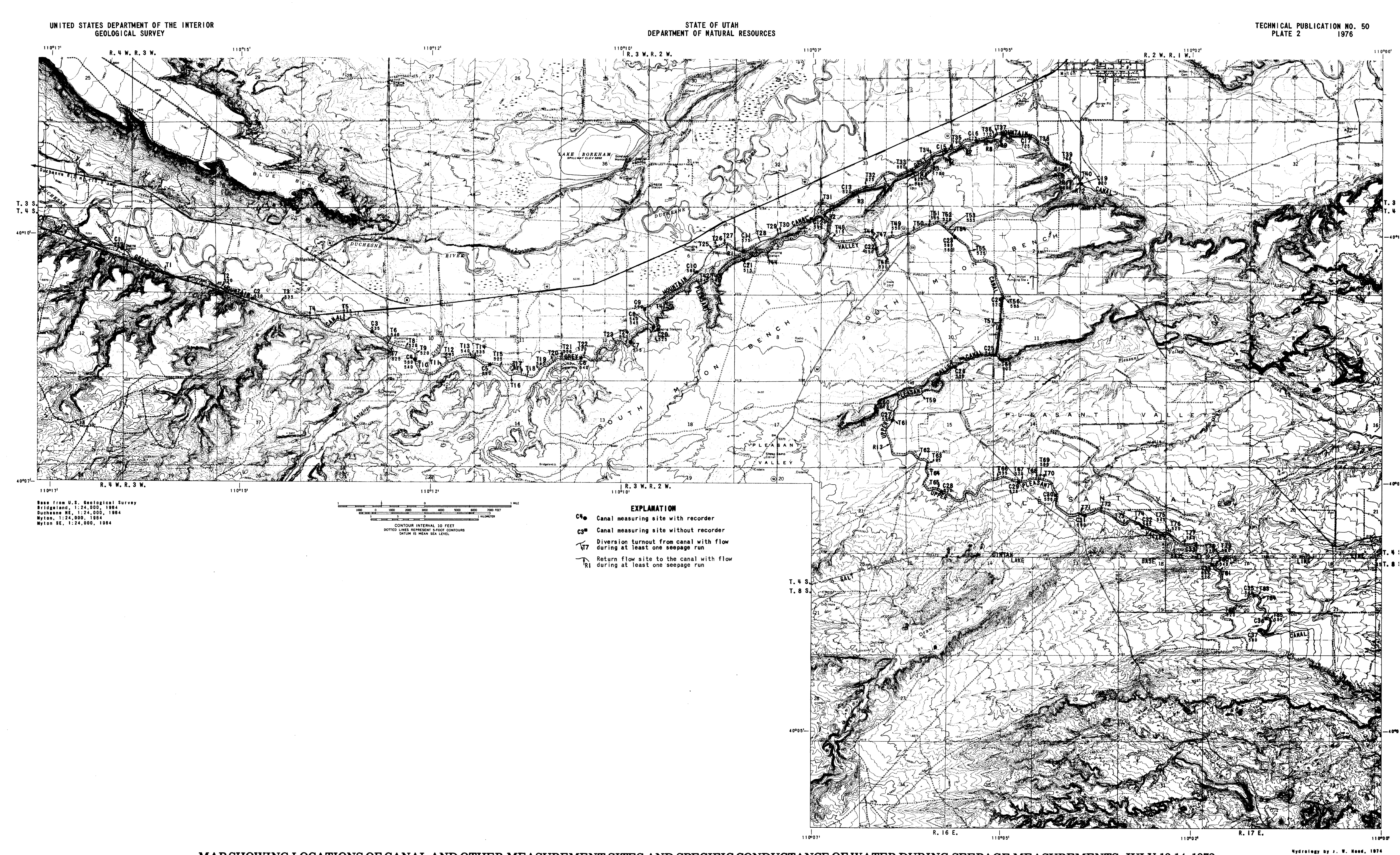
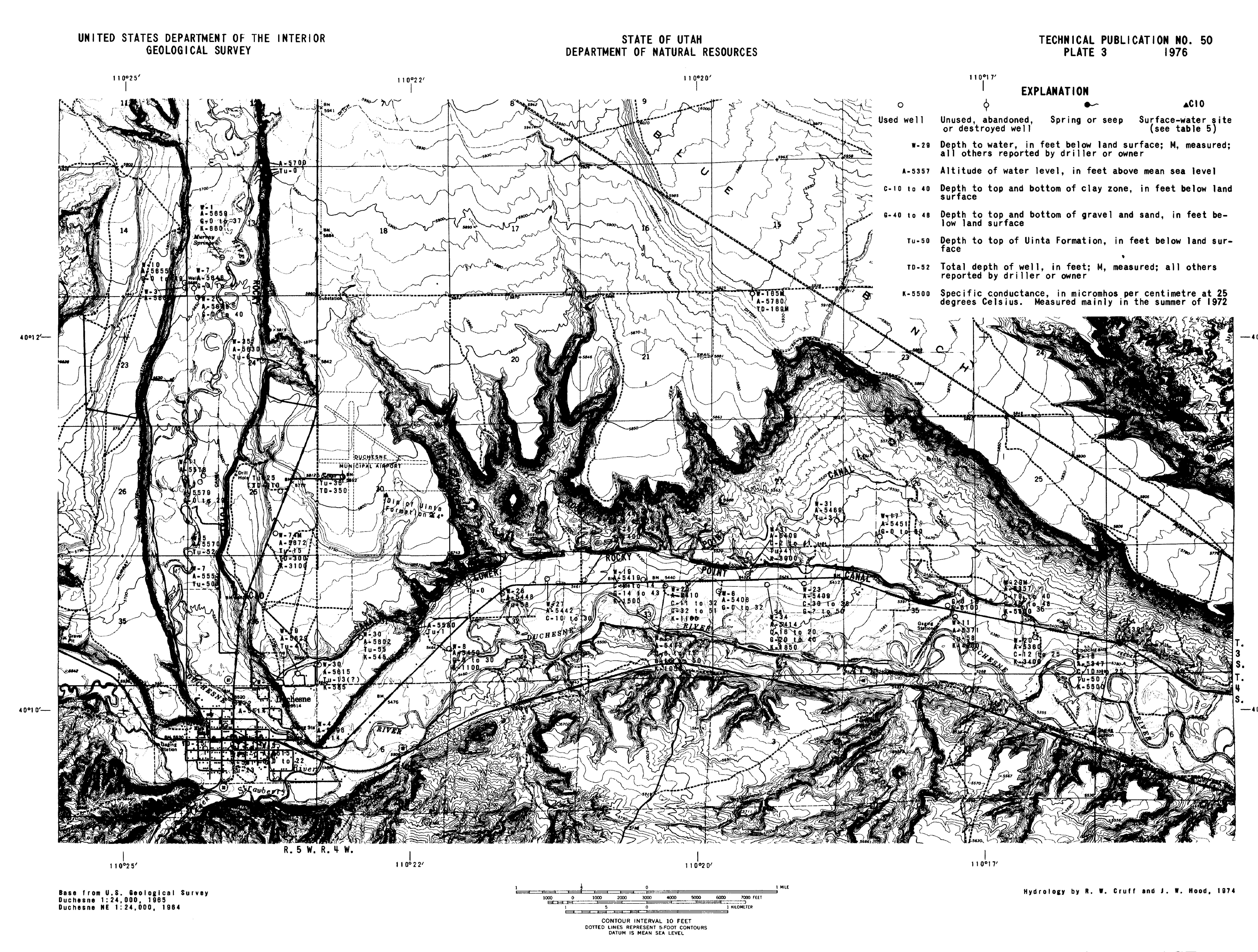
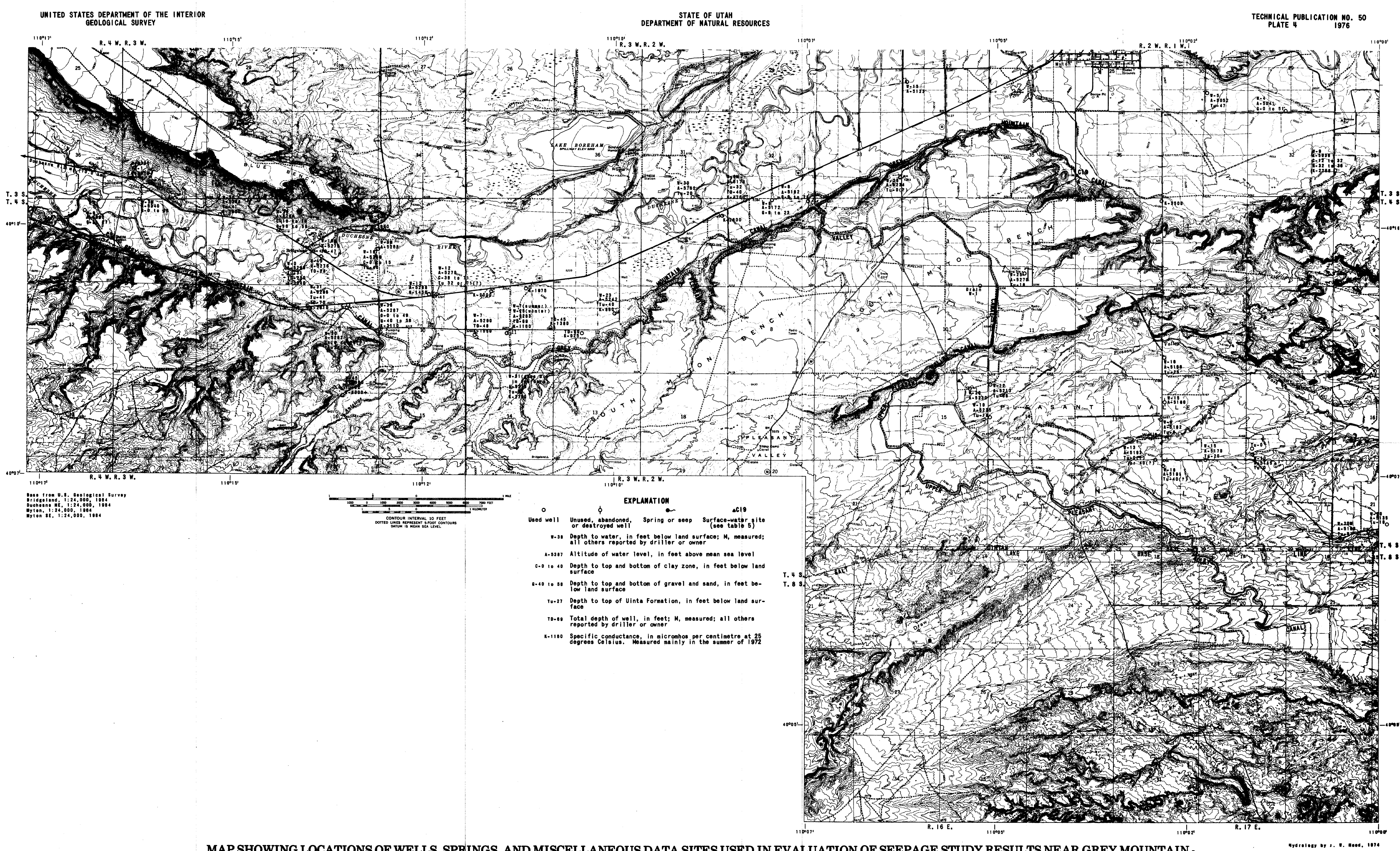


MAP SHOWING LOCATIONS OF CANAL AND OTHER MEASUREMENT SITES AND SPECIFIC CONDUCTANCE OF WATER DURING SEEPAGE MEASUREMENTS, AUGUST 30, 1972, ROCKY POINT CANAL SYSTEM, DUCHESNE COUNTY, UTAH





MAP SHOWING LOCATIONS OF WELLS, SPRINGS, AND MISCELLANEOUS DATA SITES USED IN EVALUATION OF SEEPAGE STUDY RESULTS NEAR ROCKY POINT CANAL SYSTEM, DUCHESNE COUNTY, UTAH



STATE OF UTAH DEPARTMENT OF NATURAL RESOURCES

Technical Publication No. 50



SEEPAGE STUDY OF THE ROCKY POINT CANAL AND THE GREY MOUNTAIN-PLEASANT VALLEY CANAL SYSTEMS, DUCHESNE COUNTY, UTAH

bу

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

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METRIC (SI) UNITS

Most numbers are given in this report in English units followed by metric units in parentheses. The conversion factors used 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		tric
	breviation		Unit	Abbreviation
(Multiply)		(by)	(to obtain)	
Acres		0.4047	Square hectometres	hm ²
Cubic feet	ft ³	.02832	Cubic metres	m^3
Feet	ft	.3048	Metres	m
Miles	mi	1.609	Kilometres	km
Square feet	ft ²	.0929	Square metres	m ²

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ABSTRACT

A study of the gains or losses of the Rocky Point Canal System and the Grey Mountain-Pleasant Valley canal system, Duchesne County, Utah, was made to aid in the water allocation of the canal systems. Four sets of seepage runs were made along each of the canals from May 1972 to June 1973. 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 and from a time-of-travel study.

Although significant gains and losses were found for specific reaches of the canals, the net loss for the Rocky Point Canal system, which is 96,800 feet (29,500 metres) in length, amounted to 3.4 cubic feet per second (0.10 cubic metre per second) or about 6 percent of the capacity of the canal. The net loss for the Grey Mountain-Pleasant Valley Canal system, which is 160,300 feet (48,860 metres) in length, was 24.5 cubic feet per second (0.69 cubic metre per second) or about 8 percent of the canal's capacity. Qualitative evaluation of the geohydrology of the study area indicates an estimated return of canal loss to the river system of about 20 percent, or 5.6 cubic feet per second (0.16 cubic metre per second).

INTRODUCTION

This report gives the results of the first of a series of canal-seepage studies to be made in Utah by the U.S. Geological Survey in cooperation with the Division of Water Rights, Utah Department of Natural Resources. The Division of Water Rights, when allocating water along canal systems, needs to know if an individual canal gains or loses water. It is desirable also to know where water is lost, the disposition of the lost water, and particularly how much of the lost water returns to the stream system downstream. This information is best obtained by detailed gaging of canals and by a general study of the entire hydrologic system at and near the canals.

This report describes the study of the Rocky Point Canal system in the vicinity of Duchesne and the Grey Mountain-Pleasant Valley Canal system between Duchesne and Myton, in the Uinta Basin, Duchesne County, Utah. The Rocky Point Canal (fig. 1 and pl. 1) diverts from the left bank of the Duchesne River about 4 mi (6.4 km) north of Duchesne and has a capacity of about $60~\rm ft^3/s~(1.7~m^3/s)$ at the head. This canal splits into the upper Rocky Point Canal and the lower Rocky Point Canal about

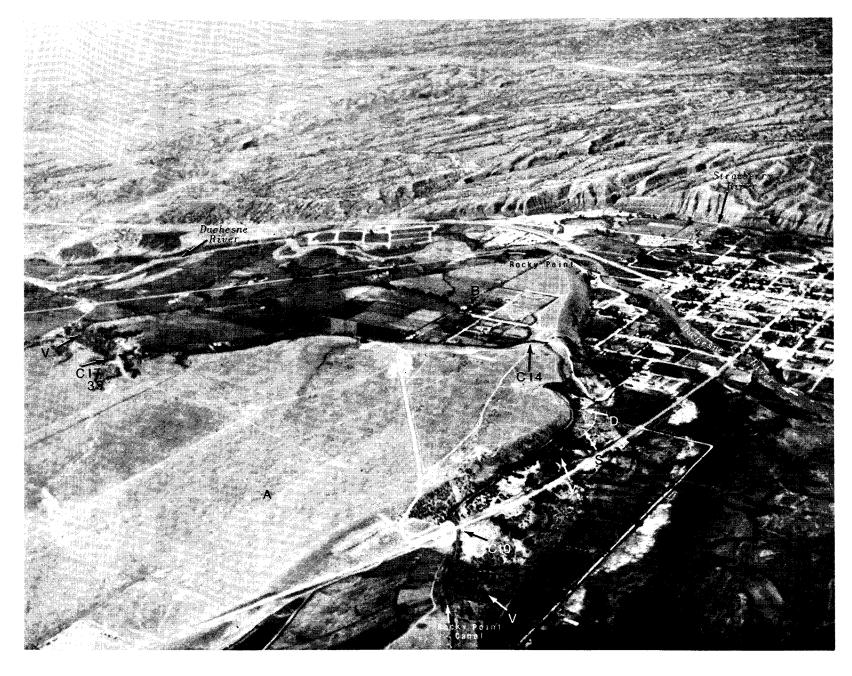


Figure 1.—Aerial view, looking southeastward, of Duchesne River at Duchesne, Utah, adjacent Rocky Point, dissection of Uinta Formation, terraces, canals, and streams. A - Blue Bench, B - terrace on Rocky Point, C - canal measuring sites and numbers, D - point of leakage behind house below canal, S - seepage from Uinta Formation when water first entered canal, V - example of vegetation that probably results from canal leakage.

5.2 mi (8.4 km) below its head. The Grey Mountain Canal (pl. 2) diverts from the right bank of the Duchesne River about 6 mi (9.7 km) east of Duchesne and has a capacity of about 320 ft 3 /s (9.1 m 3 /s) at the head. At a point about 7.6 mi (12.2 km) below the head, the Pleasant Valley Canal diverts from the right bank of the Grey Mountain Canal. At this point, the Pleasant Valley (upper) Canal has a capacity of about 200 ft 3 /s (5.7 m 3 /s) and the Grey Mountain (lower) Canal has a capacity of about 50 ft 3 /s (1.4 m 3 /s).

The canal-seepage study was made concurrently with a general hydrologic study of the northern Uinta Basin, the results of which will be published separately. Data obtained for the larger study were freely used to assist in the preparation of this report.

METHODS OF INVESTIGATION

A reconnaissance was made intermittently during late March, April, and early May 1972 by the junior author. The entire lengths of both branches of both canals were examined by walking along the banks and making notes regarding: (1) the locations of main canal controls, drops, turnouts, or other diversion structures and whether they had been used recently, (2) the nature of the rocks in which the canals are cut, and the nature of canal-bottom deposits, (3) the general condition of each canal (for example, whether or not the canal had been recently cleaned and other maintenance had been performed), (4) the nature of vegetation and its density both above and below the canal, (5) the locations of both natural and irrigation return flow to the canal, (6) direct surficial evidence of current or past leakage from the canals, and (7) the land use, in general, on both sides of the canals.

Using the information from the reconnaissance, the canals were divided into reaches, and measuring sites were located within each reach. Stage recorders or staff gages were installed at the head of each reach. Five water-stage recorders and two staff gages were installed on the Rocky Point system, and twelve water-stage recorders were installed on the Grey Mountain-Pleasant Valley system.

Four sets of seepage measurements were made on each canal system during 1972-73, timed to represent conditions at the beginning, middle, and end of the irrigation season. The number of measuring sites on the Grey Mountain-Pleasant Valley Canal system was restricted because the depth of water in the canal 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. Plates 1 and 2 show the sites where a measurement (or estimate) was made during at least one set of seepage measurements. The date and time of measurement and the discharge at each measurement site are shown in tables 3 and 4. Continuous

water-stage records were obtained at the head of each reach, except at sites C5 and C44 on the Rocky Point Canal system (pl. 1), where periodic measurements were made at staff gages. The water-stage records are shown in figures 18 and 19.

Fluctuations in flow during the seepage measurements complicated interpretation of the data, therefore, a time-of-travel study was made (Adams, 1974) on each canal system. The information from this study and the records of stage for each reach of the canals were used to route fluctuations in flow between measuring sites.

In order to assess the results of the seepage studies, and concurrently in support of the general hydrologic studies in the Uinta Basin, supplemental data were collected for wells and springs in the general reach of the Duchesne River valley from the head of the Rocky Point Canal to below the end of the Grey Mountain Canal (pls. 3 and 4). Where possible, the depth to water in wells was measured, discharges of wells and springs were measured or estimated, water temperature and specific conductance were measured, selected wells and springs were sampled for chemical analysis, and drillers' logs were obtained for the wells. Key points on the river and the canal systems were measured for temperature and specific conductance (table 5) several times, and some of these sites were sampled for chemical analyses. These data are listed in Hood, Mundorff, and Price (1975).

Numbering system for hydrologic data sites

The system of numbering wells, springs, and other hydrologic data sites in Utah is based on the cadastral land-survey system of the U.S. Government. The number, in addition to designating the well or spring, describes its position in the land net. By the land-survey system, the State is divided into four quadrants by the Salt Lake base line and meridian, and the quadrants are designated by the uppercase letters A, B, C, and D, indicating the northeast, northwest, southwest, and southeast quadrants, respectively. In like manner, the part of Utah surveyed around the Uintah base line and meridian is divided into quadrants with the same designations. Numbers designating the township and range (in that order) follow the quadrant letter, and all three are enclosed in parentheses. The Uintah meridian is designated by letter "U" which precedes the parentheses. The number after parentheses indicates the section, and is followed by three letters indicating the quarter section, the quarter-quarter section, and the quarter-quarter-quarter section (generally 10 acres or 4 hm²); 1 letters a, b, c, and d indicate, respectively, the northeast, northwest, southwest, and southeast quarters of each subdivision. The number after

 1 Although the basic land unit, the section, is theoretically 1 mi 2 (2.6 km 2), many sections are irregular. Such sections are subdivided into 10-acre (4-hm 2) tracts, generally beginning at the southeast corner, and the surplus or shortage is taken up in the tracts along the north and west sides of the section.

the letters is the serial number of the well or spring within the 10-acre (4-hm²) tract; the letter "S" preceding the serial number denotes a spring.

Thus U(C-4-3)4ada-S1 designates a spring visited in the NE $\frac{1}{4}SE\frac{1}{4}NE\frac{1}{4}Sec.$ 4, T. 4 S., R. 3 W. If a well or spring cannot be located within a 10-acre (4-hm²) tract, one or two location letters are used and the serial number is omitted.

Other sites where hydrologic data were collected are numbered in the same manner, but three letters are used after the section number and no serial number is used. Thus U(C-3-4)32aba designates a point of field observations in the NE4NW4NE4 sec. 32, T. 3 S., R. 4 W., both in the Uintah survey. The numbering system is illustrated in figure 2.

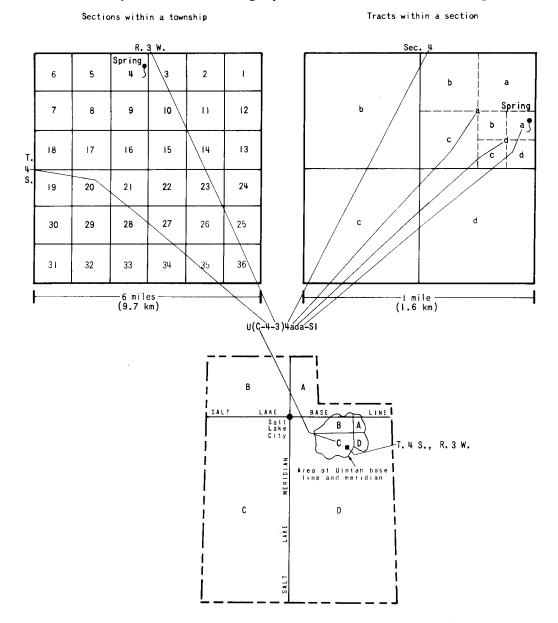


Figure 2. - Numbering system used in Utah for hydrologic-data sites.

SEEPAGE MEASUREMENTS

The results of the seepage measurements, expressed in gain or loss along the canals, are given in tables 1 and 2. The procedures used to obtain these results are described in the following pages.

Table 1.--Gain or loss along the Rocky Point Canal system

Reach	Length (ft)	$\frac{\text{Gain}(+)}{\text{ft}^3/\text{s}}$	$\frac{\text{or loss}(-)}{(\text{ft}^3/\text{s})/\text{mi}}$
C1-C5 C5-C7 C7-C10 C10-C14 C14-C17	7,200 4,400 6,200 4,600 5,000	+2.1 -2.3 0 -4.6 +1.2	+1.5 -2.8 0 -5.3 +1.3
Lower canal C17-C19 C19-C23 C23-C26 C26-C32 C32-C34	2,200 4,800 2,600 10,800 6,000	-1.3 +1.5 +1.2 +1.0 2	-3.1 +1.6 +2.4 +.5 2
Upper canal C35-C39 C39-C45 C45-C50 C50-C53	3,000 20,200 12,000 7,800	5 -1.0 2 3	9 3 1 2
Total net	96,800	-3.4	

All discharge values obtained for each of the four sets of seepage measurements were reduced to a common base by adjusting the measurements made with each current meter. The individual meter adjustment was determined by dividing the average discharge for all calibration measurements (made prior to starting each set of seepage measurements) by the individual meter measurements.

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 fluctuation in canal flow which originated above the reach being analyzed. Information required to make this adjustment is the change in discharge 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 discharge with time at the head of the reach was determined from the recorded stage and the discharge measurements at the head of the reach. The times of the two measurements are available from tables 3 and 4, and the time of travel between the two points was determined from the time-of-travel study by Adams (1974).

Table 2.--Gain or loss along the Grey Mountain-Pleasant Valley

Canal system

Reach	Length		Gain(+) or loss(-)	
	(ft)	ft ³ /s	$(ft^3/s)/mi$	
Grey Mountain main c	anal			
C1-C4	21,400	-4. 5	-1.1	
C4-C20	18,600	-15.0	-4. 3	
Pleasant Valley Cana	1			
C20-C21	13,600	0	0	
C21-C22	11,800	- 3.5	-1.6	
C22-C23	6 , 800	-6.0	-4.7	
C23-C24	5,000	-3.5	-3.7	
C24-C26	6,400	+5.0	+4.1	
C26-C27	5,800	+8.0	+7.3	
C27-C29	13,000	-6.0	-2.4	
C29-C30	2,800	+3.5	+6.6	
C30-C37	20,100	+1.5	+.4	
Grey Mountain Canal				
C8-C10	5,800	+1.0	+.9	
C10-C13	12,200	-4.5	-1.9	
C13-C17	12,600	-1.0	4	
C17-C19	4,400	+.5	+.6	
Total net	160,300	-24.5		

As an example, assume that the measurement at the head of the reach was $50.0~\rm ft^3/s$ $(1.42~\rm m^3/s)$ at $0800~\rm hours$, the measurement at the downstream measuring site was made at $1000~\rm hours$, the time required for flow to travel between the two sites is $1~\rm hour$, and the discharge at the head of the canal was dropping at the rate of $1.00~\rm ft^3/s$ $(0.028~\rm m^3/s)$ per hour. To make the adjustment, the travel time is subtracted from the time of the downstream measurement $(1000~\rm hours-1~\rm hour=0900~\rm hours)$ to give a comparable time for flow at the head of the canal. From the water-stage records and the measurements available for the head of the canal, the flow at $0900~\rm hours$ was calculated as $49.0~\rm ft^3/s$ $(1.39~\rm m^3/s)$, or an adjustment of $-1.00~\rm ft^3/s$ $(0.28~\rm m^3/s)$. 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.

Based on the rate of gain or loss shown on these plots, the canals were segmented into reaches other than those used for measurement. The data for each of the newly defined reaches were then replotted in figures 3 and 4, 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 was determined from this line. The amount and rate of gain or loss by reach is shown in table 1 for the Rocky Point Canal system and in table 2 for the Grey Mountain-Pleasant Valley Canal system.

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 figures 3 and 4. The scatter is attributed primarily to the inability to adjust completely for fluctuations in the amount of flow within a given reach during the time a set of measurements was being made. This was more of a problem on the Grey Mountain-Pleasant Valley system than on the Rocky Point system.

Another reason for the scatter probably was the unmeasurable seepage return to the canal system from irrigated fields. This was a problem principally between sites C7 and C10 of the Rocky Point Canal, on the lower Rocky Point Canal (between sites C17 and C34), and on the Grey Mountain Canal below the Pleasant Valley Canal (between sites C8 and C19). In a few cases where irrigation of a field above a reach coincided with a large gain or a much smaller loss for a given measurement period as compared to those for other sets of measurements, the measurements for the given period through that reach were not plotted.

The quantities of water lost from the two canal systems are relatively small, considering the kinds of material through which the canals are cut and the lack of canal lining. Even the larger calculated rates of loss, such as that from reach C4-C20 in the Grey Mountain-Pleasant Valley Canal system (pl. 2), might be expected. For example, in the reach cited, the depth to water in wells below the canal is at least 30 ft (9.1 m), and water leaking from the canal can move down and away from the canal bottom. At site C4, the canal has an average width of about 22 ft (6.7 m) and an average depth of water of about 4 ft (1.2 m), as measured during gaging. The sides are nearly vertical. Downstream the canal has about the same dimensions. The rate of loss from this reach was 4.3 (ft^3/s)/mi [0.08 (m^3/s)/km] (table 2), or about 70.4 ft 3 /d per lineal ft (6.54 m 3 /s per lineal m). The area of the canal banks and bottom wetted at the stage of 4 ft (1.2 m) is about 30 ft² per lineal ft (9.14 m² per lineal m). The loss, therefore, is 2.3 $(ft^3/ft^2)/d$, or 2.3 ft/d (0.70 m/d). This figure is equivalent to the hydraulic conductivity of the thin layer of sediment on the sides and bottom of the canal, but the figure must be corrected for the average head which is 2 ft (0.6 m) at the canal sides and 4 ft (1.2 m) the bottom, or $[(2 \times 8) + (4 \times 22)]/30 = 3.5$. The calculated approximation of hydraulic conductivity of the canal sides and bottom then is 2.3/3.5 = 0.66 ft/d (0.201 m/d). The figure is in the range

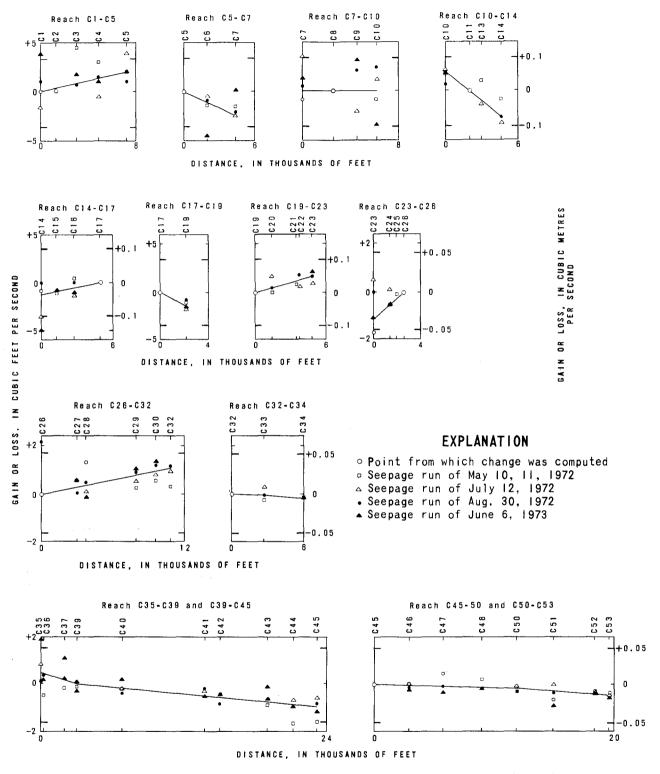


Figure 3. — Gain or loss for reaches of Rocky Point Canal system.

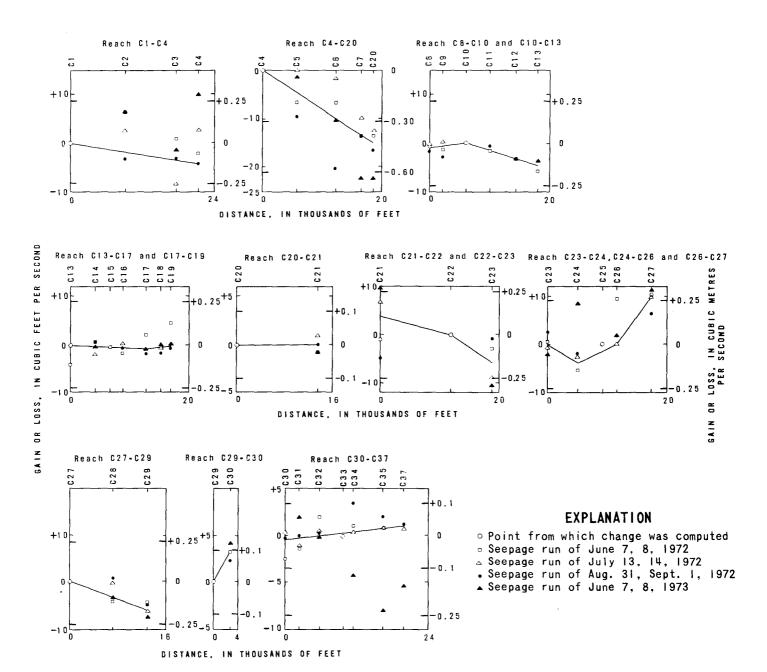


Figure 4. — Gain or loss for reaches of Grey Mountain-Pleasant Valley Canal system.

of permeabilities of silt samples as taken from Morris and Johnson (1967, table 6) and given in modified terms in the following table.

	Hydraulic	conductivity	of silt
	Range of values	Arithmetic mean	Number of samples
Vertical, ft/d	0.000027-2	0.08	39
Horizontal, ft/d	.000053-3.1	.27	39

The reader is warned that the figures calculated above for reach C4-C20 are only approximations and assume (1) that the rate of loss is absolute, not net, and (2) that the loss is uniformly distributed along the reach, not (as is probable) larger in some parts of the reach and smaller in others. The figures do demonstrate, however, that the largest calculated rates of loss are entirely possible through a silt blanket in an unlined canal.

GEOHYDROLOGY

The canal systems described in this report are cut in rocks of Tertiary and Quaternary age, and the water in the canals both affects and is affected by ground water in those rocks. The rocks that comprise the near-surface controls on water movement are consolidated sandstone, siltstone, shale, and limestone belonging to the Uinta Formation of Eocene age, which has an approximate areal dip of 4° , N. 20° W. The formation has low intergranular permeability and thus water moves slowly through it and dissolves much mineral matter. Some of the sandstones and siltstones, however, contain numerous joints, and some beds of shale show networks of fine interconnected cracks. Those parts of the formation that are fractured may transmit water relatively freely. For example, spring U(C-4-3)4ada-S1, near Bridgeland (pl. 4) discharges an estimated 1 ft 3 /s (0.03 m 3 /s) from a joint in siltstone.

Most fracturing of the formation is due to faulting or subsidence of the Uinta Basin. Locally, however, the formation has slumped, especially where the rocks are poorly supported, as along the bluffs south of the Duchesne River. Figures 5 and 6 show an example of slumping; the process accelerates both the intake and transmission of water in the Uinta Formation and the further breakdown of the formation.

The Duchesne River system and its predecessors have cut down into the Uinta Formation, planing the formation off at five or more levels ranging from the uppermost, Blue Bench (pl. 3) to a level at the base of the valley fill beneath the Duchesne River flood plain. The upper three levels are terraces—pediments that are covered with very coarse grained deposits of gravel and cobbles, possibly glacial outwash, most of which vary from a few feet to more than 25 ft (7.6 m) in thickness. The gravel and boulders in turn are covered with a thin veneer of recent soil and windblown sand. These deposits are very permeable, and when water water is available it infiltrates and is transmitted rapidly. Similar conditions exist in the area of South Myton Bench (pl. 4).



Figure 5.— Slumped area of siltstone in bluff above right (south) bank of Pleasant Valley Canal, about 0.25 mile (0.4 kilometre) below site C21. Site is below crevices (see arrow) in figure 6. Beds show much fracturing and contortion. Mineral efflorescence well above canal level indicates that water is in beds above canal.



Figure 6.— Crevices opening (four arrows to right) in Uinta Formation, parallel to face of bluff above Pleasant Valley Canal at location U(C-4-2)5cab. Bedrock is only I-2 feet (0.3-0.6 metre) below land surface and is exposed in canal cut below (arrow to left). Grey Mountain Canal and Duchesne River bottom lands shown at upper left.

The flood plain of the Duchesne River is underlain by deposits of Quaternary age that generally do not exceed 50 ft (15.2 m) in thickness and consist of (1) glacial outwash at the base, (2) an intermediate layer of clay in many places, as below the Rocky Point Canal and also near Bridgeland, and (3) a veneer of sand and recent soil. The glacial outwash is a very permeable aquifer, and the shallow sand also is an aquifer, although less permeable than the outwash. The clay, however, where present, separates the waters in the outwash and sand acts as a confining bed for water in the outwash.

Although they are not aquifers, soil, slumped gravel, and other scree that cover some of the slopes between terraces do act as transfer media when water leaks from the terrace deposits or from canals cut in the slopes.

Movement of water into, within, and out of the canal areas is complicated. Surface and ground water may go through several consecutive transfers from one channel or formation to another. Figure 7 shows the many possible paths and sources of water moving in the system. Owing to the intricacies of water movement in the system, the time allowed for this study was not adequate to develop a quantitative assessment that would apply only to that segment of the water in the system that has leaked from a canal. However, in the following discussion, each canal reach (shown in tables 1 and 2) is evaluated in the light of both the actual seepage measurements and the setting in which loss or gain occurs.

EVALUATION OF THE CANAL SYSTEMS BY REACH

Rocky Point Canal system

Reach C1-C5

From the head of the canal to site C5 (pl. 1) the canal is mostly only a few feet above the adjacent flood plain. The gain given in table 1 is derived from inflow from the Uinta Formation. Most of the gain probably occurs near the head of the reach where visible seeps and small springs can be seen in the bluff above the canal. A number of seepage areas were seen in the lower part of the reach below the canal. If these do not represent upward discharge from the underlying Uinta Formation, then they do indicate leakage from the canal; thus, the actual gain would be larger than the 2.1 $\rm ft^3/s$ (0.06 $\rm m^3/s$) given in table 1.

Reach C5-C7

The calculated loss of 2.3 ft³/s (0.07 m³/s) may be due to leakage at only a few points. Most of this reach is in alluvium, although bedrock crops out at several places along the upper side of the canal bank. Seepage was noted at the toe of the slope near the south side of sec.24, T. 3 S., R. 5 W.; and the canyon below turnouts T5 and T6 in the northern part of sec. 25 is heavily vegetated, indicating that water is available there. Most of the water lost by the canal probably is consumed by evapotranspiration in the meadows in the flood plain below.

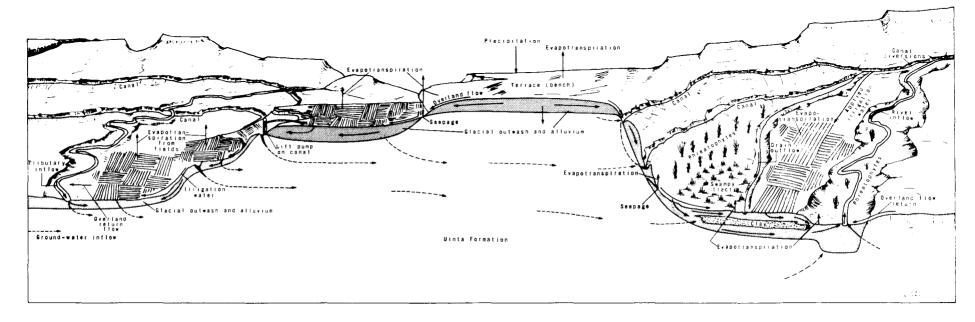


Figure 7.— Diagrammatic sketch showing movement of surface and ground waters in vicinity of canal systems near Duchesne and Myton.

Reach C7-C10

The zero loss or gain calculated for this reach is puzzling. Here the canal is high on the bluff overlooking the flood plain, and it is cut partly into the Uinta Formation and partly into very coarse grained unconsolidated deposits (fig. 8). Concentrations of phreatophytes grow at numerous places along the face of the bluff and at its toe, and wet areas (including a ditch) were observed at the toe of the slope. Seemingly, this reach should have losses similar to the next reach described. The measurements for this reach showed considerable scatter (fig. 3), which suggests that the net zero change may be due to subsurface inflow from the irrigated fields above the canal and from Blue Bench beyond, which balance out the actual losses. Any water lost in this reach is partly consumed by local evapotranspiration and partly carried away by ditches in the flood plain. A small part may return to the Duchesne River.



Figure 8.— Glacial outwash(?) overlying shale (see arrow) of Uinta Formation in left (east) bank of Rocky Point Canal at location U(C-3-5)25cdc.

Reach C10-C14

The calculated loss for this reach is $4.6~{\rm ft}^3/{\rm s}$ (0.13 m $^3/{\rm s}$). Almost the entire reach is cut in fissile shales of the Uinta Formation and a thin veneer of soil. Abundant evidence of leakage was seen at many places, including simultaneous beginning of flow of a small stream of water from the shale down the steep face of the bluff below the canal and beginning of flow in the canal. At an excavation in the Uinta Formation below the canal (point D in fig. 1), a steady flow of water was seen issuing from the contact between the Uinta Formation and the over-

burden. Numerous soggy places were found along the lower bank. Little of the water that leaks from this reach is believed to return to the Duchesne River. It is dissipated mostly by evapotranspiration, either directly from the alluvium into which it has seeped or from irrigated fields to which it has been conveyed by local ditches. Some of this water may return to the canal downstream.

Reach C14-C17

The calculated gain in this reach, 1.2 ft³/s (0.03 m³/s), probably is due to both a return to the canal of part of the water lost from the reach upstream and to inflow of locally derived water from the terrace immediately above the canal. The gain is a net figure because there is evidence of leakage from the canal along the adjacent road, especially in the lower part of the reach. Water that is lost from this reach, mixed with irrigation water that infiltrates the fields on the terrace below the canal, drains from beneath the gravels of the terrace. Part of this water is discharged by small springs and seeps at the northeast side of the terrace where the water is picked up in a ditch and returned to the canal downstream, and part is diverted to other areas via a separate ditch.

Reach C17-C19

The canal splits below site C17, and the lower reach between C17 and C19 shows a calculated loss of 1.3 $\rm ft^3/s$ (0.04 $\rm m^3/s$). Most of the loss probably occurs where the canal drops about 100 ft (30 m) through a natural drainage channel that is underlain by coarse-grained material and is choked with vegetation. Muskrats, which are known to dig holes in canal banks, were seen swimming in this reach. Losses from the reach probably recharge the deeper valley fill, and a part ultimately returns to the Duchesne River. Most of the water that is lost, however, may be dissipated by evapotranspiration in the swampy tracts between the canal and the river.

Reach C19-C23

The calculated gain in this reach of $1.5~{\rm ft^3/s}$ ($0.04~{\rm m^3/s}$) in part is due to leakage from the upper canal. The calculated loss in the upper canal is less than the gain in the lower canal, therefore, part of the gain may be due to inflow from the Uinta Formation. Any actual loss from the lower canal is most probably dissipated by evapotranspiration downgradient.

Reaches C23-C26 and C26-C32

The evaluation for these reaches is similar to that for reach C19 -C23. The gain in each reach is about $1 \text{ ft}^3/\text{s}$ (0.03 m³/s) (see table 1), the gain coming in part from leakage from the upper canal and in part from inflow from the Uinta Formation. However, landslip (fig. 9) and visible leakage (fig. 10) suggest that the canal both gains and loses. Such losses as may occur partly recharge the glacial outwash and partly are dissipated by evapotranspiration.



Figure 9.—Landslip between upper and lower Rocky Point Canals at location U(C-3-4)32aba. The tongue (arrow) of the slip is covered with saltgrass (Distichlis stricta) and has moved from left to right (in photograph), with edge of tongue on lower canal.



Figure 10.—Small spring (bottom arrow) at base of Russianolive (*Elaeagnus Augustifolia*) below bank of lower Rocky Point Canal at location U(C-3-4)32aba. Persistance of spring is indicated by saline accumulations (top arrow) on soils adjacent to flow.

Reach C32-C34

This reach has a calculated loss of $0.2 \, \mathrm{ft}^3/\mathrm{s}$ ($0.01 \, \mathrm{m}^3/\mathrm{s}$), and this water is almost entirely consumed by evapotranspiration in the low areas immediately below the canal. Little of the loss returns to the river, and that which does is of poor chemical quality. Any inflow to the canal in this reach is derived partly from losses from the upper canal and field losses between the two canals and partly from the Uinta Formation.

Reach C35-C39

This reach starts at the head of the upper Rocky Point Canal, where the canal splits. It had a calculated loss of 0.5 $\,\mathrm{ft^3/s}$ (0.01 $\,\mathrm{m^3/s}$). Most of this reach is cut in shale of the Uinta Formation, which in most of the reach looks tight, except where the canal falls through a flume that in 1972 was in poor repair. The flume, which is in the bottom of a small canyon, is probably the location of most of the calculated loss; and most of the water lost probably enters the lower canal.

Reach C39-C45

The calculated loss, which in this reach is 1.0 ft³/s (0.03 m³/s), represents an excess of loss over gain. Inflow from the Uinta Formation is believed to be small-several small springs and intermittent seeps were seen in the banks above the canal, which is mostly cut in the Uinta Formation-and there may also be some ephemeral surface inflow to the canal in the two large tributary canyons around which the canal loops. A dense growth of phreatophytes below the canal in the two tributary canyons, saltgrass (Distichlis stricta) below the canal, and landslips below the canal indicate that leakage occurs. Most of the water probably enters the lower canal.

Reach C45-C50

Although the calculated loss of 0.2 ft³/s (0.01 m³/s) in the reach is small, some leakage must occur as indicated by the vegetation below the canal in the drainage channels that issue from the bluff. A small glen below the canal loop in a canyon in the SE½SE½ sec. 28, T. 3 S., R. 4 W., in particular, supports a dense growth of phreatophytes; but the amount of water needed to sustain this small area of growth probably is small.

The bulk of the water lost in this reach probably is consumed by evapotranspiration, a smaller part seeps into the lower canal, and a small part probably enters the deeper valley fill and ultimately returns to the river with a much higher dissolved-solids concentration.

Reach C50-C53

This reach shows a loss of 0.3 ft 3 /s (0.01 m 3 /s). Below the canal and downstream along the wasteway that leads to the river flood

plain, the soils (silt and dense clay derived from shales in the Uinta Formation) are coated with a white mineral efflorescense during the dry season, which resulted from the evaporation of water. Although a part of the water may be derived from canal leakage and field irrigation, some of the white coating extends above the canal and also exists in patches along the bluffs far above the canal, thus indicating discharge from the Uinta Formation.

The water that leaks from the canal ending at site C53 is believed to be mainly consumed by evapotranspiration and by discharge to the lower canal. Leakage that recharges the ground-water system and returns to the river is saline.

Grey Mountain-Pleasant Valley Canal system

Reach C1-C4

This reach (pl. 2) starts at a headgate on a waterway cut from the Duchesne River. The upper part of the reach is cut in valley fill; but moving downstream it progressively drops deeper into the Uinta Formation, which is overlain by a thin veneer of very coarse grained scree. At the lowermost end of the reach, the canal traverses valley fill at the mouth of Antelope Creek canyon.

When the canal was observed with water in it, substantial areas of wet lowland were noted mainly between site C1 and turnout T1 (pl. 2), and pools of water standing by the lower canal bank were seen near turnout T1. In addition, thick growths of willow (Salix sp.) and other phreatophytes were seen at the edge of the terrace below the canal between turnout T3 and site C3. These two subreaches together with the subreach between sites C3 and C4 probably are the main subreaches in which the loss of 4.5 ft 3 /s (0.13 m 3 /s) occurs (table 2).

Water is lost in this reach mainly by evapotranspiration, but a small part probably recharges the valley fill and ultimately returns to the river. In the subreach at the mouth of Antelope Creek canyon, most of the apparent loss probably is by evapotranspiration. Large tracts of soggy land, mineralized soils, and growths of willow, saltgrass, and greasewood (Sarcobatus vermiculatus) indicate substantial discharge of water.

Reach C4-C20

This reach has the largest loss, $15 \, \mathrm{ft^3/s} \, (0.42 \, \mathrm{m^3/s})$, and the second largest calculated loss per mile, $4.3 \, \mathrm{ft^3/s} \, (0.12 \, \mathrm{m^3/s})$, in the Grey Mountain-Pleasant Valley Canal system. The upper part of the reach traverses the mouth of Antelope Creek canyon and passes mainly through valley fill for a distance of about 1 mi (1.6 km). It also traverses across the mouths of two other smaller canyons. The remainder of the reach is cut into the Uinta Formation. At several points along the canal, growth of willow and grass below the canal indicates leakage. Ground-water levels in this reach fluctuate widely, apparently in

response to flow in the canal and to irrigation of fields. The water lost in this reach in part is probably consumed by evapotranspiration in the flood plain nearby. Most, however, apparently recharges the valley fill and most of this water moves to the river and to the soggy tracts near the river.

Reach C20-C21

Losses and gains are apparently equal in this reach. The reach begins at the canal split and is the uppermost part of the upper or Pleasant Valley Canal. It is cut almost entirely in rocks of the Uinta Formation that have been strongly affected locally by slumping. A few hundred feet down the Pleasant Valley Canal, the area between this canal and the lower--or Grey Mountain Canal, was heavily grassed and the mouth of a small canyon was choked with brush. This indication of leakage was reinforced by the presence of soggy areas below the vegetation but above the Grey Mountain Canal. Several other areas of seepage were seen above the Grey Mountain Canal, but the principal area that seemed to indicate leakage is the tributary canyon in SE_4^1 sec. 6 and NE_2^1 sec. 7, T. 3 S., R. 4 W. (See fig. 11.) Although it is possible that only small quantities of water are needed to produce the effect, this small canyon above turnouts T42 and T43, near its mouth, was awash with small streams of water and the entire floor was green and soggy. At one point a landslip was seen below the canal bank, thus suggesting leakage.

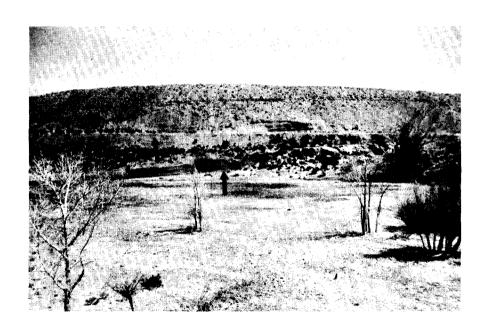


Figure II.— View eastward from location U(C-4-2)7aac of the Pleasant Valley Canal (upper arrow) along east side of a canyon tributary to Duchesne River valley. Leakage is indicated by darker vegetation (lower arrow). Valley is heavily grassed and when canal has contained water for a while, the entire valley bottom is awash.

Gains that offset any losses in reach C20-C21 must come from the Uinta Formation and the terrace gravels that overlie it, and such discharge from the formation on a perennial basis is suggested by persistent seeps near the canal. However, inflow to the canal sufficient to offset losses must occur on a seasonal basis and must be return flow from water applied to the area above the reach, because the reach generally is dry during the nonirrigation season.

Water lost from this reach partly enters the lower canal, partly is consumed by local evapotranspiration, and partly is carried away from the canal area by local ditches. A small part may enter the deeper valley fill and ultimately return to the river.

Reach C21-C22

The calculated loss of $3.5~{\rm ft^3/s}$ ($0.10~{\rm m^3/s}$) for this reach seems small considering that the area below the canal bank shows a number of scars from canal breaks, and the reach reportedly has presented long-standing canal-maintenance problems. The relatively low loss calculated may be due partly to seepage into the reach during the irrigation season and partly to the chemical treatment of the canal to minimize losses following a major break that was repaired just before measurements for this study started.

The upper part of this reach—from site C21 to the area between turnouts T44 and T45—is cut into the Uinta Formation along a precipitous part of the bluff overlooking the Duchesne River flood plain (fig. 12). Numerous bands of brush mark areas of probable discharge from the Uinta Formation, and the disasterous canal break of April 23, 1972, appears to bear out that movement of water in Uinta Formation contributes to the leakage into and out of the canal and the adjacent fields.

In the 1972 break, the water apparently did not overtop the canal bank (Mr. Sorenson, ditch rider, oral commun., April 27, 1972), but rather cut out a part of the bank where it had slumped. The slumping apparently was due to the wetting of the face of the bluff below the bank by water issuing from fractured rock beneath the scree on the nearly vertical bluff. Subsequently, the canal water cut a chute in the bluff (figs. 12 and 13), stripped the scree away, filled the Grey Mountain Canal, and inundated the field beyond. Nine days after the break, the chute had dried and the Uinta rocks could be examined. A bed of fractured siltstone in the bottom of the chute was wet (fig. 14) and actively discharging a small amount of water.

The lower part of the reach--from the area between turnouts T44 and T45 to site C22--is cut on increasingly gentler slopes but still mainly in the Uinta Formation. Three small canyons in the face of the bluff discharge some irrigation return flow and probably some canal-loss water--they are heavily vegetated (two are shown in fig. 12). At site C22 (fig. 3), some inflow to the canal is possible. The area above the site was found to be soggy and supporting a dense growth of saltgrass. Soils exposed in the grass area were white with mineral deposits. The



Figure 12.—Pleasant Valley (upper) and Grey Mountain (lower) Canals showing areas of breaks in spring 1972. Center of picture is about the center of sec. 5, T. 4 S., R. 2 W. Arrow at C points to area of crevices shown in figure 6. Arrow at N points to route of new section of canal. Lower arrow points to chute cut by break. Note heavily vegetated canyons at left. Duchesne River bottom in foreground, irrigated land on top of bluff, Pleasant Valley in distance, to south.



Figure 13.— View looking west of break of April 23, 1972, in Pleasant Valley Canal, showing chute cut in slumped beds of Uinta Formation. Note abundance of vegetation along bluff below canal in distance.

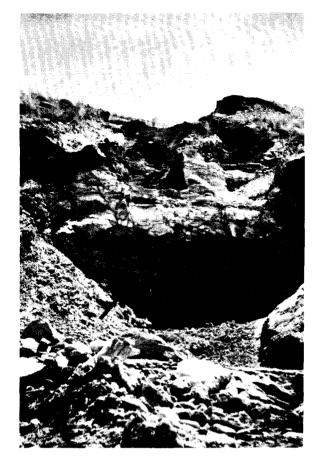


Figure 14. — View up bluff in the chute shown in figure 13. Water was actively flowing from saturated beds (arrow) in Uinta Formation at base of chute 9 days after chute was cut.

water probably is return flow from irrigated fields on the terrace (South Myton Bench) above.

Reach C22-C23

The calculated loss for this reach is 6.0 ft 3/s (0.17 m 3/s). The Pleasant Valley Canal in this reach is cut along the edge of a low scarp between the lower and middle terraces on South Myton Bench. The canal lies below fields irrigated by lift pump and above almost continuous fields supplied by the canal. Although return flow from the fields above is probable, the reach has the largest calculated loss per mile in the system, 4.7 (ft 3/s)/mi [0.21 (m 3/s)/km]. This high rate of loss is due primarily to the high infiltration capacity of the coarse-grained deposits that cover the bench and form the base of the canal. Part of the water lost in this reach is discharged by evapotranspiration in the area between the two canals, part enters the Grey Mountain Canal by both surface and subsurface flow, and part is carried to the flood plain by one or more ditches. Little of the water lost is believed to directly enter the ground-water system in the flood-plain area.

Reach C23-C24

The calculated loss for this reach is $3.5~{\rm ft}^3/{\rm s}$ ($0.10~{\rm m}^3/{\rm s}$), and the reason for the loss is the same as is described for the previous reach. A large part of the water lost from this reach is consumed by evapotranspiration in such areas as the marshy tract that trends eastward past the mutual quarter corner of secs. 2 and 3, T. 4 S., R. 2 W. A part of the water undoubtedly moves through the permeable gravels that underlie the bench surface below the reach and discharges into the several canyons above the Grey Mountain and Myton Townsite Canals. Inflow to this reach may come from seepage from the fields to the southwest. This is suggested by the depth to water of 1 ft ($0.3~{\rm m}$) in a drain (pl. 4) in the southeast corner of sec. 3, about 1,000 ft ($305~{\rm m}$) west of the canal.

Reach C24-C26

This reach heads above the "new" canal cut (west side, sec. 11, T. 4 S., R. 2 W.) that crosses the south side of South Myton Bench and ends at the Pleasant Valley Road (State Road 216). The large calculated gain of 5.0 ft 3/s (0.14 m 3/s) most likely occurs in the uppermost subreach near the split from the route of the old canal. In this subreach, the surface of the bench on both sides of the canal is irrigated, and return flow directly to the canal through the coarse-grained veneer (fig. 15) is possible. Some water seems to leak from the Uinta Formation into the cut itself, and some return flow to the canal in the cut and below it also may occur through channels in the bedrock surface that probably were formed when the overlying terrace gravels were being



Figure 15.—Gravel and cobbles (glacial outwash?) dipping southward on eroded surface of Uinta Formation dipping northward, near south edge of South Myton Bench. Location U(C-4-2)10dcb, in east side of road cut on State Road 216.

deposited. The reach may lose water in seepage areas along the slopes below the canal banks below the cut. This may represent canal leakage, but it also could be irrigation return flow that has bypassed the canal. Any water lost is consumed mainly by evapotranspiration below the canal.

Reach C26-C27

The large gain calculated for this reach was $8.0 \text{ ft}^3/\text{s}$ (0.23) m³/s). The gain must be explained in terms of the water apparently available during the irrigation season because the canal is dry during the nonirrigation season. The gain seems to be largely return flow from local diversion works and possibly from irrigated fields southwest of the canal. Most of the inflow seems to enter the lowermost subreach, near the pump (turnout T60) that lifts water into a lateral canal. Phreatophyte growth near the canal in the vicinity of the pump suggests that water is available at that point. The specific conductance of the canal water (510 to 555 micromhos/cm at 25°C) shows no significant increase near the pump; therefore, any gain that is concentrated mainly in this reach would not be from the Uinta Formation, which would contribute water with a much higher specific conductance (estimated to be at least 2,000 micromhos/cm at 25°C). Small seepage areas below the canal were noted, mainly where the canal bank is steep along the bedrock knob about 0.25 mi (0.4 km) west-southwest of State Road 216. The water lost is mainly consumed by local evapotranspiration. Some water flows away in small drainage channels to Pleasant Valley Wash.

Reach C27-C29

Most of this reach is cut in alluvium and coarser grained older unconsolidated deposits. The Uinta Formation is exposed in the upper canal bank in parts of the lower half of the reach. The losses from this reach, 6.0 ft³/s (0.17 m³/s), mainly are consumed by evapotranspiration in the fields and swampy tracts below the canal. A part of the lost water recharges the valley fill and eventually returns to Pleasant Valley Wash and flows out of the study area, and part may be the gain noted for the next lower reach. The losses due to evapotranspiration must be substantial; the cleared fields below the canal are wet and show large areas of alkaline mineral deposits that the local farmers flush away with the earliest irrigation applications.

Reaches C29-C30 and C30-C37

These two reaches share many common characteristics. The canal is cut along the edge of a low scarp that ends a long general downward slope from the west-southwest and that overlooks Pleasant Valley. Most of the canal appears to be cut in unconsolidated silts and gravels, but the Uinta Formation is not deep and it crops out in a few places along the canal. The gain of 3.5 $\rm ft^3/s$ (0.10 $\rm m^3/s$) in the upper reach is hard to explain because there are no immediately apparent seasonal sources of water above the canal. It seems most likely that any gain in the reach

is due to return of some of the loss from the upstream reach C27-C29 by movement over and through the Uinta Formation across the loop in the canal and along the strike of the northward-dipping beds. The gain of 1.5 ft 3 /s (0.04 m 3 /s) in the lower reach most probably is due to the return of water from irrigated lands above the canal near the lower end of the reach.

In both reaches, along and below the canal, numerous patches of vegetation and small swampy tracts indicate leakage from the canal. The lost water is mainly consumed locally by evapotranspiration, but a part recharges the ground-water system and ultimately is discharged into Pleasant Valley Wash. The discharged water is saline, with a measured conductance of 2,800 micromhos/cm at 25°C. (See table 5.)

Reach C8-C10

Site C8 is the head of the lower or Grey Mountain Canal, just below the split from the upper or Pleasant Valley Canal. The Grey Mountain Canal descends from the canal split in sec. 7, T. 4 S., R. 2 W., through a natural channel to the foot of the bluff that overlooks the Duchesne River flood plain, and the canal then is cut along the base of the bluff. The banks of the natural channel are heavily covered with willow and other vegetation. In the northwest corner of sec. 7, the access road between the bluff and the canal is overgrown with phreatophytes and when seen in early May 1972 was soggy with standing water. The lower canal in this reach has eroded its banks and broadened, and a small canyon below the upper canal is choked with brush. All this indicates that water is available for movement into the lower canal. actual gain is not known, however, because the calculated gain of 1.0 ft 3 /s (0.03 m 3 /s) shown in table 2 for this reach is a net figure. An unknown quantity of water leaks from this reach, and a canal-side drain has been installed parallel to the canal to collect this seepage.

Reach C10-C13

Although this reach has a calculated loss of $4.5 \text{ ft}^3/\text{s}$ (0.13 m³/s), along most of the reach evidence is abundant for water moving toward the canal from above, both through the Uinta Formation and the unconsolidated material covering it. This is particularly true in the areas of the alluvial fans at the mouths of the canyons such as that in the eastern part of sec. 6, T. 4 S., R. 2 W. Leakage from the reach is apparent in fields and pastureland below the canal, which are swampy during the irrigation season and densely covered with saltgrass and other phreatophytes. In the fall, these swampy tracts dry out to some extent and are white with mineral residue (fig. 16). Muskrats were seen swimming in the canal in this reach, therefore, the leakage may be due not only to movement through the canal bed but also through animal The water lost from the canal is mostly consumed by evapotranspiration in the fields below the canal. Drains have been installed in much of the lowlands from here to the vicinity of Myton. The drains, however, reportedly are not effective. J. Nielsen (oral commun., 1972) of the Bureau of Indian Affairs at Fort Duchesne indicates that drains



Figure 16.— View looking eastward from location U(C-4-2)7bba. Pleasant Valley Canal (arrow at upper right); Grey Mountain Canal (arrow at left) and canal-side drain at lower left. Pleasant Valley Canal is cut into Uinta Formation, which here has an apparent dip of $7\frac{1}{2}^{\circ}$ N. 20° W. Slope has thin veneer of gravel and clay, which is selectively covered with brush where leakage provides water. Much willow and other phreatophytes grow along lower canal and drain. Bottoms are marshy and have an alkaline band around old river meander scar.

were cut in the shallowest valley fill (but probably bottom in clay), that the drains did not suppress phreatophyte growth which was found up to the edges of the drains, and that, despite the installation of drains, the swampy conditions noted above persist.

Reach C13-C17

Despite the calculated loss of 1.0 $\rm ft^3/s$ (0.03 $\rm m^3/s$) in this reach, subsurface inflow to the canal is very probable during the irrigation season, particularly below the mouth of the several small canyons in the edge of the bluff of the South Myton Bench. Therefore, actual loss along this reach is greater than calculated. Losses are mainly consumed by evapotranspiration.

Reach C17-C19

This was the lowermost reach in the study area, and it ends on the county road that runs due south from Myton, about 0.5 mi (0.8 km) from the confluence of the Grey Mountain and Myton Townsite Canals. The small calculated gain of 0.5 ft 3 /s (0.01 m 3 /s) for the reach is a net figure. In this reach water returns from the South Myton Bench both as seepage through the face of the bluff and mainly as flow in a series of

canyons that are cut approximately along the strike of the Uinta Formation. Surface flow during the irrigation season amounts to more than $1 \text{ ft}^3/\text{s}$ (0.03 m³/s) in each of the two larger canyons in the southeast corner of sec. 35, T. 4 S., R. 2 W. (fig. 17), and lesser amounts of water continue to drain from the ground during the dry season.

During the dry season, the return water has a conductance of more than 3,000 micromhos/cm (table 5). During the irrigation season, the conductance of the drainage is less (pl. 2), depending on the quantity of tailwater from the canal and fields that is mixed with the ground-water seepage. In both seasons, the return of this water to the reach affects the quality of water in the canal. (See pl. 2.)

The water lost from reach C17-C19 is largely consumed by evapotranspiration. Some water may enter the ground-water system for later consumption by evapotranspiration downgradient or return to the Duchesne River.



Figure 17.— View looking west-southwestward from bank of Grey Mountain Canal at location U(C-3-2)35daa. Large canyon containing return flow from irrigation on South Myton Bench. Floor of canyon is marshy and is choked with cattails (Typha Latifolia) to near head of canyon. Several channels (arrow) empty into Grey Mountain Canal, and these contain some flow between irrigation seasons.

CONCLUSIONS

The net loss from the Rocky Point Canal system, which is 96,800 ft (29,500 m) in length, (table 1) is $3.4 \text{ ft}^3/\text{s}$ (0.10 m³/s) or about 6 percent of the 60 ft³/s (1.7 m³/s) capacity at the head of the system. The net loss from the Grey Mountain-Pleasant Valley system, which is 160,300 ft (48,860 m) in length, (table 2) is $24.5 \text{ ft}^3/\text{s}$ (0.69 m³/s), or

about 8 percent of the 320 ft 3 /s (9.1 m 3 /s) capacity. Despite these relatively small calculated net losses, certain reaches of each system have relatively large net losses or gains. A calculated estimate of the hydraulic conductivity--2.3 ft/d (0.70 m/d)--for the canal bottom deposits in reach C4 to C20 on the Grey Mountain Canal shows that even the largest rates of loss--70.4 ft 3 /d per lineal ft (6.54 m 3 /s per lineal m) --might be expected for an unlined canal with a silt blanket on the bottom and sides.

In the Rocky Point system, maximum savings of water probably could be realized by lining selected parts of the canal. Those reaches most likely to benefit are C5-C14, C17-C19, and C35-C39. These reaches are mostly where the canal traverses the high parts of the bluff and utilizes natural drainage channels to descend to lower levels; the reaches include relatively few turnouts. A covered system might be justified to avoid rock falls into the canal and the need for major cleaning.

In the Grey Mountain-Pleasant Valley system, savings would be realized by lining the system down to site C24 on the upper canal. It is uncertain whether lining of the canal where it is high in the bluff near site C21 would stabilize the rocks, but lining would enhance stability of the reach. Lining of reach C27-C29 would alleviate some waterlogging in Pleasant Valley.

The gains calculated for some of the reaches seem, at first consideration, to be unlikely because water is rarely seen in the canals during the nonirrigation season, except at the lower end of the Grey Mountain Canal. However, the calculated gains for some reaches, such as C26-C27 on the Pleasant Valley Canal, are clearly indicated by the seepage measurements. Therefore, most, if not all, the calculated gains are related to conditions during the irrigation season. It should be kept in mind that most of the gravels covering the benches and bluff faces and the fractured bedrock, have high permeabilities; they take in water, transmit it, and drain quickly. Thus when water is available, it moves readily to the canals and, when water is not available, the canals are dry.

The data necessary for determining the amount of canal loss that returns to the Duchesne River and Pleasant Valley Wash could not be obtained and calculated values are not available. However, a qualitative evaluation of the general conditions in both canal areas leads to an estimated return of about 20 percent of the canal loss. The net loss from both systems is $27.9~\rm ft^3/s~(0.79~m^3/s)$. If the return water amounts to only 20 percent, the net return to the river system would be $5.6~\rm ft^3/s~(0.16~m^3/s)$, and this amount would be difficult to identify because of the much greater quantity of water derived from natural sources and returned from irrigated fields.

REFERENCES

- Adams, D. B., 1974, Time of travel and dye dosage for an irrigation canal system near Duchesne, Utah: U.S. Geol. Survey Jour. Research, v. 2, no. 4, p. 489-493.
- Hood, J. W., Mundorff, J. C., and Price, Don, 1975, Selected hydrologic data, Uinta Basin, Utah and Colorado: U.S. Geol. Survey open-file report.
- Morris, D. A., and Johnson, A. I., 1967, Summary of hydrologic and physical properties of rock and soil materials, as analyzed by the Hydrologic Laboratory of the U.S. Geological Survey, 1948-60: U.S. Geol. Survey Water-Supply Paper 1839-D.

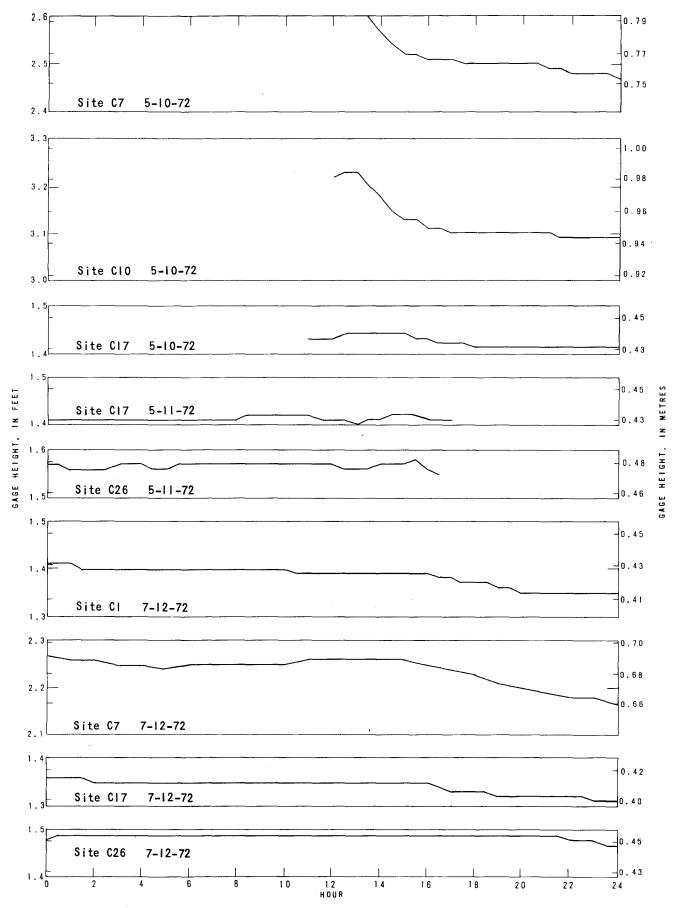


Figure 18. - Gage heights at recorders on Rocky Point Canal system.

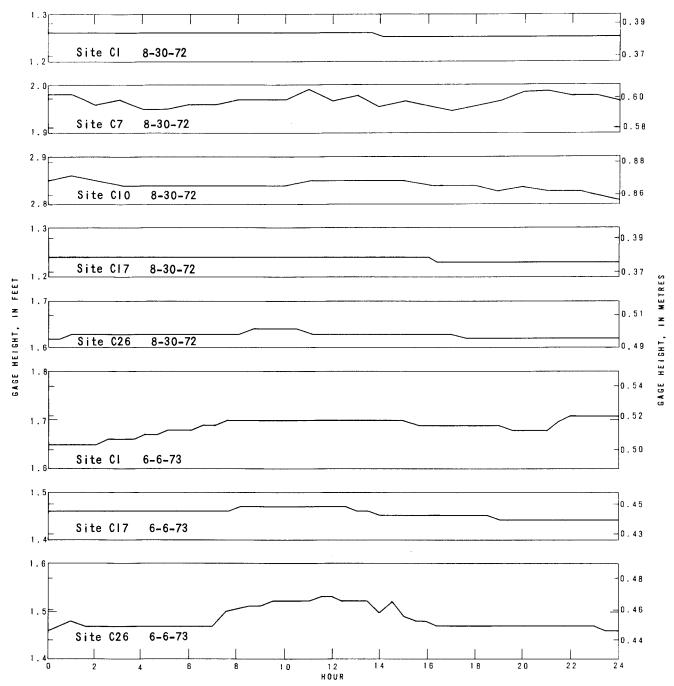


Figure 18.— Continued.

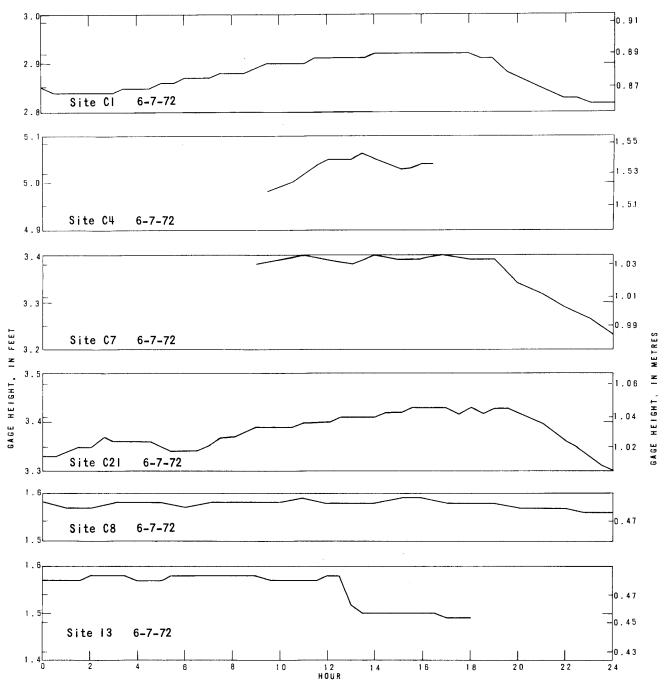
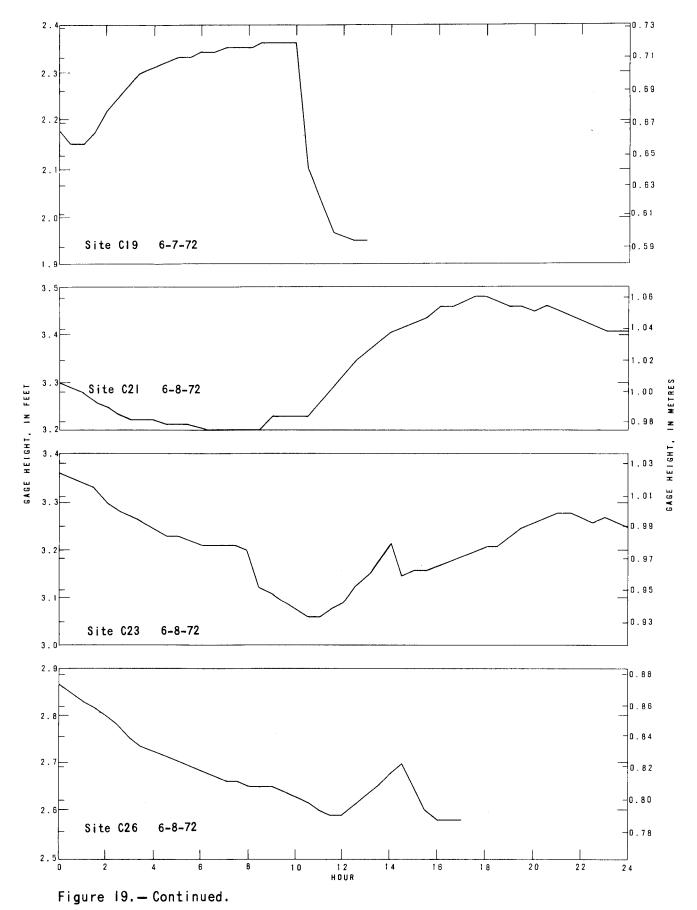
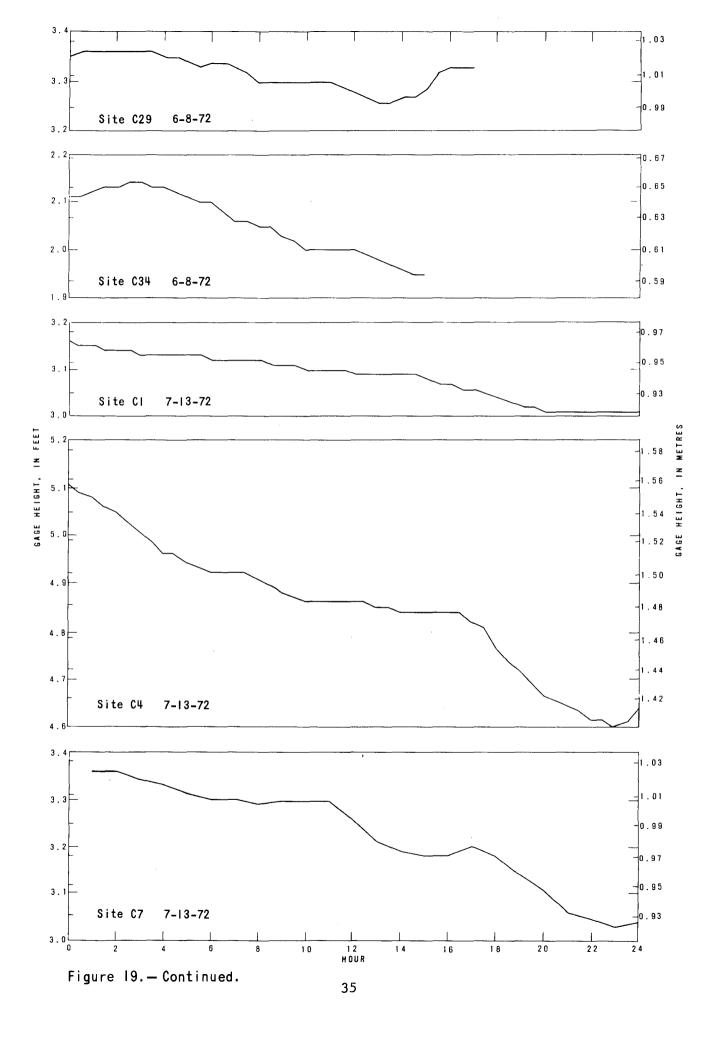
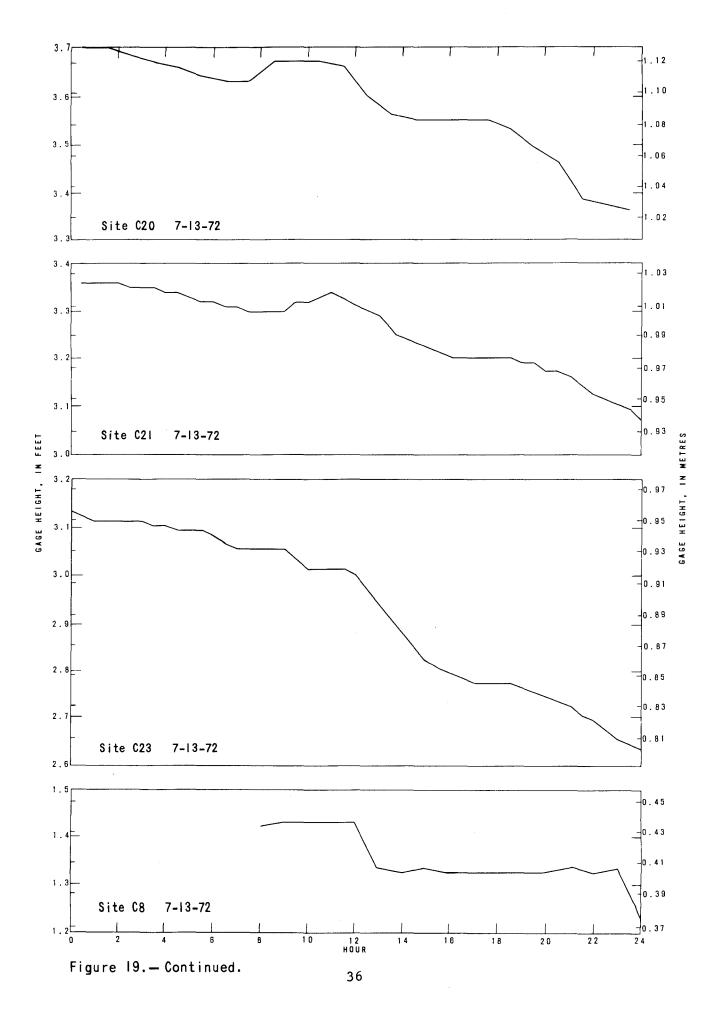
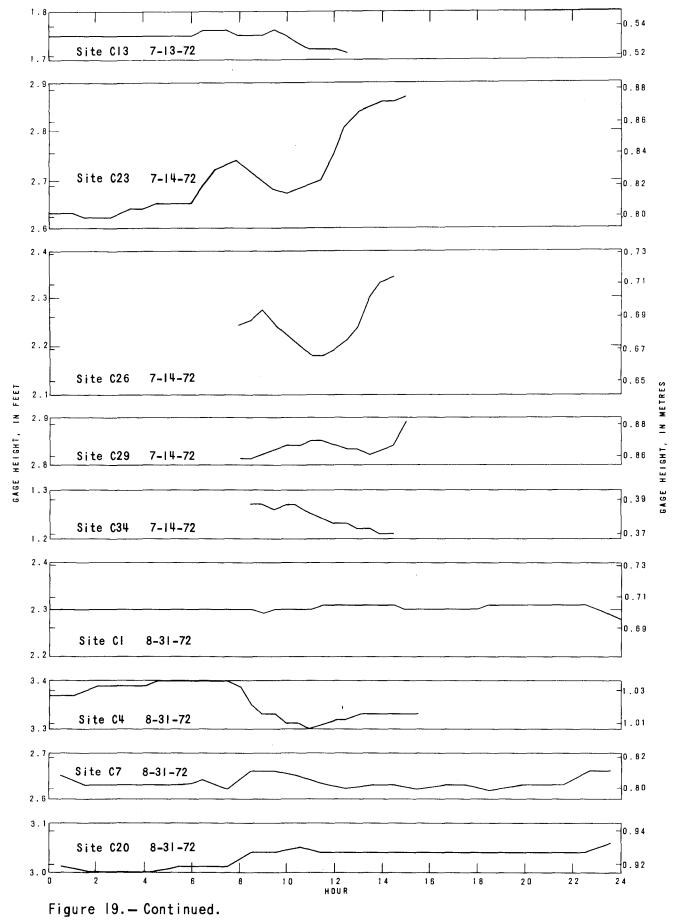


Figure 19. — Gage heights at recorders on Grey Mountain-Pleasant Valley Canal system.









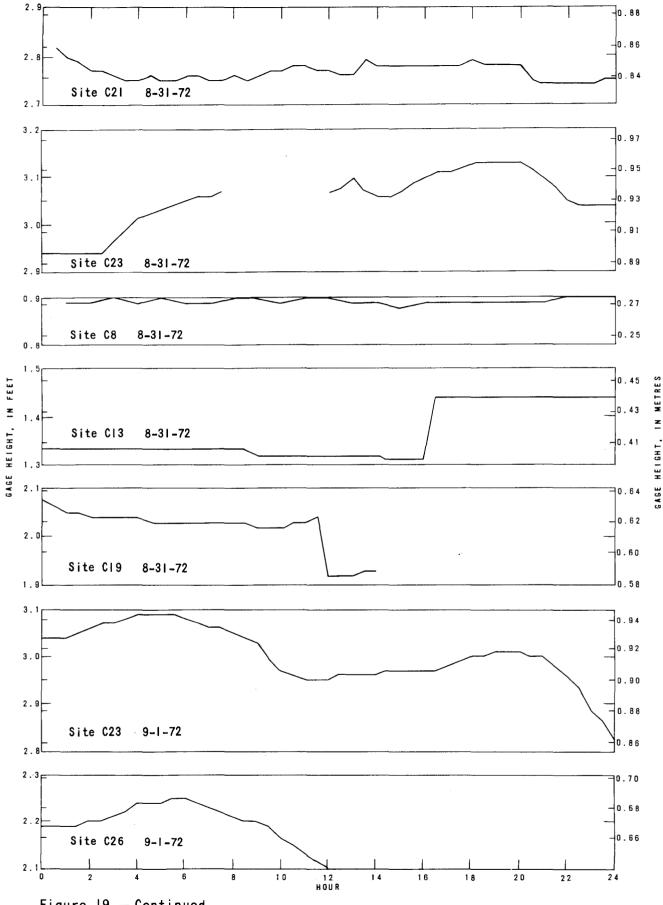


Figure 19. — Continued.

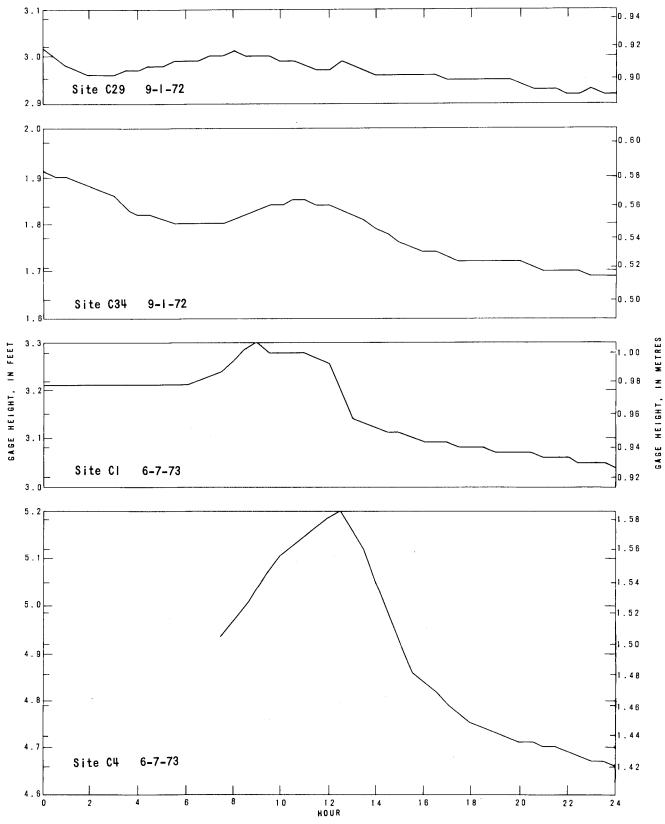
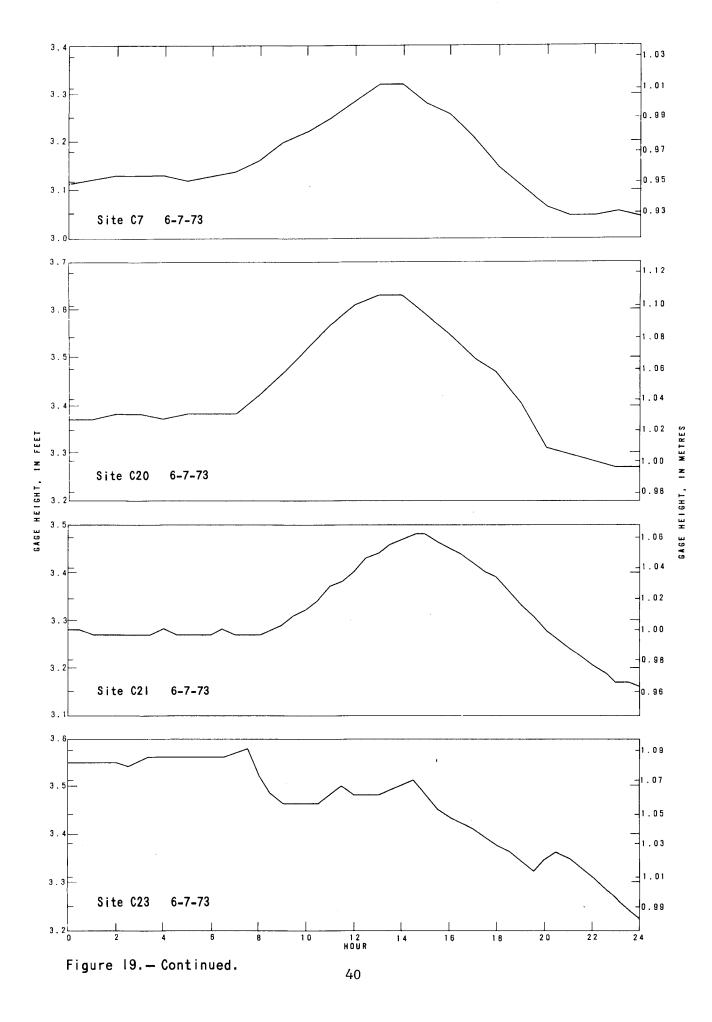
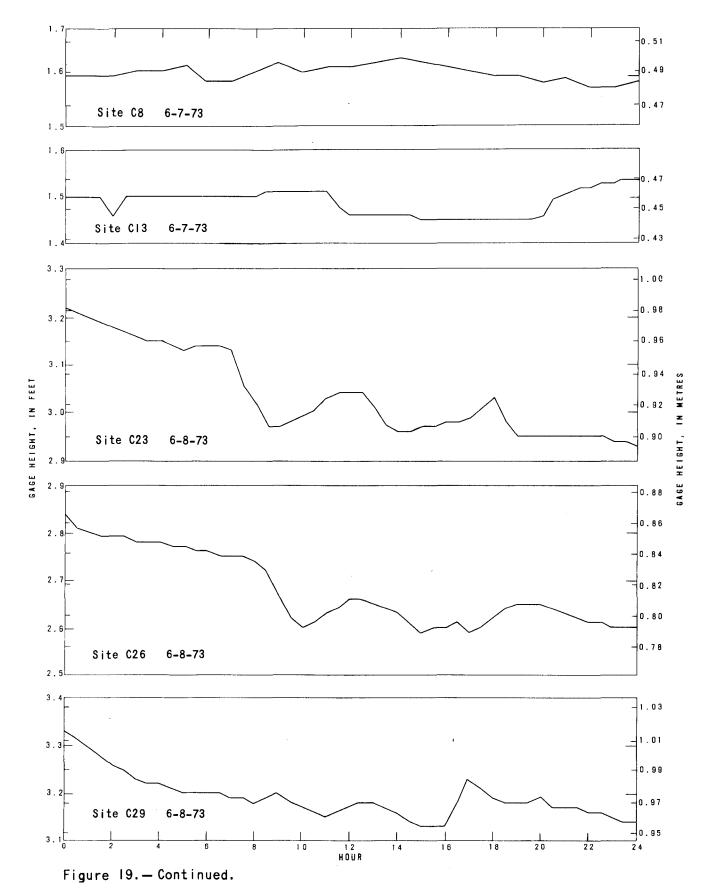


Figure 19. - Continued.





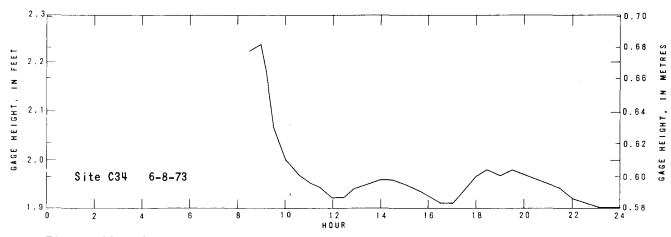


Figure 19. - Continued.

Table 3.--Measurements made on the Rocky Point Canal system

Two discharge measurements were made at each main canal point that divided two reaches, one measurement as a finishing measurement for the reach above the point, and one as a beginning measurement for the reach below.

Site	Date	Time	Discharge (ft ³ /s)	Site	Date	Time	Discharge (it ³ /s)	Site	Date	Time	Discharge (ft '/s)	Site	Date	Time	Discharge (ft³/s)
C1 C2 C3 C4 C5 C5 C6 C7 C8	5-10-72	1440 1525 1610 1655 1740 1405 1510 1555 1700 1810	44.3 44.6 48.8 47.4 46.3 43.4 47.0 46.6 47.4	C1 C2 T1 T2 C4 T3 C5 T4 C6 T6	7-12-72	0855 0950 1015 1105 1140 1225 1315 1250 1410 1540	45.1 47.0 .15 1.34 44.1 .86 47.6 2.64 44.5 3.74	C1 T1 C2 C3 T2 C4 T3 C5 T4 C6	8-30-72	0900 1040 1010 1125 1305 1720 1415 1440 1530 1615	37.6 .32 36.7 37.0 1.24 36.5 .11 36.0 1.69 33.0	C! T1 C2 C3 C4 T3 C5 T4 C6	6- 6-73	0815 0850 0920 1030 1130 1255 1330 1410 1500 1540	59.8 .01 ¹ 56.4 57.7 57.1 2.23 55.8 3.57 47.3 3.13
C10 C12 C13 T9 C14 F10 C15 T11		1730 1345 1425 1510 1620 1540 1640 1700 1810	46.2 48.7 46.6 46.2 3.68 40.3 2.74 36.7 5.73	C7 C7 C8 C9 C10 C11 T8 C13 T9		1500 0845 0930 1010 1055 1215 1310 1300 1350 1410	38.9 46.3 42.5 40.1 43.8 41.9 .51 3.09 34.7	T5 T6 C7 C7 C8 C9 T7 C10 C11		1815 1830 1720 0825 0930 1015 1100 1145 1315	2.46 .01 29.3 29.4 29.1 31.0 .24 30.9 30.3 .80	C7 C8 C9 T7 C10 C11 T8 T9 C14		1550 0820 0920 1030 1130 1205 1340 1420 1450 1515	49.3 49.8 48.4 51.3 .64 44.8 43.3 2.80 2.39 34.2
C16 C17 C18 C19 C20 C21 T15 C22 C23	5-11-72	1740 1850 0900 0945 1030 1110 1150 1215 1245 1320	31.8 31.1 20.9 20.6 20.6 21.3 3.06 14.8 14.9	T10 G15 T11 G16 G17 G17 T12 G19 G20 T14		1455 1440 1510 1530 1625 0900 0930 0950 1040 1115	2.88 34.8 5.20 28.7 30.0 29.9 .02 ¹ 18.0 19.6	T9 C14 T10 T11 C16 C17 C18 C19 T12		1515 1435 1550 1610 1645 1730 0845 0920 1020 1055	1.54 25.6 1.93 4.36 19.1 19.1 19.8 14.4 12.0	T10 T11 C16 C17 C17 C18 C19 T12 C20 C22		1550 1615 1645 1730 0800 0900 0950 1010 1030 1120	3.21 4.63 30.5 31.5 32.2 23.1 18.2 .02 ¹ 22.5 23.0
C24 T17 C25 C26 C26 T19 T20 C27 T21 C28		1410 1435 1500 1540 0900 0935 1000 1055 1025 1140	16.3 3.14 12.1 12.7 13.2 .03 .01 13.6 2.23 12.2	T15 C22 T16 C23 C24 C26 C26 T19 T20 C27		1130 1255 1320 1420 1505 1540 0935 0950 1030 1115	3.40 14.9 2.78 11.4 11.0 10.9 10.4 .14 .06	T13 C20 T15 G22 T16 C23 G24 T18 C26 C26		1130 1150 1225 1255 1320 1350 1435 1500 1520 0900	1.78 11.4 .17 12.5 2.86 9.58 9.07 .01 ¹ 9.69 9.37	T16 C23 C24 C26 C26 T19 C27 T21 C28 T22		1205 1310 1350 1420 0755 0840 0930 1000 1040 1100	4.10 16.0 16.5 17.1 16.6 4.20 13.1 2.43 10.1 1.49
T22 T24 C29 C30 T25 T26 T27 T28 C32 C33		1205 1245 1305 1345 1400 1430 1420 1400 1340 1500	.83 2.85 7.42 7.74 .04 1.76 1.18 2.16 2.34 2.31	T21 G28 T22 T23 T24 G29 G30 T25 T26 G31		1135 1235 1305 1405 1435 1500 1600 1620 1300 1425	2.36 7.88 1.18 .01 1.69 5.40 5.76 .10 1.75	T19 T20 C27 T21 C28 T23 T24 C29 C30 T25		0915 1050 1130 1200 1240 1310 1340 1400 1500	.04 1.44 5.71 .52 5.54 .53 .14 5.31 5.63	T24 C29 C30 T25 T26 T28 C32 C33 C34 C35		1135 1200 1245 1300 1250 1330 1330 1410 1405 0730	2.03 7.77 8.04 .02 1 2.20 2.26 1.95 1.82 1.67
C34 C35 T29 C36 C37 C39 C40 C41 C42 C43		1550 0845 0900 0920 1010 1100 1200 1320 1405 1500	2.10 10.1 .4 8.99 9.38 9.46 9.38 8.96 9.02 8.78	C32 T28 C33 C34 C35 T29 C37 C38 C39 C40		1500 1520 1540 1400 0845 0900 0940 1025 1100 1150	2.99 .04 3.26 2.79 9.40 .11 8.72 8.10 8.58 8.28	T26 T27 T28 C32 C33 C34 C34 C34 C36 G37 C39		1240 1255 1320 1340 1410 1440 0840 0940 1010 1040	.12 .02 2.34 1.91 1.91 1.65 7.27 7.49 7.32 7.22	C36 C37 C39 C40 C41 C42 C43 C44 C45 C45		0750 0815 0830 0910 0930 0950 1020 1050 1120 0745	9.45 10.3 8.73 9.28 8.45 8.46 8.92 8.12 7.94
T32 C44 C45 C45 C46 C47 C48 C50 C51		1525 1600 1620 0845 0925 0950 1020 1100 1200 1135	.62 7.27 7.39 7.64 7.31 7.85 7.58 7.05 6.72	C41 C42 T30 C43 C44 C45 C45 C45 C46 C47		1225 1300 1330 1355 1430 1510 0850 0925 1000 1030	8.08 7.97 .011 7.70 7.83 7.99 7.75 7.69 7.35	C40 C41 C42 T31 C43 C44 C45 C45 C46 C47		1130 1200 1230 1315 1335 1415 1455 0855 0930 1000	6.70 6.86 6.21 .66 5.74 5.72 5.67 5.54 5.35	C46 C47 C48 T34 C50 T35 T36 T37 C51		0815 0845 0915 0940 0955 1005 1010 1020 1045 1140	8.48 8.35 8.44 .04 8.45 .02 .04 .09 7.62 7.92
T38 G52 C53		1230 1250 1315	3.57 3.39 3.35	T33 C49 C50 T36 C51		1100 1110 1130 1150 1220	.01 ¹ 7.72 1.04 .07 1.04	C48 T34 C50 C51		1030 1100 1115 1200	5.27 .01 5.34 5.10	T38 T39 C53	,	1115 1200 1225	4.29 .01 3.55

 $^{^{1}}$ Estimated.

Table 4.--Measurements made on the Grey Mountain-Pleasant Valley Canal system

Two discharge measurements were made at each main canal point that divided two reaches, one measurement as a finishing measurement for the reach above the point, and one as a beginning measurement for the reach below.

1	Site	Date	Time	Discharge (ft'/s)	Site	Date	Time	Discharge (ft ³ /s)	Site	Date	Time	Discharge (ft ³ /s)	Site	Date	Time	Discharge (ft ³ /s)
100	C1	6- 7-72				6- 8-72				7-13-72				8-31-72		
1306 1506 1507 1508 1509 1609 1619 1709 1709 1209 1.49 1709	C2											31.1				
150																
150																
1.																
1.00																
100 23 100 23 100 120																
1985 1985 1986	7'8															
112 105 1.30	C4															
110	C4		0845	243	T71		1230	.05	C18		1400	.: 1. 2				
1150												8.37	20.5.3		1120	01.1
120												-/1				
110				234								- 19				
11																18.4
120									619		1440	7.1.7				
121									633	7-16-79	0000	104				
100 200 200 201				5.05						7-14-72		1.20				
100 4.92 110 4.92 110 11																
Time	C6															
C7			1700	4.92	634		0903	42.5								
CT			1720	217	ma n		0025	011					1			
1.00								3 23					G12		1120	17.6
C21												76.5	731			
Carl											0930	6.12	C13			
CS													C13			
Color					""				"							
1.10			0855		l cı	7-13-72	0830	289	T63							
127									C28							
Record Part Part			1030	1.82	C2		1050	286	T66		1215		C14			
Cil								1.73	C29							
Color							1210	.14	C29				R5		1140	4.95
Time	C11		1115	30.3			1305	273	T67				1			
Time				3.46	Т6		1420	16.7	T69							
Cit 1310 18.8 T8			1200	.94			1400		C30							
Record 1340	C12		1310				1450	1.02				40.6				•03
C13				.92			1515	4.69	T73		1230	.1'				•0:,;
Tigorian	C13		1400	20.0												.011
C14	T32						1630									
R5	T33															.01
R6 0905 1,45 C5 1315 233 1,350 26.8 C15 1005 18.7 T15 1430 3,96 179 1455 5,54 75 9-1-72 0835 92.7 C15 1005 18.7 T15 1430 3,96 179 1455 5,54 T5 1905 910 0.01 C16 1420 12.6 T17 1505 4.03 C3 0910 21.2 C24 0940 76.3 R8 1050 1.1 T19 1510 7.52 780 0930 2.12 C24 0940 76.3 R9 1130 .08 721 1520 4.11 781 0950 .01 C26 0820 76.2 C17 1215 14.8 C6 1605 210 T82 1210 5.49 C26 0820 76.2 C17 1215 14.1 170 6.09 784				15.8												
R6 0905 1.45 C5 1335 233 T78 1430 2.79 C23 9-1-72 0835 92.7 C15 1005 18.7 T15 1440 3.96 T79 1455 5.54 T59 0910 .011 T35 1545 4.83 T16 1830 1.73 C34 41430 19.1 T56 1035 131.6 C16 1420 12.6 T17 1505 4.03 C34 0910 21.2 C24 0940 76.3 R8 1050 .1° T19 1510 7.52 T80 0930 2.12 T58 1135 4.87 R9 1110 .08 T21 1520 4.11 T81 0950 .01° C26 0820 72.6 C17 1215 14.8 66 1605 210 T82 1210 5.49 72.6 0820 76.2 76.2 173 77.2 1800 </td <td>R5</td> <td></td> <td>1445</td> <td>.94</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>6.94</td> <td>619</td> <td></td> <td>1400</td> <td>14.)</td>	R5		1445	.94								6.94	619		1400	14.)
No. 1005												20.0	(2.12)	0 1 20	0036	92.7
T155														9- 1-72		96.7
C16																13.6
R8 1050 1.1 T19 1510 7.52 T80 0930 2.12 T58 1135 4.87 R9 1130 .08 T21 1520 4.11 T81 0950 .011 C25 1215 71,3 R9 1130 .08 T21 1520 4.11 T81 0950 .011 C26 1320 72.6 C17 1215 14.8 C6 1609 210 T82 1210 5.49 C26 0820 76.2 C18 1630 4.54 T24 1750 6.99 T84 1060 0.02 C27 0935 77.0 T39 1650 30 C7 0850 195 G37 1110 9.52 T63 1020 6.37 R11 1710 .17 C8 1055 33.0 C7 0850 195 C37 1110 9.52 T63 1020 6.37 R11																
Tight Tigh				12.6												
R9				1.00	1119		1310	1.32	1 100		0330					71.3
C17					22.1		1520	4 11	TR1		0950	.014				
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$																
C18												13.8				4.37
T39 1650 .30 C7 0850 195 .37 1110 9.52 163 1020 6.37 R11 1710 .37 C8 1055 33.0 C1 8-31-72 0900 182 C28 1110 68.6 C19 1630 5.84 C20 1010 159 C1 8-31-72 0900 182 C28 1110 68.6 C21 6-8-72 0845 153 T43 1550 1.29 T2 1120 5.43 C29 0835 63.6 T44 1550 4.11 745 0950 2.70 C21 1200 157 C3 1430 174 168 0935 13.5 C22 1904 147 745 0990 8.85 76 1555 8.52 C30 1040 52.1 T48 1430 1.36 C22 1320 141 78 1555 8.52 C30 1040								6.09				.021				
T39	C18		1020	4.34								5.44	""			
R11 1710 .37 C8 1055 33.0 C1 8-31-72 0900 182 C28 1110 68.6 C19 1630 5.84 C20 1010 159 C1 8-31-72 0900 182 C28 1110 68.6 C21 6-8-72 0845 153 T43 1550 1.29 T2 1120 5.43 C29 0835 63.6 T44 1550 4.11 74 1550 1.29 T2 1120 5.43 C29 0835 63.6 T45 0950 2.70 C21 1200 157 C3 1430 174 168 0935 13.5 C22 1040 147 745 0990 8.85 76 1555 8.52 C30 1040 52.1 T48 1430 1.36 C22 1320 141 78 1550 4.13 771 1105 6.9 74 78	T20		1650	:30									T63		1020	6.37
C19									1			-				
C21 6 - 8-72 0845 153 T43 1520 2.37 T1 1030 .01 C29 1200 62.5 T24 1500 4.11 T43 1550 1.29 T2 1120 5.43 C29 0835 63.6 62.5 1230 173 767 0915 .01 745 0950 2.70 C21 1200 157 C3 1430 174 768 0955 13.5 C22 1040 147 745 0900 8.85 76 1555 8.52 C30 1040 52.1 747 0920 .01 77 1550 4.13 771 1105 .04 723 747 0920 .01 77 1550 4.13 771 1105 .04 723 741 1105 .02 1330 124 1330 3.41 C4 1615 161 771 1105 .02 1330 124 751 1030 9.36 733 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>C1</td> <td>8-31-72</td> <td>0900</td> <td></td> <td></td> <td></td> <td></td> <td>68.6</td>									C1	8-31-72	0900					68.6
C21 6 - 8-72 0845 153 T43 1550 1.29 T2 T120 5,43 C29 0835 63,6 T44 1500 4.11 1 1200 157 C2 1230 173 T67 0915 .01 T45 0990 2.70 C21 1200 157 C3 1430 174 T68 0935 13.5 C22 1040 147 T45 0990 8.85 T6 1555 8.52 C30 1040 52.1 T49 1130 1.36 C22 1320 141 T8 1515 .23 C31 1130 52.8 T51 1.155 6.96 T48 1330 3.41 C4 1615 161 161 1130 52.8 C31 1110 52.8 C31 1110 52.8 C31 1210 .02 22.8 C32 1020 125 T53 1115 8.81 T10	1.1.7		10.70	3.04							1030	.01	C29		1200	62.5
T44 1500 4.11 C2 1230 173 T67 0915 .01 T45 0950 2.70 C21 1200 157 C3 1430 174 T68 0935 13.5 C22 1040 147 T45 0900 8.85 T6 1555 8.52 C30 1040 52.1 T48 1430 7.23 T47 0920 .01 T7 1550 4.13 T71 1105 .04 T49 1130 1.36 C22 1320 141 T8 1515 .23 C31 1105 .04 T51 1155 6.96 T48 1330 3.41 C4 1615 161 1100 .02 173 1210 .02 23 1330 124 T51 1030 9.36 T10 0840 161 T73 1210 .02 223 1320 10.2 125 753 1115 8.81 T	C21	6- 8-77	0845	153								5.43				63.6
T45 0950 2.70 C21 1200 157 C3 1430 174 168 0935 13.5 C22 1040 147 T45 0990 8.85 T6 1555 8.52 C30 1040 52.1 T48 1430 7.23 T47 0920 .01 T7 1550 4.13 771 1105 .04 T51 1155 6.96 T48 1130 3.41 C4 1615 161 1130 52.8 T53 1215 6.34 T49 0955 .33 C4 0840 161 T73 1210 .02 C23 1330 124 T51 1030 9.36 T10 0910 .02 C32 1320 50.5 C23 1320 18.6 C8 0820 34.5 T11 0945 .56 T75 1205 1.62 T56 1320 18.6 C8 0820 34		0 0 72			1				C2		1230	173	T67		0915	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$				2.70	C21		1200	157								
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$				147			0900	0.05	T6		1555	8.52			1040	52.1
T49 1130 1.36 C22 1320 141 16 131 1.15 6.96 148 1330 3.41 16 131 1.15 6.96 148 1330 3.41 16 161 173 1210 .02 C23 1330 124 751 1030 9.36 174 1225 1.79 174 1225 1.79 172 1232 50.5 1.62 1.20 110 111 0945 .56 755 1205 1.62 1.62 1.62 1.79 777 1245 4.33 1.62 1.62 1.62 1.79 777 1245 4.33 1.62 1.62 1.12 1015 1.79 777 1245 4.33 1.15 42.5 1.53 1.62 1.79 777 1245 4.33 1.15 42.5 1.73 1.20 50.5 1.73 1.20 50.5 1.20 1.79 777 1245 4.33 1.20 1.15			1430	7.23	T47			.01	Т7			4.13				.04
T53 1215 6.34 T49 0955 .13 C4 0840 161 T73 1210 .02 C23 1020 125 T53 1115 8.81 T10 0910 .02 C32 1320 50.5 T56 1320 18.6 C8 0820 34.5 T11 0945 .56 775 1205 1.62 C24 1225 96.5 T13 1050 2.53 C33 1315 42.5 T58 1625 12.1 C9 0850 35.0 C5 1120 145 779 1325 6.38 C25 1530 91.6 C10 0920 34.6 T15 1140 .011 C34 1345 42.5 C25 1530 91.6 C10 0920 34.6 T15 1140 .011 C34 1345 40.0 C26 1645 92.2 T25 0955 3.16 717								141					C31		1130	52.8
C23 1330 124 T51 1030 9,36 T10 0910 .02 C32 1320 125 1,79 C23 1020 125 T53 1115 8.81 T10 0910 .02 C32 1320 50.5 T56 1320 18.6 C8 0820 34.5 T12 1015 1.79 T77 1245 4.33 C24 1225 96.5 T13 1050 2.53 C33 1315 42.5 T58 1625 12.1 C9 0850 35.0 C5 1120 145 T79 1325 6.38 C25 1530 91.6 C10 0920 34.6 T15 1140 .011 G34 1345 40.0 C26 1645 92.2 T25 0955 3.16 T17 1205 5.26 C34 0845 38.6 C26 1040 102 T28 1050 3.74															1010	0.0
C23 1020 125 T53 1115 8.81 T10 0910 .02 C32 1320 50.5 T56 1320 18.6 c8 0820 34.5 T12 1015 1.79 T77 1245 4.33 C24 1225 96.5 T13 1050 2.53 C33 1315 42.5 T58 1625 12.1 C9 0850 35.0 C5 1120 145 T79 1325 6.38 C25 1530 91.6 C10 0920 34.6 T15 1140 .01 ⁴ C34 1345 40.0 C26 1645 92.2 T25 0955 3.16 T17 1205 5.26 C34 0845 38.6 C26 1900 102 T28 1050 3.74 T21 1245 .10 T62 1210 4.99 C12 1125 34.6 C6 1320 128 T81								.33	C4		0840	101				
T56											0010	62				
T56 1320 18.6 C8 0820 34.5 T12 1015 1.79 T77 1245 4.33 C24 1225 96.5 T13 1050 2.53 C33 1315 42.5 T58 1625 12.1 C9 0850 35.0 C5 1120 145 T79 1325 6.38 C25 1530 91.6 C10 0920 34.6 T15 1140 .011 C34 1345 40.0 C26 1645 92.2 T25 0955 3.16 T17 1205 5.26 C14 0845 38.6 C26 0900 93.7 C11 1025 36.7 T18 1220 .41 780 0910 1.25 C27 1040 102 T28 1050 3.74 T21 1245 .10 T62 1210 4.99 C12 11125 34.4 C6 1320 128 T81	C23		1020	125												
C24 1225 96.5 C T13 1050 2.53 C33 1315 42.5 T58 1625 12.1 C9 0850 35.0 C5 1120 145 779 1325 6.38 C25 1530 91.6 C10 0920 34.6 T15 1140 .01¹ C34 1345 40.0 C26 1645 92.2 T25 0955 3.16 T17 1205 5.26 C34 0845 38.6 C26 0900 93.7 C11 1025 36.7 T18 1220 .4¹ 180 0910 1.25 C27 1040 102 T28 1050 3.74 T21 1245 .10 126 121 4.99 C12 11125 34.6 C6 1320 128 R81 0945 4.99 125 6.36 77 4 1350 .02 T85 1140 4.13 1020 31.2																
T58 1625 12.1 C9 0850 35.0 C5 1120 145 T79 1325 6.38 C25 1530 91.6 C10 0920 34.6 T15 1140 .01¹ C34 1345 40.0 C26 1645 92.2 T25 0955 3.16 T17 1205 5.26 C34 0845 38.6 C26 0900 93.7 C11 1025 36.7 T18 1220 .4¹ 780 0910 1.25 C27 1040 102 T28 1050 3.74 T21 1245 .10 120 128 181 0945 4.99 125 1210 4.99 C12 1125 34.4 C6 1320 128 181 0945 4.99 635 1020 31.2 131.2 1350 .02 785 1140 4.13 140 4.13 120 37.2 T24 1350 .02 785 <td></td> <td></td> <td></td> <td></td> <td>C8</td> <td></td> <td>0820</td> <td>34.5</td> <td></td> <td></td> <td></td> <td>0.79</td> <td></td> <td></td> <td></td> <td>4.33 A2 S</td>					C8		0820	34.5				0.79				4.33 A2 S
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T32 0915 6.80 C7 1420 135 C37 1100 26.1									and Acres		1350	0.2				4.13
2000 1/7	T64		1300	1.91												
					T32 R4		0915	4.24	67		0900	147	1 ""		.100	2011

Site	Date	Time	Discharge (ft ³ /s)	Site	Date	Time	Discharge (ft ³ /s)	Site	Date	Time	Discharge (ft³/s)	Site	Date	Time	Discharge (ft³/s)
	6- 7-73	0845	309	T41	6- 7-73	0820	1.47	C14	6- 7-73	1105	19.7	C29	6- 8-73	1330	95.0
TI		1130	.15	T42		0845	,02 ¹	T34		1140	3.19	C29		0900	100
C2		1230	312	C21		1350	176	T35		1310	1.87	T67		1000	.78
T4		1330	.78	T45		0900	.05	R7		1335	.13	T68		1025	7.33
T5		1400	5.77	T46		0920	.30	C16		1400	13.9	T69		1040	12.6
C3		1500	295	T47		0930	.051	T36		1430	1.45	C30		1110	83.9
Т6		1510	13.4	C22		1510	165	C17		1515	12.3	C31		1220	69.4
Т7		1545	1.02	T49		0940	.05	T38		1540	.01	T72		1255	.64
Т8		1600	4.62	T50		0955	.28	C18		1710	12.6	T73		1300	1.58
Т9		1620	.02	T51		1010	.04	T39		1.735	.31	C32		1345	65.5
C4		1610	271	T52		1040	3,55	R10		1740	•011	1775		1355	5,91
C4		0840	259	T54		1120	4.55	R11		1745	.13	T77		1330	9.57
T10		0920	.06	C23		1630	147	R12		1750	.01	C33		1305	55.5
T11		1020	.85	C8		0810	43.1	C19		1755	12.1	T79		1140	7.11
T12		1000	8.48	C9		0835	44.9					C34		1220	44.5
T13		1030	2.16	C10		0915	48.2	C23	6- 8-73	0900	131	T80		0920	2.41
T14		1045	3.35	T27		0930	1.60	T55		0955	6.02	T81		0935	4.20
C5		1130	251	C11		1020	43.9	C24		1120	137	T82		1110	5.62
T15		1225	.40	T28		1045	6.26	T56		1030	11.0	C35		0955	35.1
T16		1250	1.64	T29		1110	2.32	T57		1205	3.28	т83		1010	3.59
T17		1230	6.56	T30		1130	3.85	т58		1320	6.46	T85		1050	.67
T19		1300	8.91	C12		1200	29.6	C25		1415	109	C37		1035	33.8
T21		1320	.04	Т31		1225	7.37	C26		1450	95.3				
C6		1430	230	R2		1245	.10	C26		0830	102	í			
T22		1355	.18	C13		1310	210	T59		0930	2.57				
T23		1420	3.20	C13		0830	27	T60		0955	4.42				
T24		1450	6.56	R3		0845	.011	C27		1040	101				
C7		1540	210	T32		0910	5.81	R13		1120	.05 ¹				
C7		0835	218	R4		0930	.83	T63		1130	.11				
C20		1020	175	Т33		1025	.61	C28		1215	98.9	Į.			

¹Estimated.

Table 5.--Supplementary field measurements made at miscellaneous sites during canal seepage studies in Duchesne County, 1972-73

Land net location	At or near canel site No.	Date	Time	Estimated discharge (ft ³ /s)	Temperature (°C)	Specific conductance (micromhos/ cm at 25°C)	Station description
U(C-3-5)36bda	C10	4- 2-72	1720	-	9.5	345	Rocky Point Canal at State Road 87
		5-31-72	-	-	10.0	135	
		8- 1-72	-	-	15.5	370	
		10- 6-72	1120	-	11.0	425	
		6-13-73	1240	-	13.0	140	
U(C-4-5) lade	-	5- 2-72	1910	-	13.0	400	Duchesne River at old U.S. Highway 40 (at
		8- 2-72	-	- '	16.5	400	old stream-gaging station 09279500)
		11-15-72	-	-	7.4	462	
		3- 7-73	1425	*	. 5	520	
		6-13-73	1200	-	12.5	160	
U(C-4-5) lcca	-	3-27-73	-	-	6.0	820	Strawberry River above Indian Creek
U(C-4-5) lcaa	-	3-27-73		-	6.0	1,600	Indian Creek at mouth
U(C-4-4)6cbb		5- 2-72	1900	_	13.0	800	Strawberry River at mouth
0(0-4-4)0000		8- 2-72	-	_	10.5	840	Scrawberry River at moden
		11-15-72	_	-	10.0	635	
		3- 7-73	1435	_	5.0	960	
		6-13-73	1200	_	14.1		
		6-13-73	1200	-	14.1	1,360	
U(C-4-4) 1daa	C1	4-21-72	1555	-	12.0	605	Duchesne River at Grey Mountain Canal (at
		5- 2-72	0850	-	7.0	530	head of canal)
		8- 2-72	-	-	16.0	580	
U(C-4-3) 11dad	T21	5- 2-72	0915	-	9.0	510	Grey Mountain Canal at gravel pits
U(C-4-2)4bbb	R2	5- 3-72	1550	0.1	18.5	3,400	Drainage return to Grey Mountain Canal
U(C-3-2)34bda	C15	5- 3-72	1625	5.0	21.5	680	Grey Mountain Canal at State Road 53
U(C-3-2)34acb	T35	5- 3-72	1630	1.0	20.5	2,000	Drainage return in corrugated pipe crossing Grey Mountain Canal.
U(C-3-2)35daa	R10	5- 4-72	1005	-	13.0	3,100	Drainage return to Grey Mountain Canal from canyon below South Myton Bench
U(C-3-2)36cbc	C19	5- 3-72	1700	,5	22.5	2,200	Grey Mountain Canal at county road south of
		5- 4-72	1030	5.0	11.0	950	Myton
		10-6-72	1015	-	11.5	820	··· ·
		4-12-73	1600	. 5	12.0	2,600	
U(C-3-2)36ccb	C19	5- 3-73	1705	1.0	15.5	3,400	Drainage return to Grey Mountain Canal from canyon below South Myton Bench
U(C-4-2)15aba	C26	4-27-73	•	-	22.0	2,000	Drainage return at State Road 216 below Pleasant Valley Canal
U(C-4-2)12daa	-	4-28-73	1010	1.5	11.0	4,000	Pleasant Valley Wash at county road, south-
*		8-28-73	1525	10	20.0	2,8001	east of pipeline station

Laboratory measurement.

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 Wayne D. Criddle, 1952.
- No. 8. (Revised) Consumptive use and water requirements for Utah, by W. D. Criddle, K. 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 Joseph 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.
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- 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 Allen G. Hely, R. W. Mower, and C. Albert Harr, U.S. Geological Survey, 1971.
- No. 35. Ground-water conditions in the East Shore area, Box Elder, Davis, and Weber Counties, Utah, 1960-69, by E. L. Bolke and K. M. Waddell, U.S. Geological Survey, 1972.
- 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 Jerry 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 Jerry 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. Bjorkland and L. J. McGreevy, U.S. Geological Survey, 1974.
- No. 45. Water resources of the Curlew Valley drainage basin, Utah and Idaho, by Claud 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 Jerry 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 Louise L. Miller, U.S. Geological Survey, 1975.

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.

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. William W. Donnan, Chief, Southwest Branch (Riverside, California) Soil and Water Conservation Research Division, Agricultural Research Service, U.S.D.A., and by Wayne 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 Wayne D. Criddle, Jay M. Bagley, R. Keith Higginson, and David 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 Jack A. Barnett and Francis 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 Olive 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 James D. Maxwell and Bob L. Bridges, Soil Conservation Service, 1971.
- *No. 22. Bibliography of U.S. Geological Survey water-resources reports for Utah, compiled by Barbara A. LaPray, U.S. Geological Survey, 1972.
- No. 23. Bibliography of U.S. Geological Survey water-resources reports for Utah, compiled by Barbara A. LaPray, U.S. Geological Survey, 1975.