QUALITY OF THE ARKANSAS RIVER AND IRRIGATION-RETURN FLOWS

IN THE LOWER ARKANSAS RIVER VALLEY, COLORADO

By Doug Cain

U.S. GEOLOGICAL SURVEY

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METRIC CONVERSION FACTORS

Inch-pound units used in this report may be converted to SI (International System) units by using the following conversion factors:

Multiply inch-pound units	*By*	*To obtain SI units*
acre	0.4047	hectare
acre-foot (acre-ft)	1,233	cubic meter
cubic foot per second (ft^3/s, cfs)	0.02832	cubic meter per second
cubic foot per second per square mile [$(ft^3/s)/mi^2$]	0.01093	cubic meter per second per square kilometer
foot (ft)	0.3048	meter
inch (in.)	2.54	centimeter
micromho per centimeter at 25° Celsius (micromho, UMHO)	1.000	microsiemen per centimeter at 25° Celsius
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
ton (short)	0.9072	metric ton
ton (short) per day	0.9072	metric ton per day

To convert degrees Fahrenheit (°F) to degrees Celsius (°C), use the following formula: $°C = (°F-32)X5/9$.

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ABSTRACT

Irrigation-return flows in the lower Arkansas River valley of Colorado were investigated using data from a one-time sampling at 59 sites during the 1976 and 1977 irrigation seasons, monthly sampling at 4 sites, and intensive measurement and biweekly sampling in a small irrigated area during the 1978 irrigation season. The data were evaluated to determine areal and seasonal variations in the quality of irrigation-return flows and to develop relationships between the quantity and quality of applied water and irrigation-return flow.

Specific conductance of return flows generally increased downstream, paralleling a downstream increase in the specific conductance of irrigation water. During July 1977, the source of most Arkansas River streamflow downstream from Manzanola was irrigation-return flow. A similar situation probably existed during periods of little precipitation in the early and late irrigation seasons during 1974 to 1978. Irrigation-return flows had a large effect on the quality of water in the Arkansas River during these times.

Seasonal variations of discharge, specific conductance, and dissolved oxygen of five return flows were similar to those observed in the Arkansas River. Three irrigation-return flows, composed mainly of tailwater, had larger concentrations of suspended solids, biochemical-oxygen demand, and Kjeldahl nitrogen than two flows that were composed primarily of ground-water return flow.

Irrigation-return flow accounted for 40 percent of applied water in a small (6.75-square mile) irrigated area. Three-fourths of the total return flow was ground-water return flow, which also transported 88 percent of applied salts to the ground-water system. Except for nitrite plus nitrate and total phosphorus, measured water-quality constituents were generally more concentrated in the West Holly Drain, which drains the area, than in the applied water.

INTRODUCTION

Irrigation-return flow is the volume of water applied for irrigation but not consumed by crops, which returns to its source or to another water body. Irrigation-return flows are two types: (1) Surface-water return flow, or tailwater, is excess irrigation water that runs off the end of fields and flows directly back to streams; and (2) ground-water return flow is excess irrigation water that percolates to the ground-water reservoir, and may eventually return to streams as ground-water inflow or seepage.

Approximately 300,000 acres of irrigated land in the lower Arkansas River valley of Colorado may contribute irrigation-return flow to the Arkansas River. Recognizing the possible impacts that irrigation-return flows could have on the quality of water in the Arkansas River, and, thereby, its use as an agricultural, municipal, or industrial supply, the Southeastern Colorado Water Conservancy District requested the U.S. Geological Survey to conduct a 3-year investigation to determine the quality of irrigation-return flows in this area of Colorado (fig. 1).

Description of Study Area

The study area extended from just below Pueblo Reservoir to the Colorado-Kansas State line, and focused on irrigated agricultural lands in the valley of the Arkansas River (pl. 1). According to the U.S. Bureau of the Census (1981), the 1980 population of this area was approximately 160,000, with two-thirds of the total living within the city limits of Pueblo. One-half of the remaining population lives in the towns of Rocky Ford, La Junta, Las Animas, and Lamar. About 25,000 people reside in smaller towns or rural areas. Excluding the city of Pueblo, the economy of the area is primarily agricultural. The value of crops produced in 1978 was about $60 million (Colorado Department of Agriculture, 1980). Hay, wheat, corn, and sorghum were the principal crops east of La Junta; beans, melons, vegetables, hay, and corn were the principal crops west of La Junta during the study period. Diversion of streamflow and ground-water pumpage are required to sustain agriculture because the mean annual precipitation is 12-15 in.

The Arkansas River flows from west to east through the study area. Major tributaries include Fountain Creek and the St. Charles, Huerfano, Apishapa, and Purgatoire Rivers. During the period 1974 to 1978, the mean annual flow of the Arkansas River decreased downstream by more than a factor of 10 from Avondale to Lamar, as a result of diversions for irrigation and resultant consumptive use (fig. 2).

Streamflow in the study area is regulated by Pueblo Reservoir and John Martin Reservoir near Las Animas. Both reservoirs store water during the winter and during flood periods for later release. In addition, Pueblo Reservoir is used for storage of water diverted into the Arkansas River from the Colorado River basin as part of the Fryingpan-Arkansas Project, a multipurpose, water-development project of the U.S. Bureau of Reclamation.

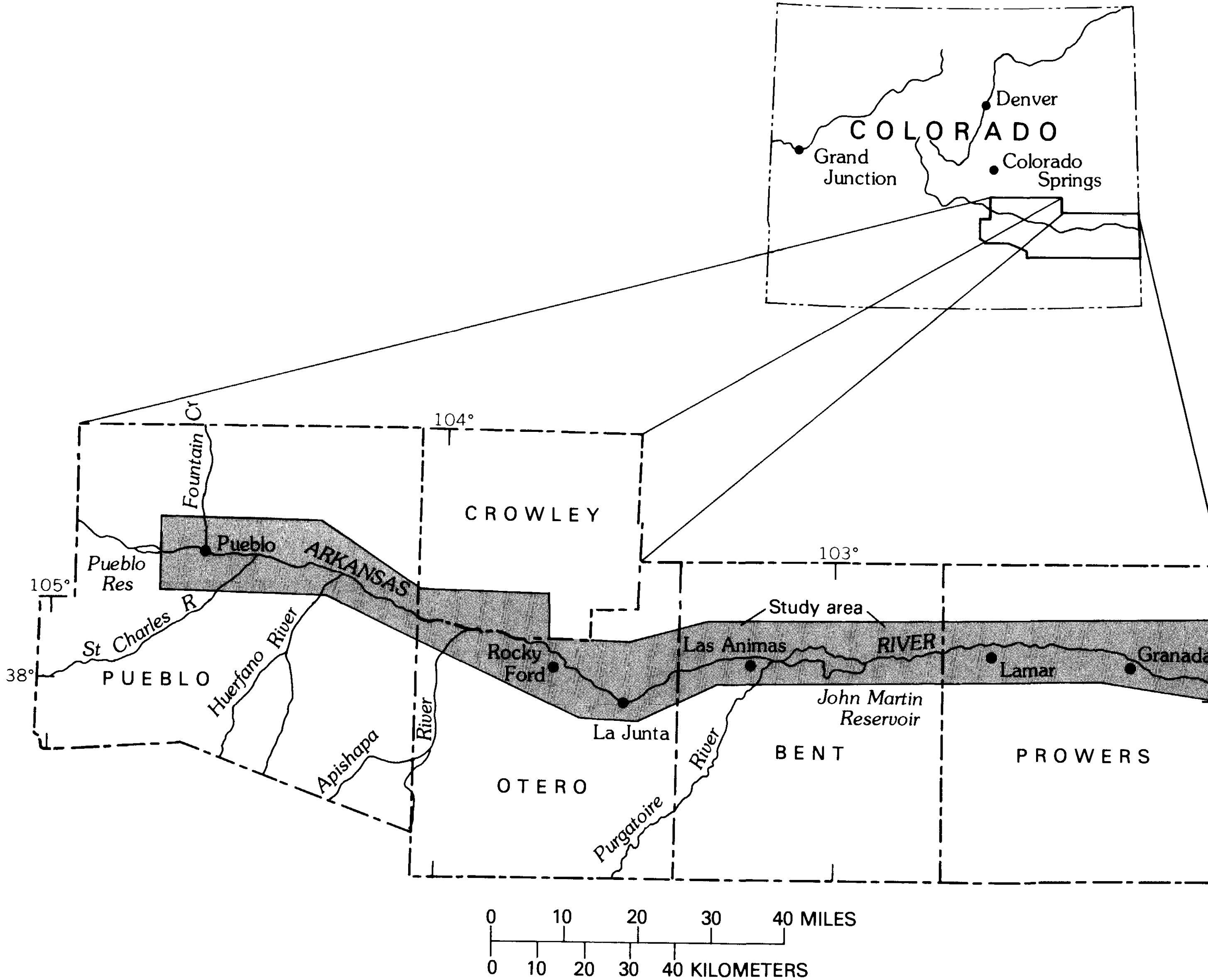

Figure 1.--Location of study area.

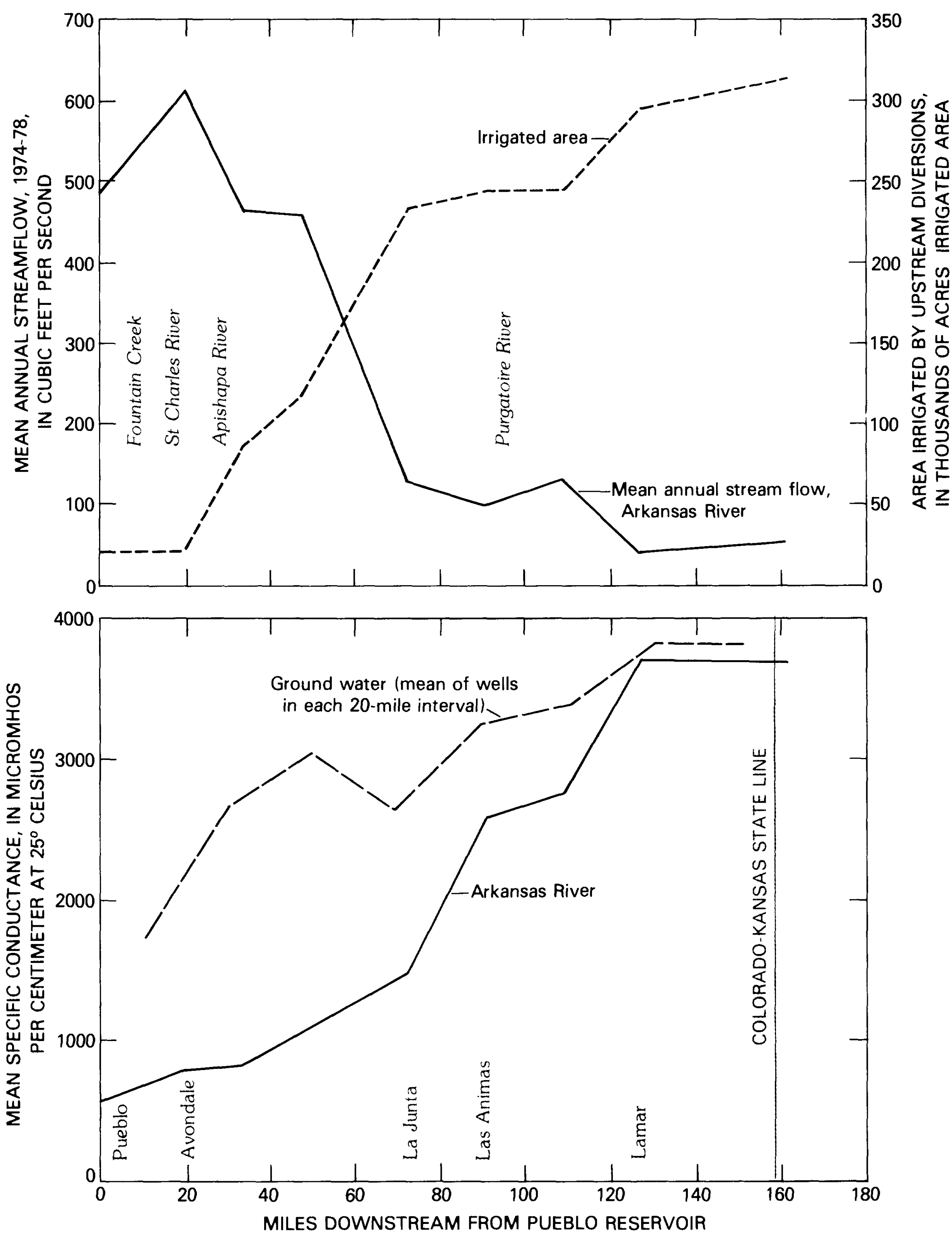

Figure 2.--Mean annual streamflow 1974-78, irrigated acreage, and mean specific conductance of ground and surface water.

Streamflow used for irrigation is diverted from the river through a system of 16 major and several minor canals. Because streamflow is not normally adequate to meet crop demands, especially in spring and late summer, the hydraulically connected alluvial aquifer adjacent to the Arkansas River has been extensively developed. According to Taylor and Luckey (1974), an estimated 153,000 acre-ft, or about 20 percent of the water applied to crops during 1941-65, was pumped from approximately 1,400 wells completed in the alluvial aquifer. Despite extensive ground-water withdrawals and efforts to supplement streamflow with imported water from the Fryingpan-Arkansas Project and from private transmountain-diversion projects, demand for irrigation water has exceeded available supply in most years.

The quality of water in the Arkansas River changes dramatically in the study area. Specific conductance, which is directly related to dissolved-solids concentrations, increased from a mean of about 500 micromhos at Pueblo Reservoir to a mean of about 3,500 micromhos at the Colorado-Kansas State line (fig. 2). According to Miles (1977), the main reason for the increase in dissolved solids is consumptive use, which concentrates the chemical constituents in both ground and surface water. Associated with this increase is a shift in the relative proportions of the major ions that comprise most of the dissolved solids. Relative proportions of sodium, chloride, and sulfate increase, whereas relative proportions of calcium, magnesium, and bicarbonate decrease (Gaydos, 1980). In addition, increases occur in stream temperature, concentrations of nitrite plus nitrate, and suspended solids (Cain and Edelmann, 1980; U.S. Geological Survey, 1978). Impacts on river-water quality related to municipal and industrial wastewater discharges are greatest just east of Pueblo; these impacts have been intensively analyzed by Cain and others, (1980). The salinity problem, located primarily east of La Junta, has been studied by Miles (1977).

Water pumped from the alluvial aquifer for irrigation also showed a large downstream increase in specific conductance (fig. 2). Ground water generally had a larger specific conductance than water from the Arkansas River, but the difference between the two sources decreased downstream. In the stream reach between Lamar and the Colorado-Kansas State line, the mean specific conductance of surface and ground water was similar.

Problem and Objectives

During the process of application and return to streams, irrigation water undergoes changes in quality that may cause adverse effects on receiving streams. Some commonly observed effects on water quality caused by irrigation-return flows are increases in concentrations of suspended sediment, nutrients, pesticides, bacteria, and salinity.

The objectives of the investigation were:

1. Identify and define the quality and areal trends in the quality of major irrigation-return flows.

2. Document seasonal variations in the quality of both surface- and ground-water return flows.

3. Document relationships between the quality and quantity of applied water and irrigation-return flows in a small irrigated area.

Approach

Water-quality samples were collected from irrigation-return flows throughout the study area during 1976 and 1977 to define areal variations in their quality. Based on these samples four irrigation-return flows were selected for monthly sampling during the 1978 irrigation season to document seasonal trends in quality. A small irrigated area was also selected for intensive study during 1978 to document relationships between the quantity and quality of applied irrigation water and irrigation-return flow. This evaluation included developing water and salt budgets for the small irrigated area.

The quality of irrigation-return flow was evaluated in comparison with the quality of applied water and with water-quality standards for the Arkansas River and selected tributaries in the study area (Colorado Department of Health, 1982). Water-use classifications and resulting numerical standards are listed in table 1. These standards are not intended to apply specifically to irrigation-return flows. However, because irrigation-return flows enter the Arkansas River and its natural tributaries and, in some places, may be a large part of the flow, these standards are used in this report as one measure of the quality of irrigation-return flows.

Acknowledgments

The author wishes to thank the many landowners who permitted access to their property to measure and to collect samples of irrigation-return flows. Special appreciation is extended to the Buffalo Mutual Irrigation Company and the Board of the Holly Drain for allowing temporary installation of continuous-recording instrumentation.

AREAL VARIATIONS IN THE QUALITY OF IRRIGATION-RETURN FLOWS

An inventory and reconnaissance sampling of irrigation-return flows was made during the 1976 and 1977 irrigation seasons to define the locations, quality, and areal variations in the quality of major irrigation-return flows. Because a drought condition existed in the study area at the time, less water than normal was available for irrigation, and it is likely that the volume of irrigation-return flows was significantly decreased. Some of the irrigation-return flow channels or ditches that contain water during normal years were dry and were not sampled.

Table 1.--*Water-quality standards*[1] *for selected streams*

[from Colorado Department of Health (1982); mg/L, milligrams per liter; µg/L, micrograms per liter]

	Streams						
	Arkansas River[2]	St. Charles River	Sixmile Creek	Huerfano River	Apishapa River	Purgatoire River	Other tributaries
Water-use classifications[3]							
Class 2 recreation[4]	X	X	X	X	X	X	X
Class 2 warm-water aquatic life	X	X	X	X	X	X	X
Water supply	X	X	X	X	X	X	X
Agriculture	X	X	X	X	X	X	X
Numeric standards[5]							
Dissolved oxygen (mg/L)[6]	5.0	5.0	5.0	5.0	5.0	5.0	5.0
pH (standard units)	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0
Fecal coliform (colonies per 100 milliliters)	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Nonionized ammonia (mg/L as N)	0.1	0.1	-------	0.1	0.1	0.1	-------
Dissolved nitrate (mg/L as N)	10	10	-------	-------	-------	-------	-------
Dissolved chloride (mg/L)	250	250	-------	-------	-------	-------	-------
Dissolved sulfate (mg/L)	2,200	1,600	-------	-------	-------	-------	-------
Dissolved iron (µg/L)	300	300	-------	-------	-------	-------	-------
Dissolved manganese (µg/L)	50	50	-------	-------	-------	-------	-------
Aldrin (µg/L)	.003	.003	.003	.003	.003	.003	.003
Dieldrin (µg/L)	.003	.003	.003	.003	.003	.003	.003
DDT (µg/)	.001	.001	.001	.001	.001	.001	.001
Endrin (µg/L)	.004	.004	.004	.004	.004	.004	.004
Heptachlor (µg/L)	.001	.001	.001	.001	.001	.001	.001
Lindane (µg/L)	.1	.1	.1	.1	.1	.1	.1
Malathion (µg/L)	.1	.1	.1	.1	.1	.1	.1
Methoxychlor (µg/L)	.03	.03	.03	.03	.03	.03	.03
Mirex (µg/L)	.001	.001	.001	.001	.001	.001	.001
PCB's (µg/L)	.001	.001	.001	.001	.001	.001	.001
Toxaphene (µg/L)	.005	.005	.005	.005	.005	.005	.005

[1]Standards are listed only for those water-quality constituents for which data are included in this report.
[2]For the reach from the confluence with Fountain Creek to the State line.
[3]X indicates classification applies to stream.
[4]Defined as secondary contact (that is, boating, kayaking).
[5]Dashes indicate no standard for that parameter.
[6]Minimum value.

Locations of Identified Irrigation-Return Flows

Identified irrigation-return flows are shown on plate 1. Most of the sites are ditches or channels constructed for collection and conveyance of return flow. Many natural tributaries in the area also contain irrigation-return flow; the five tributaries that were sampled during the study are shown on plate 1. Water-quality samples were collected at 59 irrigation-return flow sites. Data for onsite determinations (discharge, temperature, specific conductance, pH, and dissolved oxygen), major ions, nutrients, and bacteria from these samples are in table 8; data at selected sites for pesticides are listed in table 9 (tables 8 and 9 are in the Supplemental Information section at back of report).

Distribution of both identified and sampled irrigation-return flows was not uniform. Larger numbers of irrigation-return flows were identified and sampled in the St. Charles River mesa area southeast of Pueblo, in the vicinity of Rocky Ford, between John Martin Reservoir and Lamar, and between Granada and the Colorado-Kansas State line. Although most of the sampled irrigation-return flows discharged directly to the Arkansas River, some of the flow discharged into irrigation canals, then was reapplied to crops, or the flow infiltrated through sandy channels and percolated directly to the ground-water table before reaching the river. The name of the sites sampled, the source of irrigation water for each site, and the point of discharge, are listed in table 2.

Water Quality of Identified Irrigation-Return Flows

The quality of identified irrigation-return flows sampled during 1976 and 1977 was generally acceptable when compared with the water-quality standards in table 1. Water-quality standards were exceeded, however, in 3 of 24 samples analyzed for sulfate, 14 of 20 samples analyzed for manganese, 2 of 44 samples analyzed for nitrite plus nitrate, 1 of 7 samples analyzed for fecal coliform, and 3 of 15 samples analyzed for dieldrin. In all, water-quality standards for one or more constituents were exceeded at 18 to 59 sites.

The discharge and quality of irrigation-return flows sampled during 1976 and 1977 varied widely in the study area. Minimum and maximum values and other statistics for selected constituents are given in table 3. Some of the variation in amount and quality of irrigation-return flow is caused by variations in the amount and quality of applied water.

The specific conductance of irrigation-return flows shows a large downstream increase (fig. 3). The major cause of the increase is an increase in specific conductance of both surface and ground water available for irrigation (fig. 2).

The quality of applied irrigation water has a large effect on the quality of irrigation-return flow. The relationship between the two was quantitatively evaluated for an intensive study area near Holly, described later in this report. To provide an indication of the areal relationship between the quality of irrigation-return flow and applied surface water, samples were

Table 2.--*Sources of irrigation water and discharge points for irrigation-return flows and selected tributaries*

Site No. on Plate 1	Site name	Source of irrigation water[1]	Point of discharge
IR-54	21st Lane Drain	Bessemer Ditch, wells	Reapplication to fields
IR-53	23rd Lane Drain	Bessemer Ditch, wells?	Reapplication to fields
IR-52	25th Lane Drain	Bessemer Ditch, wells?	Tailwater ponds
IR-51	St. Charles Bottomland Drain	Bessemer Ditch, wells?, tailwater?	Arkansas River
IR-50	St. Charles Drain	Bessemer Ditch, wells?	St. Charles River
IR-49	37th Lane Drain	Bessemer Ditch, wells?	Tailwater Pond
IR-48	39th Lane Drain at Mouth	Bessemer Ditch, wells?	Tailwater Pond
IR-47	39th Lane Drain at Highway 50	Bessemer Ditch, wells?	Tailwater Pond through IR-48
IR-46	40th Lane Drain	Bessemer Ditch, wells?	Tailwater Pond
IR-45	Wheeler Lane Drain	Bessemer Ditch, wells?	Arkansas River
IR-44	Avondale Drain at Highway 50	Bessemer Ditch, wells	Collier Ditch
IR-43	Avondale Drain at Br 50	Bessemer Ditch, wells	Collier Ditch
IR-42	51st Lane Drain	Bessemer Ditch, wells?	Collier Ditch
IR-41	Avondale Bottomland Drain	Collier Ditch, wells?	Arkansas River
IR-40	North Nepesta Drain	Wells?	Arkansas River
IR-39	RR Junction Drain	Wells?	Arkansas River
IR-38	Oxford Farmers Drain	Oxford Farmers Ditch?, wells?	Arkansas River
IR-37	E. Manzanola Drain	Catlin Canal, wells	Arkansas River
IR-36	Vroman Drain	Rocky Ford Canal, wells?	Arkansas River
IR-35	Patterson Hollow Drain	Catlin Canal, wells	Arkansas River
IR-34	Highway 71 Drain	Rocky Ford Canal, wells?	Arkansas River
IR-33	N. Rocky Ford Drain	Rocky Ford Canal, wells?	Arkansas River
IR-32[2]	Rocky Ford STP Drain	Rocky Ford Canal, wells	Arkansas River
IR-31	Rocky Ford Drain	Rocky Ford Canal, wells	Arkansas River
IR-30	Krammes Drain	Rocky Ford Canal, wells	Arkansas River
IR-29	Newdale Drain	Rocky Ford Canal, wells	Arkansas River
IR-28	W. La Junta Drain	Catlin Canal, wells	Arkansas River
IR-27	East Swink Drain	Catlin Canal, wells	Arkansas River
IR-26	E. Purgatoire Drain	Jones Canal, wells	Arkansas River
IR-25	Miller Ditch	Ft. Lyon Canal, wells?	Arkansas River (John Martin Res.)
IR-24	McClave Drain	Ft. Lyon Canal	Arkansas River
IR-23	Lubers Drain	Ft. Lyon Canal, wells?	Alluvial aquifer
IR-22	Prowers Arroyo Drain	Ft. Lyon Canal?	Alluvial aquifer
IR-21	West Keesee Drain	Keesee Canal, wells?	Arkansas River
IR-20	East Keesee Drain	Keesee Canal	Arkansas River
IR-19	Dry Creek Drain	Ft. Bent Canal, wells	Arkansas River
IR-18	Prowers Drain	Ft. Bent Canal, wells	Arkansas River
IR-17	Vista Del Rio Drain	Amity Canal, wells	Pumped from drain for irrigation
IR-16	Markham Arroyo Drain	Amity Canal, wells	Hyde Canal
IR-15	East Lamar Drain	Lamar Canal, Ft. Bent Canal, wells	Arkansas River
IR-14	Vista Del Rio Drain	Amity Canal, Hyde Canal, wells	Big Sandy Creek
IR-13	N. Granada Drain	X-Y Canal, wells	Arkansas River through IR-10
IR-12	S. Granada Drain	X-Y Canal, wells	Arkansas River through IR-10
IR-11	Western Alfalfa Drain	X-Y Canal, wells	Arkansas River
IR-10	Granada Drain at Mouth	X-Y Canal, wells	Arkansas River
IR- 9	N. Arkansas Drain near Barton	Buffalo Canal, wells	Arkansas River through IR-6
IR- 8	N. Fork W. Holly Drain	Buffalo Canal, wells	Arkansas River through IR-6
IR- 7	S. Fork W. Holly Drain	Buffalo Canal, wells	Arkansas River through IR-6
IR- 6	W. Holly Drain at Mouth	Buffalo Canal, wells	Arkansas River
IR- 5	E. Holly Drain at Holly	Buffalo Canal, wells	Arkansas River through IR-2
IR- 4	E. Holly Drain Tributary	Buffalo Canal, wells	Arkansas River through IR-2
IR- 3	E. Holly Drain at Highway 50	Buffalo Canal, wells	Arkansas River through IR-2
IR- 2	E. Holly Drain at Mouth	Buffalo Canal, wells	Arkansas River
IR- 1	Romer Field Drain	Wells	Arkansas River
T - 1	Sixmile Creek at Highway 50	Bessemer Ditch, wells	Arkansas River
T - 2	Chicosa Creek near Fowler	Rocky Ford Highline Canal, wells	Arkansas River
T - 3	Apishapa River near Fowler	Rocky Ford Highline Canal, Oxford Farmers Ditch, wells	Arkansas River
T - 4	Timpas Creek at Highway 50	Rocky Ford Highline Canal, Otero Canal, Catlin Canal, Rocky Ford Canal, wells	Arkansas River
T - 5	Crooked Arroyo at Highway 50	Otero Canal, wells	Arkansas River

[1]Question mark indicates source is uncertain.
[2]Receives effluent from Rocky Ford sewage lagoons.

Table 3.--*Statistical summary of selected water-quality data from irrigation-return flows and selected tributaries sampled during 1976-77*
[ft^3/s, cubic feet per second; °C, degrees Celsius; micromhos, micromhos per centimeter at 25° Celsius; mg/L, milligrams per liter]

Constituent	Number of samples	Mean value	Standard deviation	Minimum value	Median value	Maximum value
Discharge (ft^3/s)	66	3.2	5.3	0.10	1.7	31
Temperature (°C)	74	21.9	4.3	14.0	22.0	34.0
Specific conductance (micromhos)	72	2,580	1,350	445	2,500	6,020
pH	68	8.0	.24	7.5	8.0	9.0
Dissolved chloride (mg/L)	70	69	61	4.9	51	250
Dissolved nitrite plus nitrate (mg/L)[1]	44	3.7	2.9	.06	3.7	15
Suspended solids (mg/L)	35	375	806	6	61	3,300

[1]Includes 13 values of total nitrite plus nitrate.

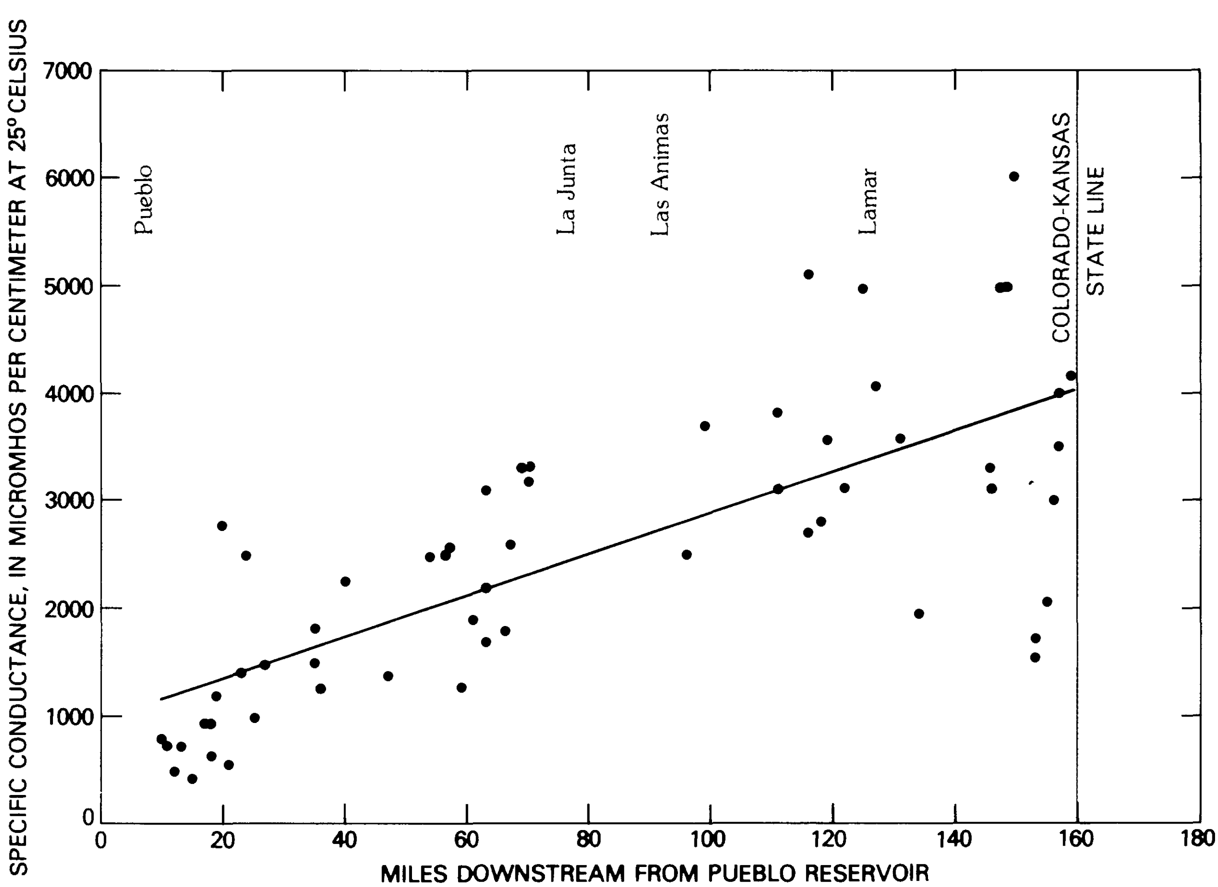

Figure 3.--Downstream increase in specific conductance of irrigation-return flows.

collected at 41 main-stem sites during July 1977. Approximately two-thirds of the irrigation-return flow samples were collected about the same time. Locations of the Arkansas River sites are shown on plate 1; results of the chemical analyses of the samples are given in table 10 (in the Supplemental Information section).

Specific conductance of the Arkansas River during July 1977 (fig. 4) showed a similar pattern to mean specific conductance (fig. 2). Specific conductance in both instances increased slowly and steadily from Pueblo to near Las Animas, where an abrupt increase occurred. The abrupt increase during July 1977 is related to canal diversions from the Arkansas River between Manzanola and Las Animas. Just downstream from Manzanola, all Arkansas River streamflow was diverted for irrigation. Between this zero-flow point and Las Animas is a distance of about 35 miles. In this reach, streamflow recovered as a result of inflows from several possible sources. These include sluicing of canal water back to the river, returns from several large irrigation-return flows near Rocky Ford, and to a lesser extent, tributary inflows and ground-water seepage. Sluice water would not show an increased specific conductance, and return flows near Rocky Ford had specific conductances similar to the river during July 1977. The specific conductance of tributary inflows and ground-water seepage to the river would be expected to be larger than the specific conductance of sluice or return-flow water in this reach.

As the replenished flow of the river was further diverted between La Junta and Las Animas, specific conductance increased abruptly as a result of the increasing proportion of streamflow composed of tributary inflow and ground-water seepage. Gaged-tributary inflow between the zero-flow point downstream from Manzanola and the Colorado-Kansas State line was less than 10 ft^3/s during the sampling period in July 1977. During the same period, the combined discharge of measured irrigation-return flows entering the Arkansas River between the zero-flow point and the Colorado-Kansas State line was about 80 ft^3/s. These data indicate that the source of most Arkansas River streamflow downstream from Manzanola was irrigation-return flow.

To determine how often this situation occurred, an analysis of streamflow data was made for 1974 through 1978. During this period, the flow of the Arkansas River at La Junta was less than 30 ft^3/s about one-half the time. These periods of low flow occurred primarily during the winter and during periods of little precipitation in the early (April, May) and late (August, September) parts of the irrigation season. Irrigation-return flows between Manzanola and the Colorado-Kansas State line of only 40 ft^3/s (one-half the July 1977 amount) would have been enough to make up more than one-half the flow of the Arkansas River downstream from La Junta when the flow at La Junta was less than 30 ft^3/s and tributary inflow was small (less than 10 ft^3/s).

Because irrigation-return flows were such a large contributor to streamflow downstream from Manzanola, they could be expected to have a major effect on the quality of water in the Arkansas River. Based on the data collected in 1976 and 1977, the volume of irrigation-return flows upstream from Manzanola was small compared to Arkansas River flow, and their effect on the quality of water in the Arkansas River was likely to be less.

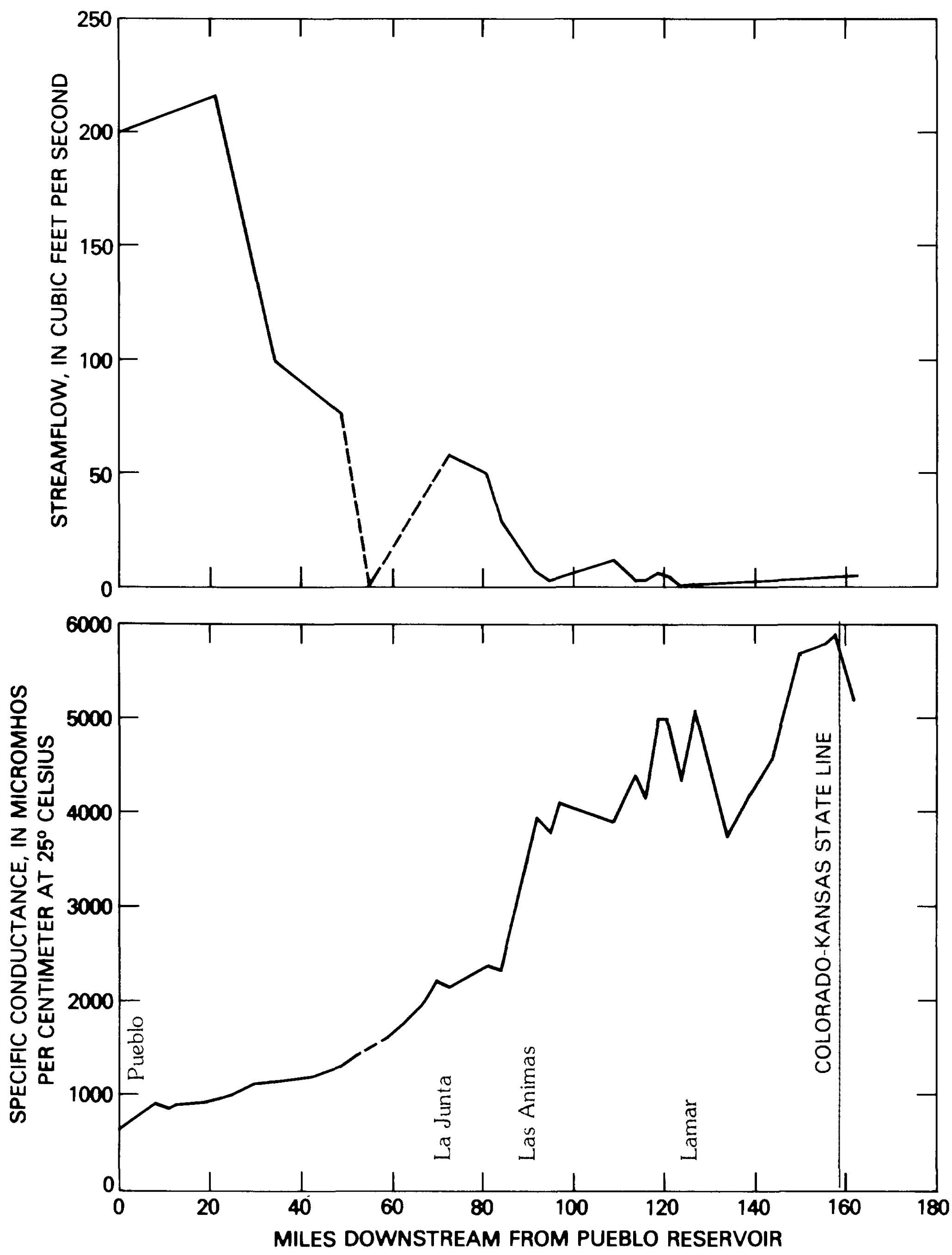

Figure 4.--Specific conductance and streamflow of the Arkansas River, July 1977.

SEASONAL VARIATIONS IN THE ARKANSAS RIVER AND SELECTED IRRIGATION-RETURN FLOWS

Water-quality samples were collected monthly during the 1978 irrigation season at four irrigation-return flow sites, and biweekly at an additional site in the intensive study area, to evaluate seasonal variations. Concurrent with collection of the monthly return-flow samples, selected onsite water-quality data were collected at eight Arkansas River sites to illustrate seasonal variations in stream quality, and to evaluate further the relationship of the quantity and quality of streamflow and irrigation-return flow.

Variations in the Arkansas River

The eight main-stem sites, where water-quality data were collected monthly during the 1978 irrigation season, are shown on plate 1; water-quality data are listed in table 11 in the Supplemental Information section.

Discharge

Arkansas River streamflow had a large seasonal variation during the 1978 irrigation season (fig. 5). Flows were small during the early part of the irrigation season (April, May). Snowmelt runoff in the mountains west of the study area caused the largest flows of the season during June. Streamflow decreased from the peak in June to successively smaller amounts in July and August and returned to discharges similar to springtime flows by September. Throughout the irrigation season, streamflow declined greatly from Pueblo to the Colorado-Kansas State line.

Specific Conductance

Streamflow variations in the study area had a strong effect on the seasonal variation of specific conductance in the Arkansas River (fig. 6). Largest specific-conductance values occurred during the low-flow periods in spring (April, May) and late summer (August, September). High streamflow in early summer (June, July) resulted in the smallest specific-conductance values observed during the irrigation season. Large downstream increases in specific conductance occurred throughout the irrigation season.

Other Water-Quality Constituents

During the 1978 irrigation season, measured dissolved-oxygen concentrations in the Arkansas River ranged from 4.0 to 13.2 mg/L (milligrams per liter). These concentrations generally were greater than the water-quality standard of 5 mg/L; the only value less than the standard was at the La Junta site in June. Measured dissolved-oxygen values were probably larger than the daily mean value at each site, because the measurements were made during daylight hours. Based on 24-hour dissolved-oxygen measurements, Cain and others (1980) and Cain and Edelmann (1980) showed that larger dissolved-oxygen

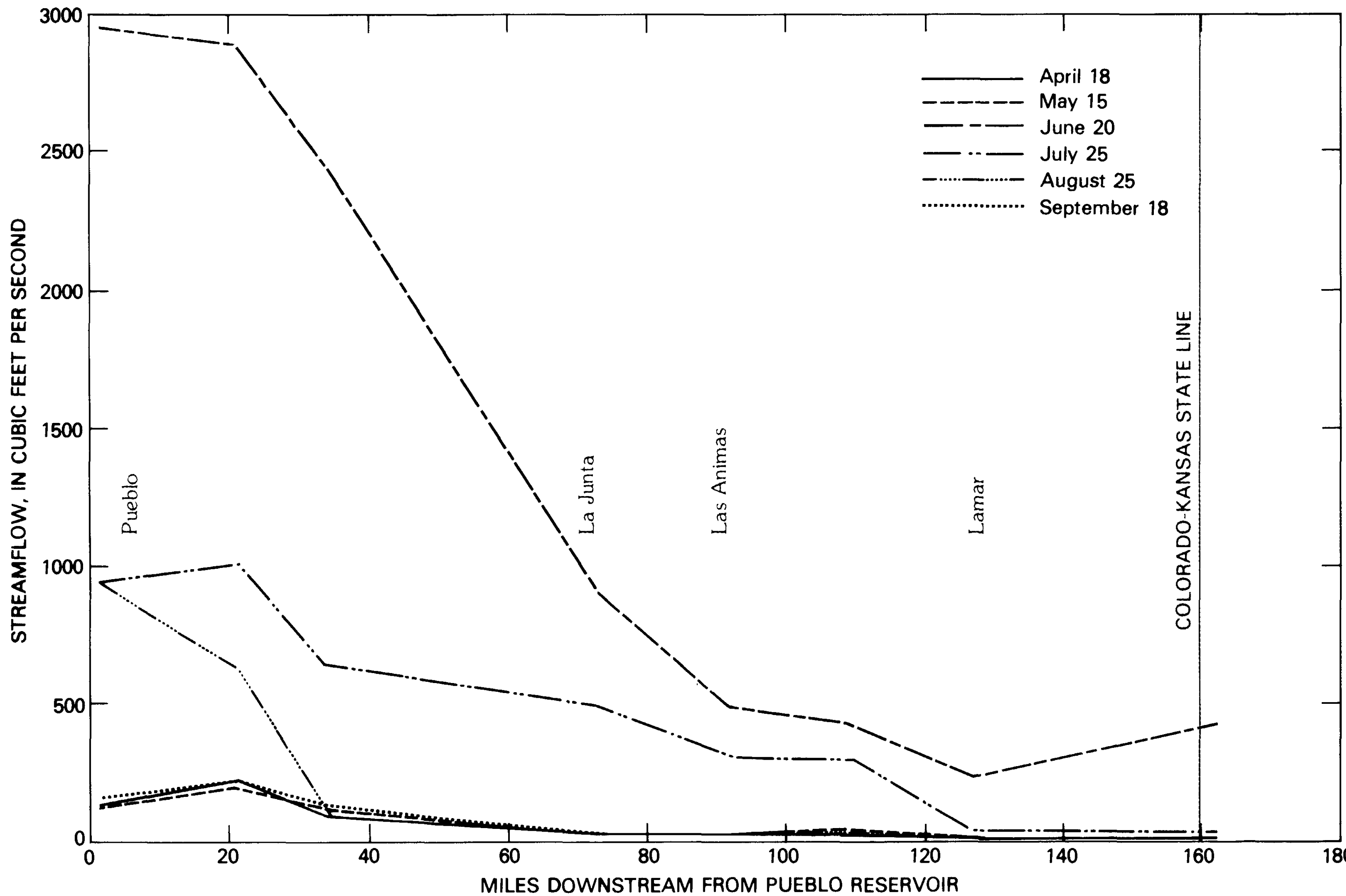

Figure 5.--Streamflow of the Arkansas River, 1978 irrigation season.

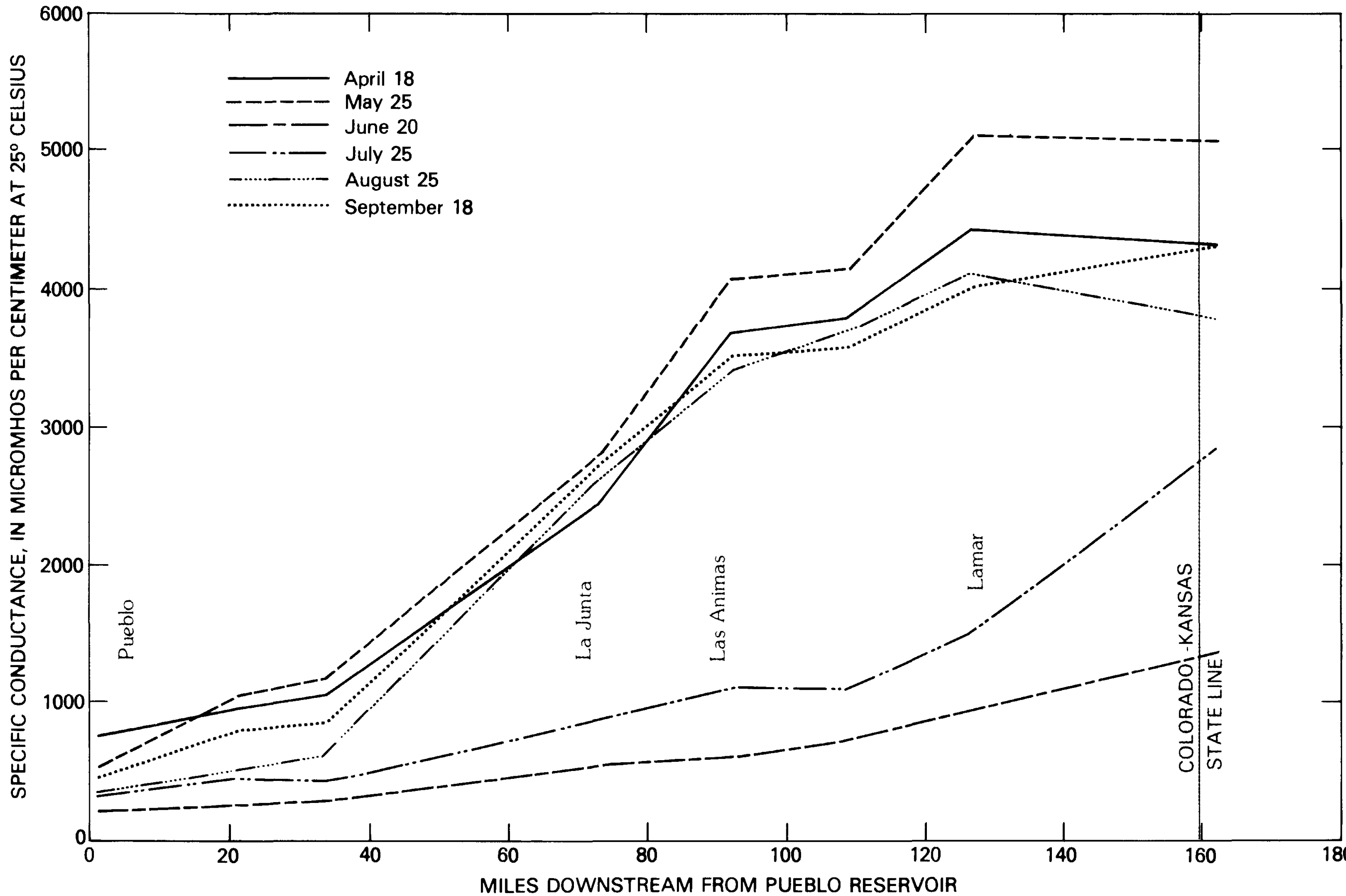

Figure 6.--Specific conductance of the Arkansas River, 1978 irrigation season.

concentrations occurred during daylight than during nightime hours at three Arkansas River sites in Pueblo County. During the 1978 irrigation season, dissolved-oxygen concentrations were generally larger during the spring and fall, and smaller during the summer.

The number of fecal-coliform bacteria in water samples from the Arkansas River was largest at most sites during the high streamflow period of June and July 1978. About one-half the samples collected during this period exceeded the standard of 2,000 colonies per 100 mL (milliliter). During the low-flow periods in spring and late summer, all but two fecal-coliform values were less than 500 colonies per 100 mL. The numbers of fecal-streptococci bacteria did not exhibit the same strong seasonal variation. Fecal-streptococci data are characterized by large, apparently unrelated variations.

Variations in Selected Irrigation-Return Flows

Four irrigation return-flow sites were chosen for collection of monthly water-quality samples during the 1978 irrigation season. Water-quality samples were also collected biweekly at one site in the intensive study area. Locations of all five sites are shown on plate 1; water-quality and streamflow data are given in tables 12 and 19 in the Supplemental Information section. The sites were chosen to represent areas with different crop types and sources of irrigation water, and to illustrate differences in the quality of tailwater and ground-water return flows. Characteristics of the sites and their contributing drainage areas are listed in table 4.

Discharge

Discharge of the five irrigation return-flows sampled during the 1978 irrigation season is plotted in figure 7. Discharge of East Lamar Drain and Sixmile Creek consisted largely of ground-water return flow and showed less variation than the other three sites. All sites had the largest measured discharge during June, July, or August, when irrigation water was most plentiful. The discharge per square mile of area drained by the Rocky Ford Drain (table 4) was much greater than the other irrigation-return flows. The Rocky Ford Canal has one of the oldest surface-water rights in the study area, resulting in the most available water per irrigated acre, and larger amounts of irrigation-return flow.

Specific Conductance

Specific conductance of water at all five sites was largest in spring and fall and smallest during the summer (fig. 7). The magnitude of variation in Rocky Ford Drain and Sixmile Creek was less than the three sites downstream from La Junta. The same variability occurred in the Arkansas River at sites upstream and downstream from La Junta (fig. 6) and thereby, for irrigation water diverted from the river.

Table 4.--*Characteristics of five irrigation-return flows sampled during the 1978 irrigation season*
[mi^2, square miles; mi, miles; $(ft^3/s)/mi^2$, cubic feet per second per square mile; ft, feet]

Site No. on plate 1	Site name	Approximate drainage area[1] (mi^2)	Approximate length of drain (mi)	Average discharge per square mile [$(ft^3/s)/mi^2$]	Type of channel	Primary source of irrigation water	Secondary source of irrigation water	Primary crops grown	Type of irrigation return flow
IR-31	Rocky Ford Drain	3.0	5.5	5.2	Excavated ditch	Rocky Ford Canal	Wells	Corn, vegetables, melons	Primarily tailwater
IR-15	East Lamar Drain	2.5	4.0	0.4	Deeply excavated (15-20 ft) ditch	Lamar and Fort Bent Canals	Wells	Corn, alfalfa, sorghum	Primarily ground-water return flow
IR-10	Granada Drain	8.5	11.0	.7	Excavated ditch with two branches	Wells	X-Y Canal	Alfalfa	Primarily tailwater
IR-6	West Holly Drain	6.75	10.7	1.2	Excavated ditch with two branches	Buffalo Canal	Wells	Alfalfa, sorghum (see table 9)	Primarily tailwater (see fig. 11)
T-1	Sixmile Creek	5.5	5.3	.5	Natural tributary; ephemeral above and perennial below Bessemer Ditch	Bessemer Ditch	Wells	Vegetables, corn	Primarily ground-water return flow from terrace deposits

[1]Area that contributes irrigation-return flow.

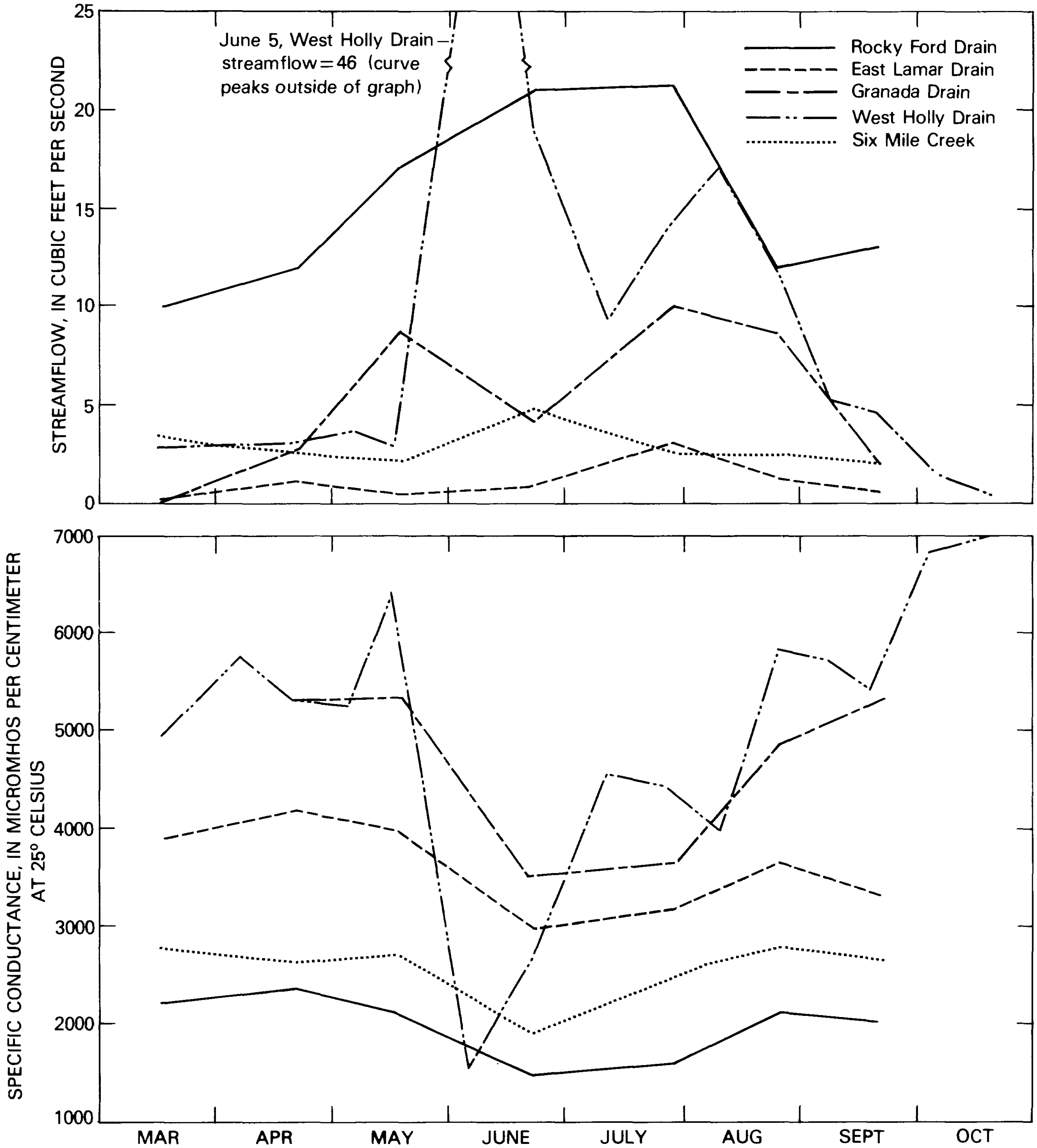

Figure 7.--Discharge and specific conductance of irrigation-return flow at five sites, 1978 irrigation season.

Specific conductance of water in Sixmile Creek was larger than water in Rocky Ford Drain, even though the area drained by Sixmile Creek is irrigated by water of less specific conductance. Average specific conductance of return flow from Sixmile Creek was about 6 times the applied surface water, whereas average specific conductance of return flow from Rocky Ford Drain was only about 1.5 times the applied surface water. The apparent reason for this large difference was that the discharge of Sixmile Creek was primarily ground-water return flow, and the discharge of Rocky Ford Drain was mostly tailwater. Ground-water return flow had a much larger specific conductance than applied irrigation water for two reasons. First, dissolved salts were concentrated by crop evapotranspiration and second, ground-water return flow has a long contact time with soluble minerals, which results in a greater pickup of dissolved salts. Tailwater did not show a large increase in dissolved solids over applied water because it generally was in contact with less soluble material during its comparatively short residence time on the irrigated field.

Other Water-Quality Constituents

Seasonal variation of dissolved oxygen for the five return-flow sites is shown in figure 8. Dissolved-oxygen concentrations were generally greatest during cooler spring and fall months of the irrigation season. This seasonal variation is related to the fact that larger amounts of oxygen can be dissolved in cooler rather than warmer water. Only 2 of 43 values measured were less than the water-quality standard of 5 mg/L.

All pH values measured at the return-flow sites were between 7.3 and 8.4, within the water-quality standard of 6.5 to 9. The smallest pH value at all sites except West Holly Drain occurred during June.

Suspended-solids concentrations were largest and showed the greatest seasonal variation in water from the Rocky Ford, Granada, and West Holly Drains, which primarily contained tailwater (fig. 8). As irrigation water flows across a field it can dislodge, suspend, and transport sediment particles, often resulting in a significant increase of suspended solids in tailwater. The concentration of suspended solids in water from East Lamar Drain and Sixmile Creek was small and relatively stable in 1978. Flow in both systems was composed primarily of ground-water return flow.

Consistent seasonal trends were not readily apparent for any of the nutrients analyzed at the five return-flow sites during 1978; however, other trends were evident. Concentrations of total Kjeldahl nitrogen (organic nitrogen plus ammonia) were generally greater in samples from both the Rocky Ford and Granada drains than concentrations that were commonly observed in the Arkansas River at three sites in 1976, 1978, and 1979 (Goddard, 1980; Cain and Edelmann, 1980; U.S. Geological Survey, 1980). These three sites were the Arkansas River above Pueblo, Arkansas River near Nepesta, and Arkansas River at Coolidge. Total Kjeldahl nitrogen would be expected to be larger in water from these two drains, because the flow consisted primarily of tailwater. Total Kjeldahl nitrogen concentrations in water from the West Holly Drain were also generally larger when the flow was primarily tailwater.

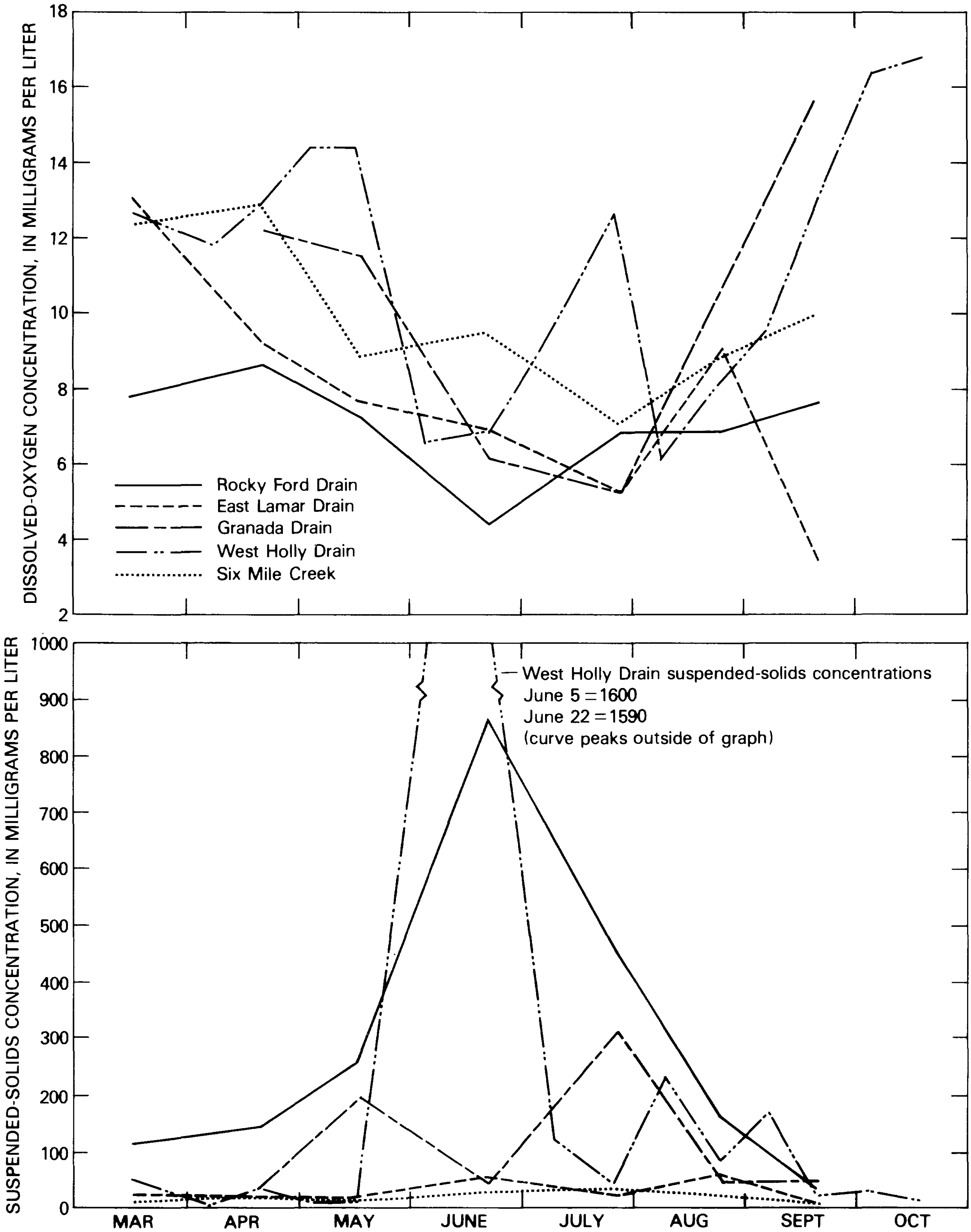

Figure 8.--Dissolved-oxygen and suspended-solids concentration of irrigation-return flow at five sites, 1978 irrigation season.

Concentrations of total nitrite plus nitrate at Rocky Ford and Granada Drains and Sixmile Creek were also greater than concentrations usually found in the Arkansas River. Concentrations of total nitrite plus nitrate (as nitrogen) at the three sites were usually between 5 and 9 mg/L; these concentrations did not exceed the water-quality standard of 10 mg/L on samples collected in 1978. In contrast, concentrations of total nitrite plus nitrate at East Lamar and West Holly Drains were less than 5 mg/L.

Total orthophosphorus concentrations were less than 0.2 mg/L (as phosphorus), except for one sample from the East Lamar Drain and two samples from the Granada Drain. All three samples were collected early in the irrigation season; the large concentrations may have been related to early season fertilization. Total phosphorus concentrations were considerably greater than total orthophosphorus, and they also were more variable.

Biochemical-oxygen demand (BOD_5) did not show an apparent seasonal variation at the five return-flow sites. Concentrations of BOD_5 for the return flows consisting primarily of tailwater (Rocky Ford, Granada, and West Holly Drains) generally were larger than for the two return flows consisting primarily of ground-water return flow (East Lamar Drain and Sixmile Creek). Concentrations of BOD_5 found in water from the Rocky Ford and Granada Drains are quite large, averaging about one-half of the 20 mg/L concentration that would be expected from a sewage-treatment plant operating at the secondary-treatment level. Concentrations of BOD_5 found in water from the East Lamar Drain were variable, with more than one-half the values greater than 5 mg/L. Because the suspended-solids concentration at this site was small, with a mean value of 32 mg/L, it was expected that some of the BOD_5 may have been caused by oxygen-demanding substances in the dissolved state. The BOD_5 of Sixmile Creek was uniformly small, 1.0 to 2.0 mg/L, similar to values commonly observed in ground water.

Numbers of both fecal-coliform and fecal-streptococci bacteria were generally smallest in samples collected early in the irrigation season. The largest counts were observed in samples collected in July, August, or September, in contrast to the Arkansas River sites, where the largest counts occurred in June or July. Counts exceeding the water-quality standard of 2,000 colonies per 100 mL for fecal coliform were recorded at all sites except the East Lamar Drain. The number of fecal-streptococci colonies found was greater than the number of fecal-coliform colonies on all but 3 of the 27 return-flow samples.

RELATIONSHIPS BETWEEN QUANTITY AND QUALITY OF APPLIED WATER AND IRRIGATION-RETURN FLOW IN A SMALL IRRIGATED AREA

Description of Small Irrigated Area

A small (6.75 mi^2) irrigated area near Holly (fig. 9 and pl. 1) was selected for intensive sampling and measurement during the 1978 irrigation season (March 16-October 31). The area was chosen because it had defined geographic boundaries, was irrigated by one canal, and had a single drain for collection and conveyance of return flow.

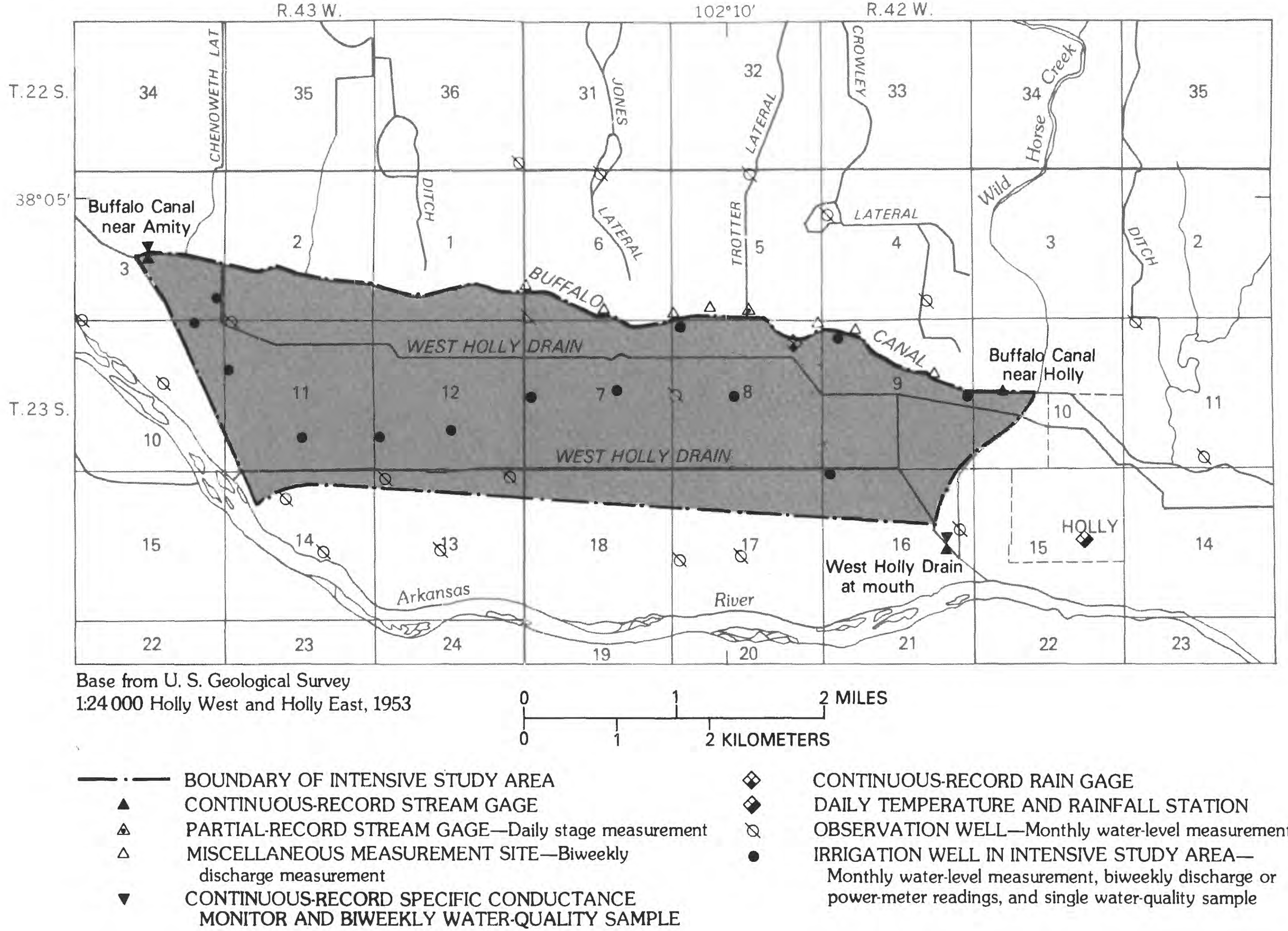

Figure 9.--Data-collection sites in the intensive study area near Holly.

The area, which is north of the Arkansas River and just west of Holly near the Colorado-Kansas State line, is bounded on the north by the Buffalo Canal, on the south by a railroad levee, on the west by a levee along the Arkansas River, and on the east by a levee along Wild Horse Creek.

In addition to an average-annual precipitation of about 15 in., water for irrigation is supplied by the Buffalo Canal and by 13 wells completed in the alluvial aquifer, which is hydraulically connected to the Arkansas River. The aquifer was mapped and studied by Vogeli and Hershey (1965), Major and others (1970), and R. T. Hurr, U.S. Geological Survey, (written commun., 1978). Some tributary inflow, consisting of rainfall runoff and tailwater from irrigation to the north, enters the Buffalo Canal and is available as irrigation water.

The West Holly Drain, which enters Wild Horse Creek about 0.25 mi upstream from its confluence with the Arkansas River, provides drainage for the area. It consists of two eastward-flowing branches, one along U.S. Highway 50, and another branch one-half to three-quarters of a mile north; these branches merge about one-half mile upstream from Wild Horse Creek. The drain, especially along the north branch, is deeply excavated; the drain provides conveyance for intercepted ground water in addition to collecting tailwater and rainfall runoff. Crops grown during the 1978 irrigation season, which were typical of the lower Arkansas River valley east of Las Animas, are listed in table 5.

Table 5.--*Land use in the intensive study area near Holly, 1978*
[mi^2, square miles]

Land use	Approximate area[1] (mi^2)	Percent of total area
	Cultivated areas	
Alfalfa	1.92	28.4
Sorghum	1.76	26.1
Pasture grasses	1.14	16.9
Sugar beets	.69	10.2
Winter wheat	.26	3.8
Corn	.24	3.6
Barley	.18	2.7
	Uncultivated areas	
Phreatophytes[2]	.23	3.4
Built-up land[3]	.33	4.9

[1]Determined from Holly West quadrangle, centered aerial photography (U.S. Geological Survey, 1976) and onsite mapping.
[2]Phreatophytes includes salt cedar, cottonwood, willow and some herbaceous plants.
[3]Includes roads, structures, and unvegetated rights-of-way.

Method of Investigation

Data were collected to provide information to calculate water and salt budgets, and to illustrate relationships between the quantity and quality of water used for irrigation and the return flow from irrigation. Location of the data-collection sites and the type and frequency of data collected at each site are shown in figure 9. The data are presented in tables 13-19 in the Supplemental Information section.

Water Budget

The water budget for the area is diagrammed in figure 10; the method of calculation and source of data for most components of the water budget are listed in table 6. The methods of calculation of other components are described in the following sections.

Errors associated with terms in the water budget vary. A rigorous evaluation of these errors is beyond the scope of this study. However, Winter (1981) has made an extensive review of the type and magnitude of errors that can be expected in the determination of many hydrologic quantities. This review, along with specific knowledge of data collection and analysis methods used during this study allows some general statements to be made about expected relative magnitudes of errors. Values which were measured directly, such as streamflow or ground-water pumpage measured by flowmeter, were probably the most accurate, having expected errors in the range of ±10 percent. Water budget components, such as precipitation and tributary inflow, which are based on data measured at a few points and extrapolated to the entire area, are likely to have somewhat larger errors. Similar magnitudes of error can be expected for water budget components that were determined indirectly, such as ground-water inflow, outflow and storage; ground-water pumpage, calculated from power records; rainfall runoff; tailwater; and ground water intercepted by West Holly Drain. The largest errors can be expected for water budget components that were calculated from other water budget components, especially if the calculation involved subtracting one component from another. This type of component would include ground-water return flow, applied surface water, applied irrigation water, and total applied water. Even though the percentage error of terms in the water budget may vary, all values (except ground-water storage) are shown to the same number of places for ease of comparison and to eliminate major discrepancies in calculated terms.

Sources of Water in West Holly Drain

Water in the West Holly Drain originates from three sources: (1) Rainfall runoff; (2) intercepted ground water; and (3) tailwater from irrigation. Where applicable, the volume of rainfall runoff was estimated by using the straight-line base-flow separation technique described by Schulz (1976, p. 315). Intercepted ground water was differentiated from tailwater by assuming the volume of intercepted ground water was directly proportional to water levels in wells near the drain. Monthly mean water levels in four wells were plotted, and a smooth curve was drawn through the points. This plot was

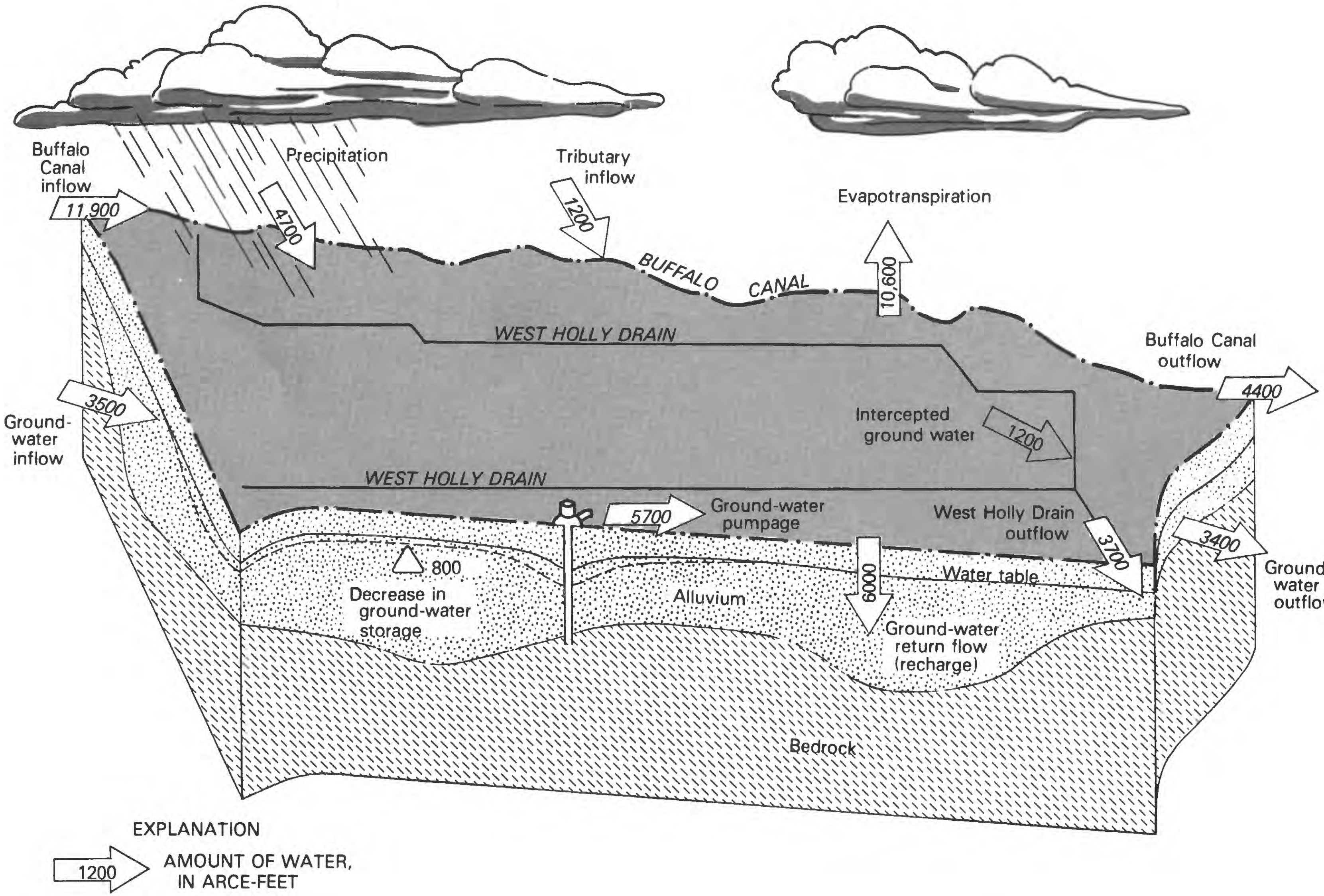

Figure 10.--Water budget in the intensive study area near Holly, 1978 irrigation season.

Table 6.--*Calculated water budget for the intensive study area near Holly, 1978 irrigation season*[1]

Water budget component	Mean daily amount (acre-feet)	Mean daily amount (cubic feet per second)	Total for season (acre-feet)	Total for season (inches for entire area)	Method of calculation and source of data
Buffalo Canal inflow	51.6	26.0	11,900	32.9	Buffalo Canal near Amity stream gage (table 15).
Buffalo Canal outflow	19.2	9.7	4,400	12.3	Buffalo Canal near Holly stream gage (table 15).
Tributary inflow	5.2	2.6	1,200	3.3	Regression relation between daily measurements at Crowley Lateral and biweekly measurements at other tributaries (table 15).
West Holly Drain outflow	15.9	8.0	3,700	10.1	West Holly Drain at Mouth stream gage (table 15).
Ground-water inflow	15.2	7.7	3,500	9.8	Darcy's Law using monthly water level data (table 16), bedrock and transmissivity maps (modified from R. T. Hurr, U.S. Geological Survey, written commun., 1978). Boundaries of area were broken down into 24 sections across which flow was calculated. These flows were summed to get total ground-water inflow and outflow.
Ground-water outflow	14.7	7.4	3,400	9.4	Same as ground-water inflow.
Ground-water storage	[2]42,300	----	------	----	Monthly water level data (table 16), bedrock map (modified from R. T. Hurr, U.S. Geological Survey, written commun., 1978) and specific yield of 0.2 (Vogeli and Hershey, 1965, p. 25).
Change in ground-water storage	-3.5	-1.8	-800	-2.3	From ground-water storage.
Ground-water pumpage	25.0	12.6	5,700	16.0	From biweekly discharge meter readings or pump rating and biweekly electric or gas meter reading.
Precipitation	20.3	10.2	4,700	13.0	From 2 rain gages (table 13), weighted according to area of Thiessen polygons constructed around each site.
Evapotranspiration	45.9	23.1	10,600	29.3	See text.
Rainfall runoff	3.0	1.5	700	1.9	See text and figure 11.
Tailwater	7.7	3.9	1,800	4.9	See text and figure 11.
Intercepted ground water	5.2	2.6	1,200	3.3	See text and figure 11.
Ground-water return flow	26.2	13.2	6,000	16.7	See text and figures 12 and 13.
Applied surface water	37.6	19.0	8,700	24.1	Buffalo Canal inflow plus tributary inflow minus Buffalo Canal outflow.
Applied irrigation water	62.6	31.6	14,400	40.0	Applied surface water plus ground-water pumpage.
Total applied water	82.9	41.8	19,100	53.0	Applied irrigation water plus precipitation.

[1]Apparent discrepancies are the result of rounding.

[2]Average amount in storage for irrigation season; storage decreased from 42,000 acre-feet at the beginning of the irrigation season to 41,200 acre-feet at the end, after reaching a peak of 43,600 acre-feet in August.

then superimposed on the plot of daily streamflow for the West Holly Drain, and the scale was adjusted until the two plots approximately corresponded during the early and late irrigation season, when most of the flow was intercepted ground water. The estimated amount of intercepted ground water was then read off the ordinate axis. Results of the separation are shown in figure 11.

Evapotranspiration

Seasonal evapotranspiration was estimated to be all the water unaccounted for in the water budget for the area. Inflows to the area were precipitation, the Buffalo Canal inflow, tributary inflow, and ground-water inflow. Outflows were evapotranspiration, West Holly Drain outflow, Buffalo Canal outflow, and ground-water outflow. A decrease in ground-water storage of 800 acre-ft was taken into account in the calculation. This technique gave an evapotranspiration estimate for the intensive study area of 10,600 acre-ft, or an average of 29.3 in. for the entire area.

The estimate for evapotranspiration calculated using the water-budget method was compared to evapotranspiration calculated using the modified Blaney-Criddle method (U.S. Soil Conservation Service, 1970). This method assumes that crop growth and yields are not limited by inadequate water at any time during the year. Seasonal consumptive use is calculated by summing the consumptive use for shorter periods. During this study, consumptive use was calculated daily for the vegetation types listed in table 5. The method uses mean air temperature (table 14 in the Supplemental Information section) and the percentage of daylight hours to calculate a consumptive-use factor. This factor is multiplied by a consumptive-use coefficient to determine consumptive use for the period. The consumptive-use coefficient takes into account variations in consumptive use resulting from various climates and growth stages of specific crops. The Blaney-Criddle method resulted in a value of seasonal evapotranspiration for the intensive study area that was only 6 percent greater then the estimate using the water-budget method. Because of the close agreement between the methods, daily estimates of evapotranspiration used in some water-budget calculations were made using the Blaney-Criddle method and reducing these values by 6 percent.

Irrigation-Return Flow

Irrigation-return flow consists of both tailwater and ground-water return flow. Ground-water return flow cannot be easily measured so it was estimated by two different methods: (1) A water balance at the land surface (fig. 12); and (2) a ground-water balance (fig. 13). According to the land-surface water-balance method, water reaching the land surface may be evaporated or transpired, or it may run off as tailwater or rainfall runoff, or it may infiltrate the soil and percolate to the water table as ground-water return flow. Because all other terms were known, ground-water return flow could be calculated. The ground-water balance method states that the difference between inflows to and outflows from the ground-water system must equal the change in ground-water storage. Ground-water inflow from outside the area is the only inflow to the ground-water system besides ground-water return flow.

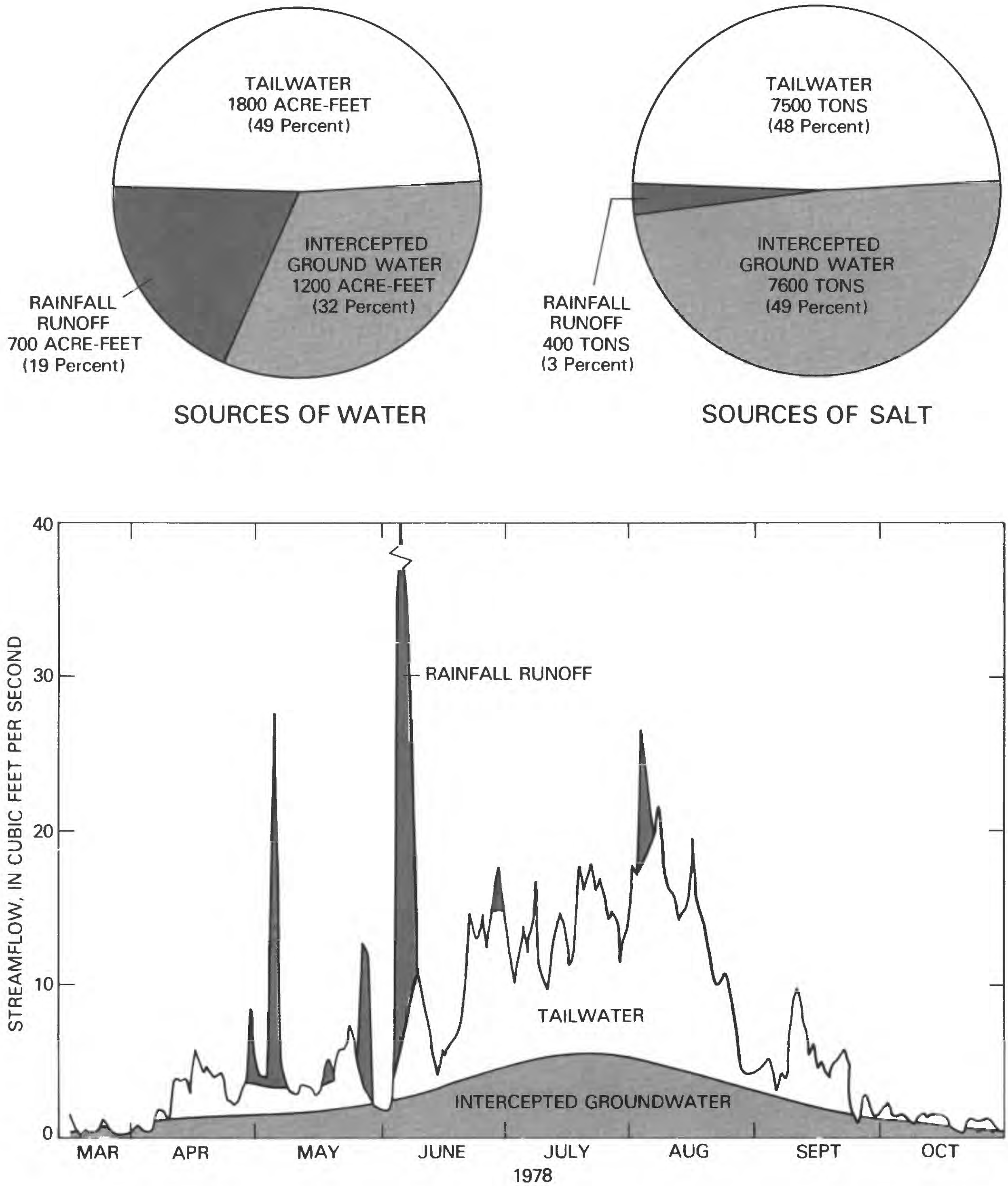

Figure 11.--Sources of water and salt in the West Holly Drain, 1978 irrigation season.

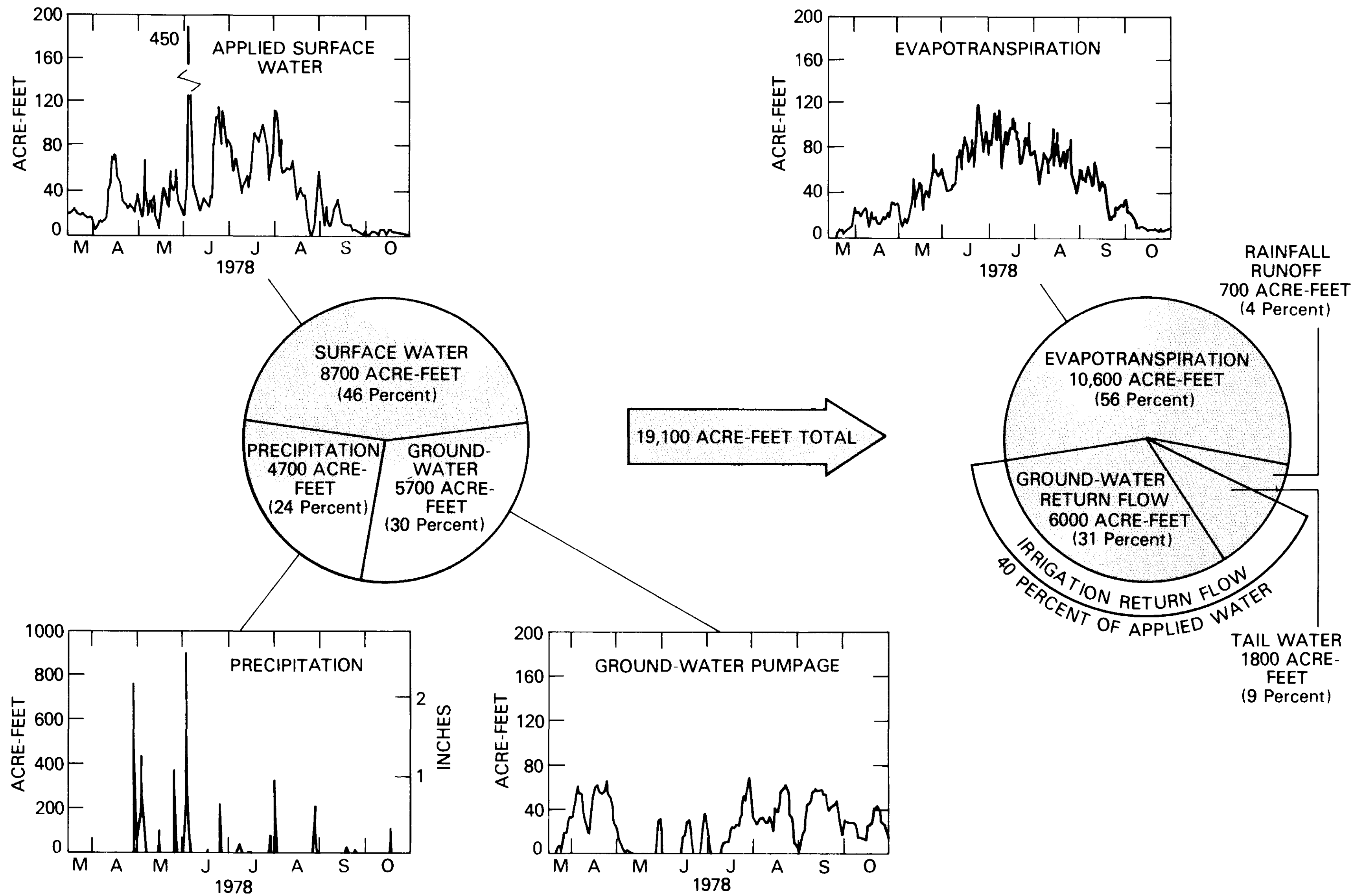

Figure 12.--Sources and fate of water applied at the land surface in the intensive study area near Holly, 1978 irrigation season.

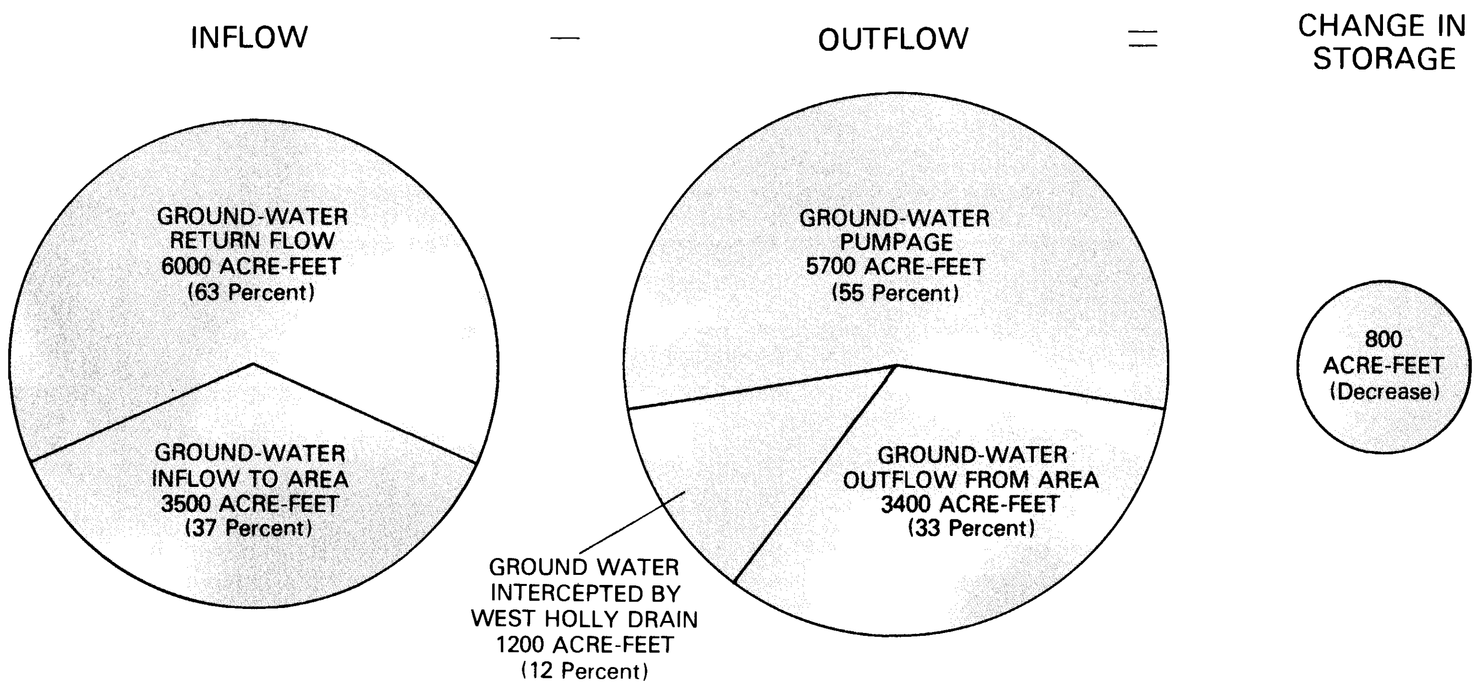

Figure 13.--Ground-water balance in the intensive study area near Holly, 1978 irrigation season.

Outflows in the area were ground-water pumpage, ground water intercepted by the West Holly Drain, and ground water that flowed out of the area. Because the change in ground-water storage and all other ground-water inflows and outflows could be estimated ground-water return flow could be calculated. As shown in figures 12 and 13, the two methods gave the same result for the seasonal ground-water return flow. However, seasonal distribution of ground-water return flow using the two methods was different, probably as a result of transient storage of ground-water return flow in the unsaturated zone. Irrigation-return flow in the intensive study area accounted for 40 percent of the total water applied to crops; about three-fourths of the irrigation return flow was ground-water return flow.

Salt Budget

The salt budget was calculated from the water budget by using measured specific-conductance data converted to dissolved-solids concentrations by means of regression equations. Data used to develop the equations were obtained from measurements made on surface and ground water collected in the intensive study area during 1978. Dissolved-solids concentrations used in developing the regression equations were computed as the sum of measured major dissolved constituents in the waters. The regression equations were developed using the General Linear Models (GLM) Procedure of SAS Institute, Inc.[1] (1979, p. 140-199) for surface and ground water. To simplify salt-budget calculation, the equations were developed without an intercept term as described by Krumbein and Graybill (1965, p. 240-241). The regression equation used for the calculation of dissolved solids in surface water was:

Dissolved solids = 0.84 X Specific conductance
(in mg/L) (in micromhos)

The equation for the calculation of dissolved solids in ground water was:

Dissolved solids = 0.82 X Specific conductance
(in mg/L) (in micromhos)

The correlation coefficient for both equations was 0.99, indicating that specific conductance is an excellent predictor of dissolved-solids concentration.

The salt budget is diagrammed in figure 14; the method of calculation and source of flow and specific-conductance data are given in table 7. Comments regarding errors in the water budget can generally be applied to the salt budget. Errors associated with a given component in the salt budget are probably somewhat larger than for the same component in the water budget because of additional errors in the measurement or estimation of specific conductance and its conversion to dissolved-solids concentration. As with the water budget, values listed in table 7 (except ground-water storage) are shown to the same number of places for ease of comparison and to eliminate discrepancies in calculated terms.

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[1]Use of the firm name in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

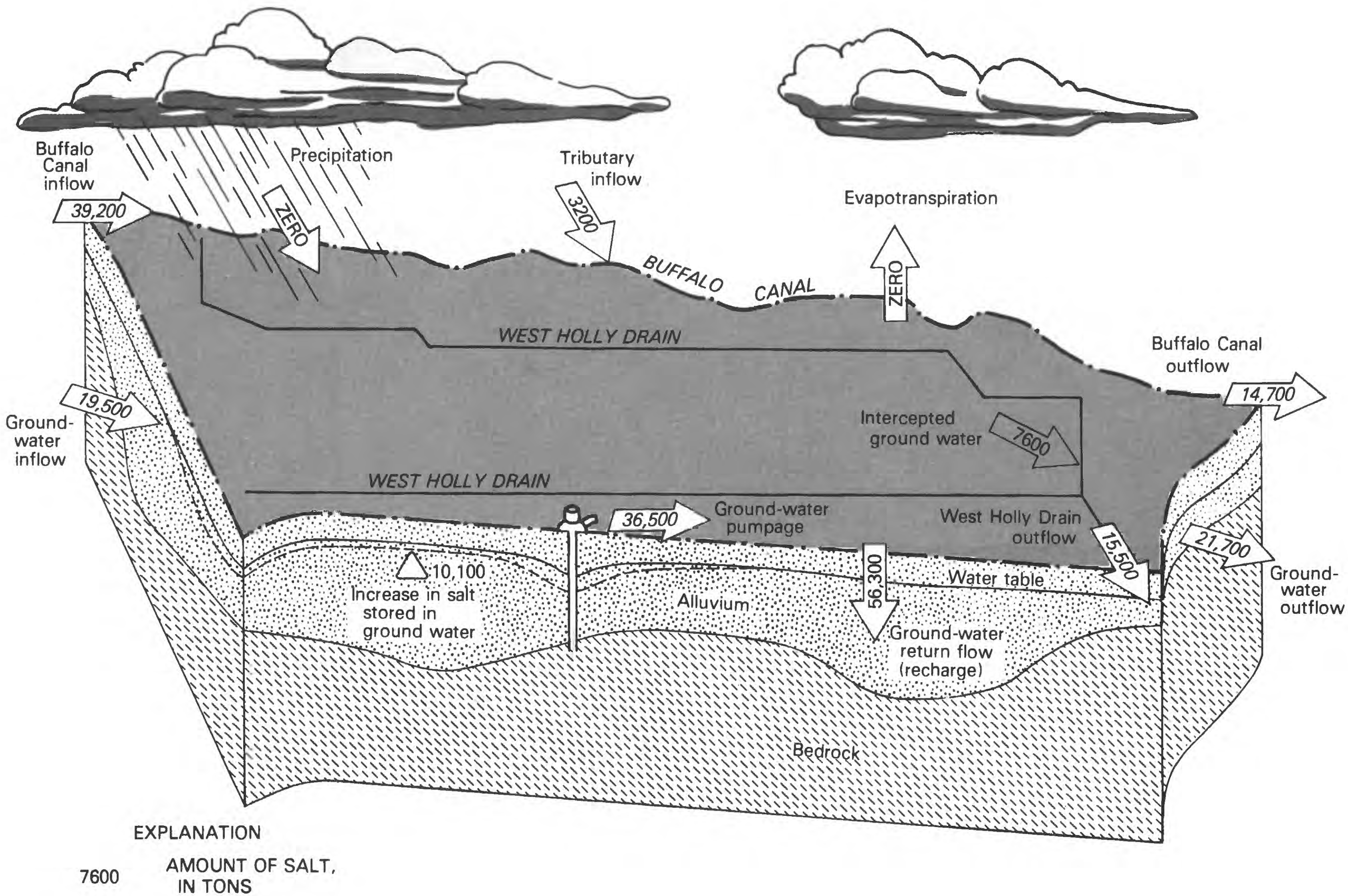

Figure 14.--Salt budget in the intensive study area near Holly, 1978 irrigation season.

Table 7.--*Calculated salt budget for the intensive study area near Holly, 1978 irrigation season*

Salt-budget component	Mean of daily specific-conductance values (micromhos per centimeter at 25° Celsius)	Mean daily amounts of salt (tons per day)	Total salt for season (tons)	Method of calculation and source of flow and dissolved-solids data[1]
Buffalo Canal inflow	3,850	170	39,200	Buffalo Canal near Amity daily streamflow (table 15), and specific conductance (table 18).
Buffalo Canal outflow	3,850	64	14,700	Buffalo Canal near Holly daily streamflow (table 15), specific conductance set equal to Buffalo Canal near Amity (table 18).
Tributary inflow	3,850	14	3,200	Daily streamflow from water budget (table 6), specific conductance set equal to Buffalo Canal near Amity (table 18).
West Holly Drain outflow	4,780	67	15,500	West Holly Drain daily streamflow (table 15) and specific conductance (table 18).
Ground-water inflow	[2]5,010	85	19,500	Flow from water budget (table 6), specific conductance for each of 24 sections where flow was calculated was taken from map of ground-water specific conductance. Loads from each section were summed to give total salt load in ground-water inflow and outflow.
Ground-water outflow	[2]5,740	94	21,700	Same as ground-water inflow.
Ground-water storage	5,740	[3]271,000	------	Amount of water from water budget (table 6) specific conductance set equal to mean specific conductance of ground-water pumpage.
Change in ground-water storage	------	43	10,000	Difference between salt inflows and outflows.
Ground-water pumpage	5,740	159	36,500	Pumpage and specific conductance at each well used to calculate salt load at each well, then loads summed for all wells.
Precipitation	0	0	0	Amount of water from water budget (table 6), specific conductance set equal to zero for purposes of salt budget.
Evapotranspiration	0	0	0	Amount of water from water budget (table 6), specific conductance set equal to zero for purposes of salt budget.
Rainfall runoff	500	2	400	Flow from water budget (table 6), specific conductance estimated to be 500 micromhos.
Tailwater	[2]4,660	33	7,500	West Holly Drain salt load minus intercepted ground-water salt load minus rainfall-runoff salt load.
Intercepted ground water	5,700	33	7,600	Flow from water budget (table 6), specific conductance estimated at 5,700 micromhos from map of ground-water specific conductance.
Ground-water return flow	[2,4]8,170	244	56,300	Total applied water-salt load minus rainfall-runoff salt load minus tailwater salt load minus evapotranspiration salt load.
Applied surface water	[2]3,850	120	27,700	Buffalo Canal inflow salt load plus tributary-inflow salt load minus Buffalo Canal outflow salt load.
Applied irrigation water	[2]4,370	279	64,200	Applied surface-water salt load plus ground-water pumpage salt load.
Total applied water	[2]4,110	279	64,200	Same as applied irrigation-water salt load, because precipitation salt load equals zero.

[1]All specific-conductance data converted to dissolved solids using regression relations shown in text.
[2]Specific conductance calculated by applying regression equation to dissolved-solids concentration determined from salt load and flow (table 6).
[3]Average amount of salt stored in ground water during irrigation season.
[4]Specific conductance calculated seasonally rather than from daily data

The source and fate of salts in water applied at the land surface are shown in figure 15. Although ground water comprised only 30 percent of applied water (fig. 12), it contributed 57 percent of the salts, because of its larger dissolved-solids concentration. Most of the salts applied at the land surface eventually were transported to the ground-water system, after a period of transient storage in the unsaturated zone. The remainder of the salts were removed in tailwater or rainfall runoff.

The salt budget indicated an increase of 10,000 tons of dissolved salts in ground water occurring during the 1978 irrigation season. This value approximates an increase in specific conductance of 4 percent. If an increase of this magnitude occurred annually, the specific conductance of ground water would double in 15 to 20 years. However, long-term increases in specific conductance have not occurred in the study area. The mean specific conductance of water produced from seven wells during 1956-65 and 1978 showed no significant change at the 90-percent confidence level.

Calculations were made for the nonirrigation season from November 1, 1978, to March 15, 1979, to determine if the excess salts had moved from the study area during this period. Because intensive hydrologic data were not collected during this time, estimates of some inflows and outflows were required. Based on available data, salt inflows and outflows were believed to be negligible from the following sources: Buffalo Canal, tributary inflow, West Holly Drain, precipitation, and evapotranspiration. Ground-water inflow and outflow were the only remaining means to transport salt across the study area boundaries. Water-level measurements made on March 9, 1979, allowed an estimate to be made of ground-water inflow and outflow and associated salt during the nonirrigation season. The estimate indicates that the excess salts were transported from the area with ground-water outflow. The difference between salt load in ground-water inflow and outflow during this period was about 10,000 tons, leaving no change in the amount of salt stored in ground water for the full year.

Because the annual salt budget can be balanced using only salt inflows and outflows, it appeared that the controlled test area contained no major net sinks or sources of salts. That is, there did not appear to be any net inflow of salts that were deposited in the area, nor any net dissolution and outflow of salts from the area.

Other Water-Quality Constituents

Because other water-quality constituents were not measured daily, it was not possible to develop budgets for these constituents similar to the water and salt budgets. Minimum, maximum, median, and mean values for other water-quality constituents in the West Holly Drain, in the Buffalo Canal, and in wells in the intensive study area are shown in figures 16 and 17. Calculated values in applied water, on the days samples were collected in the West Holly Drain, also are shown in figures 16 and 17.

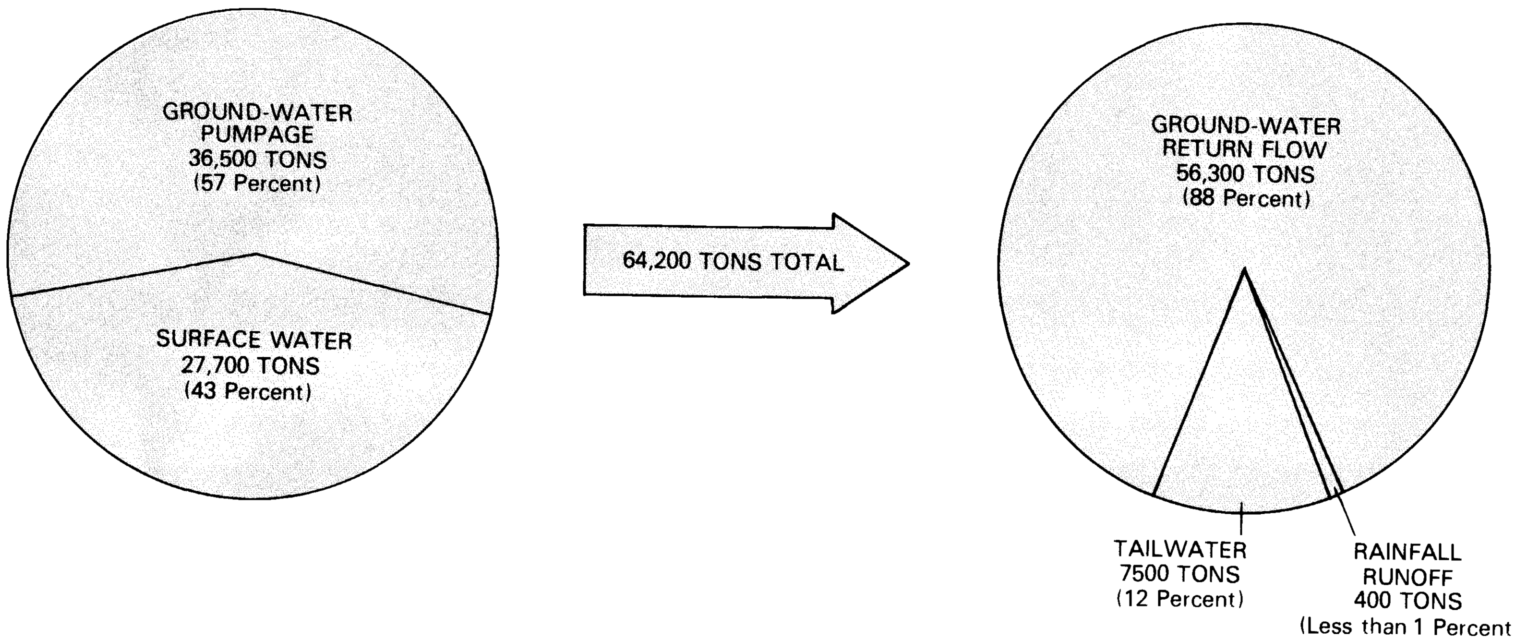

Figure 15.--Sources and fate of salt applied at the land surface in the intensive study area near Holly, 1978 irrigation season.

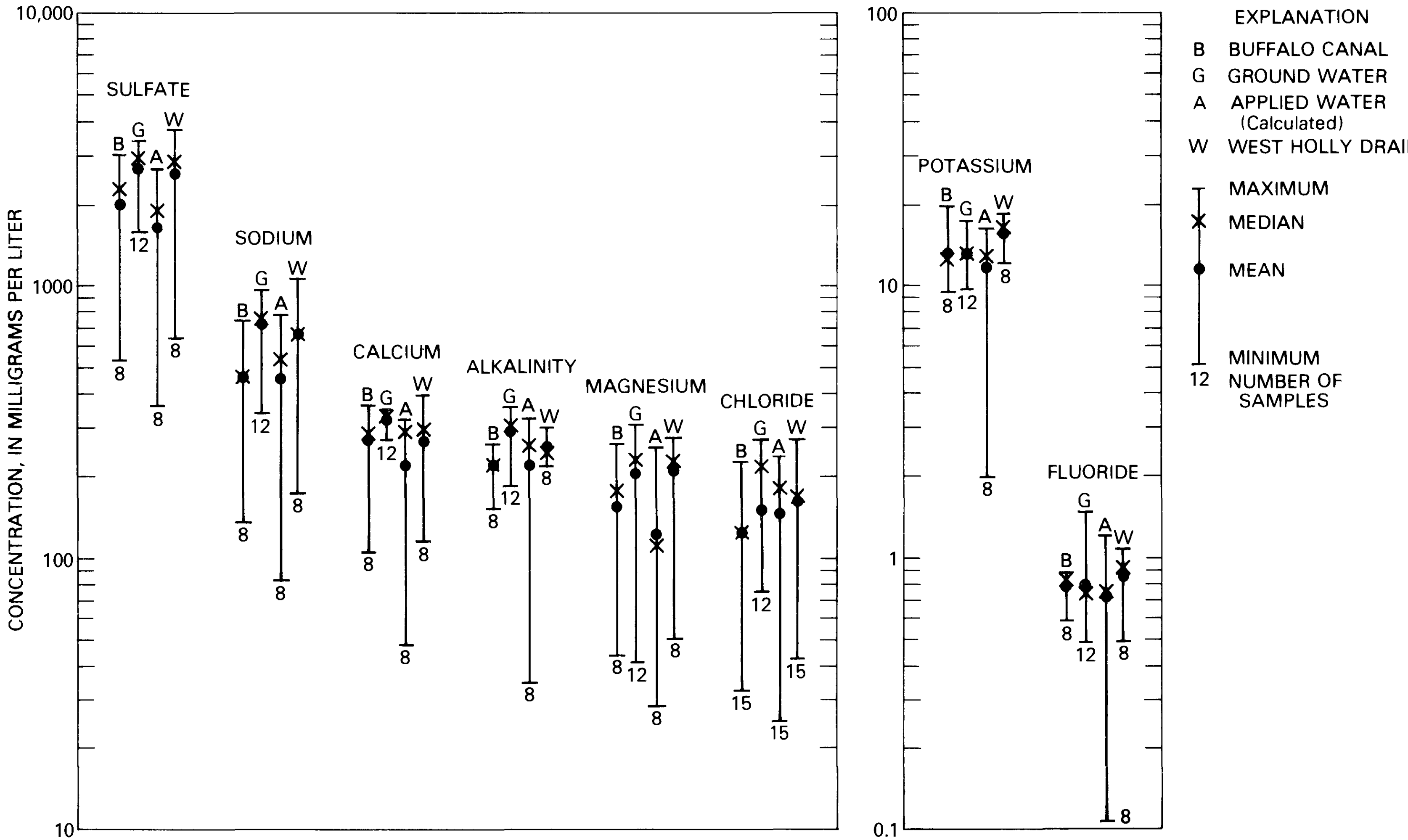

Figure 16.--Minimum, maximum, median, and mean concentrations of major ions in water from the intensive study area near Holly, 1978 irrigation season.

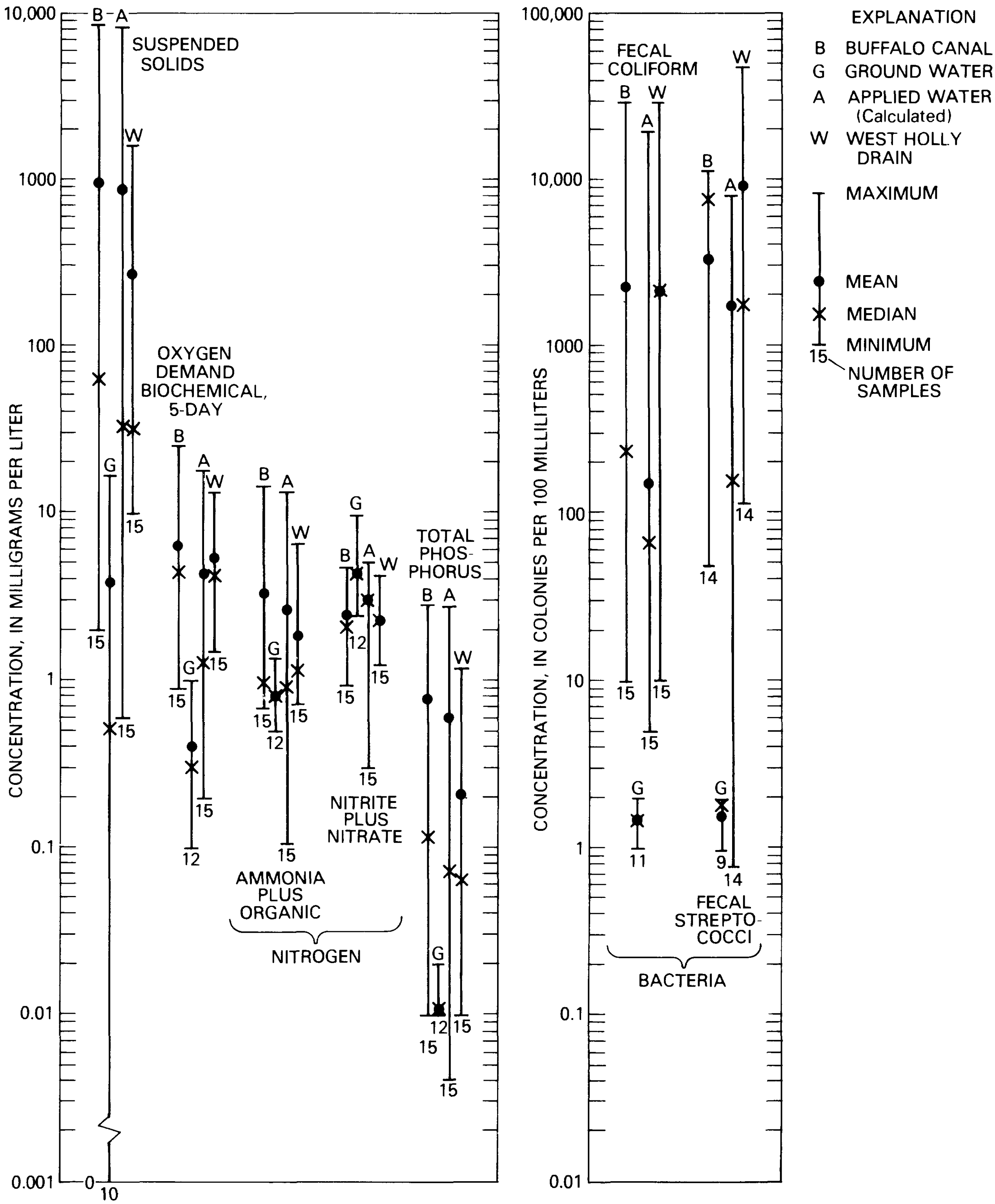

Figure 17.--Minimum, maximum, median, and mean concentrations of nutrients, suspended solids, biochemical-oxygen demand, and bacteria in the intensive study area near Holly, 1978 irrigation season.

The widest variations observed for all constituents were in the calculated quality of applied water. These variations resulted from precipitation being a large percentage of the applied water on two of the days used in the calculation. The least variation was in the quality of ground water.

Ratios of concentrations of water-quality constituents in the West Holly Drain and in applied water were calculated as a measure of water-quality changes in the study area. Median values of these ratios are shown in figure 18. Ratios less than one indicate that concentrations were smaller in the West Holly Drain than in applied water, whereas ratios greater than one indicate greater concentrations in the West Holly Drain. Median concentration ratios for all constituents except dissolved nitrite plus nitrate and total phosphorus were greater than one, indicating larger concentrations in the West Holly Drain. These constituents included all major ions, Kjeldahl nitrogen, suspended solids, biochemical-oxygen demand and fecal-coliform and fecal-streptococci bacteria.

To assess the significance of the water-quality changes shown in figure 18, a statistical evaluation was made. Because the data were not normally distributed and also were paired, the Wilcoxon signed-rank nonparametric test (Romano, 1977, p. 208-211) was used. The test evaluates the magnitude and direction of differences between paired data and was applied at a 95-percent probability level. By means of this test, sodium, potassium, magnesium, hardness, sulfate, and fecal-coliform and fecal-streptococci bacteria were determined to have been present at significantly larger concentrations in the West Holly Drain than in applied water. Only dissolved nitrite plus nitrate was determined to have been present at significantly smaller concentrations in the West Holly Drain than in applied water.

Larger concentrations of major ions in the West Holly Drain than in applied water were most likely the result of consumptive use of water by evapotranspiration and interception of ground water by the drain; ground water generally had a larger concentration of major ions than applied water. The greater bacteria count in the West Holly Drain, especially fecal streptococci, suggested the area was a source of bacteria, possibly from grazed pasture lands. Smaller concentrations of dissolved nitrite plus nitrate in the West Holly Drain than in applied water suggests that this nutrient was utilized by plants in the study area.

SUMMARY

Two types of irrigation-return flows occur: (1) Tailwater is excess irrigation water that runs off the ends of fields and flows back to streams; and (2) ground-water return flow is excess irrigation water that infiltrates the soil and percolates to the water table. Irrigation-return flows were located throughout the lower Arkansas River valley, with greater numbers observed in the St. Charles mesa area, in the vicinity of Rocky Ford, between John Martin Reservoir and Lamar, and from Granada to the Colorado-Kansas State line.

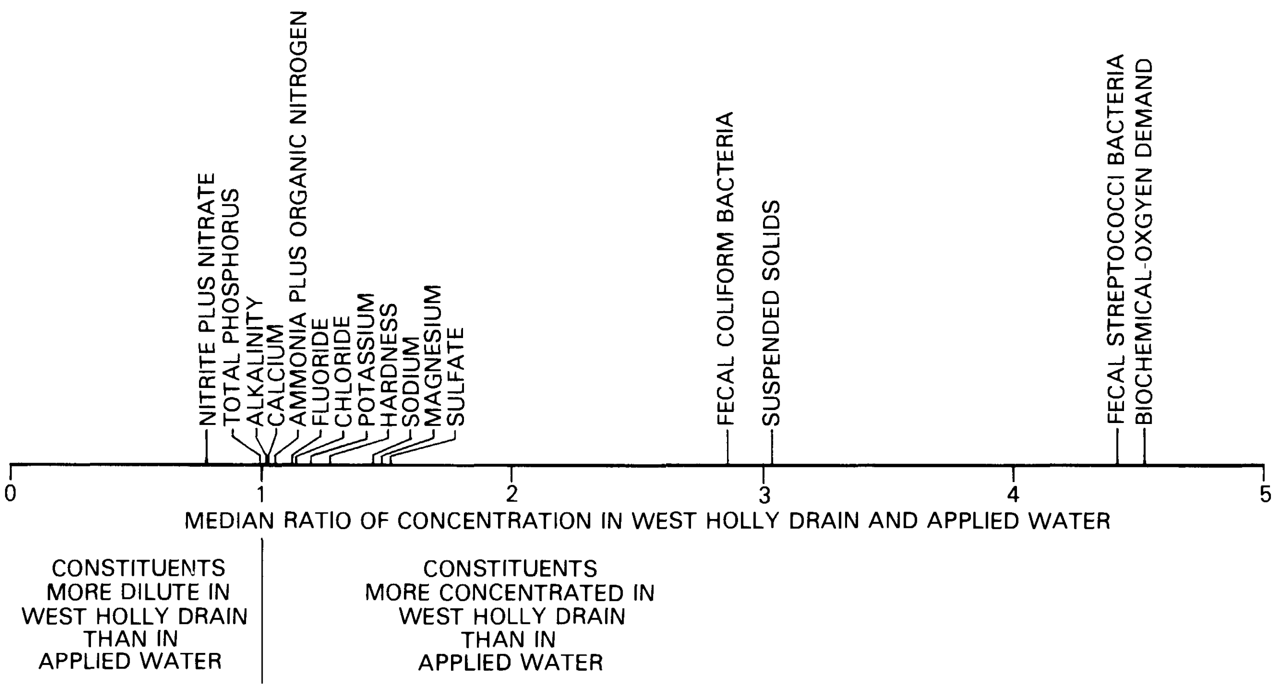

Figure 18.--Median ratios of water-quality constituents in the West Holly Drain and applied water.

Specific conductance of 59 sampled irrigation-return flows increased downstream; this increase paralleled that of available irrigation water. Water-quality standards for one or more constituents were exceeded at 18 of the 59 sites.

During July 1977, irrigation-return flow was the source of most Arkansas River streamflow downstream from La Junta. Irrigation-return flow may have a considerable effect on streamflow quality in this reach because it may comprise much of the Arkansas River flow during the early and late parts of the irrigation season.

Seasonal variations in discharge, specific conductance, and dissolved-oxygen concentrations of five irrigation-return flows sampled during the 1978 irrigation season were similar to those observed in the Arkansas River during the same period. Larger specific conductance and dissolved-oxygen concentrations were associated with lower streamflow and temperatures that occurred in the spring and fall.

Three irrigation-return flows sampled during the 1978 irrigation season and composed mainly of tailwater, had larger concentrations of suspended solids, biochemical-oxygen demand, and Kjeldahl nitrogen than two irrigation-return flows consisting primarily of ground-water return flow. Return flows composed primarily of ground water showed much smaller seasonal variations in discharge and concentrations of most water-quality constituents. Although concentrations of nitrite plus nitrate were greater at three of the sites sampled during the 1978 irrigation season than concentrations of nitrite plus nitrate commonly observed in the Arkansas River, no values greater than the water-quality standard of 10 mg/L were observed. Fecal-coliform bacteria exceeded the water-quality standard at four of the five sites.

Water and salt budgets were developed for a 6.75-mi^2 area near Holly for the 1978 irrigation season; the area was irrigated by the Buffalo Canal and by wells. This area was drained by the West Holly Drain, a major irrigation-return flow conveyance. During the 1978 irrigation season, tailwater contributed about one-half the flow of the West Holly Drain; intercepted ground water contributed about one-third; and rainfall runoff contributed the remainder. The salt load of the drain was contributed equally by tailwater and intercepted ground water, with only a small amount from rainfall runoff. About 40 percent of the water applied at land surface became irrigation-return flow. One-fourth of the total was tailwater, and three-fourths of the total was ground-water return flow. Although ground-water return flow accounted for 88 percent of the salts applied at the land surface, a long-term buildup of salts in ground water beneath the area was not occurring.

Dissolved nitrite plus nitrate was less concentrated in water leaving the area in the West Holly Drain than in applied water, suggesting removal during irrigation or plant growth. Major ions, biochemical-oxygen demand, and fecal-coliform and fecal-streptococci bacteria were more concentrated in the West Holly Drain than in applied water, suggesting concentration through consumptive use or pickup during irrigation.

REFERENCES CITED

Cain, Doug, Baldridge, Duaina, and Edelmann, Patrick, 1980, Waste-assimilation capacity of the Arkansas River in Pueblo County, Colorado, as it relates to water-quality guidelines and stream classification: U.S. Geological Survey Water-Resources Investigations 80-82, 104 p.

Cain, Doug, and Edelmann, Patrick, 1980, Selected hydrologic data, Arkansas River basin, Pueblo and southeastern Fremont Counties, Colorado: U.S. Geological Survey Open-File Report 80-1185, 233 p.

Colorado Department of Agriculture, 1980, Colorado agricultural statistics 1980: Colorado Department of Agriculture, 100 p.

Colorado Department of Health, 1982, Classifications and numeric standards for the entire Arkansas River Basin: Colorado Department of Health, Water Quality Control Commission, 59 p.

Gaydos, M. W., 1980, Summary of water-quality data for selected streams in Colorado: U.S. Geological Survey Water-Resources Investigations Open-File Report 80-682, 148 p.

Goddard, K. E., 1980, Calibration and potential uses of a digital water-quality model for the Arkansas River in Pueblo County, Colorado: U.S. Geological Survey Water-Resources Investigations 80-38, 87 p.; available only from U.S. Department of Commerce, National Technical Information Service, Springfield, VA 22151.

Krumbein, W. C., and Graybill, F. A., 1965, An introduction to statistical models in geology: New York, McGraw-Hill, 475 p.

Major, T. J., Hurr R. T., and Moore, J. E., 1970, Hydrogeologic data for the lower Arkansas River valley, Colorado: Colorado Water Conservation Board Basic-Data Release 21, 125 p.

Miles, D. L., 1977, Salinity in the Arkansas Valley of Colorado: U.S. Environmental Protection Agency, Interagency Agreement, Colorado State University, EPA-1AD-D4-0544, 80 p.

Romano, Albert, 1977, Applied statistics for science and industry: New York, Allyn and Bacon, 513 p.

SAS Institute, Inc., 1979, SAS user's guide, 1979 ed: Cary, N.C., 495 p.

Schulz, E. F., 1976, Problems in applied hydrology: Fort Collins, Colorado, Water Resources Publications, 501 p.

Taylor, O. J., and Luckey, R. R., 1974, Water-management studies of a stream-aquifer system, Arkansas River valley, Colorado: Ground Water, v. 12, no. 1, p. 22-38.

U.S. Bureau of the Census, 1981, Census of population and housing 1980, Colorado--Preliminary population and housing unit counts: Washington, D.C., U.S. Bureau of the Census, PHC80-P-7, 7 p.

U.S. Geological Survey, 1976, Holly West quadrangle--Centered aerial photography: U.S. Geological Survey, scale 1:24,000, 1 sheet.

_____1978 and 1980, Water resources data for Colorado--Water years 1977 and 1979: Volume 1. Missouri River basin, Arkansas River basin, and Rio Grande basin: U.S. Geological Survey Water-Data Reports CO-77-1 and CO-79-1; available only from U.S. Department of Commerce, National Technical Information Service, Springfield, VA 22151.

U.S. Soil Conservation Service, 1970, Irrigation water requirements: U.S. Department of Agriculture, Soil Conservation Service Technical Release No. 21, 88 p.

_____1976, Land use and natural plant communities, Crowley, Otero and Pueblo Counties, Colorado [map]: Portland, Ore., 6 sheets, scale 1:126,720.

_____1977, Land use and natural plant communities, Bent and Prowers Counties, Colorado [map]: Portland, Ore., 4 sheets, scale 1:126,720.

Voegeli P. T., Sr., and Hershey, L. A., 1965, Geology and ground-water resources of Prowers County, Colorado: U.S. Geological Survey Water-Supply Paper 1772, 101 p.

Winter, T. C., 1980, Uncertainties in estimating the water balance of lakes: Water Resources Bulletin, v. 17, no. 1, p. 82-115.

SUPPLEMENTAL INFORMATION

System of Numbering Wells

The well locations in this report are given numbers based on the U.S. Bureau of Land Mangement system of land subdivision, and show the location of the well by quadrant, township, range, section, and position within the section (fig. 19). The first letter "S" preceding the location number indicates that the well or spring is located in the area governed by the Sixth Principal Meridian. The second letter indicates the quadrant in which the well or spring is located. Four quadrants are formed by the intersection of the base line and the principal meridian--A indicates the northeast quadrant, B the northwest, C the southwest, and D the southeast.

The first three digits of the number indicate the township, the next three digits the range, and the last two digits the section in which the well or spring is located. The letters following the section number locate the well or spring within the section. The first letter denotes the quarter section, the second the quarter-quarter section, and the third the quarter-quarter-quarter section. The letters are assigned within the section in a counterclockwise direction, beginning with (A) in the northeast section and within each quarter-quarter section in the same manner. Where two or more locations are within the smallest subdivision, consecutive numbers beginning with 1 are added in the order in which the data from the wells or springs were collected.

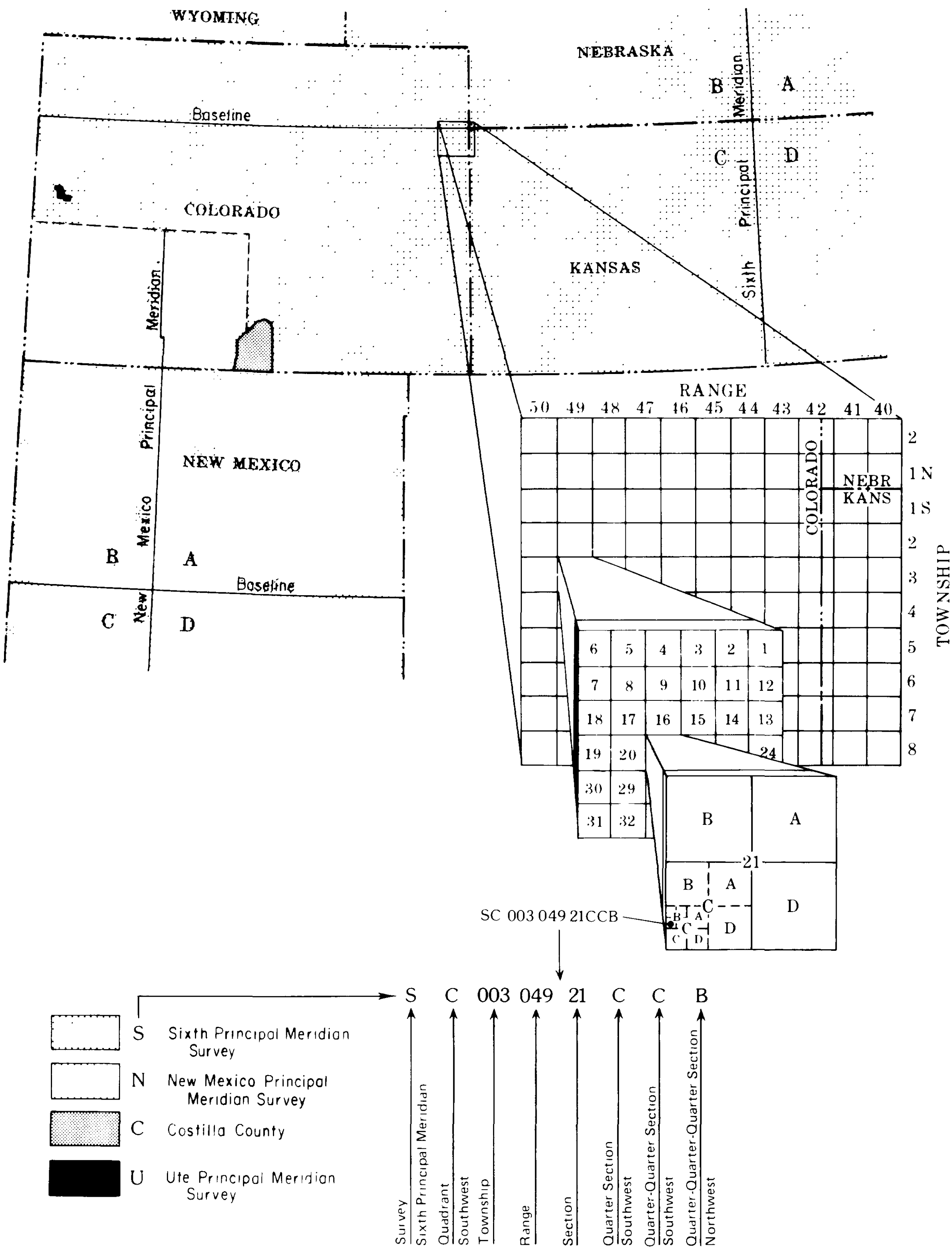

Figure 19.--System of numbering wells in Colorado.

Data

TABLE 8.--WATER-QUALITY DATA FROM RECONNAISSANCE SAMPLING OF IRRIGATION-RETURN FLOWS AND SELECTED TRIBUTARIES

(CFS=CUBIC FEET PER SECOND; DEG C=DEGREES CELSIUS; UMHOS=MICROMHOS PER CENTIMETER AT 25 DEGREES CELSIUS; MG/L= MILLIGRAMS PER LITER; UG/L=MICROGRAMS PER LITER; COLS./100 ML=COLONIES PER 100 MILLILITERS; VALUES PRECEEDED BY K INDICATE THE COLONY COUNT WAS BASED ON A NONIDEAL BACTERIA PLATE; VALUES EXCEEDING WATER-QUALITY STANDARDS ARE UNDERLINED).

SITE NO. ON PLATE 1	SITE NAME	DATE OF SAMPLE	TIME	STREAM-FLOW, INSTAN-TANEOUS (CFS)	TEMPER-ATURE (DEG C)	SPE-CIFIC CON-DUCT-ANCE (UMHOS)	OXYGEN, DIS-SOLVED (MG/L)	PH (UNITS)	SODIUM, DIS-SOLVED (MG/L AS NA)	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	CALCIUM DIS-SOLVED (MG/L AS CA)
IR-54	21ST LANE DRAIN	77-08-09	0850	0.30	17.0	790	--	8.1	--	--	--
IR-53	23RD LANE DRAIN	77-08-09	1000	.10	19.0	730	--	7.9	--	--	--
IR-52	25TH LANE DRAIN	76-08-10	0830	--	16.0	495	--	7.9	--	--	--
		77-08-09	1030	.20	23.0	1360	--	9.0	--	--	--
IR-51	ST. CHAS BTMLND DR	77-08-09	1120	.20	23.5	750	--	8.2	--	--	--
IR-50	ST. CHARLES DRAIN	76-08-10	0915	--	17.0	445	--	7.9	--	--	--
IR-49	37TH LANE DRAIN	76-08-10	1000	--	16.5	955	--	7.7	--	--	--
IR-48	39TH LANE DR AT MT	77-08-10	1130	.50	24.5	950	--	8.0	--	--	--
IR-47	39TH LN DR AT HW50	76-08-10	1030	--	16.5	659	--	7.9	--	--	--
IR-46	40TH LANE DRAIN	77-08-10	1215	.60	25.0	1200	--	8.4	--	--	--
IR-45	WHEELER LANE DRAIN	77-08-10	1315	.20	25.0	565	--	8.4	28	7.3	61
IR-44	AVONDALE D AT HW50	77-08-09	1330	.50	25.0	2500	--	8.3	--	--	--
IR-43	AVONDALE D AT BR50	76-08-10	1130	--	20.0	1410	--	8.1	--	--	--
IR-42	51ST LANE DRAIN	77-08-09	1545	.20	24.0	1000	--	8.4	--	--	--
IR-41	AVONDALE BTMLND DR	77-08-09	1420	1.5	23.0	1480	--	7.7	88	3.8	150
IR-40	NORTH NEPESTA DR	77-08-18	1230	.60	25.0	1530	--	--	--	--	--
IR-39	RR JUNCTION DRAIN	77-08-18	1200	1.2	28.0	1820	--	--	--	--	--
IR-38	OXFORD FARMERS DR	77-08-18	1000	.80	23.0	1270	--	--	--	--	--
IR-37	E MANZANOLA DRAIN	77-08-18	1220	1.0	22.0	2500	--	8.0	--	--	--
IR-36	VROMAN DRAIN	77-08-18	1130	.50	19.5	2500	--	7.5	--	--	--
IR-35	PATTERSON HOLLOW D	77-08-18	1030	1.5	19.5	2560	--	8.0	--	--	--
IR-34	HIGHWAY 71 DRAIN	77-08-18	0915	5.0	19.0	1280	--	8.0	--	--	--
		77-08-23	1140	2.0	20.0	--	--	--	--	--	--
IR-33	N ROCKY FORD DRAIN	77-08-18	0830	1.5	18.0	1900	--	7.7	--	--	--
IR-32	ROCKY FORD STP DR	77-08-17	1315	2.0	20.5	3100	--	7.7	--	--	--
IR-31	ROCKY FORD DRAIN	77-08-17	1220	14	18.0	2200	--	7.6	150	27	240
		77-08-23	1120	25	19.5	--	--	--	--	--	--
IR-30	KRAMMES DRAIN	77-08-17	1130	1.0	19.0	1700	--	7.6	--	--	--
IR-29	NEWDALE DRAIN	77-08-17	1020	8.0	18.5	1800	--	7.7	110	5.8	220
IR-28	W LA JUNTA DRAIN	77-08-15	1600	1.2	26.0	3180	--	8.1	260	9.8	403
IR-27	EAST SWINK DRAIN	77-08-15	1500	.10	34.0	3300	--	8.2	--	--	--
IR-26	E PURGATOIRE DRAIN	77-08-04	1600	2.6	26.0	2500	--	7.8	210	6.5	250
IR-25	MILLER DITCH	77-08-04	1410	.20	24.0	3700	--	7.9	--	--	--
IR-24	MCCLAVE DRAIN	77-08-04	1240	.20	21.5	5120	--	7.6	--	--	--
IR-23	LUBERS DRAIN	77-08-04	1200	9.0	24.5	3130	--	8.1	320	9.3	330
IR-22	PROWERS ARROYO DR	77-08-04	1115	.70	30.0	3830	--	8.1	--	--	--
IR-21	WEST KEESEE DRAIN	77-08-04	1000	1.7	21.5	2700	--	7.6	--	--	--
IR-20	EAST KEESEE DRAIN	77-08-04	0900	.60	17.0	2800	--	7.7	--	--	--
IR-19	DRY CREEK DRAIN	77-08-03	1130	1.7	23.0	3120	--	7.9	--	--	--
IR-18	PROWERS DRAIN	77-08-03	1030	1.7	19.0	3570	--	7.6	480	15	300

TABLE 8.—WATER-QUALITY DATA FROM RECONNAISSANCE SAMPLING OF IRRIGATION-RETURN FLOWS AND SELECTED TRIBUTARIES—CONTINUED

SITE NO. ON PLATE 1	SITE NAME	DATE OF SAMPLE	MAGNESIUM, DISSOLVED (MG/L AS MG)	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L CACO3)	ALKALINITY FIELD (MG/L AS CACO3)	BICARBONATE FET-FLD (MG/L AS HCO3)	CARBONATE FET-FLD (MG/L AS CO3)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)
IR-54	21ST LANE DRAIN	77-08-09	--	--	--	--	--	--	--	12	--
IR-53	23RD LANE DRAIN	77-08-09	--	--	--	--	--	--	--	10	--
IR-52	25TH LANE DRAIN	76-08-10	--	--	--	--	--	--	--	5.8	--
		77-08-09	--	--	--	--	--	--	--	21	--
IR-51	ST. CHAS BTMLND DR	77-08-09	--	--	--	--	--	--	--	11	--
IR-50	ST. CHARLES DRAIN	76-08-10	--	--	--	--	--	--	--	4.9	--
IR-49	37TH LANE DRAIN	76-08-10	--	--	--	--	--	--	--	12	--
IR-48	39TH LANE DR AT MT	77-08-10	--	--	--	--	--	--	--	12	--
IR-47	39TH LN DR AT HW50	76-08-10	--	--	--	--	--	--	--	9.1	--
IR-46	40TH LANE DRAIN	77-08-10	--	--	--	--	--	--	--	15	--
IR-45	WHEELER LANE DRAIN	77-08-10	19	230	140	90	110	0	0.7	9.6	190
IR-44	AVONDALE D AT HW50	77-08-09	--	--	--	--	--	--	--	26	--
IR-43	AVONDALE D AT BR50	76-08-10	--	--	--	--	--	--	--	20	--
IR-42	51ST LANE DRAIN	77-08-09	--	--	--	--	--	--	--	13	--
IR-41	AVONDALE BTMLND DR	77-08-09	50	580	370	210	260	0	8.3	24	510
IR-40	NORTH NEPESTA DR	77-08-18	--	--	--	--	--	--	--	33	--
IR-39	RR JUNCTION DRAIN	77-08-18	--	--	--	--	--	--	--	41	--
IR-38	OXFORD FARMERS DR	77-08-18	--	--	--	--	--	--	--	14	--
IR-37	E MANZANOLA DRAIN	77-08-18	--	--	--	--	--	--	--	42	--
IR-36	VROMAN DRAIN	77-08-18	--	--	--	--	--	--	--	49	--
IR-35	PATTERSON HOLLOW D	77-08-18	--	--	--	--	--	--	--	79	--
IR-34	HIGHWAY 71 DRAIN	77-08-18	--	--	--	--	--	--	--	26	--
		77-08-23	--	--	--	--	--	--	--	--	--
IR-33	N ROCKY FORD DRAIN	77-08-18	--	--	--	--	--	--	--	39	--
IR-32	ROCKY FORD STP DR	77-08-17	--	--	--	--	--	--	--	190	--
IR-31	ROCKY FORD DRAIN	77-08-17	80	930	610	320	390	0	16	59	800
		77-08-23	--	--	--	--	--	--	--	--	--
IR-30	KRAMMES DRAIN	77-08-17	--	--	--	--	--	--	--	30	--
IR-29	NEWDALE DRAIN	77-08-17	67	830	640	180	220	0	7.0	36	790
IR-28	W LA JUNTA DRAIN	77-08-15	130	1500	1300	280	340	0	4.3	76	1600
IR-27	EAST SWINK DRAIN	77-08-15	--	--	--	--	--	--	--	86	--
IR-26	E PURGATOIRE DRAIN	77-08-04	89	990	790	210	250	0	6.3	90	1100
IR-25	MILLER DITCH	77-08-04	--	--	--	--	--	--	--	100	--
IR-24	MCCLAVE DRAIN	77-08-04	--	--	--	--	--	--	--	160	--
IR-23	LUBERS DRAIN	77-08-04	120	1300	1200	130	160	0	2.0	63	1800
IR-22	PROWERS ARROYO DR	77-08-04	--	--	--	--	--	--	--	78	--
IR-21	WEST KEESEE DRAIN	77-08-04	--	--	--	--	--	--	--	78	--
IR-20	EAST KEESEE DRAIN	77-08-04	--	--	--	--	--	--	--	74	--
IR-19	DRY CREEK DRAIN	77-08-03	--	--	--	--	--	--	--	90	--
IR-18	PROWERS DRAIN	77-08-03	140	1300	1000	290	350	0	14	140	1800

TABLE 8.--WATER-QUALITY DATA FROM RECONNAISSANCE SAMPLING OF IRRIGATION-RETURN FLOWS AND SELECTED TRIBUTARIES--CONTINUED

SITE NO. ON PLATE 1	SITE NAME	DATE OF SAMPLE	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	SILICA, DIS-SOLVED (MG/L AS SIO2)	IRON, DIS-SOLVED (UG/L AS FE)	MANGA-NESE, DIS-SOLVED (UG/L AS MN)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	SOLIDS, RESIDUE AT 105 DEG. C, SUS-PENDED (MG/L)	NITRO-GEN, AM-MONIA + ORGANIC TOTAL (MG/L AS N)	NITRO-GEN, ORGANIC TOTAL (MG/L AS N)
IR-54	21ST LANE DRAIN	77-08-09	--	--	--	--	--	--	--	--	--
IR-53	23RD LANE DRAIN	77-08-09	--	--	--	--	--	--	--	--	--
IR-52	25TH LANE DRAIN	76-08-10	--	--	--	--	--	349	42	0.34	0.32
		77-08-09	--	--	--	--	--	--	--	--	--
IR-51	ST. CHAS BTMLND DR	77-08-09	--	--	--	--	--	--	--	--	--
IR-50	ST. CHARLES DRAIN	76-08-10	--	--	--	--	--	290	18	.33	.29
IR-49	37TH LANE DRAIN	76-08-10	--	--	--	--	--	783	24	.54	.54
IR-48	39TH LANE DR AT MT	77-08-10	--	--	--	--	--	--	--	--	--
IR-47	39TH LN DR AT HW50	76-08-10	--	--	--	--	--	525	45	.62	.60
IR-46	40TH LANE DRAIN	77-08-10	--	--	--	--	--	--	--	--	--
IR-45	WHEELER LANE DRAIN	77-08-10	0.6	7.5	30	<10	381	--	86	--	--
IR-44	AVONDALE D AT HW50	77-08-09	--	--	--	--	--	--	--	--	--
IR-43	AVONDALE D AT RR50	76-08-10	--	--	--	--	--	1210	26	.79	.78
IR-42	51ST LANE DRAIN	77-08-09	--	--	--	--	--	--	--	--	--
IR-41	AVONDALE BTMLND DR	77-08-09	1.2	13	30	220	971	--	46	--	--
IR-40	NORTH NEPESTA DR	77-08-18	--	--	--	--	--	--	--	--	--
IR-39	RR JUNCTION DRAIN	77-08-18	--	--	--	--	--	--	--	--	--
IR-38	OXFORD FARMERS DR	77-08-18	--	--	--	--	--	--	--	--	--
IR-37	E MANZANOLA DRAIN	77-08-18	--	--	--	--	--	--	--	--	--
IR-36	VROMAN DRAIN	77-08-18	--	--	--	--	--	--	--	--	--
IR-35	PATTERSON HOLLOW D	77-08-18	--	--	--	--	--	--	--	--	--
IR-34	HIGHWAY 71 DRAIN	77-08-18	--	--	--	--	--	--	--	--	--
		77-08-23	--	--	--	--	--	--	--	--	--
IR-33	N ROCKY FORD DRAIN	77-08-18	--	--	--	--	--	--	--	--	--
IR-32	ROCKY FORD STP DR	77-08-17	--	--	--	--	--	--	--	--	--
IR-31	ROCKY FORD DRAIN	77-08-17	1.1	18	<10	290	1600	--	150	--	--
		77-08-23	--	--	--	--	--	--	--	--	--
IR-30	KRAMMES DRAIN	77-08-17	--	--	--	--	--	--	--	--	--
IR-29	NEWDALE DRAIN	77-08-17	1.1	15	<10	20	1380	--	3303	--	--
IR-28	W LA JUNTA DRAIN	77-08-15	1.3	22	50	60	2730	--	255	--	--
IR-27	EAST SWINK DRAIN	77-08-15	--	--	--	--	--	--	--	--	--
IR-26	E PURGATOIRE DRAIN	77-08-04	1.1	15	20	<10	1910	--	2310	--	--
IR-25	MILLER DITCH	77-08-04	--	--	--	--	--	--	--	--	--
IR-24	MCCLAVE DRAIN	77-08-04	--	--	--	--	--	--	--	--	--
IR-23	LUBERS DRAIN	77-08-04	2.5	.3	20	140	2720	--	--	--	--
IR-22	PROWERS ARROYO DR	77-08-04	--	--	--	--	--	--	--	--	--
IR-21	WEST KEESEE DRAIN	77-08-04	--	--	--	--	--	--	--	--	--
IR-20	EAST KEESEE DRAIN	77-08-04	--	--	--	--	--	--	--	--	--
IR-19	DRY CREEK DRAIN	77-08-03	--	--	--	--	--	--	--	--	--
IR-18	PROWERS DRAIN	77-08-03	.8	15	70	290	3070	--	212	--	--

TABLE 8.--WATER-QUALITY DATA FROM RECONNAISSANCE SAMPLING OF IRRIGATION-RETURN FLOWS AND SELECTED TRIBUTARIES--CONTINUED

SITE NO. ON PLATE 1	SITE NAME	DATE OF SAMPLE	NITROGEN, AMMONIA TOTAL (MG/L AS N)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	NITROGEN, NO2+NO3 TOTAL (MG/L AS N)	NITROGEN, TOTAL (MG/L AS N)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)	PHOSPHORUS, DISSOLVED (MG/L AS P)
IR-54	21ST LANE DRAIN	77-08-09	--	1.4	--	--	--	--
IR-53	23RD LANE DRAIN	77-08-09	--	--	--	--	--	--
IR-52	25TH LANE DRAIN	76-08-10	0.20	--	0.52	0.86	--	0.17
		77-08-09	--	--	--	--	--	--
IR-51	ST. CHAS BTMLND DR	77-08-09	--	.37	--	--	--	--
IR-50	ST. CHARLES DRAIN	76-08-10	.04	--	.68	1.0	--	.07
IR-49	37TH LANE DRAIN	76-08-10	.00	--	3.7	4.2	--	.02
IR-48	39TH LANE DR AT MT	77-08-10	--	--	--	--	--	--
IR-47	39TH LN DR AT HW50	76-08-10	.02	--	1.5	2.1	--	.08
IR-46	40TH LANE DRAIN	77-08-10	--	3.7	--	--	--	--
IR-45	WHEELER LANE DRAIN	77-08-10	--	0.80	--	--	.01	--
IR-44	AVONDALE D AT HW50	77-08-09	--	<.10	--	--	--	--
IR-43	AVONDALE D AT BR50	77-08-10	.01	--	2.9	3.7	--	.03
IR-42	51ST LANE DRAIN	77-08-09	--	--	--	--	--	--
IR-41	AVONDALE BTMLND DR	77-08-09	--	.37	--	--	.03	--
IR-40	NORTH NEPESTA DR	77-08-18	--	--	--	--	--	--
IR-39	RR JUNCTION DRAIN	77-08-18	--	--	--	--	--	--
IR-38	OXFORD FARMERS DR	77-08-18	--	--	--	--	--	--
IR-37	E MANZANOLA DRAIN	77-08-18	--	6.1	--	--	--	--
IR-36	VROMAN DRAIN	77-08-18	--	12	--	--	--	--
IR-35	PATTERSON HOLLOW D	77-08-18	--	3.5	--	--	--	--
IR-34	HIGHWAY 71 DRAIN	77-08-18	--	2.2	--	--	--	--
		77-08-23	--	--	--	--	--	--
IR-33	N ROCKY FORD DRAIN	77-08-18	--	4.8	--	--	--	--
IR-32	ROCKY FORD STP DR	77-08-17	--	.37	--	--	--	--
IR-31	ROCKY FORD DRAIN	77-08-17	--	6.5	--	--	.04	--
		77-08-23	--	--	--	--	--	--
IR-30	KRAMMES DRAIN	77-08-17	--	1.2	--	--	--	--
IR-29	NEWDALE DRAIN	77-08-17	--	5.8	--	--	.04	--
IR-28	W LA JUNTA DRAIN	77-08-15	--	15	--	--	.20	--
IR-27	EAST SWINK DRAIN	77-08-15	--	--	--	--	--	--
IR-26	E PURGATOIRE DRAIN	77-08-04	--	5.5	--	--	.04	--
IR-25	MILLER DITCH	77-08-04	--	--	--	--	--	--
IR-24	MCCLAVE DRAIN	77-08-04	--	--	--	--	--	--
IR-23	LUBERS DRAIN	77-08-04	--	.06	--	--	<.01	--
IR-22	PROWERS ARROYO DR	77-08-04	--	--	--	--	--	--
IR-21	WEST KEESEE DRAIN	77-08-04	--	--	--	--	--	--
IR-20	EAST KEESEE DRAIN	77-08-04	--	--	--	--	--	--
IR-19	DRY CREEK DRAIN	77-08-03	--	2.3	--	--	--	--
IR-18	PROWERS DRAIN	77-08-03	--	1.9	--	--	.40	--

TABLE 8.—WATER-QUALITY DATA FROM RECONNAISSANCE SAMPLING OF IRRIGATION-RETURN FLOWS AND SELECTED TRIBUTARIES—CONTINUED

SITE NO. ON PLATE 1	SITE NAME	DATE OF SAMPLE	PHOSPHORUS TOTAL (MG/L AS P)	OXYGEN DEMAND, BIOCHEMICAL, 5 DAY (MG/L)	COLIFORM, FECAL, 0.7 UM-MF (COLS./100 ML)	STREPTOCOCCI FECAL, KF AGAR (COLS. PER 100 ML)
IR-54	21ST LANE DRAIN	77-08-09	--	--	--	--
IR-53	23RD LANE DRAIN	77-08-09	--	--	--	--
IR-52	25TH LANE DRAIN	76-08-10	.22	1.5	4400	--
		77-08-09	--	--	--	--
IR-51	ST. CHAS BTMLND DR	77-08-09	--	--	--	--
IR-50	ST. CHARLES DRAIN	76-08-10	.10	1.3	1200	--
IR-49	37TH LANE DRAIN	76-08-10	.03	.7	360	--
IR-48	39TH LANE DR AT MT	77-08-10	--	--	--	--
IR-47	39TH LN DR AT HW50	76-08-10	.13	2.0	1900	--
IR-46	40TH LANE DRAIN	77-08-10	--	--	--	--
IR-45	WHEELER LANE DRAIN	77-08-10	--	--	--	--
IR-44	AVONDALE D AT HW50	77-08-09	--	--	--	--
IR-43	AVONDALE D AT BR50	76-08-10	.06	2.1	1300	--
IR-42	51ST LANE DRAIN	77-08-09	--	--	--	--
IR-41	AVONDALE BTMLND DR	77-08-09	--	--	--	--
IR-40	NORTH NEPESTA DR	77-08-18	--	--	--	--
IR-39	RR JUNCTION DRAIN	77-08-18	--	--	--	--
IR-38	OXFORD FARMERS DR	77-08-18	--	--	--	--
IR-37	E MANZANOLA DRAIN	77-08-18	--	--	--	--
IR-36	VROMAN DRAIN	77-08-18	--	--	--	--
IR-35	PATTERSON HOLLOW D	77-08-18	--	--	--	--
IR-34	HIGHWAY 71 DRAIN	77-08-18	--	--	--	--
		77-08-23	--	--	--	--
IR-33	N ROCKY FORD DRAIN	77-08-18	--	--	--	--
IR-32	ROCKY FORD STP DR	77-08-17	--	--	--	--
IR-31	ROCKY FORD DRAIN	77-08-17	--	--	--	--
		77-08-23	--	--	--	--
IR-30	KRAMMES DRAIN	77-08-17	--	--	--	--
IR-29	NEWDALE DRAIN	77-08-17	--	--	--	--
IR-28	W LA JUNTA DRAIN	77-08-15	--	--	--	--
IR-27	EAST SWINK DRAIN	77-08-15	--	--	--	--
IR-26	E PURGATOIRE DRAIN	77-08-04	--	--	--	--
IR-25	MILLER DITCH	77-08-04	--	--	--	--
IR-24	MCCLAVE DRAIN	77-08-04	--	--	--	--
IR-23	LUBERS DRAIN	77-08-04	--	--	--	--
IR-22	PROWERS ARROYO DR	77-08-04	--	--	--	--
IR-21	WEST KEESEE DRAIN	77-08-04	--	--	--	--
IR-20	EAST KEESEE DRAIN	77-08-04	--	--	--	--
IR-19	DRY CREEK DRAIN	77-08-03	--	--	--	--
IR-18	PROWERS DRAIN	77-08-03	--	--	--	--

TABLE 8.—WATER-QUALITY DATA FROM RECONNAISSANCE SAMPLING OF IRRIGATION-RETURN FLOWS AND SELECTED TRIBUTARIES--CONTINUED

SITE NO. ON PLATE 1	SITE NAME	DATE OF SAMPLE	TIME	STREAM-FLOW, INSTANTANEOUS (CFS)	TEMPERATURE (DEG C)	SPECIFIC CONDUCTANCE (UMHOS)	OXYGEN, DISSOLVED (MG/L)	PH (UNITS)	SODIUM, DISSOLVED (MG/L AS NA)	POTASSIUM, DISSOLVED (MG/L AS K)	CALCIUM DISSOLVED (MG/L AS CA)
IR-17	VISTA DEL RIO DR	77-08-03	0850	0.70	19.5	4980	--	8.0	--	--	--
IR-16	MARKHAM ARROYO DR	77-08-03	0800	.80	16.0	4070	--	8.0	--	--	--
IR-15	EAST LAMAR DRAIN	77-07-29	1000	3.0	23.0	1160	--	7.7	--	--	--
		77-08-03	1330	1.2	30.0	3590	--	7.9	430	12	320
IR-14	VISTA DEL RIO DR	77-07-29	0915	.80	23.5	1950	--	8.2	--	--	--
IR-13	N GRANADA DRAIN	77-07-28	1410	3.0	26.0	3300	--	8.0	--	--	--
IR-12	S GRANADA DRAIN	77-07-28	1410	.50	30.0	3100	--	8.2	--	--	--
IR-11	WEST ALFALFA DRAIN	77-07-28	1245	4.0	22.5	5000	--	8.0	--	--	--
IR-10	GRANADA DR AT MTH	77-07-28	1215	8.0	24.0	3000	--	8.1	--	--	--
		77-08-03	1430	4.0	32.0	5000	--	8.2	660	20	450
IR-9	N ARK DR NR BARTON	76-09-09	1030	2.0	14.5	6010	7.4	8.0	830	19	470
		77-07-28	1130	1.5	21.0	5400	--	8.1	--	--	--
IR-8	N FORK W HOLLY DR	77-07-28	1030	3.0	22.0	1550	--	7.7	--	--	--
IR-7	S FORK W HOLLY DR	77-07-28	1015	3.0	22.0	1720	--	7.6	--	--	--
IR-6	W HOLLY DR AT MTH	76-09-09	1130	4.0	18.0	6020	13.3	8.2	820	19	460
		77-07-28	0930	6.0	20.5	2200	--	8.0	--	--	--
		77-08-02	1515	14	28.0	2050	--	7.8	240	12	190
IR-5	E HOLLY D AT HOLLY	77-07-28	0830	.50	18.0	3030	--	8.0	--	--	--
IR-4	E HOLLY DRAIN TRIB	77-07-27	1515	1.0	26.0	3500	--	8.1	--	--	--
IR-3	E HOLLY DR AT HW50	77-07-27	1445	2.0	25.0	4000	--	8.0	--	--	--
IR-2	E HOLLY DR AT MTH	77-07-27	1345	5.0	24.0	4160	--	8.1	470	15	340
IR-1	ROMER FIELD DRAIN	77-07-12	1500	1.0	28.0	4750	--	--	--	--	--
T- 1	SIXMILE CR AT HWY50	76-04-23	0945	4.0	14.0	2300	11.1	8.3	130	--	310
		76-05-21	0830	3.2	14.5	2800	9.8	8.0	140	--	320
		76-06-17	1100	4.2	18.0	2330	9.7	7.9	110	--	300
		76-07-14	1430	2.6	27.0	2130	8.8	7.9	120	--	300
		76-08-10	1100	--	17.5	2400	--	8.1	--	--	--
		76-08-18	1345	2.9	25.0	2780	8.8	8.1	140	--	360
		76-09-15	1330	3.0	21.0	2800	8.4	8.0	140	--	390
T- 2	CHICOSA CR NR FOWLER	76-08-10	1215	--	21.5	2440	--	8.0	--	--	--
		76-09-03	1230	2.0	25.0	2550	9.6	8.0	180	4.7	260
T- 3	APISHAPA R NR FOWLER	76-09-08	1030	31	1	1390	8.0	8.0	80	4.8	150
T- 4	TIMPAS CR AT HWY50	76-09-03	1030	--	17.0	2600	9.4	8.0	190	5.3	290
T- 5	CROOKED AR AT HWY50	76-09-03	0900	2.0	16.5	3325	6.4	7.8	280	3.1	410

TABLE 8.—WATER-QUALITY DATA FROM RECONNAISSANCE SAMPLING OF IRRIGATION-RETURN FLOWS AND SELECTED TRIBUTARIES—CONTINUED

SITE NO. ON PLATE 1	SITE NAME	DATE OF SAMPLE	MAGNESIUM, DISSOLVED (MG/L AS MG)	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L CACO3)	ALKALINITY FIELD (MG/L AS CACO3)	BICARBONATE FET-FLD (MG/L AS HCO3)	CARBONATE FET-FLD (MG/L AS CO3)	CARBON DIOXIDE DISSOLVED (MG/L AS CO2)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE DISSOLVED (MG/L AS SO4)
IR-17	VISTA DEL RIO DR	77-08-03	—	—	—	—	—	—	—	170	—
IR-16	MARKHAM ARROYO DR	77-08-03	—	—	—	—	—	—	—	120	—
IR-15	EAST LAMAR DRAIN	77-07-29	—	—	—	—	—	—	—	51	—
		77-08-03	140	1400	1100	260	320	0	6.4	120	1800
IR-14	VISTA DEL RIO DR	77-07-29	—	—	—	—	—	—	—	52	—
IR-13	N GRANADA DRAIN	77-07-28	—	—	—	—	—	—	—	96	—
IR-12	S GRANADA DRAIN	77-07-28	—	—	—	—	—	—	—	97	—
IR-11	WEST ALFALFA DRAIN	77-07-28	—	—	—	—	—	—	—	200	—
IR-10	GRANADA DR AT MTH	77-07-28	—	—	—	—	—	—	—	92	—
		77-08-03	190	1900	1600	330	400	0	4.0	200	2700
IR-9	N ARK DR NR BARTON	76-09-09	220	2100	1800	319	389	0	6.2	230	3100
		77-07-28	—	—	—	—	—	—	—	250	—
IR-8	N FORK W HOLLY DR	77-07-28	—	—	—	—	—	—	—	37	—
IR-7	S FORK W HOLLY DR	77-07-28	—	—	—	—	—	—	—	46	—
IR-6	W HOLLY DR AT MTH	76-09-09	250	2200	1900	335	408	0	4.1	230	3100
		77-07-28	—	—	—	—	—	—	—	64	—
		77-08-02	69	760	600	160	190	0	4.8	51	990
IR-5	E HOLLY D AT HOLLY	77-07-28	—	—	—	—	—	—	—	—	—
IR-4	E HOLLY DRAIN TRIB	77-07-27	—	—	—	—	—	—	—	130	—
IR-3	E HOLLY DR AT HW50	77-07-27	—	—	—	—	—	—	—	150	—
IR-2	E HOLLY DR AT MTH	77-07-27	170	1600	1300	250	300	0	3.9	140	2100
IR-1	ROMER FIELD DRAIN	77-07-12	—	—	—	—	—	—	—	—	—
T- 1	SIXMILE CR AT HWY50	76-04-23	120	1300	1000	235	287	0	2.3	25	1200
		76-05-21	140	1400	1200	223	272	0	4.4	25	1400
		76-06-17	110	1200	990	208	254	0	5.1	21	1100
		76-07-14	110	1200	990	214	261	0	5.3	25	1200
		76-08-10	—	—	—	—	—	—	—	26	—
		76-08-18	130	1400	1200	192	234	0	3.0	27	1400
		76-09-15	130	1500	1300	226	275	0	4.4	27	1500
T- 2	CHICOSA CR NR FOWLER	76-08-10	—	—	—	—	—	—	—	54	—
		76-09-03	120	1100	890	255	311	0	5.0	59	1100
T- 3	APISHAPA R NR FOWLER	76-09-08	49	580	410	166	202	0	3.2	26	500
T- 4	TIMPAS CR AT HWY50	76-09-03	98	1100	910	221	269	0	4.3	56	1200
T- 5	CROOKED AR AT HWY50	76-09-03	120	1500	1300	236	288	0	7.3	77	1600

TABLE 8.—WATER-QUALITY DATA FROM RECONNAISSANCE SAMPLING OF IRRIGATION-RETURN FLOWS AND SELECTED TRIBUTARIES—CONTINUED

SITE NO. ON PLATE 1	SITE NAME	DATE OF SAMPLE	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	IRON, DISSOLVED (UG/L AS FE)	MANGANESE, DISSOLVED (UG/L AS MN)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	SOLIDS, RESIDUE AT 180 DEG. C DISSOLVED (MG/L)	SOLIDS, RESIDUE AT 105 DEG. C, SUSPENDED (MG/L)	NITROGEN, AMMONIA + ORGANIC TOTAL (MG/L AS N)	NITROGEN, ORGANIC TOTAL (MG/L AS N)
IR-17	VISTA DEL RIO DR	77-08-03	—	—	—	—	—	—	—	—	—
IR-16	MARKHAM ARROYO DR	77-08-03	—	—	—	—	—	—	—	—	—
IR-15	EAST LAMAR DRAIN	77-07-29	—	—	—	—	—	—	117	—	—
		77-08-03	1.1	15	30	110	3010	—	412	—	—
IR-14	VISTA DEL RIO DR	77-07-29	—	—	—	—	—	—	578	—	—
IR-13	N GRANADA DRAIN	77-07-28	—	—	—	—	—	—	—	—	—
IR-12	S GRANADA DRAIN	77-07-28	—	—	—	—	—	—	—	—	—
IR-11	WEST ALFALFA DRAIN	77-07-28	—	—	—	—	—	—	20	—	—
IR-10	GRANADA DR AT MTH	77-07-28	—	—	—	—	—	—	187	—	—
		77-08-03	.7	23	40	100	4460	—	118	—	—
IR-9	N ARK DR NR BARTON	76-09-09	.6	17	20	80	5090	—	12	1.30	1.3
		77-07-28	—	—	—	—	—	—	—	—	—
IR-8	N FORK W HOLLY DR	77-07-28	—	—	—	—	—	—	—	—	—
IR-7	S FORK W HOLLY DR	77-07-28	—	—	—	—	—	—	—	—	—
IR-6	W HOLLY DR AT MTH	76-09-09	.8	18	40	60	5120	—	6	.60	.60
		77-07-28	—	—	—	—	—	—	2330	—	—
		77-08-02	.7	12	20	80	1660	—	2150	—	—
IR-5	E HOLLY D AT HOLLY	77-07-28	—	—	—	—	—	—	—	—	—
IR-4	E HOLLY DRAIN TRIB	77-07-27	—	—	—	—	—	—	—	—	—
IR-3	E HOLLY DR AT HW50	77-07-27	—	—	—	—	—	—	—	—	—
IR-2	E HOLLY DR AT MTH	77-07-27	1.0	23	<10	50	3430	—	61	—	—
IR-1	ROMER FIELD DRAIN	77-07-12	—	—	—	—	—	—	—	—	—
T- 1	SIXMILE CR AT HWY50	76-04-23	—	16	—	—	1940	—	9	4.20	1.2
		76-05-21	—	21	—	—	2180	—	28	.66	.52
		76-06-17	—	18	20	50	1780	—	93	.73	.66
		76-07-14	—	21	—	—	1900	—	50	.30	.26
		76-08-10	—	—	—	—	—	2300	98	.80	.77
		76-08-18	—	22	—	—	2190	—	50	.65	.65
		76-09-15	—	23	<10	50	2350	—	50	.69	.68
T- 2	CHICOSÀ CR NR FOWLER	76-08-10	—	—	—	—	—	2360	79	.62	.51
		76-09-03	1.6	21	20	150	1920	—	28	.40	.37
T- 3	APISHAPA R NR FOWLER	76-09-08	.8	9.0	30	60	931	—	65	.39	.38
T- 4	TIMPAS CR AT HWY50	76-09-03	1.0	14	<10	110	2010	—	59	.54	.52
T- 5	CROOKED AR AT HWY50	76-09-03	1.3	18	20	110	2680	—	29	.58	.47

TABLE 8.—WATER-QUALITY DATA FROM RECONNAISSANCE SAMPLING OF IRRIGATION-RETURN FLOWS AND SELECTED TRIBUTARIES—CONTINUED

SITE NO. ON PLATE 1	SITE NAME	DATE OF SAMPLE	NITRO-GEN, AMMONIA TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO-GEN, TOTAL (MG/L AS N)	PHOS-PHORUS, ORTHO, DIS-SOLVED (MG/L AS P)	PHOS-PHORUS, DIS-SOLVED (MG/L AS P)
IR-17	VISTA DEL RIO DR	77-08-03	—	—	—	—	—	--
IR-16	MARKHAM ARROYO DR	77-08-03	—	—	—	—	—	--
IR-15	EAST LAMAR DRAIN	77-07-29	—	—	—	—	—	--
		77-08-03	—	2.7	—	—	0.80	--
IR-14	VISTA DEL RIO DR	77-07-29	—	1.3	—	—	—	--
IR-13	N GRANADA DRAIN	77-07-28	—	—	—	—	—	--
IR-12	S GRANADA DRAIN	77-07-28	—	—	—	—	—	--
IR-11	WEST ALFALFA DRAIN	77-07-28	—	—	—	—	—	--
IR-10	GRANADA DR AT MTH	77-07-28	—	—	—	—	—	--
		77-08-03	—	3.8	—	—	.23	--
IR-9	N ARK DR NR BARTON	76-09-09	.40	3.2	3.3	4.6	.30	--
		77-07-28	—	2.5	—	—	—	--
IR-8	N FORK W HOLLY DR	77-07-28	—	—	—	—	—	--
IR-7	S FORK W HOLLY DR	77-07-28	--	—	—	—	—	--
IR-6	W HOLLY DR AT MTH	76-09-09	<.01	4.3	4.3	4.9	.04	--
		77-07-28	—	—	—	—	—	--
		77-08-02	—	1.4	—	—	.03	--
IR-5	E HOLLY D AT HOLLY	77-07-28	—	—	—	—	—	--
IR-4	E HOLLY DRAIN TRIB	77-07-27	—	—	—	—	—	--
IR-3	E HOLLY DR AT HW50	77-07-27	—	—	—	—	—	--
IR-2	E HOLLY DR AT MTH	77-07-27	—	4.2	—	—	.03	--
IR-1	ROMER FIELD DRAIN	77-07-12	—	—	—	—	—	--
T- 1	SIXMILE CR AT HWY50	76-04-23	3.00	—	5.7	9.9	—	--
		76-05-21	.14	—	4.8	5.5	—	--
		76-06-17	.07	—	3.6	4.3	—	--
		76-07-14	.04	—	4.2	4.5	—	--
		76-08-10	.03	—	4.5	5.3	—	0.20
		76-08-18	<.01	—	4.6	5.3	—	--
		76-09-15	.01	—	5.4	6.1	—	--
T- 2	CHICOSA CR NR FOWLER	76-08-10	.11	—	4.9	5.5	—	.05
		76-09-03	.03	4.4	4.4	4.8	.03	--
T- 3	APISHAPA R NR FOWLER	76-09-08	.01	2.5	2.5	2.9	.08	--
T- 4	TIMPAS CR AT HWY50	76-09-03	.02	4.4	4.4	4.9	.04	--
T- 5	CROOKED AR AT HWY50	76-09-03	.11	6.2	7.1	7.7	.01	--

TABLE 8.—WATER-QUALITY DATA FROM RECONNAISSANCE SAMPLING OF IRRIGATION-RETURN FLOWS AND SELECTED TRIBUTARIES—CONTINUED

SITE NO. ON PLATE 1	SITE NAME	DATE OF SAMPLE	PHOS-PHORUS, TOTAL (MG/L AS P)	OXYGEN DEMAND, BIO-CHEM-ICAL, 5 DAY (MG/L)	COLI-FORM, FECAL, 0.7 UM-MF (COLS./100 ML)	STREP-TOCOCCI FECAL, KF AGAR (COLS. PER 100 ML)
IR-17	VISTA DEL RIO DR	77-08-03	--	—	—	—
IR-16	MARKHAM ARROYO DR	77-08-03	--	—	—	—
IR-15	EAST LAMAR DRAIN	77-07-29	--	—	—	—
		77-08-03	--	—	—	—
IR-14	VISTA DEL RIO DR	77-07-29	--	—	—	—
IR-13	N GRANADA DRAIN	77-07-28	--	—	—	—
IR-12	S GRANADA DRAIN	77-07-28	--	—	—	—
IR-11	WEST ALFALFA DRAIN	77-07-28	--	—	—	—
IR-10	GRANADA DR AT MTH	77-07-29	--	—	—	—
		77-08-03	--	—	—	—
IR-9	N ARK DR NR BARTON	76-09-09	0.75	>7.0	—	—
		77-07-28	--	—	—	—
IR-8	N FORK W HOLLY DR	77-07-28	--	—	—	—
IR-7	S FORK W HOLLY DR	77-07-28	—	—	—	—
IR-6	W HOLLY DR AT MTH	76-09-09	.08	4.1	—	—
		77-07-28	--	—	—	—
		77-08-02	--	—	—	—
IR-5	E HOLLY D AT HOLLY	77-07-28	--	—	—	—
IR-4	E HOLLY DRAIN TRIB	77-07-27	--	—	—	—
IR-3	E HOLLY DR AT HW50	77-07-27	—	—	—	—
IR-2	E HOLLY DR AT MTH	77-07-27	--	—	—	—
IR-1	ROMER FIELD DRAIN	77-07-12	--	—	—	—
T- 1	SIXMILE CR AT HWY50	76-04-23	.02	.6	—	76
		76-05-21	.02	.6	—	340
		76-06-17	.03	2.8	—	1400
		76-07-14	.04	2.0	—	1900
		76-08-10	.08	1.0	680	—
		76-08-18	.08	1.0	—	520
		76-09-15	.03	.9	—	1700
T- 2	CHICOSA CR NR FOWLER	76-08-10	.19	.8	1000	—
		76-09-03	.08	1.2	—	—
T- 3	APISHAPA R NR FOWLER	76-09-08	.29	1.5	—	—
T- 4	TIMPAS CR AT HWY50	76-09-03	.13	1.9	—	—
T- 5	CROOKED AR AT HWY50	76-09-03	.08	1.6	—	—

TABLE 9.--PESTICIDE DATA FROM SELECTED IRRIGATION-RETURN FLOWS AND TRIBUTARIES (UG/L=MICROGRAMS PER LITER; VALUES EXCEEDING WATER-QUALITY STANDARDS ARE UNDERLINED).

SITE NO. ON PLATE 1	SITE NAME	DATE OF SAMPLE	TIME	ALDRIN, TOTAL (UG/L)	CHLORDANE, TOTAL (UG/L)	DDD, TOTAL (UG/L)	DDE, TOTAL (UG/L)	DDT, TOTAL (UG/L)	DI-AZINON, TOTAL (UG/L)	DI-ELDRIN TOTAL (UG/L)	ENDRIN, TOTAL (UG/L)
IR-52	25TH LANE DRAIN	76-08-10	0830	0.00	0.10	0.00	0.00	0.00	--	0.04	0.00
IR-50	ST. CHARLES DRAIN	76-08-10	0915	.00	.00	.00	.00	.00	--	.00	.00
IR-49	37TH LANE DRAIN	76-08-10	1000	.00	.00	.00	.03	.00	--	.00	.00
IR-47	39TH LN DR AT HW50	76-08-10	1030	.00	.00	.00	.00	.00	--	.03	.00
IR-43	AVONDALE D AT BR50	76-08-10	1130	.00	.00	.00	.00	.00	--	.01	.00
IR-34	HIGHWAY 71 DRAIN	77-08-23	1140	.00	.00	.00	.00	.00	0.00	.00	.00
IR-31	ROCKY FORD DRAIN	77-08-23	1120	.00	.00	.00	.00	.00	.00	.00	.00
IR-9	N ARK DR NR BARTON	76-09-09	1030	.00	.00	.00	.00.	.00	--	.00	.00
IR-6	W HOLLY DR AT MTH	76-09-09	1130	.00	.00	.00	.00	.00	--	.00	.00
		77-08-02	1515	.00	.00	.00	.00	.00	.00	.00	.00
T- 1	SIXMILE CR AT HWY50	76-08-10	1100	.00	.00	.00	.00	.00	--	.00	.00
T- 2	CHICOSA CR NR FOWLER	76-08-10	1215	.00	.00	.00	.00	.00	--	.00	.00
T- 3	APISHAPA R NR FOWLER	76-09-08	1030	.00	.00	.00	.00	.00	--	.00	.00
T- 4	TIMPAS CR AT HWY50	76-09-03	1030	.00	.00	.00	.00	.00	--	.00	.00

SITE NO. ON PLATE 1	SITE NAME	DATE OF SAMPLE	ETHION, TOTAL (UG/L)	HEPTA-CHLOR, TOTAL (UG/L)	HEPTA-CHLOR EPOXIDE TOTAL (UG/L)	LINDANE TOTAL (UG/L)	MALA-THION, TOTAL (UG/L)	METH-OXY-CHLOR, TOTAL (UG/L)	METHYL PARA-THION, TOTAL (UG/L)	METHYL TRI-THION, TOTAL (UG/L)	MIREX, TOTAL (UG/L)
IR-52	25TH LANE DRAIN	76-08-10	--	0.00	0.00	0.00	--	--	--	--	--
IR-50	ST. CHARLES DRAIN	76-08-10	--	.00	.00	.00	--	--	--	--	--
IR-49	37TH LANE DRAIN	76-08-10	--	.00	.00	.00	--	--	--	--	--
IR-47	39TH LN DR AT HW50	76-08-10	--	.00	.00	.00	--	--	--	--	--
IR-43	AVONDALE D AT BR50	76-08-10	--	.00	.00	.02	--	--	--	--	--
IR-34	HIGHWAY 71 DRAIN	77-08-23	0.00	.00	.00	.00	0.00	3.00	0.00	0.00	0.00
IR-31	ROCKY FORD DRAIN	77-08-23	.00	.00	.00	.00	.00	.00	.00	.00	.00
IR-9	N ARK DR NR BARTON	76-09-09	--	.00	.00	.00	--	--	--	--	--
IR-6	W HOLLY DR AT MTH	76-09-09	--	.00	.00	.00	--	--	--	--	--
		77-08-02	.00	.00	.00	.00	.00	--	.00	.00	.00
T- 1	SIXMILE CR AT HWY50	76-08-10	--	.00	.00	.00	--	--	--	--	--
T- 2	CHICOSA CR NR FOWLER	76-08-10	--	.00	.00	.00	--	--	--	--	--
T- 3	APISHAPA R NR FOWLER	76-09-08	--	.00	.00	.00	--	--	--	--	--
T- 4	TIMPAS CR AT HWY50	76-09-03	--	.00	.00	.00	--	--	--	--	--

SITE NO. ON PLATE 1	SITE NAME	DATE OF SAMPLE	NAPHTHALENES, POLYCHLOR. TOTAL (UG/L)	PARATHION, TOTAL (UG/L)	PCB, TOTAL (UG/L)	TOXAPHENE, TOTAL (UG/L)	TOTAL TRITHION (UG/L)
IR-52	25TH LANE DRAIN	76-08-10	--	--	--	0	--
IR-50	ST. CHARLES DRAIN	76-08-10	0.00	--	0.00	0	--
IR-49	37TH LANE DRAIN	76-08-10	.00	--	.00	0	--
IR-47	39TH LN DR AT HW50	76-08-10	.00	--	.00	0	--
IR-43	AVONDALE D AT BR50	76-08-10	.00	--	.00	0	--
IR-34	HIGHWAY 71 DRAIN	77-08-23	.00	0.00	.00	0	0.00
IR-31	ROCKY FORD DRAIN	77-08-23	.00	.00	.00	0	.00
IR-9	N ARK DR NR BARTON	76-09-09	.00	--	.00	0	--
IR-6	W HOLLY DR AT MTH	76-09-09	.00	--	.00	0	--
		77-08-02	.00	.00	.00	0	.00
T- 1	SIXMILE CR AT HWY50	76-08-10	.00	--	.00	0	--
T- 2	CHICOSA CR NR FOWLER	76-08-10	.00	--	.00	0	--
T- 3	APISHAPA R NR FOWLER	76-09-08	.00	--	.00	0	--
T- 4	TIMPAS CR AT HWY50	76-09-03	.00	--	.00	0	--

TABLE 10.—WATER-QUALITY DATA AT ARKANSAS RIVER SITES, JULY 1977

(CFS=CUBIC FOOT PER SECOND; DEG C=DEGREES CELSIUS; UMHOS=MICROMHOS PER CENTIMETER AT 25 DEGREES CELSIUS; MG/L=MILLIGRAMS PER LITER; UG/L=MICROGRAMS PER LITER; MILES=MILES DOWNSTREAM FROM PUEBLO RESERVOIR; VALUES EXCEEDING WATER-QUALITY STANDARDS ARE UNDERLINED).

SITE NO. ON PLATE 1	SITE NAME	DATE OF SAMPLE	DOWN-STREAM LOCA-TION (MILES)	TIME	STREAM-FLOW, INSTAN-TANEOUS (CFS)	TEMPER-ATURE (DEG C)	SPE-CIFIC CON-DUCT-ANCE (UMHOS)	OXYGEN, DIS-SOLVED (MG/L)	PH (UNITS)	SODIUM, DIS-SOLVED (MG/L AS NA)	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	CALCIUM DIS-SOLVED (MG/L AS CA)
M-41	ARK RIV AB PUEBLO	77-07-19	1	1530	200	20.0	675	--	8.1	--	--	--
M-40	ARK RIV AT SANTA FE	77-07-19	8	1440	--	28.0	910	--	8.2	--	--	--
M-39	ARK RIV NR 23RD LN	77-07-19	11	1410	--	29.0	875	--	8.1	--	--	--
M-38	ARK RIV NR 28TH LN	77-07-19	13	1340	--	30.0	900	--	8.0	--	--	--
M-37	ARK RIV AT BAXTER	77-07-19	14	1300	--	29.0	910	--	7.9	--	--	--
M-36	ARK RIV AT DEVINE	77-07-19	17	1240	--	30.0	920	--	8.2	--	--	--
M-35	ARK RIV AT 40TH LN	77-07-19	19	1210	--	27.0	925	--	8.1	--	--	--
M-34	ARK RIV NR AVONDALE	77-07-19	20	1130	215	26.0	950	--	8.1	--	--	--
M-33	ARK RIV AT AVONDALE	77-07-19	23	1100	--	26.0	975	--	7.9	--	--	--
M-32	ARK R AT COLO CANAL	77-07-19	25	1010	--	24.0	1000	--	7.9	--	--	--
M-31	ARK R AT RF HIGHLIN	77-07-19	30	0925	--	23.0	1125	--	8.0	--	--	--
M-30	ARK RIV NR NEPESTA	77-07-19	34	0900	100	22.0	1150	--	8.2	--	--	--
M-29	ARK RIV AT FOWLER	77-07-19	43	0810	--	22.0	1210	--	8.3	--	--	--
M-28	ARK RIVER AT CATLIN	77-07-14	50	1445	76	34.0	1310	--	8.3	91	5.8	140
M-27	ARK R AT MANZANOLA	77-07-14	52	1415	--	34.0	1420	--	8.3	--	--	--
M-26	ARK AT FT LYON STOR	77-07-14	55	1345	.00	--	--	--	--	--	--	--
M-25	ARK RIV NR ORDWAY	77-07-14	59	1315	--	34.5	1630	--	8.3	--	--	--
M-24	ARK R NR ROCKY FORD	77-07-14	63	1235	--	28.5	1790	--	8.0	--	--	--
M-23	ARK RIV AT SWINK	77-07-14	67	1120	--	25.5	1980	--	8.2	--	--	--
M-22	ARK AT FT LYON CAN	77-07-14	70	1000	--	22.0	2230	--	8.2	--	--	--
M-21	ARK RIV AT LA JUNTA	77-07-14	73	0920	58	23.0	2170	8.0	8.3	180	7.3	250
M-20	ARK RIV NR BENTS FT	77-07-14	79	0845	--	22.0	2330	--	8.4	--	--	--
M-19	ARK RIVER AT HADLEY	77-07-14	81	0800	50	21.0	2380	--	8.2	--	--	--
M-18	ARK AT CONSOLID CAN	77-07-14	84	0730	30	21.0	2350	--	8.2	--	--	--
M-17	ARK R AT LAS ANIMAS	77-07-13	92	1510	6.0	34.5	3950	--	8.2	500	6.7	340
M-16	ARK R AB PURGATOIRE	77-07-13	94	1430	3.0	36.0	3800	--	8.3	--	--	--
M-15	ARK AT FT LYON HOSP	77-07-13	97	1350	4.0	34.5	4100	--	8.2	--	--	--
M-14	ARK R BL JOHN MARTIN	77-07-13	107	1245	11	24.5	3900	--	8.3	470	6.6	330
M-13	ARK BL FT BENT CAN	77-07-13	114	1200	3.0	25.5	4400	--	7.9	--	--	--
M-12	ARK RIV AB PROWERS	77-07-13	116	1120	3.0	26.5	4150	--	7.9	--	--	--
M-11	ARK RIV AT PROWERS	77-07-13	119	1045	6.0	25.5	5300	--	7.9	--	--	--
M-10	ARK RIV NR WILEY	77-07-13	121	1010	5.0	26.5	5000	--	8.2	--	--	--
M- 9	ARK AB LAMAR CANAL	77-07-13	124	0920	.20	21.5	4350	--	8.2	--	--	--
M- 8	ARK RIVER AT LAMAR	77-07-13	127	0830	1.0	21.0	5100	11.8	8.1	660	10	300
M- 7	ARK AB BIG SANDY C	77-07-12	134	1745	--	29.5	3750	--	8.2	--	--	--
M- 6	ARK RIV NR GROTE	77-07-12	139	1700	--	31.0	4200	--	8.2	--	--	--
M- 5	ARK RIV NR GRANADA	77-07-12	144	1620	--	33.0	4600	--	8.2	--	--	--
M- 4	ARK RIV NR AMITY	77-07-12	150	1550	--	31.0	5700	--	--	--	--	--
M- 3	ARK RIV AT HOLLY	77-07-12	156	1445	--	32.0	5800	--	--	--	--	--
M- 2	ARK AT FRONTIER DCH	77-07-12	158	1420	--	34.5	5900	--	--	--	--	--
M- 1	ARK R NR COOLIDGE	77-07-12	162	1300	5.0	35.0	5200	8.1	8.1	--	--	--

TABLE 10.—WATER-QUALITY DATA AT ARKANSAS RIVER SITES, JULY 1977—CONTINUED

SITE NO. ON PLATE 1	SITE NAME	DATE OF SAMPLE	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	HARD-NESS (MG/L AS CACO3)	HARD-NESS, NONCAR-BONATE (MG/L CACO3)	ALKA-LINITY FIELD (MG/L AS CACO3)	BICAR-BONATE FET-FLD (MG/L AS HCO3)	CAR-BONATE FET-FLD (MG/L AS CO3)	CARBON DIOXIDE DIS-SOLVED (MG/L AS CO2)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	SULFATE DIS-SOLVED (MG/L AS SO4)
M-41	ARK RIV AB PUEBLO	77-07-19	--	--	--	--	--	--	--	--	--
M-40	ARK RIV AT SANTA FE	77-07-19	--	--	--	--	--	--	--	--	--
M-39	ARK RIV NR 23RD LN	77-07-19	--	--	--	--	--	--	--	--	--
M-38	ARK RIV NR 28TH LN	77-07-19	--	--	--	--	--	--	--	--	--
M-37	ARK RIV AT BAXTER	77-07-19	--	--	--	--	--	--	--	--	--
M-36	ARK RIV AT DEVINE	77-07-19	--	--	--	--	--	--	--	--	--
M-35	ARK RIV AT 40TH LN	77-07-19	--	--	--	--	--	--	--	--	--
M-34	ARK RIV NR AVONDALE	77-07-19	--	--	--	--	--	--	--	--	--
M-33	ARK RIV AT AVONDALE	77-07-19	--	--	--	--	--	--	--	--	--
M-32	ARK R AT COLO CANAL	77-07-19	--	--	--	--	--	--	--	--	--
M-31	ARK R AT RF HIGHLIN	77-07-19	--	--	--	--	--	--	--	--	--
M-30	ARK RIV NR NEPESTA	77-07-19	--	--	--	--	--	--	--	--	--
M-29	ARK RIV AT FOWLER	77-07-19	--	--	--	--	--	--	--	--	--
M-28	ARK RIVER AT CATLIN	77-07-14	50	560	380	170	210	0	1.5	30	520
M-27	ARK R AT MANZANOLA	77-07-14	--	--	--	--	--	--	--	--	--
M-26	ARK AT FT LYON STOR	77-07-14	--	--	--	--	--	--	--	--	--
M-25	ARK RIV NR ORDWAY	77-07-14	--	--	--	--	--	--	--	34	--
M-24	ARK R NR ROCKY FORD	77-07-14	--	--	--	--	--	--	--	--	--
M-23	ARK RIV AT SWINK	77-07-14	--	--	--	--	--	--	--	--	--
M-22	ARK AT FT LYON CAN	77-07-14	--	--	--	--	--	--	--	--	--
M-21	ARK RIV AT LA JUNTA	77-07-14	85	970	750	220	270	0	2.2	53	1000
M-20	ARK RIV NR BENTS FT	77-07-14	--	--	--	--	--	--	--	--	--
M-19	ARK RIVER AT HADLEY	77-07-14	--	--	--	--	--	--	--	89	--
M-18	ARK AT CONSOLID CAN	77-07-14	--	--	--	--	--	--	--	--	--
M-17	ARK R AT LAS ANIMAS	77-07-13	150	1500	1300	200	240	0	2.4	140	2100
M-16	ARK R AB PURGATOIRE	77-07-13	--	--	--	--	--	--	--	--	--
M-15	ARK AT FT LYON HOSP	77-07-13	--	--	--	--	--	--	--	--	--
M-14	ARK R BL JOHN MARTIN	77-07-13	160	1500	1300	230	280	0	2.2	130	2000
M-13	ARK BL FT BENT CAN	77-07-13	--	--	--	--	--	--	--	--	--
M-12	ARK RIV AB PROWERS	77-07-13	--	--	--	--	--	--	--	--	--
M-11	ARK RIV AT PROWERS	77-07-13	--	--	--	--	--	--	--	150	--
M-10	ARK RIV NR WILEY	77-07-13	--	--	--	--	--	--	--	--	--
M- 9	ARK AB LAMAR CANAL	77-07-13	--	--	--	--	--	--	--	--	--
M- 8	ARK RIVER AT LAMAR	77-07-13	220	1800	1600	230	280	0	3.6	160	2700
M- 7	ARK AB BIG SANDY C	77-07-12	--	--	--	--	--	--	--	170	--
M- 6	ARK RIV NR GROTE	77-07-12	--	--	--	--	--	--	--	--	--
M- 5	ARK RIV NR GRANADA	77-07-12	--	--	--	--	--	--	--	160	--
M- 4	ARK RIV NR AMITY	77-07-12	--	--	--	--	--	--	--	--	--
M- 3	ARK RIV AT HOLLY	77-07-12	--	--	--	--	--	--	--	190	--
M- 2	ARK AT FRONTIER DCH	77-07-12	--	--	--	--	--	--	--	--	--
M- 1	ARK R NR COOLIDGE	77-07-12	--	--	--	--	--	--	--	--	--

TABLE 10.—WATER-QUALITY DATA AT ARKANSAS RIVER SITES, JULY 1977—CONTINUED

SITE NO. ON PLATE 1	SITE NAME	DATE OF SAMPLE	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	IRON, DISSOLVED (UG/L AS FE)	MANGANESE, DISSOLVED (UG/L AS MN)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)
M-41	ARK RIV AB PUEBLO	77-07-19	--	--	--	--	--	--	--
M-40	ARK RIV AT SANTA FE	77-07-19	--	--	--	--	--	--	--
M-39	ARK RIV NR 23RD LN	77-07-19	--	--	--	--	--	--	--
M-38	ARK RIV NR 28TH LN	77-07-19	--	--	--	--	--	--	--
M-37	ARK RIV AT BAXTER	77-07-19	--	--	--	--	--	--	--
M-36	ARK RIV AT DEVINE	77-07-19	--	--	--	--	--	--	--
M-35	ARK RIV AT 40TH LN	77-07-19	--	--	--	--	--	--	--
M-34	ARK RIV NR AVONDALE	77-07-19	--	--	--	--	--	--	--
M-33	ARK RIV AT AVONDALE	77-07-19	--	--	--	--	--	--	--
M-32	ARK R AT COLO CANAL	77-07-19	--	--	--	--	--	--	--
M-31	ARK R AT RF HIGHLIN	77-07-19	--	--	--	--	--	--	--
M-30	ARK RIV NR NEPESTA	77-07-19	--	--	--	--	--	--	--
M-29	ARK RIV AT FOWLER	77-07-19	--	--	--	--	--	--	--
M-28	ARK RIVER AT CATLIN	77-07-14	1.0	8.7	<10	20	957	1.5	0.100
M-27	ARK R AT MANZANOLA	77-07-14	--	--	--	--	--	--	--
M-26	ARK AT FT LYON STOR	77-07-14	--	--	--	--	--	--	--
M-25	ARK RIV NR ORDWAY	77-07-14	--	--	--	--	--	2.0	--
M-24	ARK R NR ROCKY FORD	77-07-14	--	--	--	--	--	--	--
M-23	ARK RIV AT SWINK	77-07-14	--	--	--	--	--	--	--
M-22	ARK AT FT LYON CAN	77-07-14	--	--	--	--	--	--	--
M-21	ARK RIV AT LA JUNTA	77-07-14	1.2	12	<10	50	1740	4.0	.040
M-20	ARK RIV NR BENTS FT	77-07-14	--	--	--	--	--	--	--
M-19	ARK RIVER AT HADLEY	77-07-14	--	--	--	--	--	3.2	--
M-18	ARK AT CONSOLID CAN	77-07-14	--	--	--	--	--	--	--
M-17	ARK R AT LAS ANIMAS	77-07-13	1.2	11	<10	60	3370	.77	.010
M-16	ARK R AB PURGATOIRE	77-07-13	--	--	--	--	--	--	--
M-15	ARK AT FT LYON HOSP	77-07-13	--	--	--	--	--	--	--
M-14	ARK R BL JOHN MARTIN	77-07-13	1.1	4.2	<10	280	3240	.01	<.010
M-13	ARK BL FT BENT CAN	77-07-13	--	--	--	--	--	--	--
M-12	ARK RIV AB PROWERS	77-07-13	--	--	--	--	--	--	--
M-11	ARK RIV AT PROWERS	77-07-13	--	--	--	--	--	.80	--
M-10	ARK RIV NR WILEY	77-07-13	--	--	--	--	--	--	--
M- 9	ARK AB LAMAR CANAL	77-07-13	--	--	--	--	--	--	--
M- 8	ARK RIVER AT LAMAR	77-07-13	1.3	9.1	20	230	4260	.03	.010
M- 7	ARK AB BIG SANDY C	77-07-12	--	--	--	--	--	1.2	--
M- 6	ARK RIV NR GROTE	77-07-12	--	--	--	--	--	--	--
M- 5	ARK RIV NR GRANADA	77-07-12	--	--	--	--	--	1.7	--
M- 4	ARK RIV NR AMITY	77-07-12	--	--	--	--	--	--	--
M- 3	ARK RIV AT HOLLY	77-07-12	--	--	--	--	--	3.2	--
M- 2	ARK AT FRONTIER DCH	77-07-12	--	--	--	--	--	--	--
M- 1	ARK R NR COOLIDGE	77-07-12	--	--	--	--	--	--	--

TABLE 11.—WATER-QUALITY DATA AT ARKANSAS RIVER SITES, 1978 IRRIGATION SEASON

(CFS=CUBIC FOOT PER SECOND; DEG C=DEGREES CELSIUS; UMHOS=MICROMHOS PER CENTIMETER AT 25 DEGREES CELSIUS; MG/L=MILLIGRAMS PER LITER; COLS./100 ML=COLONIES PER 100 MILLILITERS; VALUES PRECEDED BY K INDICATE THE COLONY COUNT WAS BASED ON A NON-IDEAL BACTERIA PLATE; VALUES EXCEEDING WATER-QUALITY STANDARDS ARE UNDERLINED)

SITE NO. ON PLATE 1	SITE NAME	DATE OF SAMPLE	TIME	STREAM-FLOW, INSTAN-TANEOUS (CFS)	TEMPER-ATURE (DEG C)	SPE-CIFIC CON-DUCT-ANCE (UMHOS)	OXYGEN DIS-SOLVED (MG/L)	PH (UNITS)	COLI-FORM, FECAL, 0.7 UM-MF (COLS./100 ML)	STREP-TOCOCCI FECAL, KF AGAR (COLS. PER 100 ML)
M-41	ARK RIV AB PUEBLO	78-04-18	0800	122	10.5	745	10.4	7.9	<2	K50
		78-05-15	1030	112	14.0	520	11.0	8.1	K15	180
		78-06-20	0900	2950	17.0	200	6.1	7.2	K160	K100
		78-07-25	0740	937	22.0	320	8.0	7.3	K32	K67
		78-08-23	0715	940	18.0	340	7.8	7.7	K2	K10
		78-09-18	0730	156	19.5	460	8.1	8.1	K2	83
M-34	ARK RIV NR AVONDALE	78-04-18	0915	214	10.5	955	9.0	7.7	>100	4100
		78-05-15	1130	179	24.0	1050	8.4	7.6	1900	K250
		78-06-20	1030	2880	17.0	240	5.8	8.0	--	—
		78-07-25	0930	1000	22.0	440	7.2	7.5	1300	K360
		78-08-23	0830	630	21.0	500	6.5	7.5	520	250
		78-09-18	0900	220	18.0	790	6.0	7.6	K180	340
M-30	ARK RIV NR NEPESTA	78-04-18	1000	83	10.0	1050	10.6	8.0	K47	K100
		78-05-15	1230	109	27.0	1180	7.1	8.0	300	130
		78-06-20	1130	2450	18.5	280	7.0	8.0	K29000	1200
		78-07-25	1005	644	25.0	420	7.1	7.3	1100	640
		78-08-23	1340	81	31.0	610	6.2	7.8	K12	44
		78-09-18	0945	125	16.5	840	6.8	8.0	79	110
M-21	ARK RIV AT LA JUNTA	78-04-18	1115	6.0	16.5	2430	10.4	8.0	K20	—
		78-05-15	1345	5.0	31.5	2800	8.8	8.0	140	86
		78-06-20	1230	904	22.0	530	4.0	7.7	920	800
		78-07-25	1115	490	25.0	850	6.8	7.5	K15000	11000
		78-08-23	1515	11	34.0	2600	7.5	8.2	340	K270
		78-09-18	1100	3.7	19.5	2700	11.6	7.9	180	K210
M-17	ARK R AT LAS ANIMAS	78-04-18	1215	9.0	19.0	3670	9.4	8.1	K23	720
		78-05-15	1430	7.8	30.5	4050	8.0	8.1	88	110
		78-06-20	1330	484	22.0	600	6.8	7.2	1100	K500
		78-07-25	1220	313	28.0	1100	7.0	7.8	3300	3300
		78-08-23	1600	14	33.0	3400	7.2	8.0	K50	3300
		78-09-18	1200	6.9	27.0	3500	7.8	7.9	K150	110
M-14	ARK R BL JOHN MARTIN	78-04-18	1320	4.1	10.0	3790	11.4	7.8	K20	K200
		78-05-15	1530	31	23.5	4150	9.8	8.0	58	220
		78-06-20	1430	415	21.0	725	9.0	7.6	2000	2400
		78-07-25	1315	295	28.0	1100	7.8	7.8	K4500	760
		78-08-23	1645	27	26.5	3700	9.0	8.1	K58	630
		78-09-18	1300	15	20.0	3600	11.0	8.0	K42	K140
M- 8	ARK RIVER AT LAMAR	78-04-18	1415	7.4	13.5	4420	11.6	8.1	K7	1600
		78-05-15	1615	10	25.0	5100	11.6	8.2	100	140
		78-06-20	1530	234	23.0	940	5.2	7.8	2900	K17000
		78-07-25	1400	48	28.0	1500	6.7	7.8	K1500	5500
		78-08-23	1730	6.4	29.0	4100	11.6	8.2	K30	160
		78-09-18	1400	4.3	23.0	4000	13.2	8.1	K1600	K7000
M- 1	ARK R NR COOLIDGE	78-04-18	1515	16	12.5	4300	9.7	8.1	K3	980
		78-05-15	1730	16	26.0	5070	9.0	8.1	350	5400
		78-06-20	1640	411	23.5	1380	7.0	7.8	K1500	2500
		78-07-25	1515	27	32.0	2300	8.0	8.1	K110	K600
		78-08-23	1045	11	24.0	3900	9.5	7.9	350	3000
		78-09-18	1515	3.4	24.0	4300	10.6	8.0	K50	3100

TABLE 12.--WATER-QUALITY DATA AT FOUR IRRIGATION-RETURN FLOW SITES, 1978 IRRIGATION SEASON

(CFS=CUBIC FOOT PER SECOND; DEG C=DEGREES CELSIUS; UMHOS=MICROMHOS PER CENTIMETER AT 25 DEGREES CELSIUS; MG/L=MILLIGRAMS PER LITER; COLS./100 ML=COLONIES PER 100 MILLILITERS; VALUES PRECEEDED BY K INDICATE THE COLONY COUNT WAS BASED ON A NON-IDEAL BACTERIA PLATE; VALUES EXCEEDING WATER QUALITY STANDARDS ARE UNDERLINED).

SITE NO. ON PLATE 1	SITE NAME	DATE OF SAMPLE	TIME	STREAM-FLOW, INSTAN-TANEOUS (CFS)	TEMPER-ATURE (DEG C)	SPE-CIFIC CON-DUCT-ANCE (UMHOS)	OXYGEN, DIS-SOLVED (MG/L)	PH (UNITS)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	NITRO-GEN,AM-MONIA + ORGANIC TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)
IR-31	ROCKY FORD DRAIN	78-03-16	1615	10	14.5	2250	7.8	7.5	63	7.7	5.0
		78-04-20	1200	13	15.5	2400	8.6	7.6	61	4.6	10
		78-05-17	1230	17	18.5	2140	7.2	7.6	56	4.3	5.9
		78-06-22	1330	21	24.0	1520	4.4	7.3	44	6.2	4.8
		78-07-28	1130	22	22.5	1640	6.8	7.7	41	3.4	5.9
		78-08-25	1400	12	19.0	2170	6.8	7.9	56	3.5	6.9
		78-09-20	1030	14	12.0	2080	7.6	7.7	31	2.9	5.3
IR-15	EAST LAMAR DRAIN	78-03-16	1300	.10	14.0	3900	13.0	8.0	140	.71	.08
		78-04-20	0900	1.0	11.0	4200	9.2	7.7	130	1.6	4.9
		78-05-17	0930	.40	16.0	4000	7.6	7.9	86	.75	<.10
		78-07-28	0915	3.0	19.0	3220	5.2	7.8	110	1.9	2.0
		78-08-25	1100	1.2	18.0	3700	9.0	7.9	130	.61	1.1
		78-09-20	0800	.60	12.0	3400	3.4	7.8	100	1.4	2.3
IR-10	GRANADA DR AT MTH	78-04-20	0800	2.7	7.5	5300	12.2	7.9	200	2.3	7.8
		78-05-17	0830	8.7	14.0	5350	11.5	7.9	180	2.6	6.1
		78-06-22	0930	4.1	20.0	3550	6.2	7.8	120	3.2	8.6
		78-07-28	0830	11	18.0	3700	5.3	7.9	140	2.5	5.9
		78-08-25	1000	8.6	21.0	4900	10.6	8.4	180	1.2	8.0
		78-09-19	1700	1.9	20.0	5350	15.6	8.3	110	1.9	7.6
T- 1	SIXMILE CR AT HWY50	78-03-17	1200	3.2	12.0	2800	12.4	8.1	32	.57	6.2
		78-04-20	1400	2.5	18.0	2690	12.8	8.0	27	.40	8.4
		78-05-17	1400	2.1	20.0	2750	8.8	8.1	25	.90	5.5
		78-06-22	1530	4.6	25.0	1990	9.4	7.9	19	.91	2.6
		78-07-28	1330	2.3	27.5	2520	7.1	8.4	29	.82	5.5
		78-08-25	1600	2.3	23.0	2650	8.8	8.0	31	.78	5.2
		78-09-20	1330	2.0	15.0	2700	9.9	7.9	9.6	.68	6.7

TABLE 12.—WATER-QUALITY DATA AT FOUR IRRIGATION-RETURN FLOW SITES, 1978 IRRIGATION SEASON—CONTINUED

SITE NO. ON PLATE 1	SITE NAME	DATE OF SAMPLE	PHOS-PHORUS, ORTHO, TOTAL (MG/L AS P)	PHOS-PHORUS, TOTAL (MG/L AS P)	SOLIDS, RESIDUE AT 105 DEG. C, SUS-PENDED (MG/L)	OXYGEN DEMAND, BIO-CHEM-ICAL, 5 DAY (MG/L)	COLI-FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML)	STREP-TOCOCCI FECAL, KF AGAR (COLS. PER 100 ML)
IR-31	ROCKY FORD DRAIN	78-03-16	0.01	0.23	110	28	K35	10000
		78-04-20	.05	.23	141	8.0	K3	1900
		78-05-17	.05	.39	254	17	<4	3400
		78-06-22	.01	.79	854	14	K1600	K3000
		78-07-28	.13	.97	446	12	6400	12000
		78-08-25	.02	.21	166	9.5	K920	7800
		78-09-20	.02	.08	38	13	680	17000
IR-15	EAST LAMAR DRAIN	78-03-16	<.01	.04	26	1.9	K5	210
		78-04-20	.63	.66	23	7.3	K7	1300
		78-05-17	.01	.08	27	9.5	K20	K190
		78-06-22	.01	.08	52	2.8	160	400
		78-07-28	.16	.23	28	12	1200	6000
		78-08-25	.01	.08	59	3.0	370	100
		78-09-20	.13	.20	10	7.6	660	20000
IR-10	GRANADA DR AT MTH	78-04-20	1.70	1.80	39	>7.4	22	2900
		78-05-17	.29	.61	198	13	K200	6000
		78-06-22	.11	.60	45	13	<10	200
		78-07-28	.17	.49	314	15	K1400	K14000
		78-08-25	.05	.17	53	11	1200	22000
		78-09-19	.08	.24	49	11	K5500	10000
T- 1	SIXMILE CR AT HWY50	78-03-17	<.01	.02	7	.8	K4	160
		78-04-20	.02	.03	20	.8	K6	K77
		78-05-17	.01	.05	14	1.6	K280	110
		78-06-22	.01	.06	30	2.0	K180	200
		78-07-28	.02	<.01	32	2.0	400	380
		78-08-25	<.01	.04	21	1.4	2000	1300
		78-09-20	<.01	.01	4	1.2	120	870

TABLE 13.—DAILY PRECIPITATION IN THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 IRRIGATION SEASON

U.S. GEOLOGICAL SURVEY RAIN GAGE 2 MILES NORTHWEST OF HOLLY

DAY	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT
	DAILY PRECIPITATION (INCHES)							
1	---	0.00	0.15	0.00	0.00	0.00	0.00	0.00
2	---	.00	.02	.10	.00	.00	.00	.00
3	---	.00	.33	.40	.00	.90	.00	.00
4	---	.00	.40	1.94	.00	.07	.00	.00
5	---	.00	1.25	.45	.00	.00	.00	.00
6	---	.00	.37	.00	.00	.00	.00	.00
7	---	.00	.12	.02	.00	.00	.00	.00
8	---	.00	.00	.00	.00	.00	.00	.00
9	---	.00	.00	.00	.07	.00	.00	.00
10	---	.00	.00	.00	.10	.00	.00	.00
11	---	.00	.00	.00	.00	.00	.00	.00
12	---	.00	.00	.00	.00	.00	.00	.00
13	---	.00	.00	.00	.00	.00	.00	.00
14	---	.00	.00	.00	.00	.00	.00	.00
15	---	.00	.00	.00	.02	.00	.00	.00
16	0.00	.00	.00	.00	.02	.00	.00	.00
17	.00	.00	.27	.00	.00	.00	.00	.00
18	.00	.00	.00	.03	.00	.00	.00	.00
19	.00	.00	.00	.00	.00	.00	.00	.00
20	.00	.00	.00	.00	.00	.00	.08	.32
21	.00	.00	.00	.00	.00	.00	.00	.00
22	.00	.00	.00	.00	.00	.00	.00	.00
23	.00	.00	.00	.00	.00	.00	.00	.00
24	.00	.00	.00	.00	.00	.00	.00	.00
25	.00	.00	.00	.00	.00	.00	.05	.00
26	.00	.00	.00	.00	.00	.00	.02	.00
27	.00	.00	1.10	.62	.00	.00	.00	.00
28	.00	.00	.00	.00	.00	.00	.00	.00
29	.00	.02	.00	.00	.00	.57	.00	.00
30	.00	2.19	.00	.00	.22	.10	.00	.00
31	.00	---	.00	---	.00	.00	---	.00
TOTAL	.00	2.21	4.01	3.67	.43	1.64	.15	.32

TABLE 13.--DAILY PRECIPITATION IN THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 IRRIGATION SEASON—CONTINUED

NATIONAL WEATHER SERVICE RAIN GAGE AT HOLLY

DAY	DAILY PRECIPITATION (INCHES)							
	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT
1	---	0.00	1.12	0.04	0.00	0.00	0.00	0.00
2	---	.00	0.08	.00	.00	.00	.00	.00
3	---	.00	.40	.41	.00	.80	.00	.00
4	---	.00	.00	1.19	.00	.06	.00	.00
5	---	.00	.38	.43	.00	.00	.00	.00
6	---	.00	1.71	.65	.02	.00	.00	.00
7	---	.00	.06	.00	.00	.00	.00	.00
8	---	.00	.08	.00	.00	.00	.00	.00
9	---	.00	.00	.00	.00	.00	.00	.00
10	---	.00	.00	.00	.32	.00	.10	.00
11	---	.00	.00	.00	.12	.00	.00	.00
12	---	.00	.00	.00	.00	.00	.00	.00
13	---	.00	.00	.00	.00	.00	.00	.00
14	---	.00	.00	.00	.00	.00	.00	.00
15	---	.04	.00	.00	.00	.00	.00	.00
16	0.02	.00	.00	.00	.10	.00	.00	.00
17	.00	.02	.00	.00	.00	.00	.00	.00
18	.00	.00	.69	.03	.00	.00	.00	.00
19	.00	.00	.00	.00	.00	.00	.00	.00
20	.00	.00	.00	.00	.00	.00	.00	.00
21	.00	.00	.00	.00	.00	.00	.00	.53
22	.00	.00	.00	.00	.00	.00	.00	.00
23	.00	.00	.00	.00	.00	.00	.00	.00
24	.00	.00	.00	.00	.00	.00	.00	.05
25	.00	.00	.00	.00	.00	.00	.02	.00
26	.00	.00	.00	.00	.00	.00	.02	.00
27	.00	.01	.00	.25	.00	.00	.00	.00
28	.00	.00	1.27	.00	.00	.00	.00	.00
29	.00	.00	.00	.00	.00	.73	.00	.00
30	.00	.78	.00	.00	.32	.47	.00	.00
31	.00	---	.00	---	.06	.00	---	.00
TOTAL	.02	.85	5.79	3.00	.94	2.06	.14	.58

TABLE 14.—MEAN DAILY AIR TEMPERATURE IN THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 IRRIGATION SEASON

NATIONAL WEATHER SERVICE STATION AT HOLLY

DAY	MEAN DAILY TEMPERATURE (DEGREES FAHRENHEIT)							
	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT
1	---	67	57	69	74	74	76	68
2	---	62	42	64	79	76	71	71
3	---	63	38	61	77	69	72	62
4	---	58	41	62	85	63	70	55
5	---	60	48	62	88	68	74	58
6	---	55	39	62	85	68	78	50
7	---	62	44	65	79	77	78	49
8	---	65	49	64	88	76	74	57
9	---	66	56	68	78	74	68	59
10	---	49	60	76	70	74	69	61
11	---	41	73	75	68	69	82	61
12	---	61	69	78	79	75	76	62
13	---	51	54	70	82	76	73	60
14	---	57	67	78	77	87	68	49
15	---	53	71	82	81	73	67	49
16	35	48	70	80	83	78	74	52
17	37	47	68	78	82	87	72	56
18	51	45	51	72	86	78	65	56
19	50	49	64	74	82	74	72	48
20	58	46	65	81	85	74	58	55
21	49	55	62	70	79	81	47	59
22	56	55	58	74	80	74	48	53
23	52	48	67	81	70	74	55	41
24	31	57	81	87	73	83	54	46
25	42	50	75	91	78	82	63	58
26	42	64	72	88	81	87	59	38
27	51	65	74	78	78	79	65	50
28	55	62	70	75	81	72	66	50
29	58	64	71	79	86	70	67	54
30	61	63	72	82	76	64	61	59
31	67	---	74	---	75	70	---	45

TABLE 15.--DAILY STREAMFLOW IN THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 IRRIGATION SEASON

WEST HOLLY DRAIN AT MOUTH

MEAN DAILY DISCHARGE
(CUBIC FEET PER SECOND)

DAY	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT
1	---	1.0	4.6	1.7	13	18	6.3	1.7
2	---	0.74	4.0	1.6	12	17	5.0	2.3
3	---	.42	4.0	3.5	10	27	5.4	1.4
4	---	.42	3.8	140	12	25	4.0	1.4
5	---	.36	15	67	14	22	2.9	1.5
6	---	1.5	28	41	12	20	4.6	1.4
7	---	1.9	5.0	24	14	22	3.8	1.6
8	---	1.7	4.1	17	17	19	6.8	1.3
9	---	1.1	3.3	11	11	17	9.0	0.94
10	---	1.9	2.8	9.3	10	16	10	1.6
11	---	4.1	3.0	7.8	9.3	16	8.2	1.7
12	---	3.8	3.7	7.0	13	14	7.3	1.2
13	---	3.8	3.6	5.4	14	15	5.2	1.7
14	---	4.0	3.5	3.8	15	15	6.3	1.5
15	---	2.8	3.2	5.8	14	20	4.5	1.6
16	1.8	6.0	2.9	5.4	11	16	5.1	1.5
17	0.90	5.1	3.5	6.2	12	15	4.1	1.4
18	.36	4.2	4.9	6.5	16	14	3.9	.51
19	.26	4.7	5.1	7.0	18	13	4.7	.57
20	.60	4.4	3.9	8.3	16	11	5.0	.44
21	.36	4.0	5.7	12	17	10	5.6	.40
22	.36	4.3	6.0	15	18	9.8	5.8	1.1
23	.73	4.2	5.8	13	16	11	2.6	1.3
24	1.2	2.4	7.6	13	17	10	1.1	1.2
25	.90	2.5	6.2	15	16	8.9	.95	1.2
26	.67	2.1	4.4	12	14	7.2	2.5	1.4
27	.14	2.6	13	15	15	4.6	2.9	1.4
28	.17	3.7	12	17	14	4.3	1.8	1.1
29	.17	3.5	2.4	18	11	4.1	1.2	.76
30	.21	8.6	2.1	15	14	4.1	1.4	.51
31	.26	---	1.9	---	15	6.3	---	.53
MEAN	.56	3.06	5.77	17.5	13.9	13.9	4.60	1.23

TABLE 15.--DAILY STREAMFLOW IN THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 IRRIGATION SEASON—CONTINUED

BUFFALO CANAL NEAR AMITY

MEAN DAILY DISCHARGE (CUBIC FEET PER SECOND)

DAY	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT
1	---	3.7	19	18	55	69	47	1.3
2	---	2.4	20	23	55	58	31	1.2
3	---	4.8	13	39	53	94	22	1.2
4	---	5.1	11	90	43	83	21	1.1
5	---	5.7	34	86	43	62	20	1.3
6	---	5.8	64	74	48	72	13	1.2
7	---	7.8	18	29	52	65	15	2.0
8	---	7.6	18	25	47	61	15	1.1
9	---	8.0	31	21	55	46	14	2.6
10	---	7.9	19	19	43	37	19	2.1
11	---	30	31	13	50	47	15	0.87
12	---	32	29	25	44	51	15	.96
13	---	48	18	27	46	46	16	.96
14	---	46	11	30	36	49	11	.78
15	---	57	6.7	19	35	47	9.0	.96
16	10	45	13	23	39	34	6.5	.96
17	9.5	34	33	26	41	28	6.2	.96
18	10	27	40	24	51	26	5.7	.82
19	12	23	28	24	51	28	4.8	.77
20	9.6	20	25	25	47	29	5.2	.59
21	8.8	16	24	54	45	26	5.5	.62
22	8.3	14	30	71	42	25	6.2	.64
23	8.1	14	55	65	45	27	4.8	.57
24	8.8	12	45	69	52	24	4.0	.62
25	8.4	11	35	62	51	18	5.7	.58
26	8.2	9.7	42	53	45	18	4.2	.73
27	7.4	9.3	57	70	48	13	4.3	.73
28	7.0	8.2	38	73	52	13	2.4	1.5
29	7.0	7.5	27	57	48	16	1.7	1.2
30	7.3	15	23	60	44	36	1.2	.68
31	6.5	---	19	---	46	52	---	.78
MEAN	8.6	17.9	28.3	43.2	46.9	41.9	11.7	1.04

TABLE 15.--DAILY STREAMFLOW IN THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 IRRIGATION SEASON—CONTINUED

BUFFALO CANAL NEAR HOLLY

MEAN DAILY DISCHARGE
(CUBIC FEET PER SECOND)

DAY	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT
1	---	2.0	0.34	9.7	17	12	20	0.07
2	---	0.72	4.5	12	18	8.8	17	.13
3	---	1.3	2.4	19	16	38	18	1.8
4	---	1.1	4.1	60	19	35	13	1.9
5	---	1.0	17	40	21	27	6.3	1.8
6	---	2.1	30	18	20	28	7.4	2.1
7	---	4.8	9.7	15	19	33	11	1.4
8	---	3.3	9.7	11	25	32	12	1.1
9	---	3.9	15	6.5	34	16	7.8	2.9
10	---	2.3	10	5.7	30	7.9	7.8	2.7
11	---	12	15	3.2	33	16	3.4	2.4
12	---	12	15	13	28	21	0.33	.27
13	---	13	9.7	15	26	15	.10	.20
14	---	13	6.5	13	11	15	1.3	.17
15	---	21	4.6	5.3	15	23	2.4	.77
16	0.03	13	5.2	9.9	10	18	2.2	2.1
17	.17	8.0	17	16	6.2	3.5	1.8	2.4
18	.00	2.5	19	14	5.5	4.7	1.5	.23
19	.00	4.3	11	12	5.3	5.5	1.5	.11
20	.00	5.6	12	11	1.0	8.9	1.5	.91
21	.00	6.9	13	19	2.0	7.9	1.6	1.5
22	.00	2.9	15	31	0.27	6.1	2.4	1.0
23	.00	.43	26	18	.94	12	4.0	1.4
24	.00	.93	22	17	1.5	18	1.6	2.7
25	.00	.97	16	9.8	2.1	13	4.3	4.7
26	.00	.53	19	13	2.7	23	3.5	.36
27	.00	.08	27	22	8.4	13	3.6	.17
28	.00	.04	19	18	26	10	4.3	1.3
29	.00	.02	13	12	23	8.6	1.9	2.
30	.25	.79	12	21	13	15	.10	2.3
31	.03	---	10	---	11	23	---	.02
MEAN	.03	4.68	12.9	16.3	14.5	17.0	5.45	1.39

TABLE 15.--DAILY STREAMFLOW IN THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 IRRIGATION SEASON--CONTINUED

CALCULATED TRIBUTARY INFLOW

MEAN DAILY DISCHARGE
(CUBIC FEET PER SECOND)

DAY	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT
1	---	0.98	0.98	0.98	9.9	0.98	1.8	2.6
2	---	.98	.98	.98	8.1	.98	2.1	2.6
3	---	.98	.98	.98	8.1	.98	2.1	2.6
4	---	.98	.98	400	9.9	.98	2.1	2.6
5	---	2.8	.98	100	14	.98	2.6	3.0
6	---	4.3	.98	40	14	.98	2.6	3.0
7	---	4.7	.98	20	2.1	.98	2.6	3.3
8	---	4.7	.98	10	14	.98	2.6	3.7
9	---	4.7	.98	5.4	9.9	.98	2.6	3.7
10	---	4.9	.98	.98	12	.98	2.6	4.0
11	---	4.7	.98	.98	9.9	.98	2.6	4.0
12	---	.98	.98	.98	14	.98	2.6	4.4
13	---	.98	.98	.98	7.6	.98	3.0	4.4
14	---	.98	.98	.98	6.0	.98	3.0	4.9
15	---	.98	.98	3.1	4.4	.98	3.0	5.2
16	0.98	.98	.98	3.1	3.3	.98	3.0	5.2
17	.98	.98	.98	6.4	2.1	.98	3.0	5.7
18	.98	.98	.98	4.8	2.1	.98	3.0	5.3
19	.98	.98	.98	8.1	1.8	.98	3.0	5.3
20	.98	2.1	.98	6.4	1.8	.98	3.0	4.9
21	.98	9.9	.98	8.2	1.8	.98	3.0	4.4
22	.98	6.4	.98	9.9	1.3	.98	3.0	4.0
23	.98	.98	.98	14	1.3	.98	3.0	3.7
24	.98	.98	.98	2.8	0.98	.98	3.0	3.3
25	.98	4.8	.98	12	.98	.98	3.0	3.0
26	.98	9.9	.98	1.1	.98	1.3	3.0	3.0
27	.98	4.8	.98	1.1	.98	1.3	2.6	2.6
28	.98	4.8	.98	1.3	.98	1.3	2.6	2.1
29	.98	3.3	.98	1.3	.98	1.8	2.6	1.8
30	.98	3.3	.98	.98	.98	1.8	2.6	1.3
31	.98	---	.98	---	.98	1.8	---	0.98
MEAN	.98	3.1	.98	22	5.4	1.1	2.7	3.6

TABLE 16.--WATER LEVELS IN AND NEAR THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 AND 1979

LOCAL WELL NUMBER	ELEVATION OF MEASURING POINT (FEET ABOVE SEA LEVEL)	DATE	ELEVATION OF WATER LEVEL (FEET ABOVE SEA LEVEL)
SC02204336DDD	3482.01	78-03-10	3404.29
		78-04-19	3400.66
		78-05-16	3402.07
		78-06-21	3393.74
		78-07-26	3393.00
		78-08-24	3386.20
		78-09-19	3385.89
		78-10-17	3384.28
		78-11-13	3377.41
		79-03-09	3406.75
SC02304204BCB	3506.82	78-03-10	3407.22
		78-05-16	3404.01
		78-06-21	3404.38
		78-07-26	3403.72
		78-09-19	3395.89
		78-10-17	3392.62
		78-11-13	3389.99
		79-03-09	3401.72
SC02304204DCA	3467.78	78-03-10	3398.07
		78-05-16	3393.02
		78-06-21	3396.89
		78-07-26	3397.56
		78-08-24	3396.69
		78-11-13	3392.40
		79-03-09	3396.68
SC02304205ABB	3499.98	78-03-10	3407.36
		78-06-21	3404.13
		78-08-24	3403.79
		78-10-17	3404.01
		78-11-13	3399.23
		79-03-09	3406.28
SC02304206ABB	3540.29	78-03-10	3407.41
		78-06-21	3404.05
		78-07-26	3404.24
		78-09-19	3401.70
		78-10-17	3392.37
		78-11-13	3389.72
		79-03-09	3399.34

TABLE 16.--WATER LEVELS IN AND NEAR THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 AND 1979--CONTINUED

LOCAL WELL NUMBER	ELEVATION OF MEASURING POINT (FEET ABOVE SEA LEVEL)	DATE	ELEVATION OF WATER LEVEL (FEET ABOVE SEA LEVEL)
SC02304206CCC	3432.84	78-03-10	3411.83
		78-04-19	3412.45
		78-05-16	3413.46
		78-06-21	3413.86
		78-07-26	3414.66
		78-08-24	3414.30
		78-09-19	3413.54
		78-10-17	3412.88
		78-11-13	3412.52
		79-03-09	3411.42
SC02304207ACD	3415.71	78-03-10	3405.22
		78-05-16	3406.47
		78-06-21	3406.67
		78-08-24	3406.97
		78-09-19	3405.09
		78-10-17	3405.91
		78-11-13	3405.58
		79-03-09	3404.76
SC02304207CBB	3419.17	78-03-10	3410.02
		78-05-16	3410.95
		78-06-21	3411.46
		78-09-19	3408.94
		78-10-17	3410.43
		78-11-13	3410.19
		79-03-09	3409.47
SC02304208BBB	3428.91	78-03-10	3404.28
		78-04-19	3404.09
		78-05-16	3404.04
		78-06-21	3404.11
		78-07-26	3404.09
		78-08-24	3401.96
		78-09-19	3402.78
		78-10-17	3399.86
		78-11-13	3399.63
		79-03-09	3403.65

TABLE 16.--WATER LEVELS IN AND NEAR THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 AND 1979--CONTINUED

LOCAL WELL NUMBER	ELEVATION OF MEASURING POINT (FEET ABOVE SEA LEVEL)	DATE	ELEVATION OF WATER LEVEL (FEET ABOVE SEA LEVEL)
SC02304208CAA	3413.19	78-03-10	3399.77
		78-04-19	3399.76
		78-05-16	3400.65
		78-06-21	3400.73
		78-07-26	3401.29
		78-09-19	3400.57
		78-10-17	3400.35
		78-11-13	3401.07
		79-03-09	3399.35
SC02304208CBB	3412.36	78-03-10	3402.53
		78-04-19	3403.04
		78-05-16	3403.68
		78-06-21	3403.91
		78-07-26	3403.87
		78-08-24	3404.15
		78-09-19	3404.21
		78-10-17	3403.22
		78-11-13	3403.09
		79-03-09	3402.15
SC02304209BBB	3426.23	78-03-10	3398.74
		78-05-16	3396.59
		78-06-21	3398.28
		78-07-26	3398.92
		78-10-17	3390.88
		78-11-13	3395.44
		79-03-09	3398.16
SC02304209DAA	3414.47	78-03-10	3395.75
		78-04-19	3394.77
		78-05-16	3394.50
		78-06-21	3396.02
		78-07-26	3395.86
		78-08-24	3395.77
		78-09-19	3393.18
		78-10-17	3393.58
		78-11-13	3393.43
		79-03-09	3395.16

TABLE 16.--WATER LEVELS IN AND NEAR THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 AND 1979--CONTINUED

LOCAL WELL NUMBER	ELEVATION OF MEASURING POINT (FEET ABOVE SEA LEVEL)	DATE	ELEVATION OF WATER LEVEL (FEET ABOVE SEA LEVEL)
SC02304211BBB	3459.40	78-03-10	3401.20
		78-08-24	3397.44
		78-10-17	3398.97
		78-11-13	3399.15
		79-03-09	3399.84
SC02304211DCC	3420.21	78-03-10	3390.93
		78-04-19	3391.62
		78-05-16	3391.63
		78-06-21	3392.26
		78-07-26	3391.83
		78-08-24	3392.25
		78-09-19	3391.71
		78-10-17	3390.61
		78-11-13	3390.33
		79-03-09	3390.14
SC02304216ADD	3396.24	78-03-10	3386.77
		78-04-19	3387.35
		78-05-16	3387.64
		78-06-21	3387.98
		78-07-26	3388.24
		78-09-19	3386.21
		78-10-17	3386.12
		78-11-13	3386.82
		79-03-09	3386.85
SC02304216BBB	3400.11	78-03-10	3393.53
		78-04-19	3394.14
		78-05-16	3394.14
		78-06-21	3394.77
		78-09-19	3394.04
		78-10-17	3393.76
		78-11-13	3393.57
		79-03-09	3393.43
SC02304217CAA	3405.80	78-03-10	3395.28
		78-06-21	3397.56
		78-09-19	3392.93
		78-10-17	3395.57
		78-11-13	3395.26
		79-03-09	3395.27

TABLE 16.--WATER LEVELS IN AND NEAR THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 AND 1979--CONTINUED

LOCAL WELL NUMBER	ELEVATION OF MEASURING POINT (FEET ABOVE SEA LEVEL)	DATE	ELEVATION OF WATER LEVEL (FEET ABOVE SEA LEVEL)
SC02304217CBB	3409.12	78-03-10	3399.01
		78-04-19	3398.77
		78-06-21	3401.06
		78-09-19	3399.57
		78-10-17	3399.25
		78-11-13	3399.00
		79-03-09	3398.94
SC02304303DDA	3438.28	78-03-10	3426.42
		78-05-16	3424.03
		78-07-26	3428.26
		78-11-13	3422.20
		79-03-09	3426.49
SC02304310AAB	3439.93	78-03-10	3427.99
		78-05-16	3425.92
		78-07-26	3429.58
		78-11-13	3423.95
		79-03-09	3427.90
SC02304310ACC	3441.96	78-03-10	3428.90
		78-04-19	3428.69
		78-05-16	3429.08
		78-06-21	3429.67
		78-07-26	3429.63
		78-08-24	3429.41
		78-09-19	3429.14
		78-10-17	3425.93
		78-11-13	3426.18
		79-03-09	3426.88
SC02304310BBB	3444.52	78-03-10	3433.61
		78-04-19	3432.05
		78-06-21	3433.65
		78-10-17	3431.85
		78-11-13	3429.82
		79-03-09	3433.56

TABLE 16.--WATER LEVELS IN AND NEAR THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 AND 1979--CONTINUED

LOCAL WELL NUMBER	ELEVATION OF MEASURING POINT (FEET ABOVE SEA LEVEL)	DATE	ELEVATION OF WATER LEVEL (FEET ABOVE SEA LEVEL)
SC02304311BBB	3437.60	78-03-10	3425.91
		78-04-19	3422.94
		78-05-16	3423.55
		78-06-21	3425.02
		78-07-26	3427.88
		78-08-24	3426.40
		78-09-19	3423.58
		78-10-17	3421.81
		78-11-13	3421.90
		79-03-09	3425.82
SC02304311BCB	3434.69	78-03-10	3425.52
		78-05-16	3424.32
		78-07-26	3427.79
		78-10-17	3423.03
		78-11-13	3422.41
		79-03-09	3425.22
SC02304311DCB	3430.92	78-03-10	3420.04
		78-04-19	3420.02
		78-05-16	3420.09
		78-06-21	3421.15
		78-08-24	3421.39
		78-09-19	3420.22
		78-10-17	3419.40
		78-11-13	3419.25
		79-03-09	3419.71
SC02304312CCB	3428.24	78-03-10	3417.31
		78-05-16	3417.64
		78-06-21	3419.09
		78-07-26	3418.66
		78-09-19	3417.41
		78-10-17	3416.87
		78-11-13	3416.67
		79-03-09	3416.53
SC02304312DBC	3424.56	78-03-10	3413.13
		78-04-19	3413.76
		78-05-16	3413.49
		78-06-21	3413.17
		78-08-24	3415.14
		78-10-17	3413.23
		78-11-13	3413.17
		79-03-09	3412.67

TABLE 16.--WATER LEVELS IN AND NEAR THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 AND 1979--CONTINUED

LOCAL WELL NUMBER	ELEVATION OF MEASURING POINT (FEET ABOVE SEA LEVEL)	DATE	ELEVATION OF WATER LEVEL (FEET ABOVE SEA LEVEL)
SC02304313AAB	3418.24	78-03-10	3409.46
		78-04-19	3410.31
		78-05-16	3409.80
		78-06-21	3411.21
		78-07-26	3411.34
		78-08-24	3410.48
		78-09-19	3409.71
		78-10-17	3409.48
		78-11-13	3409.38
		79-03-09	3408.99
SC02304313BBB	3424.52	78-03-10	3416.07
		78-04-19	3416.48
		78-05-16	3416.34
		78-06-21	3417.56
		78-07-26	3418.12
		78-08-24	3417.39
		78-09-19	3416.41
		78-10-17	3416.02
		78-11-13	3416.00
		79-03-09	3415.75
SC02304313CAA	3419.70	78-03-10	3409.24
		78-04-19	3408.88
		78-05-16	3408.62
		78-06-21	3411.38
		78-10-17	3409.83
		78-11-13	3409.36
		79-03-09	3409.19
SC02304314BAD	3430.10	78-03-10	3419.36
		78-04-19	3419.10
		78-05-16	3419.33
		78-06-21	3420.60
		78-10-17	3418.68
		78-11-13	3418.57
		79-03-09	3419.17

TABLE 16.--WATER LEVELS IN AND NEAR THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 AND 1979--CONTINUED

LOCAL WELL NUMBER	ELEVATION OF MEASURING POINT (FEET ABOVE SEA LEVEL)	DATE	ELEVATION OF WATER LEVEL (FEET ABOVE SEA LEVEL)
SC02304314DBA	3428.28	78-03-10	3415.76
		78-04-19	3415.87
		78-05-16	3416.26
		78-06-21	3417.72
		78-10-17	3415.51
		78-11-13	3415.30
		79-03-09	3415.69

TABLE 17.--CALCULATED GROUND-WATER PUMPAGE IN THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 IRRIGATION SEASON

CALCULATED DAILY GROUND WATER PUMPAGE (ACRE-FEET)

DAY	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT
1	---	33	23	1.5	26	32	1.0	16
2	---	33	15	0.0	6.0	32	2.3	30
3	---	48	9.3	.0	0.0	27	16	28
4	---	59	6.8	.0	.0	27	19	28
5	---	60	0.0	.0	.0	27	22	28
6	---	55	.0	.0	.0	31	44	28
7	---	54	.0	.0	.0	32	44	28
8	---	54	.0	.0	.0	32	44	28
9	---	37	1.6	.0	.0	32	54	28
10	---	30	.0	.0	.0	29	57	26
11	---	21	.0	.0	2.0	28	57	14
12	---	16	.0	.0	9.3	25	60	14
13	---	16	.0	.0	9.3	34	60	14
14	---	31	.0	9.1	10	21	57	14
15	---	51	.0	15	9.3	19	59	14
16	0.0	55	.0	15	11	42	58	12
17	.0	60	.0	27	15	38	58	12
18	.0	60	.0	29	23	37	53	26
19	.0	61	.0	29	23	39	54	26
20	.0	55	.0	29	23	53	53	27
21	.0	54	.0	7.0	26	58	39	41
22	5.9	54	.0	.0	25	58	40	41
23	5.9	54	.0	.0	25	61	44	41
24	.0	61	.0	.0	33	61	45	43
25	7.7	66	.0	.0	34	59	46	41
26	18	51	.0	.0	50	53	48	41
27	18	48	.0	4.5	52	35	47	27
28	18	48	.0	24	47	33	42	26
29	28	39	15	32	59	19	34	26
30	33	25	29	37	70	6.7	25	20
31	33	---	29	---	50	5.0	---	14
MEAN	10.1	46.3	4.2	8.6	20.6	35.0	42.7	25.9

TABLE 18.--DAILY MEAN SPECIFIC CONDUCTANCE IN THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 IRRIGATION SEASON

WEST HOLLY DRAIN AT MOUTH

MEAN DAILY SPECIFIC CONDUCTANCE
(MICROMHOS PER CENTIMETER AT 25 DEGREES CELSIUS)

DAY	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT
1	---	4730	3960	5800	3720	4860	3540	6150
2	---	5130	4810	5400	3800	4100	3560	6210
3	---	4710	4700	2700	3900	3590	3970	6330
4	---	4650	4670	600	4100	3050	4160	6320
5	---	4650	3460	1400	4210	2900	4520	6120
6	---	6000	2220	1800	4330	3270	4870	6050
7	---	5770	3180	2500	4320	3360	5420	5970
8	---	5830	5490	2700	3640	3370	5560	6000
9	---	5800	5860	3450	3900	3720	5480	6180
10	---	6050	6090	4900	4130	3880	5430	6030
11	---	6180	6340	5000	4470	4160	5490	6110
12	---	5870	6390	5110	3660	4560	5530	6110
13	---	4200	5810	5260	3840	4750	5560	6130
14	---	4400	5820	5320	4050	4860	5650	6220
15	---	4480	6010	4000	4590	4680	5630	6230
16	4770	4470	6150	2980	5200	4820	5420	6230
17	4690	4680	5690	3090	4480	4970	5310	6300
18	4600	4950	4970	3040	4000	4790	5240	6500
19	4590	5090	5310	3090	4030	4710	5050	6290
20	4540	5030	5340	3030	4140	4680	4890	6490
21	4580	4960	5700	2980	4390	4640	4870	6570
22	4680	4850	5630	2270	4530	4610	4930	6370
23	4770	4740	5480	2300	4720	4520	5140	6390
24	4770	4840	5180	2300	4470	4420	5370	6640
25	4730	4890	5030	2200	4450	5370	5610	6750
26	4660	4910	5310	2650	4670	5340	5820	6790
27	4650	4830	5260	2350	4600	5320	5910	6480
28	4730	4370	3760	2380	4630	5130	6080	6010
29	4580	4230	5100	2570	4830	4850	6220	6120
30	4650	3080	5000	3100	4970	4650	6120	6240
31	4730	---	5600	---	5040	3840	---	6250
MEAN	4670	4950	5140	3210	4320	4380	5210	6280

TABLE 18.--DAILY MEAN SPECIFIC CONDUCTANCE IN THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 IRRIGATION SEASON--CONTINUED

BUFFALO CANAL NEAR AMITY

MEAN DAILY SPECIFIC CONDUCTANCE
(MICROMHOS PER CENTIMETER AT 25 DEGREES CELSIUS)

DAY	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT
1	---	4590	3920	4580	1760	1830	1530	5330
2	---	4520	4350	4710	1800	1370	2470	5500
3	---	4680	4490	3390	2160	1400	3180	5650
4	---	4690	2660	1010	2510	1350	3150	5800
5	---	4630	1710	1100	2360	1440	3560	5540
6	---	5450	2330	1380	2150	1710	3750	5550
7	---	5120	2910	1760	2090	1850	4100	5770
8	---	5150	3600	1850	2120	2260	4060	5720
9	---	5360	3730	2400	1750	2700	4170	5700
10	---	5160	4560	3800	2340	3170	4230	5650
11	---	4270	4730	3900	1930	3340	4320	5580
12	---	4360	4760	4000	1490	3560	4390	5530
13	---	3700	4370	4160	2160	3610	4530	5460
14	---	4280	4380	4200	2320	3700	4650	5400
15	---	4320	4510	2250	2720	3630	4640	5390
16	4620	4320	4500	1950	3170	3910	4610	5350
17	4540	4410	4480	2050	2210	4020	4680	5340
18	4630	4540	3460	2010	2720	4300	4710	5400
19	4620	4600	3930	2050	2590	4300	4920	5380
20	4570	4740	4410	2000	2720	4420	4830	5370
21	4610	4670	4430	1950	3030	4530	4880	5360
22	4700	4620	4720	1800	3370	4620	4880	5200
23	4800	4620	4860	1800	3010	4660	4860	5300
24	4820	4750	3790	1710	2090	4430	4840	5300
25	4800	4840	3850	1630	2730	4320	4670	5300
26	4770	4890	3810	1680	2620	4370	4650	5300
27	4730	4730	3340	1270	2540	4300	4880	5400
28	4690	3740	4110	1290	2640	4370	5050	5360
29	4620	3430	4210	1450	3250	4250	5210	5400
30	4580	3460	4470	1680	3360	3720	5230	5400
31	4510	---	4530	---	3780	1910	---	5400
MEAN	4660	4550	4000	2360	2490	3330	4320	5460

TABLE 19.--WATER-QUALITY ANALYSES IN THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 IRRIGATION SEASON

(CFS=CUBIC FEET PER SECOND; DEG C=DEGREES CELSIUS; UMHOS=MICROMHOS PER CENTIMETER AT 25 DEGREES CELSIUS; MG/L=MILLIGRAMS PER LITER; COLS/100 ML=COLONIES PER 100 MILLILITERS; VALUES PRECEEDED BY K INDICATE THE COLONY COUNT WAS BASED ON A NON-IDEAL BACTERIA PLATE; SITE: SW=SURFACE WATER; GW=GROUND WATER; VALUES EXCEEDING WATER-QUALITY STANDARDS ARE UNDERLINED).

SITE NAME	SITE	DATE OF SAMPLE	TIME	STREAM-FLOW, INSTAN-TANEOUS (CFS)	TEMPER-ATURE (DEG C)	SPE-CIFIC CON-DUCT-ANCE (UMHOS)	OXYGEN, DIS-SOLVED (MG/L)	PH (UNITS)	SODIUM, DIS-SOLVED (MG/L AS NA)	POTAS-SIUM, DIS-SOLVED (MG/L AS K)
WEST HOLLY DRAIN AT MOUTH	SW	78-03-16	1130	2.7	5.0	4950	12.7	8.0	--	—
		78-04-07	1000	2.9	11.0	5750	11.8	7.8	860	17
		78-04-19	1700	2.9	16.0	5300	12.8	8.1	--	—
		78-05-04	0900	3.6	8.5	5250	14.4	7.7	670	16
		78-05-16	1400	2.9	22.0	6400	14.4	8.2	--	—
		78-06-05	1600	46	18.0	1570	6.6	7.9	180	12
		78-06-22	0800	18	20.0	2440	6.8	7.8	--	—
		78-07-11	1400	9.3	27.0	4560	9.8	7.9	590	14
		78-07-27	1330	14	27.0	4400	12.6	8.0	--	—
		78-08-09	1500	17	26.5	4000	6.0	7.7	480	14
		78-08-25	0800	11	18.0	5800	8.1	8.0	--	—
		78-09-07	0930	5.2	17.0	5700	9.5	8.0	730	15
		78-09-19	1200	4.6	15.0	5400	12.4	8.1	--	—
		78-10-04	1500	1.5	21.0	6810	16.2	8.2	1100	18
		78-10-18	1100	.40	11.0	6940	16.6	8.3	--	—
		78-11-02	1200	.33	17.0	6000	18.6	8.4	1000	15
BUFFALO CANAL NEAR AMITY	SW	78-04-07	0800	8.9	9.5	5130	11.3	8.0	730	12
		78-04-19	1530	23	16.5	4700	9.0	8.1	--	—
		78-05-04	1130	9.7	13.0	4680	11.2	8.3	540	15
		78-05-16	1600	17	25.0	4740	10.1	8.3	--	—
		78-06-06	1000	—	17.0	1400	7.2	7.5	140	19
		78-06-21	1500	74	24.5	1640	7.2	7.9	--	—
		78-07-11	1700	52	27.0	1570	6.6	8.1	150	9.3
		78-07-27	1530	50	28.0	2680	6.2	7.9	--	—
		78-08-10	0900	41	20.5	3180	7.8	7.5	340	11
		78-08-24	1700	23	27.0	4500	7.6	8.0	--	—
		78-09-06	1400	13	24.0	4000	7.8	8.0	450	12
		78-09-16	1400	13	—	—	—	—	--	—
		78-09-19	1500	5.8	20.0	5000	10.2	8.2	--	—
		78-10-05	0930	1.3	9.0	5400	12.2	8.1	710	13
		78-10-18	0930	.70	8.0	6000	11.7	8.2	--	—
		78-11-02	0900	1.0	10.0	5700	11.4	8.1	780	14
SC02304207ACD	GW	78-07-26	1445	—	15.0	6280	—	7.0	970	17
SC02304207CBB	GW	78-07-26	1515	—	14.5	5680	—	6.9	830	15
SC02304208BBB	GW	78-09-14	1530	—	15.0	4500	—	7.1	510	9.6
SC02304208CAA	GW	78-08-09	1030	—	14.0	6000	—	6.9	750	12
SC02304209BBB	GW	78-07-27	1700	—	15.5	4220	—	6.9	440	13
SC02304209DAA	GW	78-07-12	1400	—	15.5	3280	—	7.0	360	12
SC02304216BBB	GW	78-07-26	1345	—	14.5	6410	—	6.9	1000	12
SC02304303DDA	GW	78-06-21	1200	—	13.5	6200	—	7.2	910	18
SC02304311BCC	GW	78-06-21	1100	—	13.0	5600	—	7.1	800	13
SC02304311DCB	GW	78-07-25	1730	—	15.0	5550	—	7.1	770	14
SC02304312CCB	GW	78-08-09	1215	—	13.0	6000	—	6.9	790	13
SC02304312DBC	GW	78-07-12	1000	—	15.0	6150	—	7.0	860	13

TABLE 19.--WATER-QUALITY ANALYSES IN THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 IRRIGATION SEASON--CONTINUED

SITE NAME	DATE OF SAMPLE	CALCIUM DIS- SOLVED (MG/L AS CA)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG)	HARD- NESS (MG/L AS CACO3)	HARD- NESS, NONCAR- BONATE (MG/L CACO3)	ALKA- LINITY FIELD (MG/L AS CACO3)	BICAR- BONATE FET-FLD (MG/L AS HCO3)	CAR- BONATE FET-FLD (MG/L AS CO3)	CARBON DIOXIDE DIS- SOLVED (MG/L AS CO2)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL)
WEST HOLLY DRAIN AT MOUTH	78-03-16	--	--	--	--	--	--	--	--	180
	78-04-07	310	250	1800	1500	303	370	0	9.4	230
	78-04-19	--	--	--	--	--	--	--	--	190
	78-05-04	410	240	2000	1700	303	370	0	12	170
	78-05-16	--	--	--	--	--	--	--	--	250
	78-06-05	120	53	520	290	230	280	0	5.6	48
	78-06-22	--	--	--	--	--	--	--	--	77
	78-07-11	310	200	1600	1300	250	310	0	6.2	180
	78-07-27	--	--	--	--	--	--	--	--	200
	78-08-09	300	170	1500	1200	250	300	0	9.6	150
	78-08-25	--	--	--	--	--	--	--	--	45
	78-09-07	330	230	1800	1500	300	360	0	5.8	140
	78-09-19	--	--	--	--	--	--	--	--	130
	78-10-04	310	280	1900	1700	250	310	0	3.1	260
	78-10-18	--	--	--	--	--	--	--	--	290
	78-11-02	180	290	1600	1400	260	320	0	2.0	230
BUFFALO CANAL NEAR AMITY	78-04-07	290	200	1500	1300	238	290	0	4.6	190
	78-04-19	--	--	--	--	--	--	--	--	160
	78-05-04	380	220	1900	1600	246	300	0	2.4	170
	78-05-16	--	--	--	--	--	--	--	--	170
	78-06-06	110	46	460	250	213	260	0	13	41
	78-06-21	--	--	--	--	--	--	--	--	45
	78-07-11	140	53	570	400	160	200	0	2.5	52
	78-07-27	--	--	--	--	--	--	--	--	85
	78-08-10	280	130	1200	1000	220	270	0	14	100
	78-08-24	--	--	--	--	--	--	--	--	35
	78-09-06	310	160	1400	1200	210	260	0	4.2	75
	78-09-16	--	--	--	--	--	--	--	--	--
	78-09-19	--	--	--	--	--	--	--	--	100
	78-10-05	370	270	2000	1800	270	330	0	4.2	230
	78-10-18	--	--	--	--	--	--	--	--	240
	78-11-02	370	230	1900	1600	254	310	--	--	220
SC02304207ACD	78-07-26	350	260	1900	1600	370	--	--	--	240
SC02304207CBB	78-07-26	340	250	1900	1500	340	--	--	--	200
SC02304208BBB	78-09-14	340	180	1600	1400	230	--	--	--	80
SC02304208CAA	78-08-09	350	260	1900	1700	260	--	--	--	230
SC02304209BBB	78-07-27	310	200	1600	1300	250	--	--	--	130
SC02304209DAA	78-07-12	350	130	1400	1200	190	--	--	--	110
SC02304216BBB	78-07-26	360	270	2000	1700	340	--	--	--	260
SC02304303DDA	78-06-21	290	320	2000	2000	--	--	--	--	290
SC02304311BCC	78-06-21	320	44	980	630	350	--	--	--	230
SC02304311DCB	78-07-25	350	210	1700	1400	300	--	--	--	240
SC02304312CCB	78-08-09	360	230	1800	1500	300	--	--	--	250
SC02304312DBC	78-07-12	340	260	1900	1600	330	--	--	--	270

TABLE 19.—WATER-QUALITY ANALYSES IN THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 IRRIGATION SEASON—CONTINUED

SITE NAME	DATE OF SAMPLE	SULFATE DIS-SOLVED (MG/L AS SO4)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	NITRO-GEN, AM-MONIA + ORGANIC TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	PHOS-PHORUS, DIS-SOLVED (MG/L AS P)	PHOS-PHORUS, ORTHO, TOTAL (MG/L AS P)	PHOS-PHORUS, TOTAL (MG/L AS P)
WEST HOLLY DRAIN AT MOUTH	78-03-16	—	—	2.7	2.7	—	0.02	0.12
	78-04-07	3100	0.9	1.2	2.9	—	.02	.05
	78-04-19	—	—	.75	3.7	—	.02	.10
	78-05-04	2900	.7	1.3	1.4	—	.02	.04
	78-05-16	—	—	.87	1.5	—	<.01	.06
	78-06-05	630	.5	4.6	1.3	—	.08	1.20
	78-06-22	—	—	4.1	1.8	—	.04	1.10
	78-07-11	2200	1.0	1.7	2.8	—	.01	.09
	78-07-27	—	—	6.7	3.0	—	.02	.03
	78-08-09	2000	.8	1.6	2.3	—	.05	.27
	78-08-25	—	—	.97	4.3	—	<.01	.09
	78-09-07	2900	.9	1.6	2.6	—	.02	.06
	78-09-19	—	—	.90	2.9	—	.01	.04
	78-10-04	3700	1.1	1.1	1.7	0.01	<.01	.05
	78-10-18	—	—	.94	1.8	—	.01	.02
	78-11-02	3100	1.0	1.0	1.7	.01	<.01	.01
BUFFALO CANAL NEAR AMITY	78-04-07	2700	.9	.83	1.9	—	.02	.02
	78-04-19	—	—	.80	2.8	—	.13	.16
	78-05-04	2500	.9	.89	2.1	—	.01	.04
	78-05-16	—	—	1.0	.95	—	.01	.11
	78-06-06	530	.6	13	2.9	—	.12	2.70
	78-06-21	—	—	15	1.5	—	.03	2.90
	78-07-11	670	.6	5.4	1.2	—	.09	2.90
	78-07-27	—	—	5.4	2.1	—	.11	1.90
	78-08-10	1500	.8	1.9	2.0	—	.04	.47
	78-08-24	—	—	.71	2.4	—	<.01	.09
	78-09-06	2100	.9	1.5	2.1	—	.01	.26
	78-09-16	—	—	—	—	—	—	—
	78-09-19	—	—	.89	3.0	—	.01	.04
	78-10-05	3000	.9	.77	4.9	<.01	<.01	.01
	78-10-18	—	—	.94	4.4	—	.01	<.01
	78-11-02	2900	.8	1.1	3.6	.01	.01	.01
SC02304207ACD	78-07-26	3300	.9	.97	4.3	—	.04	.01
SC02304207CBB	78-07-26	3000	1.2	.82	4.3	—	.03	<.01
SC02304208BBB	78-09-14	2300	.6	.60	5.2	—	.01	.02
SC02304208CAA	78-08-09	3000	.6	.71	9.8	—	.03	.01
SC02304209BBB	78-07-27	2000	.9	.77	5.0	—	.03	<.01
SC02304209DAA	78-07-12	1600	.7	.53	2.5	—	<.01	.01
SC02304216BBB	78-07-26	3400	.7	1.4	4.5	—	.02	<.01
SC02304303DDA	78-06-21	3400	1.5	1.0	5.5	—	.02	.02
SC02304311BCC	78-06-21	1700	.7	.84	3.0	—	.02	.01
SC02304311DCB	78-07-25	2800	.8	.84	4.1	—	.05	<.01
SC02304312CCB	78-08-09	2900	.5	.54	2.9	—	.02	<.01
SC02304312DBC	78-07-12	3000	.8	.82	3.1	—	.01	.01

TABLE 19.--WATER-QUALITY ANALYSES IN THE INTENSIVE STUDY AREA NEAR HOLLY, 1978 IRRIGATION SEASON--CONTINUED

SITE NAME	DATE OF SAMPLE	SOLIDS, RESIDUE AT 105 DEG. C, SUS-PENDED (MG/L)	OXYGEN DEMAND, BIO-CHEM-ICAL, 5 DAY (MG/L)	COLI-FORM, FECAL, 0.7 UM-MF (COLS./100 ML)	STREP-TOCOCCI FECAL, KF AGAR (COLS. PER 100 ML)
WEST HOLLY DRAIN AT MOUTH	78-03-16	51	4.8	<5	3400
	78-04-07	11	4.0	230	4400
	78-04-19	33	3.9	K60	>5000
	78-05-04	12	1.5	K68	--
	78-05-16	13	2.9	66	K400
	78-06-05	1600	11	≥30000	>30000
	78-06-22	1590	13	<10	K180
	78-07-11	127	4.1	K210	K850
	78-07-27	44	11	K900	1900
	78-08-09	230	5.3	K250	6900
	78-08-25	81	6.0	570	>5000
	78-09-07	165	4.7	1400	51000
	78-09-19	20	4.1	490	33000
	78-10-04	29	3.2	150	390
	78-10-18	10	2.1	460	640
	78-11-02	11	2.0	40	120
BUFFALO CANAL NEAR AMITY	78-04-07	2	1.5	230	820
	78-04-19	81	4.5	52	K500
	78-05-04	22	1.9	58	--
	78-05-16	63	6.0	K140	200
	78-06-06	788	25	≥30000	11000
	78-06-21	8580	18	K10	K50
	78-07-11	2140	8.3	K800	9500
	78-07-27	1740	8.5	2600	8800
	78-08-10	956	4.0	K300	4900
	78-08-24	54	5.5	210	250
	78-09-06	160	3.7	K640	12000
	78-09-16	--	--	--	--
	78-09-19	53	4.3	460	1100
	78-10-05	9	1.5	230	1800
	78-10-18	4	.9	340	250
	78-11-02	4	1.4	120	400
SC02304207ACD	78-07-26	10	.3	<2	<2
SC02304207CBB	78-07-26	13	.2	<2	<2
SC02304208BBB	78-09-14	0	.4	<1	<1
SC02304208CAA	78-08-09	0	.3	--	--
SC02304209BBB	78-07-27	4	.3	<2	<2
SC02304209DAA	78-07-12	2	.9	<1	--
SC02304216BBB	78-07-26	17	.4	<2	<2
SC02304303DDA	78-06-21	--	.1	<1	K1
SC02304311BCC	78-06-21	--	.1	<1	<1
SC02304311DCB	78-07-25	0	.3	<2	K2
SC02304312CCB	78-08-09	0	.4	<2	<2
SC02304312DBC	78-07-12	1	1.0	<1	--