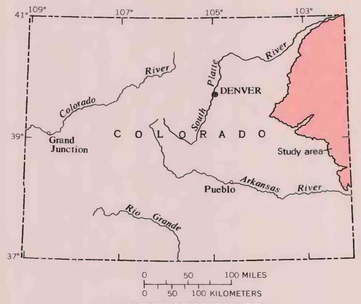
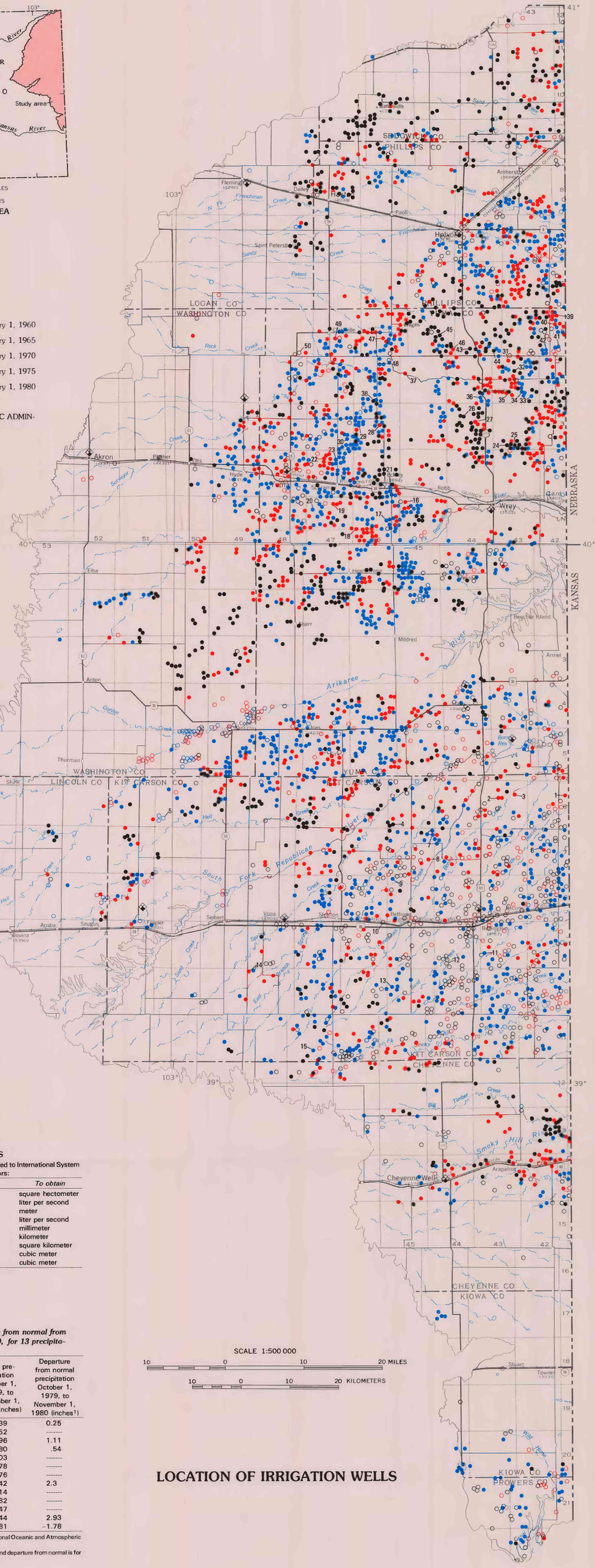


LOCATION OF STUDY AREA

EXPLANATION

IRRIGATION WELLS

- Drilled before January 1, 1950
- Drilled between January 1, 1950 and January 1, 1960
- Drilled between January 1, 1960 and January 1, 1965
- Drilled between January 1, 1965 and January 1, 1970
- Drilled between January 1, 1970 and January 1, 1975
- Drilled between January 1, 1975 and January 1, 1980
- 35 Number by well is number of well in table 1
- NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION PRECIPITATION STATION



SCALE 1:500 000
10 0 10 20 MILES
10 0 10 20 KILOMETERS

LOCATION OF IRRIGATION WELLS

CONVERSION FACTORS

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

Multiply	*By*	*To obtain*
acre	0.4047	square hectometer
cubic foot per minute	0.4719	liter per second
foot	0.3048	meter
gallon per minute	0.06309	liter per second
inch	25.4	millimeter
mile	1.609	kilometer
square mile	2.590	square kilometer
gallon	0.003785	cubic meter
cubic foot	0.02832	cubic meter

Table 2.—*Total precipitation and departure from normal from October 1, 1979, to September 30, 1980, for 13 precipitation stations*

Precipitation station	Total precipitation October 1, 1979, to November 1, 1980 (inches)	Departure from normal precipitation October 1, 1979, to November 1, 1980 (inches[1])
Akron FAA AP	17.39	0.25
Bonny Lake (Bonny Reservoir)	25.52	------
Burlington	17.96	1.11
Cheyenne Wells	16.80	.54
Flagler 2NW	19.03	------
Fleming 1S	11.78	------
Genoa 1W	17.76	------
Holyoke	20.42	2.3
Idalia	20.14	------
Otis 11NE	15.82	------
Vona	20.47	------
Wray	21.44	2.93
Yuma[2]	15.81	-1.78

[1]Climatological standard normal based on 1941–70 (National Oceanic and Atmospheric Administration, October 1979 to October 1980).
[2]Record for February 1980 is missing. Total precipitation and departure from normal is for 11 months.

Table 1.—*Well and pumpage data for irrigation sites*

SITE NUMBER—Number adjacent to well on map showing the location of irrigation wells
STATION IDENTIFIER—A 15-digit number generated from the original latitude and longitude of the site in degrees, minutes, and seconds with a 2-digit sequence code at the end to locate multiple sites within a 1-second area. The station identifier is unique for each site and is not changed once it has been entered into the U.S. Geological Survey's computer files
CROP INFORMATION
TYPE—Type of crop(s) irrigated at the site. cn =corn; al =alfalfa; so =sorghum, wh =wheat, pa =pasture grasses
SYSTEM—Type of irrigation system used. f =flood; p =center pivot
ACRES—Number of acres irrigated at the site. The source of acreage information for sites denoted by (a) is the U.S. Department of Agriculture Agricultural Stabilization and Conservation Service. All other acreage information was reported by the land owner
WELL INFORMATION
DEPTH—Depth of well, in feet below land surface
WATER LEVEL—Depth to water, in feet below land surface. The source of water-level information for sites denoted by R is the well driller. All other water levels were measured by personnel of the U.S. Geological Survey
DATE—Date when water level was measured
POWER SOURCE—Source of energy for pump. e =electrical motor; n =natural-gas engine; d =diesel engine
ENERGY RATING—Electric-meter rate of electric-energy consumption of the pump, in kilowatts. Natural-gas rate consumption of the pump, in cubic feet per minute
DISCHARGE INFORMATION
DISCHARGE—Discharge, in gallons per minute, as measured with a transient-time meter
DATE—Date when measurement was made
TIME OF OPERATION—Number of hours that the pump operated during the 1980 growing season
TIME—Hours
SOURCE—v =vibration-time totalizer; f =time reported by farmer; m =computed from energy meter; i =computed from in-line flow meter
POWER-CONSUMPTION INFORMATION—Electric =kilowatt hours per 1,000 gallons of water. Natural gas =cubic feet of gas per 1,000 gallons of water
APPLICATION—Application of water in inches for 1980

Site number	Station Identifier	Crop information: Type	System	Acres	Well information: Depth (feet)	Water Level (feet)	Date measured	Power source	Energy rating	Discharge information: Discharge (gallons per minute)	Date measured	1980 Time of operation: Time (hours)	Source	Power-consumption information	1980 Application (inches)
1	393201102034200	cn	f	183	320	193R	3-19-1970	e	67.9	674 657	7-17-1980 8-1-1980	1300	m	1.8	10.5
2	393205102123800	cn	p	120	270	165.0	6-7-1980	n	18.2	506	7-15-1980	1130	m		[1]10.5
3	393230102103201	cn al	f	60 10	140	46.6 47.1	4-29-1980 10-8-1980	e	41	916	7-16-1980	903 180	m	0.7	30.4 [2]36.5
4	392913102280401	cn al	p	125(a) 125(a)	240	137R	2-10-1975	e	80.4	675	7-15-1980	1340 670	m+f	2.0	16.0 [2]8.0
5	392930103012000	cn	f	80	167	141R	10-3-1955	e	33.4	427	8-2-1980	1260	m	1.3	14.9
6	392642102064400	cn pa	p	127.5(a) 42.5	317	195.7	4-28-1980	n	12.2	596	8-2-1980	920	v	20.5	[3]7.1
7	392752102222800	al	f	80	295	164R	5-19-1969	n	-----	610	8-1-1980	1380	v+f	-----	23.2
8	392419102240900	cn so	p	38.67(a) 77.33	234	119.9	10-30-1980	n	9.7	629	7-16-1980	630	m	15.4	[3]7.6
9	392258102282500	cn wh	p	107 100	260	182.2 185.3	6-5-1980 10-7-1980	e	108.9	887	7-9-1980	840 420	v+f	2.0	15.4 [4]8.3
10	391805102294100	cn	f	40	236	182.3	6-5-1980	n	-----	239 152	7-15-1980 9-2-1980	1620	v	-----	17.4
11	391332102135100	cn	p	127(a)	335	212.1	10-2-1980	e	117.4	766 747 751 744	7-9-1980 7-14-1980 8-1-1980 8-20-1980	1470	m	2.6	19.3
12	391327102201600	al	p	124(a)	255	123.8 125.3	4-28-1980 10-6-1980	n	10.6	538	7-14-1980	1260	m+v	19.7	12.6
13	391109102280400	cn	f	75	300	193R	6-7-1967	n	8.1	480	7-16-1980	1250	v	16.9	17.6
14	391250102481000 391230102485000	cn	f	126	180 190	131R 148R	6-11-1969 3-7-1970	d d	-----	492 527 492	7-16-1980 8-9-1980 9-3-1980	2160	f	-----	[5]19.1
15	390400102394000	cn	f	135	227	140.9	6-4-1980	n	-----	600 547	7-16-1980 8-18-1980	1460	v	-----	13.7
16	400504102263000	cn	f	161.6(a)	340	62.7	2-16-1979	n	10	629	6-25-1980	1090	m	15.9	9.4
17	400143102281400	al	p	130	260	67.2	5-11-1979	e	66.7	973 1014	6-25-1980 8-13-1980	990	m+f	1.1	16.7
18	400142102323601	cn	p	140(a)	180	77	4-5-1979	e	68.4	990 962	6-25-1980 8-13-1980	960	m	1.2	14.8
19	400450102364000	cn	p	130(a)	325	109.6 111.7	6-10-1980 10-17-1980	n	-----	863	7-29-1980	1000	v+f	-----	14
20	400350102393000	cn	p	128(a)	312	139	5-4-1979	n	11.8	754 864 781	7-31-1980 8-15-1980 9-5-1980	780	m	14.8	10.7
21	400640102283000	cn	p	132(a)	300	48R	5-10-1967	n	9.4	676 765 786	6-26-1980 7-31-1980 9-5-1980	1170	v	12.7	14.6
22	400925102375001	cn	p	135	335	133	2-28-1979	n	8.6	701	7-31-1980	1140	v+f	12.3	13.1
23	400940102363000	cn	p	128(a)	360	121	4-4-1979	e	-----	744 818	6-27-1980 7-22-1980	1020	m+f	-----	13.7
24	401128102113801	al	p	130	326	42.2 43.6	4-29-1980 12-16-1980	e	71.3	907	7-17-1980	1700	m	1.3	26.2
25	401116102103101	cn	p	135	329	43.4	2-15-1979	e	63.8	1020	6-27-1980	1420	m	1.0	23.7
26	401331102175001	cn	p	121(a)	340	64.2 65.2	6-16-1980 10-29-1980	e	72.6	968	7-29-1980	660	m+f	1.2	11.6
27	401350102160000	cn	p	135(a)	280	58.0 59.9	6-16-1980 10-29-1980	e	68.8	834 806	6-24-1980 7-29-1980	107	m+f	1.4	14.3
28	401340102301000	cn	p	130(a)	384	112.5	5-8-1980	e	87.7	875 863	7-31-1980 8-11-1980	1110	v	1.7	16.4
29	401330102331000	cn	p	130	380	123.0	5-8-1980	e	-----	777 783	6-26-1980 8-11-1980	1000	v	-----	13.2
30	401210102341000	cn	p	137(a)	345	125.0 128.2	5-9-1980 10-28-1980	e	-----	829 807	6-26-1980 8-11-1980	1100	v	-----	14.6
31	402052102111801	cn	p	240	345	68.6 71.6	7-17-1980 10-9-1980	e	116.0	1523	7-18-1980	1060	m+f	1.3	14.8
32	401933102102801	al pa	p	60 65	330	62.3 63.7	5-6-1980 12-16-1980	e	72.0	939	7-18-1980	1200	v	1.3	19.4 18.5
33	401705102081000	cn	p	170	380	42.0 42.5	6-16-1980 10-29-1980	e	79.0	951	7-18-1980	1620	v+f	1.4	20.0
34	401730102092000	cn	p	185	365	61.4	10-29-1980	e	82.0	1057	7-18-1980	1480	v+f	1.3	18.7
35	401721102113101	al	p	200	305	44.2 45.0	4-29-1980 12-16-1980	d	-----	1133 1132	7-23-1980 8-14-1980	1270	v	-----	15.8
36	401630102150000	cn	p	130	357	60.8 61.0	6-17-1980 10-9-1980	e	70.5	1033 1057	6-24-1980 7-30-1980	840	m+f	1.1	15.0
37	401914102261601	al	p	130	360	133.8 134.5	5-7-1980 12-17-1980	e	84.3	952	7-24-1980	810	m	1.5	13.1
38	401607102305001	cn	p	130	420	129.6 131.4	4-9-1979 5-8-1980	e	86.4	855	6-27-1980	850	v	1.7	12.3
39	402543102050301	cn	p	110	349	40.6 43.6	6-17-1980 10-9-1980	e	54.4	863 802	7-17-1980 8-12-1980	1280	i+f	1.1	21.5
40	402428102050501	cn	p	240	325	60.3 62.4	6-17-1980 10-9-1980	e	-----	1371 1383	7-17-1980 8-12-1980	[6]1180	f	-----	14.9
41	402150102041000	cn	p	130	300	44.1 46.7	6-16-1980 10-9-1980	e	46.0	997 977	7-17-1980 8-12-1980	1010	m	0.8	17.0
42	402140102054000	cn	p	130	333	36.5 38.2	6-16-1980 10-9-1980	e	59.6	972 956	7-17-1980 8-12-1980	1530	m	1.0	25.1
43	402204102170101	al	p	220	355	95R	4-26-1976	e	131.3	1397	7-23-1980	1400	v	1.6	19.7
44	402121102133801	pa	p	94	304	93.6 97.5	5-6-1980 10-30-1980	e	89.1	937	8-12-1980	1160	m	1.6	25.7
45	402313102210401	cn	p	311	370	120R	3-24-1977	e	169.4	1670 1628	7-23-1980 8-14-1980	1560	v	1.7	18.4
46	402152102192201	cn	p	130	290	106.0 108.0	5-7-1980 10-9-1980	e	97.6	1144 1138	7-18-1980 8-14-1980	1490	m	1.4	20.9
47	402310102294500	al	p	257(a)	386	172.8 174.6	5-7-1980 12-17-1980	e	125.2	1112 1167	6-24-1980 7-30-1980	1970	m+f	1.8	19.3
48	402120102290000	cn	f+p	225	360	158.0 161.0	5-7-1980 10-28-1980	e	126.2	1154	7-30-1980	1400	v	1.8	15.9
49	402310102365701	cn	f+p	210	379	253.9 257.4	5-9-1980 10-10-1980	e	149.0	1150 1113	7-30-1980 8-26-1980	1290	m	2.2	15.4
50	402140102420000	cn	p	130(a)	320	226.1 234.3	5-9-1980 10-10-1980	e	70.2	497 483	7-30-1980 8-27-1980	1860	m	2.4	15.4

[1] This well supplied two pivots, but pumpage was recorded on only one.
[2] Two crops were irrigated from this well.
[3] Two crops were irrigated from the same pivot.
[4] Volunteer wheat was irrigated throughout the summer as pasture.
[5] Two wells supply this system.

INTRODUCTION

The northern High Plains of Colorado, an area of about 9,500 square miles in the eastern part of the State is underlain by the Ogallala Formation of late Tertiary age. The northern High Plains of Colorado extend from the Colorado State line on the east to the edge of the Ogallala Formation on the north, west, and south. The Ogallala Formation is an unconsolidated or partly consolidated deposit of sand, gravel, clay, silt, and caliche.

The Ogallala aquifer consists of the Ogallala Formation and overlying sediments and is the major source of water for irrigation as well as for industrial, municipal, and domestic use. The aquifer may not be able to supply enough water in the future to support irrigated agriculture to the same extent as today (1982) because of declining water levels caused by irrigation pumpage. Reliable information on well location and application rates is necessary to evaluate effects of ground-water withdrawals on the aquifer.

LOCATION OF IRRIGATION WELLS

About 430 irrigation wells were operated in the northern High Plains as of 1960. Between 1960 and 1970 about 1,800 additional irrigation wells were drilled, mostly in eastern Kit Carson County, southern Phillips County, and the southern and west-central part of Yuma County. The land in those areas is relatively flat and suitable for flood irrigation. Increasing use of center-pivot irrigation systems allowed land to be irrigated that is too hilly for flood irrigation. About 1,650 wells were drilled between 1970 and 1980, many of which were in hilly areas, such as extreme southeastern Phillips County, northeastern Yuma County, and southwestern Yuma County north of the Arikaree River.

Some of the wells shown on the well-location map may have been abandoned or may have been replaced with wells drilled more recently than those shown by the symbol. The primary source for information on irrigation-well location was the Colorado Department of Natural Resources, Division of Water Resources, Office of the State Engineer.

APPLICATION RATES FOR IRRIGATED CROPLAND

Well discharge was measured at 51 randomly selected irrigation wells in northern Yuma and Kit Carson Counties, Colo., during the summer of 1980. In addition to well-discharge measurements, which were made with a transient-time flow meter (Heimes and Luckey, 1980), information about crops, time of well operation, and power consumption was collected. The table (table 1) summarizing well and pumpage data lists data for crops, wells, well discharges, time of operation, power consumption and application rates for 51 wells at 50 irrigation sites. The irrigation sites with information in the table are shown and numbered on the map showing the location of irrigation wells. The total irrigation pumpage at a site was calculated by multiplying the time of pump operation by the measured discharge, or the average measured discharge, of the pump. The application rate was determined by dividing the total pumpage by the acres irrigated.

The average application for the 50 irrigation sites was 16.5 inches. The crops included in the average were corn (40 sites), alfalfa (11 sites), pasture (3 sites), sorghum (1 site), and wheat (1 site). Some wells irrigated more than one crop. The average application for corn was 16.2 inches based on information from 38 sites and for alfalfa was 19.1 inches based on information from 11 sites. Two corn sites were not included in the average because corn and a second crop were irrigated with water from the same well and insufficient data were available to determine the volume of water applied to each crop.

Precipitation records from October 1, 1979, to September 30, 1980, indicate that it was wetter than normal in most of Kit Carson and northern Yuma Counties so, although a farm operator using supplemental irrigation is not completely responsive in his irrigation practices to greater-than-normal precipitation, the average application rates may be less than in an average year (see table 2 showing precipitation and departure from normal). Precipitation at both the Wray and Holyoke stations was more than 2 inches greater than normal, indicating greater-than-normal precipitation for northeast Yuma County. Precipitation at the Yuma station was about 2 inches less than normal, though, indicating west-central Yuma County may have been drier than normal. Precipitation in northern Kit Carson County was greater than normal. Precipitation at Burlington was 1.11 inches greater than normal and, although records are not available to determine normal precipitation at Bonny Lake (Bonny Reservoir), the precipitation of 25.52 inches may have been about 7 inches greater than normal, based on normal precipitation at Wray and Burlington. Precipitation in southern Kit Carson County probably was slightly greater than normal, based on records at Burlington and Cheyenne Wells.

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Base from U.S. Geological Survey
State base map 1:500 000, 1969

LOCATION OF IRRIGATION WELLS AND APPLICATION RATES FOR IRRIGATED CROPLAND DURING 1980 IN THE NORTHERN HIGH PLAINS OF COLORADO

By
R. G. Borman and R. L. Reed

1984

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