IRRIGATION WATER USE
IN THE YAMPA RIVER BASIN

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This report provides an updated summary of irrigation water use in the Yampa River basin that reflects current conditions and relates irrigation use to total crop acreage and to current, historic and estimated virgin streamflows.

AN OPEN LETTER ON IRRIGATION
WATER USE IN THE YAMPA RIVER BASIN

Water planning at the basin or watershed level has been initiated by several groups in Colorado and other western states. Information is one of the most important commodities used by these groups in their deliberations. Many state agencies are charged with generating raw data in their area of responsibility, but they have little time or the resources necessary to distill this data into meaningful information.

The Colorado Division of Water Resources administers the state's water resources according to water rights decrees issued by the water courts. In carrying out their charge the various Division Engineers collect and assemble data documenting water use. Although summary information is published annually, few of the details regarding water use are available in an easily accessible form. The analysis contained in this report was designed to distill raw data from water records obtained from Water Division 6 of the Division of Water Resources into a document that provided an overview of irrigation water use. Particular emphasis was placed on the magnitude and timing of water use in the Yampa River basin as they relate to streamflows and irrigated acreage. This form of information should be helpful to participants in the basin-wide planning efforts in the Yampa basin and may even serve as a model for similar groups in other watersheds.

Sincerely,

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IRRIGATION WATER USE IN THE YAMPA RIVER BASIN

INTRODUCTION

Planning efforts to pursue integrated water resources management at the basin level are underway in the Yampa River basin in northern Colorado. The existing pattern of water use in the basin is heavily weighted toward irrigation, and the production obtained from this use is of significant importance to the economy of this region.

Public policy decisions that potentially decrease the overall magnitude of agricultural water use within the basin could impact significantly the economic health of the region. The purpose of this report is to provide information on the nature and importance of irrigation water use in the Yampa River basin including the magnitude and geographical distribution of water use, the timing of water use, and the type of crop production supported by irrigation.

OVERVIEW OF YAMPA RIVER BASIN

Yampa Basin Features

An extensive inventory of the land and water resources in the overall basin was compiled earlier through joint efforts of the Colorado Water Conservation Board and various agencies of the U.S. Department of Agriculture (CWCB, 1969). Additional information on water resources use in the basin was compiled and summarized more recently by Shen et al. (1985).

The Yampa River basin encompasses an area of approximately 9,500 square miles in south-central Wyoming and northwestern Colorado. This report emphasizes the Colorado portion of the basin (Figure 1), which includes an area of approximately 6,700 square miles (CWCB,1969). Most of the basin in Colorado occurs in Moffat and Routt counties, with a small amount of the drainage basin including Rio Blanco and Garfield counties.

The headwaters of the Yampa River originate in the Flat Tops and the Park Range of the Rocky Mountains. As the river flows west, it accumulates water from the Elk River, the tributaries of the Williams Fork River, and the Little Snake River as well as other smaller tributaries. The basin terminates at the confluence of theYampa and Green Rivers, which is approximately five miles from the Utah and Colorado border.

Elevation in the basin ranges from greater than 12,000 feet above sea level along the crest of the Park Range to around 5,000 feet in the lower reaches of the Yampa River in Dinosaur National Monument.

Temperatures in the basin generally vary inversely with elevation (Table 1), with lowest recorded annual mean temperatures occurring at Yampa (elev. 7890 feet) and Steamboat Springs (elev. 6770 feet).

Variation in duration of the growing season (28 ^{o}F threshold) follows a similar trend. The areas near Yampa (100 days) and Steamboat Springs (86 days) have the shortest growing season, and the duration increases progressively downstream toward Hayden (120 days) and Craig (124 days). The growing season near Maybell is similar in duration (119 days) to that of Hayden and Craig. It should be noted that at any given site within the basin, there is significant variation in the duration of the growing season among years largely due to elevation. For the values given, the probability of a shorter growing season is 50%.

Precipitation in the basin is also variable, ranging from less than nine inches annually in the semiarid lower basin to greater than 50 inches along the upper western slopes of the Park Range where most of the annual precipitation occurs as snow.

Most of the water yield contributing to streamflows in the basin is attributable to melting of winter snowpack in higher elevation areas bordering the continental divide. The Colorado Water Conservation Board report (CWCB, 1969) provides a detailed map of annual precipitation levels developed from U.S. Weather Bureau and cooperative snow course measurement records accumulated during the period from 1943 to 1960.

For purposes of administering and reporting water use within the Yampa River basin, the Colorado Division of Water Resources has identified and delimited five different districts within the basin (Figure 1). The major towns or landmarks and streams tributary to the Yampa River are indicated in Table 2. The headwaters of the basin are in District 58 (Elk River, Bear River, and upper main stem of Yampa River) and District 54 (Slater Creek and Little Snake River). The middle reaches of the Yampa main stem and its tributaries are within the boundaries of Water Districts 57 and 44, and the lower main stem of the Yampa River and its major tributary the Little Snake River occur in District 55.

Agriculture

Economic activity in the Yampa River basin is dominated by agriculture, mining (coal, oil, and gas), and recreation and tourism. The vast majority of agricultural enterprises are devoted to livestock production, with locally grown forages forming the basis for most animal diets.

Forages on private land are produced in the form of pasture and hay from meadows adjacent to streams. This production is supplemented by grazing allotments on public lands managed by the U.S. Forest Service and the Bureau of Land Management. Shen et al. (1985) reported irrigated cropland acreage in the Yampa basin during the period from 1925 to 1979 from reports prepared by the Colorado Division of Water Resources, the census of agriculture, and annual reports of the Colorado Agricultural Statistics Service.

The data (summarized in Table 3) indicate that base irrigated acreage, which consists largely of pasture and hay meadows, remained relatively stable over this entire period even though the actual number of acres irrigated in any given year varied substantially. In addition, the acreages devoted to pasture and hay changed significantly among years, with most variability occurring in pasture acreage.

Crop acreages for the period of interest for the current analysis (1990 to 1994) are presented in Table 4. This summary includes total acreage reported by Water Division 6 of the Colorado Division of Water Resources and harvested acreages of hay and other crops reported by the Colorado Agricultural Statistics Service (Colorado Department of Agriculture, 1995).

Irrigated pasture acreage was obtained by subtracting the harvested crops acreage (obtained from surveys) from the total acreage from aerial surveys conducted by the Division of Water Resources. From these data the total irrigated acreage in the basin has declined somewhat since 1979, from around 100,000 acres to an average of 77,500 acres during the 1990 to 1994 period.

Another apparent trend observed during the period of this analysis was an increase in pasture acreage and concurrent decrease in hay acreage (Table 4). It is unclear whether this trend indicates a significant change in land use from hay production to grazing. This change has occurred much too rapidly to represent a true reflection of the long-term shift toward increasing numbers of small acreages and fewer large operations documented in agricultural census reports.

Local observers (C. J. Mucklow, Routt County Cooperative Extension, personal communication) suspect that the trend is real, but the true magnitude is not as great as the 1990 to 1994 statistics would indicate. Indeed, surveys from 1996 indicate 44,500 irrigated hay acres, which represents a substantial increase above the 1993 and 1994 values, but this acreage is still well below the historic averages reported in Table 3.

ANNUAL STREAMFLOWS

This report provides an updated summary of irrigation water use in the Yampa River basin that reflects current conditions and relates irrigation use to total crop acreage and to current, historic, and estimated virgin streamflows.

For this analysis, a water year was considered to be the period from November to October. This was done so that an entire irrigation season (May to October) would be confined to a single water year. Information on water supply and streamflows was obtained from the streamflow archives on the Internet Web page maintained by the U.S. Geological Survey **(http://water.usgs.gov/swr/)**.

Monthly and annual streamflows from the period from November, 1989 to October, 1994, the available historic record (1916 to 1996), and estimated virgin flows (from Shen et al., 1985) are presented in Table 5. Average total annual streamflow during the five-year study period was well below the 1916 to 1996 average and the estimated average virgin flow, with above-average flow observed in only one year (1992-93).

Even though total annual streamflows were lower than average during four of the five years, the monthly distribution of flow, based on the five-year average, was very similar to that observed over the long-term historical record and to the estimated monthly distribution of virgin flows.

For the five-year study period, peak flows occurring during May and June accounted for 63% of the total annual streamflow. This is comparable to May-June flows that account for 64% of the annual total streamflow based on the long-term historical average and 61% of total annual flow from estimated average virgin flows.

In addition, the percentage of total annual streamflows occurring during August to October during the five-year study period (4.4%) is similar to and actually somewhat lower than the value for the same period based on estimated virgin flows (7.5%).

These seasonal streamflow distribution comparisons indicate that return flows from irrigation diversions are largely direct rather than delayed. In contrast, a large portion of the irrigation return flows in the South Platte and Arkansas river basins are delayed, which results in supplementation of virgin streamflows during the latter portion of the growing season.

IRRIGATION WATER USE

Previous Reports

Water use in the Yampa River basin has been characterized to varying degrees in two previous studies. Shen et al. (1985) provided an analysis of estimated water use in the basin from 1910 to 1981. Estimated consumptive use representing the average during the period from 1976 to 1981 is presented in Table 6.

The USGS conducted a state-wide modeling study of water use in Colorado designed to reflect conditions of development in 1985. The report from this study (Litke and Appel, 1989) included a Yampa basin summary, which is presented in Table 7.

The smaller irrigation consumptive use values in the USGS report result from lower estimates of irrigated acreage and consumptive use per acre. Estimates of irrigated acreage and consumptive use provided by the Division of Water Resources, which were used for the Shen et al. (1985) report, are generally regarded as the most accurate ones available.

Although the two analyses vary in their estimates of consumptive use, both clearly indicate that irrigation water use constitutes the bulk of all consumptive uses in the basin, which is true for all other regions in the state (Litke and Appel, 1989).

Compared to other beneficial consumptive uses (i.e., excluding reservoir evaporation, storage changes, and transmountain diversions), irrigation use accounted for 87% of the total consumptive use during this period (Shen et al., 1985).

Irrigation Water Use: 1990 to 1994

Data sources. The water use data was obtained from Water Division 6 (Colorado Division of Water Resources, Water Division 6, Box 3450, Steamboat Springs, CO 80477) of the Colorado Division of Water Resources. The information included water diversions and pumping withdrawals, consumptive water use, and irrigated acreage during the period indicated above.

The data used was limited to diversion structures or pumps serving a minimum of 35 acres for at least three of the five years considered.

Diversions and withdrawals were obtained directly from division records. Consumptive use was estimated using a modified version of the U.S. Department of Agriculture Soil Conservation Service Blaney-Criddle formula (USDA, 1970). This modification involved use of data from local lysimeters to adjust the empirical crop coefficient for each water district during each irrigation season.

Water use in relation to streamflows. The relationship between monthly streamflows and irrigation water use for the entire basin during the five-year study period is summarized in Table 8. With the exception of the 1990 season, streamflows peaked during May, whereas irrigation diversions were highest during June. The total magnitude of monthly irrigation diversions was less than current streamflows during the months of April, May, and June.

Beginning in July, as streamflows declined after the runoff period, the absolute magnitude of monthly irrigation diversions exceeded the total basin streamflow each month until near the end of growing season.

Irrigation water use as measured by diversions in the Yampa basin can exceed streamflows on a monthly basis without depleting water supplies because of the irrigation practices used and the nature of return flows resulting from irrigation. In this basin, flood irrigation is used on almost all the irrigated acreage so the quantity of water diverted greatly exceeds consumptive use.

In addition, because of the close proximity of the irrigated acreages to streams and the porous nature of soils in these alluvial systems, return flows resulting from over-irrigation are not excessively delayed. Thus, within any short period of accounting, water from an upstream diversion returns to the stream system and is subject to downstream reuse several times.

Undepleted flows represent an estimate of the total basin water yield during any given month. They were calculated as the sum of monthly basin streamflow and estimated consumptive uses, including consumptive irrigation use and all other consumptive uses as estimated by Litke and Appel (1989).

Total annual irrigation diversions averaged 30.6% of the undepleted seasonal flows (undepleted flows during the irrigation season) over the five-year period of analysis. Consumptive use, however, averaged only 6.3% of undepleted seasonal streamflows.

Comparable values using total annual undepleted streamflows (November to October) as the basis were 26.4% for diversions and 5.4% for consumptive use. The highest proportional level of consumptive water use by irrigation, which was observed in 1994, accounted for 9.0% of seasonal undepleted flows and 7.3% of total annual flow.

These values indicated that even though irrigation water use exceeds all other developed uses combined in the Yampa basin, it accounts for a relatively small proportion of the total available supply.

In observing the relationship between irrigation water use and supplies in different years (Table 8), it was apparent that variation in the magnitude of irrigation diversions was not associated with variation in supply. The highest level of diversions occurred in 1990, when total annual streamflows were comparatively low. Conversely, diversions during 1993, the year of the highest observed streamflows, were lower than those observed in three other years of the five-year study period.

It is generally recognized that water supplies in the Yampa basin are virtually unlimited with respect to existing demand. Apparently, this results in irrigation water managers considering factors other than supply in decisions related to application.

Seasonal and regional distribution of water use. The average seasonal distribution of water use during the five-year study period is presented for each water district in Table 9. The highest levels of water use occurred during the months of May, June, and July. Averaging over all five water districts, diversions during the May to July period accounted for 78.6% of the annual total. The monthly distribution of irrigation water consumptive use was even more heavily weighted toward this period, with May to July use accounting for 86.6% of total annual consumptive use.

In addition, data compiled over all districts by Water Division 6 (unpublished reports) indicate that the crop consumptive use attributable to irrigation water during this period of the growing season ranged from 66.8 to 87.9% of total crop consumptive use during 1990 to 1994.

The seasonal distribution of both irrigation diversions and consumptive use was similar for most of the water districts, with peak use occurring during June. The only exception to this trend was observed in District 55 where diversions were highest in May and consumptive use was relatively evenly distributed among the months of May, June, and July.
April, August, September, and October were months marked by low levels of irrigation water use. This pattern is associated with climate, cropping factors, and magnitude of streamflows.

Most of the hay meadows in the basin are not free of snow until late April or early May, so irrigation is minimal during April. Most ranchers producing hay terminate irrigation in July to allow for hay harvest during the period from late July to mid-August. By the time the hay is removed from meadows, the opportunity for regrowth is limited and streamflows are declining, so late-season irrigation diversions and associated consumptive use are relatively low.

Significant variation among water districts was observed in the percentage of water diverted that was consumed. Consumptive use expressed as a percentage of diversions ranged from 19.1 to 23.0% in Districts 58, 57, 44, and 54,but was only 12.2% in District 55. Averaging over the entire basin consumptive use was 20.6% of diversions, which is typical for the flood irrigation management systems used in mountain meadows.

Water use in relation to irrigated acreage. Irrigated acreage varied little during the five-year study period used for this analysis (Table 10), so most of the variation in annual diversions among years within any given water district was associated with irrigation application rates. The greatest variation in diversions among years occurred in District 57.

Irrigation water application and consumptive use rates were relatively consistent throughout the basin except for District 55. Averaging over the five-year study period, irrigation water application rates in District 55 at the lower end of the basin were more than double those of the other districts in the basin (10.1 vs. 4.1 acre feet per acre).

These much higher application rates were associated with consumptive use rates that were about 45% higher than those occurring throughout the remainder of the basin. These large differences, however, have little impact on overall irrigation water use values for the entire basin, because District 55 contains less than 2% of the basin's irrigated acreage.

Excluding this district, application and consumptive use rates of irrigation water averaged 4.00 and 0.84 acre-feet per acre, respectively, over the five-year study period. In addition, there generally was little variation among years in irrigation water use rates per acre among Districts 58, 57, 44, and 54.

The previous modeling study conducted by USGS (Litke and Appel, 1989) reported calculated consumptive use rates of applied irrigation water of 0.73 acre-feet per acre for Routt County (District 58 and 57 and part of District 54) and 1.39 acre-feet per acre for Moffat County (District 44 and part of District 54).

These USGS calculations used evapotranspiration estimates from Whittlesey (1977), which were based on Blaney-Criddle methods. The water use values reported in this analysis were obtained using modified Blaney-Criddle estimates with corrections from local lysimeter data.

SUMMARY OBSERVATIONS

The purpose of this analysis was to provide a current assessment of irrigation water use in the Yampa River basin based on summaries of actual water use during the period from November, 1989 to October, 1994. The report provides an overview of the magnitude, regional distribution, and timing of irrigation diversions and consumptive irrigation water use in relation to supply (streamflows) and acreage.

According to previous reports, irrigation represents the single largest use of developed water resources in the Yampa River basin, accounting for 93% of the total diversions in the basin and almost 80% of the total consumptive use. The number of farm enterprises using irrigation to support crop production is approximately 350, which is about 45% of the total farms in the basin.

Irrigated acreage production accounts for the vast majority of both the hay produced in the basin and the herbage consumed by grazing livestock on private land. Thus, water used in irrigation is of vital importance to agriculture in the basin and the overall economy of the region.

The importance of water resources to agriculture in this region is underscored by noting the nature and timing of irrigation water use in relation to crop growth and production. Irrigation water diversions and consumptive use are confined to the growing season of April to October, with peak use occurring during May, June, and July.

Similarly, the period of May to July is the most critical season of growth for hay and pasture crops, which are grown on over 98% of the total irrigated acreage. Crop consumptive use attributable to irrigation water during this period of the growing season ranged from 66.8 to 87.9% during 1990 to 1994.

For some, the most important issue involving irrigation water use in the basin is the impact of current and potential future irrigation development on the available water resources. In this analysis, consumptive use of irrigation water averaged only 5.4% of available annual water supplies in basin, even though streamflows averaged only 70% of historic flows observed since 1916. In addition, the monthly distribution of streamflows in the basin appears to have been altered very little from virgin flows as a result of irrigation.

Significant expansion of irrigated agriculture in the basin is unlikely because of the marginal nature of existing farming-ranching enterprises and climatic limitations that preclude the development of alternative cropping systems.

This conclusion is supported by the long-term stability in irrigated acreage suggested in Tables 3 and 4. Thus, irrigation water use appears to have had minimal impact quantitatively on water resources in the basin and most likely will not produce further significant effects in the future.

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Figure 1. Appropriate borders of water districts in the Yampa River Basin.

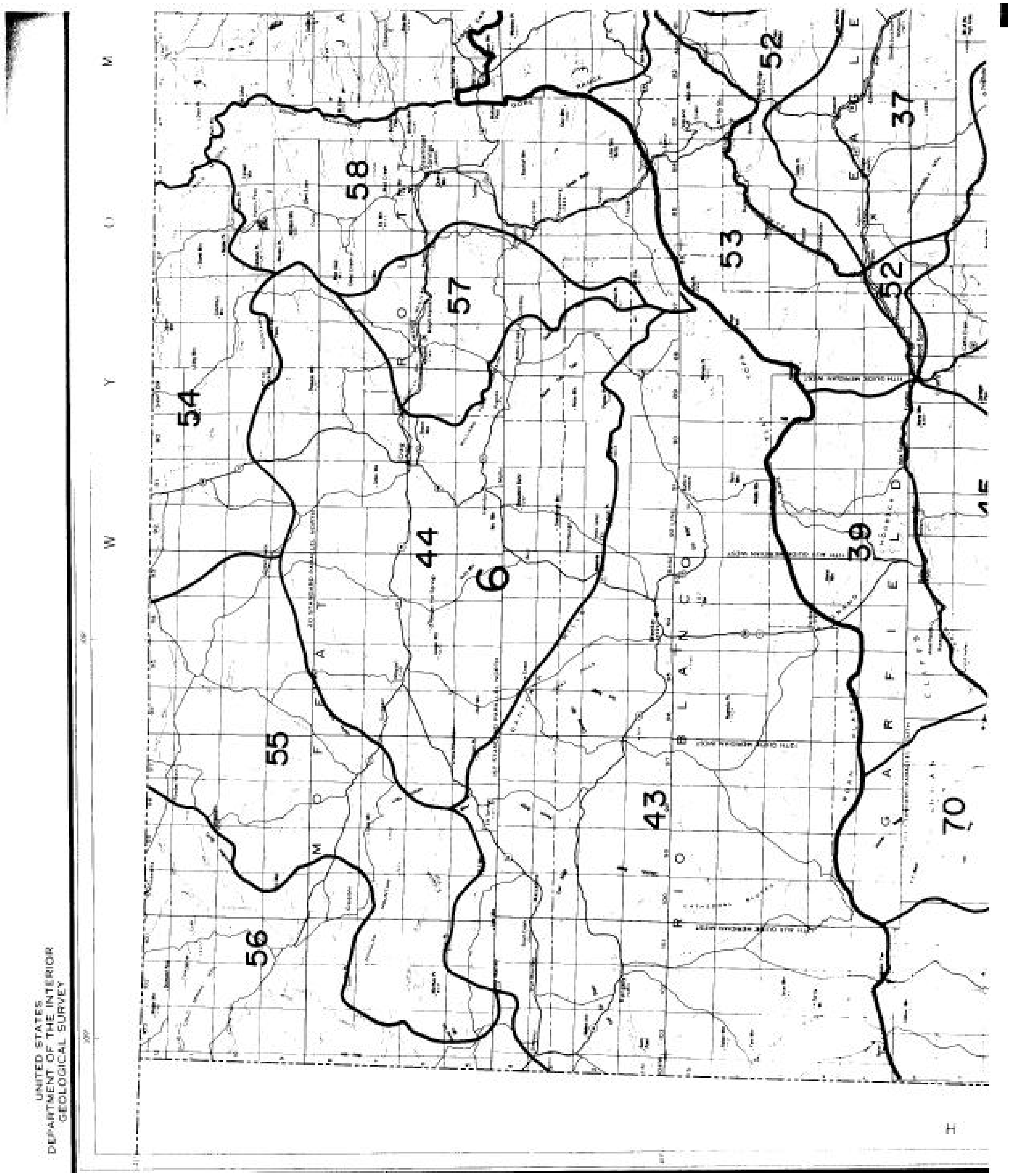

Table 1. Monthly average maximum and minimum daily temperatures for four sites in the Yampa River basin (Colorado Climate Center).

	Yampa [1]		Steamboat Springs [2]		Hayden [3]		Craig [4]		Maybell [5]	
Month	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
January	31.4	6.4	28.8	0.7	29.9	4.7	31.0	3.6	31.9	1.1
February	35.3	8.6	34.0	4.0	34.7	8.5	35.5	8.0	37.4	6.5
March	41.1	15.4	41.9	13.3	43.2	17.7	43.3	17.0	47.7	17.9
April	51.0	23.2	53.2	24.2	56.9	27.5	55.8	27.5	59.2	26.3
May	62.0	31.8	65.0	31.4	68.0	35.3	67.2	35.6	70.0	33.6
June	71.3	38.9	75.2	35.5	78.4	41.8	77.2	42.5	80.0	40.7
July	76.5	45.1	82.0	41.1	84.9	47.4	85.0	48.8	86.9	46.5
August	75.6	43.9	80.1	39.9	82.9	46.3	82.7	47.1	84.8	45.2
September	67.9	36.1	72.2	32.3	74.4	38.0	74.6	38.0	74.6	35.5
October	56.9	26.7	60.1	23.9	62.1	28.1	62.5	27.8	62.7	25.4
November	41.3	16.5	43.0	14.1	44.6	18.3	46.1	17.4	45.6	15.7
December	32.5	8.4	30.7	3.3	32.6	8.4	34.3	7.3	34.5	4.4
Annual	53.6	25.1	55.5	22.0	57.7	26.8	57.9	26.7	59.6	24.9

[1] Period of record: 33 years ending in 1996.
[2] Period of record: 88 years ending in 1996.
[3] Period of record: 49 years ending in 1996.
[4] Period of record: 28 years ending in 1976.
[5] Period of record: 33 years ending in 1996.

Table 2. Major towns/landmarks and water courses in the various designated water districts of the Yampa River basin.

Water district	Towns/landmarks	Major stream(s)	Tributaries
58	Steamboat Springs	Yampa River	Elk River, Bear River, Walton Creek, Morrison Creek
57	Hayden	Yampa River	Trout Creek
44	Craig, Maybell	Yampa River	Fortification Creek, Williams Fork River, Milk Creek, Little Bear Creek
54	Slater	Little Snake River	Slater Creek, Willow Creek, Fourmile Creek
55	Entrance to Dinosaur National Monument	Yampa River, Little Snake River	

Table 3. Irrigated acreage in the Yampa River basin for various crop categories during selected periods.

	1925 to 1943		1948 to 1959		1960 to 1979	
Acreage category	Average	Range	Average	Range	Average	Range
Harvested crops	63,500	56,200 - 7,600	56,100	40,200 - 65,600	55,400	44,100 - 64,100
Pasture			43,500	43,500	46,500	22,000 - 62,900
Total			99,600	83,700 - 109,100	101,900	71,400 - 11,900
Hay	61,500	53,300 - 5,400	54,200	38,700 - 63,300	53,600	42,400 - 62,700

Table 4. Irrigated acreage in the Yampa River basin for various crop categories from 1990 to 1994.

	State Agency Surveys						US Agr. Census
ategory	1990	1991	1992	1993	1994		1992
arvested crops	60,800	53,600	50,800	37,900	34,600		43,615
asture	16,600	23,800	26,500	39,300	43,700		23,051
otal irrigated	77,400	77,400	77,300	77,200	78,300		66,666
ay	60,600	53,500	50,500	37,700	34,300		
mall grains	200	100	300	200	300		

Table 5. Monthly and annual historic Yampa River streamflows for1989 to 1994 and 1916 to 1996 periods and estimated virgin flows (Shen et al., 1985). Values determined from combined flows measured at gauging stations on the Yampa River near Maybell, CO and Little Snake River near Lily, CO.

Period	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Annual total
1989-90	18,238	20,514	19,723	19,537	82,968	163,720	208,692	286,696	44,764	7,217	6,728	23,638	902,435
1990-91	20,199	16,457	15,793	16,618	47,235	113,430	413,506	359,211	48,196	23,491	13,408	15,088	1,102,632
1991-92	23,709	16,381	20,675	23,566	52,784	121,733	303,707	124,036	37,798	13,294	14,331	16,159	768,173
1992-93	24,426	22,860	20,249	22,084	90,672	155,202	700,737	544,199	144,087	34,514	16,281	31,478	1,806,789
1993-94	26,632	23,170	21,805	23,131	68,849	148,626	346,214	145,938	10,227	2,508	2,360	15,808	835,268
1989-94 avg.	22,641	19,876	19,649	20,987	68,502	140,542	394,571	292,016	57,014	16,205	10,622	20,434	1,083,059
1916-96 avg.	27,900	24,200	22,200	25,100	65,800	218,400	541,200	441,800	105,700	27,800	17,300	28,100	1,545,500
Virgin flows (est.)	26,300	23,400	21,400	23,800	61,100	213,000	524,900	446,200	131,000	50,000	33,500	35,500	1,590,100

Table 6. Average annual consumptive water use in the Yampa River basin from 1976 to 1981 (Colorado Division of Water Resources, Water Division 6, 1982).

Use category		Consumptive use
		acre-feet
Irrigation		84,800
Municipal/industrial		9,450
Miscellaneous		3,450

Table 7. Estimated water use in the Yampa River basin under 1985 development conditions (Litke and Appel, 1989).

Use category/subcategory		Diversions/ withdrawals			Consumptive use	
		-------------------- acre-feet --------------------				
Irrigation		421,000			73,900	
Electric power		15,600			15,600	
All other uses		15,800			3,900	
	Livestock		5,600			900
	Mining		5,100			1,700
	Domestic		4,200			1,200
	Commercial		800			100
	Industrial		100			--
Total		452,600			93,400	

Table 8. Monthly and total seasonal irrigation water use in relation to streamflows in the Yampa River basin during 1990 to 1994.

Period	Variable	Dimensions	1990	1991	1992	1993	1994	Average
April	Basin streamflow	acre-feet	163,720	113,430	121,733	155,202	148,626	140,542
	Diversions	acre-feet	9,904	1,947	8,036	2,365	9,831	6,417
	Consumptive use	acre-feet	1,411	424	547	300	1,112	759
May	Basin streamflow	acre-feet	208,692	413,506	303,707	700,737	346,214	394,571
	Diversions	acre-feet	70,498	55,482	77,031	35,663	76,825	63,100
	Consumptive use	acre-feet	18,291	15,512	10,244	11,419	19,222	14,938
June	Basin streamflow	acre-feet	286,696	359,211	124,036	544,199	145,938	292,016
	Diversions	acre-feet	120,297	119,775	89,539	99,647	99,537	105,759
	Consumptive use	acre-feet	25,369	25,557	23,181	24,749	24,454	24,662
July	Basin streamflow	acre-feet	44,764	48,196	37,798	144,087	10,227	57,014
	Diversions	acre-feet	75,832	82,567	59,653	88,783	57,104	72,788
	Consumptive use	acre-feet	15,850	16,230	12,784	16,456	15,090	15,282
August	Basin streamflow	acre-feet	7,217	23,491	13,294	34,514	2,508	16,205
	Diversions	acre-feet	29,578	32,462	23,228	39,207	27,842	30,463
	Consumptive use	acre-feet	3,344	3,374	4,160	3,809	3,449	3,627
September	Basin streamflow	acre-feet	6,728	13,408	14,331	16,281	2,360	10,622
	Diversions	acre-feet	23,575	21,978	16,481	22,196	19,340	20,714
	Consumptive use	acre-feet	3,496	3,396	3,488	3,141	3,547	3,414
October	Basin streamflow	acre-feet	23,638	15,088	16,159	31,478	15,808	20,434
	Diversions	acre-feet	7,839	9,938	5,142	9,167	9,527	8,323
	Consumptive use	acre-feet	932	401	475	796	812	683
Total	Basin streamflow	acre-feet	741,455	986,330	631,058	1,626,498	671,681	931,404
season	Undepleted flow[1]	acre-feet	821,523	1,062,599	697,312	1,698,543	750,742	1,006,144
	Diversions	acre-feet	337,523	324,149	279,110	297,028	300,006	307,563
		% of undepleted flow	41.1	30.5	40.0	17.5	40.0	30.6
	Consumptive use	acre-feet	68,693	64,894	54,879	60,670	67,686	63,364
		% of undepleted flow	8.4	6.1	7.9	3.6	9.0	6.3
Annual[2]	Basin streamflow	acre-feet	902,435	1,102,632	768,173	1,806,789	835,268	1,083,059
	Undepleted flow[1]	acre-feet	990,628	1,187,026	842,552	1,886,959	922,454	1,165,923
	Diversions	acre-feet	337,523	324,149	279,110	297,028	300,006	307,563
		% of undepleted flow	34.1	27.3	33.1	15.7	32.5	26.4
	Consumptive use	acre-feet	68,693	64,894	54,879	60,670	67,686	63,364
		% of undepleted flow	6.9	5.5	6.5	3.2	7.3	5.4

[1] Estimated as the sum of actual basin streamflows, consumptive irrigation water use, and estimated consumptive use for other uses as described by Litke and Appel (1989).

[2] Annual streamflow includes total flows from November of the previous calendar year to October of the current year.

Table 9. Average monthly and annual irrigation water diversions and consumptive water use during the period from 1990 to 1994 in the Yampa River basin.

Area	Variable	Dimensions	April	May	June	July	Aug.	Sept.	Oct.	Annual Total
Water district 58	Diversions	acre- ft	1,133	16,739	43,720	32,579	9,543	6,586	2,270	112,570
		% of total	1	14.9	38.8	28.9	8.5	5.9	2	100
	Consumptive use	acre- ft	89	4,619	10,120	8,431	1,208	1,243	204	25,914
		% of total	0.3	17.8	39.1	32.5	4.7	4.8	0.8	100
		% of diversions	7.9	27.6	23.1	25.9	12.7	18.9	9	23
Water district 57	Diversions	acre- ft	181	7,455	15,768	10,195	4,634	4,562	3,055	45,849
		% of total	0.4	16.3	34.4	22.2	10.1	10	6.7	100
	Consumptive use	acre- ft	48	1,857	3,384	2,258	599	713	249	9,108
		% of total	0.5	20.4	37.2	24.8	6.6	7.8	2.7	100
		% of diversions	26.5	24.9	21.5	22.2	12.9	15.6	8.2	19.9
Water district 44	Diversions	acre- ft	4,148	26,551	30,283	19,381	11,142	7,071	2,318	100,894
		% of total	4.1	26.3	30	19.2	11	7	2.3	100
	Consumptive use	acre- ft	590	6,070	7,522	2,565	1,108	1,173	229	19,257
		% of total	3.1	31.5	39.1	13.3	5.8	6.1	1.2	100
		% of diversions	14.2	22.9	24.8	13.2	9.9	16.6	9.9	19.1
Water district 54	Diversions	acre- ft	725	8,486	13,131	7,936	3,984	2,169	642	37,073
		% of total	2	22.9	35.4	21.4	10.7	5.8	1.7	100
	Consumptive use	acre- ft	29	2,018	3,251	1,609	578	240	0	7,723
		% of total	0.4	26.1	42.1	20.8	7.5	3.1	0	100
		% of diversions	3.9	23.8	24.8	20.3	14.5	11.1	0	20.8
Water district 55	Diversions	acre- ft	230	3,869	2,856	2,696	1,161	326	39	11,177
		% of total	2.1	34.6	25.6	24.1	10.4	2.9	0.3	100
	Consumptive use	acre- ft	3	374	385	419	134	46	0	1,361
		% of total	0.2	27.5	28.3	30.8	9.9	3.4	0	100
		% of diversions	1.3	9.7	13.5	15.5	11.6	14	0	12.2
Total basin	Diversions	acre- ft	6,417	63,100	105,759	72,788	30,463	20,714	8,323	307,563
		% of total	2.1	20.5	34.4	23.7	9.9	6.7	2.7	100
	Consumptive use	acre- ft	759	14,938	24,661	15,282	3,627	3,414	683	63,364
		% of total	1.2	23.6	38.9	24.1	5.7	5.4	1.1	100
		% of diversions	11.8	23.7	23.3	21	11.9	16.5	8.2	20.6

Table 10. Water use in relation to irrigated acreage in the Yampa River basin during 1990 to 1994.

Year	Water district	Irrigated acreage	Total diversions[a]	Application rate	Consumptive use	Cons. use rate
		acres	ac. ft.	ac. ft. / acre	ac. ft.	ac. ft. / acre
1990	58	31,998	123,371	3.86	28,493	0.89
	57	10,177	60,404	5.94	9,877	0.97
	44	22,531	104,083	4.62	21,244	0.94
	54	9,206	37,982	4.13	7,601	0.83
	55	1,121	11,683	10.42	1,478	1.32
	Total basin	75,033	337,523	4.50	68,693	0.92
1991	58	32,299	118,517	3.67	25,541	0.79
	57	10,127	57,096	5.64	9,842	0.97
	44	22,328	101,181	4.53	20,169	0.90
	54	9,206	35,549	3.86	7,869	0.85
	55	1,121	11,806	10.53	1,472	1.31
	Total basin	75081	324,149	4.32	64,893	0.86
1992	58	32,066	102,624	3.20	21,908	0.68
	57	10,177	35,511	3.49	7,988	0.78
	44	22,254	92,346	4.15	15,867	0.71
	54	9,306	37,687	4.05	8,101	0.87
	55	1,121	10,943	9.76	1,013	0.90
	Total basin	74924	279,111	3.73	54,877	0.73
1993	58	32,289	107,392	3.33	25,160	0.78
	57	10,126	34,890	3.45	8,380	0.83
	44	22,126	100,973	4.56	18,035	0.82
	54	9,236	40,023	4.33	7,371	0.80
	55	1,121	13,750	12.27	1,722	1.54
	Total basin	74,898	297,028	3.97	60,668	0.81
1994	58	32,569	110,949	3.41	28,471	0.87
	57	10,217	41,342	4.05	9,451	0.93
	44	22,872	105,885	4.63	20,972	0.92
	54	9,236	34,127	3.70	7,675	0.83
	55	1,032	7,703	7.46	1,117	1.08
	Total basin	75,926	300,006	3.95	67,686	0.89
Average	58	32,244	112,570	3.49	25,915	0.80
	57	10,164	45,849	4.51	9,108	0.90
	44	22,422	100,894	4.50	19,257	0.86
	54	9,238	37,073	4.01	7,723	0.84
	55	1,103	11,177	10.13	1,360	1.23
	Total basin	75,172	307,563	4.09	63,364	0.84

[a] includes surface diversions and pumping withdrawals

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