ANALYSIS OF GROUNDWATER AND STREAMFLOW DATA

WESTERN DAKOTAS REGION OF SOUTH DAKOTA

TASK 1: SURFACE-WATER INVENTORY

FINAL REPORT

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INTRODUCTION

This report is part of a series being conducted by the U.S. Army Corps of Engineers to evaluate the water resources of western South Dakota. The area of study is restricted to that part of the State which lies west of the Missouri River. The response to the following TASK comprises the output of this evaluation.

TASK 1 - Conduct a surface-water inventory of the major drainage basins in the study area.

A. Prepare mylar base maps for all hydrologic and geologic data.

B. Delineate major drainage basins and surface-water hydrologic units within the study area.

C. Compile a surface-water inventory for those basins with adequate data.

BASIC DATA MANIPULATION AND REPORT FORMAT

TASK 1A - Selection of Base Maps

To accomplish the objective of TASK 1A it was necessary to break the study area into two geographical regions. Because of the physical environment, it was decided that one region should be restricted Black Hills and the other region include everything outside the Black Hills area.

Black Hills Region

This TASK's interest in both geologic and hydrologic data resulted in the Niobrara Formation-Pierre Shale contact around the Black Hills becoming the first areal approximation of the Black Hills region. As delineated, this boundary incorporated two important factors:

1. Most of western South Dakota's stratigraphic section, and

2. The interface beyond which the surface-water and ground-water regimes are separate.

The boundary of the region was subsequently expanded because of the geologic contact's proximity to lines of latitude and longitude. Consequently, the 45th and 43rd degrees of latitude were chosen as the north and south boundaries, respectively. Likewise, the east boundary was expanded to the 103rd degree of longitude although the western boundary remained the Wyoming-South Dakota State Line.

The scale chosen for the base map was one-half inch to the mile. This scale was selected because many of the early (circa 1890-1910) geologic maps of the region were at this scale. This scale is also small enough so that the minute details of mapping can be shown.

Western South Dakota Region

The boundaries of this region correspond with state lines to the north, south, and west, and the Missouri River to the east.

The scale chosen for the base map of this region was 1:500,000. It is a convenient and manageable size besides being compatible with the previous studies of the eastern half of the State. Furthermore, the 1:500,000 base map best illustrates the relationships that exist between the Black Hills region and that of the western half of the State.

TASK 1B - Delineation of Drainage Basins

Black Hills Region

Drainage basins within the Black Hills region were defined on USGS 7.5 minute topographic maps. The area of each basin was determined by planimetering at this scale (1:24,000). Subsequently, the boundaries of these drainages were transferred onto two base maps. One was sketched onto a one-half inch equals 1 mile scale base map (pl. 1) while the other was sketched onto Army Map Service maps (1:250,000 scale) and then reduced to a base map at a scale of 1:500:000 (pl. 2).

The Western South Dakota Region

Boundaries for drainage basins exclusive of the Black Hills were adopted from the USGS Hydrologic Unit Map for South Dakota. Because the scale of this map is compatible with the base map chosen for this task, the basin outlines were simply traced as shown on plate 2.

Criteria for Major Basin Status

A major basin is one of recognizable importance to the State. The following factors were considered for designation of major basin status.

1. The maps previously used in TASK 2 which characterize the in-stream water quality.

2. The amount of current appropriations and authorized diversion rates as previously described by TASK 6.

3. The presence or absence of surface-water projects, such as Angostura and Belle Fourche, which regulate downstream flows.

4. The availability of streamflow data and presence of gaging stations at appropriate locations.

5. Drainage relationships.

Although 47 basins were defined in TASKS 3, 4, and 6 of this series of reports, only 15 meet the criteria of major basin status. The characteristics of each of these are summarized in the appendix and their locations are shown in figure 1.

The reduction in the total number of basins were largely made possible by the grouping together of many small watersheds within the Black Hills region. As a result, four major drainage basins were defined for the Black Hills. They comprise the small basins of the Northern Hills, the Central Hills, and the Southern Hills. The Rapid Creek drainage was distinguished from the Central Hills because three of the criteria were found to be applicable. They include the special consideration of Rapid Creek by TASK 2, the relatively large appropriations held by the City of Rapid City, and the presence of Pactola and Deerfield Dams in the headwaters of the basin. Table 1 lists the names of those smaller basins which were consolidated to form the major Black Hills basins.

By contrast, outside the Black Hills region only one large basin was subdivided. The Cheyenne River Basin, which is the largest of the western tributaries of the Missouri River in South Dakota, was broken into three parts: each with major drainage basin status. The Cheyenne was separated into the upper, middle, and lower reaches. The presence of the Angostura Dam and the confluence of the Belle Fourche River with the Cheyenne prompted this division. Streamflow records were also available at or near each of these locations. Furthermore, the creation of a Middle Cheyenne segment afforded an opportunity to examine the impact of the Central Black Hills and Rapid Creek basin on the Cheyenne River.

TASK 1C - Surface-water Inventory

An inflow-outflow technique was used for this TASK. It assumed a budget could be developed for an average year and applied to the entire area of western South Dakota. The basic data for input were derived from USGS streamflow records, although much of this data had been processed (Dornbush, 1974) into flow duration tables.

Additional data previously compiled during, but not displayed in the output for TASK 6, were also reviewed. This information specified the diversion rate (in cfs) which was assigned to each water rights permit. The sum of these rates can be used as a maximum demand on streamflow although it fails to consider that not all of the users will need water at the same time.

TABLE 1. List of minor basins in the Black Hills

NORTHERN BLACK HILLS
(contribute to Belle Fourche River basin)

Alkali Creek	Oyster Mountain
Bear Butte Creek	Redwater River
Cottonwood Creek	Sand Creek
Crow Creek	Spearfish Creek
False Bottom Creek	Stinking Water Creek
Hay Creek	Whitewood Creek
Maloney Creek	Willow Creek
Nine Mile Creek	

CENTRAL BLACK HILLS
(contribute to Middle Cheyenne River basin)

Battle Creek	Fall River
Beaver Creek	French Creek
Boxelder Creek	Lame Johnny Creek
Elk Creek	Spring Creek

SOUTHERN BLACK HILLS
(contribute to the Upper Cheyenne, Above Angostura)

Bennett Creek	Inyan Kara Creek
Cascade Creek	Pass Creek
Chilson Canyon	Red Canyon
Driftwood Creek	Stockade-Beaver Creek

A SURFACE-WATER BUDGET

Introduction

A budget often connotates a collection of items and/or a plan for dispensing them. So it is with a surface-water budget. For good management of the resource, a balance of appropriation, use, and streamflow should be strived for. Two problems are inherent in any surface-water budget: availability of supply and timing of demand.

The demand for surface water runs contrary to its occurrence in western South Dakota. This is because runoff or streamflow, which is the residual of rainfall and snowmelt that exists after the stresses of evaporation and transpiration have been met, is seasonal in western South Dakota. Furthermore, as figure 2 illustrates, the mean annual runoff also varies spatially.

The importance of time was emphasized after a review of appropriations in each major basin revealed that irrigation is the dominant usage category. Unfortunately because the greatest need for surface water by this category occurs during July and August, a problem starts to become apparent when it is realized that the period of highest streamflow occurs from late-March to mid-July. In other words, the bulk of the resource has already passed by before the need arises. So timeliness is an important factor in managing the availability of surface water.

Budget Credits

To maintain a balanced budget, inflows must equal outflows. To estimate the amount of inflow, two methods of calculation were used and the results compared with one another. If they were in accord, then it could be assumed that each was a fair estimate of western South Dakota's contribution to the surface-water budget.

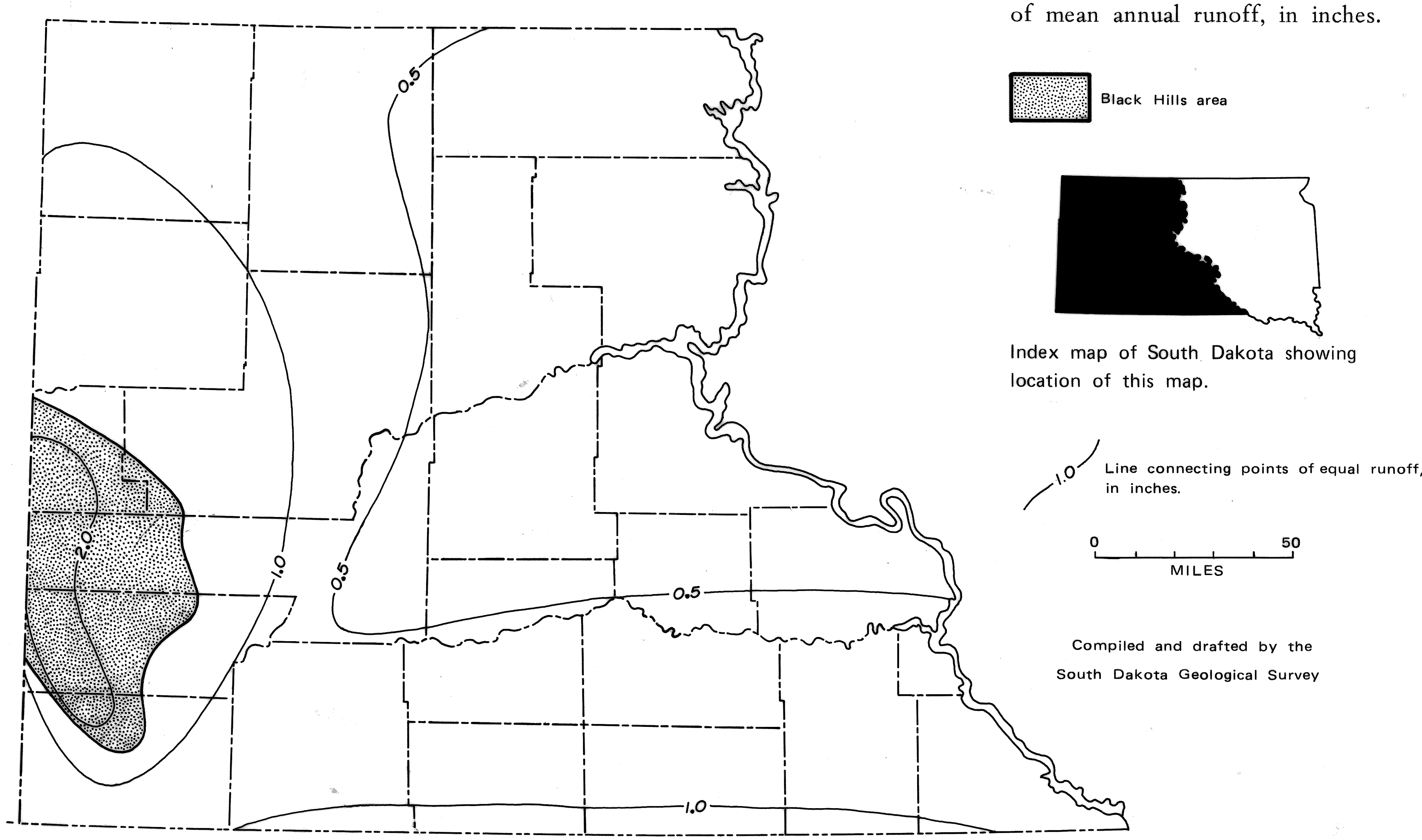
One method compared the average flow of the Missouri River at Pickstown (Ft. Randall Dam) with that of the River at the North Dakota-South Dakota State Line. Although this method seems simple enough, several assumptions were necessary. First, the flows of the Cannonball River, Beaver Creek, and Heart River (USGS Gaging Stations 354000, 3545000, and 349000 in North Dakota) were added to the flow of the Missouri River at Bismarck (Gaging Station 3425000). The summation of these flows, 23,266 cfs, then becomes an estimation of the upstream states' contribution to South Dakota's segment of the River. By subtracting this estimate from the average flow at Pickstown, it was possible to get an idea of western South Dakota's input. Because the average flow at Pickstown is 25,260 cfs and little or no contribution is made to the River by lands adjacent to the Missouri's east bank, it is concluded that about 2,000 cfs is added by western South Dakota. This first approximation, however, fails to recognize the following adjustments:

* Wyoming's contribution by way of the Cheyenne River (est. 85 cfs), the Belle Fourche River (90 cfs), and the Redwater River (36 cfs)

* Nebraska's contribution to the headwaters of the White River (53 cfs)

* North Dakota's contribution by way of the Grand River (28 cfs)

Figure 2. Map showing distribution of mean annual runoff, in inches.



(after USGS et al., 1975, p. 219)

* South Dakota's outflow to North Dakota by way of the Little Missouri River (est. 200 cfs) and Cedar Creek of the Cannonball River basin

* South Dakota's consumptive use of water

The alternative to this method of estimating input is to sum the individual average flows and subtract any outside contributions. Table 2 itemizes these flows and totals them.

TABLE 2

Western South Dakota's contribution to the Missouri River

Basin Name		Average Flow (cfs)	Gaging Station Identification
Bad River		147	064415
Cheyenne River (total)		828	064393
Grand River		240	063578
Keya Paha River		67	064645
Little Missouri		200 est.	NA
Missouri River		117	NA
Moreau River		205	063605
White River		526	064520
	Subtotal	2,330	
Less adjustments for:			
Belle Fourche (Wyoming)		90	06428500
Cheyenne (Wyoming)		85 est.	NA
Grand (North Dakota)		28	355000
Redwater (Wyoming)		36	06430500
White (Nebraska)		53	
	Subtotal	292	
	TOTAL	2,038	

Thus, a rough accord exists between the two methods of calculating western South Dakota's input to the budget. It seems that a reasonable estimate would be (2,000 cfs) about 1,447,600 acre-feet per year.

Budget Debits

The second part of any budget involves debits. In the case of a surface-water budget, this is construed to be the sums of appropriations and/or actual uses. A measure of these quantities was made by TASK 6 and is summarized by table 3.

TABLE 3

Summary of surface-water demands in western South Dakota

Type of usage	Annual appropriation (ac-ft)	Actual or estimated annual surface-water use (ac-ft)	Number of Permits
Commercial	5,998	2,999	10
Domestic	0	0	0
Fish and wildlife	27,666	0*	15
Geothermal	0	0	0
Industrial	63,059	6,530	13
Institutional	0	0	0
Irrigation			
With permit nos.	925,551	133,829	1,367
Vested rights	57,241	19,529	32
Livestock	3,133	16,164	2
Multiple	287,957	1,479	15
Municipal	65,872	1,717	20
Recreational	1,720	860**	10
Rural domestic	147	370	2
Rural water systems	3,359	737	1
Suburban housing development	72	36	1
TOTAL	1,441,775	184,250	1,488

* Considered a nonconsumptive use, although presence of a minimun flow is crucial to this usage category.

** Probably this estimate is too high because demand for this use is seasonal.

Conclusions

Each year western South Dakota inputs about 1,447,600 acre-feet to the surface-water budget. The Board of Water Management, on the other hand, has appropriated 1,441,775 acre-feet of surface water. Considering the uncertainty and variability of the input, one could reasonably conclude that a balance between supply and demand presently exists. Thus, in an average year, no unappropriated surface water exists in western South Dakota. However, as streamflow records attest, water still flows in western South Dakota. This is because average annual use amounts to only 13 percent of the input to the surface-water budget.

The situation could be quite different under drought conditions, but little reliable information is available. In 1979 western South Dakota had below normal rainfall and suffered economic losses because adequate amounts of hay were not available. Although one might expect increased amounts of water might be applied during a drought year, the results of irrigation questionnaires indicate the opposite reaction occurred. A special statement (Division of Water Rights, 1983) noted that during 1979, surface-water irrigators applied about 2 inches less irrigation water than in preceding years. The statement also shows that after the drought, application rates of irrigation water resumed their usual levels.

REFERENCES CITED

Division of Water Rights, 1983, An unpublished special statement, dated February, 1983: Department of Water and Natural Resources, Foss Building, Pierre, South Dakota.

Dornbush, James N., 1974, Seasonal flow-duration and mean flow tables for selected rivers and streams in South Dakota: OWRR Proj. No. A-033-SDAK, Water Resources Institute, South Dakota State University, Brookings, South Dakota.

United States Geological Survey, South Dakota Geological Survey, South Dakota School of Mines, the United States Bureau of Reclamation, and the United States Bureau of Mines, 1975, Minerals and water resources of South Dakota, Printed by the use of the Comm. on Interior and Insular Affairs, 94th Congress, 1st Session: South Dakota Geol. Survey Bull. no. 16, pt. 2, Vermillion, South Dakota.

APPENDIX

Budget characteristics of western South Dakota's 15 major drainage basins

The sum of the annual appropriations for all drainage basins in the appendix will not equal the total annual appropriation on table 3 because the vested rights have not been included with drainage basin appropriation groupings in the appendix.

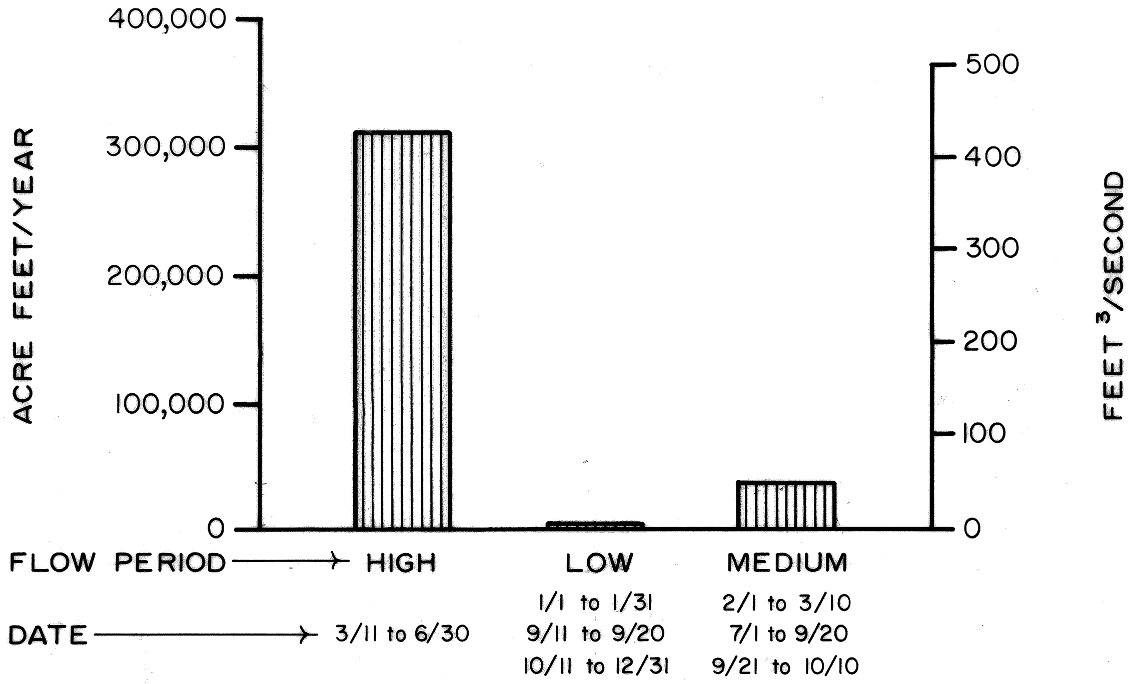
In this appendix the sum of the diversion rates in cubic feet per second calculated on an annualized basis will not equal the sum of the annual appropriations in acre-feet. This is due to the method of calculating annual appropriation for irrigation. Annual appropriation for irrigation is based on a factor of 2 or 3 acre-feet per acre (prior to July 1, 1978, the annual appropriation was 3 acre-feet per acre), not an annualized mean daily diversion rate.

BAD RIVER

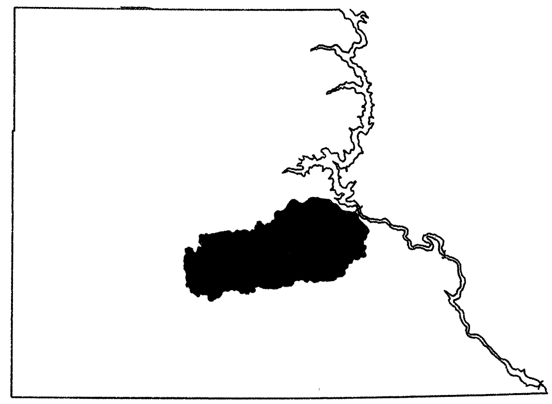
USGS GAGING STATION NO. 064415

FLOW DURATION RATE
(Dornbush, 1974)

TYPE OF FLOW	PROJECTED VOL. (ACRE FEET/YEAR)	FLOW RATE (FEET^3/SECOND)
LOW	5,941	8.22
MEDIUM	39,907	55.22
HIGH	311,281	430.72
MEAN	119,043	164.72



BAD RIVER BASIN
USGS Gaging Station No. 064415



AREA .... 3,184 sq. mi.

AVAILABILITY OF SURFACE WATER

USGS mean daily flow .... 147 cfs

USGS estimate of mean annual discharge .... 106,500 ac-ft

CURRENT ALLOCATIONS OF SURFACE WATER

Sum of diversion rates .... 272.37 cfs

Sum of annual appropriations .... 70,999 ac-ft

Total number of permits 109

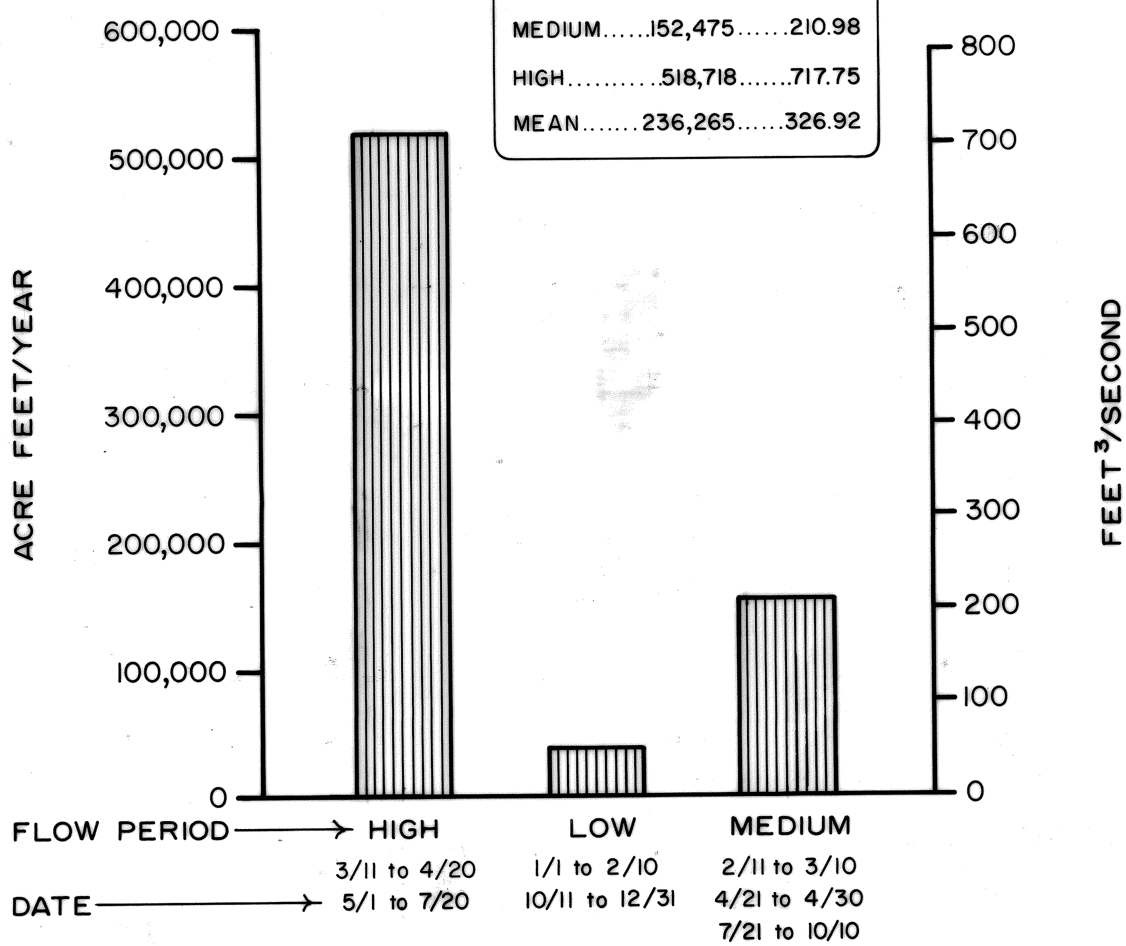
Irrigation 103

BELLE FOURCHE RIVER

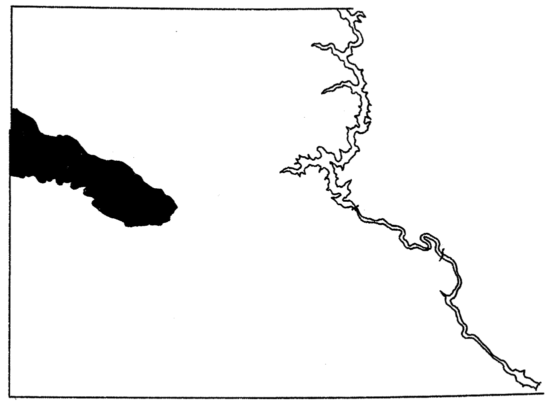
WYOMING BORDER TO CHEYENNE RIVER–USGS GAGING STATION NO. 064380

FLOW DURATION RATE
(Dornbush, 1974)

TYPE OF FLOW	PROJECTED VOL. (ACRE FEET/YEAR)	FLOW RATE (FEET³/SECOND)
LOW	37,602	52.03
MEDIUM	152,475	210.98
HIGH	518,718	717.75
MEAN	236,265	326.92



BELLE FOURCHE RIVER BASIN
USGS Gaging Station No. 064380



AREA .... 2,075 sq. mi.

AVAILABILITY OF SURFACE WATER *

USGS mean daily flow .... 361 cfs

USGS estimate of mean annual discharge .... 261,500 ac-ft

CURRENT ALLOCATIONS OF SURFACE WATER

Sum of diversion rates .... 602.97 cfs

Sum of annual appropriations .... 122,388 ac-ft

Total number of permits 214

Irrigation 213

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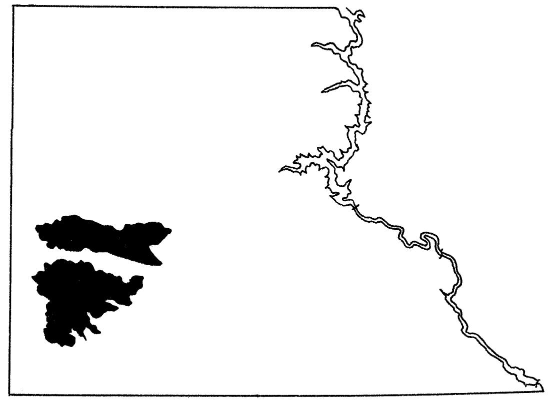
* These figures include the contributions made by the Northern Black Hills Basins, but not their demands.

CENTRAL BLACK HILLS BASINS



AREA .... 2,324 sq. mi.

AVAILABILITY OF SURFACE WATER *

Estimated mean daily flows (total) .... 160 cfs

Estimated mean annual discharge .... 115,632 ac-ft

CURRENT ALLOCATIONS OF SURFACE WATER

Sum of diversion rates .... 381.92 cfs

Sum of annual appropriations .... 132,295 ac-ft

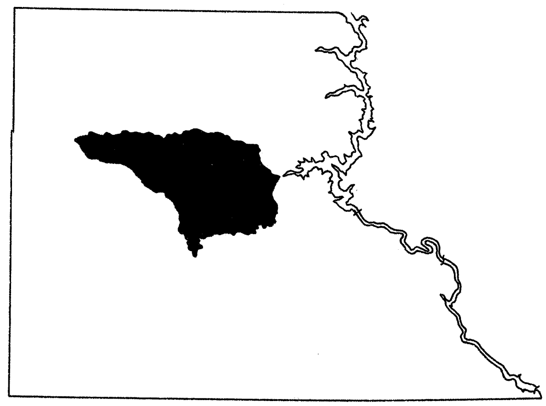
Total number of permits 109

Irrigation 86

----

* Calculated by subtracting the flow at Gage Nos. 064015 and 064215 from the sum of Gages 064235 and 064255. This approximates total flow of the Middle Cheyenne. An average runoff of 0.75 inch was assumed over the Middle Cheyenne's area which accounts for about 75 cfs. Therefore, the remainder must be contributed by the Central Black Hills Basins and the Rapid Creek Basin.

LOWER CHEYENNE RIVER BASIN



AREA .... 3,529 sq. mi.

AVAILABILITY OF SURFACE WATER *

USGS mean daily flow .... 97 cfs

Estimated mean annual discharge .... 70,208 ac-ft

CURRENT ALLOCATIONS OF SURFACE WATER

Sum of diversion rates .... 274.27 cfs

Sum of annual appropriations .... 57,153 ac-ft

Total number of permits 79

Irrigation 77

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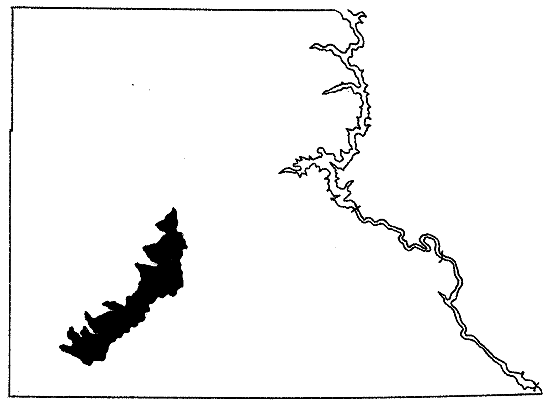
* Calculated by subtracting the flows at Gage Nos. 064380, 064255, and 064235 from Gage No. 064393.

MIDDLE CHEYENNE RIVER BASIN



AREA .... 1,352 sq. mi.

AVAILABILITY OF SURFACE WATER *

Estimated mean daily flow .... 75 cfs

Estimated mean annual discharge .... 54,285 ac-ft

CURRENT ALLOCATIONS OF SURFACE WATER

Sum of diversion rates .... 355.77 cfs

Sum of annual appropriations .... 72,671 ac-ft

Total number of permits 136

Irrigation 129

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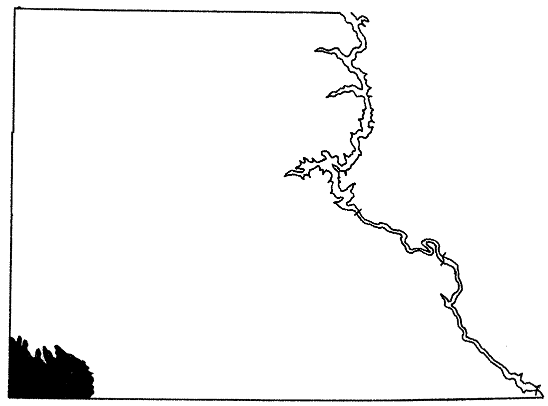
* Calculated by taking an average annual runoff figure of 0.75 inch (South Dakota Geol. Bull. 16, p. 219) over the basin.

UPPER CHEYENNE RIVER BASIN
(ABOVE ANGOSTURA)



AREA .... 1,036 sq. mi.

AVAILABILITY OF SURFACE WATER *

Estimated mean daily flow .... 85 cfs

Estimated mean annual discharge .... 61,520 ac-ft

CURRENT ALLOCATIONS OF SURFACE WATER

Sum of diversion rates .... 251.91 cfs

Sum of annual appropriations .... 46,983 ac-ft

Total number of permits 80

Irrigation 80

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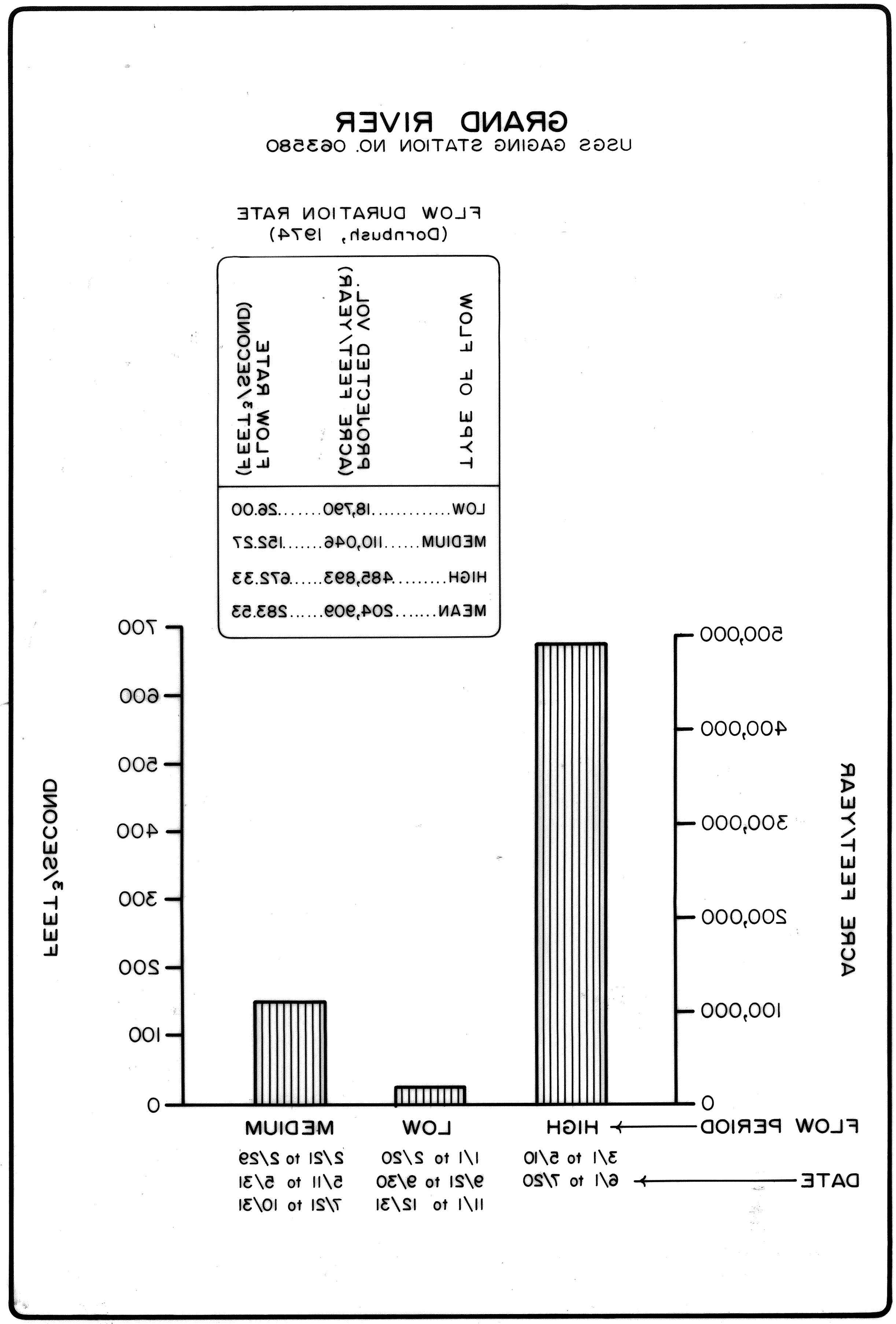
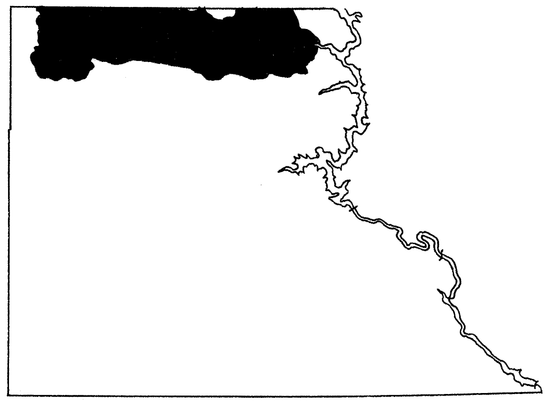
* Calculated by subtracting the flow of Stockade-Beaver Creek (12 cfs) at Newcastle, Wyoming, from the Cheyenne's flow at Edgemont, South Dakota.


GRAND RIVER
USGS GAGING STATION NO. 063580
FLOW DURATION RATE
(Dornbush, 1974)
TYPE OF FLOW
PROJECTED VOL. (ACRE FEET/YEAR)
FLOW RATE (FEET³/SECOND)
LOW............18,790.......26.00
MEDIUM.....110,046.......152.27
HIGH........485,893.....672.33
MEAN.......204,909......283.53
FEET³/SECOND
0
100
200
300
400
500
600
700
ACRE FEET/YEAR
0
100,000
200,000
300,000
400,000
500,000
FLOW PERIOD
HIGH
LOW
MEDIUM
DATE
3/1 to 5/10
6/1 to 7/20
1/1 to 2/20
9/21 to 9/30
11/1 to 12/31
2/21 to 2/29
5/11 to 5/31
7/21 to 10/31

GRAND RIVER BASIN
USGS Gaging Station No. 063578



AREA .... 4,580 sq. mi.

AVAILABILITY OF SURFACE WATER

USGS mean daily flow .... 240 cfs

USGS estimate of mean annual discharge .... 173,900 ac-ft

CURRENT ALLOCATIONS OF SURFACE WATER

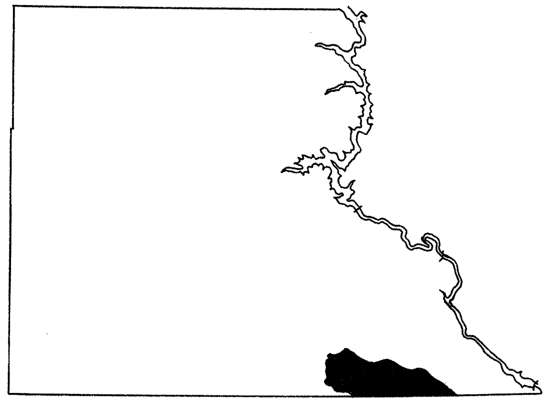
Sum of diversion rates .... 441.66 cfs

Sum of annual appropriations .... 95,206 ac-ft

Total of number of permits 136

Irrigation 136

KEYA PAHA RIVER BASIN
USGS Gaging Station No. 064645



AREA .... 1,068 sq. mi.

AVAILABILITY OF SURFACE WATER

USGS mean daily flow .... 67 cfs

USGS estimate of mean annual discharge .... 48,540 ac-ft

CURRENT ALLOCATIONS OF SURFACE WATER

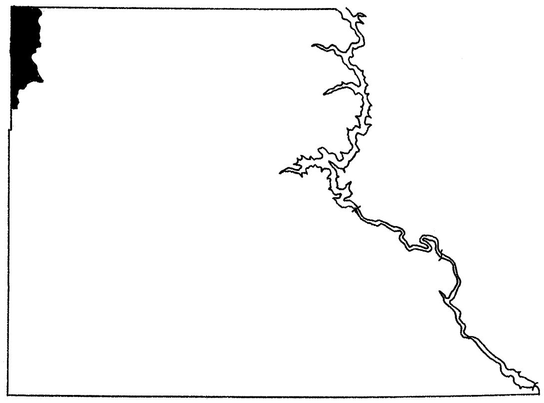
Sum of diversion rates .... 53.90 cfs

Sum of annual appropriations .... 12,247 ac-ft

Total number of permits 34

Irrigation 34

LITTLE MISSOURI RIVER BASIN



AREA .... 574 sq. mi.

AVAILABILITY OF SURFACE WATER *

Projected mean daily flow .... 200 cfs

Projected mean annual discharge .... 144,759 ac-ft

CURRENT ALLOCATIONS OF SURFACE WATER

Sum of diversion rates .... 102.03 cfs

Sum of annual appropriations .... 26,238 ac-ft

Total number of permits 36

Irrigation 36

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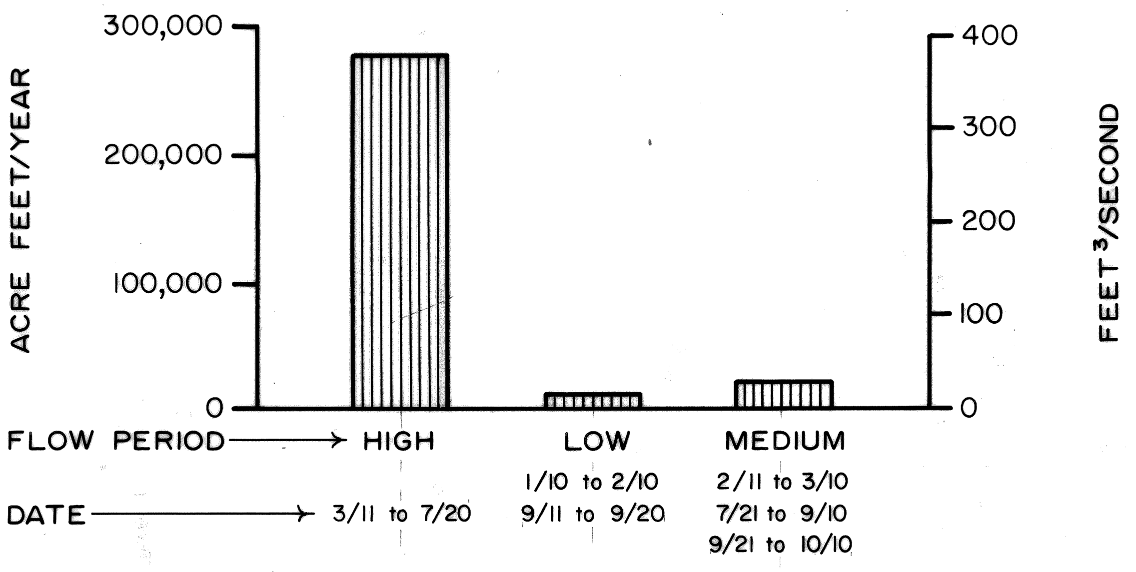
* Projection based on USGS Gaging Station Nos. in South Dakota and North Dakota whose average flows are 136 and 335 cfs, respectively.

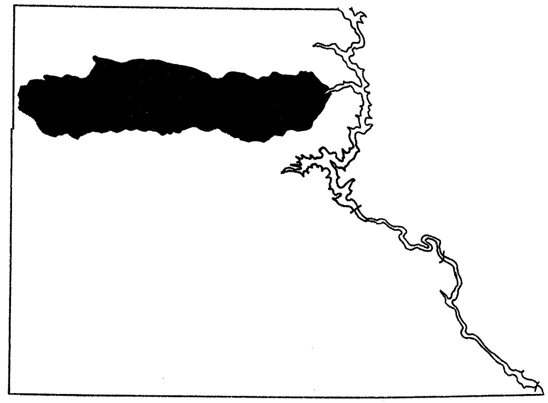
MOREAU RIVER
USGS GAGING STATION NO. 063605

FLOW DURATION RATE
(Dornbush, 1974)

TYPE OF FLOW	PROJECTED VOL. (ACRE FEET/YEAR)	FLOW RATE ($FEET^3$/SECOND)
LOW	11,737	16.24
MEDIUM	22,700	31.41
HIGH	277,799	384.89
MEAN	104,078	144.01



MOREAU RIVER BASIN
USGS Gaging Station No. 063605



AREA .... 4,921 sq. mi.

AVAILABILITY OF SURFACE WATER

UGSG mean daily flow .... 205 cfs

USGS estimate of mean annual discharge ...... 148,500 ac-ft

CURRENT ALLOCATIONS OF SURFACE WATER

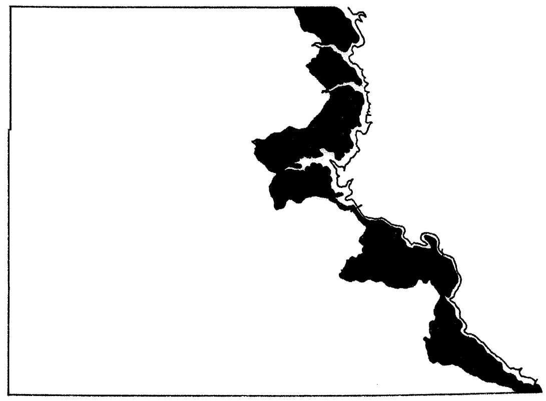
Sum of diversion rates .... 298.34 cfs

Sum of annual appropriations .... 65,954 ac-ft

Total number of permits 109

Irrigation 103

MISSOURI RIVER BASIN
(in western South Dakota)



AREA .... 5,317 sq. mi.

AVAILABILITY OF SURFACE WATER *

Estimate of mean daily flow .... 117 cfs

Estimate of mean annual discharge .... 85,072 ac-ft

CURRENT ALLOCATIONS OF SURFACE WATER **

Sum of diversion rates .... 2,113.8 cfs

Sum of annual appropriations .... 525,136 ac-ft

Total number of permits 103

Irrigation 86

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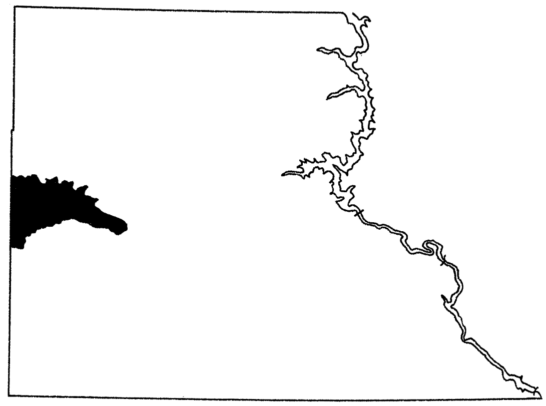
* It was assumed that 0.3 inch of runoff is available over the drainage area (5,317 x 640 x (0.3/12) x 1.983 x 365).

** Current allocations were based on January 1, 1984, data. Developments during the summer of 1984 such as the cancellation of the ETSI Project will reduce diversion rates and annual appropriations from the Missouri basin.

NORTHERN BLACK HILLS BASINS



AREA .... 1,100 sq. mi.

AVAILABILITY OF SURFACE WATER *

Estimated mean daily flow .... N/A

Estimated mean annual discharge .... N/A

CURRENT ALLOCATIONS OF SURFACE WATER

Sum of diversion rates .... 220.64 cfs

Sum of annual appropriations .... 34,880 ac-ft

Total number of permits 82

Irrigation 65

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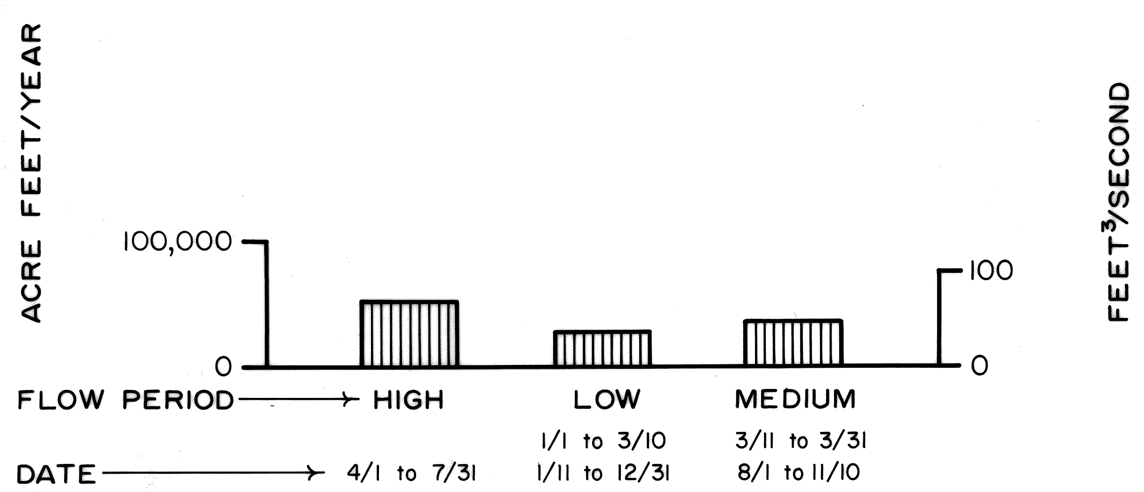
* The contribution of these basins was included in that of the Belle Fourche River basin. The average flow from the Northern Black Hills Basins may be about 100 cfs.

RAPID CREEK

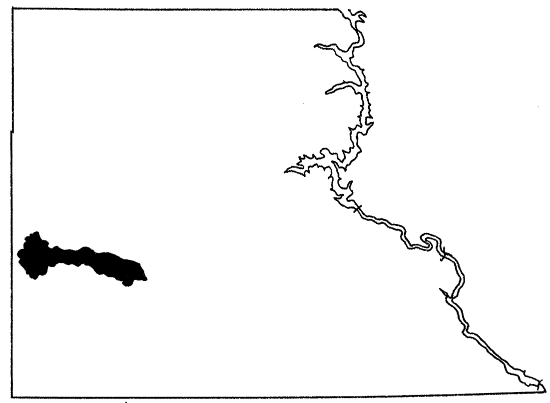
HEADWATERS TO CHEYENNE RIVER—USGS GAGING STATION NO. 064215

FLOW DURATION RATE
(Dornbush, 1974)

TYPE OF FLOW	PROJECTED VOL. (ACRE FEET/YEAR)	FLOW RATE (FEET³/SECOND)
LOW	27,788	38.45
MEDIUM	35,058	48.51
HIGH	51,753	71.61
MEAN	38,200	52.85



RAPID CREEK BASIN
USGS Gaging Station No. 064215



AREA .... 714 sq. mi.

AVAILABILITY OF SURFACE WATER

USGS mean daily flow .... 55 cfs

USGS estimate of mean annual discharge .... 39,630 ac-ft

CURRENT ALLOCATIONS OF SURFACE WATER

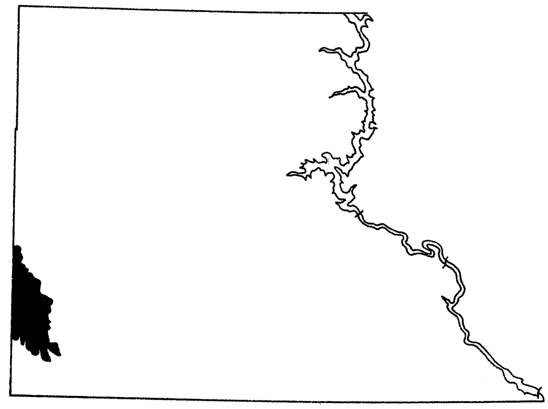
Sum of diversion rates .... 143.39 cfs

Sum of annual appropriations .... 22,465 ac-ft

Total number of permits 31

Irrigation 22

SOUTHERN BLACK HILLS BASINS



AREA .... 571 sq. mi.

AVAILABILITY OF SURFACE WATER *

Estimate of mean daily flow .... N/A

Estimate of mean annual discharge .... N/A

CURRENT ALLOCATIONS OF SURFACE WATER

Sum of diversion rates .... 114.56 cfs

Sum of annual appropriations .... 4,810 ac-ft

Total number of permits 19

Irrigation 18

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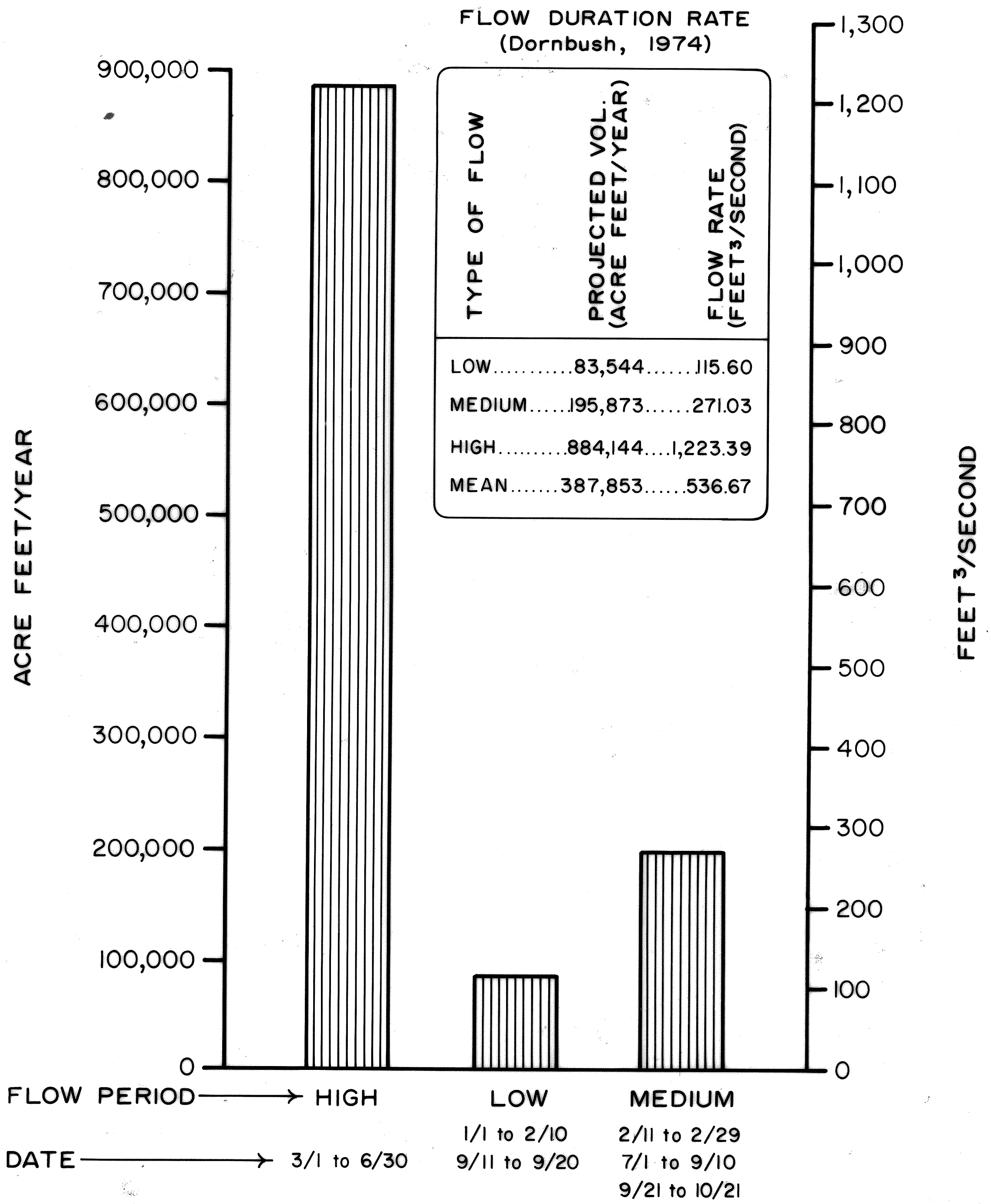
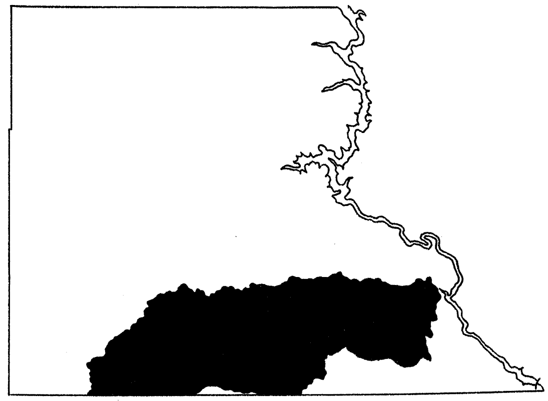
* Quantities and flow rates are unknown. Mean daily flows probably total less than 35 cfs.

WHITE RIVER

USGS GAGING STATION NO. 064520



WHITE RIVER BASIN
USGS Gaging Station No. 064520



AREA .... 8,151 sq. mi.

AVAILABILITY OF SURFACE WATER

USGS mean daily flow .... 526 cfs

USGS estimate of mean annual discharge .... 381,000 ac-ft

CURRENT ALLOCATIONS OF SURFACE WATER

Sum of diversion rates .... 842.56 cfs

Sum of annual appropriations .... 92,170 ac-ft

Total number of permits 172

Irrigation 169