

Subject: **Northeast Wyoming River Basins Plan  
Available Surface Water Determination  
Task 3D**

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**INTRODUCTION**

Spreadsheet water accounting models have been developed for the following four primary subbasins in the Northeast Wyoming River Basins planning area to represent streamflows under current levels of development.

1. Redwater Creek
2. Beaver Creek
3. Cheyenne River
4. Belle Fourche River

The models are described in the Spreadsheet Model Development and Calibration memorandum (HKM, 2002). These models are tools for identifying water shortages as well as flows that are available to Wyoming water users for future development, and to assess the impacts of potential projects at a planning level. The models are developed to represent wet year, normal year, and dry year hydrologic conditions in each of the individual subbasins. The development of monthly streamflow inputs to the model for the three hydrologic conditions is presented in the Surface Water Hydrology memorandum (HKM, 2002).

The purpose of the current task is to analyze the results of the spreadsheet model runs to determine where water shortages currently exist and to determine the location, quantity, and timing of available flows for future development.

**WATER SHORT AREAS**

HKM reviewed the results of the water availability modeling runs to make a determination of where water shortages occur under existing conditions. It is recognized that almost every area of the Northeast Wyoming River Basins planning area can be considered water short during severe dry years such as were experienced during the summer of 2001. The purpose of this investigation is to identify those areas that experience relatively high shortages in comparison to other areas in the Basin. The areas listed in Table 1 were identified as being water short in a typical year.

<b>Table 1</b>	
<b>Water Short Areas during Normal Hydrologic Conditions</b>	
<b>River Basin</b>	<b>Stream</b>
Beaver Creek	Beaver Creek Oil Creek
Cheyenne River	Dry Fork Cheyenne River Woody Creek Sheep Creek Wagonhound Creek Lodgepole Creek Snyder Creek Boggy Creek Seven Mile Creek Mule Creek Robbers' Roost Creek
Belle Fourche River	Timber Creek & Buffalo Creek Donkey Creek Trail Cr, Dry Cr, & Robinson Cr Miller Cr & Deer Cr Wind Cr & Mule Cr Arch Cr, Inyan Kara Cr, Cabin Cr, & Miller Cr Pine Cr, Kilpatrick Cr, Kruger Cr, & Oak Cr

## **AVAILABLE FLOW**

Each basin model is divided into a number of reaches, each composed of several nodes, or water balance points. Reaches are typically defined by gages or confluences, and represent tributary basins or subsections of the mainstem. A Reach Outflow worksheet is provided in each model summarizing the monthly flow at the downstream end of each reach. The information provided in these summaries is the basis for this analysis.

While simulated flow at the reach terminus indicates the estimated amount of water physically present, it does not fully reflect availability. Downstream demands relying on the water physically available at any given location must first be accounted for. These downstream demands fall into three general categories:

1. Existing irrigation, or municipal diversions
2. Instream flow constraints
3. Compact constraints

### **Available Flow in Excess of Existing Diversion Demands**

To determine how much of the physical supply is actually available in excess of existing demands, “available flow” at each reach terminus is defined as the minimum of the physically available flow at that point, and the “available flow” at all downstream reaches. Thus available flow must be defined first at the most downstream point, with upstream availability calculated in stream order. These calculations are made on a monthly basis, and annual water availability is computed as the sum of monthly values. Note that calculating annual availability in this way yields a different result than applying the same logic to annual flows for each reach. The summation of monthly values is more accurate, reflecting constraints of downstream use on a monthly basis.

### **Instream Flow Constraints**

Instream flow rights exert a demand on the river but do not affect physical supply, because the water is not removed from the stream. Sufficient flow must be bypassed through upstream reaches to satisfy downstream instream flow requirements. The available flow for reaches located upstream from permitted instream flows are determined as the minimum of physical flow at that point, and available flow in excess of existing diversion demands less the instream flow requirement at the downstream reach.

There is only one permitted instream flow right in the planning area. This right, for a 2.5-mile reach of Sand Creek in the Redwater Creek drainage, is described in the Environmental Use memorandum (HKM, 2002). The available flow in Reach 1 of the Redwater Creek sub-basin was calculated taking this instream flow demand into consideration.

The reach by reach results of the monthly available flow determination, accounting for the instream flow constraints, are provided in Tables 2 through 13 for each of the four subbasins and for each of the three hydrologic conditions (wet, normal, and dry years). The total annual available flow is summarized in Table 14 for each subbasin and hydrologic condition.

<b>Table 14</b>			
<b>Total Annual Available Flow</b>			
Subbasin	Hydrologic Condition		
	Wet Years	Normal Years	Dry Years
Redwater Creek	34,000	26,000	17,000
Beaver Creek	30,000	20,000	14,000
Cheyenne River	103,000	31,000	5,000
Belle Fourche River	151,000	71,000	13,000

**Table 2**  
**Available Flow for Redwater Creek Basin (Acre-Feet)**  
**Wet Year Hydrologic Conditions**

Reach	Reach Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	Sand Creek <sup>1</sup>	484	478	643	865	1,808	2,087	1,381	1,382	946	495	347	247	10,680
2	South Redwater Creek	632	588	701	762	1,158	1,192	833	862	672	689	688	663	8,808
3	S Redwater Cr below Sand Cr	2,137	1,980	2,341	2,586	4,108	4,374	2,946	2,981	2,558	2,308	2,236	2,190	30,607
4	Redwater Creek	321	299	356	365	504	398	159	204	172	338	331	327	3,453
5	Redwater Cr below S Redwater Cr	2,498	2,317	2,718	3,012	4,712	4,772	3,104	3,185	2,730	2,646	2,567	2,517	34,279

Note: <sup>1</sup> Constrained by Instream Flow Rights of 16 cfs (January 1 - April 30), 18 cfs (May 1 - October 31), and 21 cfs (November 1 - December 31).

**Table 3**  
**Available Flow for Redwater Creek Basin (Acre-Feet)**  
**Normal Year Hydrologic Conditions**

Reach	Reach Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	Sand Creek <sup>1</sup>	244	270	379	494	1,462	1,126	836	839	565	238	40	0	6,249
2	South Redwater Creek	529	499	587	592	992	717	568	602	500	577	556	549	6,738
3	S Redwater Cr below Sand Cr	1,737	1,685	1,964	2,048	3,603	2,956	2,128	2,117	2,022	1,874	1,804	1,776	23,977
4	Redwater Creek	259	253	298	274	401	121	8	50	74	269	264	263	2,274
5	Redwater Cr below S Redwater Cr	1,996	1,976	2,280	2,386	4,025	3,077	2,135	2,167	2,096	2,143	2,068	2,038	26,391

Note: <sup>1</sup> Constrained by Instream Flow Rights of 16 cfs (January 1 - April 30), 18 cfs (May 1 - October 31), and 21 cfs (November 1 - December 31).

**Table 4**  
**Available Flow for Redwater Creek Basin (Acre-Feet)**  
**Dry Year Hydrologic Conditions**

Reach	Reach Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	Sand Creek <sup>1</sup>	52	18	3	59	287	335	248	202	152	0	0	0	1,303
2	South Redwater Creek	446	390	425	391	420	362	315	355	306	445	461	458	4,329
3	S Redwater Cr below Sand Cr	1,343	1,216	1,426	1,417	1,673	1,671	1,441	1,538	1,577	1,285	1,411	1,379	16,034
4	Redwater Creek	200	182	216	153	27	0	0	0	0	180	204	203	1,164
5	Redwater Cr below S Redwater Cr	1,543	1,398	1,642	1,665	1,700	1,671	1,441	1,538	1,577	1,465	1,615	1,582	17,293

Note: <sup>1</sup> Constrained by Instream Flow Rights of 16 cfs (January 1 - April 30), 18 cfs (May 1 - October 31), and 21 cfs (November 1 - December 31).

**Table 5**  
**Available Flow for Beaver Creek Basin (Acre-Feet)**  
**Wet Year Hydrologic Conditions**

Reach	Reach Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	Beaver Cr above Oil Cr	33	635	1,752	0	1,011	0	50	5	0	73	36	22	3,585
2	Oil Creek	71	2,281	3,700	1,887	1,348	0	0	1,245	0	118	0	0	10,578
3	Beaver Cr above Blacktail Cr	149	2,916	5,452	1,971	2,359	176	184	1,250	53	204	172	99	14,836
4	Blacktail Cr	159	209	131	340	166	727	351	31	130	95	148	152	2,480
5	Beaver Cr above Stockade Beaver Cr	308	3,125	5,583	2,311	2,525	903	535	1,281	183	299	320	251	17,317
6	Dry Beaver Creek	117	139	203	194	79	137	143	3	49	72	108	99	1,226
7	Beaver Cr in South Dakota	116	138	201	192	79	136	141	3	49	72	107	98	1,214
8	Stockade Beaver Cr Tribs above Gage 06392950	415	429	649	495	292	416	423	9	161	262	389	382	3,907
9	Stockade Beaver Cr above Gage 06392950	648	739	1,075	880	451	689	707	15	259	407	604	578	6,403
10	Stockade Beaver Cr above Mouth	648	1,373	1,288	880	451	1,175	707	15	259	407	604	578	7,737
11	Stockade Beaver Cr Tribs above Mouth	10	438	1,251	0	667	0	49	0	0	9	0	0	2,414
12	Beaver Cr Tribs above Gage 06394000	6	282	804	0	396	0	16	0	0	1	0	0	1,499
13	Beaver Cr above Gage 06394000	972	5,219	8,927	3,822	4,038	2,079	1,308	1,296	442	715	924	829	29,599
14	Beaver Cr above Stateline	977	5,221	8,929	3,822	4,038	2,079	1,308	1,296	442	727	936	836	29,635

**Table 6**  
**Available Flow for Beaver Creek Basin (Acre-Feet)**  
**Normal Year Hydrologic Conditions**

Reach	Reach Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	Beaver Cr above Oil Cr	16	79	399	0	132	0	0	0	0	12	17	8	647
2	Oil Creek	49	1,320	4,532	0	2,591	0	0	437	0	178	0	0	9,057
3	Beaver Cr above Blacktail Cr	118	1,399	4,931	25	2,963	135	182	696	55	189	145	104	10,822
4	Blacktail Cr	135	40	136	475	311	865	482	115	157	64	127	149	2,921
5	Beaver Cr above Stockade Beaver Cr	253	1,439	5,067	502	3,333	999	664	811	212	253	271	253	13,805
6	Dry Beaver Creek	93	15	63	159	48	116	117	0	29	48	82	103	779
7	Beaver Cr in South Dakota	92	15	62	157	48	115	115	0	29	47	81	102	772
8	Stockade Beaver Cr Tribs above Gage 06392950	369	51	208	424	199	411	396	0	90	172	328	387	2,667
9	Stockade Beaver Cr above Gage 06392950	554	81	333	746	295	642	628	0	148	267	492	592	4,224
10	Stockade Beaver Cr above Mouth	554	81	333	977	295	1,135	893	0	148	267	492	592	5,213
11	Stockade Beaver Cr Tribs above Mouth	5	55	284	0	113	0	0	0	0	0	0	0	452
12	Beaver Cr Tribs above Gage 06394000	3	35	183	0	39	0	0	0	0	0	0	0	257
13	Beaver Cr above Gage 06394000	815	1,610	5,867	1,824	4,129	2,134	1,557	811	360	520	763	846	20,421
14	Beaver Cr above Stateline	821	1,614	5,870	1,824	4,129	2,134	1,557	811	360	536	779	855	20,468

**Table 7**  
**Available Flow for Beaver Creek Basin (Acre-Feet)**  
**Dry Year Hydrologic Conditions**

Reach	Reach Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	Beaver Cr above Oil Cr	2	14	9	0	0	0	0	0	0	0	3	2	28
2	Oil Creek	63	625	3,045	0	953	0	0	0	0	95	0	0	4,718
3	Beaver Cr above Blacktail Cr	78	639	3,054	38	953	298	337	310	144	95	127	55	6,050
4	Blacktail Cr	127	57	97	572	113	915	717	139	225	46	115	137	3,134
5	Beaver Cr above Stockade Beaver Cr	205	697	3,152	626	1,066	1,212	1,106	590	368	142	242	192	9,393
6	Dry Beaver Creek	56	6	5	91	41	94	55	63	0	28	65	61	509
7	Beaver Cr in South Dakota	56	6	5	90	41	94	54	62	0	28	64	60	504
8	Stockade Beaver Cr Tribs above Gage 06392950	424	32	30	467	221	300	209	254	0	165	391	427	2,496
9	Stockade Beaver Cr above Gage 06392950	536	43	41	648	304	488	317	379	0	221	520	548	3,509
10	Stockade Beaver Cr above Mouth	536	43	41	933	304	488	317	379	0	221	520	548	3,794
11	Stockade Beaver Cr Tribs above Mouth	0	10	6	0	0	0	0	0	0	0	0	0	16
12	Beaver Cr Tribs above Gage 06394000	0	6	4	0	0	0	0	0	0	0	0	0	10
13	Beaver Cr above Gage 06394000	741	756	3,202	1,887	1,370	1,701	1,424	1,162	368	363	762	740	13,734
14	Beaver Cr above Stateline	746	759	3,205	1,887	1,370	1,701	1,424	1,162	368	377	777	749	13,778

**Table 8**  
**Available Flow for Cheyenne River Basin (Acre-Feet)**  
**Wet Year Hydrologic Conditions**

Reach	Reach Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	Dry Fork Cheyenne River	8	35	9	118	1,354	287	113	9	0	7	22	13	1,967
2	Dry Fork Cheyenne River Tribs above Gage 06365900	8	167	102	0	1,062	0	0	0	0	9	0	0	1,341
3	Willow Creek	3	62	38	13	518	18	30	15	0	10	0	0	704
4	Woody Creek	0	8	5	0	0	0	0	0	0	0	0	0	13
5	Lake Creek	1	19	12	4	157	5	9	5	0	3	0	0	213
6	Dry Fork Cheyenne River above Antelope Cr	20	292	166	141	3,237	384	152	29	9	37	35	18	4,501
7	Antelope Creek	25	122	37	1,148	11,263	7,410	756	81	69	174	338	28	21,427
8	Cheyenne River above Gage 06365900	46	414	203	1,289	14,535	7,795	908	110	77	211	378	46	25,968
9	Cheyenne River above Sheep Cr	148	489	203	1,756	19,607	13,390	908	110	222	211	378	46	37,321
10	Cheyenne River Tribs above Gage 06386500	46	461	473	0	1,046	0	0	0	0	0	0	0	1,980
11	Sheep Creek	1	9	10	0	0	0	0	0	0	0	0	0	19
12	Wagonhound Creek	2	20	20	0	20	0	0	0	0	0	0	0	60
13	Cheyenne River above Black Thunder Cr	224	996	707	1,756	20,862	13,390	908	110	222	211	378	84	39,624
14	Black Thunder Creek	375	888	369	680	7,434	1,540	595	134	4,195	228	15	0	16,078
15	Cheyenne River above Lodgepole Cr	612	1,891	1,075	2,436	28,332	14,929	1,504	244	4,417	439	393	85	55,745
16	Lodgepole Creek	3	4	17	91	834	294	24	1	0	0	2	1	1,268
17	Cheyenne River above Snyder Cr	616	1,896	1,092	2,527	29,165	15,223	1,528	245	4,417	439	395	86	57,013
18	Snyder Creek	9	91	94	0	289	0	0	0	0	0	0	0	474
19	Cheyenne River above Boggy Cr	635	1,993	1,185	2,527	29,461	15,223	1,528	245	4,417	439	395	86	57,500
20	Boggy Creek	3	25	26	0	71	0	0	0	0	0	0	0	122
21	Cheyenne River above Lance Cr	638	2,018	1,211	2,527	29,532	15,223	1,528	245	4,417	439	395	86	57,621
22	Seven Mile Creek	1	12	12	0	41	0	0	0	0	0	0	0	65
23	Lance Creek	1,233	1,170	479	2,596	24,203	9,777	2,987	845	2,594	119	79	59	44,909
24	Mule Creek	4	39	40	0	0	0	0	0	0	0	0	0	80
25	Cheyenne River above Robbers' Roost Cr	1,876	3,240	1,742	5,123	53,775	25,000	4,514	1,091	7,012	559	474	144	102,675
26	Robbers' Roost Creek	6	56	57	0	26	0	0	0	0	0	0	0	138
27	Cheyenne River above Gage 06386500	2,078	3,418	1,800	5,123	54,135	25,000	4,514	1,091	7,012	559	474	144	103,270
28	Cheyenne River above Stateline	2,084	3,422	1,801	5,125	54,140	25,002	4,517	1,094	7,030	586	490	154	103,362

**Table 9**  
**Available Flow for Cheyenne River Basin (Acre-Feet)**  
**Normal Year Hydrologic Conditions**

Reach	Reach Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	Dry Fork Cheyenne River	2	6	3	30	106	42	26	3	0	2	5	5	244
2	Dry Fork Cheyenne River Tribs above Gage 06365900	9	108	55	0	0	0	0	0	0	20	0	0	183
3	Willow Creek	3	40	21	10	97	6	18	15	0	11	0	0	225
4	Woody Creek	0	5	3	0	0	0	0	0	0	0	0	0	8
5	Lake Creek	1	12	6	3	29	2	5	4	0	3	0	0	68
6	Dry Fork Cheyenne River above Antelope Cr	16	171	88	44	335	88	50	22	5	41	7	8	860
7	Antelope Creek	18	83	72	530	573	1,032	355	69	45	50	13	16	2,837
8	Cheyenne River above Gage 06365900	35	254	160	573	908	1,120	405	90	50	91	20	23	3,696
9	Cheyenne River above Sheep Cr	57	254	160	573	2,589	1,922	405	90	128	91	20	23	6,341
10	Cheyenne River Tribs above Gage 06386500	27	225	174	0	0	0	0	0	0	0	0	0	399
11	Sheep Creek	1	5	4	0	0	0	0	0	0	0	0	0	8
12	Wagonhound Creek	1	10	7	0	0	0	0	0	0	0	0	0	17
13	Cheyenne River above Black Thunder Cr	113	493	345	573	2,821	1,922	405	90	128	91	95	26	7,074
14	Black Thunder Creek	44	97	126	196	2,696	903	53	16	834	69	12	0	5,120
15	Cheyenne River above Lodgepole Cr	169	590	471	769	5,568	2,825	458	106	962	160	107	26	12,193
16	Lodgepole Creek	1	1	8	8	368	80	0	0	0	0	1	0	480
17	Cheyenne River above Snyder Cr	170	591	479	777	5,936	2,905	458	106	962	160	108	27	12,674
18	Snyder Creek	5	44	34	0	101	0	0	0	0	0	0	0	187
19	Cheyenne River above Boggy Cr	186	635	513	777	6,074	2,905	458	106	962	160	108	27	12,861
20	Boggy Creek	1	12	9	0	11	0	0	0	0	0	0	0	34
21	Cheyenne River above Lance Cr	188	646	522	777	6,085	2,905	458	106	962	160	108	27	12,895
22	Seven Mile Creek	1	6	5	0	18	0	0	0	0	0	0	0	29
23	Lance Creek	332	498	186	756	8,465	3,984	1,480	405	2,363	26	51	22	18,323
24	Mule Creek	2	19	15	0	0	0	0	0	0	0	0	0	33
25	Cheyenne River above Robbers' Roost Cr	523	1,169	727	1,534	14,567	6,889	1,938	511	3,325	186	159	48	31,280
26	Robbers' Roost Creek	3	26	21	0	0	0	0	0	0	0	0	0	47
27	Cheyenne River above Gage 06386500	695	1,196	748	1,534	14,793	6,889	1,938	511	3,325	186	159	48	31,328
28	Cheyenne River above Stateline	702	1,200	750	1,538	14,800	6,894	1,944	518	3,344	216	177	59	31,434

**Table 10**  
**Available Flow for Cheyenne River Basin (Acre-Feet)**  
**Dry Year Hydrologic Conditions**

Reach	Reach Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	Dry Fork Cheyenne River	0	2	2	6	1	0	6	0	0	0	1	1	24
2	Dry Fork Cheyenne River Tribs above Gage 06365900	1	19	26	0	0	0	0	0	0	0	0	0	44
3	Willow Creek	0	7	10	1	33	7	1	2	0	1	0	0	60
4	Woody Creek	0	1	1	0	0	0	0	0	0	0	0	0	2
5	Lake Creek	0	2	3	0	10	2	0	0	0	0	0	0	18
6	Dry Fork Cheyenne River above Antelope Cr	2	31	42	7	44	9	7	2	4	8	2	2	164
7	Antelope Creek	18	38	70	94	70	52	74	13	72	22	11	9	534
8	Cheyenne River above Gage 06365900	30	73	112	102	114	61	81	16	75	33	13	14	705
9	Cheyenne River above Sheep Cr	30	73	112	102	138	61	81	16	75	33	13	14	707
10	Cheyenne River Tribs above Gage 06386500	1	33	36	0	0	0	0	0	0	0	0	0	69
11	Sheep Creek	0	1	1	0	0	0	0	0	0	0	0	0	1
12	Wagonhound Creek	0	1	2	0	0	0	0	0	0	0	0	0	3
13	Cheyenne River above Black Thunder Cr	57	123	150	102	138	61	81	16	75	116	100	49	1,007
14	Black Thunder Creek	60	9	24	19	58	97	6	0	0	1	9	0	358
15	Cheyenne River above Lodgepole Cr	130	140	174	121	196	158	87	16	75	188	146	49	1,482
16	Lodgepole Creek	0	0	2	0	0	0	0	0	0	0	0	0	9
17	Cheyenne River above Snyder Cr	130	140	176	121	196	158	87	16	75	188	147	49	1,491
18	Snyder Creek	0	7	7	0	0	0	0	0	0	0	0	0	14
19	Cheyenne River above Boggy Cr	143	154	183	121	196	158	87	16	75	188	147	49	1,511
20	Boggy Creek	0	2	2	0	0	0	0	0	0	0	0	0	4
21	Cheyenne River above Lance Cr	143	155	185	121	196	158	87	16	75	188	147	49	1,515
22	Seven Mile Creek	0	1	1	0	0	0	0	0	0	0	0	0	2
23	Lance Creek	683	240	91	353	1,538	604	100	35	204	71	69	18	3,184
24	Mule Creek	0	3	3	0	0	0	0	0	0	0	0	0	6
25	Cheyenne River above Robbers' Roost Cr	826	399	279	473	1,734	762	187	51	280	259	216	67	4,706
26	Robbers' Roost Creek	0	4	4	0	0	0	0	0	0	0	0	0	8
27	Cheyenne River above Gage 06386500	953	430	283	473	1,734	762	187	51	280	259	216	67	4,742
28	Cheyenne River above Stateline	959	435	286	478	1,743	776	204	68	304	295	237	79	4,911

**Table 11**  
**Available Flow for Belle Fourche River Basin (Acre-Feet)**  
**Wet Year Hydrologic Conditions**

Reach	Reach Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	Belle Fourche River above Caballo Cr	43	44	212	253	732	1,380	0	0	0	24	0	13	2,658
2	Belle Fourche River Tribs above Gage 06426500	5	34	182	0	101	0	0	0	0	10	0	0	328
3	Caballo Creek	11	7	77	58	568	589	0	0	0	16	0	1	1,316
4	Dry Cr, Yellow Hammer Cr, Whitetail Cr, & Four Horse Cr	4	27	146	11	110	39	0	0	0	13	0	0	346
5	Belle Fourche River above Buffalo Cr	63	112	618	323	1,511	2,008	0	0	0	63	0	13	4,648
6	Raven Creek	2	15	79	6	60	22	0	0	0	6	0	0	187
7	Buffalo Cr & Timber Cr	4	31	164	0	17	0	0	0	0	2	0	0	214
8	Belle Fourche River above Donkey Cr	69	157	862	329	1,588	2,030	0	0	0	71	0	13	5,049
9	Donkey Creek	161	148	845	2,063	1,801	3,402	0	0	0	68	0	44	8,371
10	Trail Cr, Dry Cr, & Robinson Cr	1	8	43	0	8	0	0	0	0	0	0	0	59
11	Belle Fourche River above Gage 06426500	231	314	1,750	2,391	3,397	5,432	0	0	0	139	0	57	13,479
12	Belle Fourche River above Keyhole Reservoir	231	314	1,750	2,391	3,397	6,133	0	0	0	139	0	57	14,181
13	Tribes to Keyhole Reservoir	7	37	281	0	148	0	0	0	0	8	0	0	474
14	Miller Cr, Lone Tree Cr, Deer Cr, & Eggie Cr	10	58	432	8	247	0	0	0	0	13	0	0	757
15	Duck Cr, Smoke Cr, Berger Cr, Wind Cr, Mule Cr, & Cottonwood Cr	17	99	740	20	438	0	0	0	0	22	0	0	1,319
16	Keyhole Reservoir	265	508	3,202	2,420	4,230	6,133	0	0	0	181	0	57	16,731
17	Belle Fourche River above Inyan Kara Cr	265	508	3,202	2,420	4,230	6,499	0	0	0	181	0	57	17,096
18	Belle Fourche River Tribs above Gage 06428200	247	531	2,674	1,552	2,690	1,771	0	0	0	158	0	45	9,422
19	Arch Cr, Inyan Kara Cr, Cabin Cr, & Miller Cr	491	637	2,997	2,930	3,249	3,822	0	0	0	580	668	199	15,082
20	Belle Fourche River above Whitetail Cr	1,003	1,676	8,872	6,902	10,169	12,091	1,364	0	0	919	668	301	42,964
21	Whitetail Cr, Blacktail Cr, Lytle Cr, & Beaver Cr	726	1,384	5,165	4,440	5,427	4,778	0	0	0	481	164	175	22,013
22	Belle Fourche River above Gage 06428200	1,729	3,060	14,037	11,342	15,597	16,869	2,223	0	0	1,400	832	476	65,836
23	Belle Fourche River above Arnold Cr	1,729	3,060	14,037	11,342	15,597	18,643	3,408	0	0	1,400	832	476	68,795
24	Belle Fourche River Tribs above Gage 06428500	970	2,233	6,574	3,777	6,391	3,896	0	0	0	780	428	458	24,537
25	Arnold Cr & East Cr	592	2,012	6,126	3,244	5,645	2,330	0	0	0	274	0	145	19,776
26	Belle Fourche River above Horse Cr	3,291	7,305	26,738	18,364	27,633	24,869	4,691	256	0	2,453	1,260	1,080	114,649
27	Horse Cr, Pine Cr, Kruger Cr, Kilpatrick Cr, & Oak Cr	1,222	4,706	11,718	5,395	9,981	3,430	0	0	0	677	60	412	36,379
28	Belle Fourche River above Stateline	4,513	12,011	38,456	23,759	37,615	28,299	4,758	256	0	3,130	1,320	1,491	151,096

**Table 12**  
**Available Flow for Belle Fourche River Basin (Acre-Feet)**  
**Normal Year Hydrologic Conditions**

Reach	Reach Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	Belle Fourche River above Caballo Cr	8	9	33	87	141	318	0	0	0	29	0	10	618
2	Belle Fourche River Tribs above Gage 06426500	1	6	15	0	0	0	0	0	0	9	0	0	24
3	Caballo Creek	2	1	13	20	100	63	0	0	0	18	0	0	209
4	Dry Cr, Yellow Hammer Cr, Whitetail Cr, & Four Horse Cr	1	5	12	3	17	3	0	0	0	17	0	0	51
5	Belle Fourche River above Buffalo Cr	11	21	73	110	258	383	0	0	0	72	0	11	915
6	Raven Creek	0	2	7	2	10	2	0	0	0	8	0	0	29
7	Buffalo Cr & Timber Cr	1	5	14	0	0	0	0	0	0	0	0	0	19
8	Belle Fourche River above Donkey Cr	12	29	93	112	267	385	0	0	0	80	0	11	963
9	Donkey Creek	56	59	187	1,166	565	917	0	0	0	103	0	49	3,031
10	Trail Cr, Dry Cr, & Robinson Cr	0	1	4	0	0	0	0	0	0	0	0	0	5
11	Belle Fourche River above Gage 06426500	68	89	283	1,278	832	1,302	0	0	0	183	0	60	3,999
12	Belle Fourche River above Keyhole Reservoir	68	89	283	1,278	832	1,302	0	0	0	183	0	60	3,999
13	Tribes to Keyhole Reservoir	8	43	117	17	144	0	0	0	0	14	0	0	334
14	Miller Cr, Lone Tree Cr, Deer Cr, & Eggie Cr	13	67	180	44	248	0	0	0	0	23	0	0	563
15	Duck Cr, Smoke Cr, Berger Cr, Wind Cr, Mule Cr, & Cottonwood Cr	21	115	309	84	448	0	0	0	0	40	0	0	995
16	Keyhole Reservoir	110	314	890	1,423	1,672	1,302	0	0	0	260	0	60	5,892
17	Belle Fourche River above Inyan Kara Cr	110	314	890	1,423	1,672	2,643	0	0	0	260	0	60	7,262
18	Belle Fourche River Tribs above Gage 06428200	97	324	930	832	1,354	0	0	0	0	116	0	35	3,569
19	Arch Cr, Inyan Kara Cr, Cabin Cr, & Miller Cr	253	431	1,275	1,975	3,169	1,952	0	0	0	607	535	311	10,281
20	Belle Fourche River above Whitetail Cr	460	1,069	3,094	4,230	6,194	4,665	0	0	0	984	1,184	406	21,804
21	Whitetail Cr, Blacktail Cr, Lytle Cr, & Beaver Cr	309	844	2,289	2,651	4,154	1,878	0	0	0	438	130	216	12,562
22	Belle Fourche River above Gage 06428200	769	1,913	5,384	6,881	10,349	6,544	0	0	0	1,421	1,314	622	34,366
23	Belle Fourche River above Arnold Cr	769	1,913	5,384	6,881	10,349	8,199	0	0	0	1,421	1,314	622	36,051
24	Belle Fourche River Tribs above Gage 06428500	606	1,312	2,919	2,083	3,057	1,409	0	0	0	728	335	502	12,327
25	Arnold Cr & East Cr	283	1,068	2,561	1,526	2,055	87	0	0	0	201	0	97	7,578
26	Belle Fourche River above Horse Cr	1,658	4,293	10,864	10,489	15,461	9,731	0	0	0	2,350	1,863	1,221	56,200
27	Horse Cr, Pine Cr, Kruger Cr, Kilpatrick Cr, & Oak Cr	674	2,357	5,179	2,517	3,199	111	0	0	0	560	0	362	14,358
28	Belle Fourche River above Stateline	2,332	6,650	16,043	13,007	18,660	10,086	0	0	0	2,910	1,863	1,584	70,803

**Table 13**  
**Available Flow for Belle Fourche River Basin (Acre-Feet)**  
**Dry Year Hydrologic Conditions**

Reach	Reach Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	Belle Fourche River above Caballo Cr	0	0	13	0	0	0	0	0	0	0	0	1	14
2	Belle Fourche River Tribs above Gage 06426500	0	0	1	0	0	0	0	0	0	0	0	0	1
3	Caballo Creek	0	0	2	0	0	0	0	0	0	0	0	0	2
4	Dry Cr, Yellow Hammer Cr, Whitetail Cr, & Four Horse Cr	0	0	1	0	0	0	0	0	0	0	0	0	1
5	Belle Fourche River above Buffalo Cr	0	1	16	0	0	0	0	0	0	0	0	1	17
6	Raven Creek	0	0	0	0	0	0	0	0	0	0	0	0	0
7	Buffalo Cr & Timber Cr	0	0	1	0	0	0	0	0	0	0	0	0	1
8	Belle Fourche River above Donkey Cr	0	1	17	0	0	0	0	0	0	0	0	1	18
9	Donkey Creek	0	8	188	0	0	0	0	0	0	0	0	4	200
10	Trail Cr, Dry Cr, & Robinson Cr	0	0	0	0	0	0	0	0	0	0	0	0	0
11	Belle Fourche River above Gage 06426500	0	9	205	0	0	0	0	0	0	0	0	5	219
12	Belle Fourche River above Keyhole Reservoir	0	9	205	0	0	0	0	0	0	0	0	5	219
13	Tribes to Keyhole Reservoir	0	11	30	0	0	0	0	0	0	0	0	0	41
14	Miller Cr, Lone Tree Cr, Deer Cr, & Eggie Cr	0	17	46	0	0	0	0	0	0	0	0	0	63
15	Duck Cr, Smoke Cr, Berger Cr, Wind Cr, Mule Cr, & Cottonwood Cr	0	29	79	0	0	0	0	0	0	0	0	0	108
16	Keyhole Reservoir	0	65	361	0	0	0	0	0	0	0	0	5	431
17	Belle Fourche River above Inyan Kara Cr	4	65	361	0	0	0	0	0	0	0	0	17	443
18	Belle Fourche River Tribs above Gage 06428200	0	61	339	0	0	0	0	0	0	0	0	1	402
19	Arch Cr, Inyan Kara Cr, Cabin Cr, & Miller Cr	49	104	571	0	0	0	0	0	0	0	309	173	1,158
20	Belle Fourche River above Whitetail Cr	53	230	1,271	472	0	0	0	0	0	0	309	192	2,474
21	Whitetail Cr, Blacktail Cr, Lytle Cr, & Beaver Cr	28	178	1,027	0	0	0	0	0	0	0	46	100	1,351
22	Belle Fourche River above Gage 06428200	81	408	2,298	774	0	0	0	0	266	0	355	292	4,394
23	Belle Fourche River above Arnold Cr	81	408	2,298	801	0	0	0	0	266	0	355	292	4,420
24	Belle Fourche River Tribs above Gage 06428500	189	443	1,328	0	0	0	0	0	0	0	253	343	2,368
25	Arnold Cr & East Cr	9	293	1,038	0	0	0	0	0	0	0	0	27	1,358
26	Belle Fourche River above Horse Cr	279	1,144	4,664	1,459	143	0	0	0	601	0	608	663	9,282
27	Horse Cr, Pine Cr, Kruger Cr, Kilpatrick Cr, & Oak Cr	106	741	2,128	0	0	0	0	0	0	0	0	205	3,073
28	Belle Fourche River above Stateline	385	1,885	6,792	1,946	143	0	0	0	601	0	608	868	12,843

The yield potential of each of these basins is limited by the dry year conditions. Further, the timing of these available flows does not necessarily match the timing of the demand for this water. For example of the 14,000 acre feet of available flow from Beaver Creek during a typical dry year, roughly 60 percent of this occurs during the months of March through June. Reservoir storage would be required to store this excess flow to satisfy demands throughout the year. The available flow presented in Table 14 does not include the constraints of the Belle Fourche River Compact. This will be discussed in the next section.

### **Compact Constraints**

A determination of the amount of water available to Wyoming for future development is not complete without an evaluation of the constraints imposed by interstate compacts. Three interstate compacts have been negotiated between the States of Wyoming, Montana, North Dakota, and South Dakota for divisions of the waters of the Little Missouri River, the Belle Fourche River, and the Cheyenne River. Of these three compacts, only the Belle Fourche River Compact has been formally accepted by all interests.

The Belle Fourche Compact of 1943 is briefly summarized by the following rules for dividing the waters between the States of Wyoming and South Dakota (SEO, 1982):

1. *All existing rights in the two states as of the date of the compact are recognized;*
2. *Wyoming is allowed unlimited use for domestic and stock purposes, provided that no stock reservoir exceeds 20 acre-feet;*
3. *The unappropriated waters of the Belle Fourche River and its tributaries as of the date of the compact, as measured at the Wyoming-South Dakota State line, are allocated as follows:*

*90 percent to South Dakota*

*10 percent to Wyoming*

4. *If a reservoir is constructed in Wyoming principally for the irrigation of lands in South Dakota, sufficient water not to exceed 10 cfs shall be released at all times for stock water use. Wyoming has the right to purchase storage space, not exceeding 10 percent of the total space, in any reservoir or reservoirs constructed in Wyoming for irrigation of lands in South Dakota.*
5. *No reservoir built solely to use the water allocated to Wyoming shall have a capacity in excess of 1,000 acre-feet.*

Additional discussion of the Compact is provided in the Legal and Institutional Constraints memorandum (Lord Consulting, 2002).

HKM utilized the following methodology in determining the amount of water subject to the 90% / 10% apportionment:

Annual measured streamflow at the USGS Gages 06428500 (Belle Fourche River at Wyoming-South Dakota State Line and 06430500 (Redwater Creek at Wyoming-South Dakota State Line) are used as the basic data for this evaluation. The surface water hydrology work for this study was performed on a water year basis (October 1 through September 30). Determination of the compact apportionment was therefore also performed on a water year basis for consistency. The compact, however, specifies that apportionment shall be determined based on the accumulated flow and storage from the beginning of the calendar year. HKM performed a comparison of average annual wet year, normal year, and dry year streamflow between the water years selected through the surface water hydrology work to the corresponding calendar years. This analysis, performed for the Belle Fourche River, indicated a difference for all three conditions of less than 0.3 percent. Very little error is introduced into the analysis through the use of water-year total annual flows.

1. The streamflow at the USGS Gages 06428500 (Belle Fourche River at WY-SD State Line) is adjusted to reflect the annual change in storage of Keyhole Reservoir.
2. The streamflows are further adjusted by adding back estimated annual depletions for post compact water uses in Wyoming. These depletions are estimated as the Crop Irrigation Requirements (CIR) for the roughly 2060 acres of land served from the mainstem of the Belle Fourche River below Keyhole Reservoir and the 140 acres of land in the Redwater Creek drainage.
3. Bypass requirements for pre compact water uses in South Dakota are subtracted from the state line flows. According to the USBR, there are roughly 1025 acres in South Dakota served from the Belle Fourche River by pre compact water rights. Based on water rights data received from the South Dakota Department of Environment and Natural Resources, there are also 928 acres of land irrigated from Redwater Creek between the State Line and the confluence of Spearfish Creek. It is assumed that major tributaries in South Dakota (Crow Creek and Spearfish Creek) supply the water requirements of the lands on the lower reaches of Redwater Creek. The average annual streamflow of these two tributaries alone total more than twice the average annual streamflow of Redwater Creek at the State Line. The diversion requirement for those lands requiring bypass water (1025 acres and 928 acres) is estimated at 2.14 acre-feet per acre, based on information obtained from the NRCS in South Dakota.

Wyoming's Compact allocation is taken as 10 percent of the adjusted annual streamflows at the State Line. Wyoming's apportionment of the Belle Fourche River under the three hydrologic conditions (wet, normal, and dry years) is summarized in Table 15.

<b>Table 15</b>			
<b>Wyoming's Apportionment of Available Flow per Belle Fourche River Compact</b>			
Hydrologic Condition	Average Annual Apportionment (AF)		
	Belle Fourche River	Redwater Creek	TOTAL
Wet Years	15,600	3,300	18,900
Normal Years	7,400	2,400	9,800
Dry Years	1,100	1,400	2,500

The derivations of these estimates are described on the worksheets provided with this memorandum. The Wyoming Water Planning Program estimated Wyoming's average annual apportionment of the Belle Fourche River to be 7,300 acre-feet for the 1948 through 1968 study period (SEO, 1972).

## **REFERENCES**

HKM Engineering Inc., 2002. Environmental Water Uses, Task 2E, Technical Memorandum, Northeast Wyoming River Basins Plan. Billings, Montana

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Wyoming State Engineer's Office (SEO), April 1972, Wyoming Water Planning Program, Report 10, Water & Related Land Resources of Northeastern Wyoming, Cheyenne, Wyoming

Wyoming State Engineer's Office (SEO), 1982. Documents on the Use and Control of Wyoming's Interstate Streams - Compacts, Treaties, and Court Decrees, Cheyenne, Wyoming

DERIVATION OF THE WYOMING SHARE OF BELLE FOURCHE RIVER FLOW PER COMPACT ALLOCATION							
Water Year	Measured Streamflow at Gage 06428500 Belle Fourche R. at WY-SD State Line AF <sup>1</sup>	Keyhole Reservoir		WY Depletions for Post-1943 Irrigation Rights in the Belle Fourche Basin AF <sup>4</sup>	Bypass for d/s S. Dakota, Pre-1943 Irr. Right Diversions AF <sup>5</sup>	Allocable streamflow = Meas. streamflow + Change in stor. + WY post-1943 Dep. - S.D. pre-1943 Div. AF <sup>6</sup>	Compact Wyoming 10% share of Allocable Streamflow AF
		End-of-September Storage from USBR AF <sup>2</sup>	Annual Wtr Yr Change in Storage AF <sup>3</sup>				
		122,381	Sept. 1969				
1970	71,293	118,763	-3,618	4083	2,194	69,564	6,956
1971	114,106	153,367	34,604	4083	2,194	150,599	15,060
1972	140,900	170,543	17,176	4083	2,194	159,965	15,996
1973	81,970	157,286	-13,257	4083	2,194	70,602	7,060
1974	61,340	139,342	-17,944	4083	2,194	45,285	4,528
1975	77,336	136,097	-3,245	4083	2,194	75,980	7,598
1976	66,120	133,749	-2,348	4083	2,194	65,661	6,566
1977	55,269	113,503	-20,246	4083	2,194	36,912	3,691
1978	165,560	158,768	45,265	4083	2,194	212,714	21,271
1979	44,055	147,822	-10,946	4083	2,194	34,998	3,500
1980	38,939	106,044	-41,778	4083	2,194	0	0
1981	66,919	42,657	-63,387	4083	2,194	5,421	542
1982	55,407	55,935	13,278	4083	2,194	70,574	7,057
1983	62,090	50,508	-5,427	4083	2,194	58,552	5,855
1984	101,507	80,425	29,917	4083	2,194	133,313	13,331
1985	33,730	56,003	-24,422	4083	2,194	11,197	1,120
1986	55,027	63,963	7,960	4083	2,194	64,876	6,488
1987	59,642	78,639	14,676	4083	2,194	76,207	7,621
1988	38,251	53,417	-25,222	4083	2,194	14,918	1,492
1989	37,087	40,511	-12,906	4083	2,194	26,070	2,607
1990	37,363	31,510	-9,001	4083	2,194	30,251	3,025
1991	33,807	30,376	-1,134	4083	2,194	34,562	3,456
1992	17,079	18,990	-11,386	4083	2,194	7,582	758
1993	61,847	68,184	49,194	4083	2,194	112,930	11,293
1994	66,535	85,432	17,248	4083	2,194	85,672	8,567
1995	106,114	105,971	20,539	4083	2,194	128,542	12,854
1996	140,440	141,694	35,723	4083	2,194	178,052	17,805
1997	132,080	175,336	33,642	4083	2,194	167,611	16,761
1998	57,910	178,323	2,987	4083	2,194	62,786	6,279
1999	144,090	174,727	-3,596	4083	2,194	142,383	14,238
1970-99 avg	74,127	102,263	1,745	4,083	2,194	77,792	7,779
Wet yr avg	119,333						15,619
Dry yr avg	38,668						1,086
Normal yr avg	70,878						7,397

Notes:

- (1) Annual measured streamflow data derived from sum of monthly measured values obtained from the USGS
- (2) End-of-September storage taken from end-of-month storage file on U.S. Bureau of Reclamation web site
- (3) Annual change in storage = end-of-Sep. storage - previous year end-of-Sep. storage
- (4) Annual depletions for post-1943 irrigation rights in Wyoming estimated to equal weighted net consumptive irrigation requirements (CIR) for 2059.5 acres, where:  
 - acreage derived from HKM model of mainstem irrigation in Wyoming below Keyhole Reservoir, where, based on information from the USBR, it is assumed all the post-1943 irrigation rights are located  
 - depletion is calculated as follows:

Weather Station	Ac	Crop	% Each Crop	Crop CIR, in.	Ac x % x CIR in ft
Moorcroft	1553.9	Alfalfa	65%	24.00	2020
		Pasture	35%	22.45	1017
Colony	505.6	Pasture	100%	24.83	1046
<b>Total</b>	<b>2059.5</b>			<b>Weighted total in AF</b>	<b>4083</b>

- (5) Bypass for downstream irrigation diversions for pre-1943 rights on mainstem Belle Fourche River in S. Dakota = 1025.34 acres (from data supplied by the USBR) x 2.14 AF/ac ideal diversion demand (from data supplied by the USBR and USNRCS using a 1.5 AF/ac net irr. requirement and 70% overall efficiency)
- (6) Any calculated negative allocable flows are set to zero. Also note allocable flows in this table do not include evaporation loss from Keyhole Reservoir which is assumed already split between Wyoming and South Dakota on a 10%/90% basis.
- (7) Wet, dry, and normal year averages are based on the following years (see Surface Water Hydrology Memo):  
 Wet = 1971-72, 1978, 1984, 1993, 1997; Dry = 1980-81, 1985, 1988-89, 1992; Normal = all other years between 1970-99

DERIVATION OF THE WYOMING SHARE OF REDWATER CREEK FLOW PER COMPACT ALLOCATION					
Wtr Year	Measured Streamflow at Gage 06430500 Redwater Cr. At WY-SD State Line in AF <sup>1</sup>	Depletions for Post-1943 Irrigation Water Rights in Wyoming in AF <sup>2</sup>	Bypass for Portion of Downstream Pre-1943 Irrigation Water Rights in South Dakota in AF <sup>3</sup>	Allocable streamflow = Measured. Flow + Depletions for Post-43 Rights - Bypass for Pre-43 Rights in AF	WY Share = 10% of Allocable Flow in AF
1970	31610	230	1986	29854	2985
1971	33390	230	1986	31634	3163
1972	36220	230	1986	34464	3446
1973	40520	230	1986	38764	3876
1974	31490	230	1986	29734	2973
1975	28150	230	1986	26394	2639
1976	32770	230	1986	31014	3101
1977	27570	230	1986	25814	2581
1978	32370	230	1986	30614	3061
1979	24840	230	1986	23084	2308
1980	20736	230	1986	18980	1898
1981	15839	230	1986	14083	1408
1982	24430	230	1986	22674	2267
1983	26030	230	1986	24274	2427
1984	26248	230	1986	24492	2449
1985	14303	230	1986	12547	1255
1986	20730	230	1986	18974	1897
1987	24080	230	1986	22324	2232
1988	19457	230	1986	17701	1770
1989	17224	230	1986	15468	1547
1990	16585	230	1986	14829	1483
1991	16461	230	1986	14705	1471
1992	14049	230	1986	12293	1229
1993	17130	230	1986	15374	1537
1994	17031	230	1986	15275	1528
1995	29430	230	1986	27674	2767
1996	30590	230	1986	28834	2883
1997	32390	230	1986	30634	3063
1998	27580	230	1986	25824	2582
1999	38140	230	1986	36384	3638
1970-99 avg	25580	230	1986	23824	2382
Wet yr avg	34598				3284
Dry yr avg	15927				1417
Normal yr avg	25791				2404

Notes:

- (1) Annual measured streamflow data derived from sum of monthly measured values obtained from the USGS.
- (2) Annual depletions for post-1943 irrigation rights in Wyoming estimated to equal mean annual net consumptive irrigation requirement (CIR) of 19.72 inches for alfalfa (for the Sundance climate station) applied to 140 acres derived from HKM irrigated lands mapping and water rights database.
- (3) Bypass for downstream irrigation diversions for pre-1943 rights on mainstem Redwater Creek in S. Dakota was estimated to be 928.0 acres (see following explanation) x 2.14 AF/ac ideal diversion demand (from data supplied by the USBR and USNRCS using a 1.5 AF/ac net irr. requirement and 70% overall efficiency). Information from the S. Dakota Department of Environment & Natural Resources indicates all the downstream mainstem Redwater Creek irrigation rights have pre-1943 priority dates. The 928 acres represents the upper portion of these mainstem rights (Permit #'s 1401-1 and 1409-1) from the State line to Spearfish Creek which are assumed to be served from water bypassing the State line gage. The remaining downstream rights are assumed to be supplied from major tributaries which more than triple the average flow of Redwater Creek by the time it reaches the Belle Fourche River. Two of these tributaries (Crow Creek and Spearfish Creek) lie above most of these remaining downstream mainstem irrigation rights and contribute on average more than twice the flow that is measured at the Redwater Creek State line gage. Bypasses for irrigation in S. Dakota served by the pre-1943 rights of Murray Ditch are already excluded from the Redwater Creek State line gage data.
- (4) Wet, dry, and normal year averages are based on the following years (see Surface Water Hydrology Memo): Wet =1972-73, 1976-78, 1999; Dry=1985, 1990-94; Normal=all other years between 1970-99