1986 WATER USE REPORT

BENTON LAKE NATIONAL WILDLIFE REFUGE

Great Falls, Montana

TABLE I: WATER RIGHTS AT BENTON LAKE NWR

REFUGE WATER RIGHTS						1986 WATER USE			
Source	Point of Diversion Map	Means of Diversion	Flow Rate	Claimed Volume	Use	Type	Place	Amount	Period
Headquarters well	J	Pump	45 gpm	2 AF	Domestic	Fire Protection	Headquarters	0 AF	Annual
Diffuse runoff	A	Dam	Natural	135 AF	F & W	Marsh	Unit III	322 AF	Annual
Lake Creek runoff	B	Dam	500 cfs	14,000 AF	F & W	Marsh	Units I-VI	3876 AF	Annual
Diffuse runoff	C	Dam	Natural	392 AF	F & W	Marsh	Unit IVa	219 AF	Annual
Diffuse runoff	D	Dam	Natural	502 AF	F & W	Marsh	Unit IVa	5 AF	Annual
Other diffuse runoff	E,F,G	Dam	Natural	Unspecified	F & W	Marsh	Unit IV	125 AF	Annual
Other diffuse runoff	H,I	Dam	Natural	Unspecified	F & W	Marsh	Unit VI	96 AF	Annual
Muddy Creek (Irrigation flows)	K	Pump - 3 x 16.6 cfs	50 cfs	14,600 AF	F & W	Marsh	Units I-VI	~~3387~~ 3376 AF	Annual
Other			Dam		F & W	Marsh	Unit V	116 AF	Annual
TOTALS				29,631 AF				~~8135~~ ~~8144~~ AF	

TABLE II: WATER RIGHTS AND USE ON BENTON LAKE WETLAND MANAGEMENT DISTRICT

WATER RIGHTS						1986 WATER USE			
Source	Point of Diversion Map	Means of Diversion	Flow Rate	Claimed Volume	Use	Type	Place	Amount Acre Ft.	Period
Furnell WPA									
Trail Creek (S)	SE¼NE¼SW¼ Sec. 22	Headgate	2 cfs	480 AF	F & W	Wetlands Grasslands	Furnell WPA	None	Annual
Kingsbury Lake WPA									
Stock Dam #1 (s)		Dam	Natural flow	1 AF	F & W	Pond	NE¼NW¼NW¼, Sec. 21	2	Annual
Stock Dam #2 (s)		Dam	Natural flow	2.5 AF	F & W	Pond	SE¼SW¼SE¼ Sec. 16	2	Annual
Stock Dam #3 (s)		Dam	Natural flow	2.5 AF	F & W	Pond	NE¼NW¼SW¼ Sec. 21	0	Annual
Unnamed coulee or dry runs (s)	011806	Dam	18 cfs	6.4 AF	F & W	Pond	SW¼NE¼NW¼ Sec. 28	2	Annual
"	011807	Dam	12 cfs	6.4 AF	F & W	Pond	SE¼SE¼SW¼ Sec. 8	1	Annual
"	011808	Dam	6 cfs	6.4 AF	F & G	Pond	W½NE¼, Sec. 17	.5	Annual
"	011809	Dam	24 cfs	6.4 AF	F & G	Pond	SW¼NW¼NW¼, Sec. 21	.5	Annual
"	011811	Dam	3 cfs	6.4 AF	F & W	Pond	SW¼SW¼NW¼, Sec. 20	.5	Annual
"	011810	Direct use	12 cfs	3.25 AF	F & W	Lake	Sec. 19, T. 21 N., R. 11 E.	1400	Annual
Well, 5" casing (g)	011812	Windmill & tank - non-functional	.50 gpm .50 gpm	3.5 AF	F & W	Tank	NE¼SW¼SW¼, Sec. 21	0	Annual
TOTALS				524.75 AF				1408.5 AF	

TABLE III: RECORDED MARSH UNIT ELEVATIONS FOR 1986

BENTON LAKE NATIONAL WILDLIFE REFUGE

		UNIT I		UNIT II		UNIT III		UNIT IVa		UNIT IVb		UNIT IVc		UNIT V		UNIT VI	
Date	Flowline	Elev. 3621.0	Sal.*	Elev. 3615.0	Sal.*	Elev. 3613.0	Sal.*	Elev. 3613.0	Sal.*	Elev. 3613.0	Sal.*	Elev. 3613.0	Sal.*	Elev. 3613.0	Sal.*	Elev. 3613.0	Sal.*
01/01	Ice	3626.0		3621.65		3615.35		3616.0		3611.45	Dry	3614.65		3617.05		3617.65	
01/15	Covered	3626.7		3621.9		3615.44		3616.2		3612.75		3615.0		3617.10		3617.65	
02/01		3626.5		3622.0		3615.5		3616.2		3616.75		3614.85		3617.35		3617.65	
02/15		3626.7		3621.85		3615.65		3616.2		3613.0		3614.85		3617.60		3617.70	
03/01	4th "t"	3626.6		3622.0		3616.9		3617.0		3615.58		3615.65		3617.65		3617.75	
03/15	ice	3626.1	1400	3621.55	1000	3617.35	1300	361		3617.25	1200	3615.55	1800	3617.60	1300	3617.7	1700
04/01		3625.9		3621.4		3617.2		361		3617.0		3615.35		3617.15		3617.25	
04/15	Iced over-	3625.9		3621.3		3617.23		361		3616.97		3615.3		3617.12		3617.2	
05/01	open	3626.0		3621.35		3617.2		3616.2		3616.95		3615.3		3617.06		3617.1	
05/15		3625.9		3621.25		3617.15		3616.2		3617.0		3615.1		3617.0		3617.1	
06/01		3625.8	2200	3621.1	1500	3617.0	2000	3616.0		3616.9	1500	3615.0	2200	3616.9	1500	3616.95	2200
06/15		3625.4		3620.95		3616.75		3615.8		3616.65		3614.8		3616.7		3616.75	
07/01		3625.1		3620.6		3616.5		3615.7		3616.35		3614.7		3616.35		3616.45	
07/15		3624.85		3620.25		3616.2		3615.6		3616.13		3614.65		3616.2		3616.3	
08/01		3624.6		3620.0		3616.0		3615.5		3615.85		3614.35		3616.0		3616.0	
08/15		3625.35	2400	3620.0	2500	3615.7	4000	3615.3		3615.6	2400	3614.2	4000	3615.7	3300	3615.8	4000
09/01		3625.7		3621.4		3615.25		361		3615.4		3614.1		3615.75		3615.5	
09/15		3625.5	600	3621.55	1000	3615.2	6000	3615.4		3615.65	2800	3613.9		3616.4		3616.3	
10/01		3625.75		3621.5		3615.35		3615.2		3616.25		3614.95		3616.5		3616.85	
10/15		3625.1		3621.25		3615.5		3615.2		3616.2		3615.2		3616.4		3616.8	
11/01	11/08	3625.1		3621.25		3615.5		3615.2		3616.2		3615.2		3616.4		3616.8	
11/15	Iced	3625.1		3621.25		3615.5		3615.2		3616.2		3615.2		3616.4		3616.8	
12/01	Over	3625.1		3621.25		3615.5		3615.2		3616.2		3615.2		3616.4		3616.8	
12/15		3625.1		3621.25		3615.5		3615.2		3616.2		3615.2		3616.4		3616.8	
12/31		3625.1		3621.25		3615.5		3615.2		3616.2		3615.2		3616.4		3616.8	
Maximum Elevation		3627.0		3622.0		3618.0		3618.0		3618.0		3618.0		3618.0		3618.0	
Gen. Pool Bottom		3623.0		3619.0		3615.0		3615.0		3615.0		3615.0		3615.0		3615.0	

*Salinity is measured in micromhos/centimeter

II. NARRATIVE DESCRIPTION

A. Weather Conditions

Good soil moisture buildup in the fall of 1985 plus a good snow pack followed by mild weather and an early spring started runoff into the refuge in January. Severe winter weather prevailed from February 5 to 22 then turned into a very strong warming trend with chinook winds. Rapid runoff the last week of February briefly topped the Unit I dike as spillways and outlet structures couldn't accommodate the inflows. Nearly 3500 acre feet of water from runoff was received in February. Spring runoff ended by mid March. Strong winds coupled with warm temperatures opened the marsh units and by the fourth of March only a little ice remained windrowed along down wind shorelines.

The weather took another drastic change in mid April going from 60 to 70 degree weather, which had triggered leaf sprouting on shrubs and trees, to a blizzard with 3° temperatures - killing back many trees and shrubs in this area. The marsh units froze over solid on the 14th then opened back up on the 15th. Only a small amount of runoff occurred with this storm. April and May provided good spring soil moisture and grasslands responded dramatically in contrast to the three previous years of drought. June failed to produce very much rain and no significant moisture was received until September when nearly three inches were received. October was dry and mild followed by wintery weather and freeze-up of marsh units the first week of November. December was mild and dry with no snowpack build up.

B. Water Use at Benton Lake

Measurements of water rights and use at Benton Lake are dependent on individual marsh unit water level gauge readings and associated field observations as no other recording instruments are in place. The accuracy of these projections is somewhat limited. Volume of water pumped from the Muddy Creek pumping station is calcuated by multiplying pump hours by the rated capacity of the pumps. Runoff events occurring over long time periods or during periods of high evaporation complicate evaluation of such measurements. Runoff occurring during periods of pumping also becomes difficult to separate or measure.

The 1986 runoff totalled 4759 acre feet. See Table IV for distribution by month, marsh unit and water right source. This was more water than planned for and it had to be distributed into Unit III which was scheduled to be held dry for development activity. Pumping requirements from the Muddy Creek pumping station were proportionally reduced. Two pumps were operated during August and September with the third pump (No. 2) only able to operate intermittently due to low flows in Muddy Creek. See Tables V and VI. Power shutdowns occurred several times due to storms and twice due to equipment failure. Pumping cost efficiency rapidly goes down when service is interrupted. We ended the year about 800 acre feet short of stored supply water and the water we pumped cost us
$6.31 ~~58.66~~ per acre foot which is about the worst it has ever been. We need an electronic monitoring system that signals when any of the pumps are off. We also need one pump with about half the operating volume of the existing pumps (7500 gpm) so we can effectively and efficiently utilize the available water at the pumping station.

See Table V for details on pumped water volumes and distribution by marsh unit for 1986, and Table VII provides details on annual pumping operations.

Water manipulation between units other than the initial distribution of runoff or pumped water is documented in Table VIII. This generally covers minor water level adjustments to protect structures from wind/wave erosion, to refill the central canal and to lower units to planned winter levels.

Table IX computes average surface acres for the units and provides a means of estimating expected water consumption. This is based on long term average evaporation rates for this area of 2.5 feet for the April to October period. An annual water budget worksheet (Table XI) was developed and shows good correlation between this theoretical consumption rate and the apparent rate as measured in the individual units. Table X illustrates unit volumes and surface acres at the beginning and end of 1986.

The inter-~~agency~~ unit pumping system was used briefly to dewater Unit III in late July. After further consulting with Region 6 Engineering and the pump manufacturer, we were able to greatly reduce the problem of vibration and noisy pump operations at low water levels. Two different types of pump discharge reducers were built and tried. The use of the pump input flange or "umbrella" appeared to solve the problem and it allows us to operate the pump at desired low water levels.

TABLE IV: 1986 RUNOFF WATER RECEIVED

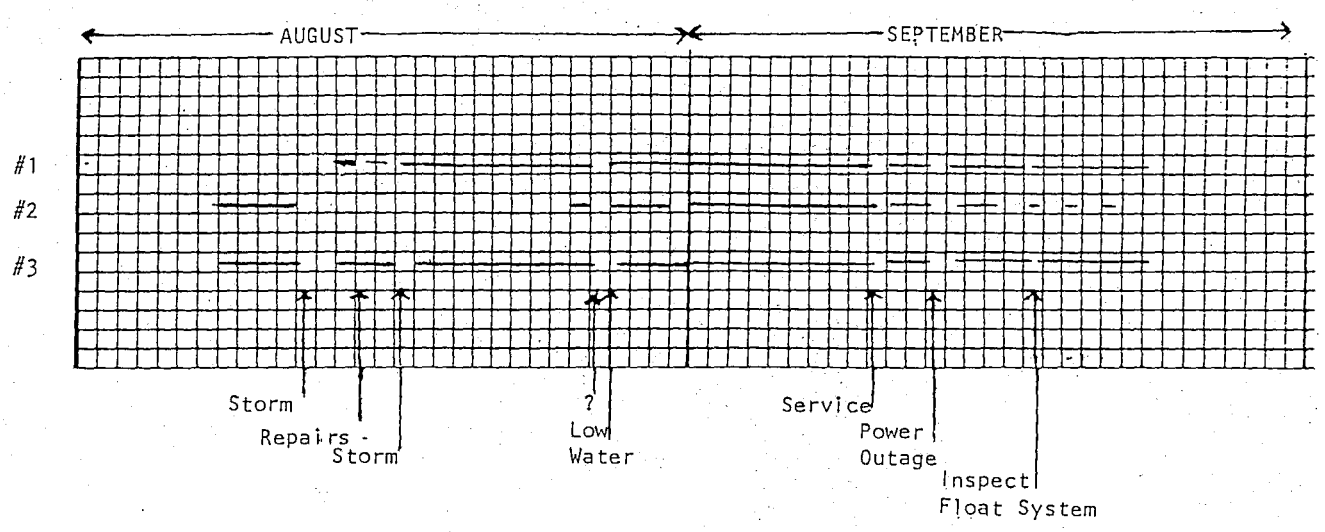
Time	UNITS I	II	III	IVa	IVb	IVc	V	VI	TOTALS
January	191	160	94	28		98	252		823
February	97	114	1315	191	27	835	299	96	2974
March			250		339				589
April	72	22							94
May									0
June									0
September			163	T			116		279
TOTALS	360	296	1822	219	366	933	667	96	4759 AF

	WATER RIGHTS:	Jan	Feb	Mar	Apr	Sept	TOTAL
A.	Unit III basin (runoff from north)	94	65			163	322
B.	Lake Creek runoff (Units I, II, plus	626	2567	589	94		3876
C.	Unit IVa (main watershed)	28	191				219
D.	Unit IVa (south watershed)		5				5
EFG	Unit IV (basin runoff)	75	50				125
HI	Unit VI (basin runoff)		96				96
	Sub-total	823	2974	589	94	163	4643
	Unit V (not filed on)	Couldn't differentiate				116	116
	TOTAL						4759 AF

TABLE V: PUMPED WATER DISTRIBUTION (ACRE FEET)

Month	Total	UNITS I	II	III	IVa	IVb	IVc	V	VI	Comments
April	0									
May	0									
June	0									
July	0									
Aug.	1605	339 150	458 200					100 358		Net volume differential 897 Evapotranspiration = 708
Sept.	1771	37	25			168	216	432	893	Net volume differential Evapotranspiration minus rain = 25
TOTALS	3376	526	683			168	216	890	893	

TABLE VI: 1986 PUMPING PATTERN



1 day for each square

TABLE VII: ANNUAL WATER PUMPING REPORT - 1986

A. PUMPING DATA

1. Hours Operated

	Aug.	Sept.	
Pump No. 1	445	474	919 Hours
Pump No. 2	188	336	524 Hours
Pump No. 3	531	474	1005 Hours
Total	1164	1284	2448 Hours

2. Acre feet pumped (2448 x 1.379) — 3376 AF
3. Kilowatt hours used — 683,520 KWH
4. Costs — $21,312.45

B. WATER QUALITY DATA

1. Acre feet on hand (beginning) — 4978 AF
2. Acre feet received — 8135 AF
3. Acre feet account — 13113 AF
4. Acre feet on hand (close) — 3863 AF
5. Acre feet consumed (check) — 9250 AF
6. Acre feet consumed (actual) — - - -
7. Acre feet difference (Jan. 1 to Dec. 31, 1986) — - 1115
8. Cost/Acre foot (pumped) — $8.66 ~~$6.31~~

?

TABLE VIII: WATER TRANSFER BETWEEN UNITS "T" ±

Month	UNITS I	II	III	IVa	IVb	IVc	V	VI	Comments
Jan.					+ 23	- 23			Opened borrow plugs on DU project
Feb.					+127	-127			To lower water against IVB dike
Mar. 11-19		-116	+255		+116		-255		To fill IVb, remove excess from II Lower V to protect islands
Apr.			+38					-38	Equalize with III
May		- 20			+ 20				Small runoff passed from I - II - IVb
June	- 45								Refill canal
July		- 54							Refill canal & lower II - botulism prevention
Aug.									
Sept.		- 23			+ 23				Runoff into I & II partially "T" into IVb
Oct.	-204	- 67				+271			Lowering I & II to winter levels in IVc
Nov.									
Dec.									
(-) TOTALS	249	280				150	255	38	BALANCE 972
(+)			293		309	271			873 (+ 99 canal)

TABLE IX: AVERAGE SURFACE ACRES

	I	II	III	IVa	IVb	IVc	V	VI	TOTAL
April	366	466	1116	230	273	977	838	762	5,028
May	366	446	1108	149	271	780	831	754	4,705
June	341	345	1053	71	254	446	796	715	4,021
July	292	230	941	29	222	254	747	654	3,369
Aug.	329	306	756	6	165	116	623	556	2,857
Sept.	354	491	505	6	174	206	768	648	3,152
Oct.	343	458	692	t	235	681	771	733	3,913
TOTAL	2391	2742	6171	491	1594	3460	5374	4822	27,045
Ave. SA	348	392	882	71	228	494	768	689	3,872
Evap. (2.5)	870	980	2205	177	570	1235	1920	1722	9,679

TABLE X: 1986 WATER BALANCES

UNIT	Elevations		Surface Acres		Acre Feet Contained		Acre Feet Received	Acre Feet Discharged	Acre Feet Consumed
	Beginning	End	Beginning	End	Beginning	End			
I	3626.0	3625.1	371	324	898	595	886		1189
II	3621.65	3621.25	508	445	782	605	979		1156
III	3615.35	3615.5	566	692	212	306	1822		1728
IVa	3616.0	3615.2	115	trace	29	trace	219		248
IVb	3611.45	3616.2	0	236	0	180	534		354
IVc	3614.65	3615.2	281	820	109	402	1149		856
V	3617.05	3616.4	835	771	1271	747	1557		2181
VI	3617.65	3616.8	791	726	1677	1028	989		1638
TOTAL			3467	4014 + 547	4978	3863 -1115	8135		9250

TABLE XI: WATER BUDGET WORKSHEET

Item/Unit	Acre Ft.	I	II	III	IVa	IVb	IVc	V	VI
12/31/85		3626.0	3621.65	3615.35	3616.0	3611.45	3614.65	3617.05	3617.65
E.O.P. Year (AF)	4978	898	782	212	29	0	109	1271	1677
Over Winter ±									
Runoff - 1986									
Jan.	823	191	160	94	28	0	98	252	0
Feb.	2974	97	114	1315	191	27	835	299	96
Mar.	589			250		339			
Apr.	94	72	22						
Sept.	279			163				116	
TOTAL	4759	360	296	1822	219	366	933	667	96
Pumped In									
Aug.	1605	489	658					458	
Sept.	1771	37	25			168	216	432	893
TOTAL	3376	526	683			168	216	890	893
Inter-Unit Pumping									
July				-100				+100	
TOTAL	(100)			-100				+100	
TOTAL IN	8135	886	979	1822	219	534	1149	1557	989
A.F. Account	13113	1784	1761	2034	248	534	1258	2828	2666
E.O.Y.	3863	595	605	306	t	180	402	747	1028
Net Difference	9250	1189	1156	1728	248	354	856	2081	1638
Transferred		-249	-280	+293		+309	+121	-255	- 38
Pumped Out				-100				+100	
Apr. - Oct.									
Ave. Sur. Acres	3872	348	392	882	71	228	494	768	689
Est. Consump. Rate	9679	870	980	2205	177	570	1235	1920	1722

C. Wetland Management District

Although the drought conditions of the past three to four years were temporarily broken with good moisture received last fall and this spring, the majority of wetland basins in the district remained dry or partially recharged. Wetland basins in the Sweetgrass Hills remained at about 1985 levels with about half of the basins holding water by June.

The Sands WPA basin was partially refilled by spring runoff and later on received benefits from irrigation tail waters and produced good numbers of waterfowl. The Jarina WPA basin received good spring recharge with noted inprovement over 1985 conditions. Spring runoff into the perimeter stock ponds at Kinsbury Lake WPA was estimated at about double 1985 catchments. Minimal creek flow was noted on Trail Creek and no water was diverted onto the Furnell WPA. Local runoff and flows most of the year in Alder Creek helped improve water conditions in Kingsbury Lake although the basin was still about two feet low and didn't appear to have produced waterfowl in 1986.