

Appendix 3.7: Determination of Wet, Normal, and Dry Years

Table of Contents

LIST OF TABLES.....	1
LIST OF ABBREVIATIONS	1
1 INTRODUCTION	2
2 JOCKO AREA.....	2
3 MISSION AREA.....	5
4 LITTLE BITTERROOT AREA	8
5 RECOMMENDATIONS	10

List of Tables

TABLE 2.1: JOCKO AREA WET / DRY / NORMAL DETERMINATION USING NATURAL FLOW MODEL RESULTS	3
TABLE 2.2: JOCKO AREA NATURAL FLOW GAGES WITH 1983 – 2002 STUDY PERIOD DATA.....	3
TABLE 2.3: JOCKO AREA WET / DRY / NORMAL FLOWS USING ACTIVE NATURAL FLOW INDICATOR GAGES.....	4
TABLE 3.1: MISSION AREA WET / DRY / NORMAL DETERMINATION USING NATURAL FLOW MODEL RESULTS.....	5
TABLE 3.2: MISSION AREA NATURAL FLOW GAGES WITH 1983 – 2002 STUDY PERIOD DATA.....	5
TABLE 3.3: MISSION AREA WET / DRY / NORMAL FLOWS USING ACTIVE NATURAL FLOW GAGES (1).....	6
TABLE 3.4: MISSION AREA WET / DRY / NORMAL FLOWS USING ACTIVE NATURAL FLOW GAGES (2).....	7
TABLE 4.1: LITTLE BITTERROOT AREA WET / DRY / NORMAL DETERMINATION USING NATURAL FLOW MODEL RESULTS	8
TABLE 4.2: LITTLE BITTERROOT AREA NATURAL FLOW GAGES WITH 1983 – 2002 STUDY PERIOD DATA.....	8
TABLE 4.3: LITTLE BITTERROOT AREA WET / DRY / NORMAL FLOWS USING ACTIVE NATURAL FLOW GAGE.....	9
TABLE 5.1: HYDROLOGIC CONDITION BASED ON APRIL-JULY FLOW AT INDICATOR GAGES	10

List of Abbreviations

CSKT	Confederated Salish and Kootenai Tribes of the Flathead Nation
MEF	Minimum Enforceable Instream Flow
RDA	River Diversion Allowance
TIF	Target Instream Flow
USGS	United States Geological Survey

1 Introduction

The River Diversion Allowances (RDA), Minimum Enforceable Instream Flows (MEF), and Target Instream Flows (TIF) of the CSKT Water Rights Compact are established to better achieve fishery objectives while also providing for existing irrigation use. The RDAs, MEFs, and TIFs are drawn from the Operational Improvements HYDROSS Model runs for the Jocko (Run Date 11/17/2011) and the Mission (Run Date 11/25/2011). The Little Bitterroot draws on the 2009 Irrigated Lands Mapping HYDROSS Model (Run Date 12/2/2011). Each of the RDAs, MEFs, and TIFs are based on hydrological conditions (wet, normal, and dry) as determined from modeled natural flow near the mouth of the Jocko River, Mission Creek, and Crow Creek, and on the Little Bitterroot River. Streamflow at these locations is impacted by storage regulation, diversions, and return flows and natural flow, therefore cannot be directly measured at these locations.

In order to implement the RDA, MEF, and TIF, the Compact Implementation Technical Team (CITT) must first determine which hydrological condition applies at the time of operation in the future. In order to determine the hydrologic condition, indicator gages must be selected for this purpose. Measurement of streamflow at these indicator gages will be used as a surrogate to the measurement of natural flow at the mouth of the Jocko, Mission, and Crow Creek, and on the Little Bitterroot. Natural flow gages on the periphery of the Project (above all diversions and storage) are selected for this purpose.

The determination of wet, dry, and normal years for the purpose of defining RDA, MEF, and TIF was based on modeled natural streamflow for the April through July forecasting period of the 1983-2002 study period. Dry years are the 4 years for which the Apr-Jul natural flow is below the 80th-percentile exceedance level. Wet years are the 4 years with Apr-Jul natural flow above the 20th-percentile exceedance level. Normal years are those falling between the 80th and 20th percentile exceedance levels.

Selection of the indicator gages for the Jocko, Mission, and Little Bitterroot areas which will be used to determine the Hydrologic Condition (Dry Year, Normal Year, or Wet Year) for future operations; and the range of Apr-Jul Streamflow for each of these conditions, is the subject of this report.

The Operational Improvements envisioned in the CSKT Water Rights Compact include development of improved tools for forecasting streamflow. These tools can be used in the future to forecast the streamflow, and the associated Hydrologic Condition, at these indicator gages.

2 Jocko Area

The Jocko River at Mouth (Node #519500) location was used to determine wet, dry, and normal years for the Jocko Area.

Table 2.1: Jocko Area Wet / Dry / Normal Determination Using Natural Flow Model Results

Rank	Exceedance		Year
	Probability	Apr-Jul Flow (AF)	
1	5%	258,304	1997
2	10%	187,857	1996
3	14%	157,564	2002
4	19%	155,092	1990
5	24%	150,146	1989
6	29%	150,006	1986
7	33%	147,155	1999
8	38%	145,931	1991
9	43%	143,353	1984
10	48%	136,384	1983
11	52%	135,085	1993
12	57%	129,598	1998
13	62%	127,940	2000
14	67%	121,203	2001
15	71%	119,387	1985
16	76%	108,497	1988
17	81%	107,913	1994
18	86%	103,619	1987
19	90%	102,941	1995
20	95%	93,204	1992

A number of natural flow gages have been maintained in the Jocko Area over the years:

Table 2.2: Jocko Area Natural Flow Gages with 1983 – 2002 Study Period Data

Station Number	Station Name	Operating Entity	Status
12381400	South Fork Jocko River near Arlee	USGS	Active
12383500	Big Knife Creek near Arlee	USGS	Discontinued
5167.00	Agency Cr ab Jocko S Cnl	CSKT	Active
5161.00	East Fork Finley Cr ab Jocko N Cnl	CSKT	Discontinued
5182.00	Lamoose Cr ab Jocko K Cnl	CSKT	Discontinued
5191.00	East Fork Valley Cr near Arlee	CSKT	Discontinued
12387450	Valley Creek near Arlee	USGS	Discontinued
5191.20	Valley Creek below Hewolf Cr	CSKT	Discontinued
12388400	Revais Cr bl West Fork nr Dixon	USGS	Discontinued

Using the combined streamflow for the active natural flow gages located on the periphery of the Project (indicator gages), the Dry, Wet, and Normal years previously determined for the Jocko area fall as shown below.

Table 2.3: Jocko Area Wet / Dry / Normal Flows Using Active Natural Flow Indicator Gages

<i>South Fork Jocko R (12381400)</i>				<i>Agency Cr (5167.00)</i>				<i>Combined</i>			
Rank	Exceedance Probability	Apr-Jul Flow (AF)	Year	Rank	Exceedance Probability	Apr-Jul Flow (AF)	Year	Rank	Exceedance Probability	Apr-Jul Flow (AF)	Year
1	5%	66,635	1997	1	5%	11,337	1997	1	5%	77,972	1997
2	10%	45,364	1996	2	10%	8,224	1996	2	10%	53,588	1996
3	14%	38,580	1989	3	14%	7,652	1989	3	14%	46,232	1989
4	19%	36,312	2002	4	19%	6,887	1986	4	19%	42,579	2002
5	24%	34,823	1991	5	24%	6,843	1990	5	24%	41,569	1991
6	29%	34,592	1986	6	29%	6,746	1991	6	29%	41,479	1986
7	33%	34,512	1990	7	33%	6,479	1984	7	33%	41,355	1990
8	38%	34,334	1999	8	38%	6,443	1999	8	38%	40,777	1999
9	43%	33,725	1984	9	43%	6,267	2002	9	43%	40,204	1984
10	48%	31,091	1983	10	48%	6,068	1983	10	48%	37,159	1983
11	52%	29,417	1993	11	52%	5,961	2001	11	52%	34,957	1993
12	57%	28,810	2000	12	57%	5,540	1993	12	57%	32,934	2000
13	62%	27,172	1985	13	62%	5,101	1985	13	62%	32,273	1985
14	67%	26,075	2001	14	67%	5,011	1988	14	67%	32,036	2001
15	71%	24,233	1998	15	71%	4,830	1994	15	71%	29,009	1998
16	76%	24,071	1994	16	76%	4,776	1998	16	76%	28,999	1988
17	81%	23,988	1988	17	81%	4,600	1992	17	81%	28,901	1994
18	86%	21,251	1995	18	86%	4,242	1995	18	86%	25,493	1995
19	90%	20,124	1987	19	90%	4,209	1987	19	90%	24,333	1987
20	95%	17,611	1992	20	95%	4,124	2000	20	95%	22,211	1992

3 Mission Area

The combined flow of Mission Creek at Mission H Canal (Node #999412) and Crow Creek at Moiese A Canal (Node #999414) was used to determine wet, dry, and normal years for the Mission Area.

Table 3.1: Mission Area Wet / Dry / Normal Determination Using Natural Flow Model Results

<i>Mission Cr</i>				<i>Crow Cr</i>				<i>Combined</i>			
Rank	Exceedance Probability	Apr-Jul		Rank	Exceedance Probability	Apr-Jul		Rank	Exceedance Probability	Apr-Jul	
		Flow (AF)	Year			Flow (AF)	Year			Flow (AF)	Year
1	5%	147,252	1997	1	5%	61,593	1997	1	5%	208,846	1997
2	10%	118,515	1984	2	10%	56,562	1983	2	10%	171,562	1984
3	14%	111,710	1983	3	14%	53,048	1984	3	14%	168,272	1983
4	19%	109,717	1990	4	19%	50,875	1996	4	19%	159,322	1990
5	24%	105,739	1996	5	24%	50,513	1993	5	24%	156,615	1996
6	29%	103,724	1998	6	29%	49,605	1990	6	29%	152,716	1993
7	33%	102,253	1986	7	33%	48,170	1991	7	33%	148,364	1986
8	38%	102,203	1993	8	38%	46,399	1989	8	38%	145,903	1998
9	43%	98,587	1989	9	43%	46,112	1986	9	43%	145,558	1991
10	48%	97,389	1991	10	48%	42,970	1995	10	48%	144,986	1989
11	52%	92,443	1999	11	52%	42,179	1998	11	52%	133,445	2002
12	57%	91,267	2002	12	57%	42,178	2002	12	57%	131,407	1999
13	62%	85,544	2001	13	62%	40,283	1985	13	62%	123,131	1995
14	67%	80,160	1995	14	67%	38,964	1999	14	67%	119,546	2001
15	71%	77,671	2000	15	71%	36,382	2000	15	71%	115,018	1985
16	76%	76,729	1987	16	76%	34,615	1994	16	76%	114,053	2000
17	81%	74,735	1985	17	81%	34,002	2001	17	81%	108,559	1994
18	86%	73,944	1994	18	86%	31,280	1987	18	86%	108,009	1987
19	90%	72,349	1988	19	90%	30,603	1988	19	90%	102,952	1988
20	95%	63,643	1992	20	95%	30,360	1992	20	95%	94,003	1992

A number of natural flow gages have been maintained in the Mission Area over the years:

Table 3.2: Mission Area Natural Flow Gages with 1983 - 2002 Study Period Data

<i>Station Number</i>	<i>Station Name</i>	<i>Operating Entity</i>	<i>Status</i>
60.00	Hellroaring Creek ab Reservoir	CSKT	Active
81.00	Centipede Cr ab Twin Fdr Cnl	CSKT	Discontinued
3566.00	Big Creek near Pablo	CSKT	Discontinued
3564.00	North Ashley Creek ab Pablo Fdr Cnl	CSKT	Discontinued
3562.00	Mud Creek above Pablo Fdr Cnl	CSKT	Discontinued
3512.00	North Crow Creek at Campground	CSKT	Active
12375900	South Crow Creek near Ronan	USGS	Active
4870.50	Marsh Creek above Pablo Fdr Cnl	CSKT	Discontinued
4872.00	Eagle Pass Creek near Ronan	CSKT	Discontinued
4860.00	Post Creek above McDonald Reservoir	CSKT	Discontinued
12377150	Mission Cr ab Reservoir nr St Ignatius	USGS	Active
4850.00	Sabine Creek above Mission F Cnl	CSKT	Discontinued
4851.00	Thorne Creek near St Ignatius	CSKT	Discontinued

Using the combined streamflow for the active natural flow gages located on the periphery of the Project (indicator gages), the Dry, Wet, and Normal years previously determined for the Mission area fall as shown below.

Table 3.3: Mission Area Wet / Dry / Normal Flows Using Active Natural Flow Gages (1)

<i>South Crow Cr (12375900)</i>				<i>Mission Cr (12377150)</i>			
<i>Rank</i>	<i>Exceedance Probability</i>	<i>Apr-Jul Flow (AF)</i>	<i>Year</i>	<i>Rank</i>	<i>Exceedance Probability</i>	<i>Apr-Jul Flow (AF)</i>	<i>Year</i>
1	5%	14,159	1983	1	5%	31,484	1997
2	10%	14,080	1997	2	10%	30,401	1993
3	14%	13,290	1984	3	14%	29,753	1983
4	19%	11,916	1993	4	19%	29,140	1990
5	24%	11,449	1990	5	24%	28,122	1998
6	29%	11,309	1996	6	29%	27,731	1991
7	33%	10,994	1986	7	33%	27,691	1984
8	38%	10,816	1991	8	38%	27,519	1996
9	43%	10,316	1995	9	43%	26,177	1989
10	48%	10,165	1998	10	48%	25,369	1999
11	52%	10,083	1989	11	52%	25,231	1986
12	57%	10,057	2002	12	57%	24,919	2001
13	62%	9,692	1985	13	62%	23,113	1995
14	67%	8,254	2001	14	67%	22,934	2002
15	71%	8,028	1994	15	71%	21,390	1987
16	76%	7,926	2000	16	76%	21,267	2000
17	81%	7,690	1999	17	81%	21,000	1992
18	86%	7,635	1987	18	86%	20,532	1985
19	90%	6,784	1988	19	90%	19,493	1994
20	95%	6,512	1992	20	95%	19,363	1988

Table 3.4: Mission Area Wet / Dry / Normal Flows Using Active Natural Flow Gages (2)

<i>Hellroaring Cr (60.00)</i>				<i>North Crow Cr (3512.00)</i>				<i>Combined</i>			
Rank	Exceedance Probability	Apr-Jul Flow (AF)	Year	Rank	Exceedance Probability	Apr-Jul Flow (AF)	Year	Rank	Exceedance Probability	Apr-Jul Flow (AF)	Year
1	5%	7,310	1997	1	5%	25,277	1997	1	5%	78,151	1997
2	10%	5,785	1996	2	10%	24,748	1983	2	10%	73,446	1983
3	14%	4,892	1990	3	14%	23,058	1993	3	14%	69,626	1993
4	19%	4,786	1983	4	19%	22,937	1984	4	19%	68,547	1984
5	24%	4,636	1991	5	24%	21,692	1996	5	24%	66,406	1990
6	29%	4,629	1984	6	29%	20,925	1990	6	29%	66,305	1996
7	33%	4,342	1985	7	33%	20,547	1991	7	33%	63,730	1991
8	38%	4,251	1993	8	38%	19,943	1986	8	38%	60,223	1998
9	43%	4,136	1998	9	43%	19,889	1989	9	43%	60,182	1989
10	48%	4,033	1989	10	48%	18,601	1999	10	48%	60,000	1986
11	52%	3,832	1986	11	52%	18,546	1995	11	52%	55,746	1995
12	57%	3,771	1995	12	57%	17,800	1998	12	57%	54,994	1999
13	62%	3,641	1994	13	62%	17,367	2002	13	62%	53,970	2002
14	67%	3,626	2000	14	67%	16,984	1985	14	67%	51,550	1985
15	71%	3,612	2002	15	71%	16,294	2000	15	71%	50,732	2001
16	76%	3,390	2001	16	76%	15,302	1994	16	76%	49,113	2000
17	81%	3,334	1999	17	81%	14,169	2001	17	81%	46,464	1994
18	86%	3,255	1987	18	86%	13,367	1988	18	86%	45,296	1987
19	90%	3,156	1992	19	90%	13,016	1987	19	90%	43,528	1992
20	95%	2,998	1988	20	95%	12,860	1992	20	95%	42,512	1988

4 Little Bitterroot Area

The Little Bitterroot River below Camas A Canal below Mill Creek (Node #313100) was used to determine wet, dry, and normal years for the Little Bitterroot Area.

Table 4.1: Little Bitterroot Area Wet / Dry / Normal Determination Using Natural Flow Model Results

<i>Rank</i>	<i>Exceedance Probability</i>	<i>Apr-Jul Flow(AF)</i>	<i>Year</i>
1	5%	53,025	1997
2	10%	33,448	1996
3	14%	30,047	1991
4	19%	26,122	1990
5	24%	21,840	2002
6	29%	20,455	1989
7	33%	19,272	1986
8	38%	16,436	1998
9	43%	16,196	1985
10	48%	13,737	1999
11	52%	13,376	1993
12	57%	13,141	1995
13	62%	12,790	1983
14	67%	12,254	1987
15	71%	12,157	2000
16	76%	9,162	1988
17	81%	8,792	1984
18	86%	8,739	1994
19	90%	7,979	2001
20	95%	6,900	1992

A number of natural flow gages have been maintained in the Little Bitterroot Area over the years:

Table 4.2: Little Bitterroot Area Natural Flow Gages with 1983 – 2002 Study Period Data

<i>Station Number</i>	<i>Station Name</i>	<i>Operating Entity</i>	<i>Status</i>
12374250	Mill Cr ab Bassoo Cr nr Niarada	USGS	Active
3122.00	Bassoo Creek near Niarada	CSKT	Discontinued
3126.00	Mill Creek bl Bassoo Creek	CSKT	Discontinued
3141.00	Mill Pocket Creek near Niarada	CSKT	Discontinued
12374800	Cromwell Creek near Niarada	USGS	Discontinued
3162.00	Deep Draw near Elmo	CSKT	Discontinued
3168.00	Sullivan Springs at Niarada	CSKT	Discontinued
3181.00	Oliver Gulch near Hot Springs	CSKT	Discontinued

Using the streamflow for the active natural flow gage located on the periphery of the Project (indicator gage), the Dry, Wet, and Normal years previously determined for the Little Bitterroot area fall as shown below.

Table 4.3: Little Bitterroot Area Wet / Dry / Normal Flows Using Active Natural Flow Gage

<i>Rank</i>	<i>Exceedance Probability</i>	<i>Apr-Jul Flow(AF)</i>	<i>Year</i>
1	5%	11,294	1997
2	10%	7,668	1991
3	14%	7,449	1996
4	19%	5,243	2002
5	24%	4,848	1990
6	29%	4,768	1986
7	33%	4,569	1989
8	38%	4,290	2000
9	43%	4,099	1999
10	48%	3,951	1985
11	52%	3,163	1983
12	57%	3,064	1998
13	62%	2,885	1995
14	67%	2,752	1987
15	71%	2,362	1984
16	76%	2,095	1993
17	81%	2,073	1988
18	86%	1,877	1994
19	90%	1,775	1992
20	95%	1,712	2001

5 Recommendations

Using the recorded April through July streamflow at the active natural flow monitoring gages around the periphery of the Project (indicator gages), the Hydrologic Condition for the Jocko, Mission, and Little Bitterroot areas can be quantified as follows:

Table 5.1: Hydrologic Condition Based on April-July Flow at Indicator Gages

<i>Hydrologic Condition</i>	<i>Jocko Area</i>	<i>Mission Area</i>	<i>Little Bitterroot Area</i>
	Combined April through July flow at: <ul style="list-style-type: none"> • South Fork Jocko River (USGS Gage 12381400) • Agency Creek above Jocko S Canal (CSKT Gage 5167.00) 	Combined April through July flow at: <ul style="list-style-type: none"> • South Crow Creek (USGS Gage 12375900) • Mission Creek above Reservoir (USGS Gage 12377150) • Hellroaring Creek above Reservoir (CSKT Gage 0060.00) • North Crow Creek at Campground (CSKT Gage 3512.00) 	April through July Flow at: <ul style="list-style-type: none"> • Mill Creek above Bassoo Creek (USGS Gage 12374250)
<i>Wet Year</i>	> 41,500 AF	> 66,500 AF	> 4,900 AF
<i>Normal Year</i>	29,000 AF – 41,500 AF	46,500 AF – 66,500 AF	2,200 AF – 4,900 AF
<i>Dry Year</i>	< 29,000 AF	< 46,500 AF	< 2,200 AF