FISH PASSAGE CENTER

847 NE 19th Avenue, #250, Portland, OR 97232
Phone: (503) 833-3900 Fax: (503) 232-1259
www.fpc.org/
e-mail us at fpcstaff@fpc.org

MEMORANDUM

TO: FPAC

FROM: Dave Benner, FPC

DATE: March 2, 2017

SUBJECT: Dworshak Modeled Operations

1. The COE at TMT presented their modeling through April 15th, with the primary objective of meeting the Apr 15 upper rule curve. The COE model runs used the STP output for Dworshak inflow and developed three scenarios for Dworshak outflows with the objective of meeting the April 15 flood control elevation (FCE). They then looked at two alternative scenarios (1989 and 1990) to describe what would happen under an early runoff situation. The table at the end of this document shows the actual monthly volumes that occurred in each of the years used. As can be observed 1989 and 1990 are the 6th and 7th highest April runoff volumes observed since the reservoir started operating in 1973. The COE's model are limited in that they only show operations through April 15 and don't consider outflows from Dworshak over the whole spring time period.

2. Prior to the TMT, the FPC provided modeling scenarios to describe a possible alternative to the COE's operation by targeting the end of April FCE elevation rather than the April 15 elevation. Operating to an April 15 FCE as the COE proposed caused the project to draft and then refill over the same month. The high outflows caused by the drafting to April 15th resulted in very high TDG levels (potentially in the range of 125 -130%) that could be detrimental to fish both in the river and at the Dworshak Hatchery. The modeling also showed that after the April 15 operation it is likely Dworshak outflow will drop significantly as the project intersects the rule curve and begins refilling. At the TMT meeting the COE pointed out that the modeling the FPC had done prior to the TMT meeting was for a more average inflow shape and did not address the potential for an early runoff. Much discussion centered on the risk for flood control that could occur under the suggested deviation from the April 15 FCE. When asked to define or quantify

that risk, the COE did not have specifics. The risk of floods would be relevant to April with an early runoff, but with the significant amount of space in the reservoir (at least 100 feet) – and the ability to catch and subsequently release water – it seems that the risk of flooding this year may be less than in a water year when the FCE are at elevations closer to a full reservoir.

3. The COE has issued a new final runoff volume forecast for March. The new forecast is for 2.87 MAF, with an end of March FCE of 1493.1 feet. The FPC modeled the new runoff volume under two scenarios - one with an average April runoff pattern and one with an early April runoff pattern. The 1984 water year was characterized as having an April –July runoff volume of 2.85 MAF, with a moderate April runoff (21% of the runoff occurred in April). The 1985 water year was characterized as having an April –July runoff volume of 2.9 MAF, with an early April runoff (30% of the runoff occurred in April).

4. The first two graphs show the 1984 (2.85 MAF) runoff scenario with an average runoff into the project during April. The first graph shows the objective of meeting the April 15th FCE. The project would operate at the 15.3 Kcfs outflow until April 15 and then outflows would have to drop to 4.5 Kcfs in order to refill to the April 30th FCE. From there the project would continue to put out low discharge until the summer period. In the second graph the project is operated to the April 30 FCE at both the April 15th and April 30th points. Here it is shown that the outflow is 12 Kcfs until Apr 15 and then increases to 12.8 Kcfs from April 15 to 30 to address the increases of inflow. In real time implementation this could probably be smoothed out. After April 30 the discharge from Dworshak deceases to 4.8 Kcfs, and then 1.6 Kcfs during refill.

5. The third and fourth graphs present the same two alternatives (operating to April 15th FCE and operating to the April 30th FCE) using 1985 with an early April runoff (30% of Apr-Jul runoff) and a similar Dworshak inflow (2.9 MAF). From the graph it is observed that a 17.4 Kcfs outflow would be needed between now and April 15th with a discharge of 4.8Kcfs decreasing to 1.6 Kcfs from April 16th through the refill period. If the project is operated to the April 30th FCE then the discharge between now and the end of April would decrease to 14 Kcfs. Discharge during refill is similar.

6. Much discussion has centered on the risk for flood control and potential high flows beyond April that could occur under the suggested deviation from the April 15 FCE in both plots two and four. The shaded portions of these plots between May and the end of June show that even if future May and June forecasts increase by 700-800 Kaf, operators could still evacuate this water without increasing discharge outflows greater than 10.5 Kcfs through May and June.

7. This is not an easy recommendation to make. Any operation implemented is going to have some risk associated with it. The COE's operation places most risk on fish at the present time – and if the conditions they suggest don't materialize then you imposed the risk on fish too early. However, the opportunity to recover from that decision may be lost. On the other hand, you may delay the operation and there is always the possibility

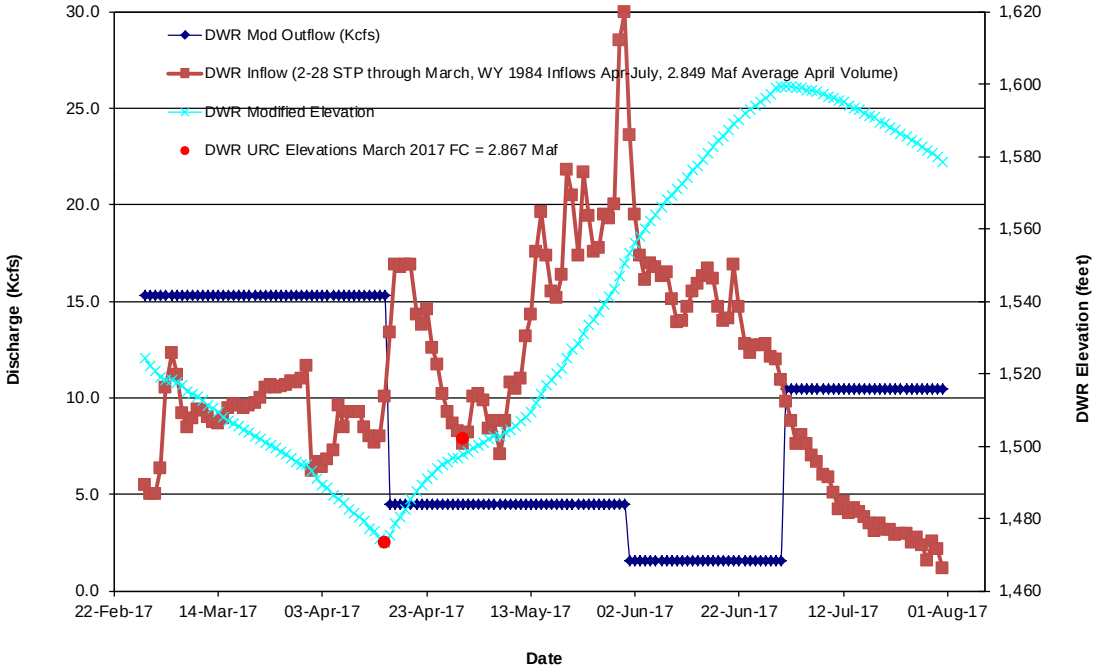
that the April runoff is historically high breaking records, or it rains from now until the end of June and inflow to the project overwhelms any operation we would deem compatible with fish survival.

8. However, what is being shown here is an attempt to bridge the competing needs by suggesting a deviation from the April 15th to April 30 FCE to try and **minimize** the impact to fish now. This deviation is suggested because of the significant amount of space available in reservoir that could possibly be managed to address competing needs. It is a question of whether you wish to take the risk to fish immediately or to manage as we go along and respond to the developing information.

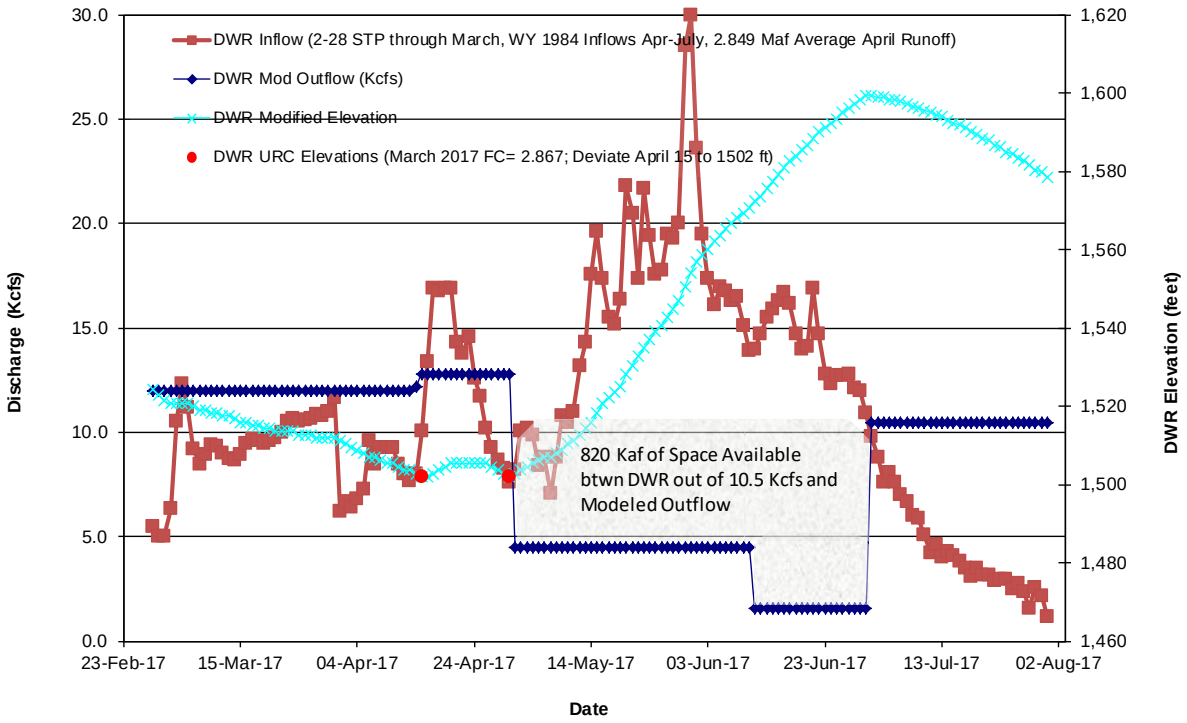
Dworshak Scenarios FPAC 3-2-17--- Using Water years 1984 and 1985 (Average and High April Runoff Years): 1984 = 2.849 Maf Apr-July at DWR, 1985 =2.91 Maf Apr-July at DWR.

Plot 1: Flood Control Elevations were taken from March of Water Year 2017 (DWR had 2.867 Maf Apr-July Forecast), Plot uses 2-28-17 STP Inflows for Dworshak from February through March, from April through July, actual Inflows from WY 1984 were used (2.849 Apr-July Runoff Volume, Average April Runoff Year). The April 15th FC Elevation targeted was 1473.5 ft. Dworshak outflows were 15.3 Kcfs through April 15th (to meet April 15th FC), then drop to 4.5 Kcfs for a period of six weeks then dropped to 1.6 Kcfs over approx. last month of refill period.

Plot 2: Alternative Operation (Same inputs as Plot 1): Flood Control Elevations were taken from March of Water Year 2017 (DWR had 2.867 Maf Apr-July Forecast; however, instead of targeting 1473.5 ft on April 15th, this scenario deviates approx. 29 ft. from April 15th FC and operates to 1502.2 ft (April 30th FC Elevation in March 2017) on both April 15th and April 30th. Plot uses 2-28-17 STP inflows for Dworshak from February through March, from April through July, actual Inflows from WY 1984 were used (2.849 Apr-July Runoff Volume, Average April Runoff). Both the The April 15th and April 30th FC Elevations targeted were 1502.2 ft. Dworshak outflows were 12.0 Kcfs through April 15th (to meet deviated April 15th FC), then 12.8 Kcfs to maintain elevation 1502.2 through April 30th, drop to 4.5 Kcfs for a period of approx. five weeks then 1.6 Kcfs through the remainder of the refill period.


DWR Mod Outflow (Kcfs)
DWR Inflow (2-28 STP through March, WY 1984 Inflows Apr-July, 2.849 Maf Average April Volume)
DWR Modified Elevation
DWR URC Elevations March 2017 FC = 2.867 Maf
Discharge (Kcfs)
DWR Elevation (feet)
Date
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1,620
1,600
1,580
1,560
1,540
1,520
1,500
1,480
1,460
22-Feb-17
14-Mar-17
03-Apr-17
23-Apr-17
13-May-17
02-Jun-17
22-Jun-17
12-Jul-17
01-Aug-17

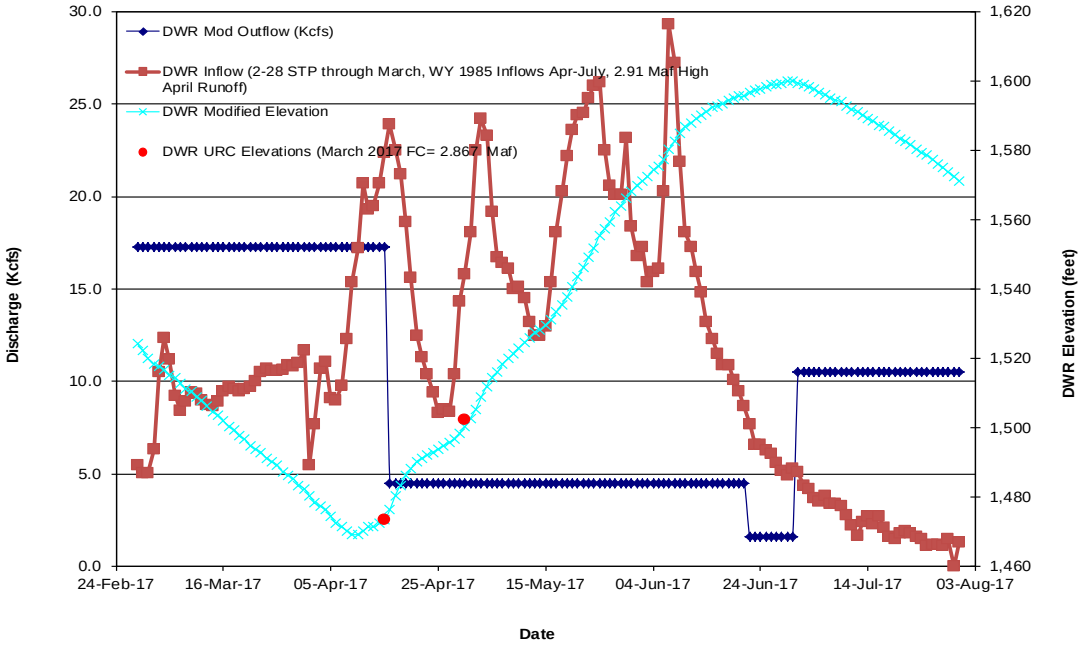
Plot 1.


DWR Inflow (2-28 STP through March, WY 1984 Inflows Apr-July, 2.849 Maf Average April Runoff)
DWR Mod Outflow (Kcfs)
DWR Modified Elevation
DWR URC Elevations (March 2017 FC= 2.867; Deviate April 15 to 1502 ft)
820 Kaf of Space Available
btwn DWR out of 10.5 Kcfs and
Modeled Outflow
Discharge (Kcfs)
DWR Elevation (feet)
Date
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1,620
1,600
1,580
1,560
1,540
1,520
1,500
1,480
1,460
23-Feb-17
15-Mar-17
04-Apr-17
24-Apr-17
14-May-17
03-Jun-17
23-Jun-17
13-Jul-17
02-Aug-17

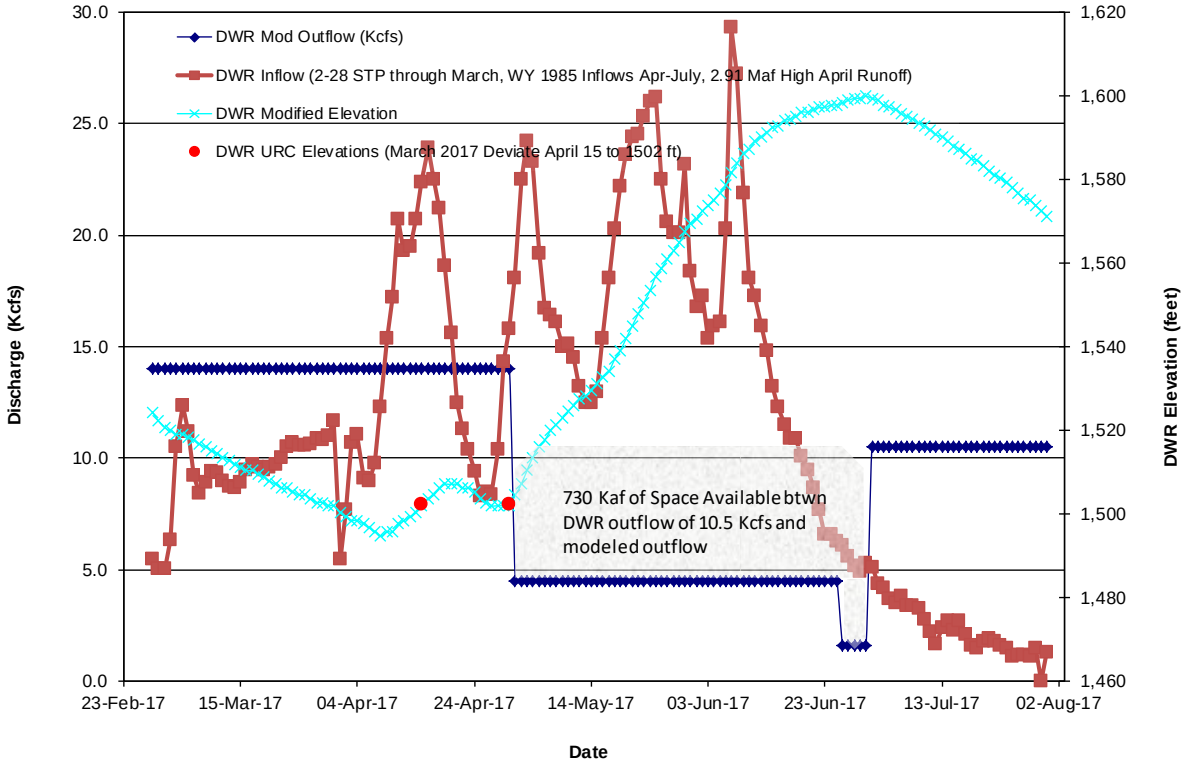
Plot 2.

Plot 3: Flood Control Elevations were taken from March of Water Year 2017 (DWR had 2.867 Maf Apr-July Forecast), Plot uses 2-28-17 STP Inflows for Dworshak from February through March, from April through July, actual Inflows from WY 1985 were used (2.91 Apr-July Runoff Volume, High April Runoff Year). The April 15th FC Elevation targeted was 1473.5 ft. Dworshak outflows were 17.3 Kcfs through April 15th (to meet April 15th FC), then drop to 4.5 Kcfs for the majority of the refill period then dropped to 1.6 Kcfs over the last nine days of the refill period.

Plot 4: Alternative Operation (Same inputs as Plot 3): Flood Control Elevations were taken from March of Water Year 2017 (DWR had 2.867 Maf Apr-July Forecast; however, instead of targeting 1473.5 ft on April 15th, this scenario devaites approx. 29 ft. from April 15th FC and operates to 1502.2 ft (April 30th FC Elevation in March 2017) on both April 15th and April 30th. Plot uses 2-28-17 STP inflows for Dworshak from February through March, from April through July, actual Inflows from WY 1985 were used (2.91 Apr-July Runoff Volume, High April Runoff Year). The April 15th FC Elevation targeted was 1502.2 ft, as was the April 30th FC. Dworshak outflows were 14.0 Kcfs through April 30th (to meet deviated April 15th FC and April 30th FC), then drop to 4.5 Kcfs for majority of refill period then 1.6 Kcfs over the last five days of the refill period.

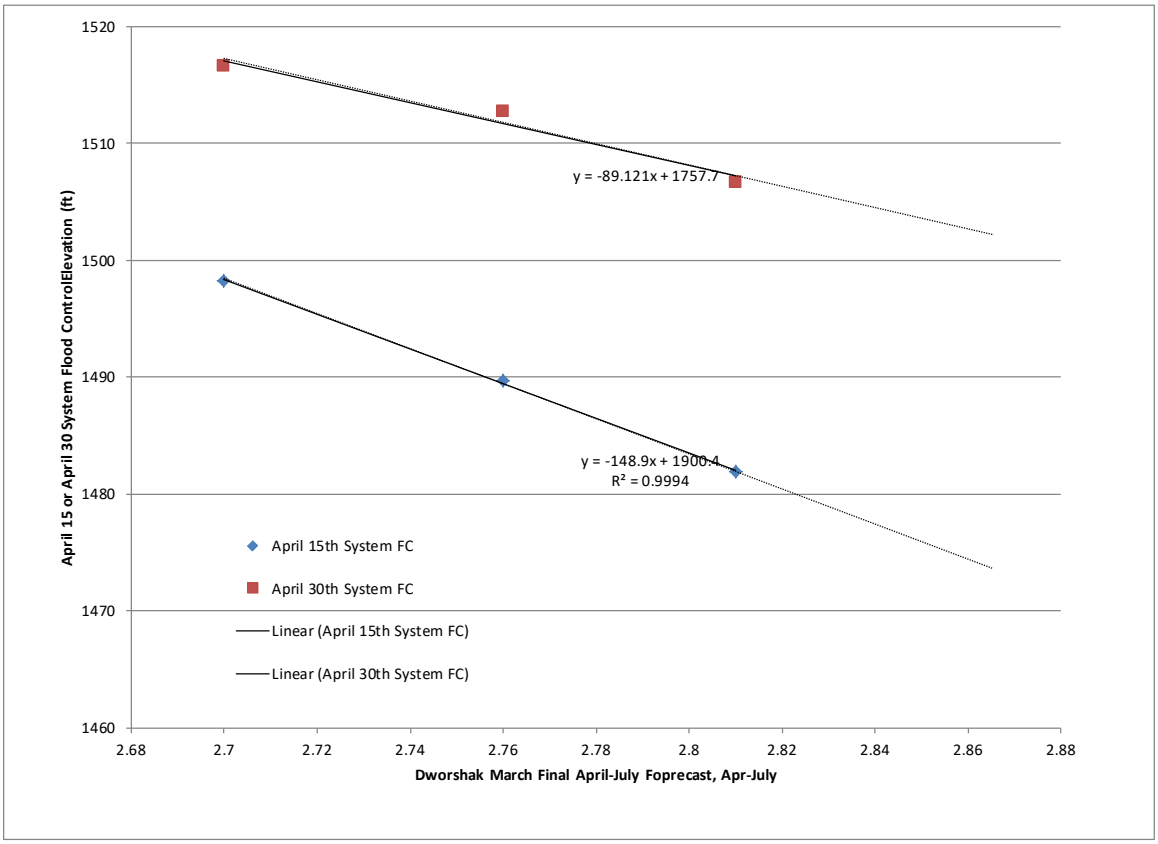

DWR Mod Outflow (Kcfs)
DWR Inflow (2-28 STP through March, WY 1985 Inflows Apr-July, 2.91 Maf High April Runoff)
DWR Modified Elevation
DWR URC Elevations (March 2017 FC= 2.867 Maf)
Discharge (Kcfs)
DWR Elevation (feet)
Date
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1,620
1,600
1,580
1,560
1,540
1,520
1,500
1,480
1,460
24-Feb-17
16-Mar-17
05-Apr-17
25-Apr-17
15-May-17
04-Jun-17
24-Jun-17
14-Jul-17
03-Aug-17

Plot 3.


DWR Mod Outflow (Kcfs)
DWR Inflow (2-28 STP through March, WY 1985 Inflows Apr-July, 2.91 Maf High April Runoff)
DWR Modified Elevation
DWR URC Elevations (March 2017 Deviate April 15 to 1502 ft)
730 Kaf of Space Available btwn DWR outflow of 10.5 Kcfs and modeled outflow
Discharge (Kcfs)
DWR Elevation (feet)
Date
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1,620
1,600
1,580
1,560
1,540
1,520
1,500
1,480
1,460
23-Feb-17
15-Mar-17
04-Apr-17
24-Apr-17
14-May-17
03-Jun-17
23-Jun-17
13-Jul-17
02-Aug-17

Plot 4.
Appendices:

	Dworshak Monthly Inflow, All Monthly Volumes in Kaf								
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Apr-July	Rank of April Volume (44 yrs)
1973	247	122	221	295	557	314	94	1260	44
1974	685	303	504	1000	1325	1959	476	4760	4
1975	139	109	260	418	1142	1307	475	3342	39
1976	368	260	302	822	1570	827	306	3525	11
1977	62	85	133	373	521	255	80	1229	41
1978	243	264	520	654	831	645	232	2362	17
1979	64	154	406	601	1345	583	162	2691	27
1980	111	192	275	635	834	517	190	2176	20
1981	315	409	313	530	752	731	263	2276	32
1982	148	601	596	641	1336	1173	349	3499	19
1983	232	331	548	451	842	622	285	2200	37
1984	270	245	468	615	992	966	276	2849	22
1985	62	90	184	856	1179	740	138	2913	10
1986	129	478	896	725	801	380	126	2032	15
1987	66	124	380	564	606	213	104	1487	29
1988	83	103	249	604	551	314	117	1586	26
1989	81	75	354	934	921	592	156	2603	7
1990	242	183	373	942	784	755	236	2717	6
1991	133	420	359	613	934	715	303	2565	24
1992	110	288	390	507	550	199	136	1392	35
1993	75	87	413	580	1066	398	183	2227	28
1994	139	82	264	557	486	270	73	1386	30
1995	203	639	544	421	679	481	153	1734	38
1996	416	962	474	1037	1078	769	215	3099	3
1997	359	296	612	1063	1965	1267	389	4684	2
1998	182	226	360	515	952	441	127	2035	33
1999	293	234	524	615	1020	1104	371	3110	22
2000	159	255	425	960	1003	619	150	2732	5
2001	79	88	219	342	713	328	110	1493	42
2002	218	153	319	865	1205	1227	312	3609	9
2003	276	415	616	635	776	608	115	2134	20
2004	117	176	405	666	939	632	139	2376	16
2005	308	214	314	509	701	324	94	1628	34
2006	349	190	338	811	1109	630	122	2672	12
2007	165	216	579	557	773	379	79	1788	30
2008	86	110	196	308	1305	1285	381	3279	43
2009	420	175	341	605	1063	701	162	2531	25
2010	155	119	189	396	625	737	164	1922	40
2011	431	225	423	780	1267	1351	644	4042	13
2012	125	178	449	1126	1072	896	249	3343	1
2013	156	161	337	644	913	448	100	2105	18
2014	133	144	674	729	1181	801	231	2942	14
2015	268	584	575	452	430	158	41	1081	36
2016	173	416	615	923	765	295	85	2068	8


1520
1510
1500
1490
1480
1470
1460
2.68
2.7
2.72
2.74
2.76
2.78
2.8
2.82
2.84
2.86
2.88
April 15 or April 30 System Flood ControlElevation (ft)
Dworshak March Final April-July Foprecast, Apr-July
y = -89.121x + 1757.7
y = -148.9x + 1900.4
R² = 0.9994
April 15th System FC
April 30th System FC
Linear (April 15th System FC)
Linear (April 30th System FC)