

BOYCE HYDRO POWER LLC

A W.D. Boyce Trusts Legacy Enterprise

Lee W. Mueller & Stephen B. Hultberg, Co-Member Managers
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15 May, 2014

Secretary Bose
Federal Energy Regulatory Commission
888 First Street, N.E., Routing Code: PJ-13
Washington, D.C. 20426

Re: Sanford - Michigan Project 2785
Response to FERC request for minimum flow data

Secretary Bose: Transmitted herewith is Boyce Hydro Power, LLC's response to Steve Hocking's letter of 18 March, 2014 requesting information about the minimum flow conditions at the above-referenced hydroelectric project.

Sincerely yours,



Lee W. Mueller, Architect
Co-Member Manager
Boyce Hydro Power, LLC

LWM/wp

Cc: Frank O. Christie, P.E.
Stephen B. Hultberg

Encl.

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15 May, 2014

Steve Hocking
Chief, Environmental Review Branch
Division of Hydropower Administration and Compliance
Federal Energy Regulatory Commission
888 First Street, N.E., Routing Code: PJ-13
Washington, D.C. 20426

Re: P-2785-086 Sanford, Michigan
Minimum Flow Information & Records

Mr. Hocking: In response to your letter dated 18 March, 2014 regarding *Allegation of Minimum Flow Non-Compliance* wherein you have requested a report containing certain records and information, the following is submitted for FERC review:

- 1) Boyce calculations utilized in determining estimated flow releases from spillway gates based on gate opening and turbine wicket gate leakage;
- 2) USGS spreadsheet results of measurements of river flow from discharges through spill gates and turbines at the Sanford Dam; and
- 3) Spreadsheet record of daily flow operations at the Sanford project covering the subject period from 1 December, 2013 through 18 March, 2014.

The minimum flow requirement for the Sanford Dam is 210 cfs except during a six week fish spawning season that typically starts on March 15th and ends on April 30th. During that time the minimum flow requirement is increased to 650 cfs. There are three turbines at the Sanford powerhouse which have a minimum operating range of approximately 400 cfs, below which they cannot properly function. Consequently, when there is not enough water flowing into the Sanford impoundment to operate at least one of the three turbines at the Sanford powerhouse without lowering the impoundment below the minimum required level, the turbine is shut down and a spill gate is opened to release approximately 126 cfs. The balance of the minimum flow, 84 cfs, is provided by the leakage that occurs through the three closed turbine wicket gates.

The leakage through the wicket gates has been determined from the USGS river gaging activities of July 2010. These gaging activities were carried out in the river below the Sanford Dam while Boyce set gate and turbine openings at pre-determined levels. Utilizing turbine discharge data and calculated flows at different spill gate openings, we were able to determine what the flow in the river should have been had there been no additional source of water. The flows in the river were in fact quite larger than the known conditions would dictate. The only other source of water is leakage through the turbine wicket gates when the turbines are shut down and off line. As can be seen at the site, there is significant flow out of the turbine bays when the turbines are shut down, indicating substantial wicket gate leakage. From this data it was determined that the average leakage per wicket gate was 28 cfs. The gaging results are contained in the spreadsheets identified in item #2 above.

The calculations which establish the flow of water through one spillway gate when opened to a determined setting are provided in item #1 above. The gate opening required to produce a flow of 126 cfs is shown to be 5.5".

Steve Hocking
Chief, Environmental Review Branch
Federal Energy Regulatory Commission
15 May, 2014
Page 2 of 2

Based on our records, as indicated in the chart identified as item #3 above, the Sanford minimum flow requirements have been met during the period of time in question. It is worth noting that prior to the summer of 2012 we did not know the amount of leakage through the wicket gates and so maintained a larger spill gate opening. This resulted in downriver flows larger than 210 cfs.

Sincerely yours,

A handwritten signature in black ink that reads "Lee W. Mueller". The signature is written in a cursive style and is positioned above the printed name.

Lee W. Mueller, Architect
Co-Member Manager
Boyce Hydro Power, LLC

LWM/wp

Cc: Frank O. Christie, P.E.
Stephen B. Hultberg

Encl.

SANFORD (P-2785) FLOW RELEASES 12/1/2013-3/18/2014

DATE	TIME	RESERVOIR LEVEL	TURBINE SETTINGS			SPILLWAY SETTINGS	AIR TEMP	WATER TEMP
			#1	#2	#3			
12/1/2013	11:00	630.56	0	0	0	5.5"		36
12/2/2013	7:00	630.61	0	94	94	0	30	34
	15:00	630.8	0	0	0	5.5"		
12/3/2013	7:00	630.69	0	94	94	0	25	34
	15:00	630.86	0	0	0	5.5"		
12/4/2013	7:00	630.8	85	85	85	0	32	34
	15:00	630.68	0	0	0	5.5"		
12/5/2013	7:00	630.55	0	98	98	0	42	34
	10:00	630.6	0	0	0	5.5"		
	14:00	630.93	94	94	94	0		
	19:00	630.94	0	0	0	5.5"		
12/6/2013	7:00	630.75	85	85	85	0	19	34
	15:00		0	98	98	0		
	17:00	630.78	0	0	0	5.5"		
12/9/2013	7:00	630.84	90	90	90	0	24	34
	15:00	630.7	0	0	0	5.5"		
12/10/2013	7:00	630.56	0	94	94	0	5	34
	15:00	630.7	0	0	0	5.5"		
12/11/2013	7:00	630.56	0	94	94	0	12	34
	15:00	630.76	0	0	0	5.5"		
12/12/2013	7:00	630.57	0	94	94	0	3	34
	22:00	630.8	0	0	70	0		
12/13/2013	7:00	630.55	0	94	94	0	19	34
	22:00	630.77	0	0	0	5.5"		
12/16/2013	7:00	630.09	0	90	90	0	-1	33
	19:00	630.27	0	98	98	0		
	22:00	630.32	0	0	70	0		
12/17/2013	7:00	630.07	0	94	94	0	17	33
	22:00	630.25	0	0	70	0		
12/18/2013	7:00	629.98	0	98	98	0	24	33
	22:00	630.17	0	0	70	0		
12/19/2013	7:00	629.89	0	98	98	0	17	33
	22:00	630.07	0	70	0	0		
12/20/2013	7:00	629.84	0	98	98	0	25	33
	22:00	630	0	0	0	5.5"		
12/23/2013	7:00	630	0	98	98	0	22	33
	22:00	629.56	0	0	70	0		
12/24/2013	7:00	629.29	0	94	94	0	3	33
	15:00	629.34	0	0	0	5.5"		
12/26/2013	7:00	628.89	0	94	94	0	25	33
	21:30	629.08	0	0	70	0		
12/27/2013	7:00	628.83	0	94	94	0	25	33
	10:15	628.78	0	90	90	0		
	19:00	628.89	0	0	0	5.5"		

SANFORD (P-2785) FLOW RELEASES 12/1/2013-3/18/2014

DATE	TIME	RESERVOIR LEVEL	TURBINE SETTINGS			SPILLWAY SETTINGS	AIR TEMP	WATER TEMP
			#1	#2	#3			
12/30/2013	7:00	628.26	0	90	90	0	10	33
	22:00	628.49	0	0	70	0		
12/31/2013	7:00	628.23	0	85	85	0	11	33
	11:45	628.27	0	85	0	0		
	14:45	628.5	0	0	0	5.5"		
1/2/2014	7:00	628.02	0	0	98	0	6	33
	15:00	628.39	0	0	0	5.5"		
1/3/2014	7:00	628.27	0	0	98	0	-8	33
	15:00	628.6	0	0	0	5.5"		
1/7/2014	9:00	628.36	0	98	0	0	-13	33
	10:00	628.39	0	90	90	0		
	15:00	628.52	0	0	0	5.5"		
1/8/2014	7:00	628.39	0	90	90	0	3	33
	15:00	628.49	0	0	0	5.5"		
1/9/2014	7:00	628.35	0	0	98	0	4	33
	15:00	628.48	0	0	0	5.5"		
1/10/2014	7:00	628.29	0	85	85	0	21	33
	13:00	628.42	0	85	0	0		
	15:00	628.56	0	0	0	5.5"		
1/13/2014	7:00	628.07	0	98	98	0	34	33
	15:00	628.26	0	0	0	5.5"		
1/14/2014	7:00	628.18	0	98	98	0	28	33
	19:00	628.52	0	0	0	5.5"		
1/15/2014	7:00	628.4	0	98	100	0	23	33
	15:00	628.57	95	95	95	0		
	22:00	628.55	0	0	0	5.5"		
1/16/2014	7:00	628.43	0	98	98	0	15	33
	22:00	628.71	0	0	0	5.5"		
1/17/2014	7:00	628.6	0	98	98	0	28	33
	15:00	628.71	0	0	0	5.5"		
1/20/2014	7:00	627.93	0	0	94	0	14	33
	15:00	628.5	0	0	0	5.5"		
1/21/2014	7:00	628.34	0	90	90	0	-2	33
	15:00	628.55	0	0	0	5.5"		
1/22/2014	7:00	628.42	0	98	98	0	-3	33
	15:00	628.55	0	0	0	5.5"		
1/23/2014	7:00	628.53	85	85	85	0	2	33
	11:00	628.48	90	90	90	0		
	18:00	628.47	0	85	85	0		
	19:00	628.57	0	0	0	5.5"		
1/24/2014	7:00	628.4	0	90	90	0	3	33
	12:00	628.48	0	0	85	0		
	15:00	628.6	0	0	0	5.5"		
1/27/2014	7:00	628.16	0	0	98	5.5"	3	33
	15:00	628.56	0	0	0	5.5"		
1/28/2014	7:00	628.37	0	85	85	5.5"	-9	33
	15:00	628.57	0	0	0	5.5"		

SANFORD (P-2785) FLOW RELEASES 12/1/2013-3/18/2014

DATE	TIME	RESERVOIR LEVEL	TURBINE SETTINGS			SPILLWAY SETTINGS	AIR TEMP	WATER TEMP
			#1	#2	#3			
1/29/2014	7:00	628.5	0	85	85	5.5"	3	33
	15:00	628.67	0	0	0	5.5"		
1/30/2014	7:00	628.54	0	94	94	5.5"	13	33
	15:00	628.52	0	0	0	5.5"		
1/31/2014	7:00	628.46	0	0	85	5.5"	27	33
	15:00	628.6	0	0	0	5.5"		
2/3/2014	7:00	628.15	0	85	85	5.5"	-9	33
	13:00	628.22	0	0	90	5.5"		
	15:00	628.39	0	0	0	5.5"		
2/4/2014	7:00	628.27	0	85	85	5.5"	6	33
	13:00	628.37	0	0	94	5.5"		
	15:00	628.57	0	0	0	5.5"		
2/5/2014	7:00	628.47	0	90	90	5.5"	14	33
	12:00	628.47	0	85	85	5.5"		
	15:00	628.47	0	0	0	5.5"		
2/6/2014	7:00	628.46	0	85	85	5.5"	11	33
	15:00	628.6	0	0	0	5.5"		
2/7/2014	7:00	628.45	0	98	0	5.5"	4	33
	15:00	628.6	0	0	0	5.5"		
2/10/2014	7:00	628.06	0	85	85	5.5"	5	33
	10:00	628	0	0	0	5.5"		
2/11/2014	7:00	628.5	0	94	94	5.5"	5	33
	15:00	628.6	0	0	0	5.5"		
2/12/2014	7:00	628.47	0	85	85	5.5"	-9	33
	15:00	628.54	0	0	0	5.5"		
2/13/2014	7:00	628.45	0	85	85	5.5"	13	33
	12:00	628.4	0	0	85	5.5"		
	15:00	628.54	0	0	0	5.5"		
2/14/2014	7:00	628.42	0	0	98	5.5"	23	33
	10:00	628.42	0	0	0	5.5"		
2/17/2014	7:00	628.28	0	85	85	5.5"	-9	33
	15:00	628.44	0	0	0	5.5"		
2/18/2014	7:00	628.4	0	85	85	5.5"	12	33
	10:00	628.4	0	0	94	5.5"		
	15:00	628.75	0	0	0	5.5"		
2/19/2014	7:00	628.6	0	94	94	0	23	33
	15:00	628.79	0	0	0	5.5"		
2/20/2014	7:00	628.6	0	98	98	0	27	33
	12:00	628.6	0	0	100	0		
	15:00	628.66	0	0	0	5.5"		
2/21/2014	7:00	628.55	0	98	98	0	34	33
	12:00	628.6	0	0	98	0		
	15:00	628.72	0	0	0	5.5"		
2/24/2014	7:00	628.02	0	85	85	0	14	33
	15:00	628.25	0	0	0	5.5"		
2/25/2014	7:00	628.1	0	85	85	0	10	33
	15:00	628.33	0	0	0	5.5"		

SANFORD (P-2785) FLOW RELEASES 12/1/2013-3/18/2014

DATE	TIME	RESERVOIR LEVEL	TURBINE SETTINGS			SPILLWAY SETTINGS	AIR TEMP	WATER TEMP
			#1	#2	#3			
2/26/2014	7:00	628.17	0	85	85	0	-2	33
	15:00	628.39	0	0	0	5.5"		
2/27/2014	7:00	628.27	0	85	85	0	3	33
	15:00	628.51	0	0	0	5.5"		
2/28/2014	11:00	628.65	0	98	98	0	-17	33
	15:00	628.82	0	0	0	5.5"		
3/3/2014	7:00	628.1	0	0	98	5.5"	-13	33
	11:00	628.25	0	90	90	0		
	15:00	628.4	0	0	0	5.5"		
3/4/2014	7:00	628.28	0	85	85	0	7	33
	15:00	628.42	0	0	0	5.5"		
3/5/2014	7:00	628.26	0	0	98	0	5	33
	15:00	628.65	0	0	0	5.5"		
3/6/2014	7:00	628.52	0	85	85	0	-8	33
	11:00	628.5	0	0	94	0		
	15:00	628.6	0	0	0	5.5"		
3/7/2014	10:00	628.7	0	0	98	0	6	33
	15:00	628.83	0	0	0	5.5"		
3/10/2014	7:00	628.12	0	85	85	0	32	33
	15:00	628.34	0	0	0	5.5"		
3/11/2014	7:00	628.19	0	90	90	0	38	33
	15:00	628.42	0	0	0	5.5"		
3/12/2014	7:00	628.26	0	98	98	0	26	33
	15:00	628.51	0	0	0	5.5"		
3/13/2014	7:00	628.3	0	98	98	0	1	33
	15:00	628.5	0	0	0	5.5"		
3/14/2014	7:00	628.33	94	0	94	0	23	33
	19:00	628.75	0	0	0	5.5"		
3/15/2014	7:00	628.59	0	98	100	0	33	33
	19:00	628.94	0	0	0	5.5"		
3/16/2014	7:00	628.73	0	98	98	0	9	33
	15:00	628.87	0	0	0	5.5"		
3/17/2014	7:00	628.62	0	98	98	0	7	33
	22:00	628.96	0	0	70	0		
3/18/2014	7:00	628.66	0	98	98	0	22	33
	19:00	628.96	0	70	0	0		

Tittabawasee River at Sanford 04153300

Transsect	Start Bank #	Start Time	Total Q	Delta Q	Top Q	Meas. Q	Bottom Q	Left Q	Right Q	Right Dist.	Width	Total Area	Q/Area	Boat Spec Flow	Spec Flow Dir.	End Time	Duration	Start Ens.	End Ens.	Velocity Ref.	Depth Ref.
meas 4	Titt07222010000	707	9:50:01	141	-84.5	49.7	75.5	14.5	12	1.059	16	493.53	0.289	0.463	209.52	9:54:01	240.27	3664	4370	Ref: BT	ADCP
	Titt07222010001	696	9:58:22	134	-85.3	48.0	71.2	14.9	13	-0.353	16	489.97	0.276	0.469	208.98	10:02:18	236	38	733	Ref: BT	ADCP
	Titt07222010002	744	10:02:39	146	-84.0	51.6	80.1	15.8	13	-0.6	16	500.07	0.293	0.443	210.9	10:06:50	250.97	800	1543	Ref: BT	ADCP
	Titt07222010003	695	10:07:13	134	-85.3	47.9	73.7	13.6	13	-0.812	16	492.92	0.272	0.463	210.28	10:11:09	236.35	1615	2309	Ref: BT	ADCP
<p>139</p> <p>Gate Q = (52)</p> <p>Note: channel still filling</p> <p>87 cfs leakage</p>																					
	Titt07222010004	859	10:33:49	199	-78.1	68.3	111.0	19.8	11	-1.059	17	508.69	0.387	0.377	206.96	10:38:41	292.19	6532	7390	Ref: BT	ADCP
	Titt07222010005	799	10:38:51	212	-76.7	73.5	118.4	22.3	11	-1.448	17	506.65	0.42	0.407	208.17	10:43:26	274.74	7421	8219	Ref: BT	ADCP
<p>224</p> <p>No good</p>																					
meas 5	Titt07222010006	746	10:43:41	218	-76.0	74.7	123.1	22.3	11	0.353	16	513.96	0.423	0.443	206.51	10:47:56	254.18	8268	9013	Ref: BT	ADCP
	Titt07222010007	771	10:48:33	223	-75.5	75.6	125.9	21.9	12	0.989	16	512.96	0.436	0.423	209.8	10:52:59	266.53	9129	9899	Ref: BT	ADCP
	Titt07222010008	724	10:53:15	224	-75.4	75.5	127.8	23.2	12	-1.307	16	523.28	0.427	0.456	207.51	10:57:23	247.43	9949	10672	Ref: BT	ADCP
	Titt07222010009	811	10:57:33	230	-74.8	78.5	130.2	23.4	12	-0.706	16	519.22	0.443	0.404	207.42	11:02:13	280.96	10703	11515	Ref: BT	ADCP
<p>meas 6</p> <p>Gate Q = (214)</p> <p>26 cfs leakage</p>																					
	Titt07222010010	832	11:02:23	241	-73.5	80.7	137.6	24.5	12	-0.918	16	529.05	0.456	0.394	203.36	11:07:10	287.07	11545	12376	Ref: BT	ADCP
	Titt07222010011	704	11:07:33	239	-73.8	79.8	136.2	24.8	12	-0.53	16	527.11	0.453	0.459	208.39	11:11:38	244.55	12448	13151	Ref: BT	ADCP
	Titt07222010012	762	11:11:45	239	-73.7	80.1	138.1	24.9	12	-0.777	16	535.29	0.446	0.43	203.69	11:16:10	265.05	13174	13937	Ref: BT	ADCP
	Titt07222010013	725	11:16:27	242	-73.4	81.0	137.9	25.5	12	-0.742	16	532.22	0.453	0.443	207.99	11:20:40	252.86	13989	14713	Ref: BT	ADCP
<p>meas 7</p> <p>Gate Q = (296)</p> <p>25 cfs leakage</p>																					
	Titt07222010015	846	12:10:39	391	-57.1	121.1	233.5	40.5	11	-1.766	15	580.12	0.673	0.413	202.12	12:15:34	294.89	8643	9488	Ref: BT	ADCP
	Titt07222010016	742	12:15:49	362	-60.2	113.5	218.7	35.7	11	-2.013	15	579.34	0.627	0.472	203.69	12:20:08	258.97	9536	10277	Ref: BT	ADCP
	Titt07222010017	864	12:20:15	383	-57.9	117.1	230.8	38.7	11	-0.777	16	589.88	0.65	0.397	202.19	12:25:17	301.14	10299	11162	Ref: BT	ADCP
	Titt07222010018	797	12:25:36	387	-57.4	121.8	232.1	38.5	11	-1.165	16	577.7	0.669	0.43	205.03	12:30:15	278.86	11223	12019	Ref: BT	ADCP
<p>Note: channel still not stable</p>																					
	Titt07222010019	828	12:43:24	649	-28.7	189.5	394.3	69.1	11	0.388	15	625.03	1.037	0.42	199.2	12:48:12	288.24	14369	15196	Ref: BT	ADCP
	Titt07222010020	741	12:48:43	629	-30.9	192.4	378.4	64.4	9	-1.801	15	624.52	1.007	0.482	204.82	12:53:00	257.13	15291	16031	Ref: BT	ADCP
<p>meas 8</p> <p>Turbine Q = 610</p> <p>54 leakage</p>																					
	Titt07222010022	376	12:56:02	675	-25.8	242.6	313.5	120.4	13	2.578	18	645.26	1.047	0.446	201.47	13:00:14	252.67	140	515	Ref: BT	ADCP
	Titt07222010023	387	13:01:52	631	-30.7	224.9	295.6	108.1	13	10.665	22	649.72	0.971	0.433	203.91	13:06:13	260.36	661	1047	Ref: BT	ADCP
	Titt07222010024	316	13:06:46	670	-26.4	235.4	321.4	114.4	13	7.981	22	664.21	1.01	0.515	204.64	13:10:19	212.52	1097	1412	Ref: BT	ADCP
	Titt07222010025	296	13:10:25	679	-25.4	240.1	315.0	124.9	13	4.308	22	659.17	1.03	0.551	202.69	13:13:45	199.7	1422	1717	Ref: BT	ADCP
<p>meas 9</p> <p>Turbine Q = 770</p> <p>95 leakage</p>																					
	Titt07222010026	352	13:40:15	849	-6.8	282.1	424.6	139.5	13	6.886	18	708.87	1.198	0.515	203.89	13:44:13	237.45	4086	4437	Ref: BT	ADCP
	Titt07222010027	340	13:44:21	876	-3.7	293.9	439.7	145.5	13	1.589	18	715.76	1.224	0.505	201.88	13:48:11	229.68	4450	4789	Ref: BT	ADCP
	Titt07222010028	306	13:48:21	892	-2.0	294.8	447.4	143.1	13	10.771	17	713.36	1.25	0.587	202.56	13:51:47	206.28	4804	5109	Ref: BT	ADCP
	Titt07222010029	329	13:51:57	845	-7.2	274.2	427.5	132.7	13	7.31	17	720.78	1.171	0.518	201.65	13:55:40	222.29	5124	5452	Ref: BT	ADCP
	Titt07222010030	310	13:56:09	859	-5.6	279.1	434.4	139.1	13	11.548	17	727.64	1.181	0.561	204.42	13:59:38	208.93	5496	5805	Ref: BT	ADCP
	Titt07222010031	358	13:59:44	871	-4.3	283.9	448.0	137.9	13	8.052	17	729.08	1.194	0.479	201.93	14:03:46	241.6	5814	6171	Ref: BT	ADCP
<p>Note: changed measurement mode from 11 to 12 for increased velocity, transects 32 and 33 in mode 11, not used for measurement.</p>																					
	Titt07222010032	325	14:28:06	1504	65.3	452.8	851.0	204.8	11	5.438	14	830.53	1.811	0.587	201.91	14:31:46	219.74	8432	8756	Ref: BT	ADCP
	Titt07222010033	347	14:32:03	1571	72.6	470.4	892.5	217.2	11	-2.86	14	835.57	1.88	0.548	202.69	14:35:58	234.88	8781	9127	Ref: BT	ADCP
<p>Ave. leakage thru closed Wicket gate = 281 cfs/turbine</p>																					

20140519 5:00 PM (Unofficial)

USGS

meas 4

meas 5

meas 6

meas 7

meas 8

meas 9

meas 10	Titt07222010034	Left	536	14:37:03	1527	67.8	447.3	864.4	224.9	-3.1	11	-6.215	13	146.83	855.17	1.785	0.627	1.614	204.06	14:40:35	212.33	60	595	Ref: BT	ADCP
		Right	561	14:40:49	1564	71.8	458.8	879.2	227.4	-6.5	11	5.156	13	147.76	866.05	1.804	0.584	1.955	203.48	14:44:32	222.99	631	1191	Ref: BT	ADCP
		Left	475	14:44:57	1569	72.4	434.9	916.6	229.0	-6.0	11	-5.544	10	153.6	950.42	1.650	0.942	1.683	203.37	14:48:07	190.3	1254	1728	Ref: BT	ADCP
		Left	437	14:52:42	1551	70.4	444.3	891.9	222.1	-5.4	11	-2.119	13	144.22	875.19	1.772	0.784	1.434	200.83	14:55:38	176.03	2418	2854	Ref: BT	ADCP
					1553																				
meas 11	Titt07222010038	Left	364	15:05:02	2154	128.7	634.2	1085.3	348.3	20.2	12	-6.674	10	148.78	861.6	2.415	0.978	2.339	202.55	15:17:28	145.51	5801	6164	Ref: BT	ADCP
		Right	362	15:20:23	2211	133.4	656.8	1128.4	330.1	11.5	10	-2.084	7	149.05	864.22	2.457	0.974	2.287	199.31	15:22:48	144.4	6606	6967	Ref: BT	ADCP
		Left	387	15:23:15	2244	138.3	649.9	1176.9	342.2	3.0	10	-3.072	10	148.64	881.08	2.461	0.912	2.533	205.52	15:25:51	156.21	7041	7427	Ref: BT	ADCP
		Right	357	15:26:01	2113	121.9	590.9	1110.3	318.5	4.2	7	-3.955	10	149.06	917.64	2.205	0.997	1.995	197.06	15:28:25	144.28	7452	7808	Ref: BT	ADCP
					2181																				
meas 12	Titt07222010043	Left	371	15:28:49	2357	150.0	674.7	1232.0	358.4	7.0	7	3.814	8	149.95	914.7	2.487	0.965	2.431	201.13	15:31:19	150.86	7870	8240	Ref: BT	ADCP
		Right	381	15:31:30	2338	146.6	669.4	1212.6	355.3	4.0	7	2.79	6	147.52	900.55	2.493	0.928	2.303	199.26	15:34:04	154.06	8267	8647	Ref: BT	ADCP
		Left	322	15:34:33	2272	140.6	622.8	1204.5	347.6	17.0	12	-2.472	6	146.11	914.14	2.395	1.076	2.231	203.07	15:36:43	129.39	8726	9047	Ref: BT	ADCP
		Right	347	15:37:59	2296	140.5	607.0	1234.9	328.1	13.7	9	5.474	7	145.27	937.3	2.336	0.994	2.067	201.82	15:40:17	138.74	9245	9591	Ref: BT	ADCP
					2316																				

(Unofficial) 10/19/2014 6:49:41 AM

#1 & #2
 Turbidity
 #1 & #2
 Turbidity
 #1 & #2
 Turbidity
 #1 & #2
 Turbidity
 #1 & #2
 Turbidity

moving bed
 corrected
 moving bed
 corrected

-28 leakage = 763/wind, OK
 moving bed
 corrected
 moving bed
 corrected

7728 wind, OK

#2
 Turbidity
 #2
 Turbidity

SANFORD SPILLWAY MINIMUM FLOW DISCHARGE				June, 2012
Turbine Wicket Gate Leakage				
calculated from the USGS river gaging of 7/22/2010				
Gate and turbine position	Calculated flow at position, cfs	USGS, cfs measurement	Difference, wicket gate leakage	Leakage per gate cfs
Gate width = 22'	$Q=CDL(2gH)^{.5}$			
One gate @ 1-3/4"	52	139	87	29
One gate @ 7-1/4"	214	240	26	9
One gate @ 10-1/8"	296	381	85	28
One turbine @ 70%	610	664	54	27
One turbine @ 94%	770	865	95	48
			Average =	28
			Discard high and low, average =	28

Sanford Spillway Gate Discharge

June, 2012

Calculate gate opening needed after deducting wicket gate leakage as calculate from USGS gaging of 7/22/2010

Ave. Wicket Gate leakage = 28 cfs/turbine

$$\text{Gate opening needed } D = \frac{Q}{CL\sqrt{2gH}}, \quad Q = 210 \text{ cfs} \\ C = 0.7, \quad L = 22', \quad H = 8.5' - \frac{D}{2} \quad - \frac{84}{126 \text{ cfs}}$$

Summer Opening, Try 5" = 0.417'

$$D = \frac{126}{0.7(22)\sqrt{64.4 \times 8.29}} = 0.354'' \approx 4\frac{1}{2}'' \leftarrow 0.375'$$

Winter Opening, Try 6" = 0.5', H = 6 - $\frac{D}{2}$

$$D = \frac{126}{0.7(22)\sqrt{64.4 \times 5.75}} = 0.435'' \approx 5\frac{1}{2}'' \leftarrow 0.458'$$

Document Content(s)

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