Packwood Lake Intake Screen Velocity Test Report
for
Energy Northwest's
Packwood Lake Hydroelectric Project
FERC No. 2244
Lewis County, Washington

Submitted to

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1.0 INTRODUCTION

Energy Northwest's Packwood Lake Hydroelectric Project (Project), FERC No. 2244, received its initial license in 1960. The majority of the Project is located in the Gifford Pinchot National Forest. The Project consists of an intake canal, a concrete drop structure (dam) and intake structure on Lake Creek located about 424 ft downstream from the outlet of Packwood Lake, a 21,691-ft system of concrete pipe and tunnels, a 5,621-ft penstock, a surge tank, and powerhouse with a 26,125 kW turbine generator.

The source of water for the Project, Packwood Lake, is a lake that pre-existed the Project, situated at an elevation of approximately 2,857 ft above mean sea level (MSL), about 1,800 ft above the powerhouse. Water discharged from the Project is released to the Cowlitz River via a tailrace channel. Power from the Project is delivered over an 8,009-ft 69 kV transmission line to the Packwood substation.

During the recreation season, May 1 through September 15, Packwood Lake is maintained at its approximate natural elevation (2,857 ft MSL). During the remainder of the year, the existing FERC license allows lowering the lake level not more than eight feet below the summer lake level down to an elevation of 2,849 ft MSL.

As part of the relicensing the Project, Energy Northwest was requested to evaluate the potential for fish entrainment at the Project intake structure. Fish entrained at the intake are removed from the lake population and no longer available for recruitment to the lake fishery. An entrainment study at the intake structure commenced during October 2004. The results were preliminary and it was determined that additional sampling was necessary before conclusions regarding the efficacy of the screens and the potential impacts of entrainment could be determined. Energy Northwest scheduled the entrainment investigation as proposed in the study plan (EES Consulting 2005); however, wind, snowfall, and high spill events in 2006 precluded field studies from beginning until July. As a result, Energy Northwest continued the study into 2007 for the months of March through June. A final report was submitted for the relicensing effort in 2007 (EES Consulting 2007).

The target species for the screen velocity tests were rainbow trout (*Oncorhynchus mykiss*) and coastal cutthroat trout (*O. clarki clarki*) in the adult life stage. It is assumed that rainbow trout would be most active in spring and travel the lake more extensively during their spawning period in search of suitable tributary spawning habitat. Rainbow trout spawning is known to occur from June through early July in the Packwood Lake tributaries. Cutthroat trout have not been observed in Packwood Lake recently.

Energy Northwest has participated in discussions with the natural resource agencies and tribes to evaluate the screen velocities at the intake structure. Earlier investigations noted that the debris screens often were not seated correctly which resulted in localized "hot spots" on the screens. Energy Northwest has agreed to use a phased approach to examine velocities at the screens. These phases are:

Phase 1: The outer (moveable) debris screens will be removed from the intake structure to determine if velocities at the traveling screens meet Washington Department of Fish and Wildlife's (WDFW) velocity criteria of 0.80 ft/sec *[Note: these are maximum velocities at the measuring point, not the mean velocities across the screen]*. The measurable objective for fish screen approach velocities are the State of Washington criteria of maximum velocities $\leq$ 0.80 ft/sec over 95% of the screen area, with maximum velocities $\leq$ 0.88 ft/sec over 99% of the screen area for all intake flows and lake elevations.

Phase 2: If testing and verification data indicate the traveling fish screens do not meet State criteria, then Energy Northwest shall consult with the Aquatics work group and determine if modifications to the existing fish screens, installation of new fish screens at the Project intake or other measures as determined in consultation with the Aquatics group are required as part of the new license.

1.1 Study Plan Goals and Objectives

The overall goal of this study was to determine the effects of Project operation on potential entrainment of adult rainbow trout.

Objectives of the 2008 Packwood Lake Hydroelectric Project Entrainment Study were:

- Determine the velocities present at the intake (e.g., traveling) screens at a range of lake elevations and Project flows.
- Examine the structural integrity of the traveling screen seals.
- Observe fish behavior within the intake wells.
- Develop a curve for lake level elevation and water diversion rate.
- Summarize the fish impingement data for 2008.

2.0 STUDY AREA AND METHODS

2.1 Study Area

The study area is the vicinity of the intake structure for the Packwood Lake Hydroelectric Project.

2.2 Methodology

The following describes the methods used to achieve the objectives listed in Section 1 of this report. Energy Northwest provided engineering details of the intake structure and hydraulic information related to lake levels, Project operational flows, and lake inflows during this period. Schematic drawings of the Project intake structure are shown in Figures 2.1 and 2.2.

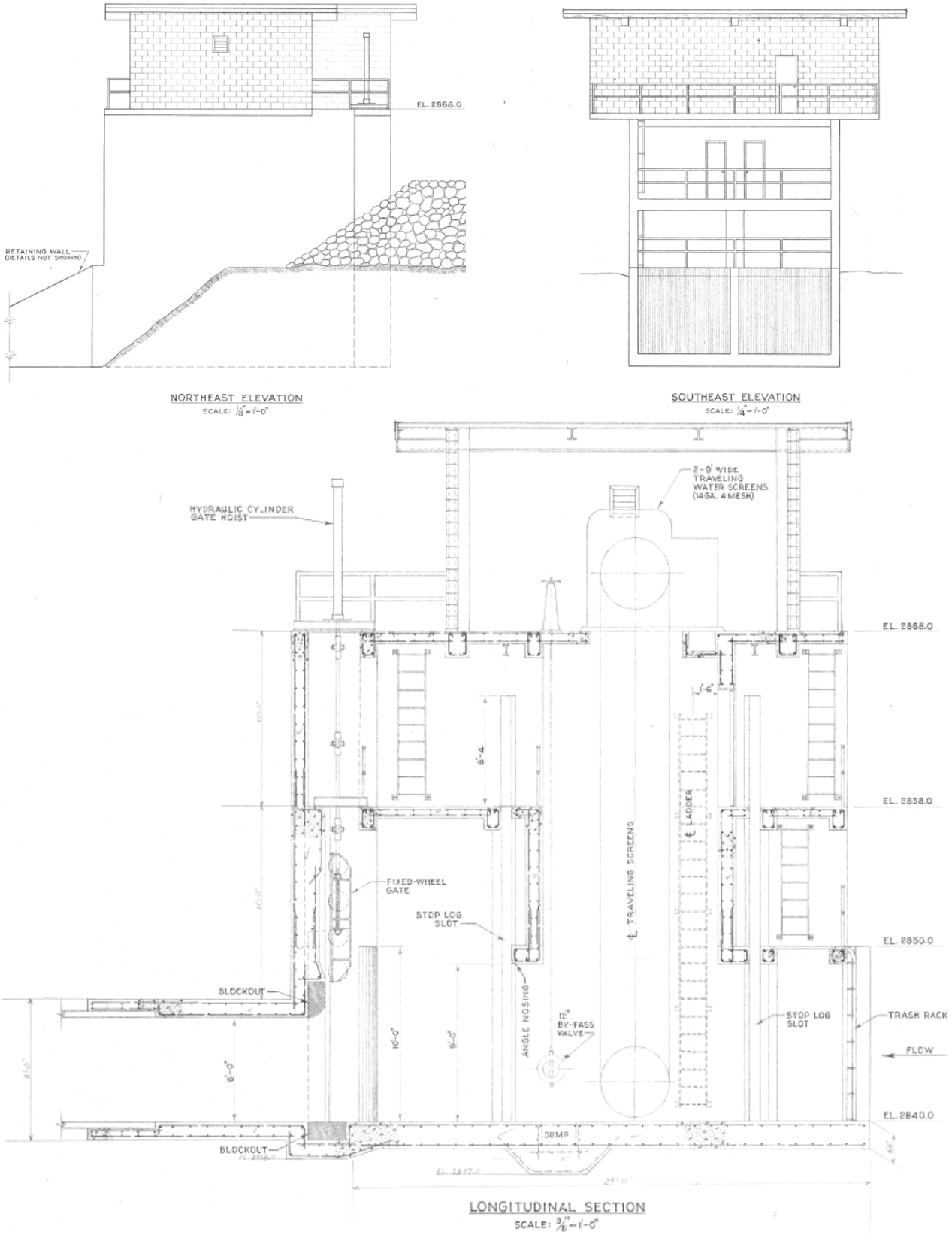

Figure 2-1. Screen Configuration at the Packwood Lake Intake Structure

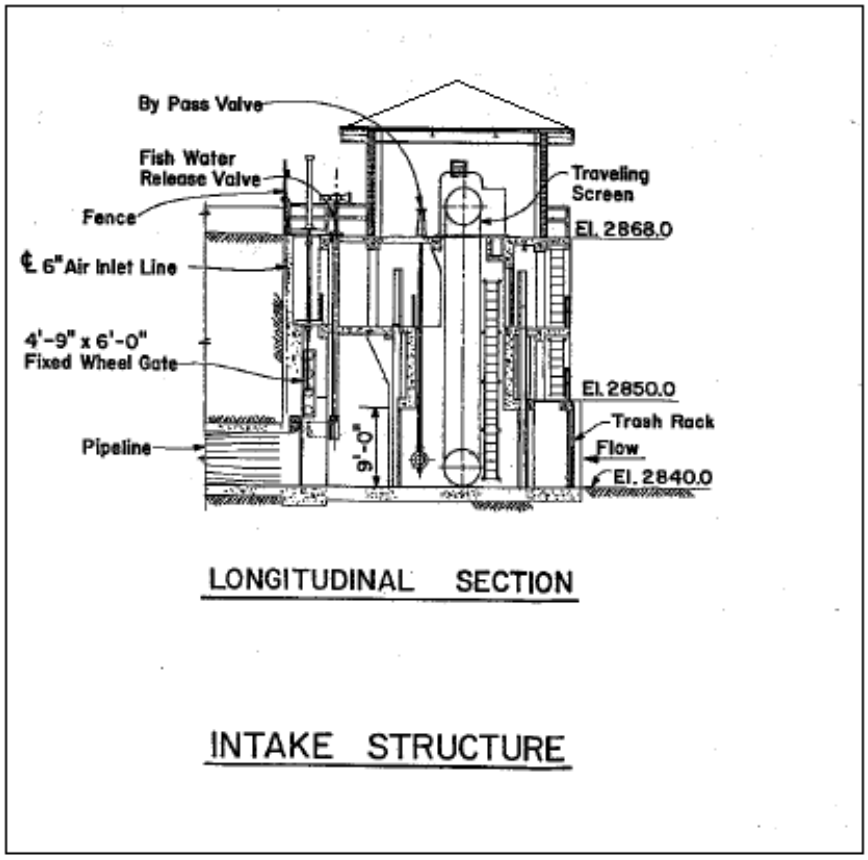

Figure 2-2. Schematic Drawing of Packwood Lake Intake Structure

2.2.1 Approach Velocities at the Intake

Several days prior to beginning the tests, Energy Northwest removed the outer debris screens from the trash racks, which allowed a number of fish access to the intake area. Debris that accumulated on the outside of the permanent trash racks was removed by divers where feasible, on September 15, 2008. The traveling screens were rotated prior to each test to remove accumulated debris and to check for fish impingement. The permanent racks were intermittently checked for debris, via underwater camera, during the tests.

The Project scheduled the testing to begin on September 16, 2008. This date provided an opportunity to perform the testing at progressively lower lake elevations and a wide range of Project flows. The Operating License allows the Project to reduce lake elevation from the normal summer level of 2857.0 ft (± 0.5 ft) mean sea level (MSL), to a potential minimum lake level of 2849.0 ft MSL beginning September 15. Total flow through the traveling screens was determined using the sum of Project flows plus bypass (e.g., fish) flows as measured in cubic feet per second (cfs) utilizing the permanently installed Panametrics flow instrumentation located in the intake structure. Lake elevations were determined using the lake staff gage and Project instrumentation.

Energy Northwest proposed the following schedule to measure the velocities at the prescribed range of Project flows and lake elevations (Table 2-1). The lake elevations were targets and

were modified based upon inflows and achievable lake level elevations. Energy Northwest measured the highest flows first at each test level (e.g., 215 cfs) and then in descending order if required. When the velocity criteria were met at a certain flow (95% of the velocities $\leq$ 0.80 ft/sec or 99% of the velocities $\leq$ 0.88 ft/sec), the balance of the test flows at that lake elevation were suspended, since screen velocities would be less at a lower flow given the same lake elevation.

Table 2-1. Proposed target lake elevations (+/- 0.5 ft) and Project flows for measuring intake screen velocities at the Packwood Lake Hydroelectric Project.

Day	Lake Elev (ft)	Project Flows (cfs) [1/]				
1	2857.0	215	160	120	82	62
2	2856.0	215	160	120	82	62
3	2855.0	215	160	120	82	62
4	2854.0	215	160	120	82	62
5	2853.0	215	160	120	82	62
6	2852.0	215	160	120	82	62
7	2851.0	215	160	120	82	62

[1/] Measurements were started at the high flow; when criteria were met, measurements at that lake elevation ceased and the lake elevation decreased to the next level for additional tests.

If velocity criteria were not met at the highest flow, measurements were taken at the target flows in descending order until the criteria were met. Energy Northwest had the option to insert an additional flow to be measured between the two bracketed target flows (when the higher Project flow does not meet screen criteria, but the lower Project flow does) in order to fine tune the Project flow at which criteria were met.

Velocities were measured using a Swoffer digital velocity meter positioned perpendicular to the screen at horizontal and vertical increments of 1 ft. Two Swoffer meters were used, one on each screen to most efficiently measure velocities. Once a Project flow had been identified as the upper limit of the velocity criteria for a given lake elevation, that Project flow then became the upper threshold for subsequent measurements at lower lake elevations. See Appendix B (DVD Section "Screen 2 Elevation 2855.95 Prop View) for how the Swoffer meter was deployed.

EES Consulting (2007) analyzed Project flows and velocities at various lake levels in 2007; the methods proposed in this study plan mirror the original study but employed a wider range of lake levels and flows.

2.2.2 Structural Integrity of the Traveling Screens

The traveling screens were visually inspected to determine their integrity. An underwater video camera was used to examine the perimeter seal between the intake structure walls and floor (2840 ft MSL) and the moving portions of the screens, up to the top of the lake surface. A visual inspection was performed from the lake surface up to the maximum lake operating elevations of 2860 ft MSL. The video tape was converted to DVD format; edited portions are included with this report and are further explained in Section 3.

2.2.3 Fish Presence and Behavior in the Intake Wells

Energy Northwest and EES Consulting staff monitored fish behavior in the intake wells during the range of lake elevations and operational flows. The traveling screens were checked at the beginning of each test to document whether fish had been impinged on the screens. Fish behavior at both screens was also monitored and videotaped at a range of flows and lake elevations. These video tapes were converted to DVD format and representative segments are included with this report. These segments are further explained in Section 3.0.

During 2008, lake levels and Project flows were recorded daily. The traveling screens were set to "Off" mode during the study. The traveling screens were rotated and any fish impinged on the screens were collected to determine the species, length, and condition (e.g., descaling, etc.). These data were recorded in a log at the intake structure. The debris screens were raised and cleaned in March for inspection to determine if any fish had been impinged.

3.0 RESULTS

3.1 Approach Velocities at the Intake Structure

3.1.1 Flows and Lake Levels Tested

Table 3-1 summarizes the dates, lake elevations and Project flows tested. A total of 11 tests were conducted at six different lake elevations. Measurements started at an approximate lake elevation of 2857 ft MSL and continued to elevation 2852 ft MSL.

Project flows ranged from a high of 215 cfs to a low of 82 cfs. Project flow, combined with instream flows, resulted in Project flows ranging from 219 cfs to a low of 86 cfs.

Table 3-1. Summary of lake levels and Project flows measured during 2008 velocity tests.

Date	Lake Elevation	Project Flow	Bypass Flow	Total Flow
9/16/2008	2857.10	214.95	3.87	218.82
9/16/2008	2857.00	158.20	3.97	162.17
9/16/2008	2856.92	114.85	3.75	118.60
9/18/2008	2855.99	121.40	3.46	124.86
9/18/2008	2855.95	82.45	3.70	86.15
9/19/2008	2855.07	121.20	3.43	124.63
9/19/2008	2855.04	83.80	3.38	87.18
9/21/2008	2854.01	119.65	4.81	124.46
9/21/2008	2854.00	82.65	4.91	87.56
9/22/2008	2853.09	82.55	4.45	87.00
9/23/2008	2852.16	83.15	4.64	87.79

3.1.2 Measured Velocities

Velocities in front of the traveling screens were measured every foot horizontally and vertically. Appendix A depicts the velocities measured at both screens for the 11 tests. Screen 1 is closer to the drop structure, while Screen 2 is closer to shore and the trail to Packwood Lake.

Tables 3-2 through 3-4 summarize the minimum, mean, and maximum velocities measured across the screens individually and in aggregate. These tables also examine how well these velocities meet the proposed WDFW screen criteria.

Several general conclusions can be made about the traveling screens based on the velocity testing results:

1. The intake structure's main openings extend from El 2840 – 2850 ft MSL and each opening is approximately 10 ft. wide at the traveling screens. The velocities recorded at these elevations tend to be higher and more perpendicular to the traveling screens.
2. Above El 2850 ft MSL, the traveling screens are located in a more confined, concrete well and the velocities tend to be lower and less perpendicular to the traveling screens. None of the velocities measured above El 2850 ft MSL exceeded 0.80 ft/s.
3. These features resulted in velocities that were more dependent upon flow than lake elevation.

Mean screen velocities at all test conditions were less than WDFW proposed criteria of .80 ft/s. In general, mean velocities were slightly higher at Screen 2 than at Screen 1, averaging 0.46 ft/s and 0.35 ft/s, respectively, with the exception of the measurement taken at 2852.16 ft MSL (see test data).

Screen compliance criteria (e.g., 95% of the screen velocities to be $\leq$ 0.80 ft/s, with 99% of the screen velocities to be $\leq$ 0.88 ft/s) were also analyzed. At flows of 162 cfs or higher at a lake elevation of 2857 ft MSL, measured velocities did not meet these criteria at either screen. At a flow of 119 cfs and a lake elevation of 2857 ft MSL, Screen 1 met the criteria while Screen 2 was slightly out of compliance. Screen 1 met both velocity criteria on seven of the eleven tests, while Screen 2 met both velocity criteria on five of the tests. Overall, the screens as a whole met both velocity criteria on five of the 11 tests, and just missed compliance on another.

One deviation in screen performance was noted. At El 2856 ft MSL and a Project flow of 125 cfs, 81% and 90% of the screen area met the 0.80 ft/s and 0.88 ft/s criteria, respectively. At El 2855 ft MSL and a Project flow of 125 cfs, however, these same two criteria were met 93% and 97% of the time, respectively. Energy Northwest noted a different directionality to the flow entering the intake structure at the 125 cfs flow at El 2856 ft MSL, with more of the flow entering the well in front of Screen 1. This resulted in higher measured velocities in front of Screen 1.

Table 3-2. Summary of velocities (ft/s) measured at Screen 1 during 2008 velocity tests.

Lake Elevation	Flow (cfs)	Minimum	Mean	Maximum	% <=.8 ft/s	% <=.88 ft/s	% >.88 ft/s
2857.10	218.82	0.04	0.62	2.09	54.4%	57.3%	42.7%
2857.00	162.17	0.00	0.39	1.33	79.9%	86.8%	13.2%
2856.92	118.60	0.01	0.19	0.59	100.0%	100.0%	0.0%
2855.99	124.86	0.00	0.38	1.18	75.0%	83.3%	16.7%
2855.95	86.15	0.00	0.25	0.80	100.0%	100.0%	0.0%
2855.07	124.63	0.00	0.29	0.83	99.3%	100.0%	0.0%
2855.04	87.18	0.01	0.30	0.82	99.3%	100.0%	0.0%
2854.01	124.46	0.01	0.43	1.17	73.8%	84.9%	15.1%
2854.00	87.56	0.00	0.32	0.83	97.6%	100.0%	0.0%
2853.09	87.00	0.00	0.33	0.85	99.1%	100.0%	0.0%
2852.16	87.79	0.01	0.33	0.86	97.2%	100.0%	0.0%

Table 3-3. Summary of velocities (ft/s) measured at Screen 2 during 2008 velocity tests.

Lake Elevation	Flow (cfs)	Minimum	Mean	Maximum	% <=.8 ft/s	% <=.88 ft/s	% >.88 ft/s
2857.10	218.82	0.02	0.73	1.85	54.9%	56.9%	43.1%
2857.00	162.17	0.02	0.54	1.32	59.7%	65.3%	34.7%
2856.92	118.60	0.02	0.73	1.85	79.9%	93.1%	6.9%
2855.99	124.86	0.01	0.66	0.93	86.1%	96.5%	3.5%
2855.95	86.15	0.00	0.30	0.68	100.0%	100.0%	0.0%
2855.07	124.63	0.00	0.38	1.02	86.7%	94.8%	5.2%
2855.04	87.18	0.00	0.32	0.73	100.0%	100.0%	0.0%
2854.01	124.46	0.00	0.51	1.10	81.0%	88.1%	11.9%
2854.00	87.56	0.02	0.35	0.69	100.0%	100.0%	0.0%
2853.09	87.00	0.00	0.35	0.79	100.0%	100.0%	0.0%
2852.16	87.79	0.00	0.23	0.65	100.0%	100.0%	0.0%

Table 3-4. Summary of velocities (ft/s) measured at both Screens 1 and Screen 2 during 2008 velocity tests.

Lake Elevation	Flow (cfs)	Mean	% <=.8 ft/s	% <=.88 ft/s	% >.88 ft/s
2857.10	218.82	0.68	54.6%	57.1%	42.9%
2857.00	162.17	0.46	69.8%	76.0%	24.0%
2856.92	118.60	0.46	89.9%	96.5%	3.5%
2855.99	124.86	0.58	80.6%	89.9%	10.1%
2855.95	86.15	0.28	100.0%	100.0%	0.0%
2855.07	124.63	0.52	93.0%	97.4%	2.6%
2855.04	87.18	0.31	99.6%	100.0%	0.0%
2854.01	124.46	0.65	77.4%	86.5%	13.5%
2854.00	87.56	0.33	98.8%	100.0%	0.0%
2853.09	87.00	0.34	99.6%	100.0%	0.0%
2852.16	87.79	0.28	98.6%	100.0%	0.0%

3.2 Structural Integrity of the Screens

Both traveling screens were checked in the "off" position using underwater video on September 17, 2008. The perimeter of each screen was examined to check for gaps. Special attention was placed on the base of each screen to ensure a proper seal between the intake structure and rotating components. Both screens were effectively sealed and no gaps were observed. A video was taken on September 22 of the traveling screen in motion in Intake Well No. 2. The entire inundated perimeter of the screen was viewed and documented. All video related to screen analysis can be seen in Appendix B – Screen View; Screen View 1; Screen View 2).

3.3 Fish Presence and Behavior in the Intake Wells

3.3.1 Fish Presence During Velocity Testing

Test Entrainment

Energy Northwest left the traveling screens in the "off" position during velocity testing. Prior to testing, the screens were manually rotated to remove debris and to check for fish impinged on the screen. No fish were impinged on the traveling screens during the velocity testing.

Fish Behavior

Underwater cameras were used to document fish activity in the intake wells on September 17, 18, and 22. During these sets of velocity measurements, fish were observed actively feeding in the wells behind both sets of permanent trash bars at a variety of elevations and flows. Appendix B summarizes the underwater video taken during these time periods. As noted above, although fish were viewed in the intake wells, no fish were impinged on the traveling screens.

Woody debris was observed at the base of each permanent trash rack, on the upstream side. The outside debris and the concrete curbing at the base of the trash racks create a pocket of low velocity water that fish utilize as resting area refugia near feeding stations. "Fish views" in Appendix B display the rainbow in the wells actively feeding. The fish utilized the low velocity areas at the bottom of the water column to rest and periodically rise up into higher velocities as food particles pass by. All of the fish observed easily moved throughout the well at the highest velocities. No fish were impinged on the traveling screens.

The September 17 and 18 videos document a large number of fish in Intake Well No. 1 and a smaller number of fish in Intake Well No. 2. During the September 22 video, no fish were observed in Intake Well No. 1 and a much higher number of fish was observed in Intake Well No. 2. These data, combined with the lack of any impinged fish on the traveling screens, suggest fish are able to move freely in and out of both wells through the permanent trash bars. Additionally, the "transition view" in Appendix B documents a change in flows on September 22 in Intake Well No. 2 as Project flows increased from 82 cfs to 215 cfs. This view demonstrates that the fish were able to easily move closer to the low velocity areas, near the bottom of the well, during the transition from low to high flows. It appears that refugia near the trash racks exist even at high intake flows.

3.3.2 2008 Fish Entrainment

Fish entrainment on the traveling screens at the Packwood Lake Intake Structure was recorded between January 8 and October 4, 2008. A total of 60 rainbow trout were recorded on the screens during this period; an additional five fish were found on the screens from January 3 through March 27. From April 30, Screen No. 1 entrained 26 fish while Screen No. 2 entrained 29 fish over this period. Figure 3-1 displays fish entrainment relative to rainbow trout spawn timing at the Packwood lake intake *[Note: the five fish entrained from January – March were not linked to a particular screen; some of these fish were noted to be impinged on the screen when the Project was not operating]*. These data are also presented in Appendix C. Eighty-four percent (n=46) of the fish entrained on the screens were observed between June 12th and July 23 (Table 3-5); fish have been observed spawning near the intake as early as the beginning of May. The timing of fish impinged on the screens is consistent with the late and post-spawn periods for rainbow trout in Packwood Lake (EES Consulting 2007a; 2007b). Weak and dead fish were likely pulled into the intake and impinged on the screens. Project staff noted that many of the fish on the screens were in advanced stages of decay, suggesting that the fish were already in poor condition when entering the intake wells.

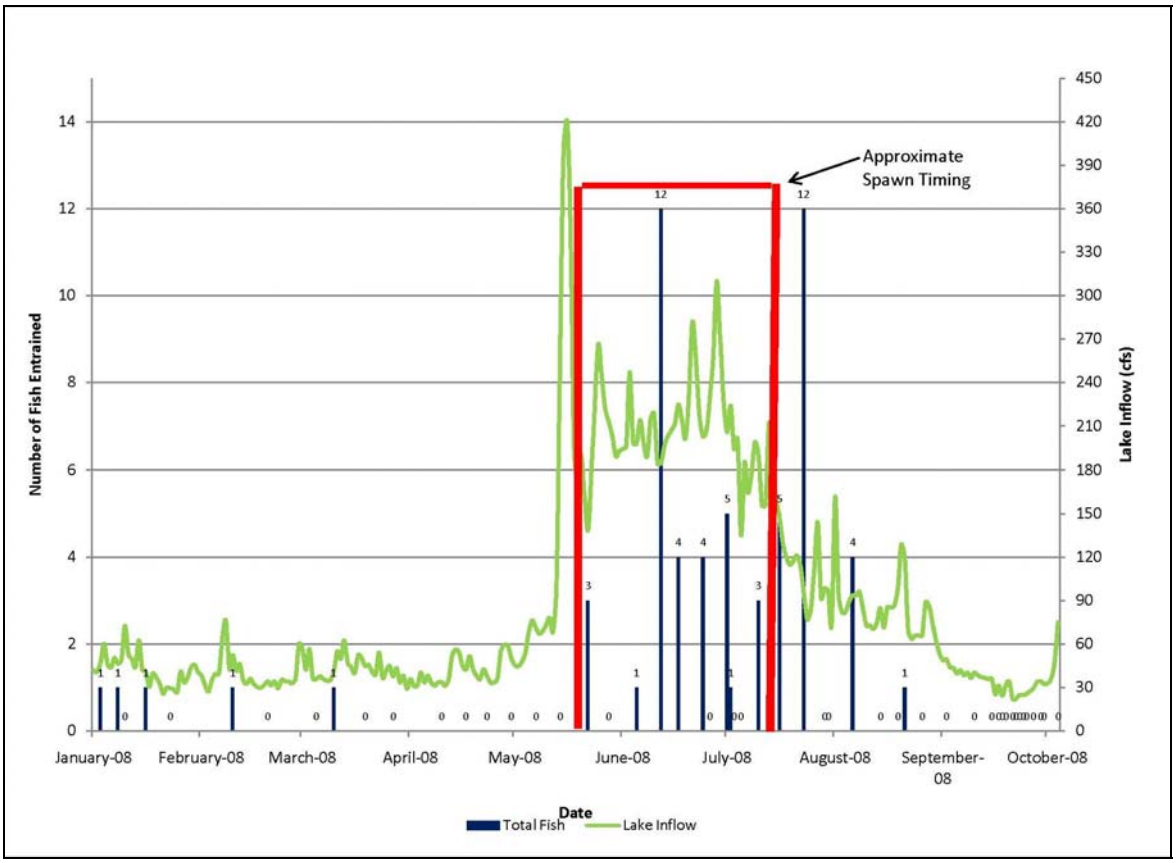

Figure 3-1. Fish Entrainment at Packwood Lake Intake and Project Flows, 2008.

The fish observed had an average length of 174 mm and ranged in size from 55 mm to 356 mm. Twenty one percent (21%) of the fish (n=12) were under 100 mm.

Table 3-5. Packwood Lake Fish Entrainment and Power Flow Data, April – November 2008.

Date	Project Flow	Screen	
		1	2
1/3/08[1/]	64	1	
1/8/08[1/]	56	1	
1/10/08[1/]	55	0	
1/16/08[1/]	58	1	
1/23/08[1/]	55	0	
2/10/08[1/]	44	1	
2/20/08[1/]	30	0	
3/5/08[1/]	32	0	
3/10/08[1/]	33	1	
3/19/08[1/]	32	0	
3/27/08[1/]	32	0	
4/10/08[1/]	0	0	
4/17/08[1/]	0	0	
4/23/08[1/]	0	0	
4/30/2008	39	0	0
5/7/2008	58	0	0
5/14/2008	95	0	0
5/22/2008	214	1	2
5/28/2008	213	0	0
6/5/2008	210	1	0
6/12/2008	208	9	3
6/17/2008	212	0	4
6/24/2008	211	2	2
6/26/2008	213	0	0
7/1/2008	216	3	2
7/2/2008	211	1	0
7/3/2008	211	0	0
7/5/2008	211	0	0
7/10/2008	211	3	0
7/16/2008	211	0	5
7/23/2008	117	5	7
7/29/2008	113	0	0
7/30/2008	113	0	0
8/6/2008	92	1	3
8/14/2008	81	0	0
8/19/2008	78	0	0
8/21/2008	150	0	1
8/26/2008	78	0	0
9/2/2008	46	0	0
9/10/2008	39	0	0
9/15/2008	32	0	0
9/17/2008	125	0	0
9/18/2008	187	0	0
9/19/2008	167	0	0
9/21/2008	190	0	0
9/22/2008	189	0	0

Table 3-5. Packwood Lake Fish Entrainment and Power Flow Data, April – November 2008.

Date	Project Flow	Screen	
		1	2
9/23/2008	129	0	0
9/24/2008	118	0	0
9/25/2008	120	0	0
9/27/2008	99	0	0
9/29/2008	45	0	0
9/30/2008	43	0	0
10/4/2008	0	0	0

[1/] Data not differentiated by screen number

3.4 Lake Elevation and Project Flows

Analysis of actual test data flows indicates that Project flows of 125 cfs or greater at any lake elevation result in slightly exceeding the WDFW proposed criteria for aggregate velocities of both screens; at lake elevation 2855 ft MSL, a Project flow of 125 cfs is slightly out of compliance, with 93% of the screen area having velocities $\leq$ 0.80 ft/sec, and 97.4% of the screen area having velocities < 0.88 ft/sec (see Table 3-4). Actual test data indicate that Project flows of 86 cfs or greater meet WDFW screen criteria at any elevation.

EES Consulting conducted simple and multiple regression analysis of lake elevation and Project flow with velocity criteria. The following relationships were developed based on the test data:

$$\boldsymbol{Z_1} = -11.3958 + 0.00445\,\boldsymbol{X} - 0.00364\,\boldsymbol{Y}\ (r^2 = 0.93);\ \text{(Equation 1) and}$$
$$\boldsymbol{Z_2} = -22.0354 + 0.00818\,\boldsymbol{X} - 0.003424\,\boldsymbol{Y}\ (r^2 = 0.94)\ \text{(Equation 2) where:}$$

$\boldsymbol{Z_1}$ = Percent of screen area with velocities $\leq$ 0.80 ft/s
$\boldsymbol{Z_2}$ = Percent of screen area with velocities $\leq$ 0.88 ft/s
$\boldsymbol{X}$ = Lake Elevation (ft)
$\boldsymbol{Y}$ = Project Flow (cfs)

Figure 3-2 shows the relationship between lake levels and Project flows, given the WDFW screen criteria. Using these equations, Project operation is limited by the criteria of 99% of the screen having velocities < 0.88 ft/sec, with the exception of a lake elevation of 2857 ft MSL. A Project flow of 82 cfs meets both the screen area criteria for 0.80 ft/s and 0.88 ft/s. At a lake elevation of 2857 ft MSL, Project flows of 100 cfs meet both criteria. Throughout the range tested, the velocity criteria are more sensitive to changes in flow than to changes in lake elevation. Mean velocites across the screens however, are less than the proposed WDFW criteria at all lake elevations and flows. In addition, visual observations of the fish at the range of flows tested, combined with the absence of any fish impinged upon the screens during the tests, indicate that the range of flows tested do not have a deleterious impact on the fish.

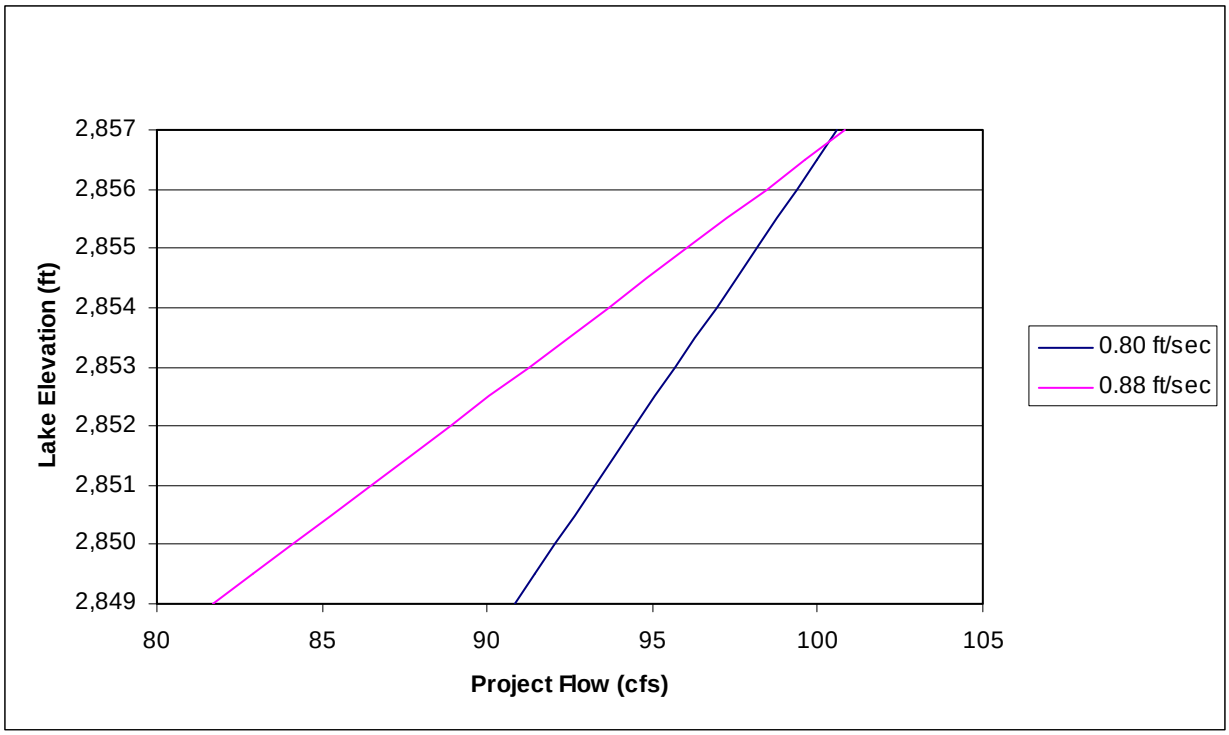

Figure 3-2. **Relationship Between Lake Elevation and Project Flows (Based Upon Regression Equations While Meeting Criteria of 95% of the Screen Area Having Velocities ≤ 0.80 ft/sec and 99% of the Screen Area Having Velocities ≤ 0.88 ft/sec).**

4.0 FUTURE STEPS

The velocity testing indicates that the Project exceeds the proposed WDFW velocity criteria under certain operating conditions. However, Energy Northwest does not believe that the exceedance of the proposed velocity criteria is critical to the Packwood Lake fish resources. The conclusion is based on the low number of fish mortalities observed/recorded during regular inspections of the traveling screens in 2008, and that the highest percentage of fish found were found on the screens during and immediately after the spawning period (both in 2007 and 2008). It is also likely that many of the fish mortalities observed were either weakened by spawning or were already dead prior to impingement on the traveling screens. That conclusion is based on the decayed condition of the carcasses found on the screens during the study. This includes the observation on July 1, 2008, of four badly decayed fish floating in the intake canal upstream of the Project intake structure.

Energy Northwest proposes to meet with the State and Federal natural resource agencies and tribes to discuss options and possible alternatives for Project operation.

5.0 LITERATURE CITED

EES Consulting (EESC). 2007a. Fish Distribution and Species Composition Study Report for the Packwood Lake Hydroelectric Project (FERC Project 2244). September 2007.

EESC. 2007b. Packwood Lake Entrainment Study Report for Energy Northwest's Packwood Lake Hydroelectric Project (FERC No. 2244), Lewis County, WA. Final Report. October 2007.

APPENDIX A

MEASURED VELOCITIES AT PACKWOOD LAKE INTAKE STRUCTURE, 2008

9/16/2008 Lake Elevation: 2857.10 Project Flow: 218.8

< 0.80
0.81 - 0.88
> 0.88

Screen 1

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.90	0.09	0.15	0.11	0.14	0.20	0.15	0.13	0.15	0.08
2854.90	0.09	0.11	0.05	0.11	0.09	0.09	0.19	0.14	0.09
2853.84	0.06	0.06	0.05	0.09	0.08	0.12	0.20	0.29	0.16
2852.84	0.04	0.08	0.07	0.06	0.16	0.12	0.12	0.17	0.06
2851.84	0.10	0.11	0.08	0.10	0.06	0.06	0.13	0.17	0.08
2850.78	0.11	0.08	0.10	0.07	0.10	0.09	0.12	0.17	0.16
2849.78	0.38	0.43	0.24	0.11	0.14	0.12	0.11	0.18	0.18
2848.65	0.52	0.87	0.76	0.80	0.39	0.14	0.18	0.11	0.15
2847.65	1.05	1.10	1.32	1.33	0.95	1.15	0.73	1.25	0.44
2846.65	1.15	1.40	1.45	1.54	1.56	1.68	1.73	1.95	2.09
2845.59	1.07	1.28	1.49	1.52	1.55	1.48	1.56	1.63	1.68
2844.59	0.78	1.13	1.30	1.44	1.56	1.58	1.43	1.47	1.28
2843.57	0.65	0.90	1.23	1.44	1.29	1.26	1.36	1.26	1.05
2842.57	0.23	0.68	1.23	1.33	1.24	0.80	0.81	0.76	0.92
2841.57	0.34	0.66	1.26	0.82	0.46	0.66	0.34	0.61	0.84
2840.57	0.20	0.25	0.88	0.72	0.80	0.35	0.13	0.32	0.76

Screen 2

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.95	0.18	0.14	0.15	0.17	0.29	0.28	0.24	0.22	0.17
2854.95	0.09	0.05	0.06	0.08	0.12	0.10	0.13	0.12	0.12
2853.95	0.15	0.09	0.07	0.10	0.08	0.09	0.11	0.12	0.10
2852.87	0.11	0.10	0.09	0.10	0.22	0.14	0.13	0.09	0.07
2851.87	0.08	0.03	0.05	0.05	0.08	0.10	0.11	0.11	0.06
2850.78	0.08	0.08	0.02	0.14	0.08	0.09	0.09	0.10	0.08
2849.78	0.08	0.08	0.13	0.07	0.08	0.15	0.07	0.10	0.09
2848.78	1.31	1.25	1.07	1.07	0.53	0.61	0.40	0.49	0.57
2847.72	1.81	1.85	1.68	1.72	1.76	1.61	1.50	1.59	1.53
2846.72	1.57	1.69	1.65	1.55	1.59	1.69	1.51	1.70	1.53
2845.66	1.62	1.59	1.51	1.47	1.50	1.43	1.47	1.44	1.35
2844.66	1.51	1.46	1.45	1.44	1.44	1.39	1.40	1.39	1.40
2843.66	1.42	1.43	1.40	1.32	1.29	1.30	1.28	1.33	1.26
2842.64	1.27	1.20	1.26	1.27	1.15	1.15	1.05	1.02	1.18
2841.64	0.86	0.81	0.91	0.90	1.12	0.99	0.73	0.81	0.77
2840.64	0.39	0.43	0.46	0.62	0.44	0.40	0.33	0.42	0.63

9/16/2008 Lake Elevation: 2857.00 Project Flow: 162.2

< 0.80
0.81 - 0.88
> 0.88

Screen 1

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.90	0.17	0.11	0.06	0.07	0.09	0.10	0.11	0.11	0.05
2854.90	0.19	0.08	0.09	0.06	0.07	0.05	0.06	0.11	0.06
2853.84	0.12	0.08	0.07	0.07	0.10	0.15	0.17	0.15	0.16
2852.84	0.05	0.03	0.04	0.08	0.14	0.10	0.06	0.12	0.09
2851.84	0.07	0.01	0.10	0.11	0.09	0.09	0.11	0.21	0.10
2850.78	0.09	0.07	0.07	0.06	0.07	0.06	0.19	0.18	0.08
2849.78	0.07	0.07	0.06	0.09	0.07	0.11	0.11	0.14	0.11
2848.65	0.45	0.46	0.27	0.24	0.07	0.12	0.18	0.07	0.09
2847.65	0.54	0.59	0.79	0.77	0.77	0.80	0.97	0.93	0.97
2846.65	0.67	0.69	0.68	0.67	0.76	0.81	0.92	1.10	1.12
2845.59	0.64	0.61	0.80	0.81	0.72	0.70	0.92	1.02	1.33
2844.59	0.63	0.73	0.86	0.89	0.91	0.82	0.93	1.05	1.12
2843.57	0.53	0.66	0.87	0.90	0.89	0.88	0.97	0.84	1.01
2842.57	0.32	0.68	0.74	0.90	0.86	0.87	0.78	0.60	0.85
2841.57	0.19	0.14	0.20	0.56	0.37	0.39	0.18	0.17	0.46
2840.57	0.33	0.18	0.12	0.09	0.08	0.14	0.11	0.00	0.17

Screen 2

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.95	0.15	0.09	0.17	0.15	0.18	0.19	0.14	0.11	0.14
2854.95	0.13	0.08	0.09	0.09	0.11	0.09	0.09	0.10	0.08
2853.95	0.09	0.06	0.09	0.13	0.09	0.08	0.11	0.06	0.08
2852.87	0.05	0.05	0.08	0.12	0.14	0.06	0.12	0.03	0.13
2851.87	0.06	0.06	0.10	0.09	0.11	0.06	0.09	0.04	0.06
2850.78	0.03	0.05	0.05	0.06	0.03	0.07	0.08	0.05	0.08
2849.78	0.02	0.03	0.05	0.07	0.09	0.05	0.06	0.09	0.07
2848.78	1.04	1.19	0.94	0.84	0.54	0.73	0.74	0.40	0.66
2847.72	1.32	1.27	1.19	1.19	1.26	1.12	1.13	1.23	1.11
2846.72	1.12	1.15	1.13	1.07	1.13	1.14	1.16	1.20	1.08
2845.66	1.14	1.06	1.09	1.07	1.08	1.08	1.05	1.06	1.05
2844.66	1.12	1.09	1.08	1.05	1.02	1.04	1.04	1.01	0.99
2843.66	1.02	0.97	0.99	0.98	0.80	0.94	0.95	0.91	0.94
2842.64	0.87	0.81	0.80	0.86	0.86	0.88	0.90	0.93	0.97
2841.64	0.52	0.49	0.57	0.65	0.79	0.64	0.55	0.82	0.81
2840.64	0.13	0.23	0.20	0.44	0.32	0.40	0.16	0.37	0.45

9/16/2008 Lake Elevation: 2856.92 Project Flow: 118.6

< 0.80
0.81 - 0.88
> 0.88

Screen 1

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.90	0.14	0.13	0.03	0.10	0.08	0.09	0.05	0.05	0.10
2854.90	0.17	0.14	0.03	0.01	0.09	0.03	0.04	0.12	0.08
2853.84	0.07	0.06	0.10	0.05	0.10	0.05	0.02	0.16	0.08
2852.84	0.04	0.07	0.05	0.07	0.04	0.05	0.07	0.24	0.06
2851.84	0.05	0.04	0.03	0.10	0.08	0.04	0.06	0.14	0.03
2850.78	0.02	0.12	0.03	0.07	0.07	0.06	0.10	0.15	0.08
2849.78	0.08	0.13	0.22	0.07	0.12	0.06	0.07	0.04	0.04
2848.65	0.25	0.52	0.55	0.44	0.38	0.44	0.34	0.23	0.30
2847.65	0.21	0.44	0.35	0.36	0.44	0.47	0.55	0.59	0.36
2846.65	0.03	0.26	0.34	0.32	0.36	0.40	0.45	0.52	0.15
2845.59	0.14	0.25	0.32	0.41	0.29	0.28	0.44	0.40	0.43
2844.59	0.10	0.13	0.35	0.35	0.38	0.32	0.37	0.35	0.28
2843.57	0.07	0.02	0.12	0.38	0.39	0.41	0.45	0.21	0.28
2842.57	0.09	0.04	0.26	0.22	0.28	0.20	0.15	0.06	0.23
2841.57	0.07	0.06	0.13	0.43	0.33	0.27	0.26	0.22	0.55
2840.57	0.03	0.15	0.30	0.13	0.13	0.07	0.05	0.19	0.04

Screen 2

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.95	0.18	0.03	0.12	0.09	0.15	0.04	0.10	0.07	0.13
2854.95	0.06	0.05	0.07	0.04	0.05	0.12	0.15	0.09	0.06
2853.95	0.02	0.03	0.05	0.07	0.08	0.07	0.04	0.03	0.02
2852.87	0.03	0.02	0.03	0.09	0.12	0.03	0.07	0.04	0.08
2851.87	0.08	0.02	0.03	0.10	0.10	0.11	0.20	0.05	0.03
2850.78	0.06	0.02	0.03	0.05	0.08	0.06	0.06	0.09	0.01
2849.78	0.01	0.01	0.04	0.05	0.06	0.04	0.03	0.06	0.07
2848.78	0.76	0.79	0.70	0.63	0.48	0.65	0.37	0.20	0.68
2847.72	0.71	0.95	0.92	0.90	0.88	0.89	0.92	0.85	0.87
2846.72	0.88	0.88	0.86	0.83	0.78	0.85	0.83	0.87	0.82
2845.66	0.89	0.89	0.87	0.89	0.91	0.89	0.85	0.85	0.81
2844.66	0.81	0.80	0.80	0.82	0.81	0.82	0.80	0.79	0.76
2843.66	0.72	0.74	0.77	0.76	0.76	0.76	0.78	0.77	0.76
2842.64	0.67	0.65	0.79	0.70	0.76	0.77	0.74	0.63	0.42
2841.64	0.47	0.32	0.32	0.59	0.74	0.69	0.38	0.08	0.32
2840.64	0.08	0.05	0.12	0.49	0.31	0.24	0.11	0.09	0.04

9/18/2008 Lake Elevation: 2855.99 Project Flow: 124.9

< 0.80
0.81 - 0.88
> 0.88

Screen 1

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.90	0.50	0.25	0.24	0.23	0.35	0.15	0.14	0.24	0.03
2854.90	0.20	0.09	0.09	0.03	0.10	0.10	0.06	0.07	0.06
2853.84	0.10	0.05	0.05	0.03	0.03	0.07	0.05	0.05	0.05
2852.84	0.11	0.04	0.06	0.04	0.60	0.05	0.04	0.04	0.05
2851.84	0.04	0.04	0.02	0.08	0.02	0.03	0.02	0.10	0.03
2850.78	0.05	0.04	0.02	0.04	0.11	0.03	0.06	0.08	0.02
2849.78	0.03	0.03	0.00	0.01	0.01	0.02	0.06	0.02	0.01
2848.65	0.23	0.37	0.18	0.09	0.07	0.04	0.01	0.03	0.05
2847.65	0.62	0.69	0.84	0.78	0.91	0.84	0.88	0.85	0.34
2846.65	0.59	0.67	0.95	0.91	0.94	0.87	0.86	1.04	1.13
2845.59	0.77	0.86	0.97	0.95	0.91	0.97	1.03	1.10	1.18
2844.59	0.70	0.87	0.91	0.92	0.92	0.85	0.96	0.99	1.02
2843.57	0.65	0.74	0.83	0.89	0.88	0.91	0.92	0.91	1.02
2842.57	0.22	0.54	0.78	0.79	0.68	0.78	0.79	0.56	0.88
2841.57	0.20	0.20	0.48	0.42	0.37	0.44	0.19	0.35	0.68
2840.57	0.01	0.06	0.06	0.01	0.03	0.17	0.00	0.02	0.09

Screen 2

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.95	0.37	0.47	0.33	0.46	0.11	0.50	0.41	0.22	0.07
2854.95	0.05	0.15	0.17	0.06	0.29	0.09	0.19	0.05	0.21
2853.95	0.10	0.06	0.02	0.09	0.04	0.09	0.03	0.10	0.09
2852.87	0.03	0.08	0.08	0.01	0.09	0.11	0.03	0.12	0.07
2851.87	0.04	0.02	0.02	0.05	0.10	0.09	0.04	0.08	0.03
2850.78	0.07	0.08	0.09	0.05	0.12	0.07	0.02	0.08	0.09
2849.78	0.04	0.03	0.05	0.08	0.05	0.06	0.05	0.03	0.05
2848.78	0.65	0.91	0.67	0.56	0.37	0.39	0.31	0.13	0.19
2847.72	0.82	0.88	0.89	0.93	0.87	0.91	0.84	0.72	0.72
2846.72	0.86	0.87	0.88	0.76	0.86	0.87	0.93	0.87	0.84
2845.66	0.84	0.83	0.83	0.83	0.80	0.79	0.80	0.77	0.75
2844.66	0.72	0.75	0.76	0.75	0.75	0.77	0.74	0.77	0.75
2843.66	0.70	0.67	0.68	0.72	0.64	0.63	0.59	0.64	0.54
2842.64	0.55	0.46	0.59	0.60	0.55	0.47	0.61	0.59	0.58
2841.64	0.39	0.28	0.29	0.31	0.48	0.48	0.39	0.34	0.45
2840.64	0.24	0.14	0.10	0.14	0.28	0.09	0.20	0.26	0.25

9/18/2008 Lake Elevation: 2855.95 Project Flow: 86.2

< 0.80
0.81 - 0.88
> 0.88

Screen 1

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.90	0.17	0.31	0.22	0.24	0.24	0.13	0.05	0.01	0.02
2854.90	0.02	0.06	0.02	0.05	0.04	0.03	0.09	0.01	0.07
2853.84	0.02	0.04	0.06	0.01	0.03	0.04	0.11	0.04	0.02
2852.84	0.01	0.04	0.02	0.02	0.01	0.04	0.00	0.05	0.04
2851.84	0.01	0.03	0.01	0.03	0.03	0.00	0.04	0.03	0.02
2850.78	0.07	0.01	0.05	0.03	0.02	0.05	0.06	0.05	0.07
2849.78	0.02	0.01	0.01	0.01	0.02	0.01	0.02	0.01	0.02
2848.65	0.23	0.33	0.18	0.09	0.03	0.03	0.04	0.03	0.02
2847.65	0.44	0.57	0.59	0.65	0.71	0.68	0.57	0.63	0.33
2846.65	0.42	0.55	0.69	0.69	0.71	0.69	0.76	0.70	0.75
2845.59	0.47	0.61	0.65	0.65	0.60	0.67	0.73	0.79	0.80
2844.59	0.35	0.47	0.61	0.60	0.66	0.61	0.65	0.68	0.74
2843.57	0.35	0.39	0.49	0.55	0.52	0.58	0.58	0.57	0.59
2842.57	0.20	0.26	0.21	0.31	0.51	0.56	0.52	0.38	0.45
2841.57	0.03	0.01	0.16	0.27	0.15	0.32	0.11	0.08	0.28
2840.57	0.04	0.03	0.06	0.09	0.00	0.00	0.00	0.01	0.12

Screen 2

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.95	0.18	0.03	0.03	0.21	0.35	0.35	0.23	0.02	0.07
2854.95	0.06	0.07	0.10	0.05	0.05	0.03	0.07	0.11	0.11
2853.95	0.03	0.09	0.05	0.05	0.03	0.09	0.10	0.05	0.11
2852.87	0.02	0.05	0.06	0.06	0.05	0.09	0.23	0.06	0.03
2851.87	0.07	0.02	0.10	0.02	0.04	0.17	0.12	0.09	0.01
2850.78	0.02	0.00	0.02	0.11	0.15	0.16	0.13	0.07	0.13
2849.78	0.01	0.01	0.02	0.05	0.07	0.06	0.02	0.04	0.03
2848.78	0.60	0.61	0.47	0.48	0.25	0.29	0.10	0.08	0.15
2847.72	0.58	0.63	0.62	0.62	0.62	0.64	0.60	0.58	0.63
2846.72	0.57	0.59	0.62	0.60	0.59	0.63	0.63	0.68	0.61
2845.66	0.59	0.59	0.60	0.59	0.59	0.61	0.60	0.63	0.59
2844.66	0.53	0.56	0.52	0.55	0.56	0.57	0.58	0.58	0.56
2843.66	0.48	0.51	0.49	0.50	0.48	0.51	0.53	0.51	0.46
2842.64	0.47	0.43	0.37	0.47	0.49	0.50	0.48	0.43	0.47
2841.64	0.32	0.16	0.18	0.40	0.45	0.42	0.47	0.40	0.46
2840.64	0.15	0.08	0.02	0.16	0.40	0.03	0.10	0.17	0.36

9/19/2008 Lake Elevation: 2855.07 Project Flow: 124.6

< 0.80
0.81 - 0.88
> 0.88

Screen 1

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.90									
2854.90	0.07	0.28	0.26	0.30	0.26	0.14	0.15	0.10	0.07
2853.84	0.11	0.09	0.11	0.12	0.08	0.05	0.06	0.05	0.06
2852.84	0.09	0.12	0.13	0.09	0.05	0.09	0.06	0.10	0.06
2851.84	0.20	0.08	0.05	0.05	0.02	0.08	0.04	0.08	0.05
2850.78	0.02	0.05	0.05	0.08	0.08	0.07	0.05	0.03	0.07
2849.78	0.07	0.04	0.05	0.07	0.10	0.03	0.09	0.04	0.14
2848.65	0.28	0.20	0.21	0.19	0.00	0.11	0.09	0.02	0.06
2847.65	0.41	0.44	0.47	0.55	0.55	0.48	0.59	0.62	0.41
2846.65	0.47	0.53	0.55	0.58	0.55	0.56	0.62	0.68	0.72
2845.59	0.57	0.64	0.80	0.72	0.57	0.64	0.66	0.76	0.83
2844.59	0.43	0.53	0.60	0.62	0.58	0.54	0.57	0.69	0.69
2843.57	0.32	0.41	0.60	0.65	0.57	0.62	0.65	0.71	0.64
2842.57	0.27	0.17	0.42	0.55	0.60	0.65	0.45	0.52	0.54
2841.57	0.20	0.00	0.03	0.04	0.04	0.20	0.27	0.08	0.34
2840.57	0.09	0.10	0.80	0.10	0.05	0.01	0.01	0.04	0.15

Screen 2

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.95									
2854.95	0.33	0.32	0.03	0.17	0.42	0.40	0.49	0.42	0.08
2853.95	0.09	0.18	0.03	0.02	0.06	0.04	0.08	0.15	0.14
2852.87	0.04	0.06	0.05	0.07	0.01	0.05	0.08	0.50	0.10
2851.87	0.13	0.10	0.04	0.08	0.04	0.01	0.08	0.04	0.05
2850.78	0.03	0.02	0.03	0.05	0.02	0.11	0.08	0.15	0.02
2849.78	0.02	0.03	0.02	0.03	0.02	0.04	0.07	0.03	0.03
2848.78	0.83	0.93	0.50	0.78	0.68	0.62	0.51	0.27	0.12
2847.72	0.75	0.84	0.91	0.85	0.87	0.91	1.02	0.89	0.85
2846.72	0.88	0.93	0.80	0.84	0.84	0.84	0.86	0.89	0.85
2845.66	0.79	0.71	0.70	0.68	0.68	0.75	0.72	0.79	0.74
2844.66	0.73	0.73	0.74	0.65	0.59	0.64	0.58	0.62	0.66
2843.66	0.59	0.62	0.62	0.59	0.56	0.55	0.50	0.50	0.45
2842.64	0.53	0.48	0.49	0.59	0.53	0.49	0.46	0.45	0.49
2841.64	0.00	0.22	0.16	0.41	0.36	0.34	0.23	0.20	0.39
2840.64	0.06	0.07	0.06	0.06	0.03	0.07	0.09	0.07	0.20

9/19/2008 Lake Elevation: 2855.04 Project Flow: 87.2

< 0.80
0.81 - 0.88
> 0.88

Screen 1

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.90									
2854.90	0.17	0.26	0.31	0.18	0.11	0.10	0.19	0.10	0.02
2853.84	0.07	0.12	0.04	0.07	0.06	0.05	0.04	0.07	0.03
2852.84	0.05	0.07	0.05	0.04	0.08	0.03	0.11	0.05	0.07
2851.84	0.02	0.01	0.06	0.04	0.12	0.05	0.12	0.04	0.11
2850.78	0.01	0.30	0.03	0.03	0.02	0.20	0.01	0.10	0.06
2849.78	0.02	0.01	0.01	0.03	0.03	0.01	0.30	0.05	0.05
2848.65	0.24	0.28	0.09	0.10	0.07	0.05	0.06	0.04	0.07
2847.65	0.40	0.56	0.60	0.74	0.72	0.65	0.63	0.72	0.50
2846.65	0.38	0.68	0.74	0.74	0.72	0.71	0.68	0.73	0.76
2845.59	0.49	0.70	0.77	0.64	0.66	0.69	0.72	0.71	0.82
2844.59	0.51	0.59	0.71	0.66	0.69	0.62	0.63	0.71	0.71
2843.57	0.30	0.53	0.55	0.59	0.62	0.66	0.71	0.63	0.69
2842.57	0.19	0.21	0.43	0.48	0.54	0.60	0.44	0.39	0.62
2841.57	0.07	0.09	0.14	0.28	0.27	0.28	0.11	0.23	0.48
2840.57	0.07	0.01	0.04	0.01	0.02	0.01	0.01	0.01	0.15

Screen 2

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.95									
2854.95	0.36	0.36	0.17	0.01	0.19	0.32	0.32	0.42	0.31
2853.95	0.01	0.09	0.14	0.05	0.02	0.02	0.02	0.05	0.03
2852.87	0.03	0.07	0.02	0.02	0.00	0.01	0.01	0.07	0.02
2851.87	0.04	0.06	0.30	0.02	0.01	0.02	0.02	0.05	0.05
2850.78	0.00	0.01	0.02	0.04	0.00	0.00	0.00	0.03	0.20
2849.78	0.01	0.20	0.00	0.00	0.02	0.00	0.00	0.01	0.01
2848.78	0.65	0.62	0.59	0.53	0.53	0.52	0.52	0.20	0.10
2847.72	0.67	0.69	0.65	0.67	0.33	0.65	0.65	0.62	0.60
2846.72	0.66	0.65	0.65	0.63	0.65	0.71	0.71	0.69	0.73
2845.66	0.61	0.57	0.59	0.60	0.61	0.66	0.66	0.66	0.68
2844.66	0.55	0.57	0.58	0.55	0.52	0.57	0.57	0.56	0.57
2843.66	0.53	0.50	0.54	0.50	0.54	0.52	0.52	0.50	0.52
2842.64	0.38	0.42	0.45	0.51	0.43	0.38	0.38	0.47	0.44
2841.64	0.26	0.31	0.27	0.17	0.25	0.42	0.42	0.37	0.40
2840.64	0.00	0.08	0.05	0.22	0.05	0.09	0.09	0.17	0.22

9/21/2008 Lake Elevation: 2854.01 Project Flow: 124.5

< 0.80
0.81 - 0.88
> 0.88

Screen 1

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.90									
2854.90									
2853.84	0.44	0.35	0.29	0.27	0.26	0.10	0.15	0.10	0.09
2852.84	0.09	0.09	0.17	0.07	0.15	0.10	0.15	0.05	0.09
2851.84	0.15	0.17	0.12	0.05	0.09	0.05	0.04	0.03	0.04
2850.78	0.03	0.08	0.06	0.04	0.04	0.06	0.02	0.03	0.07
2849.78	0.05	0.01	0.11	0.06	0.07	0.05	0.07	0.07	0.17
2848.65	0.30	0.32	0.14	0.16	0.27	0.19	0.08	0.13	0.15
2847.65	0.43	0.72	0.77	0.78	0.84	0.81	0.87	0.98	0.84
2846.65	0.58	0.67	0.97	0.94	0.92	0.90	0.96	1.08	1.17
2845.59	0.72	0.70	1.04	0.98	0.79	0.88	0.88	0.91	1.03
2844.59	0.72	0.80	0.85	0.91	0.85	0.79	0.86	0.97	0.92
2843.57	0.61	0.52	0.79	0.81	0.93	0.92	0.98	0.80	0.88
2842.57	0.12	0.44	0.72	0.76	0.87	0.96	0.81	0.46	0.84
2841.57	0.20	0.05	0.21	0.61	0.26	0.34	0.28	0.26	0.48
2840.57	0.03	0.06	0.07	0.04	0.05	0.08	0.02	0.04	0.21

Screen 2

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.95									
2854.95									
2853.95	0.21	0.21	0.06	0.00	0.57	0.51	0.58	0.61	0.07
2852.87	0.11	0.07	0.16	0.09	0.13	0.10	0.05	0.16	0.40
2851.87	0.02	0.38	0.17	0.03	0.50	0.07	0.04	0.10	0.04
2850.78	0.70	0.07	0.13	0.15	0.80	0.23	0.08	0.06	0.03
2849.78	0.03	0.03	0.02	0.14	0.11	0.10	0.05	0.18	0.09
2848.78	0.91	0.85	0.74	0.78	0.83	0.77	0.65	0.26	0.53
2847.72	0.91	0.93	0.89	0.96	1.02	1.05	0.97	0.94	0.80
2846.72	0.88	0.91	0.88	0.84	0.91	0.92	0.91	1.10	0.78
2845.66	0.77	0.74	0.75	0.72	0.78	0.88	0.81	0.86	0.91
2844.66	0.80	0.79	0.74	0.75	0.73	0.72	0.71	0.77	0.82
2843.66	0.73	0.74	0.72	0.73	0.65	0.78	0.69	0.73	0.74
2842.64	0.59	0.60	0.53	0.64	0.71	0.74	0.71	0.71	0.66
2841.64	0.28	0.30	0.34	0.70	0.63	0.27	0.50	0.58	0.45
2840.64	0.00	0.13	0.19	0.14	0.38	0.14	0.21	0.26	0.49

9/21/2008 Lake Elevation: 2854.00 Project Flow: 87.6

< 0.80
0.81 - 0.88
> 0.88

Screen 1

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.90									
2854.90									
2853.84	0.12	0.18	0.09	0.11	0.18	0.13	0.10	0.12	0.13
2852.84	0.10	0.07	0.08	0.06	0.07	0.04	0.03	0.01	0.05
2851.84	0.05	0.06	0.09	0.09	0.02	0.04	0.06	0.06	0.03
2850.78	0.01	0.03	0.06	0.08	0.70	0.04	0.04	0.04	0.04
2849.78	0.05	0.04	0.02	0.04	0.01	0.05	0.04	0.11	0.06
2848.65	0.20	0.30	0.11	0.14	0.24	0.15	0.07	0.08	0.09
2847.65	0.43	0.48	0.64	0.58	0.64	0.56	0.64	0.73	0.58
2846.65	0.35	0.49	0.65	0.71	0.61	0.71	0.68	0.81	0.83
2845.59	0.59	0.71	0.82	0.65	0.61	0.65	0.62	0.65	0.72
2844.59	0.42	0.51	0.58	0.62	0.53	0.54	0.59	0.65	0.66
2843.57	0.48	0.49	0.63	0.58	0.61	0.66	0.72	0.61	0.62
2842.57	0.23	0.09	0.44	0.56	0.69	0.64	0.61	0.52	0.50
2841.57	0.05	0.03	0.24	0.42	0.36	0.23	0.19	0.06	0.34
2840.57	0.00	0.00	0.17	0.24	0.05	0.01	0.02	0.15	0.30

Screen 2

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.95									
2854.95									
2853.95	0.09	0.16	0.04	0.27	0.08	0.48	0.49	0.05	0.30
2852.87	0.02	0.04	0.04	0.04	0.13	0.04	0.07	0.12	0.13
2851.87	0.03	0.11	0.08	0.09	0.02	0.04	0.07	0.04	0.09
2850.78	0.10	0.03	0.03	0.03	0.03	0.07	0.13	0.03	0.05
2849.78	0.05	0.02	0.02	0.03	0.06	0.02	0.05	0.50	0.08
2848.78	0.62	0.67	0.60	0.59	0.57	0.62	0.58	0.28	0.09
2847.72	0.69	0.69	0.66	0.67	0.65	0.66	0.58	0.61	0.58
2846.72	0.55	0.63	0.55	0.50	0.59	0.60	0.63	0.65	0.61
2845.66	0.55	0.50	0.50	0.50	0.53	0.59	0.55	0.66	0.60
2844.66	0.53	0.55	0.51	0.50	0.53	0.57	0.54	0.58	0.59
2843.66	0.52	0.55	0.51	0.54	0.53	0.53	0.52	0.55	0.57
2842.64	0.46	0.53	0.50	0.55	0.54	0.32	0.43	0.47	0.51
2841.64	0.16	0.13	0.25	0.45	0.42	0.42	0.39	0.34	0.57
2840.64	0.20	0.05	0.06	0.07	0.08	0.05	0.18	0.38	0.37

9/22/2008 Lake Elevation: 2853.09 Project Flow: 87.0

< 0.80
0.81 - 0.88
> 0.88

Screen 1

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.90									
2854.90									
2853.84									
2852.84	0.21	0.22	0.22	0.22	0.12	0.09	0.05	0.13	0.05
2851.84	0.09	0.05	0.07	0.11	0.06	0.02	0.15	0.11	0.04
2850.78	0.05	0.05	0.05	0.06	0.00	0.06	0.02	0.07	0.01
2849.78	0.04	0.06	0.05	0.10	0.06	0.06	0.10	0.02	0.06
2848.65	0.26	0.14	0.08	0.08	0.03	0.10	0.08	0.02	0.05
2847.65	0.38	0.47	0.57	0.56	0.61	0.55	0.71	0.76	0.46
2846.65	0.56	0.55	0.77	0.79	0.69	0.68	0.78	0.80	0.75
2845.59	0.64	0.74	0.85	0.78	0.63	0.67	0.65	0.62	0.64
2844.59	0.50	0.67	0.78	0.78	0.66	0.62	0.59	0.65	0.72
2843.57	0.34	0.38	0.69	0.69	0.66	0.58	0.65	0.59	0.68
2842.57	0.09	0.11	0.45	0.45	0.55	0.58	0.71	0.35	0.54
2841.57	0.05	0.07	0.29	0.29	0.29	0.31	0.21	0.18	0.31
2840.57	0.01	0.06	0.04	0.02	0.02	0.03	0.05	0.01	0.19

Screen 2

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.95									
2854.95									
2853.95									
2852.87	0.37	0.32	0.13	0.07	0.08	0.15	0.27	0.34	0.34
2851.87	0.11	0.03	0.13	0.01	0.03	0.07	0.01	0.05	0.02
2850.78	0.10	0.05	0.07	0.09	0.03	0.03	0.02	0.04	0.11
2849.78	0.04	0.09	0.07	0.06	0.06	0.05	0.10	0.03	0.01
2848.78	0.69	0.63	0.46	0.66	0.47	0.46	0.39	0.24	0.02
2847.72	0.76	0.79	0.74	0.73	0.71	0.76	0.71	0.62	0.44
2846.72	0.67	0.69	0.61	0.60	0.64	0.60	0.64	0.65	0.76
2845.66	0.63	0.43	0.44	0.54	0.58	0.64	0.68	0.73	0.75
2844.66	0.39	0.45	0.45	0.58	0.61	0.68	0.62	0.68	0.73
2843.66	0.31	0.37	0.40	0.48	0.57	0.57	0.51	0.53	0.58
2842.64	0.26	0.19	0.31	0.47	0.51	0.48	0.47	0.46	0.47
2841.64	0.09	0.05	0.05	0.19	0.30	0.26	0.43	0.40	0.42
2840.64	0.00	0.02	0.03	0.05	0.01	0.16	0.16	0.29	0.21

9/23/2008 Lake Elevation: 2852.16 Project Flow: 87.8

< 0.80
0.81 - 0.88
> 0.88

Screen 1

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.90									
2854.90									
2853.84									
2852.84									
2851.84	0.23	0.22	0.21	0.21	0.16	0.08	0.12	0.06	0.11
2850.78	0.05	0.08	0.05	0.09	0.05	0.05	0.06	0.02	0.10
2849.78	0.01	0.10	0.07	0.07	0.03	0.03	0.05	0.05	0.06
2848.65	0.21	0.12	0.06	0.06	0.07	0.07	0.06	0.06	0.08
2847.65	0.32	0.51	0.61	0.59	0.69	0.85	0.86	0.69	0.64
2846.65	0.36	0.57	0.78	0.85	0.73	0.79	0.75	0.75	0.73
2845.59	0.55	0.68	0.78	0.72	0.60	0.57	0.54	0.51	0.04
2844.59	0.56	0.70	0.78	0.65	0.64	0.53	0.49	0.56	0.68
2843.57	0.23	0.46	0.58	0.55	0.58	0.59	0.53	0.57	0.57
2842.57	0.09	0.17	0.36	0.41	0.52	0.41	0.52	0.42	0.09
2841.57	0.07	0.10	0.15	0.21	0.24	0.04	0.35	0.19	0.42
2840.57	0.08	0.03	0.20	0.06	0.03	0.01	0.08	0.14	0.26

Screen 2

Elevation	Horizontal Measurement (ft) 1	2	3	4	5	6	7	8	9
2855.95									
2854.95									
2853.95									
2852.87									
2851.87	0.33	0.22	0.09	0.02	0.03	0.03	0.11	0.20	0.24
2850.78	0.01	0.06	0.01	0.14	0.06	0.01	0.03	0.01	0.03
2849.78	0.02	0.04	0.03	0.09	0.00	0.04	0.03	0.01	0.07
2848.78	0.54	0.59	0.34	0.57	0.49	0.52	0.37	0.03	0.08
2847.72	0.64	0.65	0.58	0.50	0.61	0.57	0.62	0.36	0.26
2846.72	0.50	0.48	0.40	0.44	0.51	0.54	0.54	0.43	0.42
2845.66	0.44	0.44	0.40	0.35	0.35	0.38	0.41	0.38	0.39
2844.66	0.27	0.26	0.28	0.30	0.27	0.26	0.32	0.34	0.34
2843.66	0.22	0.21	0.23	0.26	0.20	0.19	0.28	0.31	0.31
2842.64	0.12	0.11	0.13	0.18	0.10	0.05	0.20	0.23	0.15
2841.64	0.05	0.02	0.13	0.09	0.06	0.01	0.03	0.02	0.09
2840.64	0.00	0.02	0.01	0.07	0.08	0.06	0.08	0.07	0.08

APPENDIX B

DVD OF FISH BEHAVIOR AND SCREEN PERFORMANCE DURING VELOCITY TESTING

PACKWOOD LAKE INTAKE STRUCTURE, 2008

APPENDIX C

DAILY FLOW STATISTICS FOR THE PACKWOOD LAKE HYDROELECTRIC PROJECT APRIL 1 – OCTOBER 31, 2008

Lake Levels and Operational Flows for Packwood Lake Hydroelectric Project, April - October, 2008					
Month	**Day**	**Lake Level (ft)**	**Project Flow (cfs)**	**Fish Flow (cfs)**	**Lake Inflow (cfs)**
April	1	2852.44	0	3.76	36
	2	2852.58	0	3.74	31
	3	2852.7	0	3.77	31
	4	2852.82	0	3.73	40
	5	2852.98	0	3.74	33
	6	2853.11	0	3.77	38
	7	2853.26	0	3.75	33
	8	2853.39	0	3.77	31
	9	2853.51	0	3.82	33
	10	2853.64	0	3.84	33
	11	2853.77	0	3.74	31
	12	2853.89	0	3.75	36
	13	2854.03	0	3.86	52
	14	2854.24	0	3.76	56
	15	2854.47	0	3.61	54
	16	2854.69	0	3.68	45
	17	2854.87	0	3.74	42
	18	2855.04	0	3.75	52
	19	2855.25	0	3.75	42
	20	2855.42	0	3.71	38
	21	2855.57	0	3.75	36
	22	2855.71	0	3.75	42
	23	2855.88	0	3.77	38
	24	2856.03	0	3.73	33
	25	2856.16	0	3.75	33
	26	2856.29	0	3.75	36
	27	2856.43	15	3.75	55
	28	2856.59	39	3.77	59
	29	2856.66	37	3.77	59
	30	2856.74	39	3.77	50
May	1	2856.77	57	3.74	45
	2	2856.7	57	3.75	45
	3	2856.63	57	3.75	47
	4	2856.57	38	3.76	53
	5	2856.62	44	3.75	68
	6	2856.71	45	3.76	76
	7	2856.83	58	3.75	71
	8	2856.87	59	3.76	67
	9	2856.89	58	3.76	69
	10	2856.92	58	3.74	73
	11	2856.97	58	3.76	78
	12	2857.04	90	3.75	69
	13	2856.93	92	3.75	102

Lake Levels and Operational Flows for Packwood Lake Hydroelectric Project, April - October, 2008

Month	Day	Lake Level (ft)	Project Flow (cfs)	Fish Flow (cfs)	Lake Inflow (cfs)
	14	2856.96	95	3.76	260
	15	2857.67	200	3.80	399
	16	2858.53	207	3.88	421
	17	2859.45	212	3.95	346
	18	2860.02	213	4.55	195
	19	2859.92	212	4.48	171
	20	2859.72	212	3.99	191
	21	2859.61	214	3.81	163
	22	2859.37	214	3.76	138
	23	2859.02	216	3.75	178
	24	2858.84	213	3.74	226
	25	2858.88	215	3.75	266
	26	2859.09	216	3.77	243
	27	2859.19	213	3.74	222
	28	2859.21	213	3.75	213
	29	2859.19	213	3.75	203
	30	2859.13	213	3.76	190
	31	2859.01	212	3.76	193
June	1	2858.91	211	3.75	195
	2	2858.82	213	3.77	197
	3	2858.73	212	3.75	247
	4	2858.87	213	3.77	198
	5	2858.79	210	3.74	198
	6	2858.72	212	3.76	214
	7	2858.71	213	3.74	198
	8	2858.63	213	3.76	189
	9	2858.51	211	3.75	215
	10	2858.51	208	3.76	219
	11	2858.54	206	3.75	185
	12	2858.43	208	3.74	185
	13	2858.31	211	3.75	197
	14	2858.23	213	3.75	203
	15	2858.17	210	3.75	207
	16	2858.14	210	3.76	212
	17	2858.13	212	3.75	225
	18	2858.17	212	3.75	214
	19	2858.16	211	3.74	201
	20	2858.1	211	3.75	231
	21	2858.17	212	3.75	282
	22	2858.46	213	3.76	256
	23	2858.63	210	3.74	218
	24	2858.65	211	3.16	203
	25	2858.6	210	2.97	206
	26	2858.57	213	3.77	229

Lake Levels and Operational Flows for Packwood Lake Hydroelectric Project, April - October, 2008

Month	Day	Lake Level (ft)	Project Flow (cfs)	Fish Flow (cfs)	Lake Inflow (cfs)
	27	2858.62	211	3.73	258
	28	2858.81	210	3.75	310
	29	2859.23	211	3.75	270
	30	2859.47	211	3.73	227
July	1	2859.52	216	3.76	206
	2	2859.46	211	3.76	224
	3	2859.50	211	3.76	194
	4	2859.41	211	3.70	201
	5	2859.35	211	3.77	135
	6	2859.00	211	3.76	185
	7	2858.87	158	3.73	164
	8	2858.88	211	3.78	178
	9	2858.72	211	3.74	199
	10	2858.65	211	3.78	190
	11	2858.54	211	3.78	156
	12	2858.28	211	3.75	155
	13	2858.02	185	3.96	212
	14	2858.12	141	4.92	180
	15	2858.27	161	3.95	160
	16	2858.25	211	4.64	147
	17	2857.95	164	4.52	130
	18	2857.78	117	4.63	119
	19	2857.77	117	4.66	115
	20	2857.74	117	4.69	117
	21	2857.72	117	4.03	121
	22	2857.72	117	3.96	114
	23	2857.69	117	3.70	96
	24	2857.58	98	3.88	77
	25	2857.47	82	3.70	84
	26	2857.46	82	3.77	111
	27	2857.57	113	3.71	144
	28	2857.69	113	3.77	92
	29	2857.58	113	3.75	98
	30	2857.50	113	3.70	96
	31	2857.41	113	3.61	73
August	1	2857.22	85	3.70	162
	2	2857.54	58	3.75	94
	3	2857.68	78	3.75	82
	4	2857.68	92	3.74	82
	5	2857.62	92	3.75	89
	6	2857.59	92	3.74	93
	7	2857.58	92	3.75	93
	8	2857.57	92	3.73	96
	9	2857.57	92	3.75	84

Lake Levels and Operational Flows for Packwood Lake Hydroelectric Project, April - October, 2008

Month	Day	Lake Level (ft)	Project Flow (cfs)	Fish Flow (cfs)	Lake Inflow (cfs)
	10	2857.52	85	3.75	73
	11	2857.45	78	3.75	73
	12	2857.41	78	3.76	70
	13	2857.36	78	3.74	75
	14	2857.33	81	3.76	85
	15	2857.33	45	3.73	71
	16	2857.43	45	3.77	85
	17	2857.59	45	3.74	85
	18	2857.75	78	3.75	86
	19	2857.77	78	3.75	98
	20	2857.84	131	3.76	128
	21	2857.81	150	3.74	120
	22	2857.66	111	3.76	69
	23	2857.46	78	3.75	64
	24	2857.38	78	3.74	66
	25	2857.31	78	3.76	66
	26	2857.24	78	3.76	66
	27	2857.17	78	3.74	89
	28	2857.2	78	3.76	86
	29	2857.22	68	3.75	74
	30	2857.23	45	3.76	62
	31	2857.29	45	3.76	53
September	1	2857.31	45	3.76	49
	2	2857.31	46	3.74	49
	3	2857.31	45	3.74	44
	4	2857.29	44	3.75	43
	5	2857.27	40	3.74	40
	6	2857.25	38	3.76	42
	7	2857.25	37	3.75	38
	8	2857.24	39	3.76	40
	9	2857.23	37	3.75	37
	10	2857.21	39	3.75	40
	11	2857.2	37	3.75	38
	12	2857.19	38	3.75	37
	13	2857.17	37	3.75	37
	14	2857.15	32	3.78	36
	15	2857.15	32	3.71	36
	16	2857.15	181	3.75	25
	17	2856.45	125	3.86	31
	18	2856.02	187	3.70	24
	19	2855.29	167	3.15	31
	20	2854.68	178	4.17	34
	21	2854.03	190	4.74	22
	22	2853.27	189	4.21	22

Lake Levels and Operational Flows for Packwood Lake Hydroelectric Project, April - October, 2008					
Month	**Day**	**Lake Level (ft)**	**Project Flow (cfs)**	**Fish Flow (cfs)**	**Lake Inflow (cfs)**
	23	2852.52	129	4.99	25
	24	2852.04	118	4.86	25
	25	2851.61	120	3.82	26
	26	2851.18	122	3.75	27
	27	2850.75	99	3.67	29
	28	2850.43	48	3.48	34
	29	2850.35	45	3.39	34
	30	2850.29	43	3.04	32
October	1	2850.23	45	3.39	33
	2	2850.16	46	3.74	36
	3	2850.1	45	3.74	46
	4	2850.09	0	3.85	75
	5	2850.4	0	4.56	59
	6	2850.64	0	4.96	73
	7	2850.94	0	5.22	105
	8	2851.38	0	5.54	60
	9	2851.62	0	4.49	55
	10	2851.84	0	4.07	43
	11	2852.01	0	4.51	41
	12	2852.17	0	4.81	50
	13	2852.37	0	4.98	60
	14	2852.61	0	4.86	53
	15	2852.82	0	4.47	45
	16	2853	0	4.28	50
	17	2853.2	0	4.49	43
	18	2853.37	0	4.87	46
	19	2853.55	0	4.85	44
	20	2853.72	0	4.87	69
	21	2854	0	4.99	44
	22	2854.17	0	5.00	41
	23	2854.33	0	4.91	44
	24	2854.5	8	3.95	40
	25	2854.62	0	3.77	38
	26	2854.77	0	3.75	36
	27	2854.91	0	4.62	37
	28	2855.05	0	4.27	34
	29	2855.18	0	5.59	33
	30	2855.3	36	5.16	39
	31	2855.29	55	4.98	35