Oregon Creek
Log Cabin Reach
Lower Log Cabin Site
Draft Hydraulic Calibration Results

Model Used

The hydraulic model for the Lower Log Cabin Site PHABSIM study was calibrated by HDR using RHABSIM 3.0 (Riverine Habitat Simulation), a commercial software program written by Thomas R. Payne and Associates of Arcata, California. RHABSIM is a commercial version of the PHABSIM computer model (Milhous et al. 1984).

Model Files

The following RHABSIM file is associated with the Lower Log Cabin site:

LWLC.RHB

Modeling Methods

Water Surface Elevations (WSEs)

For WSEs, these procedures included: the development of stage/discharge rating curves using log-log regression (IFG4); and/or Manning's formula (MANSQ); direct comparison of results; and selection of the most appropriate and accurate method. Log-log and MANSQ were run for each transect, with MANSQ set as the default modeling method. If individual transects did not calibrate sufficiently well using MANSQ, based on general guidelines of maximum Beta (0.5), and/or professional judgment, then log/log was selected. Data file construction, calibration, and simulation followed standard procedures and guidelines outlined in the PHABSIM Reference Manual Version II, Instream Flow Information Paper No. 26 (Milhous et al. 1989).

Modeling Guidelines

PHABSIM modeling guidelines considered for the Lower Log Cabin Site were as follows:

1. The beta value (a measure of the change in channel roughness with changes in streamflow) must be between 2.0 and 4.5;
2. The mean error in calculated versus given discharges must be less than 10 percent;
3. There must be no more than a 25 percent difference for any calculated versus given discharge;
4. There must be no more than a 0.1-foot difference between measured and simulated WSEs; and

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To determine whether the MANSQ model accurately predicts measured values, the second through fourth of the above criteria must be met, and the beta value parameter used by MANSQ must be within the range of -0.5 to 0.5. The first IFG4 criterion is not applicable to MANSQ.

Habitat Summary for Lower Log Cabin Site

A hydraulic model was developed for the 11 instream flow transects on the Lower Log Cabin Site on Oregon Creek above the Middle Yuba River. Meso-habitats represented in the Log Cabin Sub-Reach are presented in Table 1. Lower Log Cabin was one of two sites within the Log Cabin Sub-Reach of the Oregon Creek Reach. Final transect locations in the Lower Log Cabin site are presented in Figure 1.

Table 1. Habitat frequency based on video-mapped data and target transects for the Log Cabin Reach of Oregon Creek.

PHABSIM Habitat	Number	Number Frequency	Adjusted Number Frequency
High gradient riffles	673	3%	0%
Low gradient riffles	4,170	21%	22%
Runs/Step-Runs	2,053	10%	11%
Glides	946	5%	5%
Pocket Water	2,661	13%	14%
Pools	9,217	47%	48%
Total	**19,719**	**100%**	**100%**

[1] There are more potential transects listed in this table than there are transects at this site because the habitat frequency analysis was for the entire Log Cabin Dam Reach, which includes the Lower Log Cabin, Celestial Valley, and Upper Log Cabin sites.

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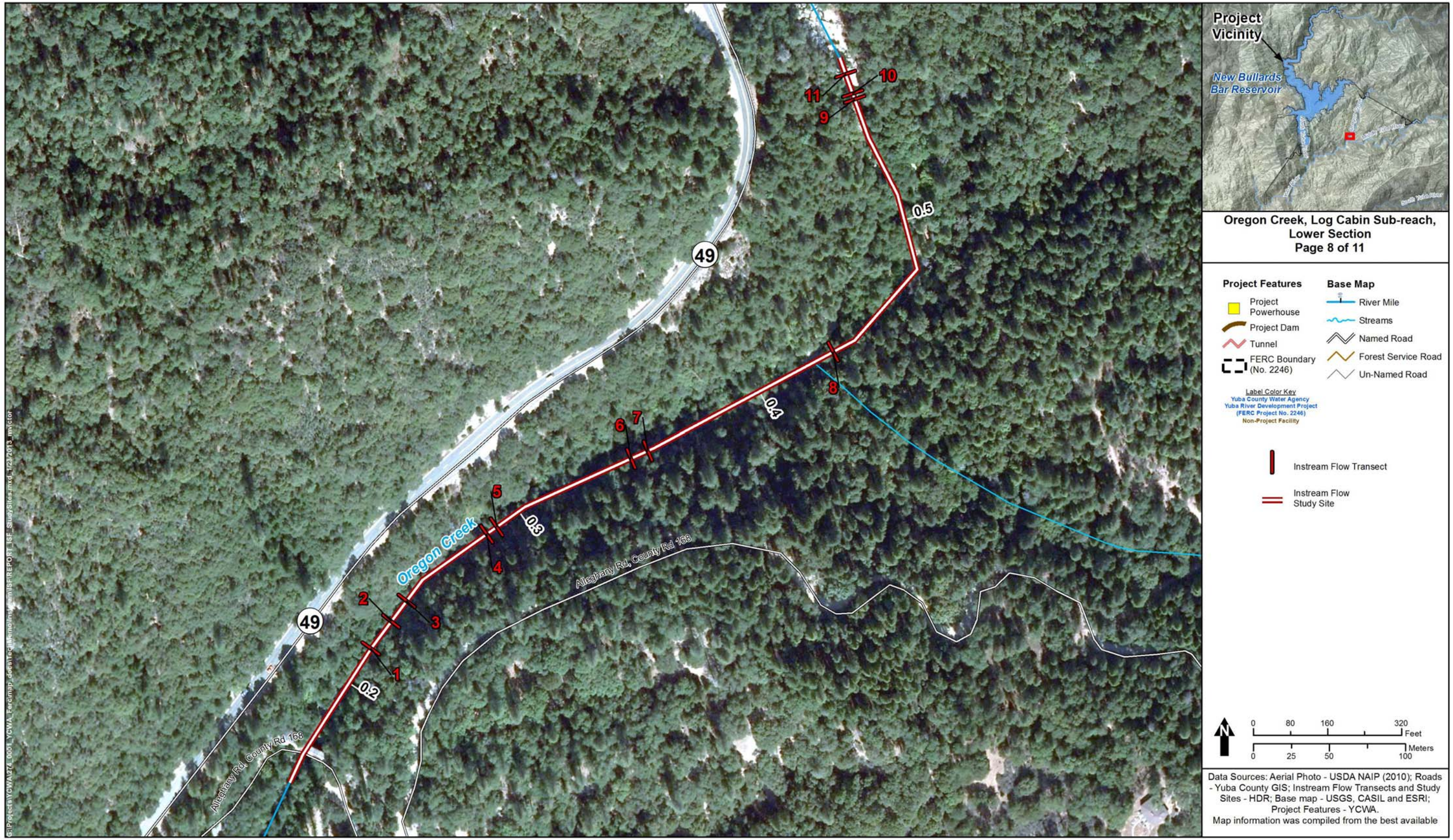

Figure 1. PHABSIM transects in the Lower Log Cabin Site of the Log Cabin Diversion Dam sub-reach on Oregon Creek.

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Calibration Summary for Lower Log Cabin Site

The Lower Log Cabin model was associated with three stage discharge pairs, and primary velocity calibration set at full channel flow of 108 cubic feet per second (cfs). When velocities couldn't be measured safely at 108 cfs, they were measured at either the mid flow of 47.4 cfs or the low flow of 16.9 cfs. Each transect in the site had one velocity set measured, which is consistent with the "one-velocity" method.

Stage/discharge regressions for Transect 1 (T-01) through T-11 were developed using the three calibration discharges: 108 cfs, 47.4 cfs, and 16.9 cfs.

Table 2 summarizes modeling statistics for each transect and modeling method, while Table B-1 and Table B-2, in Appendix B, summarize the given calibration stage and the modeled stages for each flow, at each transect, using all modeling methods used on a given transect.

Cross Sections

Cross sectional profile graphs, with measured WSEs, have been included in Appendix A, in addition to transect photos.

Calibration Details for Lower Log Cabin Site

Stage/Discharge Calibration

- All transects in the study site were calibrated using both Log/Log and MANSQ.
- For model calibration, WSEs were selected within the range of field collected data only.
- Cross-sectional geometry and a realistic rating curve fit were considered when choosing the primary modeling method.
- MANSQ was selected as the primary calibration method on five of the eleven transects: T-02, T-03, T-04, T-08 and T-11
- Log/Log was selected as the primary calibration method on six of the eleven transects: T-01, T-05, T-06, T-07, T-09 and T-10.
- Log/Log betas were between 2.0 and 4.5 except on four transects: T-04, T-06, T-07, and T-11.
- MANSQ betas in the range of -0.5 to 0.5 except 2: T-09 and T-10.
- All Log/Log and MANSQ mean errors were less than two percent.
- Both MANSQ and Log/Log mean errors can be seen in Table 2.
- Refer to Table B-1 and B-2 in the Appendix for a comparison of measured versus modeled WSEs.
- 9 of the 11 calculated discharges were within 20 percent of given discharges.

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- T-09 was outside that range due to the complexity of the bottom profile and strong lateral and negative flow vectors on transect.
- T-11 was outside the desired range due to the complexity of the bottom profile and strong lateral and negative flow vectors on transect.

Table 2. Percent Mean Error for Stage/Discharge Relationships.

	T-11	T-10	T-9	T-8	T-07	T-06
Log/Log	0.6695%	0.0263%	0.2582%	0.3495%	0.2685%	0.4781%
MANSQ	1.4465%	0.6168%	0.4614%	0.9791%	1.4245%	1.8736%
MANSQ BETA	0.431%	0.6844%	0.5797%	0.4583%	-0.1705%	-0.1611%
	T-05	**T-04**	**T-03**	**T-02**	**T-01**	
Log/Log	0.2491%	0.4753%	0.1646%	0.0034%	0.2557%	
MANSQ	1.5814%	0.515%	0.4176%	0.2212%	0.9078%	
MANSQ BETA	0.2655%	0.4876%	0.4975%	0.3863%	0.4046%	

Velocity Calibration

All transect velocity measurements were collected at the highest target flow possible for that transect. Limiting physical parameters included swift water too deep to safely wade or deep water with entrained air which limited ADCP data collection.

- Velocity measurements were modeled at the highest flow possible for each transects.
  - High Flow: T-01 and T-06 through T-08.
  - Mid Flow: T-02 through T-05, T-09, and T-11.

An incomplete velocity set was collected for T-10 at both high and low flows due to deep water and high velocities with entrained air from stations 16.0 – 39.0. Velocities were modeled using photographs and a mass balance target for the transect discharge. Low flow and high flow velocity calibrations were compared to field observations and photographs of each flow. The high flow simulation was selected as the most reasonable alternative and N values were manipulated to approximate the lower flow simulations.

Table 3 and Table 4 provide the velocity adjustment factor (VAF) for each calibration flow on each transect. VAF is the index of the difference between the requested simulation discharge and computed discharge derived from the velocity simulations (Waddle 2001). Graphical representations of the VAFs can be found in Figure 2 and Figure 3. These velocity adjustments are used to prevent the model from over or under estimating the discharge at flows other than the velocity calibration discharge.

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Table 3. Velocity adjustment factors (VAF).

Transect	**1**			**Transect**	**2**			**Transect**	**3**		
WSL	**Calibration Flow**	**Calculated Flow**	**VAF**	**WSL**	**Calibration Flow**	**Calculated Flow**	**VAF**	**WSL**	**Calibration Flow**	**Calculated Flow**	**VAF**
93.39	6.76	17.93	0.377	93.92	6.76	23.66	0.2857	93.86	6.76	23.37	0.2893
93.77	16.9	33.67	0.5019	94.37	16.9	34.41	0.4911	94.34	16.9	33.43	0.5055
94.33	47.4	64.28	0.7374	94.98	47.4	52.35	0.9055	94.98	47.4	49.21	0.9632
94.89	108	103.8	1.0405	95.61	108	74.71	1.4456	95.6	108	66.37	1.6273
95.68	270	169.61	1.5918	96.51	270	112.94	2.3906	96.44	270	92.53	2.9179
Transect	**4**			**Transect**	**5**			**Transect**	**6**		
WSL	**Calibration Flow**	**Calculated Flow**	**VAF**	**WSL**	**Calibration Flow**	**Calculated Flow**	**VAF**	**WSL**	**Calibration Flow**	**Calculated Flow**	**VAF**
89.66	6.76	19.18	0.3525	91.1	6.76	15.63	0.4325	92.27	6.76	3.94	1.7137
90.07	16.9	29.49	0.5731	91.4	16.9	23.68	0.7137	92.58	16.9	14.16	1.1932
90.65	47.4	47.8	0.9915	91.91	47.4	41.37	1.1459	93.18	47.4	47.91	0.9894
91.22	108	69.76	1.5482	92.49	108	68.79	1.5699	93.97	108	114.94	0.9396
92	270	106.02	2.5467	93.41	270	126.3	2.1377	95.38	270	291.63	0.9258
Transect	**7**			**Transect**	**8**			**Transect**	**9**		
WSL	**Calibration Flow**	**Calculated Flow**	**VAF**	**WSL**	**Calibration Flow**	**Calculated Flow**	**VAF**	**WSL**	**Calibration Flow**	**Calculated Flow**	**VAF**
95.81	6.76	5.99	1.129	95.05	6.76	51.98	0.13	89.52	6.76	39.63	0.1706
96.09	16.9	15.7	1.0765	95.4	16.9	64.66	0.2614	89.94	16.9	46.78	0.3613
96.63	47.4	45	1.0534	95.94	47.4	86.72	0.5466	90.54	47.4	57.05	0.8309
97.37	108	104.63	1.0322	96.55	108	114.34	0.9445	91.13	108	67.25	1.6059
98.8	270	262.7	1.0278	97.46	270	164.48	1.6415	91.95	270	81.25	3.3232

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Table 4. Velocity adjustment factors (cont.)

Transect	10			Transect	11		
WSL	**Calibration Flow**	**Calculated Flow**	**VAF**	**WSL**	**Calibration Flow**	**Calculated Flow**	**VAF**
89.5	6.76	66.5	0.1017	91.26	6.76	41.24	0.1639
89.93	16.9	77.18	0.219	91.54	16.9	51.44	0.3286
90.54	47.4	93.72	0.5058	92.01	47.4	72.02	0.6582
91.15	108	111.36	0.9698	92.56	108	101.45	1.0646
91.99	270	137.32	1.9662	93.38	270	157.13	1.7183

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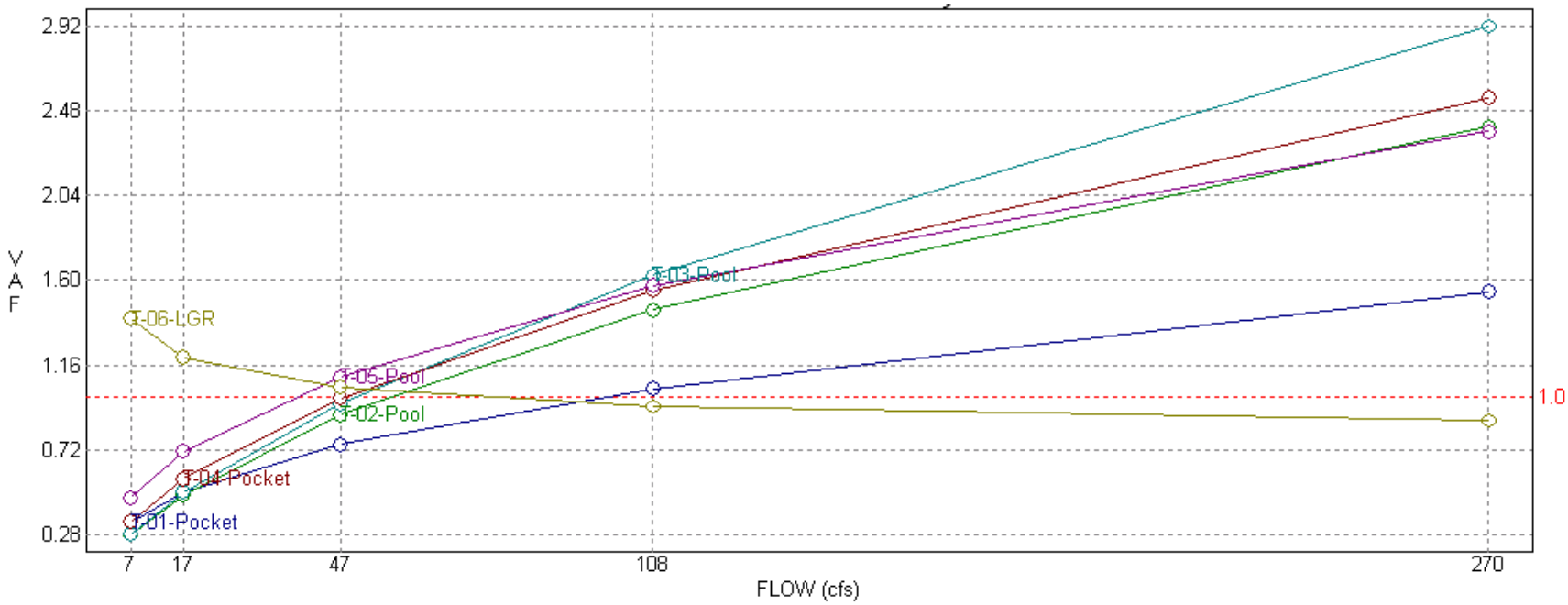

Figure 2. VAF by flow (T-01 to T-06).

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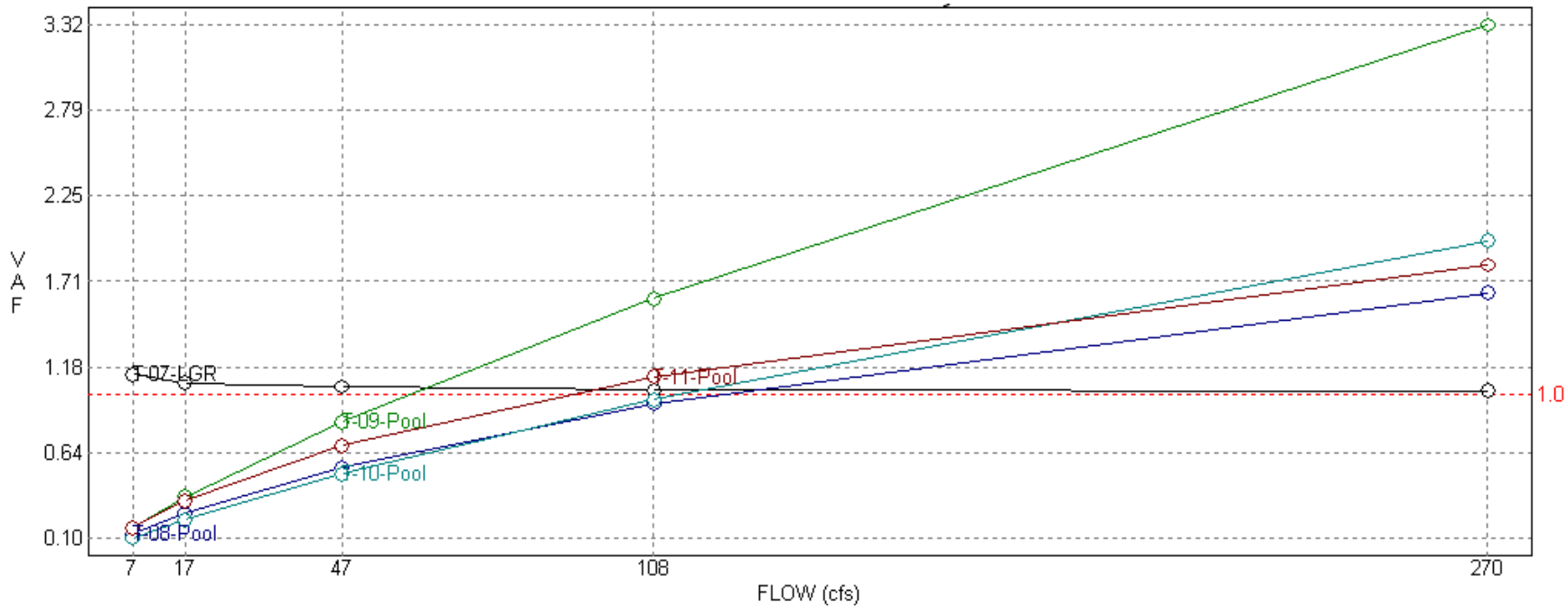

Figure 3. VAF by flow (T-07 to T-11).

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Target Discharge and Field Discharge

Discharge, like WSE, is used to calibrate stage/discharge relationships in the PHABSIM hydraulic models. The best estimate of discharge used in the model was calculated based on averaging numerous measurements from each site. Discharge selections were within the range of flows observed during data collection if the average discharge for the day was not used. Average daily discharge calculated from all field measurements are summarized below in Table 5.

Table 5. Target and measured flows for the Lower Log Cabin Site.

Sub-Reach	Number of Transects	Transect	Type	Discharge					
				Low - Target 20 cfs		Mid - Target 50 cfs		High - Target 100 cfs	
				Measured (cfs)	Method	Measured (cfs)	Method	Measured (cfs)	Method
Lower Log Cabin	11	1	Pocketwater					102	Swoffer
		2	Pool			53	Swoffer		
		3	Pool			47	Swoffer		
		4	Pocketwater			50	Swoffer		
		5	Pool			41	Swoffer		
		6	Low gradient riffle					114	Swoffer
		7	Low gradient riffle					106	Swoffer
		8	Pool					112	ADCP/Swoffer
		9	Pool	24	Swoffer	46	Swoffer		
		10	Pool	Incomplete data set	Swoffer	Incomplete data set	Swoffer	Incomplete data set	Swoffer
		11	Pool			71	Swoffer		
Additional Discharges		Q1		16.2	Swoffer				
		Q2		18.4	Swoffer				
		Q3		16.2	Swoffer				
Given Flows				16.9	Average Q1-Q3	47.4	Average without T-11	108	Average of all HF measurements

References

Milhous, R. T., D. L. Wegner, and T. Waddle. 1984. User's Guide to the Physical Habitat Simulation System (PHABSIM). Instream Flow Information Paper No. 11. U.S. Fish and Wildlife Service. FWS/OBS-81/43.

Milhous, R. T., M. A. Updike, and D. M. Schneider. 1989. PHABSIM Reference Manual Version II, Instream Flow Information Paper No. 26. U.S. Fish and Wildlife Service Biological Report 89(16).

Waddle, T. J. (ed.) 2001. PHABSIM for Windows: User's Manual and Exercises. U.S. Geological Survey Open-File Report 2001-340.

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Appendix A
Lower Log Cabin Site Cross Sectional Profiles and Photos

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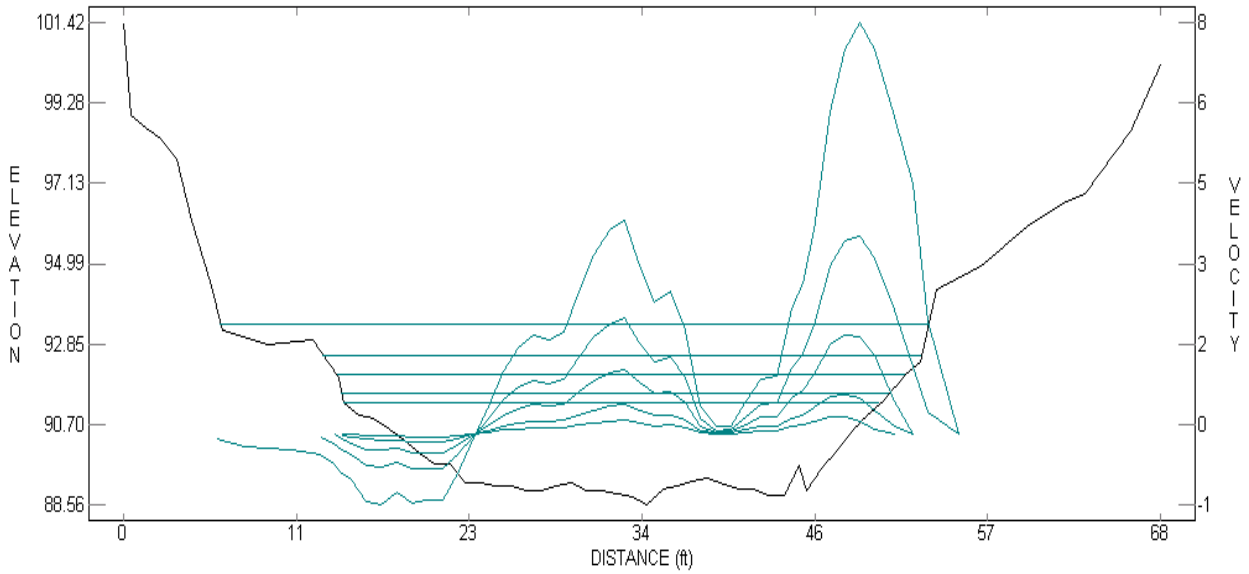

Figure A-1. Cross Section for Transect 11 (Pool Head).

Figure A-1. Transect 11-Looking from right bank to left bank at mid flow.

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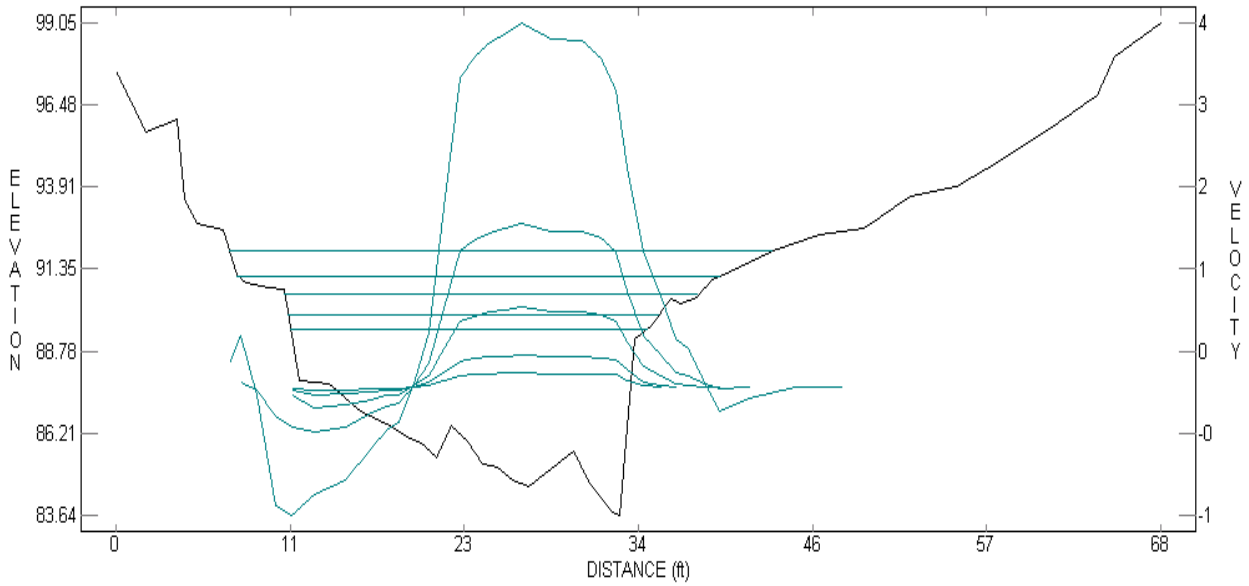

Figure A-2. Cross section for Transect 10 (Pool Belly).

Figure A-3. Transect 10-Looking from right bank to left bank at high flow.

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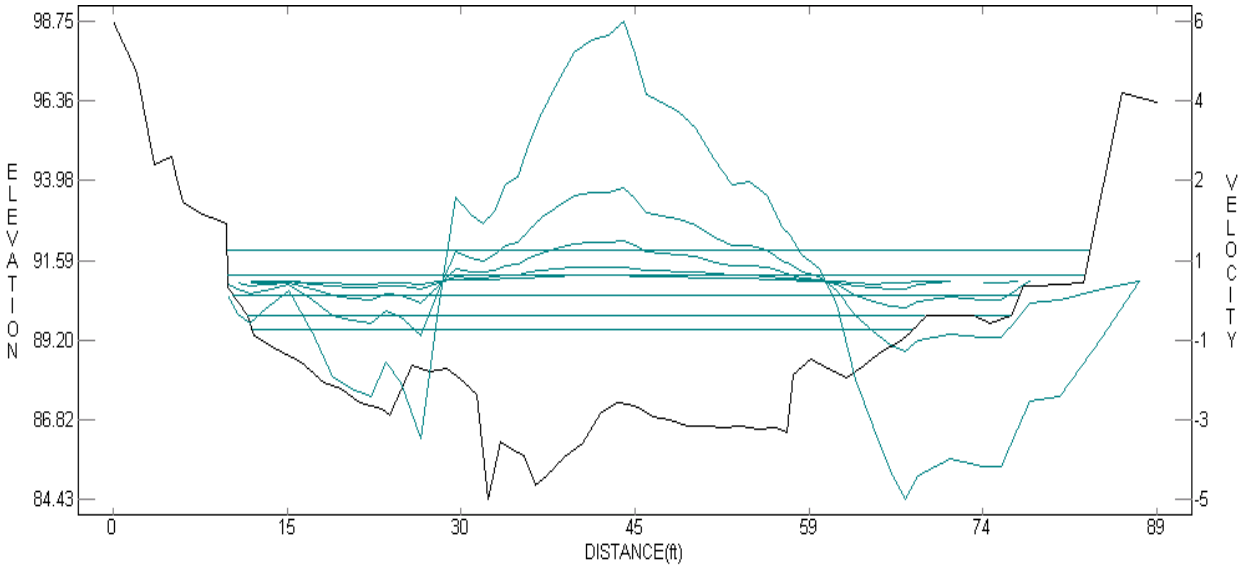

Figure A-4. Cross section for Transect 09 (Pool Tail).

Figure A-5. Transect 09-Looking from the right bank to the left bank at low flow.

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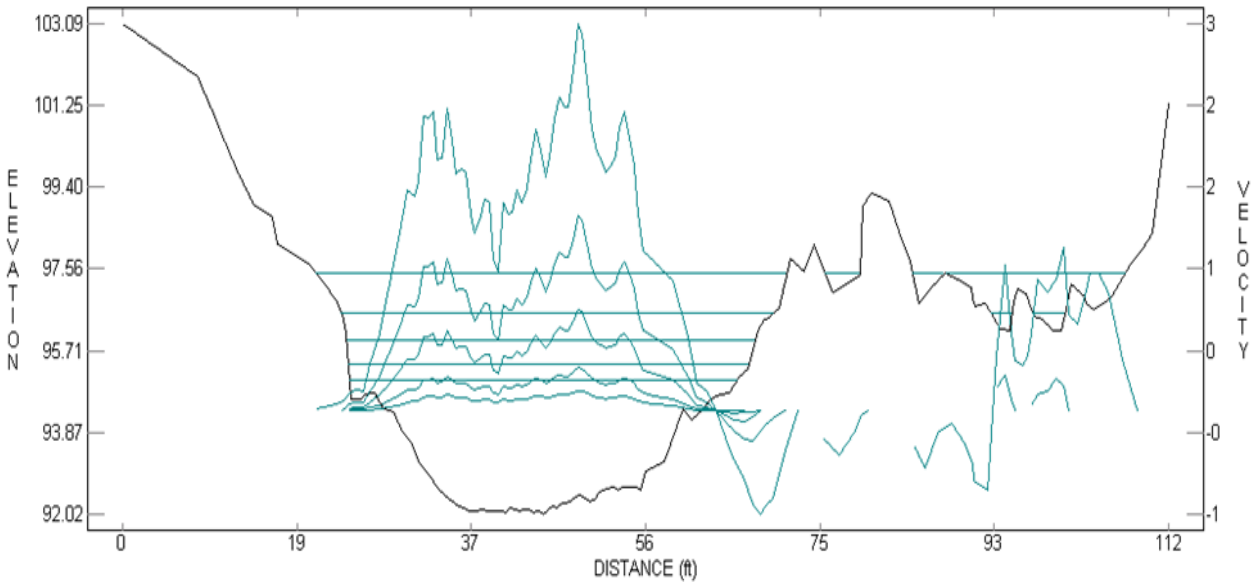

Figure A-6. Cross section for Transect 08 (Pool).

Figure A-7. Transect 08-Looking from right bank to the left bank of the left ascending channel at mid flow.

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Figure A-8. Transect 08 – Looking from left bank to right bank of the right ascending channel at high flow.

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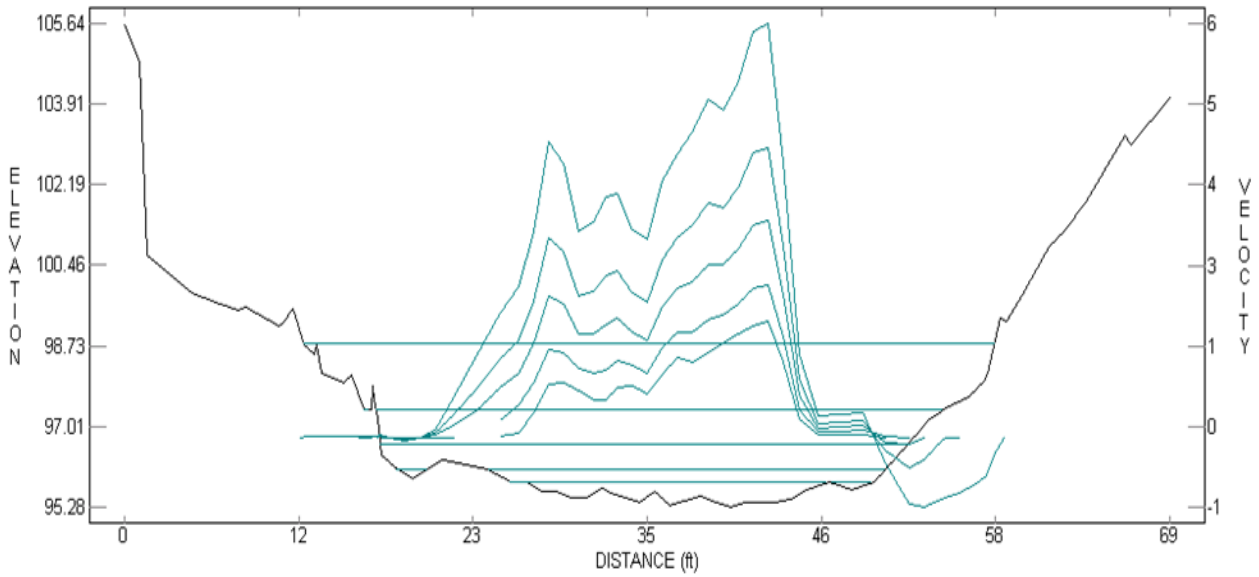

Figure A-9. Cross section for Transect 07 (Low Gradient Riffle).

Figure A-10. Transect 07-Looking from the right bank to the left bank at mid flow.

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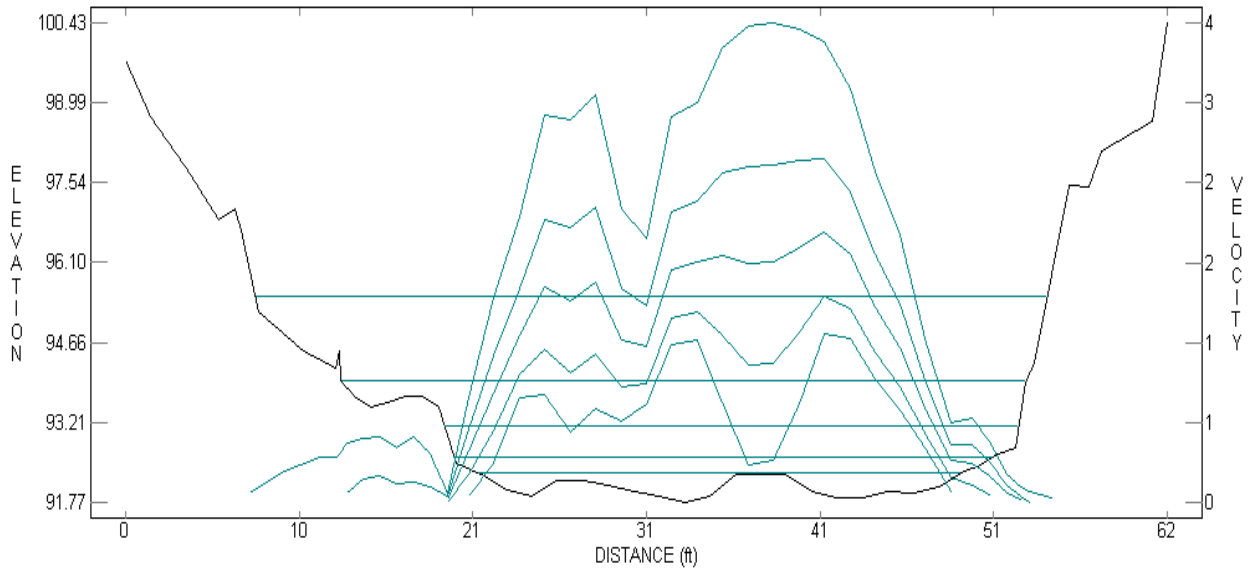

Figure A-11. Cross section for Transect 06 (Low Gradient Riffle).

Figure A-12. Transect 06-Looking from left bank to right bank of right ascending channel at mid flow.

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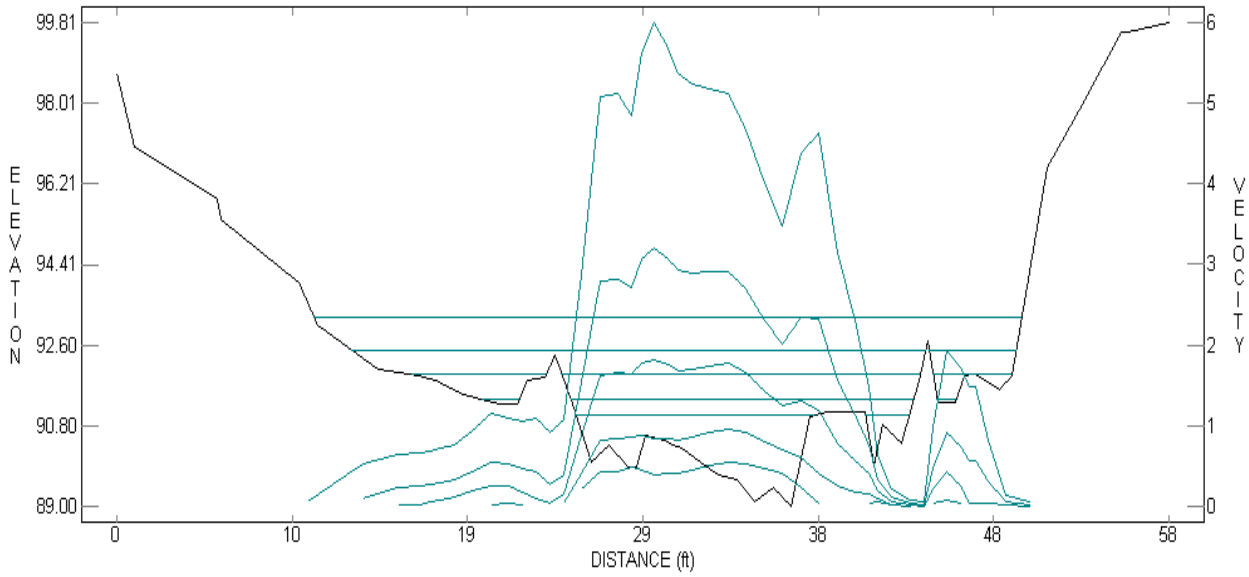

Figure A-13. Cross section for Transect 05 (Pool Tail).

Figure A-14. Transect 05-Looking from the right bank to the left bank at mid flow.

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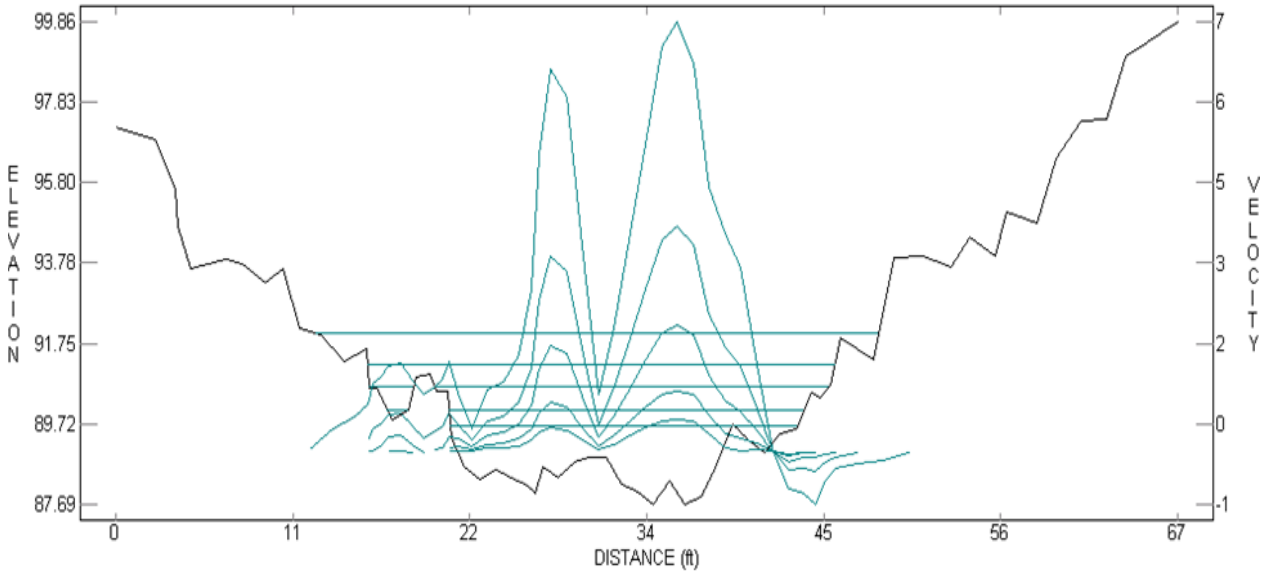

Figure A-15. Cross section for Transect 04 (Pocket Water)

Figure A-16. Transect 04-Looking from right bank to left bank at low flow.

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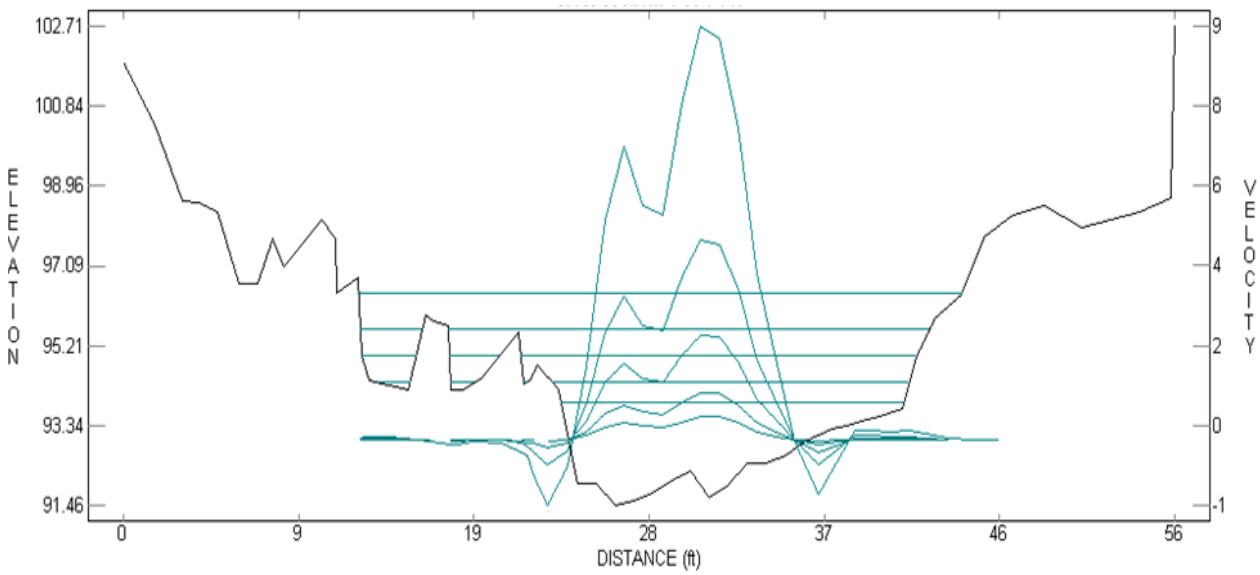

Figure A-17. Cross section for Transect 03 (Pool Head).

Figure A-18. Transect 03-Looking from left bank to right at mid flow.

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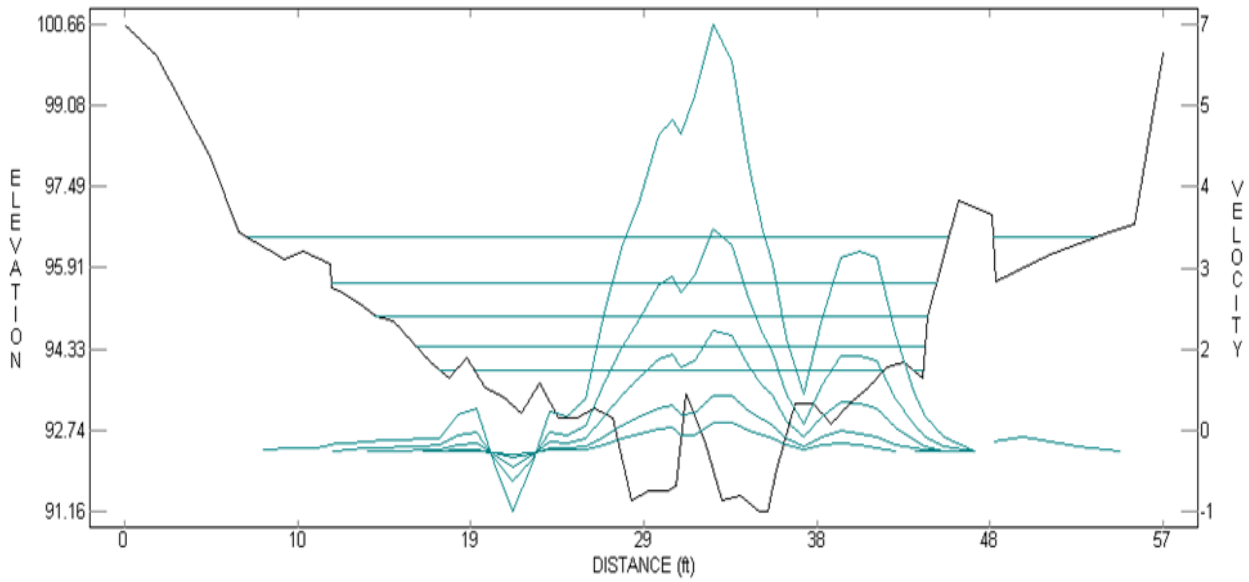

Figure A-19. Cross section for Transect 02 (Pool Belly).

Figure A-20. Transect 02-Looking from left bank to right bank at mid flow.

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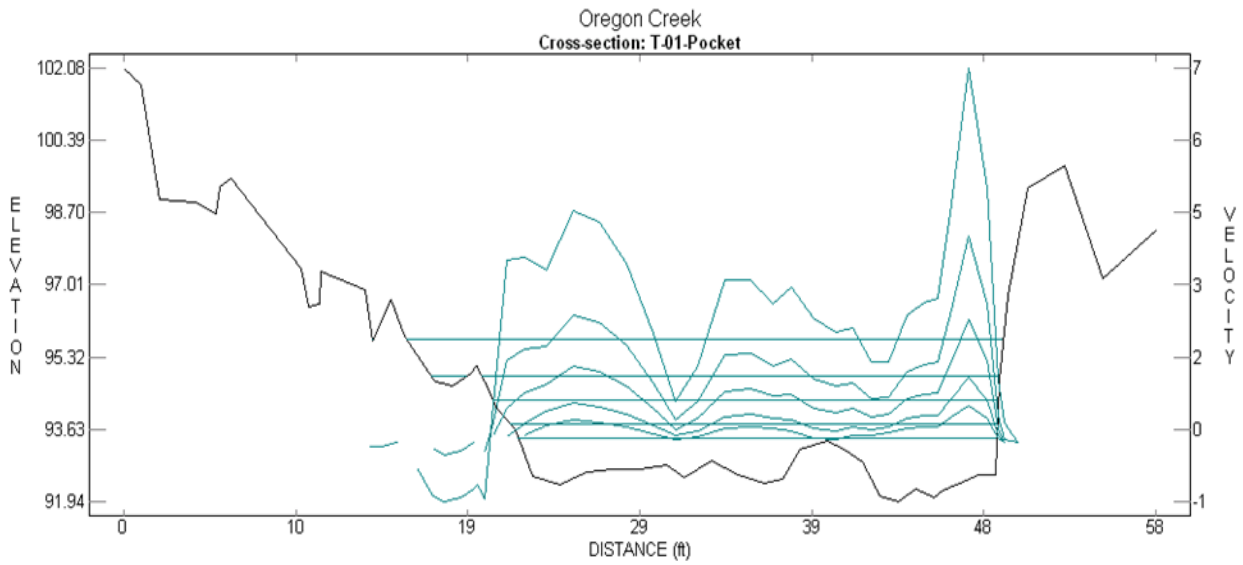

Figure A-21. Cross section for Transect 01 (Pocket Water)

Figure A-22. Transect 01-Looking from left bank to right bank at low flow.

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Appendix B
Lower Log Cabin Site Water Surface Elevation Comparison Tables

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Table B-1. Measured and Modeled WSEs (Q in cfs, all other values in ft).

Transect		1		Transect		2		Transect		3	
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
17	**93.77**	93.771	93.768	**17**	**94.37**	94.37	94.368	**17**	**94.34**	94.341	94.337
47	**94.33**	94.328	94.307	**47**	**94.98**	94.98	94.977	**47**	**94.98**	94.978	94.984
108	**94.89**	94.892	94.89	**108**	**95.61**	95.61	95.609	**108**	**95.61**	95.611	95.605
Transect		**4**		**Transect**		**5**		**Transect**		**6**	
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
17	**90.07**	90.072	90.068	**17**	**91.4**	91.401	91.398	**17**	**92.58**	92.581	92.579
47	**90.66**	90.656	90.648	**47**	**91.91**	91.908	91.948	**47**	**93.19**	93.185	93.145
108	**91.22**	91.223	91.22	**108**	**92.49**	92.492	92.487	**108**	**93.97**	93.975	93.964
Transect		**7**		**Transect**		**8**		**Transect**		**9**	
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
17	**96.09**	96.091	96.089	**17**	**95.4**	95.399	95.399	**17**	**89.94**	89.941	89.938
47	**96.66**	96.657	96.625	**47**	**95.92**	95.923	95.943	**47**	**90.54**	90.537	90.549
108	**97.38**	97.382	97.375	**108**	**96.55**	96.547	96.546	**108**	**91.13**	91.132	91.124
Transect		**10**		**Transect**		**11**					
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**				
17	**89.93**	89.93	89.924	**17**	**91.54**	91.539	91.538				
47	**90.54**	90.54	90.544	**47**	**91.98**	91.986	92.014				
108	**91.15**	91.15	91.143	**108**	**92.56**	92.555	92.556				

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Table B-2. Differences Between Measured and Modeled WSEs (Q in cfs, all other values in ft).

Transect		1		Transect		2		Transect		3	
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
17	**93.77**	-0.001	0.002	**17**	**94.37**	0	0.002	**17**	**94.34**	-0.001	0.003
47	**94.33**	0.002	0.023	**47**	**94.98**	0	0.003	**47**	**94.98**	0.002	-0.004
108	**94.89**	-0.002	0	**108**	**95.61**	0	0.001	**108**	**95.61**	-0.001	0.005
Transect		**4**		**Transect**		**5**		**Transect**		**6**	
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
17	**90.07**	-0.002	0.002	**17**	**91.4**	-0.001	0.002	**17**	**92.58**	-0.001	0.001
47	**90.66**	0.004	0.012	**47**	**91.91**	0.002	-0.038	**47**	**93.19**	0.005	0.045
108	**91.22**	-0.003	0	**108**	**92.49**	-0.002	0.003	**108**	**93.97**	-0.005	0.006
Transect		**7**		**Transect**		**8**		**Transect**		**9**	
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
17	**96.09**	-0.001	0.001	**17**	**95.4**	0.001	0.001	**17**	**89.94**	-0.001	0.002
47	**96.66**	0.003	0.035	**47**	**95.92**	-0.003	-0.023	**47**	**90.54**	0.003	-0.009
108	**97.38**	-0.002	0.005	**108**	**96.55**	0.003	0.004	**108**	**91.13**	-0.002	0.006
Transect		**10**		**Transect**		**11**					
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
17	**89.93**	0	0.006	**17**	**91.54**	0.001	0.002				
47	**90.54**	0	-0.004	**47**	**91.98**	-0.006	-0.034				
108	**91.15**	0	0.007	**108**	**92.56**	0.005	0.004				

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Appendix C
Model Calibration Notes

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T-01

- No changes.

T-02

- Station 30.5 to 34.0 - Adjusted N values to dampen velocity spike; based on adjacent cells.

T-03

- No changes

T-04

- Stations 27.0, 35.0, and 36.0 – Adjusted N values to dampen velocity spikes across the Thalweg.

T-05

- Stations 11.0 through 19.0 – Adjusted N values to increase flows across bedrock shelf to reflect empirical data gathered during high flow conditions.

T-06

- Station 17.5 – Adjusted N value to reduce velocity spike over shallow boulder during upward simulation.

T-07

- No change.

T-08

- Stations 98.5 through 100.5 – Adjusted N values to mimic increases modeled for the main channel during upward simulations.

T-09

- Stations 18.0 through 30.0, 32.0 through 34.0, and 40.0 through 60.5 – Vector corrected velocities were used in order to more accurately represent the given discharge reported at mid flow.

T-10

- An incomplete velocity set was collected at both high and low flows due to deep water and high velocities with entrained air from stations 16.0 – 39.0. Velocities were modeled using photographs and a mass balance target for the transect discharge.

T-11

- Station 38.5 – Adjusted a negative, low magnitude N value to a positive, high magnitude value to better represent the reduced intensity of a mid channel eddy during upward simulation.

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- Stations 49.0 and 50.0 – Adjusted N values to reduce velocity spikes during upward simulation.

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