Middle Yuba River
Oregon Creek Reach
Yellowjacket Creek Site
Draft Hydraulic Calibration Results

Model Used

The hydraulic model for the Yellowjacket Creek 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 files are associated with the Yellowjacket Creek site:

MYYJMAIN.RHB
MYYJ7L.RHB
MYYJ7R.RHB

Modeling Methods

Water Surface Elevations (WSE)

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 (5.0), 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, R.T., M.A. Updike, and D.M. Schneider 1989).

Modeling Guidelines

PHABSIM modeling guidelines considered for the Yellowjacket Creek 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; and

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4. There must be no more than a 0.1-foot difference between measured and simulated WSEs.
5. 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 -5.0 to 5.0. The first IFG4 criterion is not applicable to MANSQ.

Habitat Summary for Yellowjacket Creek Site

A hydraulic model was developed for the seven instream flow transects on the Yellowjacket Creek Site on the Middle Yuba River. The left and right channels of Transect 7 (T-07) were modeled as two independent transects. Meso-habitats represented in the Oregon Creek Reach are presented in Table 1. The Yellowjacket Creek Site was one of the two sites within the Oregon Creek Reach. Final transect locations are presented in Figure 1.

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

PHABSIM Habitat	Number	Number Frequency	Adjusted Number Frequency	Potential # Target Transects
High gradient riffles	26	15%	16%	3
Low gradient riffles	23	13%	14%	2
Runs/Step-Runs	26	15%	16%	3
Glides	4	2%	0%	0
Pocket Water	13	8%	8%	2
Pools	79	46%	47%	8
Total	**171**	**100%**	**100%**	**18**[1]

[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 Oregon Creek Reach, which includes both the Moonshine Creek Site and the Yellowjacket Creek Site.

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Figure 1. PHABSIM transects in the Yellowjacket Creek Site of the Oregon Creek Reach on the Middle Yuba River.

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Calibration Summary for Yellowjacket Creek Site

The Yellowjacket model was associated with a four stage discharge pairs, and primary velocity calibration set at full channel flow of 345 cubic feet per second (cfs). When velocities couldn't be safely measured at 345 cfs, they were measured at 178 cfs. Each transect in the site had one velocity set measured, which is consistent with the "one-velocity" method.

Transect 07 was split into two separate models because it was located across a vegetated cobble bar. To accurately model the full river flow, a flow partitioning assessment analysis was conducted. A mid flow velocity set was used for both sides of T-07, with the flow split 34 cfs for the left channel (T-07L) and 126.3 cfs for the right channel (T-07R).

Stage/discharge regressions for T-01 through T-06 were developed using the four calibration discharges: 345 cfs, 178 cfs, 125 cfs and 31 cfs. Stage/discharge regressions for T-07L and T-07R were developed using four calibration flows for each: 76.1 cfs, 34.0 cfs, 25.5 cfs, and 6.1 cfs; and 268.9 cfs, 126.3 cfs, 99.5 cfs, 25.2 cfs.

Table 2 summarizes modeling statistics for each transect and modeling method, while Tables B-1 and 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. Table B-3 provides the velocity adjustment factor (VAF) for each calibration flow on each transect.

Cross Sections

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

Calibration Details for Yellowjacket Creek 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 T-04, T-05 and T-07L, based on the modeling guidelines outlined above.
- All Log/Log betas were between 2.0 and 4.5 except 2: T-07L and T-07R.
- All transects had MANSQ betas inside the range of -5.0 to 5.0.
- All MANSQ mean errors were less than 7 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.

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- Six of the eight calculated discharges were within 5 percent of given discharges.
  - T-05 was within 11 percent.
  - T-06 was within 16 percent.

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

	T-07L	T-07R	T-06	T-05
Log/Log	4.6176	0.579	0.1829	0.3612
MANSQ	1.7768	1.5129	5.5915	2.3275
MANSQ BETA	0.6635	0.3771	0.6307	0.4977
	T-04	**T-03**	**T-02**	**T-01**
Log/Log	0.3517	4.6135	2.6294	0.4881
MANSQ	0.3963	6.4797	2.8582	2.0573
MANSQ BETA	0.3745	0.731	0.6831	0.6576

Velocity Calibration

All transect velocity measurements were collected at the highest target flow possible for that transect. Limiting physical parameters included deep swift water to 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 through T-03, and T-05.
  - Mid Flow: T-04, T-06, T-07L, and T-07R.

Table 3 provides 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). These velocity adjustments are used to prevent the model from over or under estimating the discharge at flows other than the velocity calibration discharge. Graphical representations of this can be found in Figure 2, Figure 3, and Figure 4.

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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**
92.8	12.52	111.27	0.1125	94.6	12.52	124.52	0.1005	93.33	12.52	148.04	0.0846
93.31	31.3	146.1	0.2142	94.84	31.3	159.22	0.1966	93.71	31.3	179.55	0.1743
94.32	125	229.86	0.5438	95.37	125	245.34	0.5095	94.51	125	258.37	0.4838
94.61	172	257.15	0.6689	95.53	172	273.74	0.6283	94.75	172	284.47	0.6046
95.3	345	331.83	1.0397	95.93	345	351.61	0.9812	95.34	345	359.94	0.9585
96.41	**862.5**	**479.88**	**1.7973**	**96.6**	**862.5**	**499.75**	**1.7259**	**96.33**	**862.5**	**540.63**	**1.5953**
Transect	**4**			**Transect**	**5**			**Transect**	**6**		
WSL	**Calibration Flow**	**Calculated Flow**	**VAF**	**WSL**	**Calibration Flow**	**Calculated Flow**	**VAF**	**WSL**	**Calibration Flow**	**Calculated Flow**	**VAF**
94.37	12.52	35.08	0.3569	96.42	12.52	62.93	0.199	90.8	12.52	73.99	0.1692
94.72	31.3	60.27	0.5194	96.8	31.3	96.97	0.3228	91.17	31.3	98.42	0.318
95.4	125	134.39	0.9301	97.53	125	188.05	0.6647	92.04	125	171.74	0.7279
95.6	172	162.38	1.0593	97.72	172	221.43	0.7768	92.32	172	199.58	0.8618
96.08	345	246.57	1.3992	98.16	345	320.74	1.0756	93.06	345	285.88	1.2068
96.88	862.5	427.91	2.0156	98.81	862.5	516.45	1.6701	94.39	862.5	493.96	1.7461
Transect	**7L**			**Transect**	**7R**						
WSL	**Calibration Flow**	**Calculated Flow**	**VAF**	**WSL**	**Calibration Flow**	**Calculated Flow**	**VAF**				
96.09	2.44	18.77	0.13	93.26	10.08	17.11	0.589				
96.52	6.1	23.79	0.2564	93.55	25.2	36.77	0.6854				
97.28	25.5	34.01	0.7497	94.09	99.5	110.98	0.8966				
97.45	34	36.57	0.9298	94.2	126.3	130.99	0.9642				
97.97	76.1	44.81	1.6984	94.59	268.9	216.59	1.2415				
98.65	190.25	56.65	3.3582	95.14	672.25	381.87	1.7604				

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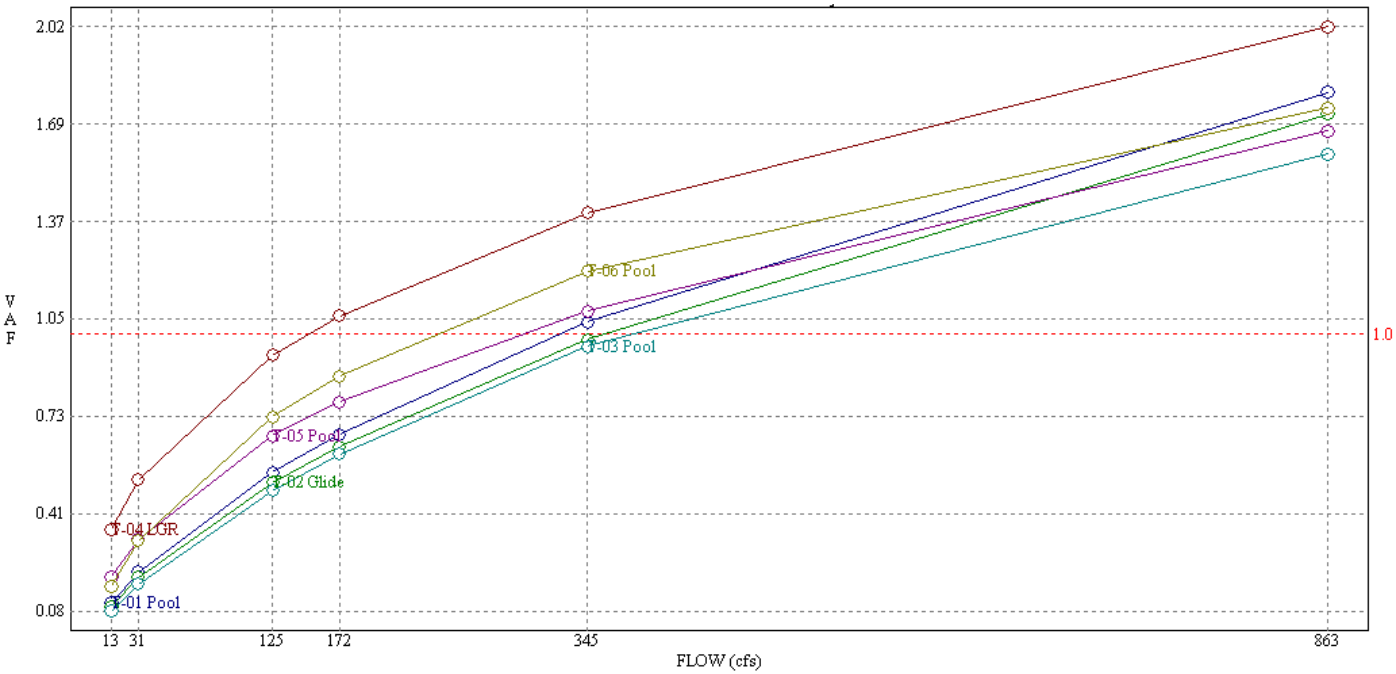

Figure 2. VAF by flow (T-01 to T-06).

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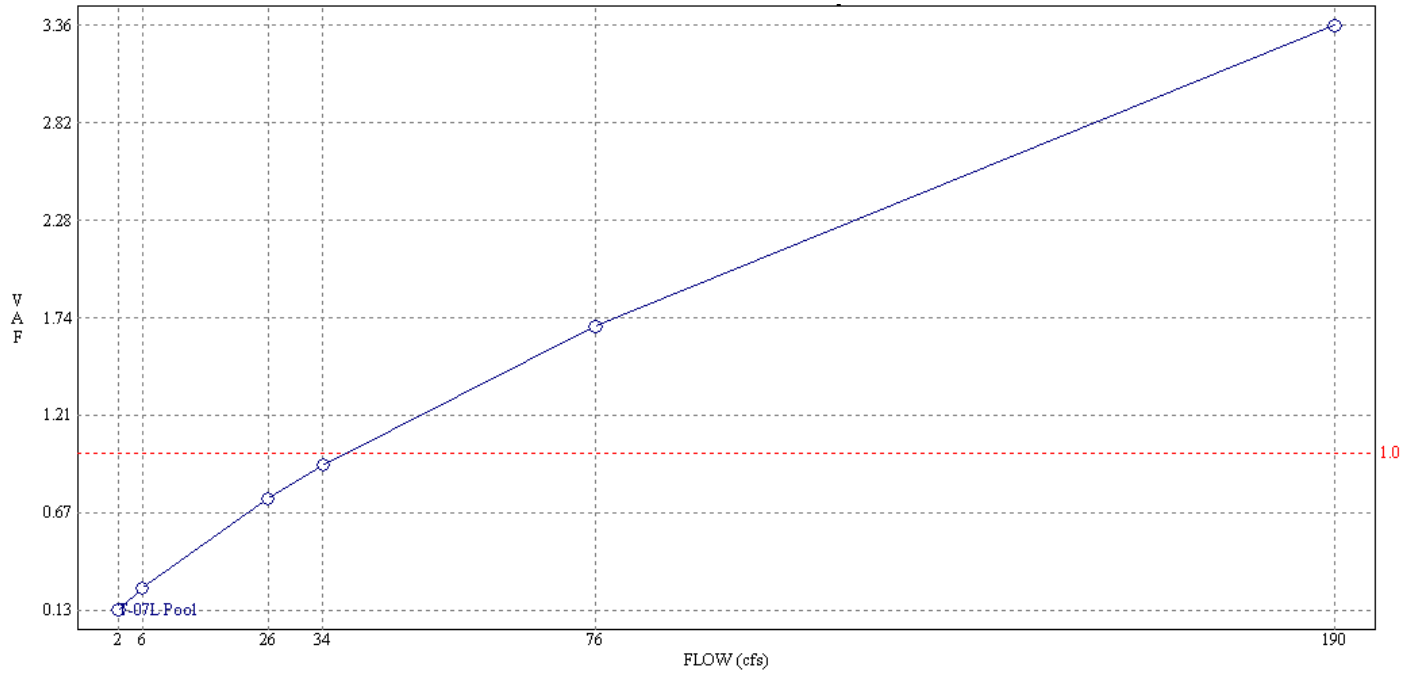

Figure 3. VAF by flow (T-07L).

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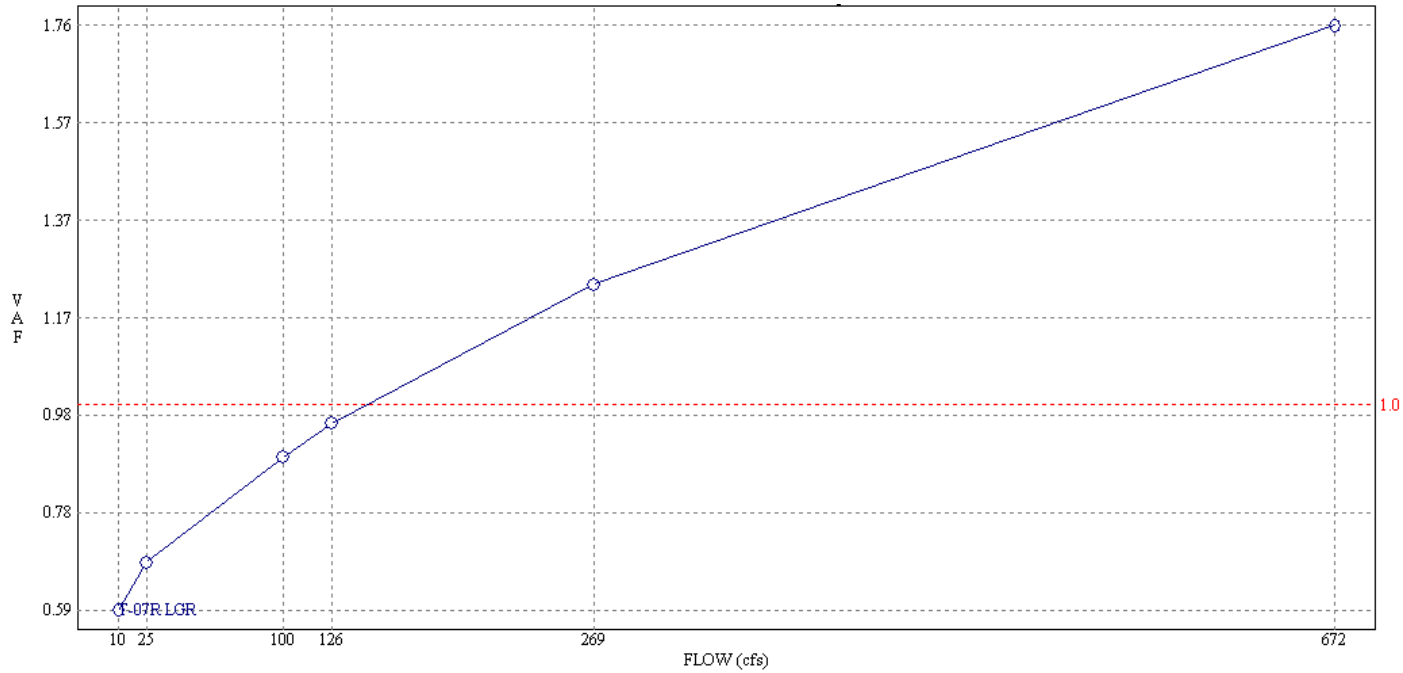

Figure 4. VAF by flow (T-07R).

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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 4.

Table 4. Target and measured flows for the Yellowjacket Creek Site.

Transect	Type	Discharge							
		Low Low Flow - Target 50 cfs		Low - Target 50 cfs		Mid - Target 115 cfs		High - Target 300 cfs	
		Measured (cfs)	Measurement Method	Measured (cfs)	Measurement Method	Measured (cfs)	Measurement Method	Measured (cfs)	Measurement Method
1	Pool	--	--	--	--	--	--	327	ADCP/ Swoofer
2	Glide	31	Swoffer	--	--	--	--	353	ADCP/ Swoofer
		31	Swoffer	--	--	--	--		
3	Pool	--	--	--	--	--	--	357	ADCP/ Swoofer
4	Low gradient riffle	--	--	--	--	166	Swoffer	--	--
5	Pool	--	--	--	--	--	--	296	ADCP/ Swoofer
6	Pool	--	--	--	--	191	ADCP/ Swoofer	--	--
7 RBA	HGR	--	--	--	--	126	ADCP/ Swoofer	--	--
7 LBA	Pool	--	--	--	--	34	Swoffer	--	--
Q1	Near T-02	--	--	125	Swoffer	--	--	--	--
Q2	Near T-02	--	--	128	Swoffer	--	--	--	--
Q3	Near T-02	--	--	122	Swoffer	--	--	--	--
Given Flow Averages using best transects		**31**	T-02 and T-02	**125**	(Q1, Q2, Q3)	**178**	(T-04, T-06)	**345**	(T-01, T-02, T-03)

Flow Partitioning for Transect 07

Once it was determined that the left and right channels of T-07 should be modeled independently of each other, partitioning of the full-reach discharge into the split-channel component flows was required. These are shown in Table 5 below. Since a full discharge measurement for both channels was only completed during one flow, alternative methods for determining the split-flow components were used at the other discharges. During High Flow, discharge was measured on the left channel but not the right channel, so the left channel discharge was subtracted from the reach average estimated total flow. The percentages of split-channel discharge versus total discharge were calculated for High and Mid Flow. A best fit line was generated for split percentages of each channel, and was used to extrapolate down to Low and Low Low Flow. These extrapolated split percentages were then applied to the reach average total discharges to

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calculate split discharges for those two flows. Since there were only two measured points used to generate the best fit line, the R-squared value was 1.0.

Table 5. T-07 flow partitioning.

	T-07 L (cfs)	T-07 R (cfs)	Total Channel Flow (cfs)	Left Channel % of Flow	Right Channel % of Flow
High Flow[1]	76.1	268.9	345.0	22.06%	77.94%
Mid Flow[2]	34.0	126.3	160.4	21.22%	78.78%
Low Flow[3,4]	25.5	99.5	125.0	20.38%	79.62%
Low Low Flow[3,4]	6.1	25.2	31.3	19.54%	80.46%

[1] T-07R cfs value calculated by subtracting left channel discharge from estimated Total Channel Flow
[2] Total Channel flow was calculated as the sum of left and right channels, rather than reach average discharge for all transects.
[3] Both split channel cfs values based on applying percentage values to the reach estimated Total Channel Flow.
[4] LF and LLF percentages based on linear trend line from HF and MF percentages

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
Yellowjacket Creek Site Cross Sectional Profiles and Photos

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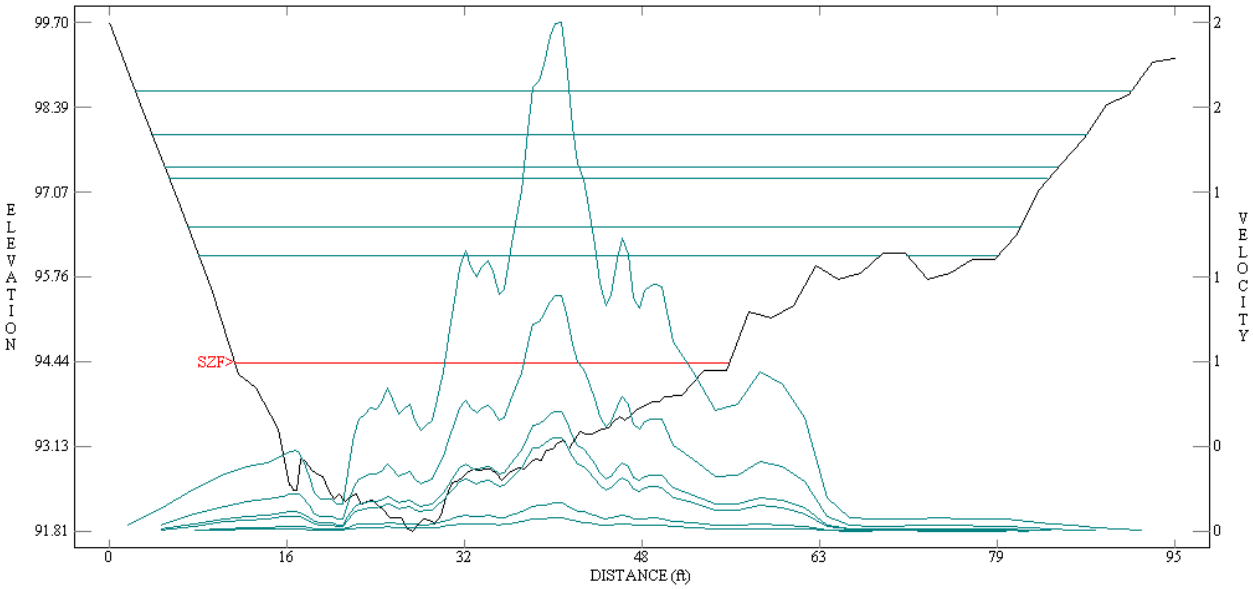

Figure A-1. Cross section for Transect 07L (Pool).

Figure A-2. Transect 07L-Looking upstream to left ascending channel at mid flow.

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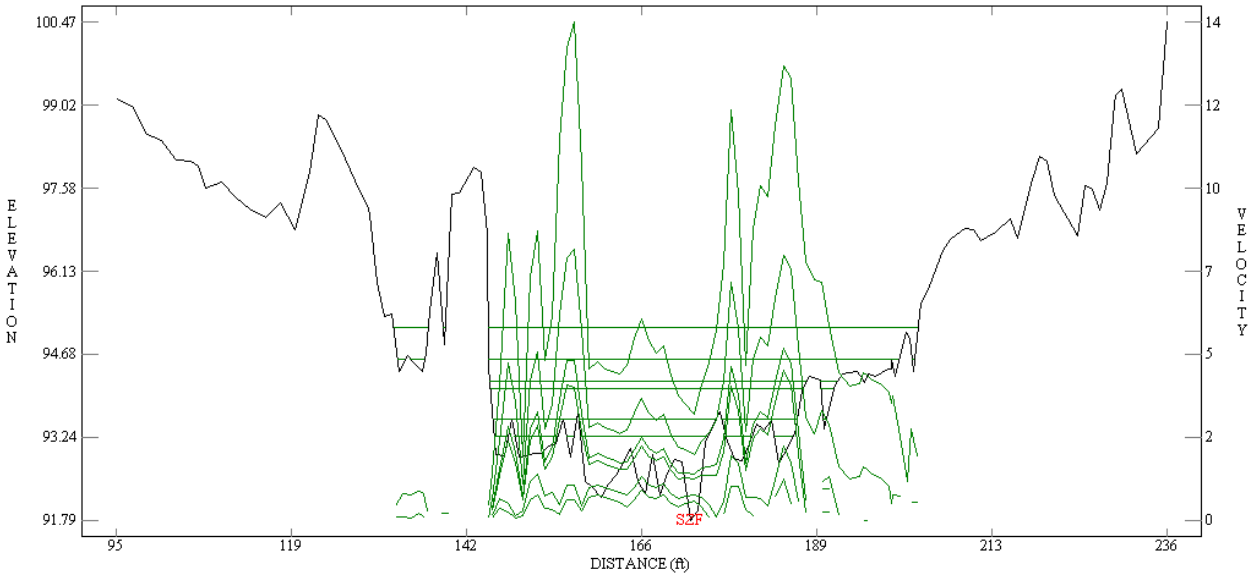

Figure A-3. Cross section for Transect 07R (High Gradient Riffle).

Figure A-4. Transect 07R-Looking from right bank to left bank at mid flow.

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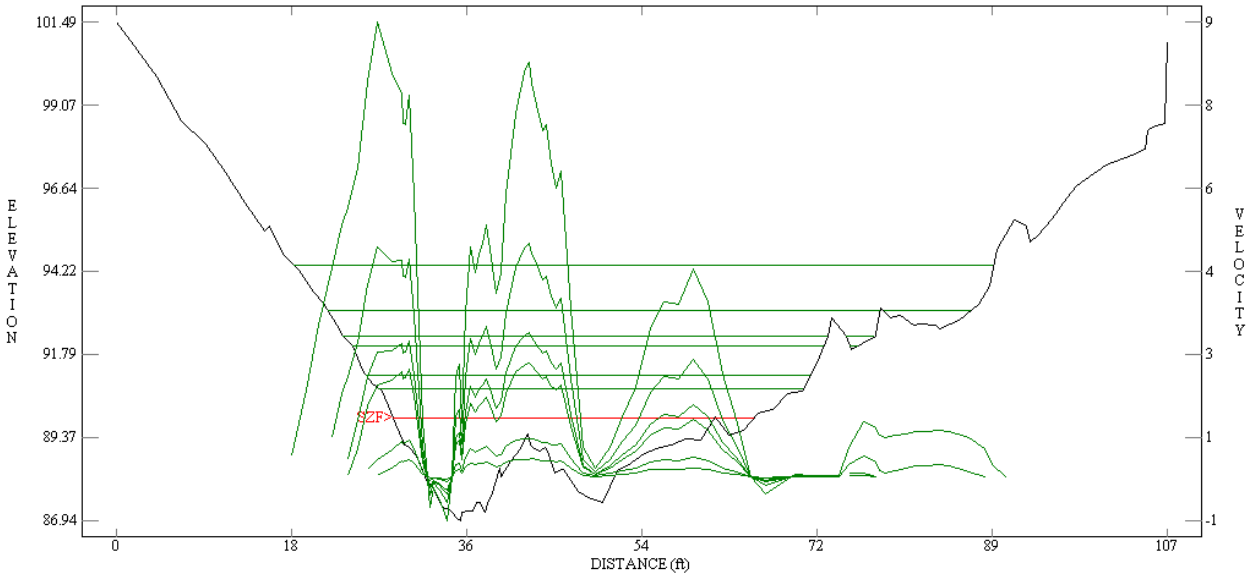

Figure A-5. Cross section for Transect 06 (Pool Head).

Figure A-6. Transect 06-Looking from right bank to left bank at mid flow.

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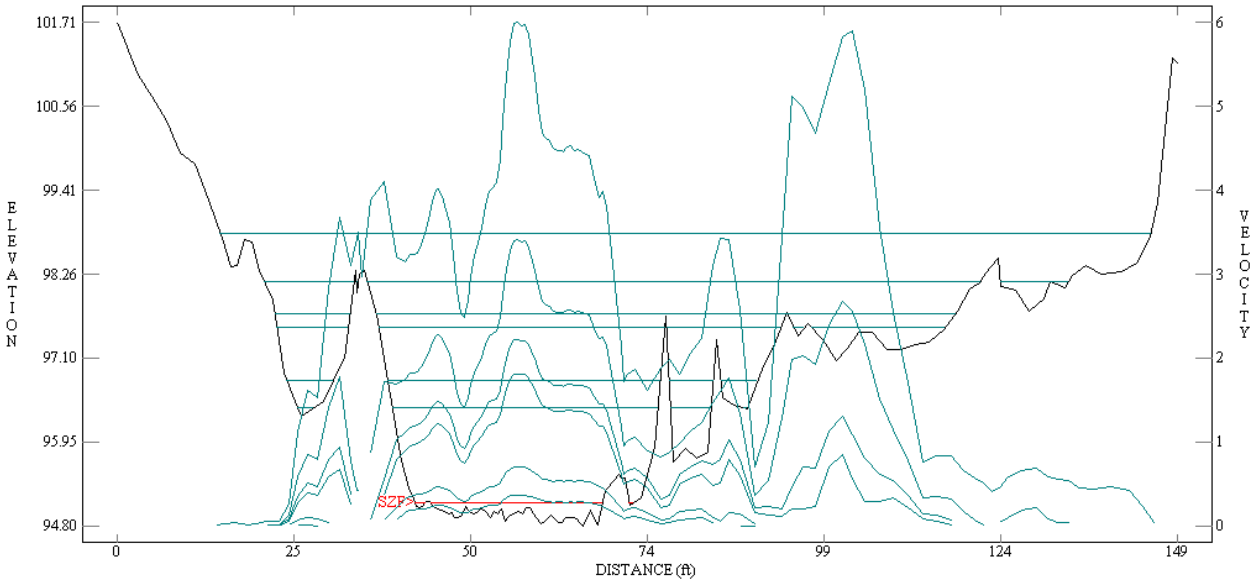

Figure A-7. Cross section for Transect 05 (Pool Tail).

Figure A-8. Transect 05-Looking downstream to whole transect at mid flow.

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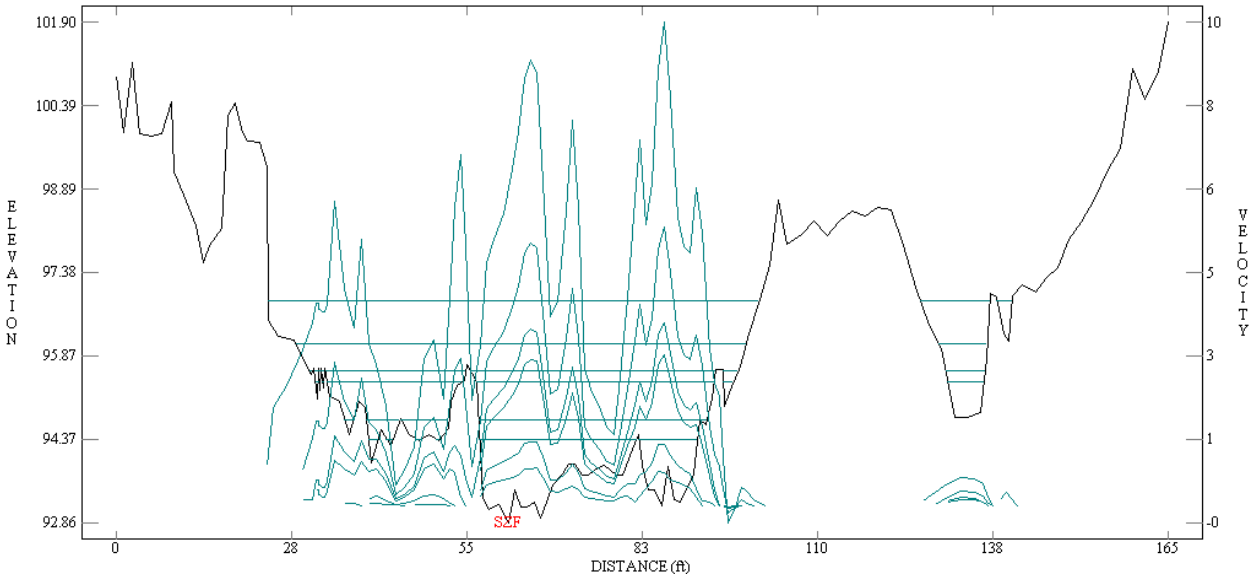

Figure A-9. Cross section for Transect 04 (Low Gradient Riffle).

Figure A-10. Transect 04-Looking from left bank to right bank at low flow.

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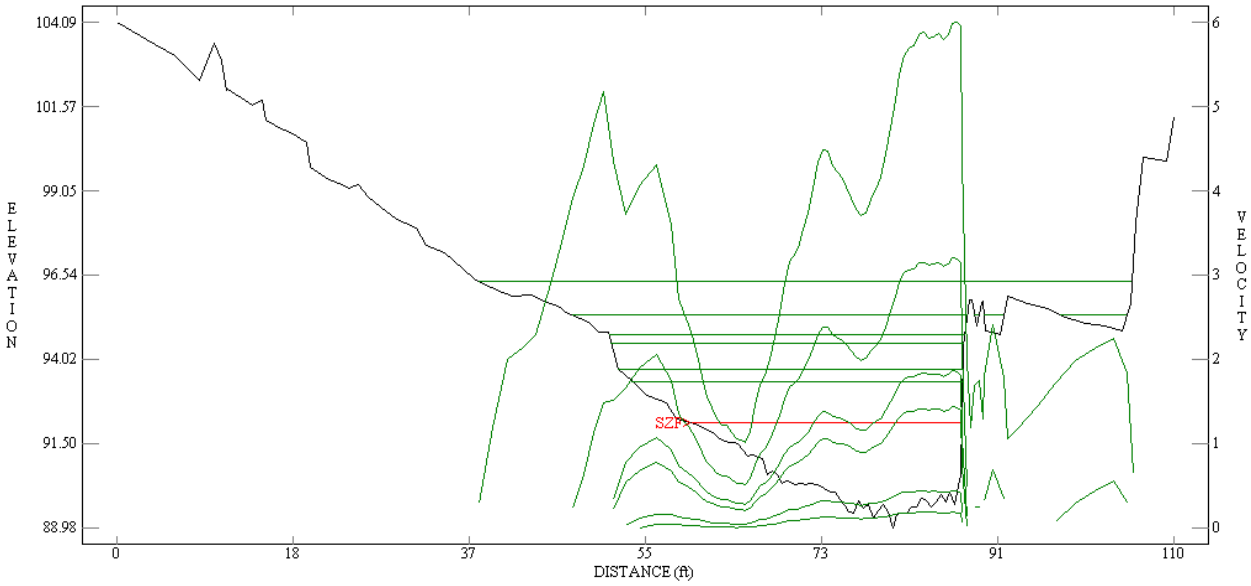

Figure A-11. Cross section for Transect 03 (Pool Belly).

Figure A-12. Transect 03-Looking from left bank to right bank at mid flow.

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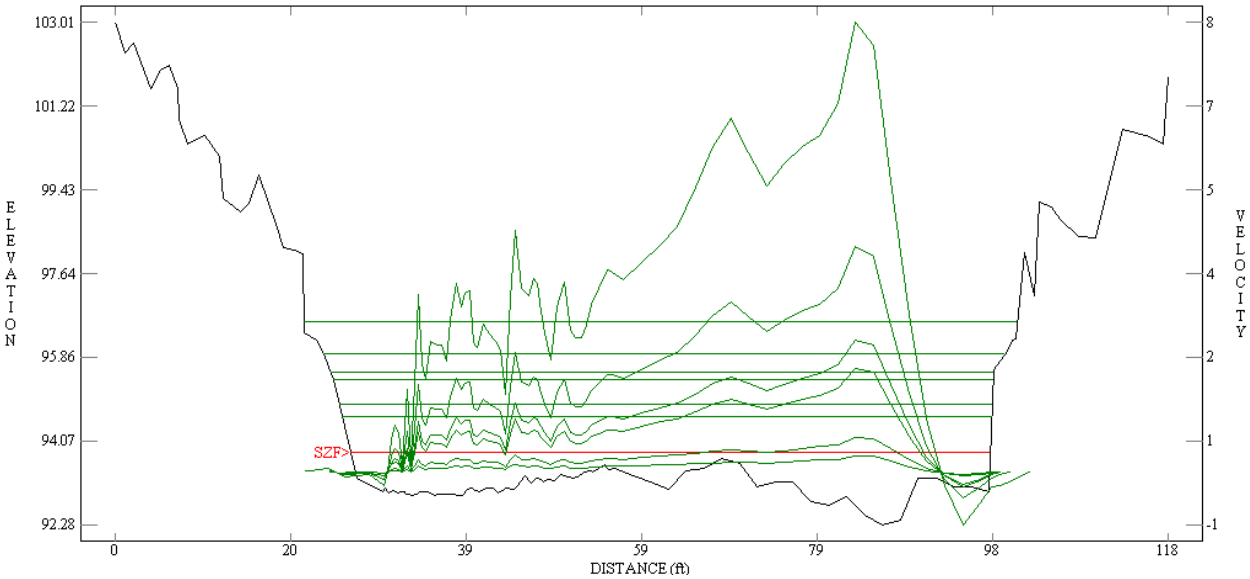

Figure A-13. Cross section for Transect 02 (Glide).

Figure A-14. Transect 02-Looking from left bank to right bank at low flow.

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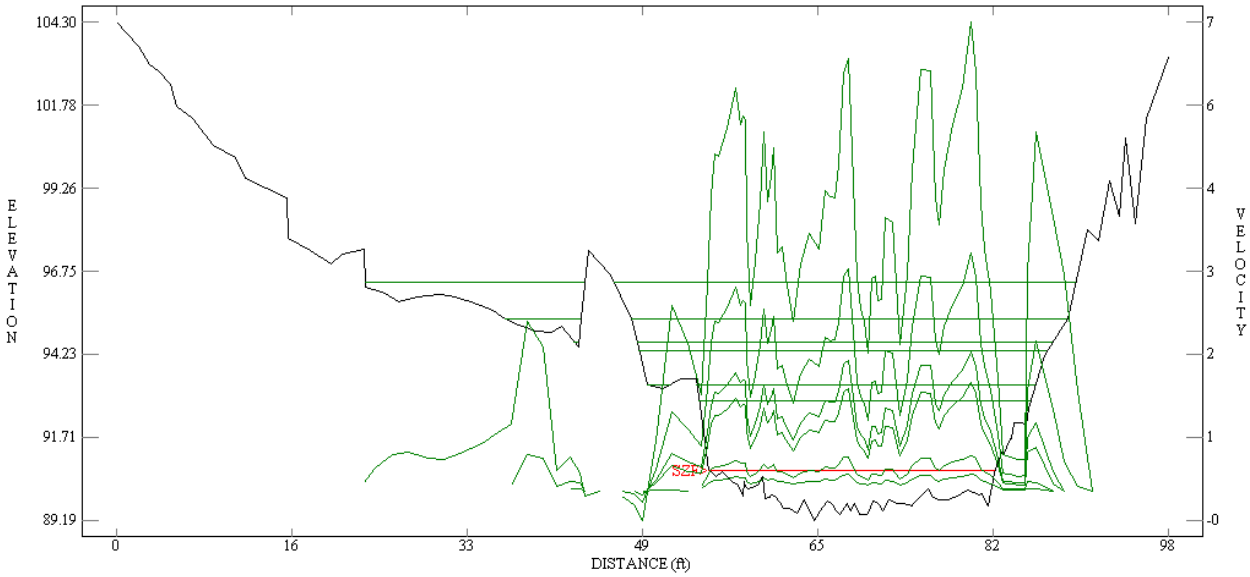

Figure A-15. Cross section for Transect 01 (Pool Belly).

Figure A-16. Transect 01-Looking downstream to whole transect at mid flow.

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Appendix B
Yellowjacket Creek Site Water Surface Elevation Comparison Tables

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

Transect		1		Transect		2		Transect		3		Transect		4	
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
31	**93.31**	93.31	93.31	**95**	**94.84**	94.85	94.84	**31**	**93.73**	93.71	93.73	**31**	**94.72**	94.72	94.72
125	**94.33**	94.32	94.36	**95**	**95.37**	95.38	95.37	**125**	**94.46**	94.51	94.52	**125**	**95.41**	95.41	95.4
172	**94.6**	94.61	94.64	**96**	**95.53**	95.53	95.53	**172**	**94.73**	94.75	94.72	**172**	**95.6**	95.6	95.6
345	**95.3**	95.3	95.29	**96**	**95.93**	95.88	95.93	**345**	**95.39**	95.34	95.21	**345**	**96.08**	96.08	96.08
Transect		**5**		**Transect**		**6**		**Transect**		**7L**		**Transect**		**7R**	
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
31	**96.8**	96.8	96.8	**31**	**91.17**	91.17	91.17	**6**	**96.53**	96.54	96.52	**25**	**93.55**	93.55	93.56
125	**97.52**	97.52	97.53	**125**	**92.04**	92.04	92.07	**26**	**97.28**	97.27	97.28	**100**	**94.09**	94.09	94.09
172	**97.72**	97.72	97.72	**172**	**92.32**	92.32	92.31	**34**	**97.5**	97.45	97.45	**126**	**94.21**	94.2	94.2
345	**98.24**	98.24	98.16	**345**	**93.06**	93.06	92.89	**76**	**97.96**	98	97.97	**269**	**94.59**	94.59	94.63

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

Transect		1		Transect		2		Transect		3		Transect		4	
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
31	**93.31**	0.00	0.00	**95**	**94.84**	0.01	0.00	**31**	**93.73**	-0.02	0.00	**31**	**94.72**	0.00	0.00
125	**94.33**	-0.01	0.03	**95**	**95.37**	0.01	0.00	**125**	**94.46**	0.05	0.06	**125**	**95.41**	0.00	-0.01
172	**94.6**	0.01	0.04	**96**	**95.53**	0.00	0.00	**172**	**94.73**	0.02	-0.01	**172**	**95.6**	0.00	0.00
345	**95.3**	0.00	-0.01	**96**	**95.93**	-0.05	0.00	**345**	**95.39**	-0.05	-0.18	**345**	**96.08**	0.00	0.00
Transect		**5**		**Transect**		**6**		**Transect**		**7L**		**Transect**		**7R**	
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
31	**96.8**	0.00	0.00	**31**	**91.17**	0.00	0.00	**6**	**96.53**	0.01	-0.01	**25**	**93.55**	0.00	0.01
125	**97.52**	0.00	0.01	**125**	**92.04**	0.00	0.03	**26**	**97.28**	-0.01	0.00	**100**	**94.09**	0.00	0.00
172	**97.72**	0.00	0.00	**172**	**92.32**	0.00	-0.01	**34**	**97.5**	-0.05	-0.05	**126**	**94.21**	-0.01	-0.01
345	**98.24**	0.00	-0.08	**345**	**93.06**	0.00	-0.17	**76**	**97.96**	0.04	0.01	**269**	**94.59**	0.00	0.04

[1] Discharge

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Appendix C
Model Calibration Notes

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T-01

- Stations 86.5 and 88.0 – Raised N value slightly to reduce velocity spike on margin.

T-02

- Station 30.29 – Reduced N value to reduce negative velocity; based on adjacent cell value.

T-03

- Stations 49.00 to 52.00 and 59.00 – Raised N values to reduce velocity spike on margin; based on adjacent cells.

T-04

- Stations 52.00 to 56.50 – Raised N values to decrease velocity spikes; based on nearby cells.
- Stations 64.50 and 65.50 – Raised N values to decrease a velocity spike; based on adjacent cells.
- Station 86.50 – Raised N value to decrease a velocity spike.
- Station 97.70 – Modified N value to positive for very small side channel.
- At high flow, side channel on right side of transect had water in it, but is heavily vegetated and water was barely moving.

T-05

- Station 95.3 and 98.80 – Adjusted N values to decrease velocity spikes, including a negative velocity spike that was at 98.80; based on adjacent cells.

T-06

- Station 24.10 and 25.10 – Raised N values to decrease velocity spike on margin; based on cell adjacent to 24.10.
- Station 75.10 - Raised N to reduce velocity pattern on right bank. Bank is lightly vegetated.

T-07L

- Assigned a SZF of 94.42. No SZF was collected for this side of the Transect 07 split, so the SZF used was the SZF that generated a HF plotting stage similar to the average HF plotting stage of the other four pools in this reach.
- Stations 49.00 and 49.50 – Increased N values to reduce velocity spike; based on nearby values.

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T-07R

- Stations 161, 162, 165 through 168, 171, and 173 – Adjusted N values to decrease velocity trough; based on adjacent cells.
- Stations 175, 176, and 187 – Adjusted N values to dampen velocity spikes; based on adjacent cells.

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