Yuba River
Yuba River Upstream of New Colgate Powerhouse Reach
Draft Hydraulic Calibration Results

Model Used

The hydraulic model for the Yuba River upstream of the New Colgate Powerhouse Reach 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 Yuba River Upstream of New Colgate Powerhouse Reach:

USCOLG.RHB

Modeling Methods

Water Surface Elevations (WSE)

Hydraulic modeling procedures appropriate to the study site and level of data collection were used for modeling WSEs and velocities across each of the 16 cross sections comprising the study reach. For WSEs, these procedures included the development of stage-discharge rating curves using Log/Log regression (IFG4) and Manning's formula (MANSQ), direct comparison of results, and selection of the most appropriate and accurate method. Data file construction, calibration, and simulation followed standard procedures and guidelines outlined in Milhous et al. 1989 and Waddle 2001.

Modeling Guidelines

PHABSIM modeling guidelines considered for the reach were as follows:

- To determine whether the IFG4 model accurately predicts measured values:
  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
  4. There must be no more than a 0.1-foot difference between measured and simulated WSEs.

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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 0.0 to 0.5. The first IFG4 criterion is not applicable to MANSQ.

Habitat Summary for Yuba River above New Colgate Powerhouse Reach

A hydraulic model was developed for the 16 Instream flow transects on the Yuba River above New Colgate Powerhouse Reach. Meso-habitats represented in this reach are presented in Table 1. Final transect locations are presented in Figure 1.

Table 1. Habitat frequency based on video-mapped data and target transects for the Yuba River above New Colgate Powerhouse Reach.

PHABSIM Habitat	Number	Number Frequency	Potential # Target Transects
High gradient riffles	0	0%	0
Low gradient riffles	4	16%	3
Runs/Step-Runs	6	24%	4
Glides	4	16%	3
Pocket Water	0	0%	0
Pools	11	44%	7
Total	**25**	**100%**	**17**[1]

[1] The transect target is based on meso-habitat, but does not take into account of differences between meso-habitats. While the target number is the baseline goal, additional transects were selected to more accurately represent the variability within the reach.

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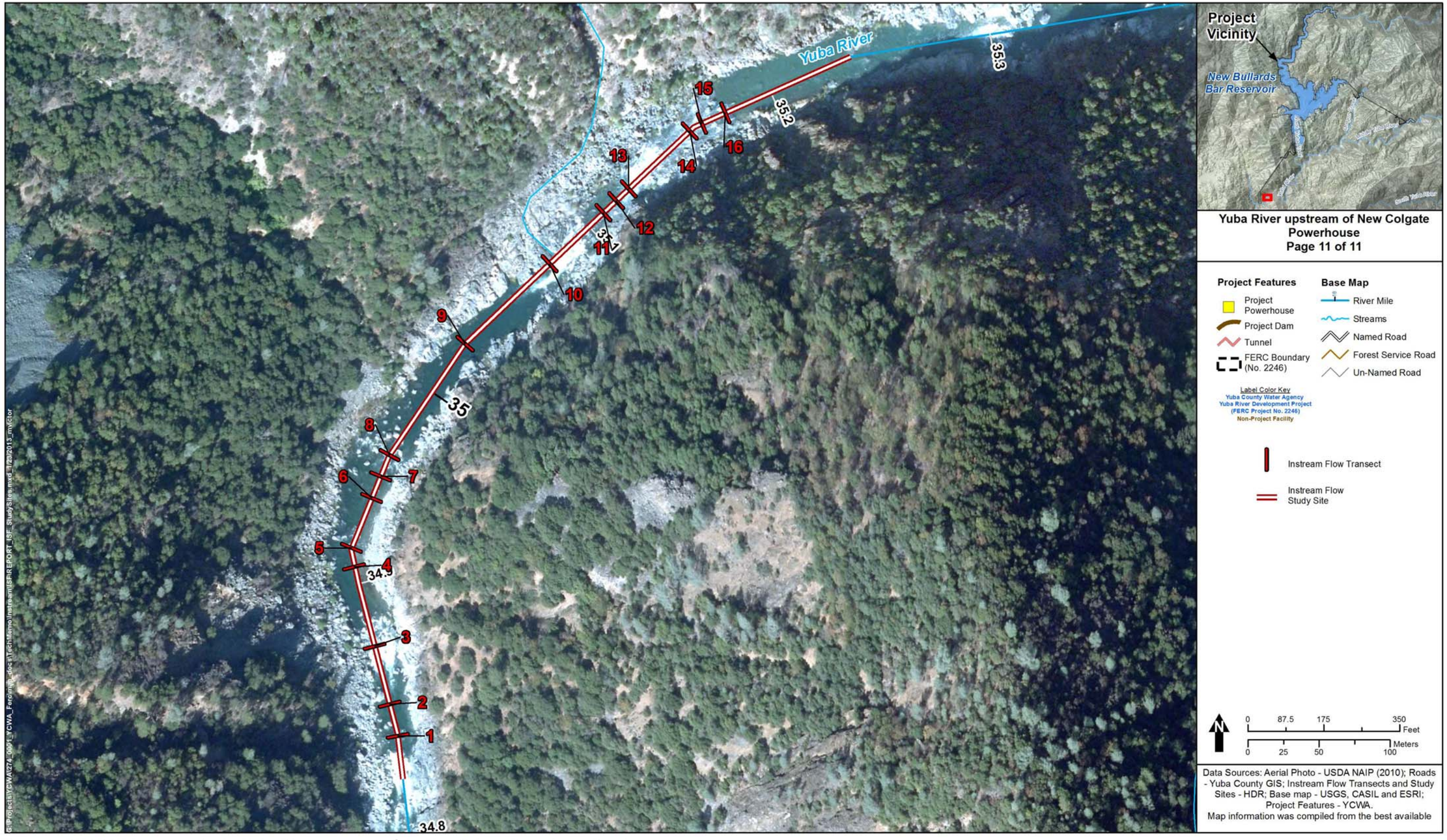

Figure 1. PHABSIM transects in the Yuba River upstream of the New Colgate Powerhouse Reach.

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Calibration Summary for Yuba River upstream of New Colgate Powerhouse Reach

The model was associated with a four or five stage discharge pairs, and primary velocity calibration set of 421 cubic feet per second (cfs). When velocities couldn't be safely measured at 421 cfs, they were measured at 93 cfs. Each transect had one velocity set measured, which is consistent with the "one-velocity" method. Stage for the high flow (717 cfs) and high high flow (1197 cfs) events were calculated using data obtained from water level recorder pressure transducers placed on all 16 transects.

Stage/discharge regressions were developed using five main channel calibration discharges: 1197 cfs, 717 cfs, 421 cfs, 93 cfs, and 40 cfs. Table 2 summarizes modeling statistics for each transect and modeling method, while Table C-1, in Appendix C, summarize the given calibration stage and the modeled stages for each flow, at each transect, using all modeling methods used on a given transect.

Additionally, several transects required piecewise regressions to accurately represent the stage discharge relationship. Piecewise modeling in the PHABSIM context means that two rating curves are developed for the range of flows modeled. In this case, due to dramatic non-linear topographic changes (e.g. broadening or narrowing) within a cross section, it was appropriate to group calibration discharges into low and high flow groups and independently model each group. For example, this technique allows the models to more accurately predict stage at a cross section that is deeply incised at the thalweg but widens and flattens at the margins, or visa-versa. This modeling method was utilized for Transects T-01, T-07 to T-10, T-15, and T-16.

Cross Sections

One limitation of 1D hydraulic flow models is that a single water surface must be used for the entirety of each transect at a given flow. When a transect involves more than one significantly different water surface, RHABSIM will over- or underwater parts of the transect, depending on what water surface elevation is used. In order to create the most realistic representation of wetted area and water depths, two transects had part of their bed shifted. Transect T-03 had WSEs on the right bank that were approximately 0.75 feet lower than those on the left bank. In order to accurately model water depths, bed elevations between station 50 and 68 were raised by 0.75 feet, and bed elevations beyond station 68 raised 0.78 feet. The average WSE from the left bank measurements was then utilized for each flow.

Cross sectional profiles with measured WSEs have been included in Appendix A. Detailed notes describing model calibration for each transect have been included in Appendix B.

Calibration Details for Yuba River Upstream of New Colgate Powerhouse Reach

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.

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- The water surface longitudinal profile, cross-sectional geometry and a realistic rating curve fit were considered when choosing the primary modeling method.
- Log/Log was selected as the primary model on T-01 H, T-02 to T-07 H, T-08 H, T-09 H, T-10 H, T-11 to T-13, T-15 H and T-16 H, because of lower mean errors with this method.
- MANSQ was selected as the primary calibration method on T-01 L, T-07 L, T-08 L, T-09 L, T-10 L, T-15 L, and T-16 L, because only two calibration discharges were utilized.
- MANSQ was selected as the primary calibration method for T-14 because of lower mean error with this method.
- All transects had Log/Log betas between 2.10 and 3.89. This does not include the portions of the piecewise regression transects with only two calibration points.
  - The lower portions of the piecewise regression transects had Log/Log betas that ranged from 1.98 to 4.68. All were modeled using MANSQ.
- All but three transects had MANSQ betas inside the range of 0.0 to 0.5.
  - T-10 H, T-10 L, and T-09 L were pools and had MANSQ betas that ranged from 0.52 to 0.75. Both transects were modeled using a Log/Log regression.
- Log/Log mean errors ranged from 0.18 to 5.61 percent, and the only transects not selected for Log/Log, other than T-14, were low flow portions of the piecewise regression transects.
- MANSQ mean errors ranged from 0.30 to 21.96 percent. The low flow portions of the piecewise regression transects selected for MANSQ had errors less than 0.66 percent. T-14 had a MANSQ mean error of 3.50 percent.
- Velocity measurements were modeled at the highest flow possible for each transects. Limiting physical parameters included deep swift water to deep to safely wade or deep water with entrained air which limited ADCP data collection.
  - Mid Flow (421 cfs): T-01, T-02, T-04 to T-09, T-11 to T-13, T-15, and T-16.
  - Low Flow (93 cfs): T-03, T-10, and T-14.
- All calculated discharges were within 18 percent of given discharges.
- Both MANSQ and Log/Log mean errors are provided in Table 2.
- Refer to Table C-1 and C-2 in the Appendix for a comparison of measured versus modeled WSEs.

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

	T-16 H	T-16 L	T-15 H	T-15 L	T-14	T-13	T-12	T-11	T-10 H	T-10 L	T-09 H	T-09 L
Log/Log	2.5571	0.0001	1.7835	0.0002	4.8399	0.6754	1.1580	1.1189	4.0439	0.0002	6.1043	0.0001
MANSQ	4.2863	0.4079	2.7668	0.2995	3.4923	9.3510	7.2547	5.8968	21.9584	0.6010	20.7696	0.6599
MANSQ BETA	0.2240	0.4180	0.2052	0.4642	0.4702	0.4458	0.4155	0.3856	0.5243	0.6995	0.4749	0.7523
	T-08 H	**T-08 L**	**T-07 H**	**T-07 L**	**T-06**	**T-05**	**T-04**	**T-03**	**T-02**	**T-01 H**	**T-01 L**	
Log/Log	1.8572	0.0001	0.1775	0.0001	3.8312	0.3342	0.6853	5.6079	3.9524	4.9864	0.0000	
MANSQ	5.3535	0.3329	1.0616	0.5251	5.8981	12.0511	11.2432	8.2990	8.1647	9.4852	0.5881	
MANSQ BETA	0.2858	0.2082	0.1526	0.2806	0.2654	0.4533	0.4318	0.1049	0.3997	0.2345	0.1772	

Velocity Calibration

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). 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 and Figure 3.

In the following tables and figures, only the higher calibration sets are considered (e.g. T-01 H or T-10 H) for transects where a piecewise regression was appropriate because only one velocity set was collected for each transect. Use of the high calibration transect, resulted in more accurate upward projection of velocities at higher simulated discharges as compared to the low calibration set.

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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**
86.34	22.00	68.12	0.3230	86.45	22.00	79.75	0.2759	89.08	22.00	25.60	0.8593
86.64	40.00	90.77	0.4407	86.83	40.00	104.75	0.3819	89.48	40.00	42.80	0.9346
87.22	93.00	143.07	0.6500	87.54	93.00	160.71	0.5787	90.19	93.00	95.37	0.9751
88.97	421.00	360.84	1.1667	89.48	421.00	390.87	1.0771	92.11	421.00	396.17	1.0627
89.91	717.00	512.63	1.3987	90.46	717.00	553.64	1.2951	93.05	717.00	628.39	1.1410
91.04	1197.00	727.69	1.6449	91.58	1197.00	782.40	1.5299	94.15	1197.00	956.36	1.2516
93.65	2880.00	1347.87	2.1367	94.06	2880.00	1457.48	1.9760	96.52	2880.00	1883.26	1.5293
Transect	**4**			**Transect**	**5**			**Transect**	**6**		
WSL	**Calibration Flow**	**Calculated Flow**	**VAF**	**WSL**	**Calibration Flow**	**Calculated Flow**	**VAF**	**WSL**	**Calibration Flow**	**Calculated Flow**	**VAF**
90.16	22.00	150.19	0.1465	90.19	22.00	179.73	0.1224	91.14	22.00	36.53	0.6023
90.56	40.00	173.28	0.2308	90.58	40.00	210.69	0.1899	91.61	40.00	62.26	0.6425
91.30	93.00	221.58	0.4197	91.33	93.00	275.53	0.3375	92.43	93.00	126.63	0.7344
93.47	421.00	399.66	1.0534	93.49	421.00	512.16	0.8220	94.53	421.00	406.79	1.0349
94.60	717.00	519.95	1.3790	94.62	717.00	668.80	1.0721	95.52	717.00	602.27	1.1905
95.96	1197.00	682.11	1.7549	95.96	1197.00	880.71	1.3591	96.64	1197.00	867.67	1.3796
99.04	2880.00	1115.77	2.5812	99.02	2880.00	1457.09	1.9765	98.99	2880.00	1582.96	1.8194
Transect	**7**			**Transect**	**8**			**Transect**	**9**		
WSL	**Calibration Flow**	**Calculated Flow**	**VAF**	**WSL**	**Calibration Flow**	**Calculated Flow**	**VAF**	**WSL**	**Calibration Flow**	**Calculated Flow**	**VAF**
89.77	22.00	41.68	0.5279	90.56	22.00	3.78	5.8173	87.76	22.00	268.49	0.0819
90.18	40.00	68.04	0.5879	90.87	40.00	11.92	3.3552	88.17	40.00	290.35	0.1378
90.95	93.00	133.45	0.6969	91.49	93.00	47.42	1.9611	88.93	93.00	332.69	0.2795
93.11	421.00	445.73	0.9445	93.46	421.00	443.81	0.9486	91.00	421.00	465.20	0.9050
94.22	717.00	687.74	1.0425	94.57	717.00	930.80	0.7703	92.05	717.00	540.30	1.3270
95.52	1197.00	1044.36	1.1462	95.95	1197.00	1808.53	0.6619	93.26	1197.00	634.11	1.8877
98.42	2880.00	2152.53	1.3380	99.24	2880.00	5012.58	0.5746	95.93	2880.00	866.00	3.3256

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Table 4. Velocity adjustment factors (cont.)

Transect	10			Transect	11			Transect	12		
WSL	**Calibration Flow**	**Calculated Flow**	**VAF**	**WSL**	**Calibration Flow**	**Calculated Flow**	**VAF**	**WSL**	**Calibration Flow**	**Calculated Flow**	**VAF**
87.75	22.00	55.78	0.3944	89.85	22.00	105.49	0.2086	89.87	22.00	147.20	0.1495
88.19	40.00	65.29	0.6126	90.18	40.00	132.63	0.3016	90.20	40.00	175.88	0.2274
89.02	93.00	84.77	1.0971	90.80	93.00	191.47	0.4857	90.82	93.00	235.35	0.3952
91.36	421.00	161.24	2.6110	92.58	421.00	418.90	1.0050	92.59	421.00	442.07	0.9523
92.57	717.00	219.87	3.2610	93.50	717.00	575.21	1.2465	93.51	717.00	569.60	1.2588
93.99	1197.00	306.12	3.9103	94.59	1197.00	795.94	1.5039	94.60	1197.00	737.84	1.6223
97.18	2880.00	564.35	5.1033	97.06	2880.00	1430.07	2.0139	97.05	2880.00	1182.67	2.4352
Transect	**13**			**Transect**	**14**			**Transect**	**15**		
WSL	**Calibration Flow**	**Calculated Flow**	**VAF**	**WSL**	**Calibration Flow**	**Calculated Flow**	**VAF**	**WSL**	**Calibration Flow**	**Calculated Flow**	**VAF**
89.87	22.00	97.73	0.2251	88.14	22.00	40.35	0.5452	88.10	22.00	40.55	0.5426
90.20	40.00	119.12	0.3358	88.44	40.00	53.99	0.7409	88.48	40.00	70.37	0.5684
90.82	93.00	170.52	0.5454	88.94	93.00	82.49	1.1274	89.16	93.00	143.45	0.6483
92.60	421.00	379.47	1.1094	90.17	421.00	179.18	2.3496	90.96	421.00	450.99	0.9335
93.52	717.00	536.78	1.3357	90.75	717.00	236.01	3.0380	91.84	717.00	666.72	1.0754
94.62	1197.00	759.34	1.5764	91.39	1197.00	308.08	3.8853	92.84	1197.00	966.73	1.2382
97.08	2880.00	1397.07	2.0615	92.66	2880.00	478.47	6.0191	95.01	2880.00	1790.29	1.6087
Transect	**16**										
WSL	**Calibration Flow**	**Calculated Flow**	**VAF**								
88.15	22.00	27.64	0.7960								
88.57	40.00	48.77	0.8202								
89.34	93.00	105.24	0.8837								
91.46	421.00	387.03	1.0878								
92.52	717.00	590.61	1.2140								
93.75	1197.00	874.59	1.3686								
96.46	2880.00	1670.76	1.7238								

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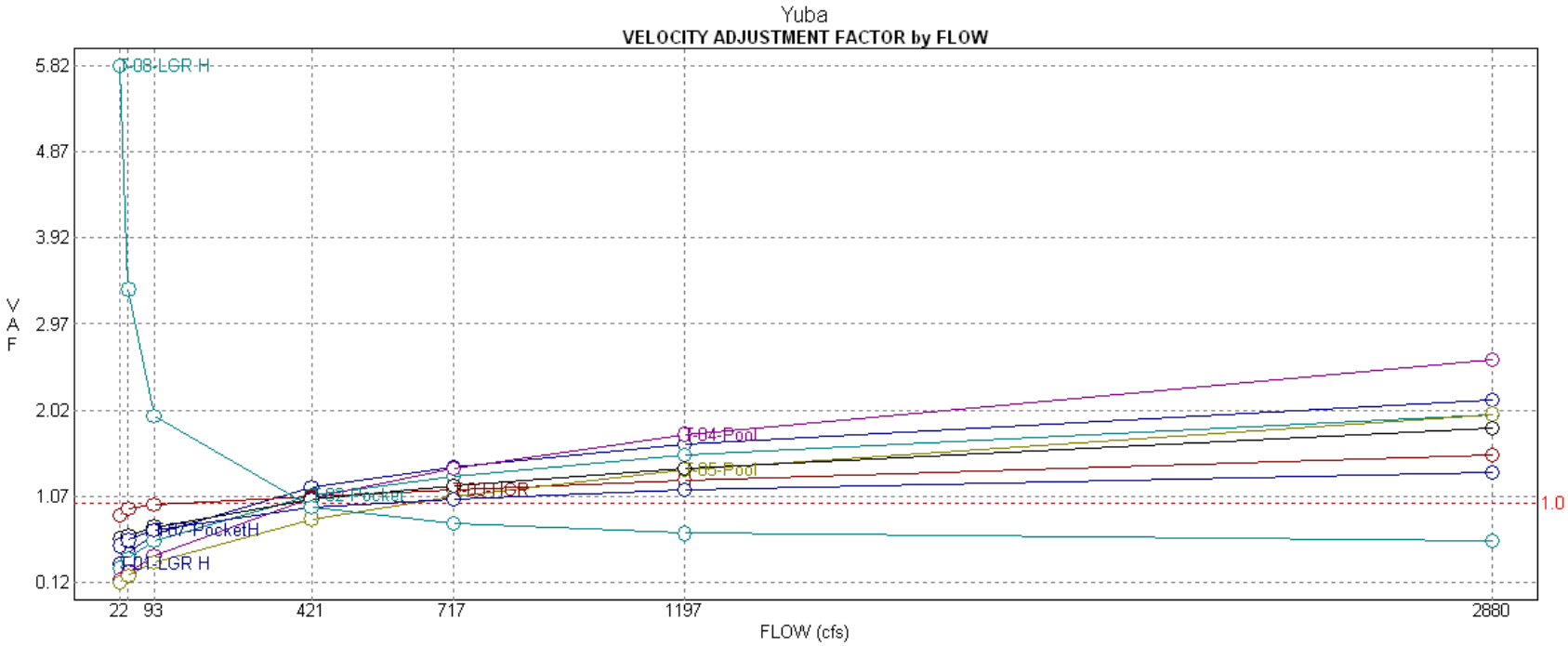

Figure 2. Velocity adjustment factor by Flow (T-01 to T-08)

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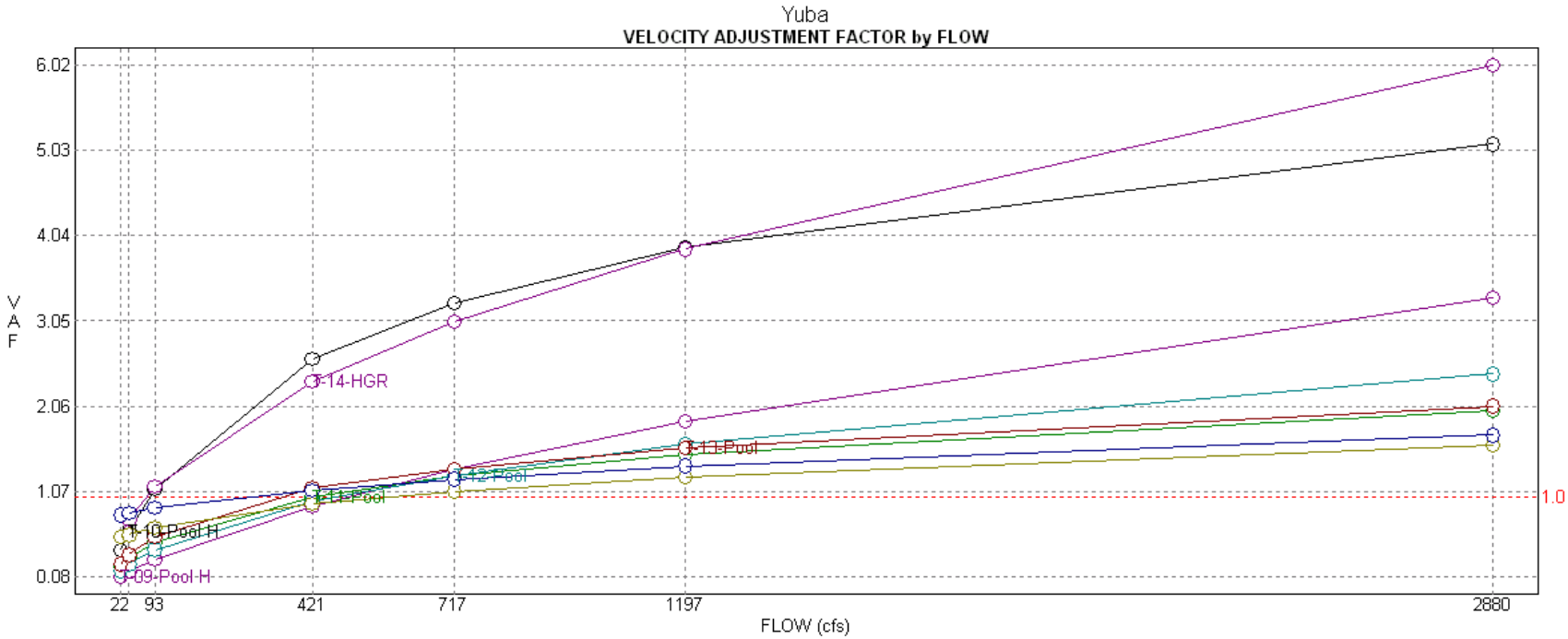

Figure 3. Velocity adjustment factor by Flow (T-09 to T-16)

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Target Discharge and Field Discharge

Discharge, like water surface elevation, is used to calibrate stage/discharge relationships in the PHABSIM hydraulic models. Modeled discharges used in the Log/Log and MANSQ routines were modified slightly from best estimates to improve model calibration. 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. Water surface elevations based on level logger data were used to calibrate stage/discharge relationships for the High and High-High discharges and are summarized in Table 6. For each transect, the minimum, maximum, average, and range of water surface elevations that were recorded during the scheduled flow releases has been provided. In addition, the water surface elevation selected for use in the model has been provided.

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Table 5. Target and measured flows for the Yuba River above New Colgate Powerhouse Reach.

Transect	Type	Discharge									
		Low-Low – Target Base Flow		Low - Target 100 cfs		Mid - Target 300 cfs		High - Target 600 cfs		High-High - Target 1,250 cfs	
		Measured (cfs)	Method	Measured (cfs)	Method	Measured (cfs)	Method	Measured (cfs)	Method	Measured (cfs)	Method
1	LGR	--	--	--	--	343	ADCP/ Swoffer	--	--	--	--
2	Pocket	--	--	--	--	410	ADCP/ Swoffer	--	--	--	--
3	HGR	--	--	124.7	Swoffer	--	--	--	--	--	--
4	Pool	--	--	--	--	397	ADCP/ Swoffer	--	--	--	--
5	Pool	--	--	--	--	520	ADCP/ Swoffer	--	--	--	--
6	Pocket	--	--	--	--	394	ADCP/ Swoffer	--	--	--	--
7	Pocket	--	--	--	--	424	ADCP/ Swoffer	--	--	--	--
8	LGR	--	--	--	--	424	ADCP/ Swoffer	--	--	--	--
9	Pool	--	--	--	--	459	ADCP/ Swoffer	--	--	--	--
10	Pool	--	--	60.4	ADCP/ Swoffer	--	--	--	--	--	--
11	Pool	--	--	--	--	393	ADCP/ Swoffer	--	--	--	--
12	Pool	--	--	--	--	435	ADCP/ Swoffer	--	--	--	--
13	Pool	--	--	--	--	216	ADCP/ Swoffer	--	--	--	--
14	HGR	--	--	93.1	ADCP/ Swoffer	--	--	--	--	--	--
15	Pocket	--	--	--	--	465	ADCP/ Swoffer	--	--	--	--
16	Pool	--	--	--	--	383	ADCP/ Swoffer	--	--	--	--
Q1 – Above PH	--	38.9	Swoffer	--	--	--	--	--	--	--	--
Q2 – Between T-06 and T-07	--	40.3	Swoffer	--	--	--	--	--	--	--	--
Q3 – Between T-06 and T-07	--	40.3	Swoffer	--	--	--	--	--	--	--	--
Given Flow Averages using best transects		**40**	Q1-Q3	**93**	(T3, T10, and T14)	**421**	(T1-T12, and T14-T16)	**712**	Flow Records + Accretion	**1,197**	Flow Records + Accretion

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Table 6. Level logger WSEs for the Yuba River above New Colgate Powerhouse Reach.

Transect	Habitat Type	High Flow - 717 cfs - Water Surface Elevations (ft)							High Flow – 1,197 cfs - Water Surface Elevation (ft)							Comment
		Date	Time	Min	Max	Average	Range	Selected	Date	Time	Min	Max	Average	Range	Selected	
16	LGR	10/27/2012	Steady Flow ~ 11:30 - 20:00	92.35	92.44	92.40	0.09	92.44	10/28/2012	Steady Flow ~ 10:00 - 20:00	93.80	93.90	93.86	0.09	93.80	
15	Pocket			91.70	91.80	91.76	0.10	91.79			92.86	92.99	92.92	0.13	92.87	
14	HGR			90.68	90.80	90.74	0.13	90.74			91.36	91.88	91.77	0.52	91.40	
13	Pool			93.38	93.51	93.46	0.14	93.51			94.50	94.78	94.69	0.28	94.64	
12	Pool			93.34	93.47	93.41	0.13	93.47			94.53	94.70	94.63	0.17	94.64	
11	Pocket			93.35	93.48	93.42	0.13	93.46			94.54	94.71	94.64	0.17	94.61	
10	Pocket			--	--	--	--	92.44			--	--	--	--	94.16	Logger missing. Data extrapolated from T-09 downstream in same meso-habitat unit
9	LGR			91.91	91.99	91.95	0.08	91.95			93.46	93.55	93.50	0.09	93.46	
8	Pool			94.64	94.72	94.68	0.07	94.64			95.86	95.96	95.92	0.10	95.90	
7	Pool			94.17	94.27	94.21	0.10	94.21			95.49	95.58	95.54	0.09	95.52	
6	Pool			95.46	95.53	95.50	0.07	95.50			96.76	96.83	96.80	0.08	96.76	
5	Pool			94.56	94.64	94.61	0.08	94.61			95.90	96.05	95.96	0.15	95.96	
4	Pool			94.57	94.72	94.65	0.15	94.62			95.85	96.14	95.97	0.28	95.97	
3	HGR			--	--	--	--	92.91			--	--	--	--	94.14	Logger missing. Data extrapolated from T-02 downstream in adjacent meso-habitat unit
2	Pocket			90.23	90.31	90.28	0.08	90.31			91.62	91.71	91.67	0.09	91.62	
1	Pool			--	--	--	--	89.76			--	--	--	--	91.11	Logger elevation data invalid. Data extrapolated from T-02 upstream in adjacent meso-habitat unit

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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
Yuba River Upstream of New Colgate Powerhouse Reach Cross Sectional Profiles and Photos

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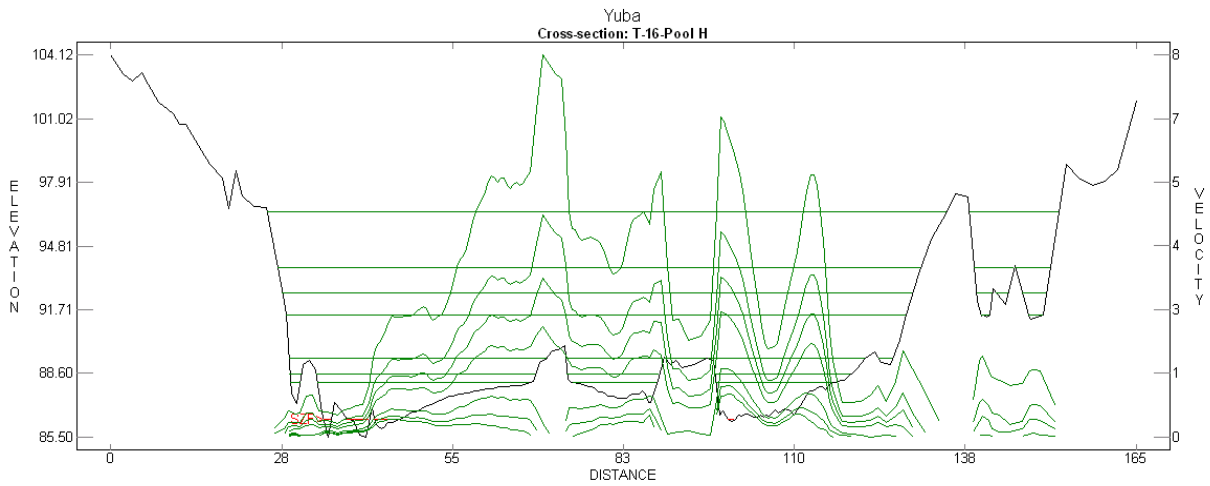

Figure A-1. Transect 16 (Pool).

Figure A-2. Transect 16-left bank to right bank at Mid Flow (421 cfs).

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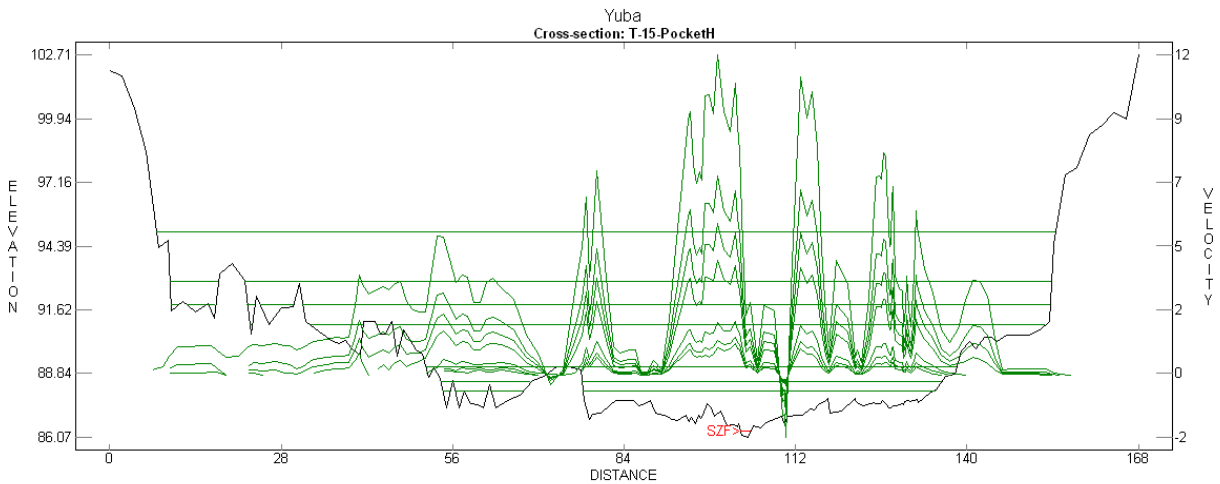

Figure A-3. Transect 15 (Pocketwater).

Figure A-4. Transect 15-right bank looking downstream at transect and left bank at Low Flow (40 cfs).

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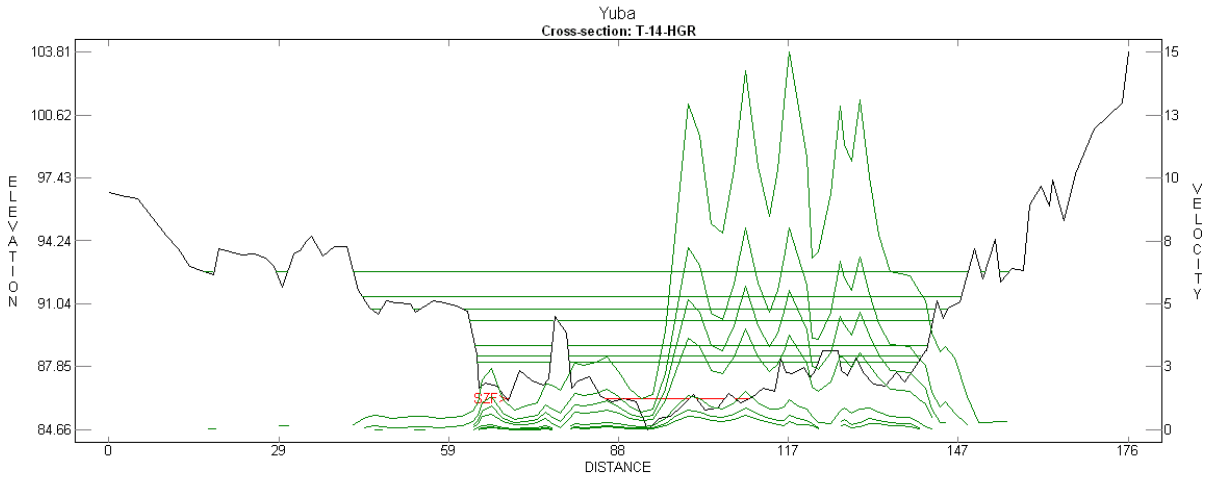

Figure A-5. Transect 14 (High Gradient Riffle)

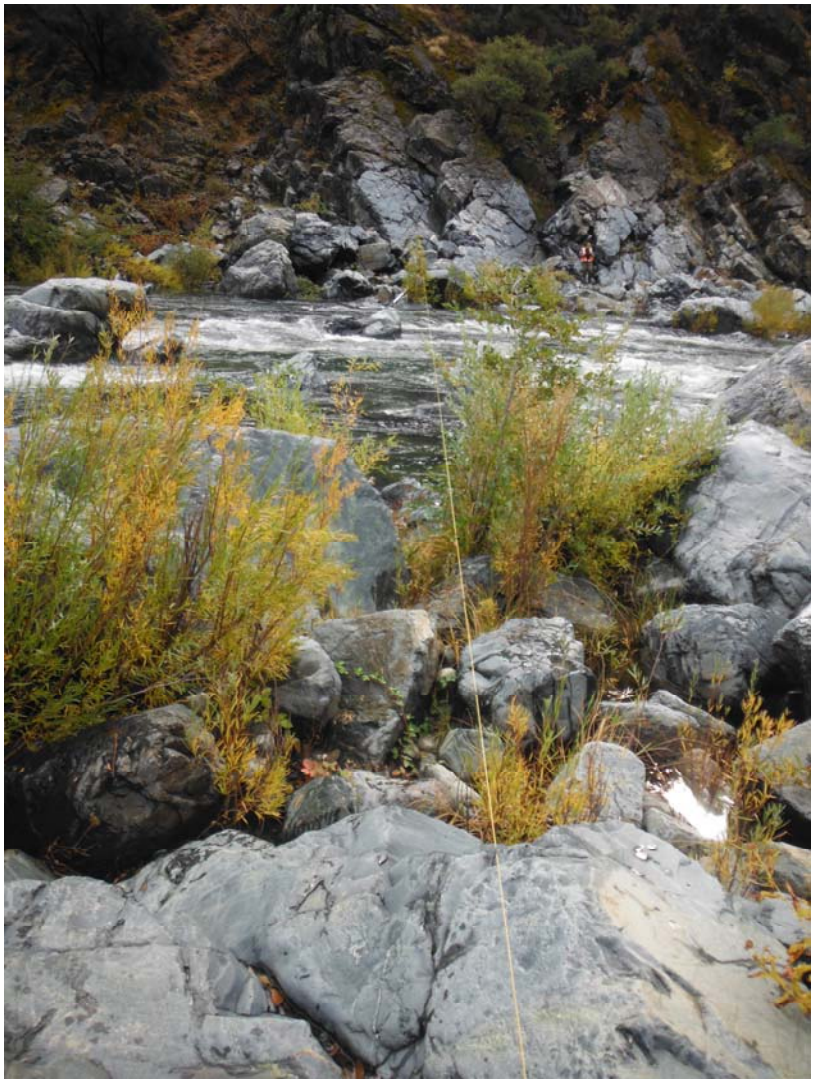

Figure A-6. Transect 14-left bank to right bank at Mid Flow (421 cfs).

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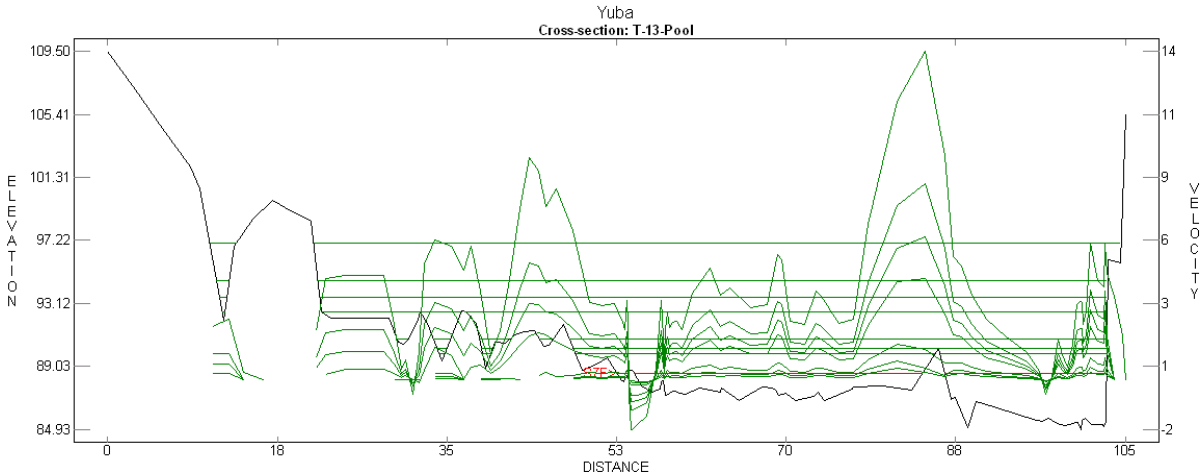

Figure A-7. Transect 13 (Pool)

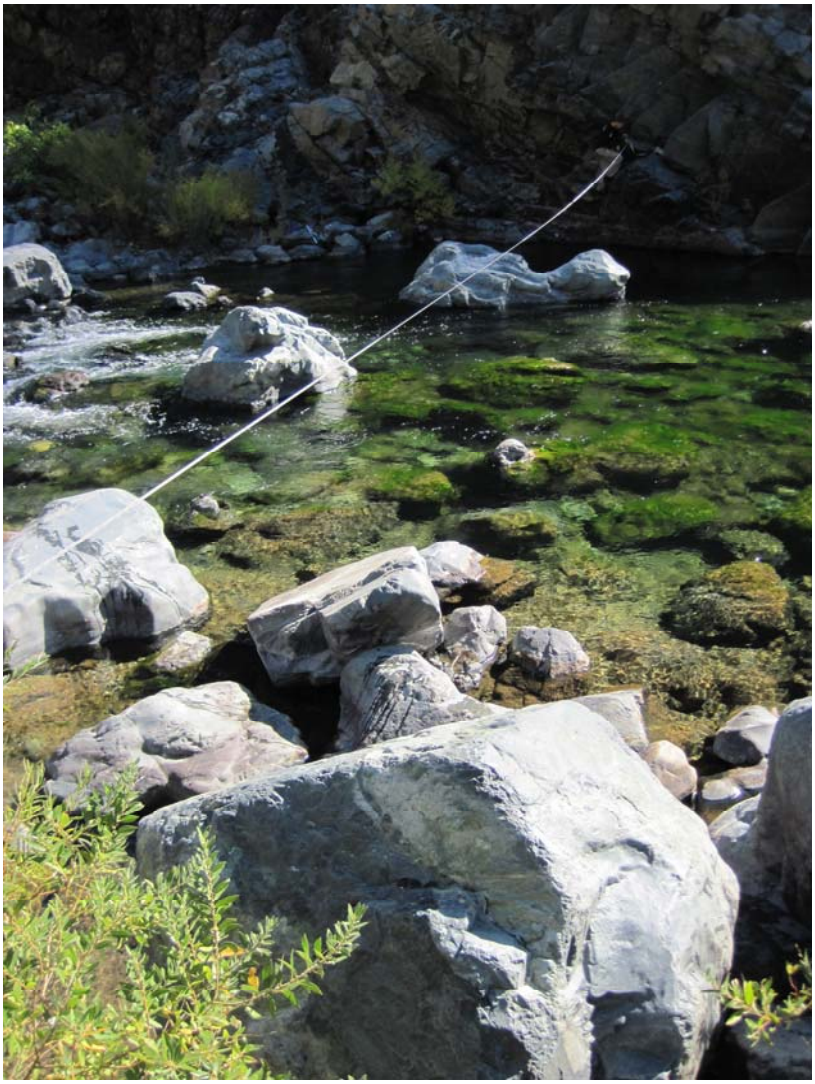

Figure A-8. Transect 13-left bank to right bank at Low Flow (40 cfs)

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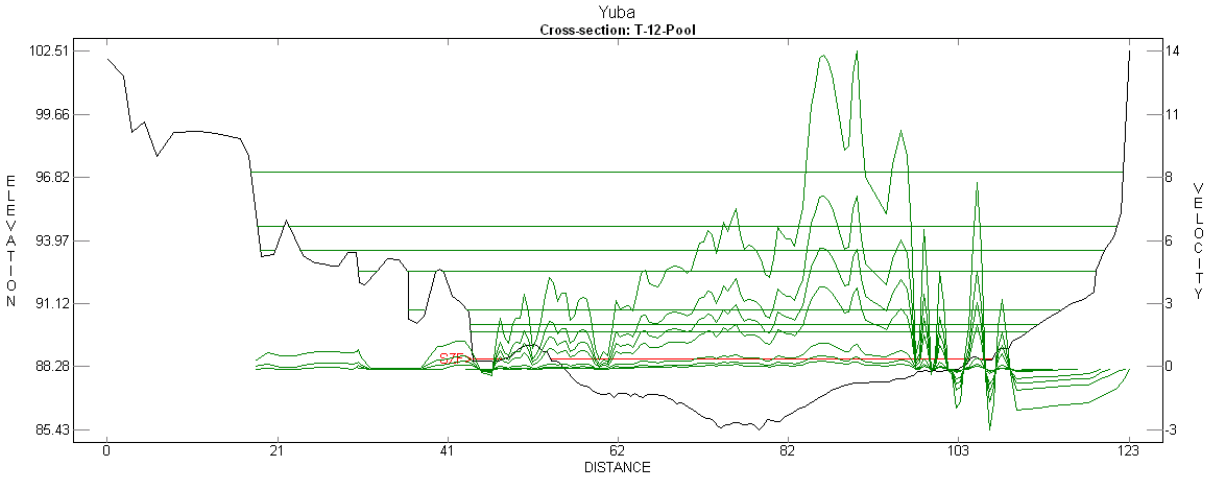

Figure A-9. Transect 12 (Pool)

Figure A-10. Transect 12-left bank to right bank at Mid Flow (421 cfs)

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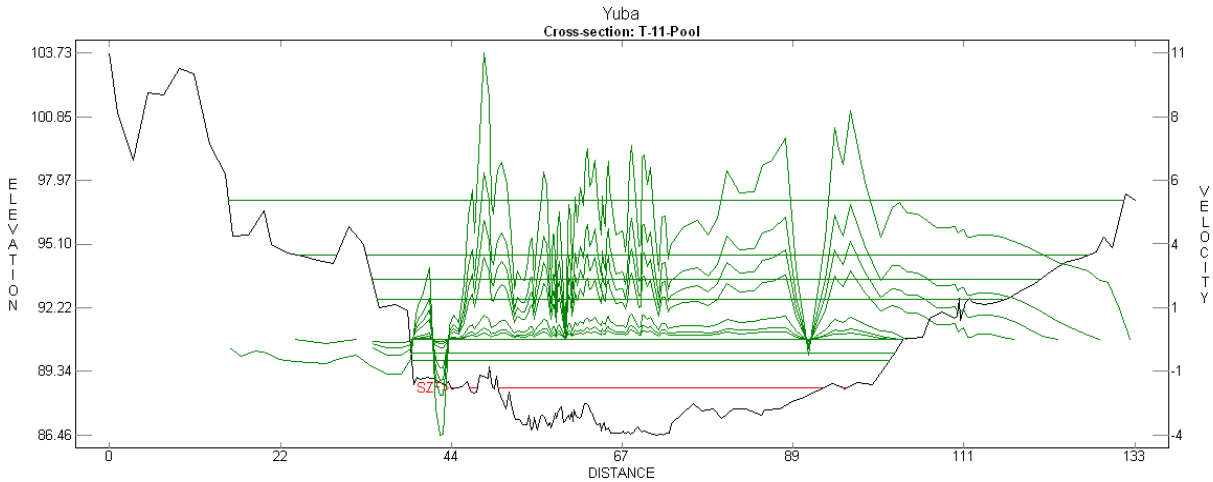

Figure A-11. Transect 11 (Pool)

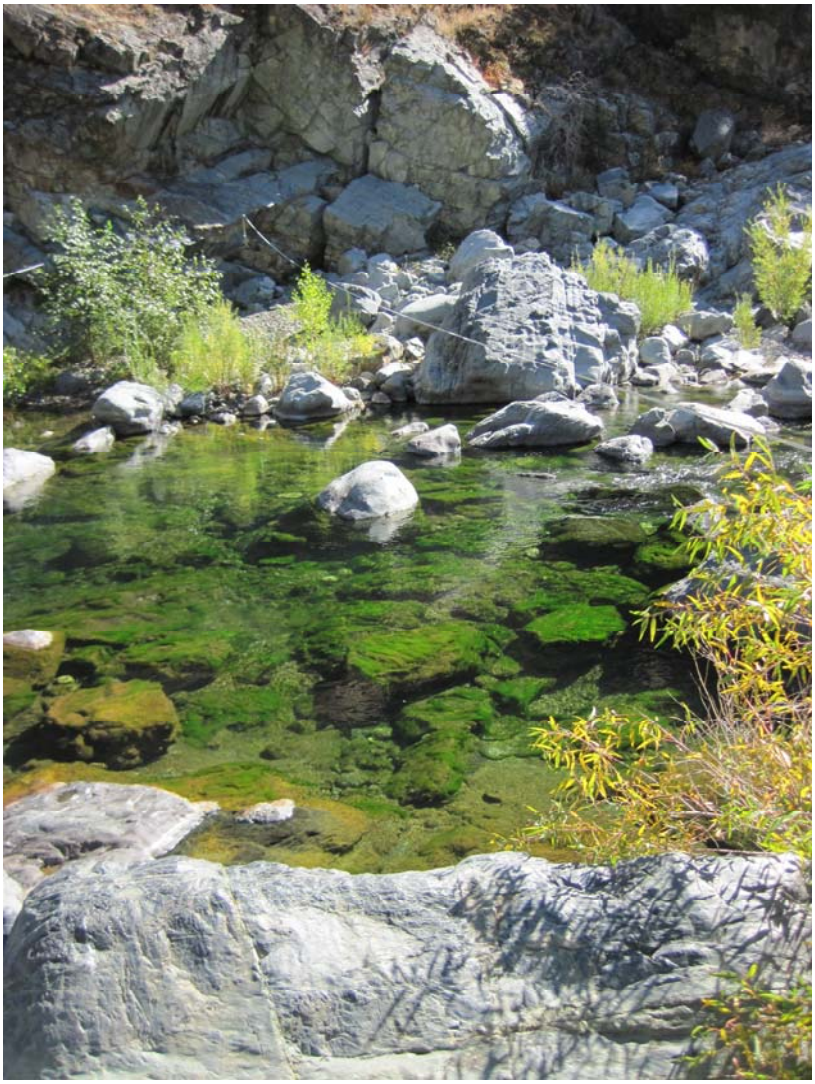

Figure A-12. Transect 11-left bank to right bank at Low Flow (40 cfs)

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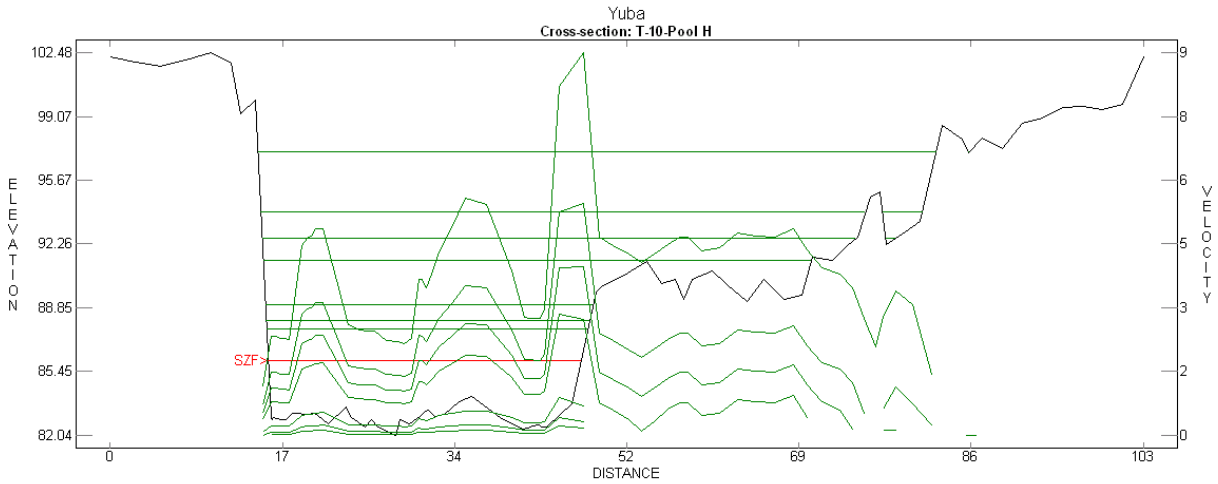

Figure A-13. Transect 10 (Pool)

Figure A-14. Transect 10-left bank to right bank at Low Flow (40 cfs)

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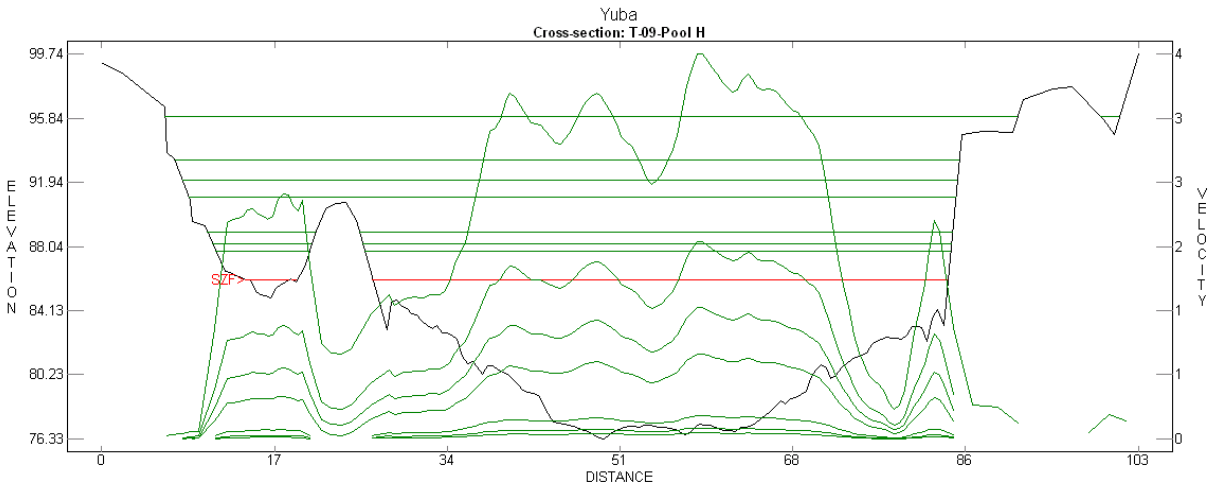

Figure A-15. Transect 09 (Pool)

Figure A-16. Transect 09-left bank to right bank at Low Flow (40 cfs)

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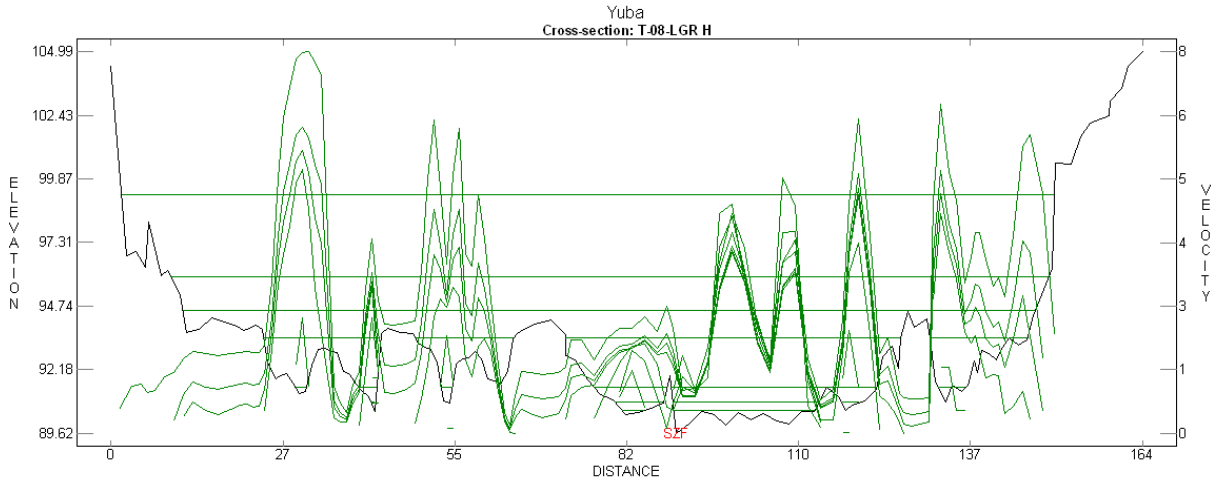

Figure A-17. Transect 08 (Low Gradient Riffle)

Figure A-18. Transect 08-left bank looking upstream at transect and right bank at Mid Flow (421 cfs)

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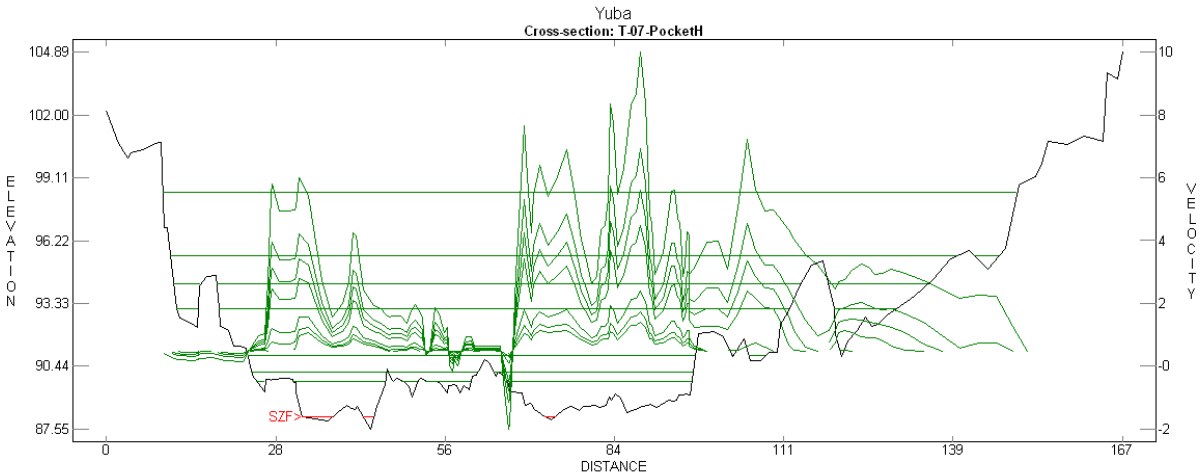

Figure A-19. Transect 07 (Pocketwater)

Figure A-20. Transect 07-left bank to right bank at Low Flow (40 cfs)

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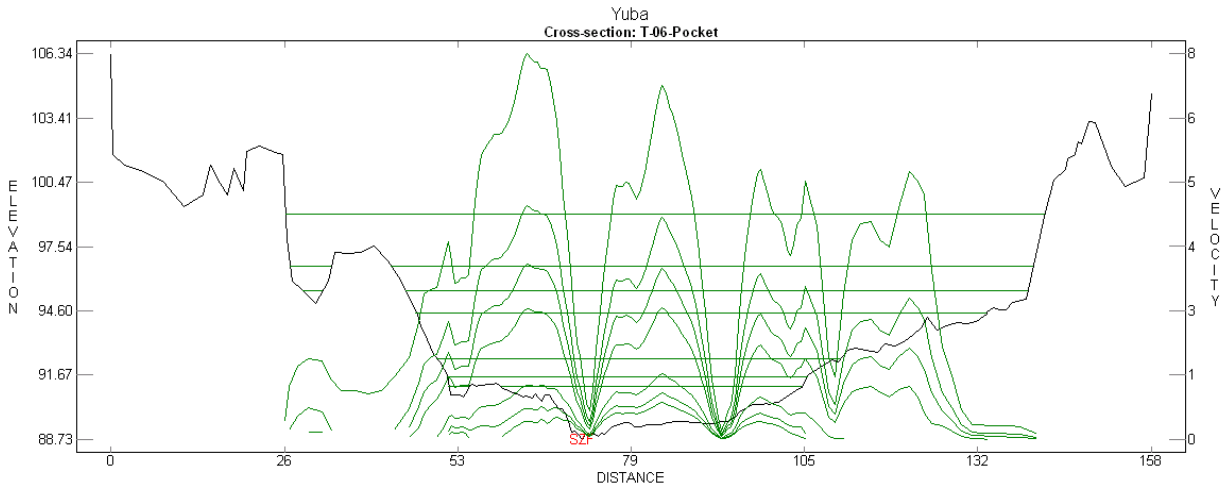

Figure A-21. Transect 06 (Pocketwater)

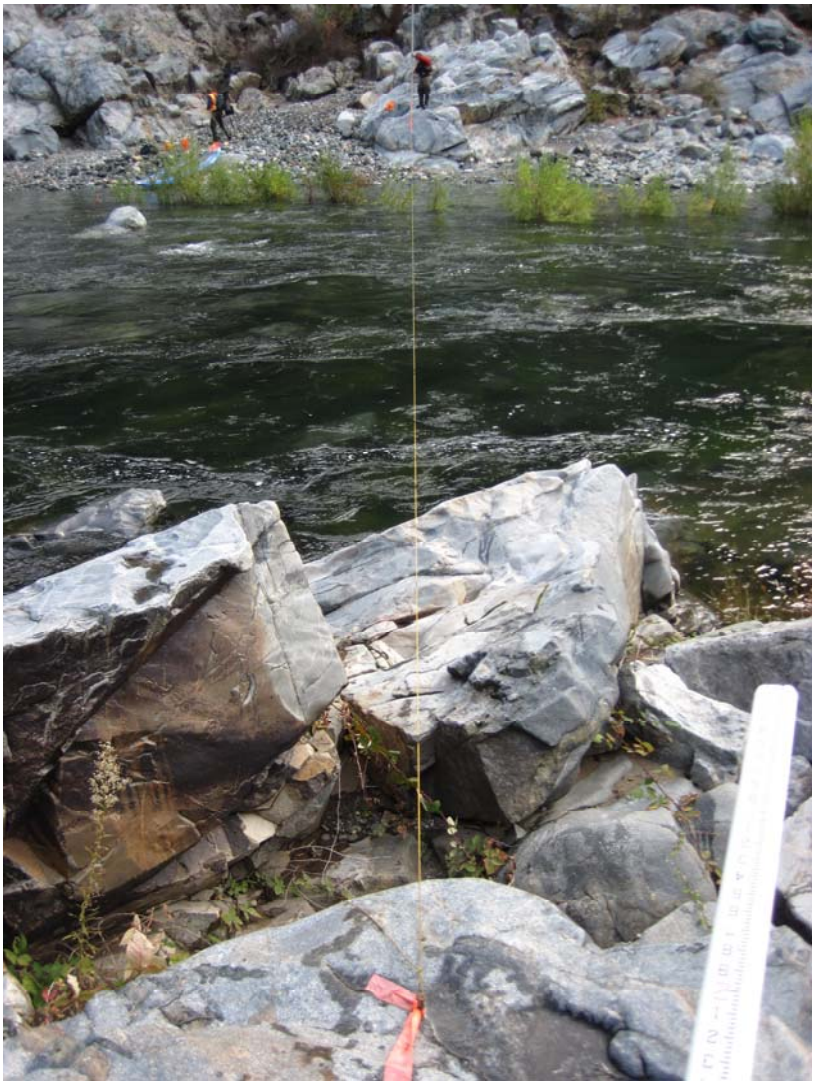

Figure A-22. Transect 06-left bank to right bank at Mid Flow (421 cfs)

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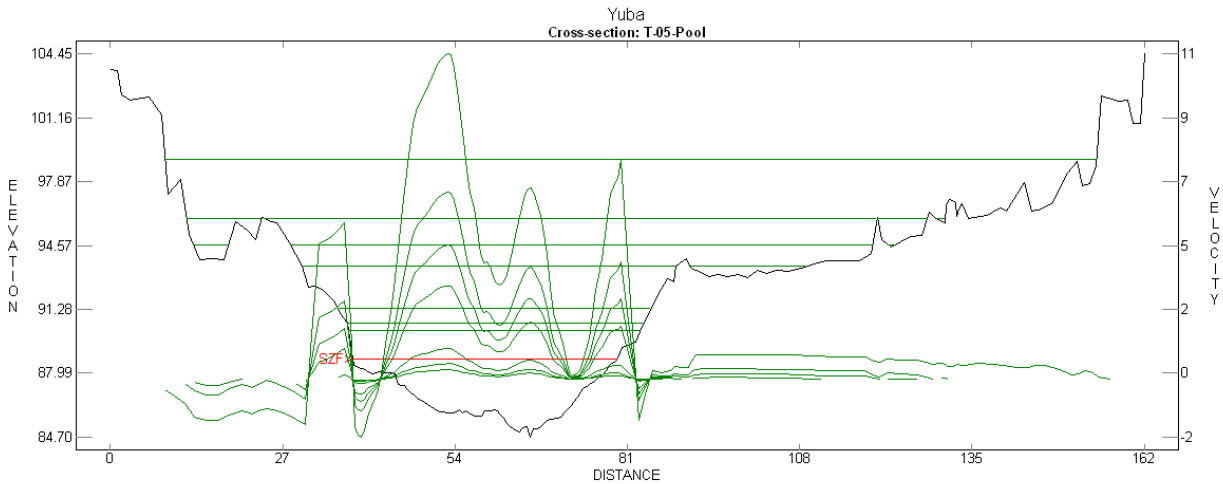

Figure A-23. Transect 05 (Pool)

Figure A-24. Transect 05-left bank looking upstream at transect at Mid Flow (421 cfs)

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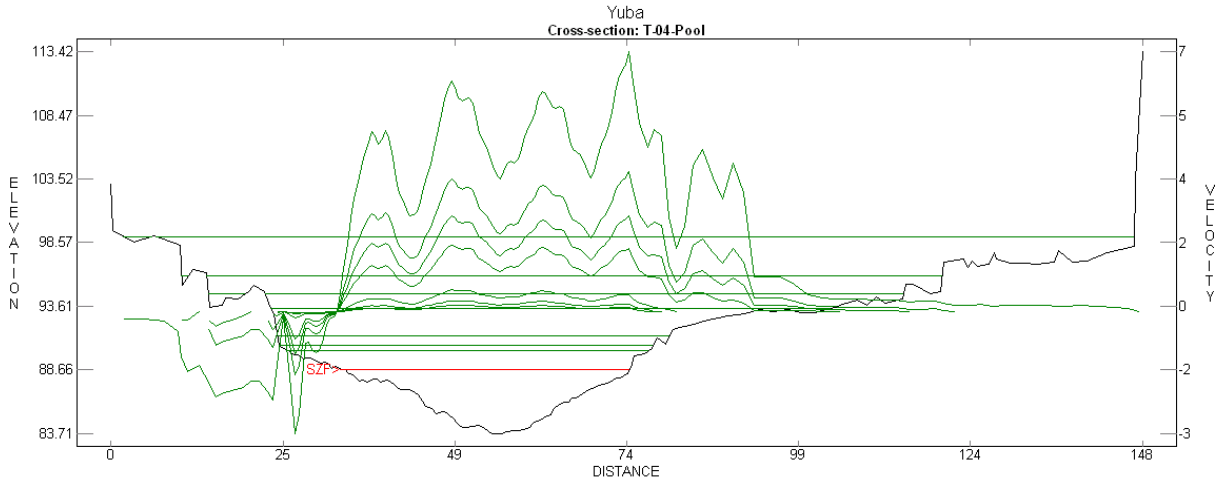

Figure A-25. Transect 04 (Pool)

Figure A-26. Transect 04-left bank towards right bank at Mid Flow (421 cfs)

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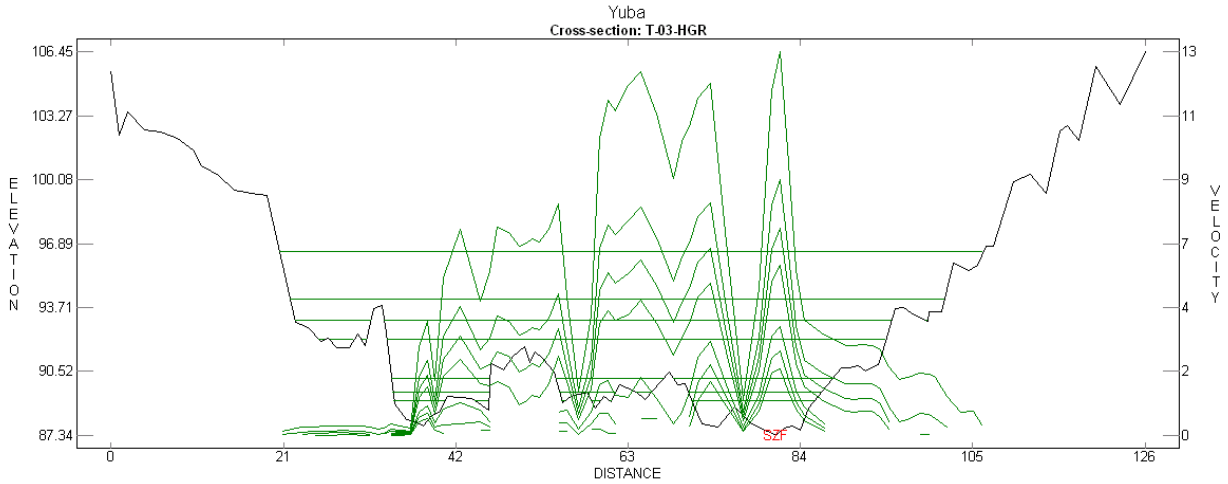

Figure A-27. Transect 03 (High Gradient Riffle)

Figure A-28. Transect 03-left bank looking upstream at transect and right bank at Mid Flow (421 cfs)

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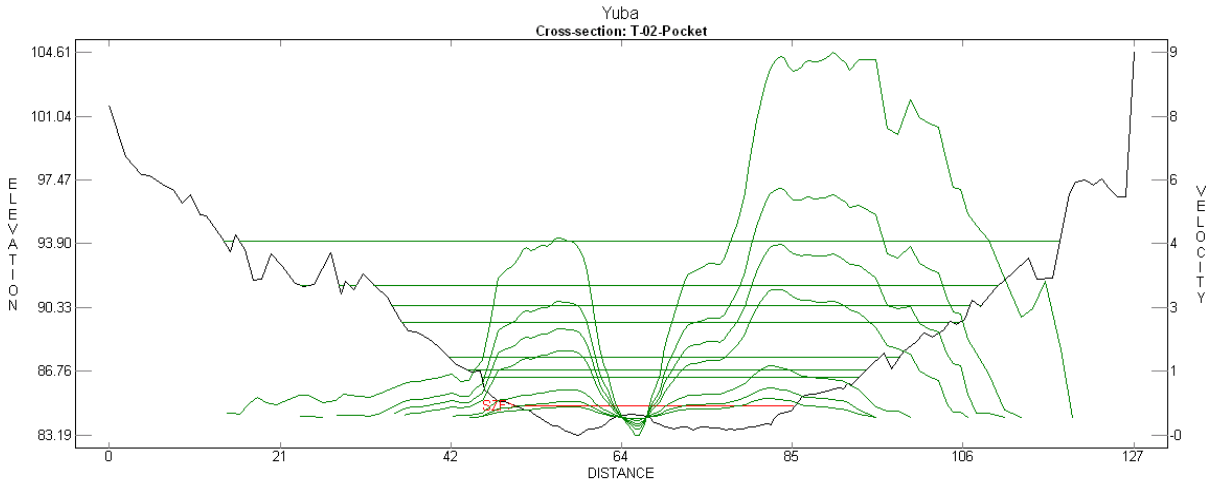

Figure A-29. Transect 02 (Pocketwater)

Figure A-30. Transect 02-left bank to right bank at Mid Flow (421 cfs)

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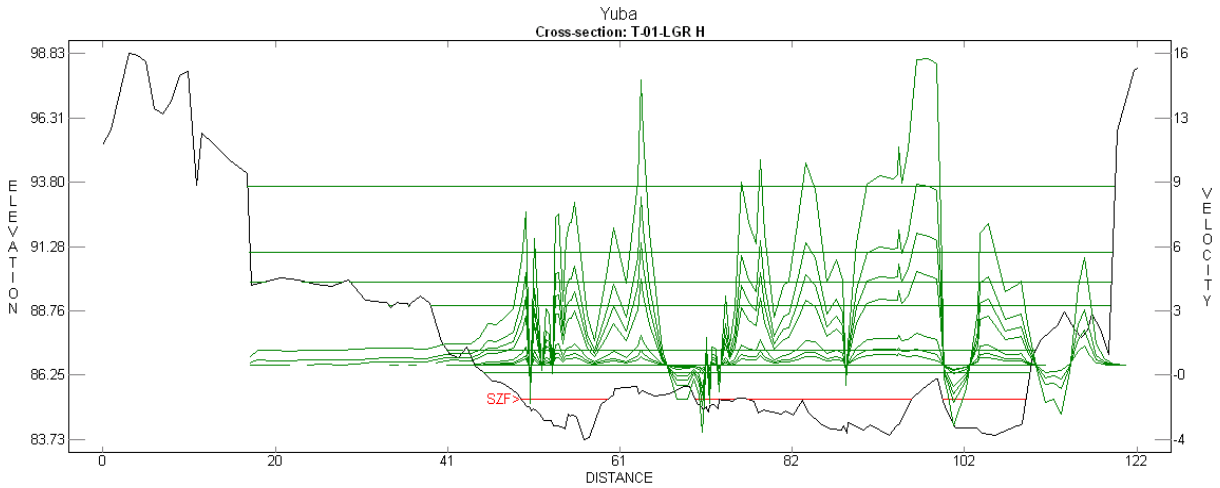

Figure A-31. Transect 01 (Low Gradient Riffle)

Figure A-32. Transect 01-left bank to right bank at Mid Flow (421 cfs)

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Appendix B
Yuba River above New Colgate Powerhouse Reach Cross Section Adjustments

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T-01

- A piecewise regression method was utilized for this transect.
- Station 0.0 to 43.0: increased N values, based on adjacent cells, to decrease high simulated flows on the left bank.
- Station 70.8 to 71.05, 96.87, 100.44, and 100.91: adjusted N values to minimize velocity spikes.

T-02

- Station 0.0 to 43.0: decreased N values, based on adjacent cells, to allow flow to propagate up the left bank at higher simulation discharges.
- Station 98.5 to end: increased N values, based on adjacent cells, to decrease high flows on the right bank at higher simulation discharges.

T-03

- Station 60.0 to 74.0: increased N values to minimize a velocity spike.
- Station 85.0: increased N value, based on adjacent cells, to decrease high flows on the right bank at higher simulation discharges.

T-04

- No changes.

T-05

- Station 33.0 to 37.0 and 91.0 to 101.0: increased N values to minimize velocity spikes.

T-06

- Station 0.0 to 46.50: increased N values, based on adjacent cells, to decrease high flows on the left bank at higher simulation discharges.
- Station 47.0, 113.0, 117.5, and 120.5 to 127: increased N values to minimize velocity spikes.

T-07

- A piecewise regression method was utilized for this transect.
- Station 29.7 to 31.25, 46.27 to 47.81, 97.5 to 101.5, 111.0 to 120.0, and 125: increased N values to minimize velocity spikes.

T-08

- A piecewise regression method was utilized for this transect.
- Station 0.0 to 25.0: increased N values, based on adjacent cells, to decrease high flows on the left bank at higher simulation discharges.
- Station 33.0, 34.0, 141.8, and 143.0: increased N values to minimize velocity spikes.

T-09

- A piecewise regression method was utilized for this transect.
- No changes.

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T-10

- A piecewise regression method was utilized for this transect.
- Station 25.45 to 29.84, 34.73, and 36.06: decreased N, based on knowledge of the transect and photographs, to release flow at higher simulation discharges.
- Station 41.08 to end: adjusted N values to release flow at higher simulation discharges and to allow flow to more accurately propagate up the right bank.

T-11

- Station 103.0 to end: increased N values, based on adjacent cells, to decrease high flows on the right bank at higher simulation discharges.

T-12

- Station 109.0 to end: increased N values, based on adjacent cells, to decrease high flows on the right bank at higher simulation discharges.

T-13

- Station 0.0 to 29.0: increased N values, based on adjacent cells, to decrease high flows on the left bank at higher simulation discharges.
- Station 32.0, and 53.75 to 55.07: adjusted N values, based on adjacent cells and transect photographs, to minimize high negative flows at simulation discharges.
- Station 43.0 to 51.5 and 77.0 to 85.8: adjusted N values, based on knowledge of the transect and photographs, to properly model velocities for stations where no velocity data were collected.
- Station 103.2 to end: decreased N values to allow flow to propagate up the right bank at higher simulation discharges.

T-14

- Stations 77.0 to 87.0, 97.0 to 111.0, and 115.0 to 120.0: increased N values to minimize velocity spikes.
- Station 123.2, 126.0: decreased N to release flow through a velocity trough.
- Station 126.5 to end: adjusted N values to minimize velocity spikes and to allow flow to propagate up the right bank at higher simulation discharges.

T-15

- A piecewise regression method was utilized for this transect.
- Stations 0.0 to 39.5: decreased N values to allow flow to propagate up the left bank at higher simulation discharges.
- Station 40.5 to 49.0, 56.0, 78.15, 78.87, and 140.5 to 142.8: increased N values to minimize velocity spikes.

T-16

- A piecewise regression method was utilized for this transect.
- Station 69.0 to 73.0: increase N values to minimize velocity spike.

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Appendix C
Yuba River above New Colgate Powerhouse Reach
Water Surface Elevation Comparison Tables

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Table C-1. Measured and Modeled WSEs.

Transect T-01 H				Transect T-01 L				Transect T-02				Transect T-03			
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
40	--	--	--	**40**	86.45	86.45	86.45	**40**	86.83	86.83	86.83	**40**	89.50	89.48	89.50
93	--	--	--	**93**	--	--	--	**93**	--	--	--	**93**	90.13	90.19	90.16
421	89.04	88.97	89.03	**421**	89.04	89.04	89.03	**421**	89.59	89.48	89.58	**421**	--	--	--
717	89.76	89.91	90.00	**717**	--	--	--	**717**	90.31	90.46	90.50	**717**	92.91	93.05	92.98
1197	91.11	91.04	91.10	**1197**	--	--	--	**1197**	91.62	91.58	91.53	**1197**	94.14	94.15	94.13
Transect T-04				**Transect T-05**				**Transect T-06**				**Transect T-07**			
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
40	90.56	90.56	90.56	**40**	90.58	90.58	90.58	**40**	91.63	91.61	91.63	**40**	--	--	--
93	--	--	--	**93**	v	--		**93**	--	--	--	**93**	--	--	--
421	93.44	93.47	93.56	**421**	93.50	93.49	93.59	**421**	94.41	94.53	94.52	**421**	93.11	93.11	93.10
717	94.62	94.60	94.61	**717**	94.61	94.62	94.60	**717**	95.50	95.52	95.53	**717**	94.21	94.22	94.20
1197	95.97	95.96	95.68	**1197**	95.96	95.96	95.61	**1197**	96.76	96.64	96.67	**1197**	95.52	95.52	95.51
Transect T-07 L				**Transect T-08 H**				**Transect T-08 L**				**Transect T-9 H**			
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
40	90.51	90.51	90.51	**40**	--	--	--	**40**	91.60	91.60	91.60	**40**	--	--	--
93	--	--	--	**93**	--	--	--	**93**	--	--	--	**93**	88.97	88.93	88.38
421	93.11	93.11	93.10	**421**	93.44	93.46	93.43	**421**	93.44	93.44	93.44	**421**	90.87	91.00	90.86
717	--	--	--	**717**	94.64	94.57	94.53	**717**	--	--	--	**717**	91.95	92.05	92.08
1197	--	--	--	**1197**	95.90	95.95	95.93	**1197**	--	--	--	**1197**	93.46	93.26	93.44

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Table C-1. (continued)

Transect T-9 L				Transect T-10 H				Transect T-10 L				Transect T-11			
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
40	88.44	88.44	88.43	**40**	--	--	--	**40**	88.44	88.44	88.43	**40**	90.18	90.18	90.18
93	88.97	88.97	88.98	**93**	89.05	89.02	89.04	**93**	89.05	89.05	89.05	**93**	--	--	--
421	--	--	--	**421**	91.30	91.36	91.42	**421**	--	--	--	**421**	92.60	92.58	92.60
717	--	--	--	**717**	92.44	92.57	92.43	**717**	--	--	--	**717**	93.46	93.50	93.45
1197	--	--	--	**1197**	94.16	93.99	93.48	**1197**	--	--	--	**1197**	94.61	94.59	94.40
Transect T-12				**Transect T-13**				**Transect T-14**				**Transect T-15 H**			
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
40	90.20	90.20	90.20	**40**	90.20	90.20	90.20	**40**	88.44	88.40	88.44	**40**	--	--	--
93	--	--	--	**93**	--	--	--	**93**	88.84	88.91	88.94	**93**	--	--	--
421	92.60	92.59	92.62	**421**	92.59	92.60	92.69	**421**	90.21	90.18	90.17	**421**	90.98	90.96	90.97
717	93.47	93.51	93.46	**717**	93.51	93.52	93.50	**717**	90.74	90.75	90.75	**717**	91.79	91.84	91.85
1197	94.64	94.60	94.40	**1197**	94.64	94.62	94.40	**1197**	91.40	91.39	91.39	**1197**	92.87	92.84	92.86
Transect T-15 L				**Transect T-16 H**				**Transect T-16 L**							
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**				
40	89.15	89.15	89.15	**40**	--	--	--	**40**	89.26	89.26	89.26				
93	--	--	--	**93**	--	--	--	**93**	--	--	--				
421	90.98	90.98	90.98	**421**	91.50	91.46	91.49	**421**	91.50	91.50	91.50				
717	--	--	--	**717**	92.44	92.52	92.54	**717**	--	--	--				
1197	--	--	--	**1197**	93.80	93.75	93.79	**1197**	--	--	--				

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Table C-2. Differences Between Measured and Modeled WSEs.

Transect T-01 H				Transect T-01 L				Transect T-02				Transect T-03			
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
40	--	--	--	**40**	86.45	0.00	0.00	**40**	86.83	0.00	0.00	**40**	89.50	0.02	0.00
93	--	--	--	**93**	--	--	--	**93**	--	--	--	**93**	90.13	-0.06	-0.03
421	89.04	0.07	0.01	**421**	89.04	0.00	0.01	**421**	89.59	0.11	0.01	**421**	--	--	--
717	89.76	-0.15	-0.24	**717**	--	--	--	**717**	90.31	-0.15	-0.19	**717**	92.91	-0.14	-0.07
1197	91.11	0.07	0.01	**1197**	--	--	--	**1197**	91.62	0.04	0.09	**1197**	94.14	-0.01	0.01
Transect T-04				**Transect T-05**				**Transect T-06**				**Transect T-07**			
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
40	90.56	0.00	0.00	**40**	90.58	0.00	0.00	**40**	91.63	0.02	0.00	**40**	--	--	--
93	--	--	--	**93**	--	--	--	**93**	--	--	--	**93**	--	--	--
421	93.44	-0.03	-0.12	**421**	93.50	0.01	-0.09	**421**	94.41	-0.12	-0.11	**421**	93.11	0.00	0.01
717	94.62	0.02	0.01	**717**	94.61	-0.01	0.01	**717**	95.50	-0.02	-0.03	**717**	94.21	-0.01	0.01
1197	95.97	0.01	0.29	**1197**	95.96	0.00	0.35	**1197**	96.76	0.12	0.09	**1197**	95.52	0.00	0.01
Transect T-07 L				**Transect T-08 H**				**Transect T-08 L**				**Transect T-9 H**			
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
40	90.51	0.00	0.00	**40**	--	--	--	**40**	91.60	0.00	0.00	**40**	--	--	--
93	--	--	--	**93**	--	--	--	**93**	--	--	--	**93**	88.97	0.04	0.59
421	93.11	0.00	0.01	**421**	93.44	-0.02	0.01	**421**	93.44	0.00	0.00	**421**	90.87	-0.13	0.01
717	--	--	--	**717**	94.64	0.07	0.11	**717**	--	--	--	**717**	91.95	-0.10	-0.13
1197	--	--	--	**1197**	95.90	-0.05	-0.03	**1197**	--	--	--	**1197**	93.46	0.20	0.02

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Table C-2. (continued)

Transect T-9 L				Transect T-10 H				Transect T-10 L				Transect T-11			
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
40	88.44	0.00	0.01	**40**	--	--	--	**40**	88.44	0.00	0.01	**40**	90.18	0.00	0.00
93	88.97	0.00	-0.01	**93**	89.05	0.03	0.01	**93**	89.05	0.00	0.00	**93**	--	--	--
421	--	--	--	**421**	91.30	-0.06	-0.12	**421**	--	--	--	**421**	92.60	0.02	0.00
717	--	--	--	**717**	92.44	-0.13	0.01	**717**	--	--	--	**717**	93.46	-0.04	0.01
1197	--	--	--	**1197**	94.16	0.17	0.68	**1197**	--	--	--	**1197**	94.61	0.02	0.21
Transect T-12				**Transect T-13**				**Transect T-14**				**Transect T-15 H**			
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
40	90.20	0.00	0.00	**40**	90.20	0.00	0.00	**40**	88.44	0.04	0.00	**40**	--	--	--
93	--	--	--	**93**	--	--	--	**93**	88.84	-0.07	-0.10	**93**	--	--	--
421	92.60	0.01	-0.02	**421**	92.59	-0.01	-0.10	**421**	90.21	0.03	0.04	**421**	90.98	0.02	0.01
717	93.47	-0.04	0.01	**717**	93.51	-0.01	0.01	**717**	90.74	-0.01	-0.01	**717**	91.79	-0.05	-0.06
1197	94.64	0.04	0.24	**1197**	94.64	0.02	0.24	**1197**	91.40	0.01	0.01	**1197**	92.87	0.03	0.01
Transect T-15 L				**Transect T-16 H**				**Transect T-16 L**							
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**				
40	89.15	0.00	0.00	**40**	--	--	--	**40**	89.26	0.00	0.00				
93	89.70	--	0.02	**93**	--	--	--	**93**	--	--	--				
421	90.98	0.00	0.00	**421**	91.50	0.04	0.01	**421**	91.50	0.00	0.00				
717	--	--	--	**717**	92.44	-0.08	-0.10	**717**	--	--	--				
1197	--	--	--	**1197**	93.80	0.05	0.01	**1197**	--	--	--				

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