
CR6 Stream Reach Summary

Study Reach: CR6, Colorado River - KB Ditch downstream to Blue River Confluence.

Reach Description: Approximate channel length: 9.75 miles with an average channel slope of 0.05%, subdivided as follows:

- KB Ditch to Elk Trout Lodge: Approximate channel length: 6 miles, approximate channel slope 0.08%.
- Elk Trout Lodge to Blue River confluence: Approximate channel length: 3.75 miles, approximate channel slope 0.01%.

CR6 has one major road crossing at Highway 9. Immediately upstream of the Highway 9 bridge crossing is a BLM Wildlife area. The Kenny Barger (KB) ditch, located on the upstream end of this reach, is one of the single largest diverters in this reach of the Colorado River. Return flows from the KB ditch extend many miles downstream. The river appears to have many remnant oxbows. Adjacent land use is predominately agriculture. Some of the ranches have maintained a river corridor buffer of predominantly cottonwood overstory, while others have not. This reach also includes the confluence of Troublesome Creek, which is one of the few tributaries in the County with a natural flow regime. Muddy Creek confluences with the Colorado almost at the same location as the Blue River but on the opposite (north) bank on the downstream end of CR6.

This reach of the Colorado River is wide, flat and sinuous with an accompanying wide river corridor and valley. The lower 3.75 miles between Elk Trout Lodge and the Blue River confluence is particularly flat and depositional. In the 1980s when Windy Gap came on-line the predicted flows and water levels in CR6 were estimated to render the surface water diversions unusable. Thus irrigation pumps were installed by NCWCD at the ranches along this reach for diverting their irrigation water. Since the 1980s it has been reported that the lower flows have resulted in thick ice build-up (extending the entire reach) which in turn forces the river to flow under the ice and with relatively high velocities. As a result the river bed in CR6 has degraded, requiring the installation of four (4) grade control structures, installed in 2006, for maintaining the necessary water levels for the ranchers to continue to pump. Algae were observed in early July, 2008 along the Colorado River in CR6 and are reportedly very problematic with the pumps. Algae are also reportedly decaying under the ice layer in the winter with accompanying gas and odor accumulation (Thompson, 2010).



Colorado River immediately downstream of KB



Algae in the River at the Thompson Ranch downstream of Highway 9



Colorado River at Confluence with Muddy Creek (on right) and Blue River (on left)

Flow Recommendations:

Environmental Flow Methodology: A PHABSIM study site was established within this reach during summer 2007. See Appendix A for methodology and Appendix E for PHABSIM survey information. CWCB instream flows have been set for CR6.

Water Users:

- Irrigators, municipalities and industry flow-related issues: Based on discussions with Bill Thompson, this area of the river becomes heavily overgrown with algae during the summer months. The Thompsons run pumps to irrigate and must clean the pump grates sometimes up to three times per day to keep the algae from blocking the grate. During the winter, this area develops large ice layers that causes scour along the bed, sometimes in excess of two feet (Thompson 2007).
- Recreation: Recreation is generally limited to angling.

Summary of Flows:

Environmental, recommended target flow ranges (See Appendix A for methodology)

- 250 to 500 cfs, April through September
- 150 to 250 cfs, October through March
- Flushing flow, at least 850 cfs for a 3-day duration with a frequency of 1 in 2 years during the late May to late June period.

CWCB Flows

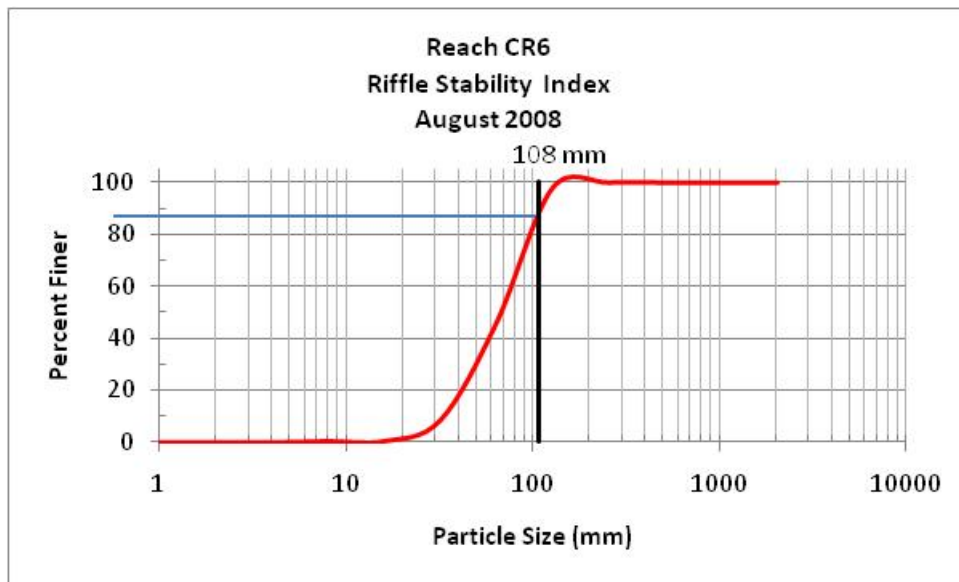
- 150 cfs round (1/1 – 12/31)

Water Users

- Irrigators, municipalities and industry: The local diversions in this reach could potentially divert up to approximately 128 cfs. Most of the diversions are made in the summer for irrigation and will likely have some return flows.
- Recreational flows:
 - Angling: 60-300 cfs

Stream Assessments: In August 2008 Tetra Tech conducted three stream assessments in CR6. These included Stream Reach Inventory/Channel Stability Evaluation (SRI/CSE), EPA Habitat Quality Assessment (HQA) and a Riffle Stability Index (RSI) evaluation. The RSI was performed at the CR6 PHABSIM site, which is located at the upstream end of this reach. The SRI/CSE evaluation ranked in the ‘fair’ category, the EPA HQA evaluation scored at the boundary between ‘marginal’ and ‘suboptimal’, and the RSI of 86 indicates the riffle substrate is highly unstable with up to 86% of the particles mobilized by recent high water events. Relevant issues revealed in the stream assessments include extensive fine sediment deposition associated with the flat gradient in the lower part of this reach, algae build up and ice formation; a lack of aquatic structure and cover, marginal riparian vegetation cover in some areas, and a lack of habitat diversity. In addition, the ice formation is also causing the streambed to lower with accompanying bank degradation. Results of the assessments are summarized in the following table and plot. Details and methodology are presented in Appendix A.

Reach CR6 Stream Assessments					
Stream Reach Inventory/Channel Stability Evaluation			EPA Habitat Quality Assessment		
Attribute			Attribute	Score	
Upper Banks			Channel		
1	Landform Slope	2	1	Aquatic Habitat Barriers/ Diversion	18
2	Mass wasting hazard	4	2	Aquatic Structure as Cover	5
3	Debris Jam Potential	2	3	Velocity/ Depth Regimes	5
4	Vegetation Cover	7	4	Channel Flow Status	16
		Upper Bank Score:	5	Channel Alteration	13
			6	Frequency of Riffles	3
Lower Banks			7	Channel Sinuosity	11
5	Channel Capacity	3	Channel Score		71
6	Bank Rock Content	8	Banks		
7	Flow obstructors & Deflectors	3	8	Bank Stability	12
8	Cutting	8	9	Riparian Vegetation Cover and Disturbance	12
9	Deposition	8	10	Riparian Vegetation zone width	10
		Lower Bank Score:	Bank Score		34
			Total Score		105
Channel Bottom			Notes		
10	Rock Angularity	3			
11	Brightness	3			
12	Consolidation/Particle Packing	8			
13	Bottom size distribution	14			
14	Bed Scour and Deposition	18			
15	Clinging Aquatic Veg	3			
		Channel Bottom Score:			
		Total Score:			94



Spawning Observations: A trout spawning survey was conducted on 30 October 2008 in the vicinity of the PHABSIM site. A number of adult brown trout exhibiting spawning behavior were observed just upstream of the site immediately below the KB Ditch diversion structure. Field measurements were made at eight redds.

Hydrologic Records: The only records available for reach CR6 are seasonal data collected by the Northern Colorado Water Conservation District from 1991 to present at a gage station located just downstream of the KB Ditch. The hydrograph plot and IHA analysis indicate the recommended environmental target flow ranges have been frequently present within the reach over the period-of-record.

Water Temperature: CR6 is a Tier II stream reach as designated by CDPHE with a chronic temperature standard of 18.2°C MWAT and an acute temperature standard of 23.8°C DM. Temperature data reviewed in reach CR6 indicate stream temperatures for the Colorado River in this area are typically below the MWAT and DM standards. However, some exceedences have occurred and resulted in placement of this reach on the 303 (d) list of impaired waters for temperature, with a high priority.

Water Quality: Algae is a constant nuisance for pumping operations and effects aesthetics. No other water quality concerns were noted from the available data.

Water Supply Issues (UPCO): Agricultural diversions are not fully addressed by UPCO.

Summary of Results and Additional Remarks:

1. Recommended environmental target flow ranges are frequently present within the reach over the period-of-record.
2. The stream assessments indicate extensive fine sediment deposition associated with the flat gradient in the lower part of this reach, algae build up, ice formation and bank degradation.
3. The lower portion of the reach has little aquatic structure and cover, marginal riparian vegetation, and limited habitat diversity.
4. CR6 is currently on the proposed 303(d) list, with high priority.
5. Flows for recreation are generally adequate except that late summer low flows combined with high temperatures are believed to be impacting the fisheries. There is little float boating in CR6 due to limited access and low flows.
6. Ice build-up in CR6 is causing the stream bed to drop resulting in problems with diversions and bank stability. Four grade control structures have been installed recently to help with the pumps.
7. Review of future flow conditions as depicted by Denver Water's PACSM model indicate that the late summer flows, flushing flows and winter base flows, without flow enhancements or restoration, may be occasionally lower than target ranges in this reach.

Restoration Opportunities: Proposed flow enhancements and flushing flow recommendations made for CR4 will provide direct benefits in CR6 as well. Additional opportunities in CR6 include the following:

- ✓ The icing and aquatic vegetation problems, as well as the overall lack of habitat structure and diversity in much of CR6 may warrant further study and ultimately the design and construction of improvements. Improvements might include reconfiguring the channel to better accommodate low flows, improving the pump systems or creating a centralized pumping system, stabilization of channel banks in eroded areas, installation of pool-cover structures, and revegetation in selected locations to provide enhanced shading. See Appendix F for details.

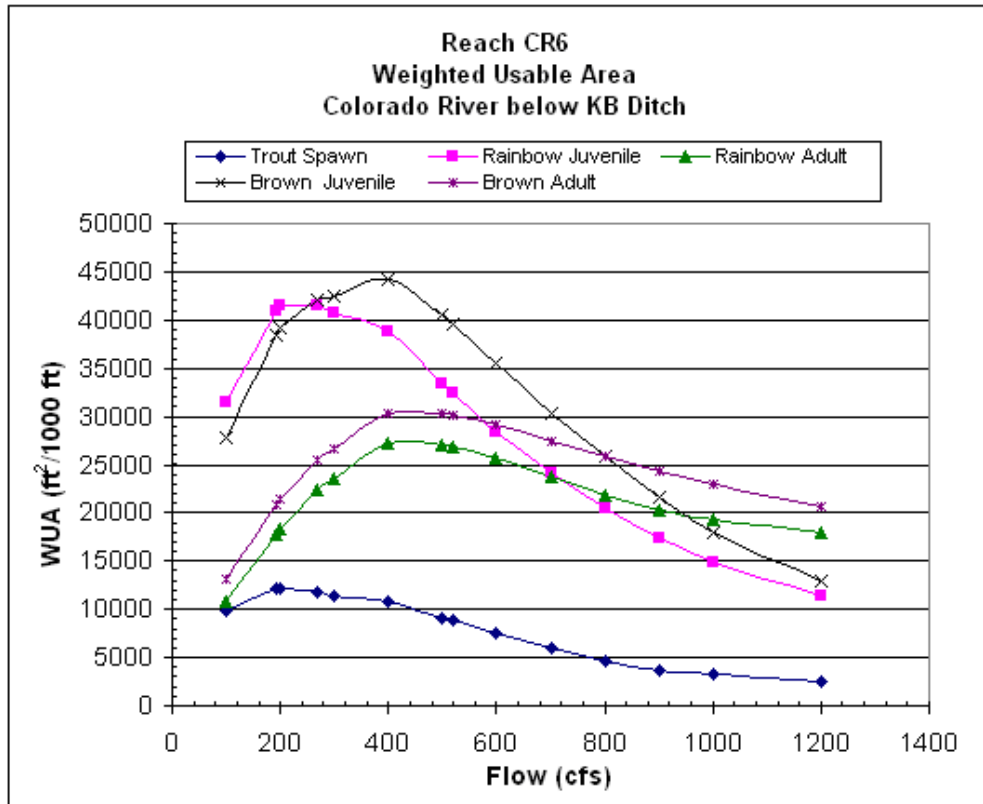
Monitoring: Consider adding a year round gage at or near U.S. Highway 9 to monitor streamflows and surface water temperature. Should physical improvements be implemented as described above, additional monitoring may be warranted. Continue to monitor for water quality.

Support Data

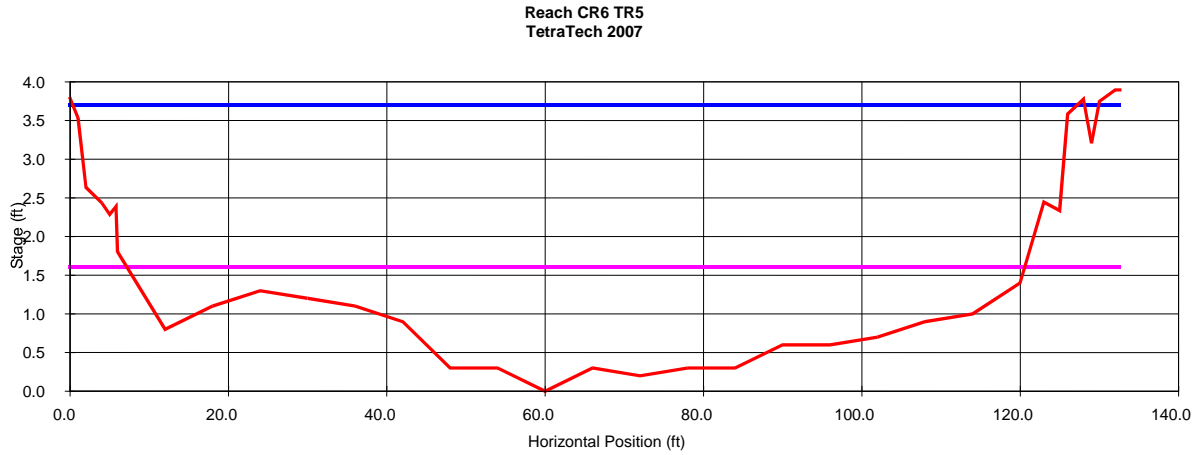
Weighted Useable Area Plots and Tables

Habitat-flow relations for the target species and life stages for Reach C6, Tetra Tech site.

Reach CR6						
Discharge	Total Area	Trout Spawn	Rainbow Juvenile	Rainbow Adult	Brown Juvenile	Brown Adult
(cfs)	(ft ²)	Weighted Usable Area (ft ² /1000 ft stream length)				
100	95685.5	9831.0	31426.6	10732.5	27749.7	13081.5
191	105924.1	12201.1	41009.4	17736.9	38462.8	20876.2
200	106733.2	12197.5	41423.5	18307.7	39113.4	21473.5
267	112643.3	11784.8	41435.2	22355.1	42000.9	25565.0
300	114184.2	11312.4	40649.5	23638.0	42501.3	26727.7
400	116592.4	10765.8	38706.8	27225.2	44128.3	30298.6
500	118381.4	9161.0	33455.2	27089.0	40487.9	30231.6
518	118580.2	8846.7	32512.7	26891.1	39543.4	30085.0
600	119792.3	7452.8	28465.1	25643.2	35509.0	29090.5
700	121288.7	5926.2	24134.6	23668.2	30330.8	27450.6
800	122244.9	4634.9	20406.2	21785.1	25787.2	25782.4
900	123140.8	3735.4	17366.5	20338.0	21620.1	24278.2
1000	123702.5	3201.4	14882.1	19236.9	18047.0	22976.3
1200	124684.9	2559.4	11354.8	18000.9	12919.4	20748.6

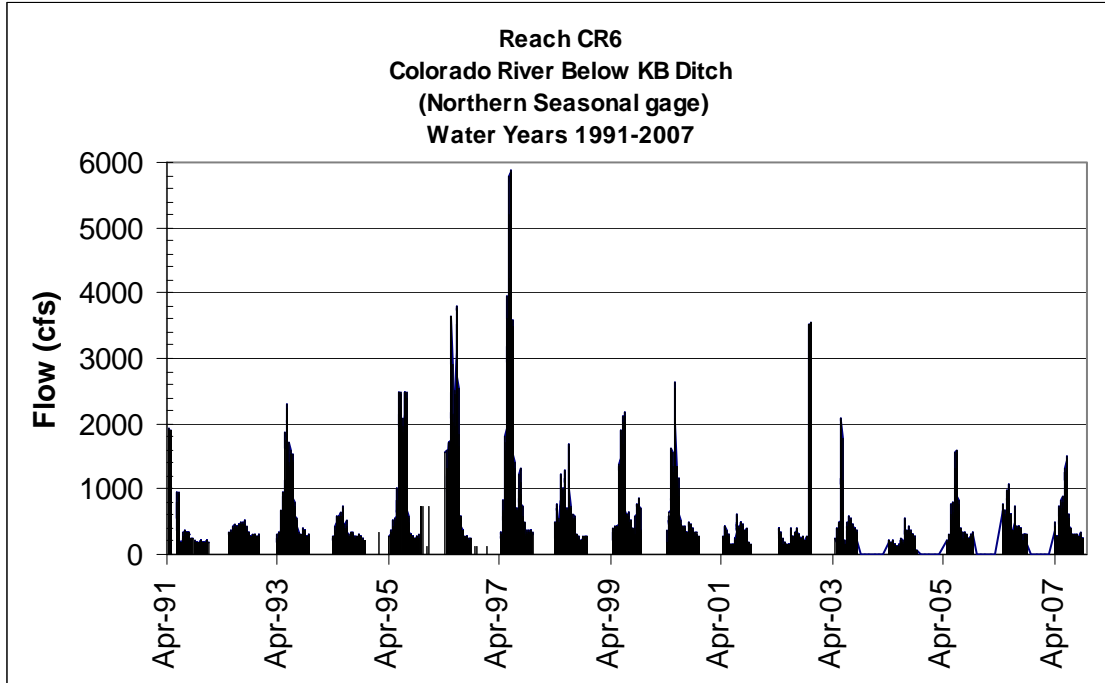


Wetted Perimeter-Flow Relationship



Reach CR6, TR5										
TT2007 Site										
Resistance Method: Jarrett's Equation										
STAGE	AREA	PERIM	WIDTH	R	DHYD	SLOPE	n	VAVG	Q	SHEAR
(ft)	(sqft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)		(ft/s)	(cfs)	(psf)
1.6	101.6	113.6	113.4	0.89	0.9	0.002	0.037	1.7	167.4	0.11
1.7	113.0	114.5	114.3	0.99	0.99	0.002	0.037	1.8	201.9	0.12
1.8	124.4	115.4	115.2	1.08	1.08	0.002	0.036	1.9	239.4	0.13
1.9	136.0	115.8	115.5	1.17	1.18	0.002	0.036	2.1	280.7	0.15
2.0	147.5	116.2	115.8	1.27	1.27	0.002	0.035	2.2	325.0	0.16
2.1	159.1	116.6	116.1	1.36	1.37	0.002	0.035	2.3	372.2	0.17
2.2	170.7	117.0	116.4	1.46	1.47	0.002	0.035	2.5	422.2	0.18
2.3	182.4	117.7	117.0	1.55	1.56	0.002	0.034	2.6	474.4	0.19
2.4	194.2	120.7	119.9	1.61	1.62	0.002	0.034	2.7	521.1	0.2
2.5	206.3	122.7	121.8	1.68	1.69	0.002	0.034	2.8	574.3	0.21
2.6	218.6	123.8	122.9	1.77	1.78	0.002	0.034	2.9	633.2	0.22
2.7	230.9	124.4	123.4	1.86	1.87	0.002	0.033	3.0	697.4	0.23
2.8	243.2	124.6	123.6	1.95	1.97	0.002	0.033	3.2	765.7	0.24
2.9	255.6	124.9	123.7	2.05	2.07	0.002	0.033	3.3	836.9	0.26
3.0	268.0	125.2	123.9	2.14	2.16	0.002	0.033	3.4	910.9	0.27
3.1	280.4	125.5	124.1	2.23	2.26	0.002	0.032	3.5	987.7	0.28
3.2	292.8	125.8	124.3	2.33	2.36	0.002	0.032	3.7	1067.3	0.29
3.3	305.3	126.4	124.9	2.41	2.45	0.002	0.032	3.8	1146.8	0.3
3.4	317.8	127.1	125.4	2.5	2.53	0.002	0.032	3.9	1228.8	0.31
3.5	330.3	127.8	126.0	2.58	2.62	0.002	0.032	4.0	1313.2	0.32
3.6	343.0	128.8	126.8	2.66	2.7	0.002	0.031	4.1	1397.5	0.33
3.7	355.7	130.7	128.7	2.72	2.77	0.002	0.031	4.2	1476.3	0.34

Hydrographs and Exceedence Plots and Tables



IHA Results

Reach CR6
Non-Parametric IHA Scorecard
Colorado River below KB Ditch (Seasonal)
Season from Julian date 92.to 274; April through September

Period of Analysis: 1991-2007 (17 years)

Mean annual flow (cfs)	578.1	
Mean flow/area (dimensionless)	578.1	
Annual C. V.	1.13	
Flow predictability (%)	0.51	
Constancy/predictability	0.74	
% of floods in 60d period	0.62	
Flood-free season (days)	10	
	Medians	Coeff. of Disp.
Parameter Group #1		
October (cfs)		
November (cfs)		
December (cfs)		
January (cfs)		
February (cfs)		
March (cfs)		
April (cfs)	321.6	0.6681
May (cfs)	522.3	1.744
June (cfs)	657.8	1.739
July (cfs)	398.3	0.5458
August (cfs)	313.8	0.3475
September (cfs)	244	0.2534
Parameter Group #2		
1-day minimum (cfs)	150.9	0.7478
3-day minimum (cfs)	154.8	0.7114
7-day minimum (cfs)	179	0.5743
30-day minimum (cfs)	219.3	0.4849
90-day minimum (cfs)	321.2	0.6123
1-day maximum (cfs)	1685	1.027
3-day maximum (cfs)	1588	1.064
7-day maximum (cfs)	1519	0.998
30-day maximum (cfs)	934	1.333
90-day maximum (cfs)	623.3	1.276
Number of zero days (count)	0	0
Base flow index (7day minimum in cfs/median in cfs)	0.2996	0.783
Parameter Group #3		
Date of minimum (Julian day)	249	0.3702
Date of maximum (Julian day)	172	0.09973
Parameter Group #4		
Low pulse count (#)	4	0.75
Low pulse duration (days)	6.5	1.231
High pulse count (#)	2	1.75
High pulse duration (days)	5	2.55
The low pulse threshold is (cfs)	247.1	
The high pulse threshold is (cfs)	598.6	
Parameter Group #5		
Rise rate (cfs difference between consecutive days)	20.73	0.7484
Fall rate (cfs difference between consecutive days)	-21.19	-0.8091
Number of reversals	58	0.1983

Reach CR6

IHA Percentile Data

Colorado River below KB Ditch (Northern Seasonal)

Season from Julian date 92 to 274. (April through Sept)

Parameter Group #1	Period of Analysis: 1991-2007 (17 years)					
	10%	25%	50%	75%	90%	(75-25)/50
October (cfs)						
November (cfs)						
December (cfs)						
January (cfs)						
February (cfs)						
March (cfs)						
April (cfs)	140.5	268.7	321.6	483.6	1459	0.6681
May (cfs)	144.4	208.9	522.3	1120	1971	1.744
June (cfs)	139.3	244.7	657.8	1389	2681	1.739
July (cfs)	239.3	325.4	398.3	542.8	990.3	0.5458
August (cfs)	247.8	283	313.8	392.1	505.8	0.3475
September (cfs)	184.4	225.4	244	287.2	383.7	0.2534
Parameter Group #2						
1-day minimum (cfs)	7.613	92.92	150.9	205.7	235.2	0.7478
3-day minimum (cfs)	15.52	100.8	154.8	211	241.9	0.7114
7-day minimum (cfs)	31.33	113.9	179	216.7	255.4	0.5743
30-day minimum (cfs)	88.25	159.8	219.3	266.2	313.4	0.4849
90-day minimum (cfs)	171.4	238.4	321.2	435	644.2	0.6123
1-day maximum (cfs)	497	670.4	1685	2401	4198	1.027
3-day maximum (cfs)	456.5	643.2	1588	2332	4177	1.064
7-day maximum (cfs)	406.9	577	1519	2093	4056	0.998
30-day maximum (cfs)	321.9	488.5	934	1733	2726	1.333
90-day maximum (cfs)	274.3	415.3	623.3	1211	2020	1.276
Number of zero days (count)	0	0	0	0	0.2	0
Base flow index (7day minimum in cfs/median in cfs)	0.08069	0.2061	0.2996	0.4407	0.5362	0.783
Parameter Group #3						
Date of minimum (Julian day)	103.2	132	249	267.5	273.2	0.3702
Date of maximum (Julian day)	138.4	153.5	172	190	208.4	0.09973
Parameter Group #4						
Low pulse count (#)	1.8	2	4	5	8.2	0.75
Low pulse duration (days)	1.8	4.5	6.5	12.5	47.9	1.231
High pulse count (#)	0	0.5	2	4	7	1.75
High pulse duration (days)	1.4	3	5	15.75	34.8	2.55
Parameter Group #5						
Rise rate (cfs difference between consecutive days)	8.541	10.12	20.73	25.63	43.81	0.7484
Fall rate (cfs difference between consecutive days)	-41.05	-27.9	-21.19	-10.75	-7.238	-0.8091
Number of reversals	44	52.5	58	64	75	0.1983
EFC Monthly Low Flows						
October Low Flow (cfs)						
November Low Flow (cfs)						
December Low Flow (cfs)						
January Low Flow (cfs)						
February Low Flow (cfs)						
March Low Flow (cfs)						
April Low Flow (cfs)	112.5	184.1	263.7	321.6	378.4	0.5213
May Low Flow (cfs)	124.4	177.5	207.6	397	417.4	1.058
June Low Flow (cfs)	133.9	146.5	206.2	263.1	302.8	0.5653
July Low Flow (cfs)	209.3	258.6	338.6	355.2	411.3	0.2851
August Low Flow (cfs)	226.4	259.5	304.5	367.3	393.2	0.3539
September Low Flow (cfs)	183.4	225.4	244	271.1	298.3	0.1871
EFC Parameters						
Extreme low peak (cfs)	0	0	0	0	0	0
Extreme low duration (days)	1	61	121	137	153	0.6281
Extreme low timing (Julian date)	126	200.5	306	306	306	0.2883
Extreme low freq. (#/year)	0	0	0	1	1	0
High flow peak (cfs)	393.8	460.8	530	616.5	719.6	0.2939
High flow duration (days)	2.8	5.5	7.5	11.5	23.8	0.8
High flow timing (Julian date)	117.5	155	193	219	278.2	0.1749
High flow frequency (#/year)	1	1.5	3	4	6.2	0.8333
High flow rise rate (cfs difference between consecutive days)	29.61	37.94	59.21	99.31	142.8	1.037
High flow fall rate (cfs difference between consecutive days)	-81.93	-67.31	-55.9	-42.57	-27.09	-0.4426
Small Flood peak (cfs)	1601	1803	2400	2769	3781	0.4026
Small Flood duration (days)	32	67.75	83.5	104.8	220	0.4431
Small Flood timing (Julian date)	52	150.8	173.5	183.3	197	0.0888
Small Flood freq. (#/year)	0	0	0	1	1.2	0
Small Flood riserate (cfs difference between consecutive days)	18.09	24.46	44.6	131.6	196.1	2.402
Small Flood fallrate (cfs difference between consecutive days)	-161.9	-92.83	-75.65	-52.63	-28.85	-0.5314
Large flood peak (cfs)			5865			
Large flood duration (days)			123			
Large flood timing (Julian date)			160			
Large flood freq. (#/year)	0	0	0	0	0.2	0
Large flood riserate (cfs difference between consecutive days)			105.1			
Large flood fallrate (cfs difference between consecutive days)			-76.99			

Surface Water Temperature Plots

