



# **INDICATORS OF HYDROLOGIC ALTERATION REPORT**

**CLAYTOR PROJECT  
FERC NO. 739**

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## **INTRODUCTION**

Appalachian Power Company (Appalachian) is making application to the Federal Energy Regulatory Commission (FERC) for a new license for the Claytor Hydroelectric Project (No. 739), located on the New River in southwestern Virginia. The process selected by Appalachian for applying for a new license is the Integrated Licensing Process (ILP), as defined under FERC's rules and regulations (18 CFR Part 5). As part of this licensing process, Appalachian solicited input from stakeholders, including governmental agencies and non-governmental organizations, to identify potential project-related issues that should be addressed during the licensing process.

Initial instream flow study plan meetings were held with stakeholders on July 19 and 20, 2006. A workgroup, comprising representatives from state resource agencies, universities, non-governmental organizations, and interested citizens, met in August 2006 to address specifics of the instream flow needs study. These meetings resulted in the development of a revised study plan, dated November 21, 2006, which included the use of The Nature Conservancy's Indicators of Hydrologic Alteration (IHA) software.

The IHA program was used to analyze a full range of statistical parameters related to hydrology data. It was used to calculate comparison statistics between two different flow regimes to help determine similarities and differences. For this task, IHA was used to analyze the unimpaired (pre-impact) and 1972-2006 (post-impact) flow data sets developed for two reaches downstream of Claytor dam on the New River. This information was directly incorporated into the Instream Flow Needs Study report.

### **Hydrology Development**

The IHA methodology uses daily average flow statistics to assess changes in flow regime associated with water resource developments. In order to account for differences associated with tributary inflows, the New River downstream of Claytor dam was divided into two reaches:

Reach 1 extends from Claytor dam downstream to just above Sinking Creek near Pembroke, approximately river mile 0 to 30.

Reach 2 extends from Sinking Creek to the upper end of Bluestone Lake, approximately river mile 30 to 65.

Two sets of daily average flows were developed, one for historic project operations and one for flows unimpaired by operation of the Claytor Project. The period of record for flow data available from USGS gages in the project vicinity is shown in table 1. There is a limited amount of flow data available from these gages prior to 1939, when the Claytor Project was constructed.

**Table 1: Gage summary**

<b>Gage number</b>	<b>Gage name</b>	<b>Period of record</b>	<b>Drainage area (square miles)</b>	<b>Tributary drainage area downstream of gage (square miles)</b>
03168000	New River at Allisonia, VA (above Claytor Lake)	10/1/1929 to present	2,212	NA
03170000	Little River at Graysontown, Va	10/1/1928 to present	309	42
03171000	New River at Radford, VA (river mile 5.5)	10/1/1907 to present <sup>a</sup>	2,767	NA
03173000	Walker Creek at Bane, VA	4/1/1938 to present	299	13
03175500	Wolf Creek near Narrows, Va	7/22/1908 to present	223	9
03176500	New River at Glen Lyn, VA (river mile 56)	10/1/1927 to present	3,783	NA

<sup>a</sup> records do not exist for the 1917 to 1939 time period.

Comparison of flow regimes prior to and after the existing license went into effect on July 1, 1981 indicate that changes in inflows to Claytor reservoir have had a greater effect on daily average outflows than any changes in project operation. Figures 1 and 2 show that during the month of September, normally a low flow month, the exceedance values for the Allisonia gage upstream of Claytor dam and the Radford gage, downstream of Claytor dam are more of a reflection of changes in the daily average inflow than of changes in project operations for flows below 6,000 cfs. The hydraulic capacity of the Claytor Project is 10,000 cfs, but the vast majority of the flows, even during peaking operations are below 6,000 cfs during the month of September.

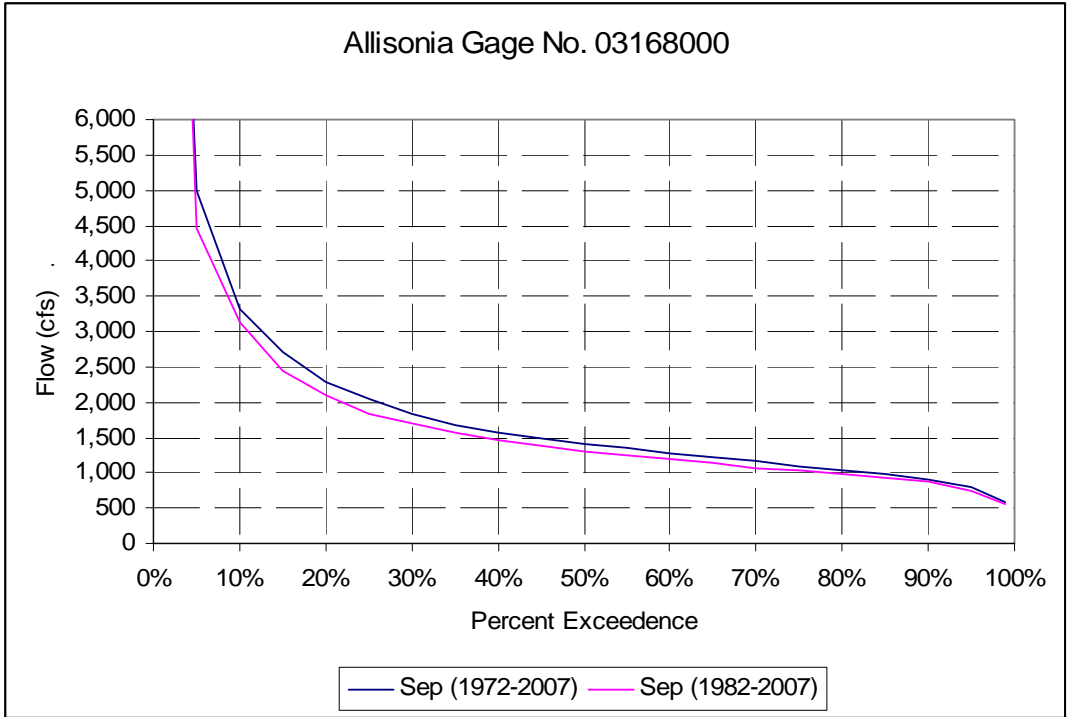


Figure 1. USGS Allisonia gage exceedance chart, daily average flows

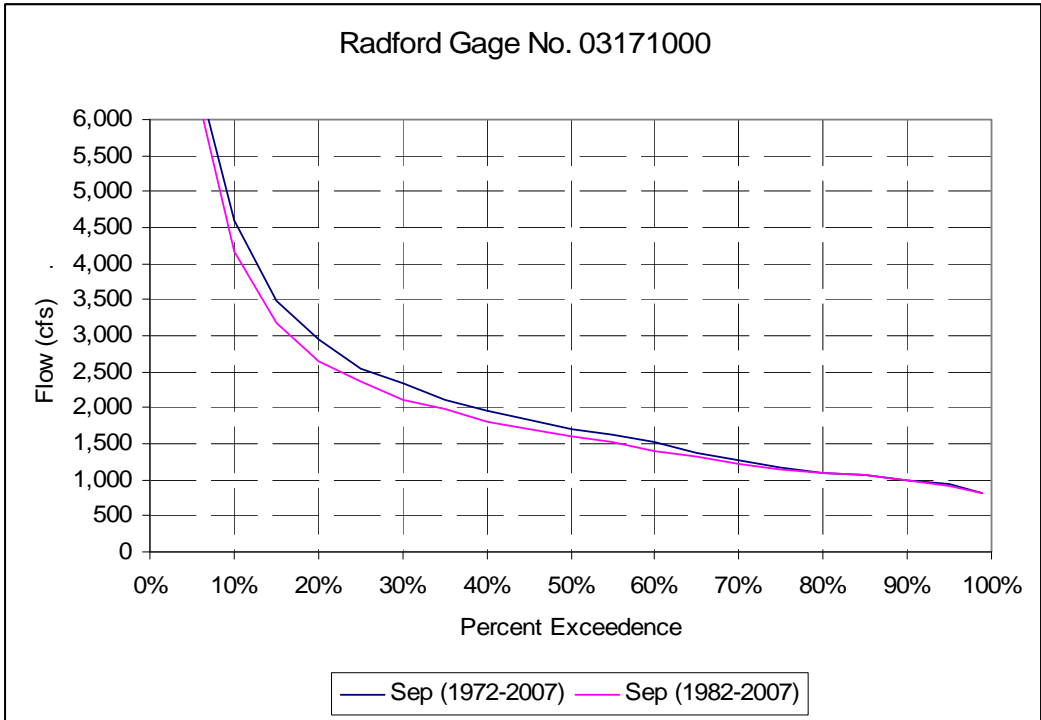


Figure 2. USGS Radford gage exceedance chart, daily average flows

Because daily average flow statistics were not altered substantially and the IHA analysis is more robust when flows over a longer period are analyzed, the hydrologic record for the 35 year period from October 1, 1971 to September 30 2006 was used to describe post-project hydrology. A period of record of 35 years is normally the minimum used for the statistical evaluation under the IHA analyses and for use in Physical Habitat Simulation (PHABSIM) time series methodologies.

### **Unimpaired Dataset Calculation**

To determine the daily flow regime for the period prior to the operation of the Claytor Project, the following methodology was used:

For Reach 1:

Daily USGS streamflow data from the Allisonia gage was prorated by a factor of 1.076 to represent the total inflow to Claytor dam, which has a drainage area of 2,380 square miles. This data set was added to a data set representing the prorated daily USGS streamflow data from the Little River gage. The Little River gage data was prorated by 1.252 to represent the combination of the drainage area of the Little River downstream of the gage (42 square miles) and the contribution drainage area (36 square miles which enter the New River before the Radford USGS stream gage). On the Little River, just upstream of the confluence with the New River, is Little River reservoir, which has a maximum storage capacity of about 500 acre-feet and has a small hydropower project. Because of its small storage capacity, however, the operation of this small facility does not substantially affect daily average flows.

For Reach 2:

Daily USGS stream flow data from the Wolf Creek and Walker Creek tributaries were prorated by a factor of 1.9098 to estimate the inflow of the tributaries in this reach. This estimation procedure was used except for water year 1996, when daily streamflow data was missing for Wolf Creek, resulting in a larger reliance on the Walker Creek gage data. The tributary inflow dataset was then added to the synthetic dataset representing the unimpaired flow at the Radford gage to develop a daily data set for the unimpaired flows at the Glen Lyn gage.

This data represent the baseline or pre-impact conditions for the IHA comparison.

### **Post Project Dataset Calculation**

Historical daily flow data from the Radford and Glen Lyn gages were used to represent flows in Reach 1 and Reach 2, respectively, for the period from October 1, 1971 to September 30, 2006. This data represents gaged (post-impact) flows in the New River which IHA compares to pre-impact.

## IHA Analysis Output

The IHA program produces numerous statistical descriptions of both the flow data for each period and differences between pre- and post- impact time periods. IHA output tables are contained in Appendix A, however selected data is summarized here.

Minimum and maximum flows differed between pre- and post-impact periods. Minimum flows showed less variation in the post-impact period compared to pre-impact. At Reach 1, this is represented by the 1-day minimum flow coefficient of dispersion (75<sup>th</sup> percentile-25<sup>th</sup> percentile / 50<sup>th</sup> percentile) of 0.3333 for the pre-impact period versus a coefficient of dispersion of 0.1902 for the post impact period (Table 2). Also represented in this table is a decrease in the median (50<sup>th</sup> percentile) maximum flows during the post-impact period. These changes generally are also found in the Reach 2 results but to a lesser degree due to the influence of tributary inflow below Claytor dam.

Table 2 Reach 1 (Radford) distribution of minimum and maximum flows for the pre- and post- impact periods

	Pre-Impact						Post-Impact					
	10%	25%	50%	75%	90%	Coeff. Dispersion	10%	25%	50%	75%	90%	Coeff. Dispersion
1-day minimum	720.2	859	1032	1203	1400	0.3333	769.2	840	894	1010	1078	0.1902
3-day minimum	768.7	941.3	1090	1323	1607	0.3502	826.7	903	989.7	1097	1141	0.1957
1-day maximum	18220	27510	38820	54340	67170	0.6912	14120	22400	35800	49600	60860	0.7598
3-day maximum	12330	19670	26180	35550	40350	0.6067	12030	17670	23530	31500	36540	0.5878

Figures 3 and 4 display daily flow data for both pre- and post- impact data during a dry period. These graphs show that in general, during low flow periods there is less variability in the post-impact flows compared to pre-impact flows. However, as shown in the late November period of these figures, peaking operations at the Claytor Project can affect the daily flow values at both locations.

Figures 5 and 6 graphically display the following flow summary statistics for each month: median, 25<sup>th</sup> percentile, and minimum. Post-impact values are indicated by bolded lines, pre-impact values are indicated by faded lines.

Radford: Pre- and Post- Impact Daily Flows  
Dry Period

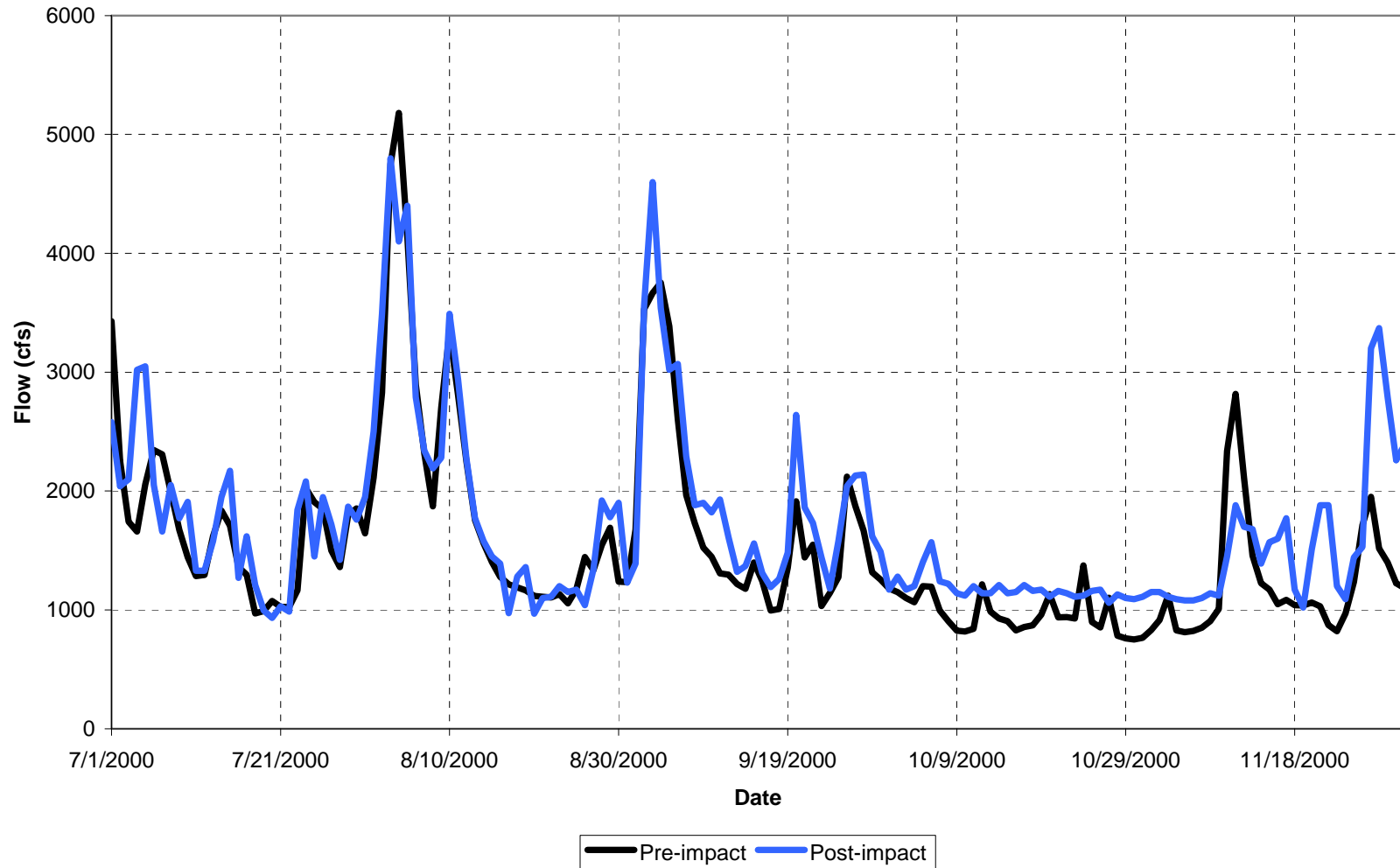


Figure 3 Reach 1 (Radford) Pre and Post Impact Daily Flows

### Glen Lyn: Pre- and Post- Impact Daily Flows Dry Period

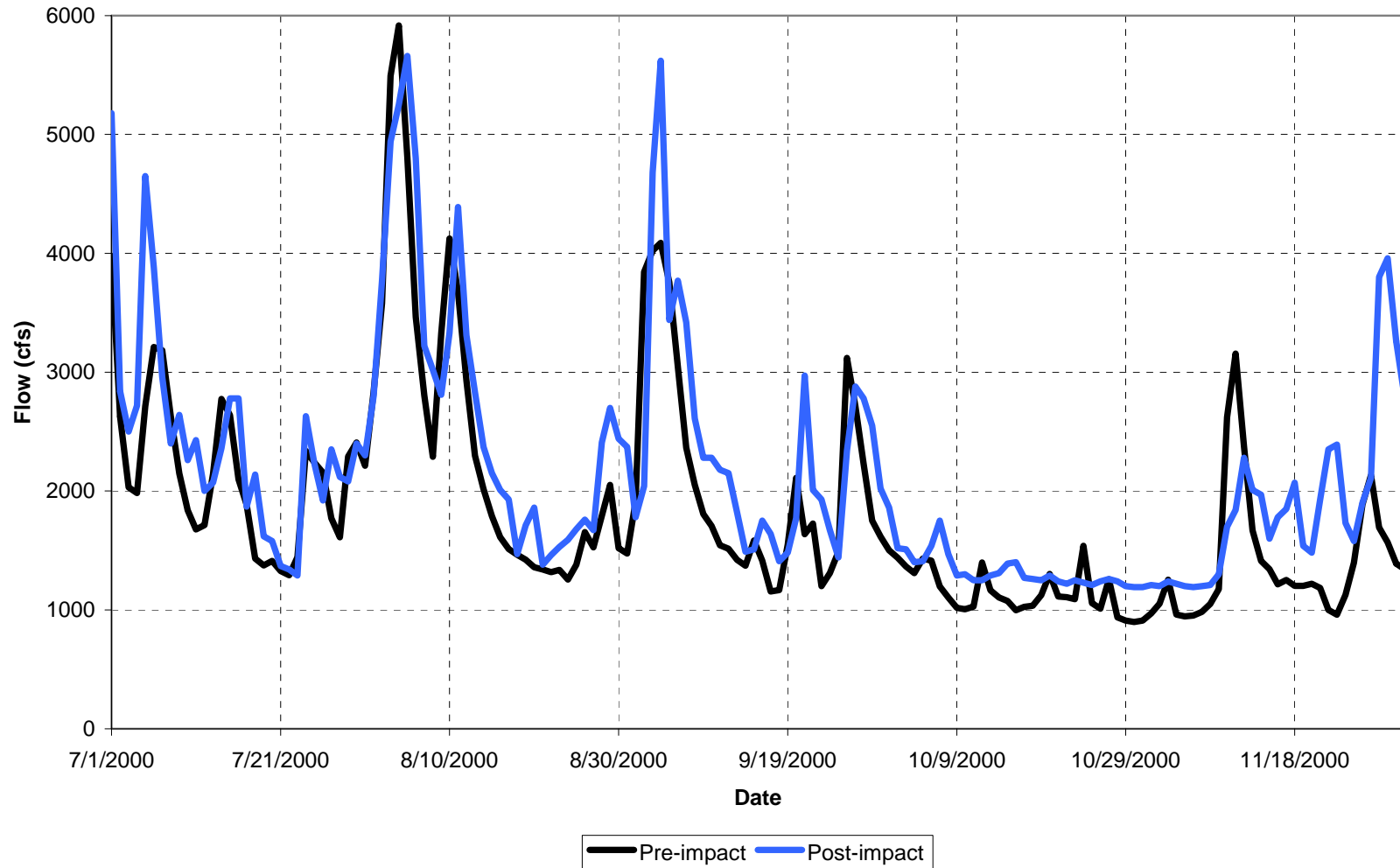


Figure 4 Reach 2 (Glen Lyn) Pre and Post Impact Daily Flows



### Radford Pre- and Post- Impact Flow Statistics

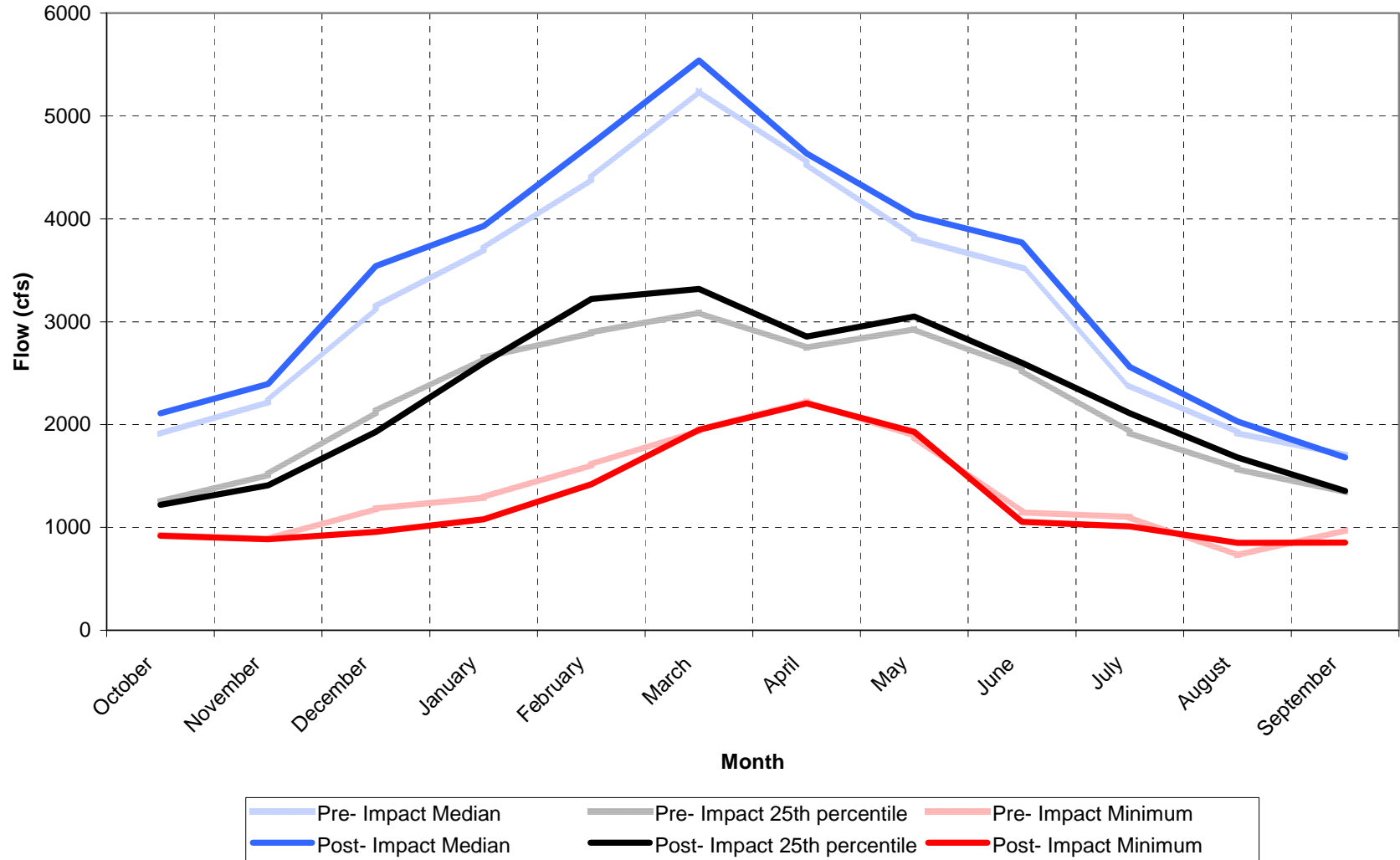


Figure 5 Reach 1 (Radford) Pre and Post Impact Monthly Median and Low Flow Statistics

### Glen Lyn Pre- and Post- Impact Flow Statistics

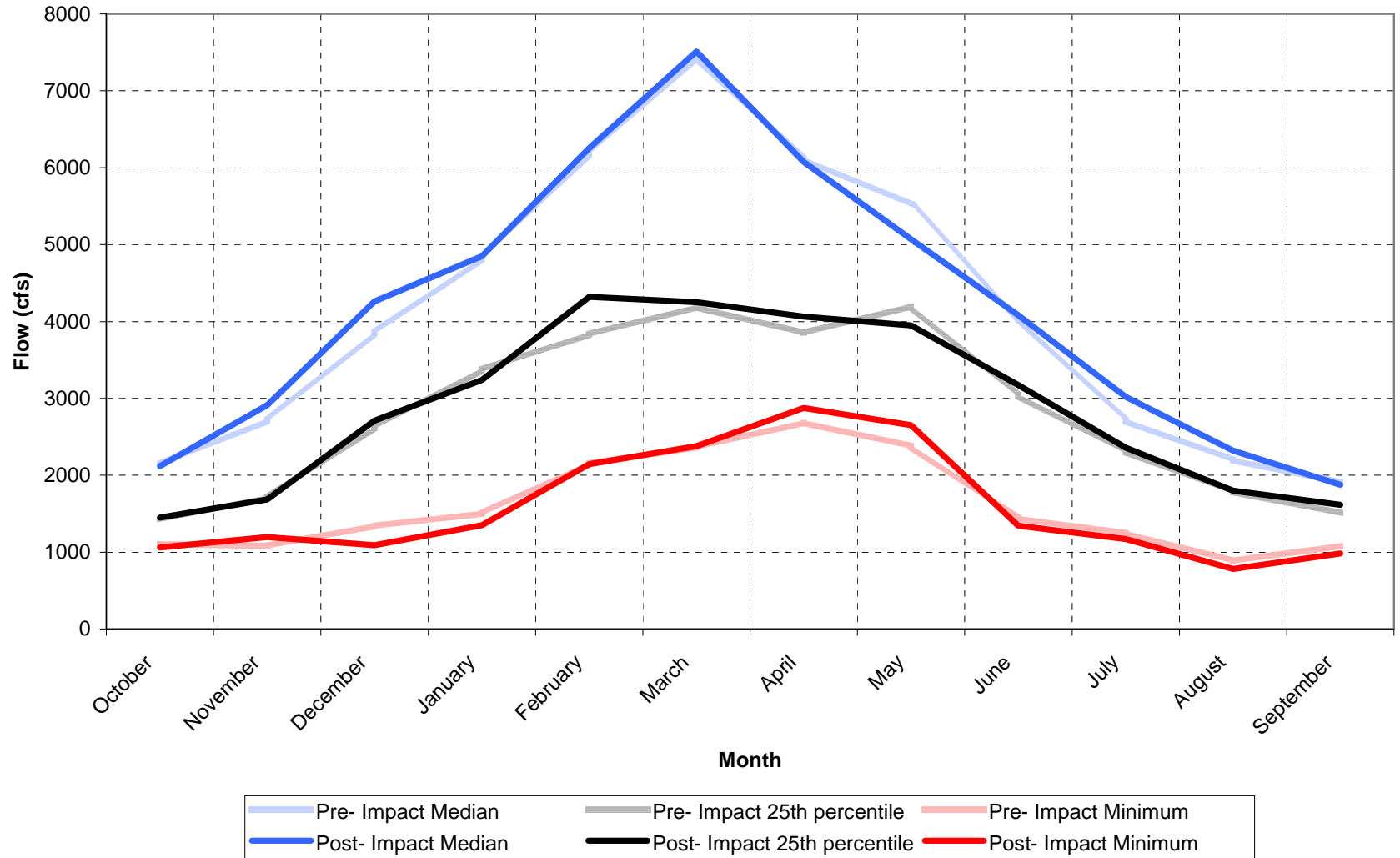


Figure 6 Reach 2 (Glen Lyn) Pre and Post Impact Monthly Median and Low Flow Statistics

## SUMMARY

An Indicators of Hydrologic Alteration (IHA) analysis was performed on New River daily flow data to assess the hydrologic impacts of the Claytor Project. Two flow regimes were analyzed for comparison purposes; the post-impact period represents the New River flow regime under the operations of the Claytor Project. The post-impact period used data recorded at the USGS flow gages at Radford and Glen Lyn. The unimpaired (pre-impact) period represents the New River flow regime that would exist without the impact of the Claytor Project. Data for the pre-impact period were estimated by prorating USGS flow gage measurements on the New River at Allisonia and on the Little River for Reach 1 (Radford), and also at the Wolf Creek and Walker Creek tributaries for Reach 2 (Glen Lyn). Flow gage periods included data from 1972 to 2006, since it was determined that operational changes occurring when the existing license went into effect (July, 1981) had little impact on daily mean flows.

Table 2 represents a section of IHA output showing the distribution of low and high flows. Low flows showed less variability during the post-impact period and high flows decreased in magnitude during the post-impact period. Summary statistics for monthly flow data are represented by Figures 5 and 6. However, the differences in the higher range of flows are more susceptible to influences from the calculations which were used to estimate pre-impact conditions. Small deviations (i.e. less than 500 cfs) occurred between pre- and post- impact periods occurred in the minimum and percentile flows.

Resulting IHA parameters are displayed in Appendix A, tables A1 through A10. This data may be referenced for parameters of interest, including mean monthly flows, percent flow exceedance, and environmental flow components. Scorecard tables represent a statistical analysis of IHA parameters. The Range of Variability tables may be used to compare parameters between the unimpaired and historical periods.

**APPENDIX A**  
**IHA Output Tables**

Tables A1 and A2 represent the percentile summary of the output from the IHA for the pre-impact and post-impact conditions for Reach 1 and Reach 2. Flows are displayed by occurrence percentile.

Tables A3 through A6 represent the annual summary of the output from the IHA for the pre and post-impact conditions for Reach 1 and Reach 2. Flows are displayed by month.

Tables A7 and A8 represent a variety of statistics for the pre- and post-impact periods for each hydrologic parameter. These 'Scorecard Tables' report a statistical analysis of a variety of hydrologic parameters calculated by the IHA program.

Tables A9 and A10 represent the Range of Variability Approach (RVA) analysis outputs for the pre and post-impact conditions for Reach 1 and Reach 2. RVA values indicate the relative alteration of IHA parameters between pre and post-impact conditions.

Table A1: Pre and Post-Impact Percentile Summary Table for Reach 1 (Radford)

Parameter Group #1	Pre-Impact						Post-Impact					
	10%	25%	50%	75%	90%	(75-25)/50	10%	25%	50%	75%	90%	(75-25)/50
October	1021	1250	1906	2566	4473	0.6905	1062	1220	2110	2770	4716	0.7346
November	1237	1512	2223	3794	4496	1.027	1269	1410	2395	4070	5388	1.111
December	1491	2127	3141	4344	5103	0.7058	1168	1930	3540	4710	5468	0.7853
January	1453	2647	3708	4467	5100	0.4908	1376	2600	3930	5140	5958	0.6463
February	2077	2892	4393	5518	6776	0.5978	1966	3220	4725	6000	7207	0.5884
March	2519	3090	5252	6740	7756	0.695	2442	3320	5540	6860	8446	0.639
April	2519	2746	4541	6482	7507	0.8227	2407	2855	4635	6465	7650	0.7789
May	2095	2929	3814	5206	6335	0.597	2314	3050	4030	5350	6330	0.5707
June	1384	2532	3516	4426	5522	0.5389	1401	2600	3770	4735	5218	0.5663
July	1306	1923	2382	3078	3885	0.4849	1296	2110	2560	3320	4028	0.4727
August	1074	1570	1920	2481	3053	0.4745	1034	1680	2030	2690	3352	0.4975
September	1167	1340	1703	2237	3898	0.5266	1116	1355	1680	2345	4233	0.5893
Parameter Group #2												
1-day minimum	720.2	859	1032	1203	1400	0.3333	769.2	840	894	1010	1078	0.1902
3-day minimum	768.7	941.3	1090	1323	1607	0.3502	826.7	903	989.7	1097	1141	0.1957
7-day minimum	838.3	1024	1208	1437	1783	0.342	885.8	942.1	1106	1340	1588	0.3597
30-day minimum	1062	1244	1469	1716	2165	0.3216	1024	1152	1468	1703	2118	0.3755
90-day minimum	1334	1504	2031	2525	3098	0.5027	1367	1481	2172	2580	3044	0.5058
1-day maximum	18220	27510	38820	54340	67170	0.6912	14120	22400	35800	49600	60860	0.7598
3-day maximum	12330	19670	26180	35550	40350	0.6067	12030	17670	23530	31500	36540	0.5878
7-day maximum	7459	13000	17970	20670	26330	0.4268	7532	12430	17400	19980	24770	0.4337
30-day maximum	4750	7021	9561	10960	13510	0.4116	4628	6949	9016	10630	12770	0.4078
90-day maximum	3452	4333	7121	8547	9450	0.5918	3411	4353	6834	8406	9094	0.5931
Number of zero days	0	0	0	0	0	0	0	0	0	0	0	0
Base flow index	0.2428	0.263	0.3112	0.3614	0.3939	0.3162	0.2055	0.2467	0.2808	0.342	0.4238	0.3391
Parameter Group #3												
Date of minimum	119.2	240	267	284	310.4	0.1202	196.6	244	279	342	11.8	0.2678
Date of maximum	323.4	25	89	157	231	0.3607	35.6	89	130	231	310.8	0.388
Parameter Group #4												
Low pulse count	4.6	7	11	15	20.2	0.7273	14	22	28	31	39.8	0.3214
Low pulse duration	1	2	3	5	9	1	1	2	2	2	2	0
High pulse count	7	10	14	17	22	0.5	10.2	17	23	29	34.8	0.5217
High pulse duration	2	3	3	4	6	0.3333	1.8	2	2	2.5	3.7	0.25
Parameter Group #5												
Rise rate	160.3	203	281	362	476	0.5658	265	470	620	800	988.7	0.5323

Fall rate	-459.4	-398.5	-288	-208	-146.3	-0.6615	-942	-810	-590	-450	-228	-0.6102
Number of reversals	115.4	126	143	157	168	0.2168	165	174	183	190	195	0.08743
EFC Monthly Low Flows												
October Low Flow	1353	1428	1849	2349	3663	0.4985	1382	1570	1970	2440	2690	0.4416
November Low Flow	1382	1516	2178	2906	3712	0.6382	1404	1570	2130	2630	3206	0.4977
December Low Flow	1587	2069	2798	3492	4064	0.5087	1782	2060	2570	2860	3335	0.3113
January Low Flow	1619	2132	3110	3751	4003	0.5205	1859	2130	2460	2910	3356	0.3171
February Low Flow	1943	2486	3552	4238	4635	0.4932	1651	2056	2565	2909	3728	0.3324
March Low Flow	2085	2828	4114	4481	4698	0.4019	1728	2298	2880	3513	4286	0.4219
April Low Flow	2375	2577	3631	4481	4760	0.5243	2112	2345	2725	3763	4449	0.5202
May Low Flow	1914	2461	3648	4265	4593	0.4944	1988	2300	2920	3840	4414	0.5274
June Low Flow	1513	2369	3067	3527	3974	0.3777	1618	2460	2740	3555	4088	0.3996
July Low Flow	1600	1815	2356	2820	3401	0.4266	1656	1930	2410	2715	2920	0.3257
August Low Flow	1479	1634	1877	2359	2695	0.3865	1500	1745	2033	2454	2940	0.3487
September Low Flow	1401	1561	1716	2034	2488	0.2753	1520	1680	1855	2300	2527	0.3342
EFC Flow Parameters												
Extreme low peak	978.5	1030	1115	1166	1202	0.1222	993.2	1020	1070	1110	1134	0.08411
Extreme low duration	1	1.125	2	3.5	4.15	1.188	1	1	2	2	2	0.5
Extreme low timing	203.5	245.9	269	290.1	324.1	0.1209	46.6	222.5	262	309	339.9	0.2363
Extreme low freq.	0	1	2	11	15.8	5	6	10	19	26	36	0.8421
High flow peak	5211	5995	6495	6958	8876	0.1483	4601	4870	5180	5470	5809	0.1158
High flow duration	3	4	5	5	6.7	0.2	2	3	3	4	4.7	0.3333
High flow timing	340.3	9.5	71	118	174.2	0.2964	355.9	37.5	74.5	115.5	202.2	0.2131
High flow frequency	9.6	12	16	20	22	0.5	18.6	24	30	35	39.4	0.3667
High flow rise rate	1170	1358	1599	1788	2220	0.2689	1311	1400	1583	1870	2123	0.297
High flow fall rate	-1169	-969	-835.7	-736	-630.4	-0.2788	-1435	-1280	-1079	-901.7	-835.6	-0.3506
Small Flood peak	39320	45750	47780	56050	61260	0.2157	40640	44350	48000	51800	62440	0.1552
Small Flood duration	9.9	17.5	24	54	67	1.521	10.6	14.25	21	39.75	45.2	1.214
Small Flood timing	340.9	54	88.5	113	196.2	0.1612	344.2	22.5	89	202.5	266.6	0.4918
Small Flood freq.	0	0	0	1	2	0	0	0	0	1	2	0
Small Flood riserate	2103	4972	8577	21800	24250	1.962	3992	5757	9518	11810	13060	0.6355
Small Flood fallrate	-5151	-4133	-2321	-1282	-802.1	-1.228	-5174	-4400	-2915	-1572	-1281	-0.97
Large flood peak	69980	69980	83610	98020	98020	0.3353	74000	74000	78250	82500	82500	0.1086
Large flood duration	12	12	15.5	21	21	0.5806	13	13	21.5	30	30	0.7907
Large flood timing	267	267	352	15	15	0.3115	312	312	346.5	15	15	0.1885
Large flood freq.	0	0	0	0	0.4	0	0	0	0	0	0	0
Large flood riserate	28420	28420	32580	47370	47370	0.5815	19870	19870	21800	23730	23730	0.1773
Large flood fallrate	-8477	-8477	-5846	-3275	-3275	-0.8897	-6286	-6286	-4616	-2945	-2945	-0.724

Table A2: Pre and Post-Impact Percentile Summary Table for Reach 2 (Glen Lyn)

	Pre-Impact						Post-Impact					
	10%	25%	50%	75%	90%	(75-25)/50	10%	25%	50%	75%	90%	(75-25)/50
Parameter Group #1												
October	1193	1425	2147	3210	5484	0.8314	1266	1450	2120	3070	5840	0.7642
November	1410	1705	2709	5078	5716	1.245	1414	1685	2910	5310	6016	1.246
December	1773	2624	3853	6082	6987	0.8975	1478	2710	4260	5930	7300	0.7559
January	1649	3375	4819	6337	7112	0.6147	1848	3240	4850	6420	7316	0.6557
February	2766	3833	6182	7327	10100	0.5652	2766	4320	6255	7890	9657	0.5707
March	3505	4186	7437	9029	10340	0.6512	3160	4250	7510	8810	10740	0.6072
April	3315	3851	6112	8239	10460	0.7179	3252	4065	6075	8285	10340	0.6947
May	2874	4199	5519	6765	8223	0.4649	2926	3950	5070	6720	7974	0.5464
June	1634	3036	4043	5525	6632	0.6156	1752	3175	4080	5910	6641	0.6703
July	1573	2308	2708	3506	4573	0.4424	1562	2360	3020	3650	4928	0.4272
August	1246	1784	2198	2722	3636	0.4268	1192	1800	2320	2970	3780	0.5043
September	1362	1508	1905	2489	4958	0.5147	1214	1615	1875	2485	5264	0.464
Parameter Group #2												
1-day minimum	825.2	1052	1162	1401	1634	0.3003	821.8	950	1110	1190	1290	0.2162
3-day minimum	895.7	1115	1238	1502	1811	0.3121	851.7	1022	1197	1313	1433	0.2432
7-day minimum	970.6	1198	1374	1653	2004	0.3311	906.3	1056	1344	1583	1781	0.3918
30-day minimum	1190	1411	1624	1930	2453	0.3195	1150	1260	1663	2001	2289	0.4459
90-day minimum	1501	1826	2352	2981	3812	0.491	1526	1741	2515	2835	3651	0.4348
1-day maximum	22810	39350	51000	76230	101800	0.7232	18980	34900	42400	72400	77400	0.8844
3-day maximum	15890	27990	34670	51560	57740	0.68	14860	24500	30500	45670	55820	0.694
7-day maximum	10460	18290	22960	30640	36410	0.5382	10010	17910	21760	28330	33180	0.4787
30-day maximum	6256	9483	12880	15210	18380	0.4444	6319	9092	12470	15080	17670	0.4806
90-day maximum	4836	5982	9473	11930	12760	0.6279	4813	5769	9131	11430	12560	0.6198
Number of zero days	0	0	0	0	0	0	0	0	0	0	0	0
Base flow index	0.2074	0.2275	0.2751	0.3061	0.367	0.2858	0.1942	0.2283	0.2512	0.2966	0.376	0.2716
Parameter Group #3												
Date of minimum	186	250	267	284	310.4	0.0929	203.8	235	255	284	321.2	0.1339
Date of maximum	319.8	25	89	157	231	0.3607	29	79	111	180	310.8	0.276
Parameter Group #4												
Low pulse count	4.6	6	10	13	19	0.7	8.6	16	21	26	35	0.4762
Low pulse duration	1.8	2	3	7	9.6	1.667	1.6	2	2	3	5	0.5
High pulse count	7	11	13	15	20.4	0.3077	9.2	12	17	23	25.8	0.6471
High pulse duration	2	3	4	5	6.2	0.5	2	2	3	4	4.7	0.6667
Parameter Group #5												
Rise rate	198.4	256	341	440	585.3	0.5396	267	460	700	840	1038	0.5429



Fall rate	-576.2	-510	-353	-259.5	-176.6	-0.7096	-914	-810	-680	-475	-272	-0.4926
Number of reversals	115.2	122	138	149	154.6	0.1957	155.2	164	170	177	183.8	0.07647
EFC Monthly Low Flows												
October Low Flow	1506	1686	2103	2764	4492	0.5124	1530	1760	2125	2730	3078	0.4565
November Low Flow	1564	1785	2562	3656	4634	0.7303	1686	1800	2660	3365	4389	0.5883
December Low Flow	1914	2427	3402	4668	5098	0.6588	1928	2300	2850	3845	5029	0.5421
January Low Flow	2006	2463	3994	4717	5364	0.5644	1972	2705	3250	3650	5470	0.2908
February Low Flow	2454	2971	4238	5494	6067	0.5954	2152	2520	2980	4675	5385	0.7232
March Low Flow	2612	3797	5211	5698	6051	0.3648	2444	2950	4310	5500	5843	0.5916
April Low Flow	3030	3458	4725	5710	6190	0.4767	2824	3035	4038	5360	6198	0.5759
May Low Flow	2426	3215	4577	5605	5901	0.5221	2481	3190	3880	5130	5572	0.5
June Low Flow	1793	2814	3710	4058	5204	0.3353	1959	2820	3440	4140	5073	0.3837
July Low Flow	1829	2148	2595	3232	4015	0.4175	1916	2320	2640	3170	3684	0.322
August Low Flow	1679	1810	2172	2722	3205	0.4201	1743	2061	2358	2855	3113	0.3367
September Low Flow	1621	1759	1979	2317	2916	0.2818	1746	1880	2100	2380	2796	0.2381
EFC Flow Parameters												
Extreme low peak	1128	1193	1290	1340	1381	0.114	1102	1184	1265	1310	1350	0.0998
Extreme low duration	1	1	2	4	6.2	1.5	1	1	2	3	4.25	1
Extreme low timing	214.4	253	261.5	286	306.4	0.09016	219.8	245	271	292.3	310.3	0.1291
Extreme low freq.	0	1	3	9	13	2.667	2.2	4	10	14	20.4	1
High flow peak	6607	7621	8434	10550	13440	0.3476	5518	5870	6265	6890	7833	0.1628
High flow duration	3.8	4	5	6	7.2	0.4	2	3	3	4	5	0.3333
High flow timing	334.4	364	71	122	183.4	0.3388	358.8	29.5	69	119.5	202.4	0.2459
High flow frequency	10	12	15	17	21	0.3333	16.2	22	25	28	31.4	0.24
High flow rise rate	1526	1866	2107	2709	3256	0.4001	1424	1740	2003	2270	2681	0.2646
High flow fall rate	-1481	-1284	-1106	-938	-846.6	-0.3125	-1597	-1287	-1088	-950	-776	-0.3096
Small Flood peak	52070	55800	68150	79980	97290	0.3548	54250	61230	73200	76800	85500	0.2128
Small Flood duration	9	10.75	21	36.25	62.6	1.214	11.25	18.75	25.5	33.5	60.5	0.5784
Small Flood timing	356.7	50	88.5	113	238.2	0.1721	338.8	19	79.5	121	221	0.2787
Small Flood freq.	0	0	0	1	2	0	0	0	0	1	1.4	0
Small Flood riserate	4105	7726	17850	28240	39840	1.149	2976	6316	10520	18300	26520	1.139
Small Flood fallrate	-7781	-6047	-3538	-2335	-1650	-1.049	-7933	-5213	-3899	-2708	-1722	-0.6423
Large flood peak	107300	107300	109700	118800	118800	0.105						
Large flood duration	12	12	12	25	25	1.083						
Large flood timing	157	157	312	15	15	0.388						
Large flood freq.	0	0	0	0	0.4	0	0	0	0	0	0	0
Large flood riserate	12850	12850	26550	57410	57410	1.678						
Large flood fallrate	-11510	-11510	-10260	-5625	-5625	-0.5741						

Table A3: Pre and Post-Impact Annual Summary 1 for Reach 1 (Radford)

Radford Daily IHA analysis for Claytor

	Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	1- day min	3-day min	7-day min	30- day min	90- day min
Pre-Impact	1972	3143	3760	3924	4514	5531	4753	5752	6747	4329	4326	2684	2014	1535	1616	1728	2133	3352
	1973	2456	4093	5619	4269	5450	7226	6589	6060	5407	3356	3156	2067	1396	1639	1865	2214	2929
	1974	2242	2403	5033	7497	6306	5252	5882	4582	4209	3383	2984	3480	1796	1842	1877	2213	3598
	1975	2323	2223	3955	4937	6592	9691	5173	5206	4843	3128	2109	2487	1294	1601	1880	2019	2698
	1976	2566	2763	2523	3708	4526	3268	2722	2712	5695	2910	1957	1571	1203	1308	1437	1716	2321
	1977	4464	2957	3998	2867	3047	5841	5022	3050	2751	1665	1776	1873	1202	1323	1375	1632	2028
	1978	3097	5498	4886	4229	3736	7057	4188	7641	3558	2421	2720	1739	1066	1152	1535	1764	2704
	1979	1407	1464	2381	4090	2882	7763	6621	5121	4499	3615	2414	5740	1124	1262	1346	1392	1921
	1980	4487	6409	4163	4988	3647	6930	7028	5064	3013	2809	1908	1703	1327	1390	1441	1668	2343
	1981	1919	1769	1638	1369	4059	2714	3032	3159	3034	1799	1079	1172	638	849.3	863.9	1113	1469
	1982	977	1241	1607	3494	5215	5100	3171	3427	3517	3078	2042	1605	728	797.3	948	1232	1504
	1983	1796	2950	4344	3435	6238	7493	9921	5605	3829	2173	1743	1373	1009	1084	1249	1469	1845
	1984	2216	2177	5208	3434	4819	5929	6832	6036	3516	3040	2481	1585	944	1069	1195	1646	2525
	1985	1634	1784	2127	1806	4067	2625	2538	2076	1684	1384	2007	1340	859	941.3	1060	1338	1877
	1986	1361	4508	3151	2245	4083	3090	2227	2705	1726	1189	1282	1408	739	775	901.9	1106	1463
	1987	1181	2086	3984	3195	4545	7751	9986	5325	3464	2523	1629	1890	923	965.7	1045	1408	2385
	1988	1538	1836	2592	2193	2436	1945	2856	2107	1285	1101	1067	1307	713	747.3	800.4	1022	1221
	1989	1050	1524	1424	2104	1689	3049	2590	3814	3573	4291	2787	6339	758	861	952.1	1112	1451
	1990	5561	4488	3714	5267	7340	6363	4889	5129	2625	2267	2052	1748	1077	1254	1589	1800	2271
	1991	5151	3053	2993	4459	4649	6421	6269	5186	3292	2457	1949	1504	1208	1340	1379	1531	2031
	1992	1250	1447	2360	2994	2336	4002	3747	4701	7148	3137	2369	2200	1086	1199	1208	1244	2083
	1993	2055	4430	4420	5566	4393	8774	8226	5557	2986	1943	1653	1776	1267	1326	1431	1698	1922
	1994	1330	1545	2945	4390	7053	5782	6482	3813	2532	2364	3249	2276	1134	1175	1247	1334	2499
	1995	1906	1805	2270	4980	4358	4734	2746	3341	4426	2297	1570	1601	1168	1182	1228	1565	1971
	1996	2146	2673	2383	4467	5604	4401	3714	4870	3653	2316	2799	2841	1132	1146	1321	2352	2643
	1997	2315	3794	4997	3857	5518	6740	4541	3803	3695	2137	1476	1217	1032	1055	1112	1273	1713
1998	1195	1400	1535	4685	8921	6013	5647	7718	4973	2218	1872	1242	1017	1072	1087	1246	1455	
1999	1248	1232	1566	2920	2581	4028	2448	2929	1364	1564	1064	973	725	795.3	840.7	1090	1410	
2000	1242	1350	1793	1483	2604	2763	4326	1885	1398	1659	1546	1444	961	1005	1024	1300	1756	
2001	927	1055	1182	1291	1625	2384	2491	2245	2399	1923	1917	1160	751	759.3	834.7	914.3	1177	
2002	931	887.5	1398	1407	1610	2609	2647	2000	1145	1173	728	1118	530	544.7	597.3	769.1	981.7	
2003	1437	3304	4265	2647	3928	5645	6742	4671	6920	5207	5706	3288	1024	1042	1105	1738	3378	
2004	2671	4412	5346	3861	5323	4167	4398	3122	4644	2382	1745	4526	1405	1465	1563	1714	2767	
2005	4053	3927	4724	3794	4476	5601	5513	3742	3279	2771	1920	1272	1015	1090	1170	1376	2219	
2006	1548	1512	3141	3330	2892	2245	2650	2627	1826	2508	1441	2237	931	1030	1199	1476	2290	
Post-Impact	2007	3490	4450	4550	3960	5385	5200	6080	6810	4835	4370	2790	1955	1090	1410	1619	2140	3291
	2008	2770	4070	5570	4290	5250	6860	6610	5790	5290	3650	3520	2025	1070	1117	1677	2104	2943
	2009	2210	2410	5240	6820	5755	5540	5425	4590	4560	3750	2980	3495	904	1061	1659	2151	3413

2010	2260	2135	3700	4930	6355	9860	5370	5110	4205	3080	2040	2730	885	1249	1568	1892	2654
2011	2830	2940	2760	3810	4455	3320	2940	2600	5170	3320	2160	1805	871	1115	1473	1731	2359
2012	4800	3270	4000	2540	2470	5660	5175	3150	2765	1620	1610	2205	752	1050	1096	1459	1983
2013	2770	5535	4710	5180	3980	8390	4600	7670	3690	2440	2940	1700	939	999	1350	1679	2605
2014	1140	1475	2600	4140	3965	7310	6465	5350	4735	3800	2690	5955	840	963.3	1034	1298	1843
2015	4660	6635	4470	5140	3885	6890	7490	5520	3320	3170	1680	1670	849	989.7	1340	1602	2329
2016	2250	1915	1720	1150	4240	2550	3275	3930	3690	1880	933	1080	803	835	877.7	1107	1469
2017	987	1160	1550	3480	6000	5370	3440	3390	3840	2980	2020	1605	811	896.7	942.1	1180	1481
2018	1670	3130	5090	3630	6295	8200	11650	5830	4235	2450	1810	1370	772	883	1145	1468	1870
2019	2310	2395	5840	3930	6390	6070	7400	6010	4110	3600	2560	1480	836	1053	1305	1605	2580
2020	1440	2020	2150	1920	4310	2450	2525	2540	1155	1440	2260	1140	917	955.3	1071	1342	1959
2021	1360	5590	3700	2140	4765	3840	2415	2480	1715	1080	1110	1420	844	894.3	920.1	1128	1467
2022	1050	2190	4860	3430	5405	8530	11550	5930	3770	2870	1530	1675	945	964	966.3	1130	2424
2023	1520	1260	2600	2600	3220	2030	2830	2100	1185	1010	1050	1200	754	789.3	812.6	1036	1194
2024	1070	1365	1180	2110	1660	3280	2855	3980	4625	5020	3460	8000	894	913	919.7	1062	1414
2025	5920	5290	3540	6390	7495	6520	4910	5180	3155	2420	2350	1680	1030	1097	1426	1703	2348
2026	5820	2935	3760	5290	4725	6230	6380	4680	3715	2910	2060	1650	1070	1097	1140	1703	2228
2027	1220	1375	1930	3210	2170	4200	4550	4440	6835	3440	2330	2090	863	903	941.1	1195	1998
2028	2130	4335	4290	5670	4510	8890	7890	5310	2985	2220	1690	1590	1020	1107	1254	1789	2046
2029	1490	1595	3000	5180	7615	5640	6470	4030	2590	2830	3280	2345	1010	1040	1217	1517	2559
2030	2110	1730	2570	5240	4855	5060	2445	3050	4890	2560	1730	1740	998	1023	1106	1623	2172
2031	2560	3225	2580	6880	7015	5170	3760	4810	4140	2600	3130	2635	1050	1090	1119	2285	2773
2032	2870	4325	5310	4290	5910	6960	4420	3830	3835	2390	1690	1355	1130	1173	1233	1453	1949
2033	1180	1380	969	4990	9125	6070	5705	8020	4825	2440	1960	1155	845	906	926.3	957.7	1472
2034	1160	1305	1180	3170	2425	3690	2390	3140	1545	1710	1010	1075	912	931	943.4	1152	1471
2035	1280	1410	1740	1500	2350	2810	3895	2110	1600	1770	1780	1775	868	895.3	1105	1400	1734
2036	1160	1415	1150	1080	1420	2830	2395	3420	2600	2110	2030	1195	798	814.3	891.1	1007	1296
2037	918	885	957	1190	1490	2430	2205	1930	1055	1050	849	851.5	765	786.7	792.6	809.8	989.7
2038	1290	3460	4180	3080	4385	5590	6800	4520	6315	4900	5050	3445	870	965	974.4	1701	3197
2039	2740	3880	6010	4020	6175	4120	4635	3020	4905	2510	1730	5340	1090	1120	1359	1723	2925
2040	4610	4270	5400	4230	5120	5760	5600	3660	3585	2990	2180	1280	980	1010	1103	1310	2358
2041	1470	1275	3010	3410	2895	1950	2755	2450	1695	2550	1330	2370	950	979.7	1119	1506	2248

Table A4: Pre and Post-Impact Annual Summary 2 for Reach 1 (Radford)

Radford Daily IHA analysis for Claytor

	Year	1-day max	3-day max	7-day max	30-day max	90-day max	Zero days	Base flow	Date min	Date max	Lo pulse #	Lo pulse L	Hi pulse #	Hi pulse L	Rise rate	Fall rate	Reversals
Pre-Impact	1972	58580	36920	20250	8988	7581	0	0.323	267	173	7	1	23	4	471	-492	148
	1973	56940	38120	21360	10780	9403	0	0.332	272	149	6	2	17	3	493	-441.5	151
	1974	39660	26180	16750	9561	7432	0	0.361	302	96	3	2	23	2	462	-435	141
	1975	48310	32930	25450	13780	8910	0	0.364	250	74	15	1	22	3.5	327	-470.5	162
	1976	36200	24040	18560	8237	5095	0	0.37	253	173	12	2.5	16	2.5	291.5	-301	165
	1977	54340	33300	20130	10680	6919	0	0.324	216	96	7	4	16	3	331.5	-341	166
	1978	97640	56710	31180	11920	8364	0	0.265	273	312	8	2	17	4	483.5	-391	144
	1979	53270	31540	20480	13320	9137	0	0.26	302	266	11	2	22	3.5	362	-427	143
	1980	36420	26880	19910	12370	7993	0	0.284	260	106	4	10.5	15	6	254.5	-346	135
	1981	23410	17680	11400	6702	4282	0	0.334	5	149	22	4.5	9	3	204	-255	156
	1982	29150	21590	13000	7021	5936	0	0.277	348	34	12	3	14	4	255	-350.5	173
	1983	45750	27450	17970	13130	9949	0	0.251	253	101	12	4	12	5.5	253	-382	155
	1984	34510	24470	15970	8908	8547	0	0.252	282	45	10	1	20	3	422	-474	156
	1985	21380	13500	7557	4793	3345	0	0.436	180	231	33	2	7	3	261	-274.5	173
	1986	38560	25540	16200	7268	4333	0	0.311	203	310	16	5	10	3	201	-210	155
	1987	50220	36750	22850	14780	10500	0	0.21	285	61	15	2	14	3.5	335	-452	162
	1988	10070	8250	5985	4045	3136	0	0.382	190	21	26	2	5	3	203	-205	171
	1989	69980	43700	25160	10330	6760	0	0.258	348	267	12	1.5	12	3	279	-299	158
	1990	37070	24510	16050	8049	7160	0	0.321	273	321	15	1	13	6	372	-398.5	140
	1991	29380	19670	13280	8356	7026	0	0.296	284	90	8	2.5	14	4.5	301	-399	156
1992	65300	35550	22080	10380	7470	0	0.296	320	157	8	3.5	14	3.5	182.5	-253	157	
1993	61540	38070	27630	14130	9520	0	0.283	258	84	13	5	13	7	414	-267	124	
1994	46800	33000	18880	10660	8551	0	0.263	303	231	7	3	12	4	312	-241	128	
1995	98020	57050	30480	10770	7121	0	0.329	252	15	15	5	15	2	300	-173	126	
1996	61070	37080	20670	12620	7676	0	0.284	11	19	6	2.5	18	3.5	277	-288	119	
1997	30610	21860	13680	8075	6357	0	0.258	253	337	8	3	11	6	281	-208	117	
1998	38820	24440	17180	10960	9261	0	0.23	282	111	8	6	10	5.5	173	-205.5	113	
1999	11400	9819	6277	4045	3524	0	0.373	232	25	13	6	10	1	158.5	-152.5	134	
2000	14130	10570	7311	4847	3991	0	0.442	28	81	19	9	9	2	161.5	-146	108	
2001	20950	14230	9422	4685	3693	0	0.366	304	212	14	9	7	3	144	-123	132	
2002	25750	18490	10760	4901	3141	0	0.333	257	78	11	17	5	2	84	-101.5	136	
2003	46140	32510	19410	10120	8183	0	0.201	283	54	4	9	21	3	523	-382.5	126	
2004	51680	34830	19320	10060	6625	0	0.319	240	325	7	2	19	5	361	-237	118	
2005	23040	18170	13940	8236	6188	0	0.273	267	89	5	3	17	2	275	-244	132	
2006	27510	20880	12260	4876	3782	0	0.412	280	179	11	5	10	2.5	173	-146.5	112	
Post-Impact	2007	47200	33630	19980	8787	7319	0	0.314	290	174	25	2	43	2	1025	-1020	195

2008	50400	35430	20460	10500	8966	0	0.307	239	149	26	1	34	2	800	-970	199
2009	36500	22470	15420	9005	6974	0	0.335	244	96	22	1	36	2	850	-760	202
2010	35000	27500	22440	12720	8406	0	0.322	315	74	25	2	29	2	790	-810	189
2011	37400	23530	17870	8174	4795	0	0.394	82	174	34	2	21	2	680	-605	183
2012	49600	31470	19020	10040	6504	0	0.271	199	96	30	2	23	2	690	-730	182
2013	82500	48470	27560	10630	7968	0	0.247	254	312	22	2	34	2	930	-900	181
2014	39600	28000	19030	12280	8594	0	0.21	282	266	23	2	33	2	1054	-890	168
2015	31300	22730	17910	11730	7817	0	0.268	245	107	28	2	37	2	964.5	-960	195
2016	17800	14200	10420	6519	4246	0	0.342	229	150	49	2	9	4	440	-515	184
2017	27700	19470	12910	6949	5816	0	0.282	348	35	29	2	24	2	570	-550	180
2018	35400	24000	17400	12780	9904	0	0.23	220	101	30	2	22	4.5	840	-842	183
2019	28000	21670	14620	9016	8605	0	0.274	283	130	38	2	28	2.5	1050	-930	183
2020	15400	12780	7800	4874	3396	0	0.43	132	231	51	2	13	2	600	-450	174
2021	35800	22030	14720	7050	4353	0	0.31	183	310	41	2	17	2	485	-500	194
2022	47900	35030	23160	14520	10490	0	0.194	279	116	28	2	23	2	650	-655	177
2023	8650	8110	6311	4392	3355	0	0.377	193	36	39	2	11	1	315	-225	188
2024	65600	35400	21900	9855	6801	0	0.245	288	267	28	2	15	3	420	-515	170
2025	29300	21230	15020	8047	7110	0	0.287	253	276	31	2	31	3	835	-900	177
2026	17800	15770	12430	7906	6761	0	0.247	266	91	23	2	18	3.5	650	-690	186
2027	50700	30770	19960	9779	7092	0	0.24	355	158	29	2	20	1.5	560	-590	195
2028	57700	38200	27190	13880	9287	0	0.253	214	84	24	2	19	4	630	-680	190
2029	42200	29030	18800	11210	8690	0	0.253	292	231	14	1.5	23	2	630	-720	176
2030	74000	49300	27830	10210	6834	0	0.296	366	15	30	1.5	23	2	470	-480	174
2031	49700	33470	20360	12770	7954	0	0.23	365	19	15	2	27	2	720	-565	167
2032	25000	17700	12750	8113	6382	0	0.277	244	338	14	1	25	2	495	-430	191
2033	37300	23730	16490	10450	8734	0	0.199	342	111	14	2	23	2	490	-380	181
2034	9170	7757	6069	4002	3421	0	0.42	292	136	29	3	17	2	250	-230	189
2035	12200	10910	7130	4642	3851	0	0.469	22	111	33	5	12	1	302	-320	186
2036	18000	13930	9987	4996	3794	0	0.388	5	212	21	2	6	3.5	250	-225	172
2037	22300	17670	10370	4607	2990	0	0.464	252	79	23	2	4	2.5	105	-100	191
2038	45300	29300	18880	9629	7731	0	0.187	40	54	16	2	24	2	595	-615	156
2039	52300	31500	18320	9407	6554	0	0.281	299	325	18	2	28	3.5	620	-480	157
2040	22400	16770	13760	8101	6132	0	0.252	267	89	11	1	33	2	545	-485	162
2041	22500	18030	11130	4665	3508	0	0.411	278	180	35	2	11	2	275	-260	170

Table A5: Pre and Post-Impact Annual Summary 1 for Reach 2 (Glen Lyn)

Glen Lyn Reach Pre and Post IHA Claytor

	Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	1-day min	3-day min	7-day min	30-day min	90-day min
Pre-Impact	1972	3634	4380	4846	6434	7482	6292	8140	9212	5210	5211	3664	2310	1755	1838	1955	2435	4219
	1973	3290	5941	7950	5463	7277	9493	8883	7564	6186	3741	3854	2314	1604	1851	2083	2479	3396
	1974	2574	2953	6887	10620	8228	7437	7225	5519	4715	3856	3190	3733	2009	2053	2095	2614	3954
	1975	2520	2474	5561	7381	10050	13310	7037	6860	5525	3506	2419	2715	1481	1792	2078	2233	3096
	1976	2921	3197	2898	4819	5946	4186	3361	3267	6584	3329	2116	1771	1345	1485	1621	1898	2592
	1977	5506	3576	4863	3375	4209	7589	6112	3544	3139	1886	1988	2042	1418	1522	1573	1829	2260
	1978	3609	7754	6082	5201	4513	9677	5077	9892	4088	2708	3036	1911	1211	1298	1686	1930	2981
	1979	1554	1614	3001	5519	3590	10080	8239	6765	5806	4426	2722	6460	1272	1408	1496	1542	2230
	1980	5470	8235	4923	6833	4768	9850	9361	6653	3496	3248	2198	1905	1514	1604	1653	1907	2868
	1981	2147	1995	1915	1605	5226	3717	4075	4530	4043	2126	1277	1381	747	985.3	1006	1332	1774
	1982	1128	1432	1863	4594	7327	7930	3978	4424	4217	3515	2472	1832	900	978.7	1098	1436	1826
	1983	2192	3752	6118	4256	8516	9777	12530	6622	4586	2453	1945	1510	1148	1219	1397	1624	2049
	1984	2522	2518	6118	4521	6830	8233	10360	7443	3971	3360	2707	1730	1073	1200	1332	1795	2803
	1985	1857	2068	2700	2426	6131	3743	3410	2643	2149	1596	2574	1508	1052	1115	1236	1553	2352
	1986	1529	5418	3853	2571	6250	4025	2683	4626	2266	1448	1553	1649	892	919.3	1043	1295	1791
	1987	1358	2709	5374	4207	6972	10740	14140	6359	3862	2739	1784	2071	1074	1126	1211	1612	2593
	1988	1681	2040	2919	2891	2988	2367	3980	2780	1550	1246	1199	1472	824	864.7	920.1	1168	1367
	1989	1222	1809	1792	2923	2434	4484	3642	5571	4314	4794	3398	7550	903	1029	1082	1325	1790
	1990	6896	5566	4354	6793	10160	8405	6166	6984	3242	2554	2325	1955	1264	1441	1809	2085	2636
	1991	6060	3585	3874	6485	6182	9029	8123	6318	4022	2760	2152	1685	1379	1502	1549	1712	2273
	1992	1425	1629	3193	3885	3037	5847	5355	6808	9239	3693	2692	2514	1300	1366	1374	1411	2574
	1993	2245	4979	4978	7258	5223	13050	10610	6591	3356	2308	1815	1987	1401	1460	1606	1885	2160
	1994	1512	1794	3563	6337	10400	8073	8813	4863	3035	2693	3617	2489	1306	1360	1446	1517	2987
	1995	2121	1982	2624	6187	5732	6191	3195	4832	6562	2624	1762	1775	1277	1294	1343	1705	2231
	1996	2340	3144	3065	7015	7284	5597	4756	6267	4205	2578	3122	3168	1517	1525	1858	2577	3278
	1997	2801	5112	6733	4969	7349	8742	5696	4594	4389	2493	1641	1333	1140	1162	1221	1413	1925
1998	1314	1574	1744	5905	12250	8037	7549	11280	5941	2481	2093	1402	1132	1185	1198	1388	1626	
1999	1385	1379	1854	3655	3271	5563	3352	4293	1588	1814	1177	1082	826	879.3	949.3	1205	1589	
2000	1402	1501	2073	1678	3536	4059	5700	2379	1665	2144	1790	1717	1129	1175	1199	1451	2001	
2001	1104	1219	1342	1501	2152	3623	3259	3026	3036	2371	2507	1494	900	906.7	984.9	1074	1364	
2002	1149	1080	1660	1605	2153	3329	3851	2936	1437	1538	888	1316	633	650.3	704.3	925.7	1214	
2003	1727	5078	6528	3732	6872	7268	8724	6143	8636	5946	7015	4426	1152	1173	1249	2162	5005	
2004	3210	5257	7323	5480	7264	5732	6551	4199	6704	3017	2096	5757	1678	1735	1890	2054	3717	
2005	5075	5385	7136	4947	6266	8019	7467	4613	3821	3178	2258	1435	1162	1238	1323	1550	2610	
2006	1751	1705	3788	4273	3833	2871	3721	3449	2188	2984	1652	2454	1086	1185	1378	1657	2645	
Post-Impact	2007	3460	4900	5170	5810	7190	6330	7780	8070	5535	5500	2950	2060	1360	1567	1719	2218	3874
	2008	3070	5480	7020	4850	7490	9050	8930	7290	5910	4110	4110	2215	1290	1343	1936	2345	3406
	2009	2410	3005	6800	9560	7355	7510	6685	5460	4740	3900	3130	3205	1190	1393	1840	2560	3612

2010	2600	2350	4930	6420	8705	12000	7640	6720	5045	3350	2080	2550	1060	1420	1741	2001	2835
2011	2910	3135	2740	4630	5675	3990	3290	2810	6020	3490	2200	2035	1070	1300	1561	1855	2491
2012	5660	3925	5080	3240	3280	6630	6300	3760	3175	2010	1890	2440	1030	1300	1403	1754	2265
2013	3470	6850	5930	6360	4700	10600	5470	11100	4045	2580	2990	1795	1090	1157	1583	1800	2791
2014	1300	1500	2860	6000	4795	10700	7585	6690	6070	4480	2970	7050	1040	1143	1209	1392	2012
2015	6110	7830	5240	6510	4950	8750	9245	6720	3515	3650	2000	1865	1020	1263	1547	1858	2720
2016	2390	1940	1860	1350	5490	3200	4220	4590	3875	1950	1150	1320	871	1022	1057	1260	1669
2017	1060	1195	1900	5000	7505	8390	4140	4380	4610	3470	2320	1705	950	994.3	1016	1258	1679
2018	1870	3565	6420	4210	8380	10600	13500	7070	4845	2610	2010	1660	1110	1270	1431	1778	2144
2019	2320	2580	7420	4790	7920	8290	11150	7910	5550	5000	3600	2050	1140	1400	1624	2250	3578
2020	1700	2450	2710	2400	5570	3820	3470	2890	1850	1700	2830	1400	1100	1150	1314	1663	2545
2021	1450	5980	4460	2260	6315	4610	2875	4470	2105	1330	1450	1615	955	987.7	1049	1308	1741
2022	1480	2910	5790	4290	7075	10800	15150	6810	4005	3460	1800	1860	1170	1197	1271	1536	2590
2023	1620	1590	2860	3100	3555	2380	4140	2950	1605	1170	1220	1615	787	816	837	1208	1442
2024	1240	1565	1490	2930	2400	4250	3680	5070	6020	4880	3560	9160	918	951.3	958.9	1203	1673
2025	7560	6070	4260	7780	9960	8500	5990	6820	3700	2530	2680	1920	1250	1430	1604	2010	2694
2026	6770	3495	4430	7200	5895	8810	8210	6000	4800	3070	2340	1875	1280	1313	1393	1973	2515
2027	1440	1705	3500	4210	3010	6070	6075	6660	8870	3710	2630	2485	1190	1210	1220	1410	2579
2028	2280	3960	5150	7490	5830	12500	9800	6600	3560	2460	1820	1850	1110	1183	1439	1938	2241
2029	1600	1725	3620	6570	11900	7690	9175	4940	3010	3020	4050	2420	1130	1177	1379	1589	3013
2030	2120	2010	2830	6250	6255	6430	3195	4450	6615	2700	1480	1640	808	851.7	926.1	1359	2047
2031	2470	3625	3150	6900	9455	5150	4620	6350	4160	2530	3040	2960	1150	1437	1617	2569	3478
2032	3070	5505	7220	5690	7890	9090	4915	3950	3820	2250	1450	1380	885	1025	1056	1252	1863
2033	1300	1650	1090	6760	14200	8630	8285	10700	6035	2500	2100	981	868	885.7	990.7	1071	1582
2034	1270	1285	1230	3910	3150	5380	3705	4520	1345	1650	782	1055	557	618	646.1	1031	1403
2035	1520	1645	2340	1980	4320	4230	5195	2650	1965	2360	2410	2165	1230	1253	1317	1653	2156
2036	1290	1715	1770	1640	2350	3760	3100	3460	3400	2550	2760	1730	1190	1193	1207	1247	1726
2037	1260	1240	1460	1650	2145	3100	4065	3410	1430	1430	1040	1010	831	851.7	876.4	947.4	1280
2038	1660	5435	7070	4490	6285	7780	9105	6460	10220	6610	6980	4530	1180	1193	1246	2252	4941
2039	3380	5310	7930	5910	8045	6130	6695	4130	6680	3020	2220	6365	1570	1623	1870	2193	3710
2040	5560	5840	7860	5410	6770	8140	7570	4700	4080	3190	2530	1560	1240	1260	1344	1585	2687
2041	1770	1685	3820	4500	3980	2860	3895	3420	2190	3200	1760	2665	1290	1300	1470	1891	2731

Table A6: Pre and Post-Impact Annual Summary 2 for Reach 2 (Glen Lyn)

Glen Lyn Reach Pre and Post IHA Claytor

	Year	1-day max	3-day max	7-day max	30- day max	90- day max	Zero days	Base flow	Date min	Date max	Lo pulse #	Lo pulse L	Hi pulse #	Hi pulse L	Rise rate	Fall rate	Reversa ls
Pre-Impact	1972	76240	48350	26490	11860	10370	0	0.272	267	173	6	2	20	6	609	-641	134
	1973	74110	46180	27610	14460	12080	0	0.283	272	77	5	3	15	4	529.5	-510.5	145
	1974	52340	34670	21830	14390	10790	0	0.309	302	96	3	2	23	2	752.5	-519.5	137
	1975	72050	47270	36000	19030	12650	0	0.306	250	74	17	2	16	5	432	-575	148
	1976	41720	29370	21590	9616	6462	0	0.339	253	173	10	2.5	14	2.5	309	-335	149
	1977	87530	53810	31250	14680	9342	0	0.292	216	96	7	4	12	4.5	356	-395.5	153
	1978	109700	65960	37020	15690	11790	0	0.226	273	312	8	1.5	19	2	569.5	-466	140
	1979	57300	45340	29590	17830	12050	0	0.226	302	266	8	1.5	17	4	440	-546.5	143
	1980	44280	33200	23540	16260	10640	0	0.251	260	106	4	10.5	13	6	341	-490.5	128
	1981	33170	26350	16640	9483	5982	0	0.304	5	149	19	6	10	3	230	-292	150
	1982	39350	30430	18290	10170	8575	0	0.24	348	34	10	4.5	15	4	275	-409.5	157
	1983	56020	34450	22530	16640	12830	0	0.223	253	101	13	2	13	3	313	-434.5	149
	1984	50970	35840	22960	12880	12350	0	0.215	282	45	10	2	14	3.5	509	-581	150
	1985	24650	16670	10930	7097	4866	0	0.388	180	231	23	3	7	3	273.5	-312	163
	1986	44590	29250	18370	8800	5283	0	0.275	215	310	16	3.5	11	4	237	-247	143
	1987	76230	57430	35180	21760	14700	0	0.184	285	116	11	3	13	4	403	-537	150
	1988	14420	12260	8650	5496	4007	0	0.354	190	21	19	4	5	3	201	-222	169
	1989	83720	51560	31430	12650	8042	0	0.228	348	267	10	1.5	12	2.5	373	-364	146
	1990	44950	34910	22040	11180	9995	0	0.277	273	276	13	3	11	7	425	-484	138
	1991	45190	29200	19260	11880	9473	0	0.257	284	90	8	2.5	16	4	326.5	-510	138
	1992	107300	55260	32210	14130	10140	0	0.254	320	157	6	3	11	5	247	-332	147
1993	98130	58210	40390	20270	12990	0	0.249	258	84	13	7	12	7	472	-344	122	
1994	51000	41690	26760	15210	11930	0	0.234	303	231	7	5	11	4	400	-342	122	
1995	118800	70950	38410	13680	9305	0	0.283	252	15	12	5	14	3	332.5	-231.5	120	
1996	97080	55190	30640	17950	10690	0	0.312	277	19	7	2	15	4	355	-353	119	
1997	44960	34670	20830	11190	8527	0	0.22	253	337	6	10.5	10	6.5	320	-296	123	
1998	52360	33730	24350	15100	12700	0	0.196	282	111	6	8	14	5.5	256	-259.5	111	
1999	14990	12950	8246	5770	4927	0	0.329	232	25	10	8	12	2	194.5	-176	129	
2000	20050	14730	9761	6443	5564	0	0.407	28	81	20	8.5	9	3	202.5	-177	104	
2001	34660	23200	18060	8891	5892	0	0.301	304	212	11	9	7	3	167	-155	118	
2002	39750	27990	16410	7381	4791	0	0.286	257	78	9	21	5	3	109	-124	122	
2003	70490	51640	30040	14500	11340	0	0.168	283	54	3	8	21	6	844	-578	120	
2004	70570	50750	27780	13010	9314	0	0.281	246	325	5	3	23	4	513.5	-395	118	
2005	31790	25130	19740	11540	8710	0	0.23	267	89	5	3	14	3.5	354.5	-345.5	128	
2006	33510	25150	14980	5976	4761	0	0.386	280	179	12	4.5	9	2	301	-178	106	
Post-Impact	2007	72400	46670	26190	11230	9162	0	0.263	270	175	14	2	27	3	1100	-920	174
	2008	66000	45670	26360	14050	11600	0	0.28	247	150	19	1	23	3	920	-875	177
	2009	40000	27770	18860	13000	9754	0	0.297	232	96	22	1	20	2	830	-910	193



2010	53200	40100	31260	17460	11430	0	0.285	316	75	21	2	23	2	890	-750	185
2011	42400	28370	20460	9092	5769	0	0.358	237	174	35	2	12	4	570	-640	181
2012	74400	50570	29630	13520	8507	0	0.279	242	96	28	2	16	2	610	-700	172
2013	75800	57400	32380	14500	11080	0	0.228	249	312	20	2	19	3	1010	-890	176
2014	55300	41270	27510	16550	11540	0	0.192	297	57	19	2	20	4.5	970	-890	176
2015	42600	28670	21760	15270	10080	0	0.245	225	107	22	2	27	3	1080	-970	176
2016	25700	18930	14100	8496	5456	0	0.344	19	150	38	2	10	2.5	474.5	-440	177
2017	40800	27170	18040	9990	8351	0	0.231	348	35	25	2	16	3	700	-700	169
2018	37000	30500	21240	15540	12180	0	0.236	235	102	26	2	18	3	840	-770	178
2019	41200	32830	23300	13350	12500	0	0.251	284	46	31	2	24	2.5	1345	-1060	167
2020	20500	15230	10080	6674	4763	0	0.398	205	232	47	2	11	2	700	-570	166
2021	40000	25270	16080	8169	5078	0	0.283	202	310	35	2	11	5	460	-500	172
2022	79800	56200	35760	21130	14310	0	0.196	279	116	21	2	21	2	750	-730	164
2023	11500	10830	8026	5412	3999	0	0.318	191	20	35	2	8	2	290	-250	169
2024	74800	41930	26400	11500	7463	0	0.209	293	267	21	2	12	3	400	-490	167
2025	38200	28300	19720	10760	9485	0	0.252	248	276	16	2.5	19	3	770	-835	163
2026	28100	24500	17910	11300	9131	0	0.233	267	90	18	2	16	4	745	-610	173
2027	61800	45030	28330	13130	9575	0	0.232	277	114	17	2	17	2	580	-600	185
2028	81600	55570	39090	19750	12640	0	0.229	246	84	16	3.5	15	6	600	-680	168
2029	50500	37170	26460	16140	12440	0	0.218	329	231	8	4	14	4	710	-740	183
2030	89400	58630	34370	12740	8851	0	0.204	239	16	25	2	18	2	580	-530	170
2031	66800	50270	30490	17990	10850	0	0.269	277	20	13	1	20	4	830	-720	159
2032	37800	29530	20080	10980	8430	0	0.196	241	338	13	2	25	2	545	-475	170
2033	48700	33630	24100	15080	12810	0	0.16	260	111	10	5.5	16	4.5	450	-410	164
2034	14600	11300	8430	5855	5001	0	0.229	232	136	21	4	13	2	255	-280	182
2035	16700	14300	9887	6415	5564	0	0.419	329	111	27	3	10	3	330	-330	162
2036	29800	23270	18660	9199	5938	0	0.361	305	144	21	5	7	3	230	-260	154
2037	37900	23900	14980	7010	4847	0	0.349	255	79	18	5.5	5	4	150	-150	172
2038	74000	48300	29900	14130	11030	0	0.166	284	54	9	2	24	5	1000	-810	140
2039	75800	43400	25280	12470	9031	0	0.287	232	325	6	3	27	4	810	-710	147
2040	33600	23970	19230	11340	8511	0	0.233	268	89	5	2	24	2.5	510	-600	156
2041	34900	25870	15030	6176	4634	0	0.414	278	180	18	5	10	2	275	-280	157

**Table A7: Pre and Post-Impact Non-Parametric IHA Scorecard for Reach 1 (Radford)**

Non-Parametric IHA Scorecard

Radford Daily IHA analysis for Claytor

	Pre-impact period: ( 35 years)				Post-impact period: ( 35 years)			
	1			1				
	Watershed area	4127		4068				
Mean annual flow	4127			4068				
Mean flow/area	1.06			0.98				
Annual C. V.	0.52			0.48				
Flow predictability	0.83			0.85				
Constancy/predictability	0.26			0.26				
% of floods in 60d period	5			2				
Flood-free season								
	MEDIANS		COEFF. of DISP.		DEVIATION FACTOR		SIGNIFICANCE COUNT	
	Pre	Post	Pre	Post	Medians	C.D.	Medians	C.D.
Parameter Group #1								
October	1906	2110	0.69	0.73	0.11	0.06	0.78	0.81
November	2223	2395	1.03	1.11	0.08	0.08	0.80	0.73
December	3141	3540	0.71	0.79	0.13	0.11	0.72	0.80
January	3708	3930	0.49	0.65	0.06	0.32	0.62	0.37
February	4393	4725	0.60	0.59	0.08	0.02	0.30	0.98
March	5252	5540	0.70	0.64	0.05	0.08	0.74	0.81
April	4541	4635	0.82	0.78	0.02	0.05	0.91	0.76
May	3814	4030	0.60	0.57	0.06	0.04	0.87	0.90
June	3516	3770	0.54	0.57	0.07	0.05	0.24	0.88
July	2382	2560	0.48	0.47	0.07	0.03	0.22	0.95
August	1920	2030	0.47	0.50	0.06	0.05	0.41	0.91
September	1703	1680	0.53	0.59	0.01	0.12	0.85	0.73
Parameter Group #2								
1-day minimum	1032	894	0.33	0.19	0.13	0.43	0.02	0.07
3-day minimum	1090	989.7	0.35	0.20	0.09	0.44	0.05	0.14
7-day minimum	1208	1106	0.34	0.36	0.08	0.05	0.29	0.84
30-day minimum	1469	1468	0.32	0.38	0.00	0.17	0.99	0.58
90-day minimum	2031	2172	0.50	0.51	0.07	0.01	0.70	0.99
1-day maximum	38820	35800	0.69	0.76	0.08	0.10	0.37	0.72
3-day maximum	26180	23530	0.61	0.59	0.10	0.03	0.44	0.89
7-day maximum	17970	17400	0.43	0.43	0.03	0.02	0.82	0.96
30-day maximum	9561	9016	0.41	0.41	0.06	0.01	0.74	0.98
90-day maximum	7121	6834	0.59	0.59	0.04	0.00	0.52	1.00

Number of zero days	0	0	0	0					
Base flow index	0.31	0.28	0.32	0.34	0.10	0.07	0.24	0.90	
Parameter Group #3									
Date of minimum	267	279	0.12	0.27	0.07	1.23	0.78	0.03	
Date of maximum	89	130	0.36	0.39	0.22	0.08	0.45	0.83	
Parameter Group #4									
Low pulse count	11	28	0.73	0.32	1.55	0.56	0.00	0.09	
Low pulse duration	3	2	1	0	0.33	1	0.001	0.22	
High pulse count	14	23	0.50	0.52	0.64	0.04	0.00	0.86	
High pulse duration	3	2	0.33	0.25	0.33	0.25	0.10	0.29	
Low Pulse Threshold	1931								
High Pulse Threshold	4873								
Parameter Group #5									
Rise rate	281	620	0.57	0.53	1.21	0.06	0.00	0.85	
Fall rate	-288	-590	-0.66	-0.61	1.05	0.08	0.00	0.83	
Number of reversals	143	183	0.22	0.09	0.28	0.60	0.00	0.11	
EFC Low flows									
October Low Flow	1849	1970	0.50	0.44	0.07	0.11	0.47	0.58	
November Low Flow	2178	2130	0.64	0.50	0.02	0.22	0.89	0.23	
December Low Flow	2798	2570	0.51	0.31	0.08	0.39	0.13	0.28	
January Low Flow	3110	2460	0.52	0.32	0.21	0.39	0.01	0.29	
February Low Flow	3552	2565	0.49	0.33	0.28	0.33	0.01	0.10	
March Low Flow	4114	2880	0.40	0.42	0.30	0.05	0.02	0.88	
April Low Flow	3631	2725	0.52	0.52	0.25	0.01	0.16	0.97	
May Low Flow	3648	2920	0.49	0.53	0.20	0.07	0.17	0.74	
June Low Flow	3067	2740	0.38	0.40	0.11	0.06	0.31	0.83	
July Low Flow	2356	2410	0.43	0.33	0.02	0.24	0.42	0.48	
August Low Flow	1877	2033	0.39	0.35	0.08	0.10	0.13	0.77	
September Low Flow	1716	1855	0.28	0.33	0.08	0.21	0.22	0.68	
EFC Parameters									
Extreme low peak	1115	1070	0.12	0.08	0.04	0.31	0.12	0.14	
Extreme low duration	2	2	1.19	0.50	0.00	0.58	0.01	0.38	
Extreme low timing	269	262	0.12	0.24	0.04	0.95	0.66	0.01	
Extreme low freq.	2	19	5.00	0.84	8.50	0.83	0.00	0.04	
High flow peak	6495	5180	0.15	0.12	0.20	0.22	0.00	0.40	
High flow duration	5	3	0.20	0.33	0.40	0.67	0.00	0.01	
High flow timing	71	74.5	0.30	0.21	0.02	0.28	0.74	0.49	
High flow frequency	16	30	0.50	0.37	0.88	0.27	0.00	0.34	
High flow rise rate	1599	1583	0.27	0.30	0.01	0.10	0.92	0.68	
High flow fall rate	-835.7	-1079	-0.28	-0.35	0.29	0.26	0.00	0.26	

Small Flood peak	47780	48000	0.22	0.16	0.00	0.28	0.90	0.59
Small Flood duration	24	21	1.52	1.21	0.13	0.20	0.60	0.57
Small Flood timing	88.5	89	0.16	0.49	0.00	2.05	0.95	0.01
Small Flood freq.	0	0	0.00	0.00				
Small Flood riserate	8577	9518	1.96	0.64	0.11	0.68	0.85	0.14
Small Flood fallrate	-2321	-2915	-1.23	-0.97	0.26	0.21	0.34	0.63
Large flood peak	83610	78250	0.34	0.11	0.06	0.68	0.63	0.29
Large flood duration	15.5	21.5	0.58	0.79	0.39	0.36	0.41	0.48
Large flood timing	352	346.5	0.31	0.19	0.03	0.39	0.83	0.42
Large flood freq.	0	0	0.00	0.00				
Large flood riserate	32580	21800	0.58	0.18	0.33	0.70	0.32	0.30
Large flood fallrate	-5846	-4616	-0.89	-0.72	0.21	0.19	0.72	0.65
EFC high flow lower percentile threshold:		3042						
EFC high flow upper percentile threshold:		4873						
EFC extreme low flow threshold:		1223						
EFC small flood peak flow threshold:		38820						
EFC large flood peak flow threshold:		67170						

**Table A8: Pre and Post-Impact Non-Parametric IHA Scorecard for Reach 2 (Glen Lyn)**

Non-Parametric IHA Scorecard

Glen Lyn Reach Pre and Post IHA  
Claytor

	Pre-impact period ( 35 years)				Post-impact period ( 35 years)			
	1	1						
Watershed area	5378	5227						
Mean annual flow	5378	5227						
Mean flow/area	1.13	1.03						
Annual C. V.	0.5	0.48						
Flow predictability	0.8	0.81						
Constancy/predictability	0.27	0.27						
% of floods in 60d period	9	6						
Flood-free season								
	MEDIANS		COEFF. of DISP.		DEVIATION FACTOR		SIGNIFICANCE COUNT	
	Pre	Post	Pre	Post	Medians	C.D.	Medians	C.D.
Parameter Group #1								
October	2147	2120	0.83	0.76	0.01	0.08	0.94	0.77
November	2709	2910	1.25	1.25	0.07	0.00	0.88	1.00
December	3853	4260	0.90	0.76	0.11	0.16	0.74	0.64
January	4819	4850	0.61	0.66	0.01	0.07	0.96	0.88
February	6182	6255	0.57	0.57	0.01	0.01	0.90	0.97
March	7437	7510	0.65	0.61	0.01	0.07	0.96	0.79
April	6112	6075	0.72	0.69	0.01	0.03	0.96	0.88
May	5519	5070	0.46	0.55	0.08	0.18	0.83	0.72
June	4043	4080	0.62	0.67	0.01	0.09	0.87	0.80
July	2708	3020	0.44	0.43	0.12	0.03	0.49	0.92
August	2198	2320	0.43	0.50	0.06	0.18	0.65	0.50
September	1905	1875	0.51	0.46	0.02	0.10	0.87	0.75
Parameter Group #2								
1-day minimum	1162	1110	0.30	0.22	0.04	0.28	0.20	0.54
3-day minimum	1238	1197	0.31	0.24	0.03	0.22	0.65	0.62
7-day minimum	1374	1344	0.33	0.39	0.02	0.18	0.85	0.64
30-day minimum	1624	1663	0.32	0.45	0.02	0.40	0.78	0.12
90-day minimum	2352	2515	0.49	0.43	0.07	0.11	0.74	0.72
1-day maximum	51000	42400	0.72	0.88	0.17	0.22	0.27	0.31
3-day maximum	34670	30500	0.68	0.69	0.12	0.02	0.33	0.92
7-day maximum	22960	21760	0.54	0.48	0.05	0.11	0.71	0.67
30-day maximum	12880	12470	0.44	0.48	0.03	0.08	0.78	0.80

90-day maximum	9473	9131	0.63	0.62	0.04	0.01	0.55	0.96
Number of zero days	0	0	0.00	0.00				
Base flow index	0.2751	0.2512	0.29	0.27	0.09	0.05	0.45	0.86
Parameter Group #3								
Date of minimum	267	255	0.09	0.13	0.07	0.44	0.40	0.08
Date of maximum	89	111	0.36	0.28	0.12	0.23	0.65	0.59
Parameter Group #4								
Low pulse count	10	21	0.70	0.48	1.10	0.32	0.00	0.29
Low pulse duration	3	2	1.67	0.50	0.33	0.70	0.24	0.13
High pulse count	13	17	0.31	0.65	0.31	1.10	0.01	0.00
High pulse duration	4	3	0.50	0.67	0.25	0.33	0.13	0.43
Low Pulse Threshold	2271							
High Pulse Threshold	6395							
Parameter Group #5								
Rise rate	341	700	0.54	0.54	1.05	0.01	0.00	0.98
Fall rate	-353	-680	-0.71	-0.49	0.93	0.31	0.00	0.24
Number of reversals	138	170	0.20	0.08	0.23	0.61	0.00	0.10
EFC Low flows								
October Low Flow	2103	2125	0.51	0.46	0.01	0.11	0.81	0.66
November Low Flow	2562	2660	0.73	0.59	0.04	0.19	0.75	0.32
December Low Flow	3402	2850	0.66	0.54	0.16	0.18	0.28	0.62
January Low Flow	3994	3250	0.56	0.29	0.19	0.48	0.04	0.08
February Low Flow	4238	2980	0.60	0.72	0.30	0.21	0.12	0.32
March Low Flow	5211	4310	0.36	0.59	0.17	0.62	0.27	0.05
April Low Flow	4725	4038	0.48	0.58	0.15	0.21	0.45	0.28
May Low Flow	4577	3880	0.52	0.50	0.15	0.04	0.36	0.91
June Low Flow	3710	3440	0.34	0.38	0.07	0.14	0.37	0.71
July Low Flow	2595	2640	0.42	0.32	0.02	0.23	0.83	0.46
August Low Flow	2172	2358	0.42	0.34	0.09	0.20	0.17	0.48
September Low Flow	1979	2100	0.28	0.24	0.06	0.16	0.24	0.58
EFC Parameters								
Extreme low peak	1290	1265	0.11	0.10	0.02	0.12	0.58	0.63
Extreme low duration	2	2	1.50	1.00	0.00	0.33	0.01	0.32
Extreme low timing	261.5	271	0.09	0.13	0.05	0.43	0.45	0.13
Extreme low freq.	3	10	2.67	1.00	2.33	0.63	0.00	0.19
High flow peak	8434	6265	0.35	0.16	0.26	0.53	0.00	0.06
High flow duration	5	3	0.40	0.33	0.40	0.17	0.00	0.37
High flow timing	71	69	0.34	0.25	0.01	0.27	0.93	0.38
High flow frequency	15	25	0.33	0.24	0.67	0.28	0.00	0.34
High flow rise rate	2107	2003	0.40	0.26	0.05	0.34	0.50	0.38

High flow fall rate	-1106	-1088	-0.31	-0.31	0.02	0.01	0.77	0.96
Small Flood peak	68150	73200	0.35	0.21	0.07	0.40	0.55	0.27
Small Flood duration	21	25.5	1.21	0.58	0.21	0.52	0.54	0.22
Small Flood timing	88.5	79.5	0.17	0.28	0.05	0.62	0.76	0.28
Small Flood freq.	0	0	0.00	0.00				
Small Flood riserate	17850	10520	1.15	1.14	0.41	0.01	0.26	0.98
Small Flood fallrate	-3538	-3899	-1.05	-0.64	0.10	0.39	0.77	0.31
Large flood peak	109700		0.11					
Large flood duration	12		1.08					
Large flood timing	312		0.39					
Large flood freq.	0	0	0.00	0.00				
Large flood riserate	26550		1.68					
Large flood fallrate	-10260		-0.57					
EFC high flow lower percentile threshold:		3761						
EFC high flow upper percentile threshold:		6395						
EFC extreme low flow threshold:		1409						
EFC small flood peak flow threshold:		51000						
EFC large flood peak flow threshold:		101800						

Table A9: Pre and Post -Impact Non-Parametric Range of Variability Approach (RVA) table for Reach 1 (Radford)

IHA Non-Parametric RVA  
Scorecard

Radford Daily IHA analysis for  
Claytor

	Pre-impact period				Post-impact period				RVA Boundaries		Hydrologic Alteration (Middle Category)
	Coeff. of		Minimum	Maximum	Coeff. of		Minimum	Maximum	Low	High	
	Medians	Dispersion			Medians	Dispersion					
Parameter Group #1											
October	1906	0.691	927	5561	2110	0.735	918	5920	1401	2316	-0.154
November	2223	1.027	887.5	6409	2395	1.111	885	6635	1742	3083	-0.385
December	3141	0.706	1182	5619	3540	0.785	957	6010	2378	4018	-0.077
January	3708	0.491	1291	7497	3930	0.646	1080	6880	2985	4284	0.000
February	4393	0.598	1610	8921	4725	0.588	1420	9125	3725	5228	-0.077
March	5252	0.695	1945	9691	5540	0.639	1950	9860	4025	6055	-0.154
April	4541	0.823	2227	9986	4635	0.779	2205	11650	3154	5767	0.077
May	3814	0.597	1885	7718	4030	0.571	1930	8020	3155	5122	0.000
June	3516	0.539	1145	7148	3770	0.566	1055	6835	2958	3875	-0.231
July	2382	0.485	1101	5207	2560	0.473	1010	5020	2169	2821	-0.231
August	1920	0.475	728	5706	2030	0.498	849	5050	1732	2140	-0.462
September	1703	0.527	973	6339	1680	0.589	851.5	8000	1440	2020	-0.077
Parameter Group #2											
1-day minimum	1032	0.333	530	1796	894	0.190	752	1130	942.4	1138	0.000
3-day minimum	1090	0.350	544.7	1842	989.7	0.196	786.7	1410	1027	1255	0.000
7-day minimum	1208	0.342	597.3	1880	1106	0.360	792.6	1677	1084	1376	0.154
30-day minimum	1469	0.322	769.1	2352	1468	0.376	809.8	2285	1297	1672	-0.077
90-day minimum	2031	0.503	981.7	3598	2172	0.506	989.7	3413	1834	2348	-0.077
1-day maximum	38820	0.691	10070	98020	35800	0.760	8650	82500	30460	50400	0.077
3-day maximum	26180	0.607	8250	57050	23530	0.588	7757	49300	21830	33040	0.000
7-day maximum	17970	0.427	5985	31180	17400	0.434	6069	27830	13900	20140	0.154
30-day maximum	9561	0.412	4045	14780	9016	0.408	4002	14520	8072	10690	0.154
90-day maximum	7121	0.592	3136	10500	6834	0.593	2990	10490	6158	8016	0.077
Number of zero days	0	0.000	0	0	0	0.000	0	0	0	0	0.000
Base flow index	0.3112	0.316	0.2006	0.4421	0.2808	0.339	0.1868	0.4693	0.2763	0.332	-0.308
Parameter Group #3											



Date of minimum	267	0.1202	5	348	279	0.2678	5	366	252.9	282	-0.500
Date of maximum	89	0.3607	15	337	130	0.388	15	338	83.64	173.7	0.154

Parameter Group #4

Low pulse count	11	0.7273	3	33	28	0.3214	11	51	8	13	-0.933
Low pulse duration	3	1	1	17	2	0	1	5	2	4.56	0.474
High pulse count	14	0.5	5	23	23	0.5217	4	43	11.88	16.12	-0.769
High pulse duration	3	0.3333	1	7	2	0.25	1	4.5	3	4	-0.632
The low pulse threshold is			1931								
The high pulse threshold is			4873								

Parameter Group #5

Rise rate	281	0.5658	84	523	620	0.5323	105	1054	254.3	331.9	-0.769
Fall rate	-288	-0.6615	-492	-101.5	-590	-0.6102	-1020	-100	-382.1	-	-0.769
Number of reversals	143	0.2168	108	173	183	0.08743	156	202	132	156	-0.938

Assessment of Hydrologic Alteration

	Middle RVA Category			High RVA Category			Low RVA Category			
	Expected	Observed	Alter.	Expected	Observed	Alter.	Expected	Observed	Alter.	
Parameter Group #1										
October	13	11	-0.154	11	12	0.091	11	12	0.091	
November	13	8	-0.385	11	14	0.273	11	13	0.182	
December	13	12	-0.077	11	13	0.182	11	10	-0.091	
January	13	13	0.000	11	13	0.182	11	9	-0.182	
February	13	12	-0.077	11	14	0.273	11	9	-0.182	
March	13	11	-0.154	11	13	0.182	11	11	0.000	
April	13	14	0.077	11	11	0.000	11	10	-0.091	
May	13	13	0.000	11	11	0.000	11	11	0.000	
June	13	10	-0.231	11	15	0.364	11	10	-0.091	
July	13	10	-0.231	11	16	0.455	11	9	-0.182	
August	13	7	-0.462	11	15	0.364	11	13	0.182	
September	13	12	-0.077	11	12	0.091	11	11	0.000	

Parameter Group #2

1-day minimum	13	13	0.000	11	0	-1.000	11	22	1.000	
3-day minimum	13	13	0.000	11	1	-0.909	11	21	0.909	
7-day minimum	13	15	0.154	11	6	-0.455	11	14	0.273	
30-day minimum	13	12	-0.077	11	12	0.091	11	11	0.000	
90-day minimum	13	12	-0.077	11	13	0.182	11	10	-0.091	
1-day maximum	13	14	0.077	11	7	-0.364	11	14	0.273	

3-day maximum	13	13	0.000	11	8	-0.273	11	14	0.273
7-day maximum	13	15	0.154	11	8	-0.273	11	12	0.091
30-day maximum	13	15	0.154	11	8	-0.273	11	12	0.091
90-day maximum	13	14	0.077	11	9	-0.182	11	12	0.091
Number of zero days	35	35	0.000	0	0		0	0	
Base flow index	13	9	-0.308	11	10	-0.091	11	16	0.455
Parameter Group #3									
Date of minimum	14	7	-0.500	10	12	0.200	11	16	0.455
Date of maximum	13	15	0.154	11	13	0.182	11	7	-0.364
Parameter Group #4									
Low pulse count	15	1	-0.933	10	34	2.400	10	0	-1.000
Low pulse duration	19	28	0.474	11	1	-0.909	5	6	0.200
High pulse count	13	3	-0.769	11	27	1.455	11	5	-0.546
High pulse duration	19	7	-0.632	8	1	-0.875	8	27	2.375
Parameter Group #5									
Rise rate	13	3	-0.7692	11	29	1.636	11	3	-0.7273
Fall rate	13	3	-0.7692	11	4	-0.6364	11	28	1.545
Number of reversals	16	1	-0.9375	9	34	2.778	10	0	-1

Table A10: Pre and Post-Impact Non-Parametric Range of Variability Approach (RVA) table for Reach 2 (Glen Lyn)

IHA Non-Parametric RVA Scorecard

Glen Lyn Reach Pre and Post IHA  
Claytor

	Pre-impact period				Post-impact period				RVA Boundaries		Hydrologic Alteration (Middle Category)
	Coeff. of				Coeff. of				Low	High	
	Medians	Dispersion	Minimum	Maximum	Medians	Dispersion	Minimum	Maximum			
Parameter Group #1											
October	2147	0.8314	1104	6896	2120	0.7642	1060	7560	1551	2601	0
November	2709	1.245	1080	8235	2910	1.246	1195	7830	1961	3827	-0.2308
December	3853	0.8975	1342	7950	4260	0.7559	1090	7930	2916	5026	-0.3846
January	4819	0.6147	1501	10620	4850	0.6557	1350	9560	3867	5565	-0.1538
February	6182	0.5652	2152	12250	6255	0.5707	2145	14200	4737	7266	0
March	7437	0.6512	2367	13310	7510	0.6072	2380	12500	5593	8254	-0.3077
April	6112	0.7179	2683	14140	6075	0.6947	2875	15150	4063	7617	0.1538
May	5519	0.4649	2379	11280	5070	0.5464	2650	11100	4517	6595	-0.3077
June	4043	0.6156	1437	9239	4080	0.6703	1345	10220	3342	4601	-0.2308
July	2708	0.4424	1246	5946	3020	0.4272	1170	6610	2478	3258	-0.07692
August	2198	0.4268	888	7015	2320	0.5043	782	6980	1929	2588	-0.2308
September	1905	0.5147	1082	7550	1875	0.464	981	9160	1681	2310	0
Parameter Group #2											
1-day minimum	1162	0.3003	633	2009	1110	0.2162	557	1570	1085	1311	0.3846
3-day minimum	1238	0.3121	650.3	2053	1197	0.2432	618	1623	1172	1444	0.5385
7-day minimum	1374	0.3311	704.3	2095	1344	0.3918	646.1	1936	1220	1577	0.07692
30-day minimum	1624	0.3195	925.7	2614	1663	0.4459	947.4	2569	1449	1886	-0.2308
90-day minimum	2352	0.491	1214	5005	2515	0.4348	1280	4941	2043	2664	-0.2308
1-day maximum	51000	0.7232	14420	118800	42400	0.8844	11500	89400	43980	70740	-0.4615
3-day maximum	34670	0.68	12260	70950	30500	0.694	10830	58630	29350	47400	-0.07692
7-day maximum	22960	0.5382	8246	40390	21760	0.4787	8026	39090	19680	28000	0
30-day maximum	12880	0.4444	5496	21760	12470	0.4806	5412	21130	11060	14520	0
90-day maximum	9473	0.6279	4007	14700	9131	0.6198	3999	14310	8469	10860	-0.1538
Number of zero days	0	0	0	0	0	0	0	0	0	0	0
Base flow index	0.2751	0.2858	0.1677	0.4068	0.2512	0.2716	0.1598	0.4186	0.2397	0.2927	-0.2308

Parameter Group #3

Date of minimum	267	0.0929	5	348	255	0.1339	19	348	253	282	-0.4
Date of maximum	89	0.3607	15	337	111	0.276	16	338	83.64	173.7	0.1538

Parameter Group #4

Low pulse count	10	0.7	3	23	21	0.4762	5	47	7	11.12	-0.7857
Low pulse duration	3	1.667	1.5	21	2	0.5	1	5.5	2.94	5	-0.5
High pulse count	13	0.3077	5	23	17	0.6471	5	27	11	14.12	-0.625
High pulse duration	4	0.5	2	7	3	0.6667	2	6	3	4	-0.1579
The low pulse threshold is			2271								
The high pulse threshold is			6395								

Parameter Group #5

Rise rate	341	0.5396	109	844	700	0.5429	150	1345	297.9	405.6	-0.8462
Fall rate	-353	-0.7096	-641	-124	-680	-0.4926	-1060	-150	-468.2	-310.1	-0.7692
Number of reversals	138	0.1957	104	169	170	0.07647	140	193	122.9	146.1	-0.9231

Assessment of Hydrologic Alteration

	Middle RVA Category			High RVA Category			Low RVA Category		
	Expected	Observed	Alter.	Expected	Observed	Alter.	Expected	Observed	Alter.
Parameter Group #1									
October	13	13	0	11	11	0	11	11	0
November	13	10	-0.2308	11	12	0.09091	11	13	0.1818
December	13	8	-0.3846	11	14	0.2727	11	13	0.1818
January	13	11	-0.1538	11	15	0.3636	11	9	-0.1818
February	13	13	0	11	12	0.09091	11	10	-0.09091
March	13	9	-0.3077	11	14	0.2727	11	12	0.09091
April	13	15	0.1538	11	12	0.09091	11	8	-0.2727
May	13	9	-0.3077	11	13	0.1818	11	13	0.1818
June	13	10	-0.2308	11	16	0.4545	11	9	-0.1818
July	13	12	-0.07692	11	13	0.1818	11	10	-0.09091
August	13	10	-0.2308	11	14	0.2727	11	11	0
September	13	13	0	11	11	0	11	11	0

Parameter Group #2

1-day minimum	13	18	0.3846	11	2	-0.8182	11	15	0.3636
3-day minimum	13	20	0.5385	11	2	-0.8182	11	13	0.1818
7-day minimum	13	14	0.07692	11	9	-0.1818	11	12	0.09091
30-day minimum	13	10	-0.2308	11	12	0.09091	11	13	0.1818
90-day minimum	13	10	-0.2308	11	14	0.2727	11	11	0
1-day maximum	13	7	-0.4615	11	9	-0.1818	11	19	0.7273

3-day maximum	13	12	-0.07692	11	7	-0.3636	11	16	0.4545
7-day maximum	13	13	0	11	9	-0.1818	11	13	0.1818
30-day maximum	13	13	0	11	9	-0.1818	11	13	0.1818
90-day maximum	13	11	-0.1538	11	11	0	11	13	0.1818
Number of zero days	35	35	0	0	0		0	0	
Base flow index	13	10	-0.2308	11	9	-0.1818	11	16	0.4545
Parameter Group #3									
Date of minimum	15	9	-0.4	10	9	-0.1	10	17	0.7
Date of maximum	13	15	0.1538	11	11	0	11	9	-0.1818
Parameter Group #4									
Low pulse count	14	3	-0.7857	11	30	1.727	10	2	-0.8
Low pulse duration	14	7	-0.5	10	2	-0.8	11	26	1.364
High pulse count	16	6	-0.625	11	23	1.091	8	6	-0.25
High pulse duration	19	16	-0.1579	10	5	-0.5	6	14	1.333
Parameter Group #5									
Rise rate	13	2	-0.8462	11	28	1.545	11	5	-0.5455
Fall rate	13	3	-0.7692	11	5	-0.5455	11	27	1.455
Number of reversals	13	1	-0.9231	11	34	2.091	11	0	-1