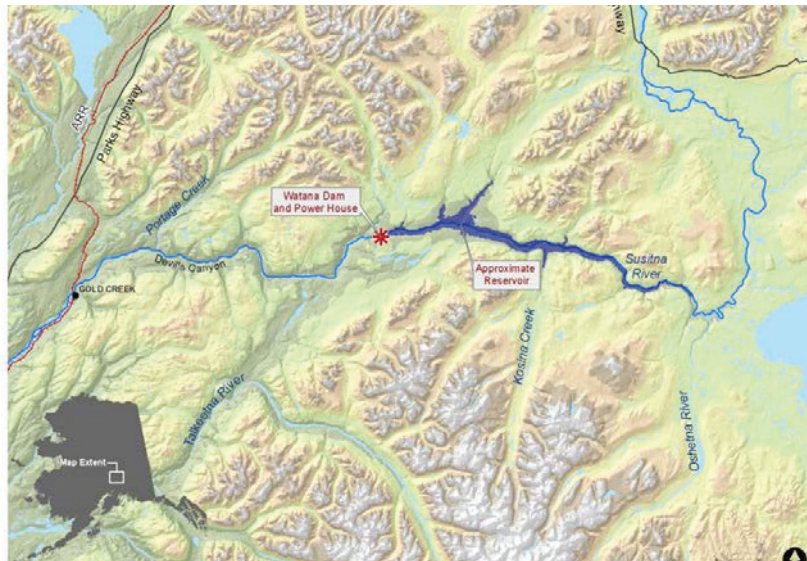

NTP 3
Technical Memorandum No. 3

Watana Hydroelectric Project
Susitna Watershed Historical Hydrology

Alaska Railbelt Large Hydro Engineering Services

AEA11-022



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WATANA HYDROELECTRIC PROJECT – SUSITNA WATERSHED HISTORICAL HYDROLOGY

The purpose of this technical memorandum is to summarize existing hydrologic data in the Susitna River watershed, and to present statistics for estimated flow at the Watana dam site. Sections of this memorandum include (1) hydrologic record; (2) monthly flow summary; (3) monthly flow frequency and flow distribution; (4) Watana dam site historical flows; (5) flood frequency; and (6) Susitna watershed flow distribution. Hydrologic change will be covered in a separate technical memorandum. Results presented herein are preliminary.

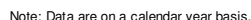
I. Hydrologic Record



A summary of recorded flow data in the Susitna River watershed is useful to many groups associated with the Watana Hydroelectric Project. Recorded flow data is also needed to develop a long-term estimate of flow and flood frequency at the Watana dam site for use in Project design, reservoir operation and power generation studies. Fourteen gaging stations have been intermittently operated by the USGS within the Susitna River watershed between 1949 and 2011 (Table 1). An additional station on the Little Susitna River, which is not a tributary of the Susitna River, was included in Table 1 due to its proximity to the Susitna River and the exceptionally long period of record for this gage.

Table 1: USGS Streamflow Gages in the Susitna Watershed

USGS Gage Number	Gage Name	Drainage Area (sq.mi.)	Latitude	Longitude	Gage Datum (feet)	Available Period of Record
15290000	Little Susitna River near Palmer	62	61°42'37"	149°13'47"	917	63 years: 1948 - 2011
15291000	Susitna River near Denali	950	63°06'14"	147°30'57"	2,440	27 years: 1957 - 1976; 1978 - 1986
15291200	Maclaren River near Paxson	280	63°07'10"	146°31'45"	2,866	28 years: 1958 - 1986
15291500	Susitna River near Cantwell	4,140	62°41'55"	147°32'42"	1,900	17 years: 1961 - 1972; 1980 - 1986
15292000	Susitna River at Gold Creek	6,160	62°46'04"	149°41'28"	677	57 years: 1949 - 1996; 2001 - 2011
15292400	Chulitna River near Talkeetna	2,570	62°33'31"	150°14'02"	520	20 years: 1958 - 1972; 1980 - 1986
15292700	Talkeetna River near Talkeetna	1,996	62°20'49"	150°01'01"	400	47 years: 1964 - 2011
15292780	Susitna River at Sunshine	11,100	62°10'42"	150°10'30"	270	5 years: 1981 - 1986
15292800	Montana Creek near Montana	164	62°06'19"	150°03'27"	250	4 years: 2005 - 2006; 2008 - 2011
15294005	Willow Creek Near Willow	166	61°46'51"	149°53'04"	350	25 years: 1978 - 1993; 2001 - 2011
15294010	Deception Creek near Willow	48	61°44'52"	149°56'14"	250	7 years: 1978 - 1985
15294100	Deshka River near Willow	591	61°46'05"	150°20'13"	80	11 years: 1978 - 1986; 1998 - 2001
15294300	Skwentna River near Skwentna	2,250	61°52'23"	151°22'01"	200	23 years: 1959 - 1982
15294345	Yentna River near Susitna Station	6,180	61°41'55"	150°39'02"	80	6 years: 1980 - 1986
15294350	Susitna River at Susitna Station	19,400	61°32'41"	150°30'45"	40	19 years: 1974 - 1993

Figure 1 shows the chronological availability of USGS flow data in the Susitna watershed. A modeled daily flow data set for the Watana dam site was developed from the daily data at the downstream gage at Gold Creek and the upstream gage near Cantwell. The drainage area at the Watana dam site, 5,180 square miles, is approximately half way between the drainage area at Cantwell (4,140 square miles) and Gold Creek (6,160 square miles). The drainage areas for these sites were confirmed with GIS measurements. The 17 years of concurrent data at the Cantwell and Gold Creek gaging stations were used to calculate monthly scaling factors for use in estimating flows at Watana, as described below. Figure 1 also shows an active period of flow gaging in the early 1980s, with at least four years of concurrent data at almost all sites.



Legend	
Complete years of record	
Partial years of record	

Other useful gaging stations for describing flow in the watershed are located on the Susitna River at Sunshine and at Susitna Station, and on the Chulitna River near Talkeetna. This memo presents detailed summaries (flow duration, flow frequency, flood frequency) for data at these four sites in addition to Cantwell and Gold Creek. Flow data for the remaining 10 sites is summarized with average monthly flow data tables.

Within the period of record for gages in the Susitna watershed, there have been several periods of no gage-height record, some lasting for several consecutive months. The USGS has developed estimated flows for the period of no gage-height records, as is their customary practice, to provide a continuous period of record during operational years. All of the data used in hydrologic analyses for the Susitna watershed are accepted measured or estimated values published by the USGS.

II. Monthly Flow Summary

Average monthly flows over the period of record for the gage sites listed in Table 1 are presented below (Table 2). As shown in Table 1 and in Figure 2, flow in the Susitna River and its tributaries is highly seasonal, with peak flows in July corresponding with summer snow melt conditions, and low winter flows occurring when much precipitation is stored in the watershed as snow. Tables 3 through 17 below present the average monthly flows on an annual basis for the period of record at the USGS gaging stations listed in Table 1.

Table 2: Average Monthly Flows (cfs) at USGS Gages in the Susitna Watershed

	Gage Location (drainage area)														
	Little Susitna River near Palmer (61.9mi ²)	Susitna River near Denali (950mi ²)	Maclaren River near Paxson (280mi ²)	Susitna River near Cantwell (4,140mi ²)	Susitna River at Gold Creek (6,160mi ²)	Chulitna River near Talkeetna (2,570mi ²)	Talkeetna River near Talkeetna (1,996mi ²)	Susitna River at Sunshine (11,100mi ²)	Montana Creek near Montana (164.1mi ²)	Willow Creek near Willow (166mi ²)	Deception Creek near Willow (48mi ²)	Deshka River near Willow (591mi ²)	Skwentna River near Skwentna (2,250mi ²)	Yentna River near Susitna Station (6,180mi ²)	Susitna River at Susitna Station (19,400mi ²)
January	31	262	105	961	1,590	1,367	666	4,375	39	84	18	277	1,120	3,265	8,487
February	25	220	90	828	1,414	1,132	562	3,939	33	73	15	239	953	2,985	7,739
March	21	199	82	779	1,297	1,001	508	3,496	31	61	15	240	837	2,576	7,136
April	27	233	89	915	1,753	1,171	703	3,948	54	95	39	590	1,095	3,863	10,021
May	240	2,135	850	7,908	14,138	8,169	5,050	27,970	888	653	169	2,800	8,599	26,433	64,825
June	661	7,279	2,894	18,230	26,417	21,474	10,631	56,472	547	981	95	902	19,001	47,997	118,479
July	485	9,831	3,240	17,542	23,871	26,363	10,151	66,238	346	637	89	831	17,644	53,394	130,317
August	409	8,159	2,548	14,918	21,365	22,516	9,102	60,972	576	619	84	1,140	13,401	49,070	113,051
September	306	3,296	1,136	7,936	13,741	11,834	5,860	35,202	541	633	91	1,231	8,466	27,608	74,446
October	148	1,181	421	3,365	6,345	5,188	2,946	16,600	246	427	72	1,161	4,522	14,003	39,578
November	64	525	192	1,575	2,679	2,169	1,201	6,787	70	158	47	673	1,945	5,823	15,966
December	41	339	130	1,117	1,892	1,576	820	4,877	47	105	25	338	1,327	3,893	9,983
Annual	206	2,793	981	6,340	9,805	8,792	4,039	23,864	242	388	65	903	6,640	20,208	50,417

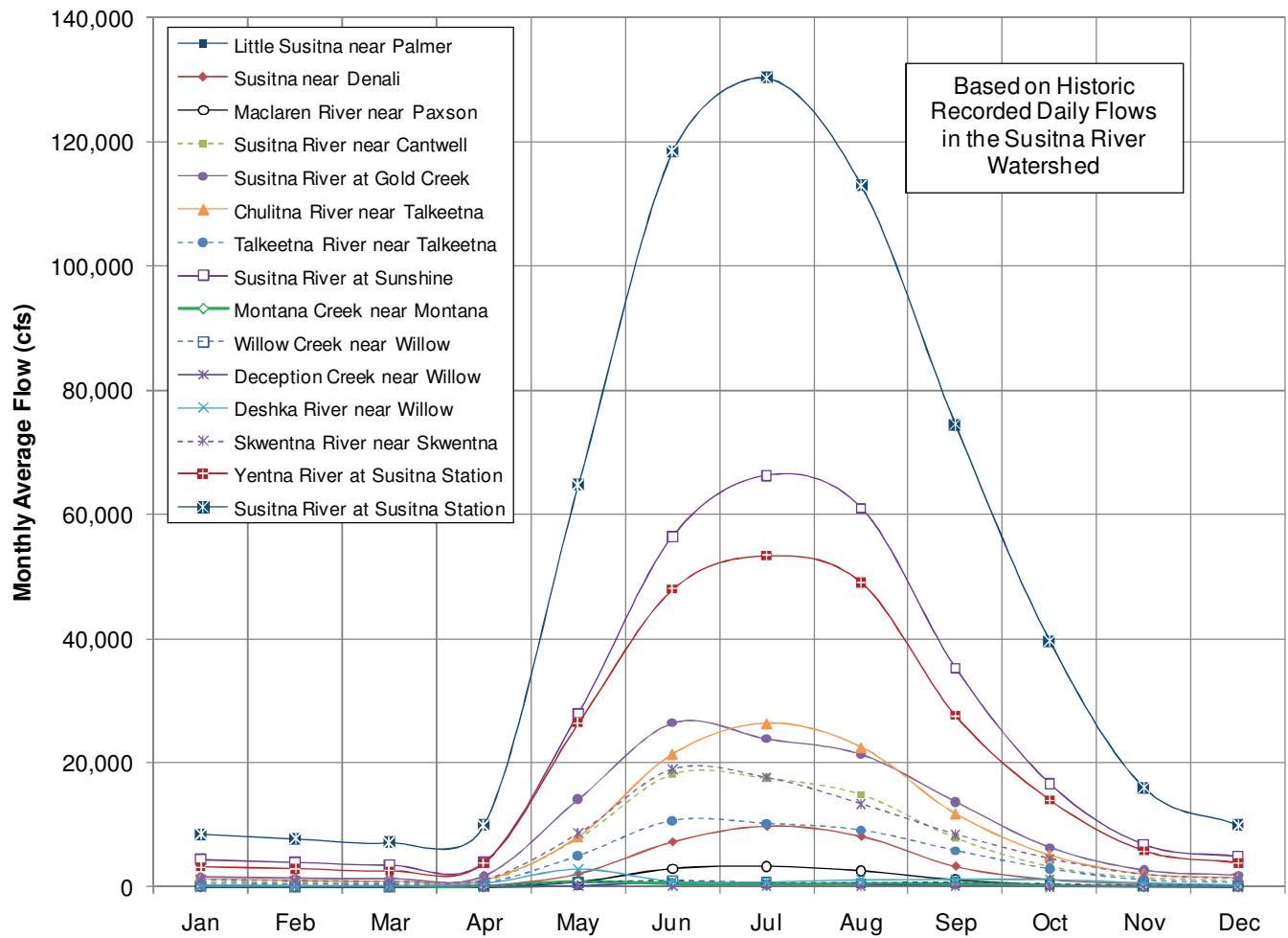


Figure 2: Average Monthly Flows in the Susitna Watershed

**Table 3: Average Flows (cfs) at USGS Gage 15290000 - Little Susitna River near Palmer**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1948	---	---	---	---	---	---	557.9	661.2	280.0	136.7	60.0	43.9	---
1949	30.9	21.7	20.4	23.5	314.7	1,176.0	940.3	680.6	321.4	134.5	50.8	30.8	313.6
1950	25.0	16.6	17.8	17.8	57.4	519.1	358.1	296.4	154.0	67.9	35.0	31.0	133.4
1951	27.0	21.0	16.5	22.1	214.0	708.5	488.7	445.9	543.5	138.6	50.3	36.0	226.5
1952	23.1	14.0	13.0	15.0	151.6	966.5	697.4	427.9	386.9	133.8	80.4	38.5	246.3
1953	31.0	20.7	16.0	22.3	267.9	642.2	278.0	443.6	245.7	83.0	47.0	31.0	178.0
1954	21.0	16.0	13.0	18.0	202.1	297.5	381.4	499.5	298.2	126.7	56.2	17.4	163.4
1955	19.6	15.9	11.3	10.0	88.4	665.6	805.9	556.3	279.8	85.2	37.7	27.0	218.2
1956	20.0	16.0	10.0	17.0	129.3	576.9	609.6	398.4	304.6	86.6	56.3	32.9	189.0
1957	24.1	19.4	10.5	17.7	348.2	701.9	309.9	217.6	539.6	170.5	81.4	43.1	207.1
1958	24.4	20.7	14.5	20.0	157.7	398.4	240.4	304.7	125.3	111.4	44.5	31.9	125.1
1959	17.5	15.5	14.5	16.5	212.0	797.4	458.9	735.7	305.2	111.1	54.0	30.9	231.9
1960	29.5	19.6	13.0	19.1	381.6	398.1	367.3	361.5	351.2	129.1	60.7	44.1	182.3
1961	54.1	25.0	17.5	20.5	185.5	605.5	505.9	456.4	348.4	156.3	65.2	33.1	207.0
1962	36.4	27.4	24.8	25.6	141.7	994.2	568.5	533.6	345.0	98.7	47.9	37.3	240.6
1963	33.2	24.7	22.3	23.9	319.5	857.9	1,047.0	825.3	201.7	167.8	59.6	38.1	304.2
1964	27.4	22.9	19.8	24.5	72.2	932.1	456.0	294.1	178.2	122.9	62.5	41.9	188.0
1965	31.0	26.3	25.6	34.1	121.4	481.6	496.7	450.9	606.1	180.7	70.3	47.4	215.0
1966	30.5	25.1	21.0	23.0	83.5	546.2	361.0	401.9	223.3	109.6	69.2	42.5	161.9
1967	27.3	23.1	21.4	23.2	247.6	789.9	632.8	524.0	311.7	88.3	46.5	33.3	231.8
1968	29.8	29.0	27.6	26.7	374.2	919.9	600.7	231.4	115.2	51.3	24.5	19.8	204.9
1969	24.0	22.5	18.1	21.9	178.9	289.1	241.9	169.3	82.2	76.3	45.9	33.0	100.8
1970	25.9	20.4	19.7	19.7	194.5	405.8	418.9	422.1	199.2	117.9	71.6	43.0	164.3
1971	30.5	24.5	18.2	18.3	52.9	675.4	622.3	908.5	177.3	92.3	63.9	35.2	228.2
1972	31.2	25.9	19.6	18.0	117.1	883.9	743.4	297.4	408.7	209.5	80.2	44.2	240.5
1973	31.6	27.7	25.0	24.0	157.3	671.1	373.7	392.1	164.9	90.4	50.8	36.3	171.0
1974	32.4	27.7	19.8	21.0	395.5	643.0	407.2	258.7	177.6	96.2	56.3	36.1	181.7
1975	30.0	25.8	21.4	20.8	134.6	731.1	720.4	347.7	521.8	156.6	65.7	44.9	235.7
1976	28.1	23.8	18.7	20.5	121.8	708.8	426.8	215.8	102.9	76.2	51.5	44.5	153.6
1977	31.1	25.6	22.0	25.4	179.6	1,215.0	619.3	246.5	465.0	183.4	61.5	48.1	260.1
1978	29.0	24.9	19.8	26.1	135.5	405.7	375.2	238.1	144.0	85.7	56.8	40.8	132.4
1979	30.8	26.2	23.4	31.8	625.1	928.0	741.5	265.5	214.2	201.6	134.1	61.7	275.1
1980	39.6	29.3	24.5	24.7	152.5	863.0	929.8	555.5	508.1	129.5	62.0	37.0	280.8
1981	27.0	20.4	16.3	25.5	248.6	312.6	723.9	776.4	142.2	113.6	67.6	35.5	211.5
1982	37.2	41.2	26.8	22.2	140.9	868.4	823.4	414.0	566.4	160.0	56.2	43.5	267.3
1983	30.5	23.5	25.5	34.6	314.8	738.2	401.4	574.6	352.2	391.4	95.2	51.6	254.1
1984	35.2	30.2	21.9	21.5	278.6	702.9	523.5	512.3	260.6	148.2	55.8	40.3	220.4
1985	31.8	21.0	17.9	17.2	183.9	748.1	920.5	772.6	651.3	208.5	58.2	37.7	307.4
1986	33.5	29.0	18.6	19.5	125.6	380.9	397.9	281.4	357.9	371.4	103.9	51.2	181.8
1987	28.4	25.3	21.6	27.7	177.3	447.7	463.5	427.0	381.0	123.5	60.2	41.3	186.2
1988	31.6	22.8	23.7	28.5	209.9	563.3	400.8	287.9	213.3	139.5	67.5	45.2	170.2
1989	33.1	27.7	22.8	34.7	204.0	624.7	435.2	355.8	372.9	182.7	64.2	49.2	201.2
1990	37.7	28.9	23.1	68.0	648.9	721.5	274.5	245.1	530.4	117.4	61.0	49.3	234.3
1991	39.7	34.9	29.7	33.5	248.5	674.7	402.6	182.3	155.7	128.1	55.3	36.4	168.9
1992	31.2	23.9	20.9	25.0	157.2	540.1	303.5	222.1	177.1	81.9	50.3	35.7	139.4
1993	28.7	26.7	22.7	43.5	463.2	596.8	261.0	292.6	494.7	263.2	110.0	55.5	222.2
1994	41.2	38.9	21.8	37.7	264.3	1,006.0	406.6	285.5	175.2	118.1	61.8	45.9	208.8
1995	35.2	27.9	24.4	37.5	306.2	626.4	380.5	272.3	316.2	113.3	52.8	39.2	186.5
1996	28.8	22.7	18.2	24.9	196.7	275.5	192.6	272.6	146.5	69.1	58.3	36.9	112.5
1997	28.8	25.1	23.0	28.9	239.0	540.3	249.4	372.5	284.5	104.5	55.2	44.8	166.8
1998	36.5	31.4	27.9	32.6	155.2	574.9	325.5	439.6	265.0	150.8	67.5	47.1	180.1
1999	36.3	29.4	23.5	21.1	132.2	560.0	338.9	393.2	212.0	163.3	83.5	59.4	171.7
2000	41.7	33.5	26.3	30.4	184.3	849.9	643.5	324.3	405.4	169.1	75.2	48.4	236.5
2001	31.5	25.9	22.0	27.3	140.1	806.7	357.6	274.7	192.2	92.9	47.6	32.8	171.1
2002	26.6	22.1	19.4	24.7	388.9	410.6	253.8	421.9	425.1	346.8	112.2	54.8	210.1
2003	36.8	31.6	27.5	38.8	163.1	585.4	462.4	361.8	198.1	188.6	72.6	50.5	185.6
2004	36.3	25.3	22.4	35.2	419.3	415.9	214.1	164.8	161.5	211.7	69.9	50.0	153.0
2005	41.9	30.2	25.7	73.3	759.5	1,180.0	575.5	414.7	851.6	206.8	65.0	45.5	356.4
2006	28.7	22.5	20.0	21.4	210.0	480.7	304.5	870.3	236.9	344.1	87.6	47.4	224.7
2007	29.7	23.2	18.2	30.2	151.5	574.3	299.8	376.4	477.3	169.0	71.8	45.4	189.2
2008	33.9	26.6	23.8	19.2	210.1	778.3	654.6	370.3	214.4	98.5	48.0	37.9	210.5
2009	38.8	33.6	27.4	67.8	781.7	688.6	415.1	395.6	186.9	181.9	75.9	46.0	246.6
2010	35.0	30.0	29.1	34.7	268.7	319.9	356.3	369.9	255.7	---	---	---	---
Average	31	25	21	27	240	661	485	409	306	148	64	41	206
Maximum	54	41	30	73	782	1,215	1,047	909	852	391	134	62	356
Minimum	18	14	10	10	53	276	193	165	82	51	25	17	101

**Table 4: Average Flows (cfs) at USGS Gage 15291000 - Susitna River near Denali**

<u>Year</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Annual</u>
1957	---	---	---	---	---	12,210	11,170	9,769	4,017	1,277	610	288	---
1958	219	150	120	210	1,163	8,367	9,150	6,536	1,879	939	390	170	2,457
1959	119	81	42	43	1,782	8,891	8,333	7,882	2,498	1,577	760	575	2,733
1960	444	321	275	265	3,349	5,237	9,039	7,910	4,817	1,781	660	483	2,904
1961	331	271	281	415	2,959	6,412	8,078	7,253	2,695	1,290	680	440	2,612
1962	280	240	220	280	2,197	9,087	10,220	9,454	3,649	1,079	510	310	3,148
1963	250	230	200	210	3,253	6,763	10,500	10,210	3,949	925	290	185	3,107
1964	140	140	110	130	910	11,630	7,577	6,552	2,633	1,468	702	279	2,698
1965	220	200	208	320	2,464	4,647	6,756	5,764	6,955	920	300	240	2,427
1966	210	200	200	280	1,629	6,850	8,287	6,432	3,200	---	---	---	---
1968	---	---	---	---	---	---	11,840	9,825	2,192	700	304	172	---
1969	145	140	145	229	1,768	8,146	9,445	3,919	2,213	1,002	501	339	2,346
1970	265	221	193	319	2,210	5,013	8,454	6,216	1,946	528	395	276	2,188
1971	170	125	120	135	629	8,099	10,410	10,400	3,288	1,039	478	380	2,962
1972	339	307	287	270	3,468	6,562	10,450	8,664	2,778	667	323	211	2,886
1973	178	164	153	153	1,042	5,741	8,346	7,268	2,445	876	462	366	2,284
1974	310	271	235	262	2,541	5,642	9,547	9,292	5,452	2,135	673	381	3,085
1975	300	200	200	200	1,640	7,040	12,110	7,295	3,571	1,539	375	169	2,910
1976	112	97	90	123	1,805	5,939	8,558	10,080	1,822	894	467	331	2,551
1977	267	240	231	246	1,498	8,253	10,010	10,180	3,707	1,148	652	439	3,094
1978	348	300	246	263	2,031	5,250	8,993	8,644	3,622	865	463	312	2,633
1979	263	229	203	250	2,791	7,650	9,504	9,178	4,512	2,165	878	533	3,202
1980	395	330	290	280	1,889	6,413	11,750	7,167	2,643	1,298	745	473	2,830
1981	344	274	236	210	3,010	7,162	11,860	12,010	2,742	831	481	326	3,322
1982	227	157	127	120	2,457	5,866	9,749	6,454	4,448	1,153	439	363	2,649
1983	330	300	277	281	1,969	7,455	10,460	8,045	2,597	1,224	433	277	2,826
1984	220	205	200	196	2,049	8,381	10,780	8,816	2,147	1,305	611	438	2,969
1985	357	306	291	376	2,481	8,058	10,490	7,223	3,860	1,269	589	404	2,995
1986	304	238	201	229	2,671	7,060	13,240	---	---	---	---	---	---
Average	262	220	199	233	2,135	7,279	9,831	8,159	3,296	1,181	525	339	2,793
Maximum	444	330	291	415	3,468	12,210	13,240	12,010	6,955	2,165	878	575	3,322
Minimum	112	81	42	43	629	4,647	6,756	3,919	1,822	528	290	169	2,188

Table 5: Average Flows (cfs) at USGS Gage 15291200 - Maclaren River near Paxson

<u>Year</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Annual</u>
1958	---	---	---	---	---	3,532	3,525	2,699	784	378	115	123	---
1959	129	95	63	78	587	2,879	2,680	2,083	856	549	250	190	875
1960	150	110	94	92	1,742	2,124	3,359	3,048	2,439	687	195	149	1,191
1961	110	94	96	145	1,237	2,678	3,369	3,299	1,168	381	210	170	1,088
1962	120	100	92	120	632	2,916	3,265	2,927	1,127	383	210	130	1,008
1963	100	91	80	83	2,131	3,110	4,649	3,136	1,213	416	140	98	1,282
1964	85	88	71	72	386	4,297	2,764	2,224	871	379	147	49	956
1965	44	42	41	62	984	2,268	3,223	2,409	2,098	522	180	55	1,000
1966	45	45	43	50	265	2,990	2,505	2,095	954	369	95	70	797
1967	65	60	55	53	1,023	3,634	3,255	3,605	1,416	417	130	100	1,158
1968	97	95	95	95	208	3,245	3,427	2,129	680	265	121	69	882
1969	58	55	58	95	849	2,613	2,692	974	470	249	117	73	696
1970	59	50	53	69	746	1,751	2,441	2,367	773	301	192	131	751
1971	83	60	55	66	365	3,414	3,528	3,659	1,165	375	156	123	1,095
1972	115	107	97	99	1,218	3,069	3,255	2,676	1,366	550	243	136	1,084
1973	87	65	53	51	576	2,906	2,856	2,271	821	308	123	83	855
1974	69	62	57	57	649	2,069	2,634	2,439	1,543	385	232	140	867
1975	115	110	100	103	768	3,178	3,649	1,982	1,574	553	235	139	1,047
1976	106	94	90	105	781	2,870	2,810	2,604	600	302	168	119	893
1977	97	92	90	93	367	3,942	3,834	3,394	1,297	512	265	187	1,187
1978	162	140	121	134	709	2,317	3,196	2,356	924	307	192	142	898
1979	122	110	100	111	634	2,430	3,056	2,223	1,137	734	370	246	945
1980	160	106	82	81	901	2,516	3,534	2,471	917	368	257	202	974
1981	159	130	111	95	1,164	2,504	3,666	4,122	1,113	443	230	170	1,169
1982	138	93	77	69	496	1,941	2,735	1,676	1,558	517	287	199	820
1983	148	123	117	123	853	2,751	3,001	2,536	1,196	481	200	121	977
1984	95	90	83	88	967	3,143	2,942	2,400	598	278	164	128	921
1985	113	102	107	110	1,562	4,233	3,344	1,531	1,143	380	145	101	1,077
1986	100	100	115	105	992	2,613	4,756	---	---	---	---	---	---
Average	105	90	82	89	850	2,894	3,240	2,548	1,136	421	192	130	981
Maximum	162	140	121	145	2,131	4,297	4,756	4,122	2,439	734	370	246	1,282
Minimum	44	42	41	50	208	1,751	2,441	974	470	249	95	49	696

Table 6: Average Flows (cfs) at USGS Gage 15291500 - Susitna River near Cantwell

<u>Year</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Annual</u>
1961	---	---	---	---	9,688	15,710	14,820	16,700	6,725	3,281	1,800	1,400	---
1962	1,300	1,000	940	1,200	10,000	28,320	20,890	16,000	9,410	4,326	2,200	1,400	8,116
1963	1,000	850	760	720	11,340	15,000	22,790	18,190	9,187	3,848	1,300	877	7,214
1964	644	586	429	465	2,806	34,630	17,040	11,510	5,352	3,134	1,911	921	6,625
1965	760	680	709	1,097	8,818	16,430	18,350	13,440	12,910	3,116	1,000	750	6,538
1966	700	650	650	875	4,387	18,500	12,220	12,680	6,523	2,322	780	720	5,103
1967	680	640	560	513	9,452	19,620	16,880	19,190	10,280	3,084	1,490	1,332	7,018
1968	1,232	1,200	1,200	1,223	9,268	19,500	17,480	10,940	5,410	2,406	1,063	618	5,992
1969	508	485	548	998	7,471	12,330	13,510	6,597	3,376	1,638	815	543	4,094
1970	437	426	463	887	7,580	9,909	13,900	12,320	5,211	2,155	1,530	1,048	4,693
1971	731	503	470	529	1,915	21,970	18,130	22,710	9,800	4,058	2,050	1,371	7,056
1972	1,068	922	881	876	9,694	20,000	16,690	15,620	9,423	---	---	---	---
1980	---	---	---	---	---	17,370	20,460	14,870	8,570	5,472	2,487	1,658	---
1981	1,694	1,186	919	1,218	12,150	14,020	20,870	22,760	9,417	3,829	1,627	1,297	7,646
1982	1,061	698	573	573	8,219	16,500	16,540	11,010	9,942	3,309	1,600	1,400	5,982
1983	1,300	1,200	1,148	1,210	8,196	16,460	16,250	17,000	8,656	5,377	2,130	1,600	6,751
1984	1,500	1,500	1,481	1,403	8,571	18,810	17,700	14,260	5,137	2,758	1,632	1,167	6,362
1985	990	880	844	1,028	5,541	15,810	19,880	12,730	7,522	3,087	1,367	891	5,916
1986	729.4	674.3	660	734.7	7,245	15,490	18,890	---	---	---	---	---	---
Average	961	828	779	915	7,908	18,230	17,542	14,918	7,936	3,365	1,575	1,117	6,340
Maximum	1,694	1,500	1,481	1,403	12,150	34,630	22,790	22,760	12,910	5,472	2,487	1,658	8,116
Minimum	437	426	429	465	1,915	9,909	12,220	6,597	3,376	1,638	780	543	4,094

Table 7: Average Flows (cfs) at USGS Gage 15292000 - Susitna River at Gold Creek

<u>Year</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Annual</u>
1949	---	---	---	---	---	---	---	24,250	15,650	6,335	2,583	1,439	---
1950	1,027	788	726	870	11,510	19,600	22,600	19,880	8,301	3,848	1,300	1,100	7,687
1951	960	820	740	1,617	14,090	20,790	22,570	19,670	21,240	5,571	2,744	1,900	9,439
1952	1,600	1,000	880	920	5,419	32,370	26,390	20,920	14,480	8,202	3,497	1,700	9,820
1953	1,100	820	820	1,615	19,270	27,320	20,200	20,610	15,270	5,604	2,100	1,500	9,738
1954	1,300	1,000	780	1,235	17,280	25,250	20,360	26,100	12,920	5,370	2,760	2,045	9,762
1955	1,794	1,400	1,100	1,200	9,319	29,860	27,560	25,750	14,290	4,951	1,900	1,300	10,087
1956	980	970	940	950	17,660	33,340	31,090	24,530	18,330	5,806	3,050	2,142	11,712
1957	1,700	1,500	1,200	1,200	13,750	30,160	23,310	20,540	19,800	8,212	3,954	3,264	10,758
1958	1,965	1,307	1,148	1,533	12,900	25,700	22,880	22,540	7,550	4,811	2,150	1,513	8,891
1959	1,448	1,307	980	1,250	15,990	23,320	25,000	31,180	16,920	6,558	2,850	2,200	10,824
1960	1,845	1,452	1,197	1,300	15,780	15,530	22,980	23,590	20,510	7,794	3,000	2,694	9,872
1961	2,452	1,754	1,810	2,650	17,360	29,450	24,570	22,100	13,370	5,916	2,700	2,100	10,575
1962	1,900	1,500	1,400	1,700	12,590	43,270	25,850	23,550	15,890	6,723	2,800	2,000	11,633
1963	1,600	1,500	1,000	830	19,030	26,000	34,400	23,670	12,320	6,449	2,250	1,494	10,961
1964	1,048	966	713	745	4,307	50,580	22,950	16,440	9,571	6,291	2,799	1,211	9,807
1965	960	860	900	1,360	12,990	25,720	27,840	21,120	19,350	7,205	2,098	1,631	10,225
1966	1,400	1,300	1,300	1,775	9,645	32,950	19,860	21,830	11,750	4,163	1,600	1,500	9,121
1967	1,500	1,400	1,200	1,167	15,480	29,510	26,800	32,620	16,870	4,900	2,353	2,055	11,390
1968	1,981	1,900	1,900	1,910	16,180	31,550	26,420	17,170	8,816	3,822	1,630	882	9,560
1969	724	723	816	1,510	11,050	15,500	16,100	8,879	5,093	3,124	1,215	866	5,502
1970	824	768	776	1,080	11,380	18,630	22,660	19,980	9,121	5,288	3,407	2,290	8,076
1971	1,442	1,036	950	1,082	3,745	32,930	23,950	31,910	14,440	5,847	3,093	2,510	10,291
1972	2,239	2,028	1,823	1,710	21,890	34,430	22,770	19,290	12,400	4,826	2,253	1,465	10,641
1973	1,200	1,200	1,000	1,027	8,235	27,800	18,250	20,290	9,074	3,733	1,523	1,034	7,897
1974	874	777	724	992	16,180	17,870	18,800	16,220	12,250	3,739	1,700	1,603	7,694
1975	1,516	1,471	1,400	1,593	15,350	32,310	27,720	18,090	16,310	7,739	1,993	1,081	10,595
1976	974	950	900	1,373	12,620	24,380	18,940	19,800	6,881	3,874	2,650	2,403	8,027
1977	1,829	1,618	1,500	1,680	12,680	37,970	22,870	19,240	12,640	7,571	3,525	2,589	10,511
1978	2,029	1,668	1,605	1,702	11,950	19,050	21,020	16,390	8,607	4,907	2,535	1,681	7,810
1979	1,397	1,286	1,200	1,450	13,870	24,690	28,880	20,460	10,770	7,311	4,192	2,416	9,892
1980	1,748	1,466	1,400	1,670	12,060	29,080	32,660	20,960	13,280	7,725	3,569	1,915	10,689
1981	2,013	1,975	1,585	2,040	16,550	19,300	33,940	37,870	13,790	7,463	3,260	1,877	11,910
1982	1,681	1,486	1,347	1,783	13,380	26,100	24,120	15,270	17,780	6,892	2,633	2,358	9,608
1983	2,265	1,996	1,690	1,900	14,950	24,510	21,150	24,500	13,590	8,301	3,153	2,258	10,079
1984	2,048	1,969	1,900	1,810	12,960	26,770	23,540	20,400	9,429	5,670	3,093	2,394	9,382
1985	1,939	1,643	1,726	1,977	11,170	26,330	26,510	19,920	15,640	6,944	2,673	1,929	9,915
1986	1,658	1,561	1,394	1,565	12,080	20,010	21,870	17,250	12,860	12,680	3,450	1,955	9,084
1987	1,615	1,518	1,500	2,048	12,990	23,000	29,890	21,750	13,340	5,924	2,483	1,600	9,868
1988	1,561	1,500	1,500	1,587	17,370	29,720	25,690	19,540	13,780	7,674	3,013	2,000	10,467
1989	2,000	1,800	1,800	2,137	13,740	26,770	23,650	22,390	15,430	8,025	2,997	1,848	10,267
1990	1,765	1,700	1,852	4,250	25,630	33,800	23,510	23,730	26,510	6,895	2,447	2,200	12,906
1991	1,897	1,800	1,619	1,613	6,048	25,630	21,220	18,280	12,350	5,817	2,440	2,200	8,441
1992	1,965	1,800	1,868	2,100	6,104	23,140	25,540	21,150	10,170	4,379	2,733	2,039	8,628
1993	1,865	1,754	1,639	2,537	20,880	23,480	19,350	18,750	21,290	9,915	3,327	2,529	10,660
1994	2,058	1,786	1,526	3,221	14,610	31,090	20,960	18,580	9,357	4,530	2,780	2,097	9,421
1995	1,855	1,718	1,700	2,846	17,710	24,710	25,500	18,380	19,140	6,482	2,657	1,442	10,394
1996	1,248	1,186	1,100	1,350	6,613	15,710	16,010	17,130	10,410	---	---	---	---
2001	---	---	---	---	---	31,000	22,050	21,790	10,360	4,840	2,627	1,897	---
2002	1,548	1,421	1,303	1,330	11,510	16,550	18,150	23,780	16,250	10,950	5,394	2,590	9,288
2003	1,655	2,243	1,509	2,173	8,019	24,330	29,200	21,120	13,510	8,109	2,500	1,810	9,732
2004	1,471	1,276	1,081	2,730	23,570	25,330	20,160	17,720	6,452	3,300	1,733	1,610	8,930
2005	1,439	1,239	1,045	2,611	26,940	34,320	26,760	21,970	22,860	8,238	2,143	1,497	12,650
2006	1,400	1,389	1,361	1,535	15,730	23,290	23,140	30,810	12,300	10,390	3,140	2,319	10,648
2007	2,024	1,905	1,744	2,273	17,190	19,710	21,580	19,260	13,500	5,017	3,222	2,813	9,241
2008	1,842	1,343	1,360	1,670	11,860	21,120	22,030	19,730	14,520	5,529	1,548	1,300	8,703
2009	1,385	1,300	1,340	4,547	22,930	23,110	19,370	18,470	12,480	7,122	2,807	1,842	9,783
2010	1,468	1,350	1,305	1,847	19,610	20,020	27,520	20,080	15,820	---	---	---	---
Average	1,590	1,414	1,297	1,753	14,138	26,417	23,871	21,365	13,741	6,345	2,679	1,892	9,805
Maximum	2,452	2,243	1,900	4,547	26,940	50,580	34,400	37,870	26,510	12,680	5,394	3,264	12,906
Minimum	724	723	713	745	3,745	15,500	16,010	8,879	5,093	3,124	1,215	866	5,502

**Table 8: Average Flows (cfs) at USGS Gage 15292400 - Chulitna River near Talkeetna**

<u>Year</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Annual</u>
1958	---	1,044	948	1,220	10,460	23,170	25,010	20,760	8,000	4,197	1,883	1,262	---
1959	1,097	1,049	738	890	7,413	23,660	25,650	22,100	9,957	4,723	2,283	1,700	8,491
1960	1,448	1,103	933	1,000	13,890	17,390	23,650	19,320	12,420	5,135	1,950	1,745	8,393
1961	1,452	1,100	1,079	1,600	10,100	20,490	27,420	24,580	16,030	5,777	2,400	1,500	9,522
1962	1,300	1,000	930	1,170	7,743	20,620	27,220	21,980	13,490	3,506	1,500	1,552	8,555
1963	1,600	1,300	846	700	11,060	17,750	28,950	18,390	11,330	8,062	2,300	1,000	8,674
1964	1,007	820	770	1,133	2,355	40,330	24,430	20,250	9,235	5,642	2,900	2,100	9,271
1965	1,600	1,400	1,300	1,400	7,452	20,070	23,230	22,550	22,260	6,071	1,620	1,350	9,232
1966	1,200	1,100	1,100	1,300	3,971	21,740	23,750	27,720	12,200	4,682	1,680	1,500	8,548
1967	1,458	1,257	1,045	972	12,400	25,520	35,570	33,670	12,510	3,483	1,660	1,397	10,999
1968	1,235	1,200	1,148	1,347	10,940	29,000	30,140	20,710	7,375	2,898	1,480	1,139	9,107
1969	974	900	824	1,333	6,001	18,560	20,820	11,300	6,704	4,578	1,887	1,316	6,301
1970	1,200	1,154	1,100	1,437	9,643	19,670	26,100	24,660	11,330	3,826	2,210	1,403	8,706
1971	1,113	950	934	982	4,468	22,180	27,280	23,810	11,080	5,439	2,157	1,432	8,541
1972	1,174	1,041	939	893	9,765	17,900	25,770	20,970	12,120	---	---	---	---
1980	---	---	---	---	9,142	22,490	34,950	20,780	8,240	5,711	3,213	2,016	---
1981	1,623	1,414	1,171	1,440	9,972	22,420	29,860	33,170	11,960	4,828	2,253	1,219	10,189
1982	1,031	873	789	1,072	6,289	18,360	25,610	20,360	18,240	5,499	2,513	1,853	8,587
1983	1,573	1,039	1,050	1,248	8,881	18,890	22,320	22,190	10,960	8,618	2,923	2,387	8,568
1984	2,045	1,507	1,258	1,377	7,315	18,600	22,270	22,780	9,921	4,726	2,673	2,161	8,106
1985	1,903	1,396	1,165	1,130	5,713	18,900	27,150	20,780	13,150	6,361	1,900	1,481	8,473
1986	1,316	1,132	959	956	4,755	14,710	22,840	---	---	---	---	---	---
Average	1,367	1,132	1,001	1,171	8,169	21,474	26,363	22,516	11,834	5,188	2,169	1,576	8,792
Maximum	2,045	1,507	1,300	1,600	13,890	40,330	35,570	33,670	22,260	8,618	3,213	2,387	10,999
Minimum	974	820	738	700	2,355	14,710	20,820	11,300	6,704	2,898	1,480	1,000	6,301

**Table 9: Average Flows (cfs) at USGS Gage 15292700 - Talkeetna River near Talkeetna**

<u>Year</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Annual</u>
1964	---	---	---	---	---	17,080	9,820	8,396	3,815	3,115	1,568	1,100	---
1965	720	620	540	580	3,474	11,090	12,180	11,150	10,610	4,438	1,460	876	4,834
1966	711	526	395	422	2,410	12,970	10,100	10,730	5,370	2,388	897	750	3,990
1967	637	546	471	427	4,112	9,286	12,600	14,160	6,971	2,029	1,253	987	4,488
1968	851	777	743	983	8,840	14,100	11,230	7,546	4,120	1,637	827	557	4,373
1969	459	401	380	519	3,869	5,207	7,080	3,787	2,070	1,450	765	587	2,230
1970	504	458	440	545	3,950	7,979	10,320	8,752	5,993	2,817	1,647	1,103	3,732
1971	679	459	402	503	2,145	19,040	11,760	16,770	5,990	2,632	1,310	845	5,234
1972	727	628	481	519	3,516	12,700	12,030	9,576	8,709	3,630	1,373	889	4,583
1973	748	654	574	577	3,860	12,210	7,676	9,927	3,861	1,807	960	745	3,649
1974	645	559	482	535	5,678	8,030	7,755	7,704	4,763	1,967	1,002	774	3,344
1975	694	586	508	522	4,084	13,180	12,070	8,487	7,960	2,884	773	558	4,376
1976	524	480	470	613	3,439	10,580	9,026	8,088	3,205	1,857	1,105	1,069	3,390
1977	700	549	506	548	4,244	18,280	9,344	8,005	5,963	3,268	1,121	860	4,459
1978	746	576	485	534	2,950	7,429	10,790	7,001	3,567	1,660	1,138	932	3,172
1979	762	652	577	710	7,790	12,010	14,440	8,274	4,039	3,379	1,718	868	4,634
1980	808	741	700	1,038	4,823	11,380	13,900	7,224	5,402	2,600	1,144	717	4,229
1981	652	535	546	671	4,529	6,589	15,410	14,680	4,384	2,346	1,236	708	4,401
1982	650	467	285	480	3,313	12,940	11,070	7,271	9,555	3,351	1,243	1,082	4,321
1983	836	580	566	669	4,551	9,013	8,703	8,803	3,944	3,280	1,097	781	3,592
1984	690	626	600	555	4,008	9,328	8,896	9,762	3,816	2,197	1,158	897	3,567
1985	717	548	498	522	4,174	10,400	11,140	10,180	8,425	3,317	1,002	783	4,331
1986	681	590	400	396	2,538	6,209	9,149	8,032	6,889	10,000	1,992	1,122	4,029
1987	832	737	659	894	5,062	9,712	11,070	9,872	5,358	1,723	1,137	965	4,026
1988	818	707	607	595	5,271	10,110	9,675	7,974	5,123	2,504	1,133	965	3,810
1989	697	577	550	600	3,628	10,660	8,356	12,410	8,550	4,102	1,553	1,050	4,415
1990	997	990	1,058	1,912	11,510	13,110	8,451	8,706	11,000	2,206	820	673	5,136
1991	610	407	340	716	6,163	12,780	9,972	6,361	4,077	1,898	672	540	3,729
1992	494	480	521	690	2,800	10,370	11,170	8,528	3,992	1,573	1,213	961	3,586
1993	716	552	502	907	10,190	11,570	9,208	8,387	12,090	5,151	1,660	968	5,181
1994	790	675	531	1,053	6,920	13,600	8,643	8,827	3,014	1,813	973	773	3,987
1995	637	548	540	629	6,738	10,260	10,220	7,483	7,629	2,502	1,089	538	4,088
1996	457	440	467	749	4,721	6,179	8,066	8,373	3,601	1,424	808	698	3,021
1997	616	545	478	609	3,794	7,607	10,250	10,470	5,384	1,590	718	569	3,577
1998	481	446	413	660	3,988	10,440	11,120	9,241	6,331	3,059	1,242	873	4,047
1999	666	486	374	492	3,668	9,691	9,476	11,420	4,439	2,737	1,267	834	3,821
2000	648	562	500	658	4,492	15,190	13,840	6,336	6,234	3,201	1,253	869	4,499
2001	715	598	526	613	3,623	12,340	8,008	8,357	4,146	2,025	943	665	3,560
2002	539	493	430	439	7,203	6,543	7,210	10,150	8,700	5,742	2,400	1,020	4,267
2003	464	513	417	1,025	4,443	9,840	12,050	8,271	4,455	2,920	1,383	816	3,908
2004	656	541	482	843	7,532	8,711	8,947	7,231	2,992	2,779	1,225	777	3,586
2005	682	579	666	1,967	14,240	16,470	10,940	8,697	10,960	3,704	880	771	5,905
2006	671	514	479	573	4,675	7,698	9,054	13,320	5,439	6,152	1,458	665	4,260
2007	500	382	309	717	3,266	5,481	8,522	8,591	6,699	2,686	1,058	615	3,256
2008	479	414	416	531	3,795	8,518	8,455	8,542	5,442	2,449	873	694	3,403
2009	654	547	517	823	7,791	8,873	7,956	6,712	4,541	3,531	1,679	834	3,728
2010	665	575	515	763	4,502	6,859	9,931	9,219	5,800	---	---	---	---
Average	666	562	508	703	5,050	10,631	10,151	9,102	5,860	2,946	1,201	820	4,039
Maximum	997	990	1,058	1,967	14,240	19,040	15,410	16,770	12,090	10,000	2,400	1,122	5,905
Minimum	457	382	285	396	2,145	5,207	7,080	3,787	2,070	1,424	672	538	2,230

**Table 10: Average Flows (cfs) at USGS Gage 15292780 - Susitna River at Sunshine**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1981	---	---	---	---	36,160	50,890	85,600	84,940	32,460	16,450	7,030	4,035	---
1982	3,500	3,229	2,877	3,803	26,560	62,820	63,030	45,590	48,830	16,180	6,300	5,613	24,128
1983	5,216	4,664	3,481	4,197	31,390	58,100	55,380	60,580	30,010	21,340	8,273	5,555	24,162
1984	4,897	4,600	4,497	4,553	25,920	59,280	59,140	58,720	23,950	12,350	6,253	4,877	22,554
1985	4,565	3,821	3,748	4,087	25,750	60,870	68,040	55,030	40,760	16,680	6,077	4,306	24,610
1986	3,697	3,379	2,877	3,100	22,040	46,870	---	---	---	---	---	---	---
Average	4,375	3,939	3,496	3,948	27,970	56,472	66,238	60,972	35,202	16,600	6,787	4,877	23,864
Maximum	5,216	4,664	4,497	4,553	36,160	62,820	85,600	84,940	48,830	21,340	8,273	5,613	24,610
Minimum	3,500	3,229	2,877	3,100	22,040	46,870	55,380	45,590	23,950	12,350	6,077	4,035	22,554

Table 11: Average Flows (cfs) at USGS Gage 15292800 - Montana Creek near Montana

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2005	---	---	---	---	1,497.0	828.5	262.6	332.4	885.3	260.4	57.2	51.3	---
2006	42.6	31.0	31.0	35.4	539.5	520.0	418.0	1,347.0	854.0	---	---	---	---
2008	---	---	---	---	---	570.9	454.6	405.0	377.3	222.5	57.1	36.0	---
2009	35.7	30.8	30.6	60.2	1,117.0	477.3	158.0	323.9	249.3	255.4	94.6	53.0	242.4
2010	39.8	36.2	32.1	66.9	399.5	335.9	437.4	470.8	339.8	---	---	---	---
Average	39	33	31	54	888	547	346	576	541	246	70	47	242
Maximum	43	36	32	67	1,497	829	455	1,347	885	260	95	53	242
Minimum	36	31	31	35	400	336	158	324	249	223	57	36	242

Table 12: Average Flows (cfs) at USGS Gage 15294005 - Willow Creek Near Willow

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1978	---	---	---	---	---	646.9	606.7	307.0	258.8	232.4	90.9	110.0	---
1979	83.4	74.3	75.0	99.5	1,055.0	1,430.0	1,154.0	398.3	368.2	402.3	364.1	152.0	473.6
1980	112.3	85.4	73.2	102.3	472.5	1,411.0	1,287.0	954.7	699.6	287.8	127.1	57.3	474.5
1981	57.1	52.9	57.7	85.7	481.2	484.3	1,019.0	1,286.0	367.3	398.5	176.7	99.5	384.3
1982	96.0	74.2	33.7	74.8	579.0	1,186.0	815.8	500.2	1,077.0	409.0	150.2	118.7	427.0
1983	93.7	77.6	63.6	103.0	599.6	888.5	337.8	766.2	564.6	631.4	170.0	118.1	369.5
1984	94.6	84.2	71.9	74.5	393.7	828.1	578.7	537.1	380.1	176.8	81.5	69.0	281.8
1985	66.0	70.0	66.6	65.8	339.6	1,344.0	1,233.0	1,130.0	951.7	418.8	131.0	91.5	494.4
1986	69.2	53.0	42.3	50.5	370.7	607.8	668.7	612.3	704.8	1,197.0	190.8	137.1	394.8
1987	101.0	77.2	61.4	87.1	496.8	823.3	573.4	580.7	631.7	263.9	95.8	80.4	323.8
1988	66.6	74.3	62.3	87.9	631.7	996.9	672.0	563.3	586.6	408.0	185.3	127.7	373.3
1989	90.3	73.6	68.9	140.6	576.9	1,142.0	541.4	783.5	808.5	475.3	214.9	138.2	422.3
1990	109.1	98.8	97.5	204.7	1,578.0	1,500.0	481.1	378.4	1,142.0	321.3	180.7	143.9	520.5
1991	104.2	83.0	71.1	89.2	782.4	1,230.0	703.9	401.9	463.2	269.3	165.4	126.1	375.3
1992	93.1	72.5	58.8	67.4	456.0	1,256.0	581.8	439.8	437.1	187.7	101.7	76.3	319.4
1993	62.3	60.0	64.2	75.2	968.0	1,020.0	356.1	439.3	1,177.0	---	---	---	---
2001	---	---	---	---	376.1	1,471.0	660.3	457.4	324.8	189.5	94.8	70.6	---
2002	60.2	56.4	49.7	45.8	664.1	661.7	310.4	666.5	904.7	794.0	246.3	130.0	384.3
2003	94.2	134.3	59.4	97.6	328.5	789.7	495.8	469.4	400.8	449.4	169.1	83.2	298.2
2004	70.2	57.6	50.0	85.2	828.6	633.6	228.3	210.4	340.4	622.4	163.9	122.6	286.1
2005	110.7	91.9	75.3	257.7	1,623.0	1,583.0	700.7	650.9	1,262.0	402.8	100.0	70.6	578.9
2006	60.3	54.5	51.3	50.1	555.2	927.9	558.4	1,685.0	653.6	789.8	211.7	114.7	479.7
2007	79.0	65.9	49.9	84.2	359.2	579.9	362.1	412.4	631.7	300.2	119.3	72.1	260.2
2008	60.0	52.4	51.4	66.0	414.2	822.0	744.8	552.8	504.7	262.4	126.7	102.7	314.8
2009	88.1	56.7	50.2	117.2	942.7	707.8	336.7	370.0	290.2	353.6	133.6	106.4	297.9
2010	93.7	69.3	48.2	74.1	457.2	540.7	562.9	527.8	529.3	---	---	---	---
Average	84	73	61	95	653	981	637	619	633	427	158	105	388
Maximum	112	134	98	258	1,623	1,583	1,287	1,685	1,262	1,197	364	152	579
Minimum	57	52	34	46	329	484	228	210	259	177	82	57	260

Table 13: Average Flows (cfs) at USGS Gage 15294010 - Deception Creek near Willow

<u>Year</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Annual</u>
1978	---	---	---	---	---	88.5	78.4	26.2	31.7	57.4	21.8	25.5	---
1979	17.5	16.2	25.2	76.8	312.9	91.1	124.3	39.7	55.0	79.2	148.8	46.0	86.6
1980	33.1	23.5	22.2	73.4	140.6	165.4	109.5	102.3	112.8	97.5	28.7	4.1	76.3
1981	6.8	11.1	10.4	28.2	99.6	48.7	142.4	188.3	82.4	126.5	43.1	26.4	68.5
1982	11.6	5.2	2.9	9.4	75.0	93.1	129.0	62.6	203.3	78.2	39.8	35.5	62.3
1983	22.0	17.4	15.8	31.9	173.6	80.2	28.0	83.8	62.8	34.6	32.0	26.5	51.0
1984	21.3	21.7	21.3	40.4	152.9	66.1	44.7	45.3	55.8	27.6	17.3	14.0	44.2
1985	14.5	11.0	9.6	9.8	228.2	128.1	54.6	122.4	125.2	---	---	---	---
Average	18	15	15	39	169	95	89	84	91	72	47	25	65
Maximum	33	24	25	77	313	165	142	188	203	127	149	46	87
Minimum	7	5	3	9	75	49	28	26	32	28	17	4	44

Table 14: Average Flows (cfs) at USGS Gage 15294100 - Deshka River near Willow

<u>Year</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Annual</u>
1,978	---	---	---	---	---	---	---	---	---	553	424	329	---
1,979	290	266	263	774	4,295	876	717	547	790	1,366	2,669	561	1,123
1,980	393	362	332	1,215	2,585	1,631	1,768	1,113	904	1,457	577	232	1,053
1,981	275	216	277	583	1,708	518	2,580	2,714	826	1,557	762	403	1,046
1,982	250	184	177	367	1,706	1,268	852	813	2,561	1,168	407	300	840
1,983	298	257	181	879	2,626	646	247	787	513	1,399	452	303	720
1,984	244	233	290	575	1,884	490	318	913	443	480	327	289	544
1,985	241	210	205	215	4,367	1,911	466	1,332	2,528	1,513	277	235	1,131
1,986	193	182	185	311	1,361	421	488	1,615	2,125	---	---	---	---
1,998	---	---	---	---	---	---	---	---	---	939	446	218	---
1,999	191	188	190	486	2,616	814	474	1,454	1,179	1,748	660	502	882
2,000	377	271	261	344	4,160	670	742	399	773	594	400	348	785
2,001	290	260	283	739	3,495	673	488	856	899	---	---	---	---
Average	277	239	240	590	2,800	902	831	1,140	1,231	1,161	673	338	903
Maximum	393	362	332	1,215	4,367	1,911	2,580	2,714	2,561	1,748	2,669	561	1,131
Minimum	191	182	177	215	1,361	421	247	399	443	480	277	218	544

**Table 15: Average Flows (cfs) at USGS Gage 15294300 - Skwentna River near Skwentna**

<u>Year</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Annual</u>
1959	---	---	---	---	---	---	---	---	---	3,532.0	1,850.0	1,400.0	---
1960	1,097	961	843	835	10,480	13,440	16,690	15,990	9,171	3,889	1,600	1,597	6,429
1961	1,403	1,154	1,155	1,700	11,210	20,570	16,480	13,910	12,020	4,605	2,200	1,400	7,348
1962	1,200	860	760	1,000	6,613	15,630	14,930	12,080	6,723	2,801	1,250	1,100	5,442
1963	1,000	810	700	650	7,765	14,050	20,430	12,020	7,180	5,355	1,550	840	6,074
1964	970	750	600	840	1,635	27,250	16,480	12,680	6,224	4,425	1,790	1,300	6,260
1965	920	800	740	770	4,810	17,160	19,370	14,010	13,090	4,122	1,575	1,150	6,573
1966	1,100	1,100	1,100	1,300	4,502	19,550	14,180	17,320	9,812	5,576	1,400	900	6,514
1967	720	650	650	780	1,794	14,430	14,740	15,760	9,517	3,832	1,560	1,181	5,495
1968	1,023	1,000	950	1,293	13,460	20,770	17,480	10,560	3,855	1,929	678	624	6,172
1969	600	600	626	1,487	11,070	19,580	13,650	7,471	3,783	5,654	1,607	832	5,610
1970	766	700	650	728	11,710	22,880	21,120	13,030	6,665	2,919	2,023	1,184	7,072
1971	865	721	613	607	5,963	25,400	20,600	15,920	6,024	3,020	1,327	1,103	6,881
1972	989	898	811	742	8,045	15,330	16,840	13,370	9,256	4,551	2,340	1,316	6,243
1973	910	702	607	727	6,349	15,200	13,850	9,874	6,164	3,540	1,700	1,265	5,100
1974	1,023	902	811	1,005	6,765	10,650	11,670	10,480	11,800	4,557	2,328	919	5,265
1975	800	750	750	767	7,852	19,060	19,520	11,710	8,471	4,704	1,973	1,258	6,503
1976	971	897	800	1,270	8,806	15,120	14,580	11,120	8,165	6,196	2,880	2,871	6,175
1977	2,829	1,821	1,200	1,200	8,906	36,670	25,270	20,160	10,290	5,799	2,373	1,548	9,874
1978	1,213	944	841	1,023	9,006	13,840	18,100	13,740	7,478	4,936	1,580	1,555	6,233
1979	1,165	1,036	981	1,597	11,660	14,980	15,830	16,210	7,448	7,254	4,195	2,226	7,098
1980	1,781	1,617	1,352	1,957	11,850	24,780	28,620	13,860	8,785	5,628	2,687	1,476	8,748
1981	1,237	1,270	926	2,138	22,370	24,670	21,400	16,490	7,639	5,177	2,267	1,481	8,982
1982	1,171	986	777	770	5,165	16,020	13,980	10,460	15,150	---	---	---	---
Average	1,120	953	837	1,095	8,599	19,001	17,644	13,401	8,466	4,522	1,945	1,327	6,640
Maximum	2,829	1,821	1,352	2,138	22,370	36,670	28,620	20,160	15,150	7,254	4,195	2,871	9,874
Minimum	600	600	600	607	1,635	10,650	11,670	7,471	3,783	1,929	678	624	5,100

Table 16: Average Flows (cfs) at USGS Gage 15294345 - Yentna River near Susitna Station

<u>Year</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Annual</u>
1980	---	---	---	---	---	---	---	---	---	18,540	8,367	4,368	---
1981	3,710	3,736	2,748	5,480	45,640	55,120	64,380	58,860	25,890	12,260	6,247	4,539	24,227
1982	3,661	2,850	2,226	2,177	13,900	40,870	46,740	39,750	47,600	12,510	5,663	4,116	18,573
1983	3,339	3,236	3,087	4,418	25,900	48,800	44,620	47,140	15,750	10,740	5,443	3,577	18,119
1984	2,635	2,308	2,277	5,755	30,880	50,090	52,470	53,390	18,970	13,720	4,373	3,013	20,138
1985	2,961	2,850	2,619	2,500	19,290	48,490	58,760	46,210	29,830	16,250	4,847	3,742	19,985
1986	3,284	2,932	2,497	2,850	22,990	44,610	---	---	---	---	---	---	---
Average	3,265	2,985	2,576	3,863	26,433	47,997	53,394	49,070	27,608	14,003	5,823	3,893	20,208
Maximum	3,710	3,736	3,087	5,755	45,640	55,120	64,380	58,860	47,600	18,540	8,367	4,539	24,227
Minimum	2,635	2,308	2,226	2,177	13,900	40,870	44,620	39,750	15,750	10,740	4,373	3,013	18,119

Table 17: Average Flows (cfs) at USGS Gage 15294350 - Susitna River at Susitna Station

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1974	---	---	---	---	---	---	---	---	---	19,520	10,400	9,419	---
1975	8,597	7,804	7,048	6,867	47,540	128,800	135,700	91,360	77,740	31,550	9,933	6,000	46,795
1976	6,529	5,614	5,368	7,253	70,460	107,000	115,200	99,650	48,910	30,140	18,270	13,100	44,258
1977	10,100	8,911	6,774	6,233	56,180	165,900	143,900	125,500	83,810	38,230	12,630	7,529	55,730
1978	6,974	6,771	6,590	7,033	48,670	90,930	117,600	102,100	55,500	36,810	15,000	9,306	42,227
1979	8,823	7,946	7,032	8,683	81,260	119,900	142,500	128,200	74,340	58,640	31,590	14,690	57,352
1980	10,120	9,017	8,906	12,030	66,580	142,900	181,400	126,400	77,970	34,970	16,200	8,516	58,272
1981	7,774	7,589	6,177	10,350	83,580	108,700	152,800	159,600	67,170	33,900	17,570	11,740	56,024
1982	9,032	7,214	5,435	5,817	44,940	108,100	114,800	94,630	109,700	34,010	15,200	9,890	46,743
1983	8,368	8,421	7,123	7,681	62,090	103,900	103,300	107,900	54,870	39,440	19,030	11,480	44,742
1984	7,435	6,703	6,468	13,020	60,430	107,100	109,200	111,000	51,010	30,770	10,950	8,226	43,807
1985	7,968	6,946	6,500	6,817	45,660	112,700	134,700	108,700	84,110	50,690	18,430	11,130	49,814
1986	8,871	7,750	5,974	7,193	47,590	91,000	125,400	101,700	76,980	88,500	17,500	9,345	49,331
1987	7,794	7,500	7,348	9,860	65,360	108,500	138,800	119,900	73,510	34,370	19,080	12,480	50,702
1988	10,690	9,745	9,500	11,120	83,570	135,900	140,600	103,200	70,430	41,440	13,830	7,000	53,390
1989	6,242	6,232	7,000	8,900	70,340	115,500	127,100	154,600	115,700	59,120	18,670	8,839	58,543
1990	8,368	8,211	9,058	21,430	121,000	142,400	119,400	106,900	107,400	33,660	11,380	7,500	58,331
1991	7,500	7,475	6,565	8,617	56,480	134,200	124,100	106,400	71,650	37,450	14,030	12,230	49,142
1992	10,600	9,500	9,694	21,480	55,120	109,200	119,200	87,180	39,230	18,770	13,670	11,260	42,301
1993	9,468	7,696	7,032	---	---	---	---	---	---	---	---	---	---
Average	8,487	7,739	7,136	10,021	64,825	118,479	130,317	113,051	74,446	39,578	15,966	9,983	50,417
Maximum	10,690	9,745	9,694	21,480	121,000	165,900	181,400	159,600	115,700	88,500	31,590	14,690	58,543
Minimum	6,242	5,614	5,368	5,817	44,940	90,930	103,300	87,180	39,230	18,770	9,933	6,000	42,227

III. Monthly Flow Frequency and Flow Duration

Flow frequency and flow duration plots were created from daily flow data on the Susitna River at Cantwell, Gold Creek, Sunshine, and Susitna Station, and on the Chulitna River near Talkeetna. Tables 18, 19, 20, 21, and 22 present monthly flow frequencies for flows in the Susitna River at Cantwell and Gold Creek, in the Chulitna River near Talkeetna, and in the Susitna River at Sunshine and Susitna Station, respectively. The flow frequency was calculated at 5% exceedance intervals except at the high and low flow ends where 1% exceedance intervals were used to provide additional definition where the flow duration values change rapidly.

Figures 3 through 12 show the flow frequency and flow duration curves for these sites. The flow frequency curves demonstrate the same seasonal flow as Figure 2, with peak flows occurring in June at the middle watershed sites of Cantwell and Gold Creek, June through August in the Chulitna River at Talkeetna, and in July and August at the lower Susitna watershed gage locations at Sunshine and Susitna Station.

**Table 18: Flow (cfs) Frequency at USGS Gage 15291500 – Susitna River near Cantwell**

% of Time Flow is Exceeded	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (all months)
0	1,800	1,500	1,500	3,000	32,500	49,100	34,000	55,000	21,000	9,400	3,600	1,900	55,000
1	1,800	1,500	1,500	1,800	23,740	43,310	29,400	35,886	18,427	7,353	3,200	1,774	28,775
2	1,700	1,500	1,500	1,682	22,000	37,848	28,000	28,800	17,088	7,000	2,982	1,600	26,000
3	1,700	1,500	1,500	1,500	20,200	35,251	27,036	28,258	16,183	6,536	2,600	1,600	24,000
4	1,696	1,500	1,500	1,400	20,000	33,396	26,248	26,000	16,000	6,070	2,500	1,600	22,100
5	1,600	1,500	1,400	1,400	19,100	32,455	25,860	24,600	15,010	6,000	2,400	1,600	21,000
10	1,500	1,200	1,200	1,400	16,000	27,000	23,100	20,830	13,010	5,200	2,200	1,600	18,000
15	1,300	1,200	1,100	1,226	14,000	25,360	21,800	18,445	12,000	5,000	2,200	1,400	16,000
20	1,300	1,200	940	1,200	12,700	23,240	20,700	17,960	10,520	4,500	2,000	1,400	14,500
25	1,300	1,000	940	1,200	11,300	21,150	19,900	17,100	9,500	4,175	1,900	1,400	12,000
30	1,200	965	900	1,100	10,000	20,000	19,000	16,490	8,624	3,918	1,800	1,400	9,865
35	1,094	904	850	1,070	10,000	19,000	18,600	16,000	8,000	3,600	1,800	1,400	7,100
40	1,000	850	825	1,000	9,380	18,000	18,000	15,800	7,900	3,600	1,700	1,300	4,970
45	1,000	850	760	940	8,660	17,000	17,600	15,200	7,570	3,406	1,600	1,200	3,200
50	970	690	690	900	7,500	16,000	17,000	14,700	7,100	3,200	1,530	1,200	2,100
55	760	680	660	850	6,500	15,805	16,700	14,000	6,786	3,000	1,500	1,080	1,600
60	760	670	650	750	5,200	15,200	16,000	13,100	6,600	2,844	1,486	994	1,400
65	730	650	600	720	3,700	15,000	15,580	12,400	6,230	2,600	1,400	932	1,200
70	700	647	560	660	3,000	14,970	15,000	12,000	5,975	2,400	1,364	860	1,100
75	680	640	550	650	2,500	14,200	14,800	11,400	5,515	2,200	1,100	800	950
80	680	560	550	550	2,200	13,600	14,000	10,700	5,132	2,026	1,100	750	850
85	610	500	480	500	1,700	12,635	13,300	9,856	4,430	1,900	918	720	720
90	500	480	460	500	1,500	11,000	12,200	9,267	3,818	1,800	800	650	650
95	460	440	460	485	800	8,823	11,340	7,637	3,396	1,586	780	565	500
96	440	423	440	467	750	8,381	11,000	7,121	3,200	1,423	780	550	500
97	436	420	431	460	750	7,951	11,000	5,684	3,034	1,239	758	550	480
98	420	420	400	440	710	7,232	10,904	4,728	2,800	1,100	709	500	460
99	420	420	400	440	580	6,980	10,000	4,371	2,515	1,026	655	500	440
100	420	420	400	440	580	6,130	8,550	3,600	2,080	840	600	480	400

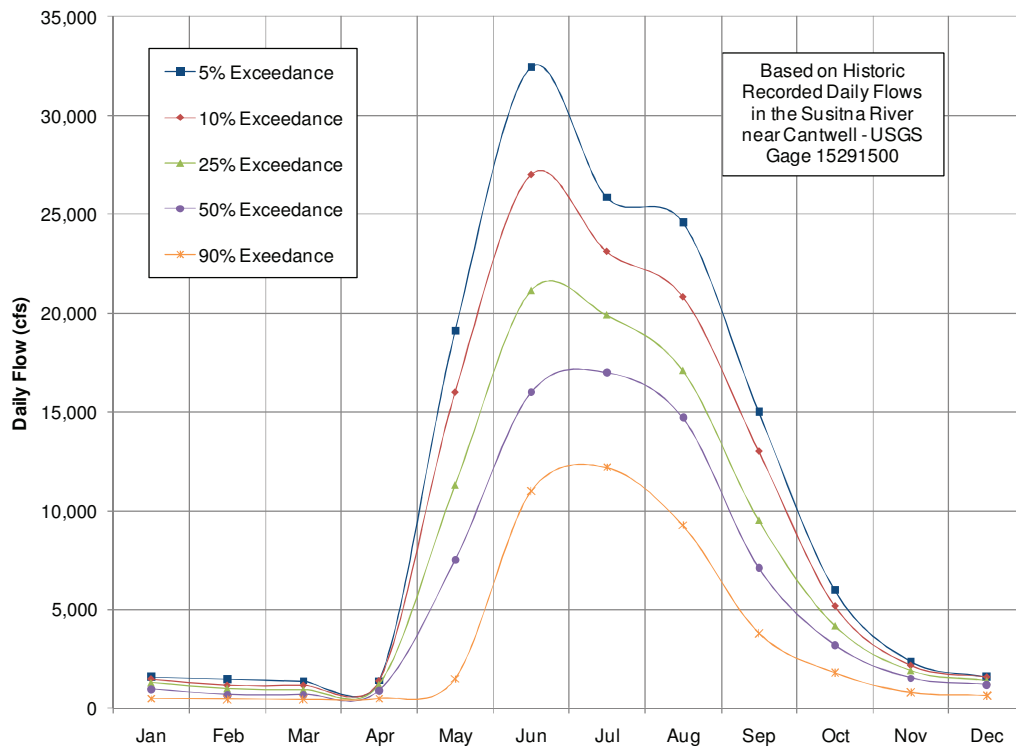


Figure 3: Susitna River Flow Frequency at Cantwell

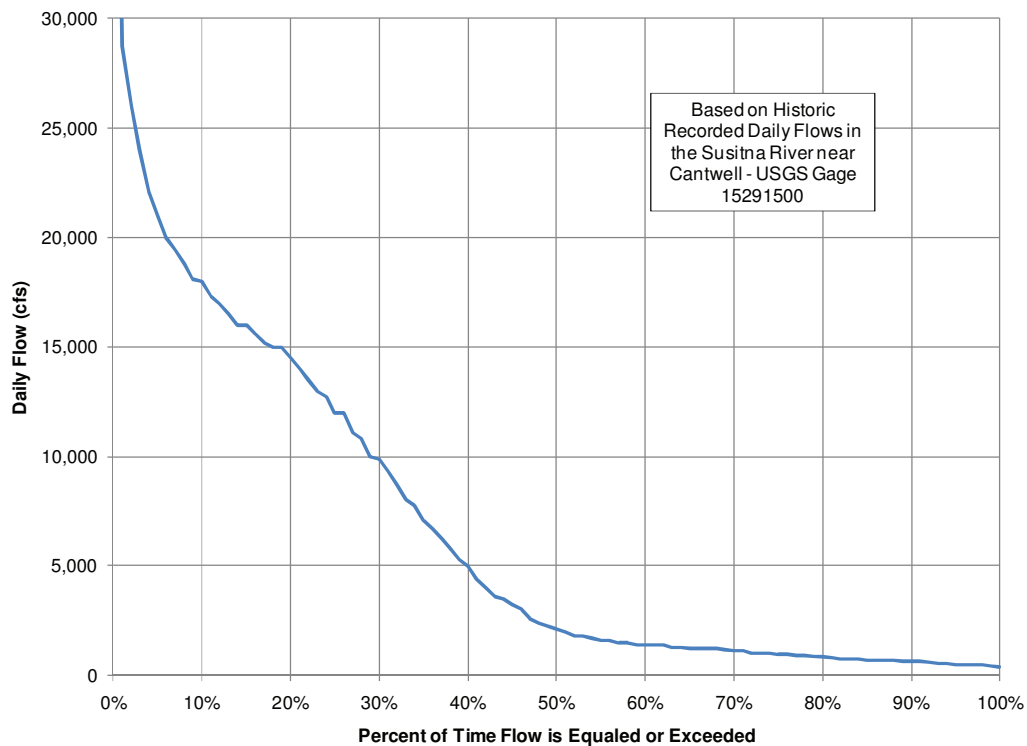


Figure 4: Susitna River Flow Duration at Cantwell

**Table 19: Flow (cfs) Frequency at USGS Gage 15292000 – Susitna River at Gold Creek**

% of Time Flow is Exceeded	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (all months)
0	2,900	3,700	2,400	24,000	55,500	85,900	60,800	77,700	47,700	36,200	8,940	4,400	85,900
1	2,500	2,400	2,100	7,242	37,958	62,003	42,934	51,206	32,305	16,860	5,184	3,500	39,857
2	2,400	2,150	1,900	5,384	35,116	51,782	39,000	43,006	30,300	14,630	4,800	3,200	35,300
3	2,400	2,000	1,900	4,169	33,074	46,473	37,008	39,045	27,900	13,100	4,500	2,900	32,700
4	2,300	2,000	1,900	3,684	31,532	43,428	35,436	34,824	26,088	12,460	4,400	2,800	31,000
5	2,200	2,000	1,900	3,400	31,000	41,710	34,500	32,900	25,000	12,000	4,202	2,713	30,000
10	2,025	1,900	1,800	2,500	27,800	37,110	31,300	29,000	21,710	10,300	3,700	2,500	25,470
15	2,000	1,800	1,700	2,200	24,270	34,265	29,500	26,445	19,500	9,268	3,400	2,400	22,600
20	2,000	1,790	1,600	2,000	22,000	32,420	28,000	25,200	18,000	8,480	3,200	2,300	20,200
25	1,900	1,700	1,600	1,900	20,350	30,600	26,800	24,000	16,900	7,800	3,100	2,200	18,000
30	1,850	1,600	1,500	1,800	18,800	29,300	25,800	23,000	15,600	7,210	3,000	2,200	15,300
35	1,800	1,500	1,500	1,700	17,700	28,000	25,000	22,400	14,700	6,740	2,900	2,100	12,000
40	1,700	1,500	1,400	1,650	16,400	27,000	24,200	21,700	14,000	6,300	2,800	2,000	8,400
45	1,600	1,500	1,350	1,600	15,000	26,000	23,500	21,000	13,200	5,900	2,700	2,000	5,200
50	1,600	1,400	1,300	1,540	13,600	25,350	22,800	20,200	12,500	5,500	2,600	1,900	3,500
55	1,600	1,400	1,300	1,500	12,000	24,300	22,200	19,600	11,900	5,200	2,600	1,900	2,650
60	1,500	1,300	1,200	1,500	10,360	23,300	21,700	18,800	11,300	4,950	2,400	1,700	2,200
65	1,500	1,300	1,100	1,400	9,000	22,200	21,200	18,000	10,665	4,600	2,400	1,700	1,950
70	1,400	1,200	1,000	1,200	7,160	21,200	20,600	17,500	10,100	4,500	2,300	1,600	1,800
75	1,300	1,200	995	1,200	5,050	20,000	19,900	17,000	9,520	4,215	2,100	1,500	1,600
80	1,200	1,000	940	1,100	4,400	18,900	19,200	16,200	8,936	4,000	1,900	1,500	1,500
85	1,100	970	880	1,000	3,400	17,800	18,500	15,400	8,249	3,700	1,700	1,300	1,400
90	960	860	800	920	2,800	16,400	17,560	14,500	7,199	3,400	1,600	1,110	1,200
95	900	800	750	830	2,055	15,000	16,300	12,985	6,000	2,898	1,400	1,000	950
96	850	750	740	830	1,900	14,700	16,000	12,288	5,791	2,784	1,300	1,000	900
97	850	750	740	780	1,700	13,827	15,600	11,800	5,500	2,500	1,300	900	850
98	800	720	700	756	1,500	13,218	15,032	10,988	5,316	2,200	1,200	850	800
99	718	700	660	710	1,400	12,200	14,600	8,088	4,900	1,900	1,100	850	750
100	700	600	660	700	900	10,000	11,800	5,280	3,710	1,500	950	800	600

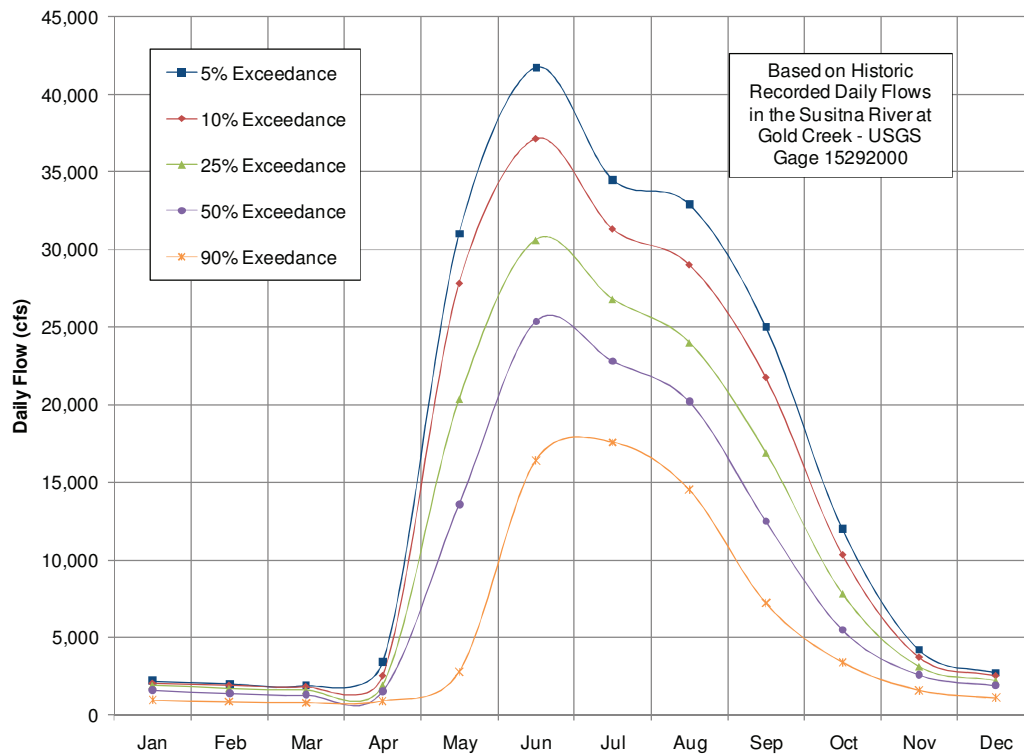


Figure 5: Susitna River Flow Frequency at Gold Creek

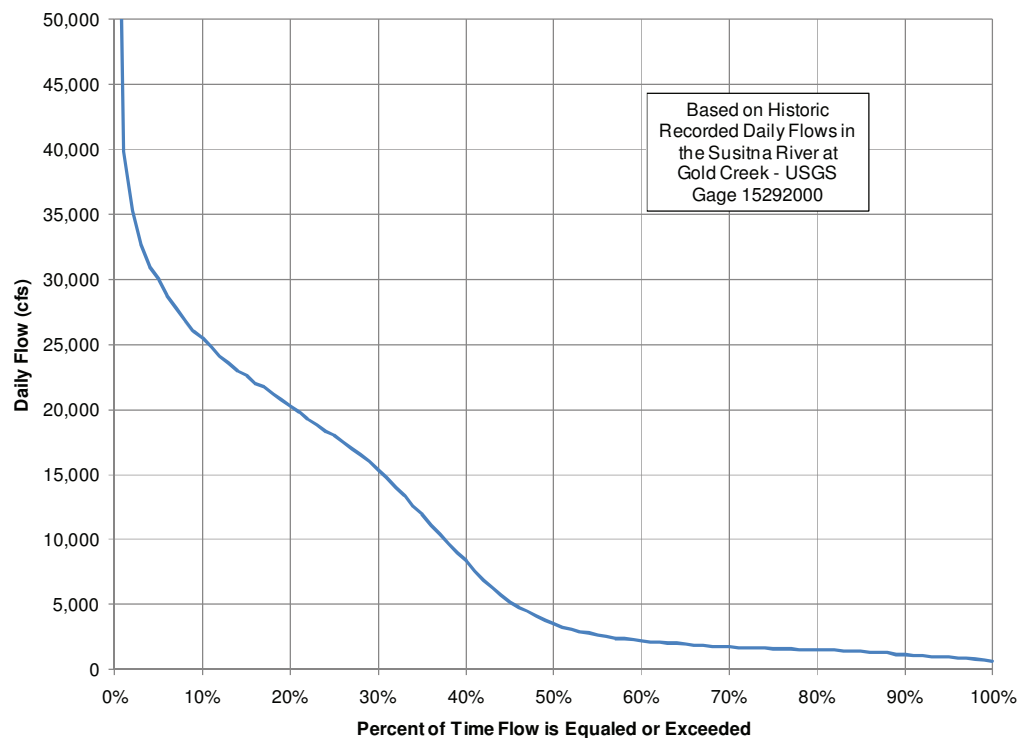


Figure 6: Flow Duration Curve for the Susitna River at Gold Creek

**Table 20: Flow (cfs) Frequency at USGS Gage 15292400 – Chulitna River at Talkeetna**

% of Time Flow is Exceeded	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (all months)
0	2,300	1,800	1,300	4,000	35,700	56,000	71,200	73,000	41,100	22,600	4,000	2,600	73,000
1	2,200	1,600	1,300	2,200	26,319	45,000	43,214	49,200	32,739	12,481	3,700	2,500	37,924
2	2,131	1,600	1,300	2,000	22,532	39,328	39,838	40,600	29,642	12,000	3,502	2,400	34,400
3	2,000	1,500	1,300	1,900	21,000	39,000	38,957	38,400	27,265	11,286	3,202	2,400	32,386
4	2,000	1,500	1,300	1,700	20,000	38,000	37,276	36,200	25,488	10,648	3,200	2,400	30,648
5	2,000	1,500	1,300	1,700	19,495	37,000	36,390	35,600	23,275	10,000	3,100	2,300	29,200
10	1,800	1,400	1,200	1,500	16,000	30,600	34,000	32,000	18,700	9,200	3,000	2,100	24,900
15	1,600	1,400	1,200	1,500	14,000	27,015	32,585	28,900	16,000	8,000	2,900	2,100	22,000
20	1,600	1,300	1,200	1,400	12,300	25,520	31,000	26,700	15,000	7,000	2,800	1,900	19,400
25	1,600	1,300	1,100	1,400	11,600	24,300	29,875	25,600	14,000	6,200	2,800	1,800	16,000
30	1,500	1,200	1,100	1,300	10,700	23,600	28,870	25,000	13,000	5,632	2,600	1,700	12,300
35	1,500	1,200	1,100	1,243	10,000	23,000	27,400	24,000	12,100	5,247	2,400	1,600	9,400
40	1,400	1,200	1,050	1,200	9,400	22,200	26,900	23,000	11,700	5,000	2,200	1,600	6,580
45	1,300	1,100	1,000	1,100	8,482	21,800	25,900	22,000	11,000	4,800	2,100	1,500	4,009
50	1,300	1,100	990	1,100	7,200	20,900	25,000	21,400	10,300	4,500	2,000	1,500	2,900
55	1,300	1,100	950	1,000	5,716	20,000	24,700	20,600	10,000	4,246	1,900	1,500	2,100
60	1,200	1,100	950	1,000	5,000	19,000	24,000	20,000	9,500	4,000	1,800	1,460	1,700
65	1,200	1,000	940	1,000	4,200	18,000	23,500	19,500	9,138	3,800	1,800	1,400	1,500
70	1,200	1,000	900	950	3,500	17,100	23,000	19,000	8,528	3,554	1,700	1,350	1,400
75	1,200	1,000	900	940	3,200	16,550	22,025	18,000	8,000	3,400	1,620	1,300	1,300
80	1,100	980	850	940	2,600	15,580	21,400	16,700	7,488	3,200	1,600	1,300	1,200
85	1,100	950	800	900	2,200	14,400	20,900	15,850	7,070	3,000	1,600	1,200	1,100
90	1,000	900	770	850	2,100	13,500	19,900	14,000	6,690	2,800	1,500	1,100	1,000
95	950	820	750	780	1,500	12,000	18,105	12,800	5,800	2,395	1,400	1,000	900
96	950	820	730	750	1,400	11,636	18,000	12,000	5,506	2,176	1,400	1,000	900
97	950	820	730	750	1,400	11,154	17,600	11,000	5,255	2,000	1,400	1,000	850
98	920	820	690	650	1,300	10,636	17,162	8,380	5,000	2,000	1,400	1,000	800
99	920	800	690	650	1,200	10,000	16,886	7,500	4,550	1,900	1,300	954	750
100	920	800	690	650	1,100	8,580	14,400	7,500	4,150	1,700	1,100	900	650

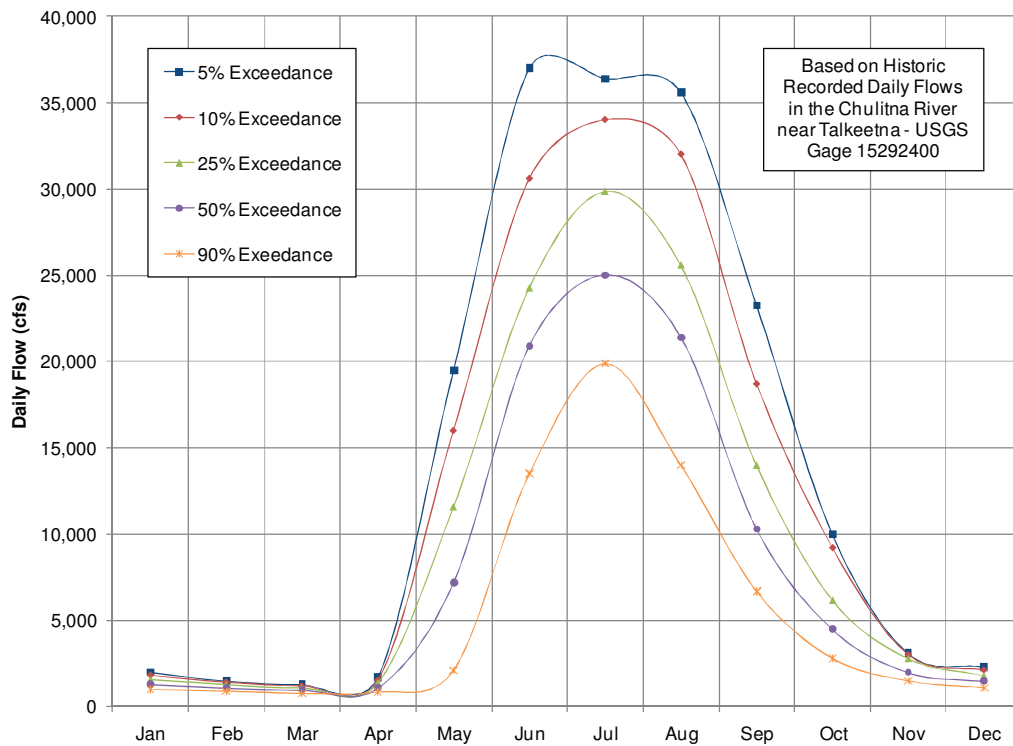


Figure 7: Flow Frequency Curve for the Chulitna River at Talkeetna

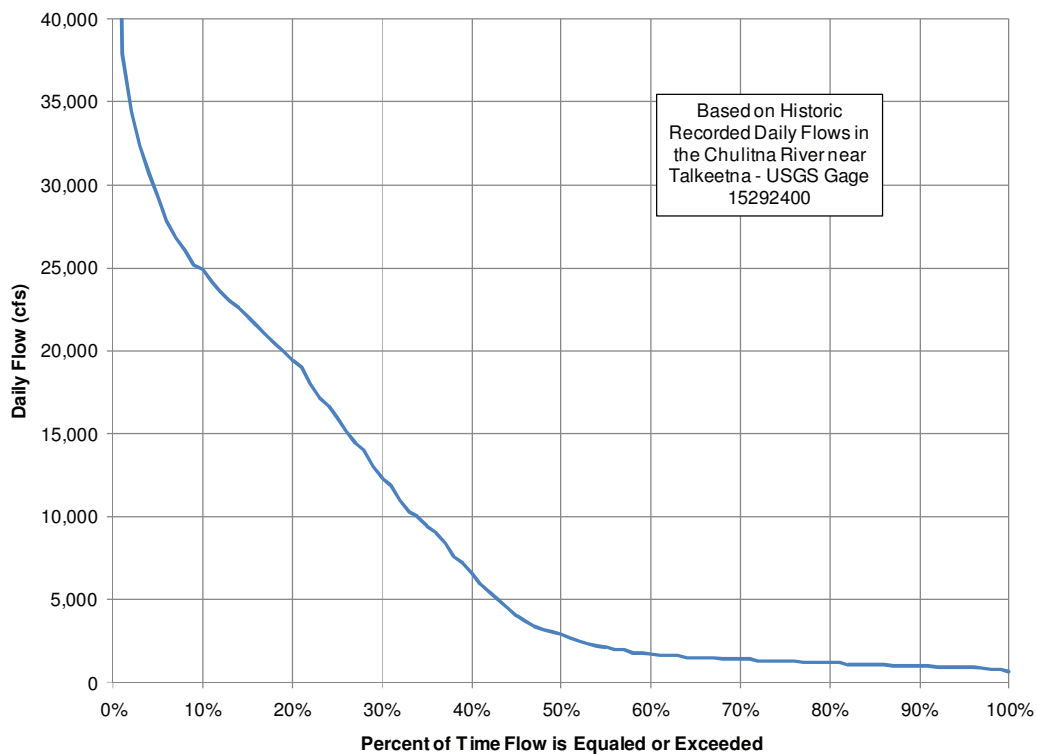


Figure 8: Flow Duration Curve for the Chulitna River at Talkeetna

Table 21: Flow (cfs) Frequency at USGS Gage 15292780 – Susitna River at Sunshine

% of Time Flow is Exceeded	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (all months)
0	6,800	5,100	4,600	7,800	85,400	93,000	150,000	126,000	91,300	43,300	12,800	6,800	150,000
1	6,692	5,060	4,600	7,004	78,720	83,732	131,900	117,460	82,569	36,344	12,702	6,584	97,812
2	6,384	5,000	4,600	6,212	70,470	79,988	123,400	115,520	75,422	32,612	12,208	5,800	89,180
3	6,076	5,000	4,600	5,800	60,745	78,789	101,900	106,280	72,371	30,980	11,330	5,800	82,168
4	5,768	4,940	4,600	5,608	54,600	76,276	99,204	103,360	69,600	30,276	9,456	5,800	76,500
5	5,530	4,900	4,600	5,400	49,825	74,055	98,560	99,580	69,085	28,680	9,310	5,800	73,600
10	5,000	4,600	4,400	4,910	46,150	71,250	92,600	85,240	56,820	25,040	8,500	5,600	63,480
15	5,000	4,600	4,400	4,600	43,000	70,000	86,500	81,410	47,395	22,090	8,130	5,600	56,600
20	4,820	4,600	4,160	4,420	41,200	67,700	80,000	74,140	42,500	20,920	7,800	5,500	50,560
25	4,800	4,600	4,000	4,400	40,150	66,475	74,600	69,850	40,450	19,100	7,400	5,500	44,700
30	4,800	4,600	3,900	4,400	38,150	64,800	70,400	65,200	37,720	18,600	7,200	5,480	38,700
35	4,700	4,500	3,710	4,400	35,800	62,505	66,020	62,010	36,240	18,000	7,000	5,400	32,000
40	4,600	4,400	3,540	4,200	34,000	60,440	64,000	60,200	34,740	17,000	6,700	5,200	21,620
45	4,600	4,200	3,500	4,000	32,400	57,245	61,850	57,910	33,895	16,500	6,600	5,000	15,500
50	4,600	3,800	3,500	3,900	30,000	54,700	60,000	56,400	32,850	15,700	6,400	4,800	8,920
55	4,500	3,600	3,300	3,900	25,000	53,055	58,660	55,230	31,420	15,000	6,200	4,730	6,600
60	4,260	3,600	3,160	3,700	21,000	51,960	57,860	53,620	29,000	14,760	6,200	4,700	5,600
65	3,800	3,500	3,000	3,500	18,000	50,065	56,100	52,490	27,320	13,870	6,000	4,600	5,000
70	3,700	3,500	2,900	3,300	15,100	47,970	55,240	49,160	25,970	12,920	5,800	4,420	4,600
75	3,600	3,500	2,900	3,300	12,350	46,575	54,400	47,900	25,000	11,800	5,800	4,300	4,500
80	3,500	3,400	2,900	3,200	9,800	45,120	52,380	46,400	22,940	10,920	5,600	4,100	4,100
85	3,500	3,300	2,800	3,100	8,000	44,125	50,040	43,100	21,350	9,812	5,600	4,000	3,700
90	3,500	3,000	2,700	2,790	6,700	41,890	48,300	39,000	20,360	8,952	5,400	4,000	3,500
95	3,500	2,800	2,700	2,600	5,850	39,370	46,540	37,600	19,000	8,400	5,090	3,800	3,100
96	3,500	2,760	2,700	2,600	5,680	37,876	46,148	37,432	18,300	8,232	5,000	3,800	2,900
97	3,500	2,700	2,700	2,600	5,400	37,022	45,468	36,920	18,141	8,200	5,000	3,600	2,900
98	3,500	2,700	2,700	2,600	5,140	33,916	44,048	36,300	17,996	8,016	5,000	3,600	2,700
99	3,500	2,700	2,700	2,600	4,885	32,916	43,270	35,816	17,749	7,908	4,949	3,600	2,700
100	3,500	2,700	2,700	2,600	4,700	32,000	41,000	34,900	17,400	7,800	4,900	3,600	2,600

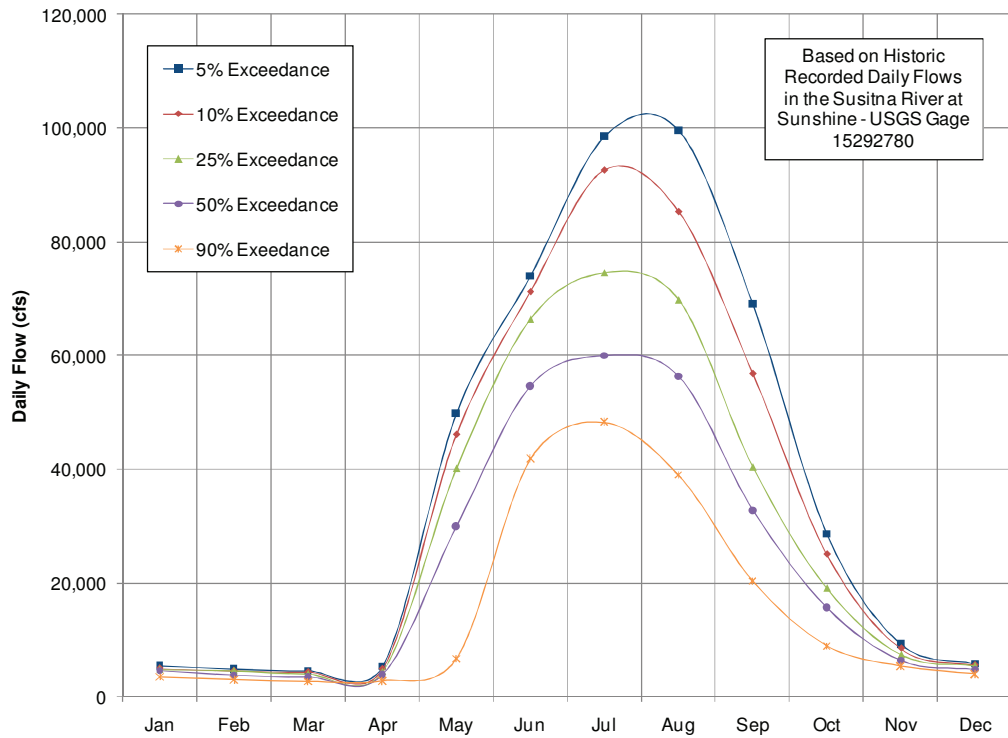


Figure 9: Susitna River Flow Frequency at Sunshine

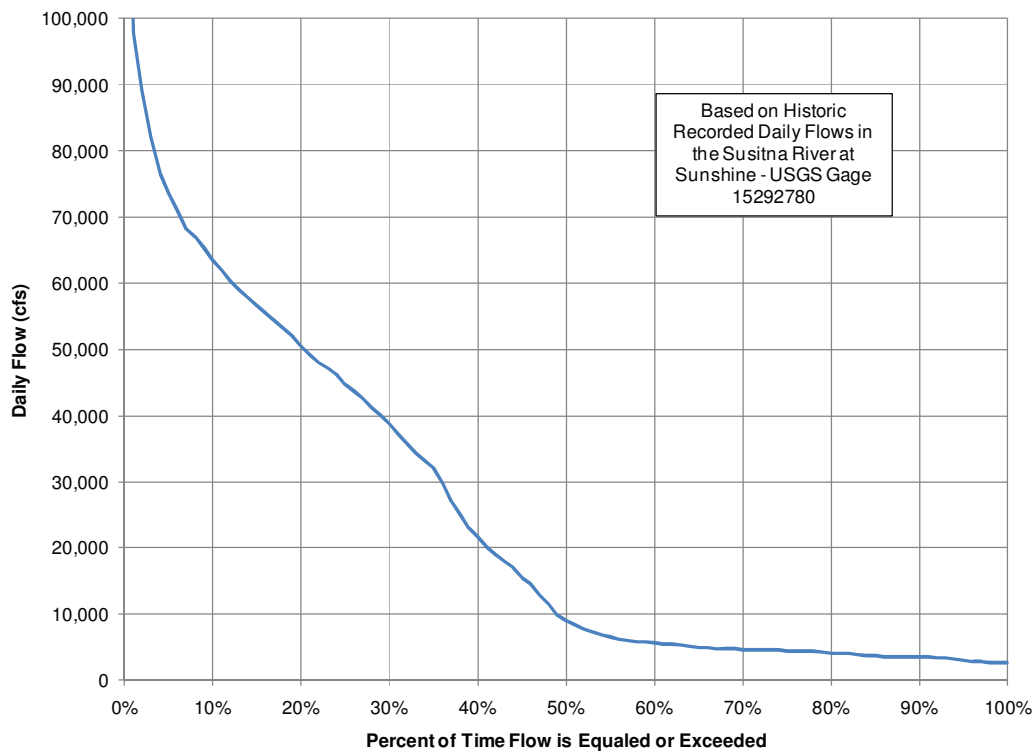


Figure 10: Susitna River Flow Duration at Sunshine

**Table 22: Flow (cfs) Frequency at USGS Gage 15292780 – Susitna River at Susitna Station**

% of Time Flow is Exceeded	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (all months)
0	12,000	10,000	10,000	53,000	175,000	195,000	226,000	228,000	208,000	293,000	48,200	19,000	293,000
1	11,500	10,000	10,000	43,610	147,290	185,610	200,430	216,430	170,000	122,640	42,572	17,060	178,440
2	11,000	9,900	9,620	35,440	139,580	175,220	190,860	196,860	159,220	95,472	34,974	16,000	163,000
3	11,000	9,792	9,500	29,660	134,290	170,000	188,290	185,000	149,660	89,616	30,000	15,000	154,000
4	11,000	9,700	9,500	24,000	128,720	166,440	183,440	175,440	138,880	83,096	28,000	15,000	148,000
5	11,000	9,600	9,500	22,000	124,000	163,100	178,150	171,300	133,050	77,400	26,000	14,000	142,000
10	10,500	9,500	9,500	16,000	108,600	151,000	162,300	146,600	110,100	62,920	23,000	13,000	126,000
15	10,000	9,100	9,000	13,075	98,490	143,000	155,000	139,000	100,150	55,880	21,000	12,000	115,000
20	10,000	8,900	8,600	12,000	90,060	137,000	151,000	134,000	93,240	49,580	20,000	12,000	104,000
25	9,500	8,500	7,400	10,500	85,000	133,000	145,000	129,000	89,075	45,000	19,000	12,000	91,600
30	9,000	8,200	7,300	10,000	80,580	129,000	141,000	124,000	84,830	42,060	18,000	11,000	77,020
35	9,000	8,000	7,000	9,500	75,000	126,000	137,000	120,000	80,935	39,920	17,000	11,000	60,440
40	8,500	8,000	7,000	8,880	70,040	123,000	133,000	116,000	77,560	36,900	16,000	11,000	44,000
45	8,500	8,000	7,000	8,000	68,640	121,000	130,000	113,000	74,000	35,000	15,000	10,000	30,000
50	8,400	7,500	7,000	7,500	65,100	118,000	126,000	108,000	69,900	34,000	14,750	9,500	20,000
55	8,200	7,500	6,920	7,200	60,000	115,000	122,650	105,650	66,700	33,000	14,000	9,460	14,000
60	8,000	7,500	6,600	7,000	56,980	112,000	120,000	103,000	63,100	31,000	14,000	9,000	11,000
65	8,000	7,500	6,500	7,000	52,000	109,650	117,000	99,895	59,500	30,000	13,000	8,800	10,000
70	7,600	7,000	6,500	6,500	46,600	105,000	115,000	95,510	56,000	28,000	13,000	8,600	9,100
75	7,500	6,800	6,500	6,500	40,100	101,750	112,000	92,625	53,775	26,000	12,000	8,000	8,500
80	7,500	6,800	6,200	6,500	34,000	98,540	109,000	88,000	50,380	24,000	11,000	7,500	7,600
85	7,000	6,500	6,000	6,000	27,000	93,900	106,000	84,400	47,285	22,000	10,000	7,400	7,200
90	6,800	6,500	5,600	6,000	20,000	88,980	102,000	80,000	41,930	19,800	10,000	7,000	6,800
95	6,400	6,000	5,400	5,400	12,000	78,880	96,140	73,700	37,000	16,400	8,645	6,000	6,400
96	6,400	6,000	5,400	5,400	11,000	74,912	94,928	70,712	34,648	16,000	8,380	6,000	6,000
97	6,400	5,600	5,200	5,400	10,000	71,053	93,942	68,271	32,000	15,000	8,000	6,000	6,000
98	6,000	5,600	5,000	5,000	9,500	67,934	92,300	65,098	29,780	15,000	7,500	6,000	6,000
99	6,000	5,200	5,000	5,000	8,500	66,739	89,671	61,128	22,000	13,000	7,000	6,000	5,400
100	6,000	5,200	5,000	5,000	7,500	61,800	82,500	55,000	19,000	11,000	6,500	6,000	5,000

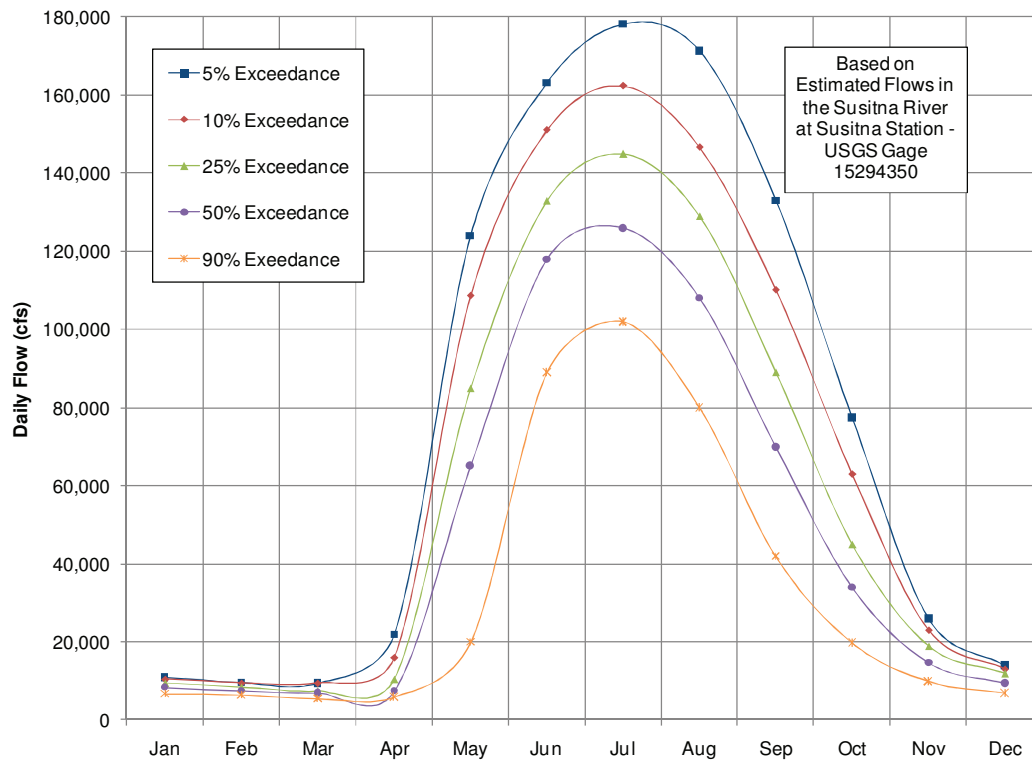


Figure 11: Susitna River Flow Frequency at Susitna Station

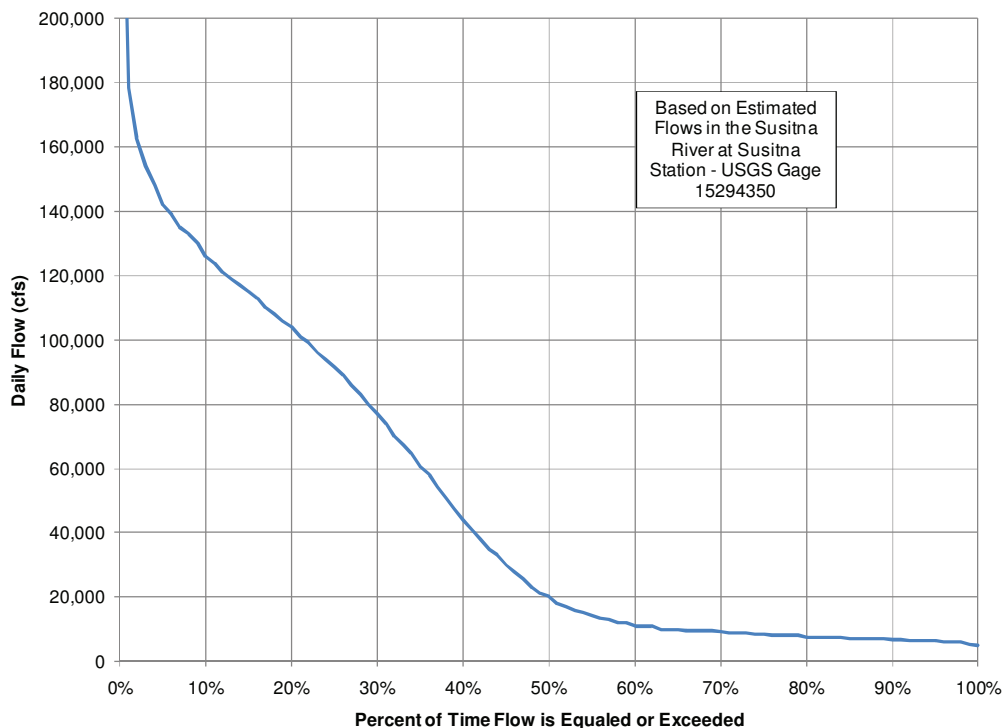


Figure 12: Susitna River Flow Duration at Susitna Station

IV. Watana Dam Site Historical Flows

The Watana dam site is located between USGS gage locations at Cantwell and Gold Creek. Because long term flow data are not available for the dam site, daily flow data from Cantwell and Gold Creek were used to create a modeled historical flow data set for Watana. The flow record at Gold Creek includes 57 years of daily data, and the flow record at Cantwell record includes 17 years. A 57 year modeled record was created for Watana through application of a monthly scaling factor, as described below.

For each month in the 17 year period of concurrent Gold Creek and Cantwell gaging, a between-gage flow was calculated by subtracting the average monthly flow at Cantwell from the average monthly flow at Gold Creek. A 17 year average monthly flow record for the Watana dam site was modeled by multiplying the between-gage flow by the ratio of the between-gage drainage area that is upstream of the Watana site to the total between-gage drainage area, and subtracting the resulting value from the flow at Gold Creek. The estimated monthly average flow at the Watana dam site was divided by the average monthly flow at Gold Creek for each month in the 17 concurrent year record; this ratio was then averaged over all 17 years to create an average monthly scaling factor for estimating flow at Watana from flows at Gold Creek where concurrent individual monthly scaling factors were unavailable. A daily flow record for Watana was modeled by applying the monthly scaling factors to the 57 year daily flow record at Gold Creek. This modeled flow record was used to calculate the monthly flow averages, flow exceedances, and flow durations presented below. A separate technical memorandum will be prepared that estimates modified future reservoir inflows that could occur based on observed historical trends in streamflow and climate data.

Estimated monthly average flow at Watana is between 78 and 86 percent of the flow at Gold Creek, with the higher percentages occurring during the summer snowmelt, and lower percentages occurring during the winter when precipitation is stored as snow in the upper watershed (Table 23). As shown on Table 24, the long-term average inflow at the Watana dam site is 8,116 cfs. Table 25 presents the flow frequency at the Watana dam site.

Table 23: Monthly Scaling Factor Susitna River Flows at Gold Creek Adjusted to Watana

<u>Month</u>	<u>Factor</u>
January	0.807
February	0.794
March	0.803
April	0.811
May	0.808
June	0.827
July	0.857
August	0.846
September	0.813
October	0.784
November	0.808
December	0.813

Table 24: Modeled Monthly Average Flow (cfs) at the Watana Dam Site

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1949	---	---	---	---	---	---	---	20,518	12,726	4,970	2,086	1,170	---
1950	829	625	583	706	9,297	16,203	19,360	16,821	6,750	3,019	1,050	894	6,394
1951	775	651	594	1,312	11,381	17,187	19,334	16,643	17,272	4,370	2,216	1,544	7,813
1952	1,291	794	707	746	4,377	26,760	22,607	17,701	11,775	6,434	2,825	1,382	8,150
1953	888	651	658	1,310	15,565	22,585	17,304	17,439	12,417	4,396	1,696	1,219	8,055
1954	1,049	794	626	1,002	13,958	20,874	17,441	22,084	10,506	4,213	2,229	1,662	8,089
1955	1,448	1,112	883	973	7,527	24,685	23,609	21,788	11,620	3,884	1,535	1,057	8,388
1956	791	770	755	771	14,265	27,562	26,633	20,755	14,905	4,555	2,464	1,741	9,718
1957	1,372	1,191	963	973	11,107	24,933	19,968	17,379	16,101	6,442	3,194	2,653	8,893
1958	1,586	1,038	922	1,243	10,420	21,246	19,600	19,072	6,139	3,774	1,737	1,230	7,383
1959	1,168	1,038	787	1,014	12,916	19,279	21,416	26,382	13,759	5,145	2,302	1,788	8,979
1960	1,489	1,153	961	1,054	12,746	12,839	19,686	19,960	16,678	6,114	2,423	2,190	8,163
1961	1,979	1,393	1,453	2,149	13,638	22,784	19,840	19,480	10,146	4,638	2,263	1,760	8,509
1962	1,609	1,257	1,177	1,457	11,333	36,017	23,444	19,887	12,746	5,560	2,509	1,709	9,927
1963	1,309	1,185	884	777	15,299	20,663	28,767	21,011	10,800	5,187	1,789	1,195	9,143
1964	852	782	575	609	3,579	42,842	20,083	14,048	7,524	4,759	2,368	1,070	8,263
1965	863	773	808	1,232	10,966	21,213	23,236	17,394	16,226	5,221	1,565	1,204	8,436
1966	1,060	985	985	1,338	7,094	25,940	16,153	17,391	9,214	3,270	1,202	1,122	7,172
1967	1,102	1,031	890	850	12,556	24,712	21,987	26,104	13,673	4,019	1,934	1,704	9,269
1968	1,618	1,560	1,560	1,577	12,827	25,704	22,083	14,148	7,164	3,135	1,355	754	7,829
1969	619	608	686	1,262	9,314	13,962	14,843	7,772	4,260	2,403	1,021	709	4,819
1970	636	602	624	986	9,536	14,399	18,410	16,264	7,224	3,768	2,496	1,687	6,435
1971	1,097	778	717	814	2,857	27,613	21,126	27,447	12,189	4,979	2,587	1,957	8,722
1972	1,671	1,491	1,366	1,305	15,973	27,429	19,820	17,510	10,956	3,786	1,820	1,191	8,734
1973	968	953	803	833	6,652	22,982	15,634	17,168	7,379	2,928	1,230	840	6,559
1974	705	617	581	804	13,069	14,773	16,105	13,724	9,961	2,933	1,373	1,303	6,372
1975	1,223	1,168	1,124	1,292	12,399	26,711	23,746	15,306	13,263	6,071	1,610	879	8,773
1976	786	754	723	1,114	10,194	20,155	16,225	16,753	5,595	3,039	2,141	1,953	6,661
1977	1,476	1,285	1,204	1,363	10,242	31,390	19,591	16,279	10,278	5,939	2,847	2,104	8,697
1978	1,637	1,325	1,289	1,380	9,653	15,749	18,007	13,868	6,999	3,849	2,048	1,366	6,471
1979	1,127	1,021	963	1,176	11,203	20,411	24,740	17,312	8,758	5,735	3,386	1,964	8,205
1980	1,411	1,164	1,124	1,355	9,741	23,399	26,741	18,005	10,995	6,632	3,044	1,790	8,836
1981	1,858	1,592	1,262	1,641	14,415	16,738	27,599	30,539	11,668	5,700	2,468	1,596	9,841
1982	1,380	1,103	971	1,196	10,876	21,443	20,443	13,203	13,977	5,154	2,132	1,893	7,849
1983	1,797	1,610	1,427	1,565	11,673	20,605	18,773	20,861	11,196	6,882	2,657	1,939	8,465
1984	1,782	1,741	1,697	1,613	10,831	22,908	20,707	17,421	7,347	4,257	2,384	1,799	7,917
1985	1,479	1,273	1,298	1,517	8,439	21,226	23,293	16,432	11,702	5,073	2,039	1,426	7,975
1986	1,207	1,131	1,038	1,162	9,734	17,817	20,424	14,596	10,457	9,947	2,787	1,589	7,707
1987	1,303	1,205	1,204	1,661	10,493	19,014	25,605	18,403	10,848	4,647	2,006	1,301	8,195
1988	1,260	1,191	1,204	1,287	14,031	24,569	22,007	16,533	11,206	6,020	2,434	1,626	8,661
1989	1,614	1,429	1,445	1,733	11,098	22,131	20,260	18,945	12,547	6,296	2,421	1,502	8,496
1990	1,424	1,350	1,487	3,447	20,703	27,942	20,140	20,078	21,557	5,409	1,977	1,788	10,650
1991	1,531	1,429	1,300	1,308	4,885	21,188	18,178	15,467	10,043	4,563	1,971	1,788	6,998
1992	1,586	1,429	1,500	1,703	4,930	19,130	21,879	17,895	8,270	3,435	2,208	1,657	7,175
1993	1,505	1,393	1,316	2,058	16,866	19,411	16,576	15,865	17,312	7,778	2,687	2,056	8,778
1994	1,661	1,418	1,225	2,612	11,801	25,702	17,955	15,721	7,609	3,554	2,246	1,705	7,800
1995	1,497	1,364	1,365	2,308	14,305	20,428	21,844	15,552	15,564	5,085	2,146	1,172	8,595
1996	1,007	942	883	1,095	5,342	12,987	13,715	14,494	8,465	---	---	---	---
2001	---	---	---	---	---	25,628	18,889	18,437	8,424	3,797	2,122	1,542	---
2002	1,249	1,128	1,046	1,079	9,297	13,682	15,548	20,121	13,214	8,590	4,357	2,105	7,666
2003	1,336	1,781	1,212	1,762	6,477	20,114	25,014	17,870	10,986	6,361	2,019	1,471	8,077
2004	1,187	1,013	868	2,214	19,039	20,940	17,270	14,993	5,247	2,589	1,400	1,309	7,390
2005	1,161	984	839	2,118	21,761	28,372	22,924	18,589	18,589	6,463	1,731	1,217	10,448
2006	1,130	1,103	1,093	1,245	12,706	19,254	19,823	26,069	10,002	8,151	2,536	1,885	8,818
2007	1,633	1,513	1,400	1,844	13,885	16,294	18,486	16,296	10,978	3,936	2,603	2,287	7,643
2008	1,486	1,066	1,092	1,355	9,580	17,460	18,872	16,694	11,807	4,337	1,250	1,057	7,213
2009	1,118	1,032	1,076	3,688	18,522	19,105	16,593	15,628	10,148	5,587	2,267	1,497	8,071
2010	1,185	1,072	1,048	1,498	15,840	16,550	23,575	16,990	12,864	---	---	---	---
Average	1,282	1,122	1,041	1,419	11,415	21,818	20,420	18,054	11,173	4,978	2,164	1,536	8,116
Maximum	1,979	1,781	1,697	3,688	21,761	42,842	28,767	30,539	21,557	9,947	4,357	2,653	10,650
Minimum	619	602	575	609	2,857	12,839	13,715	7,772	4,260	2,403	1,021	709	4,819

Table 25: Modeled Flow (cfs) Frequency at the Watana Dam Site

% of Time Flow is Exceeded	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual (all months)
0	2,340	2,938	1,927	19,466	44,830	71,013	52,084	65,744	38,788	28,398	7,221	3,577	71,013
1	2,017	1,906	1,686	5,874	30,660	51,258	36,779	43,326	26,270	13,226	4,188	2,845	33,233
2	1,937	1,707	1,525	4,367	28,365	42,808	33,409	36,388	24,639	11,477	3,877	2,601	29,513
3	1,937	1,588	1,525	3,382	26,715	38,419	31,703	33,037	22,687	10,277	3,635	2,357	27,413
4	1,856	1,588	1,525	2,988	25,470	35,902	30,356	29,465	21,214	9,775	3,554	2,276	25,956
5	1,775	1,588	1,525	2,758	25,040	34,481	29,554	27,837	20,329	9,414	3,394	2,205	24,922
10	1,634	1,509	1,445	2,028	22,455	30,679	26,813	24,538	17,654	8,080	2,989	2,032	21,416
15	1,614	1,429	1,365	1,784	19,604	28,327	25,271	22,376	15,857	7,270	2,746	1,951	18,947
20	1,614	1,421	1,285	1,622	17,770	26,801	23,986	21,322	14,637	6,652	2,585	1,870	16,962
25	1,533	1,350	1,285	1,541	16,438	25,297	22,958	20,307	13,743	6,119	2,504	1,788	14,892
30	1,493	1,271	1,204	1,460	15,186	24,222	22,101	19,461	12,685	5,656	2,423	1,788	12,692
35	1,453	1,191	1,204	1,379	14,297	23,147	21,416	18,953	11,954	5,287	2,342	1,707	9,692
40	1,372	1,191	1,124	1,338	13,247	22,321	20,731	18,361	11,384	4,942	2,262	1,626	6,668
45	1,291	1,191	1,084	1,298	12,116	21,494	20,131	17,769	10,734	4,628	2,181	1,626	4,125
50	1,291	1,112	1,044	1,249	10,985	20,957	19,531	17,092	10,165	4,315	2,100	1,544	2,824
55	1,291	1,112	1,044	1,217	9,693	20,089	19,017	16,584	9,677	4,079	2,100	1,544	2,135
60	1,210	1,032	963	1,217	8,368	19,262	18,589	15,907	9,189	3,883	1,939	1,382	1,788
65	1,210	1,032	883	1,136	7,270	18,353	18,161	15,230	8,672	3,609	1,939	1,382	1,569
70	1,130	953	803	973	5,783	17,526	17,647	14,807	8,213	3,530	1,858	1,301	1,445
75	1,049	953	799	973	4,079	16,534	17,047	14,384	7,741	3,307	1,696	1,219	1,300
80	968	794	755	892	3,554	15,625	16,448	13,707	7,267	3,138	1,535	1,219	1,210
85	888	770	707	811	2,746	14,715	15,848	13,030	6,707	2,903	1,373	1,057	1,112
90	775	683	642	746	2,262	13,558	15,043	12,269	5,854	2,667	1,292	902	963
95	726	635	602	673	1,660	12,400	13,963	10,987	4,879	2,273	1,131	813	770
96	686	596	594	673	1,535	12,152	13,706	10,397	4,709	2,184	1,050	813	732
97	686	596	594	633	1,373	11,431	13,364	9,984	4,472	1,961	1,050	732	689
98	646	572	562	613	1,212	10,927	12,877	9,297	4,322	1,726	969	691	650
99	579	556	530	576	1,131	10,086	12,507	6,844	3,985	1,491	889	691	600
100	565	476	530	568	727	8,267	10,108	4,468	3,017	1,177	767	650	476

The monthly flow frequency based on modeled daily flow at the Watana dam site is presented graphically in Figure 13. Figure 14 shows the annual flow duration curve for modeled flow at the Watana dam site, and Figures 15 and 16 show monthly flow duration curves for low and high flow months, respectively.

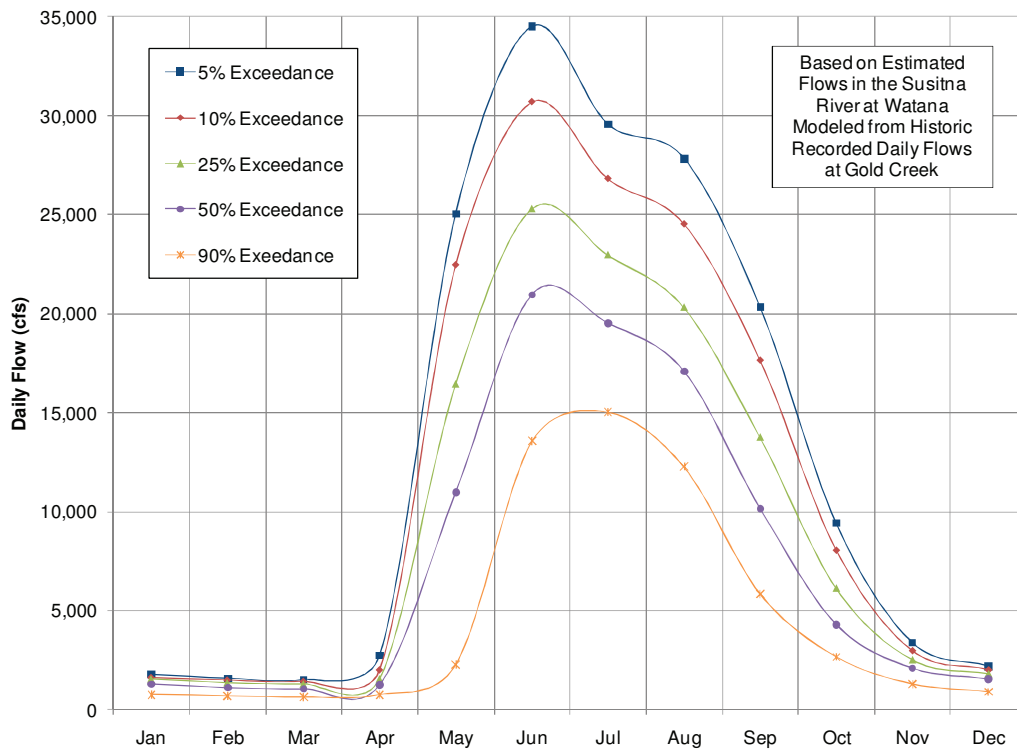


Figure 13: Modeled Susitna River Flow Frequency at Watana

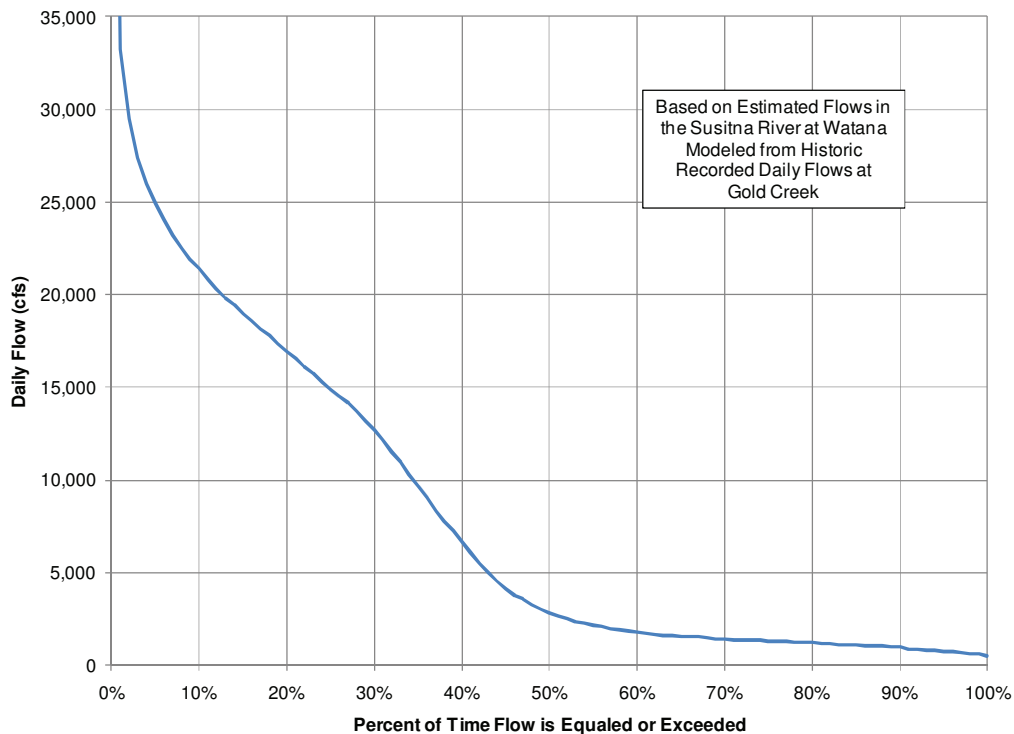


Figure 14: Modeled Susitna River Flow Duration at Watana

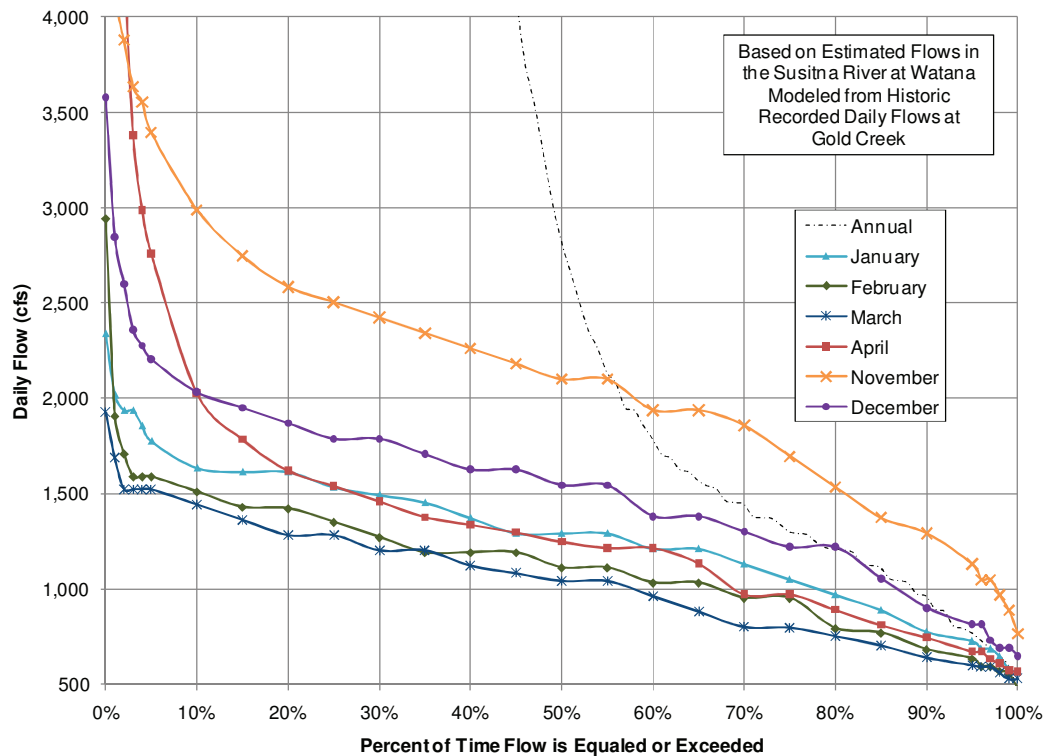


Figure 15: Modeled Susitna River Flow Duration at Watana for Low Flow Months

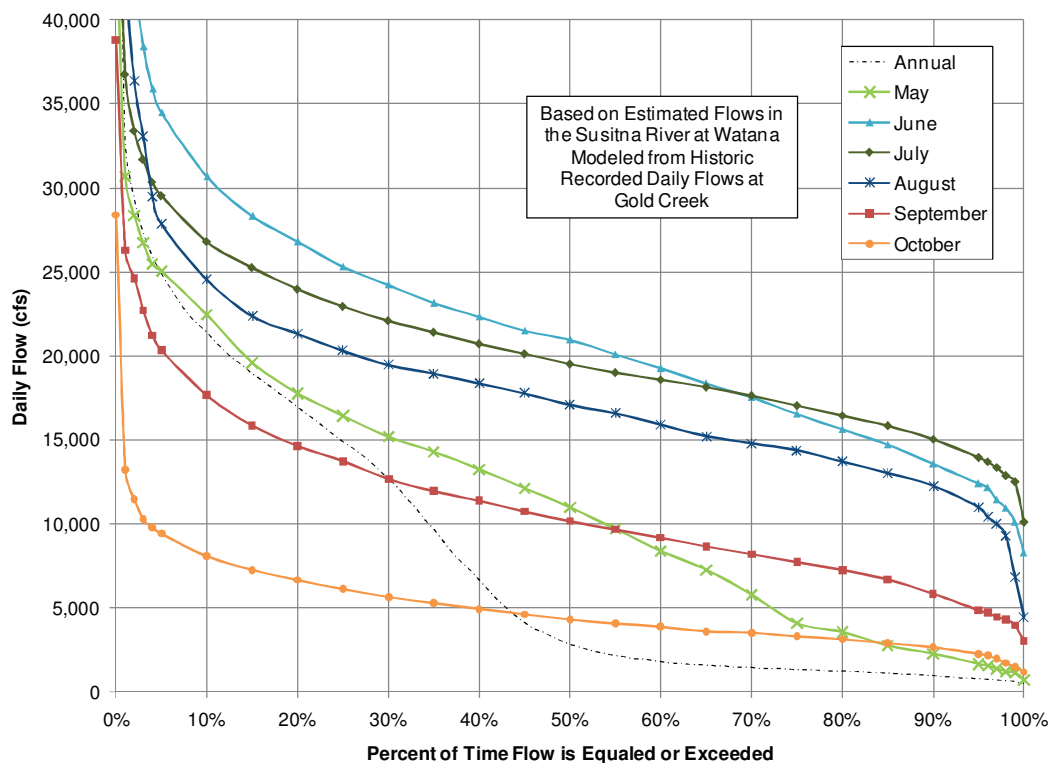


Figure 16: Modeled Susitna River Flow Duration at Watana for High Flow Months

V. Flood Frequency

Peak annual flows have been recorded by the USGS at Cantwell, Gold Creek, Sunshine, and Susitna Station on the Susitna River, and on the Chulitna River near Talkeetna, as summarized in Tables 26, 28, 30, 32 and 33. Peak flow rates provided by the USGS include both average daily values and instantaneous peaks.

Peak flows for return periods up to 10,000 years were estimated for the Susitna River at Cantwell and Gold Creek, and the Chulitna River at Talkeetna. The five year record of peak flows on the Susitna River at Sunshine is not sufficient for statistical evaluation, so peak flows at longer return periods were not estimated at this location. Peak flows were estimated for various return periods by fitting recorded peak flow data with a Log Pearson type III distribution according to methods in Bulletin 17B (IACWD, 1982). Estimated peak flows for the Susitna River at Cantwell and Gold Creek, the Chulitna River near Talkeetna, and the Susitna River at Susitna Station are presented in Tables 27, 29, 31, and 34.

Table 26: Peak Annual Flows in the Susitna River at Cantwell

Date	Peak Flow (cfs)
June 23, 1961	30,400
June 15, 1962	46,800
July 18, 1963	32,000
June 08, 1964	51,200
July 13, 1965	26,000
June 06, 1966	27,000
August 14, 1967	38,800
May 22, 1968	25,000
July 15, 1969	19,300
August 01, 1970	20,500
August 10, 1971	55,000
June 17, 1972	44,700
July 29, 1980	28,500
August 14, 1981	30,900
June 21, 1982	24,100
June 04, 1983	25,800
June 16, 1984	33,400
July 03, 1985	28,200

The quality of the fit of the parameterized Log Pearson Type III distribution to the observed data is evaluated by plotting the data and the parameterized distribution together. A good fit is indicated by data points for observed annual peaks which are close to and randomly distributed above and below the computed Log Pearson Type III curve. The probability values assigned to each data point, called plotting positions, and the scale of the x-axis, are selected

so that the Log Pearson Type III distribution appears as a straight line when the skew value is zero. For evaluation of flood frequency on the Susitna River, Weibul plotting positions, as recommended in Bulletin 17B, were used to plot the data, and the x-axis scale was based on the standard normal deviate, z .

The fitted distribution and resulting estimated peak flows at specified return periods are approximations. The ability to fit a distribution depends on the size and the variability within the sample. Confidence limits around the computed distribution curve provide a measure of the uncertainty for the predicted discharge at a specified exceedance probability.

Figures 17 through 20 below show the fit Log Pearson Type III distribution as a solid line, 5% and 95% upper and lower confidence limits on the distribution as dashed lines, the observed annual peak flow data, and return periods for which peak flows were estimated in Tables 27, 29, 31, 34, and 35.

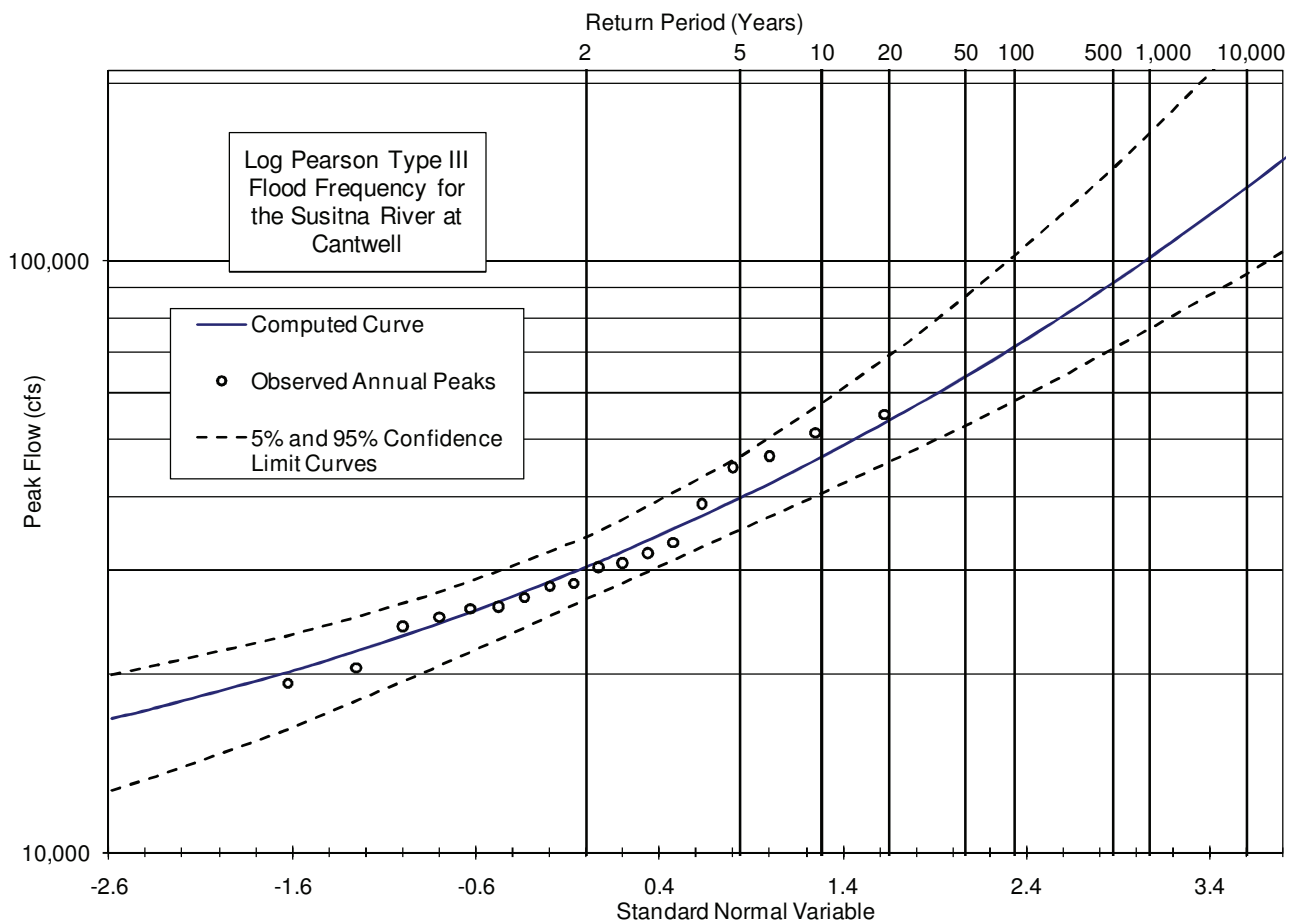


Figure 17: Log Pearson Type III Flood Frequency Plot for the Susitna River at Cantwell

Table 27: Calculated Flood Frequency for the Susitna River at Cantwell

Return Period (Years)	Flow (cfs)
2	30,300
5	39,700
10	46,600
25	56,000
50	63,600
100	71,700
200	80,200
500	91,900
1,000	101,000
10,000	133,000

Table 28: Peak Annual Flows in the Susitna River at Gold Creek

Date	Peak Flow (cfs)	Date	Peak Flow (cfs)	Date	Peak Flow (cfs)
June 21, 1950	34,000	May 25, 1969	28,400	June 16, 1988	43,600
June 8, 1951	37,400	June 30, 1970	33,400	June 15, 1989	46,800
June 17, 1952	44,700	August 10, 1971	87,400	September 15, 1990	50,300
June 7, 1953	38,400	June 17, 1972	82,600	June 23, 1991	35,300
August 4, 1954	42,400	June 16, 1973	54,100	July 19, 1992	33,300
August 26, 1955	58,100	May 29, 1974	37,200	September 3, 1993	36,300
June 9, 1956	51,700	June 3, 1975	47,300	June 22, 1994	46,600
June 8, 1957	42,200	June 12, 1976	35,700	June 25, 1995	37,800
August 3, 1958	49,600	June 15, 1977	54,300	August 26, 1996	26,100
August 25, 1959	62,300	June 23, 1978	25,000	August 1, 2001	40,200
September 13, 1960	41,900	July 16, 1979	41,300	August 23, 2002	36,200
June 23, 1961	54,000	July 29, 1980	51,900	July 28, 2003	51,700
June 15, 1962	80,600	July 12, 1981	64,900	May 8, 2004	43,400
July 18, 1963	49,000	June 21, 1982	37,900	June 19, 2005	50,200
June 7, 1964	90,700	June 3, 1983	37,300	August 20, 2006	59,800
June 28, 1965	43,600	June 17, 1984	59,100	May 28, 2007	30,800
June 6, 1966	63,600	May 28, 1985	40,400	July 30, 2008	34,400
August 15, 1967	80,200	June 18, 1986	29,100	May 5, 2009	40,400
May 22, 1968	41,800	July 31, 1987	47,300		

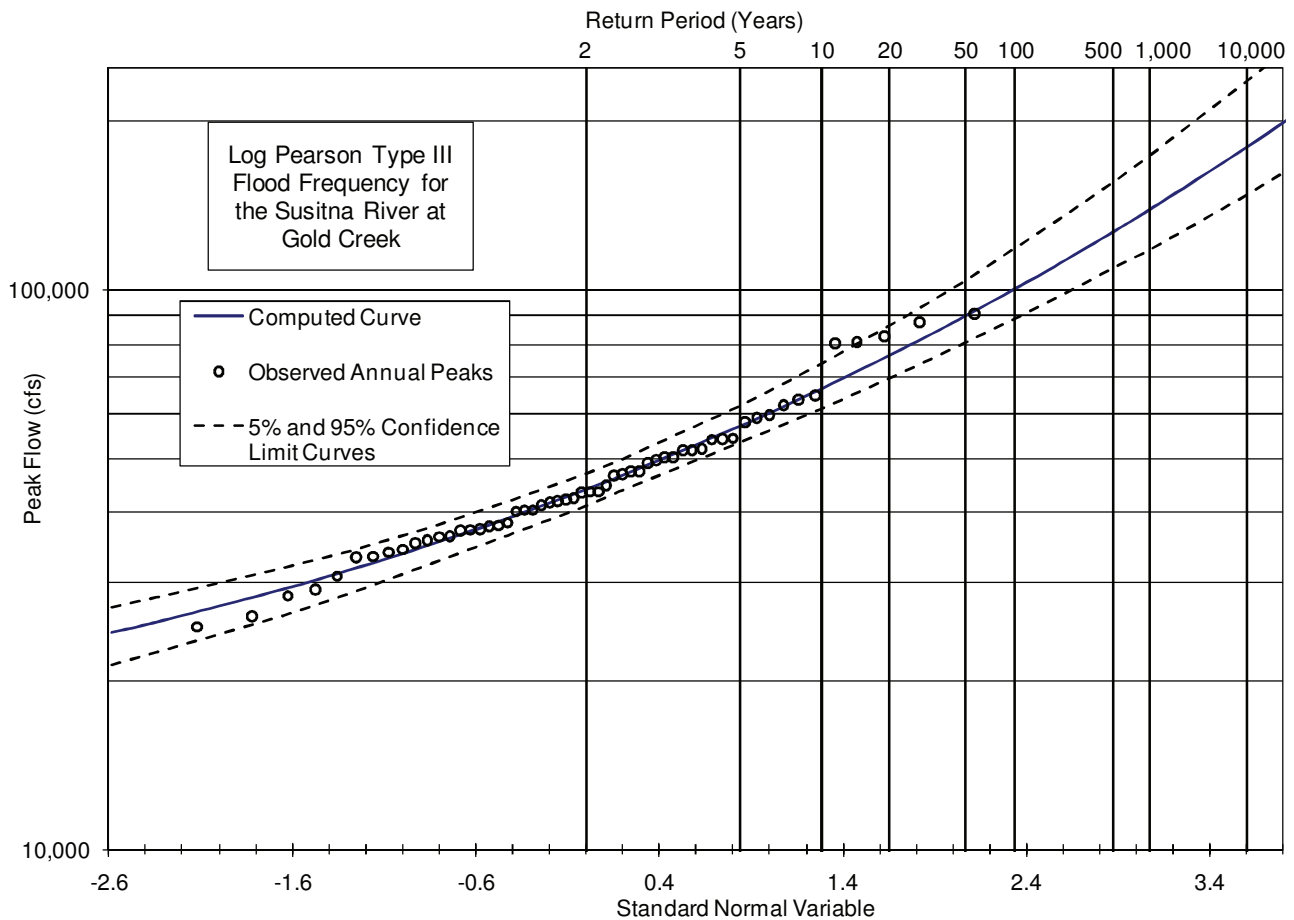


Figure 18: Log Pearson Type III Flood Frequency Plot for the Susitna River at Gold Creek

Table 29: Calculated Flood Frequency for the Susitna River at Gold Creek

Return Period (Years)	Flow (cfs)
2	44,000
5	57,200
10	66,600
25	79,500
50	89,800
100	101,000
200	112,000
500	127,000
1,000	139,000
10,000	180,000

Table 30: Peak Annual Flows in the Chulitna River at Talkeetna

Date	Peak Flow (cfs)	Date	Peak Flow (cfs)
August 3, 1958	35,100	August 31, 1974	32,200
July 12, 1959	38,800	July 12, 1975	36,700
May 26, 1960	38,000	June 11, 1976	38,000
August 5, 1961	41,100	June, 1977	33,400
June 16, 1962	39,600	September 21, 1979	35,700
September 7, 1965	42,100	July 28, 1980	59,000
August 23, 1966	38,600	August 2, 1981	62,700
July 20, 1967	75,900	July 25, 1982	46,600
June 13, 1968	40,200	August 9, 1983	48,500
June 17, 1969	28,400	August 26, 1984	37,000 ^a
August 2, 1970	36,400	July 2, 1985	40,700
August 11, 1971	50,800	July 14, 1986	36,300
July 10, 1972	34,700	October 11, 1986	57,700
1973	36,700	August 19, 2006	100,000 ^a

^a Discharge is an estimate.

Two peak flow values, 75,900 cfs on July 20, 1967, and 100,000 cfs on August 19, 2006, were identified as high outliers using procedures in Bulletin 17B (IACWD, 1982). The August 19, 2006 flow was also flagged as estimated by the USGS. Both of these values were included in the peak flow analysis for this site.

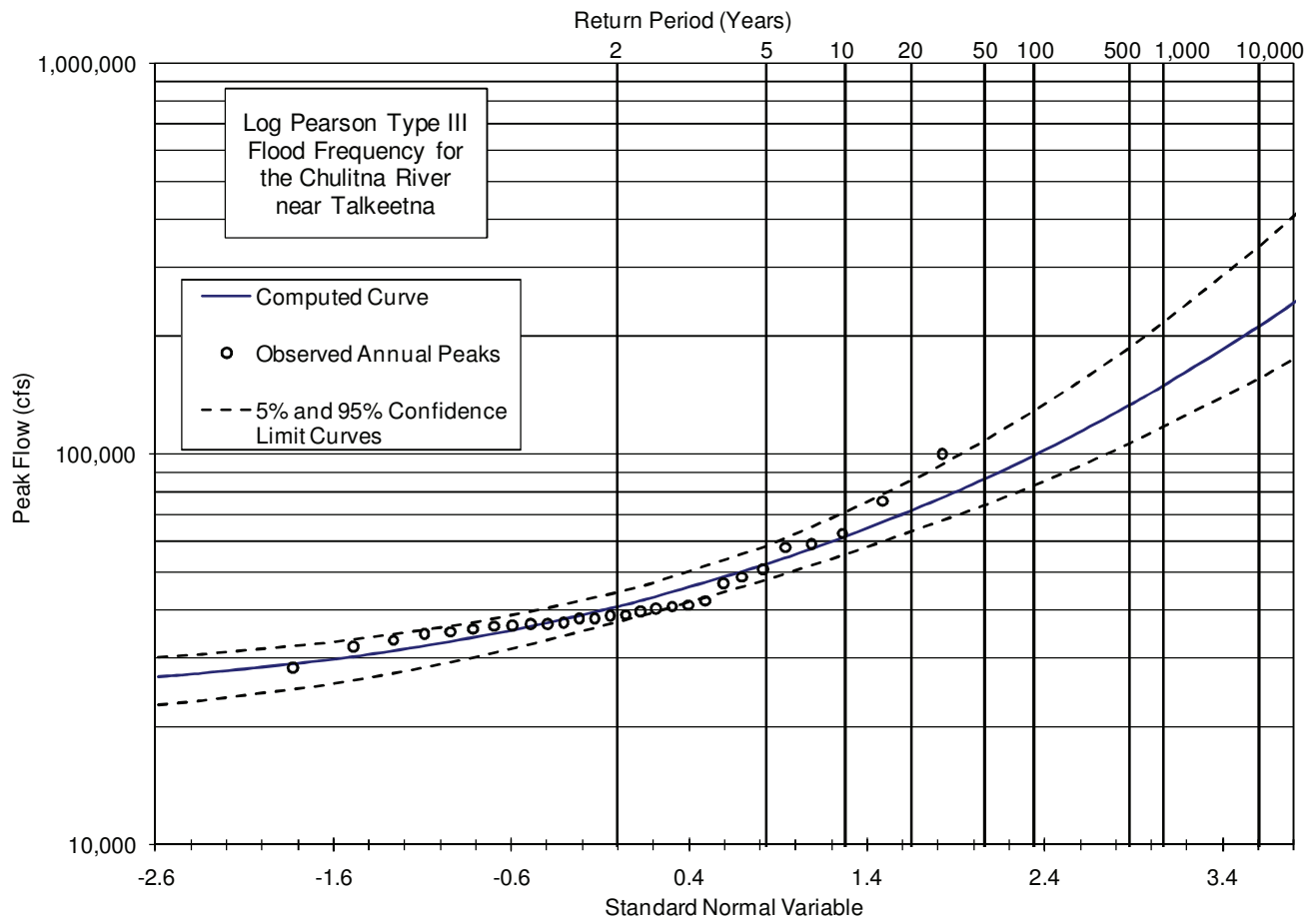


Figure 19: Log Pearson Type III Flood Frequency Plot for the Chulitna River at Talkeetna

Table 31: Calculated Flood Frequency for the Chulitna River at Talkeetna

Return Period (Years)	Flow (cfs)
2	40,600
5	52,200
10	61,400
25	74,800
50	86,200
100	98,800
200	113,000
500	133,000
1,000	149,000
10,000	211,000

Table 32: Peak Annual Flows in the Susitna River at Sunshine

Date	Peak Flow (cfs)
August 10, 1971	200,000 ^a
July 11, 1981	150,000
July 25, 1982	125,000
August 10, 1983	103,000
August 26, 1984	114,000
July 2, 1985	100,000
October 11, 1986	185,000 ^a

^a Discharge is a historic peak

Due to the small sample size for peak flow at the Sunshine gage, a Log Pearson Type III distribution could not be fit. Discharge at longer return periods was therefore not calculated for this station.

Table 33: Peak Annual Flows in the Susitna River at Susitna Station

Date	Peak Flow (cfs)	Date	Peak Flow (cfs)
July 1, 1975	173,000	August 26, 1984	171,000
July 3, 1976	147,000	July 3, 1985	190,000
June 16, 1977	197,000	July 22, 1986	167,000
July 7, 1978	136,000	October 12, 1986	312,000
July 26, 1979	185,000	June 17, 1988	171,000
July 29, 1980	230,000	August 29, 1989	217,000
August 16, 1981	230,000	September 15, 1990	210,000
September 17, 1982	208,000	June 24, 1991	173,000
August 10, 1983	223,000	July 6, 1992	157,000

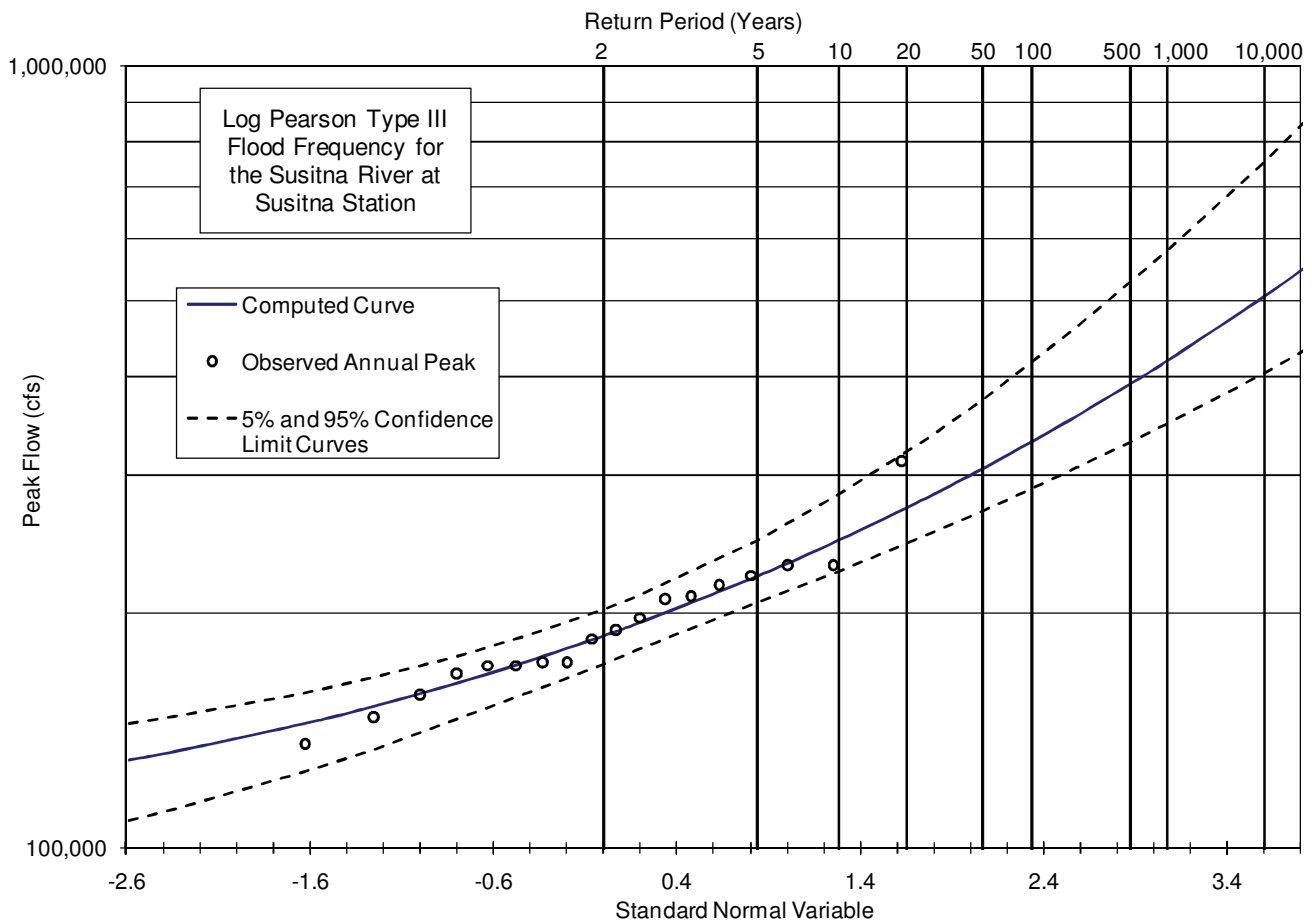

Figure 20: Log Pearson Type III Flood Frequency Plot for the Susitna River at Susitna Station

Table 34: Calculated Flood Frequency for the Susitna River at Susitna Station

Return Period (Years)	Flow (cfs)
2	187,000
5	223,000
10	247,000
25	280,000
50	305,000
100	331,000
200	357,000
500	393,000
1,000	419,000
10,000	508,000

Peak flows were estimated for return periods up to 10,000 years at the Watana dam site by transposing peak flow analysis results at Gold Creek to Watana according to the following equation:

$$Q_{Watana} = Q_{Gold\ Creek} \times \left(\frac{A_{Watana}}{A_{Gold\ Creek}} \right)^{0.86}$$

where A is the drainage area for each site. The exponent in this equation was selected as the value that minimized the percent error between the calculated peak flows at Cantwell presented in Table 27 and the estimated peak flows that resulted from transposing the calculated peak flows at Gold Creek to Cantwell.

Table 35: Estimated Peak Annual Flows in the Susitna River at Watana

Return Period (Years)	Peak Flow (cfs)
2	37,900
5	49,200
10	57,400
25	68,500
50	77,400
100	86,600
200	96,300
500	110,000
1,000	120,000
10,000	155,000

VI. Susitna Watershed Flow Distribution

Future reservoir development and alteration of the current flow regime, including lower summer flows, higher winter flows, and dampening of peak flows, resulting from reservoir regulation may affect downstream habitat, and therefore is of interest. The potential magnitude of this impact can be preliminarily evaluated by comparing flow in the river at the Watana dam site to flow at downstream locations. Gages in the lower Susitna River watershed were used to determine the average monthly and annual flow distribution for the river. Figure 21 presents the annual average flow distribution, and Table 36 presents the average monthly flow at gaging stations, as a percent of the flow at Susitna Station, the most downstream gaging station. Flows at the Watana dam site account only for between 15 and 20 percent of the total flow in the river as measured at the Susitna Station USGS gage.

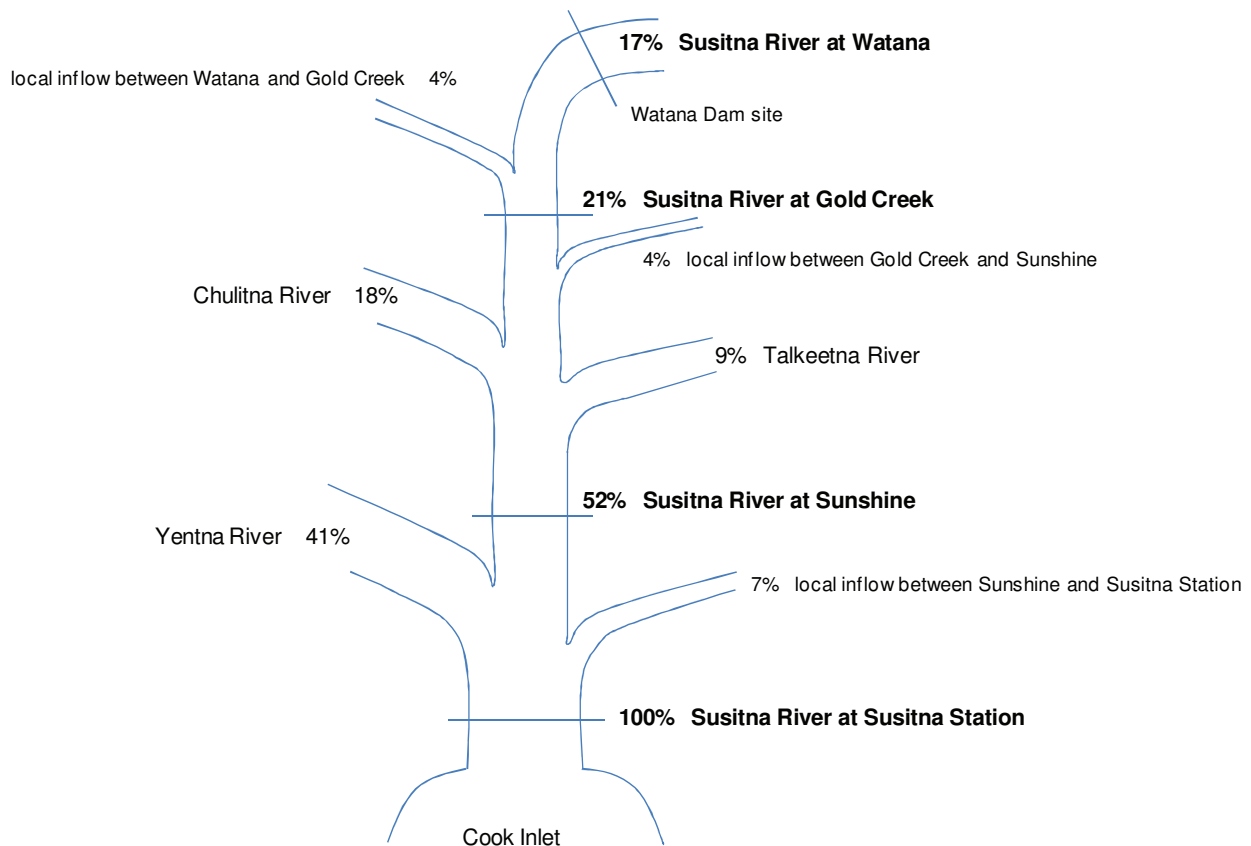


Figure 21: Average Annual Flow Distribution for the Susitna River

The percent contribution values presented in Table 36 were calculated from monthly averages for the four years of concurrent data, from 1982 to 1985, available for the Susitna River at Gold Creek, Sunshine, and Susitna Station, and for the Chulitna, Talkeetna, and Yentna Rivers. Local inflow between gaging locations in Figure 21 and Table 36 was calculated as the difference in flow between gaging stations. The drainage area contributing to local inflow was similarly assumed to be the difference in drainage area for gaged sites.

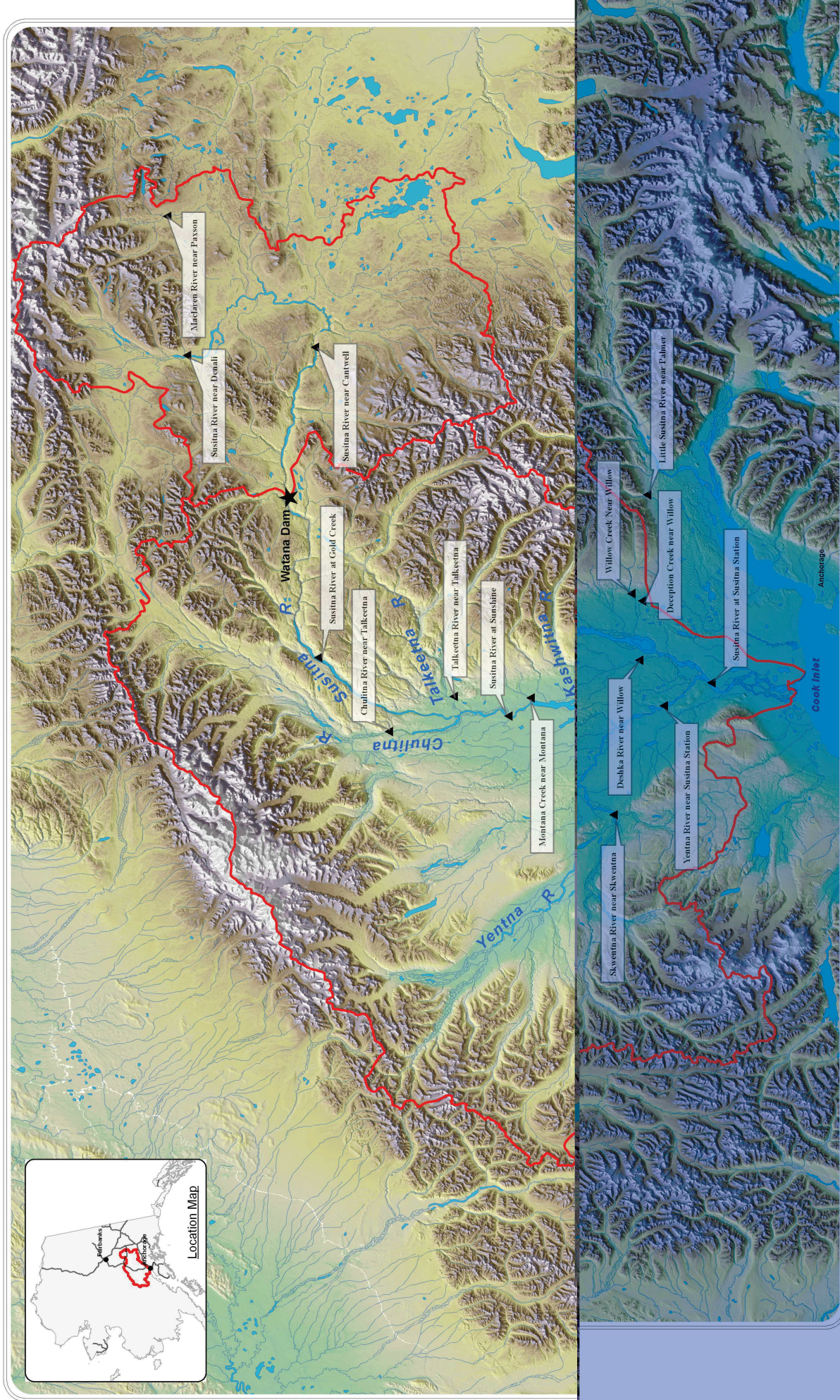
Table 36: Percent Contribution of Flow at Susitna River Watershed USGS Gage Stations to Flow at the Susitna Station USGS Gage

	Drainage Area (sq.mi.)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Susitna River at Watana	5,180	20	19	21	18	20	20	18	16	15	14	15	18	17
local inflow ^a	980	5	5	5	4	5	4	3	3	4	4	3	4	4
Susitna River at Gold Creek	6,160	24	24	26	22	25	24	21	19	19	18	18	22	21
Chulitna River near Talkeetna	2,570	20	16	17	14	13	17	21	20	17	16	16	19	18
Talkeetna River near Talkeetna	1,996	9	8	8	7	8	10	9	9	9	8	7	9	9
local inflow ^a	374	2	7	7	6	6	5	3	4	3	1	1	0	4
Susitna River at Sunshine	11,100	55	56	57	50	51	56	53	52	48	43	42	50	52
Yentna River near Susitna Station	6,180	38	38	40	45	42	44	44	44	37	34	32	35	41
local inflow ^a	2,120	6	6	3	6	6	1	3	4	15	23	26	15	7
Susitna River at Susitna Station	19,400	100	100	100	100	100	100	100	100	100	100	100	100	100

^a Percent of flow attributed to local inflow is equal to the increase in flow between gaged locations on the Susitna River.

VII. References

U.S. Interagency Advisory Committee on Water Data [IACWD], 1982. *Guidelines for determining flood flow frequency, Bulletin 17-B of the Hydrology Subcommittee*: Reston, Virginia, U.S. Geological Survey, Office of Water Data Coordination. 183 p.




LEGEND:


- ★ Watana Dam Site
- ▲ Gaging Station
- 🔴 Basin Boundary

- NOTES:
1. Spatial Reference: NAD83 Alaska Albers, meters
 2. Topography: USGS National Elevation Dataset (NED), 2-Arc Second
 3. Basin boundary based on modified USGS HUCs 19020501-5


EXHIBIT 1
SUSITNA RIVER DRAINAGE BASIN BOUNDARY
AND
STREAMFLOW GAGE LOCATIONS



N



0 5 10 20 Miles



M

Date: May