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Water Resources of Two Anadromous Tributaries to the Gulkana Wild and Scenic River, Alaska: Stream Gage Data, 2008–2014

July 2026



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Cover photo
View downstream on Hungry Hollow Creek.

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Water Resources of Two Anadromous Tributaries to the Gulkana Wild and Scenic River, Alaska: Stream Gage Data, 2008–2014

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Abstract

This report summarizes stream gage information collected by the Bureau of Land Management (BLM) from 2008 to 2014 in the Hungry Hollow and Twelvemile Creek watersheds. Both creeks are tributaries to the Gulkana Wild and Scenic River system managed by the BLM. The information presented supports achievement of various BLM management goals and objectives for this watershed, with an emphasis on the Gulkana Wild and Scenic River and the Hungry Hollow and Twelvemile Creek corridors. The Hungry Hollow watershed drains approximately 56 square miles, with the creek originating in the Alaska Range at about 4,000 feet and flowing south 16.5 miles to the Middle Fork of the Gulkana River. The Twelvemile Creek watershed drains approximately 43 square miles, with the creek originating on the east end of the Alphabet Hills at about 3,500 feet and flowing east 15.5 miles to the main stem of the Gulkana River. The Gulkana River drains into the Copper River and ultimately the Gulf of Alaska. Hungry Hollow and Twelvemile Creeks are both high-value anadromous streams, and they provide a variety of recreational, fish, wildlife, and other socioeconomic values. Management objectives established for the Gulkana Wild and Scenic River and tributaries within the corridor include maintaining the pristine, free-flowing condition of the river and tributaries, optimal and long-term utilization of fish and wildlife resources, and high-quality primitive recreational opportunities. This report summarizes BLM continuous and instantaneous gage data and other relevant hydrologic and physical information to support achievement of these and other BLM management goals and objectives for the Hungry Hollow and Twelvemile Creek watersheds.

1. Introduction

This open file report summarizes continuous and instantaneous stream gage data collected by the Bureau of Land Management (BLM) from 2008 through 2014. Data collected and analyzed are from Hungry Hollow and Twelvemile Creeks, tributaries to the Gulkana Wild and Scenic River corridor and watershed (Figure 1). Other relevant hydrologic and physical information collected in this watershed between 2008 and 2014 are also reported. This information is summarized to support various BLM management goals and objectives for the watershed.

Both Hungry Hollow and Twelvemile Creeks are clear-running, freshwater tributaries of the Gulkana River and ultimately the Copper River. Most of the Hungry Hollow Creek drainage is within BLM-managed land with a small portion owned by the state. Roughly 50 percent of the Twelvemile Creek drainage is within BLM-managed land and 50 percent is on state land. Both creeks are managed under the East Alaska Resource Management Plan (BLM 2007). Short segments (0.80 miles of Hungry Hollow Creek and 0.50 miles of Twelvemile Creek) are within the Gulkana Wild and Scenic River corridor. Management objectives established for the Gulkana Wild and Scenic River corridor include maintaining the pristine, free-flowing condition of the river and tributaries, optimal and long-term utilization of its fish and wildlife resources, and high-quality primitive recreational opportunities.

Hungry Hollow and Twelvemile Creeks receive a moderate amount of annual recreational and subsistence use. Management objectives established in the resource management plan for these streams and other streams within the boundaries of the plan include:

- All water sources provide water quality and quantity sufficient to meet Alaska State standards and to protect beneficial uses.
- Stream channels display the dimensions, pattern, and profile that are representative of site potential to allow floodplain aquifer recharge, moderate stream flows, and buffer the effects of flooding.

The hydrologic information reported in this publication may be used to support the adjudication and/or amendment of existing applications. This information may also be used to create new water reservation applications for additional stream reaches, as needed.



Figure 1. Locations of the Hungry Hollow Creek and Twelvemile Creek stream gages.

2. Description of the Study Area

2.1 Physiography

The Hungry Hollow and Twelvemile Creek watersheds drain approximately 56 and 43 square miles respectively. Hungry Hollow originates off the southern flanks of the Alaska Range and flows in a southerly direction for about 16.5 miles until it drains into the Middle Fork of the Gulkana River. The headwaters of Twelvemile Creek originate off the eastern tip of the Alphabet Hills and flow in an easterly direction for about 15.5 miles until draining into the main stem of the Gulkana River. The Gulkana River flows south until it drains into the Copper River and ultimately into the Gulf of Alaska. Multiple ponds and small lakes are scattered throughout both drainages. The area through most of both reaches is spruce-dominated forest with thick brush. As the elevation increases, trees begin to thin and disappear and the low brush of the alpine dominates.

The Hungry Hollow and Twelvemile drainages are mostly soils formed in glacial till or loamy colluvial sediment and covered with tundra vegetation. Dwarf birch, other low shrubs, mosses, lichens, short grasses, and forbs are the principal plants on well-drained soils, with sparse forests of white spruce occurring at lower elevations. The vegetation on poorly drained soils that have a shallow permafrost table is mainly sedge tussocks, mosses, low shrubs, and scattered forests of black spruce. In general, soils are not suitable for cultivation or commercial forestry and have severe limitations for roads and structures. Well-drained soils on terraces and low-rolling moraines, however, usually have moderate limitations for construction. Most of the soil provides habitats suitable for caribou, moose, and a wide variety of small mammals and birds (Rieger et al. 1979).

Stream channel width varies at different points on both streams, depending on gradient and beaver activity, but in general the stream width increases as you travel downstream. For example, channel width ranges from about 3–5 feet in places along the upper reaches to as much as 50 feet in the lower reaches where they join the Gulkana River. Both streams have a moderate stream gradient (mostly single thread) with moderately meandering channels. Twelvemile Creek is slightly more incised with more meanders since it begins at a higher elevation and has a steeper gradient than Hungry Hollow Creek. The headwaters originate in small mountain terrain above tree line in the tundra. Immediately adjacent to the river channel, the landscape consists of nearly level to moderately sloping floodplains and stream terraces. Other common floodplain features include point bars, overflow channels, meander cutoffs, and swamps. Meanders cutoffs and ponds are present on many stream terraces.

2.2 Climate

The climate of the northern Copper River Basin where Hungry Hollow and Twelvemile Creeks reside is subarctic continental, characterized by long, cold winters and short, warm summers. The mean January temperature reported between 1975 and 2010 is -0.7°F (-18.2°C) at Paxson at the north end of Paxson Lake (Table 1). Daily low temperatures of -50.0°F (-45.6°C) or less occur frequently during the winter (mid-October to April), and 2-week or longer periods of severe cold weather are common within the stream drainages. The mean July temperature is 53.8°F (12.1°C) at Paxson (Table 1). Daily high temperatures in summer within the area occasionally exceed 80.0°F (26.7°C). Daily minimum temperatures in summer are generally between 37.0° to 42.0°F (2.8° to 5.6°C). However, freezing temperatures have been recorded in every month (WRCC 2025). At Paxson, the mean annual precipitation reported between 1975 and

Table 1. Temperature and precipitation data for Paxson, Alaska, from 1975–2010 (WRCC 2025).

Month	Temperature			Precipitation	Snow
	Maximum Monthly Average (°F)	Minimum Monthly Average (°F)	Mean Monthly Average (°F)	Mean Monthly Total (inches)	Mean Monthly Total (inches)
January	8.3	-10.2	-0.7	1.00	15.3
February	15.6	-5.2	4.9	0.75	10.6
March	24.9	-0.1	12.7	0.78	11.3
April	37.1	13.9	25.5	0.61	5.3
May	51.7	29.1	40.1	1.28	2.8
June	63.7	38.2	51.0	2.45	0.4
July	65.5	42.1	53.8	3.20	0.0
August	60.7	38.7	49.7	3.16	0.0
September	48.7	30.5	39.5	3.30	3.6
October	32.1	15.6	23.9	2.14	16.8
November	14.9	-2.3	6.3	1.03	14.9
December	11.0	-5.9	1.8	1.37	19.9
Yearly Average	**36.2**	**15.4**	**25.7**	**—**	**—**
Yearly Total	**—**	**—**	**—**	**21.08**	**100.9**
Extreme	**86.0**	**-50.0**	**—**	**—**	**—**
Month/Year	**June 2004**	**January 2009**	**—**	**—**	**—**

2010 is 21.1 inches (53.6 cm) and average annual snowfall is 100.9 inches (256.3 cm) (WRCC 2025).

2.3 Permafrost

Since the mean annual air temperature in the region is less than 26.0°F (-3.3°C), permafrost (perennially frozen ground) underlies most of the basin (Ray 1993). With increasing terrace height, age, and distance from the stream channel, permafrost is common within the soil at a relatively shallow depth. Shallow permafrost is extensive on the highest and oldest stream terraces and in the uplands. In most places, permafrost results in small ice crystals disseminated throughout the soil. On glaciolacustrine terraces, a perched water table and saturated conditions are common above the permafrost during the summer due to restricted drainage (Clark and Kautz 1999). Melting permafrost significantly alters streamflow by changing groundwater pathways, often leading to increased summer streamflow in some areas but also cooler summer stream temperatures due to deeper, cooler water inputs, while causing more variable flows, longer recession periods, and increased sedimentation (Sjöberg et al. 2021). The BLM recognizes that permafrost may have an impact on surface water/groundwater relationships, but this study did not identify specific impacts.

3. Methods and Data Sources

To determine the annual hydrology within a drainage basin, stream gaging is often used to generate continuous streamflow information year-round. Stream gaging is the process of measuring and monitoring the height (stage) and volume of water flow (discharge) in a stream, river, or other body of water. The stage data recorded on the gaging equipment is corrected to the elevation surveyed at the site and correlated by regression analysis to instantaneous discharge measurements. The daily, monthly, and annual discharges are then used to characterize the streamflow of the basin (USGS 2019).

3.1 Continuous Gaging Locations

To obtain at least 5 years of continuous mean daily flow records within the Hungry Hollow and Twelvemile Creek drainages, the BLM operated temporary continuous measurement stream gages. The locations of the gages are illustrated in Figure 1 and summarized in Table 2. BLM stream gage measurement and analyses methods followed U.S. Geological Survey (USGS) procedures described in Rantz et al. (1982a, 1982b) and in Melcher and Walker (1990).

Table 2. BLM gage locations and periods of record used for calculating long-term stream gage hydrology in the Hungry Hollow and Twelvemile Creek drainages.

Gage Site Name	Location	Period of Record
Hungry Hollow	62°55'3.18"N, 145°53'9.02"W	June 2008 through March 2014
Twelvemile	62°48'39.21"N 145°41'20.90"W	June 2008 through March 2014

4. Descriptions of the Stream Gage Sites

4.1 BLM Hungry Hollow Gage

The BLM Hungry Hollow stream gage site (Figure 2) was located on Hungry Hollow Creek approximately 1.2 stream miles upstream from the confluence with the Middle Fork of the Gulkana River. Access to the stream gage during ice-free periods was by ATV traveling about 9.5 miles south on the Swede Lake Trail (off the Denali Highway at milepost 16.2). Once onto the Hungry Hollow ATV trail, travel continued 1.25 miles first to the east and then southward again until the stream gage site was reached. During the winter period, the gage site was accessed only once by snowmachine. The only difference was that the Denali Highway was traveled by snowmachine to milepost 16.2. From there, the same trails were followed to the gage site.

The Hungry Hollow gage site was located on a straight section of the creek within a riffle. Gaging started with an initial summer measurement in June 2007, and an automated stream gage was deployed in June 2008. The gage was discontinued in March 2014, with a final winter streamflow measurement. This resulted in approximately 6 years of data. For the period of record, continuous recorded gage data were collected only during the late spring, summer, and early fall during ice-free periods, generally from late May/early June to late September/early October.

River stage data were stored and recorded onsite by a Stevens AxSys Data Logger with a Stevens Submersible Depth Transmitter II (accuracy -1% of full scale, 4.0 ± 0.2 mA at 22˚C). The depth



Figure 2. Hungry Hollow stream gage site.

transmitter and cable were weighed down with small sections of rebar up to the river's edge where the cable was buried 3 inches into the soil until it reached the AxSys data logger approximately 15 feet away from the creek. The data logger was programmed to record maximum depth every 30 minutes and was housed in a small metal box and hidden under the protection of thick moss and a spruce tree.

The stream gage was surveyed to elevation benchmarks located near the gage site and to the current water level using an engineers level and stadia rod. There were two benchmarks established near the gaging area, both utilizing the base of spruce trees with 8-inch spike nails.

Stream discharge (streamflow) measurements were made (3–4 per open water season) using a Price AA current meter or a Price Pygmy meter (depending on water level) to measure water velocity and a top-setting wading rod and tag line for depth and width. All discharge measurements were made by wading. For the winter period (only measured one time in March 2014), an under-ice discharge measurement consisted of drilling a series of holes in the ice to define the cross section and then measuring the depth and velocity in each hole using a USGS vertical-axis, vane type current meter mounted on a graduated rod. The stream gaging methods used at this site were based on those described in Rantz et al. (1982a, 1982b) and in Melcher and Walker (1990). For the period of record (June 2008 through March 2014), 17 instantaneous discharge measurements were conducted at the Hungry Hollow gage site. After each site visit, discharge data recorded in survey books were input into Excel spreadsheets and stored on the BLM computer server.

4.2 BLM Twelvemile Gage

The BLM's Twelvemile stream gage site (Figure 3) was located on Twelvemile Creek approximately 1.75 stream miles upstream from the confluence with the main stem of the Gulkana River. Access to the stream gage during ice-free periods was by ATV traveling about 5.2 miles west on the Middle Fork Trail (off the Richardson Highway at milepost 169.5). The ATVs were parked on the trail, and the remainder of the distance (2.3 miles) to the stream gage site was hiked. This hike included crossing the main stem of the Gulkana River. During the winter period, the gage site was



Figure 3. Twelvemile stream gage site.

accessed only once by snowmachine. Access was also via the Middle Fork Trail which was followed to the main stem of the Gulkana River. The ice-covered Gulkana River was crossed close to Twelvemile Creek, and from there a trail was broken to the gaging site.

The Twelvemile gage site was located on a straight section of the creek within a riffle. Like Hungry Hollow, gaging started with an initial summer measurement in June 2007, and an automated gage was deployed in June 2008. The gage was discontinued in March 2014, with a final winter streamflow measurement. This resulted in approximately 6 years of data. For the period of record, continuous recorded gage data were collected only during the late spring, summer, and early fall during ice-free periods, generally from late May/early June to late September/early October.

River stage data were stored and recorded with the same type of equipment as Hungry Hollow. The depth transmitter and cable were weighed down with small sections of rebar up to the river's edge where the cable was buried 3 inches into the soil until it reached the AxSys data logger approximately 20 feet away from the creek. Again, the data logger was programmed to record maximum depth every 30 minutes and was housed in a small metal box and hidden under the protection of a large spruce log.

The stream gage was surveyed to elevation benchmarks located near the gage site and to the current water level using an engineers level and stadia rod. There were two benchmarks established near the gaging area, both utilizing the base of spruce trees with 8-inch spike nails.

Stream discharge (streamflow) measurements were made (3–4 per open water season) using a Price AA current meter or a Price Pygmy meter (depending on water level) to measure water velocity and a top-setting wading rod and tag line for depth and width. All discharge measurements were made by wading. For the winter period (only measured one time in March 2014), an under-ice discharge measurement consisted of drilling a series of holes in the ice to define the cross section and then measuring the depth and velocity in each hole using a USGS vertical-axis, vane type current meter mounted on a graduated rod. The stream gaging methods used at this site were based on those described in Rantz et al. (1982a, 1982b) and in Melcher and Walker (1990). For the period of record (June 2008 through March 2014), 16 instantaneous discharge measurements were conducted at the Twelvemile gage site. After each site visit, discharge data recorded in survey books were input into Excel spreadsheets and stored on the BLM computer server.

4.3 Gage Site Methods

The techniques and standards for making discharge measurements followed what is described in Turnipseed and Sauer 2010. Site visits were made at the Hungry Hollow and Twelvemile continuous (long-term, year-round) data gage locations 2–5 times a year to download data, measure discharge, perform routine maintenance, and survey water levels for quality control/assurance. The sites were established to measure both continuous 30-minute stage values, along with instantaneous discharge measurements of volumetric flow rate (discharge in cubic feet per second (cfs)) throughout the entire year. These measurements were used to establish rating curves of the stage-discharge relationship to allow computation of continuous discharge values. The values of continuous discharge were then statistically summarized into mean daily values over the full range of seasonal flows throughout the open water period, when the data recorder was operational (Sauer 2002).

A systematic process of streamflow records computation was used following processes described in Rantz et al. (1982a, 1982b), Melcher and Walker (1990), and Parks and Madison (1985). Excel spreadsheets and included functions were used to make all discharge computations. Before being converted to discharge, the stage records were corrected to reference elevation based on level surveys. These corrected stage values were used to develop rating curves and then shifts were applied to the discharge rating curves due to fill and scour of

the hydraulic control. The discharge from the rating curves was then used to compute half hourly discharge values, which are the basis to compute mean daily, mean monthly, and mean annual flow values for the calendar year (January through December). When discharge measurements were not collected at the gage sites or when recorded data were considered unreliable, such as during spring ice breakup, fall freeze-up, or when the recorder malfunctioned, measurements were estimated from a simple linear regression analysis with USGS streamflow data. The USGS Gulkana River at Sourdough gage was used for almost all periods when the data recorder was not in operation (USGS 2023; Parks and Madison 1985).

Daily mean discharge data were estimated using linear regression analyses. The statistical accuracy of the estimates was determined by the R-squared (or R^2) and standard error (SE) values. R^2 is the coefficient of determination. It is a statistical measure in a regression model that determines the proportion of variance in the dependent variable that can be explained by the independent variable. In other words, R^2 shows how well the data fit the regression model. R^2 values range from 0 to 1. The higher the R^2 value, the better a regression model fits the dataset. SE of the regression is the precision that the regression coefficient is measured. A smaller standard error means a more precise estimate, tighter confidence intervals, and higher statistical significance. If the coefficient is large compared to the SE (double or more), then the coefficient is probably significant. The R^2 and SE values for the Hungry Hollow and Twelvemile gage sites, using published data from the USGS Gulkana River at Sourdough stream gage, are listed in Table 3.

Due to the difficulty of accessing these remote sites, only one winter (March 2014) under-ice flow measurement was conducted for each site. For this measurement, streamflow was computed from an instantaneous winter under-ice discharge measurement by regressing discharge between measurements at the site. This method assumes that once ice and snow cover isolate the stream from precipitation and temperature changes, the flow to the stream recedes uniformly as the water table is lowered by reduction of water volume in the aquifer (Rogers and Armbruster 1990). The other years were estimated using a regression analysis with the USGS Gulkana River at Sourdough data. Temperature and precipitation data from the Paxson climate site were used, when available, to help determine when freeze-up and spring breakup occurred. For the winter period, October to April, discharges less than 10 cfs were rounded to the nearest whole integer, due to the limited data available for the estimates.

Table 3. Regression statistics for the Hungry Hollow and Twelvemile gage sites using USGS Gulkana River at Sourdough stream gage data.

	Hungry Hollow Gage		Twelvemile Gage	
Year	R^2	SE	R^2	SE
2008	0.73	0.26	0.83	0.30
2009	0.81	0.23	0.89	0.22
2010	0.72	0.24	0.82	0.33
2011	0.70	0.31	0.88	0.26
2012	0.73	0.37	0.85	0.29
2013	0.74	0.28	0.80	0.30
2014	0.74	0.28	0.80	0.30

5. Results

The instantaneous discharge measurements and time series daily mean discharge values for the Hungry Hollow and Twelvemile gage sites are listed in Appendix A (Tables A1 and A2) and Appendix B (Tables B1–B14). The monthly mean discharge data, calculated from the daily flow values for the BLM gage sites, are listed in Tables 4 and 5. The peak and minimum recorded data, calculated from the daily flow values for the same sites, are listed in Tables 6 and 7. Hydrologically, the gage sites (see Figure 1 and Table 2 for location information) are characterized by low winter flow, large increases in flow during spring ice breakup, occasional summer peaks in response to rainfall, and a gradual decline during autumn, as shown by the concurrent data plots in the hydrographs (Figures 4 and 5).

Table 4. Monthly mean discharge (cfs) for the Hungry Hollow gage site (2008–2014).

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
2008	ND	ND	ND	ND	ND	76	84	67	78	72	62	53
2009	45	39	34	44	314	41	31	56	58	55	49	44
2010	39	35	34	43	102	82	65	49	62	49	42	35
2011	29	24	23	31	209	120	84	90	63	51	45	39
2012	35	31	27	48	176	167	58	52	72	84	56	50
2013	45	40	36	33	101	136	53	77	82	61	56	51
2014	46	43	39	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mean	**40**	**35**	**32**	**38**	**181**	**104**	**63**	**65**	**69**	**62**	**51**	**45**

ND = not determined. The first measurement was performed June 2008, and prior flows for the year were not estimated. Final flows for 2014 were measured in March, and the remainder of 2014 flows were not estimated.

Table 5. Monthly mean discharge (cfs) for the Twelvemile gage site (2008–2014).

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
2008	ND	ND	ND	ND	ND	36	75	72	50	31	24	19
2009	14	11	9	11	83	55	25	46	31	23	19	15
2010	12	10	9	11	73	52	74	42	34	17	14	12
2011	10	8	7	9	87	41	38	54	31	25	20	17
2012	14	11	9	17	105	110	55	33	39	40	26	20
2013	15	12	9	8	45	59	20	41	78	48	35	26
2014	19	14	11	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mean	**14**	**11**	**9**	**11**	**78**	**59**	**48**	**48**	**44**	**31**	**23**	**18**

ND = not determined. The first measurement was conducted June 2008, and prior flows for the year were not estimated. Final flows for 2014 were measured in March, and the remainder of 2014 flows were not estimated.

Table 6. Instantaneous peak and minimum recorded discharge values (cfs) for the Hungry Hollow gage site (2008–2014).

Year	Peak	Date	Minimum	Date
2008	336	July 29	ND	ND
2009	451*	May 5	32*	Mar. 21–27
2010	213	July 24	33*	Feb. 25–Mar. 19
2011	280*	May 23	22*	Mar. 1–19
2012	417	June 13	26*	Mar. 25–31
2013	290	Aug. 22	32*	Apr. 10–15
2014	ND	ND	38*	Mar. 23–30

*Estimated daily value. ND = not determined (partial year).

Table 7. Instantaneous peak and minimum recorded discharge values (cfs) for the Twelvemile gage site (2008–2014).

Year	Peak	Date	Minimum	Date
2008	296	July 29	ND	ND
2009	300	Aug. 19	8*	Mar. 21–Apr. 18
2010	322	July 24	8*	Mar. 12–29
2011	136	Aug. 20	6*	Mar. 19–Apr. 10
2012	328	June 13	8*	Mar. 30–Apr. 13
2013	303	Aug. 21	8*	Mar. 30–May 4
2014	ND	ND	10*	Mar. 22–30

*Estimated daily value. ND = not determined (partial year).

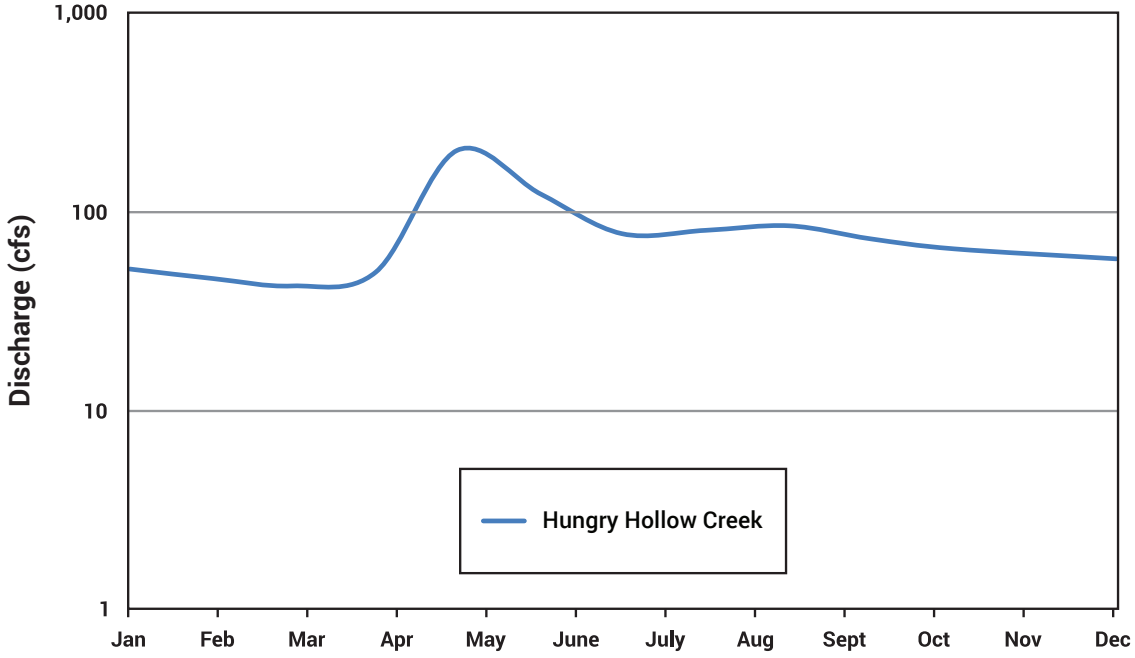


Figure 4. Monthly mean annual discharge hydrograph for the BLM Hungry Hollow gage site.

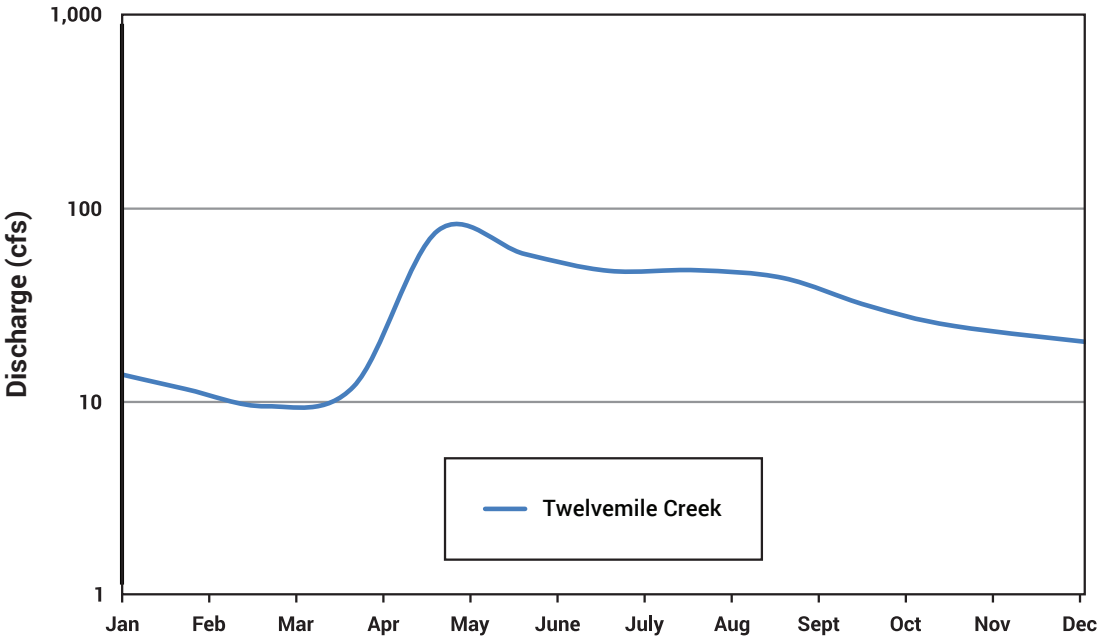


Figure 5. Monthly mean annual discharge hydrograph for the BLM Twelvemile gage site.

Flow-duration data are often used to statistically characterize streamflow. The exceedance probability, also referred to as the flow-duration percentile, is usually expressed as a percentage of a specified time interval (Risley et al. 2008). For example, the 50% flow-duration value would be exceeded about half of the time (and is the same as the median value). The monthly discharge values for the period of record are used to determine at what percentile a certain discharge would be exceeded. The calculated flow-duration values for the stream gage sites are listed in Tables 8 and 9.

Table 8. Flow-duration percentile of monthly discharges (cfs) for the Hungry Hollow gage site (2008–2014).

Flow-Duration Percentile	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0%	46	42	39	44	310	165	84	89	82	83	62	53
5%	46	42	38	44	293	159	84	87	81	81	60	53
10%	46	41	37	44	272	151	84	84	80	78	59	52
15%	45	40	36	43	251	144	84	81	79	75	58	51
20%	45	40	36	43	230	136	84	77	78	72	56	51
25%	45	40	35	43	209	132	79	75	77	69	56	51
30%	45	39	35	42	203	128	74	72	75	67	56	50
35%	45	39	34	42	196	124	70	70	74	64	56	50
40%	45	39	34	41	189	120	65	67	72	61	56	50
45%	43	38	34	41	183	110	63	64	70	59	54	48
50%	42	37	34	40	176	101	61	62	67	58	52	47
55%	40	36	34	39	161	91	59	59	65	56	51	45
60%	39	35	34	37	146	82	58	56	63	55	49	44
65%	38	34	32	36	132	80	57	55	62	54	48	42
70%	37	33	31	35	117	79	56	54	62	53	47	41
75%	36	32	29	33	102	77	55	53	62	52	46	40
80%	35	31	27	33	102	76	53	52	62	51	45	39
85%	33	29	26	32	102	67	48	51	61	50	44	38
90%	32	28	25	32	101	58	42	50	60	50	43	37
95%	30	26	24	31	101	50	36	50	59	50	42	36
100%	29	25	23	31	101	43	32	49	58	49	42	35

Table 9. Flow-duration percentile of monthly discharges (cfs) for the Twelvemile gage site (2008–2014).

Flow-Duration Percentile	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0%	19	14	11	17	104	107	75	71	77	48	35	26
5%	18	14	11	16	101	97	75	68	71	46	33	25
10%	17	13	10	15	98	85	75	63	64	44	31	23
15%	16	13	10	14	94	72	74	59	57	42	28	22
20%	15	12	9	13	91	59	74	54	50	40	26	20
25%	15	12	9	12	87	58	69	52	47	39	26	20
30%	15	12	9	12	86	57	65	50	45	37	26	20
35%	14	11	9	12	85	56	60	48	42	36	26	19
40%	14	11	9	11	85	55	55	46	39	34	26	19
45%	14	11	9	11	84	54	51	45	38	32	25	19
50%	14	11	9	11	83	54	47	44	37	30	23	18
55%	14	11	9	11	81	53	42	43	35	27	22	18
60%	14	11	9	10	79	52	38	42	34	25	20	17
65%	14	11	9	10	77	49	35	42	33	25	20	17
70%	13	11	9	9	75	47	32	42	33	24	20	16
75%	13	10	9	9	73	44	28	41	32	24	19	16
80%	12	10	9	9	67	41	25	41	31	23	19	15
85%	12	10	9	9	62	40	24	39	31	22	18	14
90%	11	9	8	8	56	39	23	37	31	20	17	14
95%	11	9	8	8	51	37	21	35	31	19	15	13
100%	10	8	7	8	46	36	20	33	31	17	14	12

6. Discussion

The hydrographs of monthly mean annual discharge for the Hungry Hollow and Twelvemile gage sites are shown in Figures 4 and 5. The hydrographs are characterized by long cold winters, generally from November to late April. The stream surface forms ice, and the land surface is snow covered, isolating the stream and soil from precipitation. Under-ice stream discharge over the winter period gradually decreases and is driven by groundwater base flow. The winter period is followed by a 2–3-week spring breakup starting approximately the third week of April and ending approximately the second week of May. During this period, rising air temperatures, increased solar exposure, and accelerated snowmelt, along with rain, result in river ice melt and fracture; a very rapid increase in flows creates high water and sometimes flooding conditions. Starting in mid-May to the first week of June, peak flows occur at the gage sites. This is followed by a steady recession of flows due to warmer temperatures and drier climatic conditions, extending to mid-July. From August through the middle of October, the hydrographs are influenced by more frequent rainfall with a moderate increase in flows through August and into September and flows decreasing from mid-October onwards into winter.

7. Recommendations

Future data collection for this and other locations with relevant hydrologic characteristics of this watershed should include anadromous fisheries data and be periodically reported through open file reports or equivalent reporting and be cross-referenced to the electronic online version of this report.

Appendix A. Instantaneous Discharge Measurements

Tables A1 and A2 contain instantaneous discharge measurement data for the Hungry Hollow and Twelvemile stream gage sites. All streamflow data are from June 2007 through March 2014. Refer to Figure 1 and Table 2 in the report for gage site locations.

Table A1. Instantaneous discharge measurements for the Hungry Hollow stream gage site (2007–2014).

Number	Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (sq ft)	Average Velocity (fps)	Average Depth (ft)
1	6/7/07	ND	103	37	35	2.94	0.95
2	6/5/08	2.17	74	32	39	1.88	1.23
3	7/7/08	2.66	105	36	44	2.39	1.24
4	9/25/08	2.97	76	39	29	2.62	0.74
5	5/28/09	3.20	343	60	90	3.81	1.50
6	7/28/09	2.45	41	33	25	1.65	0.76
7	9/30/09	2.46	56	34	30	1.87	0.88
8	6/9/10	2.33	63	31	28	2.22	0.93
9	9/29/10	2.50	50	36	31	1.61	0.86
10	5/28/11	3.02	221	40	58	3.79	1.48
11	10/5/11	2.54	53	30	29	1.81	0.97
12	5/31/12	3.28	227	42	59	3.84	1.40
13	7/17/12	2.59	61	33	36	1.68	1.09
14	9/28/12	2.66	66	33	37	1.79	1.12
15	6/21/13	2.22	94	36	47	2.00	1.31
16	8/8/13	2.10	50	35	38	1.32	1.09
17	9/25/13	2.32	65	36	40	1.63	1.11
18	3/7/14	ND	40	12	16	2.50	1.33

ND = not determined.

Table A2. Instantaneous discharge measurements for the Twelvemile stream gage site (2007–2014).

Number	Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (sq ft)	Average Velocity (fps)	Average Depth (ft)
1	6/6/07	2.77	37	19	15	2.45	0.79
2	7/10/07	2.79	29	40	31	0.94	0.78
3	6/7/08	2.17	26	19	24	1.06	1.26
4	9/5/08	2.45	40	40	26	1.53	0.65
5	6/4/09	2.39	40	45	28	1.44	0.62
6	7/23/09	2.26	23	37	23	0.99	0.62
7	10/2/09	2.34	25	41	26	0.96	0.63
8	6/8/10	2.28	36	40	27	1.32	0.68
9	9/28/10	2.28	22	37	25	0.90	0.67
10	10/4/11	2.35	26	20	15	1.76	0.75
11	6/4/12	2.81	103	46	42	2.46	0.91
12	8/8/12	2.37	29	41	25	1.16	0.61
13	9/27/12	2.38	35	39	27	1.31	0.69
14	6/27/13	1.81	21	20	17	1.23	0.85
15	8/14/13	1.78	14	20	13	1.05	0.65
16	9/30/13	2.18	57	45	36	1.59	0.80
17	3/10/14	ND	11	19	9.1	1.21	0.48

ND = not determined.

Appendix B. Daily Mean Discharge Values

Tables B1–B14 contain daily mean discharge data for the Hungry Hollow and Twelvemile stream gage sites. All continuous streamflow data are from June 2008 through March 2014. Refer to Figure 1 and Table 2 in the report for the gage site locations. All data are listed in cubic feet per second (cfs).

Table B1. Daily mean discharge (cfs) data for Hungry Hollow Creek for 2008.

2008							
Day	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
1	79	101	134	43	78	66	57
2	76	80	107	43	77	66	57
3	74	62	96	44	77	66	57
4	73	52	80	44	76	65	56
5	73	46	80	44	76	65	56
6	68	53	88	44	76	65	56
7	67	96	88	46	75	65	56
8	82	107	83	47	75	64	55
9	109	91	78	54	75	64	55
10	106	73	81	75	74	64	55
11	105	61	80	111	74	63	54
12	91	54	75	111	73	63	54
13	92	51	69	112	73	63	54
14	86	47	64	105	73	62	54
15	86	43	60	97	72	62	53
16	76	41	56	91	72	62	53
17	68	40	56	97	72	61	53
18	61	43	59	100	71	61	53
19	57	43	58	96	71	61	52
20	53	44	56	93	71	60	52
21	50	44	54	98	70	60	52
22	50	46	53	96	70	60	51
23	52	59	51	91	70	60	51
24	93	96	50	83	69	59	51
25	89	85	49	80	69	59	51
26	67	71	48	80	68	59	50
27	57	93	47	79	68	58	50
28	60	141	47	79	68	58	50
29	78	312	46	78	67	58	50
30	93	252	45	78	67	57	49
31		180	44		67		49
Mean	**76**	**84**	**67**	**78**	**72**	**62**	**53**
Maximum	**109**	**312**	**134**	**112**	**78**	**66**	**57**
Minimum	**50**	**40**	**44**	**43**	**67**	**57**	**49**

The Hungry Hollow gage operated from June 5–September 25. Estimates were calculated from data obtained at the USGS Gulkana River at Sourdough gage for June 1–4 and September 26–December 31.

Table B2. Daily mean discharge (cfs) data for Hungry Hollow Creek for 2009.

2009												
Day	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
1	49	41	36	33	190	51	25	43	62	58	51	46
2	48	41	36	33	240	44	24	42	60	58	51	46
3	48	41	36	33	306	48	23	42	57	57	51	46
4	48	41	35	33	395	47	23	42	57	57	51	45
5	48	41	35	33	451	55	23	42	57	57	51	45
6	47	40	35	33	423	52	22	46	56	57	51	45
7	47	40	35	33	418	44	23	47	57	57	50	45
8	47	40	35	33	402	39	23	45	57	56	50	45
9	47	40	35	33	384	33	23	48	55	56	50	45
10	46	40	34	34	372	28	24	45	54	56	50	44
11	46	39	34	34	369	26	24	42	54	56	50	44
12	46	39	34	34	360	26	25	41	55	55	49	44
13	46	39	34	34	352	41	25	40	56	55	49	44
14	45	39	34	34	349	49	26	45	56	55	49	44
15	45	39	33	34	337	43	28	52	55	55	49	44
16	45	38	33	34	330	34	29	63	54	55	49	44
17	45	38	33	35	326	30	30	76	56	54	48	43
18	45	38	33	36	318	46	31	82	57	54	48	43
19	44	38	33	36	315	57	32	83	56	54	48	43
20	44	38	33	37	310	55	34	80	56	54	48	43
21	44	37	32	37	306	44	34	67	58	54	48	43
22	44	37	32	39	296	36	36	61	59	53	48	43
23	43	37	32	40	294	50	36	56	60	53	47	42
24	43	37	32	41	288	57	37	55	60	53	47	42
25	43	37	32	44	294	45	38	57	62	53	47	42
26	43	37	32	47	298	37	40	60	66	53	47	42
27	43	36	32	54	304	34	41	65	66	52	47	42
28	42	36	33	77	306	30	42	66	63	52	47	42
29	42		33	106	193	27	43	69	61	52	46	41
30	42		33	162	131	26	42	67	58	52	46	41
31	42		33		87		42	65		52		41
Mean	**45**	**39**	**34**	**44**	**314**	**41**	**31**	**56**	**58**	**55**	**49**	**44**
Maximum	**49**	**41**	**36**	**162**	**451**	**57**	**43**	**83**	**66**	**58**	**51**	**46**
Minimum	**42**	**36**	**32**	**33**	**87**	**26**	**22**	**40**	**54**	**52**	**46**	**41**

The Hungry Hollow gage operated from May 28–September 30. Estimates were calculated from data obtained at the USGS Gulkana River at Sourdough gage for January 1–May 27 and October 1–December 31.

Table B3. Daily mean discharge (cfs) data for Hungry Hollow Creek for 2010.

2010												
Day	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
1	41	37	33	35	96	69	74	42	93	54	45	38
2	41	36	33	35	113	71	55	40	79	53	45	38
3	41	36	33	35	148	68	51	38	70	53	45	38
4	41	36	33	35	165	66	54	36	64	53	44	37
5	40	36	33	35	196	64	54	37	62	52	44	37
6	40	36	33	35	181	64	48	40	60	52	44	37
7	40	36	33	36	134	63	43	39	59	52	44	37
8	40	36	33	36	121	62	40	38	65	52	43	37
9	40	35	33	36	100	67	36	39	68	51	43	36
10	40	35	33	37	98	68	32	37	64	51	43	36
11	40	35	33	37	95	63	35	36	58	51	43	36
12	39	35	33	37	91	81	37	35	56	50	42	36
13	39	35	33	38	88	153	37	34	55	50	42	36
14	39	35	33	38	84	154	39	34	53	50	42	35
15	39	35	33	39	80	138	52	36	53	50	42	35
16	39	35	33	39	79	117	116	38	53	49	41	35
17	39	34	33	40	76	106	84	40	53	49	41	35
18	38	34	33	40	74	97	59	43	52	49	41	35
19	38	34	33	40	74	90	48	44	51	48	41	34
20	38	34	34	41	84	79	46	43	51	48	41	34
21	38	34	34	41	104	72	61	42	53	48	40	34
22	38	34	34	42	109	64	91	46	51	48	40	34
23	38	34	34	43	102	59	158	47	50	47	40	34
24	38	34	34	45	94	54	166	45	47	47	40	33
25	38	33	34	48	88	50	118	44	45	47	39	33
26	37	33	34	51	86	51	86	44	52	47	39	33
27	37	33	34	57	86	58	71	49	67	46	39	33
28	37	33	34	63	84	83	64	68	157	46	39	33
29	37		34	71	80	107	56	112	54	46	39	33
30	37		35	81	75	116	49	127	54	46	38	32
31	37		35		72		46	112		45		32
Mean	**39**	**35**	**34**	**43**	**102**	**82**	**65**	**49**	**62**	**49**	**42**	**35**
Maximum	**41**	**37**	**35**	**81**	**196**	**154**	**166**	**127**	**157**	**54**	**45**	**38**
Minimum	**37**	**33**	**33**	**35**	**72**	**50**	**32**	**34**	**45**	**45**	**38**	**32**

The Hungry Hollow gage operated from June 9–September 29. Estimates were calculated from data obtained at the USGS Gulkana River at Sourdough gage for January 1–June 8 and September 30–December 31.

Table B4. Daily mean discharge (cfs) data for Hungry Hollow Creek for 2011.

2011												
Day	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
1	32	26	22	21	110	182	83	79	76	54	47	42
2	31	26	22	20	125	171	90	95	75	53	47	42
3	31	26	22	20	145	159	100	89	74	53	47	42
4	31	26	22	20	160	152	102	81	73	53	47	41
5	31	26	22	21	174	143	97	76	71	53	47	41
6	31	26	22	21	188	135	95	73	71	53	46	41
7	30	26	22	21	202	127	97	72	69	53	46	41
8	30	25	22	22	211	121	99	72	66	52	46	41
9	30	25	22	22	220	119	105	72	64	52	46	41
10	30	25	22	23	210	116	91	79	64	52	46	40
11	30	25	22	23	224	113	83	83	63	52	45	40
12	30	25	22	23	211	112	78	79	62	51	45	40
13	29	25	22	23	200	109	75	74	62	51	45	40
14	29	25	22	24	190	106	74	76	62	51	45	40
15	29	24	22	24	181	103	72	93	61	51	45	40
16	29	24	22	25	191	103	70	102	61	51	45	39
17	29	24	22	25	203	107	73	96	60	50	44	39
18	29	24	22	25	218	107	78	93	59	50	44	39
19	28	24	22	26	247	106	96	96	58	50	44	39
20	28	24	23	27	242	103	109	108	58	50	44	39
21	28	24	23	29	238	122	100	124	57	50	44	39
22	28	23	24	30	259	139	90	120	57	49	43	38
23	28	23	25	30	280	131	82	113	58	49	43	38
24	28	23	26	32	273	123	77	111	58	49	43	38
25	27	23	27	35	264	113	75	106	58	49	43	38
26	27	23	27	43	255	105	73	98	58	49	43	38
27	27	23	26	54	238	98	72	93	57	48	43	38
28	27	23	26	65	221	94	71	88	56	48	42	37
29	27		25	74	213	90	69	84	55	48	42	37
30	27		25	84	203	88	69	80	54	48	42	37
31	27		24		192		70	78		48		37
Mean	**29**	**24**	**23**	**31**	**209**	**120**	**84**	**90**	**63**	**51**	**45**	**39**
Maximum	**32**	**26**	**27**	**84**	**280**	**182**	**109**	**124**	**76**	**54**	**47**	**42**
Minimum	**27**	**23**	**22**	**20**	**110**	**88**	**69**	**72**	**54**	**48**	**42**	**37**

The Hungry Hollow gage operated from May 28–October 5. Estimates were calculated from data obtained at the USGS Gulkana River at Sourdough gage for May 27, May 29–31, and June 1–October 4.

Table B5. Daily mean discharge (cfs) data for Hungry Hollow Creek for 2012.

2012												
Day	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
1	37	33	29	28	191	202	66	47	74	62	59	53
2	37	33	29	28	181	166	64	51	79	59	59	53
3	37	32	29	28	163	182	61	57	74	59	59	52
4	37	32	29	28	141	225	58	56	68	59	59	52
5	37	32	29	28	127	263	55	55	65	60	59	52
6	36	32	29	28	120	279	53	53	64	85	58	52
7	36	32	28	28	118	276	53	50	64	165	58	52
8	36	32	28	28	123	268	59	49	62	181	58	51
9	36	32	28	29	137	307	58	47	64	172	58	51
10	36	32	28	29	157	214	61	46	62	159	57	51
11	36	31	28	29	154	235	68	46	59	143	57	51
12	36	31	28	29	144	311	68	45	59	117	57	51
13	35	31	28	29	140	372	64	45	61	102	57	50
14	35	31	28	30	139	273	64	44	60	89	57	50
15	35	31	28	31	132	179	62	43	58	84	56	50
16	35	31	27	33	127	150	61	43	62	80	56	50
17	35	31	27	35	142	115	60	43	68	68	56	50
18	35	31	27	37	149	97	57	43	69	63	56	50
19	35	30	27	39	152	89	54	43	66	63	55	49
20	34	30	27	40	153	82	52	45	76	62	55	49
21	34	30	27	45	161	83	54	48	111	62	55	49
22	34	30	27	49	175	82	58	46	121	62	55	49
23	34	30	27	54	192	76	57	46	105	62	55	49
24	34	30	27	58	220	71	60	46	89	61	54	48
25	34	30	26	68	243	65	58	46	81	61	54	48
26	34	30	26	80	260	70	55	54	74	61	54	48
27	33	29	26	94	300	74	53	78	71	61	54	48
28	33	29	26	106	299	72	50	89	69	60	54	48
29	33	29	26	115	260	67	49	79	66	60	53	47
30	33		26	154	227	67	49	70	65	60	53	47
31	33		26		230		48	66		60		47
Mean	**35**	**31**	**27**	**48**	**176**	**167**	**58**	**52**	**72**	**84**	**56**	**50**
Maximum	**37**	**33**	**29**	**154**	**300**	**372**	**68**	**89**	**121**	**181**	**59**	**53**
Minimum	**33**	**29**	**26**	**28**	**118**	**65**	**48**	**43**	**58**	**59**	**53**	**47**

The Hungry Hollow gage operated from May 31–September 28. Estimates were calculated from data obtained at the USGS Gulkana River at Sourdough gage for January 1–May 30 and September 29–December 31.

Table B6. Daily mean discharge (cfs) data for Hungry Hollow Creek for 2013.

2013												
Day	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
1	47	42	38	33	33	262	64	50	70	64	58	53
2	47	42	37	33	33	260	59	49	79	64	58	53
3	47	42	37	33	33	257	57	48	106	63	58	53
4	47	41	37	33	33	237	57	49	108	63	58	53
5	46	41	37	33	35	213	54	50	96	63	58	53
6	46	41	37	33	35	194	55	49	87	63	57	52
7	46	41	37	33	35	182	55	48	81	63	57	52
8	46	41	37	33	36	174	56	47	85	63	57	52
9	46	41	36	33	36	170	59	47	95	62	57	52
10	46	40	36	32	37	163	59	50	95	62	57	52
11	45	40	36	32	38	153	56	49	96	62	57	52
12	45	40	36	32	42	144	54	47	113	62	56	52
13	45	40	36	32	45	134	52	44	108	62	56	51
14	45	40	36	32	48	125	52	43	96	61	56	51
15	45	40	36	32	54	118	52	44	86	61	56	51
16	45	40	36	33	64	112	51	43	78	61	56	51
17	44	39	35	33	74	107	52	44	74	61	56	51
18	44	39	35	33	83	103	51	51	85	61	55	51
19	44	39	35	33	87	101	54	50	89	61	55	50
20	44	39	35	33	99	96	55	61	79	60	55	50
21	44	39	35	33	106	92	54	181	74	60	55	50
22	44	39	35	33	117	90	51	283	69	60	55	50
23	43	39	35	33	131	81	50	237	60	60	55	50
24	43	38	34	33	146	78	49	187	65	60	54	50
25	43	38	34	33	168	73	50	128	65	59	54	50
26	43	38	34	33	199	72	51	95	65	59	54	49
27	43	38	34	33	237	72	49	77	65	59	54	49
28	43	38	34	33	255	72	49	68	64	59	54	49
29	42	0	34	33	265	71	49	62	64	59	54	49
30	42		34	33	268	69	50	58	64	59	53	49
31	42		34		265		49	62		58		49
Mean	**45**	**40**	**36**	**33**	**101**	**136**	**53**	**77**	**82**	**61**	**56**	**51**
Maximum	**47**	**42**	**38**	**33**	**268**	**262**	**64**	**283**	**113**	**64**	**58**	**53**
Minimum	**42**	**38**	**34**	**32**	**33**	**69**	**49**	**43**	**60**	**58**	**53**	**49**

The Hungry Hollow gage operated from June 21–September 25. Estimates were calculated from measurements at the Hungry Hollow gage for September 26–December 31. Estimates were calculated from data obtained from the Gulkana River at Sourdough gage for January 1–June 20.

Table B7. Daily mean discharge (cfs) data for Hungry Hollow Creek for 2014.

2014			
Day	**Jan.**	**Feb.**	**Mar.**
1	49	44	41
2	48	44	41
3	48	44	40
4	48	44	40
5	48	44	40
6	48	44	40
7	48	43	40
8	48	43	40
9	47	43	40
10	47	43	40
11	47	43	39
12	47	43	39
13	47	43	39
14	47	43	39
15	47	42	39
16	46	42	39
17	46	42	39
18	46	42	39
19	46	42	39
20	46	42	39
21	46	42	39
22	46	42	38
23	45	41	38
24	45	41	38
25	45	41	38
26	45	41	38
27	45	41	38
28	45	41	38
29	45		38
30	45		38
31	44		39
Mean	**46**	**43**	**39**
Maximum	**49**	**44**	**41**
Minimum	**44**	**41**	**38**

The Hungry Hollow gage operated from January 1–March 7. Estimates were calculated from data obtained from the USGS Gulkana River at Sourdough gage for March 8–31.

Table B8. Daily mean discharge (cfs) data for Twelvemile Creek for 2008.

2008							
Day	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
1	34	39	109	39	40	27	21
2	32	43	95	38	35	27	21
3	31	35	94	38	34	27	21
4	31	30	91	42	34	26	21
5	31	28	92	40	34	26	21
6	29	42	107	38	33	26	20
7	27	197	102	41	33	26	20
8	32	120	103	42	33	26	20
9	31	88	93	55	33	25	20
10	35	69	99	72	32	25	20
11	45	56	100	80	32	25	20
12	42	52	90	63	32	25	19
13	41	49	78	56	32	25	19
14	41	45	81	56	31	24	19
15	38	43	82	54	31	24	19
16	34	40	69	50	31	24	19
17	30	41	63	56	31	24	19
18	28	56	59	59	30	24	18
19	26	56	55	52	30	23	18
20	24	68	51	50	30	23	18
21	24	65	50	64	30	23	18
22	25	65	53	62	29	23	18
23	31	69	50	56	29	23	18
24	67	81	49	51	29	22	18
25	77	68	52	45	29	22	17
26	47	59	50	43	28	22	17
27	39	78	48	41	28	22	17
28	37	114	47	39	28	22	17
29	39	255	45	40	28	22	17
30	37	151	43	35	28	21	17
31		123	41		27		17
Mean	**36**	**75**	**72**	**50**	**31**	**24**	**19**
Maximum	**77**	**255**	**109**	**80**	**40**	**27**	**21**
Minimum	**24**	**28**	**41**	**35**	**27**	**21**	**17**

The Twelvemile gage operated from June 7–October 2. Estimates were calculated from data obtained from the USGS Gulkana River at Sourdough gage for June 1–6 and October 3–December 31.

Table B9. Daily mean discharge (cfs) data for Twelvemile Creek for 2009.

2009												
Day	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
1	16	13	10	8	60	50	41	17	46	26	20	17
2	16	12	10	8	111	45	39	17	42	25	20	17
3	16	12	10	8	154	41	36	16	39	25	20	17
4	16	12	10	8	183	38	33	16	36	25	20	16
5	16	12	10	8	169	35	31	15	34	25	20	16
6	16	12	10	8	142	36	29	17	33	24	20	16
7	15	12	9	8	117	33	28	19	31	24	20	16
8	15	12	9	8	105	30	26	18	31	24	20	16
9	15	12	9	8	100	25	26	19	30	24	19	16
10	15	12	9	8	96	24	25	22	29	24	19	16
11	15	12	9	8	88	22	24	19	29	24	19	16
12	15	11	9	8	85	34	23	18	29	23	19	16
13	15	11	9	8	82	89	22	18	30	23	19	15
14	15	11	9	8	78	114	22	23	28	23	19	15
15	14	11	9	8	76	89	21	33	27	23	19	15
16	14	11	9	8	71	59	21	61	27	23	19	15
17	14	11	9	8	66	56	21	124	27	23	18	15
18	14	11	9	8	63	65	29	137	27	23	18	15
19	14	11	9	9	62	67	26	197	27	22	18	15
20	14	11	9	9	61	84	24	89	26	22	18	15
21	14	11	8	9	58	79	24	58	27	22	18	15
22	14	11	8	9	56	60	23	47	27	22	18	15
23	14	10	8	10	52	78	22	41	27	22	18	14
24	13	10	8	10	50	76	20	39	26	22	18	14
25	13	10	8	11	49	59	20	37	28	21	17	14
26	13	10	8	12	49	51	19	40	34	21	17	14
27	13	10	8	14	49	62	19	54	33	21	17	14
28	13	10	8	19	62	57	18	55	30	21	17	14
29	13		8	29	60	49	18	60	28	21	17	14
30	13		8	42	56	44	17	56	27	21	17	14
31	13		8		50		17	51		21		14
Mean	**14**	**11**	**9**	**11**	**83**	**55**	**25**	**46**	**31**	**23**	**19**	**15**
Maximum	**16**	**13**	**10**	**42**	**183**	**114**	**41**	**197**	**46**	**26**	**20**	**17**
Minimum	**13**	**10**	**8**	**8**	**49**	**22**	**17**	**15**	**26**	**21**	**17**	**14**

The Twelvemile gage operated from June 4–October 2. Estimates were calculated from data obtained from the USGS Gulkana River at Sourdough gage for January 1–June 3 and October 3–December 31.

Table B10. Daily mean discharge (cfs) data for Twelvemile Creek for 2010.

2010												
Day	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
1	14	11	9	9	54	47	54	54	56	18	15	13
2	13	11	9	9	65	49	39	50	54	18	15	13
3	13	11	9	9	88	47	43	45	48	18	15	12
4	13	11	9	9	129	45	76	42	42	18	15	12
5	13	11	9	9	157	44	73	43	41	18	15	12
6	13	11	9	9	143	43	51	44	39	18	15	12
7	13	11	9	9	101	42	40	42	38	18	15	12
8	13	11	9	9	90	42	34	41	44	18	15	12
9	13	10	9	9	72	47	30	42	49	18	14	12
10	13	10	9	9	71	46	27	41	40	17	14	12
11	13	10	9	9	68	38	27	38	37	17	14	12
12	13	10	8	9	65	42	29	45	34	17	14	12
13	13	10	8	9	63	89	29	42	33	17	14	12
14	12	10	8	9	59	74	31	39	32	17	14	12
15	12	10	8	10	56	51	39	37	32	17	14	12
16	12	10	8	10	55	56	101	34	32	17	14	11
17	12	10	8	10	53	52	64	33	31	17	14	11
18	12	10	8	10	51	47	46	35	31	17	14	11
19	12	10	8	10	51	45	42	32	30	16	14	11
20	12	10	8	10	59	40	61	30	29	16	14	11
21	12	10	8	10	76	37	107	29	29	16	13	11
22	12	10	8	11	80	37	150	29	29	16	13	11
23	12	10	8	11	74	53	208	34	28	16	13	11
24	12	9	8	11	67	55	269	32	27	16	13	11
25	12	9	8	12	62	50	147	30	27	16	13	11
26	11	9	8	13	61	66	93	29	27	16	13	11
27	11	9	8	15	61	54	77	29	24	16	13	11
28	11	9	8	17	59	50	92	46	19	16	13	11
29	11		8	19	56	73	81	85	19	15	13	11
30	11		9	23	52	90	66	89	19	15	13	11
31	11		9		49		57	70		15		10
Mean	**12**	**10**	**9**	**11**	**73**	**52**	**74**	**42**	**34**	**17**	**14**	**12**
Maximum	**14**	**11**	**9**	**23**	**157**	**90**	**269**	**89**	**56**	**18**	**15**	**13**
Minimum	**11**	**9**	**8**	**9**	**49**	**37**	**27**	**29**	**19**	**15**	**13**	**10**

The Twelvemile gage operated from June 8–September 28. Estimates were calculated from data obtained from the Gulkana River at Sourdough gage for January 1–June 7 and September 29–December 31.

Table B11. Daily mean discharge (cfs) data for Twelvemile Creek for 2011.

2011												
Day	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
1	10	9	7	6	34	69	29	101	35	26	23	18
2	10	9	7	6	39	63	32	63	35	26	22	18
3	10	8	7	6	46	58	37	48	38	26	22	18
4	10	8	7	6	56	55	38	43	37	27	22	18
5	10	8	7	6	63	51	35	38	36	27	22	18
6	10	8	7	6	70	47	34	50	35	27	22	18
7	10	8	7	6	77	44	35	44	33	27	22	18
8	10	8	7	6	87	41	36	36	31	27	22	18
9	10	8	7	6	92	40	39	47	31	26	21	17
10	10	8	7	7	97	39	36	62	32	26	21	17
11	10	8	7	7	92	38	32	45	32	26	21	17
12	10	8	7	7	99	37	30	36	31	26	21	17
13	10	8	7	7	92	36	30	32	31	26	21	17
14	10	8	7	7	86	35	29	59	32	26	21	17
15	10	8	7	7	80	34	27	80	33	25	21	17
16	9	8	7	7	76	34	34	57	31	25	20	17
17	9	8	7	8	81	35	43	48	30	25	20	16
18	9	8	6	8	88	35	44	54	29	25	20	16
19	9	8	6	8	96	35	91	61	29	25	20	16
20	9	8	6	8	112	34	67	109	29	25	20	16
21	9	8	6	9	109	42	51	96	29	24	20	16
22	9	8	6	9	107	49	40	65	31	24	20	16
23	9	8	6	10	112	45	33	67	33	24	19	16
24	9	7	6	10	118	42	33	57	31	24	19	16
25	9	7	6	11	114	38	34	48	29	24	19	16
26	9	7	6	15	109	34	33	44	28	24	19	15
27	9	7	6	20	105	32	37	42	27	23	19	15
28	9	7	6	25	96	30	34	39	27	23	19	15
29	9		6	29	88	28	33	37	27	23	19	15
30	9		6	0	83	28	33	36	27	23	19	15
31	9		0		0		43	35		23		15
Mean	**10**	**8**	**7**	**9**	**87**	**41**	**38**	**54**	**31**	**25**	**20**	**17**
Maximum	**10**	**9**	**7**	**29**	**118**	**69**	**91**	**109**	**38**	**27**	**23**	**18**
Minimum	**9**	**7**	**6**	**6**	**34**	**28**	**27**	**32**	**27**	**23**	**19**	**15**

The Twelvemile gage operated from July 12–October 4. Estimates were calculated from data obtained from the Gulkana River at Sourdough gage for January 1–July 11 and October 5–December 31.

Table B12. Daily mean discharge (cfs) data for Twelvemile Creek for 2012.

2012												
Day	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
1	15	12	10	8	115	119	82	28	44	31	29	22
2	15	12	10	8	110	108	76	32	74	30	29	22
3	15	12	10	8	100	99	92	45	57	30	28	22
4	15	12	10	8	88	96	87	46	44	30	28	22
5	15	12	10	8	80	105	67	39	38	30	28	22
6	15	12	10	8	77	147	57	35	36	41	28	22
7	15	12	10	8	76	138	69	32	35	74	27	21
8	14	12	10	8	78	108	72	29	33	80	27	21
9	14	12	10	8	86	119	59	28	31	77	27	21
10	14	12	10	8	97	97	65	27	30	72	27	21
11	14	12	10	8	96	123	128	27	30	65	27	21
12	14	11	10	8	90	207	81	26	30	55	26	21
13	14	11	9	8	88	296	64	26	33	49	26	20
14	14	11	9	9	87	188	56	25	36	43	26	20
15	14	11	9	9	83	127	51	24	35	42	26	20
16	14	11	9	9	81	103	48	23	35	40	25	20
17	14	11	9	10	83	87	47	24	39	35	25	20
18	14	11	9	11	89	75	44	24	36	32	25	20
19	13	11	9	12	92	66	40	25	34	32	25	19
20	13	11	9	13	95	78	38	25	41	32	25	19
21	13	11	9	14	95	92	38	31	63	31	24	19
22	13	11	9	17	99	86	40	29	52	31	24	19
23	13	11	9	19	107	71	39	27	46	31	24	19
24	13	11	9	22	116	58	39	31	40	31	24	19
25	13	11	9	27	131	51	37	36	38	30	24	18
26	13	10	9	32	143	84	34	35	36	30	23	18
27	13	10	9	37	151	106	32	51	35	30	23	18
28	13	10	9	44	171	119	31	71	34	30	23	18
29	13	10	9	56	171	89	30	49	33	29	23	18
30	12		8	78	151	74	29	38	33	29	23	18
31	12		8		134		28	34		29		18
Mean	**14**	**11**	**9**	**17**	**105**	**110**	**55**	**33**	**39**	**40**	**26**	**20**
Maximum	**15**	**12**	**10**	**78**	**171**	**296**	**128**	**71**	**74**	**80**	**29**	**22**
Minimum	**12**	**10**	**8**	**8**	**76**	**51**	**28**	**23**	**30**	**29**	**23**	**18**

The Twelvemile gage operated from June 4–September 27. Estimates were calculated from data obtained from the Gulkana River at Sourdough gage for January 1–June 3 and September 28–December 31.

Table B13. Daily mean discharge (cfs) data for Twelvemile Creek for 2013.

2013												
Day	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
1	17	13	11	8	8	151	20	16	91	56	41	30
2	17	13	11	8	8	149	19	14	80	55	40	30
3	17	13	11	8	8	146	18	13	75	55	40	29
4	17	13	10	8	8	128	18	13	62	54	39	29
5	17	13	10	8	9	109	18	13	53	53	39	29
6	17	13	10	8	9	94	18	13	48	53	39	29
7	17	13	10	8	9	85	18	12	61	52	38	28
8	16	13	10	8	9	79	21	12	81	52	38	28
9	16	13	10	8	9	76	26	11	121	51	38	28
10	16	13	10	8	10	72	26	12	87	51	37	27
11	16	12	10	8	10	65	39	14	89	50	37	27
12	16	12	10	8	12	59	32	20	148	50	36	27
13	16	12	10	8	12	53	25	17	100	49	36	27
14	16	12	10	8	13	47	22	14	77	49	36	26
15	16	12	10	8	16	43	20	13	65	48	35	26
16	15	12	9	8	20	40	19	13	56	48	35	26
17	15	12	9	8	23	37	19	13	56	47	35	26
18	15	12	9	8	24	35	19	28	89	47	34	25
19	15	12	9	8	28	34	21	38	131	46	34	25
20	15	12	9	8	36	31	20	44	107	46	34	25
21	15	11	9	8	39	29	19	197	82	45	33	24
22	15	11	9	8	42	27	18	174	70	45	33	24
23	15	11	9	8	51	26	17	120	60	45	33	24
24	14	11	9	8	60	24	16	125	53	44	32	24
25	14	11	9	8	75	22	16	71	52	44	32	24
26	14	11	9	8	98	21	16	50	65	43	32	23
27	14	11	9	8	128	20	16	41	80	43	31	23
28	14	11	9	8	144	19	15	36	71	42	31	23
29	14		9	8	153	20	15	36	62	42	31	23
30	14		8	8	156	22	15	34	56	42	30	22
31	14		8		153		17	48		41		22
Mean	**15**	**12**	**9**	**8**	**45**	**59**	**20**	**41**	**78**	**48**	**35**	**26**
Maximum	**17**	**13**	**11**	**8**	**156**	**151**	**39**	**197**	**148**	**56**	**41**	**30**
Minimum	**14**	**11**	**8**	**8**	**8**	**19**	**15**	**11**	**48**	**41**	**30**	**22**

The Twelvemile gage operated from June 27–September 30. Estimates were calculated from measurements at the Twelvemile gage for October 1–December 31. Estimates were calculated from data obtained from the USGS Gulkana River at Sourdough gage for January 1–June 26.

Table B14. Daily mean discharge (cfs) data for Twelvemile Creek for 2014.

2014			
Day	**Jan.**	**Feb.**	**Mar.**
1	22	16	12
2	22	16	12
3	21	16	12
4	21	16	12
5	21	15	12
6	21	15	11
7	21	15	11
8	20	15	11
9	20	15	11
10	20	15	11
11	20	14	11
12	20	14	11
13	19	14	11
14	19	14	11
15	19	14	11
16	19	14	11
17	19	14	11
18	18	13	11
19	18	13	11
20	18	13	11
21	18	13	11
22	18	13	10
23	18	13	10
24	17	13	10
25	17	13	10
26	17	12	10
27	17	12	10
28	17	12	10
29	16		10
30	16		10
31	16		11
Mean	**19**	**14**	**11**
Maximum	**22**	**16**	**12**
Minimum	**16**	**12**	**10**

Estimates were calculated from measurements at the Twelvemile gage for January 1–March 10. Estimates were calculated from data obtained from the USGS Gulkana River at Sourdough Gage for March 11–31.

References

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