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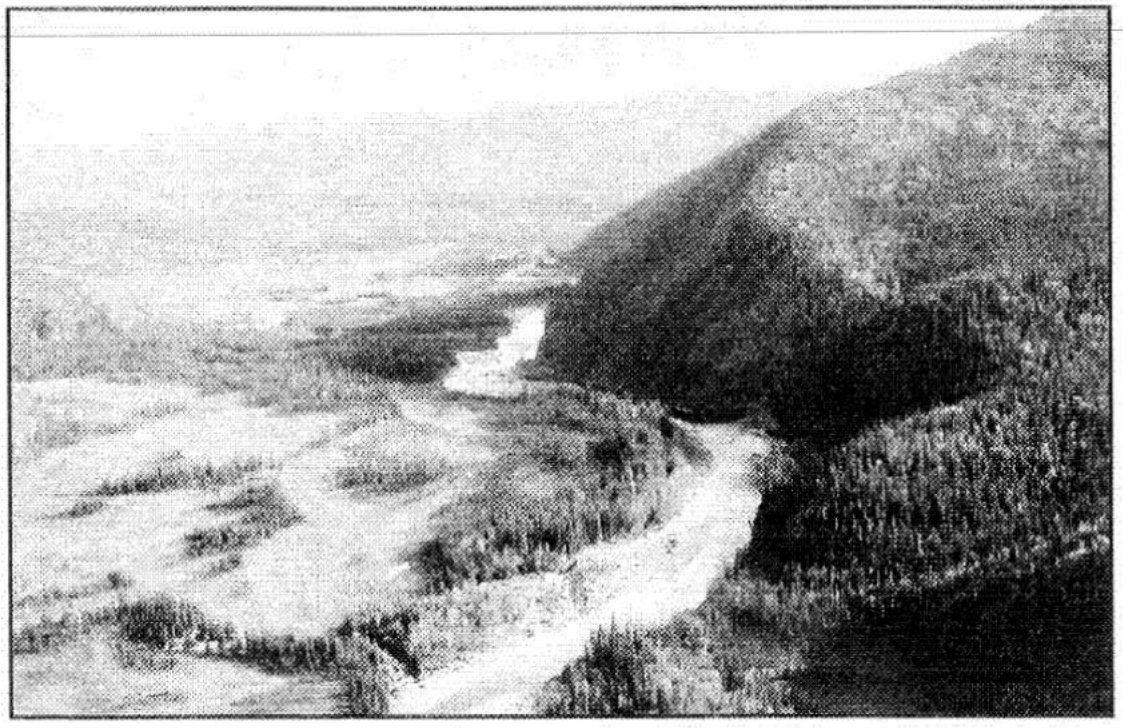
Water Resources of the Fortymile National Wild & Scenic River, Alaska:

Stream Gaging Data, 1989 – 1995

Jon Kostohrys, Bunny B.G. Sterin and Tim Hammond



Cover Photo

North Fork of the Fortymile River above Champion Creek

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The Bureau of Land Management sustains the health, diversity and productivity of the public lands for the use and enjoyment of present and future generations.

Water Resources of the Fortymile National Wild and Scenic River, Alaska:

A Component of the

National Wild and Scenic Rivers System

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Water Resources of the Fortymile National Wild and Scenic River, Alaska: A Component of the National Wild and Scenic Rivers System. Stream Gaging Data, 1989–1995

Abstract

Beginning in August 1989, the Bureau of Land Management's Northern Field Office staff established streamflow monitoring sites on the Fortymile River and its principal tributaries.

While the early work focused on road-accessible sites, the more remote sites on the North, Middle and Dennison Forks were surveyed beginning in 1991 in cooperation with staff from the state of Alaska, Division of Mining and Water. A total of 26 sites were surveyed and six had sufficient data to determine the annual discharge hydrograph, including mean monthly, peak and minimum streamflow.

The information will be used to apply for state of Alaska instream flow water rights as well as to aid resource management practices involving fisheries, mining and reclamation. BLM staff also completed a geographical information system analysis to determine stream basin characteristics.

Acknowledgments

Many people have been involved with the stream-gaging program. Work in the early years was greatly assisted by BLM staffers Michael Kunz, Kathleen O'Reilly-Doyle and Lon Kelly. In more recent years, thanks go to BLM staffers Nathan Collin and Eric Yeager, as well as Bob Burritt and the staff of the Tok Field Station, who continue to provide logistical support and observer readings. Special thanks go to Larry and June Taylor, year-round residents of the Fortymile. We greatly appreciate the professional consultation and data collection we received from the staff of the Alaska Division of Mining and Water, including Bill Long (now retired), Roy Ireland and Jim Vohden. The U.S. Geological Survey staff of Bob Burrows, Richard Kemnitz, Matt Schellekens, Melanie Jackson and Tim Brabets also aided in the data collection and loaned the wire-weight gages used in the project.

INTRODUCTION

The Alaska National Interest Lands and Conservation Act of December 2, 1980 (ANILCA, P.L. 96- 487), established the Fortymile River, and certain tributaries, as a component of the National Wild and Scenic Rivers System.

The Wild and Scenic Rivers Act (WSRA, P.L. 90-542) allows that: "Designation of any stream or portion thereof as a national wild, scenic, or recreational river area shall not be construed as a reservation of the waters of such streams for purposes other than those specified in this Act, or in quantities greater than necessary to accomplish these purposes." However, the Wild and Scenic Rivers Act status does not necessarily protect river flows, and the language contained in the Wild and Scenic Rivers Act does not guarantee a specific flow regime.

It is the current policy of the Bureau of Land Management (BLM Manual Section 7250) to assert federal-reserved water rights for designated wild, scenic or recreational rivers under BLM management responsibility. Manual Section 7250 states that wild and scenic river designation does not automatically reserve the entire unappropriated flow of the river and that flow determinations, related to the minimum amount of water necessary to fulfill the primary purpose of the reservation, must be made on a case-by-case basis.

While the Fortymile River Management Plan does not have an action item on water rights, the introduction notes that "The BLM intends that these management policies be flexible in order to remain responsive to future management needs, while at the same time serving as a standard to assure the protection of the rivers' resources from possible future changes in resource quality and use. The WSRA created a Federal reserved water right for such instream flows as necessary to prevent impairment of the purposes for which the river was designated. The BLM intends to work with the Alaska Department of Natural Resources (DNR) toward the complex goal of qualification of the reservation." (BLM 1983)

In August and September 1989, BLM instituted streamflow survey sites on the Fortymile River at the bridges that cross the five principal forks. In 1991 BLM staff, along with personnel from DNR, floated down the Middle and North Forks to the Fortymile River Bridge. A number of additional sites were surveyed at this time. Meetings with DNR personel over the next several years resulted in more survey sites being added. To achieve the best estimates possible for annual streamflow and to satisfy the requirements of the water rights application, BLM continues to collect streamflow data at numerous sites throughout the Fortymile River basin.

This report covers the 392 miles of the Fortymile River (Figure 1) included in the National Wild and Scenic Rivers System. It includes streamflow data collected from 1989 to 1995 by the BLM, the U.S. Geological Survey (USGS) and the Water Survey of Canada (WSC). The BLM will continue to inventory water resources on the Fortymile River not only to comply with DNR's request, but also to provide managers and resource users with information necessary for informed management and utilization of this watershed.

STUDY AREA

The Fortymile River is located in the east-central interior of Alaska adjacent to the United States - Canada border. This area, often referred to as the Yukon-Tanana region, is bounded on the north by the Yukon River and the south by the Tanana River. The Fortymile River is the largest of the northerly flowing tributaries to the Yukon River in this area and drains about one-sixth of the Yukon-Tanana region. It is an international river with the lower 20 miles flowing easterly through the Yukon Territory, Canada, to its confluence with the Yukon River approximately midway between Dawson, Yukon Territory, and Eagle, Alaska.

The Yukon-Tanana region is dominated by a central upland area that extends from the international border northeasterly to the confluence of the Yukon and Tanana rivers. This upland, created by regional uplift, has been modified by extensive local warping of the bedrock and differential erosion of the older land surface (Mertie 1937). The Fortymile River, including the North and South Forks for over 20 miles above their confluence, are unlike most other tributaries of the Yukon in that the lower rivers are incised in deep valleys with steep-walled

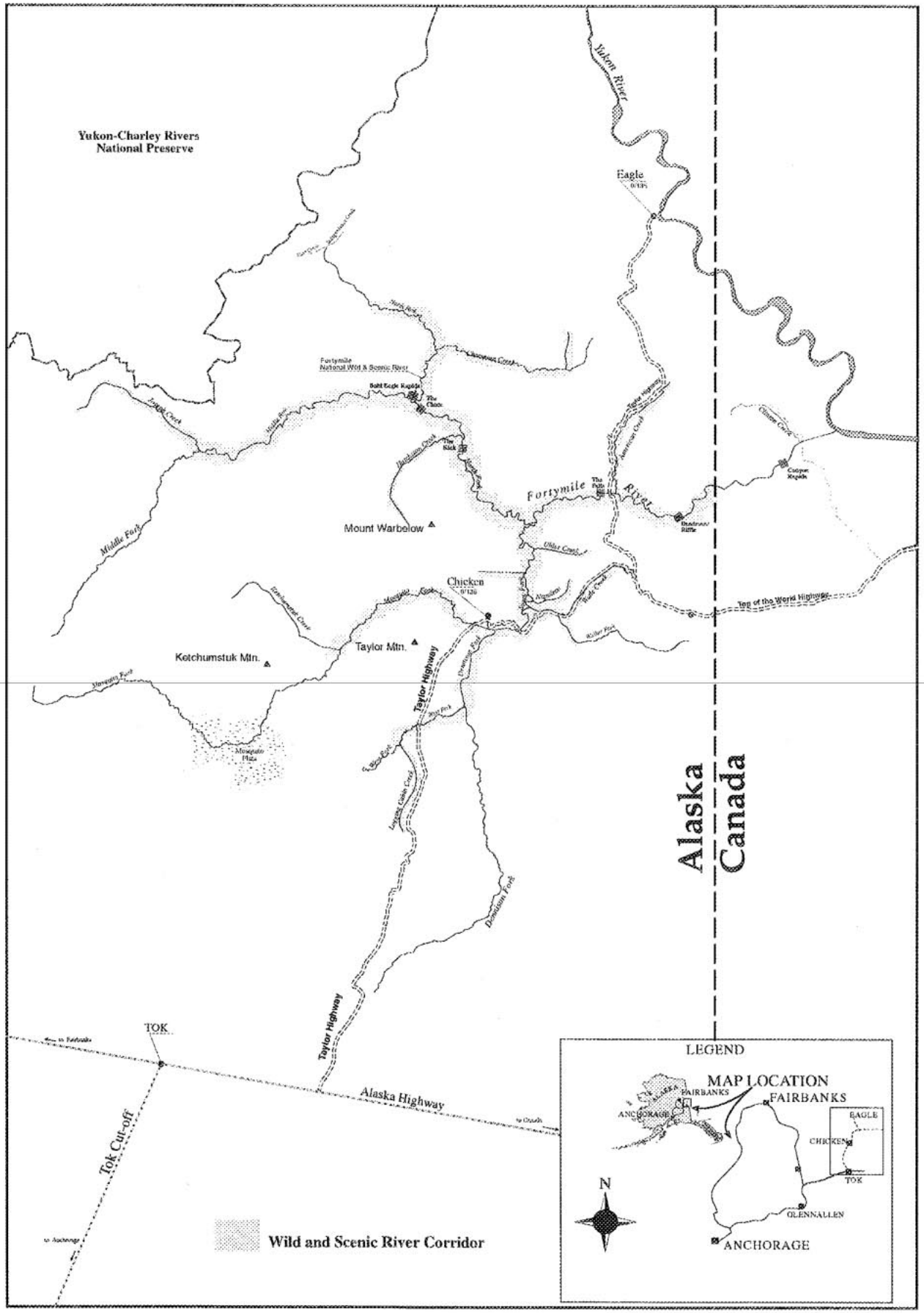

Figure 1. Location Map of Fortymile River Study Area.

canyons cut into bedrock, while the upper portions of the drainage, especially the Dennison, Mosquito and Middle forks, flow sluggishly on relatively flat headwater valleys dotted with lakes, sloughs and marshlands. The relatively flat upland valleys form extensive floodplains, often up to several miles wide, that are underlain by discontinuous permafrost. The lower river valleys are, by comparison, very narrow and consist largely of entrenched meanders, inherited from an ancient river valley, that have been down-cut through a process of stream rejuvenation. The ancient floodplain is now an isolated terrace that forms the tops of the canyon walls, several hundred feet high (Mertie 1937). Springs occur sporadically within the basin and contribute significantly to the limited winter streamflow.

The region has a subpolar continental climate with severe subarctic winters and warm summers. Extended periods of temperatures from plus 50°F to minus 60°F are common and minus 75°F has been recorded. Summers are short and warm with temperatures reaching the 80s, and occasionally the 90s. Freeze-up usually occurs in early October. In most years, the rivers become ice-free between late April to mid-May.

The Fortymile River basin is accessible by road, air and water. The Alaska Highway skirts the entire southern part of the region. Travelers coming from the Lower 48, Canada, and Alaska connect to the Taylor Highway from the Alaska Highway. Other travelers coming through Dawson City, Yukon Territory, connect to the Taylor Highway via the Top of the World Highway. Small airplanes land on gravel air strips and gravel bars along the rivers throughout the area.

Mining activity has occured within the basin from the latter part of the 19th century (the first gold strike in Alaska is attributed to the lower Fortymile) to current times. While much of the river basin remains pristine, there is evidence of varying levels of placer mining activity in the upper Walker Fork, lower Mosquito Fork at Chicken, Hutchinson, Franklin, Wade, Uhler and Napolean creeks. The Fortymile Placer Mining EIS (BLM 1985) discusses mining activities in greater detail.

Given the diverse nature of the various forks of the Fortymile River, the principal sub-drainages are described in detail in the following section. The narratives and river mile references come largely from the *River Management Plan for the Fortymile River, a Component of the National Wild and Scenic Rivers System* (USDI 1983).

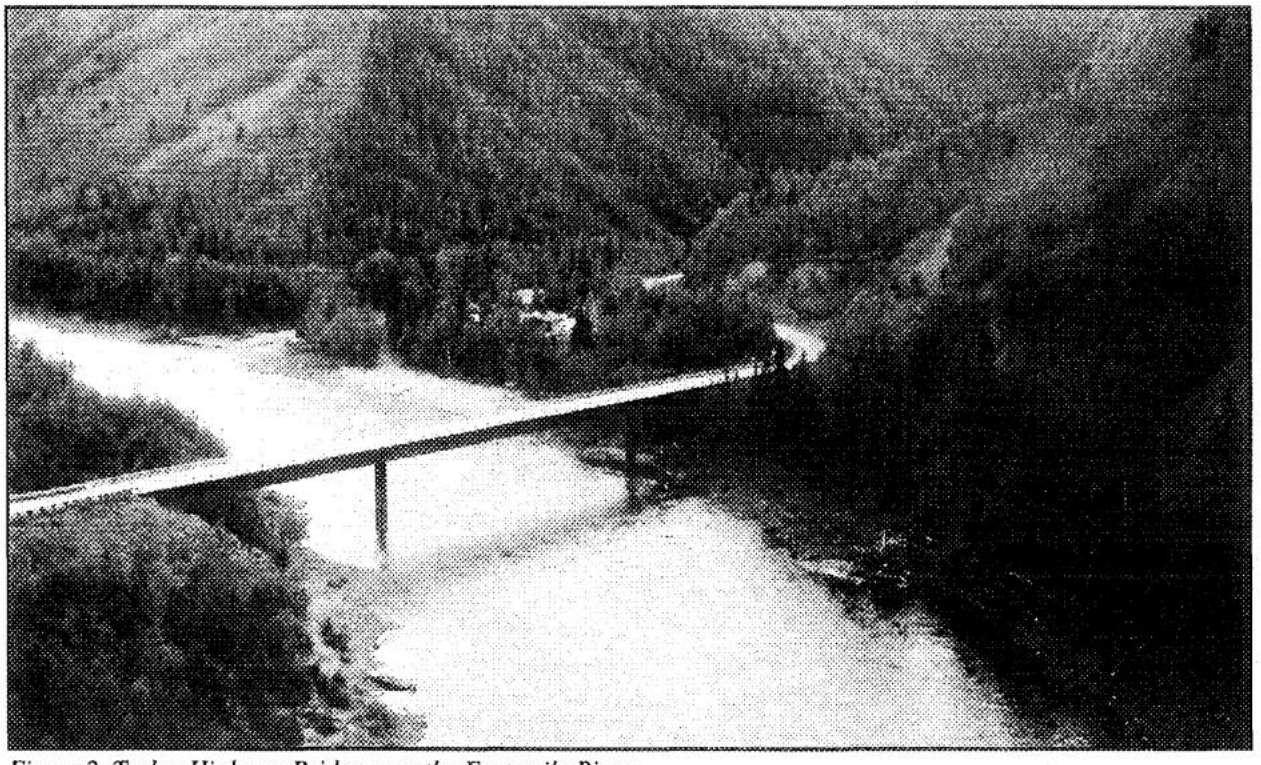

Figure 2. Taylor Highway Bridge over the Fortymile River.

Principal Sub-drainages

West Fork: This drainage, which includes Logging Cabin Creek, heads in the hills adjacent to Mount Fairplay and the Taylor Highway and abuts the north side of the Tanana River and east side of the Mosquito Fork drainages. Most of the upper river and its tributaries flow through wide valleys with numerous swamps and abandoned meanders. In contrast, the lower West Fork flows through a somewhat more narrow valley confined by grassy hills, steep banks and rock bluffs, with fewer meanders and a higher gradient. At the bridge put-in, the channel is aggrading, with sand and gravel bars, and banks subject to flooding during high water.

Dennison Fork: This drainage, which includes both the West Fork and Logging Cabin Creek, heads in the 3,000 to 5,000 foothills adjacent to the Tanana and Ladue river drainages. While most of the upper river and its tributaries flow through wide valleys with numerous swamps and abandoned meanders, the lower Dennison Fork has a somewhat narrower valley with steeper banks, fewer meanders and a higher gradient. At its confluence with Mosquito Fork, the channel is aggrading, with sand and gravel bars, and banks subject to flooding during high water.

Mosquito Fork: The upper Mosquito Fork heads in the uplands directly west of the West Fork of the Dennison Fork and north of the Tanana River Basin. Just east of its headwaters, the upper Mosquito Fork flows sluggishly through Mosquito Flats, a flat swampy area with numerous lakes and abandoned meanders. Below Kechumstuk Creek, the valley narrows and the river gradient increases, at times flowing on a shallow rocky bed. As it approaches Chicken, the valley widens and the Mosquito Fork gradient decreases as the river meanders and braids into several channels upstream of the confluence with the Dennison Fork. The channel is on bedrock and a boulder bed at the bridge put-in/take-out, and the banks are subject to flooding during moderate to high water.

South Fork: Formed by the joining of Dennison and Mosquito forks, the South Fork runs through a river valley that is generally nar-

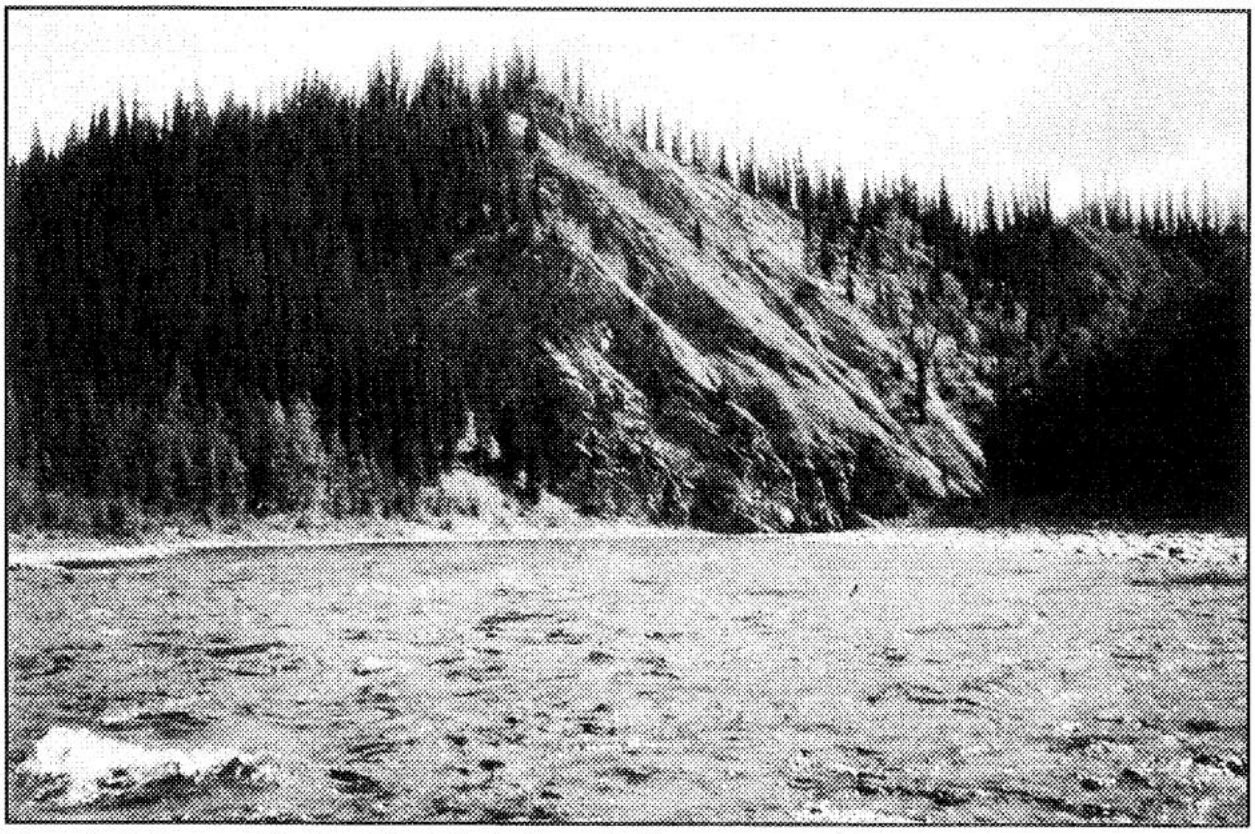

Figure 3. Confluence of North and South Forks, Fortymile River.

row and confined by steep ridges. While a few abandoned meanders occur on a widened floodplain in the vicinity of Wall Street Creek, the river becomes deeply entrenched within its meanders above Walker Fork. From here to the confluence with the North Fork, the river is flanked by steep bedrock outcrops and terraced gravel benches, while the river gradient increases with alternating boulder rapids and deep pools. The channel is on unconsolidated bedrock and boulder bed at the bridge put-in/take-out, and the banks are subject to flooding only during extreme high water.

Walker Fork: The largest of the South Fork tributaries entering below the confluence of the Dennison and Mosquito forks, Walker Fork heads in the uplands of Canada, north of the Dennison Fork and west of the Sixtymile River. While most of the upper river is sinuous or meandering through an open, moderately sloping valley, the river becomes entrenched within a canyon just below Wade Creek. The river gradient increases, having some of the steepest reaches of the principal forks. From here to the confluence with the South Fork, Walker Fork flows on a shallow rocky bed with numerous boulder rapids. The channel at the bridge is aggrading, with well-developed sand and gravel bars, and the banks are subject to flooding during moderate to high water.

Middle Fork: The upper Middle Fork heads in the uplands directly west of the Mosquito Fork, east of the Goodpaster River and south of the Charley River Basin. Just below its headwaters, the upper Middle Fork flows sluggishly through a flat swampy area similar to Mosquito Flats, with numerous lakes and abandoned meanders. Below Joseph Creek the valley narrows and the river gradient increases, flowing over a shallow rocky bed. As it approaches the confluence with the North Fork, the river drops over steep bedrock and boulder rapids. Here the channel flows over unconsolidated bedrock and boulder bed, and the banks are subject to flooding only during extreme high water.

North Fork: The upper North Fork heads in the uplands directly north of the Middle Fork, east of the Charley River and south of the Seventymile River Basin. Formed by the confluence of Slate and Independence creeks, the upper North Fork flows through a fairly narrow valley, generally entrenched within its meanders and flowing over a shallow rocky bed. Below Champion Creek, the valley widens and the river gradient decreases, allowing for the river to meander across a wide floodplain. As it approaches its confluence with the Middle Fork, the North Fork again becomes entrenched within a canyon. Just below the confluence, the river drops over a bedrock falls and continues within the canyon to its confluence with the South Fork. Just below Hutchinson Creek, turn-of-the-century gold miners blasted a cut-off channel through a meander (called the Kink) that isolated approximately three miles of the river bed. Subsequent head-cutting through this over-steepened gradient channel has created a series of bedrock falls, wherein the river drops close to 20 feet in less than a mile. From the Kink downstream to the confluence with the South Fork, the North Fork channel flows on unconsolidated bedrock and boulder beds, and the banks are subject to flooding only during extreme high water.

O'Brien Creek: Largest of the Fortymile tributaries entering below the confluence of the South and North forks, O'Brien Creek heads in uplands east of the North Fork and south of American Creek and the Yukon River. Most of the upper creek is sinuous or meandering through an open valley, but the creek becomes entrenched within a canyon just below Dome Creek. The river gradient increases from here to its confluence with the Fortymile River and flows over a shallow rocky bed with numerous boulder rapids. The channel is on a bedrock and boulder bed at the bridge, and the banks are subject to flooding only during extreme high water.

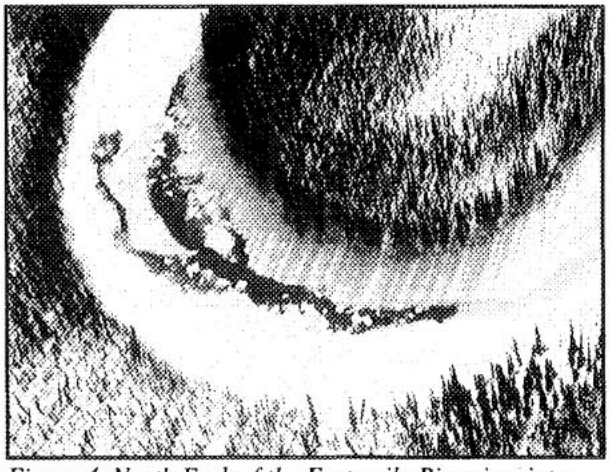

Figure 4. North Fork of the Fortymile River in winter. Open water is seeping from a groundwater spring.

Figure 5. Joseph Creek, tributary to the Middle Fork, Fortymile River.

Fortymile River: Formed by the confluence of the South and North forks, the upper Fortymile River flows through a fairly narrow valley, generally entrenched within its meanders. The river is flanked by steep bedrock outcrops and terraced gravel benches, while alternately flowing through boulder rapids and deep pools. A rapids area called the Falls is formed as the water surges over bedrock and boulders about three miles upstream of the Taylor Highway Bridge. A similar formation, called Canyon Rapids, occurs in Canada several miles below the border. The river ultimately flows into the Yukon River, midway between Dawson and Eagle. The channel flows on a bedrock and boulder bed at the bridge put-in/take-out, and the banks are subject to flooding only during extreme high water.

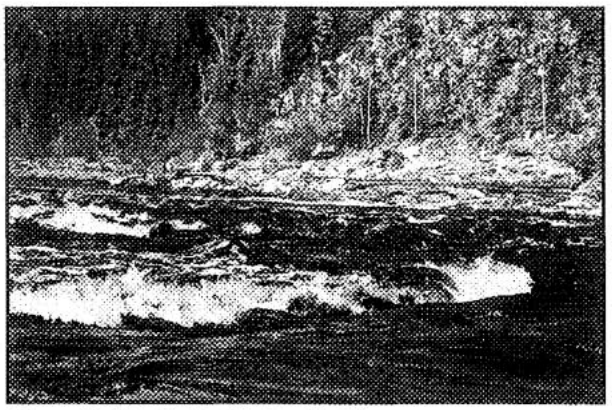

Figure 6. The Falls, Fortymile River.

METHODS

Hydrology

BLM currently operates stream gages at six locations in the Fortymile Basin (Table 1). The Water Survey of Canada data from the Fortymile River gage at Clinton Creek, Canada, was also used for comparative purposes. The natural flow regime for these sites was quantified in terms of mean daily, mean monthly and annual streamflow, as well as flood-frequency and low-flow analysis. Similar analysis of historical USGS and WSC discharge data was also done for comparative purposes and to check regionalized flood-frequency estimators.

Additionally, BLM has established 19 supplementary reference sites (Table 1) where hydraulic geometry information was developed using rod and level survey techniques and indirect (Manning Equation) discharge models. Indirect methods were verified with direct measurements to confirm or modify the computer models. Information developed at each cross section included low-flow and bankfull hydraulic-geometry relationships as well as instantaneous peak-flow. The hydraulic-geometry data will be published in a subsequent instream flow report.

Table 1. Gage Locations and Basin Characteristics for the Fortymile River (sites listed in downstream order).

Site No.	Principal Gaging Sites Name	Location at Wild & Scenic River Mile	Period of Record	Gradient at gage ft/ft	Drainage Area (sq mi)	Mean Basin Elevation (ft)	Area of Lakes and Ponds (sq mi)	Area of Forest (sq mi)
1	West Fork at Taylor Highway	WF 5	1989-95	0.21%	598	2,623	1.3	549
2	Mosquito Fork at Taylor Highway	MF 33	1989-95	0.47%	1,114	2,974	2.9	759
3	South Fork at Taylor Highway	SF 5	1989-95	0.21%	2,730	2,777	5.0	2,193
4	Walker Fork at Taylor Highway	WKF 5	1989-95	0.34%	396	3,049	0.0	292
5	North Fork above South Fork	NF 56	1991-95	0.29%	1,919	3,270	0.6	1,109
6	Fortymile River at Taylor Highway	FM16	1989-95	0.14%	5,848	2,966	5.7	4,220
	Supplementary Gaging Sites							
7	Logging Cabin Creek at Taylor Highway	LC 8	1991-95	0.27%	28	3,166	0.0	23
8	Mosquito Fork at Chicken	MF 33	1991	0.21%	1,137	2,963	2.9	777
9	Dennison Fork at Mouth	DF 18	1991,92,95	0.36%	1,560	2,652	2.1	1,389
10	Wade Creek at Mouth	WC 10	1993-95	0.51%	48	2,933	0.0	33
11	Walker Fork at Mouth	WKF 12	1992-94	0.63%	396	3,030	0.0	299
12	South Fork above Uhler Creek	SF 20	1991-92	0.18%	3,261	2,808	5.1	2,595
13	Uhler Creek at Mouth	UC 9	1991-92	0.77%	29	2,595	0.0	24
14	South Fork at Mouth	SF 27	1993-95	0.15%	3,308	2,803	5.1	2,635
15	Joseph Creek above Middle Fork	JC 21	1992	0.24%	186	3,617	0.1	78
16	Middle Fork below Joseph Creek	MIF 2	1991,92,95	0.09%	623	3,561	0.4	282
17	McKinley Creek at Mouth	MIF 30	1991	0.57%	70	3,127	0.0	52
18	Pittsburgh Creek at Mouth	MIF 27	1991	0.23%	83	3,452	0.0	40
19	Middle Fork above North Fork	MIF 40	1991,92,95	0.20%	1,073	3,341	0.4	605
20	North Fork above Little Bonanza Crk.	NF 6	1992	0.29%	324	3,421	0.1	175
21	North Fork above Champion Creek	NF 15	1992	0.07%	528	3,390	0.1	274
22	Champion Creek at Mouth	CC 27	1992	0.65%	177	3,124	0.0	122
23	North Fork above Middle Fork	NF 24	1991,92,95	0.27%	750	3,296	0.1	428
24	Hutchinson Creek at Mouth	HC 18	1991-92	0.08%	70	3,352	0.0	45
25	North Fork below Hutchinson Creek	NF 35	1991-92	0.12%	1,784	3,327	0.6	1,007
26	O'Brien Creek at Taylor Highway	FM16	1991-95	0.27%	359	2,773	0.0	284

All of the 25 stream-gaging site locations were entered into a GIS database created from USGS 1:250,000 coordinate files, supplemented with hand-digitized data from Canadian topographic maps where needed. The area map in Fig. 1 and the basin characteristics in Table 1 were produced from this database.

For the period of record covered by this report, the stream-gaging sites were located as near as posssible to the locations specified by DNR in preliminary discussions held in 1991 and 1992. Automated water-level recorders (WLR), consisting of a data logger and pressure transducer, were installed at several locations beginning in 1990. Other sites had crest-stage gages and wire-weight gages installed in 1991 and 1992. A crest-stage gage (CSG) is a non-automated gage that records the peak water level whenever it exceeds a pre-set minimum (base) level. A wire-weight gage (WWG) is also a non-automated gage that reads the water level by lowering a bronze weight to the water surface. The weight is suspended by a cable wound on a drum that has a calibrated disc and counter attached that provide the water-level readings. Supplemental sites consisted of a permanent reference-elevation mark (RM) and a channel-geometry cross section.

At each visit to the site, the current water surface is determined by a level survey referenced to the RMs or by reading the WWG and noting the current gage reading. Cross-sectional discharge (streamflow) measurements are made using a Price AA current meter to measure water velocity and a top-setting wading rod and tag line for depth and width, respectively. At least once a year the stream banks, high-water marks and water surface profiles were surveyed using a level and stadia rod (Benson and Dalrymple, 1967). The reference datum elevation was adjusted so that the lowest streambed elevation at the reference cross section corresponds to zero (and zero flow) on the gage reading. A water level vs. discharge rating was then developed by combining the direct discharge measurements (Rantz and others, 1982) and computer-simulated peak flows using the slope-area method (Dalrymple and Benson, 1967). Rating curves (log-log regression plots of this data) were then used to compute mean daily, monthly and peak discharge from the WLR, WWG and CSG data. Where the discharge ratings varied over time due to scour or fill in the channel, the ratings were adjusted with the shifting-control method by adding or subtracting a constant to the gage-height record to

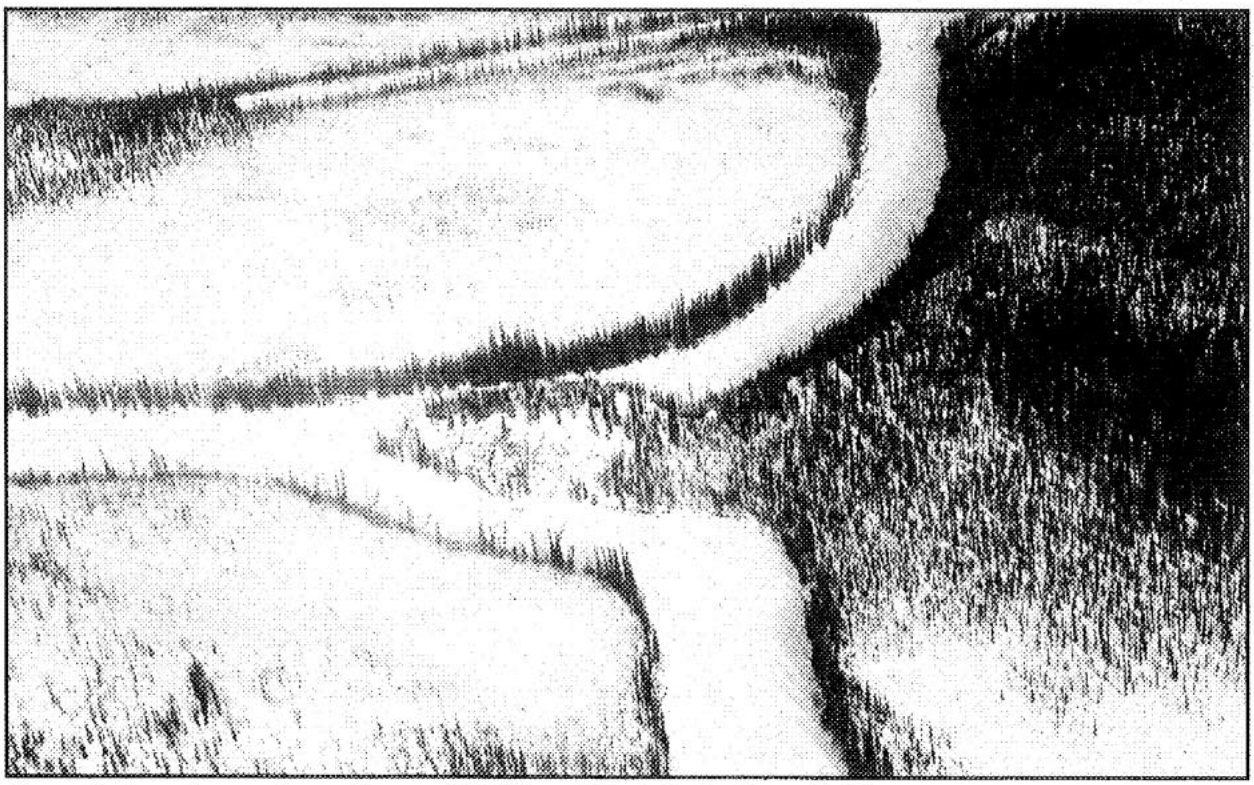

Figure 7. Late winter at the confluence of Middle and North Forks, Fortymile River.

match the base rating to the measured discharge (Rantz and others, 1982). Whenever sufficient WWG readings were available to determine the monthly mean discharge, it was computed directly. When too few readings were taken, the monthly means were estimated from regression analysis.

By comparing differences in discharge measurements and peak flows at the sites using regression analysis, data from the nearest automated gage was used as the independent variable to compute mean monthly streamflows for the dependent variable—the discharge at the non-automated gaging sites. Thomas (1967) states that the nearest gaging station with the most reliable and longest period of streamflow record is to be used as the reference site. Consequently, when no data was available from the BLM gages (such as during spring break-up, fall freeze-up, or recorder malfunction), the data was estimated from regression analysis with the WSC data from the gage on the Fortymile River at Clinton Creek, Canada (WSC, 1989 to 1995), approximately 20 miles downstream from the Alaska-Canada border. Comparison was also made to historical USGS data (USDI 1915, 1977 to 1983) and DNR data (DNR 1987). To provide the greatest possible accuracy, the discharge regressions were computed separately for both high- and low-flow conditions.

For the winter period beginning in the fall of 1991, under-ice discharge measurements were made as nearly simultaneous as possible at several sites, two or three times during the winter. These measurements were made by drilling a series of holes in the ice to define the cross section, then measuring the water depth and velocity in each hole using a USGS vertical-axis, vane-type current meter mounted on a graduated rod. Accuracy of winter flows is low: as discharge approaches zero, flow measurements become unreliable as the water velocity diminshes below the measuring range of the instrumentation. Variability in the basin can occur as flows diminish downstream of the headwaters due to storage as ice. Streamflow may cease altogether if additional groundwater sources are not available. A flow measurement at one site may have little relationship to other sites in the basin unless geological conditions remain constant. Flow in unconfined alluvial channels is greater and shows more uniformity than in a basin where bedrock confines the aquifer and groundwater sources are non-

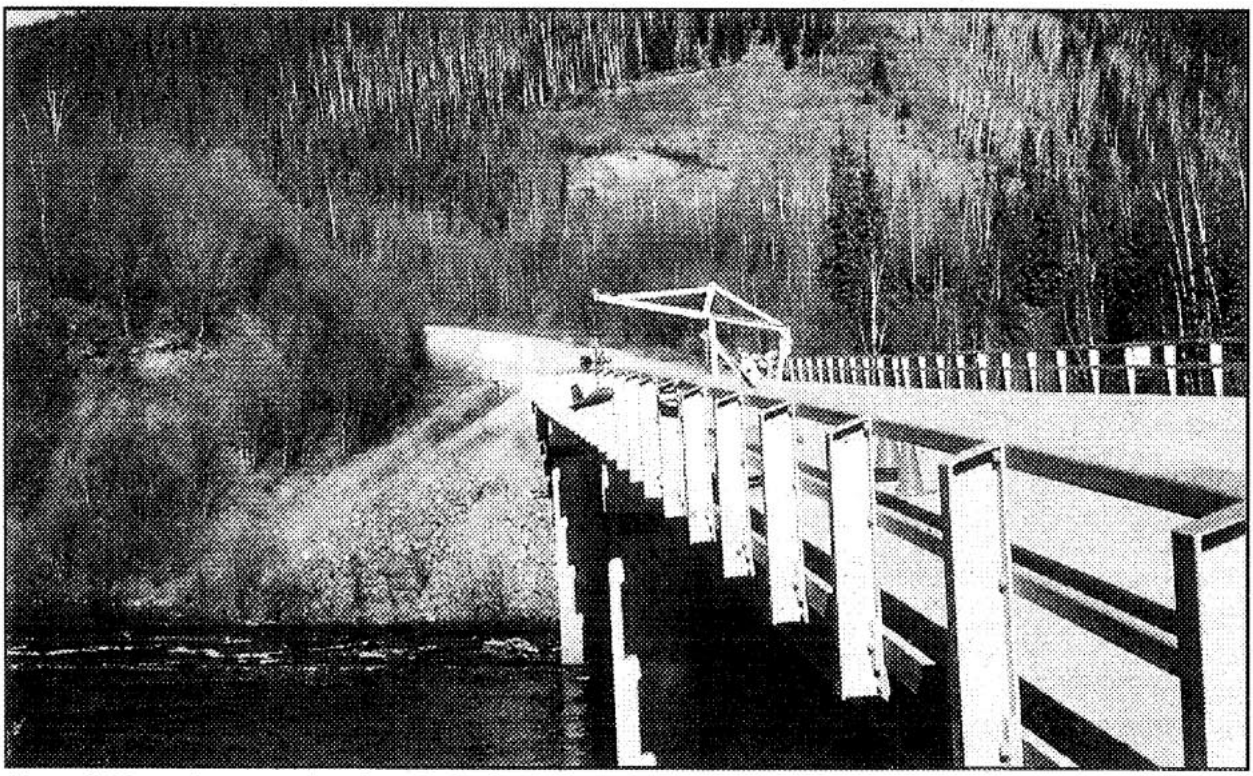

Figure 8. Measuring streamflow from the Taylor Highway bridge over South Fork.

continuous (Nelson 1978). Because of these factors, discharges less than about 10 cubic feet per second should be considered estimates.

Where the measurements were sufficiently accurate to represent the winter flow conditions, streamflow was computed directly by regressing discharge on time (date) for the periods covered for each site. Since recession curves often take the form of exponential decay, discharge can be expressed as a constant times the intial discharge raised to a negative power of the time interval (Chow, et al. 1988). This methodology is based on the assumption 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 in the aquifer is lowered by reduction of water volume in the aquifer (Rogers and Armbruster, 1990). Where no data was available, such as the winter periods of 1989 to 1991, data from other gages were used to compute the estimated streamflow for the period. Where some discharge measurements were considered unreliable, such as late winter of 1993 when flows were difficult to measure, the most reliable discharge records were used to compute all the sites based on their previously measured differences.

Rantz (1982) suggests that comparison with other streamflow records is the most important basis for determing the most probable estimate of ice-affected discharge. In making hydrologic comparisons, consequently, the regression equations for the Fortymile River basin were computed using the Fortymile River at Clinton Creek, Canada (WSC 1983-1996), as the reference station, since it best satisfied this criteria. Wherever regression equations were used to compute mean monthly discharge, the values have been identified in the table as estimates.

Low-flow statistics for the summer period were computed at sites where sufficient low-flow data were available. Since most resource activity occurs in the summer and winter streamflow is usually near zero, a summer low-flow analysis was considered a better assessment for resource evaluation purposes. This was calculated from the minimum recorded discharge from May to September using a two-parameter lognormal distribution, minimum events method of maximum likelihood (Kite 1991). This distribution was used because it provides the most reliable estimates from a small data set (Kite 1991) and, along with the regional log-Pearson type III, provides the least-biased frequency estimates (Beard 1982).

Peak flow statistics were computed from the annual instantaneous peak discharge data as well as maximum recorded mean daily discharge using a regional skew applied to a log-Pearson Type III flood-frequency relationship (Interagency Advisory Committee on Water Data 1982).

Geographic Information System

Development and analysis of the drainage basins was performed using Arc/Info software.

Terrain modeling: Contour lines and streams from portions of a Canadian 1:250,000 series map were digitized and used as input to a third order trend surface analysis to generate a digital elevation model (DEM) for the Canadian portion of the study area. This DEM was merged and edge-matched with the 48 USGS 15-minute series DEMs for the Eagle and Tanacross quadrangles to produce a 60-meter resolution DEM of the entire study area.

USGS DEMs often contain errors, due to sampling and rounding effects that create hydrologic sinks. These sinks interfere with hydrologic analyses performed in a GIS, and filling them is a standard practice prior to using DEMs for hydrologic analyses. Filling sinks is an iterative process involving five steps:

1. Determine the direction of flow for each grid cell in the DEM.
2. Locate all sinks in the DEM.
3. Find the contributing area to each sink.
4. Find the depth of each sink.
5. Fill the sinks to the level of the lowest neighboring grid cell.

The process is repeated until there are no remaining sinks. Arc/Info's GRID module provides pre-written routines to facilitate each of these steps.

This process produces two new data layers: a "hydrologically corrected" digital terrain model (DTM) and a corresponding grid in

which the cell values represent the direction of flow for each grid cell in DTM. These are both used in the hydrologic modeling process.

Hydrologic modeling: The flow-direction grid is used to determine the flow accumulation, or the total number of cells that drain into each grid cell. A threshold is applied to the flow accumulation grid to determine which grid cells represent stream channels. In this exercise, choosing all grid cells with a flow accumulation of 500 or more grid cells produced a reasonable approximation of the stream channels in the study area.

Gaging sites were digitized on the computer screen using USGS 1 Degree Digital Raster Graphics (DRGs) as a background to identify locations previously marked on USGS 1 Degree quadrangle maps. These points were moved to the nearest grid cell within 300 meters of the digitized location and in a stream channel, as determined above. This ensures that the gaging site will be in the stream network that is represented by the terrain model.

Using a pre-written routine in Arc/Info, the flow direction grid was used to determine groups of cells that drain to the same gaging site. This provided an initial approximation of the contributing areas to each gaging site.

The perimeter of each contributing area was plotted over USGS 1 Degree DRGs. Errors in the basins were identified by the hydrologist, then manually edited to produce perimeters for the area contributing exclusively to each gaging site. The immediate contributing area to each gaging site was combined with the contributing areas for all upstream gaging sites to produce a perimeter for the total contributing basin to each gaging site. The perimeters are stored as polygons in a GIS database. The area, perimeter and a unique ID number of each polygon is automatically generated in the polygon attribute table.

Terrain description: Each basin was converted to a raster data set at the same resolution as the DTM. Descriptive statistics (mean, minimum, maximum) about the population of DTM cells that fall within each basin were generated and stored in a database table.

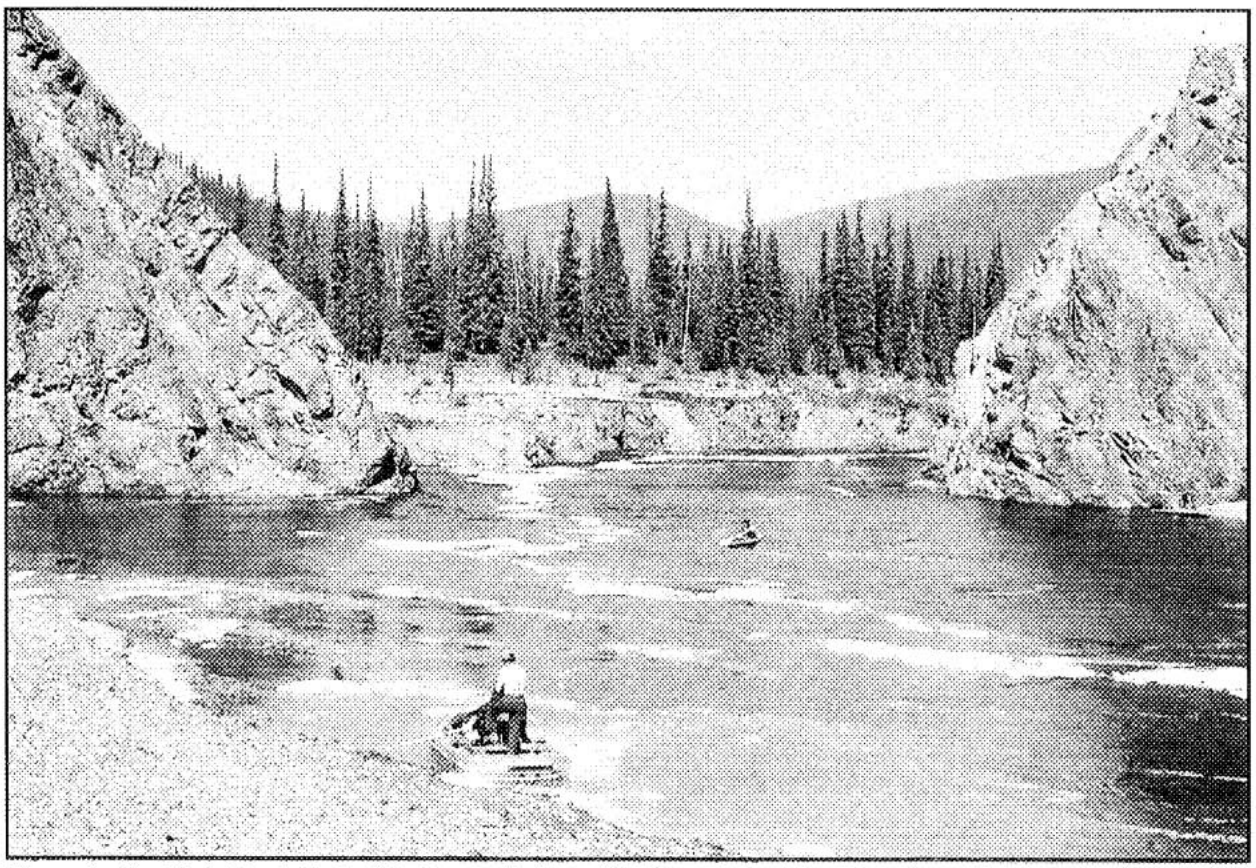

Figure 9. The Kink, North Fork of the Fortymile River. The V-notch was blasted out by gold miners, creating the rapids upstream.

Lake area determination: All lakes contained in the USGS 15-minute Digital Line Graph (DLG) files were extracted into a separate GIS database. The union of each basin with the lakes was calculated. This, in effect, added the basin ID number to the polygon attribute table record for each lake that fell within the basin. The area was summed for all lakes with the same basin ID number to determine the total area of lakes within each basin.

Forested area: Green pixels in the USGS 1 Degree DRGs were used as an approximation of the forested portion of the study area. The green pixels were extracted into a separate data set. Each group of pixels in this data set was expanded by 1 pixel width (30 m) to account for the area lost where contour lines, land net lines, text and other narrow non-green features crossed the green areas. This produced a grid representing the forested portion of the study area.

The raster version of each basin was combined with the forested area grid to produce an attribute table containing the number of 30x30m forested pixels falling within the basin. This was used to calculate the total forested area within each basin.

RESULTS AND DISCUSSION

The basin characteristics listed in Table 1 and the location map in Figure 10 were produced from the GIS analysis described above.

Appendix A contains discharge data, listed by site location, for all the gaged sites. Appendix B lists the discharge ratings and regression equations used in the computations.

A mean monthly discharge summary for the six principal sites, compiled in Table 2, was computed from a combination of recorded daily discharge values, the regression equations determined from winter under-ice measurements and from hydrographic comparisons to other sites in the basin, principally the site at Clinton Creek, Canada. This data, plotted as a hydrograph in Fig. 11, shows very little streamflow during winter, flood flows from spring snow melt and early summer storms, moderate streamflow during much of the summer, and flow levels dropping quickly in the fall. For analysis purposes, the data for the Fortymile River was compared to current WSC data for the gage at Clinton Creek, Canada (Table 3) The BLM data agreed reasonably well with the WSC data, although both show higher than expected streamflow in the winter. This was probably due to higher than normal snowfall during the late winters for 1990 to 1995.

Summaries of extreme values as well as low-flow and peak-flow statistics for the period are listed in Tables 4 - 6. For comparison purposes, peak-flow statistics were also computed from the historical USGS data, listed in Table 7. The differences between the two peak-flow statistical tables are probably due to the small (five years) set of measured data used for the comparison. Childers (1970) states that peak-flow statistics are only valid for recurrence intervals up to twice the length of streamflow data used in the computation. Based on this criteria, the reliability of flood frequency estimates is uncertain for recurrence intervals greater than 10 years for the data listed in Table 6.

In general, the data and statistical calculations presented here should be considered preliminary. Future stream-gaging work will include expanding the number of automated data loggers and crest-stage gages, as well as collecting at least 10 years of data at most sites. While five years of data is considered the minimum for computing flood-frequency statistics and meets state of Alaska requirements, the additional data should provide a more reliable database as well as statistics that meet federal guidelines (Interagency Advisory Committee on Water Data 1982).

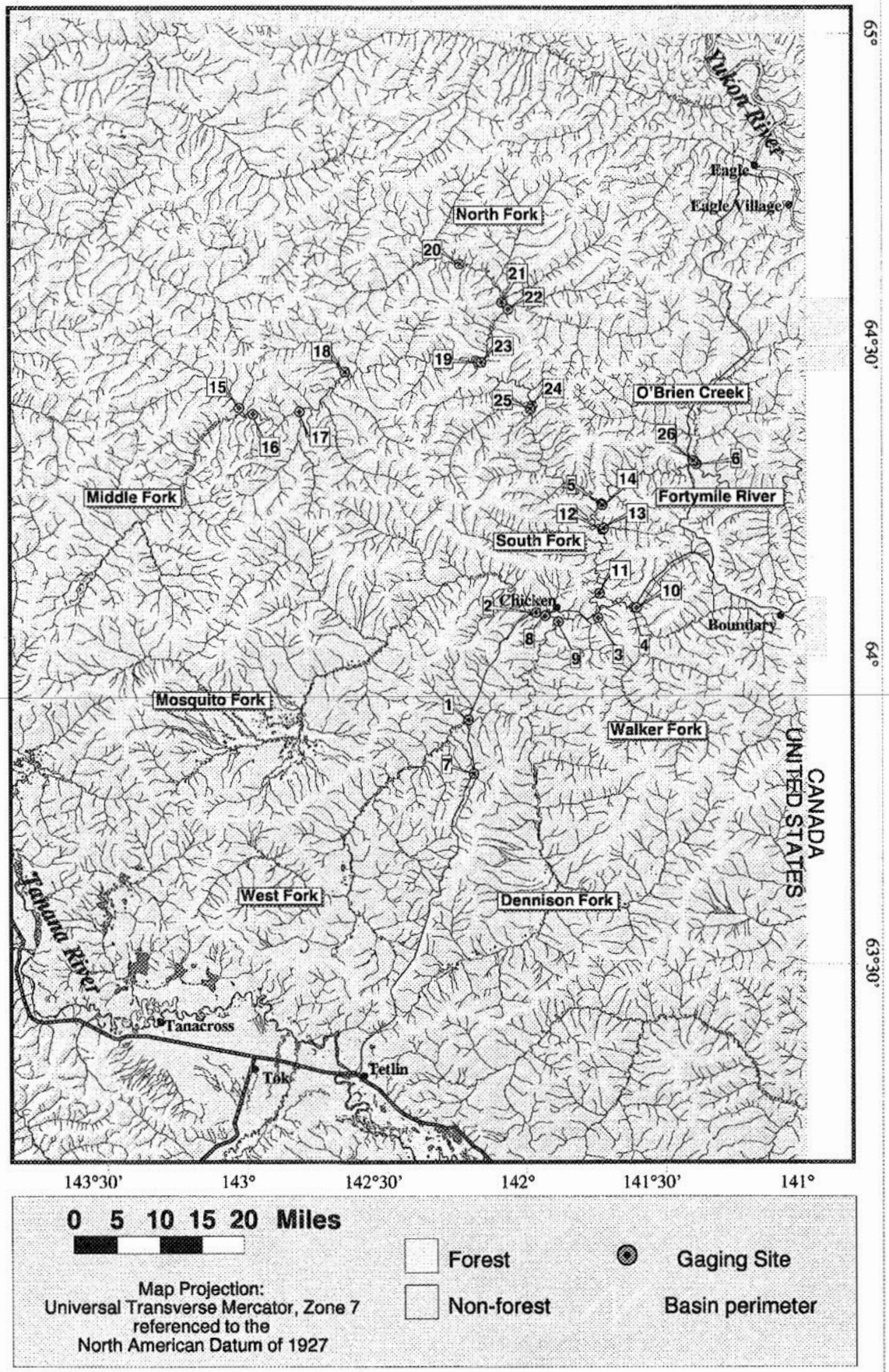

Figure 10. Hydrologic basin map of the Fortymile River from GIS analysis.

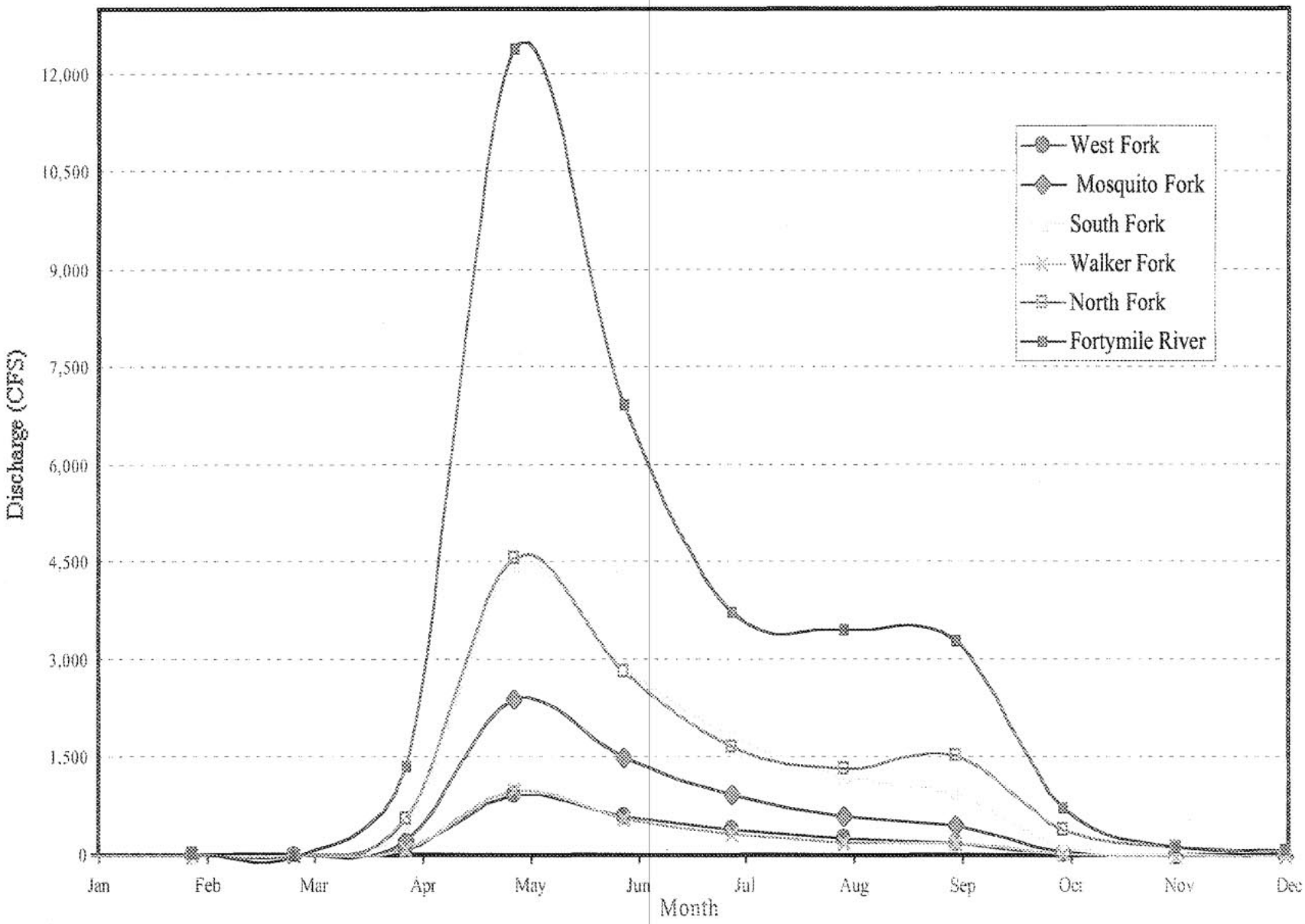

Figure 11. Monthly mean discharge hydrograph for the Fortymile River basin.

Table 2. Mean Monthly Discharge Summary (cfs) for the Fortymile River Basin, 1990 to 1995.

Month	West Fork	Mosquito Fork	South Fork	Walker Fork	North Fork*	Fortymile River
January	0.8	1.0	3.0	0.7	25	37
February	0.6	0.7	2.0	0.5	17	18
March	0.4	0.6	1.0	0.4	14	14
April	113	223	469	99	568	1,360
May	918	2,400	4,430	987	4,580	12,400
June	612	1,510	2,860	583	2,830	6,950
July	403	942	1,830	339	1,660	3,740
August	274	608	1,210	206	1,350	3,460
September	212	455	920	192	1,520	3,300
October	36	61	137	34	384	730
November	6.0	8.0	19	7.0	144	149
December	1.0	3.0	3.0	1.0	66	84

* 1991 to 1995

Table 3. Comparative Monthly Discharge for 1990 to 1995.

Month	Fortymile River at Taylor Highway	Fortymile River* at Clinton Creek	Difference in Data Sets (Percentage)
January	37	38	-3%
February	18	18	0%
March	14	20	-30%
April	1,360	1,380	-1%
May	12,400	12,800	-3%
June	6,950	7,130	-3%
July	3,740	3,820	-2%
August	3,460	3,530	-2%
September	3,300	3,360	-2%
October	730	782	-7%
November	149	181	-17%
December	84	90	-7%

*Data from Water Survey of Canada

Table 4. Summary of Annual Runoff and Extremes for the Fortymile River, 1990 to 1995.

Statistic	West Fork Taylor Highway Bridge Bridge	Mosquito Fork Taylor Highway Bridge	South Fork Taylor Highway Bridge	Walker Fork Taylor Highway Bridge	North Fork* above South Fork Confluence	Fortymile River Taylor Highway
Annual Mean Discharge	215	518	991	203	1,096	2,689
Annual Runoff (cfsm)	0.42	0.47	0.38	0.61	0.53	0.47
Annual Runoff (inches)	5.7	6.4	5.2	8.3	7.2	6.4
Instantaneous Peak Flow	5,497	10,411	21,700	4,625	22,400	62,500
Instantaneous Minimum (Winter)	0.0	0.0	0.0	0.0	0.0	0.0
Highest Mean Daily (Summer)	ND	ND	19,400	ND	17,600	ND
Lowest Mean Daily (Summer)	ND	ND	117	ND	305	ND

ND = Not Determined

* 1991 to 1995

Table 5. Low-Flow Frequency Computed from Two Parameter Lognormal Distribution, Minimum Events Method (discharge in cfs).

Recurrence Interval (yrs)	West Fork Taylor Highway Bridge	Mosquito Fork Taylor Highway Bridge	South Fork Taylor Highway Bridge	Walker Fork Taylor Highway Bridge	North Fork above South Fork Confluence	Fortymile River Taylor Highway Bridge
2	52	96	304	39	448	968
5	26	48	195	21	322	539
10	18	34	155	15	271	397
20	14	25	128	11	235	308
50	9.8	18	103	8.0	199	232
100	7.8	15	89	6.5	179	192

Table 6. Instantaneous Flood-Frequency Computed from a Log Pearson Type III Analysis (discharge in cfs).

Recurrence Interval (yrs)	West Fork Taylor Highway Bridge	Mosquito Fork Taylor Highway Bridge	South Fork Taylor Highway Bridge	Walker Fork Taylor Highway Bridge	North Fork* above South Fork Confluence	Fortymile River Taylor Highway Bridge
2	3,960	6,160	13,500	2,870	17,400	35,500
5	5,030	8,550	18,800	4,300	22,500	46,700
10	5,730	10,200	21,600	5,350	26,100	54,800
25	6,620	12,500	27,600	6,820	30,400	65,800
50	7,270	14,200	31,500	8,010	34,100	74,600
100	7,930	16,000	36,000	9,280	40,000	83,800

*Data from USGS (9 years: 1911-12, 1976-1982)

Table 7. Comparative Instantaneous Flood-Frequency from Historical Data.

Recurrence Interval (yrs)	Fortymile River* Taylor Highway Bridge	Difference with BLM Data (Percentage)
2	35,800	-1%
5	47,800	-2%
10	56,700	-3%
25	68,900	-4%
50	78,900	-5%
100	89,600	-6%

*Data from USGS (9 years: 1911-12, 1976-1982)

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Appendix A
Gaging Site Descriptions and Annual Data Tables

Part 1: Principal Stream Gaging Sites

West Fork: Monitoring at this site began in September 1989 by surveying cross-sectional data and high-water mark profiles upstream of the Taylor Highway Bridge. A U.S. Coast and Geodetic Survey Bench Mark (BM) on the right abutment was used for elevation reference. In 1991, a wire-weight gage was installed on the upstream guard rail above the main channel and a crest-stage gage placed on the left upstream bank. The crest-stage gage was relocated in 1995 to the right downstream bank after being crushed by ice during spring breakup in 1992 and again in 1994. Discharge measurements are usually made from the upstream side of the bridge during high water and wading measurents can be made either up or downstream of the bridge. The gage reach consists of a meandering channel, confined on the left bank by a gently sloping ridge, with an extensive floodplain and low bank on the right side. The streambed consists of angular cobbles and gravel, with well-developed gravel bars and an island about 300 feet downstream of the bridge.

Figure 12. West Fork of the Fortymile River looking downstream from Taylor Highway Bridge.

Table A-1. Discharge Measurement Summary for West Fork of the Dennison Fork, Fortymile River, at Taylor Highway Bridge.

Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (ft)	Avg. Velocity (ft/sec)	Avg. Depth (ft)
9/28/89	1.87	382	115	211	1.81	1.8
5/10/90	3.88	2,165	115	388	5.57	3.4
8/21/90	1.48	225	90	130	1.73	1.4
5/14/91	1.69	232	102	117	1.98	1.1
7/1/91	1.26	125	87	132	0.95	1.5
5/22/92	2.57	886	112	311	2.85	2.8
6/25/93	2.26	451	114	206	2.19	1.8
5/13/94	1.96	301	124	171	1.76	1.4
7/29/94	1.13	93	60	56	1.66	0.9
9/22/94	0.83	51	55	43	1.19	0.8
5/16/95	3.54	1,640	110	371	4.43	3.4
6/30/95	1.69	249	83	103	2.42	1.2
9/22/95	1.51	192	79	90	2.13	1.1
12/13/95	ND	1.3	29	8.7	0.15	0.3

ND=Not Determined

Table A-2. Peak and Minimum Discharge Summary for West Fork of the Dennison Fork, Fortymile River, at Taylor Highway Bridge.

Year	Date	Peak Discharge (cfs)	Date	Minimum Discharge (cfs)
1989	6-Jun	5,500		ND
1990	1-May	4,480		ND
1991	1-May	3,600	26-Jun	71
1992	10-Jun	4,640	16-Sep	192
1993	12-May	4,480	20-Aug	121
1994	10-May	3,850	24-Aug	26
1995	15-May	5,320	23-Jul	99

ND=Not Determined

Table A-3. 1991 Wire-Weight Gage Readings and Discharge for West Fork of the Dennison Fork, Fortymile River, at the Taylor Highway Bridge. (Note: Wire-weight gage correction is -4.13 ft. to stream datum.)

Date	Wire-Weight Reading (ft)	Discharge (cfs)	Date	Wire-Weight Reading (ft)	Discharge (cfs)
May			August		
5	5.82	241	5	5.97	300
14	5.82	241	6	6.13	335
18	5.75	216	9	6.08	313
23	5.75	216	11	5.81	237
31	5.37	118	22	5.11	78
June			30	5.35	113
9	6.50	526	September		
12	6.29	412	1	5.28	97
18	5.79	230	4	5.08	73
25	5.19	78	10	5.08	73
26	5.07	71	13	5.98	305
27	5.38	121	23	5.58	176
July			25	5.45	139
8	5.88	264	26	5.18	77
10	6.99	1,050	28	5.30	102
22	5.19	78			
23	5.08	73			
30	5.28	97			

Table A-4. 1992 Wire-Weight Gage Readings and Discharge for West Fork of the Dennison Fork, Fortymile River, at the Taylor Highway Bridge. (Note: Wire-weight gage correction is -4.13 ft. to stream datum.)

Date	Wire-Weight Reading (ft)	Discharge (cfs)	Date	Wire-Weight Reading (ft)	Discharge (cfs)
May			August		
19	5.77	223	3	7.90	2,020
22	6.70	818	7	6.89	968
June			14	7.18	1,225
2	8.08	2,250	15	6.88	959
15	6.04	296	21	6.67	796
17	6.58	643	September		
18	6.57	636	8	5.88	264
19	6.48	514	16	5.68	192
25	8.58	2,980			
30	6.97	1,035			
July					
1	6.67	796			
6	5.88	264			
13	6.18	358			
20	8.48	2,825			
31	6.78	879			

Table A-5. 1993 Wire-Weight Gage Readings and Discharge for West Fork of the Dennison Fork, Fortymile River, at the Taylor Highway Bridge. (Note: Wire-weight gage correction is -4.13 ft. to stream datum.)

Date	Wire-Weight Reading (ft)	Discharge (cfs)	Date	Wire-Weight Reading (ft)	Discharge (cfs)
May			August		
10	7.68	1,750	1	5.78	226
13	7.48	1,530	4	5.58	176
18	6.82	911	11	5.68	192
21	6.20	368	13	5.68	192
June			14	5.68	192
2	5.48	147	16	5.58	176
7	6.08	313	19	5.48	147
9	7.18	1,225	20	5.38	121
17	6.28	407	25	6.68	803
22	6.41	475	26	6.48	514
23	6.38	458	27	6.38	458
25	6.38	458	28	6.28	407
30	6.18	358	30	6.08	313
July			31	6.08	313
4	6.48	514	September		
5	6.28	407	1	6.08	313
13	6.38	458	8	5.88	264
15	5.98	305	9	5.88	264
17	5.78	226	11	5.78	226
18	5.68	192	13	5.85	252
20	5.58	176	18	5.73	209
21	5.57	173	21	5.58	176
26	6.30	417			
27	6.28	407			
29	6.08	313			
30	5.98	305			

Table A-6. 1994 Wire-Weight Gage Readings and Discharge for West Fork of the Dennison Fork, Fortymile River, at the Taylor Highway Bridge. (Note: Wire-weight gage correction is -4.13 ft. to stream datum.)

Date	Wire-Weight Reading (ft)	Discharge (cfs)	Date	Wire-Weight Reading (ft)	Discharge (cfs)
May			August		
2	7.32	1,360	1	5.35	113
4	6.75	856	3	5.35	113
5	6.42	480	5	5.25	91
10	6.00	313	9	5.05	67
11	5.75	216	12	4.95	51
13	6.08	313	13	4.95	51
20	6.25	392	15	4.90	44
31	7.05	1,105	16	4.95	51
June			24	4.75	26
3	6.55	623	25	4.75	26
5	6.65	781	29	4.75	26
8	7.05	1,105	30	4.75	26
14	6.05	300	31	4.75	26
21	6.45	497	September		
30	6.18	623	6	4.95	51
July			7	4.95	51
7	7.35	1,390	9	4.95	51
12	5.95	292	15	5.05	67
14	6.25	392	21	4.95	51
17	6.35	442	22	4.95	51
18	6.35	442			
19	6.25	392			
20	6.05	300			
21	6.05	300			
25	5.40	126			
26	5.25	91			
28	5.15	71			
29	5.25	91			
31	5.65	183			

Table A-7. 1995 Wire-Weight Gage Readings and Discharge for West Fork of the Dennison Fork, Fortymile River, at theTaylor Highway Bridge. (Note: Wire-weight gage correction is -4.13 ft. to stream datum.)

Date	Wire-Weight Reading (ft)	Discharge (cfs)	Date Reading (ft)	Wire-Weight (cfs)	Discharge
May			August		
15	8.05	1,220	1	5.65	237
16	7.65	1,013	2	5.85	293
17	7.15	777	3	5.35	162
19	6.70	588	4	5.55	211
June			5	5.65	237
1	6.25	421	6	5.85	293
2	6.95	690	7	5.75	264
7	6.17	394	8	5.65	237
8	6.05	355	9	5.55	211
10	5.85	293	10	5.55	211
11	5.65	237	11	5.55	211
12	5.65	237	12	5.45	186
13	5.55	211	13	5.65	237
14	5.45	186	14	5.99	336
19	6.49	507	15	6.65	568
20	6.05	355	16	6.85	648
21	6.35	456	17	6.95	690
24	6.85	648	18	6.80	628
26	6.85	648	19	6.60	549
27	6.53	522	20	6.45	492
29	6.05	355	21	6.45	492
30	5.80	279	22	6.65	568
June Average		400	23	6.55	530
July			24	6.45	492
4	6.25	421	25	6.35	456
5	6.65	568	26	6.24	418
6	6.65	568	29	6.15	387
10	6.35	456	30	6.05	355
12	5.85	293	Aug. Average		378
15	6.05	355	September		
16	5.85	293	2	5.95	323
17	5.65	237	3	5.95	323
18	5.60	224	5	6.15	387
19	5.35	162	6	6.35	456
20	5.25	140	9	6.35	456
22	5.15	119	11	6.15	387
23	5.05	99	12	6.05	355
24	5.15	119	14	5.95	323
25	5.15	119	15	5.95	323
27	5.75	264	18	5.78	273
30	5.65	237	19	5.75	264
31	5.59	221	21	5.65	237
July Average		272	22	5.62	229
			26	5.45	186
			Sept. Average		323

Mosquito Fork: Monitoring at this site began in September 1989 by surveying cross-sectional data and high-water mark profiles upstream of the Taylor Highway bridge. A U.S. Coast and Geodetic Survey Bench Mark (BM) on the right abutment was used for elevation reference. In 1991, a wire-weight gage was installed on the upstream guard rail above the main channel and a creststage gage was placed on the right upstream bank. Discharge measurements are usually made from the upstream side of the bridge during high water. Wading measurents are made just upstream of the bridge. The gage reach consists of a straight channel confined on the left bank by a rock bluff, with an extensive floodplain and somewhat lower bank on the right side. The stream bed consists of angular cobbles and boulders, with lateral gravel bars evident only at extreme low water.

Figure 13. Mosquito Fork Fortymile River looking upstream from Taylor Highway Bridge.

Table A-8. Discharge Measurement Summary for Mosquito Fork of the Fortymile River at Taylor Highway Bridge.

Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (ft)	Avg. Velocity (ft/sec)	Avg. Depth (ft)
9/28/89	3.43	1,420	142	463	3.07	3.3
5/10/90	4.35	2,718	136	500	5.44	3.7
6/21/90	1.72	259	105	128	2.03	1.2
8/20/90	1.93	362	130	240	1.51	1.8
6/30/91	1.57	207	110	169	1.22	1.5
5/22/92	3.65	1,040	139	441	2.36	3.2
6/18/92	5.32	4,280	163	747	5.73	4.6
6/22/93	2.85	965	138	374	2.58	2.7
5/13/94	3.00	999	138	374	2.67	2.7
7/28/94	1.18	140	102	107	1.31	1.0
9/22/94	1.22	148	88	96	1.54	1.1
5/16/95	4.68	2,912	147	550	5.29	3.7
8/26/95	2.96	988	137	367	2.69	2.7
9/18/95	2.26	505	130	273	1.85	2.1
12/13/95	ND	0	River frozen solid to bottom at riffle near gage.			

ND=Not Determined

Table A-9. Peak and Minimum Discharge Summary for Mosquito Fork of the Fortymile River at Taylor Highway Bridge.

Year	Date	Peak Discharge (cfs)	Date	Minimum Discharge (cfs)
1989	6-Jun	9,720		ND
1990	1-May	5,820		ND
1991	1-May	4,610	23-Jul	154
1992	10-Jun	11,500	16-Sep	184
1993	12-May	3,670	28-Sep	218
1994	10-May	6,860	31-Aug	34
1995	15-May	5,390	4-Jul	321

ND=Not Determined

Table A-10. 1991 Wire-Weight Gage Readings and Discharge for Mosquito Fork of the Fortymile River at Taylor Highway Bridge. (Note: Wire-weight gage correction is -9.9 ft. to stream datum.)

Date	Wire-Weight Reading (ft)	Discharge (cfs)	Date	Wire-Weight Reading (ft)	Discharge (cfs)
May			August		
15	13.12	1,280	5	12.12	508
18	13.35	1,510	9	12.20	557
23	13.33	1,490	11	11.95	414
31	12.40	691	22	11.39	181
June			30	11.48	211
9	12.80	1,015	September		
12	12.95	1,125	1	11.40	184
22	11.39	181	10	11.40	184
25	11.52	225	13	12.40	691
26	11.45	201	23	12.10	497
29	11.55	236	25	11.97	424
30	11.47	208	28	11.80	340
July			30	11.40	184
8	12.80	1,015			
10	12.09	491			
22	11.39	181			
23	11.30	154			

Table A-11. 1992 Wire-Weight Gage Readings and Discharge for Mosquito Fork of the Fortymile River at Taylor Highway Bridge. (Note: Wire-weight gage correction is -9.9 ft. to stream datum.)

Date	Wire-Weight Reading (ft)	Discharge (cfs)	Date	Wire-Weight Reading (ft)	Discharge (cfs)
May			August		
19	14.40	2,845	3	13.30	1,460
22	13.55	1,730	7	13.00	1,170
29	17.10	8,710	14	13.00	1,170
June			16	12.70	927
2	18.00	11,500	21	12.30	622
7	15.30	4,390	September		
9	14.20	2,550	8	11.70	296
15	13.15	1,310	10	11.80	340
17	15.70	5,205	16	11.40	184
18	15.18	4,160			
24	14.70	3,320			
25	15.00	3,830			
30	14.30	2,695			
July					
1	13.50	1,670			
6	12.20	557			
13	12.20	557			
15	12.40	691			
20	13.60	1,785			
31	13.90	2,150			

Table A-12. 1993 Wire-Weight Gage Readings and Discharge for Mosquito Fork Fortymile River at Taylor Highway Bridge. (Note: Wire-weight gage correction is -9.9 ft. to stream datum.)

Date	Wire-Weight Reading (ft)	Discharge (cfs)	Date	Wire-Weight Reading (ft)	Discharge (cfs)
May			August		
10	15.10	4,010	1	12.00	440
13	14.80	3,480	2	11.90	388
18	15.12	4,050	4	11.80	340
21	13.67	1,865	11	11.80	340
29	17.10	8,710	13	12.00	440
June			14	12.00	440
7	13.70	1,902	16	11.80	340
8	14.10	2,410	18	11.80	340
9	14.10	2,410	19	11.70	296
11	13.30	1,460	21	12.30	622
17	12.50	765	25	13.30	1,460
22	12.73	953	26	13.40	1,560
23	13.00	1,170	27	12.90	1,080
24	13.19	1,350	28	12.70	927
25	13.03	1,200	30	12.50	765
30	12.80	1,015	31	12.60	844
July			September		
1	12.60	844	1	12.60	844
4	13.00	1,170	8	12.20	557
7	14.20	2,550	9	12.20	557
8	14.20	2,550	11	12.20	557
13	12.90	1,080	13	12.10	497
15	12.50	765	15	12.06	474
17	12.10	497	18	11.97	424
18	12.00	440	21	11.90	388
20	11.80	340	28	11.50	218
21	12.90	1,080			
26	12.10	497			
29	12.33	642			
30	12.30	622			

Table A-13. 1994 Wire-Weight Gage Readings and Discharge for Mosquito Fork of the Fortymile River at Taylor Highway Bridge.(Note: Wire-weight gage correction is -9.9 ft. to stream datum.)

Date	Wire-Weight Reading (ft)	Discharge (cfs)	Date	Wire-Weight Reading (ft)	Discharge (cfs)
May			August		
4	13.80	1,925	1	11.20	165
10	12.55	735	3	11.10	144
11	12.60	770	5	11.20	165
13	12.99	1,080	9	10.90	88
20	14.90	3,570	11	10.90	88
June			12	10.90	88
3	13.80	1,925	13	10.90	88
5	13.40	1,470	15	10.90	88
5	13.40	1,470	16	10.80	66
8	13.70	1,805	24	10.70	48
14	12.40	636	28	10.70	48
15	12.30	575	31	10.60	34
19	12.00	420	September		
21	12.40	636	15	11.12	145
July			19	11.10	144
7	12.80	920	22	11.12	145
9	12.03	432			
12	11.50	247			
13	11.40	218			
14	11.40	218			
15	12.50	701			
17	12.90	1,000			
18	12.90	1,000			
19	11.80	346			
21	11.80	346			
25	11.24	175			
26	11.20	165			
28	11.10	144			
29	11.07	134			

Table A-14. 1995 Wire-Weight Gage Readings and Discharge for Mosquito Fork of the Fortymile River at Taylor Highway Bridge. (Note: Wire-weight gage correction is -9.9 ft. to stream datum.)

Date	Wire-Weight Reading (ft)	Discharge (cfs)	Date	Wire-Weight Reading (ft)	Discharge (cfs)
May			August		
15	15.37	4,460	1	12.50	701
16	14.60	3,060	2	12.60	770
17	14.00	2,180	3	12.40	636
18	13.60	1,690	4	12.30	575
19	13.48	1,555	5	12.30	575
June			6	12.20	517
1	13.00	1,085	14	12.19	511
2	13.00	1,085	16	13.20	1,270
7	13.33	1,400	18	13.30	1,370
8	13.10	1,175	19	13.30	1,370
10	12.70	843	20	13.15	1,220
11	12.50	701	21	13.10	1,175
12	12.40	636	22	13.10	1,175
13	12.60	770	23	13.99	2,165
14	12.40	636	24	12.90	1,000
19	13.79	1,910	26	12.83	944
20	13.10	1,175	29	12.85	960
21	12.80	920	30	12.80	920
24	13.30	1,370	31	12.70	843
26	13.10	1,175	Aug. Average		984
27	12.67	821	September		
29	12.30	575	3	12.40	636
30	12.10	460	4	12.60	770
June Average		985	5	12.49	695
July			6	12.39	630
4	11.80	321	9	12.40	636
5	11.80	346	11	12.40	636
8	12.58	756	12	12.39	630
10	12.30	575	13	12.39	630
12	12.00	420	14	12.39	630
15	13.30	1,370	15	12.29	569
18	12.55	735	19	12.04	436
15	13.30	1,370	21	11.99	416
22	11.80	346	26	11.90	382
23	12.00	420	Sept. Average		592
24	12.10	460			
25	12.20	517			
26	13.60	1,690			
27	13.30	1,370			
30	12.50	701			
31	12.37	617			
July Average		709			

Walker Fork: This site was begun in September 1989 by surveying cross-sectional data and high-water mark profiles downstream of the Taylor Highway bridge. A U.S. Coast and Geodetic Survey Bench Mark (BM) on the left abutment was used for elevation reference. In 1991, a wire-weight gage was installed on the downstream guard rail above the main channel. Discharge measurements are usually made from the downstream side of the bridge during high water and wading measurents can made either upstream or downstream of the bridge. The gage reach consists of a meandering channel confined on the right bank by the road, with an extensive floodplain and low bank on the left side above the bridge. The stream bed consists of angular cobbles and gravel, with well-developed gravel bars and islands about 200 feet upstream of the bridge and about 300 feet downstream of the bridge.

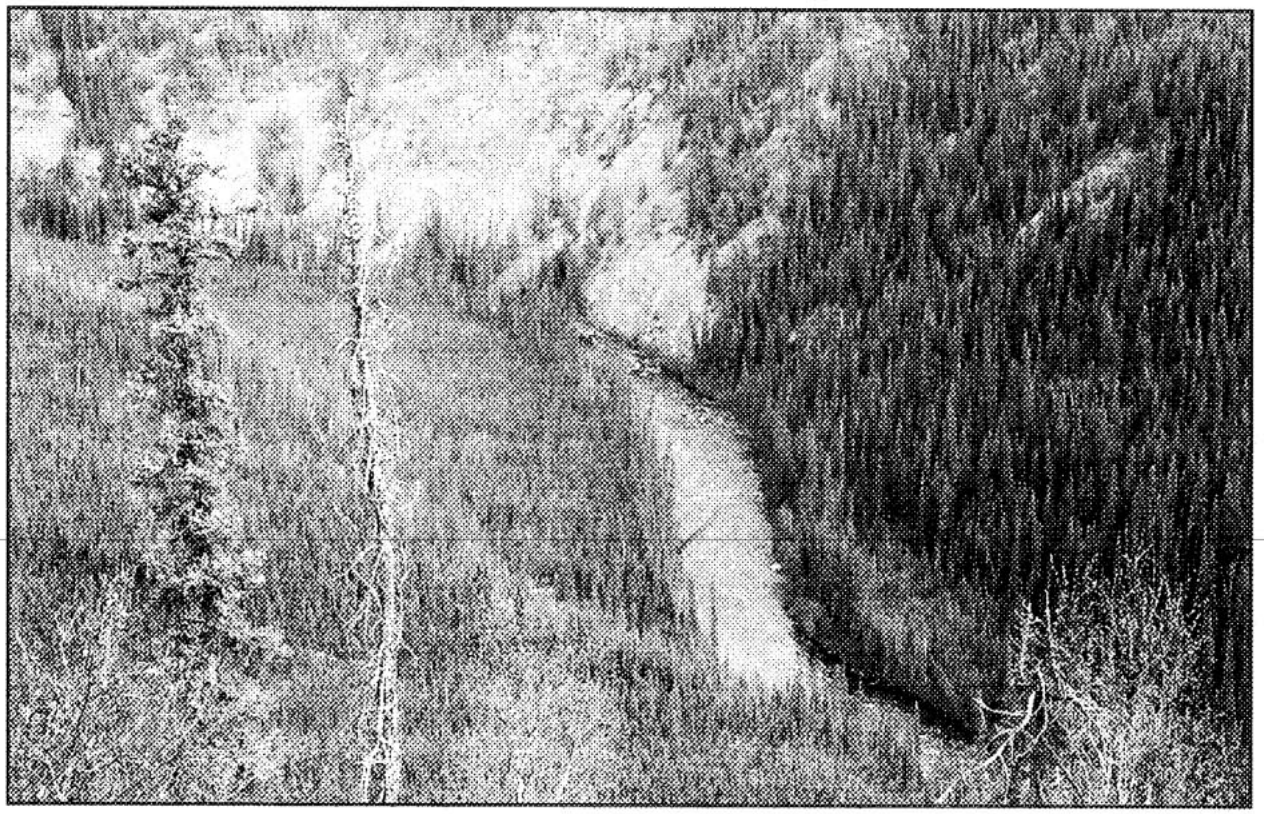

Figure 14. Walker Fork of the Fortymile River.

Table A-15. Discharge Measurement Summary for Walker Fork of the Fortymile River at Taylor Highway Bridge.

Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (ft)	Avg. Velocity (ft/sec)	Avg. Depth (ft)
9/27/89	2.50	318	82	132	2.42	1.6
8/20/90	2.44	346	85	125	2.76	1.5
8/11/91	2.20	275	96	138	2.00	1.4
6/17/92	5.89	2,550	102	497	5.13	4.9
6/24/93	1.96	167	55	79	2.11	1.4
9/15/93	1.73	142	59	65	2.18	1.1
9/18/93	1.60	118	58	72	1.64	1.2
7/28/94	1.25	68	49	65	1.05	1.3
9/21/94	1.51	106	58	63	1.68	1.1
5/18/95	2.82	554	105	201	2.76	1.9
8/26/95	2.01	223	65	100	2.23	1.5
9/19/95	1.98	214	70	81	2.64	1.2

Table A-16. Peak and Minimum Discharge Summary for Walker Fork of the Fortymile River at Taylor Highway Bridge.

Year	Date	Peak Discharge (cfs)	Date	Minimum Discharge (cfs)
1989	6-Jun	4,625		ND
1990	1-May	3,300		ND
1991	1-May	4,540	28-Jun	117
1992	1-Jun	3,540	3-Aug	117
1993	12-May	1,830	19-Jul	41
1994	10-May	3,140	26-Jul	52
1995	15-May	1,580	6-Jul	45

ND=Not Determined

Table A-17. 1991 Wire-Weight Gage Readings and Discharge for Walker Fork of the Fortymile River at the Taylor Highway Bridge. (Note: Wire-weight gage correction is -7.45 ft. to stream datum.)

Date	Wire-Weight Reading (ft)	Discharge (cfs)	Date	Wire-Weight Reading (ft)	Discharge (cfs)
May			August		
17	10.66	725	11	9.65	283
18	10.35	587	September		
June			28	9.12	134
28	9.04	117			

Table A-18. 1992 Wire-Weight Gage Readings and Discharge for Walker Fork of the Fortymile River at the Taylor Highway Bridge. (Note: Wire-weight gage correction is -7.45 ft. to stream datum.)

Date	Wire-Weight Reading (ft)	Discharge (cfs)	Date	Wire-Weight Reading (ft)	Discharge (cfs)
May			August		
19	9.10	130	3	9.04	117
21	9.80	338	5	9.34	187
28	11.82	1,375	14	9.73	312
June			16	9.54	246
2	11.34	1,079	21	9.34	187
3	10.73	758	September		
7	10.02	431	10	9.23	159
11	9.33	185			
12	9.33	185			
16	12.20	1,630			
17	13.34	2,550			
19	10.54	670			
23	10.34	583			
24	12.24	1,661			
30	9.44	215			
July					
1	9.34	187			
3	9.13	136			
6	8.73	65			
14	9.02	113			
15	9.02	113			
20	12.12	1,575			
28	10.13	483			
31	9.73	312			

Table A-19. 1993 Wire-Weight Gage Readings and Discharge for Walker Fork of the Fortymile River at Taylor Highway Bridge. (Note: Wire-weight gage correction is -7.45 ft. to stream datum.)

Date	Wire-Weight Reading (ft)	Discharge (cfs)	Date	Wire-Weight Reading (ft)	Discharge (cfs)
May			August		
20	9.87	366	3	8.73	65
June			12	8.63	52
2	9.44	215	13	8.54	42
8	9.97	409	14	8.54	42
10	9.92	387	15	8.54	42
18	9.33	185	18	8.54	42
19	8.83	80	25	9.43	213
21	8.82	78	27	9.13	136
22	8.73	65	29	9.03	115
24	9.41	207	30	9.03	115
25	9.41	207	31	9.53	243
July			September		
1	9.33	185	9	9.03	115
2	9.83	350	10	9.03	115
5	9.23	159	15	9.18	147
7	9.08	125	16	9.15	141
15	8.73	65	18	9.05	119
17	8.63	52	21	8.93	97
19	8.53	41			
20	8.53	41			
21	8.63	52			
27	8.53	41			
28	8.60	49			
29	8.93	97			
31	9.43	213			

Table A-20. 1994 Wire-Weight Gage Readings and Discharge for Walker Fork of the Fortymile River at Taylor Highway Bridge. (Note: Wire-weight gage correction is -7.45 ft. to stream datum.)

Date	Wire-Weight Reading (ft)	Discharge (cfs)	Date	Wire-Weight Reading (ft)	Discharge (cfs)
May			August		
12	10.25	544	1	9.35	190
June			2	9.23	159
2	11.83	1,380	3	9.65	283
3	12.03	1,515	4	9.43	213
4	11.02	903	5	8.92	95
14	8.82	78	10	8.93	97
20	10.44	625	11	8.83	80
28	10.73	758	12	9.24	162
July			14	9.54	246
6	11.82	1,375	15	9.44	215
9	10.44	625	21	8.96	102
13	9.80	338	24	9.43	213
14	9.90	379	26	9.23	159
15	10.02	431	28	9.03	115
16	10.55	674	30	9.04	117
18	9.60	266	31	9.02	113
19	9.44	215	September		
20	9.23	159	6	9.23	159
21	9.23	159	7	9.13	136
26	8.63	52	8	9.13	136
27	8.68	59	11	9.13	136
28	8.72	64	12	9.13	136
31	9.65	283	14	9.13	136
			15	9.12	134
			22	8.93	97

Table A-21. 1995 Wire-Weight Gage Readings and Discharge for Walker Fork of the Fortymile River at Taylor Highway Bridge. (Note: Wire-weight gage correction is -7.45 ft. to stream datum.)

Date	Wire-Weight Reading (ft)	Discharge (cfs)	Date	Wire-Weight Reading (ft)	Discharge (cfs)
May			August		
17	10.63	711	1	9.35	190
18	10.31	570	2	9.40	204
June			3	9.25	164
2	10.54	670	4	9.30	177
7	9.35	190	7	9.13	136
8	9.23	159	8	9.13	136
11	8.93	97	9	9.13	136
12	10.43	621	11	9.96	404
13	9.93	391	13	9.50	234
19	9.36	193	14	9.08	125
21	8.92	95	15	9.45	218
22	8.95	100	16	9.50	234
23	9.60	266	17	9.13	136
24	10.57	683	18	9.54	246
25	10.13	483	19	9.05	119
26	9.43	213	21	9.93	391
27	9.28	172	22	9.73	312
28	9.56	253	24	9.34	187
29	8.93	97	25	9.41	207
30	8.84	82	26	9.62	272
June Average		163	27	9.63	276
July			28	10.35	587
1	8.83	80	29	10.15	493
2	8.83	80	30	9.70	301
3	9.04	117	31	9.57	256
4	9.32	182	Aug. Average		364
5	9.16	143	September		
6	8.57	45	1	9.35	190
7	8.88	88	2	9.30	177
10	8.33	24	3	9.43	213
11	9.23	159	6	9.63	276
12	9.12	134	7	9.53	243
13	9.60	266	9	9.54	246
14	10.45	630	10	9.82	346
15	9.67	290	13	9.93	391
16	9.29	174	14	9.83	350
22	8.73	65	19	9.44	215
23	8.73	65	20	9.35	190
25	9.33	185	21	9.33	185
26	9.93	391	26	9.23	159
28	9.21	154	Sept. Average		245
29	9.08	125			
30	8.90	91			
31	9.15	141			
July Average		181			

South Fork: Monitoring at this site began in August 1989 with a discharge measurent about 800 feet upstream of the Taylor Highway bridge, followed by surveys of high-water-mark profiles in September. In June 1990, a data logger was installed in this same reach upstream of the bridge. In 1992, a wire-weight gage was installed on the upstream guard rail. The U.S. Coast and Geodetic Survey Bench Mark (BM) on the left abutment was used for elevation reference. The data logger was relocated about 200 feet downstream in 1994 after suction dredge activity in 1993 undercut the banks and created an unstable channel in the gage reach. Discharge measurements are usually made from the upstream side of the bridge during high water. Wading measurents are made upstream of the bridge. The gage reach consists of a straight channel confined on the right bank by a gently sloping ridge, with a somewhat lower bank on the left side. The stream bed consists of angular cobbles and boulders, with lateral gravel bars and suction dredge piles evident at low water.

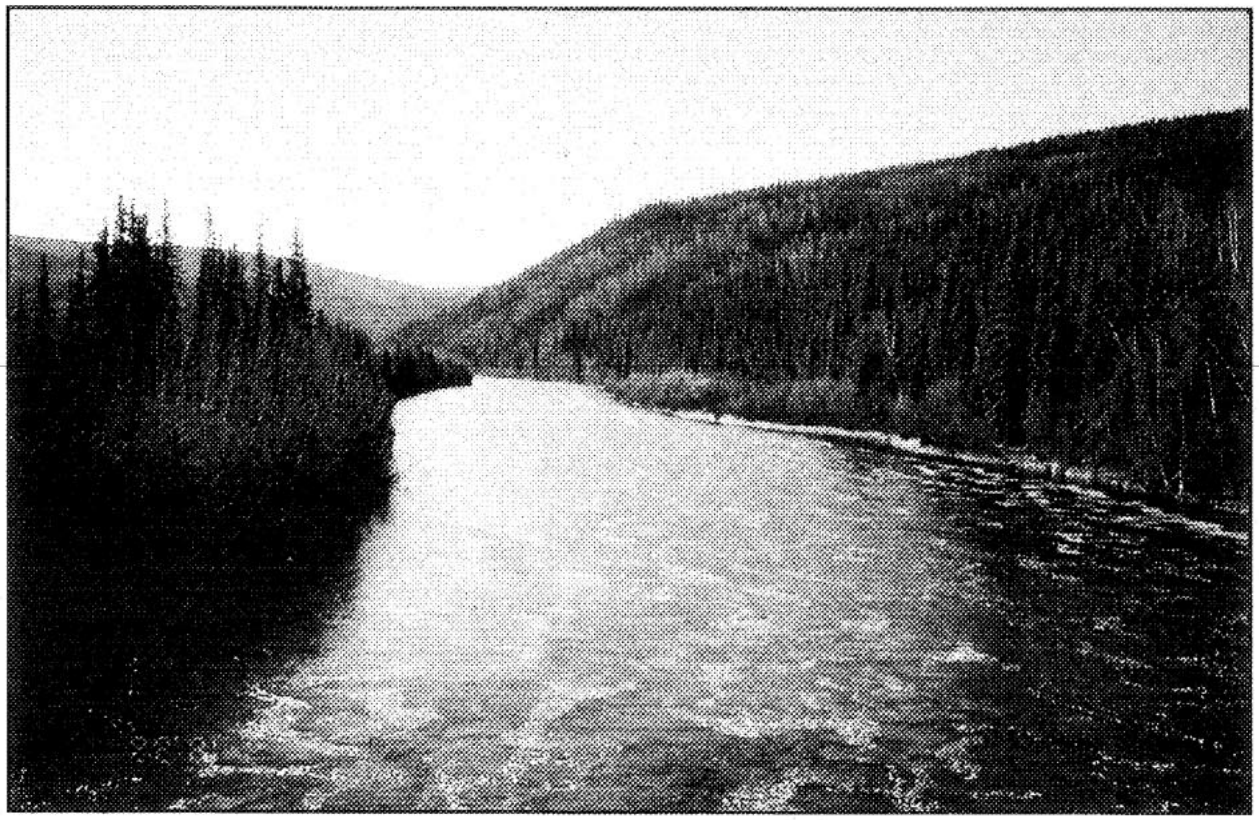

Figure 15. South Fork of the Fortymile River.

Table A-22. Discharge Measurement Summary for South Fork of the Fortymile River at the Taylor Highway Bridge.

Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (ft)	Avg. Velocity (ft/sec)	Avg. Depth (ft)
5/1/89	13.25	21,500	333	2,550	8.43	7.7
8/19/89	2.15	156	128	172	0.91	1.3
5/10/90	8.52	8,030	215	1,550	5.18	7.2
6/21/90	2.61	460	93	253	1.82	2.7
8/20/90	3.23	672	171	368	1.83	2.2
6/29/91	2.83	498	158	298	1.67	1.9
9/25/91	3.35	785	180	386	2.03	2.1
12/21/91	ND	2	40	30	0.05	0.8
2/20/92	ND	1	53	15	0.05	0.3
4/14/92	ND	1	165	29	0.03	0.2
5/22/92	4.94	2,291	206	979	2.34	4.8
5/21/93	5.64	3,251	206	979	3.32	4.8
7/26/93	3.33	797	174	355	2.25	2.0
9/15/93	3.89	1,135	175	449	2.53	2.6
5/12/94	4.38	1,529	196	757	2.02	3.9
7/28/94	2.77	370	177	238	1.55	1.3
9/22/94	2.81	268	159	195	1.37	1.2
5/16/95	8.57	8,554	219	1,587	5.39	7.2
5/18/95	6.79	4,409	210	1,184	3.72	5.6
6/30/95	4.24	1,181	168	432	2.73	2.6
9/22/95	3.89	939	170	386	2.43	2.3
12/12/95	ND	0	40	8	0.05	0.2

ND=Not Determined

Table A-23. Peak and Minimum Discharge Summary for South Fork of the Fortymile River at the Taylor Highway Bridge.

Year	Date	Peak Discharge (cfs)	Date	Minimum Discharge (cfs)
1989	1-May	21,500	19-Aug	156
1990	7-May	11,600	4-Aug	117
1991	10-May	9,970	9-Sep	267
1992	27-May	21,700	21-Sep	561
1993	9-May	12,500	22-Aug	431
1994	27-May	13,800	29-Aug	158
1995	12-May	14,900	22-Jul	560

Table A-24. 1990 Daily and Summary Discharge (cfs) for South Fork of the Fortymile River at the Taylor Highway Bridge.

Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge
1-Jun		1-Jul	1,075	1-Aug	180	1-Sep	1,096
2-Jun		2-Jul	784	2-Aug	181	2-Sep	1,052
3-Jun		3-Jul	829	3-Aug	142	3-Sep	1,006
4-Jun		4-Jul	683	4-Aug	123	4-Sep	995
5-Jun		5-Jul	587	5-Aug	145	5-Sep	990
6-Jun		6-Jul	505	6-Aug	200	6-Sep	1,049
7-Jun		7-Jul	430	7-Aug	413	7-Sep	1,069
8-Jun		8-Jul	484	8-Aug	1,183	8-Sep	1,087
9-Jun		9-Jul	498	9-Aug	1,304	9-Sep	1,189
10-Jun		10-Jul	775	10-Aug	1,236	10-Sep	3,052
11-Jun		11-Jul	1,211	11-Aug	1,053	11-Sep	6,526
12-Jun		12-Jul	1,050	12-Aug	873	12-Sep	7,291
13-Jun		13-Jul	923	13-Aug	718	13-Sep	6,514
14-Jun		14-Jul	767	14-Aug	627	14-Sep	5,372
15-Jun		15-Jul	637	15-Aug	557	15-Sep	4,551
16-Jun		16-Jul	564	16-Aug	585	16-Sep	3,985
17-Jun		17-Jul	507	17-Aug	760	17-Sep	3,510
18-Jun		18-Jul	419	18-Aug	707	18-Sep	2,946
19-Jun		19-Jul	318	19-Aug	667	19-Sep	2,531
20-Jun		20-Jul	298	20-Aug	706	20-Sep	2,239
21-Jun		21-Jul	249	21-Aug	1,287	21-Sep	2,018
22-Jun	569	22-Jul	225	22-Aug	1,769	22-Sep	1,836
23-Jun	591	23-Jul	210	23-Aug	1,829	23-Sep	1,720
24-Jun	839	24-Jul	183	24-Aug	1,572	24-Sep	1,655
25-Jun	827	25-Jul	166	25-Aug	1,333	25-Sep	
26-Jun	706	26-Jul	151	26-Aug	1,160	26-Sep	
27-Jun	598	27-Jul	145	27-Aug	1,112	27-Sep	
28-Jun	708	28-Jul	142	28-Aug	1,150	28-Sep	
29-Jun	819	29-Jul	125	29-Aug	1,178	29-Sep	
30-Jun	1,272	30-Jul	134	30-Aug	1,193	30-Sep	
		31-Jul	137	31-Aug	1,138		
Mean		Mean	491	Mean	874	Mean	2,720
Max.		Max.	1,211	Max.	1,829	Max.	7,291
Min.		Min.	125	Min.	123	Min.	990

Table A-25. 1991 Daily and Summary Discharge (cfs) for South Fork of the Fortymile River at the Taylor Highway Bridge.

Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge
1-May		1-Jun	1,352	1-Jul		1-Aug		1-Sep	509
2-May		2-Jun	2,880	2-Jul		2-Aug		2-Sep	470
3-May		3-Jun	4,579	3-Jul		3-Aug		3-Sep	449
4-May		4-Jun	3,825	4-Jul		4-Aug		4-Sep	362
5-May		5-Jun	2,799	5-Jul		5-Aug		5-Sep	322
6-May		6-Jun	2,181	6-Jul		6-Aug		6-Sep	306
7-May		7-Jun	1,856	7-Jul		7-Aug		7-Sep	284
8-May		8-Jun	1,703	8-Jul		8-Aug		8-Sep	270
9-May		9-Jun	1,742	9-Jul		9-Aug		9-Sep	267
10-May		10-Jun	1,814	10-Jul		10-Aug		10-Sep	295
11-May		11-Jun	1,963	11-Jul		11-Aug	1,025	11-Sep	392
12-May		12-Jun	2,073	12-Jul		12-Aug	879	12-Sep	524
13-May	1,951	13-Jun	2,139	13-Jul		13-Aug	720	13-Sep	1,052
14-May	1,989	14-Jun	2,167	14-Jul		14-Aug	652	14-Sep	1,727
15-May	2,433	15-Jun	1,903	15-Jul		15-Aug	586	15-Sep	1,944
16-May	2,547	16-Jun	1,563	16-Jul		16-Aug	539	16-Sep	1,679
17-May	2,425	17-Jun	1,297	17-Jul		17-Aug	505	17-Sep	1,436
18-May	2,262	18-Jun	1,111	18-Jul		18-Aug	470	18-Sep	1,263
19-May	2,394	19-Jun	789	19-Jul		19-Aug	461	19-Sep	1,240
20-May	2,253	20-Jun	757	20-Jul		20-Aug	445	20-Sep	1,203
21-May	2,187	21-Jun	665	21-Jul		21-Aug	443	21-Sep	1,170
22-May	2,158	22-Jun	577	22-Jul		22-Aug	351	22-Sep	1,138
23-May	2,136	23-Jun	527	23-Jul		23-Aug	315	23-Sep	1,065
24-May	2,009	24-Jun	521	24-Jul		24-Aug	298	24-Sep	1,005
25-May	1,849	25-Jun	479	25-Jul		25-Aug	295	25-Sep	894
26-May	1,711	26-Jun	426	26-Jul		26-Aug	324	26-Sep	757
27-May	1,652	27-Jun	373	27-Jul		27-Aug	382	27-Sep	716
28-May	1,406	28-Jun	359	28-Jul		28-Aug	559	28-Sep	673
29-May	1,236	29-Jun	479	29-Jul		29-Aug	575	29-Sep	
30-May	1,087	30-Jun	627	30-Jul		30-Aug	546	30-Sep	
31-May	991			31-Jul		31-Aug	509		
Mean	1,930	Mean	1,518	Mean		Mean	518	Mean	836
Max.	2,547	Max.	4,579	Max.		Max.	1,025	Max.	1,944
Min.	991	Min.	359	Min.		Min.	295	Min.	267

Table A-26. 1992 Daily and Summary Discharge (cfs) for South Fork of the Fortymile River at the Taylor Highway Bridge.

Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge
1-May		1-Jun		1-Jul	3,576	1-Aug	2,771	1-Sep	1,401
2-May		2-Jun	14,253	2-Jul	2,664	2-Aug	3,187	2-Sep	1,359
3-May		3-Jun	12,021	3-Jul	2,093	3-Aug	4,502	3-Sep	1,285
4-May		4-Jun		4-Jul	1,741	4-Aug	4,728	4-Sep	1,219
5-May		5-Jun		5-Jul	1,493	5-Aug	4,253	5-Sep	1,173
6-May		6-Jun		6-Jul	1,243	6-Aug	3,426	6-Sep	1,115
7-May		7-Jun	7,186	7-Jul	1,230	7-Aug	2,799	7-Sep	1,047
8-May		8-Jun		8-Jul	1,575	8-Aug	2,337	8-Sep	999
9-May		9-Jun	4,667	9-Jul	1,892	9-Aug	2,061	9-Sep	960
10-May		10-Jun		10-Jul	1,826	10-Aug	1,849	10-Sep	936
11-May		11-Jun	3,020	11-Jul	1,608	11-Aug	1,686	11-Sep	799
12-May		12-Jun	2,766	12-Jul	1,396	12-Aug	1,954	12-Sep	767
13-May		13-Jun		13-Jul	1,320	13-Aug	3,167	13-Sep	750
14-May		14-Jun		14-Jul	1,512	14-Aug	3,382	14-Sep	739
15-May		15-Jun	2,176	15-Jul	1,833	15-Aug	3,013	15-Sep	658
16-May		16-Jun	3,838	16-Jul	3,034	16-Aug	2,620	16-Sep	658
17-May		17-Jun	7,631	17-Jul	5,099	17-Aug	2,339	17-Sep	683
18-May		18-Jun	5,623	18-Jul	5,674	18-Aug	2,239	18-Sep	671
19-May	1,076	19-Jun	3,956	19-Jul	6,074	19-Aug	2,261	19-Sep	640
20-May		20-Jun	2,832	20-Jul	9,855	20-Aug	2,207	20-Sep	591
21-May	1,276	21-Jun	2,895	21-Jul	11,984	21-Aug	2,023	21-Sep	561
22-May	2,247	22-Jun	2,915	22-Jul	9,962	22-Aug	1,891	22-Sep	
23-May	4,794	23-Jun	3,322	23-Jul	6,778	23-Aug	1,812	23-Sep	
24-May	7,805	24-Jun	6,906	24-Jul	4,718	24-Aug	1,722	24-Sep	
25-May	10,448	25-Jun	12,956	25-Jul	3,939	25-Aug	1,608	25-Sep	
26-May	13,414	26-Jun	13,480	26-Jul	3,718	26-Aug	1,497	26-Sep	
27-May	19,377	27-Jun	10,704	27-Jul	4,161	27-Aug	1,409	27-Sep	
28-May	13,654	28-Jun	8,677	28-Jul	4,074	28-Aug	1,352	28-Sep	
29-May		29-Jun	6,425	29-Jul	3,538	29-Aug	1,333	29-Sep	
30-May		30-Jun	4,611	30-Jul	3,018	30-Aug	1,350	30-Sep	
31-May				31-Jul	2,797	31-Aug	1,344		
Mean	9,127	Mean	6,494	Mean	3,723	Mean	2,391	Mean	905
Max.	19,377	Max.	14,253	Max.	11,984	Max.	4,728	Max.	1,401
Min.	1,276	Min.	2,176	Min.	1,230	Min.	1,333	Min.	561

Table A-27. 1993 Daily and Summary Discharge (cfs) for South Fork of the Fortymile River at the Taylor Highway Bridge.

Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge
1 May		1-Jun	1,308	1-Jul	1,638	1-Aug	1,058		
2-May		2-Jun	1,084	2-Jul	1,860	2-Aug	928	1-Sep	1,575
3-May		3-Jun	867	3-Jul	3,123	3-Aug	784	2-Sep	1,604
4-May		4-Jun	760	4-Jul	2,966	4-Aug	662	3-Sep	1,558
5-May		5-Jun	683	5-Jul	2,232	5-Aug	577	4-Sep	1,439
6-May		6-Jun	1,076	6-Jul	3,461	6-Aug	521	5-Sep	1,358
7-May		7-Jun	2,526	7-Jul	5,899	7-Aug	528	6-Sep	1,271
8-May		8-Jun	3,843	8-Jul	5,390	8-Aug	560	7-Sep	1,195
9-May		9-Jun	5,012	9-Jul	4,617	9-Aug	612	8-Sep	1,141
10-May		10-Jun	4,004	10-Jul	3,659	10-Aug	684	9-Sep	1,106
11-May	7,888	11-Jun	3,129	11-Jul	3,184	11-Aug	705	10-Sep	1,067
12-May		12-Jun	2,496	12-Jul	2,718	12-Aug	700	11-Sep	1,058
13-May	7,070	13-Jun	2,465	13-Jul	2,272	13-Aug	764	12-Sep	1,075
14-May		14-Jun	2,317	14-Jul	1,850	14-Aug	793	13-Sep	1,129
15-May		15-Jun	1,913	15-Jul	1,467	15-Aug	757	14-Sep	1,142
16-May		16-Jun	1,753	16-Jul	1,184	16-Aug	710	15-Sep	1,150
17-May		17-Jun	1,711	17-Jul	1,010	17-Aug	646	16-Sep	1,099
18-May	6,587	18-Jun	2,000	18-Jul	897	18-Aug	602	17-Sep	1,065
19-May	5,416	19-Jun	2,158	19-Jul	783	19-Aug	545	18-Sep	1,018
20-May	4,627	20-Jun	1,984	20-Jul	716	20-Aug	503	19-Sep	
21-May	3,060	21-Jun	1,731	21-Jul	675	21-Aug	467	20-Sep	
22-May	2,266	22-Jun	1,752	22-Jul	606	22-Aug	447	21-Sep	893
23-May	1,888	23-Jun	1,935	23-Jul	547	23-Aug	994	22-Sep	
24-May	1,982	24-Jun	2,173	24-Jul	555	24-Aug	2,027	23-Sep	
25-May	2,111	25-Jun	2,164	25-Jul	651	25-Aug	2,895	24-Sep	
26-May	1,852	26-Jun	2,835	26-Jul	804	26-Aug	2,510	25-Sep	
27-May	1,678	27-Jun	3,457	27-Jul	1,209	27-Aug	2,135	26-Sep	
28-May	3,275	28-Jun	3,253	28-Jul	1,157	28-Aug	1,866	27-Sep	
29-May	2,646	29-Jun	2,510	29-Jul	1,093	29-Aug	1,624	28-Sep	441
30-May	2,143	30-Jun	1,993	30-Jul	1,134	30-Aug	1,449	29-Sep	
31-May	1,646			31-Jul	1,122	31-Aug	1,441	30-Sep	
Mean	3,509	Mean	2,230	Mean	1,951	Mean	1016	Mean	1169
Max.	7,888	Max.	5,012	Max.	5,899	Max.	2895	Max.	1604
Min.	1,646	Min.	683	Min.	547	Min.	447	Min.	441

Table A-28. 1994 Daily and Summary Discharge (cfs) for South Fork of the Fortymile River at the Taylor Highway Bridge.

Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge
1-May		1-Jun	4,175	1-Jul	785	1-Aug	446	1-Sep	163
2-May		2-Jun	3,273	2-Jul	593	2-Aug	332	2-Sep	178
3-May		3-Jun	3,045	3-Jul	590	3-Aug	296	3-Sep	192
4-May	4,470	4-Jun	3,277	4-Jul	806	4-Aug	290	4-Sep	216
5-May		5-Jun	2,808	5-Jul	874	5-Aug	274	5-Sep	249
6-May		6-Jun	2,782	6-Jul	1,238	6-Aug	234	6-Sep	273
7-May		7-Jun	3,391	7-Jul	4,389	7-Aug	208	7-Sep	274
8-May		8-Jun	3,443	8-Jul	5,334	8-Aug	207	8-Sep	278
9-May		9-Jun	2,761	9-Jul	3,658	9-Aug	200	9-Sep	282
10-May	1,514	10-Jun	2,119	10-Jul	2,128	10-Aug	196	10-Sep	283
11-May	1,496	11-Jun	1,866	11-Jul	1,402	11-Aug	180	11-Sep	278
12-May	1,535	12-Jun	1,716	12-Jul	1,004	12-Aug	176	12-Sep	290
13-May	1,873	13-Jun	1,454	13-Jul	850	13-Aug	194	13-Sep	307
14-May	2,696	14-Jun	1,209	14-Jul	1,046	14-Aug	231	14-Sep	317
15-May	2,661	15-Jun	973	15-Jul	1,229	15-Aug	216	15-Sep	314
16-May	2,164	16-Jun	806	16-Jul	1,837	16-Aug	207	16-Sep	307
17-May	1,823	17-Jun	690	17-Jul	1,937	17-Aug	196	17-Sep	297
18-May	1,578	18-Jun	597	18-Jul	1,752	18-Aug	188	18-Sep	290
19-May	1,426	19-Jun	873	19-Jul	1,613	19-Aug	174	19-Sep	294
20-May	4,304	20-Jun	1,356	20-Jul	1,330	20-Aug	166	20-Sep	301
21-May	4,164	21-Jun	1,331	21-Jul	1,064	21-Aug	169	21-Sep	288
22-May	3,261	22-Jun	1,193	22-Jul	783	22-Aug	165	22-Sep	278
23-May	2,286	23-Jun	924	23-Jul	614	23-Aug	170	23-Sep	
24-May	1,749	24-Jun	707	24-Jul	481	24-Aug	173	24-Sep	
25-May	1,466	25-Jun	553	25-Jul	381	25-Aug	173	25-Sep	
26-May	3,884	26-Jun	595	26-Jul	329	26-Aug	174	26-Sep	
27-May	12,470	27-Jun	929	27-Jul	290	27-Aug	169	27-Sep	
28-May	11,772	28-Jun	1,196	28-Jul	278	28-Aug	164	28-Sep	
29-May	8,877	29-Jun	1,270	29-Jul	319	29-Aug	158	29-Sep	
30-May	7,122	30-Jun	1,071	30-Jul	372	30-Aug	158	30-Sep	
31-May	5,728			31-Jul	461	31-Aug	158		
Mean	3,927	Mean	1,746	Mean	1,283	Mean	208	Mean	270
Max.	12,470	Max.	4,175	Max.	5,334	Max.	446	Max.	317
Min.	1,426	Min.	553	Min.	278	Min.	158	Min.	163

Table A-29. 1995 Daily and Summary Discharge (cfs) for South Fork of the Fortymile River at the Taylor Highway Bridge.

Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge
1-May		1-Jun	2,994	1-Jul	875	1-Aug	1,323	1-Sep	1720
2-May		2-Jun	3,138	2-Jul	750	2-Aug	1,566	2-Sep	1825
3-May		3-Jun		3-Jul	689	3-Aug	1,452	3-Sep	1849
4-May		4-Jun		4-Jul	1,026	4-Aug	1,281	4-Sep	1813
5-May		5-Jun		5-Jul	2,039	5-Aug	1,238	5-Sep	1780
6-May		6-Jun		6-Jul	2,128	6-Aug	1,305	6-Sep	1807
7-May		7-Jun	2,288	7-Jul	1,733	7-Aug	1,289	7-Sep	1771
8-May		8-Jun	2,002	8-Jul	1,374	8-Aug	1,129	8-Sep	1700
9-May		9-Jun		9-Jul	1,397	9-Aug	963	9-Sep	1635
10-May		10-Jun		10-Jul	2,033	10-Aug	963	10-Sep	1583
11-May		11-Jun	1,325	11-Jul	1,666	11-Aug	802	11-Sep	1609
12-May		12-Jun	1,690	12-Jul	1,364	12-Aug	751	12-Sep	1578
13-May		13-Jun	1,594	13-Jul	1,265	13-Aug	722	13-Sep	1486
14-May		14-Jun		14-Jul	1,858	14-Aug	1,081	14-Sep	1390
15-May	12,577	15-Jun		15-Jul	2,706	15-Aug	2,081	15-Sep	1324
16-May	9,212	16-Jun		16-Jul	2,623	16-Aug	3,286	16-Sep	1248
17-May	6,712	17-Jun		17-Jul	1,952	17-Aug	3,428	17-Sep	1187
18-May	4,806	18-Jun		18-Jul	1,410	18-Aug	3,192	18-Sep	1117
19-May	3,407	19-Jun	3,825	19-Jul	1,084	19-Aug	2,964	19-Sep	1049
20-May	3,006	20-Jun		20-Jul	853	20-Aug	2,925	20-Sep	977
21-May	2,499	21-Jun		21-Jul	687	21-Aug	3,020	21-Sep	920
22-May	2,037	22-Jun	1,760	22-Jul	576	22-Aug	2,971	22-Sep	924
23-May	1,643	23-Jun		23-Jul	581	23-Aug	2,757	23-Sep	927
24-May	1,374	24-Jun	3,153	24-Jul	647	24-Aug	2,413	24-Sep	
25-May	1,267	25-Jun	3,943	25-Jul	904	25-Aug	2,194	25-Sep	
26-May	1,305	26-Jun	3,302	26-Jul	2,116	26-Aug	2,129	26-Sep	843
27-May	1,434	27-Jun	2,184	27-Jul	2,151	27-Aug	2,060	27-Sep	
28-May	1,421	28-Jun	1,756	28-Jul	1,934	28-Aug	2,129	28-Sep	
29-May	2,077	29-Jun	1,319	29-Jul	1,582	29-Aug	2,117	29-Sep	
30-May	3,845	30-Jun	1,077	30-Jul	1,282	30-Aug	1,962	30-Sep	
31-May	3,471			31-Jul	1,159	31-Aug	1,810		
Mean	3,652	Mean	2,334	Mean	1,434	Mean	1,913	Mean	1419
Max.	12,577	Max.	3,943	Max.	2,706	Max.	3,428	Max.	1849
Min.	1,267	Min.	1,077	Min.	576	Min.	722	Min.	843

North Fork: This site was begun in June 1991 with installation of a data logger, discharge measurement and cross-sectional survey about 800 feet upstream of the confluence with the South Fork. Discharge measurements, made from a boat during high water and by wading at low water, are usually made several hundred feet downstream of the gage. The gage reach consists of a straight channel confined on both banks by ridges, with steep rock bluffs just upstream. The stream bed consists of angular cobbles and boulders, with lateral gravel bars evident only at extreme low water.

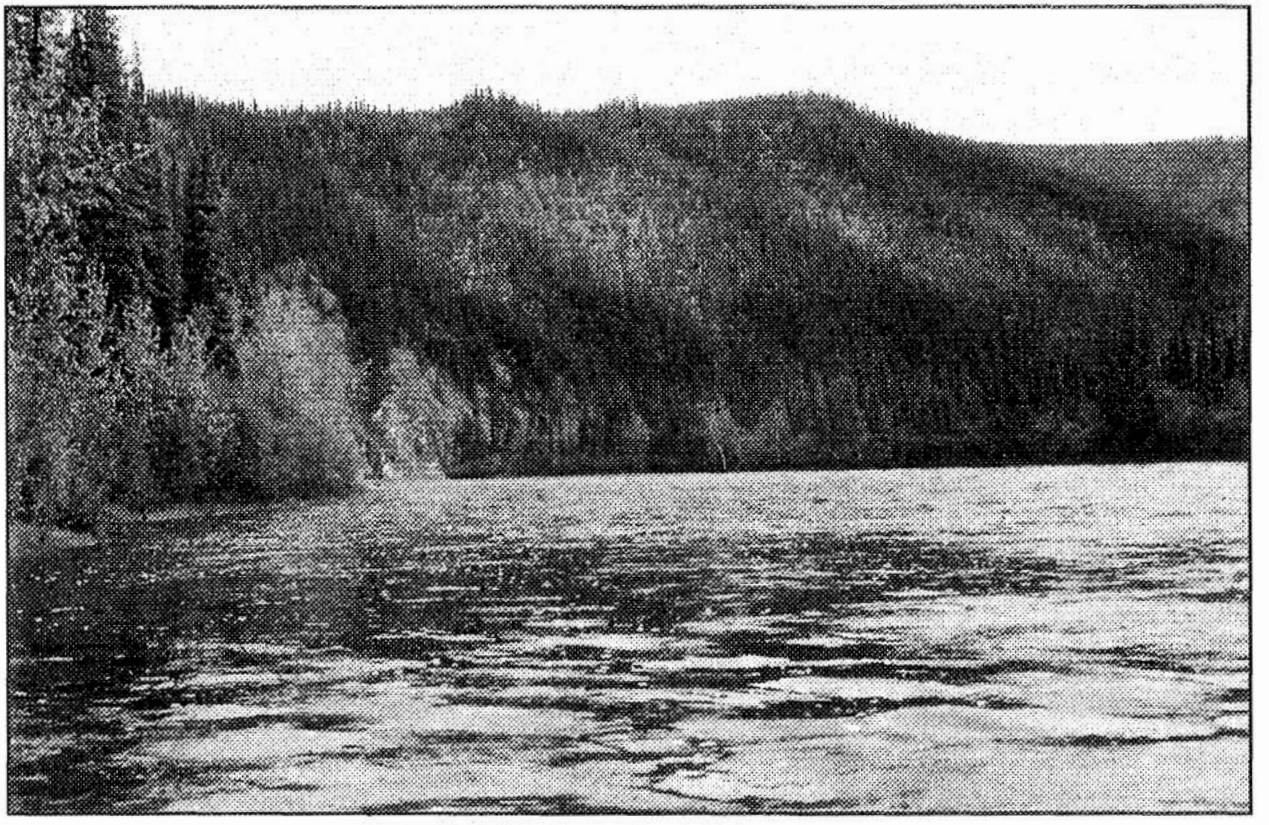

Figure 16. North Fork of the Fortymile River, upstream of South Fork confluence.

Table A-30. Discharge Measurement Summary for North Fork of the Fortymile River at the South Fork Confluence.

Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (ft)	Avg.Velocity (ft/sec)	Avg. Depth (ft)
6/27/91	2.51	817	255	418	1.95	1.6
8/9/91	3.16	1,440	281	531	2.71	1.9
9/26/91	2.46	758	205	340	2.23	1.7
2/20/92	ND	38	46	24	1.58	0.5
4/14/92	ND	30	28	15	1.95	0.5
8/4/92	4.00	2,770	222	861	3.22	3.9
11/13/92	ND	120	65	60	2.00	0.9
3/26/93	ND	12	19	8.4	1.43	0.4
6/23/93	3.25	1,390	280	554	2.51	2.0
7/27/93	3.53	1,680	300	625	2.69	2.1
3/26/94	ND	1	78	8	0.19	0.1
7/26/94	2.15	450	255	337	1.34	1.3
9/21/94	2.60	735	281	379	1.94	1.3
12/12/94	ND	58	100	55	1.05	0.6
6/29/95	3.58	1,830	282	620	2.95	2.2
8/25/95	3.45	1,650	245	615	2.68	2.5
9/21/95	3.11	1,320	276	536	2.46	1.9
2/12/95	ND	10	29	14	0.69	0.5

ND=Not Determined

Table A-31. Peak and Minimum Discharge Summary for North Fork of the Fortymile River at the South Fork Confluence.

Year	Date	Peak Discharge (cfs)	Date	Minimum Discharge (cfs)
1991	5-May	10,400	24-Jul	330
1992	25-May	20,000	17-Sep	618
1993	15-May	18,200	6-Jun	355
1994	27-May	19,600	20-Aug	350
1995	17-May	22,400	6-Jul	768

Table A-32. 1991 Daily and Summary Discharge (cfs) for North Fork of the Fortymile River at the South Fork Confluence.

Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge
1-Jun		1-Jul	570	1-Aug	805	1-Sep	542
2-Jun		2-Jul	662	2-Aug	722	2-Sep	521
3-Jun		3-Jul	1,102	3-Aug	790	3-Sep	493
4-Jun		4-Jul	1,968	4-Aug	1,090	4-Sep	473
5-Jun		5-Jul	1,734	5-Aug	1,728	5-Sep	469
6-Jun		6-Jul	1,210	6-Aug	1,374	6-Sep	480
7-Jun		7-Jul	906	7-Aug	1,558	7-Sep	529
8-Jun		8-Jul	874	8-Aug	1,712	8-Sep	546
9-Jun		9-Jul	1,041	9-Aug	1,407	9-Sep	582
10-Jun		10-Jul	919	10-Aug	1,156	10-Sep	657
11-Jun		11-Jul	870	11-Aug	989	11-Sep	713
12-Jun		12-Jul	824	12-Aug	851	12-Sep	1,041
13-Jun		13-Jul	926	13-Aug	745	13-Sep	2,101
14-Jun		14-Jul	1,003	14-Aug	699	14-Sep	1,890
15-Jun		15-Jul	833	15-Aug	662	15-Sep	1,523
16-Jun		16-Jul	710	16-Aug	625	16-Sep	1,285
17-Jun		17-Jul	607	17-Aug	606	17-Sep	1,159
18-Jun		18-Jul	537	18-Aug	587	18-Sep	1,170
19-Jun		19-Jul	488	19-Aug	932	19-Sep	1,134
20-Jun		20-Jul	463	20-Aug	1,138	20-Sep	1,088
21-Jun		21-Jul	433	21-Aug	942	21-Sep	1,122
22-Jun		22-Jul	397	22-Aug	797	22-Sep	1,054
23-Jun		23-Jul	362	23-Aug	720	23-Sep	984
24-Jun		24-Jul	350	24-Aug	696	24-Sep	920
25-Jun		25-Jul	348	25-Aug	867	25-Sep	827
26-Jun		26-Jul	432	26-Aug	875	26-Sep	766
27-Jun	782	27-Jul	409	27-Aug	796	27-Sep	
28-Jun	972	28-Jul	387	28-Aug	705	28-Sep	
29-Jun	800	29-Jul	407	29-Aug	658	29-Sep	
30-Jun	655	30-Jul	654	30-Aug	626	30-Sep	
		31-Jul	910	31-Aug	585		
Mean		Mean	753	Mean	918	Mean	926
Max.		Max.	1,968	Max.	1,728	Max.	2,101
Min.		Min.	348	Min.	585	Min.	469

Table A-33. 1992 Daily and Summary Discharge (cfs) for North Fork of the Fortymile River at the South Fork Confluence.

Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge
1-Jun		1-Jul	2,016	1-Aug	2,272	1-Sep	1,988
2-Jun		2-Jul	1,918	2-Aug	2,027	2-Sep	1,998
3-Jun		3-Jul	1,724	3-Aug	2,631	3-Sep	1,806
4-Jun		4-Jul	1,324	4-Aug	2,681	4-Sep	1,656
5-Jun		5-Jul	1,156	5-Aug	2,247	5-Sep	1,292
6-Jun		6-Jul	1,049	6-Aug	1,966	6-Sep	1,224
7-Jun		7-Jul	918	7-Aug	1,754	7-Sep	1,156
8-Jun		8-Jul	1,006	8-Aug	1,613	8-Sep	1,070
9-Jun		9-Jul	1,055	9-Aug	1,394	9-Sep	1,036
10-Jun		10-Jul	972	10-Aug	1,242	10-Sep	1,026
11-Jun		11-Jul	906	11-Aug	1,172	11-Sep	964
12-Jun		12-Jul	954	12-Aug	1,262	12-Sep	901
13-Jun		13-Jul	1,016	13-Aug	2,790	13-Sep	859
14-Jun		14-Jul	978	14-Aug	2,803	14-Sep	867
15-Jun		15-Jul	968	15-Aug	2,476	15-Sep	844
16-Jun	8,833	16-Jul	1,030	16-Aug	2,161	16-Sep	811
17-Jun	15,840	17-Jul	1,486	17-Aug	1,918	17-Sep	656
18-Jun	9,768	18-Jul	1,934	18-Aug	1,811	18-Sep	
19-Jun	5,489	19-Jul	1,988	19-Aug	1,782	19-Sep	
20-Jun	3,990	20-Jul	2,453	20-Aug	1,749	20-Sep	
21-Jun	3,785	21-Jul	4,578	21-Aug	1,685	21-Sep	
22-Jun	4,474	22-Jul	3,003	22-Aug	1,678	22-Sep	
23-Jun	6,176	23-Jul	2,226	23-Aug	1,754	23-Sep	
24-Jun	10,031	24-Jul	2,046	24-Aug	1,742	24-Sep	
25-Jun	9,651	25-Jul	2,014	25-Aug	1,659	25-Sep	
26-Jun	7,867	26-Jul	2,264	26-Aug	1,484	26-Sep	
27-Jun	5,184	27-Jul	3,661	27-Aug	1,269	27-Sep	
28-Jun	3,588	28-Jul	3,631	28-Aug	1,606	28-Sep	
29-Jun	2,780	29-Jul	3,093	29-Aug	1,724	29-Sep	
30-Jun	2,290	30-Jul	2,972	30-Aug	1,708	30-Sep	
		31-Jul	2,672	31-Aug	1,743		
Mean	6,650	Mean	1,904	Mean	1,865	Mean	1,186
Max.	15,840	Max.	4,578	Max.	2,803	Max.	1,998
Min.	2,290	Min.	906	Min.	1,172	Min.	656

Table A-34. 1993 Daily and Summary Discharge (cfs) for North Fork of the Fortymile River at the South Fork Confluence.

Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge
1-Jun	2,213	1-Jul	1,781	1-Aug	1,090	1-Sep	2,320
2-Jun	1,669	2-Jul	1,684	2-Aug	975	2-Sep	2,246
3-Jun	1,224	3-Jul	2,276	3-Aug	903	3-Sep	2,124
4-Jun	967	4-Jul	3,866	4-Aug	841	4-Sep	1,939
5-Jun	695	5-Jul	3,928	5-Aug	797	5-Sep	1,799
6-Jun	433	6-Jul	4,267	6-Aug	796	6-Sep	1,724
7-Jun	571	7-Jul	3,549	7-Aug	870	7-Sep	1,558
8-Jun	776	8-Jul	2,674	8-Aug	1,126	8-Sep	1,518
9-Jun	1,397	9-Jul	2,078	9-Aug	1,153	9-Sep	1,491
10-Jun	1,987	10-Jul	1,856	10-Aug	1,036	10-Sep	1,429
11-Jun	1,966	11-Jul	1,524	11-Aug	1,034	11-Sep	1,591
12-Jun	1,994	12-Jul	1,315	12-Aug	1,101	12-Sep	1,572
13-Jun	1,776	13-Jul	1,208	13-Aug	1,103	13-Sep	1,479
14-Jun	1,566	14-Jul	1,284	14-Aug	1,017	14-Sep	1,395
15-Jun	1,418	15-Jul	1,533	15-Aug	985	15-Sep	1,352
16-Jun	1,193	16-Jul	1,739	16-Aug	946	16-Sep	
17-Jun	1,121	17-Jul	1,931	17-Aug	863	17-Sep	
18-Jun	1,317	18-Jul	1,787	18-Aug	818	18-Sep	
19-Jun	1,946	19-Jul	1,636	19-Aug	795	19-Sep	
20-Jun	2,051	20-Jul	1,504	20-Aug	757	20-Sep	
21-Jun	1,601	21-Jul	1,523	21-Aug	722	21-Sep	
22-Jun	1,182	22-Jul	1,635	22-Aug	822	22-Sep	
23-Jun	1,565	23-Jul	2,006	23-Aug	3,801	23-Sep	
24-Jun	1,402	24-Jul	2,196	24-Aug	6,121	24-Sep	
25-Jun	1,442	25-Jul	2,028	25-Aug	4,279	25-Sep	
26-Jun	1,537	26-Jul	1,680	26-Aug	3,349	26-Sep	
27-Jun	1,579	27-Jul	1,584	27-Aug	2,860	27-Sep	
28-Jun	2,167	28-Jul	1,371	28-Aug	2,327	28-Sep	
29-Jun	2,305	29-Jul	1,308	29-Aug	1,960	29-Sep	
30-Jun	1,864	30-Jul	1,411	30-Aug	1,826	30-Sep	
		31-Jul	1,318	31-Aug	1,969		
Mean	1,497	Mean	1,983	Mean	1,582	Mean	1,702
Max.	2,305	Max.	4,267	Max.	6,121	Max.	2,320
Min.	433	Min.	1,208	Min.	722	Min.	1,352

Table A-35. 1994 Daily and Summary Discharge (cfs) for North Fork of the Fortymile River at the South Fork Confluence.

Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge
1-May		1-Jun	2,333	1-Jul	1,361	1-Aug	493	1-Sep	414
2-May		2-Jun	3,225	2-Jul	1,065	2-Aug	482	2-Sep	501
3-May		3-Jun	4,386	3-Jul	1,097	3-Aug	470	3-Sep	553
4-May		4-Jun	4,321	4-Jul	1,806	4-Aug	1,192	4-Sep	571
5-May		5-Jun	3,497	5-Jul	1,695	5-Aug	832	5-Sep	550
6-May		6-Jun	4,391	6-Jul	1,806	6-Aug	625	6-Sep	629
7-May		7-Jun	4,607	7-Jul	3,361	7-Aug	521	7-Sep	884
8-May		8-Jun	3,833	8-Jul	2,449	8-Aug	468	8-Sep	775
9-May		9-Jun	2,771	9-Jul	1,530	9-Aug	439	9-Sep	701
10-May		10-Jun	2,361	10-Jul	1,091	10-Aug	422	10-Sep	715
11-May	4,122	11-Jun	2,984	11-Jul	855	11-Aug	404	11-Sep	632
12-May	4,886	12-Jun	3,203	12-Jul	808	12-Aug	386	12-Sep	617
13-May	6,546	13-Jun	2,595	13-Jul	996	13-Aug	405	13-Sep	617
14-May	6,500	14-Jun	1,849	14-Jul	1,481	14-Aug	444	14-Sep	609
15-May	4,541	15-Jun	1,423	15-Jul	1,286	15-Aug	440	15-Sep	591
16-May	3,474	16-Jun	1,238	16-Jul	1,000	16-Aug	420	16-Sep	570
17-May	2,980	17-Jun	1,119	17-Jul	821	17-Aug	398	17-Sep	550
18-May	2,941	18-Jun	982	18-Jul		18-Aug	379	18-Sep	526
19-May	3,171	19-Jun	1,481	19-Jul		19-Aug	362	19-Sep	560
20-May	10,535	20-Jun	2,372	20-Jul		20-Aug	350	20-Sep	753
21-May	7,124	21-Jun	2,310	21-Jul		21-Aug	355	21-Sep	787
22-May	4,434	22-Jun	2,144	22-Jul		22-Aug	401	22-Sep	
23-May	3,686	23-Jun	1,417	23-Jul		23-Aug	479	23-Sep	
24-May	3,104	24-Jun	1,123	24-Jul		24-Aug	530	24-Sep	
25-May	2,901	25-Jun	969	25-Jul		25-Aug	515	25-Sep	
26-May	10,843	26-Jun	1,223	26-Jul	451	26-Aug	474	26-Sep	
27-May	15,291	27-Jun	1,866	27-Jul	453	27-Aug	439	27-Sep	
28-May	8,760	28-Jun	1,831	28-Jul	447	28-Aug	416	28-Sep	
29-May	4,716	29-Jun	2,194	29-Jul	452	29-Aug	392	29-Sep	
30-May	3,006	30-Jun	1,829	30-Jul	472	30-Aug	388	30-Sep	
31-May	2,449			31-Jul	461	31-Aug	398		
Mean	5,678	Mean	2,396	Mean	1,185	Mean	475	Mean	616
Max.	15,291	Max.	4,607	Max.	3,361	Max.	1,192	Max.	884
Min.	2,901	Min.	969	Min.	447	Min.	350	Min.	414

Table A-36. 1995 Daily and Summary Discharge (cfs) for North Fork of the Fortymile River at the South Fork Confluence.

Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge	Date	Discharge
1-May		1-Jun	3,122	1-Jul	1,354	1-Aug	2,621	1-Sep	2,127
2-May		2-Jun	3,654	2-Jul	1,219	2-Aug	2,572	2-Sep	2,142
3-May		3-Jun	3,533	3-Jul	1,144	3-Aug	2,445	3-Sep	2,103
4-May		4-Jun	2,990	4-Jul	1,020	4-Aug	2,183	4-Sep	1,972
5-May		5-Jun	2,365	5-Jul	889	5-Aug	2,044	5-Sep	1,803
6-May		6-Jun	2,133	6-Jul	799	6-Aug	1,871	6-Sep	1,698
7-May		7-Jun	2,976	7-Jul	894	7-Aug	1,676	7-Sep	1,622
8-May		8-Jun	2,902	8-Jul	853	8-Aug	1,523	8-Sep	1,554
9-May		9-Jun	2,606	9-Jul	953	9-Aug	1,415	9-Sep	1,722
10-May		10-Jun	1,965	10-Jul	1,382	10-Aug	1,371	10-Sep	1,733
11-May		11-Jun	1,716	11-Jul	1,279	11-Aug	1,323	11-Sep	2,287
12-May		12-Jun	2,051	12-Jul	1,183	12-Aug	1,246	12-Sep	3,146
13-May		13-Jun	2,037	13-Jul	1,535	13-Aug	1,175	13-Sep	2,589
14-May		14-Jun	1,476	14-Jul	2,380	14-Aug	1,293	14-Sep	2,120
15-May		15-Jun	1,165	15-Jul	4,989	15-Aug	1,504	15-Sep	1,927
16-May		16-Jun	1,098	16-Jul	7,054	16-Aug	1,695	16-Sep	1,796
17-May	3,887	17-Jun	3,300	17-Jul	4,507	17-Aug	2,035	17-Sep	1,670
18-May	3,158	18-Jun	5,182	18-Jul	3,042	18-Aug	2,362	18-Sep	1,551
19-May	2,796	19-Jun	3,564	19-Jul	2,209	19-Aug	2,120	19-Sep	1,437
20-May	2,426	20-Jun	2,462	20-Jul	1,844	20-Aug	1,988	20-Sep	1,344
21-May	2,238	21-Jun	1,806	21-Jul	1,521	21-Aug	2,061	21-Sep	1,252
22-May	1,857	22-Jun	1,561	22-Jul	1,529	22-Aug	2,121	22-Sep	
23-May	1,404	23-Jun	3,186	23-Jul	2,265	23-Aug	1,998	23-Sep	
24-May	1,195	24-Jun	6,736	24-Jul	3,217	24-Aug	1,799	24-Sep	
25-May	1,585	25-Jun	4,839	25-Jul	4,393	25-Aug	1,684	25-Sep	
26-May	2,612	26-Jun	4,062	26-Jul	6,652	26-Aug	1,724	26-Sep	
27-May	3,314	27-Jun	3,227	27-Jul	4,914	27-Aug	1,762	27-Sep	
28-May	2,276	28-Jun	2,440	28-Jul	3,626	28-Aug	2,230	28-Sep	
29-May	2,767	29-Jun	1,823	29-Jul	2,937	29-Aug	2,419	29-Sep	
30-May	4,694	30-Jun	1,570	30-Jul	2,395	30-Aug	2,113	30-Sep	
31-May	3,654			31-Jul	2,216	31-Aug	2,141		
Mean	2,586	Mean	2,785	Mean	2,458	Mean	1,888	Mean	2,001
Max.	4,694	Max.	6,736	Max.	7,054	Max.	2,621	Max.	3,146
Min.	1,195	Min.	1,098	Min.	799	Min.	1,175	Min.	1,554

Fortymile River: Monitoring at this site began in June 1910 at Steele Creek by USGS and was discontinued in 1912. In October 1975, the USGS installed a wire-weight gage on the upstream guard rail of the Taylor Highway bridge. A water level recorder was installed in May 1976 about 300 feet downstream on the left bank. The recorder was removed in October 1982 and the gage discontinued. BLM began using the wire-weight gage in 1989, as well as surveying annual high-water marks. Discharge measurements began in the winter of 1991. A data logger installed by BLM at the USGS site was destroyed by flooding shortly after installation in 1992. Discharge measurements are usually made from the upstream side of the bridge. During extreme low water and in the winter, measurements can be made about one mile downstream of the bridge. The gage reach consists of a straight channel confined on both banks by ridges, with steep rock bluffs on the left bank. The stream bed consists of angular cobbles and boulders, with lateral gravel bars evident only at extreme low water.

Figure 17. Fortymile River at Taylor Highway Bridge.

Table A-37. Discharge Measurement Summary for Fortymile River at Taylor Highway Bridge.

Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (ft)	Avg. Velocity (ft/sec)	Avg. Depth (ft)
12/21/91	ND	95	125	200	0.48	1.6
2/20/92	ND	39	93	137	0.29	1.5
4/14/92	ND	29	45	35	0.83	0.8
11/13/92	ND	185	110	212	0.87	1.9
3/26/93	ND	12	55	93	0.13	1.7
7/28/93	72.57	3,163	231	1,121	2.82	4.9
12/8/93	ND	177	118	317	0.56	2.7
3/26/94	ND	3.8	50	68	0.06	1.4
5/12/94	75.92	8,824	294	1,989	4.44	6.8
7/27/94	70.67	1,105	185	687	1.61	3.7
12/12/94	ND	171	150	301	0.57	2.0
5/18/95	76.48	10,190	300	2,126	4.79	7.1
9/19/95	72.88	3,470	248	1,163	2.98	4.7
12/12/95	ND	8.3	42	10	0.83	0.2

ND=Not Determined

Table A-38. Peak and Minimum Discharge Summary for Fortymile River at Taylor Highway Bridge.

Year	Date	Peak Discharge (cfs)	Date	Minimum Discharge (cfs)
1989	7-Jun	38,500	19-Aug	719
1990	11-May	26,100	24-Jul	584
1991	6-May	25,800	24-Jul	751
1992	26-May	59,600	23-Sep	751
1993	16-May	31,600	20-Aug	1,703
1994	27-May	35,500	11-Aug	852
1995	18-May	48,400	21-Sep	3,270

Table A-39. 1989 Wire-Weight Gage Readings and Discharge for Fortymile River at the Taylor Highway Bridge.

Date	Wire-Weight Reading (ft)	Discharge (cfs)
August		
16	70.27	768
18	70.22	727
19	70.21	719

Table A-40. 1990 Wire-Weight Gage Readings and Discharge for Fortymile River at the Taylor Highway Bridge.(Note: Wire-weight gage correction is -69 ft. to stream datum.)

Date	Wire-Weight Reading (ft)	Discharge (cfs)	Date	Wire-Weight Reading (ft)	Discharge (cfs)
May			August		
11	81.10	22,895	2	72.65	3,266
12	80.00	19,578	17	72.62	3,229
29	73.45	4,286	September		
June			1	73.30	4,089
21	71.40	1,838	11	78.60	12,301
23	73.35	4,155			
25	72.95	3,640			
July					
12	72.55	3,144			
24	69.65	584			

Table A-41. 1991 Wire-Weight Gage Readings and Discharge for Fortymile River at the Taylor Highway Bridge. (Note: Wire-weight gage correction is -69 ft. to stream datum.)

Date	Wire-Weight Reading (ft)	Discharge (cfs)	Date	Wire-Weight Reading (ft)	Discharge (cfs)
May			August		
5	73.53	4,392	10	72.88	3,552
12	80.00	19,578	13	71.72	2,182
15	78.90	12,831	16	71.27	1,703
17	76.50	8,769	24	71.05	1,481
25	73.50	8,253	September		
June			4	70.70	1,145
27	71.30	1,734	8	70.88	1,315
28	71.95	2,439	9	70.94	1,373
July			12	72.75	3,389
12	73.22	3,985	13	74.35	5,518
20	70.95	1,383	23	72.25	2,786
24	70.25	751	25	71.75	2,215
30	70.70	1,145	26	71.75	2,215
			27	71.71	2,171
			28	71.60	2,051

Table A-42. 1992 Wire-Weight Gage Readings and Discharge for Fortymile River at the Taylor Highway Bridge. (Note: Wire-weight gage correction is -69 ft. to stream datum.)

Date	Wire-Weight Reading (ft)	Discharge (cfs)	Date	Wire-Weight Reading (ft)	Discharge (cfs)
May			August		
19	71.22	1,652	3	75.15	6,680
21		2,269	5	74.85	6,237
22		5,773	7	73.70	4,620
23		13,386	14	74.85	6,237
24		19,089	16	74.05	5,098
June			21	73.15	3,895
2	84.75	35,298	September		
17	84.24	33,441	10	71.95	2,439
July			16	71.25	1,682
2	73.75	4,687	23	70.25	751
14	71.95	2,439			
21	79.55	18,281			
31	74.65	5,946			

Table A-43. 1993 Wire-Weight Gage Readings and Discharge for Fortymile River at the Taylor Highway Bridge. (Note: Wire-weight gage correction is -69 ft. to stream datum.)

Date	Wire-Weight Reading (ft)	Discharge (cfs)	Date	Wire-Weight Reading (ft)	Discharge (cfs)
May			August		
12	79.85	19,491	13	71.85	2,462
18	79.53	18,566	18	71.34	1,901
20	76.35	10,370	20	71.15	1,703
June			31	73.44	4,611
2	72.85	3,665	September		
9	77.05	12,014	9	72.64	3,402
10	76.05	9,695	15	72.44	3,156
11	74.75	6,981	16	72.43	3,144
19	73.25	4,300			
21	73.15	4,140			
22	72.95	3,826			
23	72.95	3,826			
July					
2	74.04	5,084			
16	72.04	2,680			
20	71.44	2,008			
28	72.44	3,156			
29	72.45	3,168			
31	72.64	3,402			

Table A-44. 1994 Wire-Weight Gage Readings and Discharge for Fortymile River at the Taylor Highway Bridge. (Note: Wire-weight gage correction is -69 ft. to stream datum.)

Date	Wire-Weight Reading (ft)	Discharge (cfs)	Date	Wire-Weight Reading (ft)	Discharge (cfs)
May			August		
4	77.95	14,263	1	71.15	1,703
5	75.88	9,321	2	70.85	1,402
11	75.41	8,316	4	71.55	2,127
12	75.78	9,103	10	70.45	1,027
June			11	70.25	852
9	74.75	6,981	25	70.55	1,118
21	73.55	4,795	26	70.45	1,027
29	75.04	7,556	28	70.34	930
July			30	70.25	852
6	73.34	4,446	31	70.25	852
9	75.08	7,637	September		
15	70.65	1,211	15	70.89	1,441
19	72.65	3,414	21	71.00	1,550
20	72.25	2,928			
25	70.55	1,118			
27	70.55	1,118			

Table A-45. 1995 Wire-Weight Gage Readings and Discharge for Fortymile River at the Taylor Highway Bridge. (Note: Wire-weight gage correction is -69 ft. to stream datum.)

Date	Wire-Weight Reading (ft)	Discharge (cfs)	Date	Wire-Weight Reading (ft)	Discharge (cfs)
May			August		
17	77.82	13,826	1	74.00	5,506
18	76.40	10,393	2	75.25	7,901
June			3	73.86	5,259
2	75.65	8,738	7	73.15	4,076
7	74.82	7,040	9	72.75	3,489
11	72.75	3,489	14	72.85	3,615
19	75.85	9,168	17	74.65	6,710
22	73.15	4,076	18	74.55	6,518
24	77.55	13,144	22	74.64	6,690
28	74.04	5,577	26	73.82	5,189
29	73.11	4,013	30	74.04	5,577
July			September		
5	72.74	3,477	3	73.95	5,417
15	75.94	9,365	6	73.54	4,711
16	76.84	11,416	9	73.45	4,562
23	73.10	3,997	10	73.45	4,562
26	77.65	13,395	19	72.82	3,577
29	73.08	3,966	20	72.65	3,365
			21	72.57	3,266

Appendix A

Part 2: Stream-Gaging Data from Partial-Record Sites

Logging Cabin Creek

Table A-46. Discharge Measurement Summary for Logging Cabin Creek at the Taylor Highway Bridge.

Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (ft)	Avg. Velocity (ft/sec)	Avg . Depth (ft)
9/28/91	1.05	6.0	18	9	0.67	0.5
5/22/92	2.00	52	27	21	2.49	0.8
6/18/92	1.61	45	20	20	2.22	1.0
6/25/93	1.27	39	27	26	1.50	1.0
5/13/94	1.47	38	31	21	1.81	0.7
9/19/94	0.72	6.4	17	11	0.58	0.6
9/22/94	0.69	5.6	16	10	0.54	0.6
6/30/95	0.86	12	25	15	0.80	0.6
9/22/95	0.81	8.5	14	10	0.83	0.7

Table A-47. Peak and Minimum Discharge Summary for Logging Cabin Creek at the Taylor Highway Bridge.

Year	Date	Peak Discharge (cfs)	Date	Minimum Discharge (cfs)
1993	12-May	168	18-Sep	12
1994	10-May	184	22-Sep	5.6
1995	15-May	218	22-Sep	8.5

Dennison Fork

Table A-48. Discharge Measurement Summary for Dennison Fork of the Fortymile River at Mosquito Fork.

Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (ft)	Avg. Velocity (ft/sec)	Avg. Depth (ft)
5/16/91	3.20	1,184	210	358	3.30	1.7
6/29/91	0.81	276	139	184	1.51	1.3
8/7/92	3.55	1,768	177	355	4.98	2.0
9/20/95	ND	547	114	255	2.15	2.2

ND=Not Determined

Table A-49. Peak and Minimum Discharge Summary for the Dennison Fork at the Taylor Highway Bridge.

Year	Date	Peak Discharge (cfs)	Date	Minimum Discharge (cfs)
1991	12-May	7,920	29-Jun	276
1992	15-May	9,850		ND

ND=Not Determined

Wade Creek

Table A-50. Discharge Measurement Summary for Wade Creek at Walker Fork.

Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (ft)	Avg. Velocity (ft/sec)	Avg. Depth (ft)
6/24/93	0.80	7.5	14	6.9	1.09	0.5
9/18/93	0.88	12	19	9	1.32	0.5
5/12/94	1.58	74	31	27	2.74	0.9
7/28/94	0.81	5.6	13	7.8	0.72	0.6
5/18/95	2.08	52	26	25	2.12	0.9
6/29/95	0.92	16	21	11	1.45	0.5
9/19/95	1.09	15	23	16	0.94	0.6

Table A-51. Peak and Minimum Discharge Summary for Wade Creek at Walker Fork.

Year	Date	Peak Discharge (cfs)	Date	Minimum Discharge (cfs)
1994	10-May	231	28-Jul	5.6
1995	15-May	350	19-Sep	15

Middle Fork

Table A-52. Discharge Measurement Summary for Middle Fork below Joseph Creek.

Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (ft)	Avg. Velocity (ft/sec)	Avg. Depth (ft)
8/6/91	2.75	444	128	237	1.87	1.9
8/5/92	2.02	586	191	257	2.28	1.3
8/22/95	2.88	830	183	275	3.02	1.5

Table A-53. Peak and Minimum Discharge Summary for Middle Fork below Joseph Creek.

Year	Date	Peak Discharge (cfs)	Date	Minimum Discharge (cfs)
1991	12-May	5,570		ND
1992	15-May	5,210		ND

ND=Not Determined

Table A-54. Discharge Measurement Summary for Middle Fork at the North Fork Confluence.

Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (ft)	Avg. Velocity (ft/sec)	Avg. Depth (ft)
8/7/91	3.50	801	145	316	2.53	2.2
8/5/92	3.60	964	164	339	2.85	2.1
3/26/93	ND	16	46	27	0.59	0.6
8/23/95	3.91	1,095	157	339	3.23	2.2

ND=Not Determined

Table A-55. Peak and Minimum Discharge Summary for Middle Fork at the North Fork Confluence.

Year	Date	Peak Discharge (cfs)	Date	Minimum Discharge (cfs)
1991	10-May	9,580		ND
1992	27-May	8,350		ND

ND=Not Determined

North Fork

Table A-56. Discharge Measurement Summary for North Fork Fortymile River at Middle Fork Confluence.

Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (ft)	Avg. Velocity (ft/sec)	Avg. Depth (ft)
8/8/91	2.40	870	179	276	3.15	1.5
8/5/92	1.88	467	139	181	2.58	1.3
8/23/95	2.15	569	176	227	2.51	1.3

Table A-57. Peak and Minimum Discharge Summary for North Fork at the Middle Fork Confluence.

Year	Date	Peak Discharge (cfs)	Date	Minimum Discharge (cfs)
1991	10-May	9,580		ND
1992	27-May	6,550		ND

ND=Not Determined

O'Brien Creek

Table A-58. Discharge Measurement Summary for O'Brien Creek at the Taylor Highway Bridge.

Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (ft)	Avg. Velocity (ft/sec)	Avg. Depth (ft)
6/28/91	1.60	110	67	64	1.72	1.0
9/28/91	1.68	120	68	72	1.67	1.1
6/24/93	0.87	44	39	40	1.10	1.0
9/21/94	1.40	83	46	55	1.51	1.2
6/29/95	1.52	126	54	65	1.94	1.2
9/19/95	2.01	229	54	82	2.79	1.5

Table A-59. Peak and Minimum Discharge Summary for O'Brien Creek at the Taylor Highway Bridge.

Year	Date	Peak Discharge (cfs)	Date	Minimum Discharge (cfs)
1991	13-Sep	560		ND
1992	27-May	1,850		ND
1993	9-May	1,260	25-Jun	38
1994	27-May	1,080	27-Jul	56
1995	12-May	1,140	30-Jun	133

ND=Not Determined

Appendix A

Part 3: Stream-Gaging Data from Miscellaneous Sites in the Fortymile River Basin

Table A-60. Discharge Measurement Summary for Miscellaneous Sites in the South Fork Fortymile River Basin.

Site	Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (ft)	Avg. Velocity (ft/sec)	Avg. Depth (ft)
Walker Fork at Mouth	9/14/93	ND	155	54	62	2.50	1.1
	7/26/94	ND	65	62	40	1.63	0.7
South Fork at Uhler Creek	6/27/91	ND	672	168	515	1.30	3.1
	6/16/92	ND	5,955	208	1240	4.81	6.0
Uhler Creek at South Fork	6/27/91	ND	3.5	12	7.7	0.49	0.7
	6/16/92	ND	136	22	36	4.26	1.9
South Fork at Mouth	7/27/93	ND	1,260	213	577	4.81	6.0
	7/26/94	ND	455	215	184	4.81	6.0
	12/12/95	ND	0.2	37	3	4.81	6.0

Table A-61. Discharge Measurement Summary for Miscellaneous Sites in the Middle Fork Fortymile River Basin.

Site	Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (ft)	Avg. Velocity (ft/sec)	Avg. Depth (ft)
Joseph Ck. at Middle Fork	8/5/92	1.80	125	67	71	1.77	1.3
McKinley Ck. at Middle Fk.	8/6/91	1.40	56	39	31	1.80	0.8
Pittsburg Ck. at Middle Fork	8/6/91	1.30	28	29	24	1.18	0.9

Table A-62. Discharge Measurement Summary for Miscellaneous Sites in the North Fork Fortymile River Basin.

Site	Date	Stage (ft)	Discharge (cfs)	Width (ft)	Area (ft)	Avg.Velocity (ft/sec)	Avg. Depth (ft)
North Fork at Little Bonanza Ck	8/6/92	1.52	137	86	77	1.70	0.3
North Fork at Champion Ck.	8/4/92	3.60	355	105	215	1.57	2.5
	8/6/92	3.40	262	97	197	1.26	2.3
Champion Ck. at North Fk.	8/4/92	2.00	131	65	71	1.74	1.2
Hutchinson Ck. at North Fk.	8/8/91	3.50	47	31	71	0.72	2.9
	8/6/92	3.60	45	37	54	0.82	1.6
North Fk. at Hutchinson Ck.	8/8/91	3.78	1,683	201	499	3.29	2.7
	8/6/92	3.26	1,370	200	499	2.59	2.7

Appendix B
Regression Statistics

Table B-1. Discharge Regressions based on South Fork Fortymile River at Bridge Data.

Gage Site	Parameters				
	m	b	r^2	Standard error	Remarks
West Fork at Taylor Highway	1.059	-1.105	0.930	0.250	
Mosquito Fork at Taylor Highway	0.932	-1.001	0.860	0.330	
Walker Fork at Taylor Highway	0.977	-1.415	0.750	0.350	Low flow
Walker Fork at Taylor Highway	1.209	-3.253	0.740	0.420	High flow

m=slope of regression line
b=Y-intercept of regression line
r^2=coefficient of determination

Table B-2. Discharge Regressions based on Fortymile River at Clinton Creek Data.

Gage Site	Parameters				
	m	b	r^2	Standard error	Remarks
South Fork at Taylor Hwy. Bridge	1.116	-1.988	0.835	0.330	
North Fork above South Fork Confl.	0.948	-0.520	0.813	0.295	
Fortymile River at Taylor Highway	1.085	-0.638	0.941	0.469	Low flow
Fortymile River at Taylor Highway	0.992	0.044	0.938	0.198	High flow

m=slope of regression line
b=Y-intercept of regression line
r^2=coefficient of determination

Table B-3. Sample Log/Linear Regression based on Fortymile River Winter Discharge Data.

Site: Fortymile River at Taylor Highway Bridge.

Period	Date	Discharge (cfs)	Period	Equation
Fall 1991	9/28/91	2210		
	12/21/91	95	Oct - Dec	$Q = 2210 \times Date^{0.963}$
Winter 1991/92	2/20/92	39	Jan - Feb	$Q = 323.7 \times Date^{0.986}$
	4/14/92	29	Mar - Apr	$Q = 86.41 \times Date^{0.995}$

Note: All winter-period regressions were computed similarly using pairs of measurements at each end of the period to define the limits; coefficient of determination is always 1 and standard error is 0, since only two data points are used per period.

Table B-4. Stage-Discharge Regressions for the Principal Fortymile River Gaging Sites.

Gage Site	Parameters				
	m	b	r^2	Standard Error	Remarks
West Fork at Taylor Highway	2.289	4.326	0.977	0.108	Low flow
West Fork at Taylor Highway	2.173	4.701	0.993	0.056	High flow
Mosquito Fork at Taylor Highway	2.080	4.491	0.988	0.078	Low flow
Mosquito Fork at Taylor Highway	2.497	4.168	0.999	0.027	High flow
South Fork at Taylor Highway	2.248	3.929	0.958	0.060	Low flow
South Fork at Taylor Highway	2.504	3.626	0.997	0.046	High flow
Walker Fork at Taylor Highway	2.610	3.563	0.997	0.031	Low flow
Walker Fork at Taylor Highway	2.131	4.069	0.998	0.053	High flow
North Fork above South Fork Confl.	2.674	4.135	0.979	0.080	Low flow
North Fork above South Fork Confl.	2.085	4.963	0.998	0.052	High flow
Fortymile River at Taylor Highway	1.371	6.316	0.998	0.033	Low flow
Fortymile River at Taylor Highway	1.642	5.945	0.998	0.040	High flow

m=slope of regression line

b=Y-intercept of regression line

r^2=coefficient of determination