WATER RESOURCES
IDYLWILDE HYDROELECTRIC PROJECT

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Introduction

The City of Loveland, Colorado (City) is proposing to relicense Federal Energy Regulatory Commission (FERC) Project No. 2829, Idylwilde Hydroelectric Project (the Project). The Project is owned and operated by the City. Water Consult retained ERO Resources Corporation (ERO) to prepare preapplication materials associated with water resources for the proposed relicensing. This report addresses the requirements for a preapplication document described in FERC's Integrated License Application Process (18 CFR 5.6).

Project Description

The Project is on the Big Thompson River along U.S. Highway 34 (U.S. 34), 14 miles west of the City (Figure 1). The dam is on National Forest lands managed by the Arapaho-Roosevelt National Forest. A hydroelectric plant was built on municipally owned property, allowing generation and distribution of energy from the Project to begin in 1925. The original dam and hydroelectric plant were destroyed in the Big Thompson River flood on July 31, 1976, and were subsequently rebuilt and returned to full service in 1981.

The dam is 50.5 feet high and has a total length of 239.1 feet. The reservoir has a surface area of 3.67 acres at spillway elevation, and impounds about 45 acre-feet of water. A minimum bypass flow of 7 cubic feet per second (cfs) is maintained through the dam to provide suitable habitat in the stream reach below. The penstock, 9,534 feet in length, originates at the dam and delivers water to two 450-kilowatt turbine-generator units in Loveland's Viestenz-Smith Mountain Park. The penstock crosses Forest Service and privately owned lands, and U.S. 34. Two taps along the penstock provide access to water for fire protection and 15 irrigation services are tapped into the line. The power generated is connected to the City's distribution system through a 22-kilovolt transmission line 1,153 feet in length.

Existing Environment

WATER RIGHTS

The Project has a decreed right to divert 74 cfs of water from the Big Thompson River at the NW¼ NW¼ of Section 1, Township 5 North, Range 71 West for the purpose of power generation. The appropriation date of the right is 1913 and the right was adjudicated in 1939 in Case #10077 (Colorado Division of Water Resources and Colorado Water Conservation Board (CDWR and CWCB) 2010). There are many other

water rights, including rights both junior and senior to the Project in the same part of the river upstream and downstream of the Project to the canyon mouth and beyond (CDWR and CWCB 2010). However, these rights do not affect the operation of the Project and the Project, operating in accordance with the priority system, does not affect other water rights.

Instream Flows

Three instream flow water rights on the Big Thompson River are in the vicinity of the Project, two upstream of the project and one below, all with appropriation dates of November 1989 (Table 1).

Table 1. Instream flow water rights in Project area.

Water Right Name	Decreed Amount May 1 – Oct. 31	Decreed Amount Nov. 1 – Apr. 30
Olympus to Drake	40 cfs	15 cfs
Drake to Idylwilde Reservoir	50 cfs	20 cfs
Below power plant to Dille Tunnel	50 cfs	20 cfs

Source: CDWR and CWCB 2010.

There is no instream flow right in the reach from the dam to the power plant return flow; however, a minimum flow is provided in this reach pursuant to an agreement between the City and the Colorado Division of Wildlife. A 1994 Memorandum of Agreement between the City and the Colorado Division of Wildlife, which requires a release of 7 cfs through Idylwilde Dam except during extremely low flow occurrences in the winter, when a release of 3 cfs is required (City of Loveland 1994).

BUREAU OF RECLAMATION RELEASES TO BIG THOMPSON RIVER FROM LAKE ESTES

The Colorado-Big Thompson Project (C-BT), the largest transmountain water diversion project in Colorado, commenced full operations in 1957. A project map is provided in Appendix A. The C-BT Project provides water from the upper Colorado River basin to the South Platte River basin via the Alva B. Adams Tunnel to Mary's Lake in the upper Big Thompson River watershed. The C-BT Project delivers water to Lake Estes upstream of the Idylwilde Project.

According to the U.S. Bureau of Reclamation's *Standard Operating Procedure for Olympus Dam and Estes Power Plant* (Bureau of Reclamation 2010), the required minimum flows below Olympus Dam near Estes Park are provided below, with the caveat that the required amount is the lower of either the flow listed below for each time period, or the actual inflows into Lake Estes:

25 cfs	November 1 – April 15
50 cfs	April 16 – 30
100 cfs	May 1 – 15
125 cfs	May 16 – 31
125 cfs	June 1 – August 15
100 cfs	August 16 – 31
75 cfs	September 1 – 15
50 cfs	September 16 – October 31

Flows greater than these values may be 'skimmed' by Reclamation at either Olympus Dam or Dille Tunnel near the mouth of the Big Thompson River and used for power generation before returning the water to the river at the canyon mouth (Bureau of Reclamation 2010).

Reclamation's releases from Lake Estes have permanently altered the flow of the Big Thompson River into Idylwilde Reservoir since 1957, when current operations were initiated. The hydrograph of the river, however, is similar to an unregulated Colorado mountain stream with major runoff occurring in the spring and low flows for much of the rest of the year (see the following *Watershed and Streamflows* section). A number of tributaries enter the Big Thompson River between Lake Estes and Idylwilde Reservoir, particularly the North Fork Big Thompson River, which contributes average monthly flows ranging from 7 to 120 cfs to the Big Thompson River mainstem (CDWR and CWCB 2010).

BIG THOMPSON RIVER WATERSHED AND STREAMFLOWS

The drainage area for Idylwilde Reservoir, from the watershed divide to the dam, is 276.6 square miles. The gradient of the Big Thompson River downstream of Idylwilde Reservoir to the canyon mouth is 0.024. The volume of river water diverted to the power plant and bypass reach are not directly gaged. There are stream discharge data for several locations in the Big Thompson River upstream and downstream of Idylwilde Dam. A hydrology analysis technique was developed to compute inflow to the forebay, bypass flows, and penstock flows (Miller Ecological Consultants, Inc. 2010). The analysis determined that the combined gage data from these two locations provides an approximation of inflow to the forebay. These gages are:

- USGS gage for the Big Thompson River at the mouth of the canyon (06738000).
- USBR Dille tunnel diversions (State of Colorado – DILTUNCO).

The period of record applied in this analysis for the gaged flows was January 1, 2002 to September 30, 2009. Power generation data from 2002 to 2010 were used to calculate the inflow to the penstock, then bypass flows were calculated by subtracting the penstock flow from the inflow to the forebay.

Using the same two gaging stations, the monthly minimum, mean, and maximum calculated flows of the river at the Project forebay for WY 1957 to 2009 were calculated and are provided in Table 2.

Table 2. Monthly flow characteristics of the Big Thompson River at Idylwilde Hydroelectric Project forebay.

Month	Minimum Monthly Flow (cfs)	Mean Monthly Flow (cfs)	Maximum Monthly Flow (cfs)
January	4	23	74
February	4	23	49
March	6	29	252
April	8	77	1,885
May	26	246	2,146
June	42	388	1,975
July	67	276	1,500
August	41	155	1,650
September	24	94	516
October	13	67	435
November	8	46	415
December	6	30	250

Data from the two gaging stations were also used to generate a hydrograph of average daily flows for water years 1957 through 2009 (Figure 2). Peak flows typically occur in mid-June and the lowest flows (less than 30 cfs) typically occur from January through March. Using the same data, monthly flow duration curves were created and are provided in Appendix B. The flow duration curves show how frequently during each month flows of 50 to 55 cfs are available for generation of about 700 to 750 KW, and how frequently flows of 35 to 45 cfs are available for generation of 450 KW. For example, flows of 50 to 55 cfs are available in October, on average, 60 to nearly 70 percent of the time, and flows of 35 to 40 cfs are available in October, on average, 80 to 90 percent of the time.

Because significant changes in operations of the Project began in 2006, an analysis of computed inflows to the forebay and bypass flows (Miller Ecological Consultants, Inc. 2010) was completed to provide average monthly forebay and bypass flows and flow duration curves for present operations. Average monthly forebay flows are provided in Figure 3 and average monthly bypass flows are provided in Figure 4. Using the same data, monthly flow duration curves were created and are provided in Appendix C.

On July 31, 1976, a large stationary thunderstorm released as much as 7.5 inches of rain in about one hour (and a total of about 12 inches in a few hours) in the Big Thompson River Canyon, downstream of Olympus Dam and southeast of Estes Park. The peak

discharge in the Big Thompson River at the canyon mouth was estimated to be 31,200 cfs, which was much greater than the estimated 100-year flood. The depth of the river increased from a few feet to nearly 20 feet (Jarrett and Costa 2006). The high water velocities resulted in severe channel erosion and transport of large boulders that destroyed nearly everything in the canyon, including the Idylwilde Dam and hydroelectric plant. These features were subsequently rebuilt and returned to full service by 1981.

Potential Impacts

DIRECT AND INDIRECT IMPACTS

Because reservoir operations will not change, there would be no effect to water storage in Idylwilde Reservoir, the existing flows of the Big Thompson River, or water rights below the reservoir.

CUMULATIVE IMPACTS

The only reasonably foreseeable action is implementation of the Windy Gap Firming Project, which would slightly increase flows in the river in the Project area during some months (Table 3) in average flow years or wet years (Bureau of Reclamation 2007). This would be at most a 9 percent increase in the average monthly flow of the river. In April of a wet year, there would be an estimated flow decrease of 1 cfs (a 1 percent decrease), but flows would not decrease during any other month or in April of an average flow year. Flows during a dry year would not change. The increased flow would be brought through the Adams Tunnel to the Big Thompson River.

Table 3. Maximum possible monthly streamflow increase in Big Thompson River below Lake Estes due to Windy Gap Firming Project during an average or wet year.

Month	Predicted Monthly Flow Increase (cfs)
November – March	0
April	1
May	15
June	19
July	18
August	3
September – October	1

MITIGATION MEASURES

Because the Project would not alter existing streamflows, water storage in Idylwilde Reservoir, or water rights on the Big Thompson River, no mitigation measures are recommended.

Preliminary Issues and Recommended Studies

PRELIMINARY ISSUES

A preliminary issue is that inflows to the forebay and penstock and bypass flows are not directly measured. Inflow to the forebay can be approximately estimated by adding the measured flows of the Big Thompson River at the mouth of the canyon (USGS gage 06738000) to the Bureau of Reclamation Dille Tunnel diversions (State of Colorado site DILTUNCO). Penstock flows can be calculated from power generation data and turbine characteristics. Bypass flows can be calculated by subtracting the penstock flow from the inflow to the forebay (Miller Ecological Consultants, Inc. 2010). However, these methods may not provide accurate values of water use by the Project or of the bypass flows to the Big Thompson River downstream of the Project.

In addition, evaporation from the reservoir has not been measured; therefore, any water loss from the Big Thompson River as a result of evaporative losses from the reservoir has not been quantified. Leakage from the reservoir also has not been measured, but could be measured below the dam and considered part of the required bypass flows.

RECOMMENDED STUDIES

It is recommended that inflows to the forebay and penstock and bypass flows be directly measured with accurate and appropriate flow measurement equipment. It is also recommended that a water balance for the reservoir be completed to quantify all gains and losses to Idylwilde Reservoir and to the Big Thompson River below the Project.

Agencies Contacted

The agencies contacted for this report were:

U.S. Geological Survey

U.S. Bureau of Reclamation
Ron Thomasson, Reclamation Eastern Colorado Area Office
11056 W. County Rd. 18E
Loveland, CO 80537-9711
970-667-4410
RThomasson@usbr.gov)

City of Loveland

Colorado Division of Water Resources and Colorado Water Conservation Board

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Bureau of Reclamation. 2007. Windy Gap Firming Project Draft Water Resources Technical Report. U.S. Department of the Interior, Bureau of Reclamation, Great Plains Region. December.

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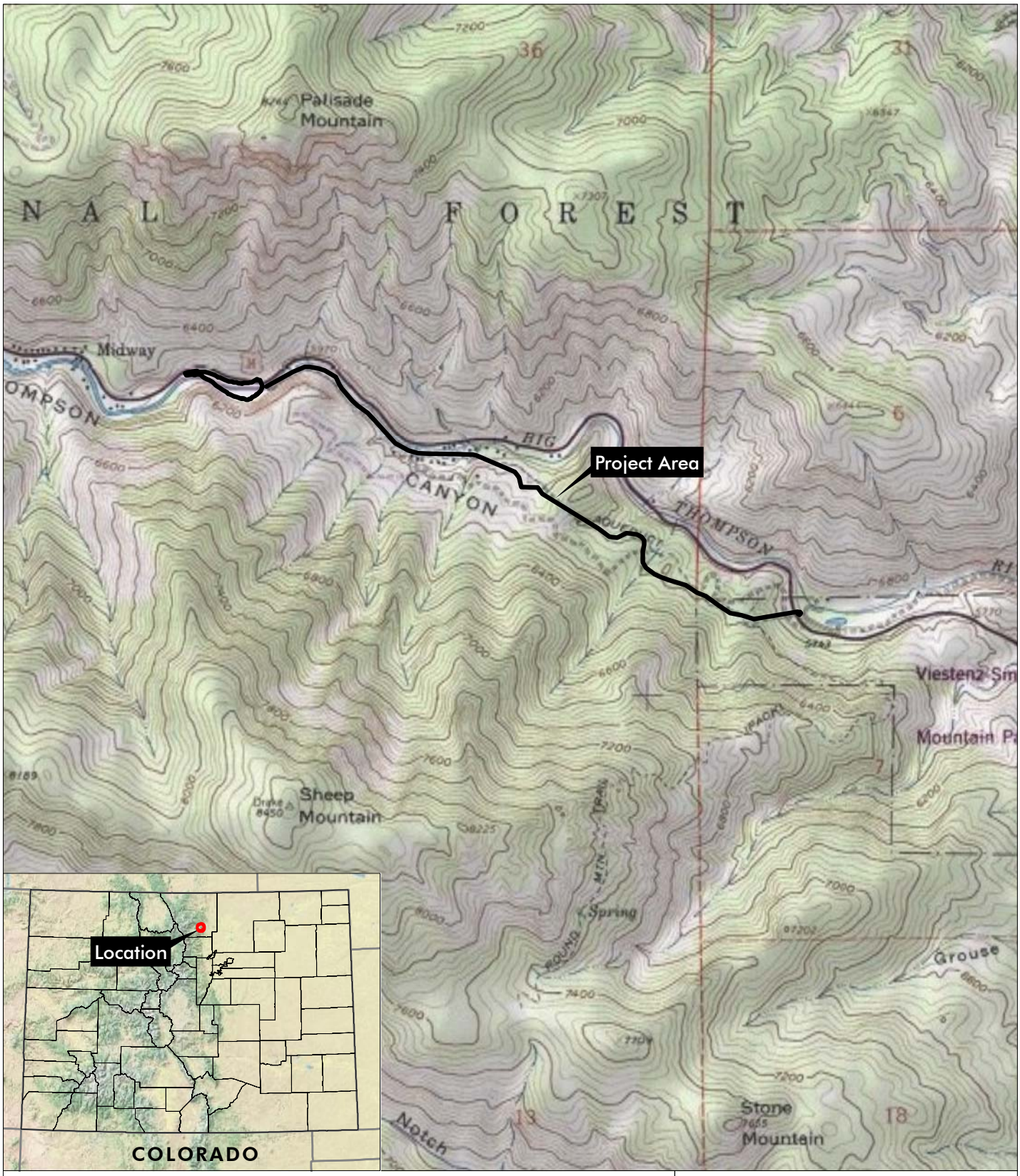
Jarrett, R.D. and J.E. Costa. 2006. 1976 Big Thompson Flood, Colorado—Thirty Years Later. U.S. Geological Survey Fact Sheet 2006-3095. July.

Miller Ecological Consultants, Inc.. 2010. Technical Memorandum: Hydrology for the Idylwilde Dam and Power Plant, 2002-2009. Prepared for Water Consult, Loveland, Colorado. December 30.



Idylwilde Hydroelectric Project

Sections 1 and 2, T5N, R71W; Section 7, T5N, R70W; 6th PM
UTM NAD 83: Zone 13N; 474730mE, 4474958mN
Latitude, Longitude: 40.424874°N, 105.297895°W
USGS Drake, CO Quadrangle
Larimer County, Colorado

Figure 1
Site Location

Prepared for: Water Consult
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December 2010

ERO Resources Corp.

Figure 2. Average daily flow of Big Thompson River at Idylwilde Hydroelectric Project forebay.

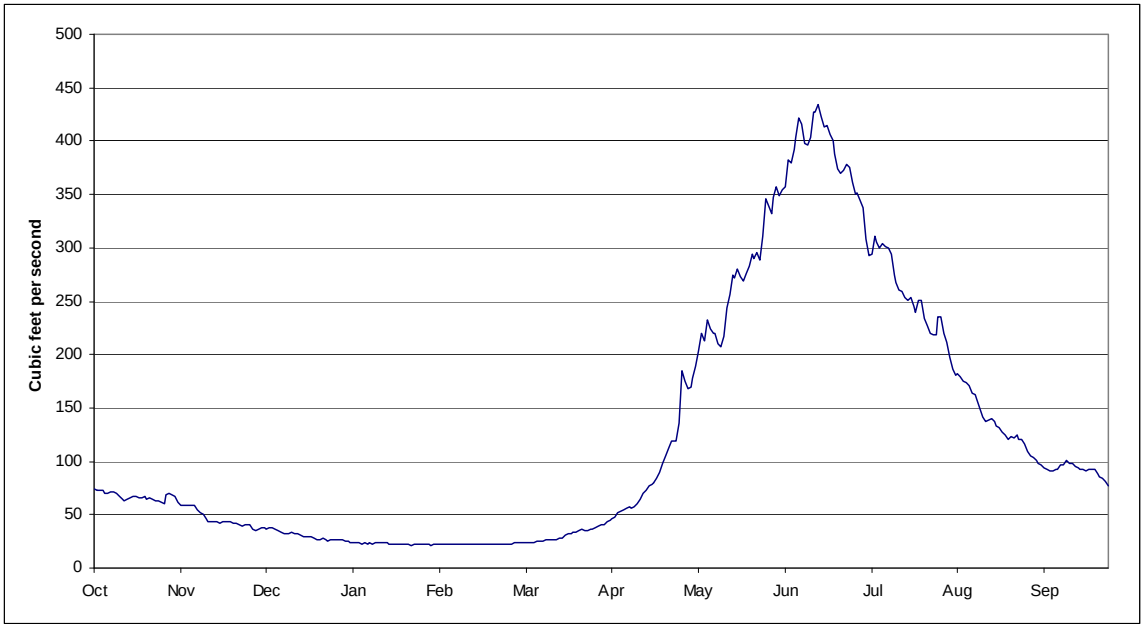


Figure 3. Average monthly forebay flows at Idylwilde Reservoir, 2006 to 2009.

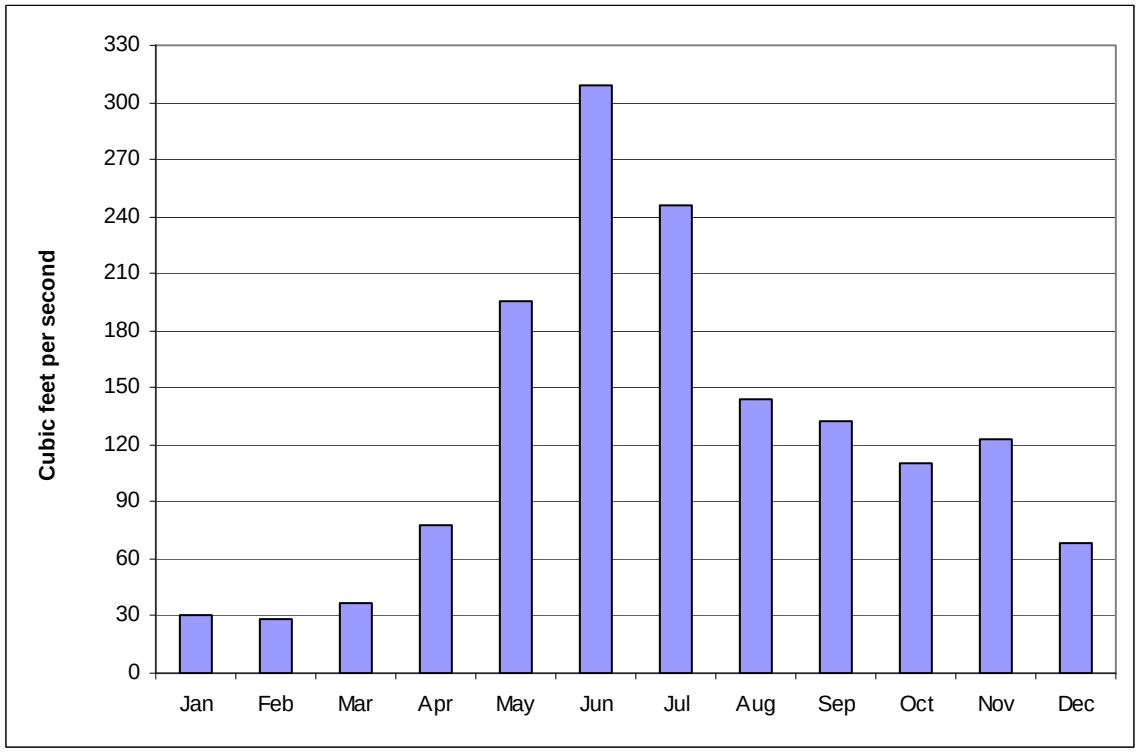
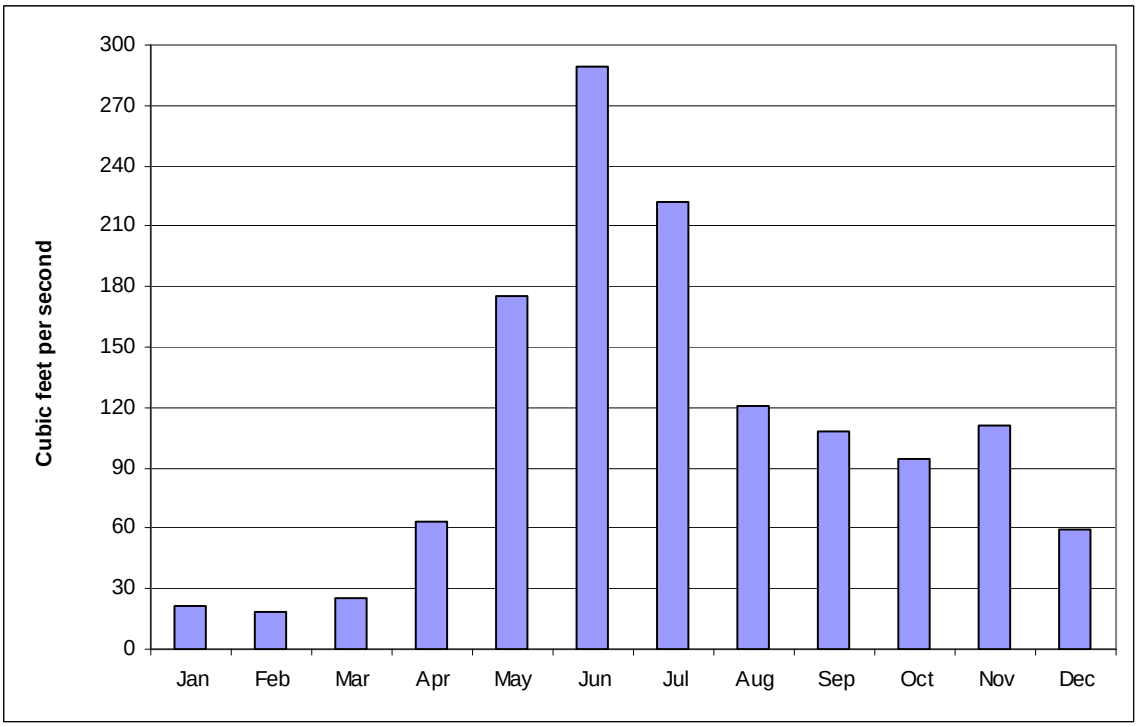


Figure 4. Average monthly bypass flows at Idylwilde Reservoir, 2006 to 2009.



Appendix A
C-BT Project Map

Northern Water

Northern Colorado Water Conservancy District

Colorado-Big Thompson Project

Northern Water Boundaries and Facilities

COLORADO

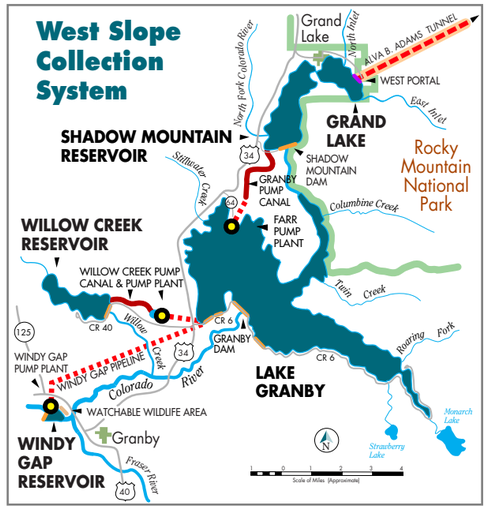
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

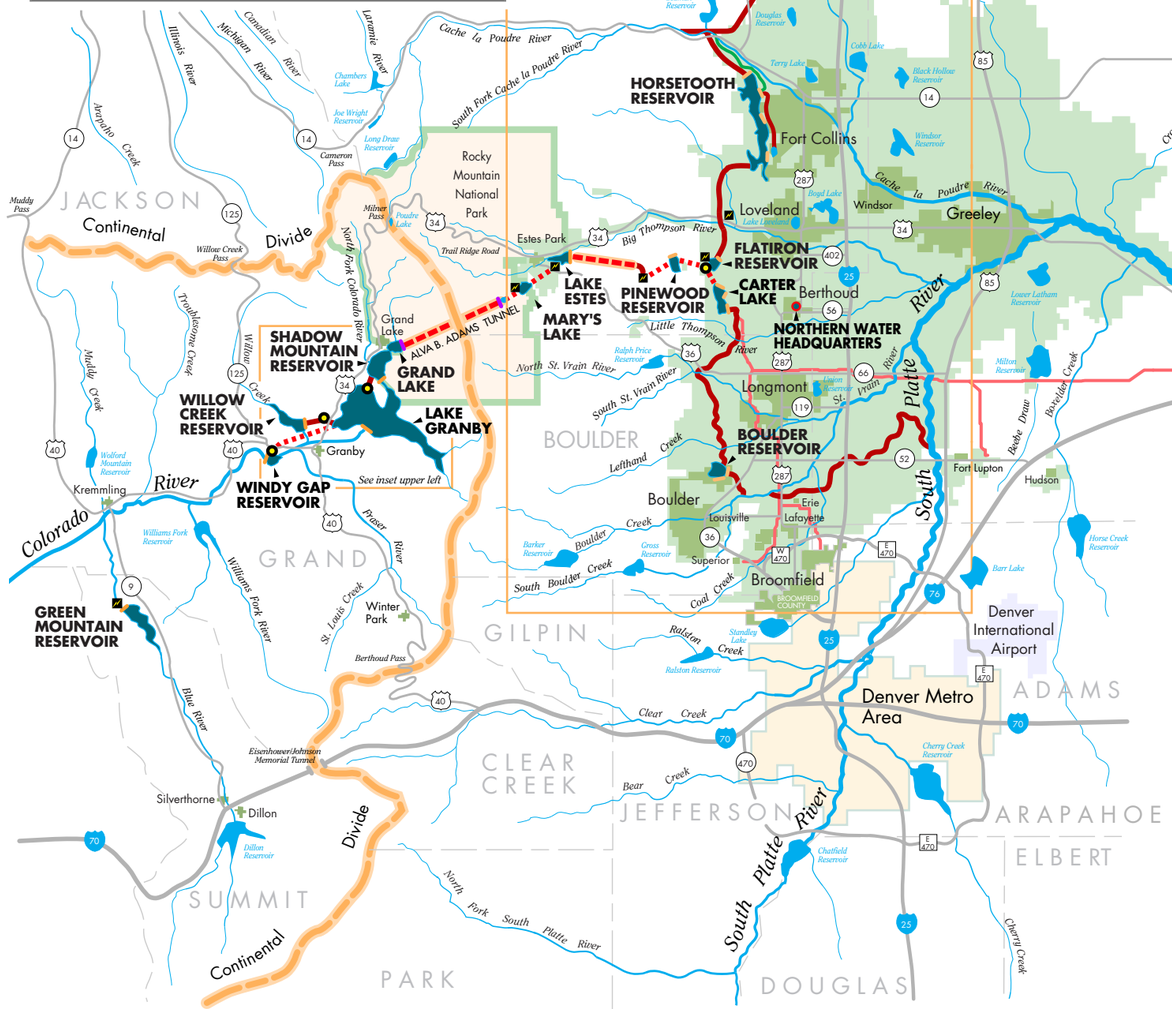
Legend

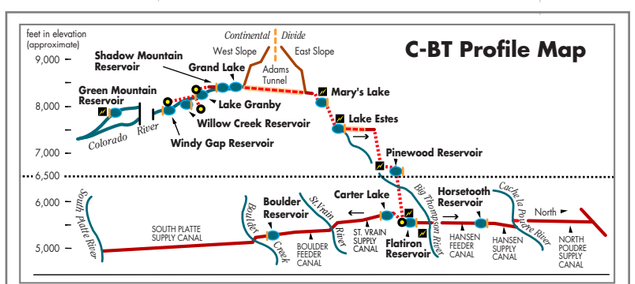
- Canal
- Pipeline/Conduit
- Tunnel
- Dam
- Power Plant
- Pump Plant
- Colorado-Big Thompson Reservoirs
- City/Town
- Northern Water Boundaries
- Southern Water Supply Pipeline
- Pleasant Valley Pipeline
- Berthoud Headquarters

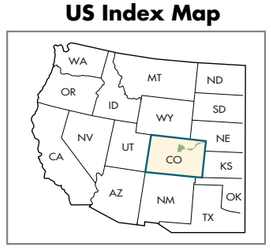
0 5 10 15 20
Scale of Miles (Approximate)

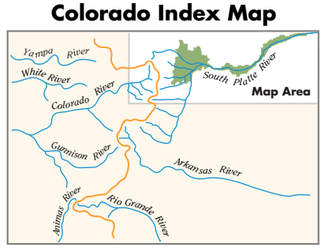
JA Dahlstrom 06/01 revised 04/10

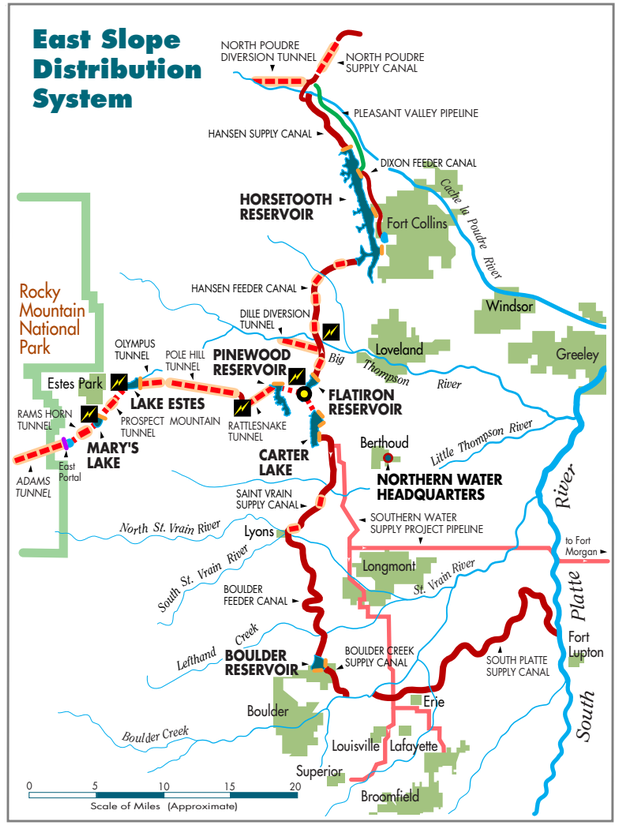




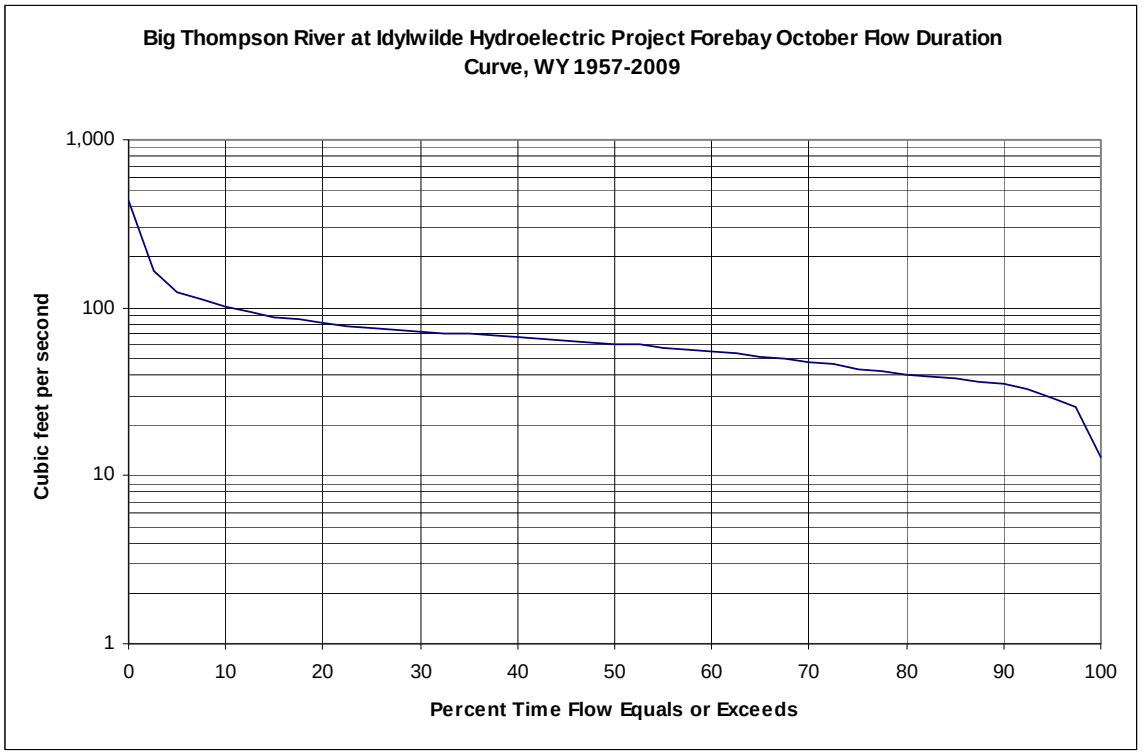


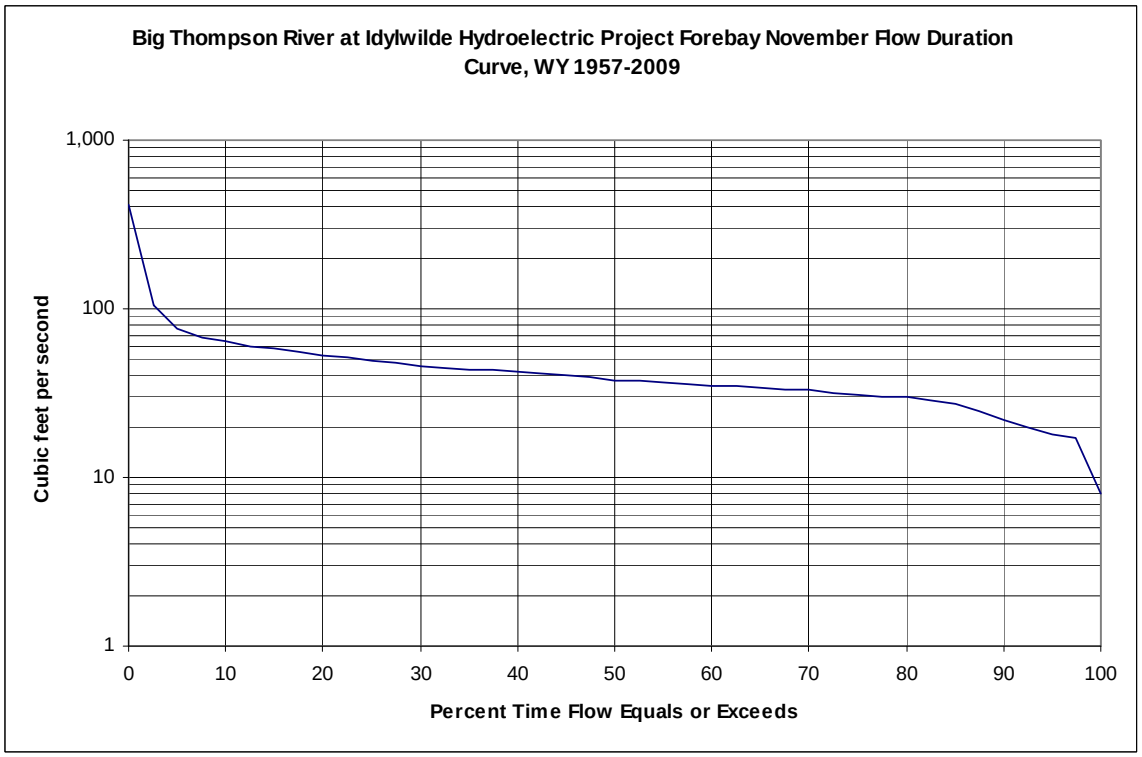


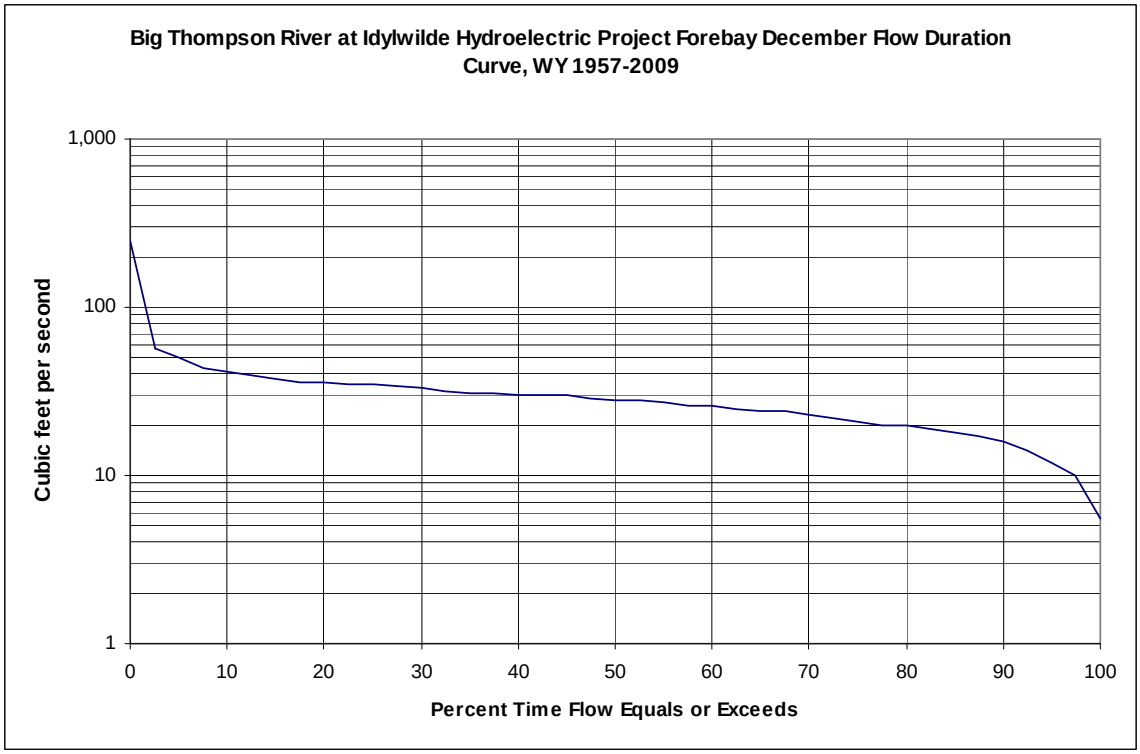




Appendix B
Monthly Flow Duration Curves, WY 1957–2009



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Cubic feet per second
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1
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10
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70
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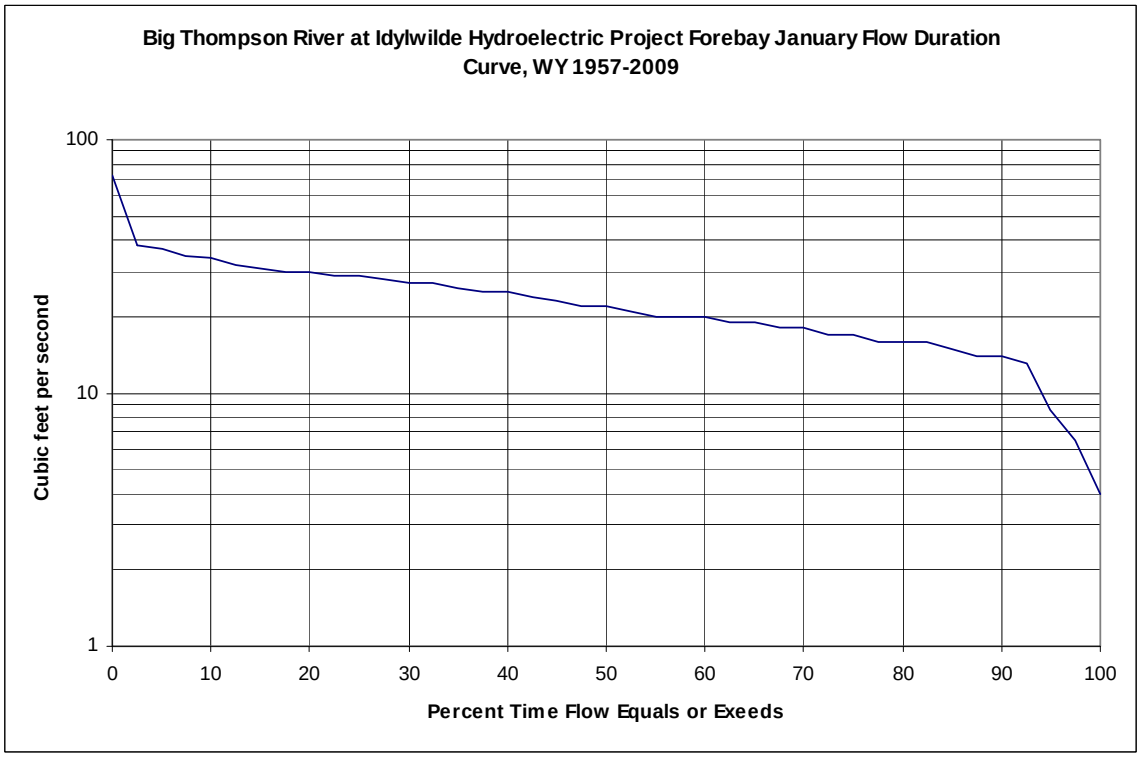
100
Percent Time Flow Equals or Exceeds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Cubic feet per second
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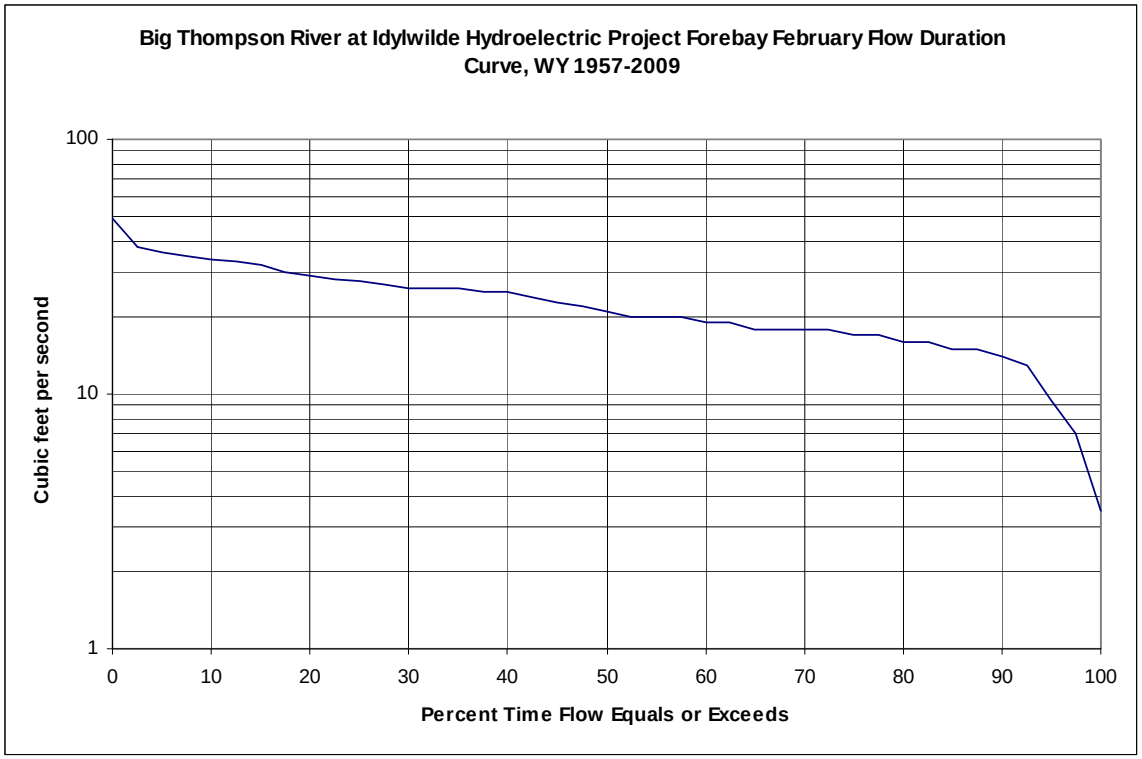
Percent Time Flow Equals or Exeeds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100
10
1
Cubic feet per second
0
10
20
30
40
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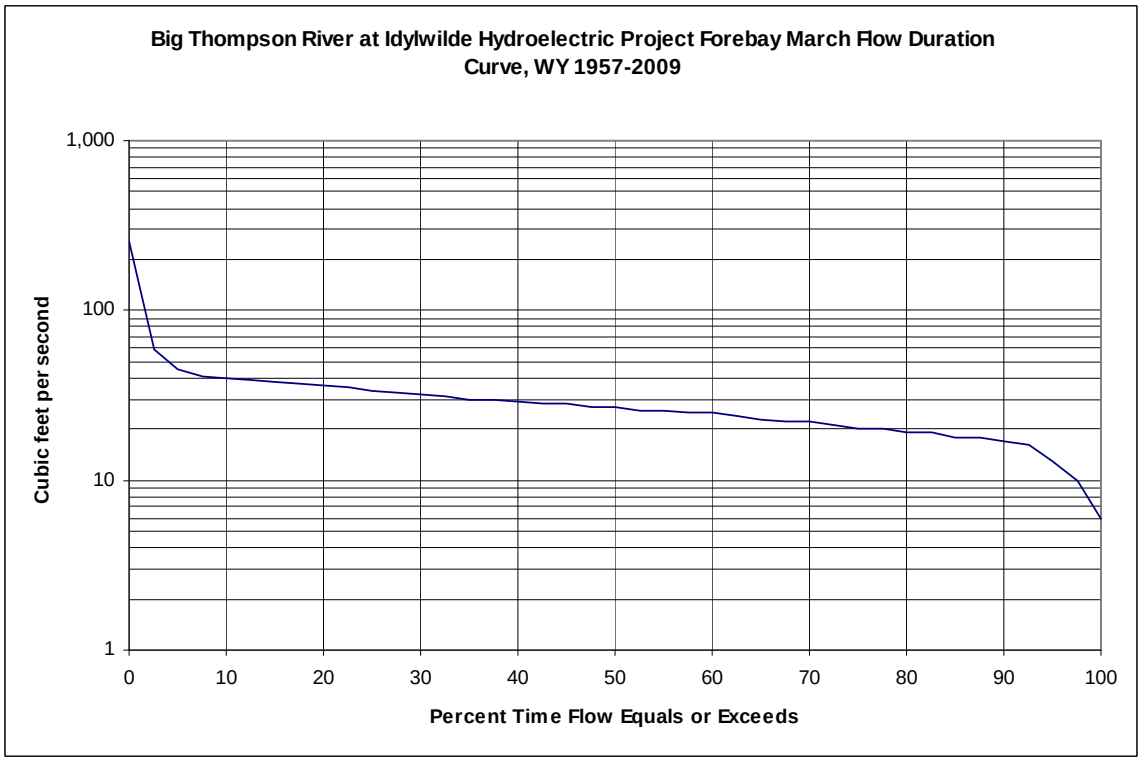
90
100
Percent Time Flow Equals or Exceeds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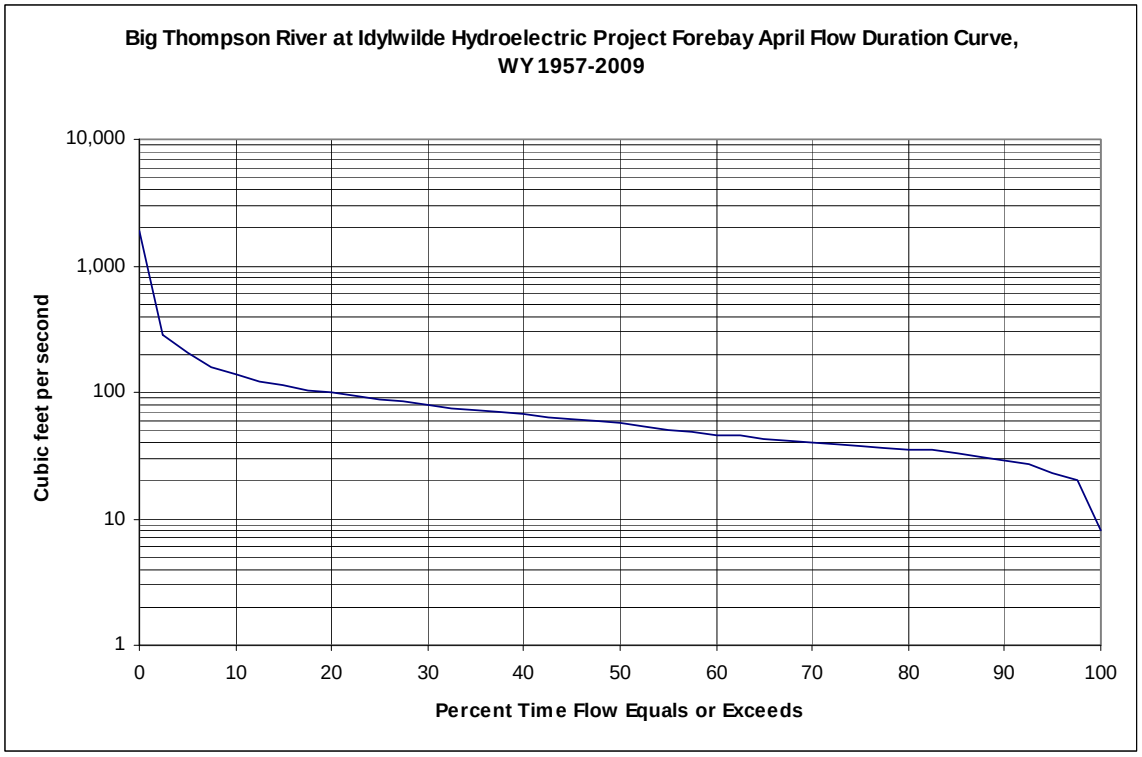
100
Percent Time Flow Equals or Exceeds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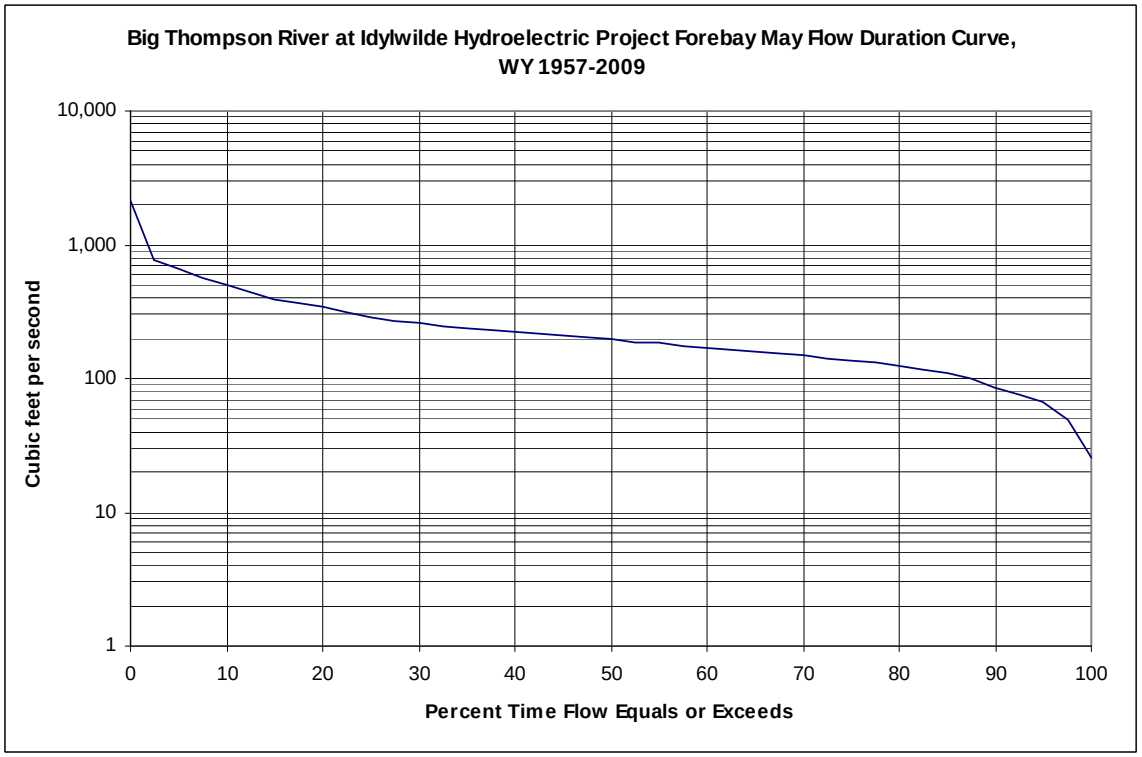
90
100
Percent Time Flow Equals or Exceeds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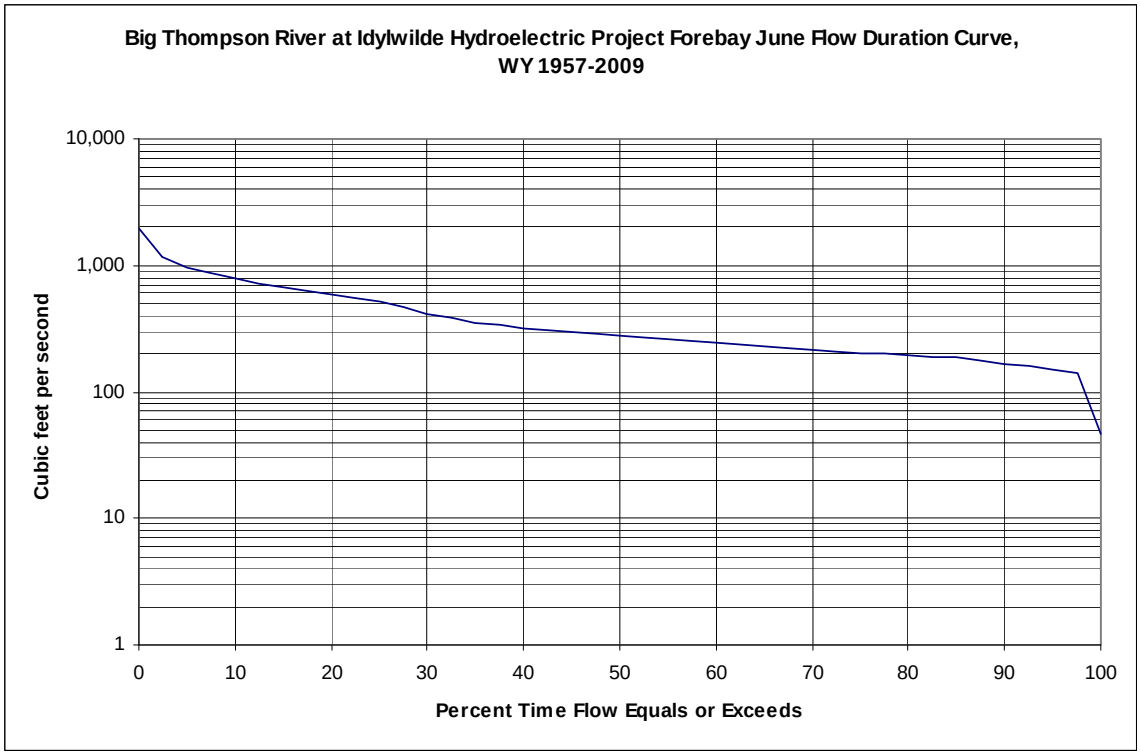
Percent Time Flow Equals or Exceeds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100
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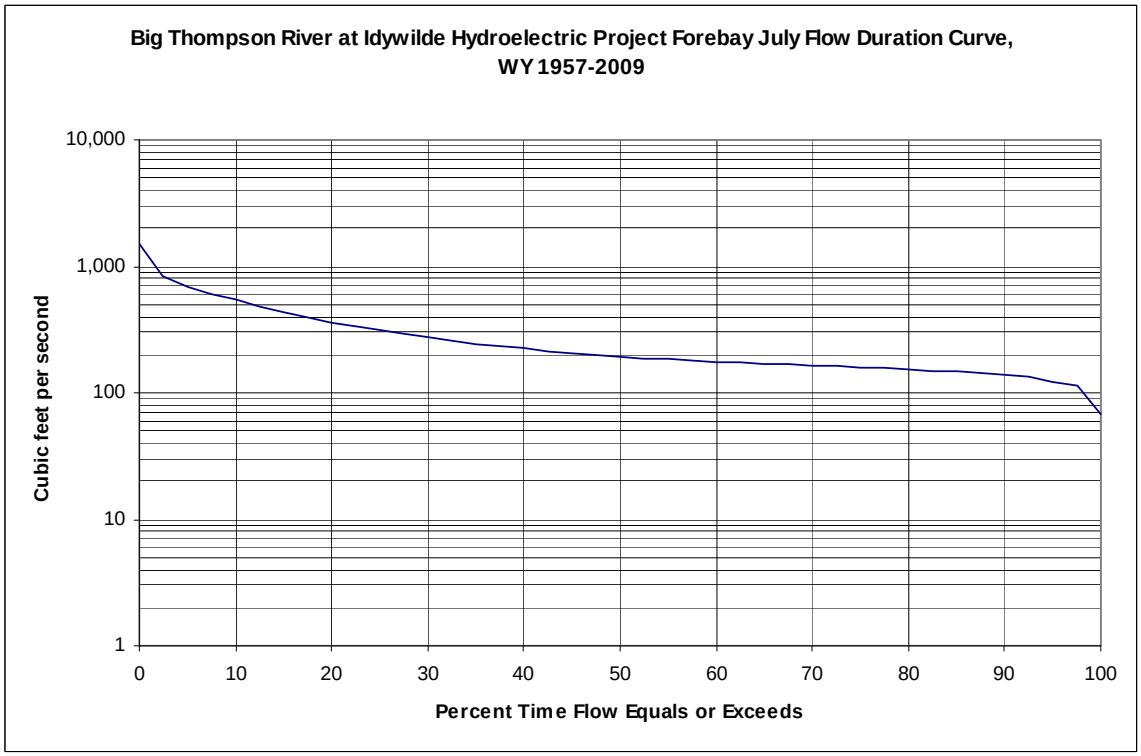
90
100
Percent Time Flow Equals or Exceeds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1,000
100
10
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Cubic feet per second
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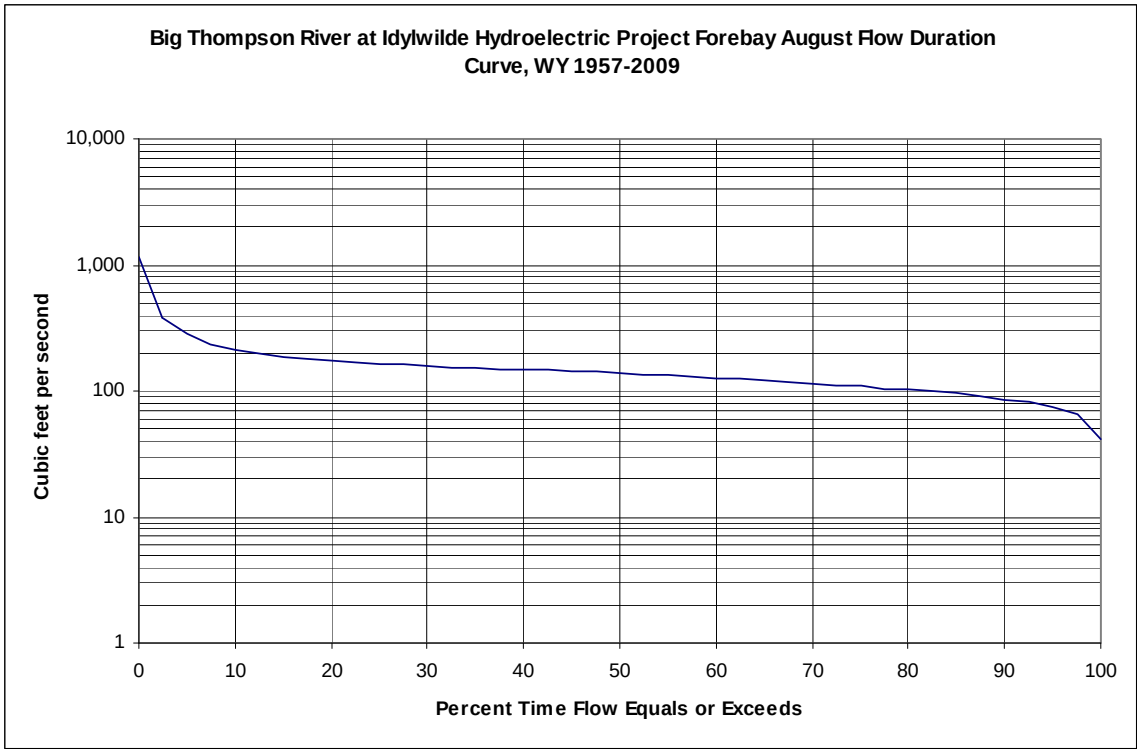
60
70
80
90
100
Percent Time Flow Equals or Exceeds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Cubic feet per second
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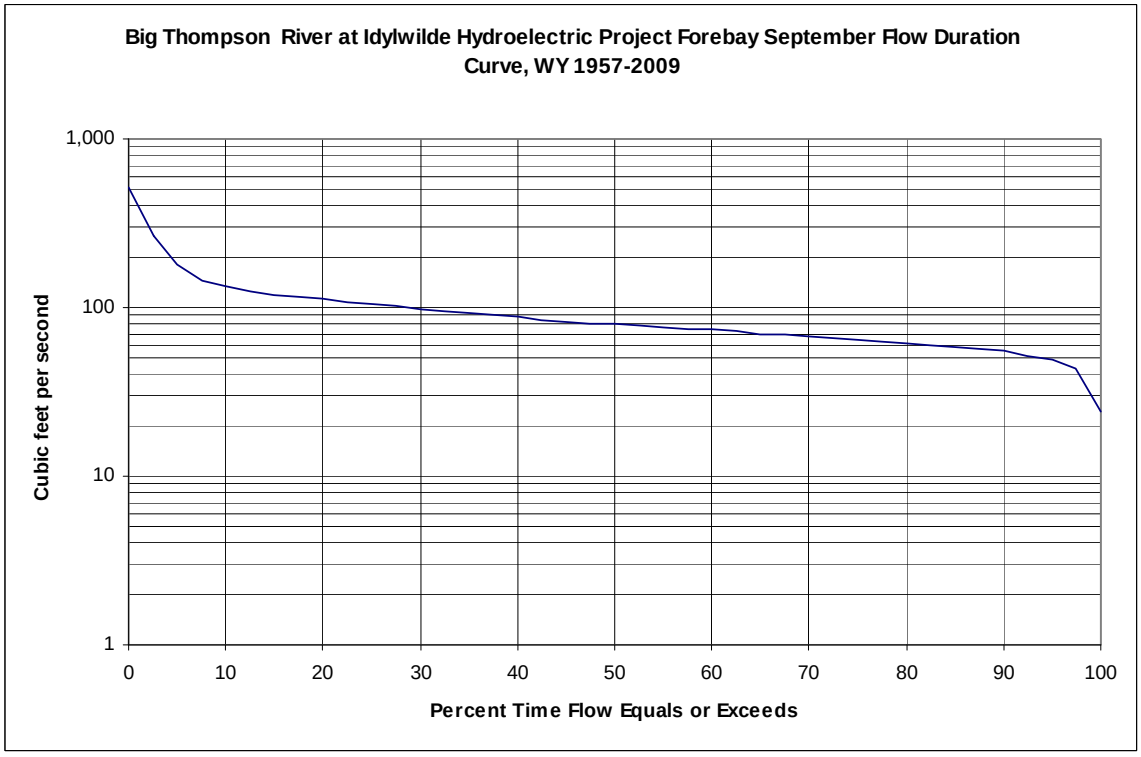
90
100
Percent Time Flow Equals or Exceeds


Big Thompson River at Idylwilde Hydroelectric Project Forebay September Flow Duration Curve, WY 1957-2009
Cubic feet per second
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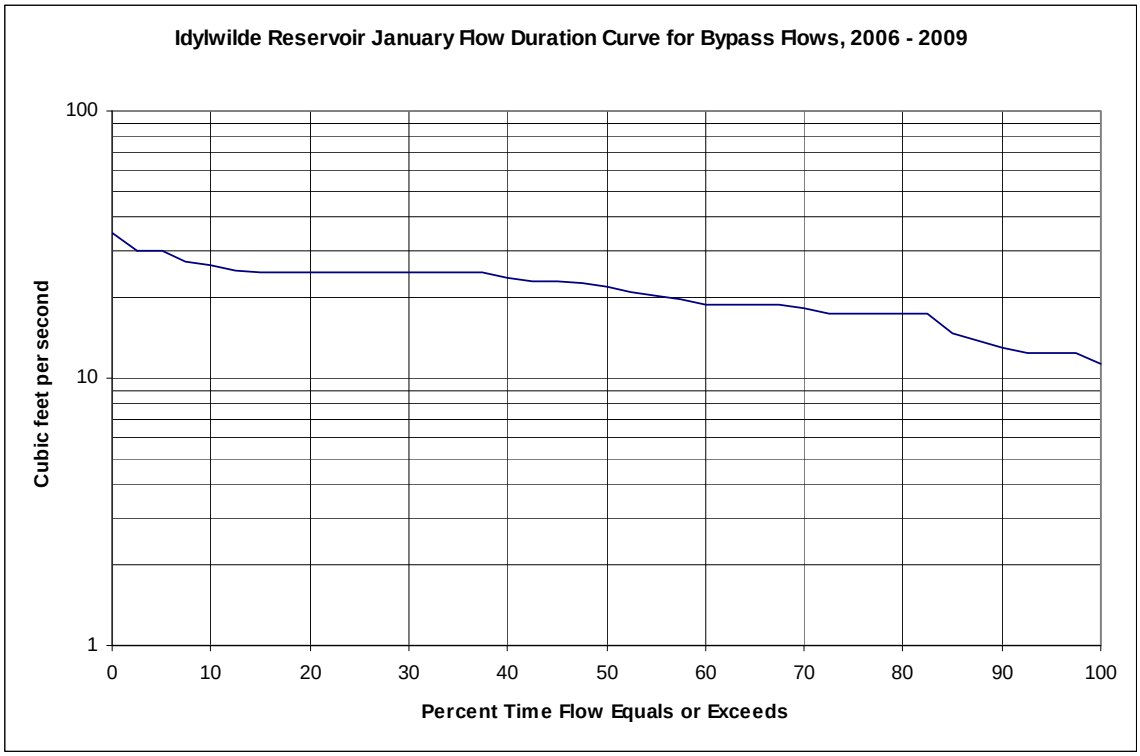
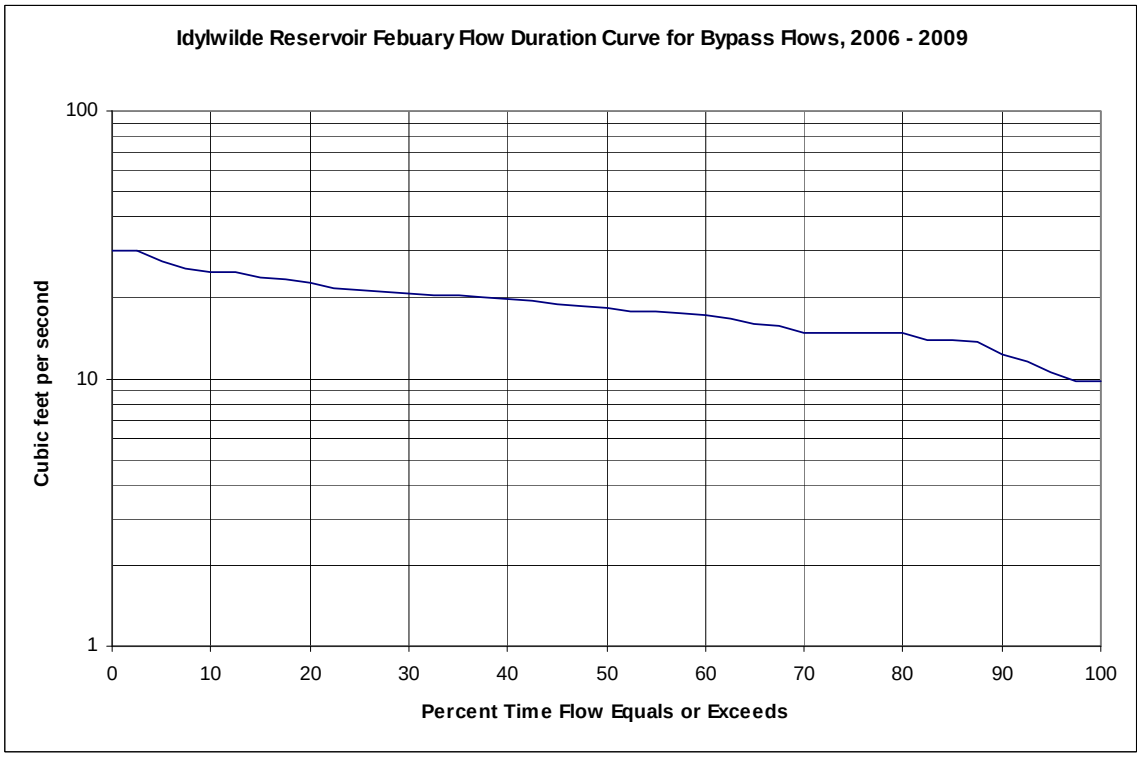
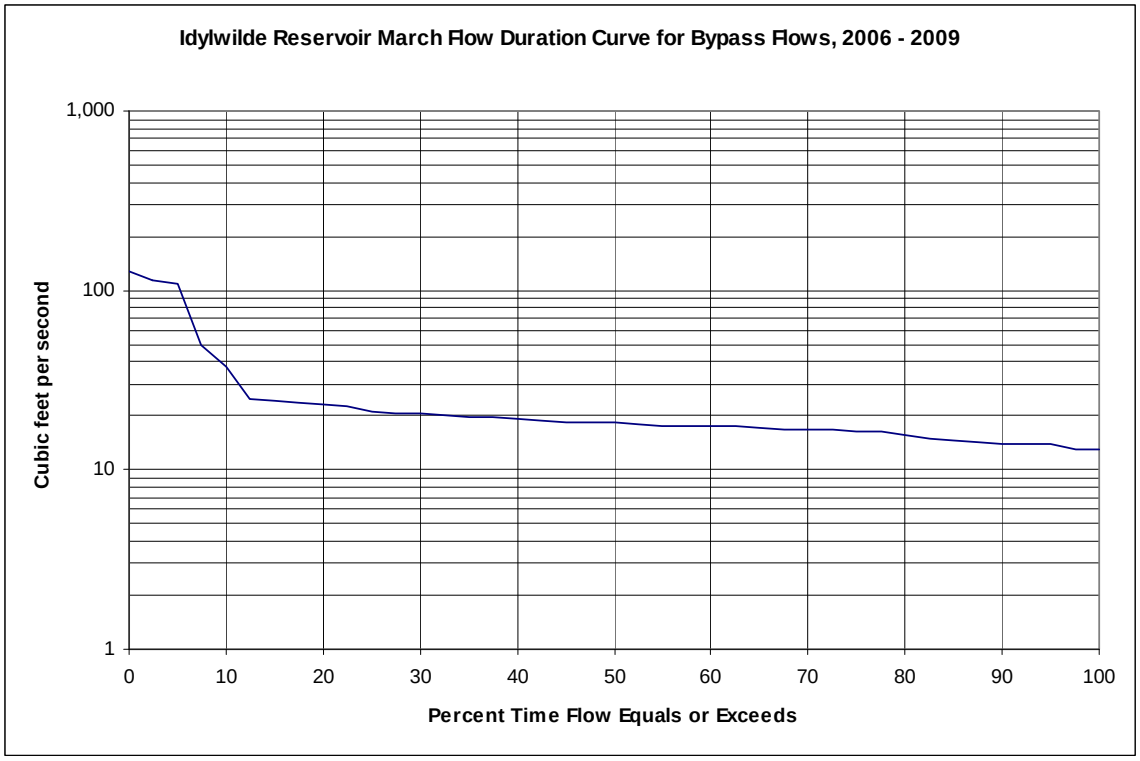
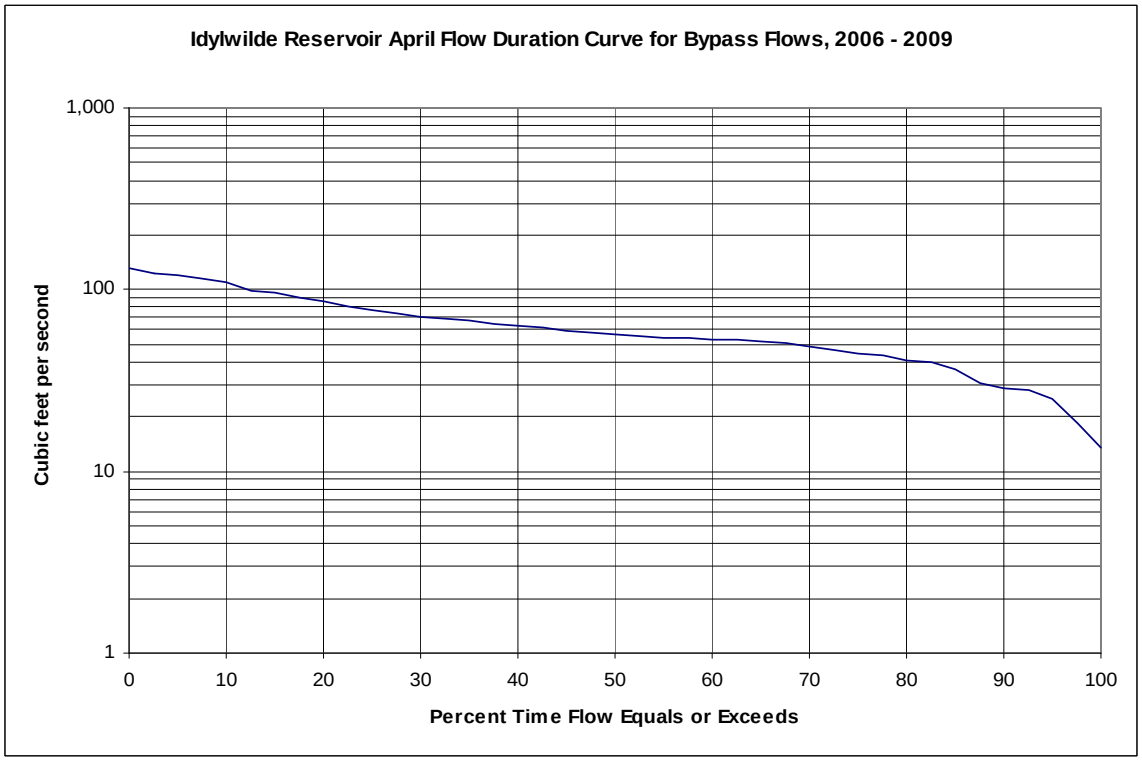
Percent Time Flow Equals or Exceeds

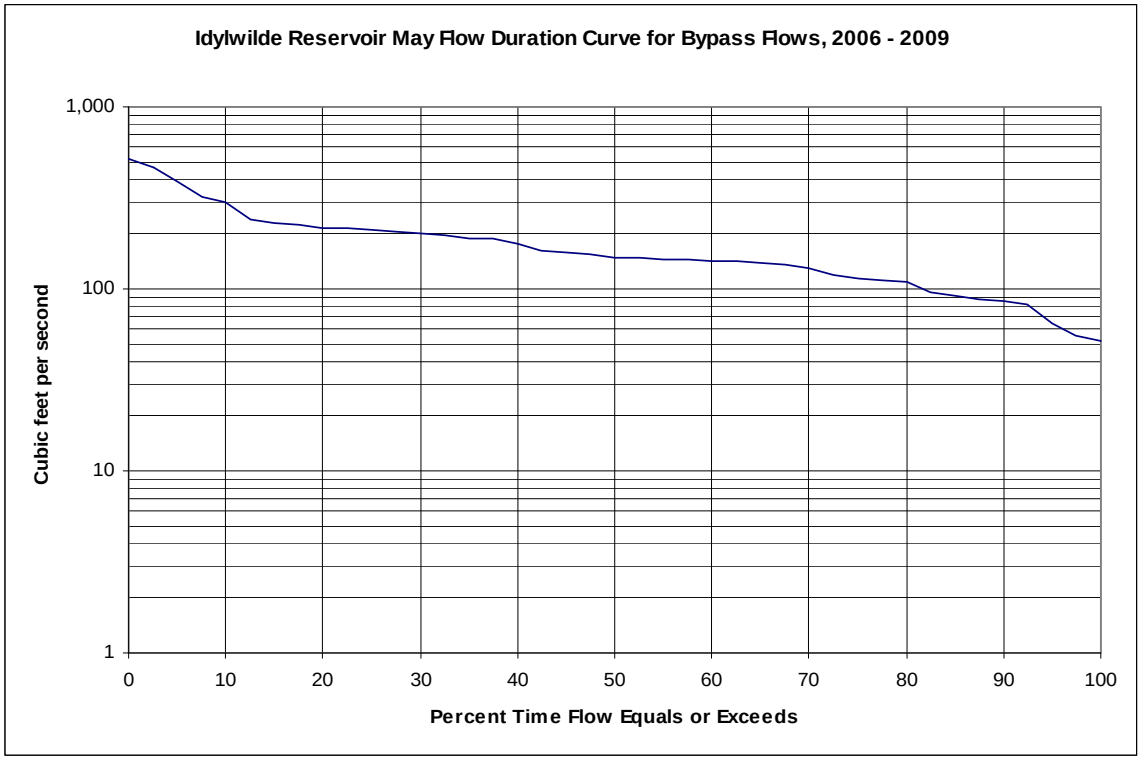
Appendix C
Monthly Flow Duration Curves, 2006–2009

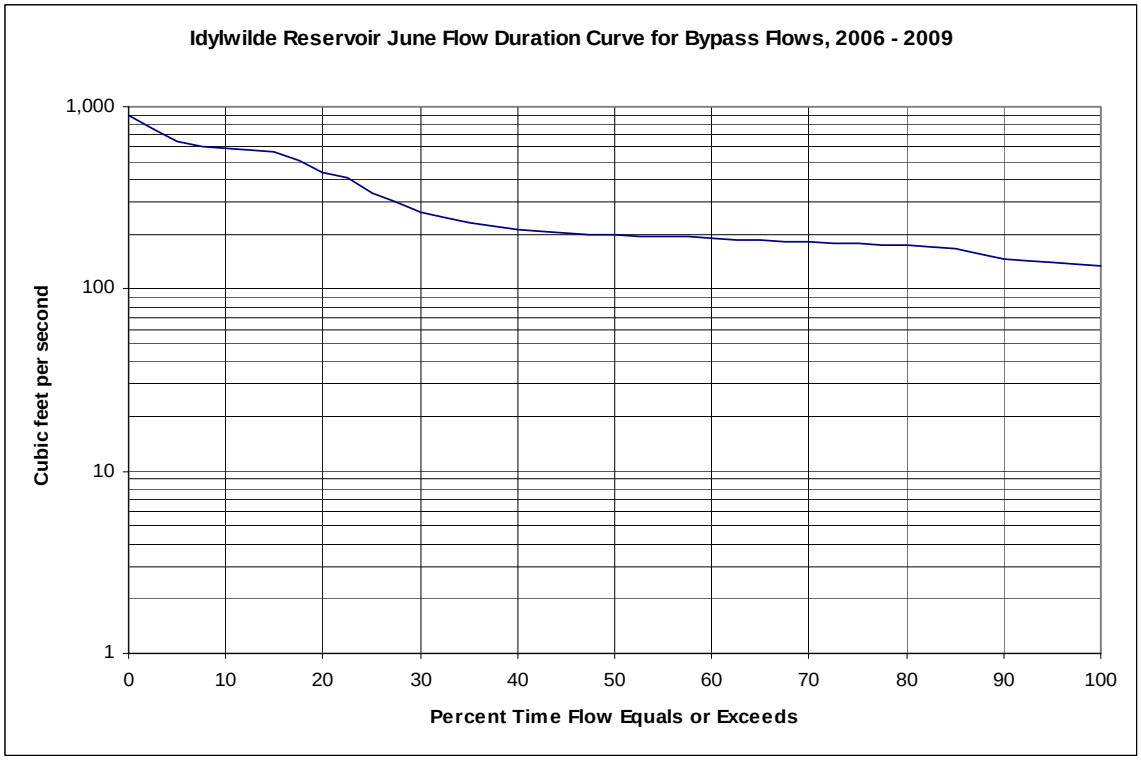


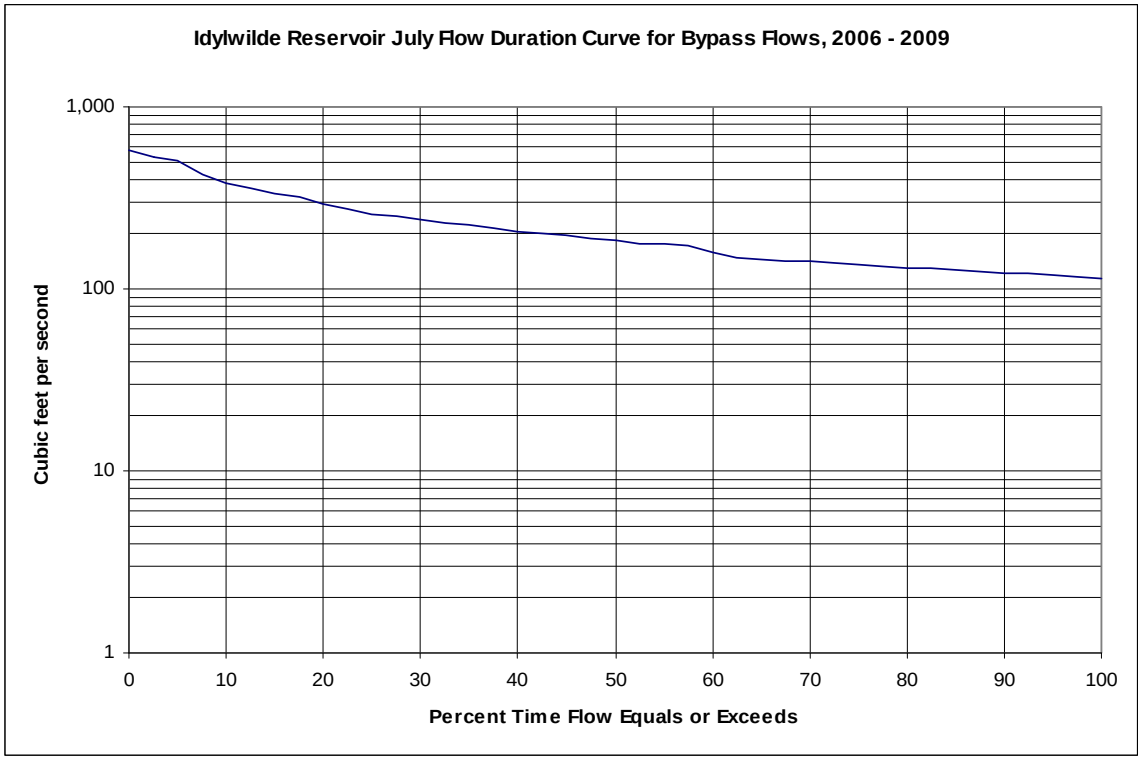


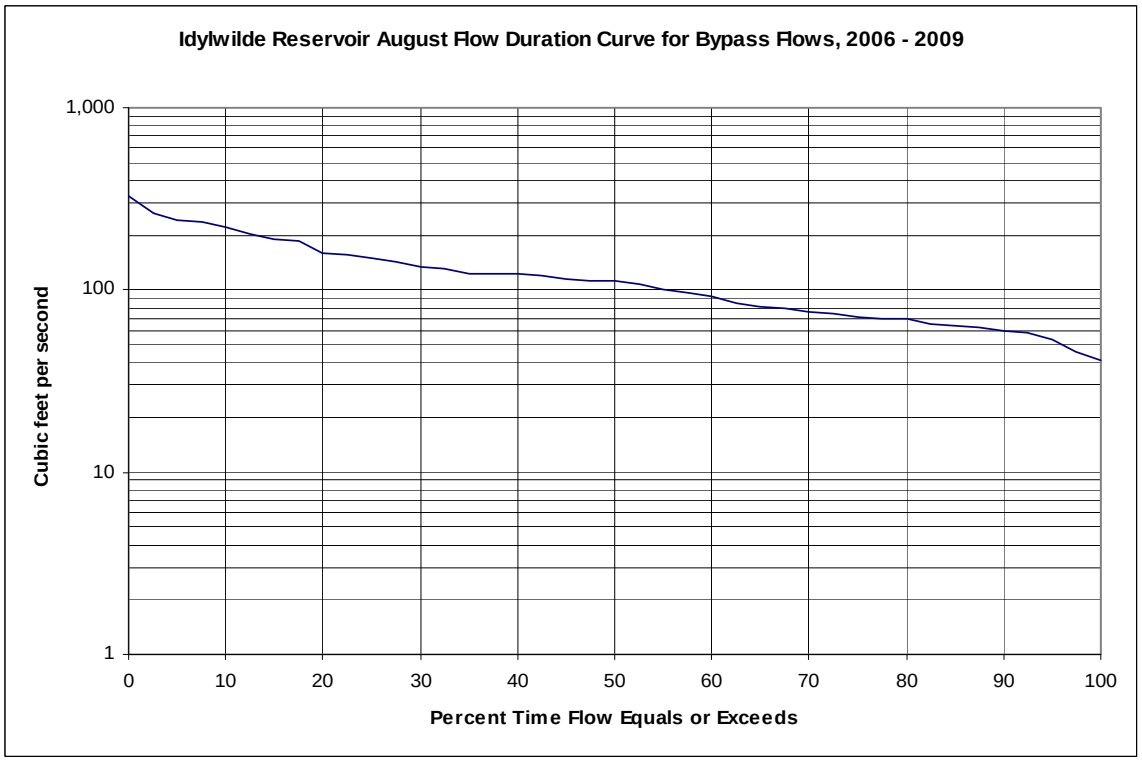

Idylwilde Reservoir March Flow Duration Curve for Bypass Flows, 2006 - 2009
Cubic feet per second
1,000
100
10
1
0
10
20
30
40
50
60
70
80
90
100
Percent Time Flow Equals or Exceeds

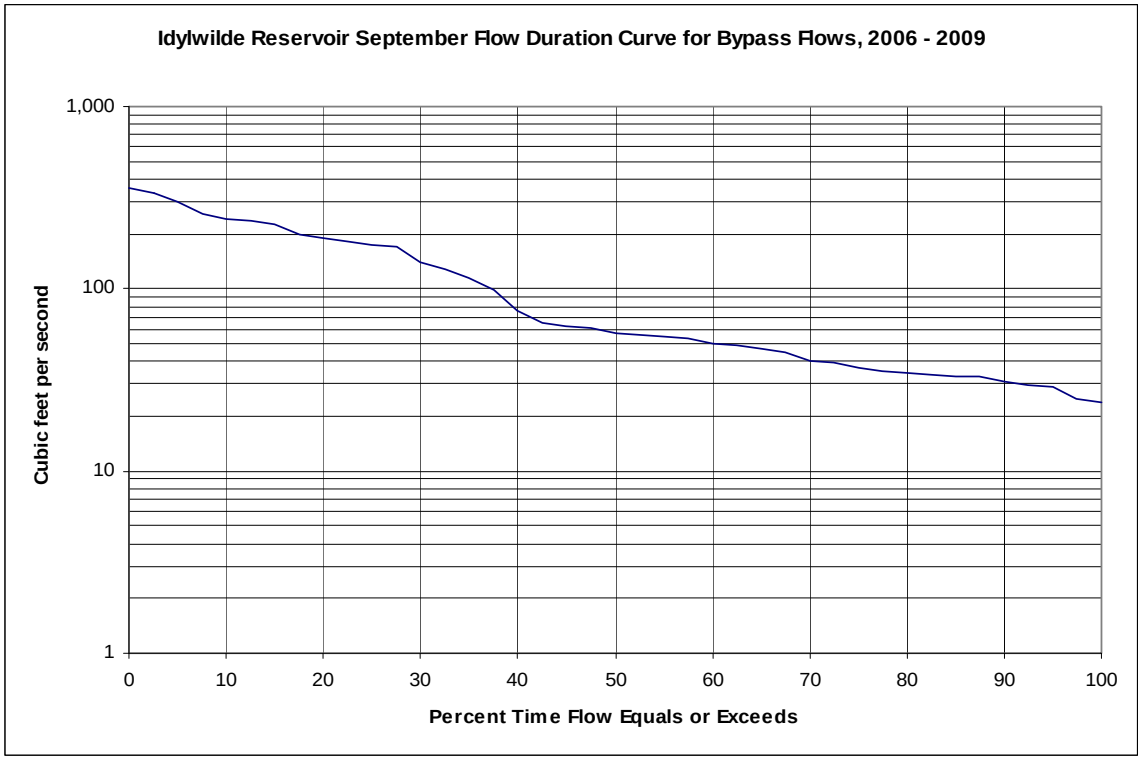

Idylwilde Reservoir April Flow Duration Curve for Bypass Flows, 2006 - 2009
Cubic feet per second
1,000
100
10
1
0
10
20
30
40
50
60
70
80
90
100
Percent Time Flow Equals or Exceeds

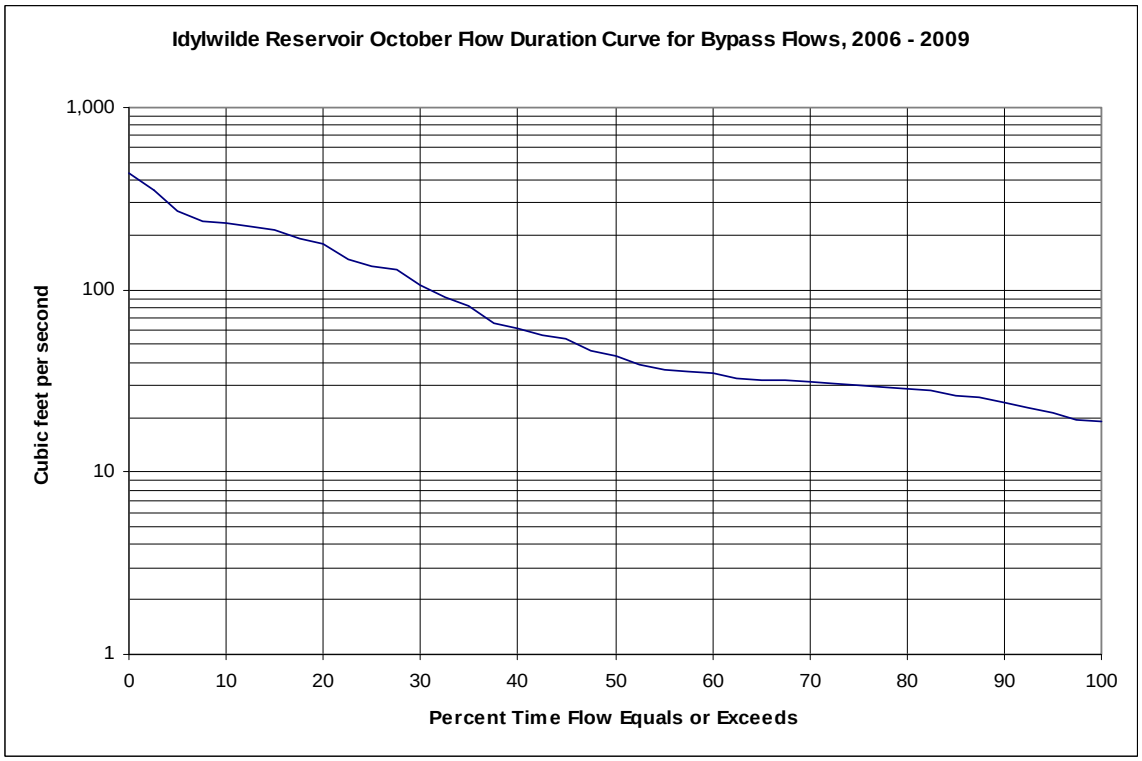

Idylwilde Reservoir May Flow Duration Curve for Bypass Flows, 2006 - 2009
Cubic feet per second
1,000
100
10
1
0
10
20
30
40
50
60
70
80
90
100
Percent Time Flow Equals or Exceeds

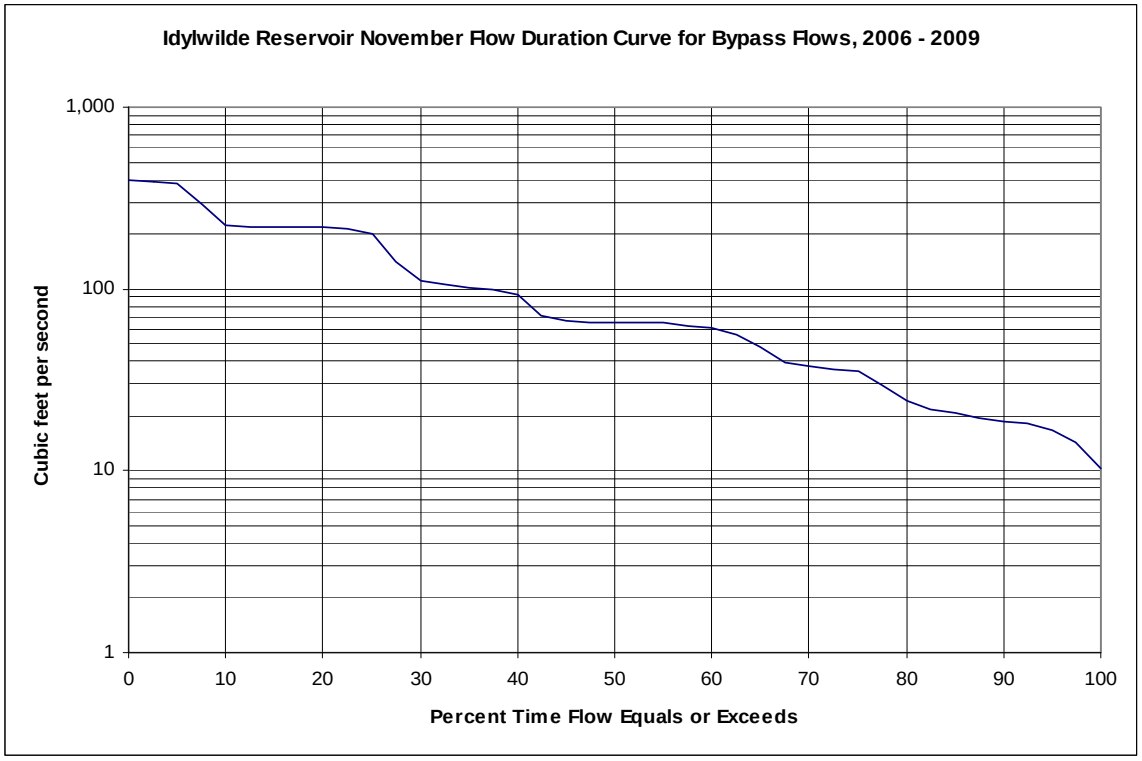

Idylwilde Reservoir June Flow Duration Curve for Bypass Flows, 2006 - 2009
Cubic feet per second
1,000
100
10
1
0
10
20
30
40
50
60
70
80
90
100
Percent Time Flow Equals or Exceeds

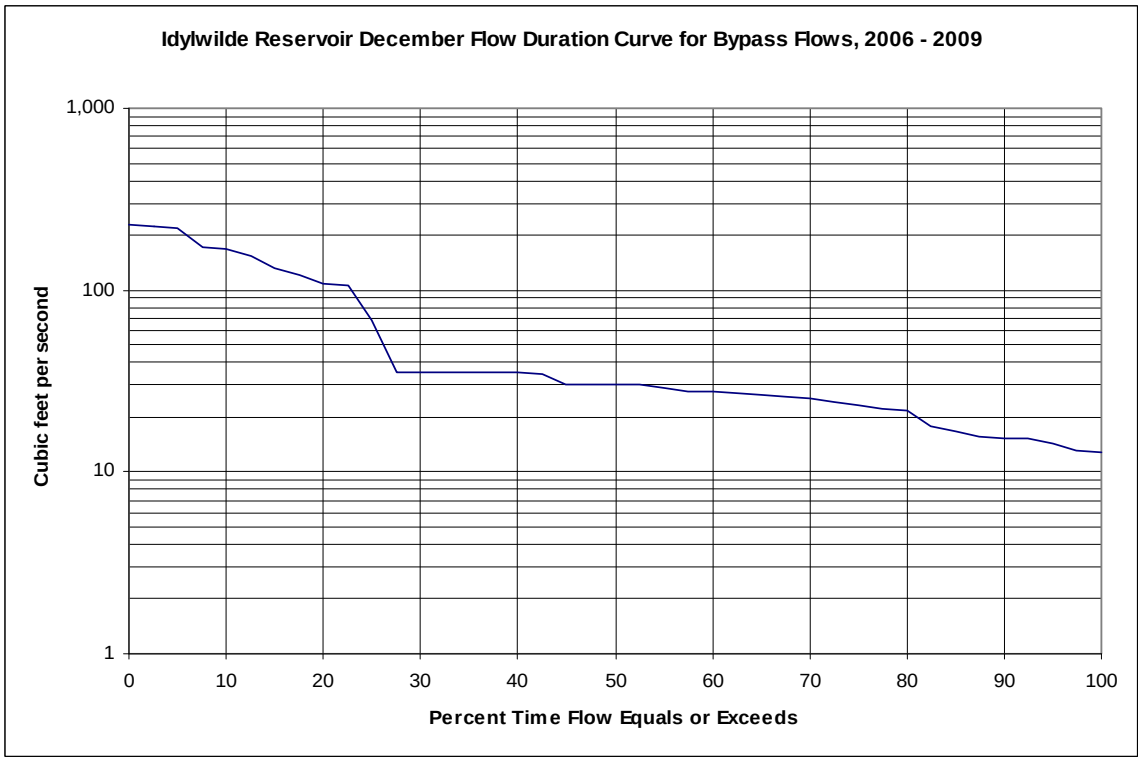

Idylwilde Reservoir July Flow Duration Curve for Bypass Flows, 2006 - 2009
Cubic feet per second
1,000
100
10
1
0
10
20
30
40
50
60
70
80
90
100
Percent Time Flow Equals or Exceeds


Idylwilde Reservoir August Flow Duration Curve for Bypass Flows, 2006 - 2009
Cubic feet per second
1,000
100
10
1
0
10
20
30
40
50
60
70
80
90
100
Percent Time Flow Equals or Exceeds


Idylwilde Reservoir September Flow Duration Curve for Bypass Flows, 2006 - 2009
Cubic feet per second
1,000
100
10
1
0
10
20
30
40
50
60
70
80
90
100
Percent Time Flow Equals or Exceeds


Idylwilde Reservoir October Flow Duration Curve for Bypass Flows, 2006 - 2009
Cubic feet per second
1,000
100
10
1
0
10
20
30
40
50
60
70
80
90
100
Percent Time Flow Equals or Exceeds


Idylwilde Reservoir November Flow Duration Curve for Bypass Flows, 2006 - 2009
Cubic feet per second
1,000
100
10
1
0
10
20
30
40
50
60
70
80
90
100
Percent Time Flow Equals or Exceeds


Idylwilde Reservoir December Flow Duration Curve for Bypass Flows, 2006 - 2009
Cubic feet per second
1,000
100
10
1
0
10
20
30
40
50
60
70
80
90
100
Percent Time Flow Equals or Exceeds