

## Appendix C Details of Flow Duration Analyses

### Contents

Appendix C Details of Flow Duration Analyses .....	C-1
Calaveras River Upstream of Bellota .....	C-1
Calaveras River Downstream of the Headworks.....	C-3
Mormon Slough Upstream of Potter Creek.....	C-5
Stockton Diverting Canal and Mormon Slough Downstream of Potter Creek.....	C-8

### Figures

Figure C-1. Flow duration curves for Calaveras River upstream of Bellota – Adult <i>O. mykiss</i> migration (Oct–Mar).....	C-2
Figure C-2 Flow duration curves for Calaveras River upstream of Bellota – Juvenile salmonid migration (Jan–Jun) .....	C-2
Figure C-3 Flow duration curves for Calaveras River downstream of the Headworks – Adult Chinook migration (Sep–Dec) .....	C-4
Figure C-4 Flow duration curves for Calaveras River downstream of the Headworks– Adult <i>O. mykiss</i> migration (Oct–Mar) .....	C-4
Figure C-5 Flow Duration Curves for Calaveras River downstream of the Headworks – Juvenile salmonid migration (Jan–Jun).....	C-5
Figure C-6 Flow duration curves for Mormon Slough upstream of Potter Creek – Adult Chinook migration (Sep–Dec) .....	C-6
Figure C-7 Flow duration curves for Mormon Slough upstream of Potter Creek – Adult <i>O. mykiss</i> migration (Oct–Mar) .....	C-7
Figure C-8 Flow duration curves for Mormon Slough upstream of Potter Creek – Juvenile salmonid migration (Jan–Jun).....	C-7
Figure C-9 Flow duration curves for Mormon Slough downstream of Potter Creek and Stockton Diverting Canal – Adult Chinook migration (Sep–Dec) .....	C-8
Figure C-10 Flow duration curves for Mormon Slough downstream of Potter Creek and Stockton Diverting Canal – Adult <i>O. mykiss</i> migration (Oct–Mar) .....	C-9
Figure C-11 Flow duration curves for Mormon Slough downstream of Potter Creek and Stockton Diverting Canal – Juvenile salmonid migration (Jan–Jun) .....	C-9

### Tables

Table C-1. Exceedance flow data Calaveras River upstream of Bellota .....	C-1
Table C-2. Exceedance flow data Calaveras River downstream of the Headworks .....	C-3
Table C-3. Exceedance flow data Mormon Slough upstream of Potter Creek .....	C-6
Table C-4. Exceedance flow data Mormon Slough downstream of Potter Creek and Stockton Diverting Canal .....	C-8



## Appendix C Details of Flow Duration Analyses

### Calaveras River Upstream of Bellota

Flows of the Calaveras River upstream of Bellota below New Hogan Dam consist mainly of the regulated releases from the dam and flow from Cosgrove and Indian Creeks (Duck Creek flows into the Calaveras River at Bellota Weir were disregarded in this analysis). Flow data was retrieved for the dam releases from 1965 to 2005 and for Cosgrove Creek from 1990 to 2005. Indian Creek is not gauged and not included in the duration analysis. To reflect impacts of the tributary inflows from Cosgrove Creek, the record for the New Hogan Dam was shortened to match the Cosgrove Creek period of record, and the flows were combined. The flow duration analysis was performed on the combined flows to reflect Cosgrove Creek’s contribution of flow to the Calaveras River when flows are being impounded by New Hogan Dam and not released downstream. Likewise, the curves depict times when the dam is releasing water to the river and Cosgrove Creek is dry.

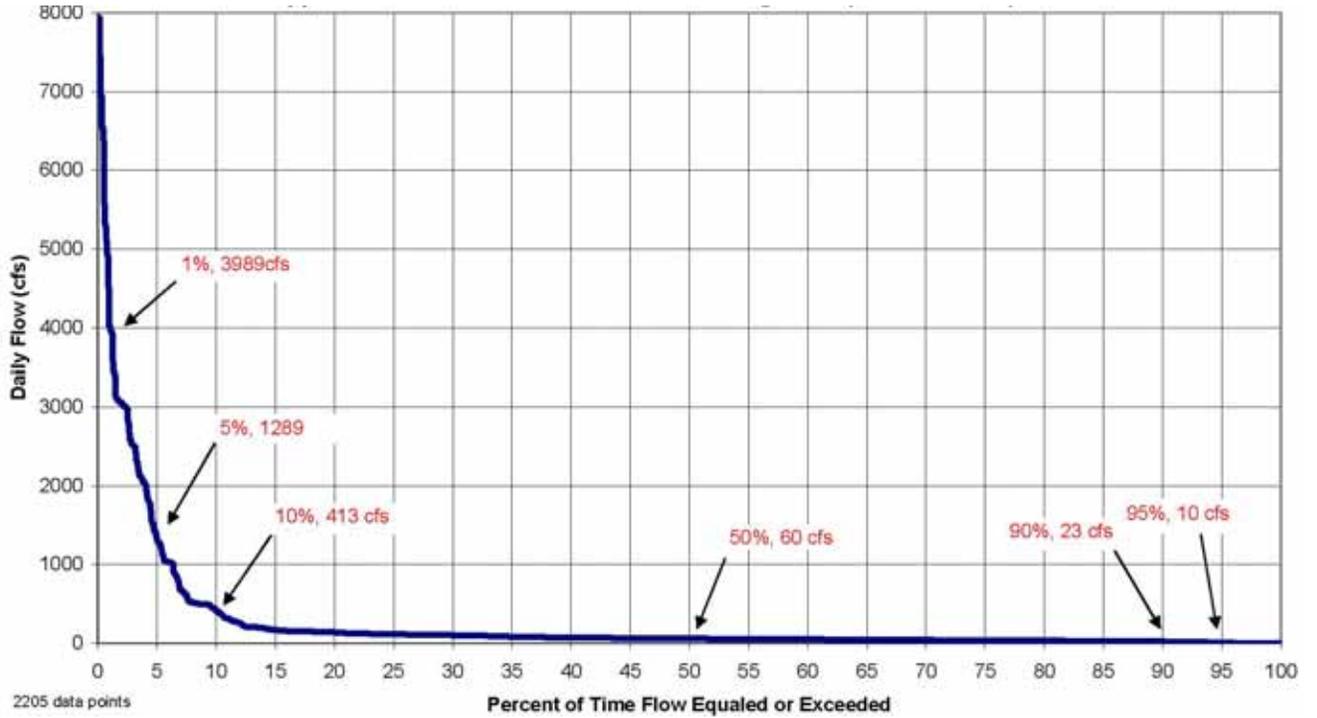
Combining the flows had only a slight impact on the upper passage flows when compared to New Hogan Dam flows from 1965 to 2005. As expected, the lower passage flows were higher than if the flow duration analysis were only performed for the New Hogan Dam releases. Because of the difference in timing of the flows, combining the flows from Cosgrove Creek and New Hogan Dam more accurately represents the actual flow in the Calaveras River upstream of Bellota. The resulting curve also better reflects the current operation of the dam to meet minimum flow requirements in the Calaveras River above Bellota Weir. The flow duration curves for the Calaveras River upstream of Bellota are shown on Figures C-1, and C-2; Table C-1 shows the exceedance values.

**Table C-1. Exceedance flow data Calaveras River upstream of Bellota**

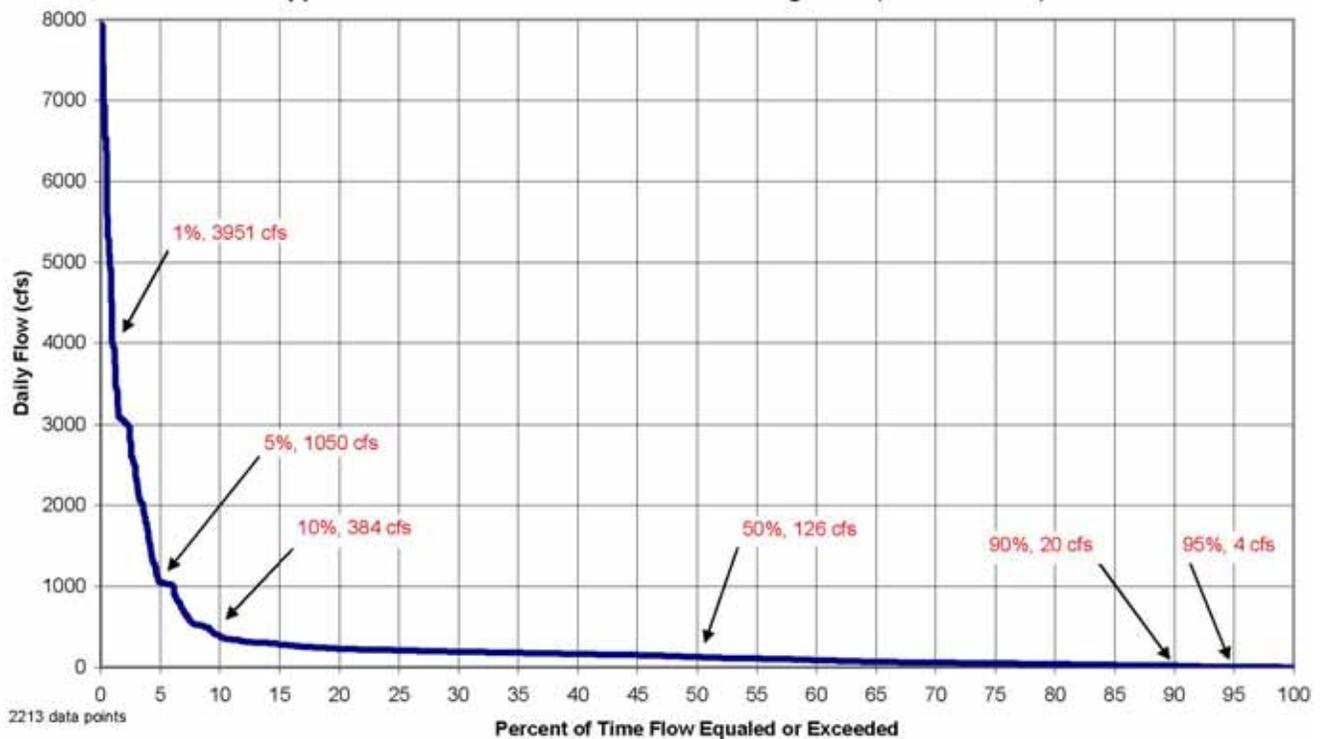
Percent of time flow equaled or exceeded	Adult Chinook (Sept-Dec)	Adult <i>O. mykiss</i> (Oct-Mar)	Juvenile salmonid (Jan-Jun)
1%	1,426	3,989	384
10%	72	60	4
50%			
95%			

Data from water year 1990–2005

**Figure C-1. Flow duration curves for Calaveras River upstream of Bellota –  
Adult *O. mykiss* migration (Oct–Mar)**



**Figure C-2 Flow duration curves for Calaveras River upstream of Bellota –  
Juvenile salmonid migration (Jan–Jun)**



## Calaveras River Downstream of the Headworks

Flows on the Calaveras River downstream of the Headworks consist of releases from the Calaveras Headworks, Podesta Reservoir, and small tributary inflows. Currently, no flow data are being collected for any of these flows. The flow duration curves for the Calaveras River from Bellota Weir to the Stockton Diverting Canal were developed from the Calaveras River near Stockton gage which is about 2 miles upstream of Highway 99. The period of record used for this analysis is 1965 to 1987. An analysis was made to evaluate the use of the gage to represent flow conditions for the entire channel reach as seepage losses, irrigation pumping, and tributary inflows may play a significant role in forming the channel's flow pattern. Though little data exist to detail these factors, a correlation was performed between the near Stockton gage and a historical gage at the Headworks at the Bellota Weir. The correlation showed that the flow on the river for the higher exceedance flows was relatively steady, but there did seem to be a significant loss as the flow traveled downstream for the lower exceedance flows. Because the lower passage flows were all at or below the California Department of Fish and Game (DFG) guidelines and minimum specified flows would be used regardless of the data, the gage appeared valid for the entire reach. For the upper passage flows, irrigation pumping and seepage losses likely make the curves conservative estimates of flows for the reach of the river below the Calaveras Headworks. With the lack of other data, the curves were deemed adequate for use in defining fish passage flows. The flow duration curves for the Calaveras River downstream of the Headworks are shown on Figures C-3, C-4, and C-5; Table C-2 shows the exceedance values.

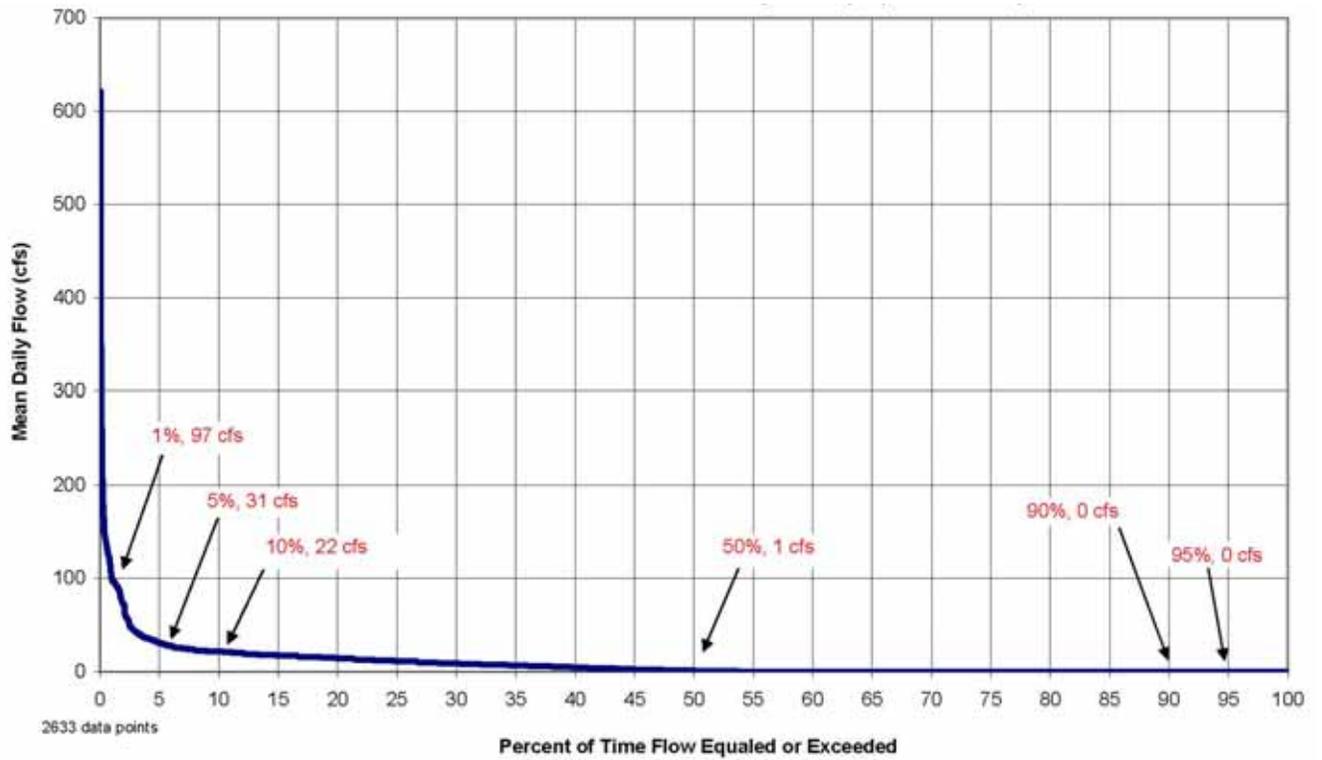
**Table C-2. Exceedance flow data Calaveras River downstream of the Headworks**

Percent of time flow equaled or exceeded	Adult Chinook (Sept-Dec)	Adult <i>O. mykiss</i> (Oct-Mar)	Juvenile salmonid (Jan-Jun)
1%	97	166	
10%			38
50%	1 (3)	2 (3)	
95%			0 (1)

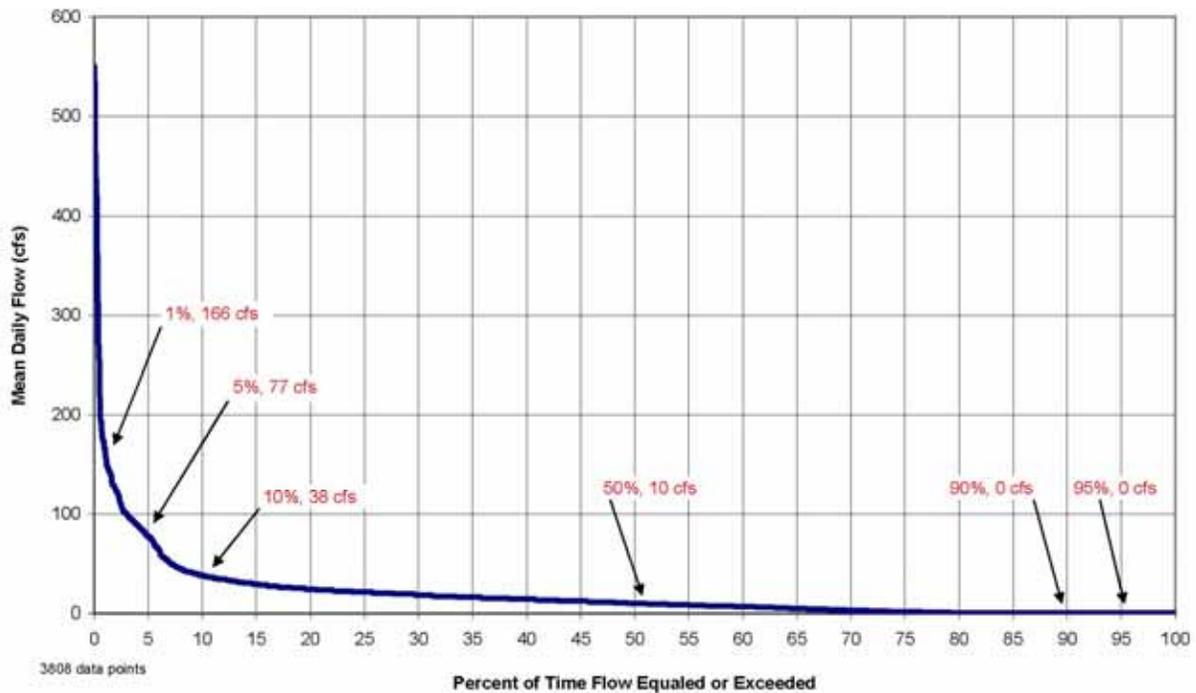
Data from water year 1965–1987

( ) Minimum lower passage flow value from DFG guidelines should be used

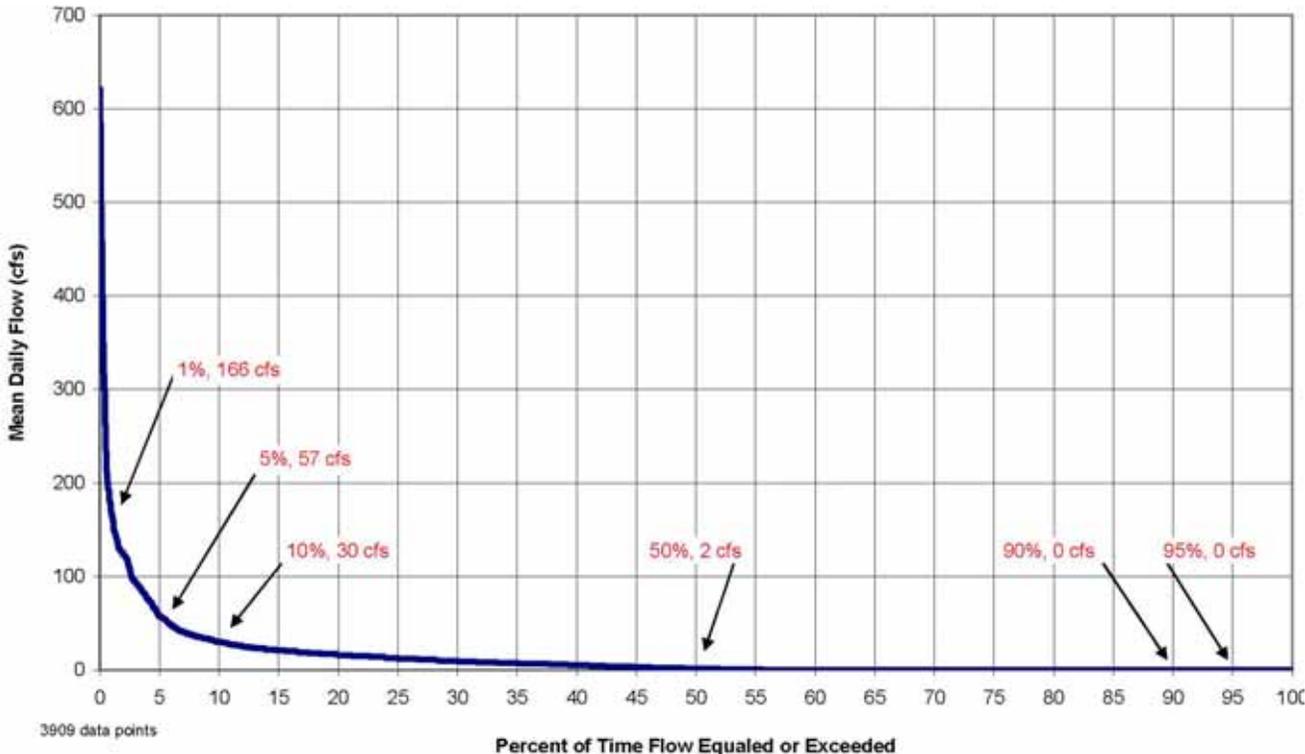
**Figure C-3 Flow duration curves for Calaveras River downstream of the Headworks – Adult Chinook migration (Sep–Dec)**



**Figure C-4 Flow duration curves for Calaveras River downstream of the Headworks– Adult *O. mykiss* migration (Oct–Mar)**



**Figure C-5 Flow Duration Curves for Calaveras River downstream of the Headworks – Juvenile salmonid migration (Jan–Jun)**



### Mormon Slough Upstream of Potter Creek

Mormon Slough receives flow from releases at Bellota Weir, Potter Creek which enters below Mormon Slough Railroad Crossing, and another unnamed tributary that inflows below Jack Tone Road about 2 miles above the Stockton Diverting Canal. Only the releases from Mormon Slough at Bellota are gauged; these flows were used to develop the flow duration curves for Mormon Slough upstream of Potter Creek. This gage has a record from 1965 to 1975 and from 1995 to 2005. To examine the appropriateness of the gage to represent the entire reach of Mormon Slough, a correlation of flow data at Bellota Weir and on the Stockton Diverting Canal was made. The data showed that—though the impact is slight—the flows appear to exhibit some losses for the 18-mile reach. The losses are likely the result of attenuation in the long travel reach, seepage losses, and irrigation pumping. With the impact of the attenuation, losses, and tributary inflows, Mormon Slough flows were broken down into Mormon Slough upstream of Potter Creek and Mormon Slough downstream of Potter Creek.

The Mormon Slough at Bellota gage will be used to detail the Mormon Slough upstream of Potter Creek flows. The flow duration curve for Mormon Slough upstream of Potter Creek is shown on Figure C-6, C-7, and C-8; Table C-3 shows the exceedance values. The Mormon Slough downstream of Potter Creek will be portrayed with the gage on the Stockton Diverting Canal. The Stockton Diverting Canal flows are discussed in the following section.

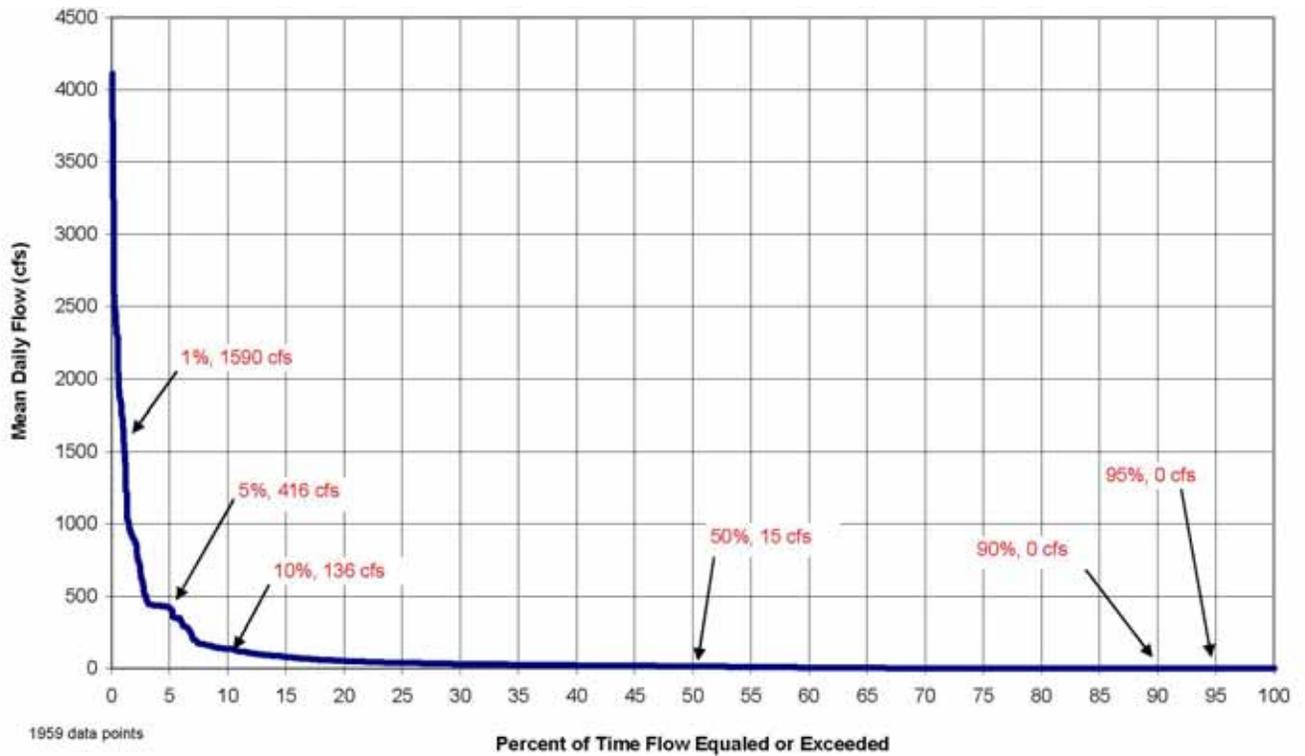
**Table C-3. Exceedance flow data Mormon Slough upstream of Potter Creek**

Percent of time flow equaled or exceeded	Adult Chinook (Sep-Dec)	Adult <i>O. mykiss</i> (Oct-Mar)	Juvenile salmonid (Jan-Jun)
1%	1,590	5,460	
10%			1,248
50%	15	19	
95%			0 (1)

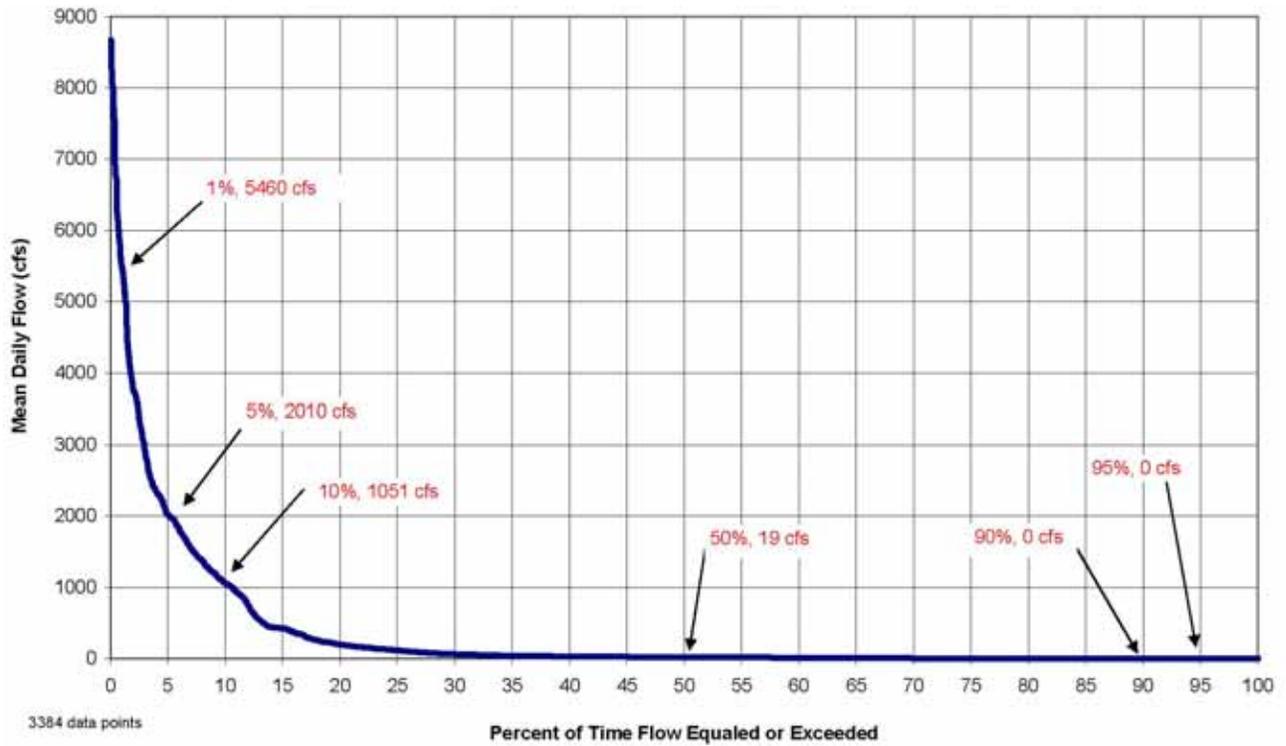
Data from water year 1965–1975 and 1995–2005

(1) Minimum lower passage flow value from DFG guidelines should be used

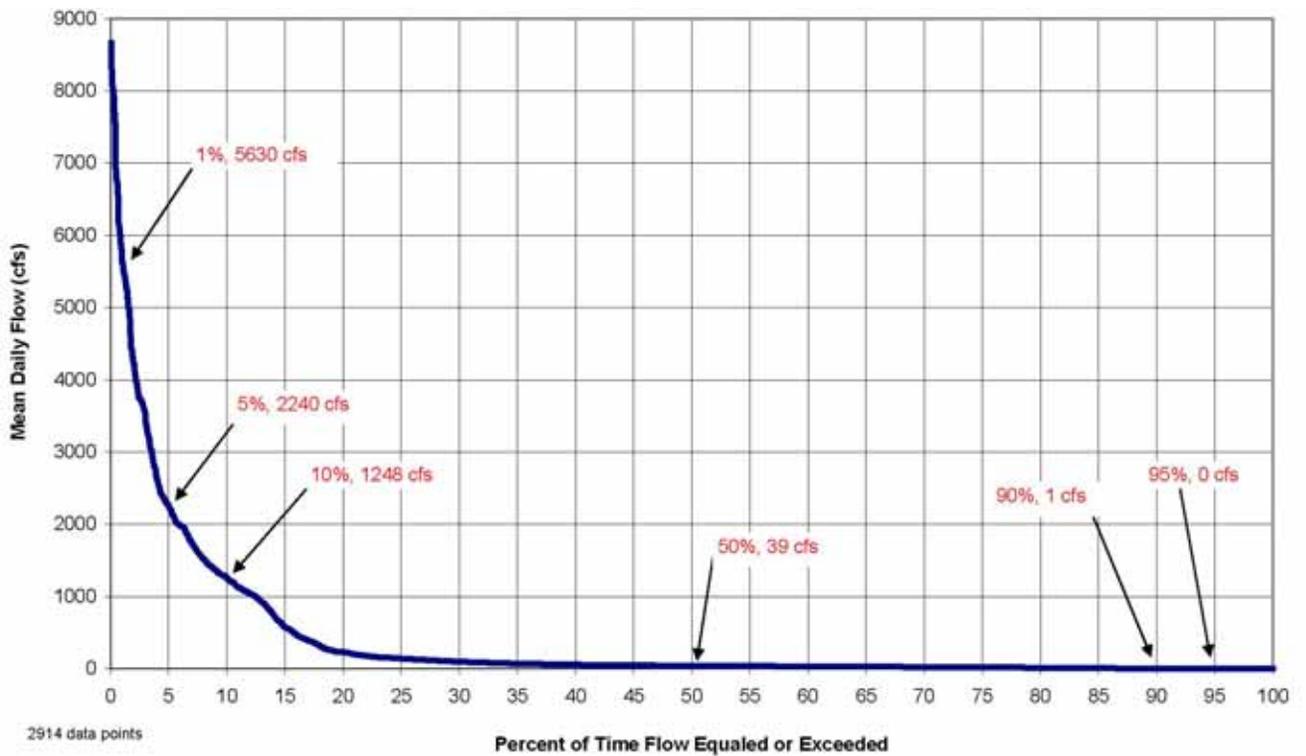
**Figure C-6 Flow duration curves for Mormon Slough upstream of Potter Creek – Adult Chinook migration (Sep–Dec)**



**Figure C-7 Flow duration curves for Mormon Slough upstream of Potter Creek –  
Adult *O. mykiss* migration (Oct–Mar)**



**Figure C-8 Flow duration curves for Mormon Slough upstream of Potter Creek –  
Juvenile salmonid migration (Jan–Jun)**



## Stockton Diverting Canal and Mormon Slough Downstream of Potter Creek

The Stockton Diverting Canal routes water from Mormon Slough back to the Calaveras River before it enters the San Joaquin River. Flow in the Stockton Diverting Canal is solely from Mormon Slough. No gage records on the canal, but a gage at Stockton once recorded flows since 1944. The Stockton Diverting Canal at Stockton gage record was used for the 1965 to 1982 period to develop the flow duration curves. The flows for Mormon Slough downstream of Potter Creek were also depicted using this gage. The flow duration curves for the Stockton Diverting Canal and Mormon Slough downstream of Potter Creek are shown on Figure C-9, C-10, and C-11; Table C-4 shows the exceedance values.

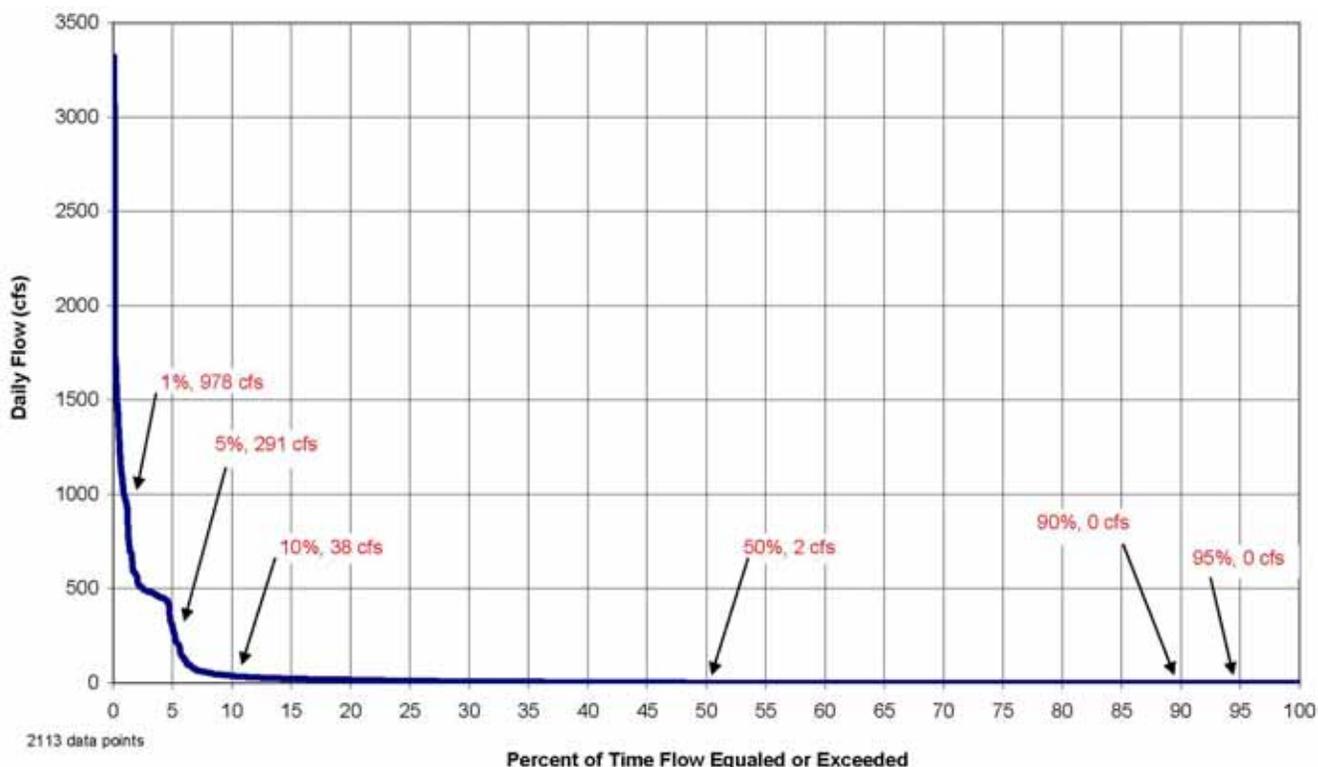
**Table C-4. Exceedance flow data Mormon Slough downstream of Potter Creek and Stockton Diverting Canal**

Percent of time flow equaled or exceeded	Adult Chinook (Sep-Dec)	Adult <i>O. mykiss</i> (Oct-Mar)	Juvenile salmonid (Jan-Jun)
1%	978	4,540	
10%			847
50%	2 (3)	6	
95%			0 (1)

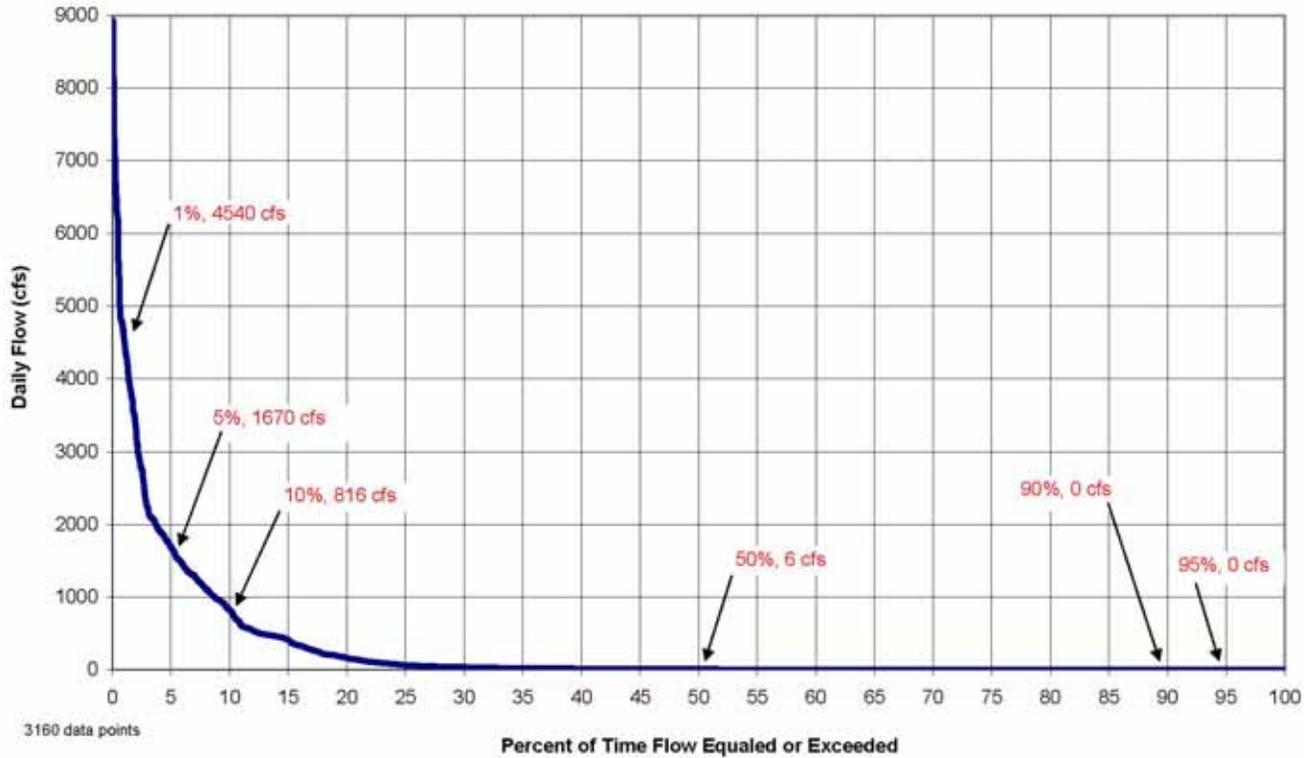
Data from water year 1965–1982

( ) Minimum lower passage flow value from DFG guidelines should be used

**Figure C-9 Flow duration curves for Mormon Slough downstream of Potter Creek and Stockton Diverting Canal – Adult Chinook migration (Sep–Dec)**



**Figure C-10 Flow duration curves for Mormon Slough downstream of Potter Creek and Stockton Diverting Canal – Adult *O. mykiss* migration (Oct–Mar)**



**Figure C-11 Flow duration curves for Mormon Slough downstream of Potter Creek and Stockton Diverting Canal – Juvenile salmonid migration (Jan–Jun)**

