LA GRANGE HYDROELECTRIC PROJECT
FERC NO. 14581

DRAFT LICENSE APPLICATION

ATTACHMENT A

DISTRICTS' RESPONSE TO NMFS-4, ELEMENT 1 THROUGH 6
EFFECTS OF DON PEDRO PROJECT AND RELATED FACILITIES ON HYDROLOGY FOR ANADROMOUS FISH:
MAGNITUDE, TIMING, DURATION, AND RATE OF CHANGE

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Districts' Response to NMFS-4, Element 1 through 6
Effects of Don Pedro Project and Related Facilities on Hydrology for Anadromous Fish:
Magnitude, Timing, Duration, and Rate of Change

1.0 Background

On June 10, 2011, the National Marine Fisheries Service ("NMFS") filed a number of requests for studies in connection with the relicensing of the Don Pedro Project (FERC No. 2299). NMFS Study Request 4 ("NMFS-4") contained six subsections, referred to as "elements." Specifically, these requests related to information on the effects of the project hydrology on anadromous fish. The six elements are listed below.

- Element #1: Data development and statistical analysis;
- Element #2: Additional analysis of Tuolumne River below La Grange Dam (USGS #11289650);
- Element #3: Peak flow analysis;
- Element #4: Rate of stage change analysis;
- Element #5: Quantify lower Tuolumne flow accretion and depletion; and
- Element #6: Evaluate potential to increase lower Tuolumne River flood capacity.

In the Study Plan Determination ("SPD") issued December 22, 2011, FERC staff noted that Turlock Irrigation District ("TID") and Modesto Irrigation District ("MID") (collectively, the "Districts") had agreed to provide substantially all of the information requested by NMFS in NMFS-4, Elements 2 through 6. With regard to Element 1, FERC staff stated that the NMFS request for the Districts to provide flow statistics for either a "partially unimpaired flow scenario" or a "full unimpaired flow simulation" was not necessary to evaluate Project effects and therefore was not required. NMFS and other agencies subsequently filed a Notice of Study Dispute on January 11, 2012, contesting parts of FERC's SPD. FERC convened a Dispute Resolution Panel which filed its findings on May 4, 2012, and on May 24, 2012, FERC issued the Director's Study Dispute Determination.

As part of the Dispute Determination, FERC directed the Districts to undertake the following work related to NMFS-4:

- Using the Workshop Consultation protocols, finalize the number and location of the accretion/depletion measurements in the lower Tuolumne River (NMFS-4, Element 5);

- Using the Workshop Consultation process, generate the statistics requested by Element 1; provide discharge information from the resulting W&AR-02: Operations Model report for the five flow paths available at the La Grange development; provide NMFS-4, Element 3 peak flow analysis for the "base case"; and perform the analysis needed to meet the NMFS-4, Element 4 rate of change analysis.

All of the requested information in NMFS-4 involved hydrology and hydrologic analysis. Project hydrology was a prominent part of the W&AR-02: Operations Modeling study plan that was carried out in accordance with the Consultation Workshop protocols. As directed by FERC, the details of developing a consensus on the exact information needed to address the NMFS-4 requests and the methods to be employed were left to be discussed, decided, and documented through the Consultation Workshop process. The Districts issued a draft Consultation Workshop protocol on March 5, 2012, and conducted a workshop with relicensing participants on March 20, 2012, to review and discuss the proposed Workshop protocols. NMFS did not participate in the March 20th workshop. At the March 20, 2012 workshop, relicensing participants recommended that action items resulting from each Workshop be included in the meeting notes and reviewed during subsequent meetings. The Districts modified the protocols to reflect these changes. Additional time was provided for relicensing participants to comment further on the protocols following the March 20th meeting. No further comments were received and the Districts filed the amended Consultation Workshop protocols with FERC as final on May 18, 2012.

The Districts proceeded to conduct a series of Workshops in accordance with Workshop protocols in conjunction with W&AR-02: Operations Modeling. The first Workshop was held on April 9, 2012, with the specific title of "Hydrology Workshop". Issues related to the development of the appropriate hydrology for the Operations Model were the topic of discussion. Also discussed was the schedule and approach to obtaining accretion/depletion flow measurements (see NMFS-4, Element 5). NMFS did not participate in the Workshop. The second Workshop was held on September 21, 2012, to discuss the results of the first set of accretion measurements and to discuss the details of the various hydrologic analyses required by NMFS-4, Elements 1 through 4 (see Workshop Agenda provided as Attachment 1). NMFS participated in the Workshop. Substantial agreement was reached on the scope and methods to be used for all of the NMFS-requested analyses, except for the rate of stage change assessment (NMFS-4, Element 4). NMFS agreed to provide to the Districts specific subdivisions of flow ranges to be evaluated. Workshop meeting notes were circulated that identified all Action Items from the Workshop. No further breakdown of flow ranges for the rate of stage change was provided by NMFS; therefore, the Districts have attempted to break down the flow ranges as appropriate to the purpose of the analysis. In total, the Districts conducted five Workshops dedicated to the Operations Modeling study, which included the topics of hydrology development and hydrologic analyses, accretion flow measurement and estimation, and overall Don Pedro project operations. NMFS did not participate in subsequent W&AR-02 Workshops.

The Districts filed their Initial Study Report (ISR) on January 16, 2013, and held an ISR Meeting on January 30 and 31, 2013. The ISR contained a report on Operations Modeling and a section that identified existing hydrology information applicable to the reach of the Tuolumne River

from La Grange diversion dam to USGS Gage No. 11289650. In the same section of the ISR, the Districts also provided an analysis of the hydrologic effects of the La Grange project operations on flows in the Tuolumne River between La Grange diversion dam and USGS Gage No. 11289650.

On March 11, 2013, NMFS filed comments on the Districts' ISR. No comments were received from NMFS related to NMFS-4.

2.0 Response to NMFS-4, Element 1

In accordance with the request contained in NMFS-4, Element 1, FERC's December 21, 2011 SPD, and the results of discussions and presentations in the various Consultation Workshops, the Districts have completed various statistical analyses of project hydrology for the "base case" scenario developed in the W&AR-02: Operations Modeling. As requested in NMFS-4, Element 1, these analyses include:

- average, maximum and minimum monthly flows for the period of record used in the Operations Model and by water year type;
- average and monthly flow duration curves for the period of record and by water year type;
- average annual flow;
- 1-, 3-, and 7-day maximum-mean daily flow for all years;
- 1-, 3-, and 7-day minimum-mean daily flow for all years;
- Julian Date and magnitude of annual maximum daily flow; and
- Julian date and magnitude of annual minimum daily flow.

As further agreed during the Consultation Workshops, the Districts are providing this information for the following locations:

- Tuolumne River inflow to Don Pedro Reservoir;
- Tuolumne River above La Grange diversion dam;
- Turlock Canal near La Grange diversion dam;
- Modesto Canal near La Grange diversion dam;
- Tuolumne River below La Grange diversion dam; and
- Tuolumne River at Modesto.

Using the hydrology developed for the "base case" Operations Model, the Districts have developed a spreadsheet containing all of the requested information. Attachment 2 to this report contains plots and tables addressing NMFS-4, Element 1. A "live" spreadsheet is available upon request.

3.0 Response to NMFS-4, Element 2

By this request, NMFS was seeking additional information about how the flows recorded at the La Grange gage are passed at the La Grange development. As NMFS stated, flow arriving at the

USGS La Grange gage "has a multitude of potential conduits to be released from" the La Grange development. Therefore, NMFS study request "seeks to partition the flow recorded at the Tuolumne River below La Grange diversion dam near La Grange CA gage" into "four potential conduits for flow", consisting of (1) the La Grange powerhouse; (2) the MID canal "spillway"; (3) TID canal "spillway", and (4) La Grange diversion dam spillway. The Districts subsequently provided through the Consultation Workshop process information on the available records of flow at the various La Grange discharge points. FERC directed the Districts to provide such information to the extent it was available. The various locations that flow can be passed at the La Grange diversion dam and the records associated with each are discussed in the following sections.

3.1 General Operational Procedures for Passing Flows at La Grange Project

Generally speaking, it is the preference of TID, which acts as the managing operator of the La Grange development, to first pass downstream flows through the La Grange powerhouse up to its two-unit hydraulic capacity of roughly 550 cfs to 575 cfs (flow capacity will vary with available head). Records of flow through the La Grange powerhouse are generally available. However, normal operations at the La Grange development also include the passing of 25 cfs through the historical MID canal headworks (the upper section is no longer used for irrigation/M&I flows) to the plunge pool below La Grange spillway. There are no records collected or maintained for this flow, but personal communications with TID and MID operations staff confirm that this flow passage route is normally open year-round and is estimated to be about 25 cfs. The two sluice gates adjacent to the TID penstock intakes can pass approximately 550 cfs. These are normally closed, except when the TID powerhouse is off-line for maintenance or when flows passing downstream exceed the hydraulic capacity of the powerhouse. Records of sluice gate openings are intermittently available since 2004 on TID's computer database; however, flows are not available. The old MID canal headworks, no longer in use for irrigation and M&I deliveries, can still pass approximately 350 cfs to the river below the La Grange diversion dam, and may be used to do so when flows will exceed the powerhouse capacity. No records are available for these discharges. There is also a slide gate located in the face of the La Grange spillway. This gate can pass a maximum of about 200 cfs and is used when repairs are being made on the spillway or during high flow events. No records are kept of the flows from this gate.

3.2 Flows in the Lower Tuolumne River

Lacking actual flow records of discharges from each of the various gates, it is only possible to draw general inferences about the points of flow passage at the La Grange project. The "partitioning" of flows recorded at the La Grange gage can be considered as the following based upon general operational procedures at the La Grange project:

- Flows less than 75 cfs at the gage (this amount of flow is exceeded at the La Grange gage 99 percent of the time since 1997): 50 cfs from the TID powerhouse and 25 cfs from the MID canal headworks;

- Flows from 75 cfs to 600 cfs at the gage: 25 cfs from MID headworks, remainder from the TID powerhouse;
- Flows from 600 cfs to 1,150 cfs at the gage: 25 cfs from the MID canal headworks, 575 cfs from the TID powerhouse, and the remainder from the two TID sluice gates;
- Flows from 1,150 cfs to 1,400 cfs at the gage: 550 cfs from the TID powerhouse (tailwater levels are rising), 550 cfs from the two TID sluice gates, 300 cfs from the old MID canal headworks;
- Flows from 1,400 cfs to 1,600 cfs at the gage: 550 cfs from the TID powerhouse (tailwater levels are rising), 550 cfs from the two TID sluice gates, 300 cfs from the MID canal headworks, and 200 cfs from the slide gate in the spillway.

At flows above 1,600 cfs, water would start to be discharged over the La Grange spillway, assuming all the other facilities are in use. Actual decisions about which facilities are used are based on real-time information on facility condition and river conditions.

4.0 Response to NMFS-4, Element 3: Peak Flow Analysis

NMFS-4, Element 3, requested a peak flow analysis, also known as a flood flow-frequency analysis, using Bulletin 17B methods from the Interagency Advisory Committee on Water Data (1982) for three flow scenarios and eight locations. The NMFS request specified that records of daily average flow rates be converted to instantaneous peaks using the MOVE equations presented in the California regional skew document (Parrett et al. 2011).

Flood frequency analysis is a way of summarizing and extrapolating historical information on the probability and magnitude of flood flows at a given location. The analysis consists of annual peak instantaneous flow estimates from a streamflow gage, regional flood characteristics (regional skew), and a Log-Pearson Type III fitting and extrapolation of the peak flow data. When instantaneous peak flow data are limited, various statistical techniques such as MOVE can be employed to develop a relationship between the annual maximum daily average flow to instantaneous peak annual flow. However, Bulletin 17B flood frequency analysis is not applicable to streams with more than a small fraction of flow regulation, and is therefore not applicable to the USGS La Grange gage records.

Some methods have been developed for flood frequency analysis of regulated systems; however, there are no widely accepted or industry standard scientific methods for conducting such an analysis. The shape of a regulated frequency curve varies based on storm duration, spillway capacity, operational decisions, reservoir surface area-volume relationships, and the frequency of peak inflows (Ergish 2010). To develop estimates of flood frequency applicable to instantaneous flows, the only applicable flow scenario from the NMFS-4 request would be the "fully unimpaired" scenario, and the only applicable sites are Dry Creek at Modesto, and estimated unimpaired flow at La Grange.

4.1 Analysis of Peak Flow

Flood frequency analysis has already been completed by USGS for both of the applicable sites in the NMFS-4 request (Parrett et al. 2011). The flood frequency analysis for Dry Creek at Modesto was extended using instantaneous data from the California Water Data Library from water years 1989 through 2013. The impact of extending the period of record for this gage resulted in a slightly increased flood frequency curve compared to the results from Parrett et al.

The gage designation for Tuolumne River above La Grange (11288099) has been changed, from ending in 00 to ending in 99 to indicate that it is a simulated unimpaired relationship with the Mokelumne River (11323599) that was used to extend its period of record and convert annual maximum daily average flow to peak flow. Table 4-1 shows the flood frequency results, and Figures 4-1 and 4-2 show the flood frequency results in graphical form for the Tuolumne River and Dry Creek respectively.

Table 4-1. Flood frequency results for selected sites.

Station number	Station name	Period of historic record (water years)	Annual peak flow, in thousand cubic feet per second, for recurrence interval, in years, and annual exceedance probability, in percent							
			2	5	10	25	50	100	200	500
			50	20	10	4	2	1	0.5	0.2
11288099	TUOLUMNE R AB LA GRANGE DAM NR LA GRANGE CA	1862-2006	21.7	41.2	58.8	87.4	114	146	183	244
11289950 AND DCM	DRY C NR MODESTO CA (USGS & WDL)	1939-73, 1989-2013	1.85	3.72	5.12	6.53	8.38	9.78	11.2	13.0

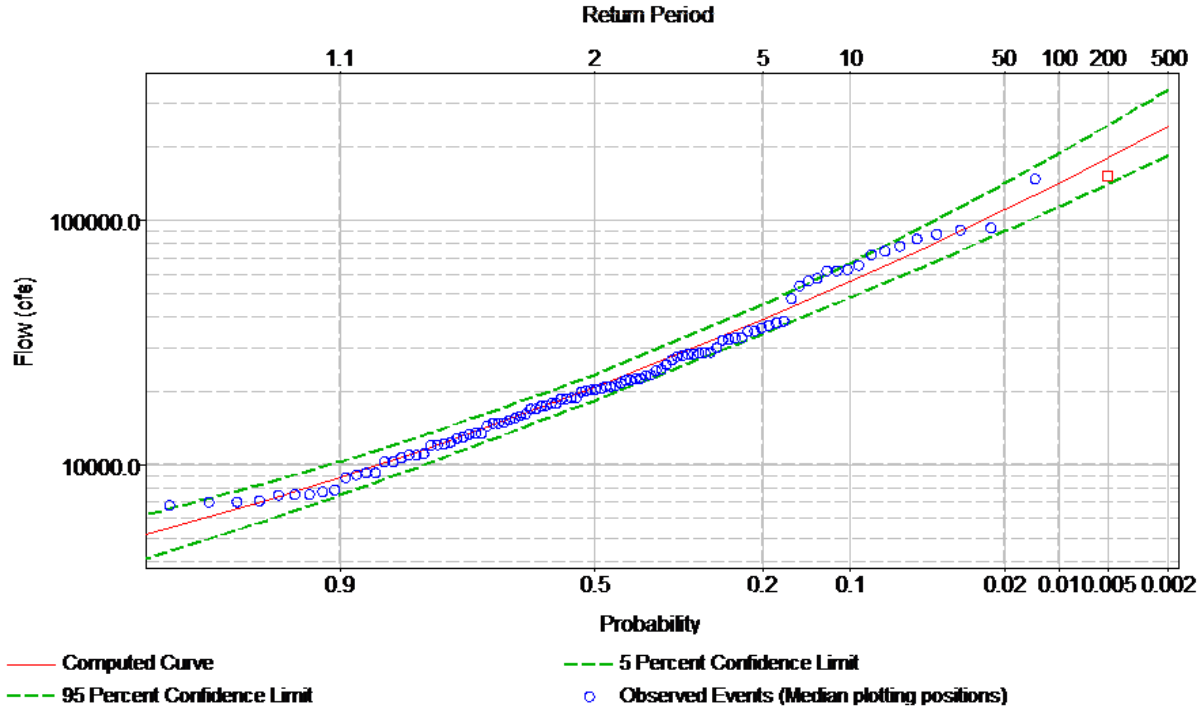


Figure 4-1. Flood frequency for Tuolumne River above La Grange, unimpaired.

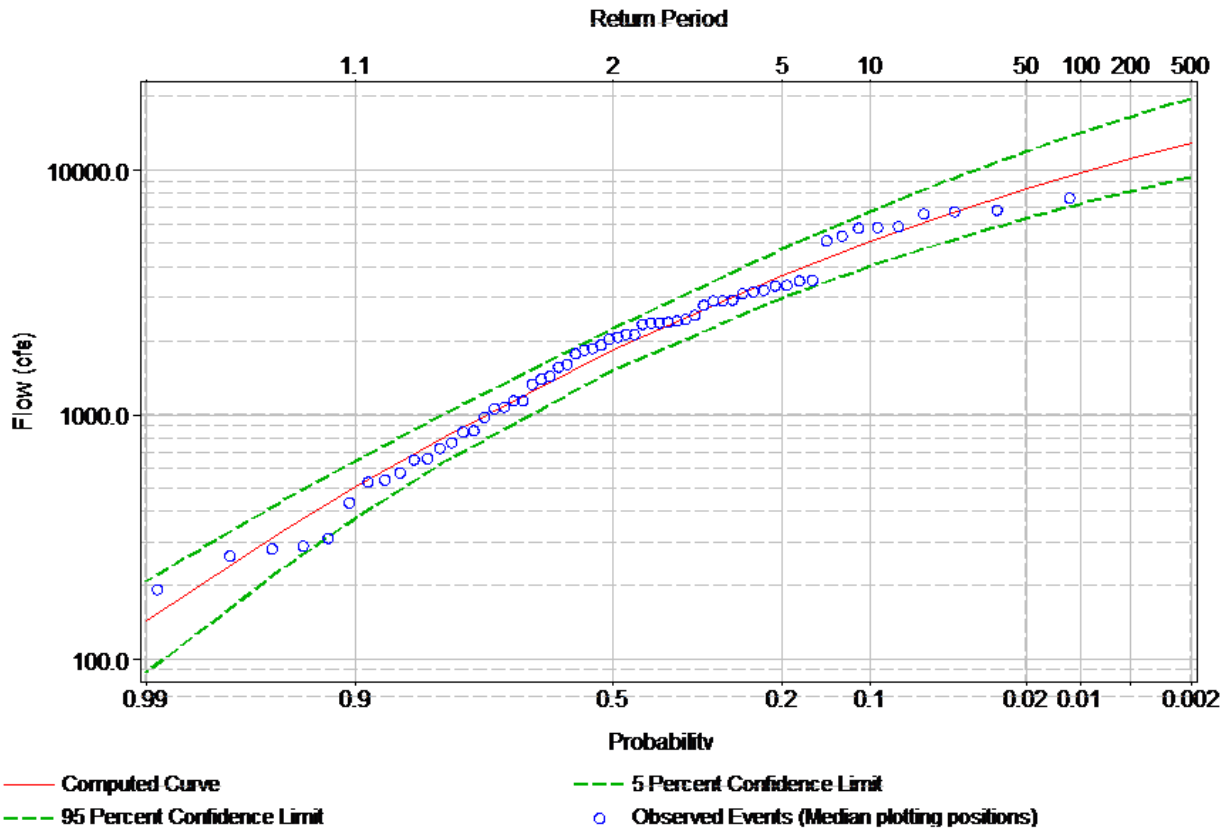


Figure 4-2. Flood frequency for Dry Creek near Modesto.

4.3 References

Ergish, Natalie J., 2010, Flood Frequency Analysis for Regulated Watersheds, Masters Thesis, University of California, Davis. 40p. Available at http://cee.engr.ucdavis.edu/faculty/lund/students/ErgishThesis.pdf

Interagency Advisory Committee on Water Data, 1982, Guidelines for determining flood-flow frequency, Bulletin #17B of the Hydrology Subcommittee: Office of Water Data Coordination, U.S. U.S. Geological Survey, 183 p. Available at http://water.usgs.gov/osw/bulletin17b/dl_flow.pdf.

Parrett, Charles, Veilleux, Andrea, Stedinger J.R., Barth, N.A., Knifong, D.L, Ferris, J.C., 2011, Regional Skew for California and Flood Frequency for Selected Sites in the Sacramento-San Joaquin River Basin Based on Data through Water Year 2006: U.S. Geological Survey Scientific Investigations Report 2010–5260, 94 p.

5.0 Response to NMFS-4, Element 4: Rate of Stage Change Analysis

In NMFS-4, Element 4, NMFS requested an analysis of the rate of stage change that has occurred historically at the Tuolumne River below La Grange gage (USGS 11289650) located about 0.2 miles below the La Grange tailrace. In the request, NMFS indicated it was seeking an analysis of stage changes at the gage based on both 15 minute and rolling one hour time intervals

using the 15-minute data available from the USGS records. NMFS requested that the results be summarized in histogram and exceedance plot form, and the largest rate of stage changes be summarized in a table. NMFS had indicated during Consultation Workshop No. 2 that it would provide the flow/stage ranges to be selected (e.g., using starting stages between 1 ft and 1.25 ft; 1.25 and 1.5 ft; etc.) No further direction from NMFS was forthcoming; therefore, the Districts have used their judgment in this matter.

The request is herein fulfilled in its entirety with one exception. The 15-minute data for the full project period of record (WY 1971-2012) is not available from USGS. Therefore, this analysis focuses on the period of the current FERC license conditions, from 1997 to 2013.

5.1 Analysis of Stage Changes

The original stage recordings are not available from the USGS. However, the 15-minute flow data was converted back into stage by using the latest rating curve available from the USGS (Figure 5-1). While this may not result in the exact recorded stage, the magnitude of stage changes will be valid assuming the gage cross-section hasn't had significant changes in overall shape.

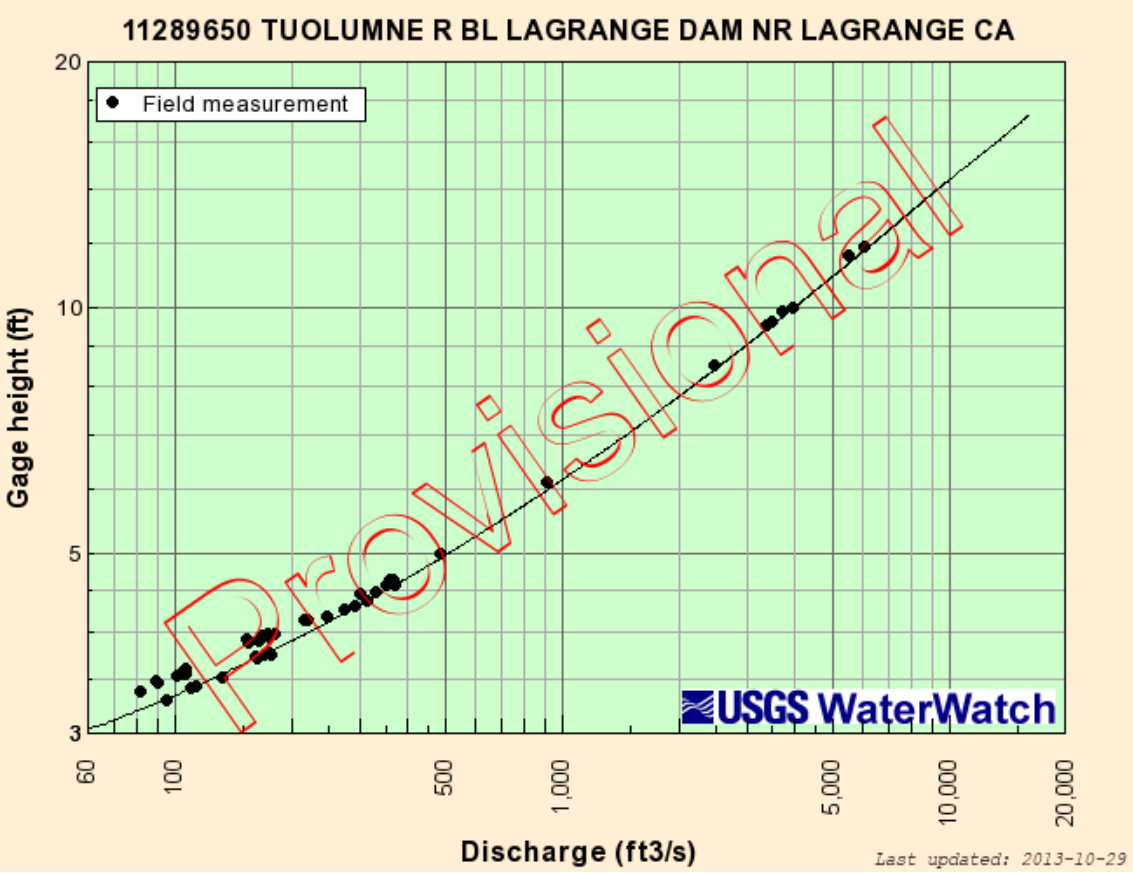


Figure 5-1. Rating curve for Tuolumne River below La Grange gage.

The gage rating only goes to 16,000 cfs without extrapolation, so the period of analysis did not

start until the 1997 storm dropped below 16,000 cfs on Jan 9th, 1997, at 1300 hours, and the analysis is continuous from then until June 17, 2013 at 0800, which amounts to over 16 years, or about 6,000 days of analysis.

The largest stage change events were examined manually by TID to determine a cause for the change, when records were available to help determine such a cause. For single time step jumps in the flow data, the cause was suspected to be gage error.

5.2 Discussion of Results

The stage change in fifteen minutes is less than two inches (0.17 ft.) up or down 99.4% of the time, less than four inches (0.33 ft.) 99.9% of the time, and less than eight inches (0.67 ft.) 99.99% of the time. One hour stage change is less than two inches up or down 96.6% of the time, less than four inches 99.0% of the time, and less than eight inches 99.8% of the time. Tables 5-1 and 5-2 summarize the ten largest 15-minute and 1-hour stage change events respectively. Most of the largest stage changes were related to flood control operations at the Don Pedro Project, especially the 1997 flood event when river flows were very high.

Table 5-1. Ten largest fifteen minute stage changes (negative denotes a drop in stage).

Change (ft)	Julian Day	Date and Time	Cause of Stage Change
-1.92	98	09Apr1999 1145	Suspected Gage Error
1.91	98	09Apr1999 1200	Suspected Gage Error
-1.84	17	18Jan1997 0830	Flood Control Operations
1.75	17	18Jan1997 0900	Flood Control Operations
-1.73	16	17Jan1997 1530	Flood Control Operations
1.59	16	17Jan1997 1600	Flood Control Operations
-1.56	18	19Jan1997 0830	Flood Control Operations
-1.51	17	18Jan1997 1530	Flood Control Operations
1.41	38	09Feb1999 0000	Flood Control Operations – increased flow to keep Don Pedro below 801.9 ft
1.29	18	19Jan1997 0900	Flood Control Operations

Table 5-2. Ten largest one hour stage changes (negative denotes a drop in stage).

Change (ft)	Julian Day	Date and Time	Cause of Stage Change
2.82	17	18Jan1997 0900	Flood Control Operations
-2.89	17	18Jan1997 0800	Flood Control Operations
-2.57	16	17Jan1997 1500	Flood Control Operations
2.43	16	17Jan1997 1600	Flood Control Operations
2.42	104	15Apr1997 0645	Pre-Flood Releases
2.31	86	28Mar1999 2015	La Grange tripped offline
-2.23	16	17Jan1997 0800	Flood Control Operations
2.22	246	04Sep1998 1045	Pre-Flood Releases

Change (ft)	Julian Day	Date and Time	Cause of Stage Change
2.12	15	16Jan1998 0100	Pre-Flood Releases
2.11	16	17Jan1997 0900	Flood Control Operations

NMFS also requested that the largest stage change of each water year be identified. The summaries provided in Tables 5-3 and 5-4 are by calendar year for 15-minute and 1-hour stage changes, respectively. Because stage change direction was not specified in the NMFS request, the largest magnitude stage changes both up and down are shown for each year. In addition to flood control operations, stage changes can also occur due to La Grange generation unit outages, normal fish-related pulse flow requirements, or rapid flow adjustments to remain under 9,000 cfs at the 9th St. Modesto Gage (USGS 11290000) in response to rapid changes in natural Dry Creek flows.

Table 5-3. Largest fifteen minute stage changes up and down each year (negative denotes a drop in stage).

Change (ft)	Julian Day	Date and Time	Cause of Stage Change
1.75	17	18Jan1997 0900	Flood Control Operations
-1.84		18Jan1997 0830	
0.92	246	04Sep1998 1115	Flood Control Operations – Don Pedro releases increased to get reservoir down before commencing the 45 day minimum flow period
-0.65	53	23Feb1998 0715	Don Pedro flow decreased to keep 9,000 cfs @ Modesto requirement
1.91	98	09Apr1999 1200	Suspected Gage Error
-1.92		09Apr1999 1145	
1.08	44	14Feb2000 1030	Flood Control Operations - Releases increased to keep reservoir below 801.9
-0.71	302	29Oct2000 1200	Unknown
0.76	128	09May2001 1130	Unknown
-0.81		09May2001 1030	
0.88	342	09Dec2002 1100	La Grange Unit 1 tripped offline – sluice gate opens resulting in increased flow to compensate for unit loss
-0.53	121	02May2002 1845	Suspected Gage Error
0.91	272	30Sep2003 1330	Unknown
-0.82	106	17Apr2003 1615	La Grange Unit 2 Tripped offline
0.76	65	06Mar2004 0830	Pre-Flood Releases
-0.62	357	23Dec2004 2215	Suspected Gage Error
0.84	261	19Sep2005 0945	Suspected Gage Error
-0.85		19Sep2005 1000	
0.59	169	19Jun2006 0800	Flood Control Operations – old MID canal headworks gate brought online
-0.73	92	03Apr2006 1945	9,000 cfs requirement - Dry Creek went from 274 cfs to 5,068 cfs
0.64	251	09Sep2007 0230	Unknown
-0.36	339	06Dec2007 1730	Suspected Gage Error

Change (ft)	Julian Day	Date and Time	Cause of Stage Change
0.60	111	21Apr2008 1445	Unknown
-0.35		21Apr2008 1245	
0.54	106	17Apr2009 1415	Normal Increase for fish-related pulse flow requirement
-0.21	142	23May2009 0815	Unknown
0.51	181	01Jul2010 0930	Normal pre-flood release operations; sluice gate opened
-0.42		01Jul2010 0615	
0.70	261	19Sep2011 1100	Unit 2 tripped offline; sluice gate opens to compensate
-0.65	82	24Mar2011 2100	9,000 cfs requirement - Dry Creek went from 117 cfs to 3,510 cfs
0.65	120	30Apr2012 2115	Normal increase/decrease for fish-related pulse flow requirement
-0.40	145	25May2012 0645	

Table 5-4. Largest one hour stage changes up and down each year (negative denotes a drop in stage).

Change (ft)	Julian Day	Date and Time	Cause of Stage Change
2.82	17	18Jan1997 0900	Flood Control Operations
-2.89		18Jan1997 0800	
2.22	246	04Sep1998 1045	Flood Control Operations – Don Pedro releases increased to get reservoir down before commencing the 45 day minimum flow period
-1.32	36	06Feb1998 2115	Flood Control Operations
2.31	86	28Mar1999 2015	La Grange unit tripped offline; sluice gate opens to compensate
-1.94	98	09Apr1999 1100	Suspected Gage Error
2.10	102	12Apr2000 2000	Flood control space encroached upon - Pre-flood releases made to get out of flood control space in 15 days
-1.30	76	17Mar2000 2030	Flood control flow temporarily diverted to put water in Turlock Lake
1.76	52	22Feb2001 0830	Flood Control Operations - Releases from Don Pedro increased to keep Don Pedro reservoir below 801.9 ft
-0.93	128	09May2001 1015	Unknown
1.11	342	09Dec2002 1015	La Grange Unit 1 tripped offline – sluice gate opens resulting in increased flow to compensate for unit loss
-0.67	101	12Apr2002 1130	Flood Control Operations
1.64	106	17Apr2003 1645	La Grange Unit 2 tripped offline; then came back on-line
-0.90		17Apr2003 1545	
1.48	215	03Aug2004 1130	La Grange units tripped offline; then came back on-line
-1.17		03Aug2004 1315	
1.42	353	20Dec2005 1400	Pre-Flood Releases
-1.22	212	01Aug2005 1130	Unit 1 taken offline for repair of brushes
1.22	93	04Apr2006 0445	9,000 cfs Requirement - Dry Creek went from 274 cfs to 5,068 cfs and back down to 945 cfs
-1.77	92	03Apr2006 1915	
1.33	339	06Dec2007 1800	Gage Error - River Flow did not change, EMS had elevation 174.17 and flow of 179 cfs
-0.91		06Dec2007 1700	
0.90	111	21Apr2008 1515	La Grange Units 1 and 2 tripped offline; then came back on-line.
-0.75		21Apr2008 1245	

Change (ft)	Julian Day	Date and Time	Cause of Stage Change
0.65	107	18Apr2009 1330	Normal Increase for Pulse flow requirement
-0.45	265	23Sep2009 0330	Unknown
1.10	160	10Jun2010 1245	Unknown
-1.11	181	01Jul2010 0700	Flood Control Operations
1.33	282	10Oct2011 0815	Pre-Flood Releases
-1.90	82	24Mar2011 2015	9,000 cfs requirement, Dry Creek went from 117 cfs to 3,510 cfs
0.92	144	25May2012 0000	Normal Increase/Decrease for Pulse flow requirement
-0.46	134	14May2012 0930	

The NMFS request also asked that specific additional exceedance and histogram figures be provided summarizing stage change data by month. The requested figures are provided as Attachment 3 to this report.

6.0 Response to NMFS-4, Element 5: Lower Tuolumne River Flow Accretion and Depletion

NMFS-4, Element 5, NMFS requested additional information about accretion and depletion in the lower Tuolumne River. In the December 21, 2011 SPD, FERC directed that the specific methods, locations, and scope of this work be developed through the Consultation Workshop process. At the April 9, 2012 Hydrology Workshop, the Districts provided a proposal for initial accretion/depletion measurements in the lower Tuolumne River. All parties present agreed with the approach; NMFS was not present nor provided any comments. On June 6, 2012, the Districts issued a detailed map showing locations and further describing field measurement methods, asking for any final comments to be provided by June 20, 2012. No further comments were provided. The initial set of accretion measurements took place on June 25, 2012. The results of the measurements were provided to relicensing participants on July 26, 2012. At Consultation Workshop No. 2 held on September 21, 2012, relicensing participants reviewed the results of the first measurements and agreed that two additional field accretion measurements should be taken with several measurement locations added. The additional field accretion measurements were taken on October 3-4, 2012 and February 11-12, 2013. The results of the three sets of field measurements were provided to relicensing participants as part of W&AR-02 Consultation Workshop No. 2 Final Meeting Notes filed with FERC on March 19, 2013. The same results were provided to relicensing participants again in separate form via email on April 25, 2013.

In addition to the three episodes of field measurements, the Districts also proposed to develop a continuous daily flow record of the accretion flows occurring between the La Grange and Modesto USGS gages for use in the W&AR-02: Tuolumne River Operations Model. On November 6, 2012, the Districts issued an updated draft of the proposed approach for developing this hydrology. No comments were received from relicensing participants on the proposed methods. The analysis and resulting daily flow record were published with the Initial Study Report on January 17, 2013 as part of the W&AR-02 report. This data set is built into and available via the Tuolumne River Operations Model.

6.1 Analysis of Field Accretion/Depletion Measurements

The three episodes of field measurements can be used to further inform accretion/depletion estimates by specific river mile locations examined by the flow measurements taken at numerous locations along the lower Tuolumne River. Discharge at each site was measured using standard methods for collecting data in wadeable streams (Rantz 1982).

Table 6-1 summarizes the results of the accretion measurements and Figure 6-1 shows the results graphically by river mile.

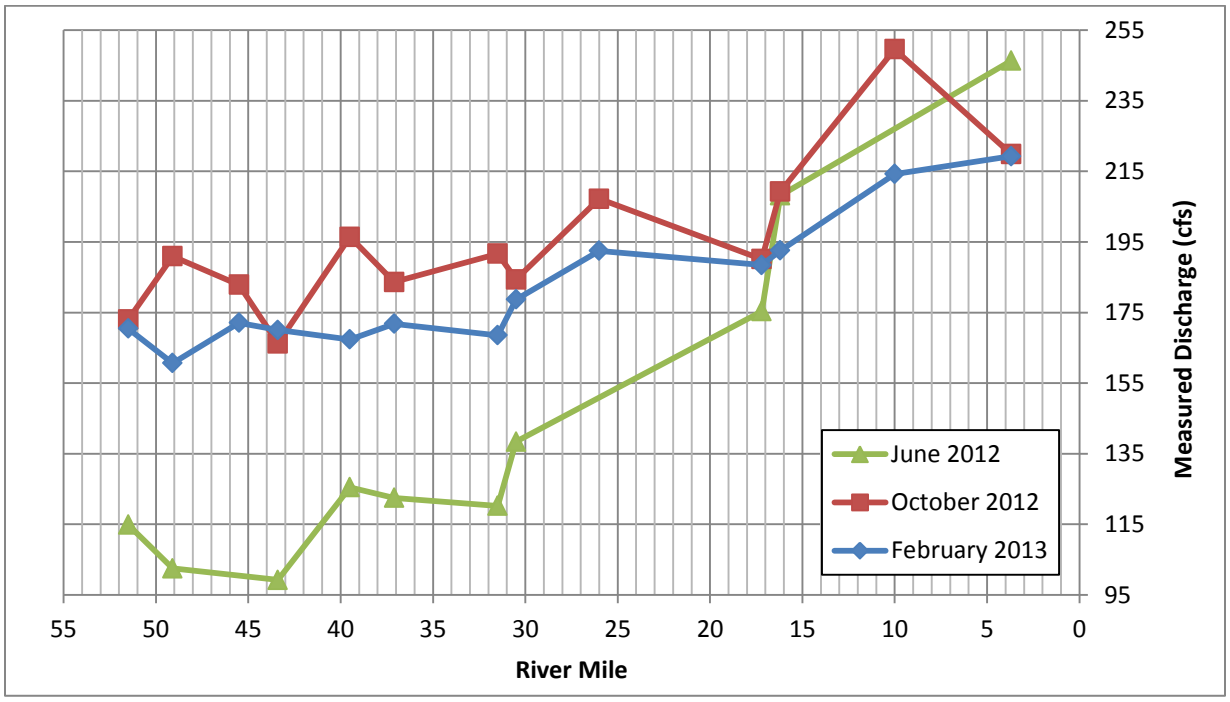


Figure 6-1. Discharge measurements by River Mile.

All measurements were taken during extended dry periods and specific efforts were made to eliminate irrigation system operational spills. The timing of the measurements were chosen to capture the three primary seasons of accretion flows – irrigation season (June), end-of-irrigation season (October), and winter season (February). Overall, the Tuolumne River can be considered a slightly accreting river between the USGS gage at La Grange and Dry Creek, and generally greater accretions between Dry Creek and the mouth.

Table 6-1. Discharge measurement locations and results.

Site	Dry Creek River Mile	Tuolumne River Mile	Irrigation Season[a]	Flow (cfs)	Irrigation Season--Low Flow[a]	Flow (cfs)	Non-Irrigation Season[b]	Flow (cfs)	Reason behind location selection	Reach[c]	Notes
Tuolumne River at La Grange gage house	--	51.5	6/25/12	115	10/3/12	202[g]	2/11/13	170	For comparing measured values to gaged values	Dominant Salmon Spawning Reach	--
Tuolumne River at La Grange (USGS 11289650)	--	51.5	6/25/12	130	10/3/12	179[g]	2/11/13	182	Gage	Dominant Salmon Spawning Reach	--
Tuolumne River at La Grange (CDEC LGN)	--	51.5	6/25/12	94	10/3/12	170	2/11/13	164	Gage	Dominant Salmon Spawning Reach	--
Tuolumne River at Basso Pool	--	49.1	6/25/12	103	10/3/12	191	2/11/13	161	From Instream Flow Study	Dominant Salmon Spawning Reach	--
Tuolumne River at Zanker property	--	45.5	--	--	10/4/12	183	2/12/13	172	Targets potential depletion/ recharge area	Dredger Tailings Reach	--
Tuolumne River at Bobcat Flat	--	43.4	6/25/12	99	10/4/12	166	2/12/13	170	From Instream Flow Study	Dredger Tailings Reach	--
Tuolumne River at Roberts Ferry Bridge	--	39.5	6/25/12	125	10/4/12	196	2/11/13	167	Downstream of Turlock Lake but above Modesto Reservoir	Gravel Mining Reach	--
Tuolumne River at Santa Fe Aggregates	--	37.1	6/25/12	123	10/4/12	184	2/12/13	182	From Instream Flow Study	Gravel Mining Reach	--
Waterford Main (MID)	--	33.0	6/25/12	8	10/3/12	1	2/12/13	0	Operational outflow	--	--
Hickman Spill (TID)	--	33.0	6/25/12	0	10/3/12	0	2/12/13	0	Operational outflow	--	--
Tuolumne River at Waterford	--	31.5	6/25/12	120	10/3/12	192	2/11/13	169	From Instream Flow Study	In-channel Gravel Mining Reach	--
Tuolumne River at Delaware Road	--	30.5	6/29/12	138	10/3/12	184	2/11/13	179	From Instream Flow Study	In-channel Gravel Mining Reach	--
Tuolumne River at Fox Grove Park	--	26.0	--	--	10/4/12	207	2/12/13	192	Information between RM 30.5 and RM 17.2	In-channel Gravel Mining Reach	--
Faith Home Spill (TID)	--	20.0	6/25/12	0	10/3/12	0	2/12/13	0	Operational outflow	--	--
Lateral No. 1 (MID)	--	18.0	6/25/12	1	10/3/12	1.6	2/12/13	0	Operational outflow	--	--
Tuolumne River at Legion Park	--	17.2	6/25/12	175	10/3/12	190	2/11/13	188	Added at 9/21/12 Workshop	Urban Sand-Bedded Reach	--
Dry Creek (CDEC DCM)	5.3	16.4	6/25/12	32	10/4/12	33	2/12/13	0.6	Gage	--	MID's Lateral 2 outlet is the only true operational outlet with consistent flow into Dry Creek at latitude/longitude 37.652142; -120.930206 (Loschke, pers. comm. 2013). [d,e,f]
Dry Creek at gage	5.3	16.4	--	--	10/4/12	37	2/12/13	0.5	For comparing measured values to gaged values	--	
Dry Creek 2.0	2.0	16.4	--	--	10/4/12	31	2/12/13	0.8	Information between RM 5.3 and RM 0.0	--	
Mouth of Dry Creek	0.0	16.4	6/25/12	56	10/3/12	37	2/12/13	0.6	Inflow to Tuolumne River	--	
Tuolumne River at Modesto 9th St. Bridge	--	16.2	6/25/12	208	10/3/12	209	2/11/13	193	For comparing measured values to gaged values	Urban Sand-Bedded Reach	--
Tuolumne River at Modesto (USGS 11290000)	--	16.2	6/25/12	219	10/3/12	227	2/11/13	197	Gage	Urban Sand-Bedded Reach	--
Tuolumne River at Modesto (CDEC MOD)	--	16.2	6/25/12	216	10/3/12	238	2/11/13	197	Gage	Urban Sand-Bedded Reach	--
Lateral 1 (TID)	--	11.0	6/25/12	0	10/3/212	0	2/11/13	0	Operational outflow	--	--
Tuolumne River near Riverdale Park	--	10.0	--	--	10/3/12	250	2/12/13	214	Information between RM 16 and RM 3.7	Lower Sand-Bedded Reach	--
Tuolumne River at Shiloh Bridge	--	3.7	6/25/12	246	10/3/12	220	2/11/13	219	Added at 9/21/12 Workshop	Lower Sand-Bedded Reach	
Lateral No. 5 (MID)	--	2.0	6/25/12	29	10/3/12	14.3	2/11/13	0	Operational outflow	--	--

[a] Irrigation deliveries for 2012 started mid-March and ended October 10.
[b] Irrigation deliveries for 2013 started March 5.
[c] See W&AR-04 Spawning Gravel (TID/MID 2013).
[d] Lateral 2 has 15 minute flow records back to 2007 and chart recorders and staff gage records back to 1972 (Loschke, pers. comm. 2013).
[e] As of 10/30/2012, the small amount of flow in MID's WTFD L-3 is captured by a private land owner (Loschke, pers. comm. 2013).
[f] All spills from the Waterford system into dry creek are inconsistent and minimal (Loschke, pers. comm. 2013).
[g] Gage discharge was not steady on this day, and the measurement occurred during a small peak in flow reading 196 cfs at the Gage.

6.2 References

Rantz, S.E. 1982. Measurement and computation of streamflow: volume 1. Measurements of stage and discharge. USGS Water Supply Paper 2175. U.S. Geological Survey.

7.0 Response to NMFS-4, Element 6: Potential to Increase Lower Tuolumne River Flood Capacity

NMFS-4, Element 6 requested that the Districts evaluate the possibility of increasing the current target allowable flood flow from 9,000 cfs at the Modesto gage to 15,000 cfs above the gage and 20,000 cfs from the gage to the confluence with the San Joaquin River. The maximum flood flow targets on the lower Tuolumne River are contained within the 1971 Army Corps of Engineers (ACOE) Flood Control Manual. The Districts operations are consistent with the flood control manual.

To evaluate the possibility of modifying the maximum target flood flows, the Districts submitted a letter to Colonel William Leady, District Commander of the ACOE on July 12, 2012, inquiring as to the feasibility of amending the flood control manual to allow for higher flows to the lower Tuolumne River. On March 4, 2013, the ACOE responded (see Attachment 4) that there has been no "changes to the authorized flood control criteria since 1996 that would allow the Corps to increase the maximum flood release to the Tuolumne River." Without support from the ACOE to increase flood flows, the Districts intend to continue compliance with the Flood Control Manual.

ATTACHMENT 1

September 21, 2012
Hydrologic Investigations Workshop Agenda

Don Pedro Relicensing Participants
Hydrologic Investigations Workshop
AGENDA

September 21, 2012 - 9:00 a.m. – 12:30 p.m.
Modesto Irrigation District Offices
Conference Call-In Number 866-994-6437; Code 5424697994

9:00 a.m.- 9:15 a.m. — **Introductions & Purpose of Meeting**

(1) Review of Accretion Flow Measurements Conducted on June 25, 2012
(2) Discussion of Hydrologic Analyses the Districts are Planning to Undertake

9:15 a.m.-10:30 a.m. — **Discussion of Results and Path Forward Related to Accretion Flow Measurements Conducted on June 25, 2012 and Provided to Relicensing Participants on July 26, 2012**

10:30 a.m.-11:30 a.m. — **Discussion of Hydrologic Analyses to be Conducted by the Districts in Accordance with FERC's Study Plan Determination and Dispute Resolution**

(1) Available Streamflow Data Records/Sources Confirmed by Districts
(2) Overview of FERC's Study Plan Determination and Dispute Decision as Relates to Hydrologic Analyses
(3) Statistical Analyses to be Conducted for Existing Project Conditions
   a. Average, maximum and minimum monthly flows for 1971-2009, 1996-2009, and by water year type
   b. Annual and monthly flows duration curves for 1971-2009, 1996-2009, and by water year type
   c. Average annual flows for 1971-2009 and 1996-2009
   d. 1-, 3-, and 7-day maximum mean daily flow for each year of 1971-2009
   e. 1-, 3-, and 7-day minimum mean daily flows for each year of 1971-2009
   f. Julian date and magnitude of annual maximum and minimum
(4) Watershed Locations for Statistical Analyses
   a. Tuolumne River, inflow to Don Pedro Reservoir
   b. Tuolumne River just above La Grange Dam
   c. Turlock Canal near La Grange CA (USGS gage)
   d. Modesto Canal near La Grange CA (USGS gage)
   e. Tuolumne River below La Grange Dam near La Grange CA (USGS gage)
   f. Dry Creek at Modesto (CDWR gage)
   g. Tuolumne River at Modesto CA (USGS gage)

11:30 a.m.-12:30 p.m. — **Other Hydrologic Analyses to be Conducted (these analyses need further clarification and discussion)**

(1) Peak Flow Analysis using log-Pearson type III flood flow frequency for existing conditions and return intervals of 1 to 100 years for Tuolumne River locations above using USGS Regional skew for California
(2) Rate of Stage Change Analysis Tuolumne River below La Grange Dam near La Grange CA (USGS gage) for 1971-2009 using 15-minute gage records

ATTACHMENT 2

Districts' Response to NMFS-4, Element 1

Base Case Hydrologic Statistics

Inflow to Don Pedro Reservoir:

Operations Model Base Case

Table 1. Average inflow to Don Pedro Reservoir by water year type, by water year, and for the period of record for the Base Case (cfs).

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
C	339	423	309	337	904	1,056	1,285	1,850	653	500	387	276	692
D	435	431	319	501	1,323	1,684	1,898	3,129	990	411	385	315	983
BN	234	494	541	629	1,842	2,326	2,236	4,746	1,252	539	423	319	1,297
N	283	638	781	1,442	3,340	3,332	3,224	6,424	4,238	849	473	413	2,110
AN	372	1,426	1,782	2,240	4,240	4,168	3,887	7,214	6,186	1,450	568	529	2,826
W	527	1,155	2,296	4,844	6,096	6,515	5,949	8,883	8,907	5,209	1,138	763	4,345
1971	299	888	1,402	1,255	2,240	2,601	2,655	5,337	3,116	1,387	472	489	1,843
1972	217	615	1,019	831	1,880	2,077	1,906	4,512	1,520	529	427	288	1,318
1973	200	597	1,018	1,938	4,606	3,719	3,565	6,612	6,666	645	483	309	2,510
1974	370	2,066	1,662	2,402	2,756	4,149	4,265	6,987	6,135	1,122	569	512	2,744
1975	381	416	479	668	3,878	4,293	3,412	6,474	7,686	1,484	630	577	2,515
1976	727	979	455	217	569	804	740	1,171	426	403	450	377	610
1977	195	301	128	192	318	338	338	626	533	305	312	208	316
1978	122	283	1,028	2,693	4,501	5,120	5,540	6,717	8,266	4,512	887	1,198	3,392
1979	294	611	452	2,023	3,887	4,230	3,608	7,453	4,903	666	477	435	2,408
1980	434	654	631	7,385	7,232	4,636	4,091	8,356	5,793	5,121	854	705	3,817
1981	317	331	400	711	1,405	2,127	1,953	4,410	1,205	468	492	333	1,180
1982	401	2,214	2,737	3,638	7,175	6,832	9,334	10,166	8,663	4,724	996	1,293	4,823
1983	2,162	3,632	3,914	4,092	7,539	9,789	5,952	8,521	14,743	9,854	3,035	956	6,170
1984	826	4,905	6,324	3,326	3,669	3,525	3,105	6,362	5,293	909	452	385	3,253
1985	422	1,179	685	486	1,781	2,206	2,488	4,978	975	450	468	402	1,375
1986	397	790	1,123	1,549	10,977	7,695	4,478	8,113	7,851	1,435	514	633	3,741
1987	334	308	210	135	778	1,169	1,044	1,685	551	369	365	234	598
1988	185	427	610	881	988	1,015	1,029	1,705	757	440	339	228	717
1989	134	494	420	438	1,916	3,267	2,806	5,484	1,377	395	314	283	1,442
1990	662	549	278	407	1,159	1,451	1,563	2,248	1,353	379	310	226	880
1991	117	187	105	129	951	2,246	1,982	4,052	1,905	1,091	517	341	1,137
1992	296	215	181	271	1,533	1,829	3,215	2,965	782	913	419	301	1,074
1993	187	140	491	3,526	3,737	4,202	4,189	7,366	6,886	2,951	673	572	2,903
1994	301	311	271	324	1,222	1,182	1,345	2,951	866	570	439	308	839
1995	136	706	724	4,658	4,242	9,148	6,362	10,968	9,872	9,884	2,157	580	4,965
1996	183	228	821	1,630	5,927	5,279	4,523	8,927	5,553	1,112	482	549	2,920
1997	258	1,255	5,816	16,121	4,164	3,666	3,218	7,159	5,068	645	583	504	4,054
1998	244	440	510	2,936	7,879	5,899	5,724	8,686	8,988	8,262	1,017	688	4,247
1999	283	804	918	1,886	5,437	3,558	3,826	7,170	5,565	1,123	600	580	2,622
2000	240	426	259	1,691	5,573	4,431	3,694	7,049	3,815	640	533	415	2,383
2001	352	426	339	428	1,628	2,145	2,266	4,698	712	481	390	357	1,184
2002	238	560	1,313	1,330	1,999	2,421	2,667	5,829	1,662	531	406	262	1,602
2003	136	855	940	990	2,248	2,479	3,145	5,678	5,108	541	528	472	1,919
2004	182	333	956	1,049	2,532	2,523	2,372	5,168	949	380	402	278	1,426
2005	588	913	954	3,508	4,955	5,645	4,806	9,841	9,706	3,356	691	608	3,786
2006	274	394	2,737	3,959	4,113	5,958	9,669	10,556	9,950	2,723	551	537	4,277
2007	286	417	423	360	1,610	1,549	1,516	2,346	727	366	337	385	855
2008	214	226	262	1,043	2,169	1,817	1,827	4,334	1,326	446	440	287	1,197
2009	170	813	339	1,162	2,892	3,621	2,958	6,897	3,163	655	469	424	1,957
2010	690	349	522	1,144	3,196	3,154	3,504	6,537	5,468	1,728	414	501	2,257
2011	784	1,419	5,081	2,744	4,244	7,276	6,264	8,635	9,079	6,783	1,237	686	4,523
2012	477	425	175	527	1,125	1,609	2,558	3,515	675	431	401	317	1,019
1971-2012	374	811	1,169	2,064	3,392	3,635	3,464	5,934	4,420	1,934	632	477	2,352

Table 2. Minimum daily inflow to Don Pedro Reservoir by water year type, by water year, and for the period of record for the Base Case (cfs).

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Min	3-day Min	7-day Min
C	114	144	87	111	249	307	270	497	359	301	307	126	87	--	--	--
D	178	167	118	161	906	1,204	1,105	1,896	453	321	307	132	118	--	--	--
BN	81	105	99	116	679	1,259	1,600	3,394	457	312	307	135	81	--	--	--
N	96	121	197	198	1,705	1,855	2,177	4,902	1,183	424	377	180	96	--	--	--
AN	106	100	156	310	2,608	2,425	2,771	4,824	4,355	458	413	190	100	--	--	--
W	86	93	202	436	2,647	2,971	2,867	5,635	4,333	544	428	249	86	--	--	--
1971	226	233	783	655	2,022	1,855	2,177	4,925	2,556	522	446	242	226	17	227	229
1972	134	183	381	682	1,511	1,686	1,675	4,140	1,108	447	408	197	134	13	136	138
1973	160	191	366	465	2,726	2,948	2,562	5,778	4,986	495	452	212	160	13	161	166
1974	251	277	949	1,207	2,645	3,215	3,470	6,123	4,851	604	482	310	251	18	253	257
1975	260	261	294	310	2,754	3,186	3,032	4,824	5,726	624	548	345	260	19	261	262
1976	335	643	310	195	413	712	621	676	359	373	368	187	187	341	190	195
1977	138	149	87	118	249	307	270	497	370	301	307	126	87	80	88	89
1978	86	93	202	1,165	2,647	2,971	4,286	5,635	6,113	2,084	515	337	86	16	86	86
1979	184	271	312	399	2,523	3,220	3,054	6,654	3,671	525	458	272	184	24	188	189
1980	237	454	336	1,179	3,282	3,784	3,332	7,365	5,150	2,171	602	451	237	11	239	241
1981	221	190	330	316	1,248	1,425	1,614	3,912	719	419	418	196	190	36	192	199
1982	247	478	695	2,074	3,650	5,483	4,481	8,772	7,690	2,464	538	493	247	9	259	298
1983	745	1,715	1,554	1,871	5,093	6,383	4,814	6,511	10,018	5,454	979	824	745	21	775	799
1984	686	948	2,621	1,771	3,063	3,006	2,771	5,712	4,547	458	413	190	190	339	191	204
1985	334	468	504	449	1,332	1,642	2,001	4,293	628	410	410	222	222	337	232	263
1986	330	388	669	1,045	3,567	5,352	4,054	7,646	6,699	604	436	251	251	337	252	354
1987	227	183	166	111	532	643	810	1,209	376	352	337	133	111	108	113	116
1988	114	165	470	537	792	808	860	1,544	565	368	318	126	114	7	116	120
1989	88	105	303	382	1,724	1,923	2,013	5,041	1,029	367	307	135	88	13	88	88
1990	315	428	182	206	979	1,204	1,324	1,896	631	321	307	132	132	347	133	133
1991	81	125	99	116	679	1,259	1,742	3,620	1,161	504	427	222	81	11	81	81
1992	147	144	133	225	642	1,489	2,416	1,741	449	410	368	185	133	77	140	145
1993	118	116	156	447	2,608	2,425	3,686	6,534	6,060	982	535	333	116	50	116	119

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Min	3-day Min	7-day Min
1994	198	178	222	263	866	1,031	1,125	2,626	535	484	401	208	178	34	190	211
1995	87	108	510	547	3,784	3,792	4,889	9,544	7,048	5,174	664	423	87	16	87	87
1996	106	100	255	572	3,455	4,126	3,848	7,857	4,355	665	447	277	100	31	104	110
1997	159	309	1,923	3,127	3,521	3,505	2,867	6,716	4,333	544	472	250	159	17	162	170
1998	174	193	357	436	4,125	3,714	4,727	7,601	6,837	2,383	570	365	174	24	176	178
1999	176	292	629	533	2,999	3,329	2,890	6,746	4,629	616	536	349	176	22	178	182
2000	155	186	199	198	2,703	3,769	3,433	6,559	3,071	528	482	284	155	20	155	156
2001	267	260	279	289	1,281	1,552	1,600	3,394	457	409	371	201	201	339	202	232
2002	153	168	735	780	1,705	1,997	2,184	5,517	1,183	424	377	180	153	17	155	158
2003	96	121	333	816	2,091	2,154	2,404	4,902	3,822	471	422	223	96	10	96	96
2004	110	134	318	786	1,774	2,040	1,853	4,610	722	312	354	161	110	20	110	111
2005	165	710	570	1,475	3,886	3,989	4,299	7,689	7,864	964	517	346	165	7	169	170
2006	186	216	783	1,846	3,614	4,575	6,511	7,502	7,415	1,009	428	249	186	20	193	197
2007	178	167	248	252	906	1,285	1,105	1,933	453	351	325	152	152	340	158	188
2008	147	127	183	267	1,594	1,636	1,604	3,809	1,024	372	357	167	127	36	127	131
2009	106	252	197	500	2,318	2,882	2,556	6,241	2,816	473	418	224	106	23	108	109
2010	172	319	309	459	2,607	2,825	2,439	5,951	4,273	507	388	240	172	12	173	246
2011	396	908	1,480	1,976	3,735	4,005	5,210	7,655	6,417	2,907	675	441	396	17	399	404
2012	312	305	118	161	1,095	1,247	1,412	2,878	560	384	374	212	118	82	121	123
1971-2012	81	93	87	111	249	307	270	497	359	301	307	126	81	--	--	--

Table 3. Maximum daily inflow to Don Pedro Reservoir by water year type, by water year, and for the period of record for the Base Case (cfs).

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Max	3-day Max	7-day Max
C	1,793	1,567	1,018	1,871	3,186	2,508	4,066	4,066	1,810	2,416	928	545	4,066	--	--	--
D	2,096	1,173	1,223	3,610	3,883	4,617	6,330	5,461	2,811	686	540	509	6,330	--	--	--
BN	744	2,958	4,377	4,030	6,073	6,485	3,558	6,728	2,696	2,322	644	541	6,728	--	--	--
N	1,879	3,491	3,797	15,001	18,878	7,913	5,896	8,935	10,841	4,252	839	613	18,878	--	--	--
AN	1,283	18,209	21,615	12,099	16,468	11,553	9,790	20,177	10,892	6,254	963	734	21,615	--	--	--
W	7,249	13,697	26,023	116,502	45,341	36,225	37,729	22,350	18,146	19,407	5,703	8,557	116,502	--	--	--
1971	439	3,491	3,797	2,163	2,591	6,903	3,095	5,845	4,987	3,332	527	610	6,903	177	5,812	5,715
1972	537	1,605	4,377	1,070	3,211	2,347	2,152	4,865	2,523	687	442	433	4,865	215	4,839	4,802
1973	345	1,329	2,410	7,343	13,391	4,714	5,012	8,935	10,841	892	532	486	13,391	134	10,469	8,872
1974	913	6,102	4,696	5,099	3,028	9,480	9,790	7,793	8,374	3,285	894	636	9,790	183	8,231	7,907
1975	853	696	2,354	1,933	8,573	11,553	4,864	7,809	10,892	3,065	800	722	11,553	176	10,383	10,106
1976	1,793	1,567	700	268	938	1,198	999	1,678	545	439	928	545	1,793	26	1,573	1,541
1977	390	435	301	318	525	407	441	789	1,326	323	317	327	1,326	253	1,050	762
1978	280	716	3,846	7,718	15,769	12,427	12,779	7,623	11,257	7,186	2,051	2,483	15,769	132	10,823	9,813
1979	780	1,285	900	15,001	9,119	7,913	5,141	8,111	8,708	827	514	613	15,001	103	8,827	7,971
1980	748	993	1,997	36,867	24,804	7,025	5,054	9,279	10,151	11,265	2,072	796	36,867	104	30,276	19,740
1981	643	396	1,223	3,610	1,543	4,617	2,534	5,461	2,179	526	540	459	5,461	213	5,196	4,702
1982	1,037	7,941	11,309	17,110	36,655	10,569	37,729	11,969	11,105	6,251	2,186	8,557	37,729	193	26,110	16,838
1983	7,249	13,697	19,981	14,721	13,996	23,730	8,770	11,610	18,146	17,440	5,703	1,939	23,730	152	18,709	16,480
1984	1,283	18,209	21,615	8,237	6,148	4,624	3,431	9,512	8,575	2,014	478	529	21,615	85	19,179	13,598
1985	591	2,958	1,377	612	5,904	4,419	3,019	5,609	1,382	506	511	541	5,904	131	5,418	5,382
1986	464	2,167	3,108	3,469	45,341	24,257	5,396	8,556	12,159	2,397	670	999	45,341	140	40,102	27,330
1987	692	354	341	217	2,955	2,508	1,730	2,384	936	394	380	329	2,955	136	2,319	2,158
1988	324	565	1,018	1,871	1,511	1,647	1,431	2,034	1,470	511	365	348	2,034	229	1,941	1,857
1989	316	1,394	619	543	2,282	6,485	3,558	6,115	1,984	499	323	518	6,485	159	5,980	5,834
1990	2,096	1,173	582	773	1,598	1,778	1,994	2,898	2,811	686	317	328	2,898	240	2,652	2,532
1991	270	250	126	147	1,062	6,016	2,379	4,753	2,696	2,322	644	419	6,016	155	4,588	4,250
1992	1,740	293	370	355	3,186	2,416	4,066	4,066	1,698	2,416	557	359	4,066	201	4,066	4,066
1993	481	214	2,076	12,099	6,076	8,164	5,865	8,131	7,615	6,254	963	681	12,099	114	8,507	7,505

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Max	3-day Max	7-day Max
1994	538	412	410	544	2,100	1,318	1,593	3,316	1,810	676	495	470	3,316	224	3,229	3,079
1995	366	1,206	1,264	14,977	5,045	36,225	13,856	22,350	16,564	19,407	4,518	675	36,225	161	26,183	17,614
1996	495	263	2,272	6,020	13,235	11,296	5,525	20,177	8,176	2,596	567	658	20,177	228	13,477	10,850
1997	535	4,116	14,051	116,502	6,256	3,972	3,757	7,551	7,986	1,009	677	653	116,502	94	77,439	45,929
1998	521	957	990	14,349	24,658	20,669	6,861	10,708	13,025	12,917	2,007	1,076	24,658	126	15,442	12,506
1999	580	1,569	1,889	8,510	16,468	4,283	4,729	7,629	7,540	2,156	691	734	16,468	132	12,016	8,666
2000	553	608	531	11,304	18,878	5,650	4,518	8,617	5,362	1,029	611	586	18,878	136	12,431	8,423
2001	744	532	494	1,078	2,566	5,534	3,461	5,976	2,186	611	422	494	5,976	223	5,685	5,408
2002	443	1,316	3,087	3,759	2,524	3,482	3,249	7,024	3,509	851	448	376	7,024	243	6,455	6,062
2003	318	1,898	2,712	1,264	2,544	3,474	5,896	6,604	7,470	717	839	611	7,470	253	7,309	6,662
2004	500	432	2,378	2,963	6,073	2,914	3,036	6,728	1,386	423	448	370	6,728	217	6,492	5,974
2005	1,441	1,146	4,880	10,413	8,104	14,769	5,365	14,514	15,103	6,289	1,108	819	15,103	244	14,493	13,638
2006	552	596	26,023	14,287	9,591	8,151	25,622	15,431	13,223	5,573	1,038	635	26,023	92	19,296	13,767
2007	543	555	668	498	3,883	1,777	2,129	2,944	1,770	382	380	509	3,883	134	3,157	2,815
2008	467	272	510	4,030	5,451	2,160	2,225	5,515	1,786	796	506	374	5,515	231	5,342	5,022
2009	342	1,064	640	3,996	5,528	7,703	3,801	8,653	4,227	1,333	507	563	8,653	214	7,956	7,412
2010	1,879	463	1,420	3,554	8,924	3,842	4,900	7,179	7,498	4,252	513	612	8,924	150	7,289	6,931
2011	2,535	2,095	18,955	6,462	6,818	15,709	8,087	9,778	16,554	13,448	3,311	846	18,955	80	15,529	13,210
2012	739	484	351	2,443	1,236	3,596	6,330	4,390	873	490	462	402	6,330	208	5,123	4,524
1971-2012	7,249	18,209	26,023	116,502	45,341	36,225	37,729	22,350	18,146	19,407	5,703	8,557	116,502	--	--	--

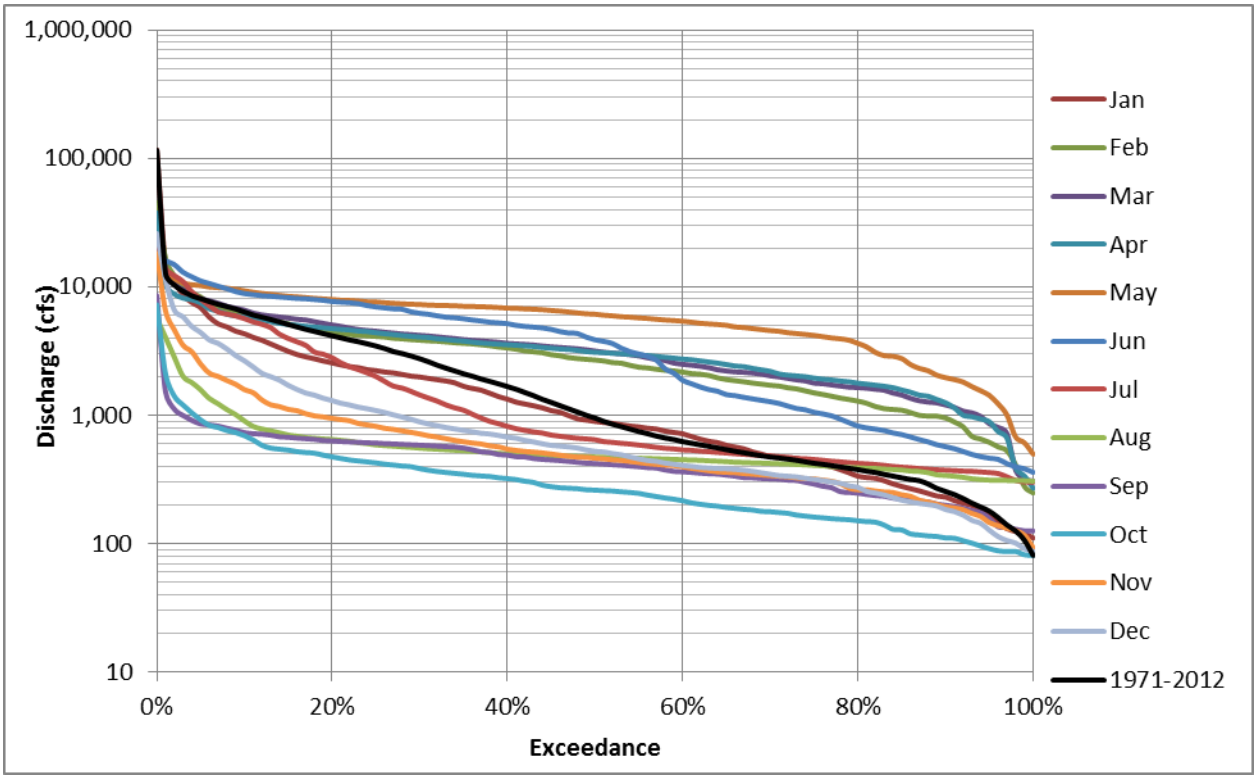


Figure 1. **Base Case inflow to Don Pedro: flow duration curves by month and for the period of record**

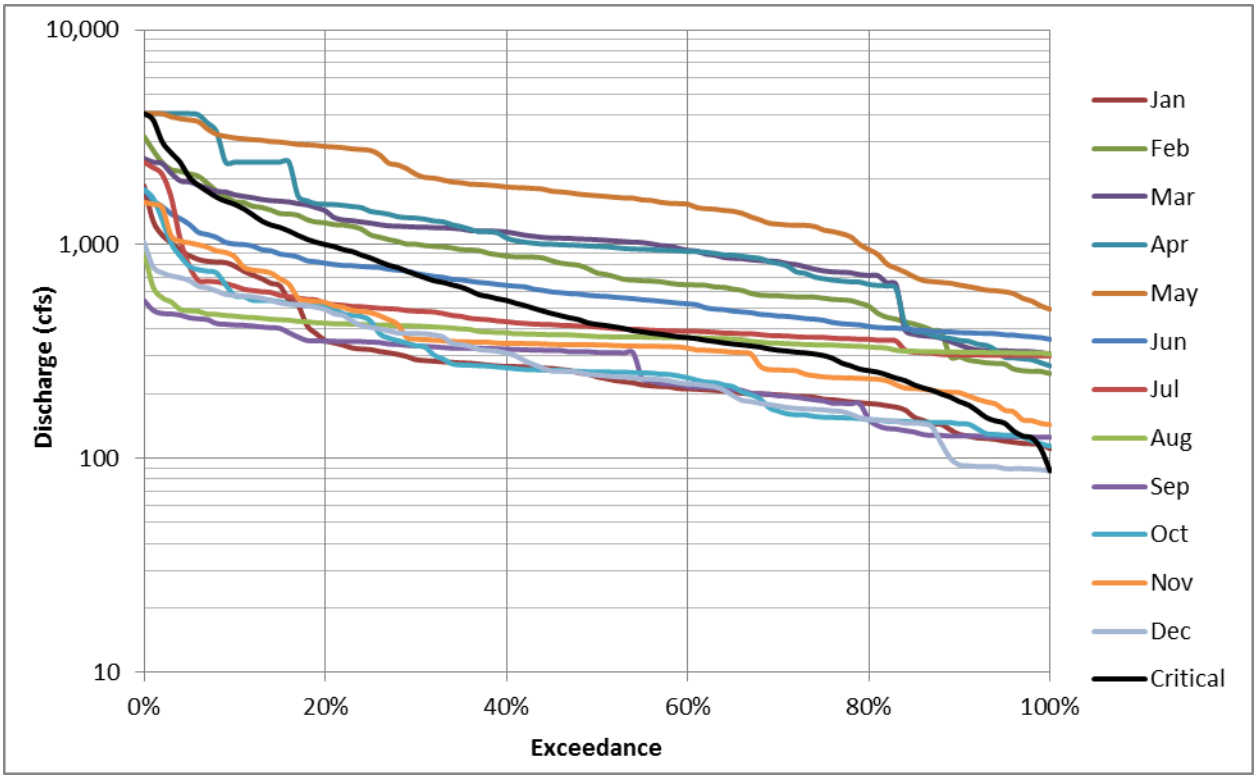


Figure 2. **Base Case inflow to Don Pedro: flow duration curves for Critical years by month and for all Critical years**

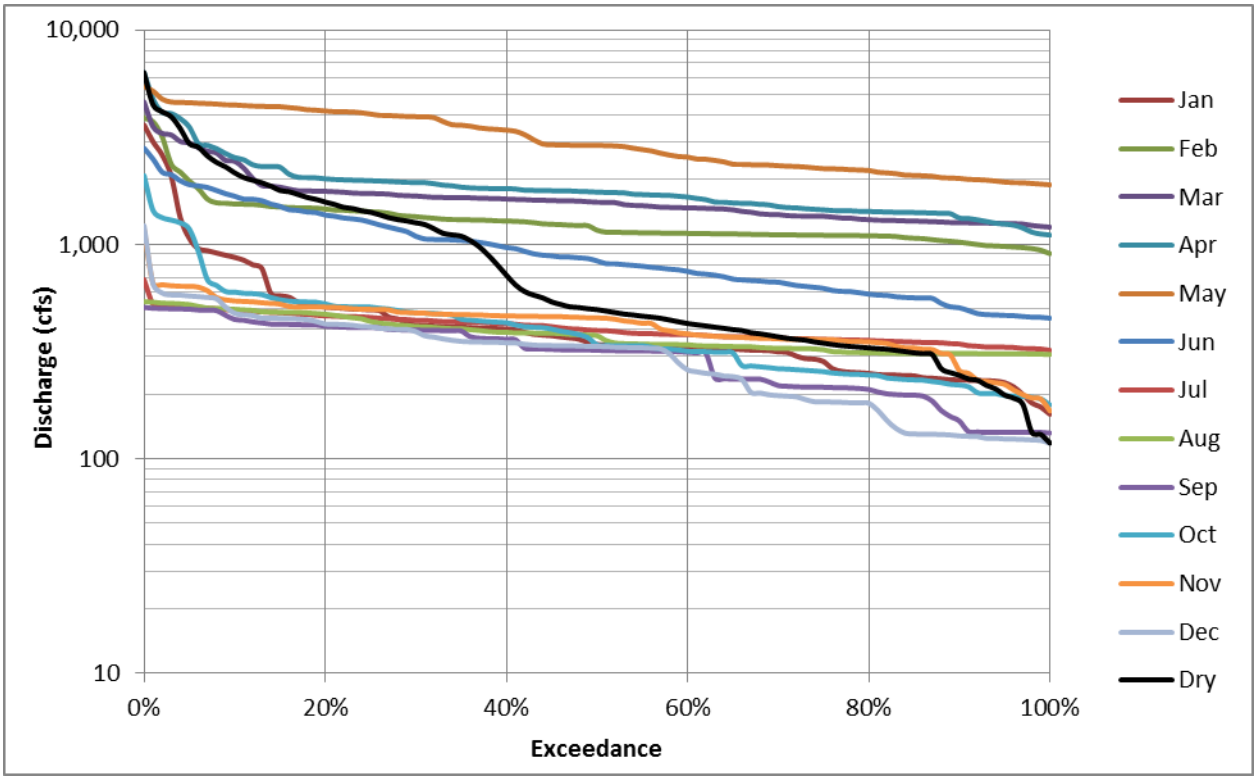


Figure 3. **Base Case inflow to Don Pedro flow: duration curves for Dry years by month and for all Dry years**

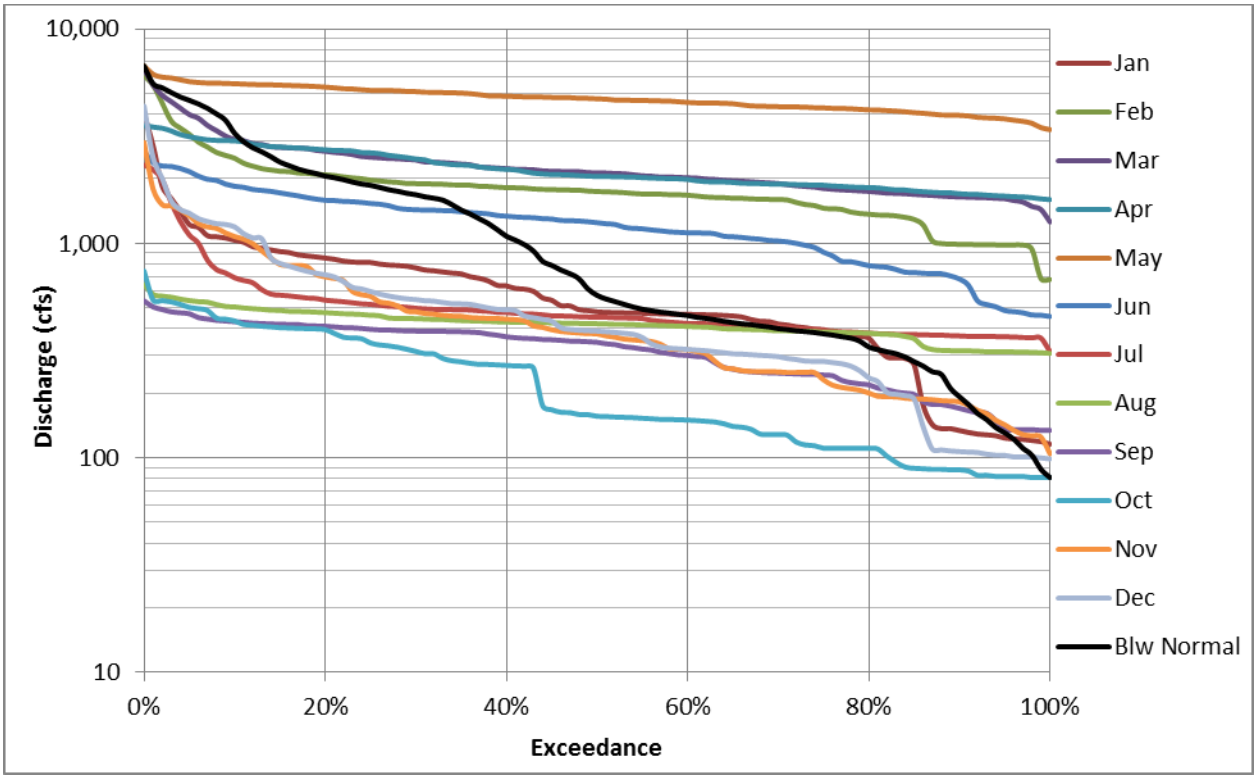


Figure 4. **Base Case inflow to Don Pedro: flow duration curves for Below Normal years by month and for all Below Normal years**

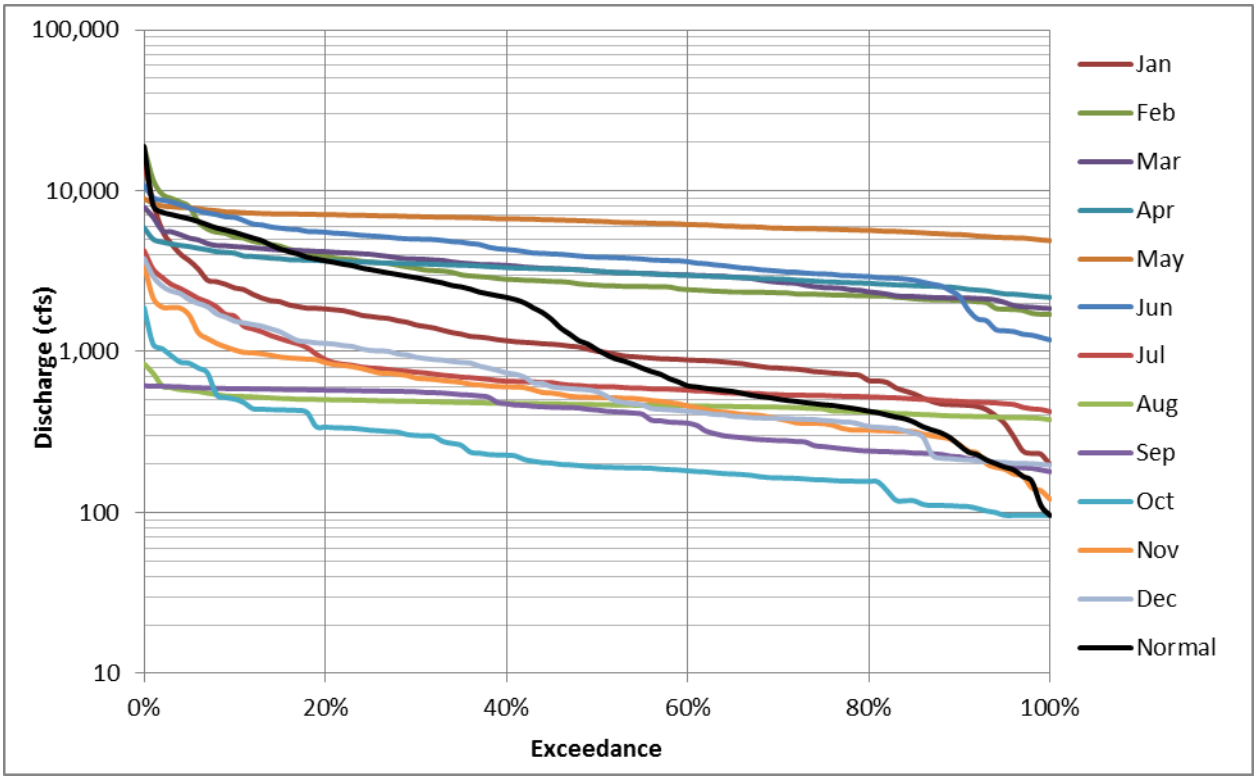


Figure 5. **Base Case inflow to Don Pedro: flow duration curves for Normal years by month and for all Normal years**

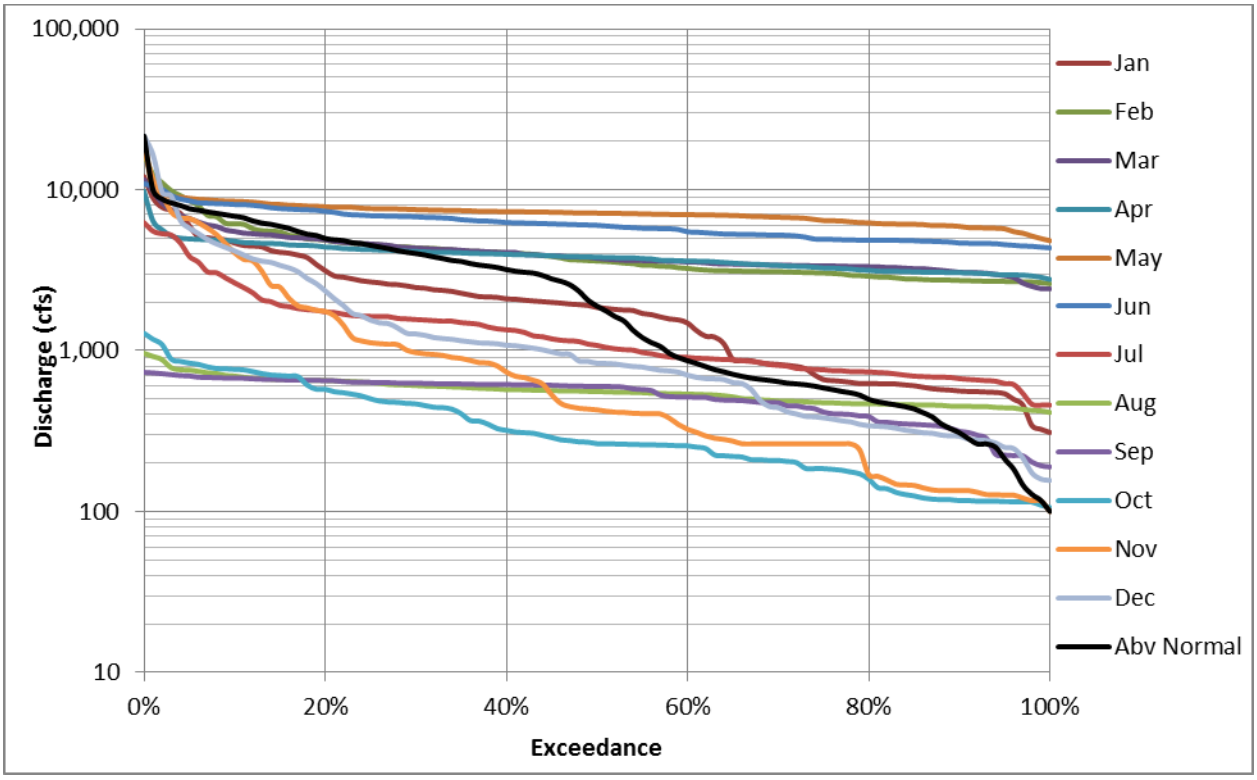


Figure 6. **Base Case inflow to Don Pedro: flow duration curves for Above Normal years by month and for all Above Normal years**

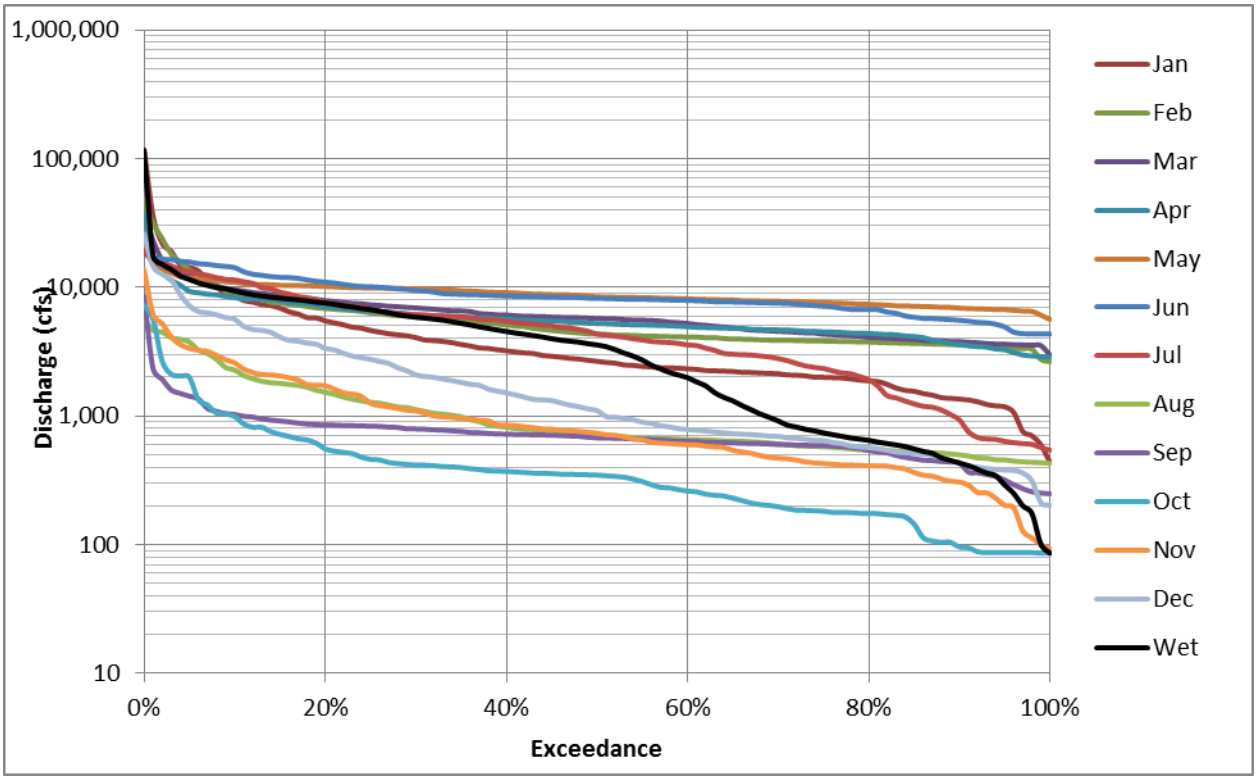


Figure 7. Base Case inflow to Don Pedro: flow duration curves for Wet years by month and for all Wet years

Tuolumne River above La Grange Dam:

Operations Model Base Case

Table 1. Average Tuolumne River above La Grange Dam flow by water year type, by water year, and for the period of record for the Base Case (cfs).

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
C	1,893	804	597	777	951	2,558	3,728	4,106	4,140	4,771	4,035	2,326	2,566
D	2,197	825	631	851	1,055	3,092	4,515	4,712	4,599	5,242	4,538	2,660	2,921
BN	1,833	707	507	727	1,424	3,246	4,852	5,064	4,540	5,242	4,512	2,538	2,941
N	2,100	647	558	1,116	2,602	4,921	6,340	5,712	5,995	5,949	4,986	3,110	3,674
AN	2,310	1,452	2,629	3,501	5,941	7,753	7,885	6,417	8,064	6,218	5,098	3,344	5,043
W	2,211	1,150	2,235	6,132	8,350	11,816	12,001	12,009	14,482	11,357	7,006	3,704	7,698
1971	2,304	718	942	2,236	4,070	4,819	7,453	5,958	4,897	5,565	4,827	2,900	3,888
1972	1,944	655	460	679	963	3,627	4,953	5,384	4,797	5,515	4,778	2,759	3,052
1973	1,814	421	410	630	701	6,267	7,527	6,414	9,100	6,372	5,174	3,307	4,027
1974	2,304	718	1,797	4,716	5,432	8,050	9,269	6,169	8,910	5,879	5,174	3,307	5,137
1975	2,304	936	708	927	4,762	8,262	8,257	6,631	10,200	6,717	4,718	3,572	4,823
1976	2,517	1,048	943	928	1,268	3,901	4,245	4,940	4,633	5,325	4,045	2,269	3,014
1977	1,479	502	410	630	1,014	2,893	3,697	3,109	3,446	4,004	3,462	1,940	2,224
1978	1,065	524	390	611	701	2,119	2,770	6,662	5,244	5,912	5,463	4,337	2,999
1979	2,923	718	708	2,568	5,816	8,930	8,212	6,290	7,225	5,844	5,174	3,307	4,801
1980	2,304	718	708	8,761	12,588	13,725	8,611	9,276	8,984	11,607	6,655	3,751	7,298
1981	2,681	1,109	708	927	1,110	3,503	4,888	5,262	4,897	5,565	4,827	2,960	3,217
1982	1,928	480	470	2,243	10,674	14,978	15,173	16,108	16,448	11,198	6,811	3,703	8,326
1983	4,444	6,248	7,714	6,931	14,217	17,237	16,057	19,936	19,817	17,235	11,848	4,472	12,169
1984	2,983	4,692	11,362	11,143	6,266	7,717	7,763	6,450	5,202	5,899	5,174	3,272	6,509
1985	2,304	718	708	927	2,040	4,424	5,845	5,493	4,734	5,565	4,827	2,909	3,384
1986	1,814	421	410	630	5,996	18,453	12,622	10,222	10,886	6,728	5,174	3,208	6,379
1987	2,304	1,098	708	927	1,110	2,352	4,375	5,067	4,664	5,338	4,603	2,707	2,950
1988	1,479	617	410	630	667	2,004	3,285	3,928	3,994	4,672	4,033	2,373	2,348
1989	1,416	410	400	621	895	1,869	4,202	4,566	4,090	4,672	3,956	1,237	2,372
1990	1,272	630	400	621	905	2,555	4,062	3,257	4,090	4,672	4,033	2,342	2,411
1991	1,272	734	400	621	955	1,869	4,095	4,559	3,895	4,672	3,910	2,373	2,455
1992	1,272	724	400	621	657	1,683	2,671	3,817	3,437	3,952	3,462	2,039	2,067
1993	1,065	540	390	611	701	2,119	4,322	5,421	4,897	5,912	5,174	3,307	2,885
1994	2,304	833	708	927	999	2,512	4,095	3,775	4,664	5,338	4,603	2,628	2,794
1995	1,527	421	410	630	701	8,359	12,931	16,057	19,934	17,175	10,485	3,970	7,757
1996	2,619	1,109	708	927	8,986	11,874	9,610	7,608	11,169	6,712	5,174	3,307	5,794
1997	2,304	718	5,717	27,259	15,885	8,172	7,933	6,378	6,026	5,928	5,174	3,287	7,870
1998	2,352	718	708	2,257	12,944	11,730	12,789	9,767	18,284	15,744	7,564	3,754	8,172
1999	2,587	718	807	2,682	9,382	8,496	8,089	6,226	8,009	6,189	5,174	3,297	5,104
2000	2,465	1,012	708	927	7,213	10,827	8,201	4,938	5,695	5,912	5,174	3,292	4,685
2001	2,304	947	708	927	999	2,808	4,297	5,045	4,874	5,565	4,827	2,835	3,025
2002	1,839	421	410	630	701	2,119	4,624	5,089	4,897	5,565	4,827	2,960	2,854
2003	1,983	421	410	630	701	2,119	6,146	5,757	4,897	5,565	4,712	2,960	3,038
2004	2,113	785	460	686	3,410	6,068	6,006	5,260	4,723	5,367	4,683	2,944	3,542
2005	1,814	421	410	630	4,186	11,088	11,614	9,229	20,252	9,581	5,154	3,127	6,451
2006	2,462	1,011	927	9,245	6,819	11,345	16,877	14,650	20,427	9,750	5,174	3,302	8,492
2007	2,304	718	708	927	1,242	3,561	4,510	5,078	4,664	5,338	4,603	2,492	3,026
2008	1,479	703	410	630	677	2,055	4,567	5,139	4,664	5,338	4,603	2,707	2,755
2009	1,527	638	410	630	701	2,119	5,341	5,459	4,847	5,565	4,827	2,844	2,922
2010	1,944	828	460	679	751	2,169	3,215	5,789	6,405	7,204	5,174	3,307	3,177
2011	2,304	964	6,724	8,261	6,989	12,769	14,631	13,818	13,003	14,072	7,568	3,829	8,766
2012	2,533	844	708	927	964	2,748	4,602	5,251	4,743	5,395	4,688	2,846	3,029
1971-2012	2,094	943	1,297	2,632	3,994	6,340	7,248	7,029	7,873	7,051	5,274	3,049	4,571

Table 2. Minimum daily Tuolumne River above La Grange Dam flow by water year type, by water year, and for the period of record for the Base Case (cfs).

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Min	3-day Min	7-day Min
C	480	491	400	621	657	883	1,578	2,526	2,265	3,221	2,740	888	400	--	--	--
D	480	584	400	621	873	1,093	2,318	2,532	2,691	3,809	3,190	1,069	400	--	--	--
BN	480	410	400	621	677	935	2,234	3,439	2,564	3,809	3,094	596	400	--	--	--
N	568	421	410	630	701	1,052	1,299	2,935	3,170	4,579	3,774	1,435	410	--	--	--
AN	440	492	390	611	701	1,052	2,027	3,496	3,423	4,821	3,856	1,820	390	--	--	--
W	440	421	390	611	701	1,052	1,035	4,288	3,602	4,926	4,195	1,744	390	--	--	--
1971	1,136	718	708	1,698	3,106	3,442	5,275	3,637	3,298	4,579	3,864	1,462	708	62	708	708
1972	914	640	460	679	903	1,389	2,680	4,037	3,215	4,529	3,815	1,369	460	61	460	460
1973	838	421	410	630	701	2,363	5,333	4,214	5,752	5,285	4,211	1,833	410	62	410	410
1974	1,136	718	708	2,989	5,252	5,800	6,549	4,124	5,803	4,821	4,211	1,833	708	62	708	711
1975	1,136	895	708	927	999	6,819	5,999	5,006	6,784	5,491	3,856	2,680	708	62	708	708
1976	1,136	914	817	927	1,163	1,634	2,374	3,897	3,046	4,341	3,204	1,058	817	85	817	817
1977	520	491	410	630	889	1,165	2,212	2,526	2,274	3,265	2,740	888	410	62	410	410
1978	440	492	390	611	701	1,052	1,035	5,709	3,645	4,926	4,211	2,716	390	62	390	390
1979	1,204	718	708	927	2,777	7,549	6,540	4,161	3,954	5,101	4,211	1,833	708	62	708	708
1980	1,136	718	708	927	7,675	8,751	6,513	8,234	7,385	9,793	4,306	2,920	708	61	708	708
1981	1,183	933	708	927	1,099	1,422	2,892	4,015	3,298	4,579	3,864	1,486	708	62	708	708
1982	898	480	470	689	4,851	13,026	4,758	12,102	14,905	5,980	4,528	2,590	470	62	470	470
1983	1,449	2,757	4,457	4,355	3,839	5,724	13,348	19,006	18,218	13,244	7,978	3,823	1,449	24	1,485	1,678
1984	1,223	718	7,370	4,835	4,506	6,315	5,597	4,343	3,619	4,915	4,211	1,820	718	31	718	718
1985	1,136	718	708	927	999	3,514	4,407	4,019	3,193	4,579	3,864	1,463	708	62	708	708
1986	838	421	410	630	701	13,749	9,264	9,200	7,394	5,285	4,211	1,795	410	62	410	410
1987	1,136	933	708	927	1,099	1,285	2,382	3,893	3,065	4,352	3,640	1,233	708	62	708	708
1988	520	591	410	630	667	968	2,013	3,178	2,628	3,809	3,190	1,083	410	61	410	410
1989	512	410	400	621	872	935	2,286	3,440	2,691	3,809	3,130	596	400	62	400	400
1990	480	584	400	621	873	1,093	2,318	2,532	2,691	3,809	3,190	1,069	400	62	400	400
1991	480	612	400	621	881	935	2,234	3,439	2,564	3,809	3,094	1,083	400	62	400	400
1992	480	612	400	621	657	883	1,578	2,971	2,265	3,221	2,740	933	400	61	400	400
1993	440	492	390	611	701	1,052	2,027	3,496	3,423	4,926	4,211	1,833	390	62	390	390

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Min	3-day Min	7-day Min
1994	1,136	812	708	927	999	1,315	2,235	2,803	3,065	4,352	3,640	1,203	708	62	708	708
1995	568	421	410	630	701	1,052	11,075	15,255	18,488	14,074	5,658	2,482	410	62	410	410
1996	1,204	933	708	927	3,438	9,701	7,803	6,293	8,954	5,285	4,211	1,833	708	61	708	708
1997	1,136	718	708	9,810	8,701	6,673	5,144	4,288	3,602	4,926	4,211	1,826	708	62	708	708
1998	1,156	718	708	927	4,360	8,006	9,620	9,170	16,909	10,169	4,474	2,863	708	62	708	708
1999	1,136	718	708	1,173	5,468	7,357	5,313	4,167	4,781	5,285	4,211	1,827	708	62	708	708
2000	1,201	919	708	927	964	8,432	6,655	2,935	3,170	4,926	4,211	1,825	708	61	708	708
2001	1,136	900	708	927	999	1,350	3,100	3,731	3,283	4,579	3,864	1,433	708	62	708	708
2002	849	421	410	630	701	1,052	2,477	3,709	3,298	4,579	3,864	1,486	410	62	410	410
2003	907	421	410	630	701	1,052	3,407	3,747	3,298	4,579	3,774	1,486	410	62	410	410
2004	982	672	460	679	875	4,329	3,754	3,966	3,190	4,409	3,750	1,477	460	61	460	460
2005	838	421	410	630	701	8,459	8,626	7,694	17,629	5,285	4,195	1,744	410	62	410	410
2006	1,168	908	708	3,187	5,290	8,246	1,592	11,237	17,522	5,285	4,211	1,830	708	62	708	708
2007	1,136	718	708	927	1,183	1,569	2,451	3,863	3,065	4,352	3,640	1,144	708	62	708	708
2008	520	610	410	630	677	988	2,474	3,876	3,065	4,352	3,640	1,233	410	61	410	410
2009	568	597	410	630	701	1,052	2,705	3,825	3,265	4,579	3,864	1,435	410	62	410	410
2010	914	679	460	679	751	1,102	1,299	3,787	3,812	5,474	4,211	1,833	460	62	460	460
2011	1,136	718	1,934	4,823	4,894	9,193	11,180	12,784	11,799	11,337	4,661	2,629	718	32	718	718
2012	1,136	812	708	927	964	1,350	2,446	3,861	3,183	4,426	3,743	1,414	708	61	708	708
1971-2012	440	410	390	611	657	883	1,035	2,526	2,265	3,221	2,740	596	390	--	--	--

Table 3. Maximum daily Tuolumne River above La Grange Dam flow by water year type, by water year, and for the period of record for the Base Case (cfs).

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Max	3-day Max	7-day Max
C	5,763	1,504	1,079	931	1,410	6,991	5,677	6,410	6,346	6,289	5,613	4,117	6,991	--	--	--
D	5,914	1,541	708	927	1,332	6,472	6,526	6,831	6,579	6,516	5,837	4,370	6,831	--	--	--
BN	5,763	1,063	708	927	5,784	7,205	7,844	7,157	6,545	6,516	5,837	4,341	7,844	--	--	--
N	7,125	1,236	1,893	5,287	12,899	13,741	10,601	9,861	14,757	8,839	6,184	4,717	14,757	--	--	--
AN	6,920	13,453	17,406	17,805	14,036	13,453	12,024	10,293	18,295	10,217	6,184	4,717	18,295	--	--	--
W	9,798	8,290	14,407	132,971	17,997	20,726	19,524	27,370	29,752	24,075	15,400	7,380	132,971	--	--	--
1971	5,763	718	1,893	3,034	4,670	5,868	9,694	8,504	6,579	6,516	5,837	4,279	9,694	199	9,416	9,340
1972	3,818	693	460	679	1,053	6,388	6,478	6,912	6,456	6,466	5,787	4,078	6,912	226	6,799	6,178
1973	3,743	421	410	630	701	8,204	9,943	9,861	14,757	8,709	6,184	4,717	14,757	255	13,333	11,632
1974	5,763	718	2,770	5,961	5,578	10,006	12,024	10,293	14,061	8,255	6,184	4,717	14,061	258	13,320	11,742
1975	5,763	1,037	708	927	7,661	11,223	11,179	8,445	18,295	9,657	5,613	4,717	18,295	259	15,386	13,287
1976	5,763	1,326	1,079	931	1,410	6,991	5,432	6,144	6,305	6,274	4,919	3,460	6,991	181	6,366	6,240
1977	3,402	520	410	630	1,189	5,133	4,614	3,788	4,688	4,715	4,219	2,935	5,133	181	4,773	4,685
1978	2,493	604	390	611	701	3,468	4,199	7,744	6,926	6,863	6,852	5,457	7,744	226	7,649	7,159
1979	7,125	718	708	5,287	9,157	9,934	10,601	8,825	13,301	6,807	6,184	4,717	13,301	256	12,405	10,546
1980	5,763	718	708	17,871	17,818	18,978	10,362	10,093	10,666	16,477	10,514	4,812	18,978	153	18,861	18,413
1981	5,914	1,541	708	927	1,128	6,472	6,307	6,681	6,579	6,516	5,837	4,370	6,681	226	6,571	6,190
1982	3,803	480	470	4,803	17,963	19,053	18,790	21,709	18,065	17,655	10,364	7,380	21,709	213	21,010	20,822
1983	9,798	8,290	10,504	12,635	16,805	20,480	18,369	20,670	21,498	23,283	15,400	5,013	23,283	287	22,718	21,046
1984	6,920	13,453	17,406	17,805	7,950	9,081	10,200	8,788	6,871	6,848	6,184	4,666	17,805	95	17,768	17,648
1985	5,763	718	708	927	3,196	5,779	7,844	7,157	6,355	6,516	5,837	4,287	7,844	199	7,401	7,030
1986	3,743	421	410	630	17,937	20,726	19,524	11,023	14,730	10,286	6,184	4,571	20,726	181	20,471	20,449
1987	5,763	1,504	708	927	1,128	3,701	5,677	6,410	6,346	6,289	5,613	4,117	6,410	226	6,296	5,930
1988	3,402	681	410	630	667	3,312	4,081	4,779	5,423	5,504	4,916	3,606	5,504	288	5,356	5,120
1989	3,257	410	400	621	926	3,049	5,480	5,845	5,561	5,504	4,823	1,837	5,845	226	5,746	5,207
1990	2,947	742	400	621	953	4,467	5,172	4,086	5,561	5,504	4,916	3,557	5,561	272	5,396	5,195
1991	2,947	1,033	400	621	1,065	3,049	5,340	5,833	5,287	5,504	4,765	3,606	5,833	226	5,735	5,197
1992	2,947	1,000	400	621	657	2,695	3,419	4,785	4,666	4,659	4,219	3,096	4,785	226	4,702	4,374
1993	2,493	660	390	611	701	3,468	6,112	7,543	6,452	6,863	6,184	4,717	7,543	226	7,458	6,996

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Max	3-day Max	7-day Max
1994	5,763	886	708	927	999	4,132	5,339	4,879	6,346	6,289	5,613	4,001	6,346	272	6,159	5,930
1995	3,450	421	410	630	701	17,570	15,852	16,552	21,461	22,307	15,391	6,118	22,307	284	21,304	21,093
1996	5,996	1,541	708	927	14,036	13,453	11,895	10,152	15,935	10,217	6,184	4,717	15,935	252	15,236	13,870
1997	5,763	718	10,950	132,971	17,997	9,779	9,667	8,699	9,997	6,925	6,184	4,689	132,971	95	99,271	65,273
1998	5,828	718	708	5,063	17,169	16,818	15,336	10,601	19,752	19,872	13,090	4,707	19,872	274	19,706	19,534
1999	5,763	718	1,250	5,809	12,902	11,274	10,443	8,514	14,606	7,759	6,184	4,698	14,606	262	13,365	12,902
2000	5,986	1,236	708	927	12,899	13,741	10,531	8,506	10,354	6,863	6,184	4,688	13,741	153	13,471	13,134
2001	5,763	1,059	708	927	999	4,981	5,474	6,936	6,545	6,516	5,837	4,175	6,936	213	6,368	6,142
2002	3,786	421	410	630	701	3,468	6,104	6,627	6,579	6,516	5,837	4,370	6,627	226	6,511	6,161
2003	4,097	421	410	630	701	3,468	9,394	7,975	6,579	6,516	5,693	4,370	9,394	204	9,222	9,044
2004	4,172	1,063	460	747	5,784	7,205	7,499	6,723	6,355	6,305	5,670	4,341	7,499	199	7,112	6,990
2005	3,743	421	410	630	11,019	14,756	13,908	27,370	29,752	19,349	6,161	4,387	29,752	244	28,516	25,293
2006	5,857	1,267	2,967	15,801	7,508	13,019	19,232	21,383	25,945	19,924	6,184	4,707	25,945	250	24,901	23,689
2007	5,763	718	708	927	1,332	6,113	5,870	6,464	6,346	6,289	5,613	3,787	6,464	226	6,352	5,930
2008	3,402	932	410	630	677	3,403	5,962	6,575	6,346	6,289	5,613	4,117	6,575	226	6,460	5,930
2009	3,450	740	410	630	701	3,468	7,186	7,283	6,507	6,516	5,837	4,186	7,283	226	7,176	6,706
2010	3,818	1,197	460	679	751	3,517	4,728	7,992	14,591	8,839	6,184	4,717	14,591	271	14,175	11,138
2011	5,763	1,944	14,407	14,522	8,967	18,632	17,470	14,726	14,309	24,075	11,178	4,983	24,075	280	22,397	18,715
2012	5,763	924	708	927	964	4,946	6,526	6,831	6,393	6,338	5,683	4,230	6,831	213	6,600	6,145
1971-2012	9,798	13,453	17,406	132,971	17,997	20,726	19,524	27,370	29,752	24,075	15,400	7,380	132,971	--	--	--

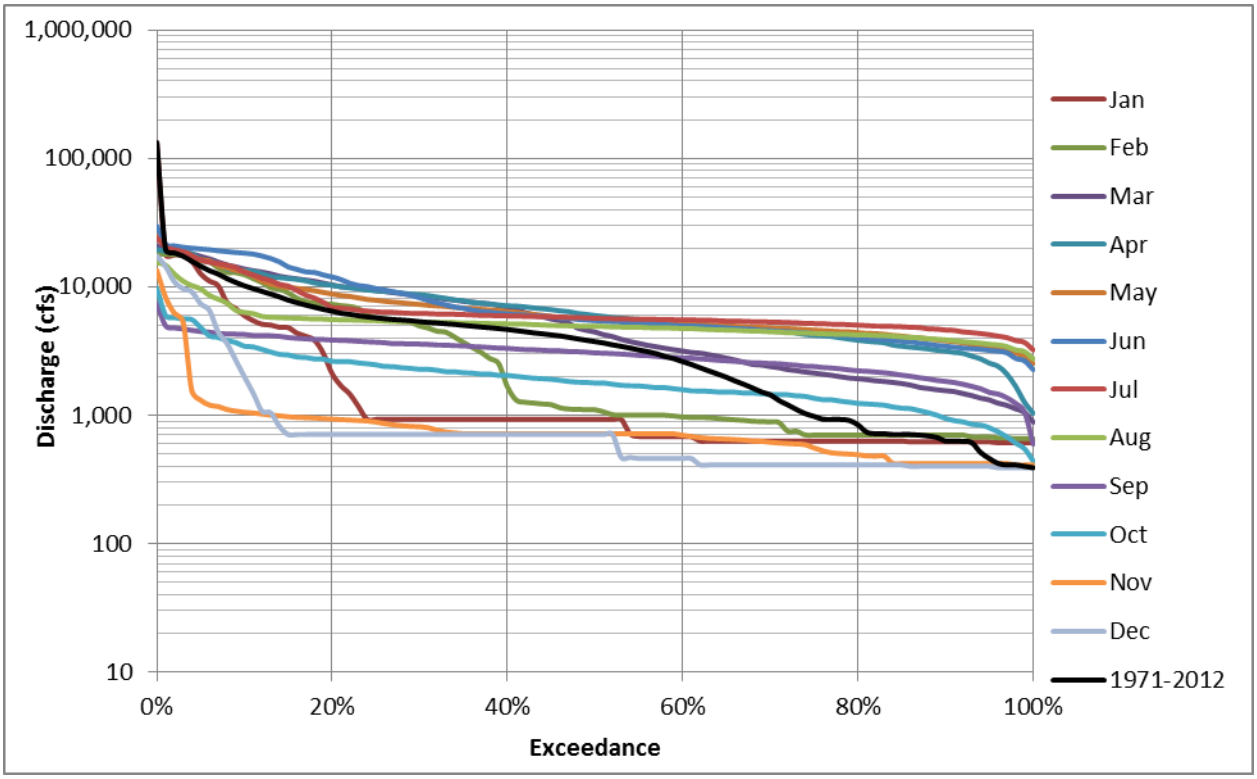


Figure 1. **Tuolumne River above La Grange Dam flow duration curves by month and for the period of record for the Base Case (cfs).**

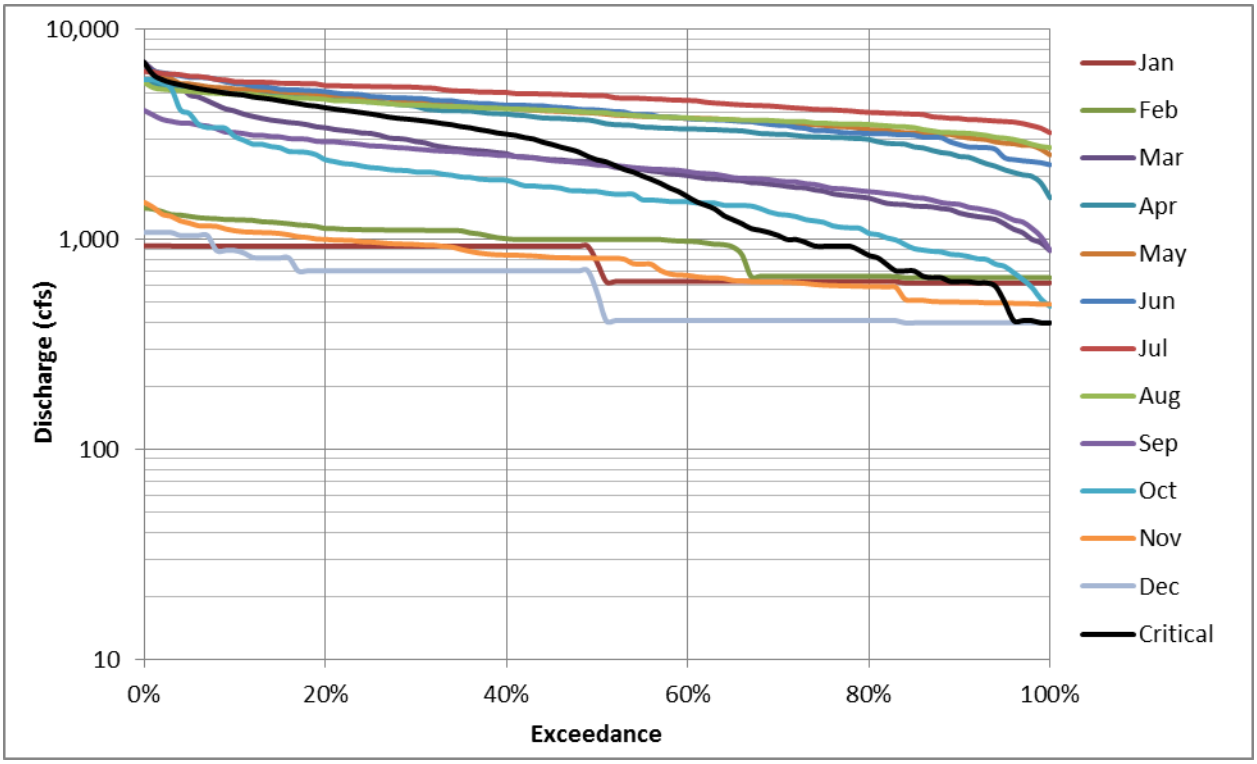


Figure 2. **Tuolumne River above La Grange Dam flow duration curves for Critical years by month and for all Critical years for the Base Case (cfs).**

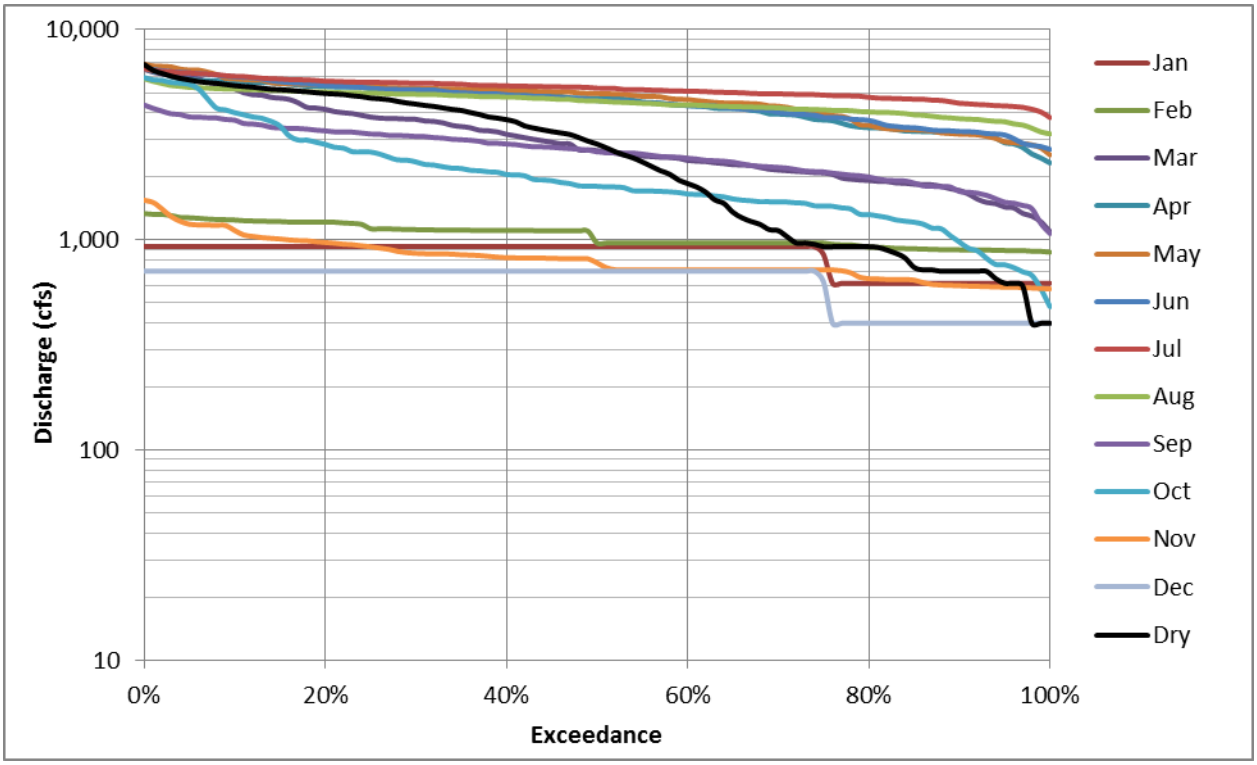


Figure 3. **Tuolumne River above La Grange Dam flow duration curves for Dry years by month and for all Dry years for the Base Case (cfs).**

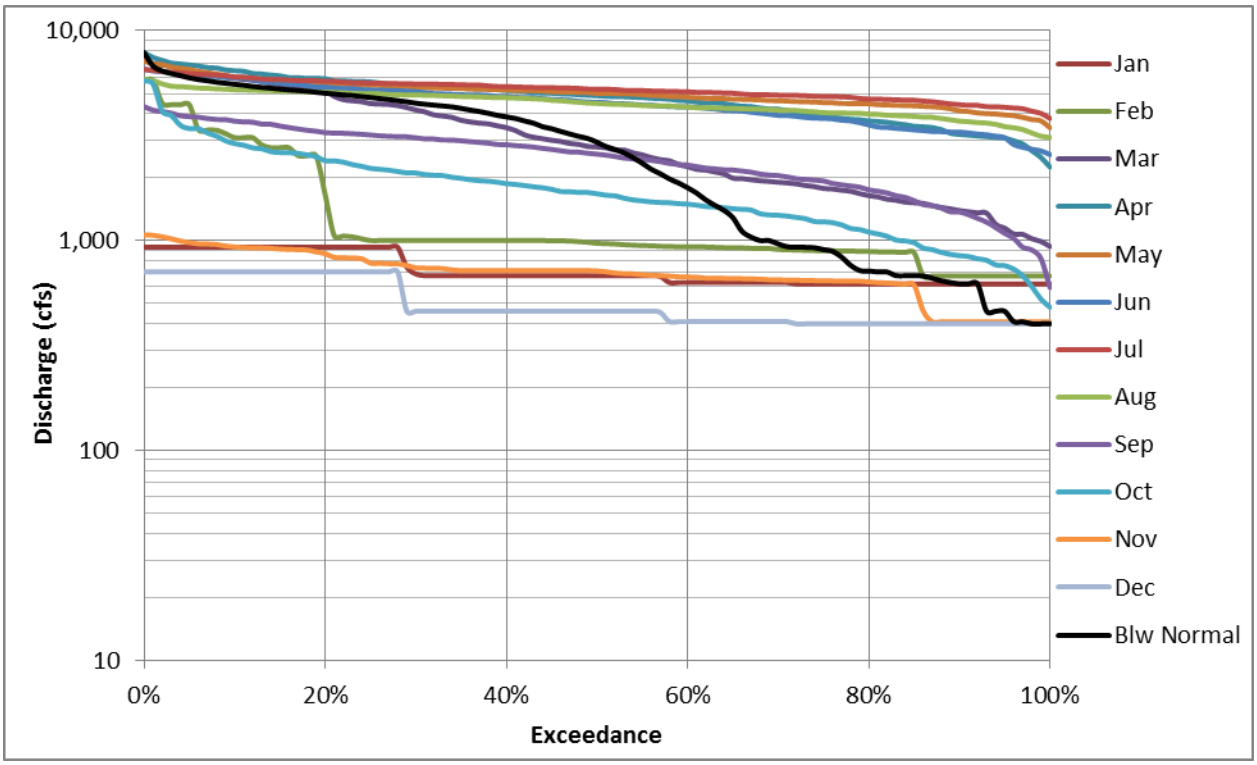


Figure 4. **Tuolumne River above La Grange Dam flow duration curves for Below Normal years by month and for all Below Normal years for the Base Case (cfs).**

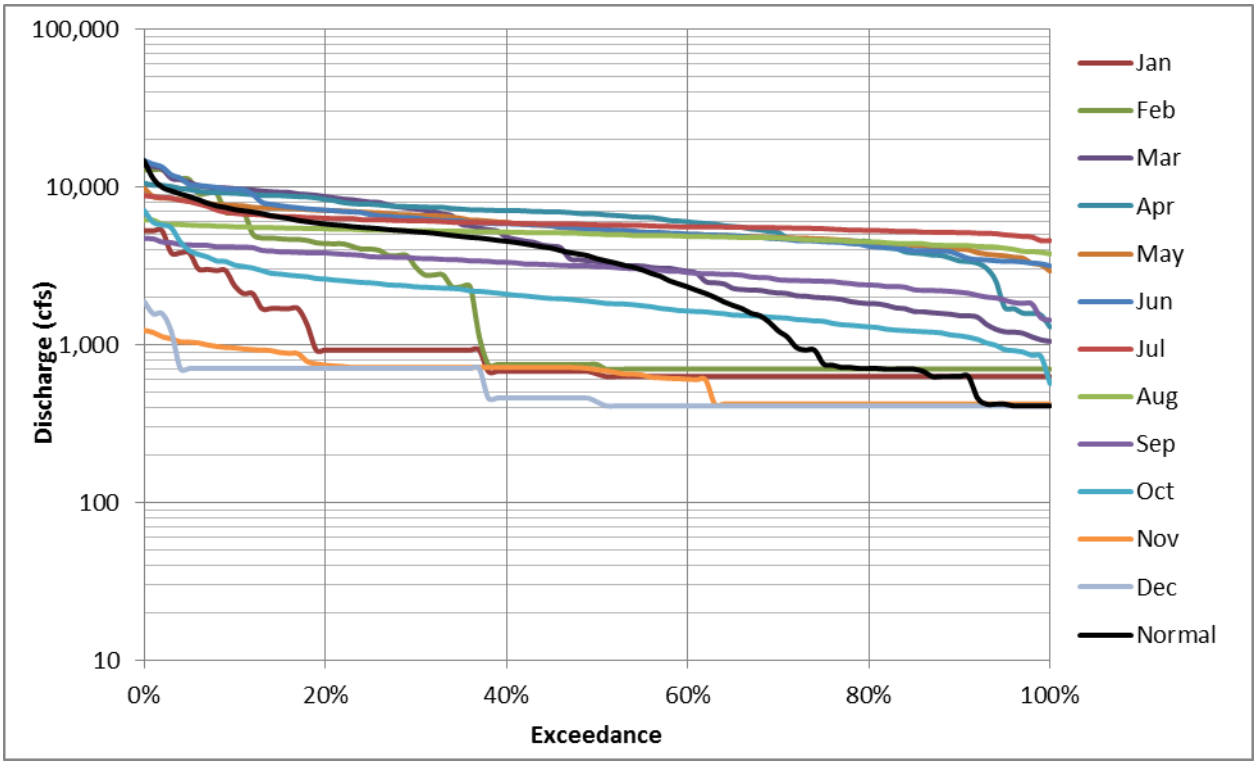


Figure 5. **Tuolumne River above La Grange Dam flow duration curves for Normal years by month and for all Normal years for the Base Case (cfs).**

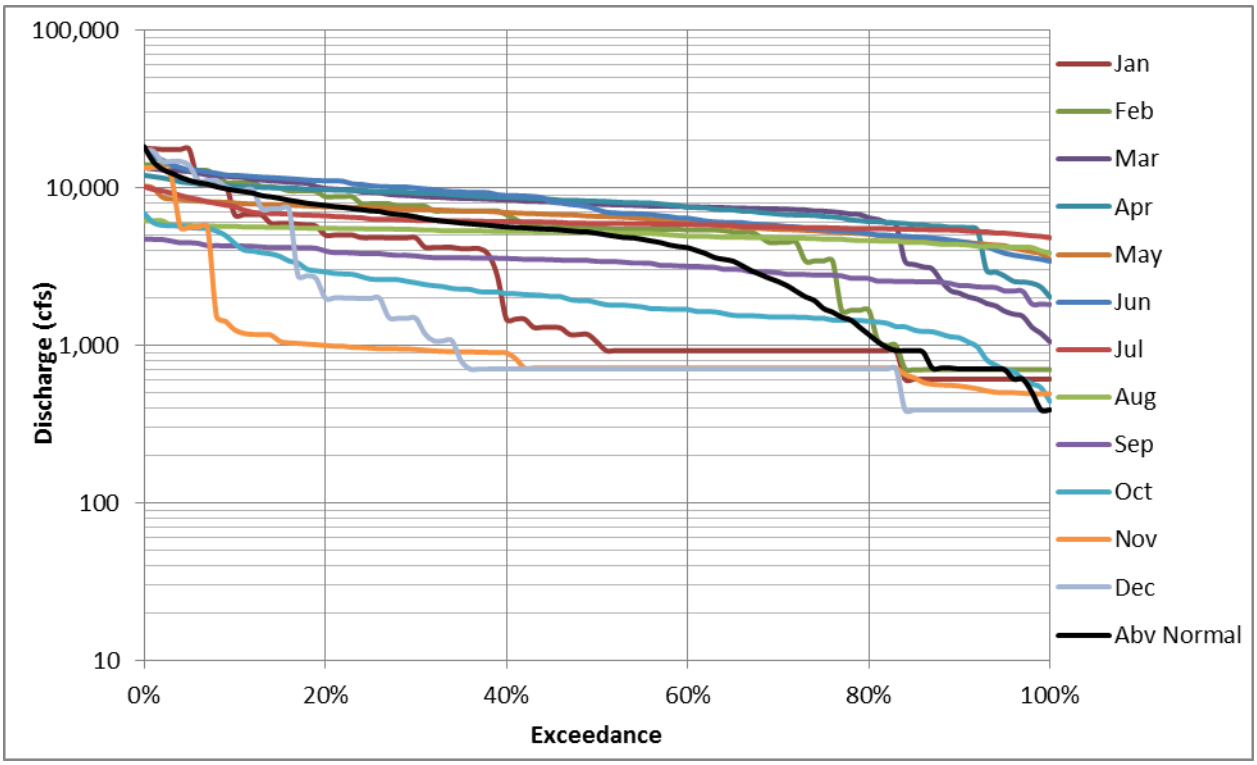


Figure 6. **Tuolumne River above La Grange Dam flow duration curves for Above Normal years by month and for all Above Normal years for the Base Case (cfs).**

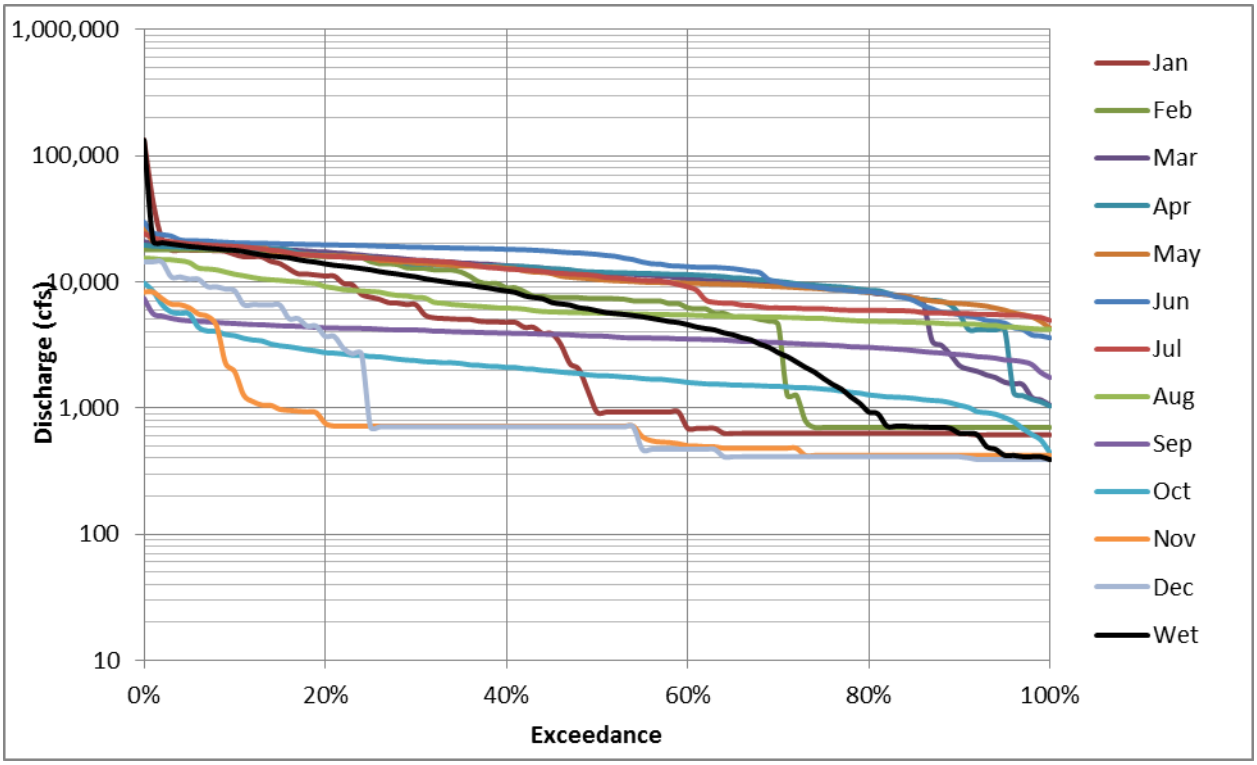


Figure 7. **Tuolumne River above La Grange Dam flow duration curves for Wet years by month and for all Wet years for the Base Case (cfs).**

Turlock Canal

Table 1. Average Turlock Canal flow by water year type, by water year, and for the period of record for the Base Case (cfs).

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
C	374	86	16	98	185	784	1,020	1,168	1,376	1,595	1,310	670	726
D	393	78	16	98	193	834	1,129	1,288	1,517	1,742	1,472	777	798
BN	383	72	16	98	174	724	1,147	1,385	1,493	1,738	1,460	740	789
N	431	48	16	98	143	679	882	1,278	1,569	1,830	1,556	861	787
AN	396	59	16	98	142	679	898	1,279	1,565	1,803	1,537	866	782
W	399	31	16	98	144	679	584	1,175	1,526	1,829	1,554	751	737
1971	424	17	16	98	144	679	990	1,273	1,600	1,836	1,560	846	795
1972	424	69	16	98	218	1,134	1,283	1,482	1,586	1,836	1,560	826	881
1973	424	17	16	98	144	679	737	1,428	1,594	1,836	1,560	869	788
1974	424	17	16	98	144	679	649	1,324	1,539	1,656	1,560	869	753
1975	424	80	16	98	144	679	982	1,374	1,600	1,821	1,423	869	797
1976	424	112	16	98	236	1,156	1,131	1,449	1,544	1,791	1,326	626	829
1977	346	17	16	98	252	985	1,081	888	1,125	1,326	1,108	557	653
1978	212	80	16	98	144	679	146	1,163	1,600	1,836	1,560	605	683
1979	468	17	16	98	144	679	885	1,401	1,600	1,786	1,560	869	798
1980	424	17	16	98	139	679	812	1,311	1,600	1,741	1,560	869	775
1981	444	134	16	98	200	679	1,083	1,447	1,600	1,836	1,560	869	835
1982	424	17	16	98	144	679	299	1,273	1,549	1,836	1,560	421	699
1983	424	17	16	98	144	679	223	1,173	1,600	1,836	1,493	416	682
1984	424	17	16	98	139	679	1,236	1,484	1,578	1,832	1,560	854	829
1985	424	17	16	98	144	679	1,121	1,476	1,539	1,836	1,560	856	819
1986	424	17	16	98	144	679	591	1,290	1,600	1,836	1,560	826	762
1987	424	128	16	98	200	679	1,148	1,448	1,558	1,796	1,507	800	821
1988	346	75	16	98	139	664	969	1,157	1,335	1,561	1,307	691	699
1989	315	17	16	98	205	609	1,119	1,259	1,359	1,561	1,279	315	683
1990	279	83	16	98	210	843	1,130	885	1,359	1,561	1,307	682	707
1991	279	111	16	98	231	609	1,091	1,262	1,301	1,561	1,263	691	712
1992	279	106	16	98	139	540	711	1,069	1,135	1,302	1,108	582	592
1993	212	88	16	98	144	679	710	1,125	1,471	1,836	1,560	869	738
1994	424	75	16	98	144	679	1,082	1,001	1,558	1,796	1,507	765	766
1995	346	17	16	98	144	679	404	937	1,441	1,832	1,560	869	700
1996	468	134	16	98	139	679	757	943	1,600	1,836	1,560	869	761
1997	424	17	16	98	144	679	1,310	1,468	1,578	1,836	1,560	859	837
1998	432	17	16	98	144	679	512	613	1,353	1,836	1,560	869	682
1999	424	17	16	98	144	679	1,052	1,422	1,600	1,836	1,560	869	814
2000	468	96	16	98	139	679	597	901	1,375	1,836	1,560	869	722
2001	424	80	16	98	144	679	815	1,338	1,594	1,836	1,560	826	789
2002	424	17	16	98	144	679	1,174	1,305	1,600	1,836	1,560	869	814
2003	468	17	16	98	144	679	1,095	1,321	1,600	1,836	1,525	869	810
2004	468	107	16	98	139	679	1,363	1,440	1,512	1,736	1,488	869	828
2005	424	17	16	98	144	679	903	1,301	1,600	1,836	1,550	792	785
2006	428	107	16	98	144	679	477	1,144	1,600	1,836	1,560	869	751
2007	424	17	16	98	224	1,136	1,208	1,436	1,558	1,796	1,507	723	850
2008	346	102	16	98	139	679	1,235	1,438	1,558	1,796	1,507	800	812
2009	346	80	16	98	144	679	1,262	1,363	1,584	1,836	1,560	834	821
2010	424	123	16	98	144	679	314	1,231	1,600	1,836	1,560	869	746
2011	424	17	16	98	144	681	750	1,253	1,258	1,860	1,568	869	750
2012	424	80	16	98	139	679	1,093	1,386	1,549	1,776	1,515	836	802
1971-2012	398	57	16	98	159	716	894	1,254	1,512	1,769	1,494	778	766

Table 2. Minimum daily Turlock Canal flow by water year type, by water year, and for the period of record for the Base Case (cfs).

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Min	3-day Min	7-day Min
C	1	17	16	98	139	230	465	606	682	1,100	829	152	1	--	--	--
D	1	17	16	98	139	264	700	604	826	1,321	982	196	1	--	--	--
BN	1	17	16	98	139	247	537	851	790	1,321	948	66	1	--	--	--
N	1	17	16	98	139	264	231	626	852	1,520	1,162	295	1	--	--	--
AN	1	17	16	98	139	264	435	654	911	1,408	1,083	302	1	--	--	--
W	1	17	16	98	139	264	111	436	790	1,481	1,137	146	1	--	--	--
1971	1	17	16	98	144	264	643	872	991	1,562	1,189	299	1	14	16	16
1972	1	64	16	98	190	379	822	1,010	982	1,562	1,189	292	1	13	16	16
1973	1	17	16	98	144	264	489	974	987	1,562	1,189	307	1	14	16	16
1974	1	17	16	98	144	264	435	906	953	1,408	1,189	307	1	14	16	16
1975	1	64	16	98	144	264	638	939	991	1,549	1,083	307	1	14	16	16
1976	1	64	16	98	191	385	722	977	940	1,518	997	176	1	13	16	16
1977	1	17	16	98	198	342	691	606	682	1,121	829	152	1	12	1	16
1978	1	64	16	98	144	264	111	800	991	1,562	1,189	213	1	12	1	16
1979	7	17	16	98	144	264	580	957	991	1,520	1,189	307	7	14	16	16
1980	1	17	16	98	139	264	535	897	991	1,481	1,189	307	1	13	16	16
1981	2	64	16	98	195	264	700	987	991	1,562	1,189	307	2	14	16	16
1982	1	17	16	98	144	264	222	872	959	1,562	1,189	148	1	14	16	16
1983	1	17	16	98	144	264	176	806	991	1,562	1,137	146	1	14	16	16
1984	1	17	16	98	139	264	794	1,011	977	1,559	1,189	302	1	13	16	16
1985	1	17	16	98	144	264	724	1,006	953	1,562	1,189	303	1	14	16	16
1986	1	17	16	98	144	264	400	883	991	1,562	1,189	292	1	14	16	16
1987	1	64	16	98	195	264	732	976	949	1,522	1,135	238	1	14	16	16
1988	1	64	16	98	139	261	623	784	811	1,321	982	199	1	11	1	16
1989	1	17	16	98	195	247	714	851	826	1,321	960	66	1	12	1	16
1990	1	64	16	98	196	306	721	604	826	1,321	982	196	1	12	1	16
1991	1	64	16	98	197	247	697	853	790	1,321	948	199	1	12	1	16
1992	1	64	16	98	139	230	465	726	688	1,100	829	161	1	11	1	16
1993	1	64	16	98	144	264	473	774	911	1,562	1,189	307	1	12	1	16
1994	1	64	16	98	144	264	692	681	949	1,522	1,135	226	1	14	16	16

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Min	3-day Min	7-day Min
1995	1	17	16	98	144	264	286	650	893	1,559	1,189	307	1	12	1	16
1996	7	64	16	98	139	264	501	654	991	1,562	1,189	307	7	13	16	16
1997	1	17	16	98	144	264	839	1,001	977	1,562	1,189	304	1	14	16	16
1998	1	17	16	98	144	264	352	436	839	1,562	1,189	307	1	14	16	16
1999	1	17	16	98	144	264	681	970	991	1,562	1,189	307	1	14	16	16
2000	7	64	16	98	139	264	403	626	852	1,562	1,189	307	7	13	16	16
2001	1	64	16	98	144	264	537	915	987	1,562	1,189	292	1	14	16	16
2002	1	17	16	98	144	264	756	893	991	1,562	1,189	307	1	14	16	16
2003	7	17	16	98	144	264	708	903	991	1,562	1,162	307	7	14	16	16
2004	7	64	16	98	139	264	871	982	936	1,477	1,133	307	7	13	16	16
2005	1	17	16	98	144	264	590	891	991	1,562	1,181	280	1	14	16	16
2006	1	64	16	98	144	264	330	787	991	1,562	1,189	307	1	14	16	16
2007	1	17	16	98	196	380	769	968	949	1,522	1,135	211	1	14	16	16
2008	1	64	16	98	139	264	785	969	949	1,522	1,135	238	1	11	1	16
2009	1	64	16	98	144	264	810	931	981	1,562	1,189	295	1	12	1	16
2010	1	64	16	98	144	264	231	844	991	1,562	1,189	307	1	14	16	16
2011	1	17	16	98	144	264	492	850	790	1,562	1,189	307	1	14	16	16
2012	1	64	16	98	139	264	706	946	959	1,510	1,154	296	1	13	16	16
1971-2012	1	17	16	98	139	230	111	436	682	1,100	829	66	1	--	--	--

Table 3. Maximum daily Turlock Canal flow by water year type, by water year, and for the period of record for the Base Case (cfs).

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Max	3-day Max	7-day Max
C	1,206	290	16	98	341	2,072	1,470	1,841	2,211	2,057	1,768	1,236	2,211	--	--	--
D	1,254	308	16	98	270	2,034	1,549	1,828	2,253	2,097	1,822	1,305	2,253	--	--	--
BN	1,312	228	16	98	287	2,030	1,744	1,873	2,244	2,097	1,822	1,305	2,244	--	--	--
N	1,312	271	16	98	144	1,170	1,613	1,804	2,253	2,097	1,822	1,305	2,253	--	--	--
AN	1,312	308	16	98	144	1,170	1,580	1,875	2,253	2,097	1,822	1,305	2,253	--	--	--
W	1,225	214	16	98	144	1,170	1,676	1,855	2,253	2,478	1,822	1,305	2,478	--	--	--
1971	1,206	17	16	98	144	1,170	1,258	1,605	2,253	2,097	1,822	1,272	2,253	268	2,069	1,945
1972	1,206	83	16	98	263	2,030	1,640	1,873	2,233	2,097	1,822	1,242	2,233	268	2,051	1,940
1973	1,206	17	16	98	144	1,170	929	1,804	2,244	2,097	1,822	1,305	2,244	268	2,061	1,943
1974	1,206	17	16	98	144	1,170	815	1,671	2,167	1,892	1,822	1,305	2,167	268	1,990	1,861
1975	1,206	120	16	98	144	1,170	1,248	1,735	2,253	2,080	1,661	1,305	2,253	268	2,069	1,934
1976	1,206	233	16	98	308	2,072	1,448	1,841	2,191	2,052	1,558	975	2,191	268	2,009	1,974
1977	1,125	17	16	98	341	1,749	1,383	1,121	1,600	1,522	1,304	873	1,749	176	1,688	1,667
1978	789	120	16	98	144	1,170	165	1,465	2,253	2,097	1,822	910	2,253	268	2,069	1,945
1979	1,312	17	16	98	144	1,170	1,122	1,769	2,253	2,040	1,822	1,305	2,253	268	2,069	1,934
1980	1,206	17	16	98	139	1,170	1,028	1,654	2,253	1,988	1,822	1,305	2,253	268	2,069	1,934
1981	1,254	308	16	98	210	1,170	1,380	1,828	2,253	2,097	1,822	1,305	2,253	268	2,069	1,945
1982	1,206	17	16	98	144	1,170	359	1,605	2,181	2,097	1,822	634	2,181	268	2,003	1,927
1983	1,206	17	16	98	144	1,170	260	1,477	2,253	2,097	1,743	627	2,253	268	2,069	1,945
1984	1,206	17	16	98	139	1,170	1,580	1,875	2,222	2,092	1,822	1,283	2,222	268	2,041	1,934
1985	1,206	17	16	98	144	1,170	1,430	1,865	2,167	2,097	1,822	1,287	2,167	268	1,990	1,926
1986	1,206	17	16	98	144	1,170	739	1,627	2,253	2,097	1,822	1,242	2,253	268	2,069	1,945
1987	1,206	290	16	98	210	1,170	1,470	1,838	2,211	2,057	1,768	1,236	2,211	268	2,027	1,904
1988	1,125	101	16	98	139	1,143	1,237	1,465	1,896	1,789	1,536	1,073	1,896	268	1,738	1,649
1989	1,049	17	16	98	221	1,039	1,433	1,597	1,930	1,789	1,503	508	1,930	268	1,769	1,658
1990	957	130	16	98	234	1,480	1,447	1,117	1,930	1,789	1,536	1,060	1,930	268	1,769	1,658
1991	957	228	16	98	287	1,039	1,396	1,601	1,848	1,789	1,485	1,073	1,848	268	1,694	1,639
1992	957	212	16	98	139	909	901	1,353	1,615	1,494	1,304	909	1,615	268	1,480	1,384
1993	789	149	16	98	144	1,170	895	1,415	2,071	2,097	1,822	1,305	2,097	284	1,987	1,926

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Max	3-day Max	7-day Max
1994	1,206	101	16	98	144	1,170	1,385	1,266	2,211	2,057	1,768	1,184	2,211	268	2,027	1,904
1995	1,125	17	16	98	144	1,170	496	1,175	2,029	2,092	1,822	1,305	2,092	284	1,982	1,921
1996	1,312	308	16	98	139	1,170	955	1,182	2,253	2,097	1,822	1,305	2,253	268	2,069	1,945
1997	1,206	17	16	98	144	1,170	1,676	1,855	2,222	2,097	1,822	1,290	2,222	268	2,041	1,938
1998	1,225	17	16	98	144	1,170	636	759	1,905	2,097	1,822	1,305	2,097	284	1,987	1,926
1999	1,206	17	16	98	144	1,170	1,339	1,796	2,253	2,097	1,822	1,305	2,253	268	2,069	1,945
2000	1,312	177	16	98	139	1,170	746	1,128	1,935	2,097	1,822	1,305	2,097	284	1,987	1,926
2001	1,206	120	16	98	144	1,170	1,031	1,688	2,244	2,097	1,822	1,242	2,244	268	2,061	1,943
2002	1,206	17	16	98	144	1,170	1,498	1,646	2,253	2,097	1,822	1,305	2,253	268	2,069	1,945
2003	1,312	17	16	98	144	1,170	1,396	1,666	2,253	2,097	1,781	1,305	2,253	268	2,069	1,945
2004	1,312	214	16	98	139	1,170	1,744	1,818	2,128	1,983	1,737	1,305	2,128	268	1,955	1,839
2005	1,206	17	16	98	144	1,170	1,145	1,642	2,253	2,097	1,810	1,190	2,253	268	2,069	1,945
2006	1,216	214	16	98	144	1,170	591	1,440	2,253	2,097	1,822	1,305	2,253	268	2,069	1,945
2007	1,206	17	16	98	270	2,034	1,549	1,824	2,211	2,057	1,768	1,121	2,211	268	2,027	1,938
2008	1,125	196	16	98	139	1,170	1,584	1,826	2,211	2,057	1,768	1,236	2,211	268	2,027	1,904
2009	1,125	120	16	98	144	1,170	1,613	1,720	2,231	2,097	1,822	1,253	2,231	268	2,049	1,940
2010	1,206	271	16	98	144	1,170	378	1,551	2,253	2,097	1,822	1,305	2,253	268	2,069	1,945
2011	1,206	17	16	98	144	1,170	1,098	1,563	1,795	2,478	1,822	1,305	2,478	274	2,143	1,964
2012	1,206	120	16	98	139	1,170	1,392	1,750	2,181	2,028	1,769	1,257	2,181	268	2,003	1,882
1971-2012	1,312	308	16	98	341	2,072	1,744	1,875	2,253	2,478	1,822	1,305	2,478	--	--	--

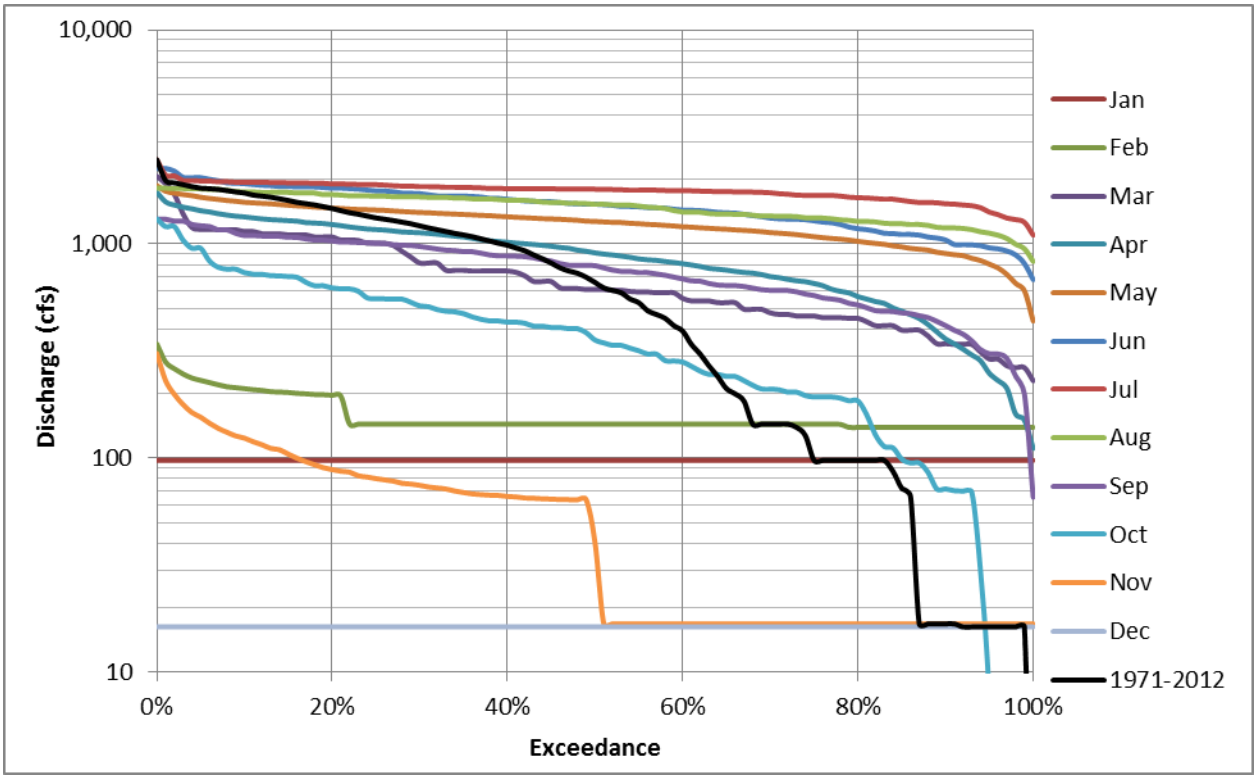


Figure 1. **Turlock Canal flow duration curves by month and for the period of record for the Base Case (cfs).**

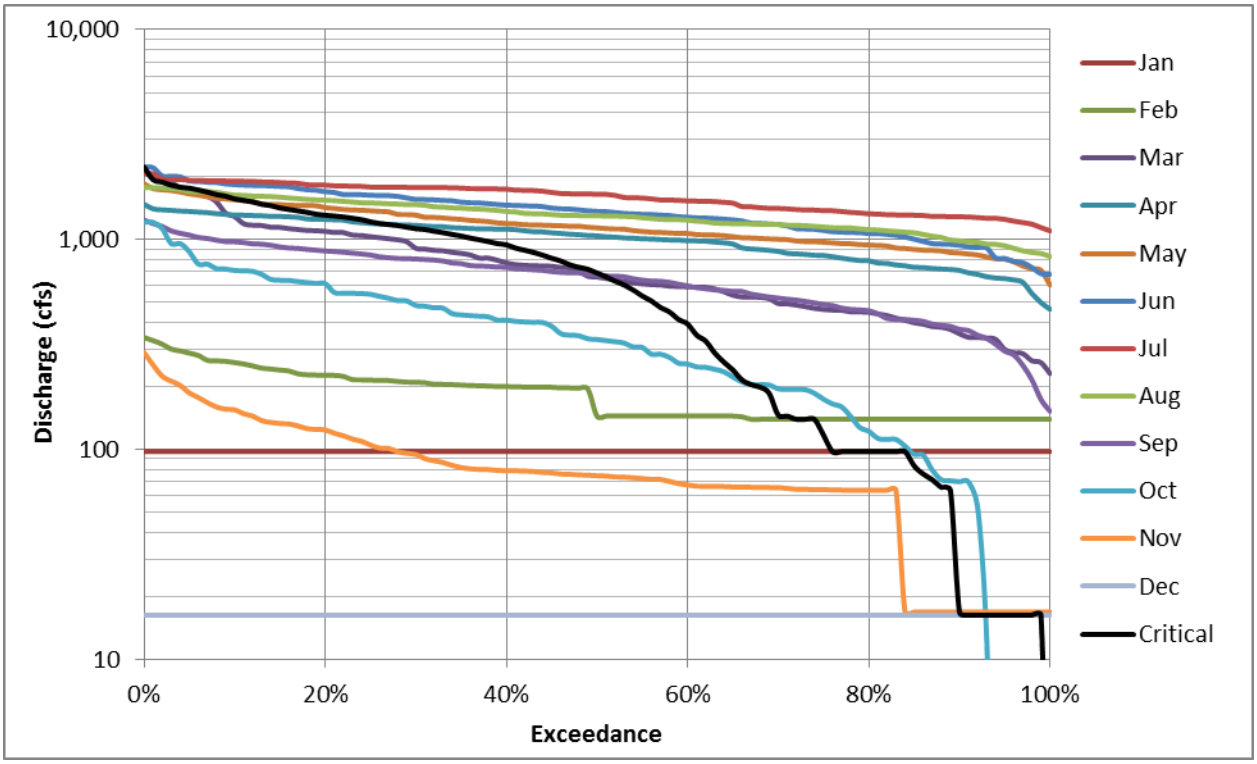


Figure 2. **Turlock Canal flow duration curves for Critical years by month and for all Critical years for the Base Case (cfs).**

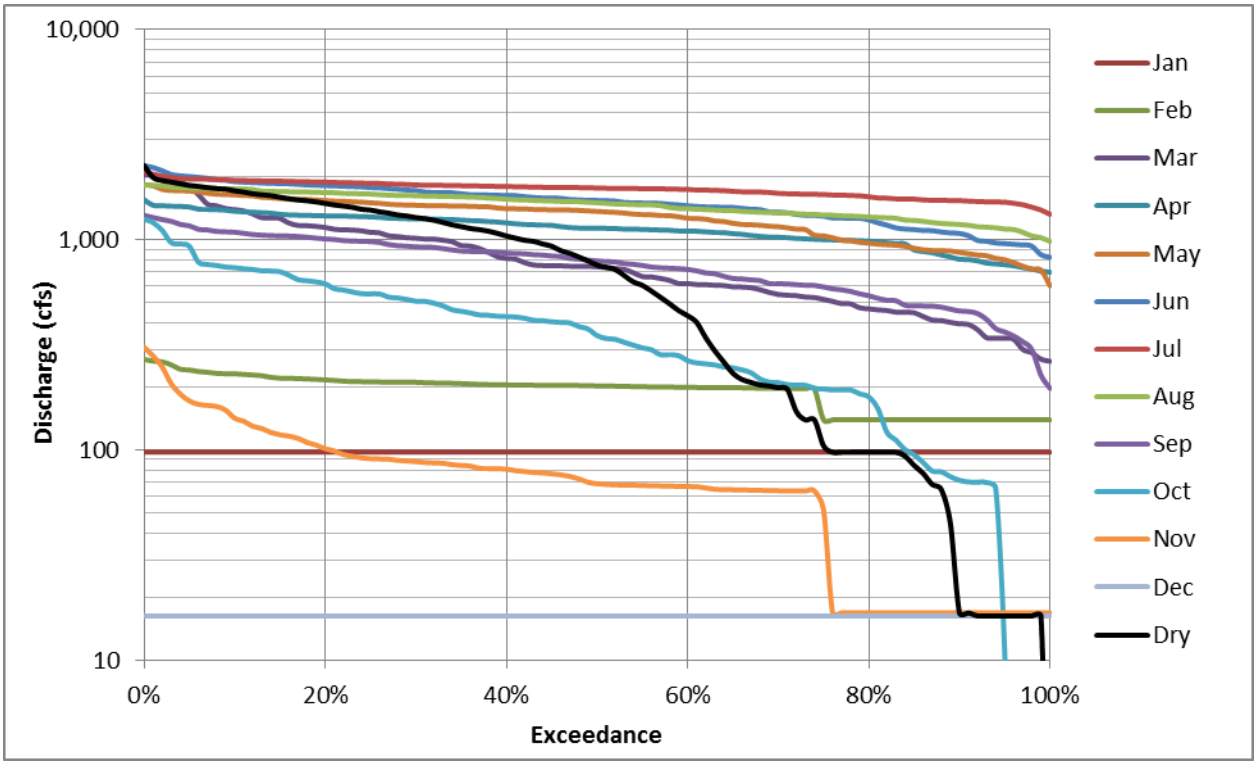


Figure 3. **Turlock Canal flow duration curves for Dry years by month and for all Dry years for the Base Case (cfs).**

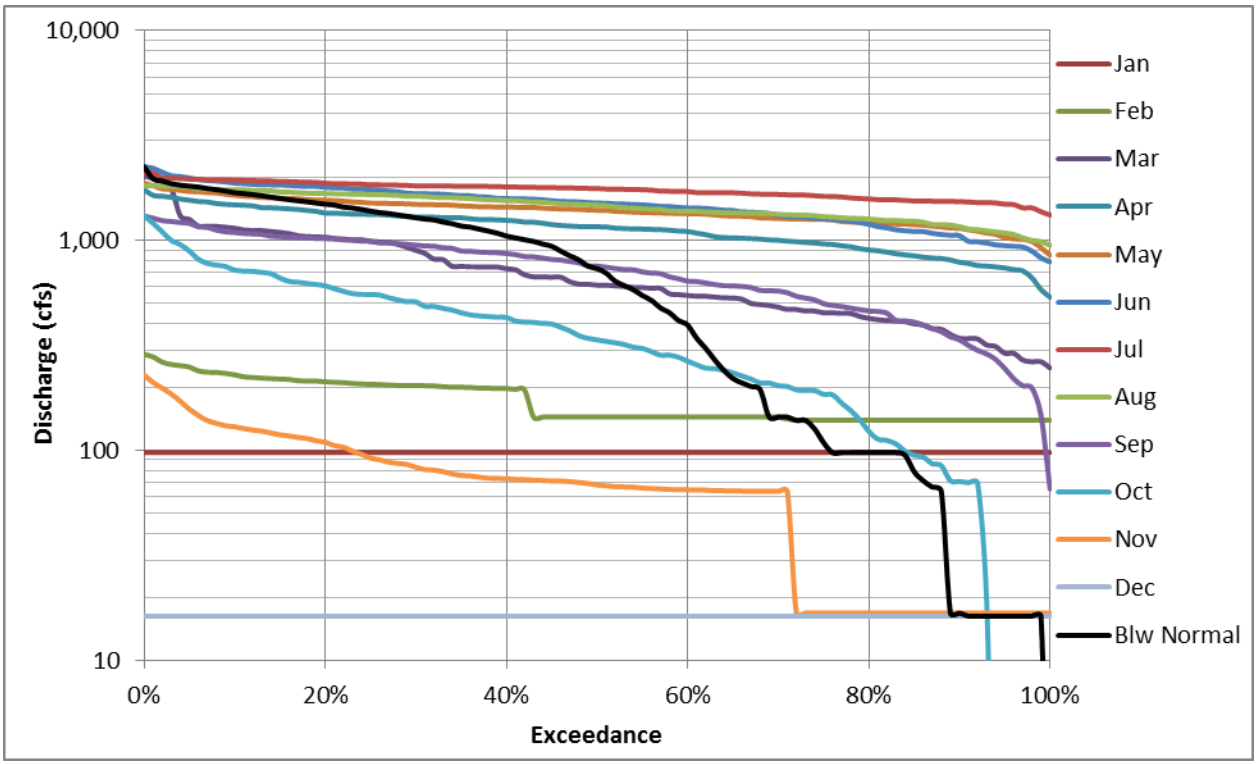


Figure 4. **Turlock Canal flow duration curves for Below Normal years by month and for all Below Normal years for the Base Case (cfs).**

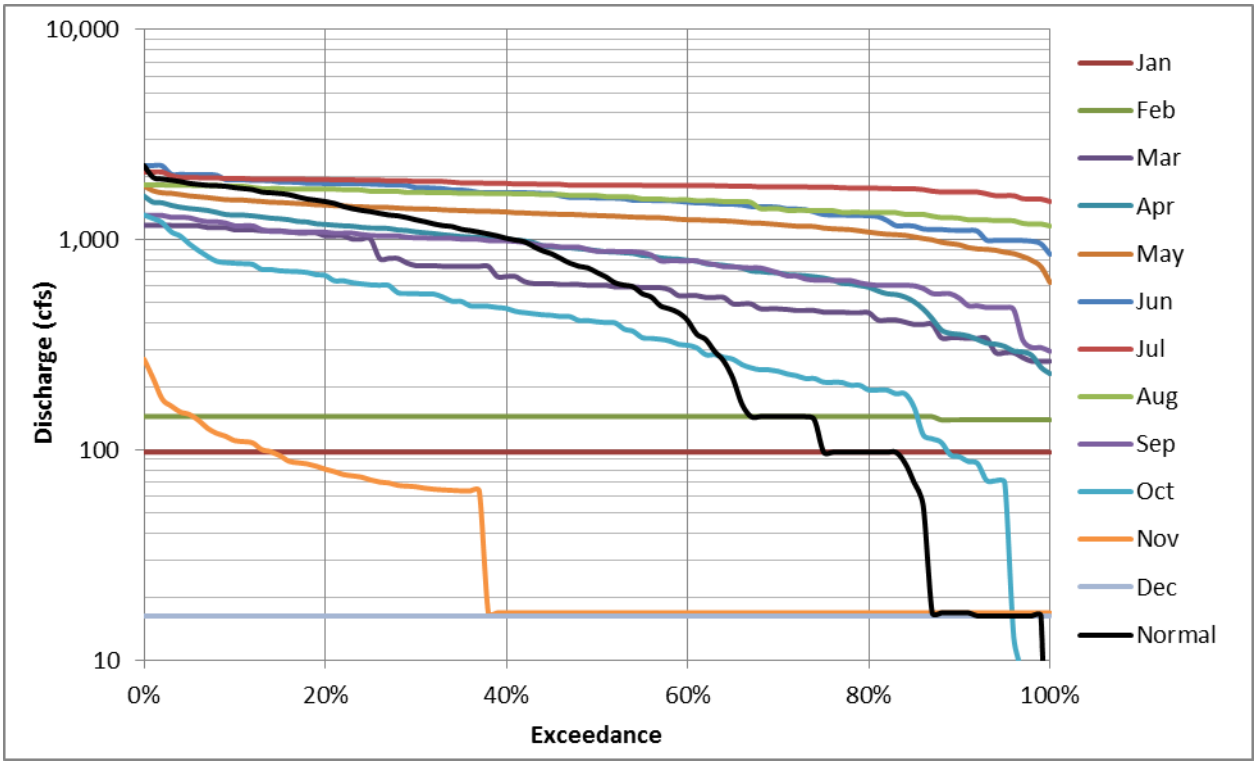


Figure 5. **Turlock Canal flow duration curves for Normal years by month and for all Normal years for the Base Case (cfs).**

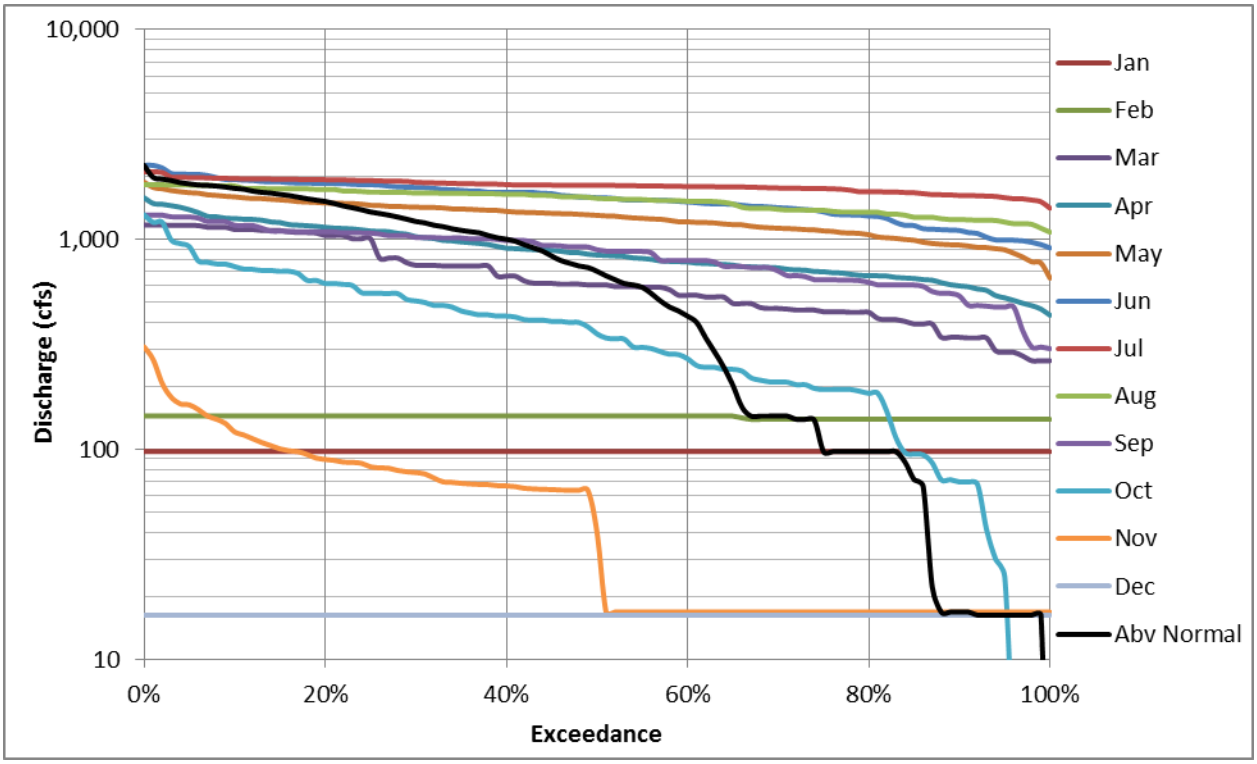


Figure 6. **Turlock Canal flow duration curves for Above Normal years by month and for all Above Normal years**

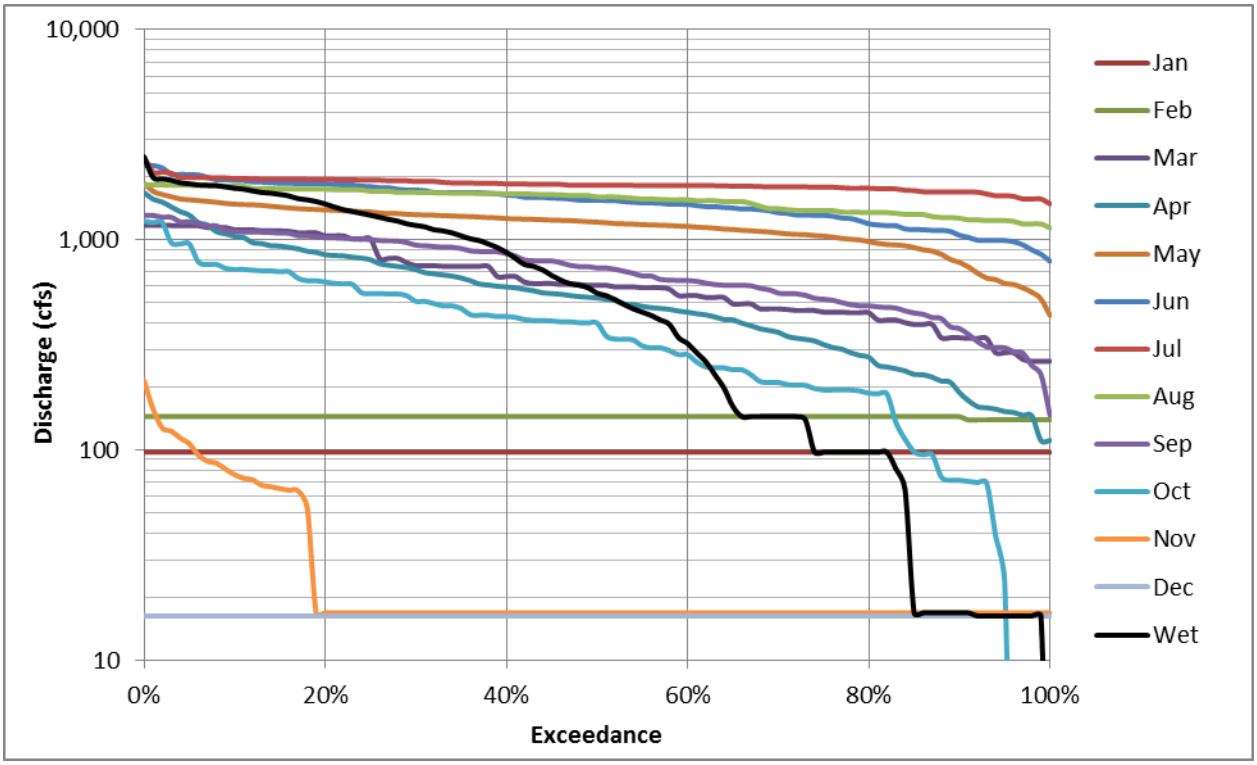


Figure 7. Turlock Canal flow duration curves for Wet years by month and for all Wet years for the Base Case (cfs).

Modesto Canal

Table 1. Average Modesto Canal flow by water year type, by water year, and for the period of record for the Base Case (cfs).

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
C	301	93	40	69	73	281	524	583	661	760	674	453	378
D	324	75	39	69	79	284	598	664	746	845	759	508	417
BN	313	85	39	69	82	268	587	710	735	845	754	479	415
N	349	69	41	70	59	240	464	689	774	892	795	544	418
AN	324	64	39	68	59	240	459	666	780	879	783	548	411
W	326	50	40	69	59	240	352	643	763	888	796	485	395
1971	341	45	41	70	59	240	515	698	794	894	798	541	422
1972	341	86	41	70	99	404	705	757	782	894	798	515	459
1973	341	45	41	70	59	240	399	738	790	894	798	549	416
1974	341	45	41	70	59	240	304	698	760	809	798	549	395
1975	341	92	41	70	59	240	484	727	794	892	706	549	418
1976	341	108	41	70	113	510	671	720	742	843	663	468	442
1977	274	86	41	70	109	323	537	443	562	642	588	371	339
1978	199	34	30	61	59	240	170	645	794	894	798	429	365
1979	382	45	41	70	59	240	459	734	794	878	798	549	423
1980	341	45	41	70	57	240	413	700	794	826	798	549	408
1981	378	125	41	70	59	240	561	742	794	894	798	549	440
1982	341	45	41	70	59	240	213	698	764	894	798	290	374
1983	341	45	41	70	59	240	186	652	794	894	773	267	366
1984	341	45	41	70	57	240	634	761	794	892	798	546	436
1985	341	45	41	70	59	240	556	751	772	894	798	536	428
1986	341	45	41	70	59	240	331	687	794	894	798	541	406
1987	341	125	41	70	59	207	646	720	744	845	764	515	425
1988	274	86	41	70	52	196	441	586	629	745	676	456	355
1989	273	40	36	65	96	183	563	633	653	745	666	259	353
1990	237	85	36	65	96	296	593	448	653	745	676	449	366
1991	237	109	36	65	101	183	539	628	613	745	658	456	365
1992	237	109	36	65	47	158	300	537	548	641	588	396	306
1993	199	34	30	61	59	240	389	601	748	894	798	549	386
1994	341	45	41	70	59	288	547	494	744	845	764	510	398
1995	274	45	41	70	59	240	268	536	738	894	798	549	378
1996	382	125	41	70	57	240	416	502	792	894	798	549	407
1997	341	45	41	70	59	240	692	740	782	894	798	549	440
1998	357	45	41	70	59	240	343	316	730	894	798	546	372
1999	341	45	41	70	59	240	525	709	792	894	798	544	424
2000	378	114	41	70	57	240	336	477	651	894	798	541	385
2001	341	97	41	70	59	240	367	719	788	894	798	528	414
2002	353	45	41	70	59	240	607	747	794	894	798	549	436
2003	382	45	41	70	59	240	457	717	794	894	775	549	421
2004	382	114	41	70	104	419	771	761	794	894	798	541	475
2005	341	45	41	70	59	240	612	751	792	894	798	517	432
2006	374	103	41	70	59	240	220	679	794	894	798	546	404
2007	341	45	41	70	102	359	627	712	744	845	764	484	430
2008	274	103	41	70	57	207	605	720	744	845	764	515	413
2009	274	92	41	70	59	240	709	719	784	894	798	525	436
2010	341	120	41	70	59	240	228	681	794	894	798	549	404
2011	341	45	41	70	59	240	418	675	613	894	798	549	398
2012	341	45	41	70	57	240	610	753	792	894	798	549	434
1971-2012	324	70	40	69	67	255	476	660	747	858	766	502	405

Table 2. Minimum daily Modesto Canal flow by water year type, by water year, and for the period of record for the Base Case (cfs).

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Min	3-day Min	7-day Min
C	102	45	36	65	47	65	141	315	338	472	433	235	36	--	--	--
D	102	45	36	65	57	92	233	321	401	547	496	280	36	--	--	--
BN	102	40	36	65	57	73	204	437	378	547	483	179	36	--	--	--
N	120	45	41	70	57	114	111	357	424	656	577	340	41	--	--	--
AN	84	34	30	61	57	114	186	373	479	608	529	349	30	--	--	--
W	84	34	30	61	57	114	111	253	402	620	575	202	30	--	--	--
1971	187	45	41	70	59	114	249	499	506	668	592	348	41	62	41	41
1972	187	81	41	70	97	142	306	537	499	668	592	334	41	61	41	41
1973	187	45	41	70	59	114	214	525	503	668	592	352	41	62	41	41
1974	187	45	41	70	59	114	186	499	486	608	592	352	41	62	41	41
1975	187	81	41	70	59	114	239	517	506	667	529	352	41	62	41	41
1976	187	81	41	70	105	134	260	499	454	618	489	294	41	61	41	41
1977	120	81	41	70	99	92	212	315	346	473	433	235	41	62	41	41
1978	84	34	30	61	59	114	111	465	506	668	592	288	30	62	30	30
1979	203	45	41	70	59	114	232	522	506	656	592	352	41	62	41	41
1980	187	45	41	70	57	114	218	500	506	620	592	352	41	61	41	41
1981	201	81	41	70	59	114	263	527	506	668	592	352	41	62	41	41
1982	187	45	41	70	59	114	111	499	489	668	592	214	41	62	41	41
1983	187	45	41	70	59	114	111	469	506	668	575	202	41	62	41	41
1984	187	45	41	70	57	114	284	539	506	667	592	351	41	61	41	41
1985	187	45	41	70	59	114	261	533	493	668	592	345	41	62	41	41
1986	187	45	41	70	59	114	194	491	506	668	592	348	41	62	41	41
1987	187	81	41	70	59	82	253	499	455	619	558	319	41	62	41	41
1988	120	81	41	70	52	75	187	410	387	547	496	284	41	61	41	41
1989	116	40	36	65	94	73	224	440	401	547	489	179	36	62	36	36
1990	102	75	36	65	94	92	233	321	401	547	496	280	36	62	36	36
1991	102	75	36	65	97	73	216	437	378	547	483	284	36	62	36	36
1992	102	75	36	65	47	65	141	376	338	472	433	249	36	61	36	36
1993	84	34	30	61	59	114	211	436	479	668	592	352	30	62	30	30

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Min	3-day Min	7-day Min
1994	187	45	41	70	59	95	223	353	455	619	558	316	41	62	41	41
1995	120	45	41	70	59	114	175	395	474	668	592	352	41	62	41	41
1996	203	81	41	70	57	114	219	373	504	668	592	352	41	61	41	41
1997	187	45	41	70	59	114	302	526	499	668	592	352	41	62	41	41
1998	193	45	41	70	59	114	197	253	469	668	592	351	41	62	41	41
1999	187	45	41	70	59	114	252	506	504	668	592	349	41	62	41	41
2000	201	81	41	70	57	114	195	357	424	668	592	348	41	61	41	41
2001	187	81	41	70	59	114	204	512	502	668	592	341	41	62	41	41
2002	192	45	41	70	59	114	276	531	506	668	592	352	41	62	41	41
2003	203	45	41	70	59	114	231	511	506	668	577	352	41	62	41	41
2004	203	81	41	70	99	145	325	539	506	668	592	348	41	61	41	41
2005	187	45	41	70	59	114	278	533	504	668	592	336	41	62	41	41
2006	200	81	41	70	59	114	111	487	506	668	592	351	41	62	41	41
2007	187	45	41	70	100	108	247	494	455	619	558	302	41	62	41	41
2008	120	81	41	70	57	82	240	499	455	619	558	319	41	61	41	41
2009	120	81	41	70	59	114	307	512	500	668	592	340	41	62	41	41
2010	187	81	41	70	59	114	111	488	506	668	592	352	41	62	41	41
2011	187	45	41	70	59	114	220	484	402	668	592	352	41	62	41	41
2012	187	45	41	70	57	114	277	534	504	668	592	352	41	61	41	41
1971-2012	84	34	30	61	47	65	111	253	338	472	433	179	30	--	--	--

Table 3. Maximum daily Modesto Canal flow by water year type, by water year, and for the period of record for the Base Case (cfs).

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Max	3-day Max	7-day Max
C	531	199	41	70	135	1,278	895	977	1,153	1,208	1,018	877	1,278	--	--	--
D	597	199	41	70	108	870	834	1,007	1,204	1,257	1,052	910	1,257	--	--	--
BN	604	170	41	70	115	978	1,014	1,017	1,204	1,257	1,052	896	1,257	--	--	--
N	604	184	41	70	59	496	929	999	1,204	1,257	1,052	910	1,257	--	--	--
AN	604	199	41	70	59	496	825	1,017	1,204	1,257	1,052	910	1,257	--	--	--
W	589	140	41	70	59	496	905	1,004	1,204	1,257	1,052	910	1,257	--	--	--
1971	531	45	41	70	59	496	660	929	1,204	1,257	1,052	896	1,257	288	1,224	1,126
1972	531	95	41	70	104	937	923	1,012	1,184	1,257	1,052	847	1,257	288	1,224	1,113
1973	531	45	41	70	59	496	500	985	1,197	1,257	1,052	910	1,257	288	1,224	1,122
1974	531	45	41	70	59	496	369	929	1,149	1,130	1,052	910	1,149	271	1,130	1,058
1975	531	110	41	70	59	496	617	969	1,204	1,253	924	910	1,253	288	1,221	1,125
1976	531	155	41	70	135	1,278	895	977	1,150	1,205	877	789	1,278	181	1,173	1,073
1977	464	95	41	70	133	793	715	590	870	913	778	620	913	288	889	813
1978	342	34	30	61	59	496	195	853	1,204	1,257	1,052	687	1,257	288	1,224	1,126
1979	604	45	41	70	59	496	583	980	1,204	1,232	1,052	910	1,232	288	1,200	1,120
1980	531	45	41	70	57	496	520	931	1,204	1,155	1,052	910	1,204	271	1,184	1,101
1981	597	199	41	70	59	496	724	991	1,204	1,257	1,052	910	1,257	288	1,224	1,126
1982	531	45	41	70	59	496	245	929	1,156	1,257	1,052	429	1,257	288	1,224	1,094
1983	531	45	41	70	59	496	212	864	1,204	1,257	1,017	386	1,257	288	1,224	1,126
1984	531	45	41	70	57	496	825	1,017	1,204	1,253	1,052	906	1,253	288	1,221	1,125
1985	531	45	41	70	59	496	717	1,004	1,168	1,257	1,052	886	1,257	288	1,224	1,103
1986	531	45	41	70	59	496	406	913	1,204	1,257	1,052	896	1,257	288	1,224	1,126
1987	531	199	41	70	59	463	861	977	1,153	1,208	1,018	877	1,208	288	1,176	1,076
1988	464	95	41	70	52	442	580	790	972	1,062	898	772	1,062	288	1,034	919
1989	467	40	36	65	101	407	748	856	1,011	1,062	884	406	1,062	288	1,034	945
1990	403	101	36	65	101	710	789	595	1,011	1,062	898	759	1,062	288	1,034	945
1991	403	166	36	65	110	407	714	849	947	1,062	873	772	1,062	288	1,034	916
1992	403	166	36	65	47	350	387	723	846	911	778	667	911	288	887	796
1993	342	34	30	61	59	496	486	792	1,130	1,257	1,052	910	1,257	288	1,224	1,090

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Max	3-day Max	7-day Max
1994	531	45	41	70	59	680	724	657	1,153	1,208	1,018	867	1,208	288	1,176	1,076
1995	464	45	41	70	59	496	319	700	1,114	1,257	1,052	910	1,257	288	1,224	1,090
1996	604	199	41	70	57	496	523	652	1,200	1,257	1,052	910	1,257	288	1,224	1,124
1997	531	45	41	70	59	496	905	988	1,184	1,257	1,052	910	1,257	288	1,224	1,113
1998	560	45	41	70	59	496	423	389	1,101	1,257	1,052	906	1,257	288	1,224	1,090
1999	531	45	41	70	59	496	674	945	1,200	1,257	1,052	901	1,257	288	1,224	1,124
2000	597	170	41	70	57	496	413	617	973	1,257	1,052	896	1,257	288	1,224	1,090
2001	531	125	41	70	59	496	456	958	1,194	1,257	1,052	872	1,257	288	1,224	1,120
2002	553	45	41	70	59	496	788	999	1,204	1,257	1,052	910	1,257	288	1,224	1,126
2003	604	45	41	70	59	496	580	956	1,204	1,257	1,020	910	1,257	288	1,224	1,126
2004	604	170	41	70	115	978	1,014	1,017	1,204	1,257	1,052	896	1,257	288	1,224	1,126
2005	531	45	41	70	59	496	794	1,004	1,200	1,257	1,052	852	1,257	288	1,224	1,124
2006	589	140	41	70	59	496	255	902	1,204	1,257	1,052	906	1,257	288	1,224	1,126
2007	531	45	41	70	108	870	834	966	1,153	1,208	1,018	818	1,208	288	1,176	1,076
2008	464	140	41	70	57	463	804	977	1,153	1,208	1,018	877	1,208	288	1,176	1,076
2009	464	110	41	70	59	496	929	958	1,188	1,257	1,052	867	1,257	288	1,224	1,116
2010	531	184	41	70	59	496	265	905	1,204	1,257	1,052	910	1,257	288	1,224	1,126
2011	531	45	41	70	59	496	527	896	912	1,257	1,052	910	1,257	288	1,224	1,090
2012	531	45	41	70	57	496	791	1,007	1,200	1,257	1,052	910	1,257	288	1,224	1,124
1971-2012	604	199	41	70	135	1,278	1,014	1,017	1,204	1,257	1,052	910	1,278	--	--	--

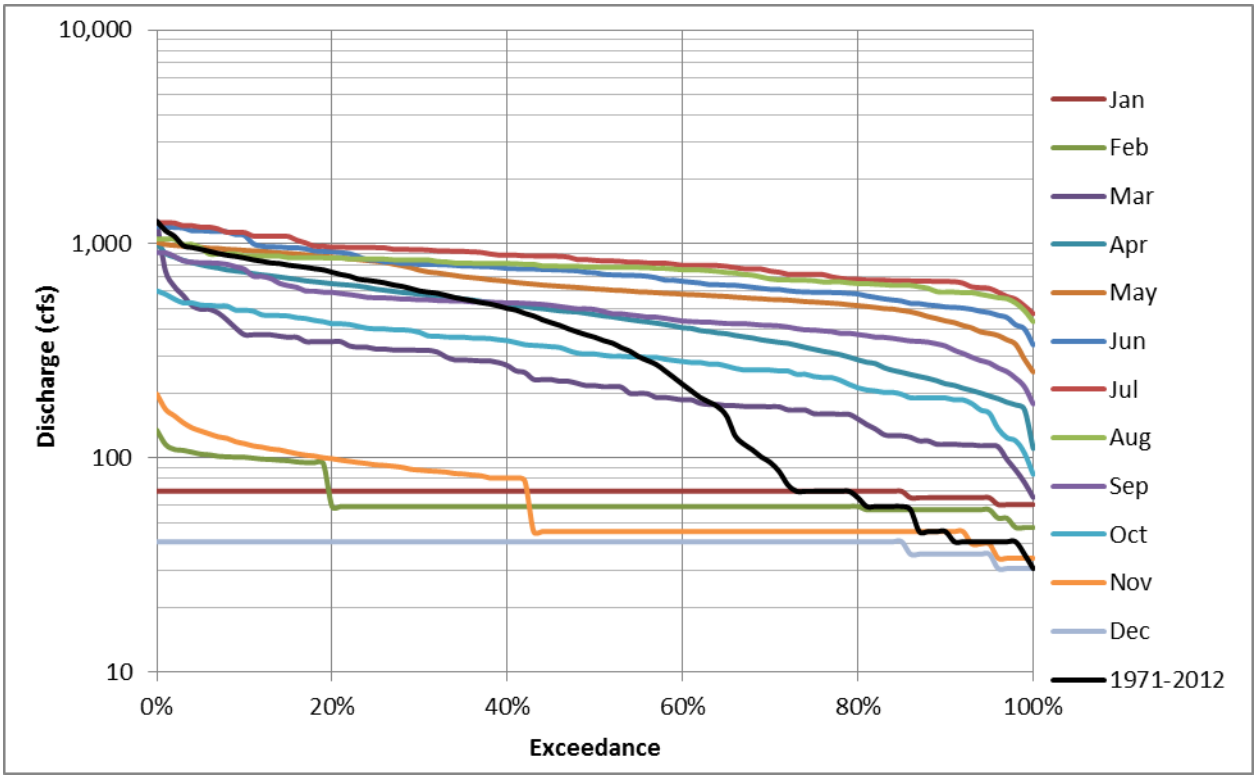


Figure 1. **Modesto Canal flow duration curves by month and for the period of record for the Base Case (cfs).**

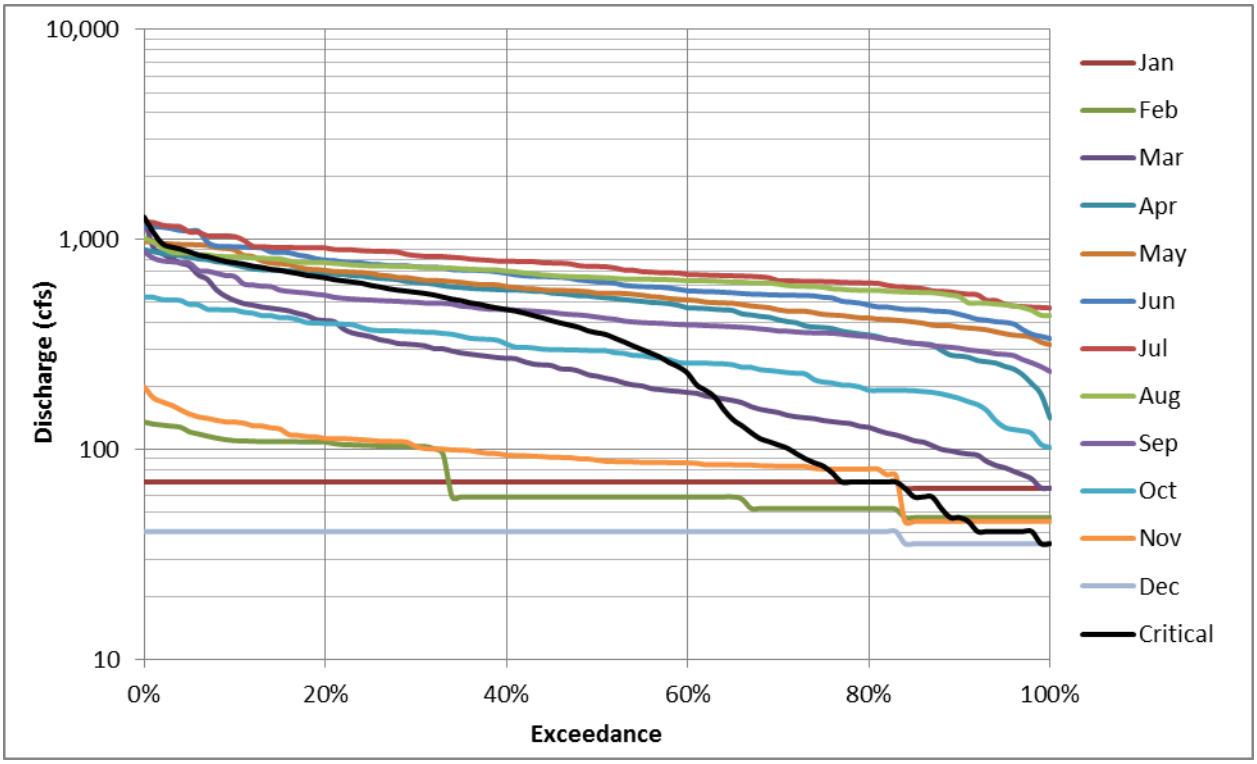


Figure 2. **Modesto Canal flow duration curves for Critical years by month and for all Critical years for the Base Case (cfs).**

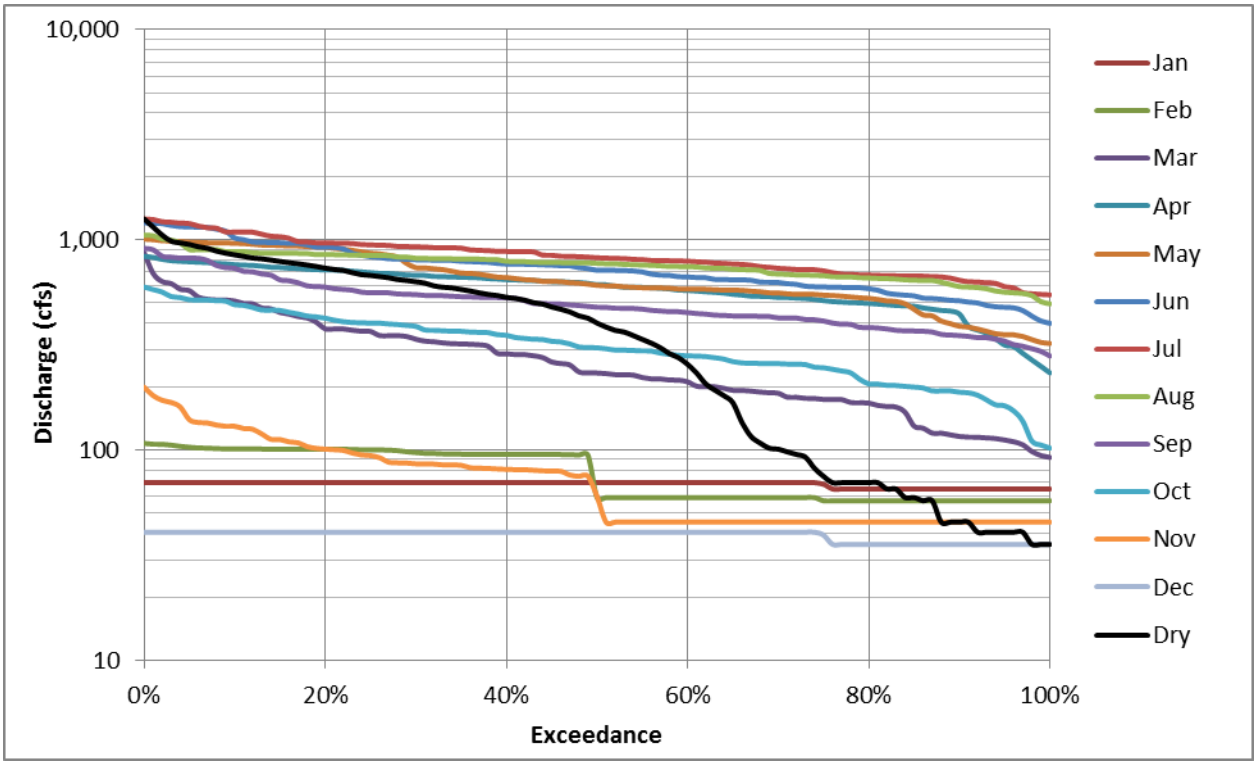


Figure 3. **Modesto Canal flow duration curves for Dry years by month and for all Dry years for the Base Case (cfs).**

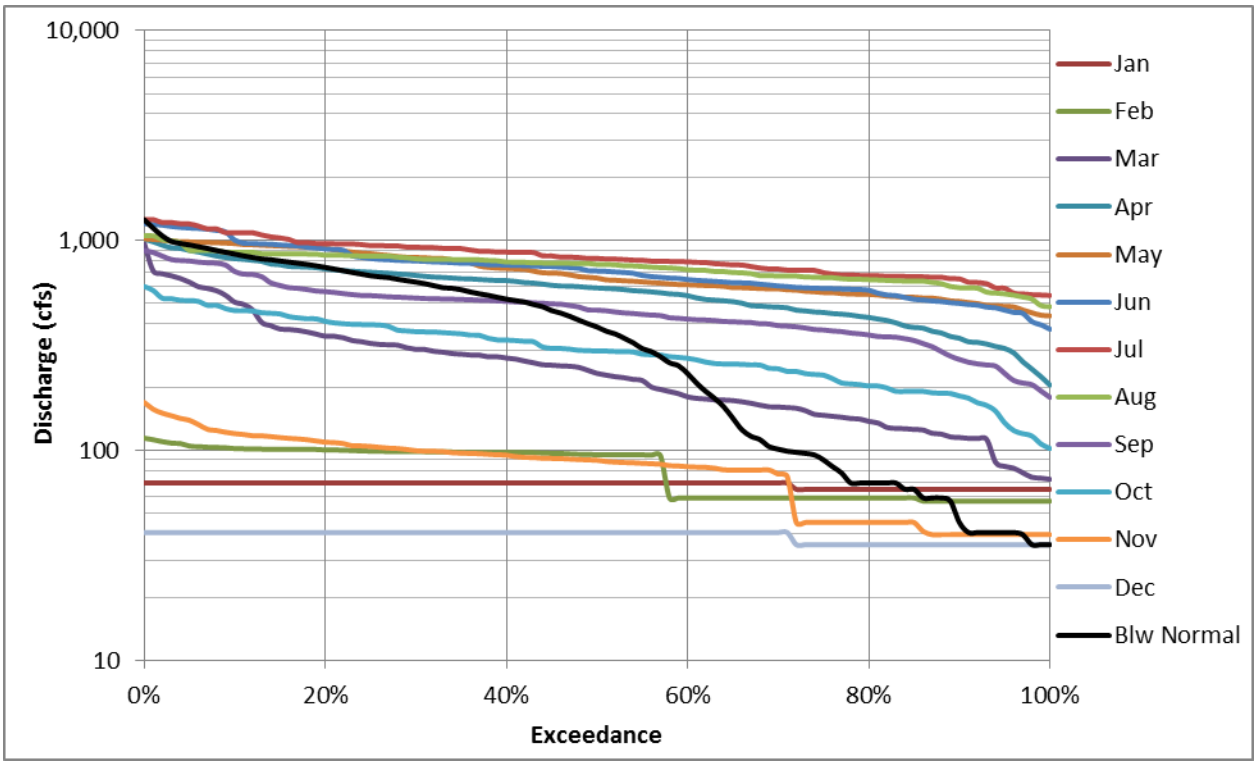


Figure 4. **Modesto Canal flow duration curves for Below Normal years by month and for all Below Normal years for the Base Case (cfs).**

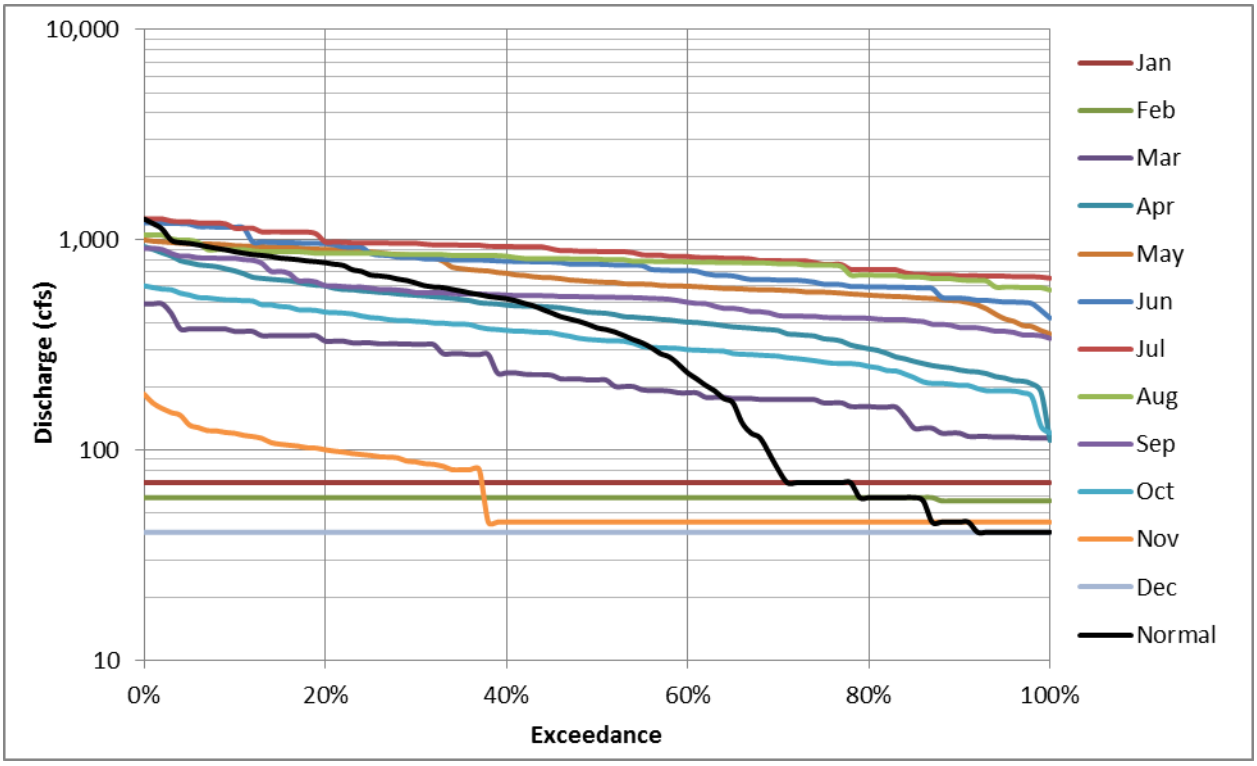


Figure 5. **Modesto Canal flow duration curves for Normal years by month and for all Normal years for the Base Case (cfs).**

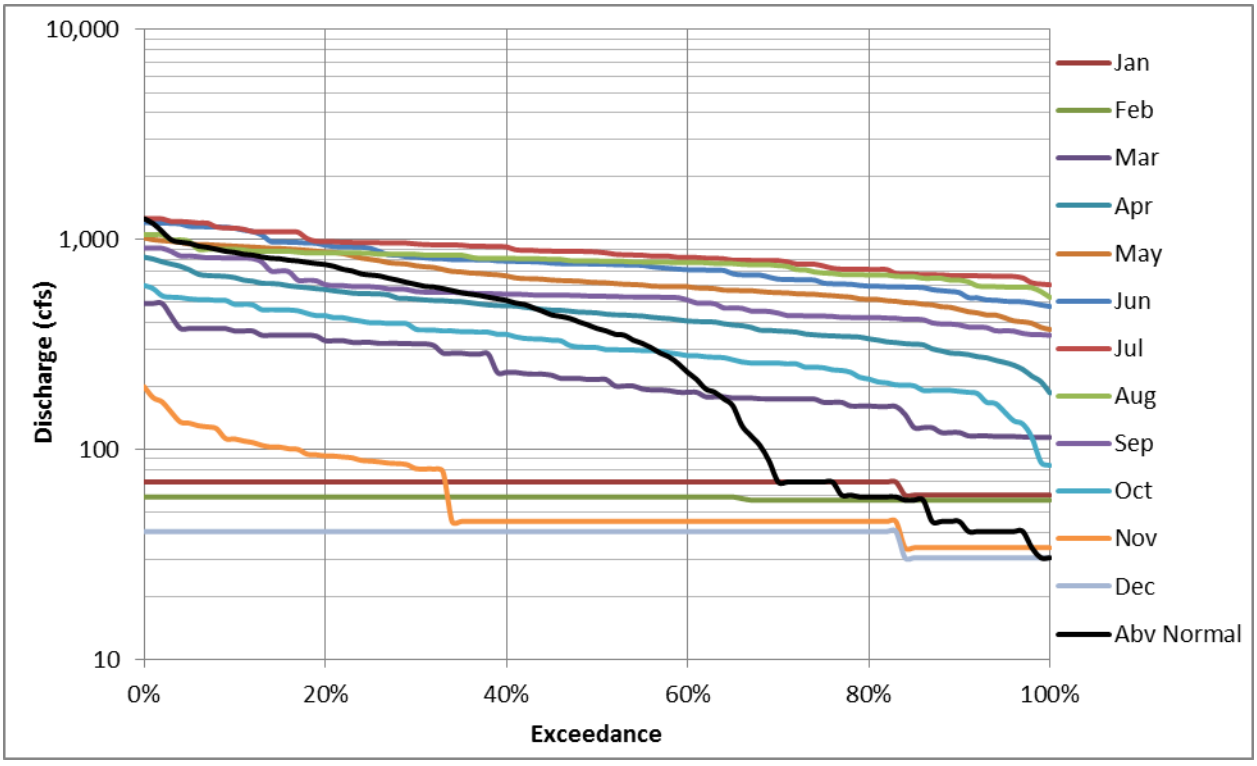


Figure 6. **Modesto Canal flow duration curves for Above Normal years by month and for all Above Normal years for the Base Case (cfs).**

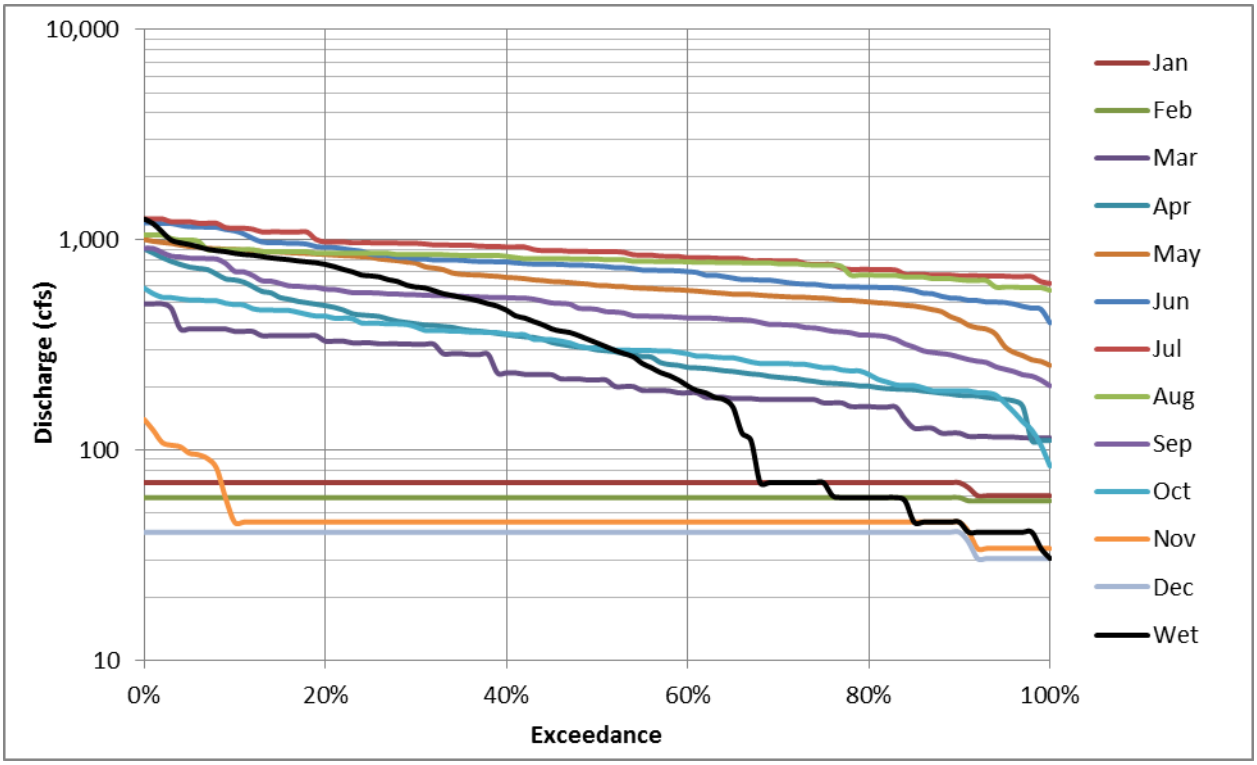


Figure 7. **Modesto Canal flow duration curves for Wet years by month and for all Wet years for the Base Case (cfs).**

Tuolumne River below La Grange Dam

Table 1. Average Tuolumne River below La Grange Dam flow by water year type, by water year, and for the period of record for the Base Case (cfs).

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
C	279	226	245	225	221	225	336	318	50	50	50	50	190
D	391	263	263	263	260	441	550	423	56	56	56	56	257
BN	229	200	200	200	461	645	713	458	61	61	61	61	278
N	279	209	224	395	1,109	1,563	1,851	913	679	277	163	163	648
AN	445	609	1,270	1,599	2,794	2,990	2,619	1,290	1,721	453	250	272	1,350
W	390	499	1,071	2,925	4,007	5,039	5,114	4,236	5,013	3,009	1,182	631	2,749
1971	397	300	418	960	1,848	1,511	2,253	1,033	75	75	75	75	743
1972	215	175	175	175	169	291	509	476	50	50	50	50	199
1973	150	150	150	150	150	2,241	2,659	1,068	2,204	482	250	250	825
1974	397	300	849	2,210	2,535	3,140	3,720	1,088	2,192	499	250	250	1,442
1975	397	300	300	300	2,198	3,247	2,697	1,242	2,748	673	250	384	1,217
1976	504	308	419	300	290	300	339	321	50	50	50	50	249
1977	126	150	150	150	150	150	246	237	50	50	50	50	130
1978	126	150	150	150	150	150	1,080	1,551	250	250	395	1,153	463
1979	624	300	300	1,127	2,729	3,584	2,795	1,036	1,248	282	250	250	1,199
1980	397	300	300	4,249	6,150	6,001	3,116	2,666	2,136	3,286	996	474	2,497
1981	530	300	300	300	300	848	820	464	75	75	75	75	347
1982	207	180	180	963	5,178	6,633	7,137	6,151	5,979	2,915	1,075	1,155	3,124
1983	1,476	3,088	3,832	3,327	6,964	7,772	7,686	8,226	7,597	5,959	3,708	1,572	5,086
1984	739	2,303	5,672	5,450	2,962	2,972	2,044	1,007	250	250	250	250	2,016
1985	397	300	300	300	825	1,312	1,269	542	75	75	75	75	460
1986	150	150	150	150	2,819	8,385	5,442	3,177	3,095	661	250	250	2,048
1987	397	300	300	300	300	300	411	387	50	50	50	50	241
1988	126	150	150	150	145	150	246	237	50	50	50	50	129
1989	126	150	150	150	150	150	437	410	50	50	50	50	160
1990	126	150	150	150	150	150	325	309	50	50	50	50	142
1991	126	150	150	150	150	150	435	408	50	50	50	50	160
1992	126	150	150	150	145	150	336	319	50	50	50	50	144
1993	126	150	150	150	150	150	1,080	1,007	250	250	250	250	331
1994	397	300	300	300	300	300	435	409	50	50	50	50	245
1995	150	150	150	150	150	3,296	5,847	6,622	7,870	5,933	2,927	584	2,832
1996	470	300	300	300	4,334	5,068	3,672	2,391	3,239	653	250	250	1,754
1997	397	300	2,826	13,576	7,805	3,202	1,997	1,007	677	258	250	250	2,691
1998	397	300	300	970	6,323	4,995	5,593	3,996	7,134	5,207	1,455	478	3,066
1999	540	300	350	1,184	4,527	3,365	2,501	1,007	1,646	390	250	250	1,335
2000	397	300	300	300	3,440	4,540	3,202	1,111	845	250	250	250	1,255
2001	397	300	300	300	300	497	984	487	75	75	75	75	322
2002	150	150	150	150	150	150	550	513	75	75	75	75	189
2003	150	150	150	150	150	150	1,546	865	75	75	75	75	300
2004	215	175	175	178	1,477	1,962	894	451	75	75	75	75	482
2005	150	150	150	150	1,907	4,672	4,340	2,600	7,818	2,100	250	268	2,035
2006	440	300	410	4,494	3,235	4,801	7,812	5,563	7,905	2,185	250	250	3,126
2007	397	300	300	300	300	300	438	412	50	50	50	50	246
2008	126	150	150	150	145	150	462	433	50	50	50	50	164
2009	150	150	150	150	150	150	721	671	75	75	75	75	216
2010	215	175	175	175	175	175	1,080	1,007	835	901	250	250	452
2011	397	424	3,333	3,997	3,320	5,517	6,208	5,039	4,685	4,341	1,449	513	3,271
2012	512	300	300	300	290	467	618	508	50	50	50	50	292
1971-2012	334	348	598	1,160	1,788	2,226	2,285	1,630	1,711	928	399	258	1,134

Table 2. Minimum daily Tuolumne River below La Grange Dam flow by water year type, by water year, and for the period of record for the Base Case (cfs).

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Min	3-day Min	7-day Min
C	126	150	150	150	145	150	150	150	50	50	50	50	50	--	--	--
D	126	150	150	150	150	150	150	150	50	50	50	50	50	--	--	--
BN	126	150	150	150	145	150	150	150	50	50	50	50	50	--	--	--
N	150	150	150	150	150	150	150	150	75	75	75	75	75	--	--	--
AN	126	150	150	150	150	150	300	300	250	250	250	250	126	--	--	--
W	126	150	150	150	150	150	232	300	250	250	250	250	126	--	--	--
1971	300	300	300	688	1,362	1,355	1,712	175	75	75	75	75	75	244	75	75
1972	188	175	175	175	169	175	150	150	50	50	50	50	50	244	50	50
1973	150	150	150	150	150	774	1,946	300	1,319	250	250	250	150	32	117	107
1974	300	300	300	1,340	2,444	2,354	2,354	374	1,399	250	250	250	250	281	250	250
1975	300	300	300	300	300	2,859	2,092	755	1,832	250	250	250	250	281	250	250
1976	300	300	355	300	290	300	150	150	50	50	50	50	50	244	50	50
1977	126	150	150	150	150	150	150	150	50	50	50	50	50	244	50	50
1978	126	150	150	150	150	150	300	1,353	250	250	250	260	126	1	101	93
1979	300	300	300	300	1,196	3,177	2,208	300	406	250	250	250	250	281	250	250
1980	300	300	300	300	3,673	3,086	2,486	2,666	2,136	2,067	250	250	250	325	250	250
1981	300	300	300	300	300	300	434	180	75	75	75	75	75	244	75	75
1982	180	180	180	180	2,242	5,569	1,887	4,443	5,979	250	325	467	180	1	145	135
1983	300	1,328	2,190	2,028	1,732	2,505	6,321	8,226	7,597	3,936	2,222	1,556	300	21	300	300
1984	300	300	3,659	2,270	2,075	2,394	1,481	300	250	250	250	250	250	244	250	250
1985	300	300	300	300	300	1,191	961	150	75	75	75	75	75	244	75	75
1986	150	150	150	150	150	6,216	3,775	3,177	2,140	250	250	250	150	32	125	118
1987	300	300	300	300	300	300	150	150	50	50	50	50	50	244	50	50
1988	126	150	150	150	145	150	150	150	50	50	50	50	50	244	50	50
1989	126	150	150	150	150	150	150	150	50	50	50	50	50	244	50	50
1990	126	150	150	150	150	150	150	150	50	50	50	50	50	244	50	50
1991	126	150	150	150	150	150	150	150	50	50	50	50	50	244	50	50
1992	126	150	150	150	145	150	150	150	50	50	50	50	50	244	50	50
1993	126	150	150	150	150	150	300	300	250	250	250	250	126	1	101	93

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Min	3-day Min	7-day Min
1994	300	300	300	300	300	300	150	150	50	50	50	50	50	244	50	50
1995	150	150	150	150	150	150	4,922	6,583	7,870	4,284	957	341	150	32	117	107
1996	300	300	300	300	1,537	3,565	3,173	2,046	2,104	250	250	250	250	281	250	250
1997	300	300	300	4,778	4,183	2,646	1,378	300	250	250	250	250	250	244	250	250
1998	300	300	300	300	1,995	3,604	3,833	3,906	7,134	2,185	382	250	250	338	250	250
1999	300	300	300	424	2,553	2,460	1,687	300	824	250	250	250	250	281	250	250
2000	300	300	300	300	290	2,925	2,726	300	250	250	250	250	250	244	250	250
2001	300	300	300	300	300	300	697	150	75	75	75	75	75	244	75	75
2002	150	150	150	150	150	150	150	150	75	75	75	75	75	244	75	75
2003	150	150	150	150	150	150	175	175	75	75	75	75	75	244	75	75
2004	188	175	175	175	203	1,552	618	150	75	75	75	75	75	244	75	75
2005	150	150	150	150	150	3,884	2,684	2,162	6,862	250	250	250	150	32	125	118
2006	300	300	300	1,439	2,463	3,501	232	3,897	7,162	250	250	250	232	187	250	250
2007	300	300	300	300	300	300	150	150	50	50	50	50	50	244	50	50
2008	126	150	150	150	145	150	150	150	50	50	50	50	50	244	50	50
2009	150	150	150	150	150	150	175	175	75	75	75	75	75	244	75	75
2010	188	175	175	175	175	175	300	300	334	250	250	250	175	62	150	140
2011	300	300	918	2,264	2,264	4,225	4,452	5,039	4,685	3,137	464	250	250	343	250	250
2012	300	300	300	300	290	300	150	150	50	50	50	50	50	244	50	50
1971-2012	126	150	150	150	145	150	150	150	50	50	50	50	50	--	--	--

Table 3. Maximum daily Tuolumne River below La Grange Dam flow by water year type, by water year, and for the period of record for the Base Case (cfs).

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Max	3-day Max	7-day Max
C	1,800	357	487	302	300	300	685	685	50	50	50	50	1,800	--	--	--
D	1,800	300	300	300	300	1,665	1,545	1,208	75	75	75	75	1,800	--	--	--
BN	1,800	300	300	300	2,674	2,680	1,985	1,343	75	75	75	75	2,680	--	--	--
N	1,800	300	898	2,498	6,307	6,180	4,236	2,837	4,806	1,514	250	250	6,307	--	--	--
AN	1,844	6,720	8,719	8,809	6,880	5,859	4,961	3,884	7,551	2,037	250	720	8,809	--	--	--
W	3,202	4,117	7,207	66,872	8,870	8,865	8,889	12,080	13,354	9,902	5,251	3,152	66,872	--	--	--
1971	1,800	300	898	1,362	2,151	2,037	3,126	1,948	75	75	75	75	3,126	197	3,126	3,126
1972	612	175	175	175	169	501	823	823	50	50	50	50	823	197	823	823
1973	150	150	150	150	150	2,825	3,695	2,696	4,806	1,276	250	250	4,806	255	4,260	3,666
1974	1,800	300	1,340	2,838	2,609	4,121	4,961	3,067	5,248	1,354	250	250	5,248	258	4,961	4,356
1975	1,800	300	300	300	3,659	4,060	4,060	1,762	7,551	1,773	250	720	7,551	259	5,838	4,486
1976	1,800	357	487	302	290	300	504	504	50	50	50	50	1,800	15	1,300	729
1977	126	150	150	150	150	150	330	330	50	50	50	50	330	197	330	330
1978	126	150	150	150	150	150	1,762	1,762	250	250	587	1,707	1,762	197	1,762	1,762
1979	1,800	300	300	2,498	4,413	4,261	3,775	2,208	4,172	393	250	250	4,413	145	4,413	4,413
1980	1,800	300	300	8,842	8,787	8,829	3,948	2,666	2,136	5,636	2,629	865	8,842	121	8,840	8,830
1981	1,800	300	300	300	300	1,665	1,545	767	75	75	75	75	1,800	16	1,665	1,648
1982	602	180	180	2,254	8,853	8,859	8,889	8,885	5,979	5,786	2,674	3,152	8,889	212	8,888	8,886
1983	3,202	4,117	5,239	6,202	8,269	8,746	8,872	8,226	7,597	8,875	5,251	1,702	8,875	287	8,871	8,823
1984	1,844	6,720	8,719	8,809	3,812	3,469	2,942	1,762	250	250	250	250	8,809	95	8,791	8,730
1985	1,800	300	300	300	1,408	1,408	1,985	961	75	75	75	75	1,985	197	1,985	1,778
1986	150	150	150	150	8,840	8,865	8,860	3,177	5,398	2,071	250	250	8,865	158	8,863	8,858
1987	1,800	300	300	300	300	300	640	640	50	50	50	50	1,800	16	1,300	729
1988	126	150	150	150	145	150	330	330	50	50	50	50	330	197	330	330
1989	126	150	150	150	150	150	688	688	50	50	50	50	688	197	688	688
1990	126	150	150	150	150	150	479	479	50	50	50	50	479	197	479	479
1991	126	150	150	150	150	150	684	684	50	50	50	50	684	197	684	684
1992	126	150	150	150	145	150	499	499	50	50	50	50	499	197	499	499
1993	126	150	150	150	150	150	1,762	1,762	250	250	250	250	1,762	197	1,762	1,762

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Max	3-day Max	7-day Max
1994	1,800	300	300	300	300	300	685	685	50	50	50	50	1,800	16	1,300	729
1995	150	150	150	150	150	7,311	7,232	6,755	7,870	8,309	5,183	957	8,309	284	7,870	7,870
1996	1,800	300	300	300	6,880	5,859	4,635	3,884	5,421	2,037	250	250	6,880	145	6,880	6,725
1997	1,800	300	5,464	66,872	8,870	4,183	2,839	1,762	2,711	376	250	250	66,872	95	49,882	32,741
1998	1,800	300	300	2,385	8,453	7,080	6,881	4,301	7,134	6,904	3,951	770	8,453	140	8,225	7,829
1999	1,800	300	573	2,761	6,301	4,937	3,417	1,762	4,710	797	250	250	6,301	134	6,301	6,301
2000	1,800	300	300	300	6,307	6,180	4,236	2,837	3,175	251	250	250	6,307	139	6,307	6,307
2001	1,800	300	300	300	300	913	1,343	1,343	75	75	75	75	1,800	16	1,343	1,343
2002	150	150	150	150	150	150	900	900	75	75	75	75	900	197	900	900
2003	150	150	150	150	150	150	2,854	1,600	75	75	75	75	2,854	199	2,854	2,854
2004	612	175	175	209	2,674	2,680	1,267	773	75	75	75	75	2,680	152	2,680	2,676
2005	150	150	150	150	5,352	5,841	5,412	12,080	13,354	6,640	250	516	13,354	244	12,726	10,989
2006	1,800	300	1,439	7,799	3,582	5,441	8,887	8,889	10,892	6,931	250	250	10,892	250	10,585	9,870
2007	1,800	300	300	300	300	300	691	691	50	50	50	50	1,800	16	1,300	729
2008	126	150	150	150	145	150	734	734	50	50	50	50	734	213	734	734
2009	150	150	150	150	150	150	1,199	1,199	75	75	75	75	1,199	197	1,199	1,199
2010	612	175	175	175	175	175	1,762	1,762	4,330	1,514	250	250	4,330	271	4,116	2,604
2011	1,800	918	7,207	7,154	4,317	7,854	7,291	5,039	4,685	9,902	3,137	967	9,902	280	8,907	7,532
2012	1,800	300	300	300	290	947	1,208	1,208	50	50	50	50	1,800	15	1,300	1,208
1971-2012	3,202	6,720	8,719	66,872	8,870	8,865	8,889	12,080	13,354	9,902	5,251	3,152	66,872	--	--	--

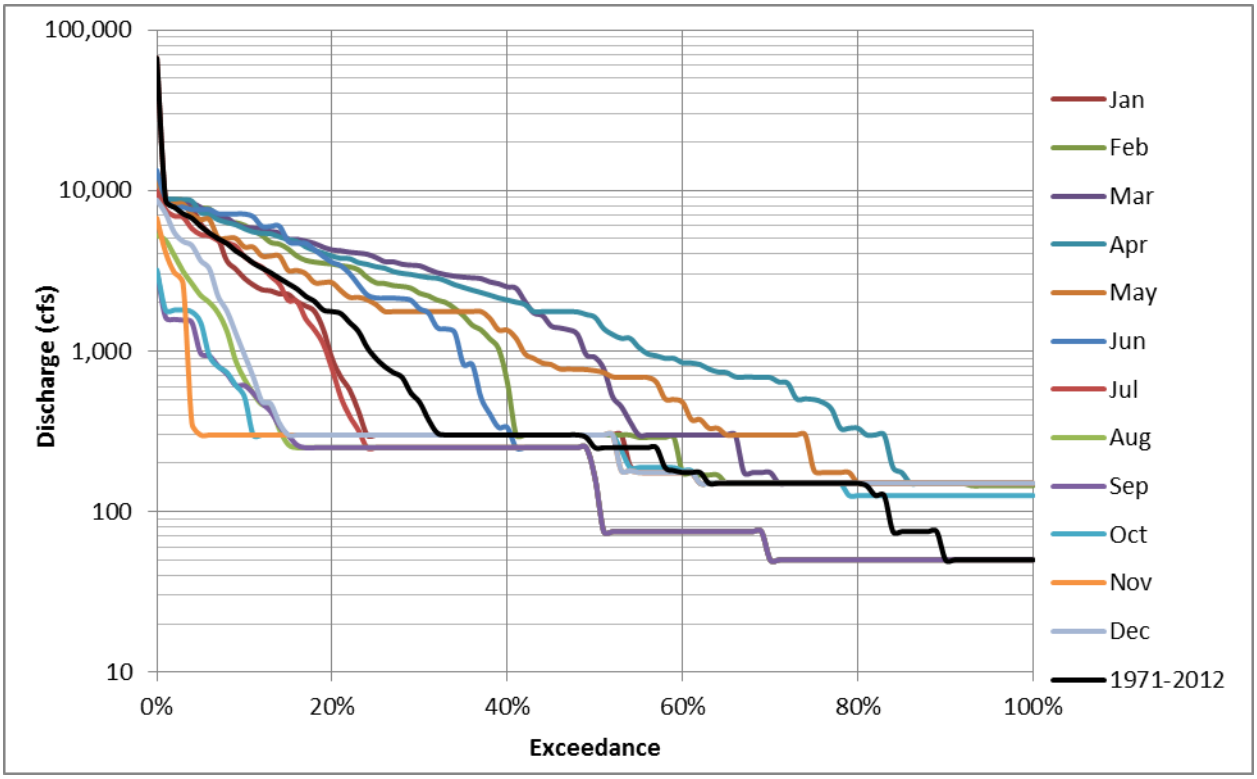


Figure 1. **Tuolumne River below La Grange Dam flow duration curves by month and for the period of record for the Base Case (cfs).**

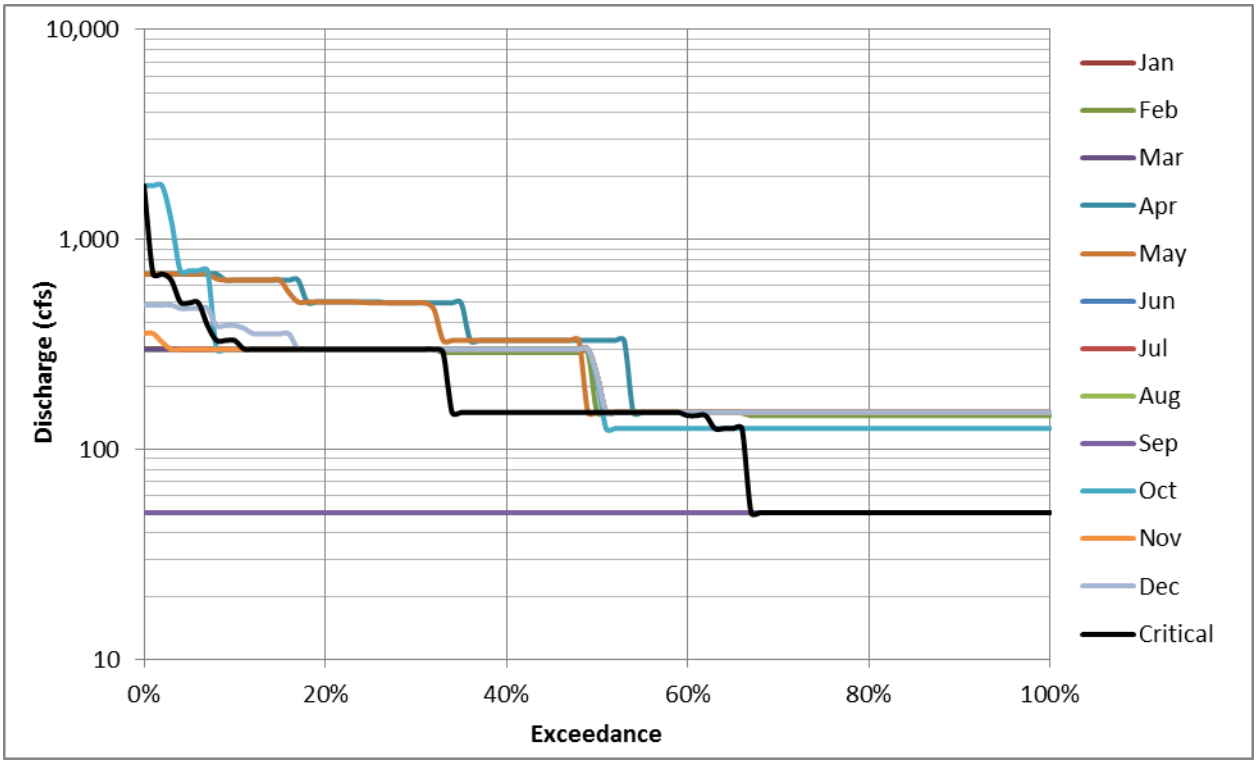


Figure 2. **Tuolumne River below La Grange Dam flow duration curves for Critical years by month and for all Critical years for the Base Case (cfs).**

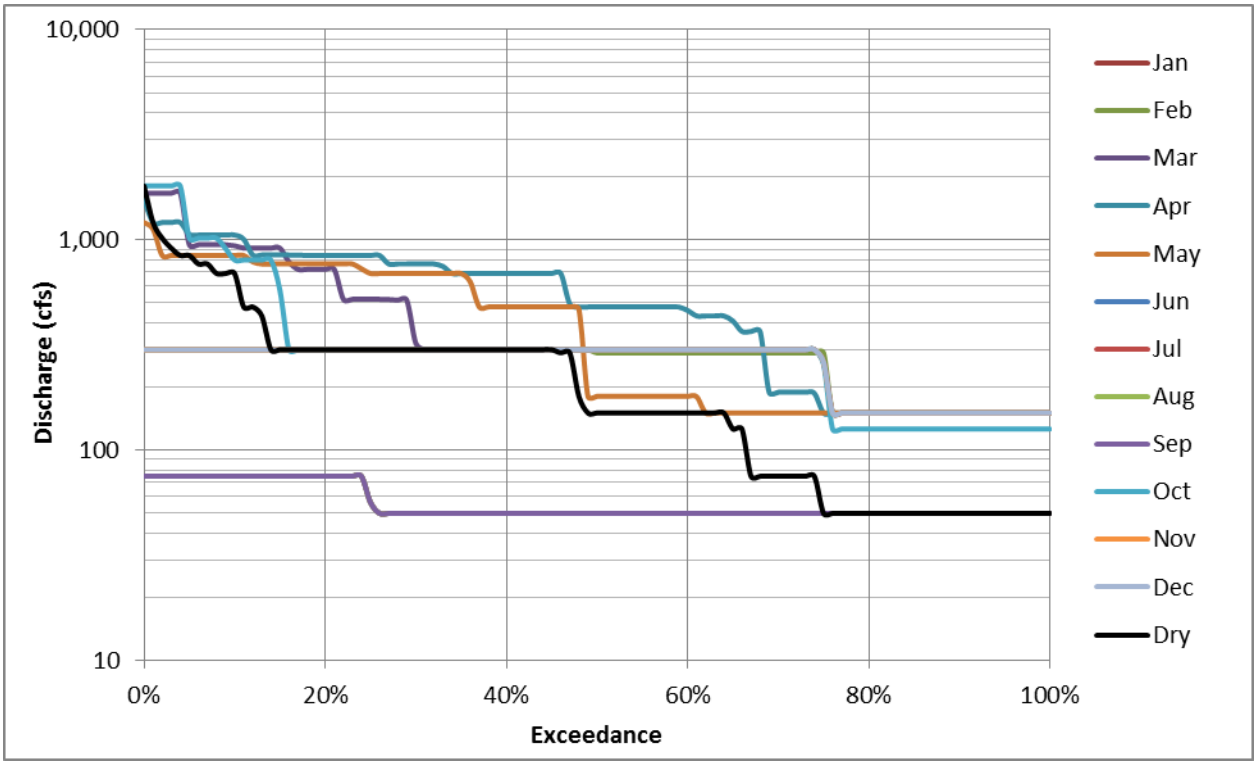


Figure 3. **Tuolumne River below La Grange Dam flow duration curves for Dry years by month and for all Dry years for the Base Case (cfs).**

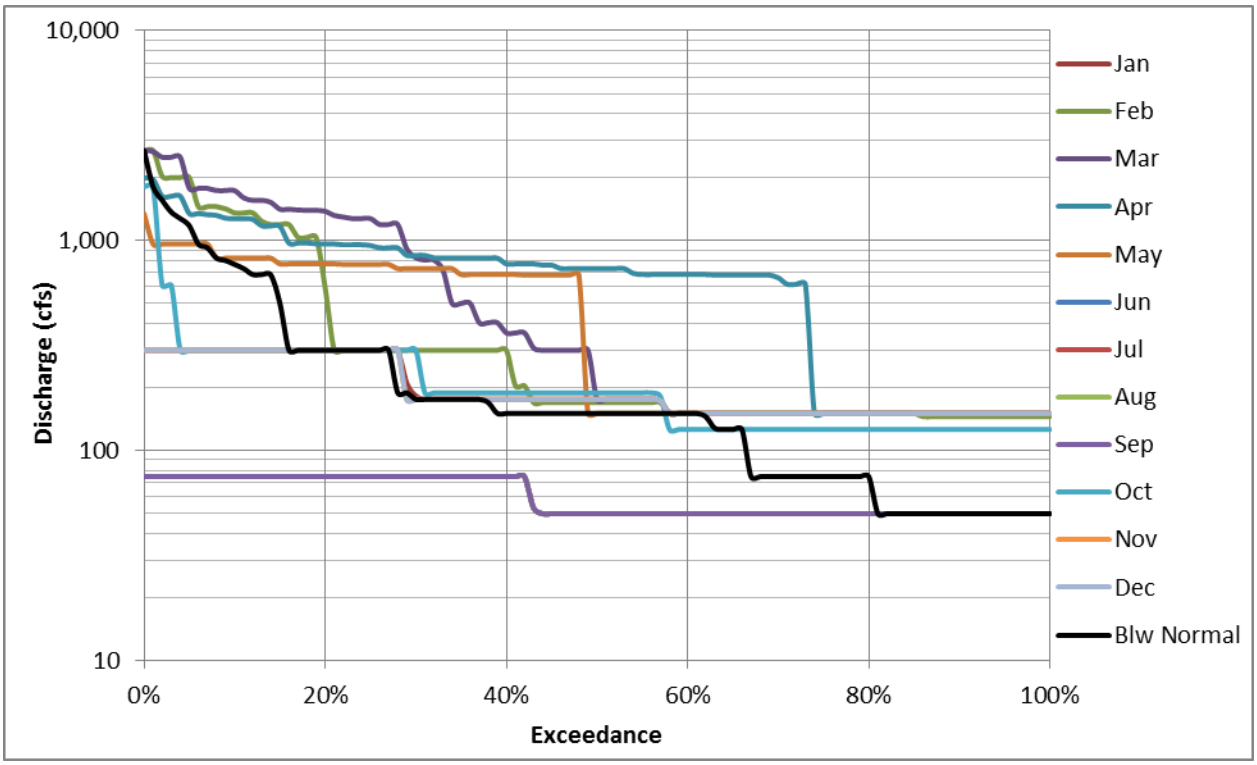


Figure 4. **Tuolumne River below La Grange Dam flow duration curves for Below Normal years by month and for all Below Normal years**

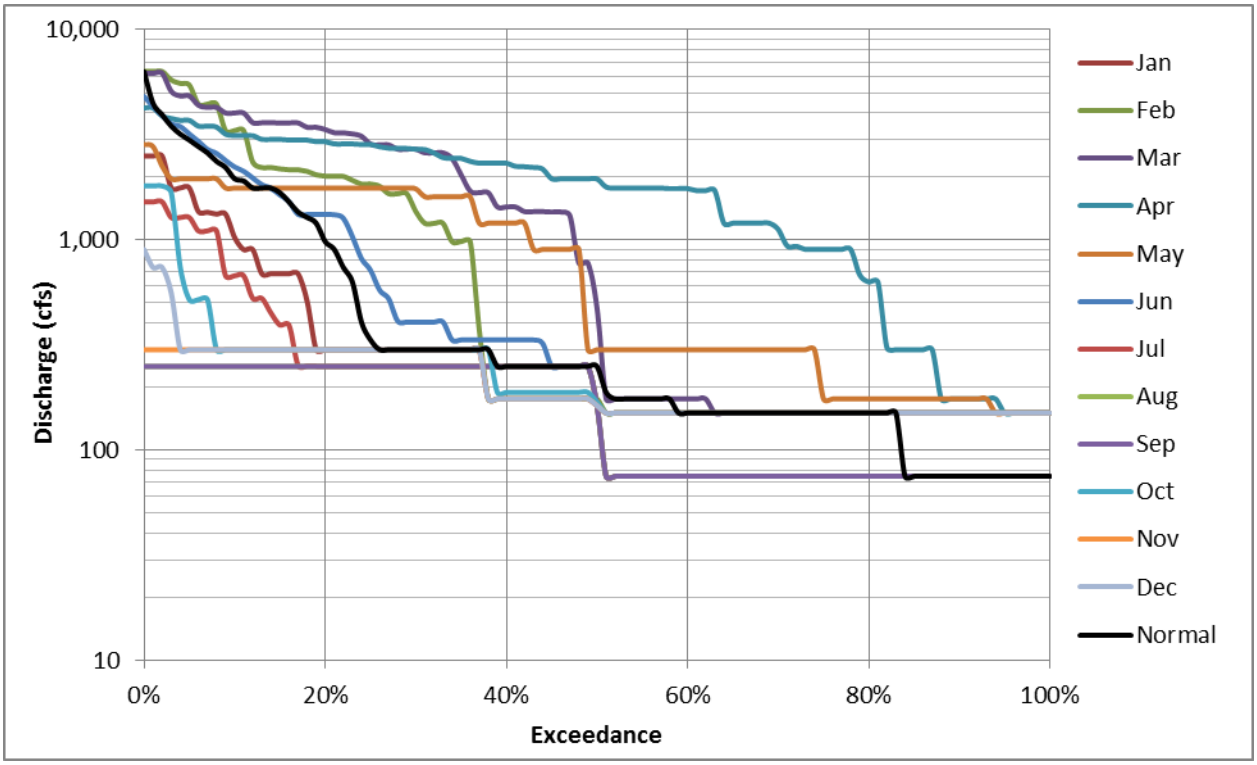


Figure 5. **Tuolumne River below La Grange Dam flow duration curves for Normal years by month and for all Normal years for the Base Case (cfs).**

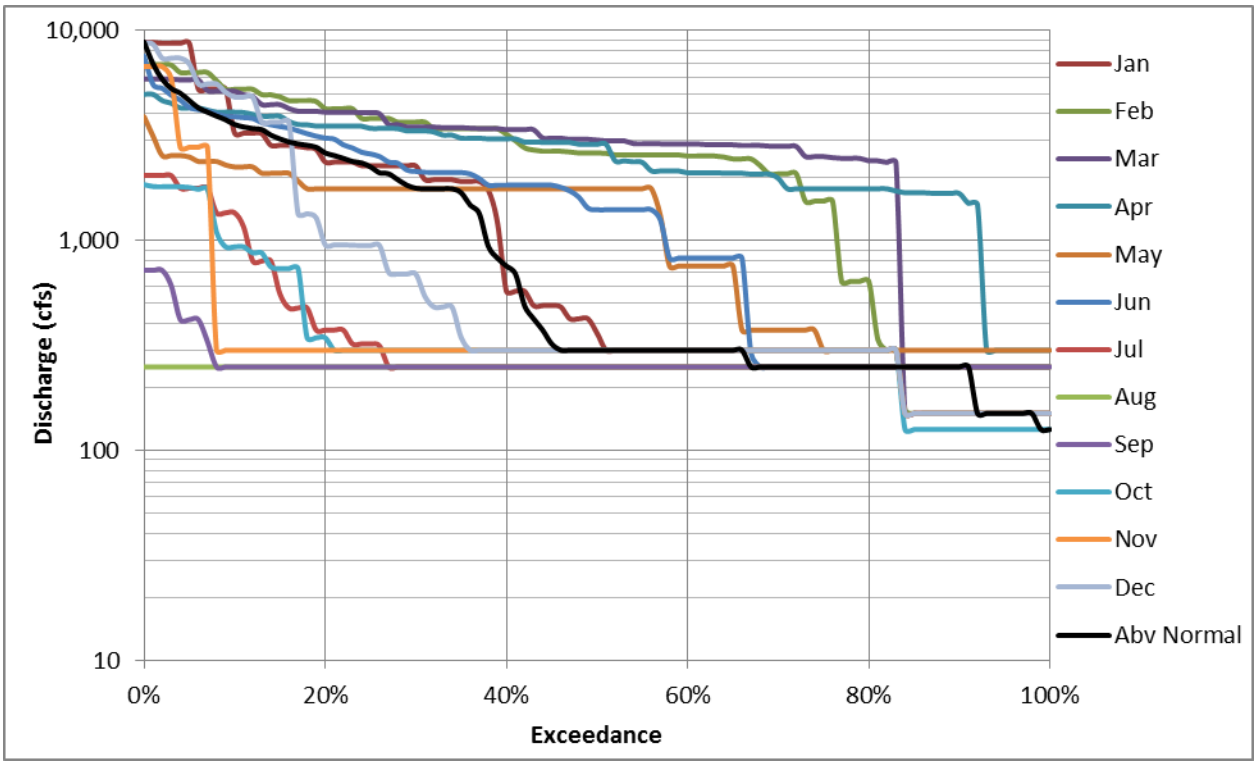


Figure 6. **Tuolumne River below La Grange Dam flow duration curves for Above Normal years by month and for all Above Normal years for the Base Case (cfs).**

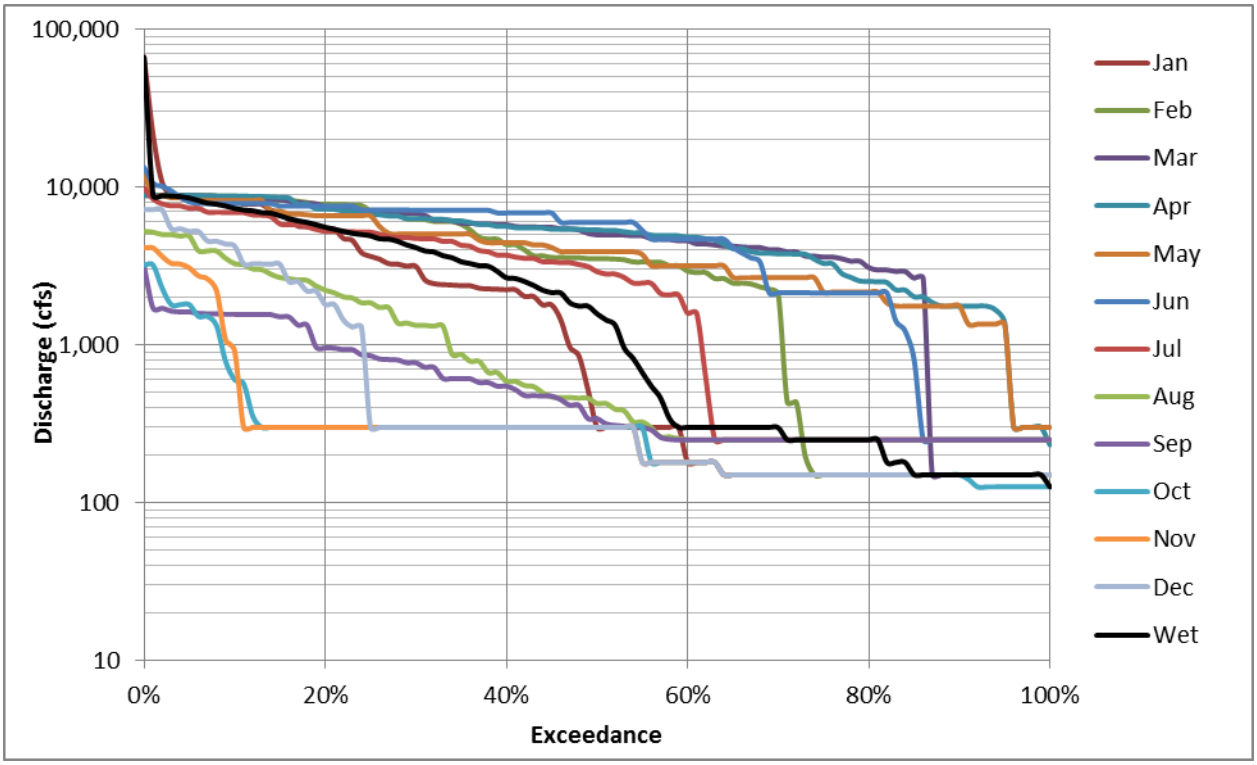


Figure 7. **Tuolumne River below La Grange Dam flow duration curves for Wet years by month and for all Wet years for the Base Case (cfs).**

Tuolumne River at Modesto 9th St Bridge

Table 1. Average Tuolumne River at Modesto flow by water year type, by water year, and for the period of record for the Base Case (cfs).

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
C	389	309	326	333	437	398	461	433	170	175	190	190	317
D	501	345	343	406	401	649	679	538	176	181	196	195	384
BN	339	283	296	352	663	847	838	573	181	186	201	201	412
N	389	297	352	643	1,457	1,810	1,978	1,028	799	402	303	302	808
AN	574	783	1,502	1,954	3,180	3,219	2,771	1,405	1,841	578	390	412	1,540
W	500	582	1,262	3,598	4,610	5,603	5,414	4,352	5,133	3,134	1,322	771	3,011
1971	507	422	649	1,118	1,978	1,641	2,378	1,148	195	200	215	215	881
1972	325	258	331	304	317	421	635	591	170	175	190	190	326
1973	260	233	231	680	964	2,673	2,788	1,183	2,324	607	390	390	1,057
1974	533	383	1,100	2,461	2,665	3,459	3,941	1,203	2,312	624	390	390	1,612
1975	598	402	381	400	2,497	3,614	2,874	1,357	2,868	798	390	523	1,380
1976	614	391	500	400	420	430	464	436	170	175	190	190	365
1977	236	233	231	250	280	280	372	352	170	175	190	190	246
1978	236	233	231	533	698	599	1,615	1,673	370	375	535	1,292	697
1979	734	383	381	1,535	3,025	3,892	2,921	1,151	1,368	407	390	390	1,369
1980	507	383	381	5,038	6,849	6,203	3,241	2,781	2,256	3,411	1,136	614	2,723
1981	640	383	381	575	444	1,263	947	579	195	200	215	215	504
1982	317	263	353	1,412	5,736	7,110	7,767	6,266	6,099	3,040	1,215	1,295	3,382
1983	1,586	3,171	3,913	4,387	7,988	9,000	7,845	8,341	7,717	6,084	3,848	1,711	5,449
1984	849	2,915	6,482	5,583	3,189	3,105	2,169	1,122	370	375	390	390	2,248
1985	507	383	411	400	1,071	1,475	1,396	657	195	200	215	215	590
1986	260	233	231	251	3,694	9,000	5,567	3,292	3,215	786	390	390	2,263
1987	507	383	381	400	496	622	537	502	170	175	190	190	379
1988	236	233	231	294	275	280	372	352	170	175	190	190	250
1989	236	233	231	250	280	351	562	525	170	175	190	190	283
1990	236	233	231	250	280	280	451	424	170	175	190	190	259
1991	236	233	231	250	280	548	560	523	170	175	190	190	299
1992	236	233	231	250	662	345	462	434	170	175	190	190	296
1993	236	233	231	1,125	571	366	1,219	1,122	370	375	390	390	552
1994	507	383	381	408	488	430	561	524	170	175	190	190	367
1995	260	233	231	1,157	305	4,372	6,001	6,737	7,990	6,058	3,067	724	3,110
1996	580	383	386	748	5,187	5,270	3,798	2,506	3,359	778	390	390	1,964
1997	507	383	3,569	14,629	7,958	3,332	2,122	1,122	797	383	390	390	2,947
1998	507	383	381	1,836	8,119	5,318	5,833	4,111	7,254	5,332	1,595	618	3,401
1999	650	383	431	1,409	4,900	3,500	2,627	1,122	1,766	515	390	390	1,481
2000	507	383	381	463	4,266	4,920	3,339	1,226	965	375	390	390	1,454
2001	509	385	381	419	477	739	1,109	602	195	200	215	215	453
2002	260	233	407	457	280	280	676	628	195	200	215	215	338
2003	260	233	284	269	280	280	1,671	980	195	200	215	215	423
2004	325	258	256	310	1,751	2,099	1,020	566	195	200	215	215	614
2005	260	233	239	1,021	2,281	5,205	4,468	2,715	7,938	2,225	390	408	2,271
2006	550	383	515	4,959	3,365	5,321	8,756	5,678	8,025	2,310	390	390	3,376
2007	507	383	381	400	459	444	564	527	170	175	190	190	365
2008	236	233	231	532	446	292	587	548	170	175	190	190	319
2009	260	233	231	250	280	357	847	786	195	200	215	215	339
2010	325	258	256	374	482	441	1,205	1,122	955	1,026	390	390	602
2011	507	507	3,838	4,354	3,637	6,175	6,341	5,154	4,805	4,466	1,589	648	3,505
2012	622	380	380	400	420	608	753	623	170	175	190	185	409
1971-2012	447	445	741	1,489	2,144	2,532	2,461	1,745	1,831	1,053	539	397	1,313

Table 2. Minimum daily Tuolumne River at Modesto flow by water year type, by water year, and for the period of record for the Base Case (cfs).

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Min	3-day Min	7-day Min
C	236	233	231	240	275	280	277	265	170	175	190	185	170	--	--	--
D	236	233	231	240	280	280	277	265	170	175	190	180	170	--	--	--
BN	236	233	231	240	275	280	277	265	170	175	190	185	170	--	--	--
N	260	233	231	240	280	280	277	265	195	200	215	210	195	--	--	--
AN	236	233	231	240	278	280	427	415	370	375	390	385	231	--	--	--
W	236	233	231	240	263	280	483	415	370	375	390	382	231	--	--	--
1971	410	383	410	803	1,492	1,485	1,839	290	195	200	215	210	195	244	195	195
1972	298	258	256	274	294	305	277	265	170	175	190	185	170	244	170	170
1973	260	233	231	240	340	1,038	2,076	415	1,439	375	390	385	231	62	231	231
1974	410	383	381	1,559	2,574	2,518	2,555	489	1,519	375	390	385	375	281	375	375
1975	410	383	381	390	430	3,061	2,208	870	1,952	375	390	385	375	281	375	375
1976	410	383	436	392	420	430	277	265	170	175	190	185	170	244	170	170
1977	236	233	231	240	280	280	277	265	170	175	190	185	170	244	170	170
1978	236	233	231	240	263	280	483	1,468	370	375	390	395	231	62	222	218
1979	410	383	381	390	1,330	3,307	2,319	415	526	375	390	385	375	281	375	375
1980	410	383	381	390	3,833	3,216	2,613	2,781	2,256	2,192	390	386	381	61	381	381
1981	410	383	381	390	430	430	561	295	195	200	215	210	195	244	195	195
1982	290	263	261	338	2,398	5,704	5,750	4,558	6,099	375	465	602	261	62	261	260
1983	410	1,411	2,271	2,306	6,506	9,000	6,432	8,341	7,717	4,061	2,362	1,692	410	21	410	410
1984	410	383	3,815	2,376	2,205	2,524	1,608	415	370	375	390	385	370	244	370	370
1985	410	383	381	390	430	1,350	1,072	265	195	200	215	210	195	244	195	195
1986	260	233	231	240	316	9,000	3,886	3,292	2,260	375	390	385	231	62	231	231
1987	410	383	381	390	430	425	277	265	170	175	190	185	170	244	170	170
1988	236	233	231	240	275	280	277	265	170	175	190	185	170	244	170	170
1989	236	233	231	240	280	280	277	265	170	175	190	185	170	244	170	170
1990	236	233	231	240	280	280	277	265	170	175	190	185	170	244	170	170
1991	236	233	231	240	280	280	277	265	170	175	190	185	170	244	170	170
1992	236	233	231	240	275	280	277	265	170	175	190	185	170	244	170	170
1993	236	233	231	240	278	280	427	415	370	375	390	385	231	62	222	218

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Min	3-day Min	7-day Min
1994	410	383	381	390	430	430	277	265	170	175	190	185	170	244	170	170
1995	260	233	231	240	280	280	5,033	6,698	7,990	4,409	1,097	478	231	62	231	231
1996	410	383	381	393	2,132	3,695	3,300	2,161	2,224	375	390	385	375	281	375	375
1997	410	383	381	6,260	4,313	2,776	1,505	415	370	375	390	385	370	244	370	370
1998	410	383	381	390	2,596	3,738	3,944	4,021	7,254	2,310	522	386	381	62	381	381
1999	410	383	381	522	2,706	2,590	1,814	415	944	375	390	385	375	281	375	375
2000	410	383	381	390	462	3,055	2,855	415	370	375	390	385	370	244	370	370
2001	410	383	381	390	430	430	824	265	195	200	215	210	195	244	195	195
2002	260	233	231	258	280	280	277	265	195	200	215	210	195	244	195	195
2003	260	233	231	245	280	280	314	290	195	200	215	210	195	244	195	195
2004	298	258	256	271	333	1,682	745	265	195	200	215	210	195	244	195	195
2005	260	233	231	274	280	4,014	2,795	2,277	6,982	375	390	385	231	62	231	231
2006	410	383	381	1,683	2,593	3,665	5,722	4,012	7,282	375	390	385	375	285	375	375
2007	410	383	381	390	430	430	277	265	170	175	190	185	170	244	170	170
2008	236	233	231	240	275	280	277	265	170	175	190	185	170	244	170	170
2009	260	233	231	240	280	280	302	290	195	200	215	210	195	244	195	195
2010	298	258	256	265	305	305	427	415	454	375	390	385	256	62	256	256
2011	410	383	999	2,379	2,394	4,355	4,563	5,154	4,805	3,262	604	382	382	343	383	383
2012	410	380	380	390	420	430	278	265	170	175	190	180	170	244	170	170
1971-2012	236	233	231	240	263	280	277	265	170	175	190	180	170	--	--	--

Table 3. Maximum daily Tuolumne River at Modesto flow by water year type, by water year, and for the period of record for the Base Case (cfs).

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Max	3-day Max	7-day Max
C	1,910	440	568	1,189	3,934	3,919	811	800	170	175	190	195	3,934	--	--	--
D	1,910	383	381	2,511	984	3,665	1,705	1,323	195	200	215	220	3,665	--	--	--
BN	1,910	410	906	2,794	4,235	2,873	2,111	1,458	195	200	215	220	4,235	--	--	--
N	1,910	962	3,691	3,196	9,000	9,000	4,502	2,952	4,926	1,639	390	395	9,000	--	--	--
AN	1,954	9,000	9,000	9,000	9,000	6,611	5,098	3,999	7,671	2,162	390	865	9,000	--	--	--
W	3,312	4,200	9,000	72,099	9,000	9,000	9,000	12,195	13,474	10,027	5,391	3,297	72,099	--	--	--
1971	1,910	962	1,031	1,490	2,281	2,167	3,252	2,063	195	200	215	220	3,252	197	3,251	3,249
1972	722	258	906	662	546	631	949	938	170	175	190	195	949	197	948	946
1973	260	233	231	3,119	7,403	4,859	3,821	2,811	4,926	1,401	390	395	7,403	135	4,380	3,786
1974	1,910	383	4,200	3,510	2,739	4,839	5,098	3,182	5,368	1,479	390	395	5,368	258	5,090	4,481
1975	1,910	514	381	409	4,938	4,454	4,229	1,877	7,671	1,898	390	865	7,671	259	5,958	4,606
1976	1,910	440	568	409	420	430	630	619	170	175	190	195	1,910	15	1,410	847
1977	236	233	231	259	280	280	456	445	170	175	190	195	456	197	455	453
1978	236	233	231	2,408	3,645	4,001	4,963	1,935	370	375	727	1,851	4,963	208	3,398	2,603
1979	1,910	383	381	3,176	4,804	6,720	3,901	2,323	4,292	518	390	395	6,720	153	5,914	5,228
1980	1,910	383	381	9,000	9,000	9,000	4,074	2,781	2,256	5,761	2,769	1,010	9,000	108	9,000	9,000
1981	1,910	383	381	2,511	595	3,665	1,705	882	195	200	215	220	3,665	171	2,495	2,110
1982	712	263	1,290	3,845	9,000	9,000	9,000	9,000	6,099	5,911	2,814	3,297	9,000	139	9,000	9,000
1983	3,312	4,200	5,320	9,000	9,000	9,000	9,000	8,341	7,717	9,000	5,391	1,846	9,000	119	9,000	9,000
1984	1,954	9,000	9,000	9,000	4,696	3,622	3,068	1,877	370	375	390	395	9,000	55	9,000	9,000
1985	1,910	383	708	409	2,975	1,676	2,111	1,076	195	200	215	220	2,975	132	2,110	1,901
1986	260	233	231	296	9,000	9,000	9,000	3,292	5,518	2,196	390	395	9,000	143	9,000	9,000
1987	1,910	383	381	409	1,502	3,919	766	755	170	175	190	195	3,919	157	2,013	1,189
1988	236	233	231	1,189	275	280	456	445	170	175	190	195	1,189	109	669	453
1989	236	233	231	259	280	1,214	814	803	170	175	190	195	1,214	154	813	811
1990	236	233	231	259	280	280	605	594	170	175	190	195	605	197	604	602
1991	236	233	231	259	280	2,207	810	799	170	175	190	195	2,207	178	1,578	1,141
1992	236	233	231	259	3,934	1,421	625	614	170	175	190	195	3,934	135	2,437	1,782
1993	236	233	231	6,521	3,351	1,318	1,888	1,877	370	375	390	395	6,521	110	3,254	2,602

cfs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Julian Day of Annual Max	3-day Max	7-day Max
1994	1,910	383	381	535	1,536	430	811	800	170	175	190	195	1,910	16	1,410	839
1995	260	233	231	5,068	415	9,000	7,358	6,870	7,990	8,434	5,323	1,093	9,000	174	8,912	8,418
1996	1,910	383	477	2,465	9,000	6,611	4,761	3,999	5,541	2,162	390	395	9,000	144	8,050	7,562
1997	1,910	383	9,000	72,099	9,000	4,313	2,965	1,877	2,831	501	390	395	72,099	95	53,225	34,318
1998	1,910	383	381	7,460	9,000	8,674	7,388	4,416	7,254	7,029	4,091	915	9,000	127	9,000	9,000
1999	1,910	383	654	3,507	6,787	5,082	3,543	1,877	4,830	922	390	395	6,787	134	6,610	6,523
2000	1,910	383	381	1,715	9,000	9,000	4,502	2,952	3,295	376	390	395	9,000	150	7,520	6,970
2001	1,910	410	381	619	826	2,496	1,458	1,458	195	200	215	220	2,496	157	1,476	1,457
2002	260	233	3,691	3,196	280	280	1,026	1,015	195	200	215	220	3,691	91	2,132	1,765
2003	260	233	609	427	280	280	2,978	1,715	195	200	215	220	2,978	199	2,977	2,975
2004	722	258	256	667	4,235	2,873	1,393	888	195	200	215	220	4,235	149	3,731	3,244
2005	260	233	481	3,660	5,881	8,903	5,626	12,195	13,474	6,765	390	661	13,474	244	12,844	11,108
2006	1,910	383	1,778	8,382	3,712	7,675	9,000	9,000	11,012	7,056	390	395	11,012	250	10,705	9,990
2007	1,910	383	381	409	984	718	817	806	170	175	190	195	1,910	16	1,410	839
2008	236	233	231	2,794	1,691	406	860	849	170	175	190	195	2,794	115	1,816	1,296
2009	260	233	231	259	280	1,975	1,325	1,314	195	200	215	220	1,975	156	1,324	1,322
2010	722	258	256	1,333	2,031	1,969	1,888	1,877	4,450	1,639	390	395	4,450	271	4,236	2,726
2011	1,910	1,001	9,000	9,000	5,845	9,000	7,489	5,154	4,805	10,027	3,277	1,107	10,027	280	9,032	8,647
2012	1,910	380	380	409	420	1,077	1,323	1,323	170	175	190	190	1,910	15	1,410	1,321
1971-2012	3,312	9,000	9,000	72,099	9,000	9,000	9,000	12,195	13,474	10,027	5,391	3,297	72,099	--	--	--

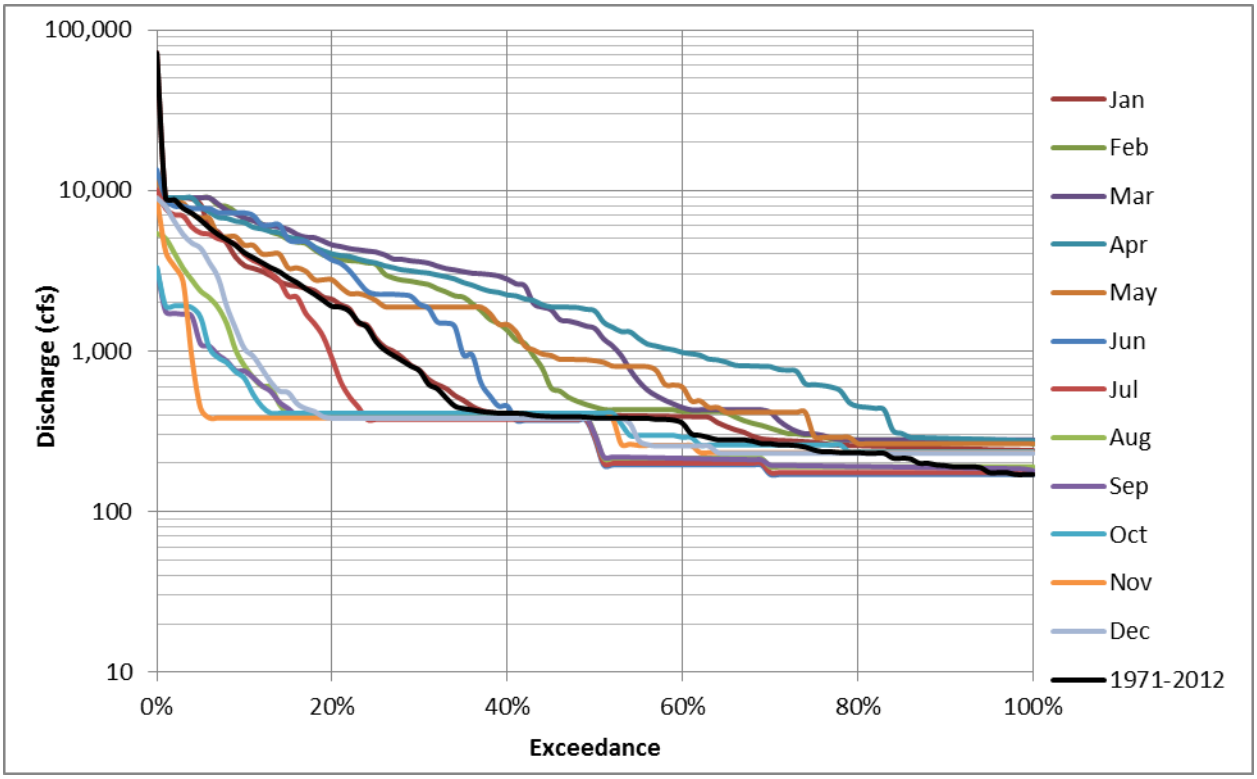


Figure 1. **Tuolumne River at Modesto flow duration curves by month and for the period of record for the Base Case (cfs).**

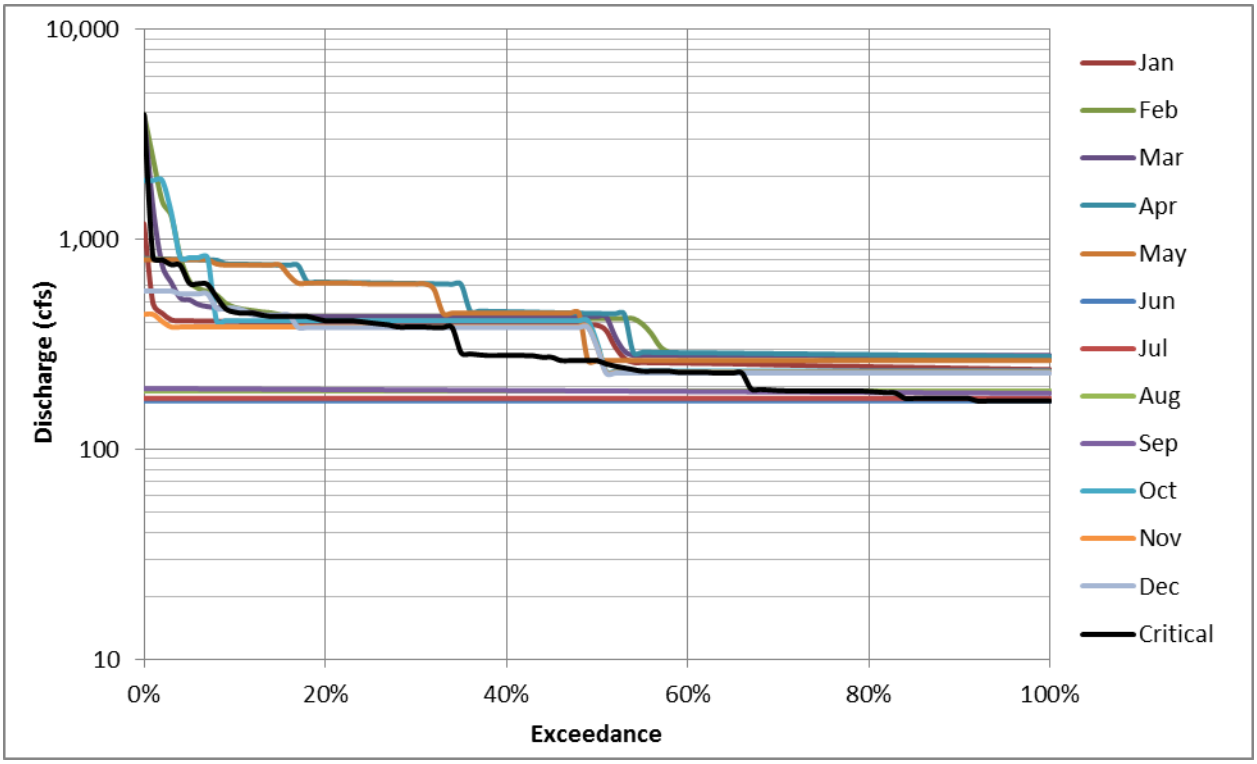


Figure 2. **Tuolumne River at Modesto flow duration curves for Critical years by month and for all Critical years for the Base Case (cfs).**

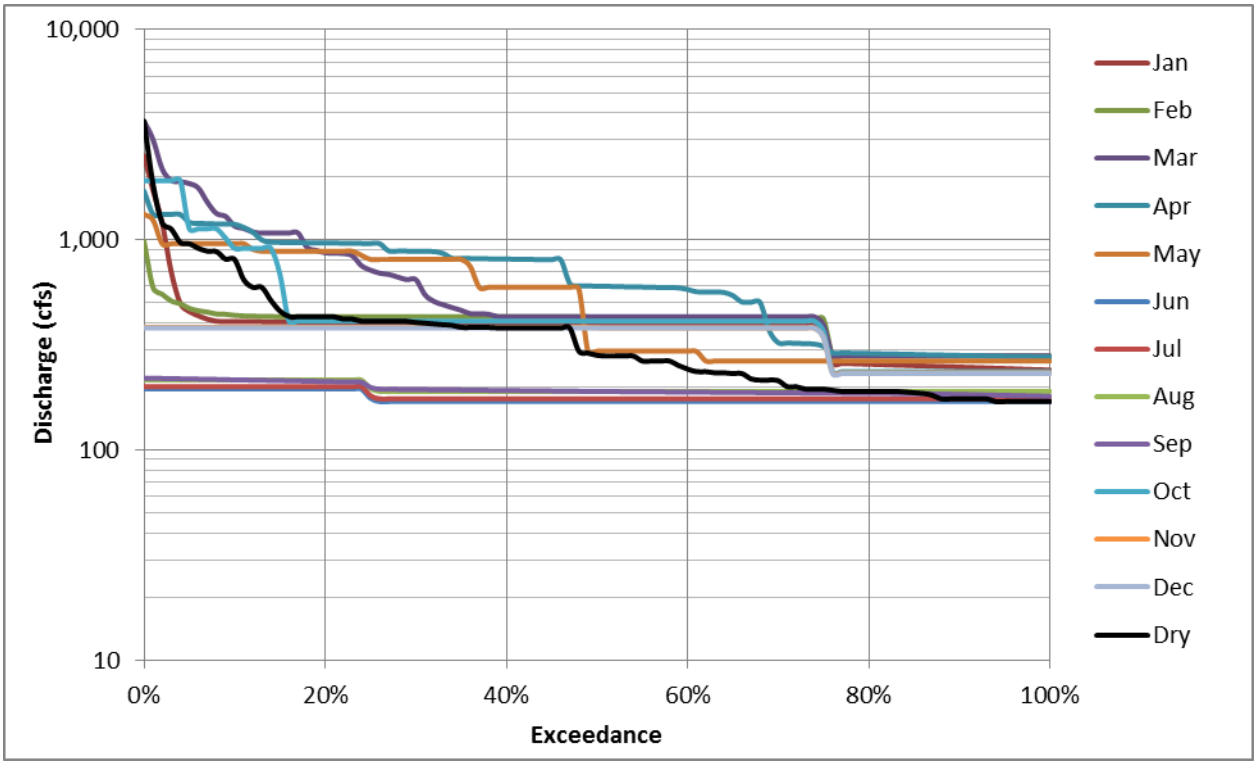


Figure 3. **Tuolumne River at Modesto flow duration curves for Dry years by month and for all Dry years for the Base Case (cfs).**

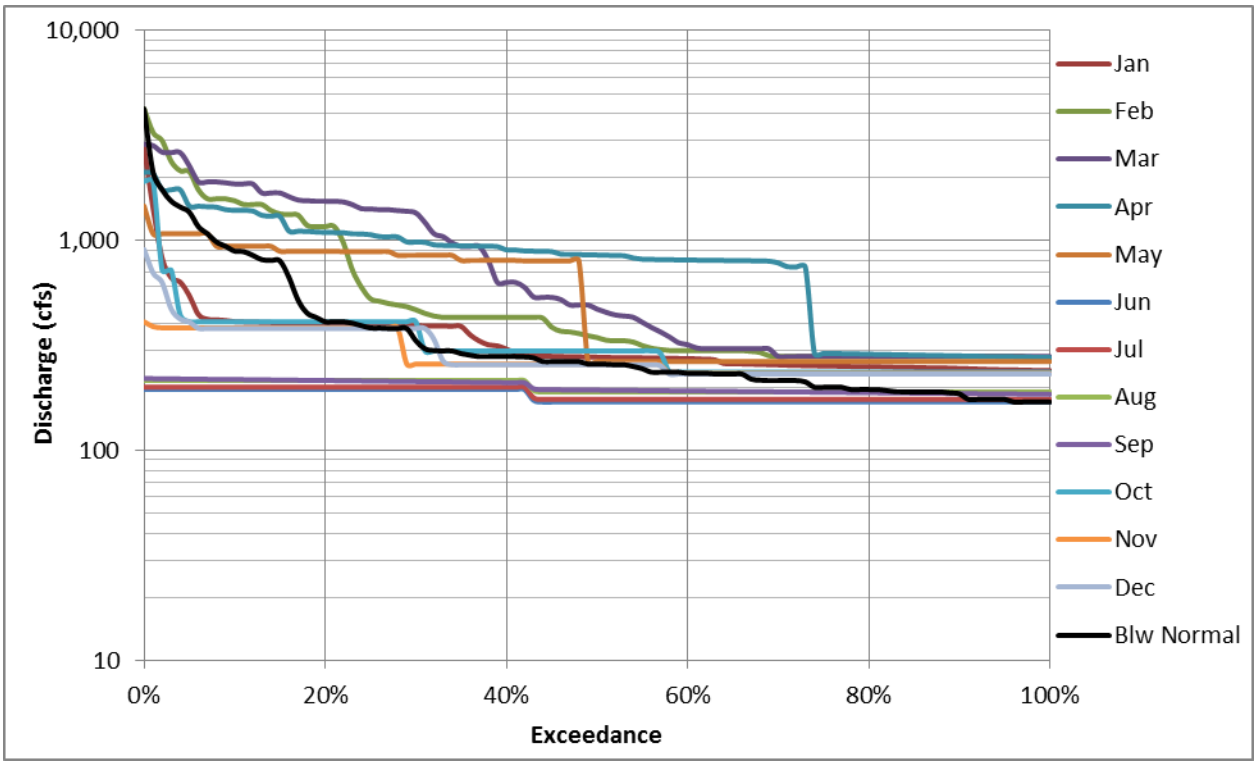


Figure 4. **Tuolumne River at Modesto flow duration curves for Below Normal years by month and for all Below Normal years for the Base Case (cfs).**

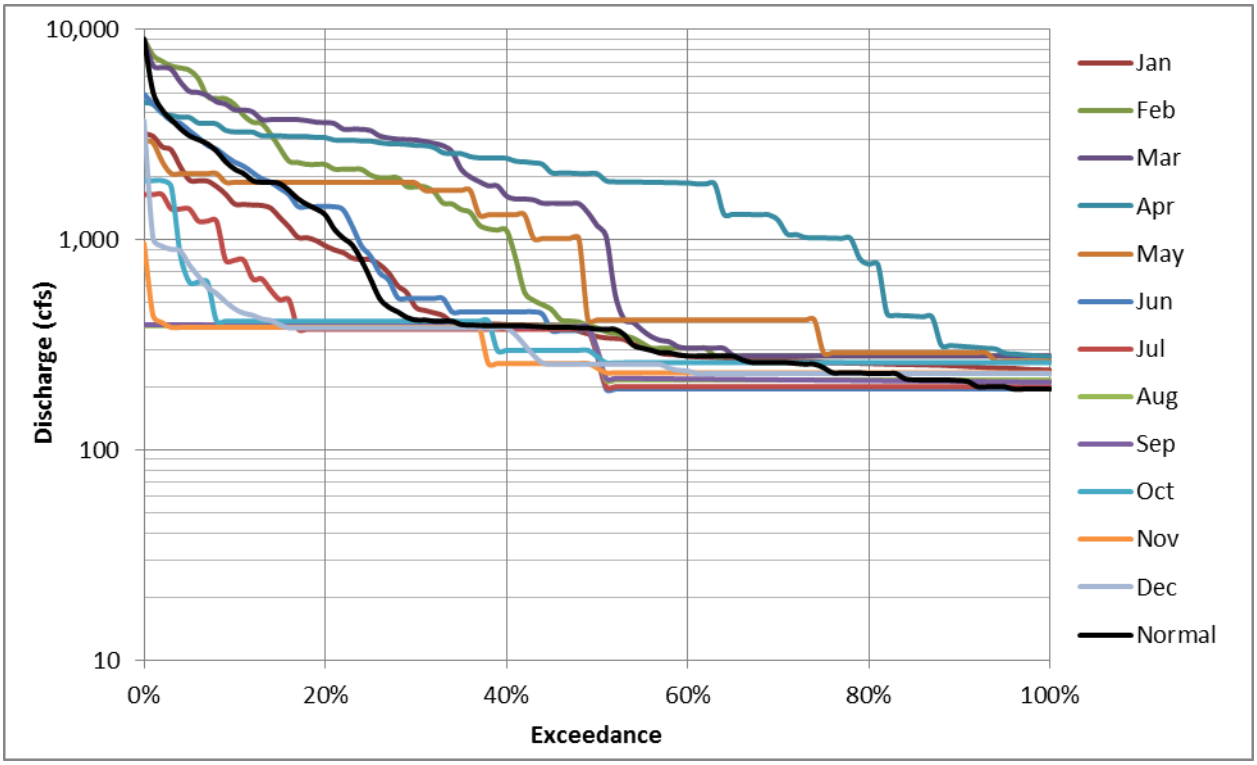


Figure 5. **Tuolumne River at Modesto flow duration curves for Normal years by month and for all Normal years for the Base Case (cfs).**

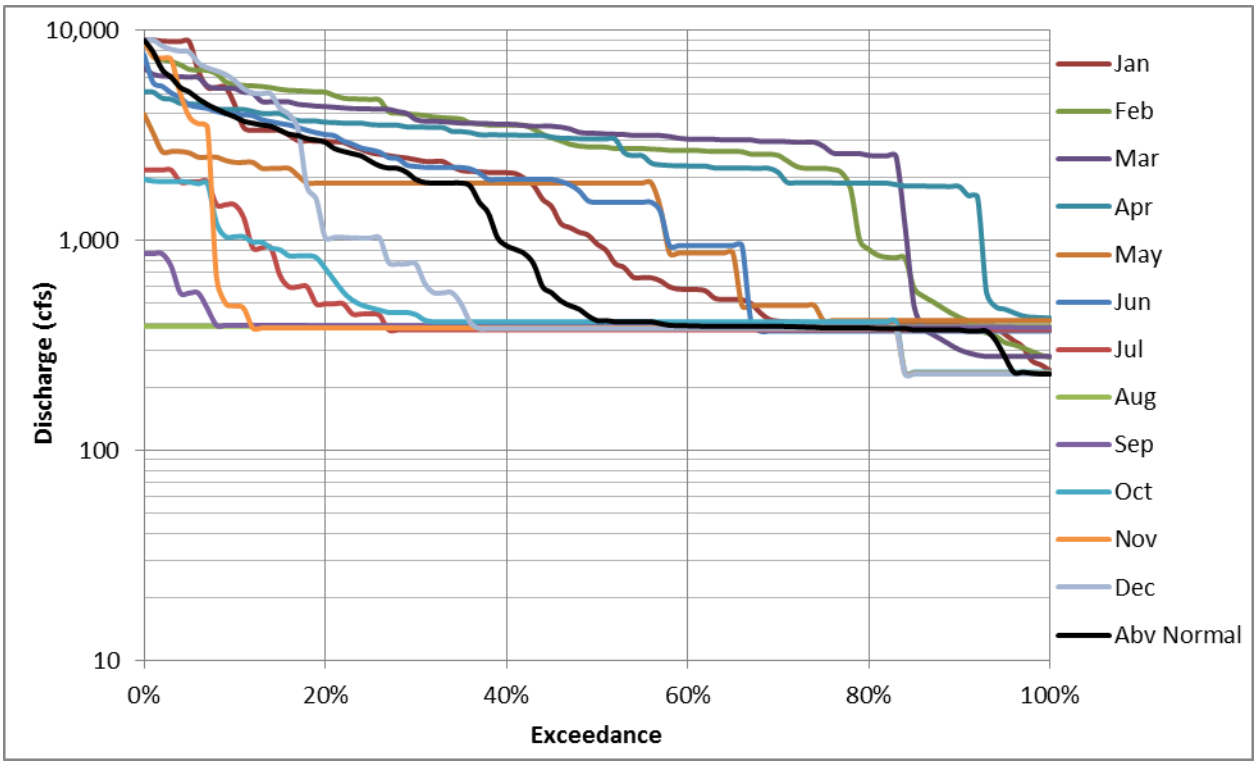


Figure 6. **Tuolumne River at Modesto flow duration curves for Above Normal years by month and for all Above Normal years for the Base Case (cfs).**

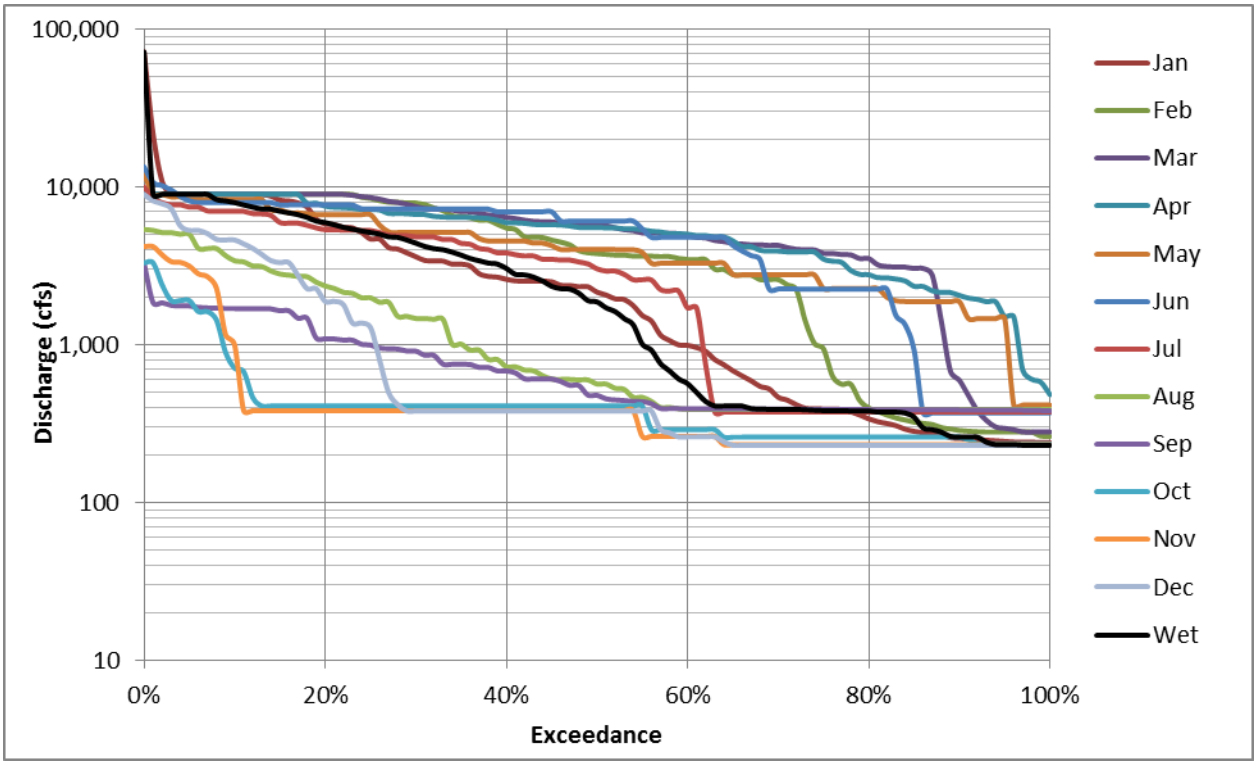


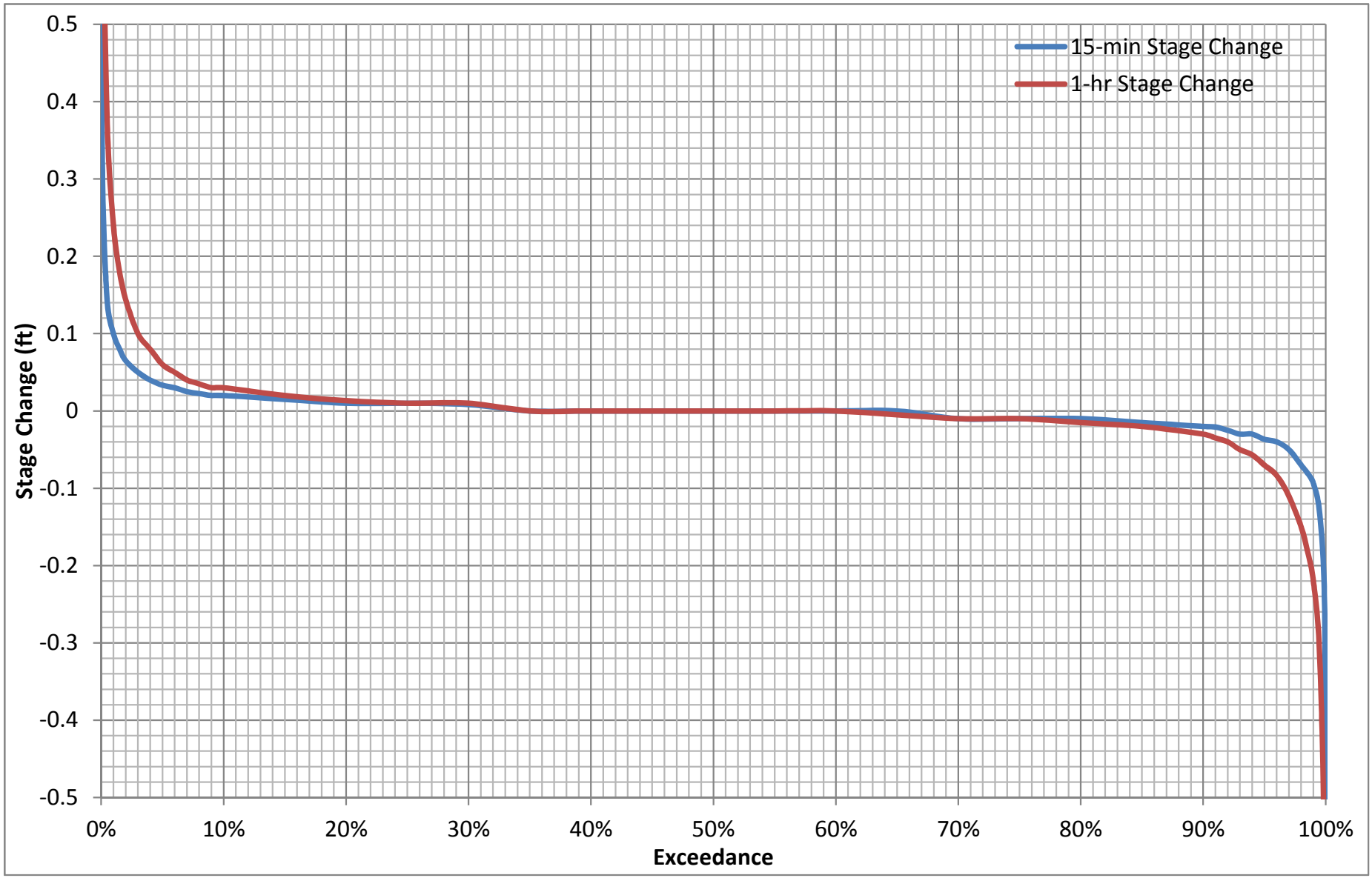
Figure 7. **Tuolumne River at Modesto flow duration curves for Wet years by month and for all Wet years for the Base Case (cfs).**

ATTACHMENT 3

Districts' Response to NMFS-4, Element 4

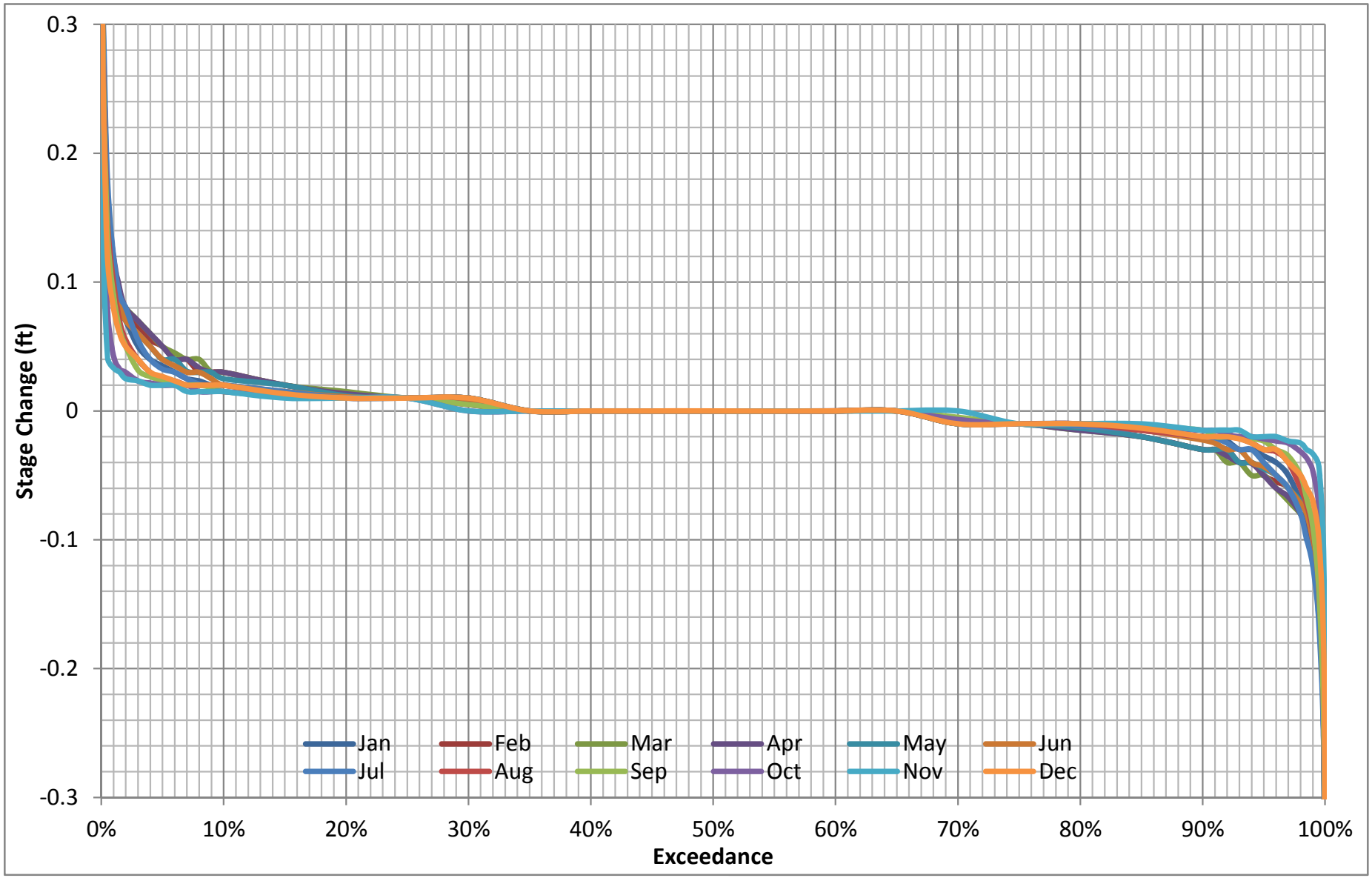
Rate of Stage Change Assessment

Tuolumne River below La Grange Dam, Gage Site
Stage Change Exceedance 1/9/1997-6/17/2013



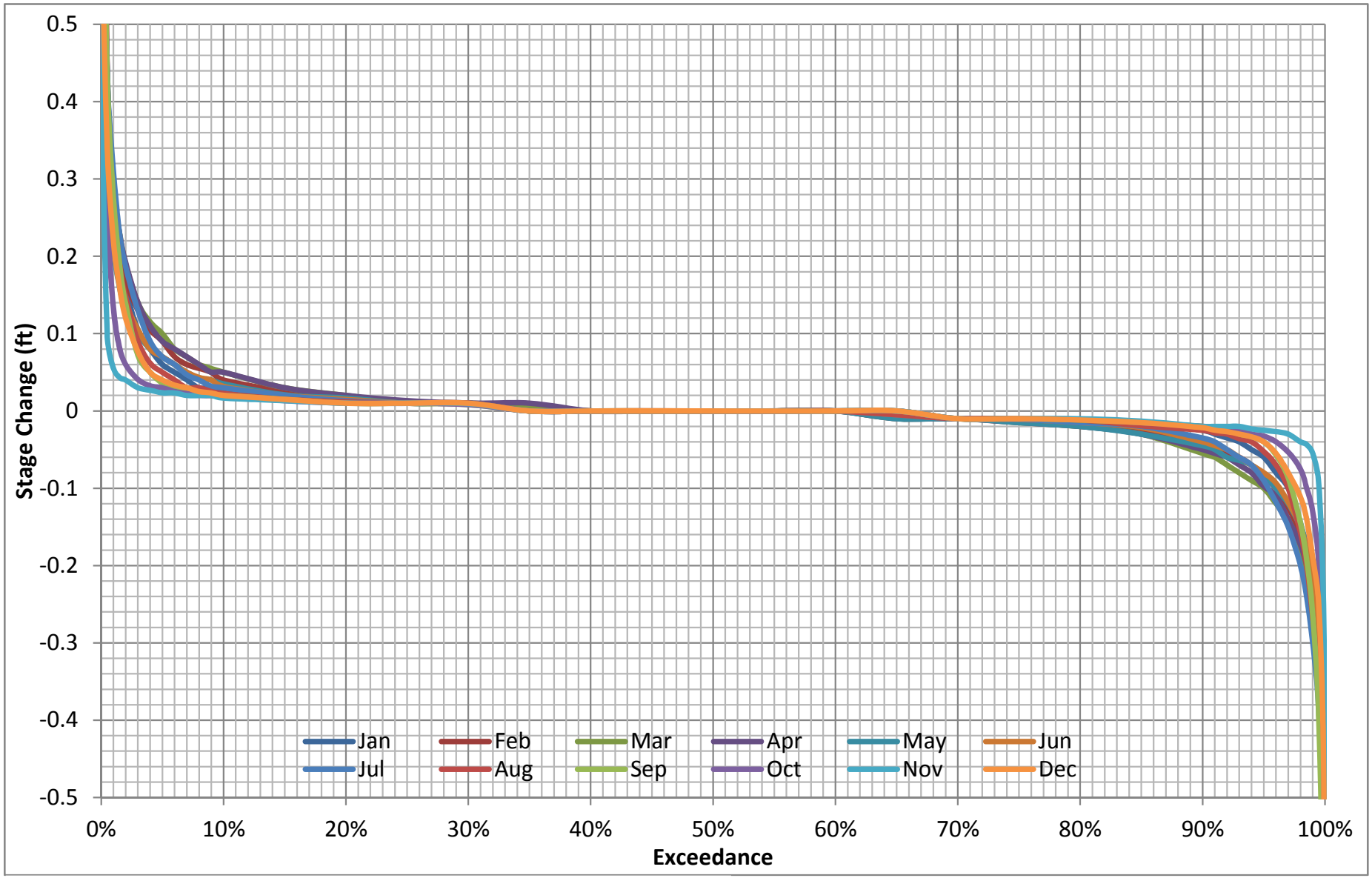
Note: Positive stage change is an increase in water elevation and negative stage change is a decrease

Tuolumne River below La Grange Dam, Gage Site
15-min Stage Change Exceedance by month

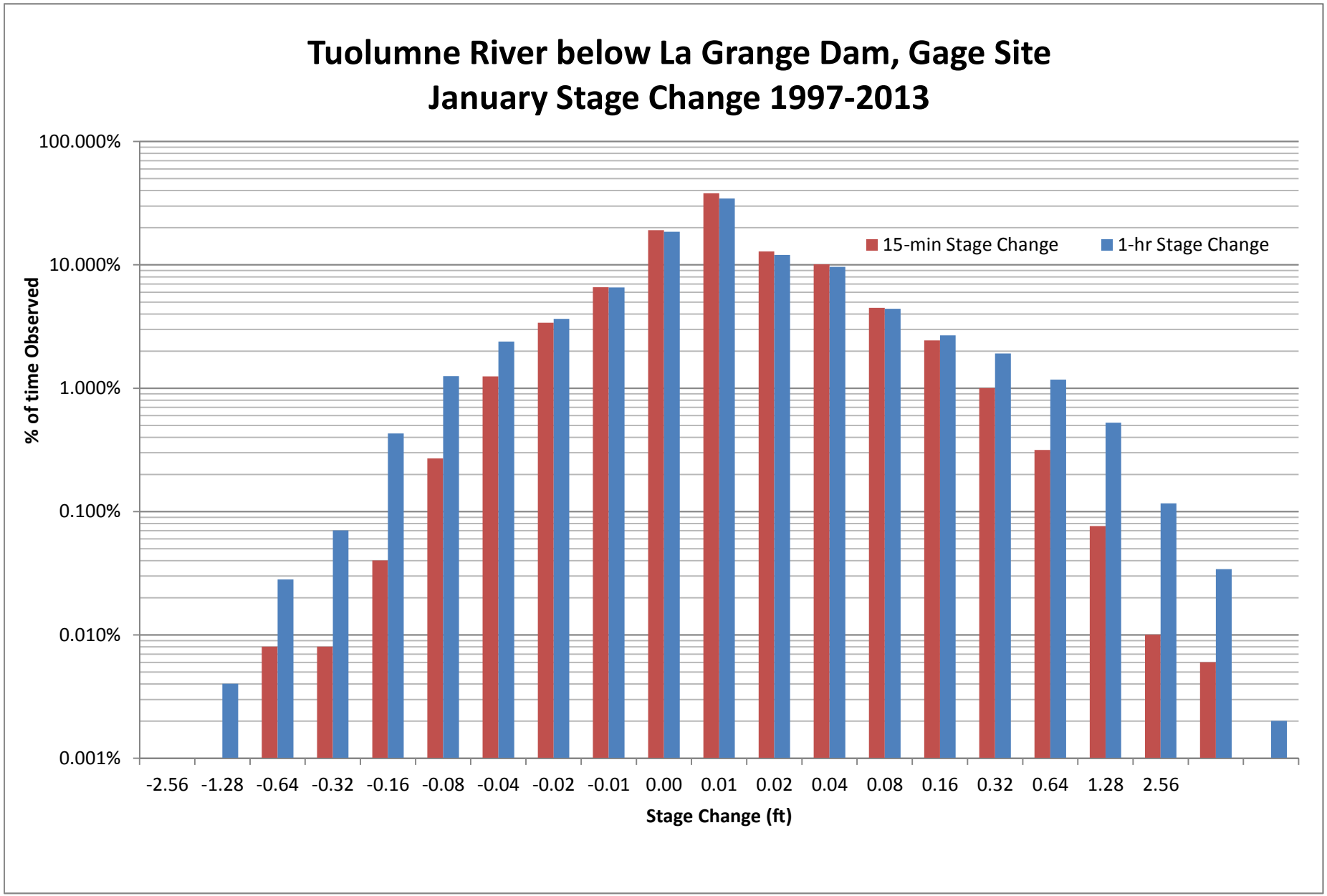


Note: Positive stage change is an increase in water elevation and negative stage change is a decrease

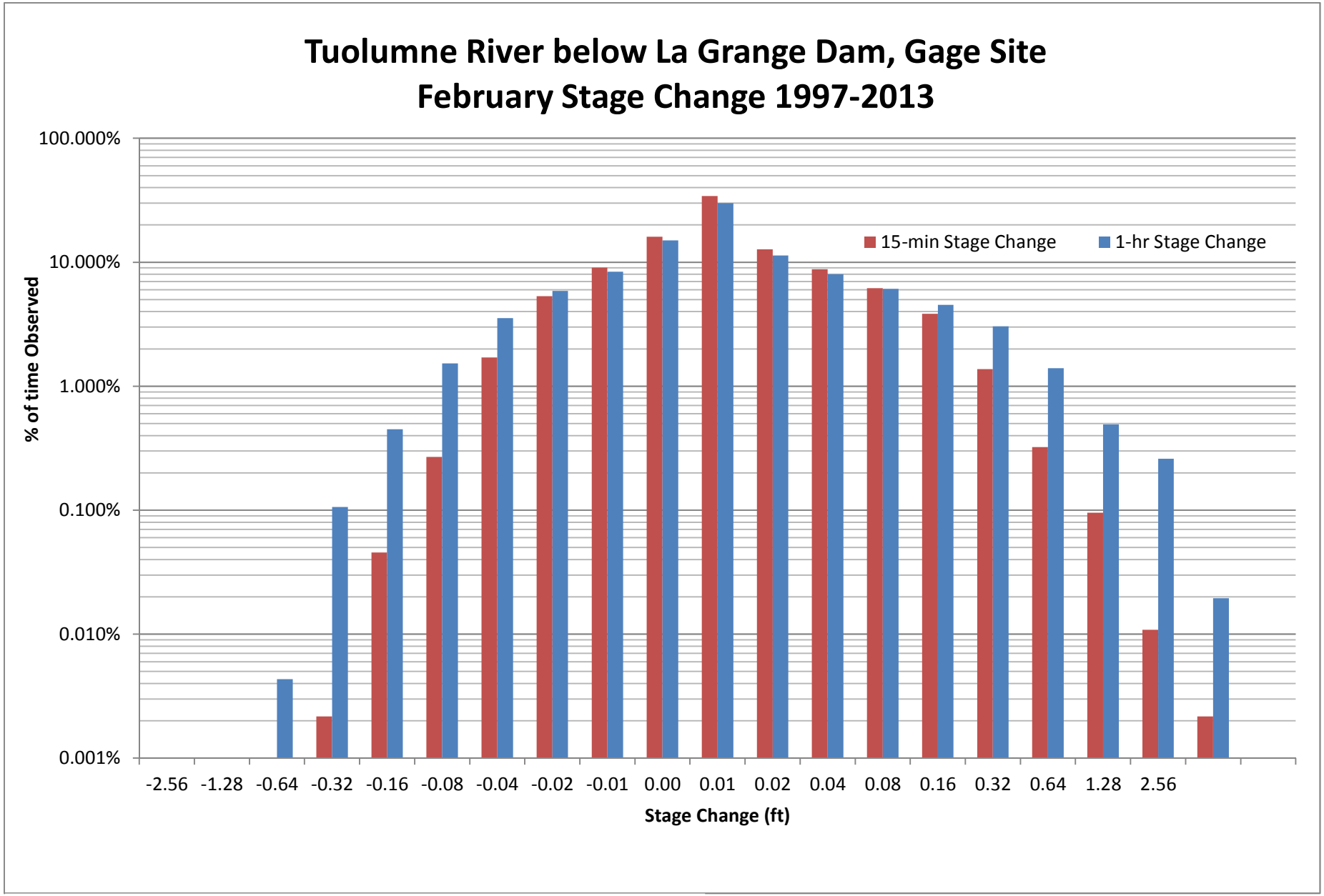
Tuolumne River below La Grange Dam, Gage Site
1-hr Stage Change Exceedance by month



Note: Positive stage change is an increase in water elevation and negative stage change is a decrease

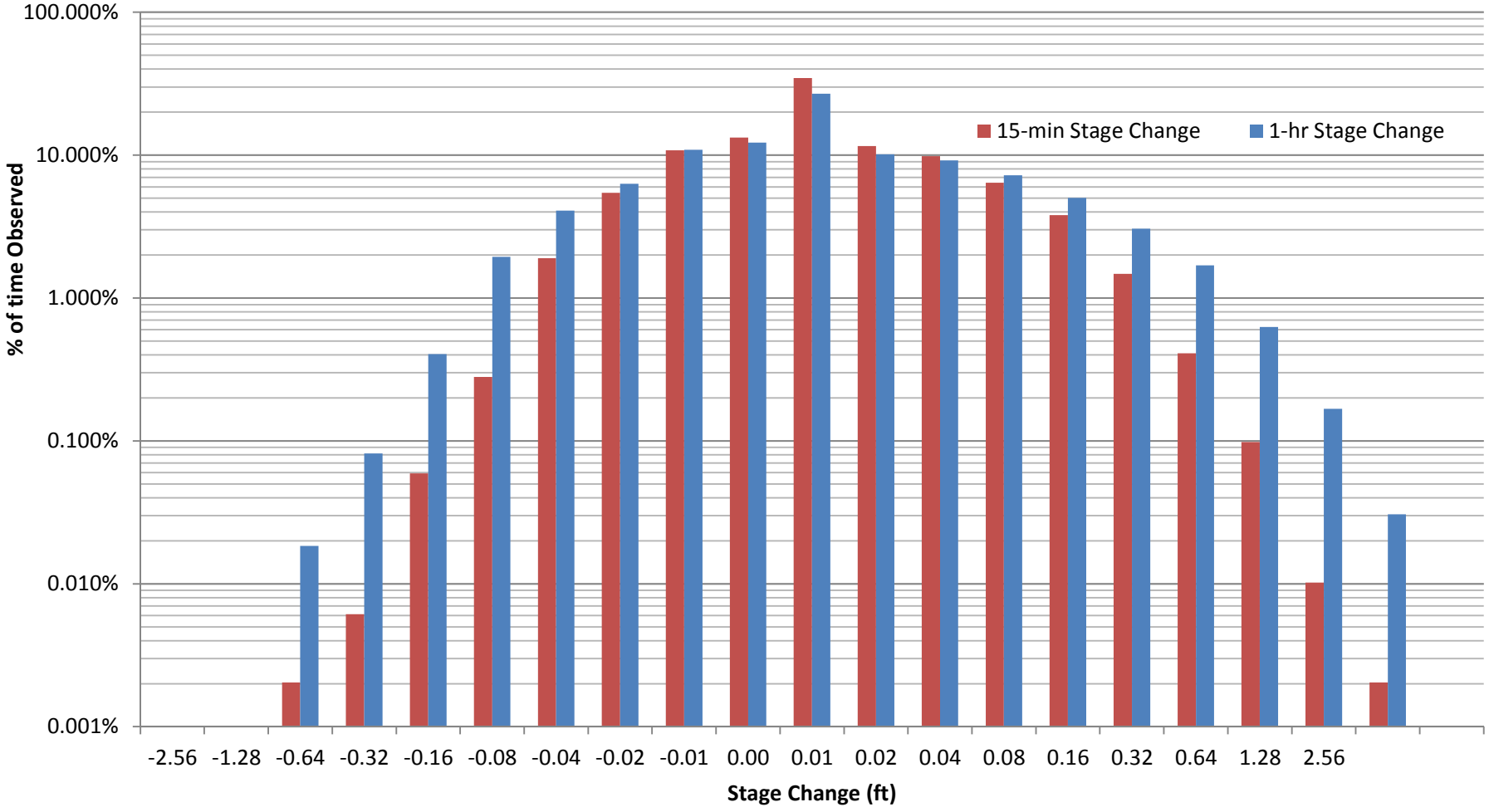


Note: Positive stage change is an increase in water elevation and negative stage change is a decrease



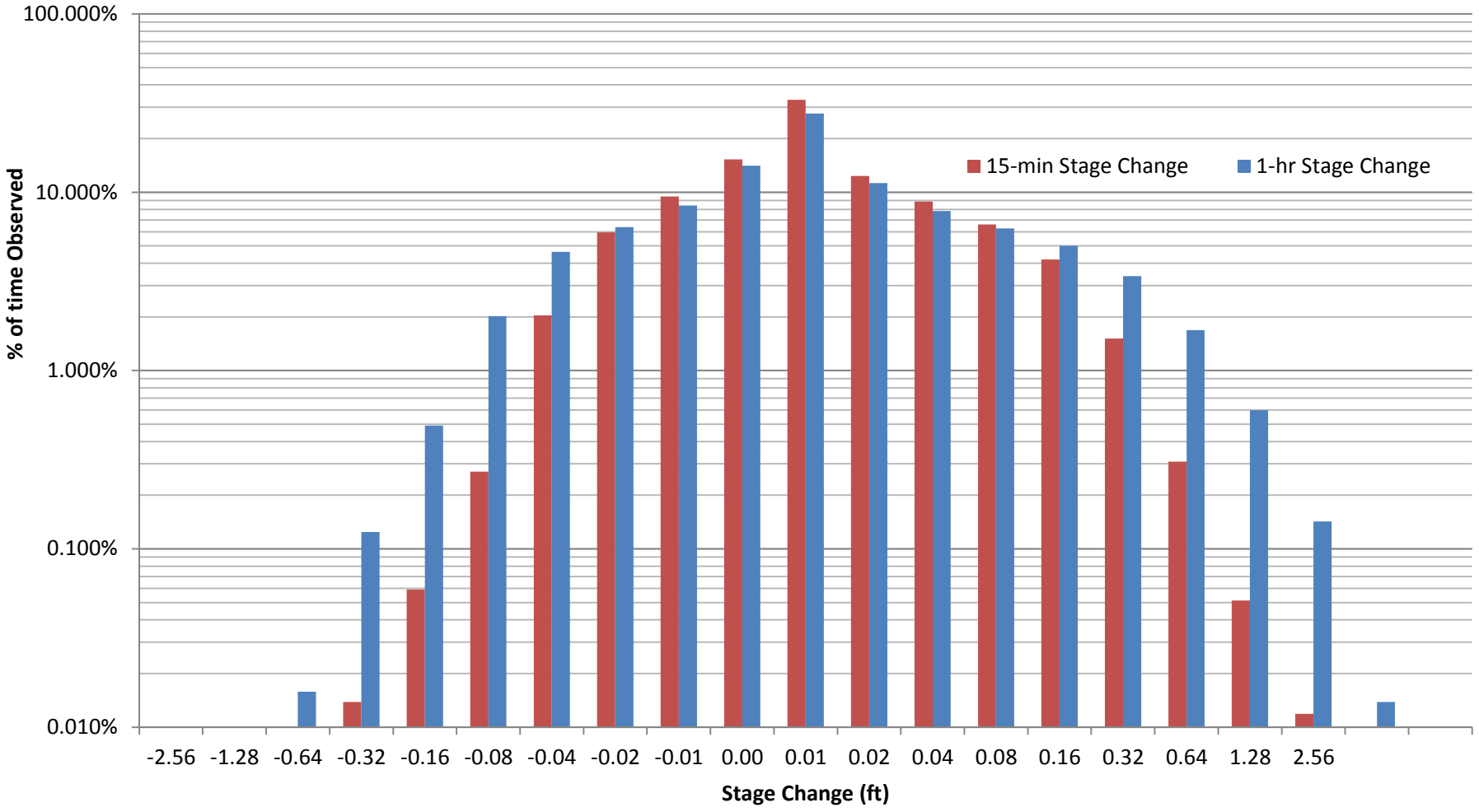
Note: Positive stage change is an increase in water elevation and negative stage change is a decrease

Tuolumne River below La Grange Dam, Gage Site
March Stage Change 1997-2013



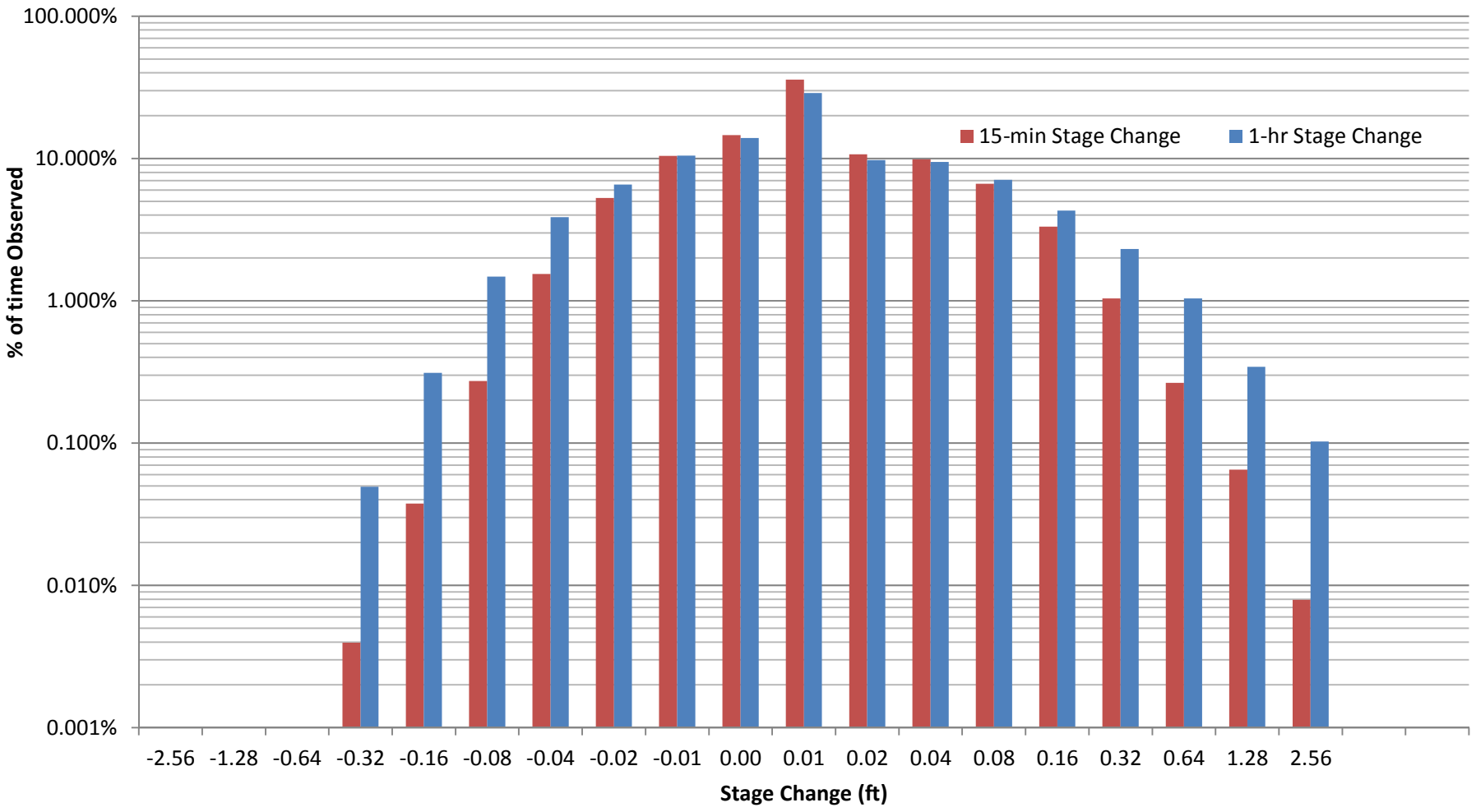
Note: Positive stage change is an increase in water elevation and negative stage change is a decrease

Tuolumne River below La Grange Dam, Gage Site
April Stage Change 1997-2013

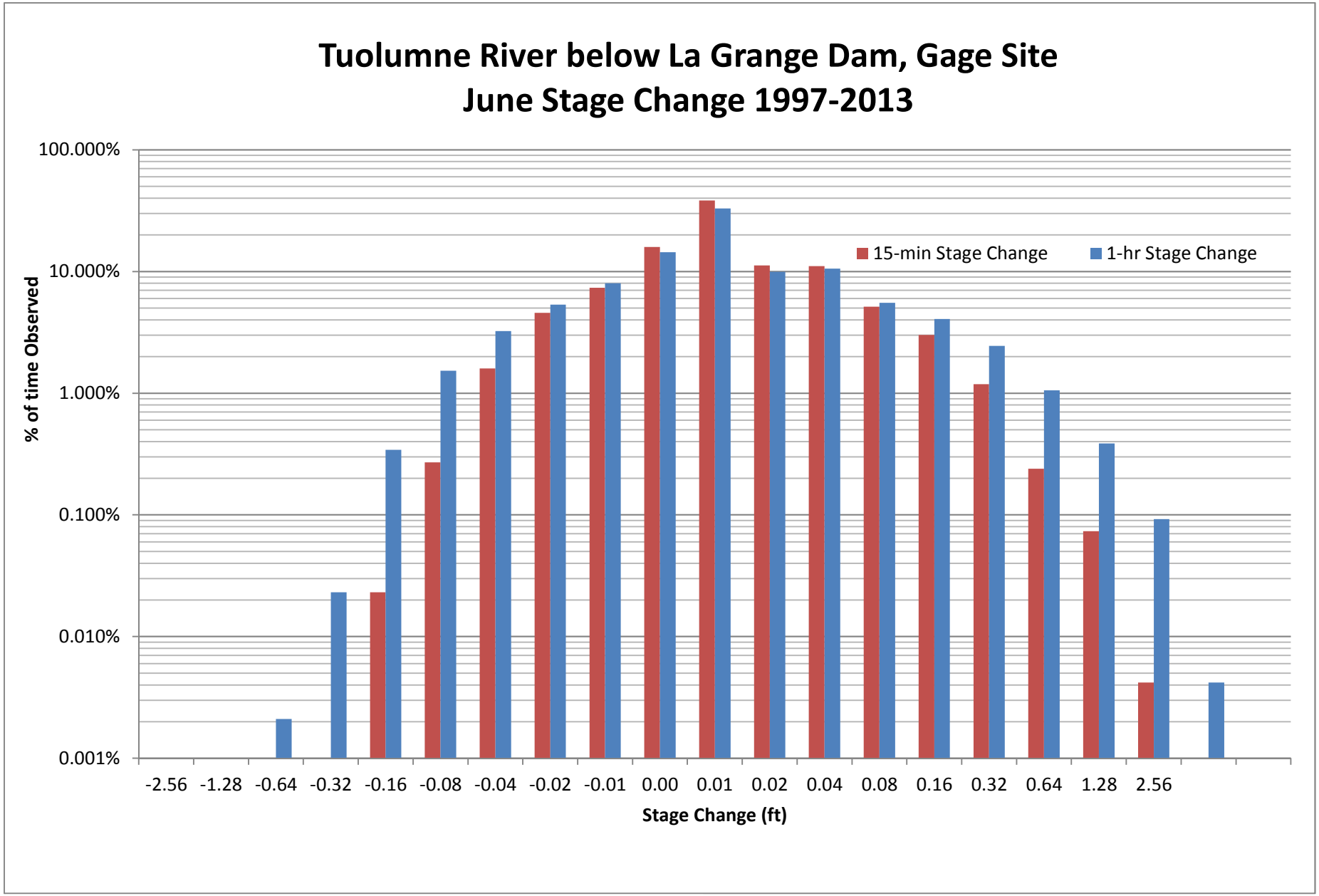


Note: Positive stage change is an increase in water elevation and negative stage change is a decrease

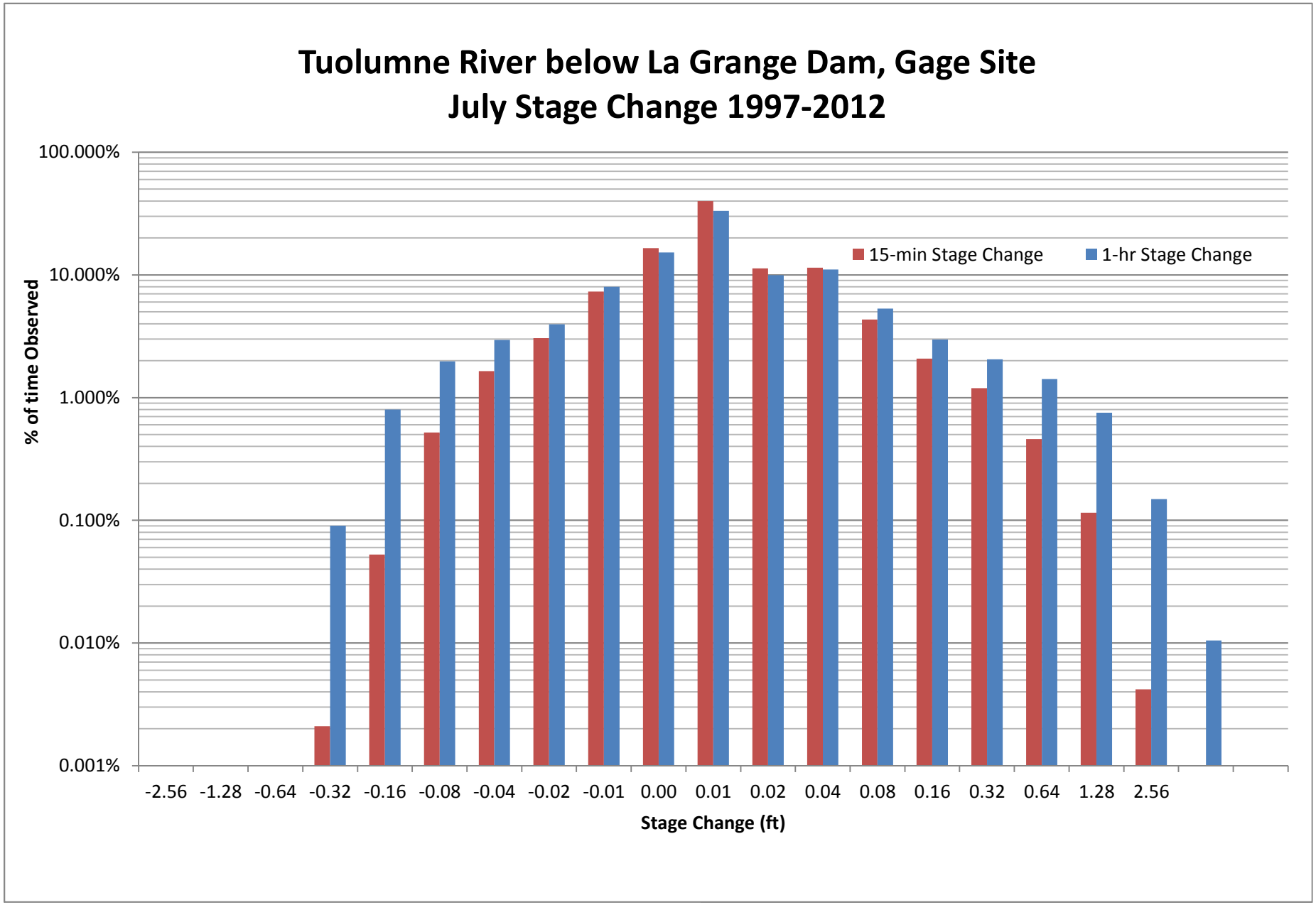
Tuolumne River below La Grange Dam, Gage Site
May Stage Change 1997-2013



Note: Positive stage change is an increase in water elevation and negative stage change is a decrease

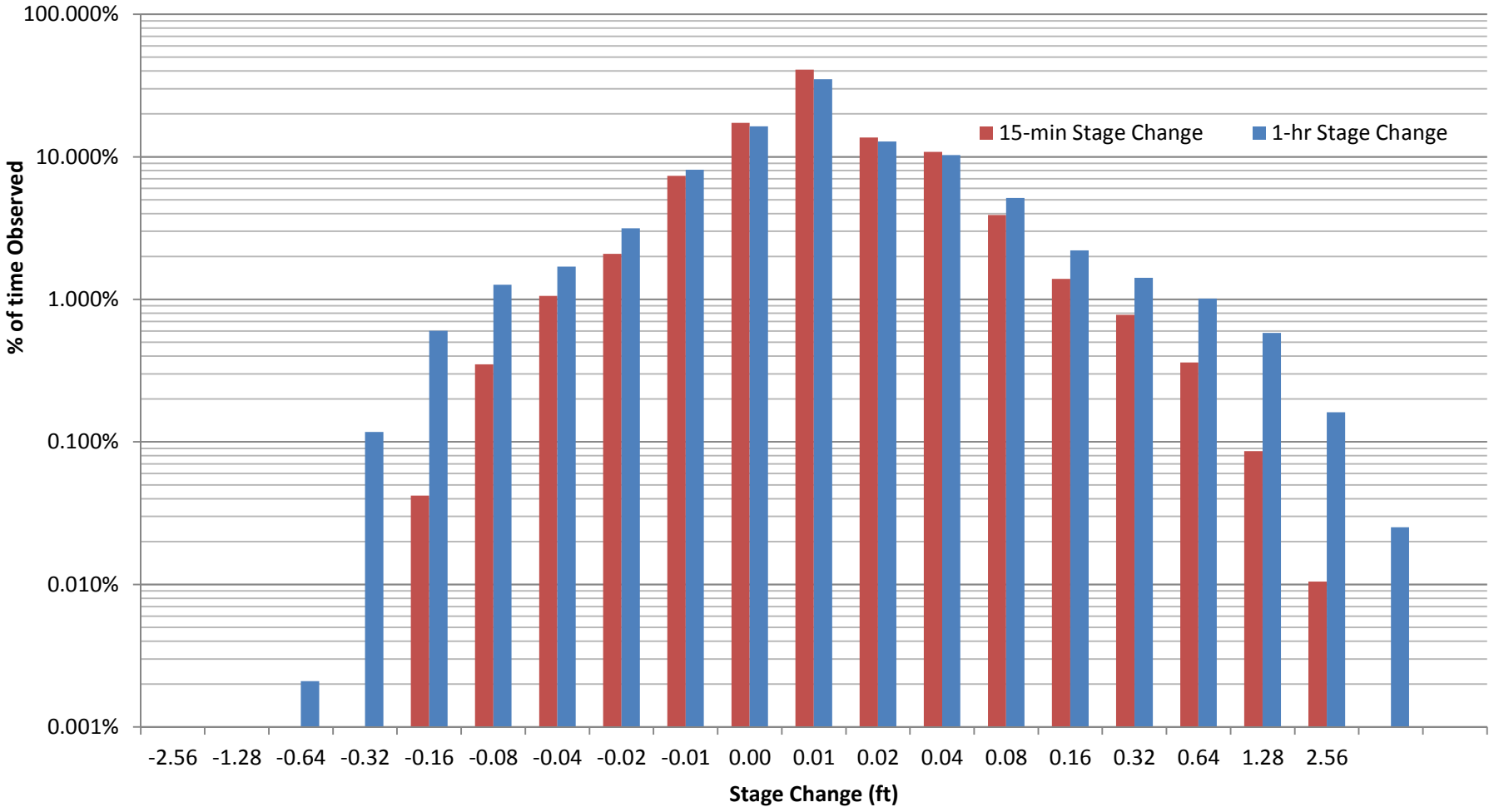


Note: Positive stage change is an increase in water elevation and negative stage change is a decrease

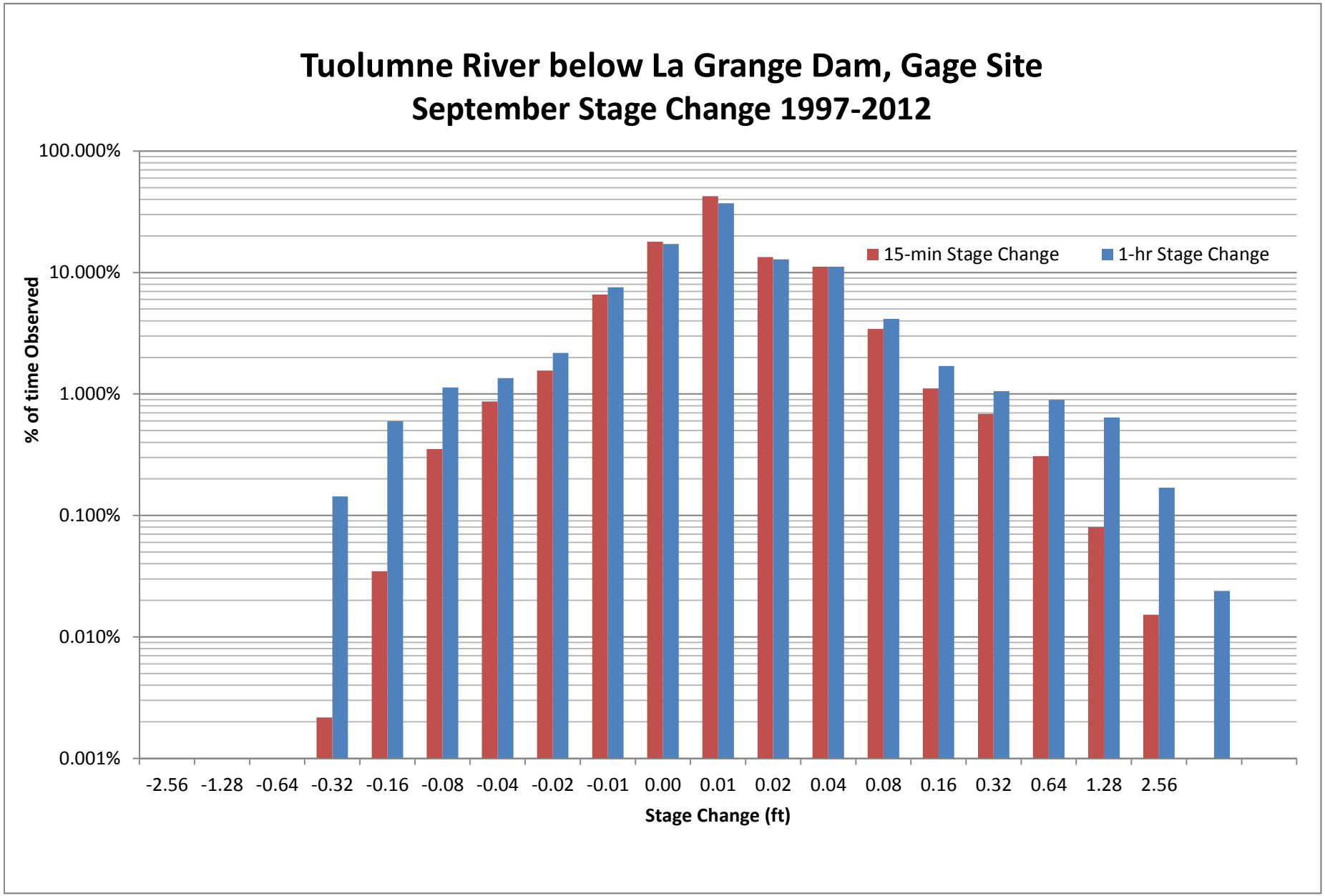


Note: Positive stage change is an increase in water elevation and negative stage change is a decrease

Tuolumne River below La Grange Dam, Gage Site
August Stage Change 1997-2012

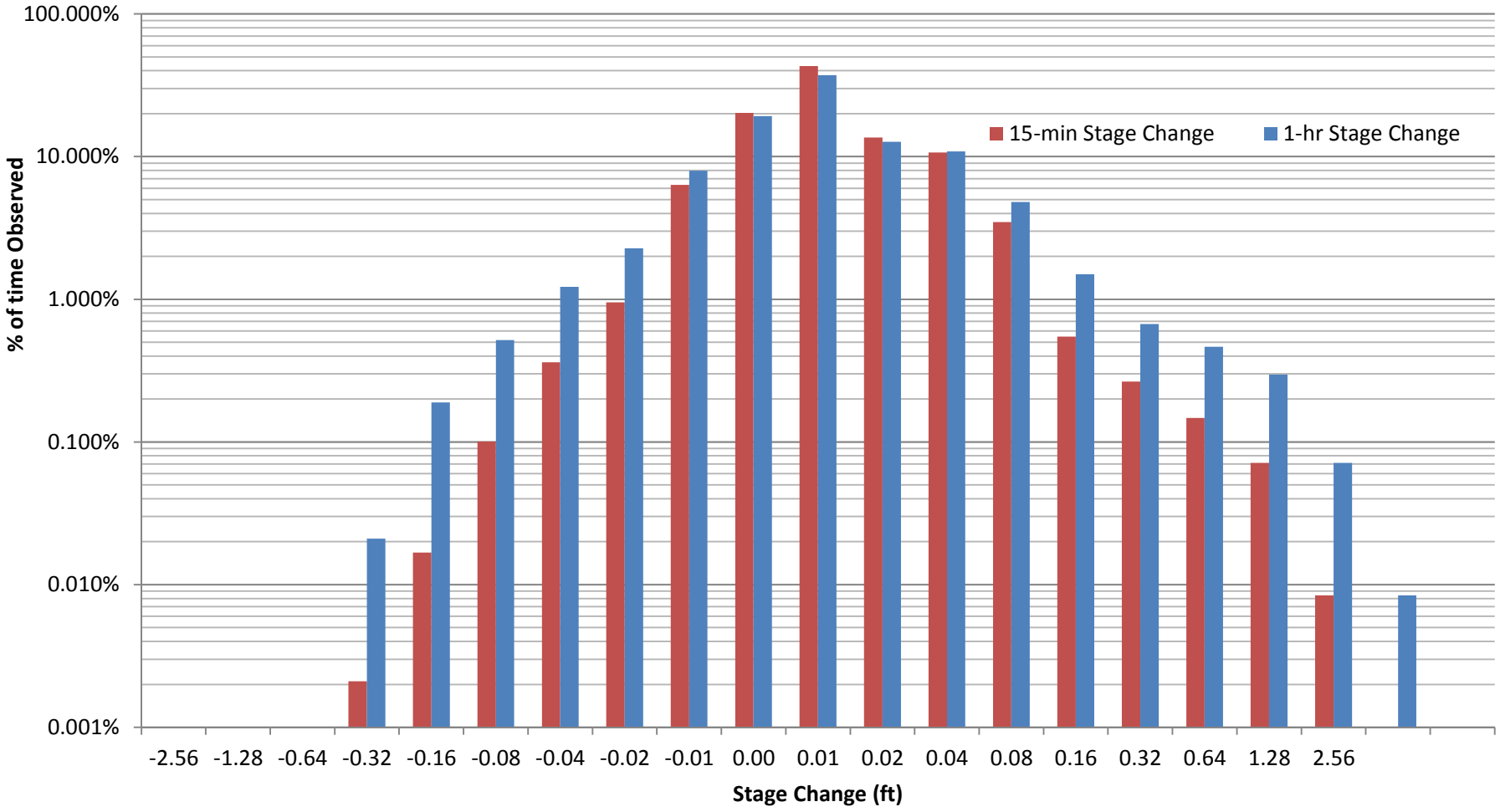


Note: Positive stage change is an increase in water elevation and negative stage change is a decrease



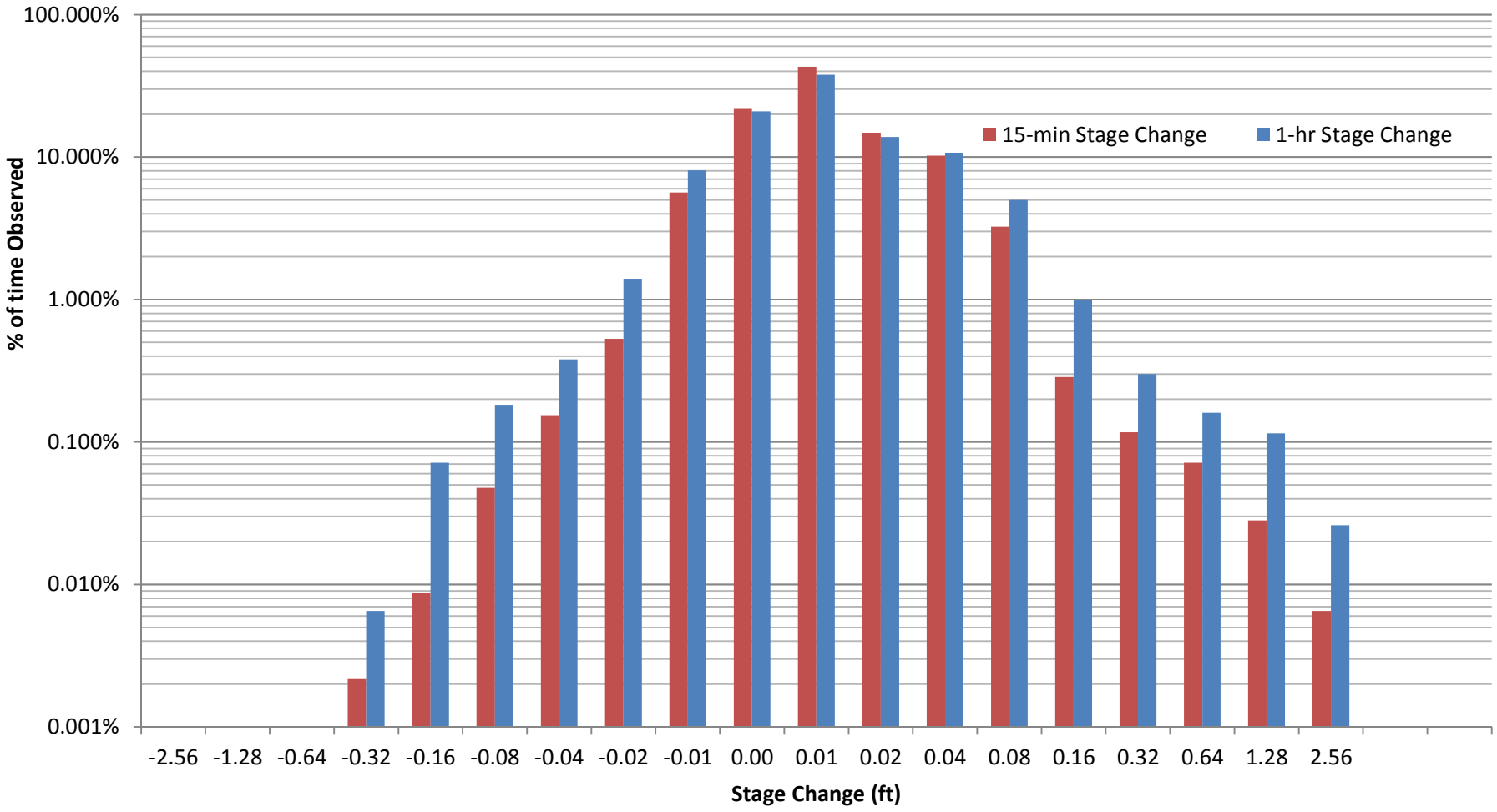
Note: Positive stage change is an increase in water elevation and negative stage change is a decrease

Tuolumne River below La Grange Dam, Gage Site
October Stage Change 1997-2012



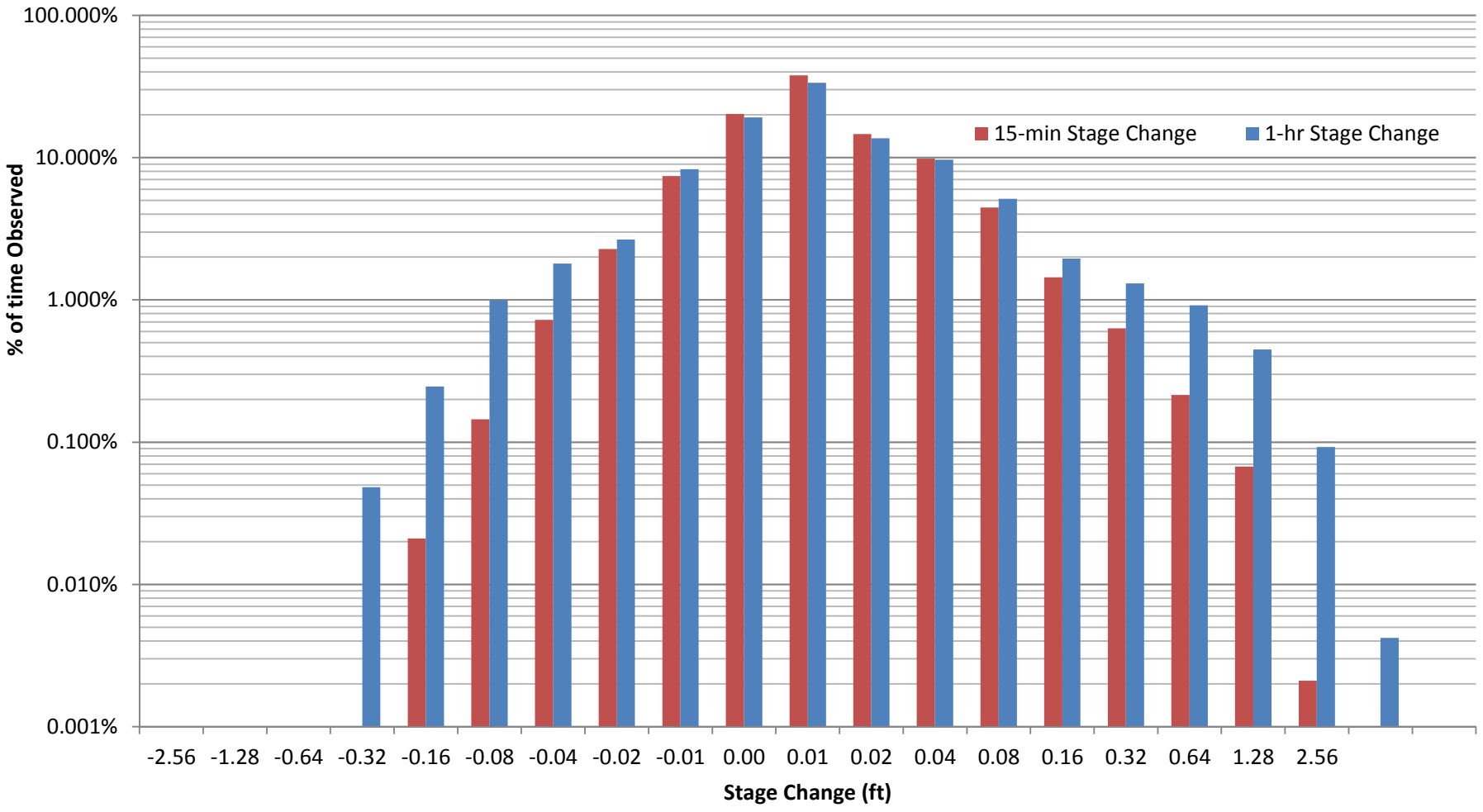
Note: Positive stage change is an increase in water elevation and negative stage change is a decrease

Tuolumne River below La Grange Dam, Gage Site
November Stage Change 1997-2012



Note: Positive stage change is an increase in water elevation and negative stage change is a decrease

Tuolumne River below La Grange Dam, Gage Site
December Stage Change 1997-2012



Note: Positive stage change is an increase in water elevation and negative stage change is a decrease

ATTACHMENT 4

March 4, 2013 ACOE Response Regarding Request to Investigate Increasing Don Pedro Project Releases

ORIGINAL

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO CA 95814-2922

REPLY TO
ATTENTION OF

March 04, 2013

Engineering Division – CESPK-ED

Mr. John J Devine
Project Manager
HDR Engineering, Inc.
970 Baxter Boulevard, Suite 301
Portland, ME 04103-5346

RE: Don Pedro Project – FERC Project #2299-075 - Request to increase releases (per your letter of July 12, 2012)

Dear Mr. Devine:

Your letter of July 12 requested the U.S. Army Corps of Engineers (Corps) to investigate increasing the maximum objective releases from Don Pedro Dam into the Tuolumne River. The increases you describe would be from 9,000 cfs to 15,000 cfs above Dry Creek and to 20,000 cfs below Dry Creek during flood events. Your letter also mentioned that this same request was made in 1996, and at that time the Corps rejected that request as it would not meet the flood protection goals along the lower Tuolumne River.

There have been no improvements in the downstream capacity or any changes to the authorized flood control criteria since 1996 that would allow the Corps to increase the maximum flood release to the Tuolumne River. Some agricultural damage to low-lying unprotected areas below Waterford would occur when flows exceed 9,000 cfs, and significant damage would begin at 12,000 cfs.

If you have any other questions or concerns, please contact Wayne Johnson, Chief of the Water Management Section (email Wayne.L.Johnson@usace.army.mil, phone (916) 557-7139) or Christy Jones, Lead Senior Water Manager (email Christy.A.Jones@usace.army.mil, phone (916) 557-7107).

Sincerely,

Rick L. Poeppelman

RICK L. POEPPELMAN, P.E.
Chief, Engineering Division

Cc: Robert Nees, Turlock Irrigation District
Greg Dias, Modesto Irrigation District
Jim Hastreiter, FERC

LA GRANGE HYDROELECTRIC PROJECT
FERC NO. 14581

DRAFT LICENSE APPLICATION

ATTACHMENT B

FLOW RECORDS FOR FIVE DISCHARGE STRUCTURES AT THE LA GRANGE PROJECT TECHNICAL MEMORANDUM

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FLOW RECORDS FOR FIVE DISCHARGE STRUCTURES AT THE LA GRANGE PROJECT TECHNICAL MEMORANDUM

LA GRANGE HYDROELECTRIC PROJECT FERC NO. 14581

Prepared for:
Turlock Irrigation District – Turlock, California
Modesto Irrigation District – Modesto, California

Prepared by:
HDR, Inc.

February 2017

1.0 BACKGROUND

Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) own the La Grange Diversion Dam (LGDD) located on the Tuolumne River in Stanislaus County, California. On February 2, 2015, the Federal Energy Regulatory Commission (the Commission or FERC) issued its Study Plan Determination (SPD) for the La Grange Hydroelectric Project (La Grange Project or Project; FERC No. 14581). In its SPD, FERC directed the Districts to continue monitoring existing flow conduits where flow monitoring is already occurring, conduct two years of flow monitoring at flow conduits not currently monitored (i.e., the Modesto hillside discharge and LGDD sluice gate), develop estimates of historical flows, data permitting, for each of the five flow conduits at the Project, and, based on existing information, to the extent available, characterize the magnitude and rate of flow and stage changes when Project conduits are shut down.

On February 2, 2016, the Districts filed with FERC the Initial Study Report (ISR) for the La Grange Project. In its April 4, 2016 comments on the ISR, the National Marine Fisheries Service (NMFS) requested flow records described in the February 2016 Flow Records for Five Discharge Structures at the La Grange Project Technical Memorandum. In their May 2, 2016 response to licensing participants' comments on the ISR, the Districts stated they would provide the requested information to NMFS and any other interested licensing participants. On May 23, 2016, the Districts mailed NMFS a CD containing spreadsheets that provide hourly flow data for La Grange powerhouse Units 1 and 2, TID sluice gates 1 and 2, the sum of flows at the MID hillside discharge and Portal 1, and the La Grange Diversion Dam spillway for the period of January 2005 through October 2015. On May 26, 2016, the Districts provided a copy of this CD to FERC.

The flow records included herein are provided in accordance with FERC's request in the SPD. In addition to the records provided herein, the Districts note that as part of the Don Pedro Hydroelectric Project (FERC No. 2299) relicensing, a list of available flow information for the La Grange Project was provided in the Initial Study Report (TID/MID 2013) and an assessment of rates of change of flow as measured at the U.S. Geological Survey (USGS) La Grange gage located just below LGDD was provided in the Updated Study Report (TID/MID 2014).

The Districts continued flow monitoring through the end of water year (WY) 2016. The results of the WY 2016 flow monitoring are reported herein. Spreadsheets that provide hourly flow data for La Grange powerhouse Units 1 and 2, TID sluice gates 1 and 2, the sum of flows at the MID hillside discharge and Portal 1, and the La Grange Diversion Dam spillway are now available for the period of January 2005 through November 2016. These spreadsheets are available upon request to Jenna Borovansky at jenna.borovansky@hdrinc.com.

2.0 STUDY AREA

The study area encompasses five discharge structures of the La Grange Project by which water can be passed downstream to the Tuolumne River. The structures are as follows:

- TID La Grange powerhouse structure, Units 1 and 2
- TID sluice gate structure, Gates 1 and 2
- MID hillside discharge gate structure
- Portal 1 gate located in the dam near the MID abutment (i.e., the LGDD sluice gate)
- LGDD spillway

Figure 2.0-1 shows the location of each discharge structure. Portals 3, 4, and 5 were used during construction and are no longer in use. The maximum powerhouse flow capacity is approximately 575 cubic feet per second (cfs) with both units operating; the TID sluice gate capacity is approximately 550 cfs with both gates open full; the MID hillside gate has a reported capacity of approximately 350 cfs; and the Portal 1 gate can pass approximately 200 cfs when fully open and water level in the La Grange pool is at or near the spillway crest.

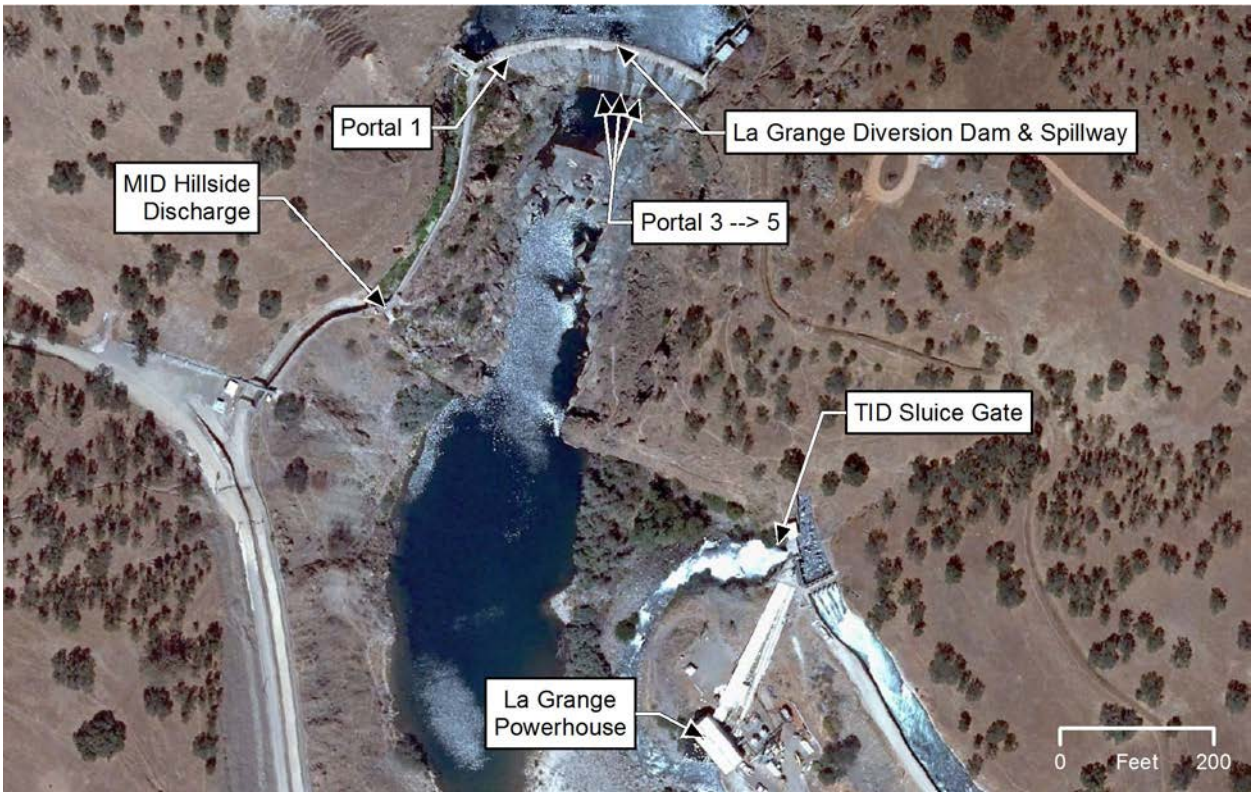

Figure 2.0-1. Location of five discharge structures at the La Grange Project.

3.0 DATA AVAILABILITY AND ANALYSIS

Flow data available for the La Grange Project was identified in the Don Pedro Hydroelectric Project Initial Study Report (TID/MID 2013). Data consist of flow records for the two units in the TID powerhouse, sluice gate openings as a percent of full open, and pool level, all of which would pass flows that would be recorded at the downstream USGS La Grange gage. The USGS La Grange gage is the only continuous record of both flow and stage and therefore records of the rate of stage change in the tailrace or in the pool below the LGDD are not available.

Discharge records for the MID hillside gate and Portal 1 gate do not exist. Records of operation of the MID hillside gate and the Portal 1 gate are limited to narrative text of changes to the gate openings for April through December 2013 and calendar years 2014 and 2015. Narrative descriptions of changes to gate openings and approximate flow targets were provided for WY 2016 to fulfill the purposes of this report. When the Tainter gates that control flow to the hillside gates are closed, a constant leakage of approximately 10 cfs occurs, and this flow is discharged at the hillside valves (see Figure 3.0-1).

Figure 3.0-1. Hillside valves which pass flow from the MID canal to the plunge pool below LGDD.

For purposes of this current analysis, the flow record was divided into two time periods: 2014 through 2016 and 2005 through 2013. The former period had a record of gate changes for the hillside and Portal 1 gates, while the latter period only had records for the TID powerhouse and TID sluice gate openings, but represents a period when the current minimum flow requirements were in place.

The data analysis for 2014 through 2016 was conducted using the USGS La Grange gage as the best indicator of total flow being passed at the La Grange Project. The flow from each of the TID generating units at the La Grange powerhouse was directly available; the flow from each of the TID sluice gates was calculated based on the gate position when open. The flows at the MID hillside and Portal 1 gates were estimated from the MID operator's narrative notes of gate

changes. The total individual discharges were summed and compared to the discharge recorded at the USGS La Grange gage. When adjustments to flow were needed to "true up" to the USGS gage, flow from the MID hillside and/or Portal 1 gate were adjusted, these being the least reliable flow record. There were no spills at the spillway during the 2014/2015 period. In WY 2016, spills between 1200 and 1600 cfs occurred on April 16, 2016, April 23, 2016, and April 30, 2016; and a spill of approximately 400 cfs occurred on May 6, 2016. The resulting flow record for the 2014 through 2016 period, based on hourly discharges, is provided in Figures 3.0-2 through 3.0-4. In Figures 3.0-2 through 3.0-4, "USGS Total" refers to flows recorded by the USGS La Grange gage, "Unit 1" refers to flows through La Grange powerhouse Unit 1, "Unit 2" refers to flows through La Grange powerhouse Unit 2, "Sluice A" refers to flows through TID sluice gate 1, "Sluice B" refers to flows through TID sluice gate 2, "MID Total" refers to the sum of flows at the MID hillside discharge and Portal 1, and "Spill" refers to flow at the LGDD spillway. Attachments A, B, and C contain records of discharges by month in years 2014, 2015, and 2016, respectively.

For the period 2005 to 2013, the records available are limited to the TID La Grange powerhouse units, the TID sluice gates, the pool level and the USGS La Grange gage. To estimate flows from the other structures, flows were back-calculated by identifying the difference between the USGS gage flow and the powerhouse plus TID sluice gate flow. If the USGS flow was still greater, then flows were assigned as follows: MID hillside gate up to 350 cfs; Portal 1 gate up to 200 cfs; spill at spillway assuming pool level was greater than 296.5 feet (spillway crest elevation). These estimated flows from 2005 to 2013 are presented in Attachment D for each calendar year.

A minimum flow of 10 cfs was estimated to occur at the MID hillside gate at all times as the amount of the leakage from the MID Tainter gates. Using a pygmy flow meter, a measurement of flow in the mainstem Tuolumne River parallel to the La Grange powerhouse tailrace channel was made in 2015 when only the leakage was occurring. This flow was measured to be slightly less than 10 cfs. TID currently maintains in an open position an 18-inch pipe that continuously delivers flow from the TID forebay to the channel downstream of the sluice gates. This water flows into the tailrace just upstream of the powerhouse. The flow quantity is not measured and is unknown, but is roughly estimated to be about 5 to 10 cfs. This flow is not included in the computations contained in the analyses conducted for this report due to the uncertainty of the quantity of flow discharged and lack of records about its history of operation.

FERC indicated in the SPD that having additional historical flow records below LGDD would help inform an evaluation of Project effects on anadromous fish habitat. These flow records, to the extent able to be estimated, are provided herein.

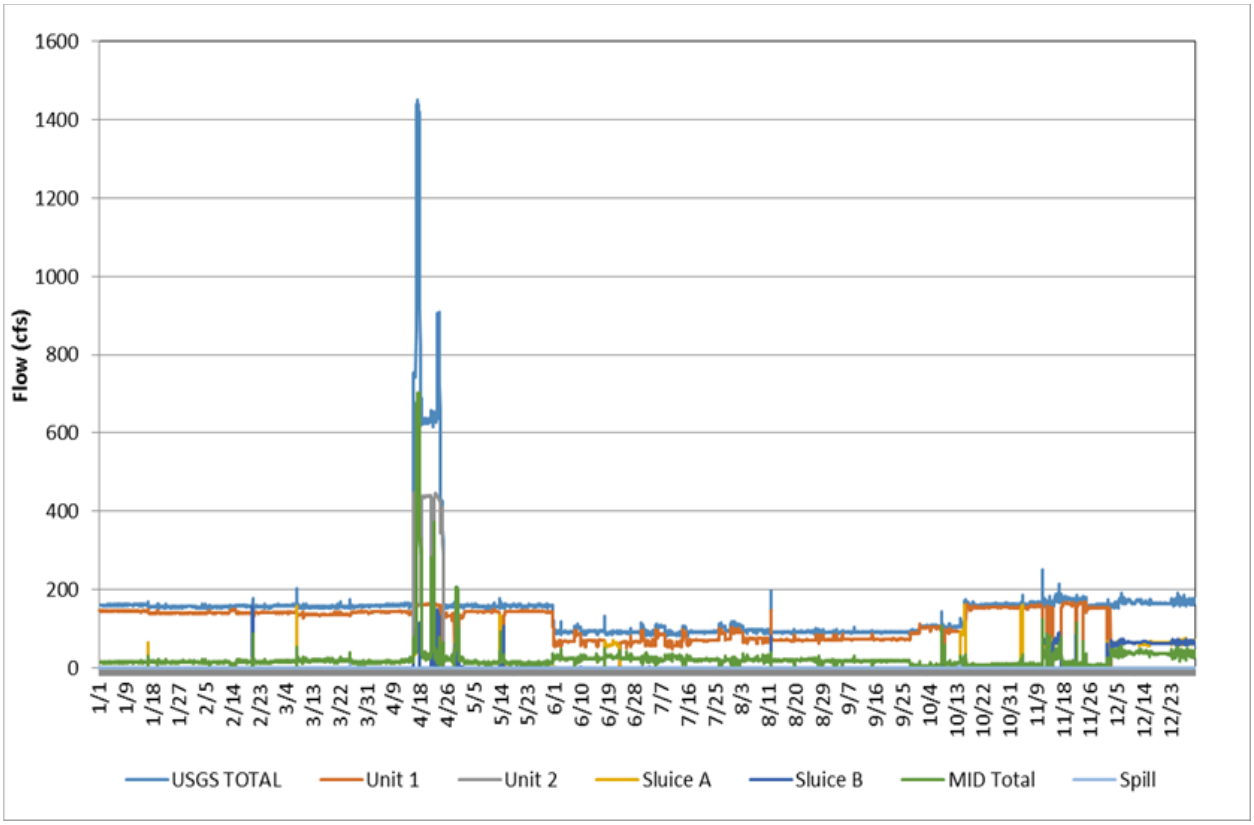

Figure 3.0-2. Flow record for year 2014, based on hourly discharges.

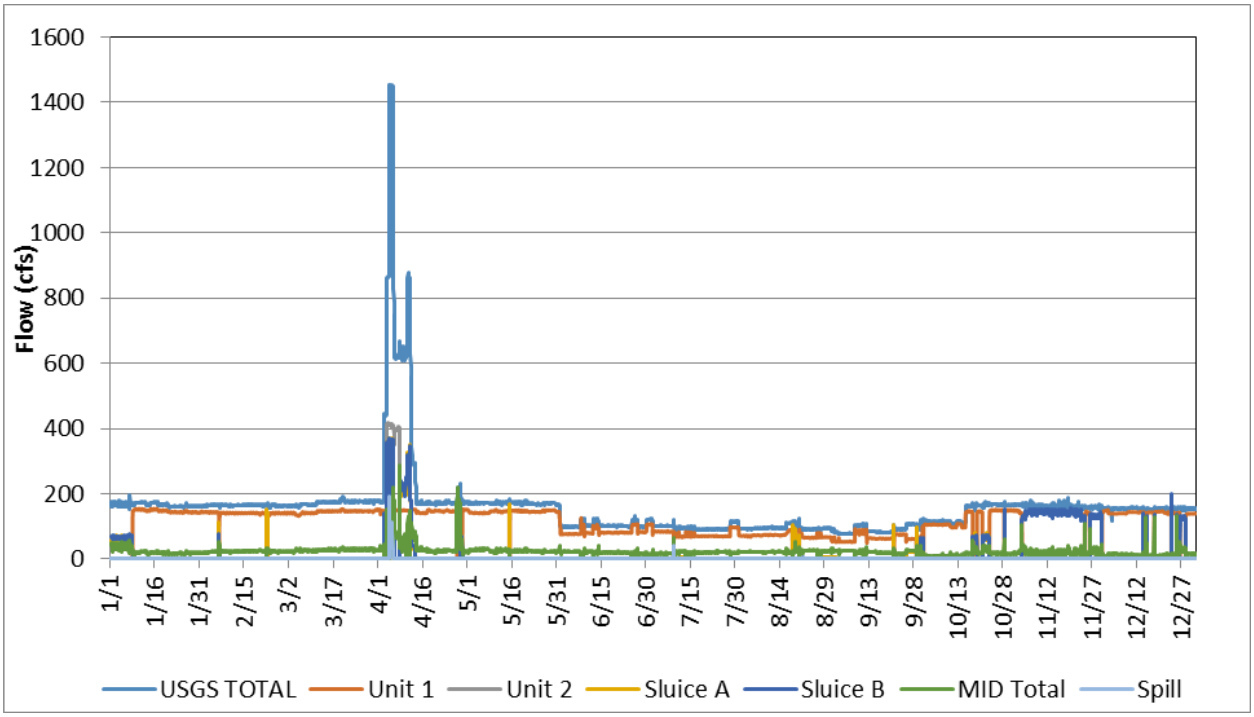

Figure 3.0-3. Flow records for year 2015, based on hourly discharges.

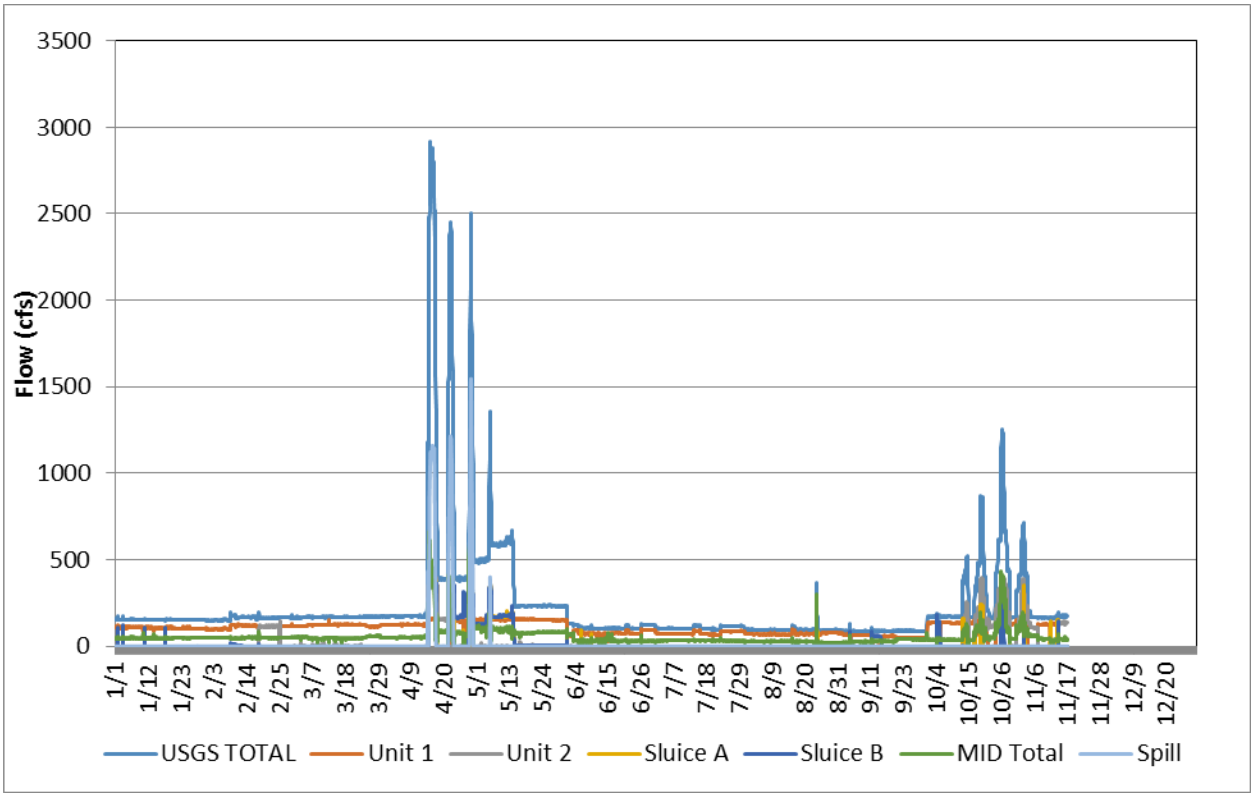

Figure 3.0-4. Flow records for year 2016, based on hourly discharges.

4.0 STUDY VARIANCES AND MODIFICATIONS

This study was conducted consistent with the FERC-approved study plan. No variances or modifications occurred.

5.0 REFERENCES

Turlock Irrigation District and Modesto Irrigation District (TID/MID). 2013. Don Pedro Hydroelectric Project Initial Study Report. January 2013.

_____. 2014. Don Pedro Hydroelectric Project Updated Study Report, Attachment: *Technical Memorandum: NMFS Information Requests*, pages 1-96. January 2014.

FLOW RECORDS FOR FIVE DISCHARGE STRUCTURES AT THE LA GRANGE PROJECT
TECHNICAL MEMORANDUM

ATTACHMENT A

2014 MONTHLY FLOW RECORDS

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Please refer to the legend below for all figures in this attachment:

- USGS Total = Flows recorded by the USGS La Grange gage.
- Unit 1 = Flows through La Grange powerhouse Unit 1.
- Unit 2 = Flows through La Grange powerhouse Unit 2.
- Sluice A = Flows through TID sluice gate 1.
- Sluice B = Flows through TID sluice gate 2.
- MID Total = The sum of flows at the MID hillside discharge and Portal 1.
- Spill = Spill at the LGDD spillway.
- TID currently maintains in an open position an 18-inch pipe that continuously delivers flow from the TID forebay to the channel downstream of the sluice gates. The flow quantity is not measured and is unknown, but is roughly estimated to be about 5 cfs. This flow is not included in the computations contained in the analyses conducted for this report due to the uncertainty of the quantity of flow discharged and its history of operation.

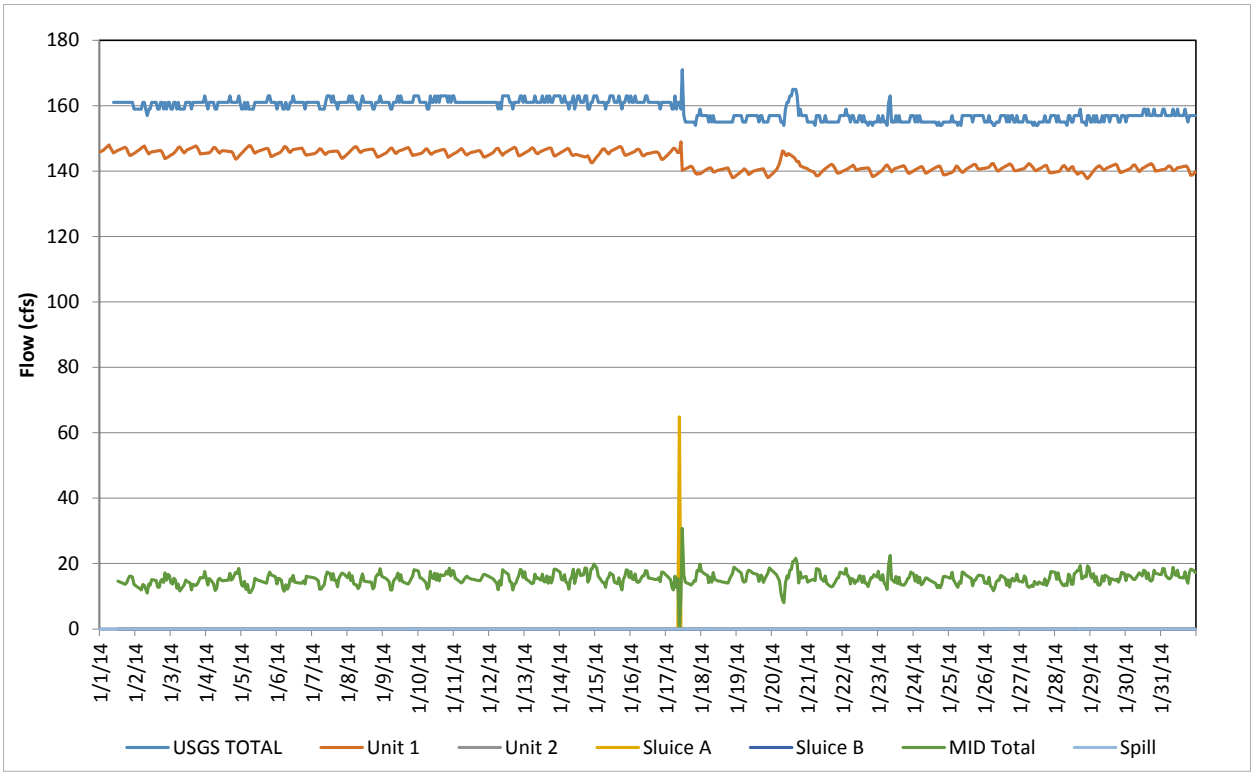

Figure A-1. Flow record in January 2014, based on hourly discharges.

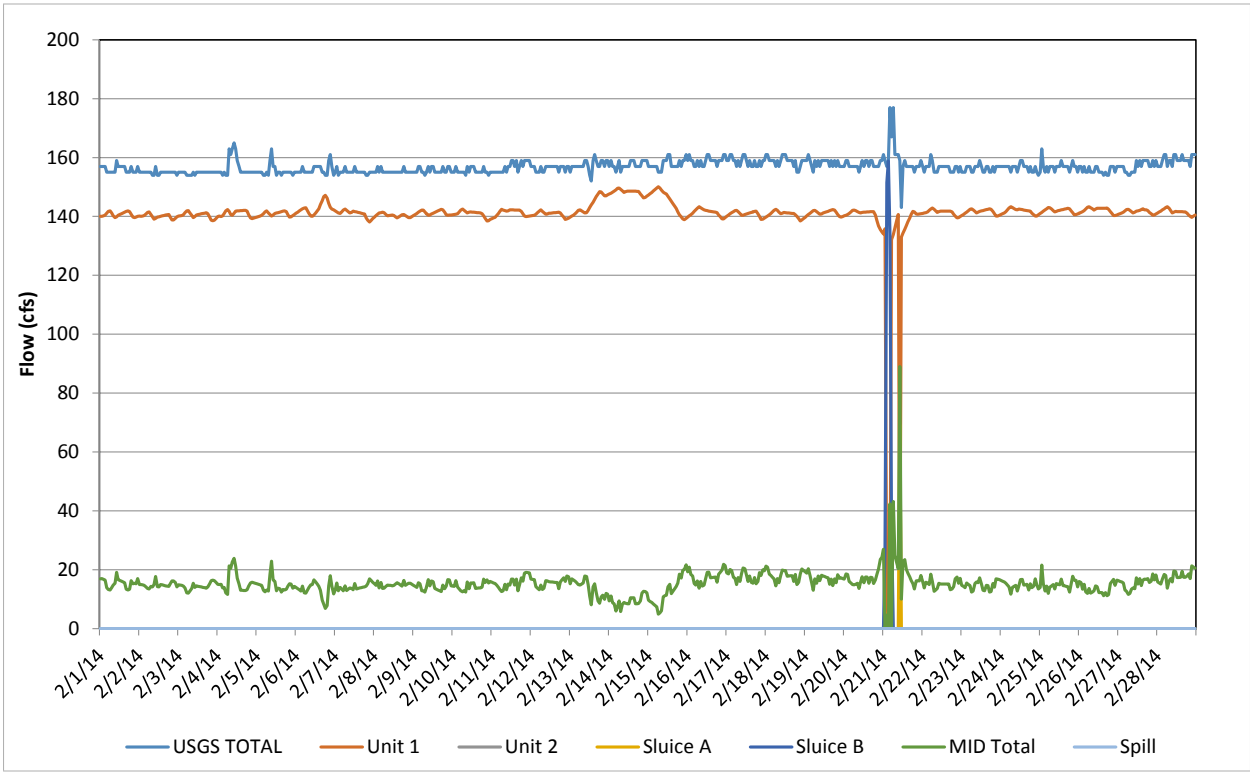

Figure A-2. Flow record in February 2014, based on hourly discharges.

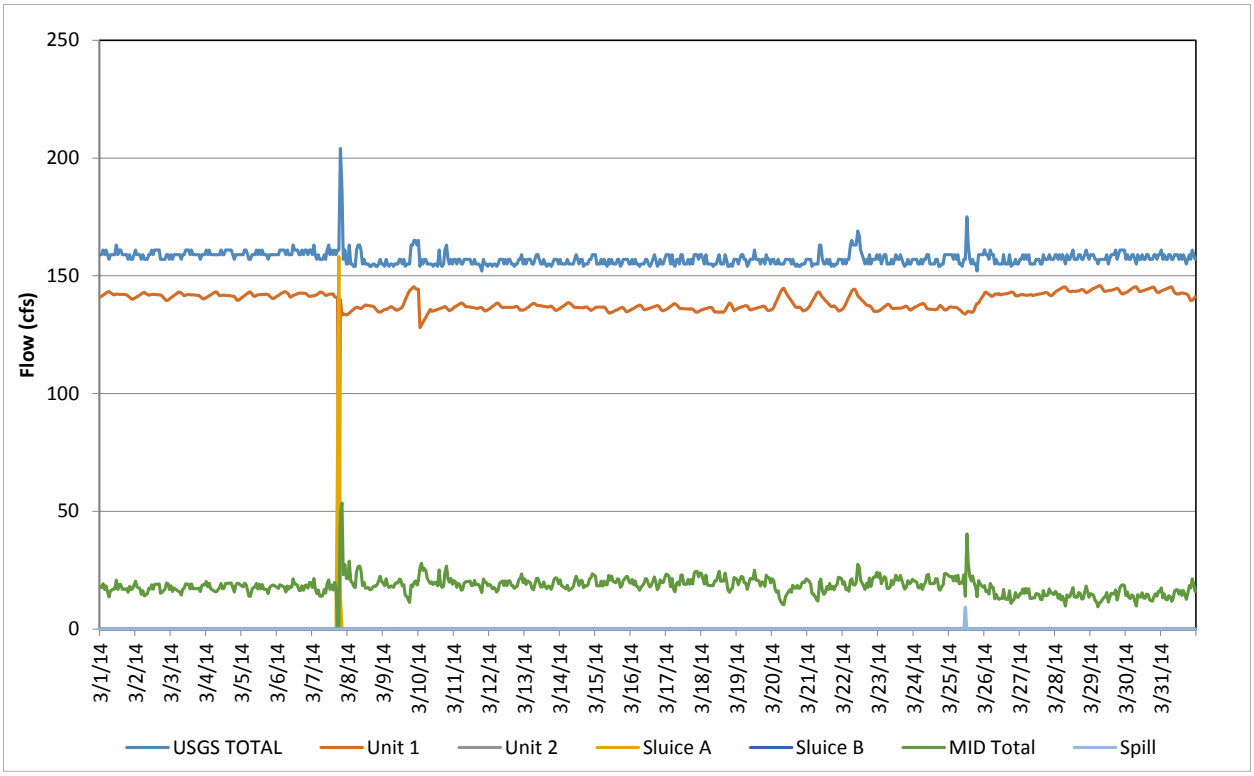

Figure A-3. Flow record in March 2014, based on hourly discharges.

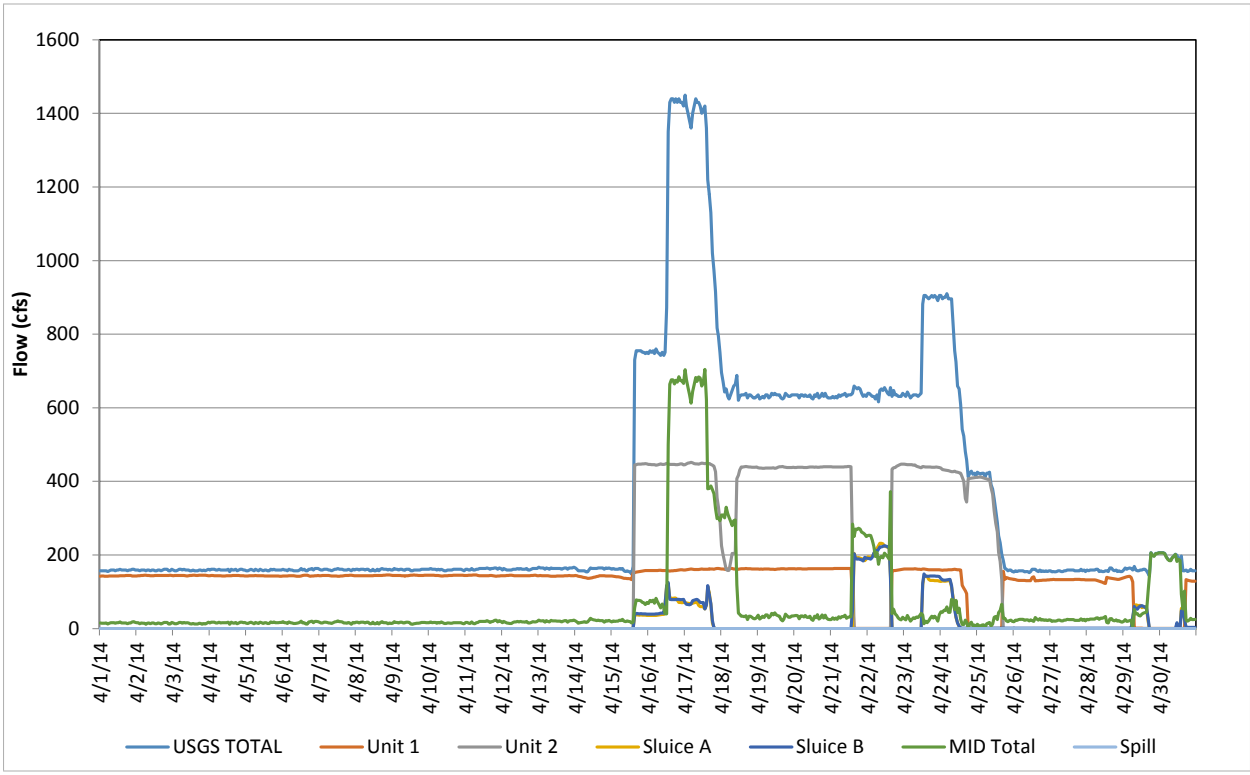

Figure A-4. Flow record in April 2014, based on hourly discharges.

Figure A-5. Flow record in May 2014, based on hourly discharges.

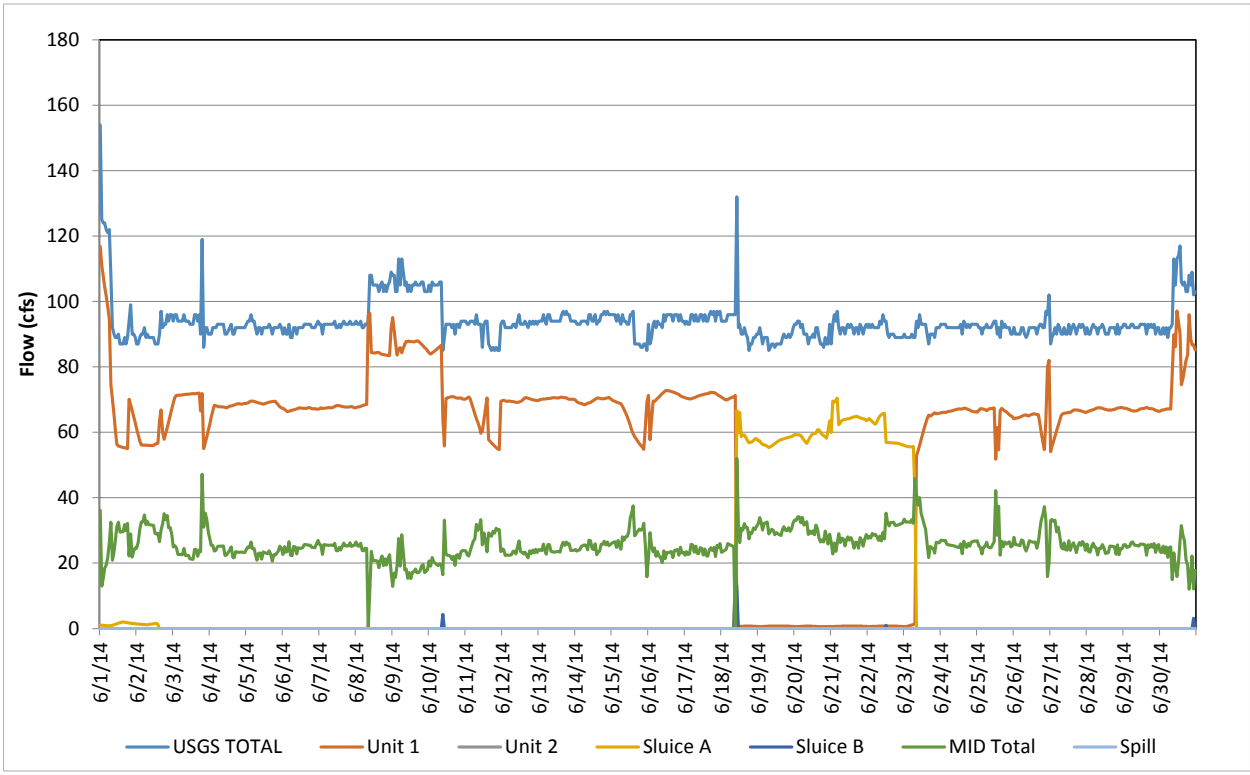

Figure A-6. Flow record in June 2014, based on hourly discharges.

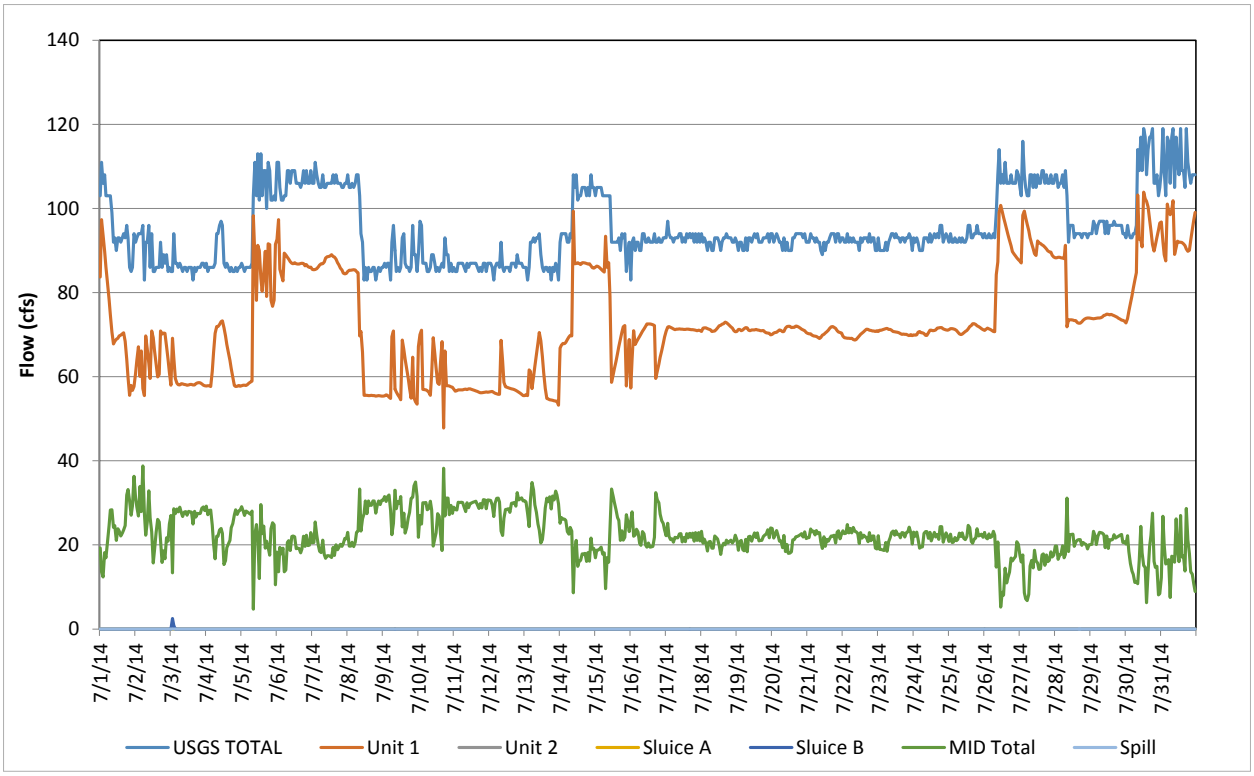

Figure A-7. Flow record in July 2014, based on hourly discharges.

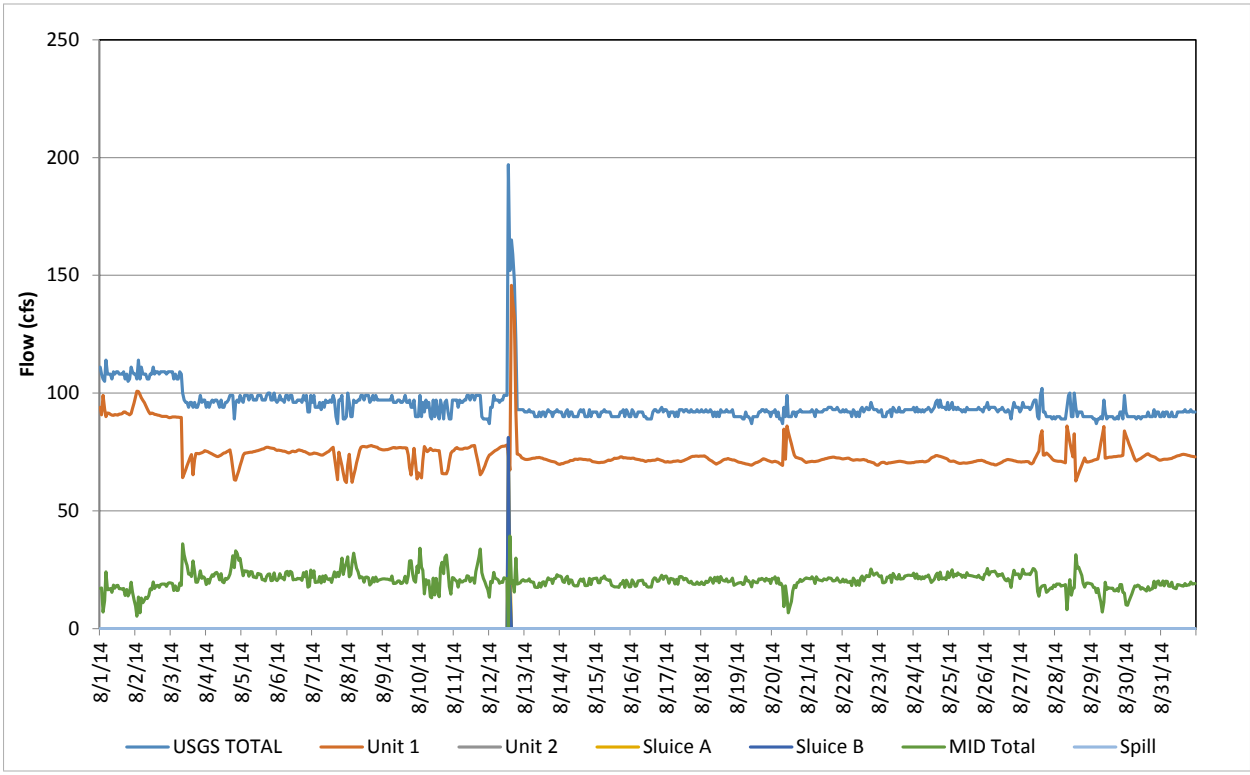

Figure A-8. Flow record in August 2014, based on hourly discharges.

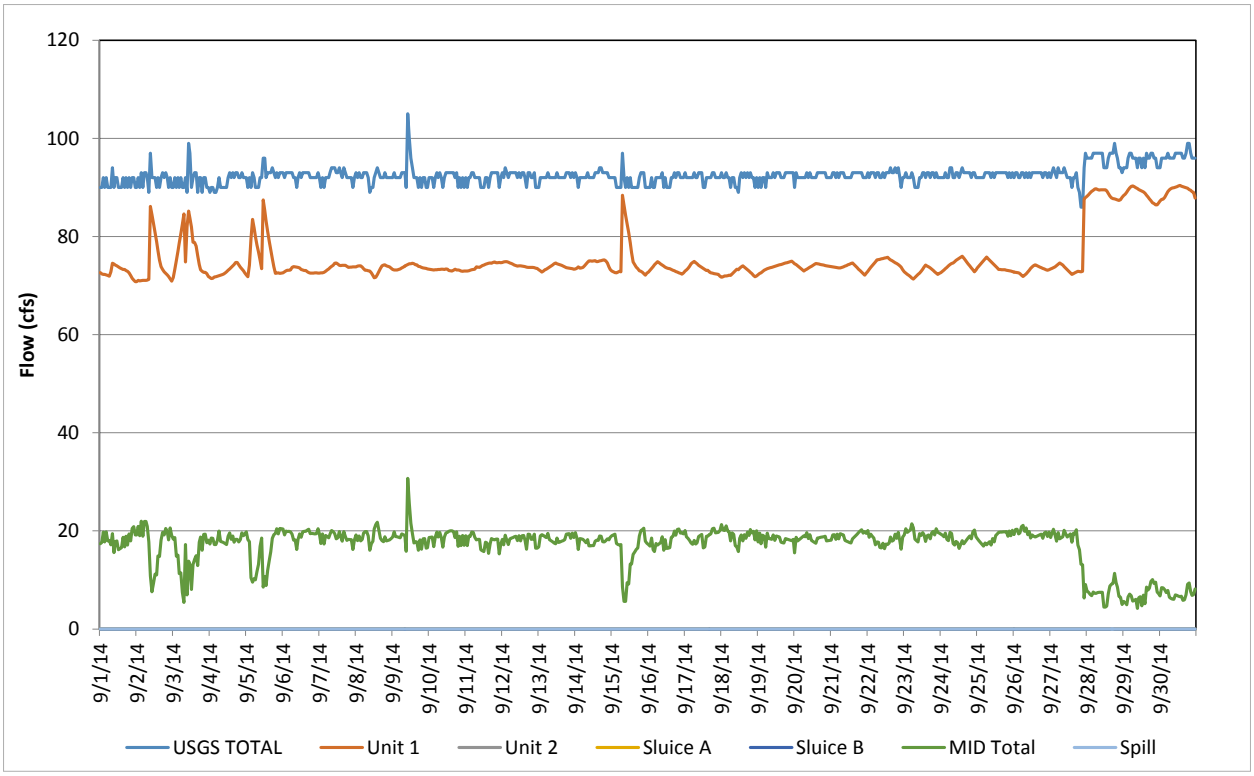

Figure A-9. Flow record in September 2014, based on hourly discharges.

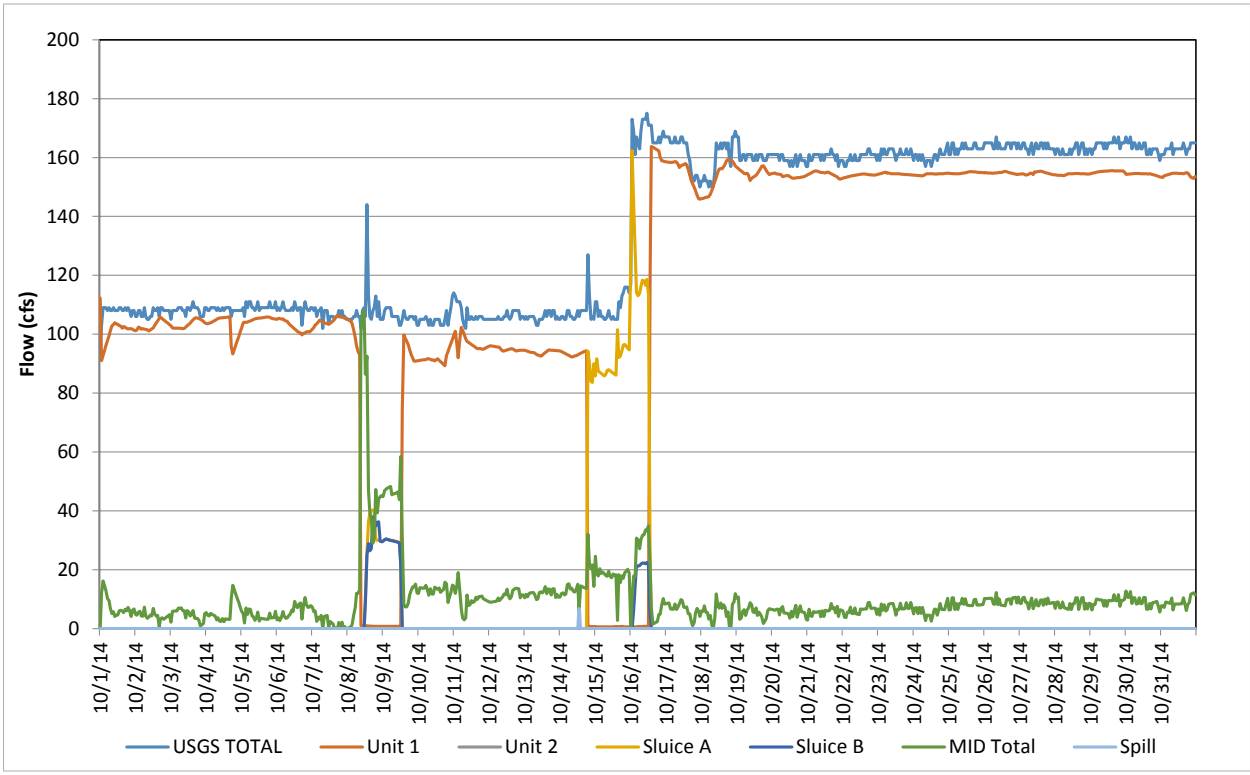

Figure A-10. Flow record in October 2014, based on hourly discharges.

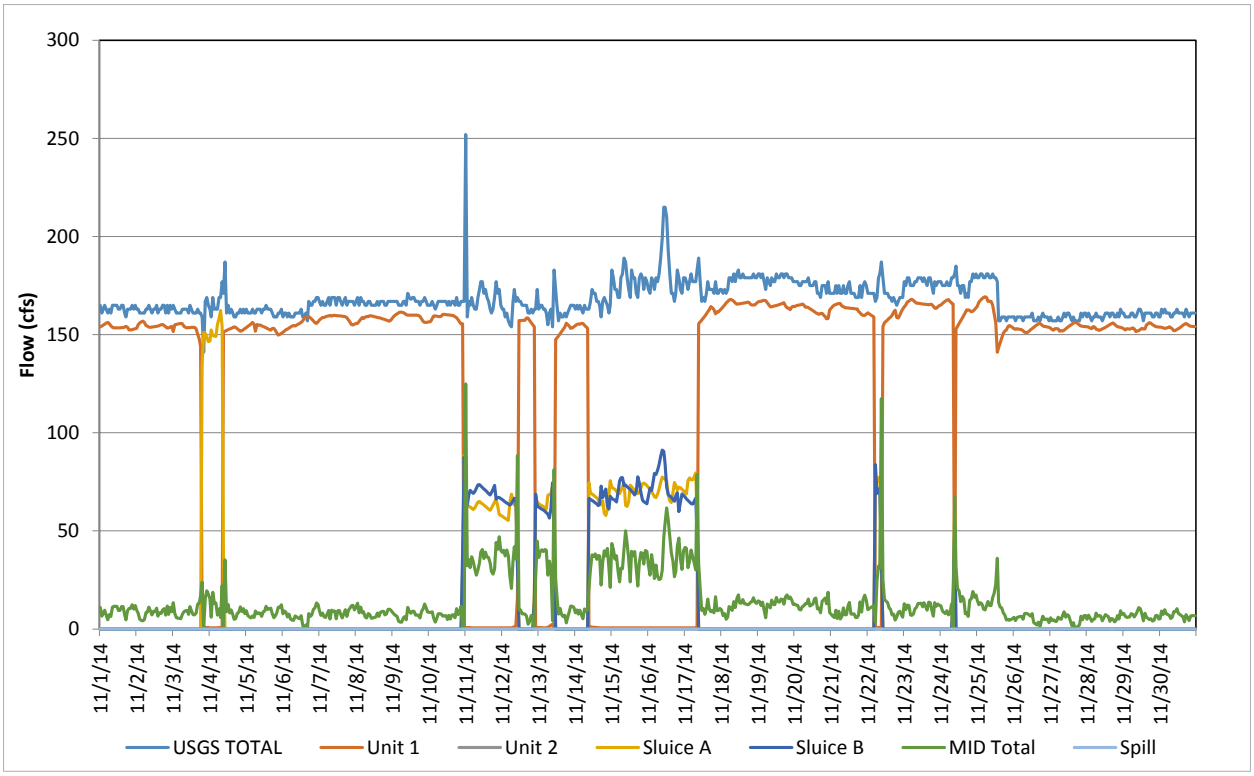

Figure A-11. Flow record in November 2014, based on hourly discharges.

Figure A-12. Flow record in December 2014, based on hourly discharges.

FLOW RECORDS FOR FIVE DISCHARGE STRUCTURES AT THE LA GRANGE PROJECT

ATTACHMENT B

2015 MONTHLY FLOW RECORDS

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Please refer to the legend below for all figures in this attachment:

- USGS Total = Flows recorded by the USGS La Grange gage.
- Unit 1 = Flows through La Grange powerhouse Unit 1.
- Unit 2 = Flows through La Grange powerhouse Unit 2.
- Sluice A = Flows through TID sluice gate 1.
- Sluice B = Flows through TID sluice gate 2.
- MID Total = The sum of flows at the MID hillside discharge and Portal 1.
- Spill = Spill at the LGDD spillway.
- TID currently maintains in an open position an 18-inch pipe that continuously delivers flow from the TID forebay to the channel downstream of the sluice gates. The flow quantity is not measured and is unknown, but is roughly estimated to be about 5 cfs. This flow is not included in the computations contained in the analyses conducted for this report due to the uncertainty of the quantity of flow discharged and its history of operation.

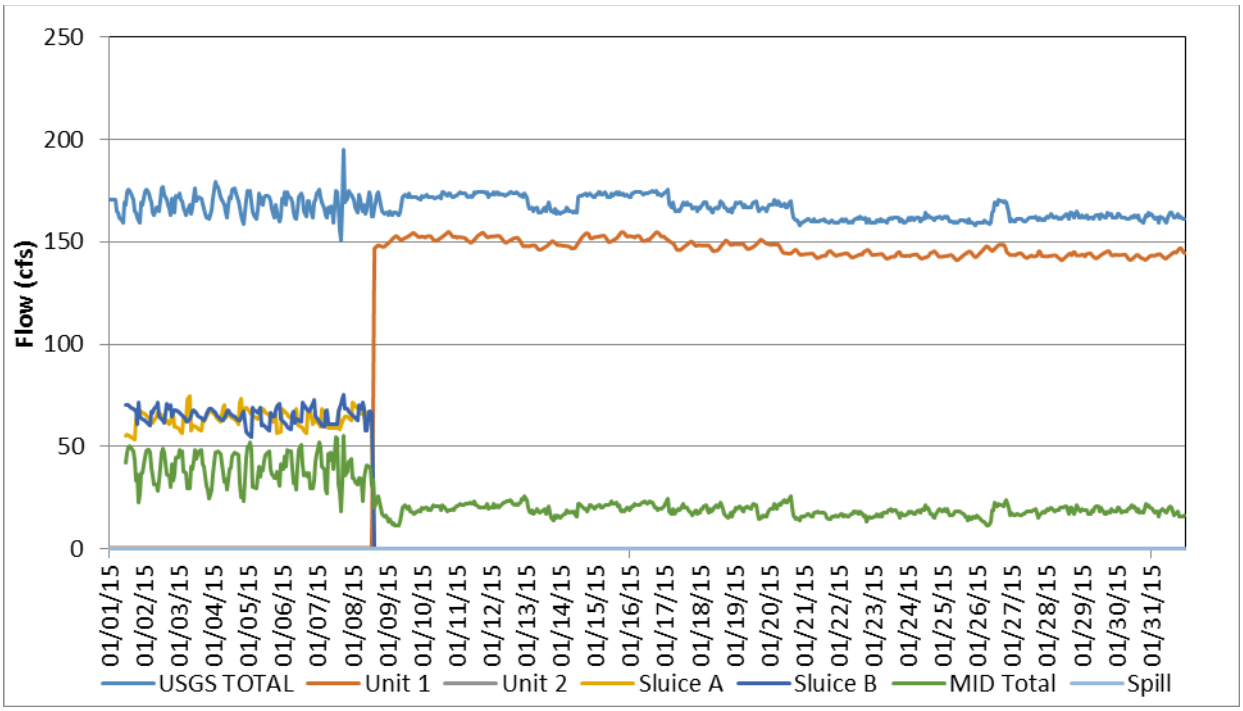

Figure B-1. Flow record in January 2015, based on hourly discharges.

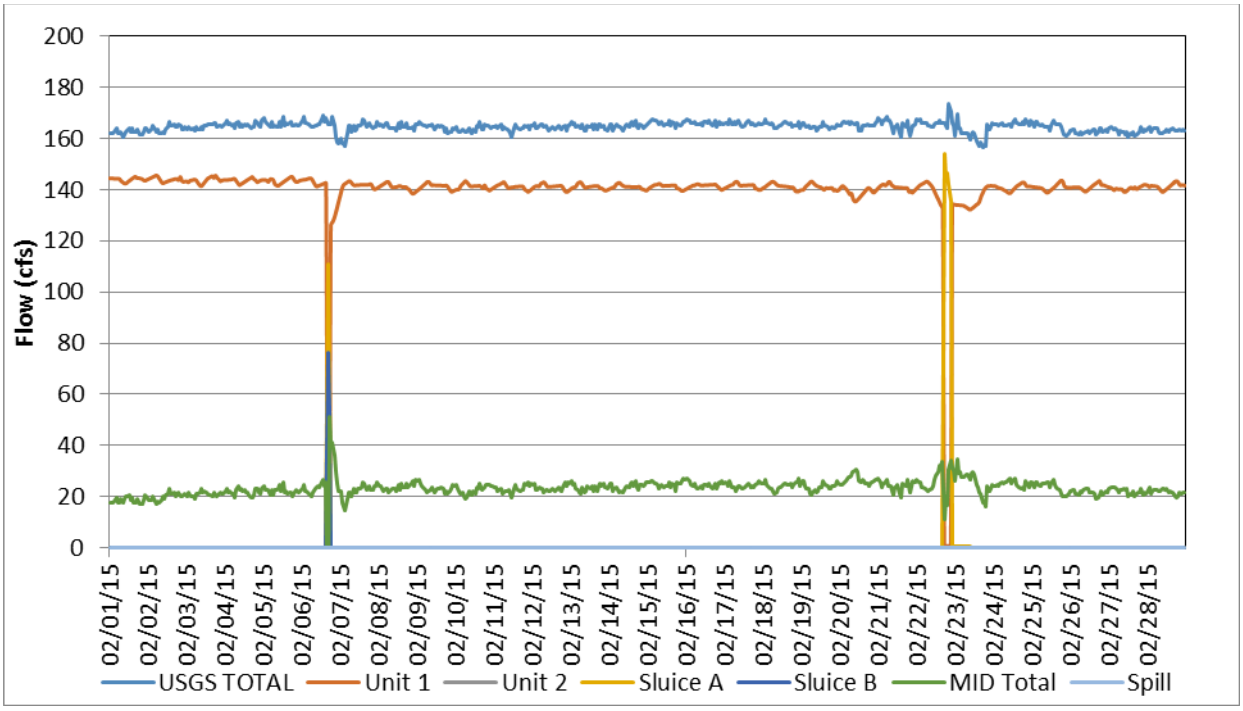

Figure B-2. Flow record in February 2015, based on hourly discharges.

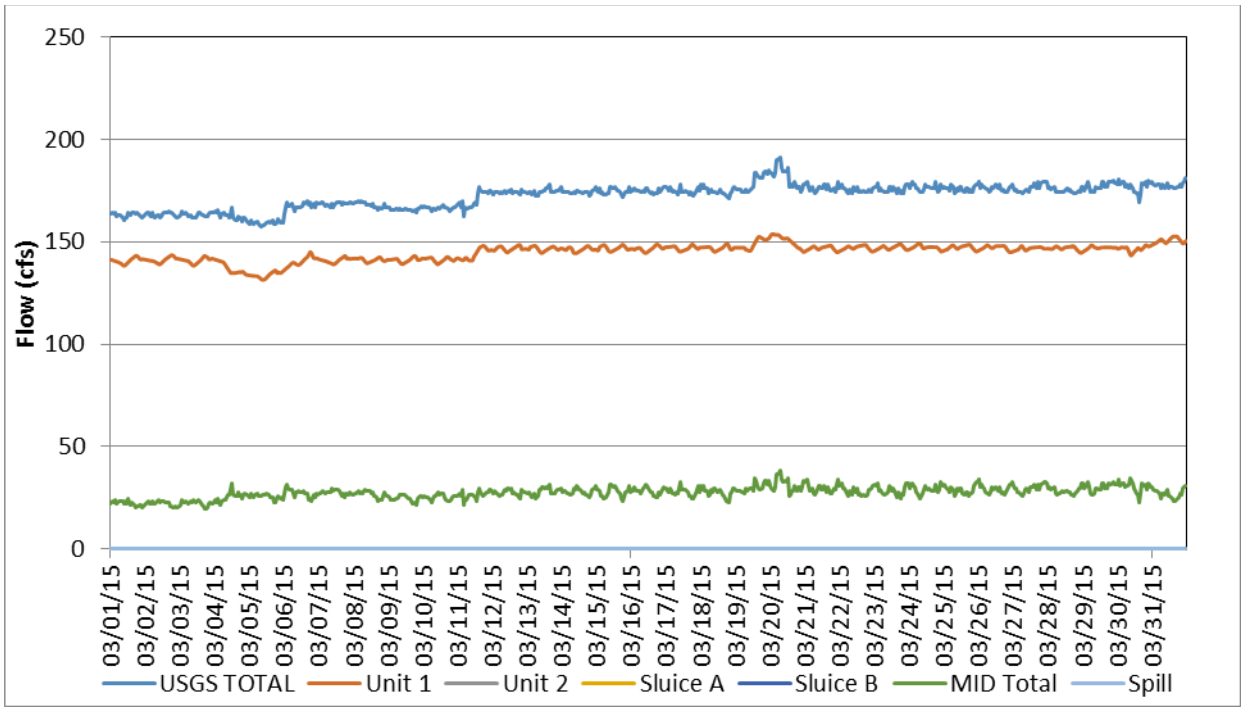

Figure B-3. Flow record in March 2015, based on hourly discharges.

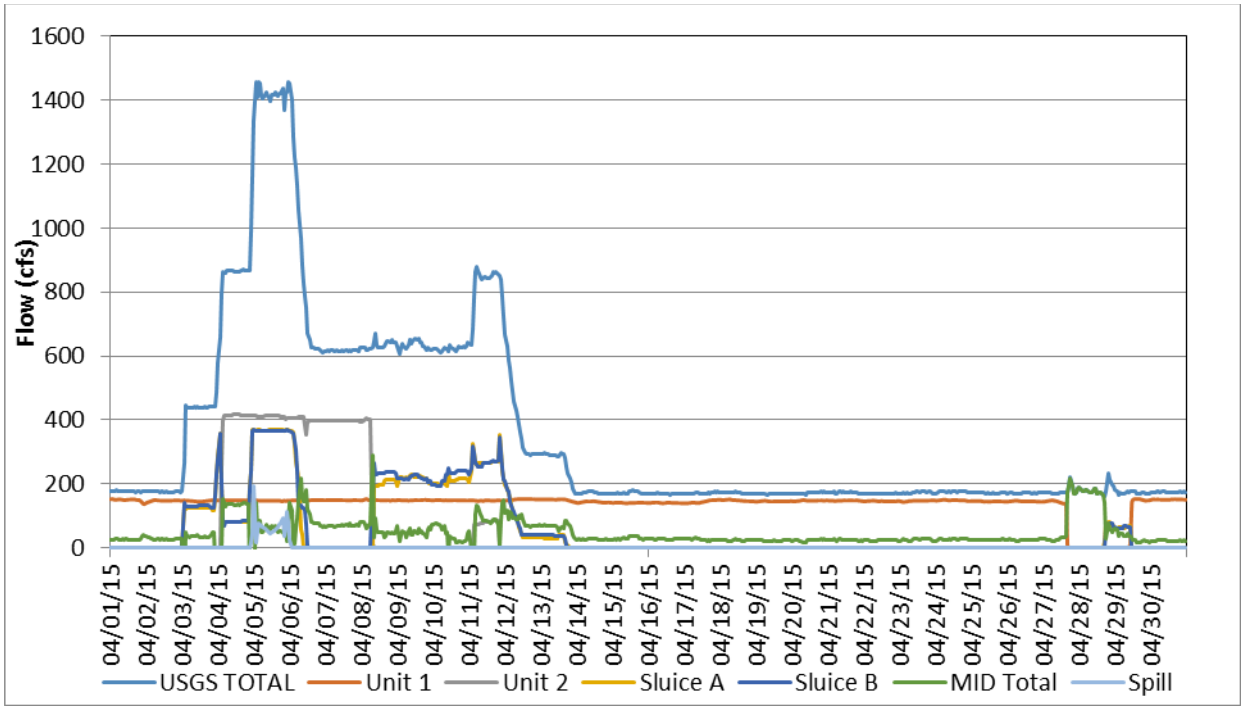

Figure B-4. Flow record in April 2015, based on hourly discharges.

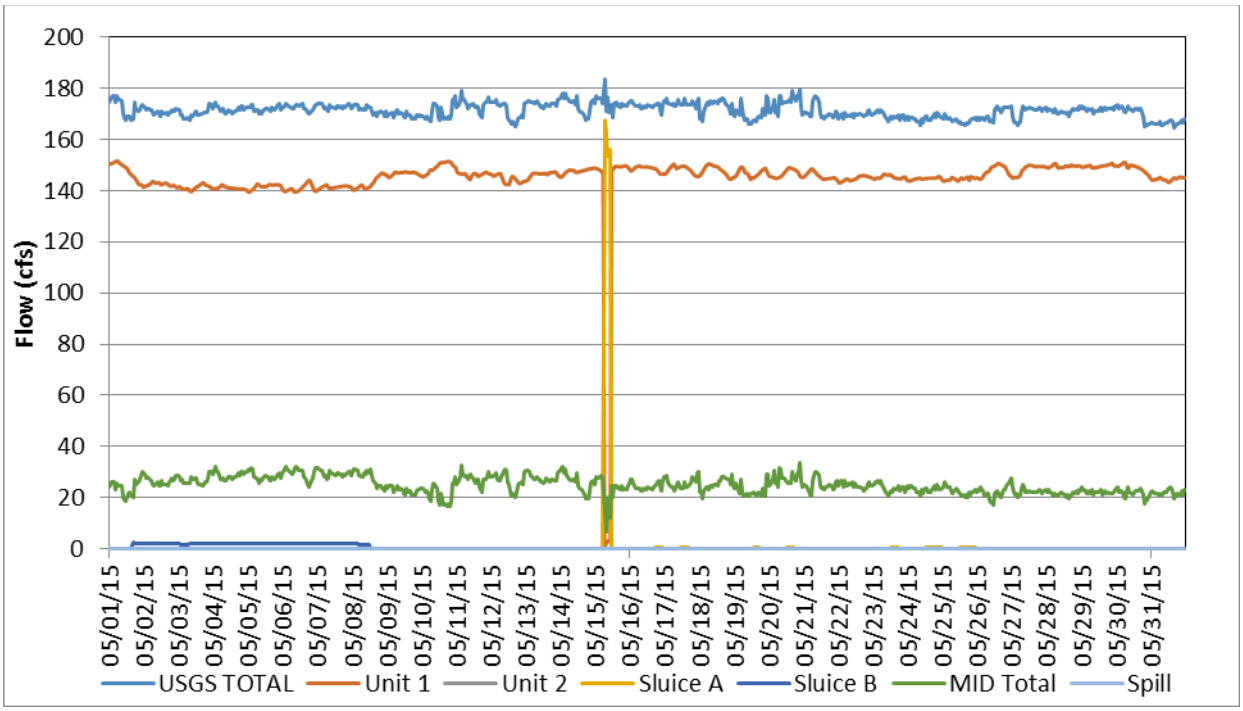

Figure B-5. Flow record in May 2015, based on hourly discharges.

Figure B-6. Flow record in June 2015, based on hourly discharges.

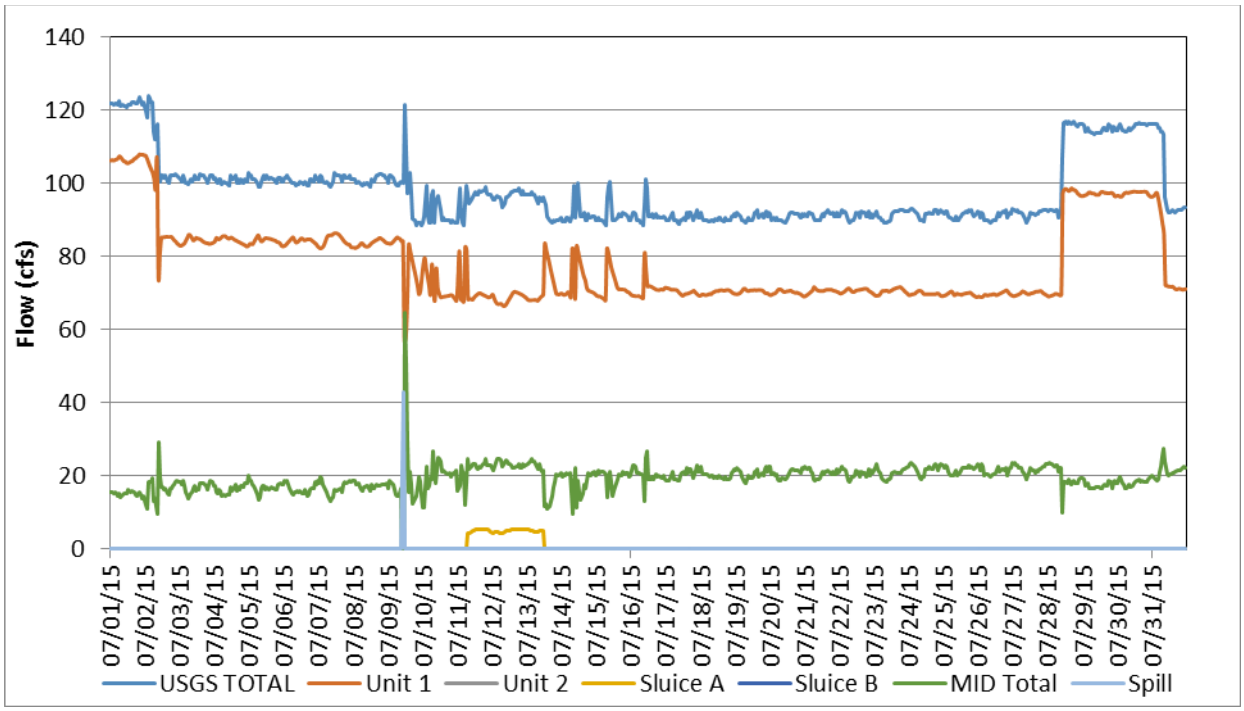

Figure B-7. Flow record in July 2015, based on hourly discharges.

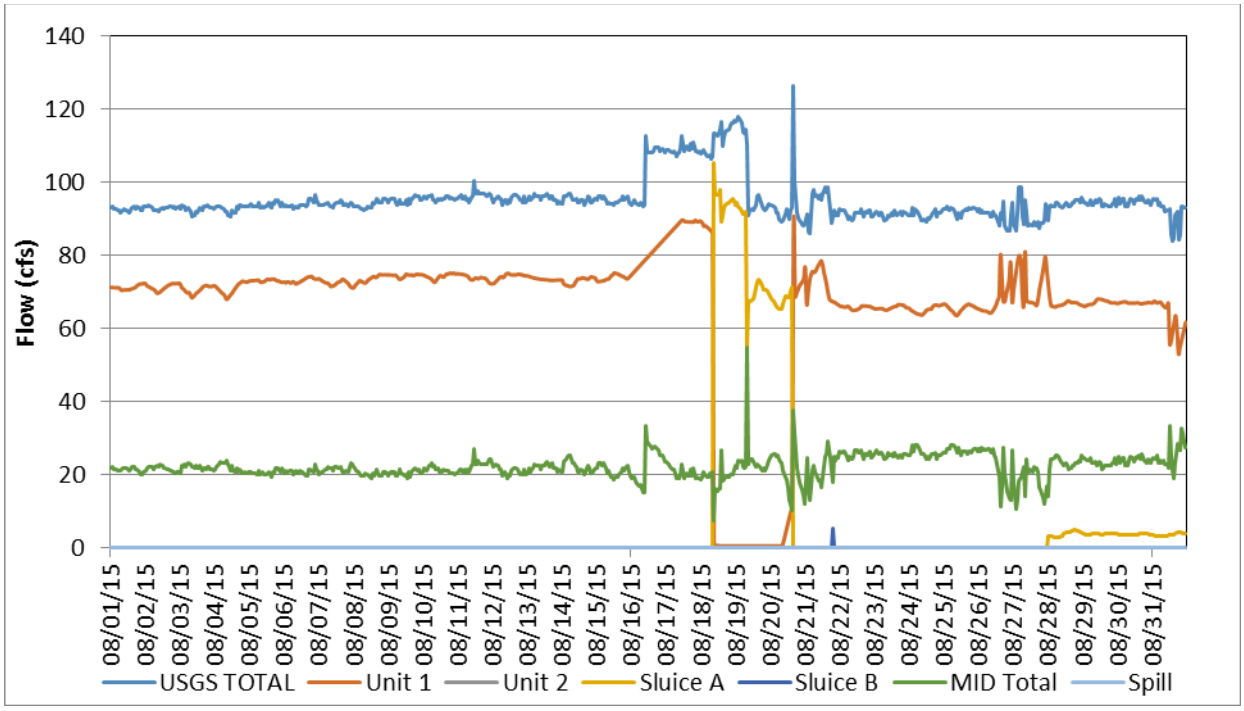

Figure B-8. Flow record in August 2015, based on hourly discharges.

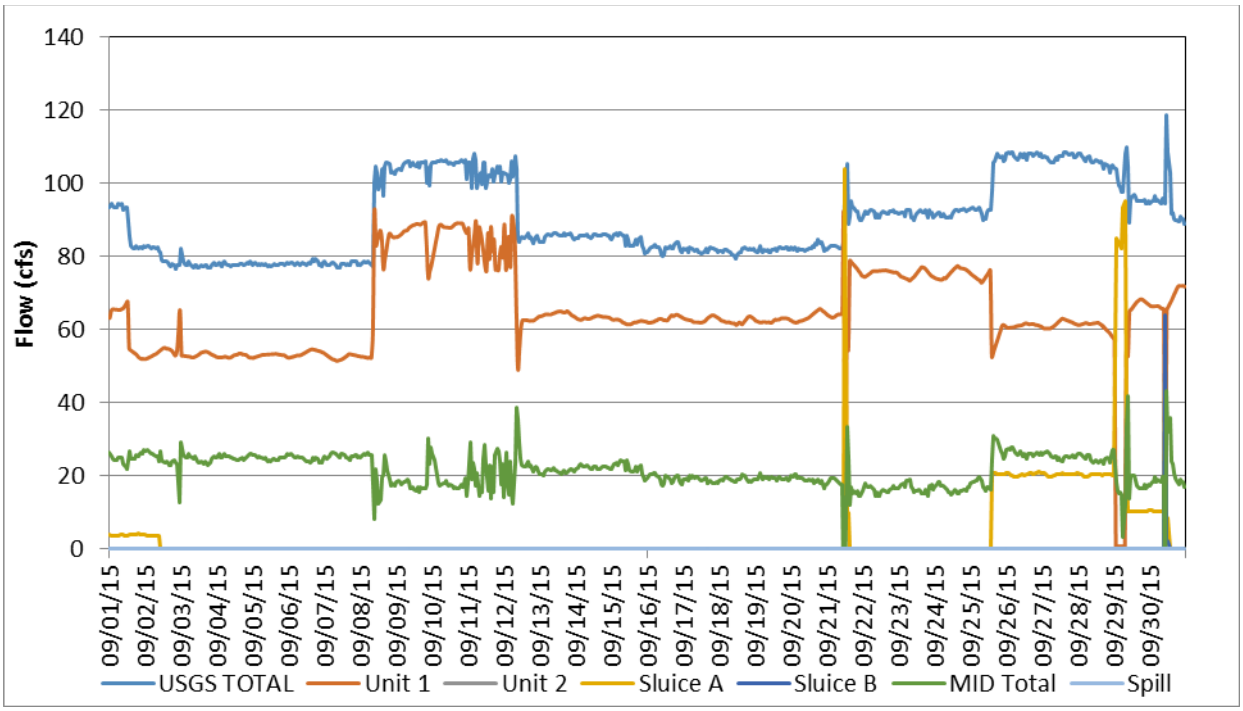

Figure B-9. Flow record in September 2015, based on hourly discharges.

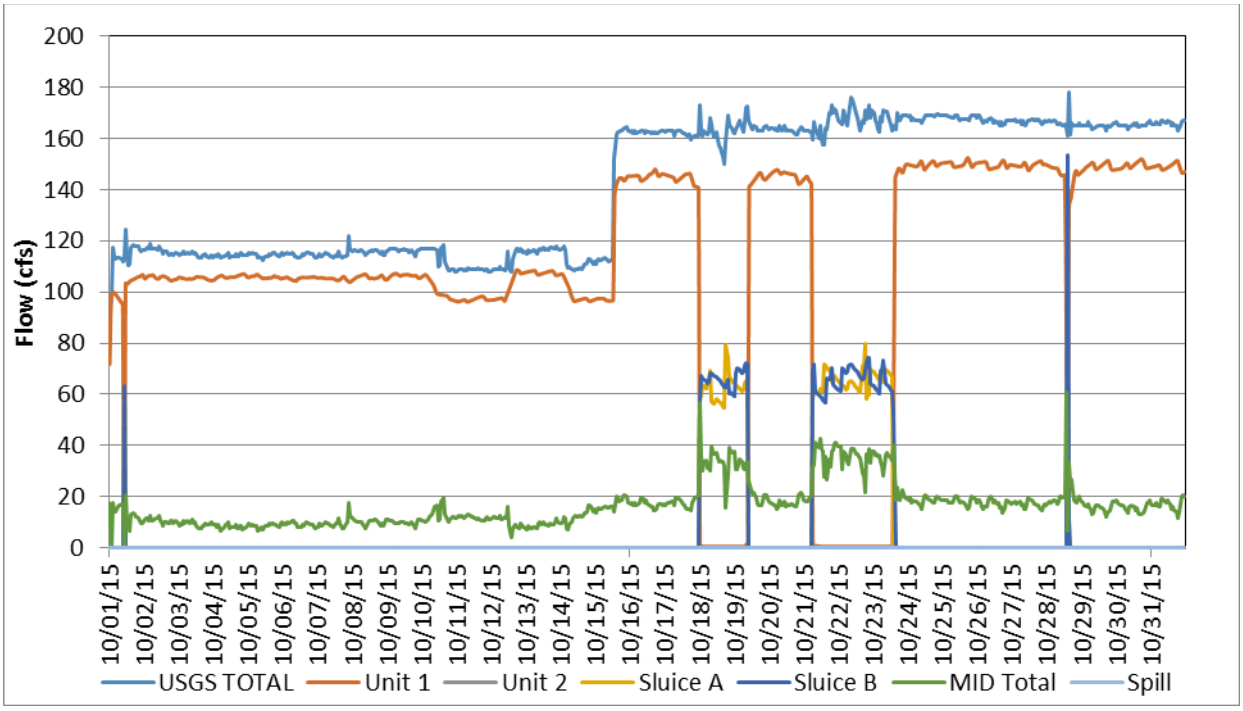

Figure B-10. Flow record in October 2015, based on hourly discharges.

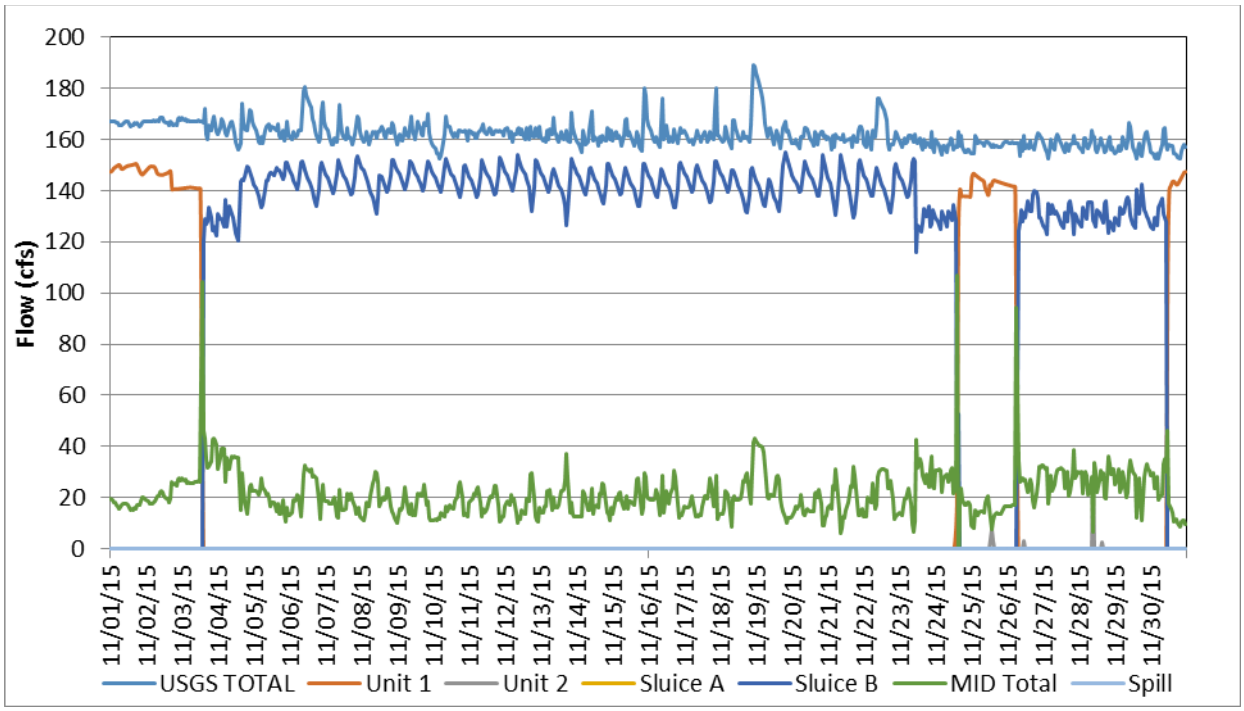

Figure B-11. Flow record in November 2015, based on hourly discharges.

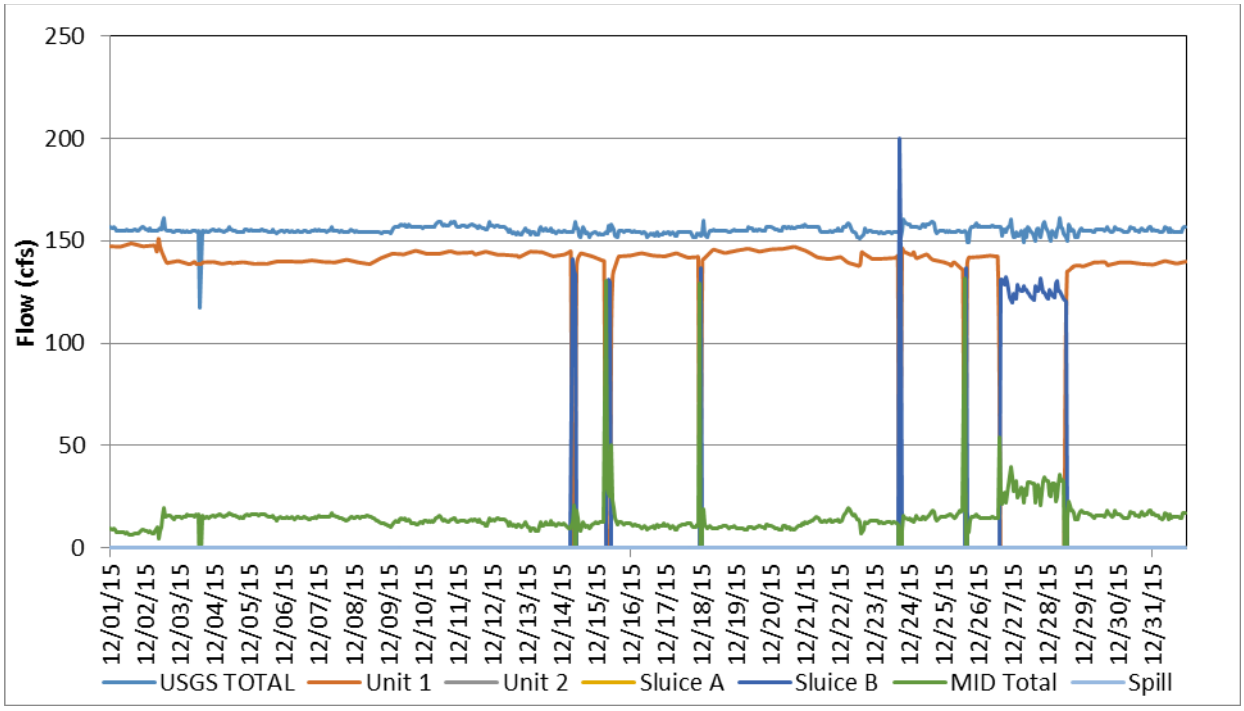

Figure B-12. Flow record in December 2015, based on hourly discharges.

FLOW RECORDS FOR FIVE DISCHARGE STRUCTURES AT THE LA GRANGE PROJECT

ATTACHMENT C

2016 MONTHLY FLOW RECORDS (JANUARY – NOVEMBER)

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Please refer to the legend below for all figures in this attachment:

- USGS Total = Flows recorded by the USGS La Grange gage.
- Unit 1 = Flows through La Grange powerhouse Unit 1.
- Unit 2 = Flows through La Grange powerhouse Unit 2.
- Sluice A = Flows through TID sluice gate 1.
- Sluice B = Flows through TID sluice gate 2.
- MID Total = The sum of flows at the MID hillside discharge and Portal 1.
- Spill = Spill at the LGDD spillway.
- TID currently maintains in an open position an 18-inch pipe that continuously delivers flow from the TID forebay to the channel downstream of the sluice gates. The flow quantity is not measured and is unknown, but is roughly estimated to be about 5 cfs. This flow is not included in the computations contained in the analyses conducted for this report due to the uncertainty of the quantity of flow discharged and its history of operation.

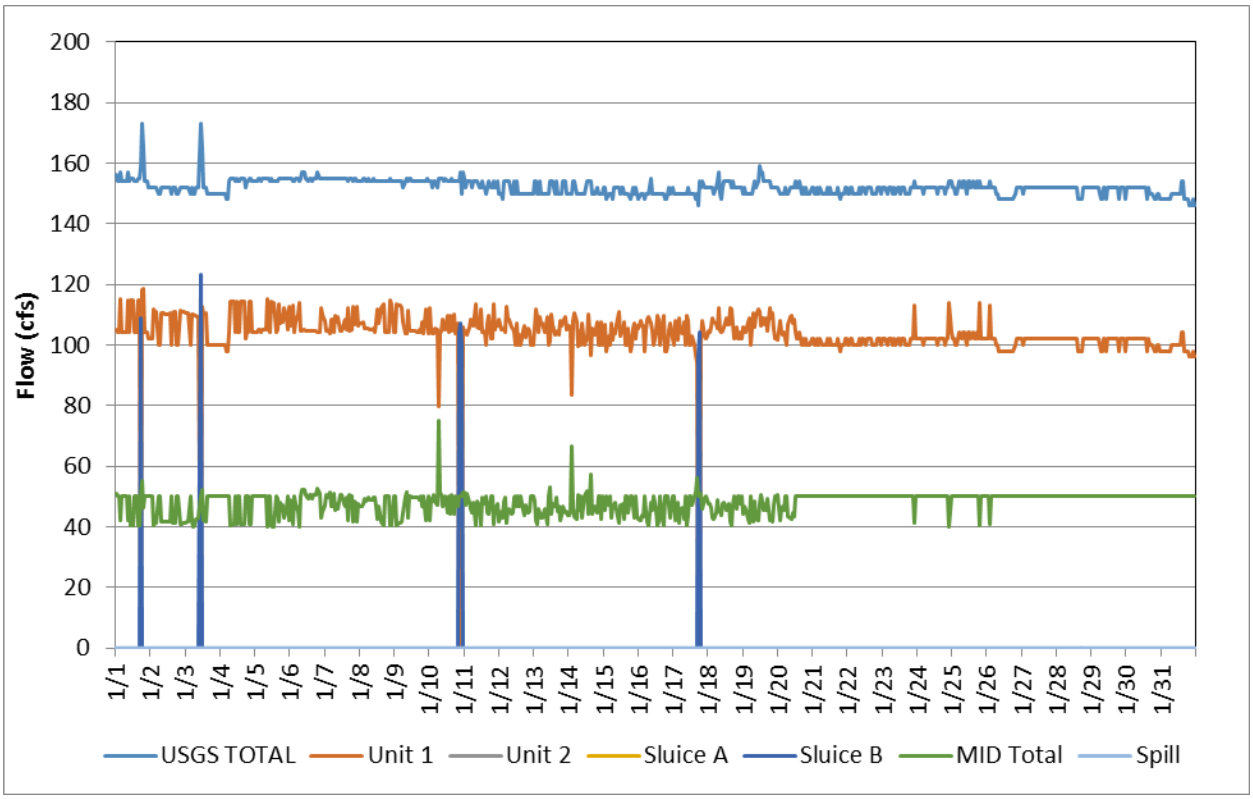

Figure C-1. Flow record in January 2016, based on hourly discharges.

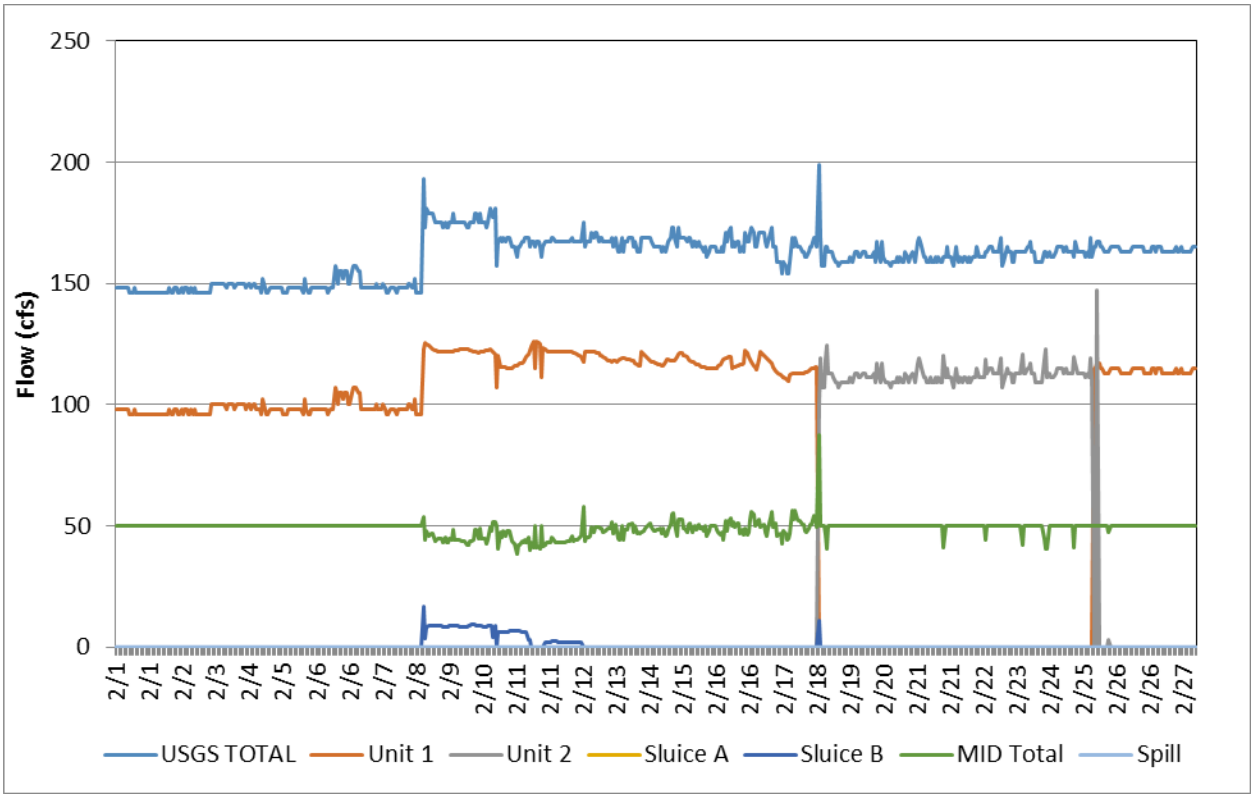

Figure C-2. Flow record in February 2016, based on hourly discharges.

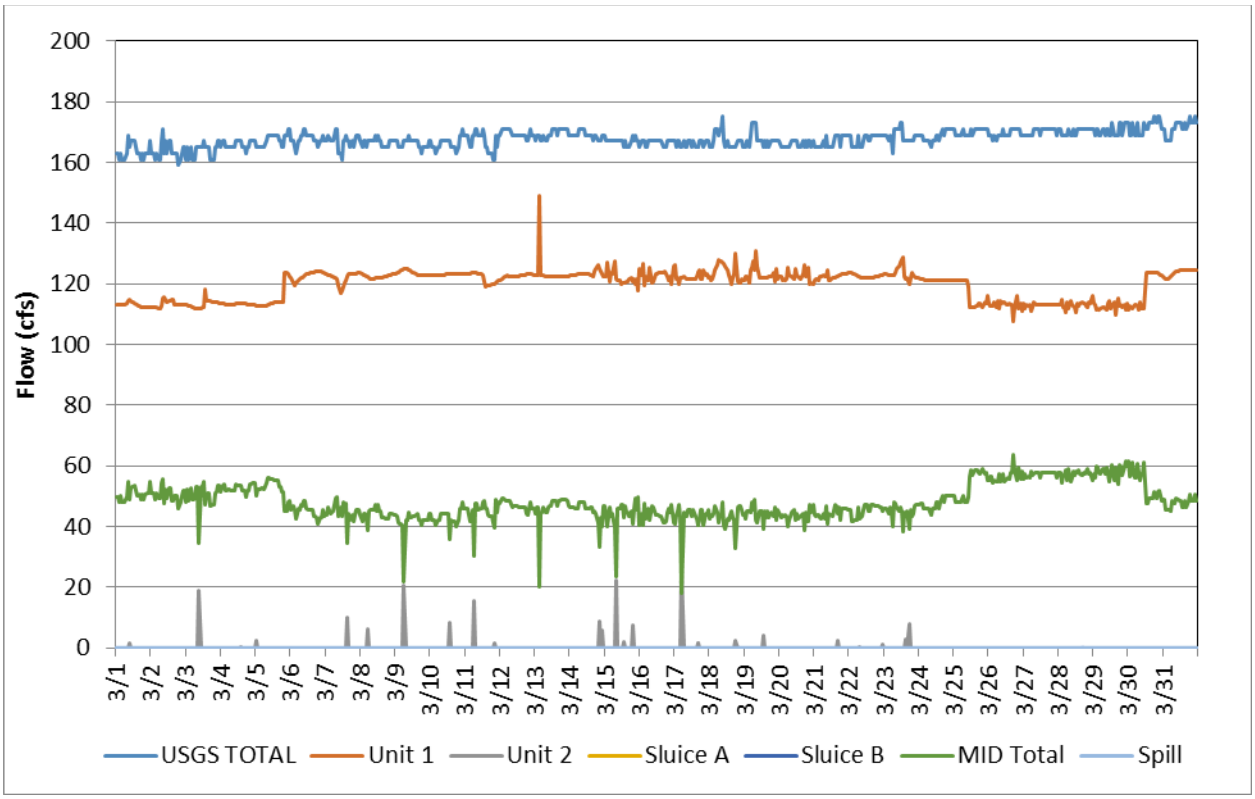

Figure C-3. Flow record in March 2016, based on hourly discharges.

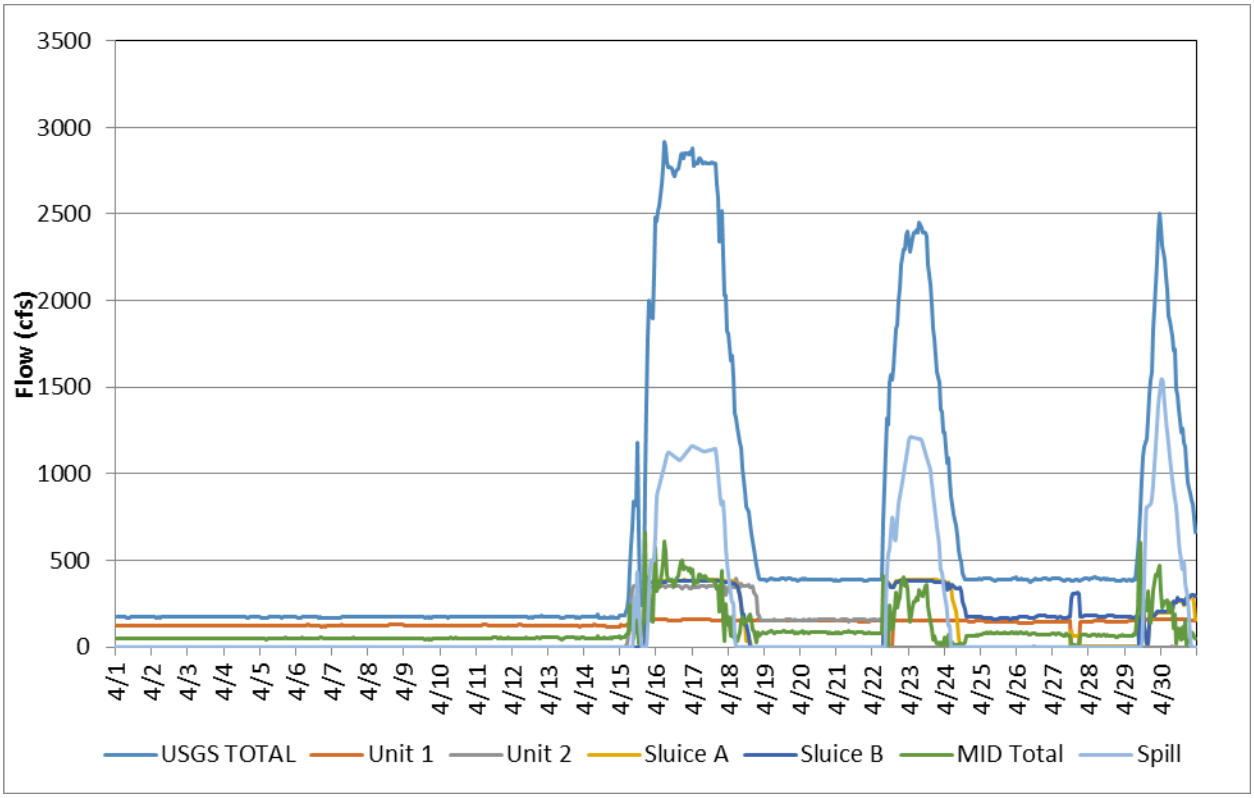

Figure C-4. Flow record in April 2016, based on hourly discharges.

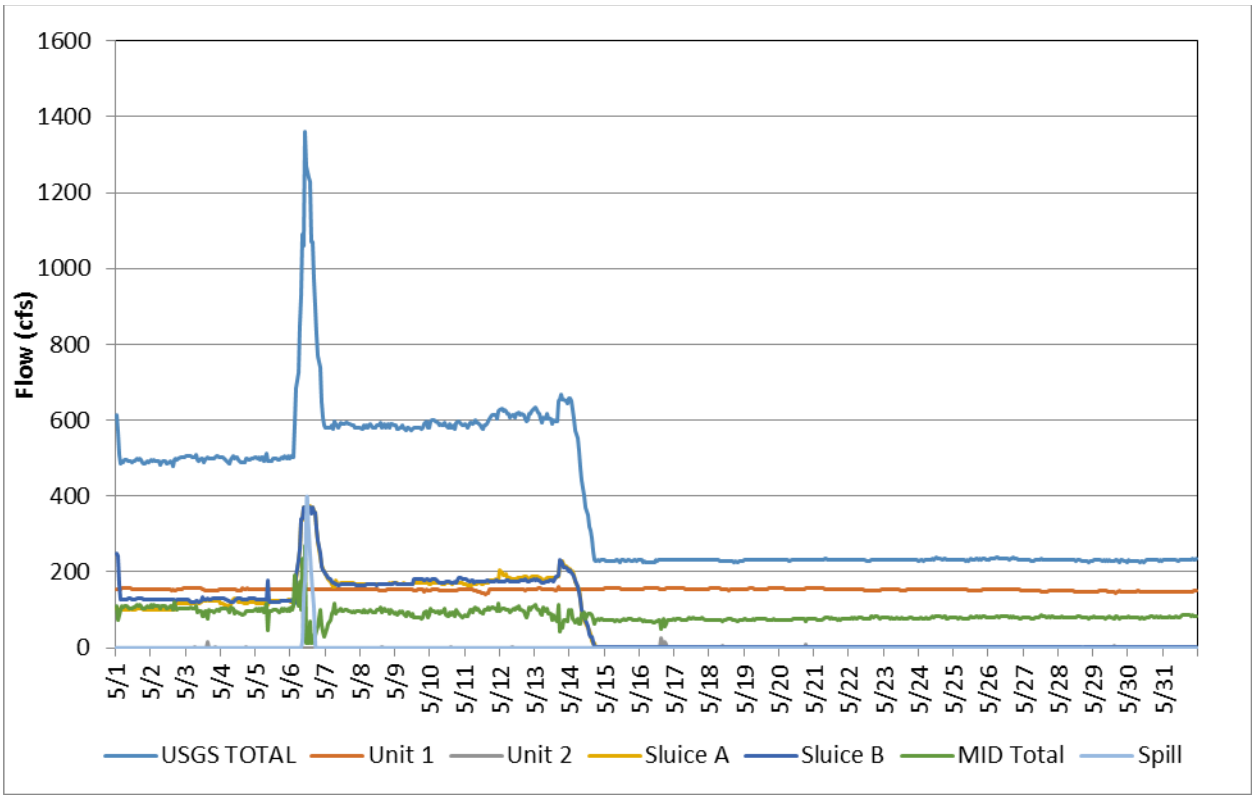

Figure C-5. Flow record in May 2016, based on hourly discharges.

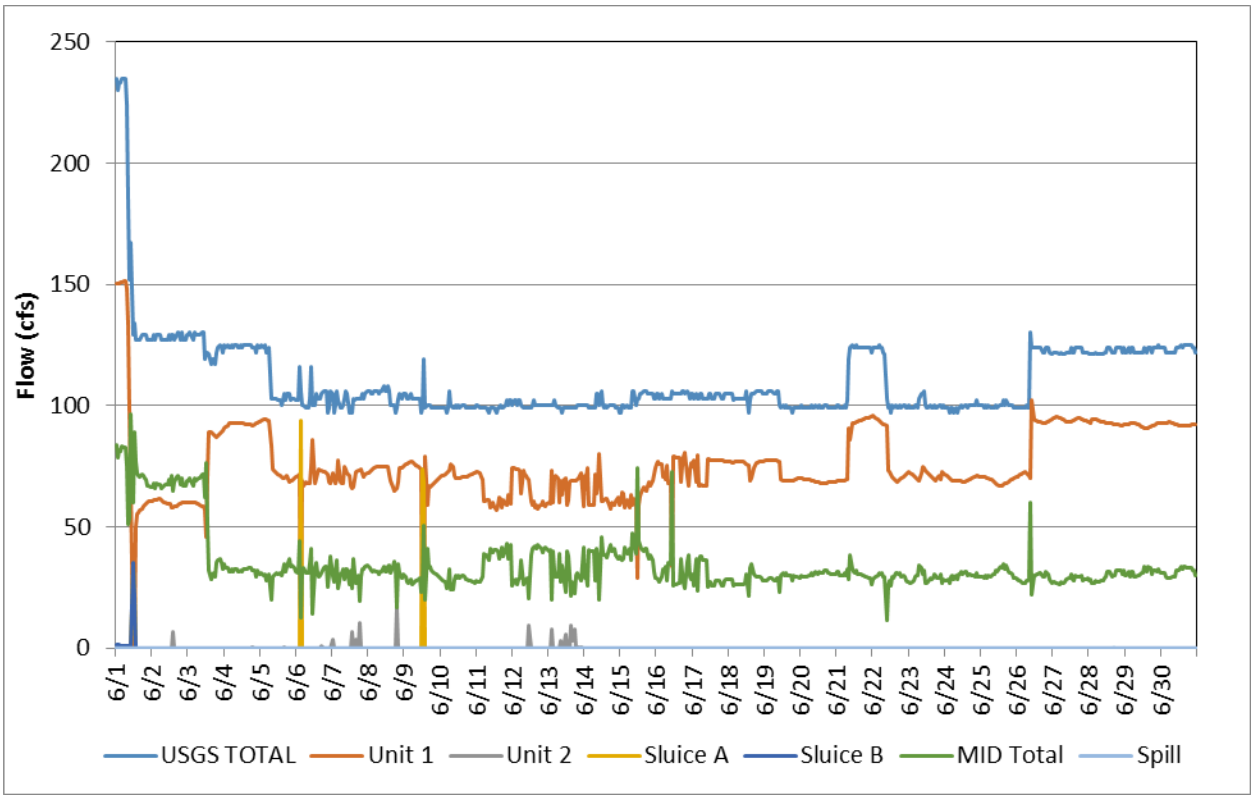

Figure C-6. Flow record in June 2016, based on hourly discharges.

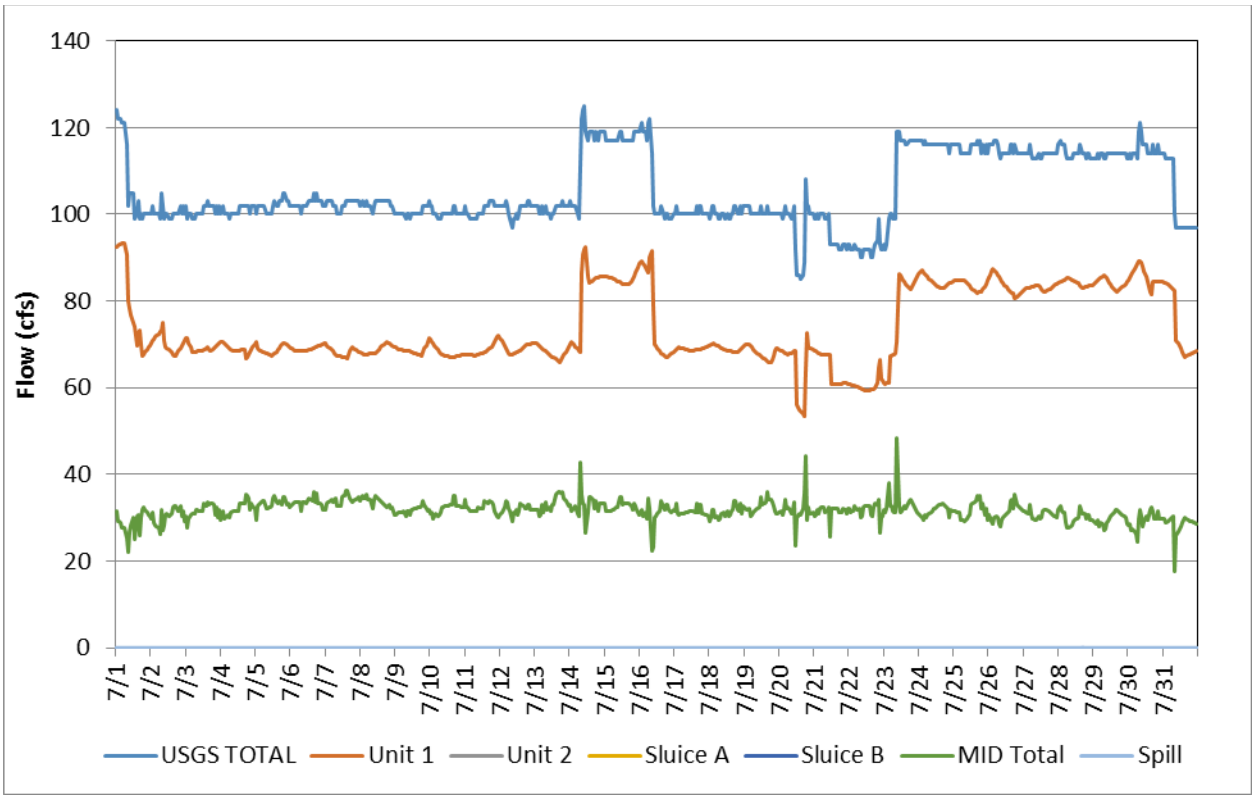

Figure C-7. Flow record in July 2016, based on hourly discharges.

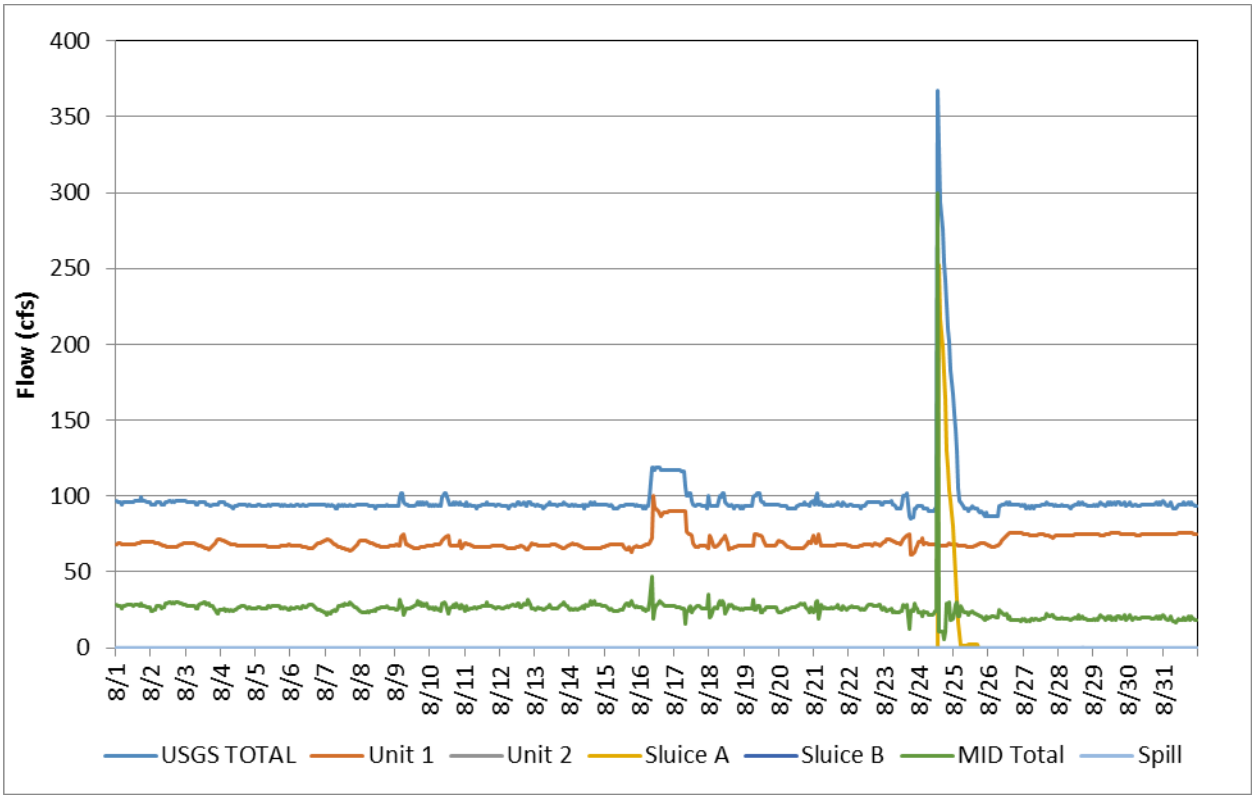

Figure C-8. Flow record in August 2016, based on hourly discharges.

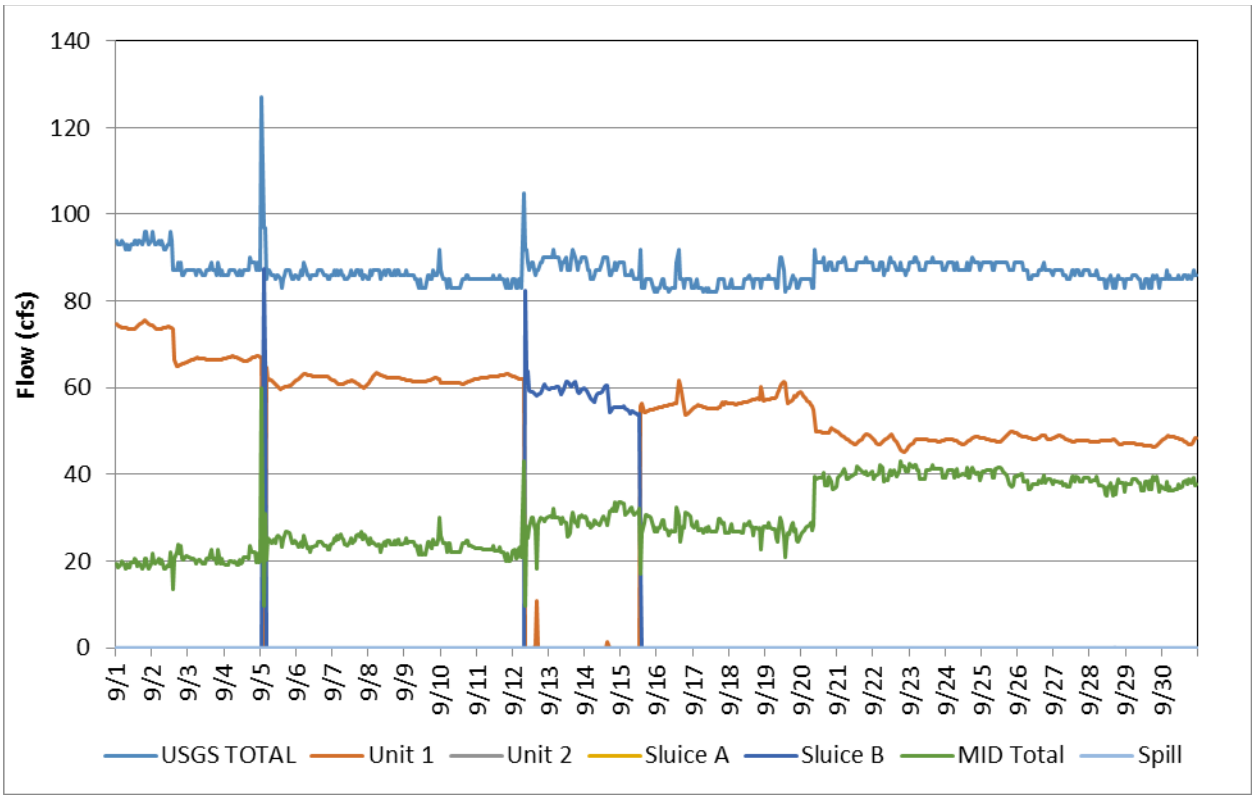

Figure C-9. Flow record in September 2016, based on hourly discharges.

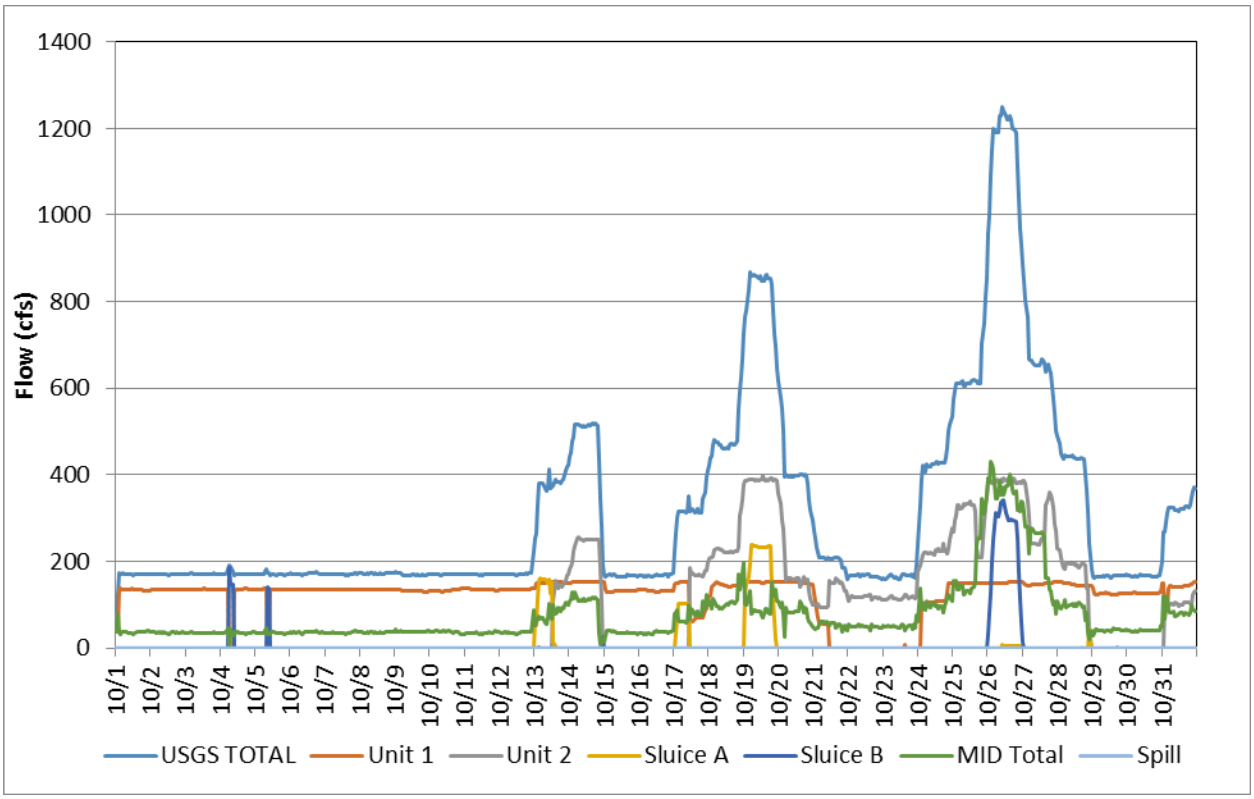

Figure C-10. Flow record in October 2016, based on hourly discharges.

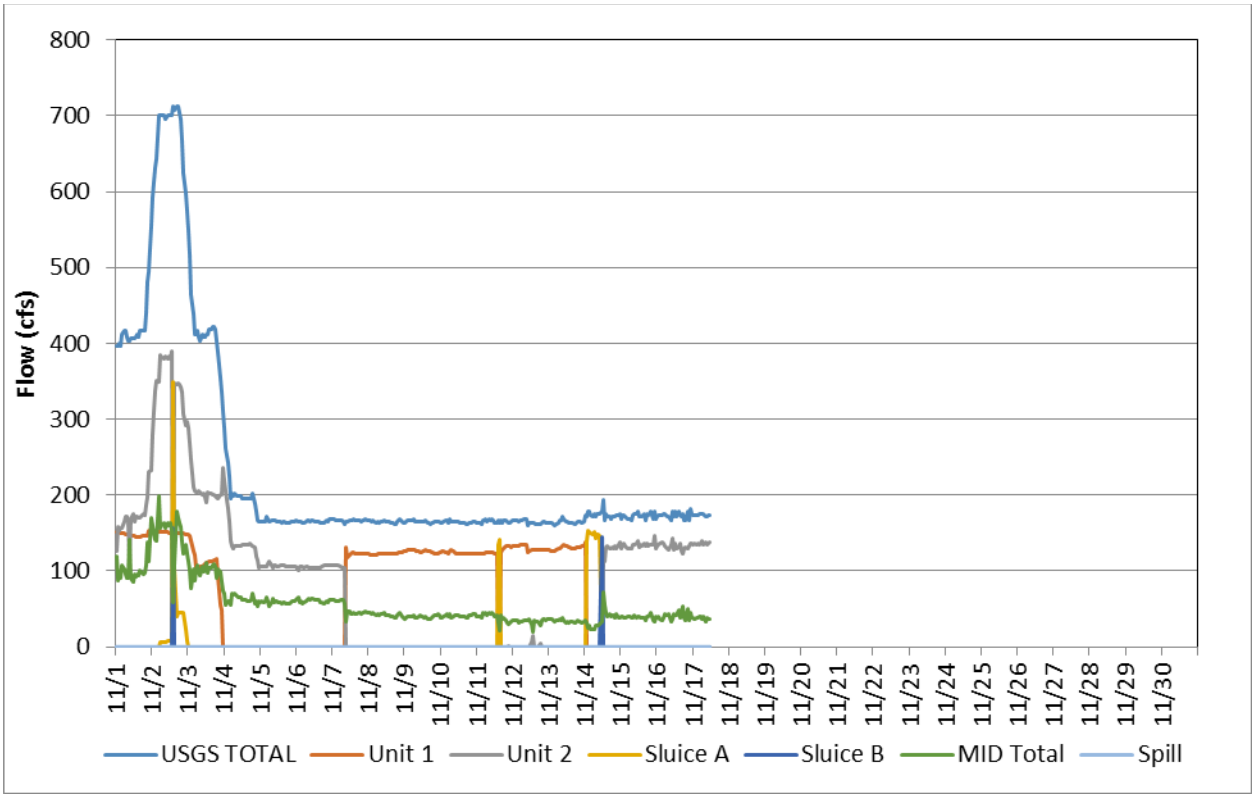

Figure C-11. Flow record in November 2016, based on hourly discharges.

FLOW RECORDS FOR FIVE DISCHARGE STRUCTURES AT THE LA GRANGE PROJECT

ATTACHMENT D

2005 – 2013 FLOW RECORDS

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Please refer to the legend below for all figures in this attachment:

- USGS Total = Flows recorded by the USGS La Grange gage.
- Unit 1 = Flows through La Grange powerhouse Unit 1.
- Unit 2 = Flows through La Grange powerhouse Unit 2.
- Sluice A = Flows through TID sluice gate 1.
- Sluice B = Flows through TID sluice gate 2.
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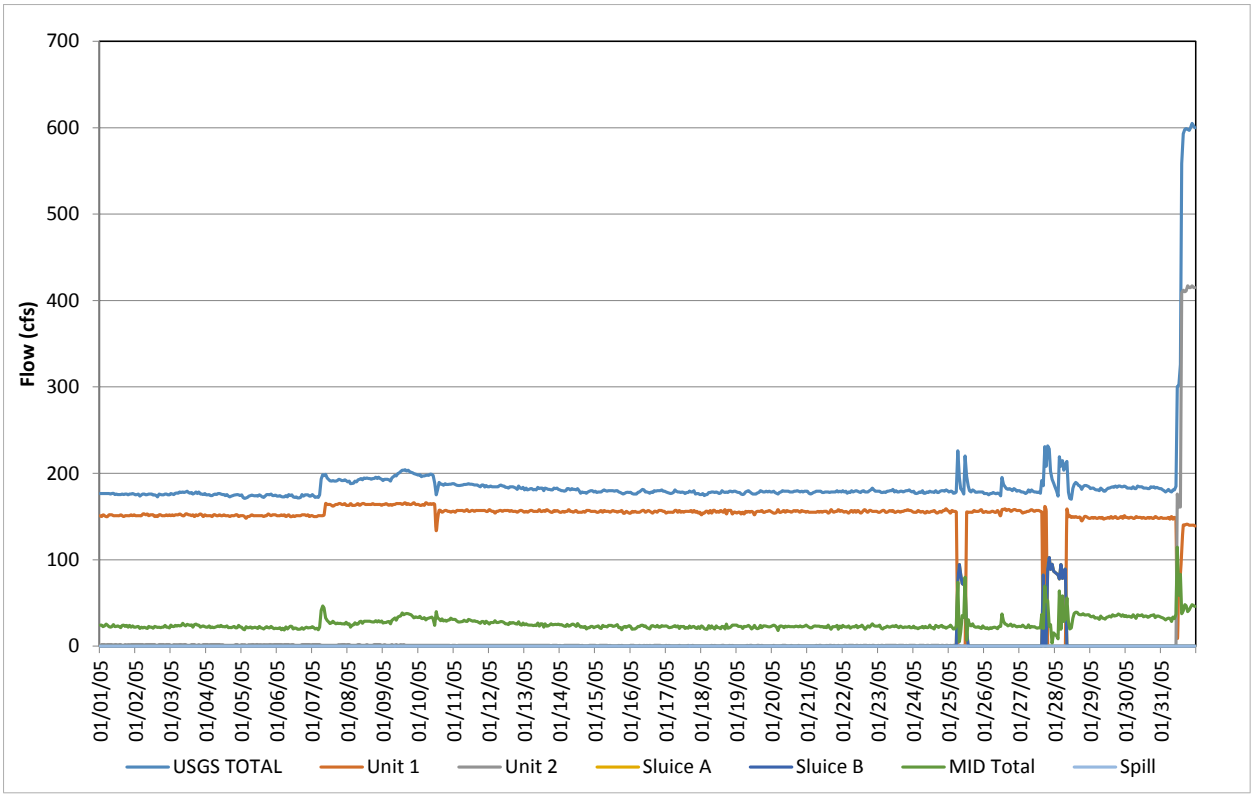

Figure D-1. Flow record in January 2005, based on hourly discharges.

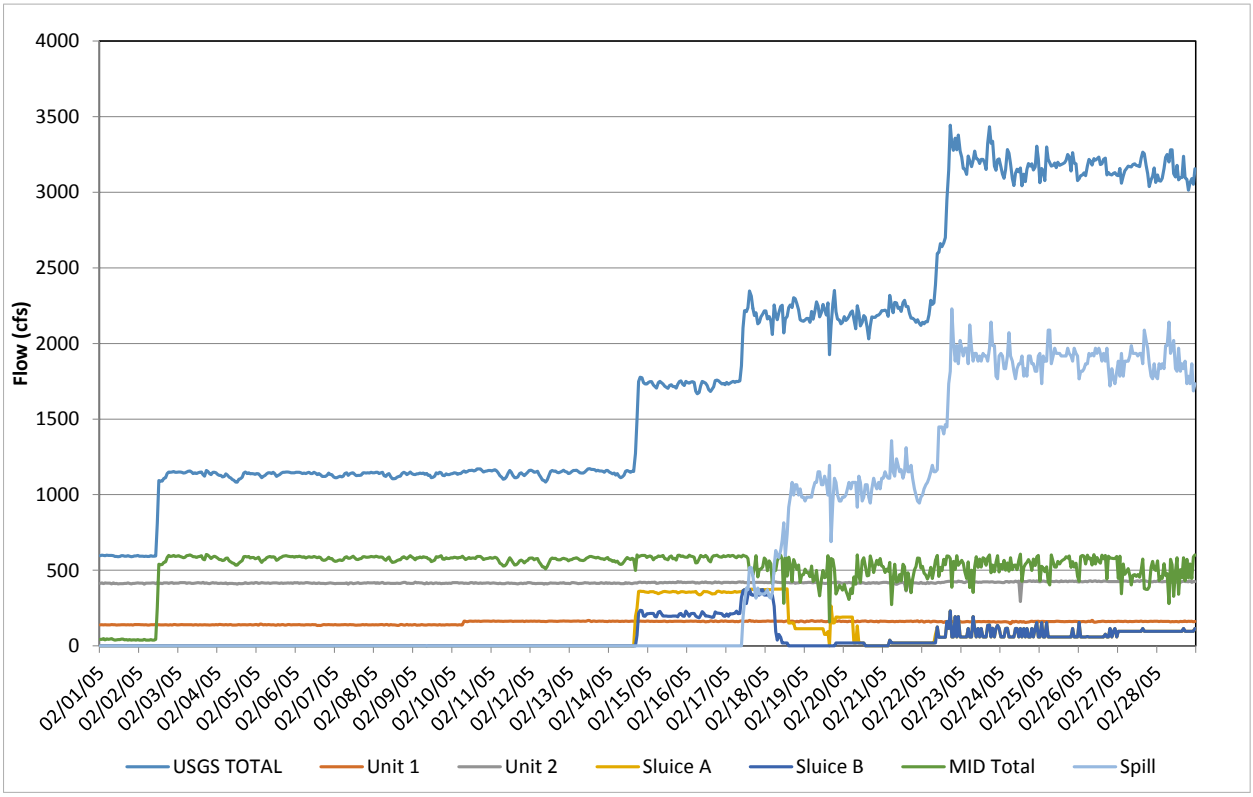

Figure D-2. Flow record in February 2005, based on hourly discharges.

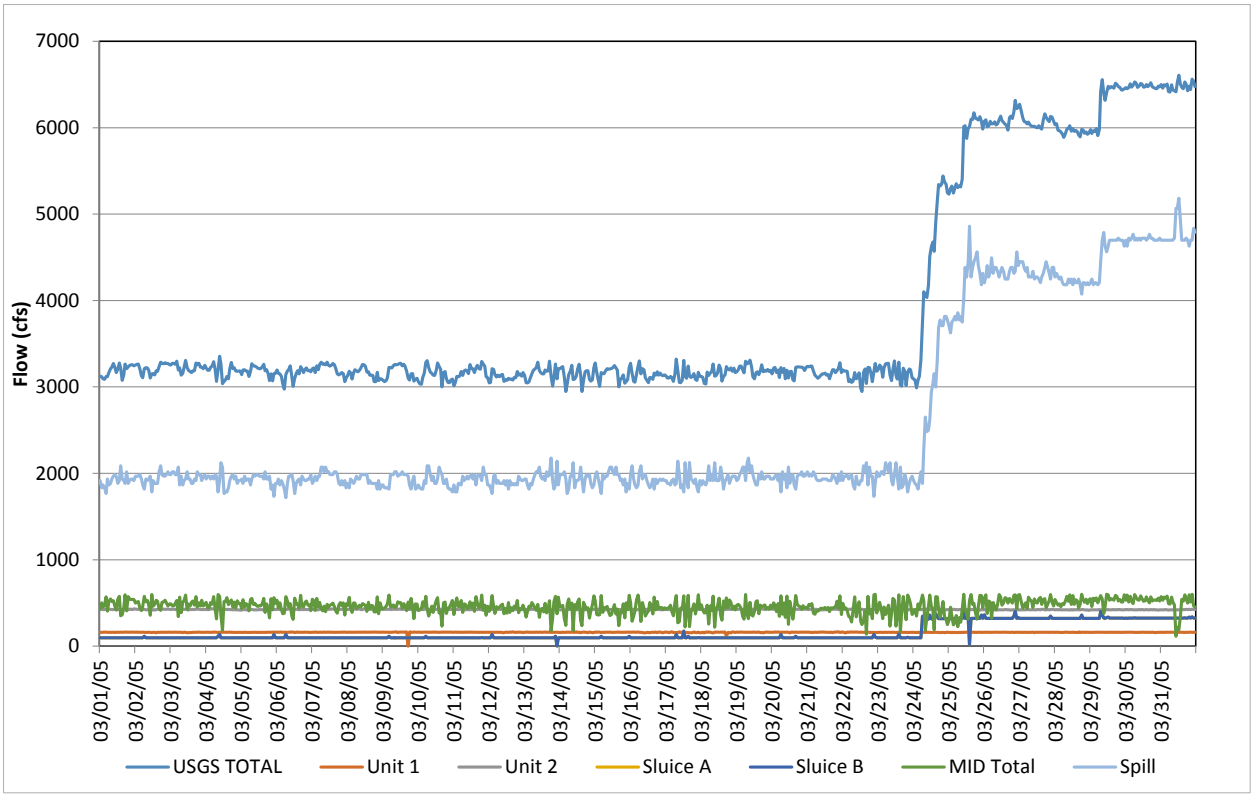

Figure D-3. Flow record in March 2005, based on hourly discharges.

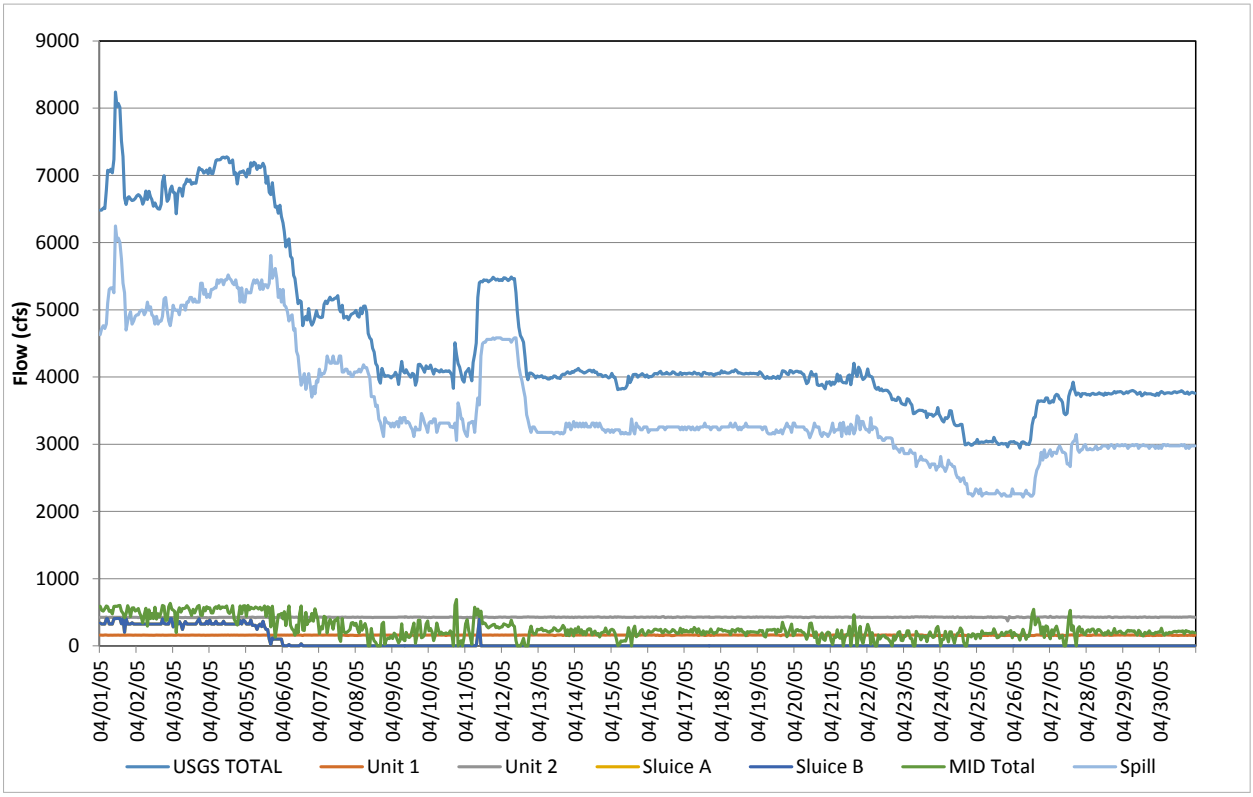

Figure D-4. Flow record in April 2005, based on hourly discharges.

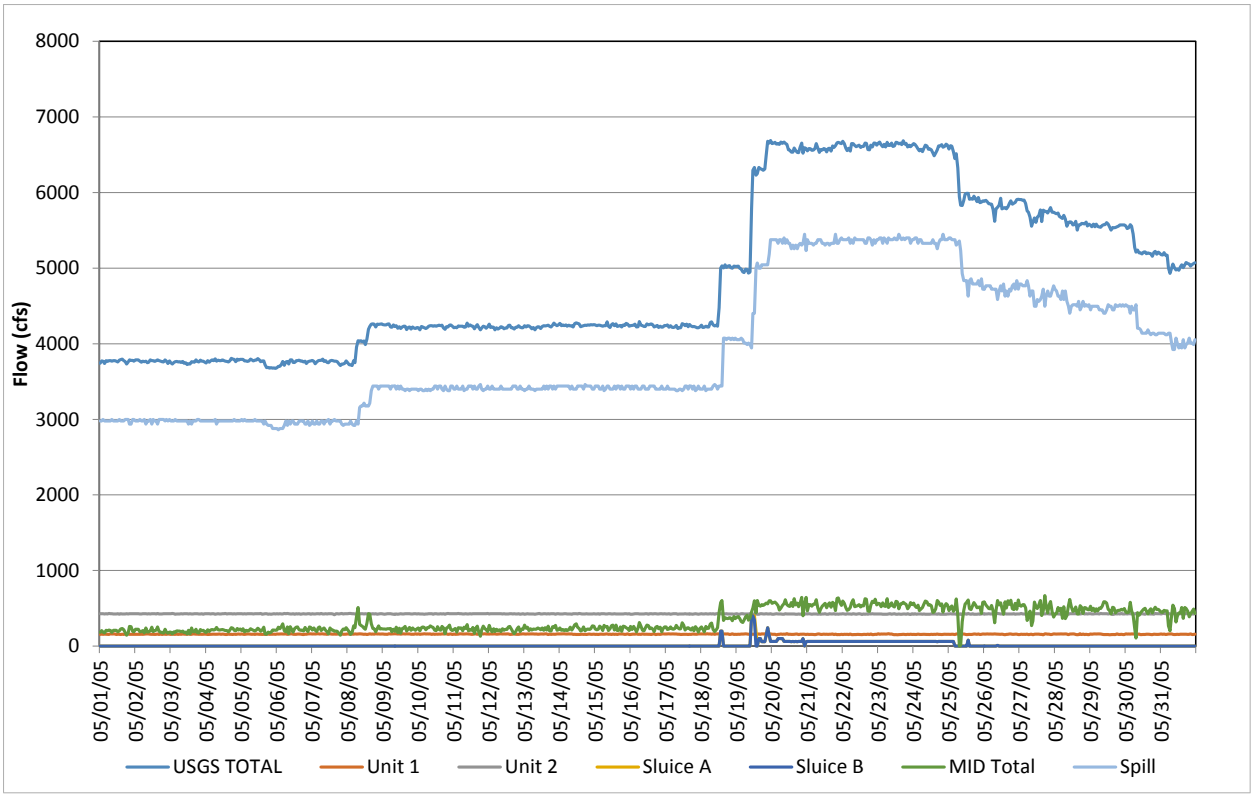

Figure D-5. Flow record in May 2005, based on hourly discharges.

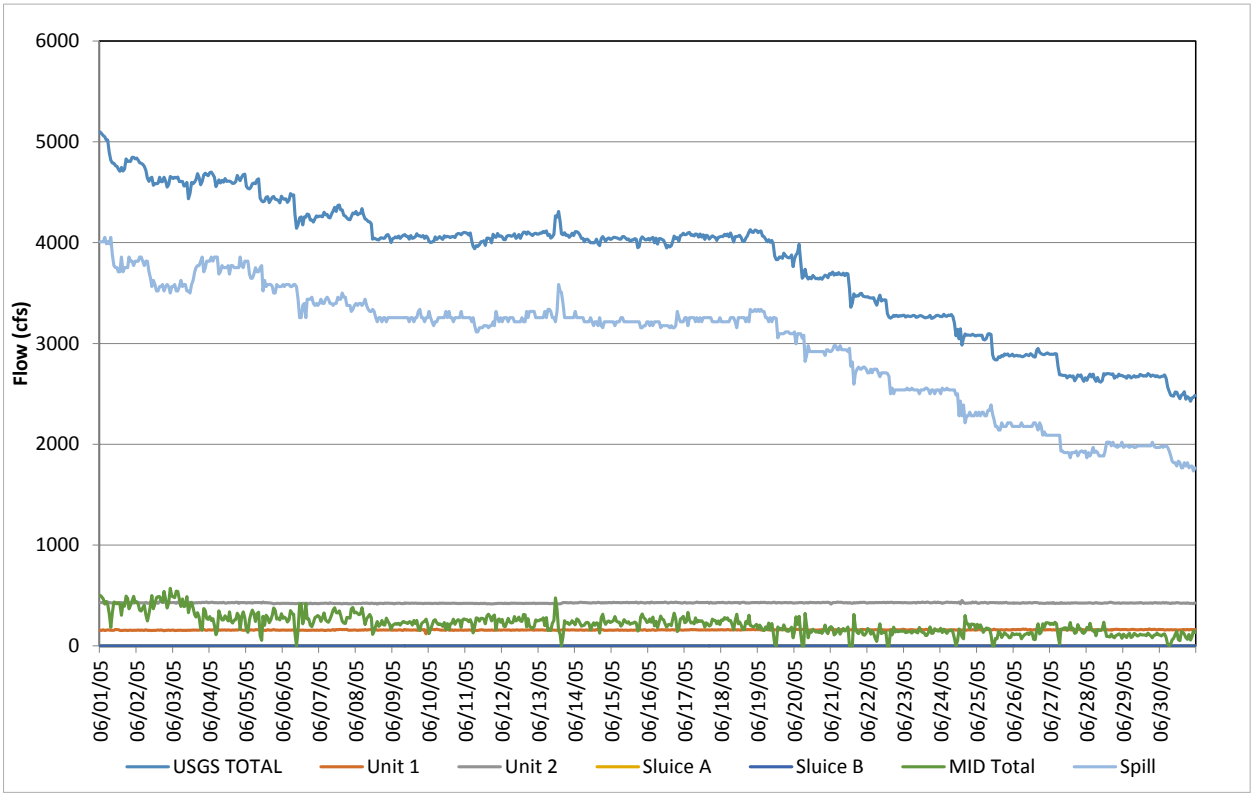

Figure D-6. Flow record in June 2005, based on hourly discharges.

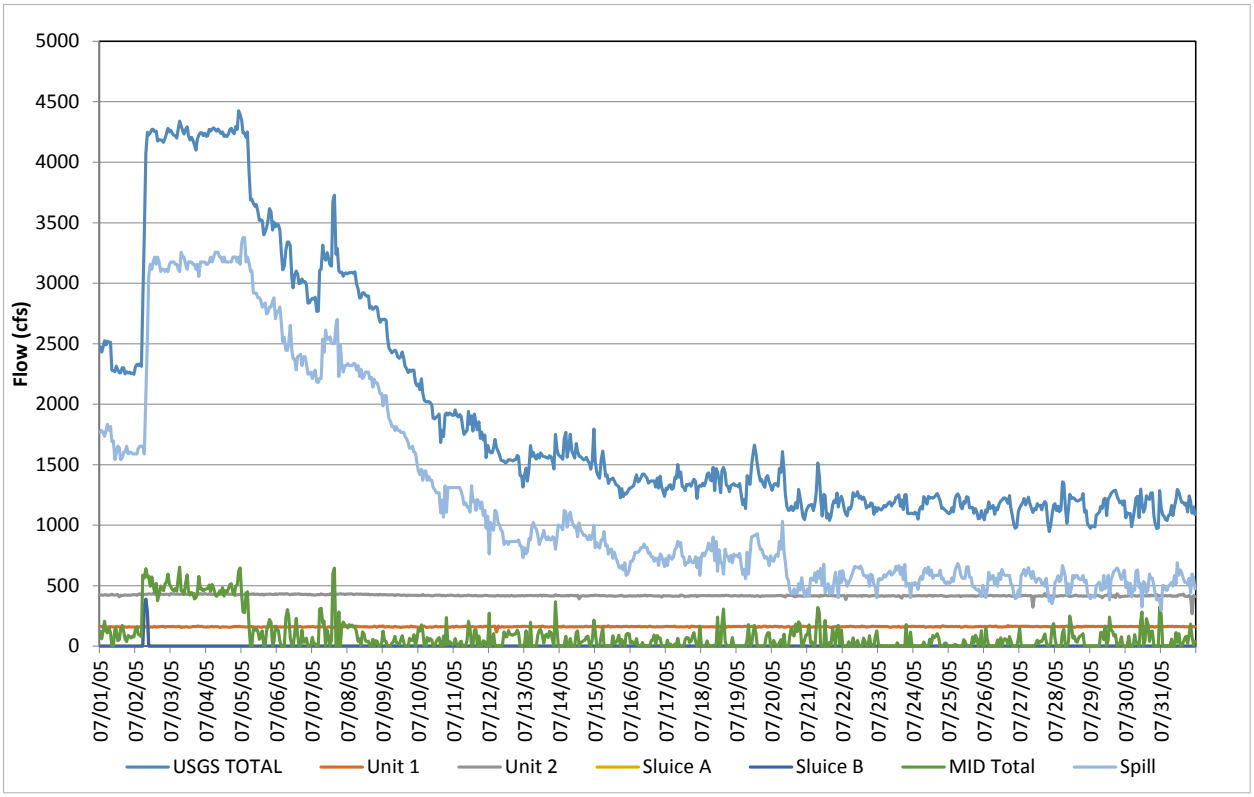

Figure D-7. Flow record in July 2005, based on hourly discharges.

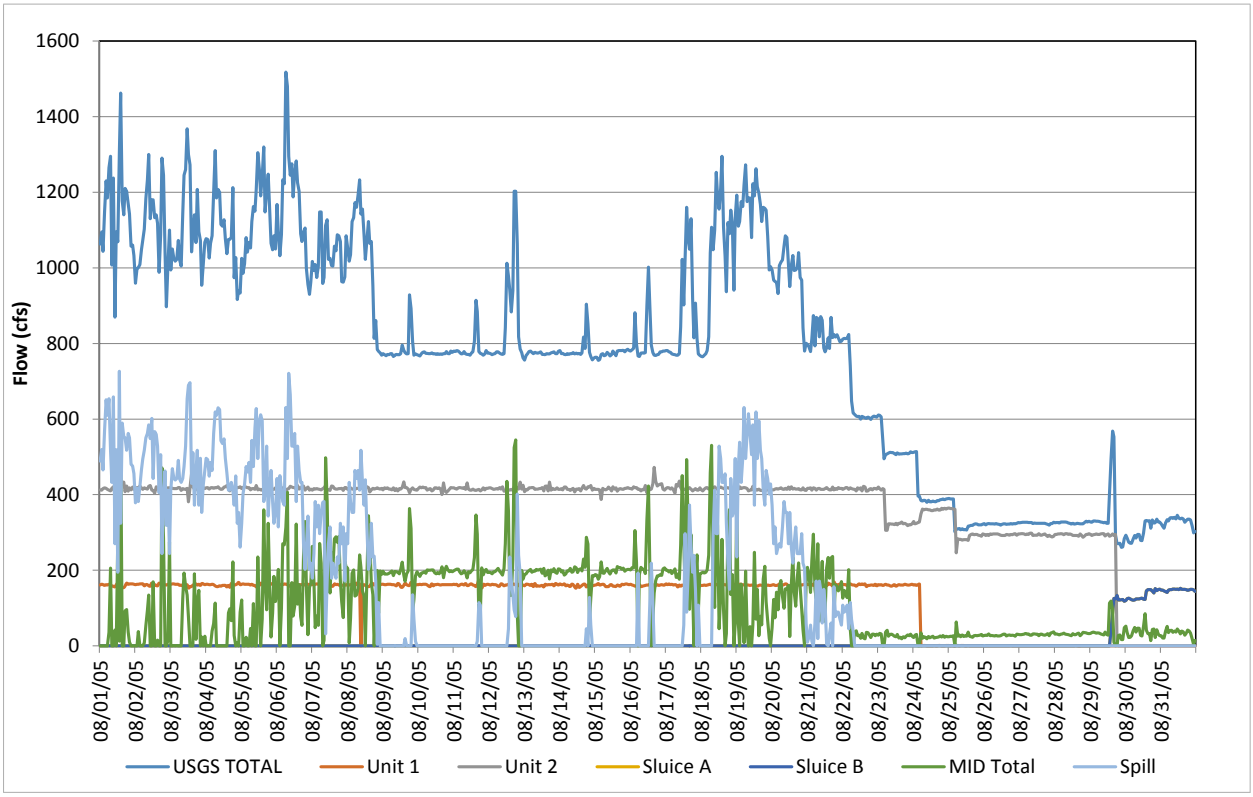

Figure D-8. Flow record in August 2005, based on hourly discharges.

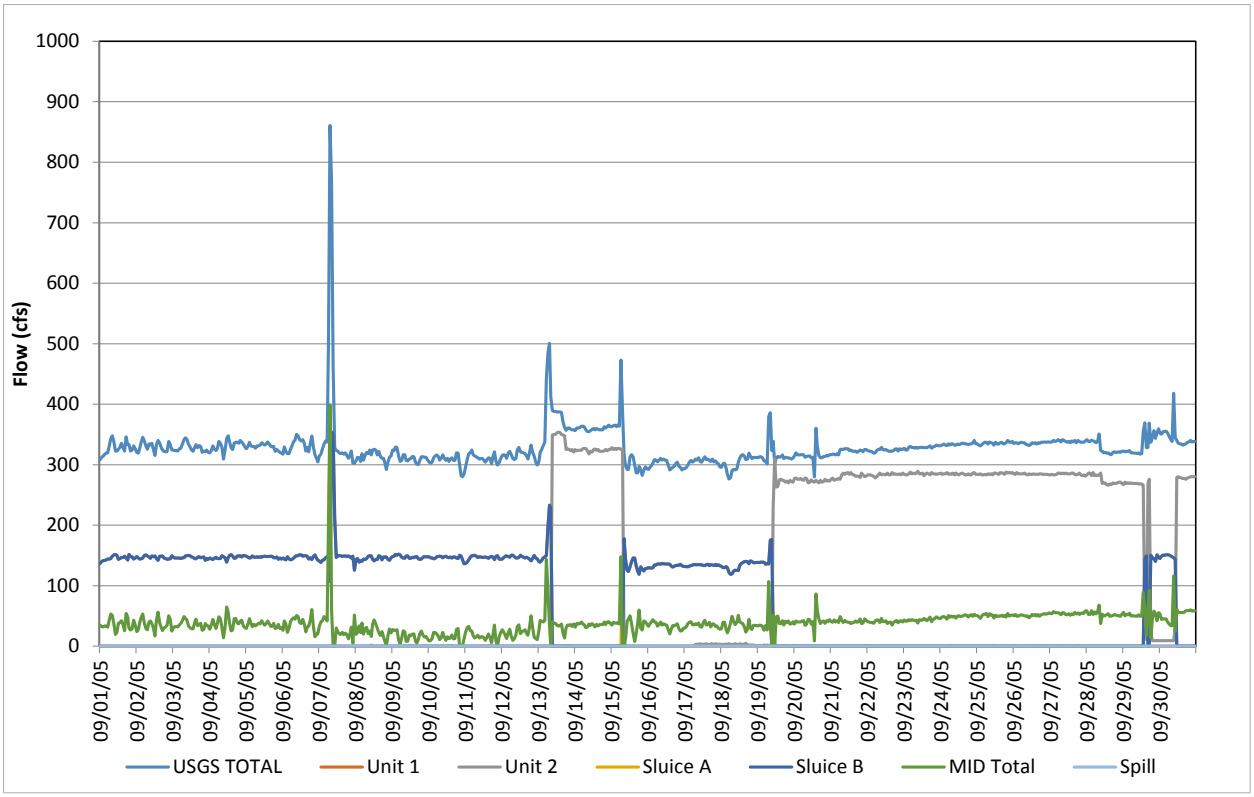

Figure D-9. Flow record in September 2005, based on hourly discharges.

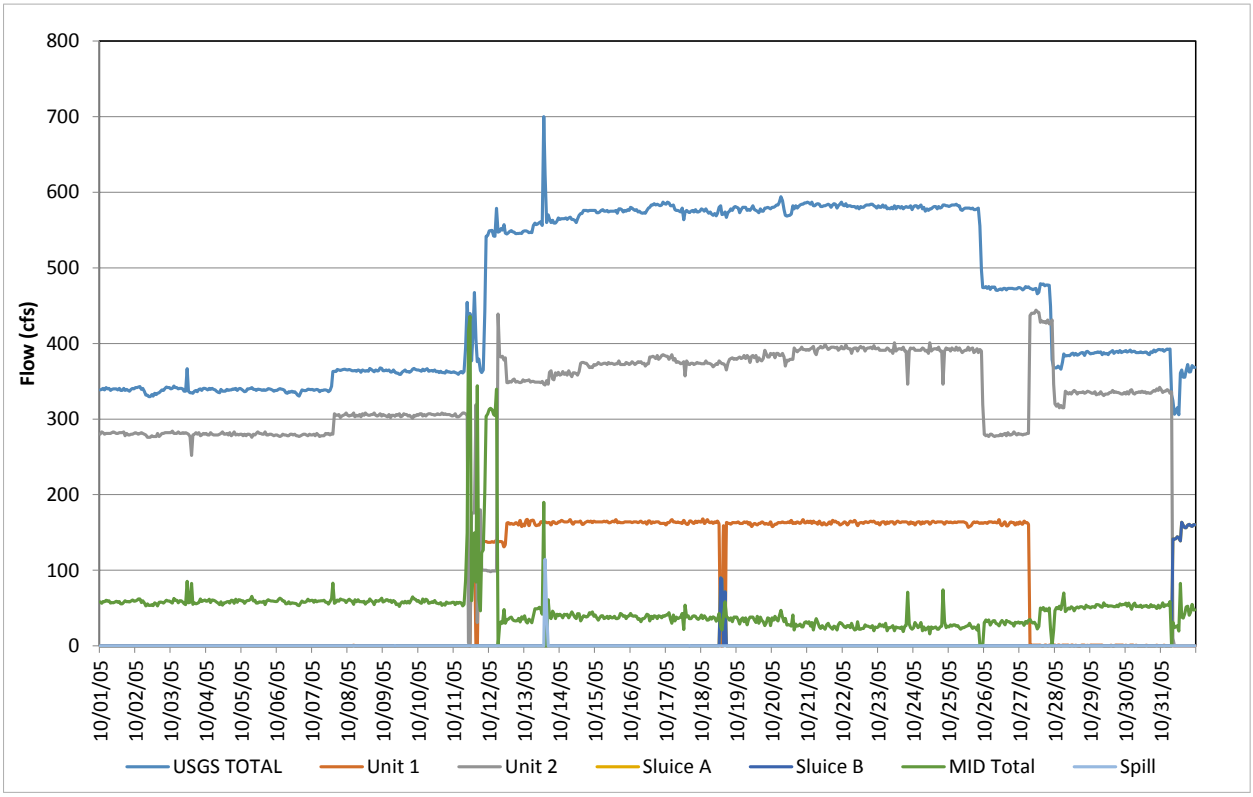

Figure D-10. Flow record in October 2005, based on hourly discharges.

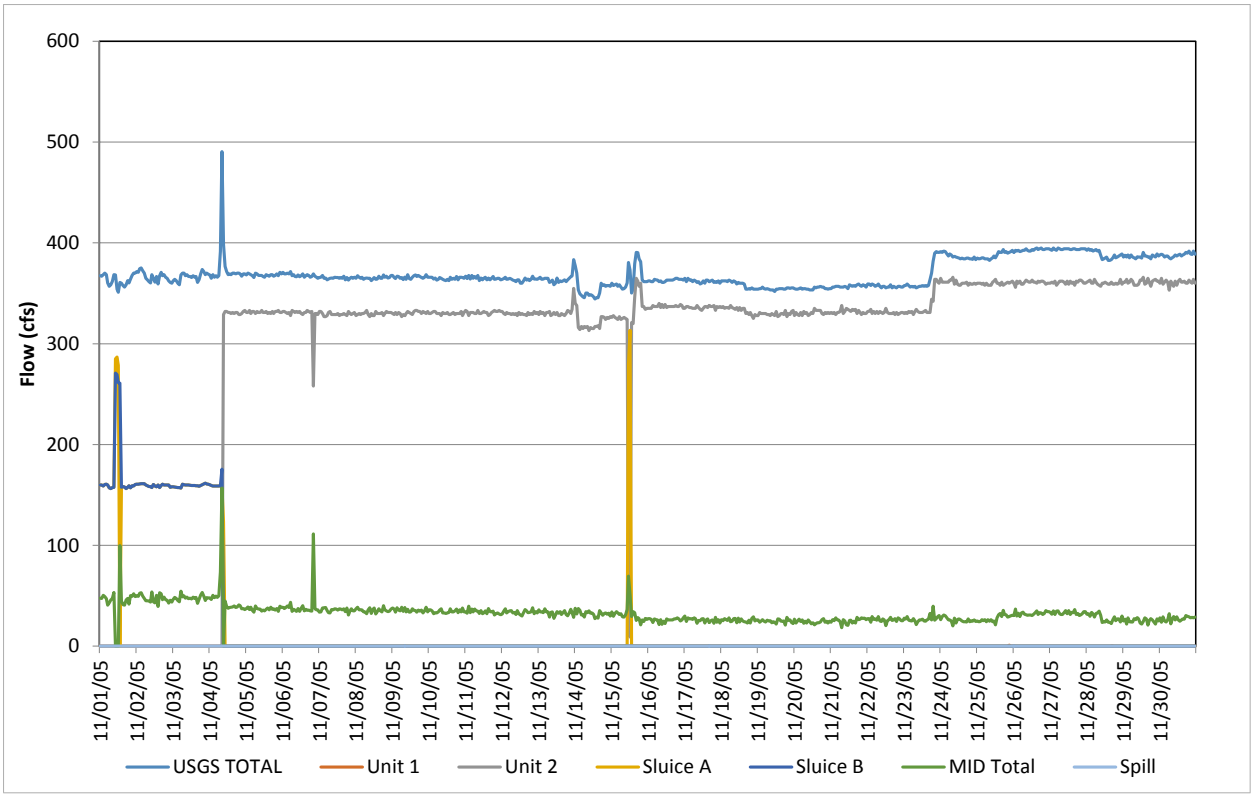

Figure D-11. Flow record in November 2005, based on hourly discharges.

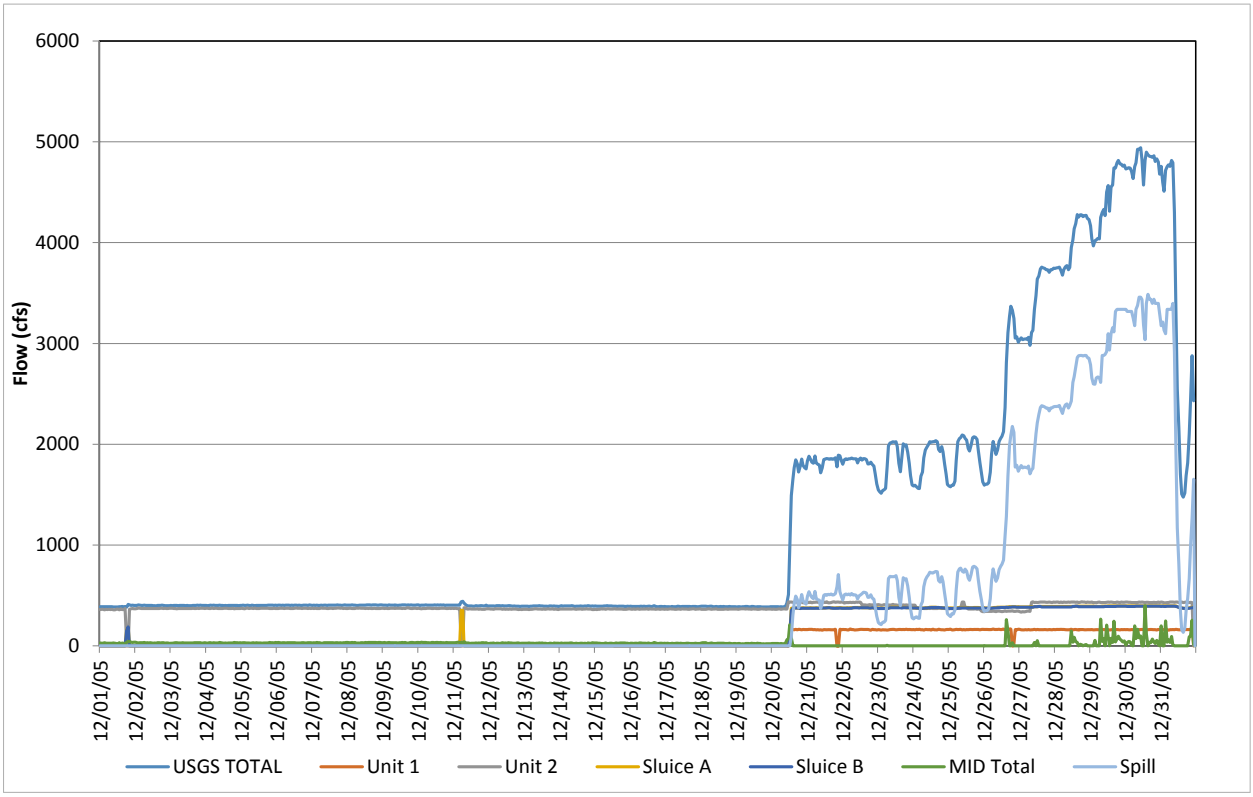

Figure D-12. Flow record in December 2005, based on hourly discharges.

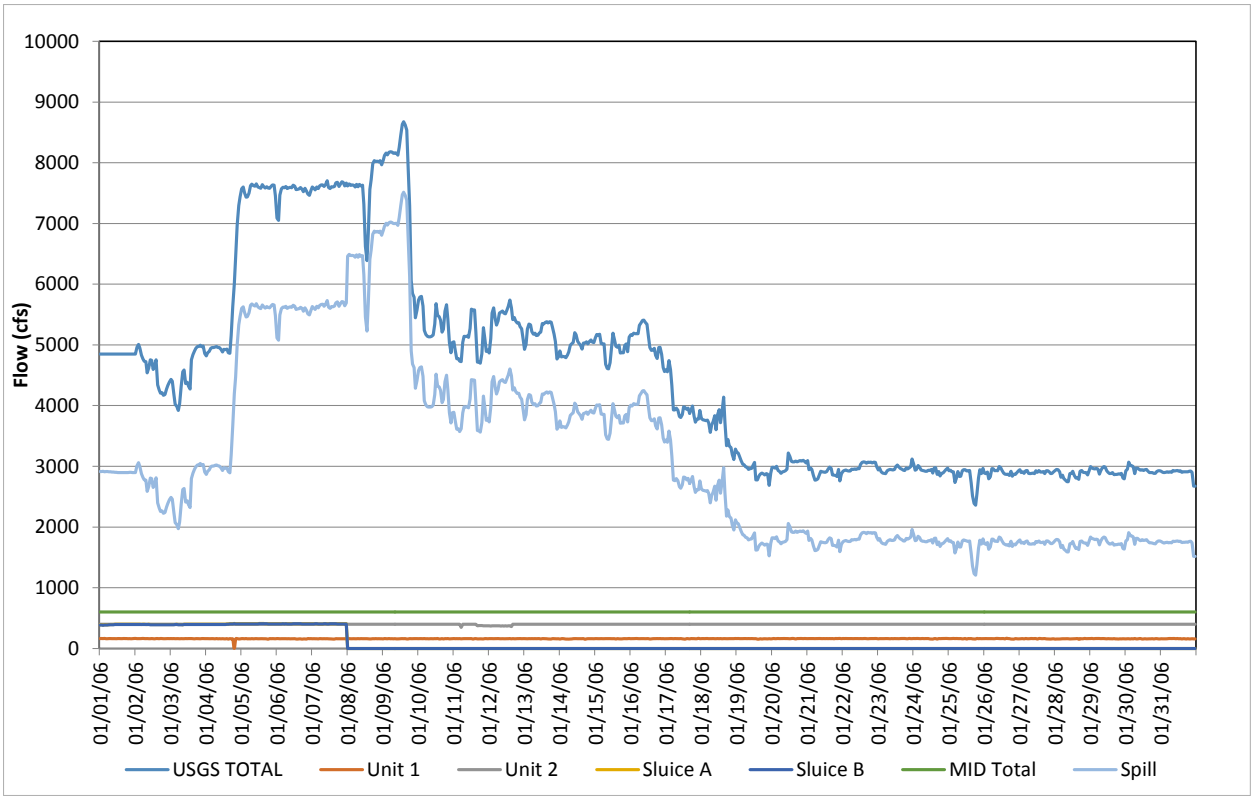

Figure D-13. Flow record in January 2006, based on hourly discharges.

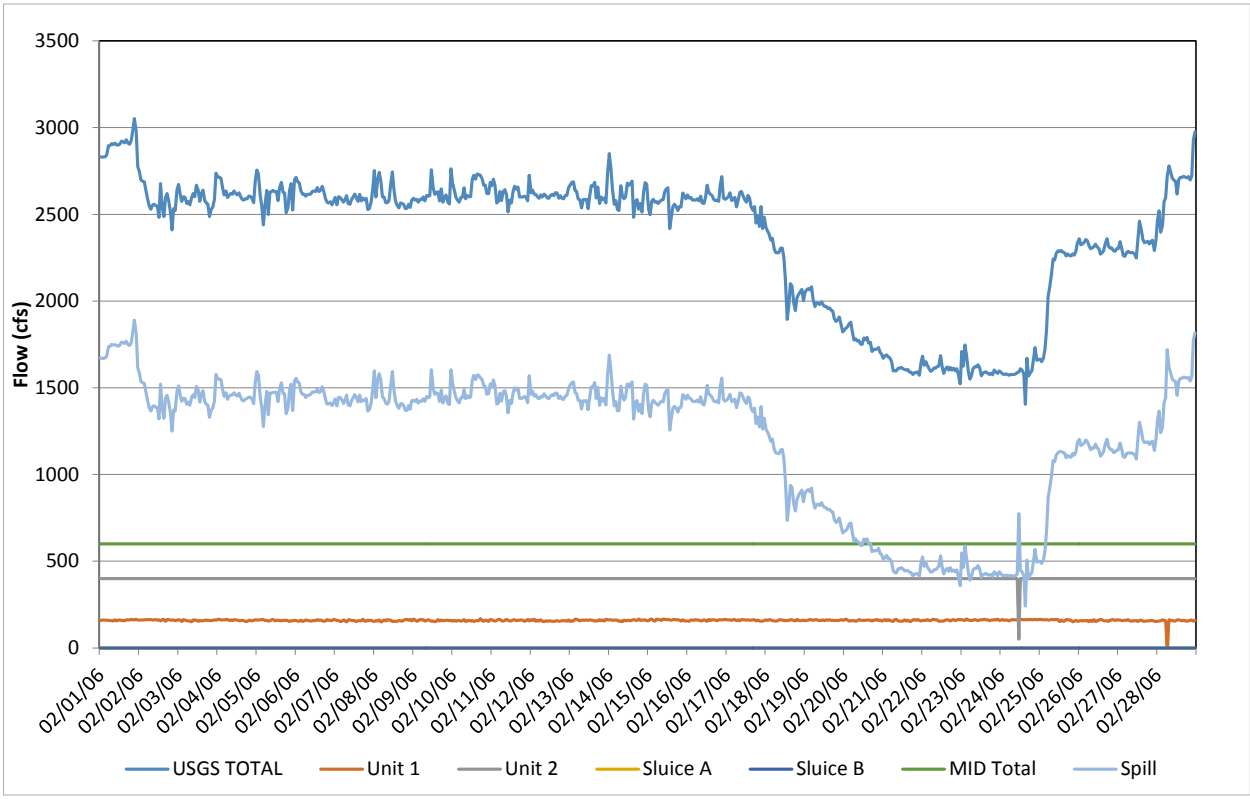

Figure D-14. Flow record in February 2006, based on hourly discharges.

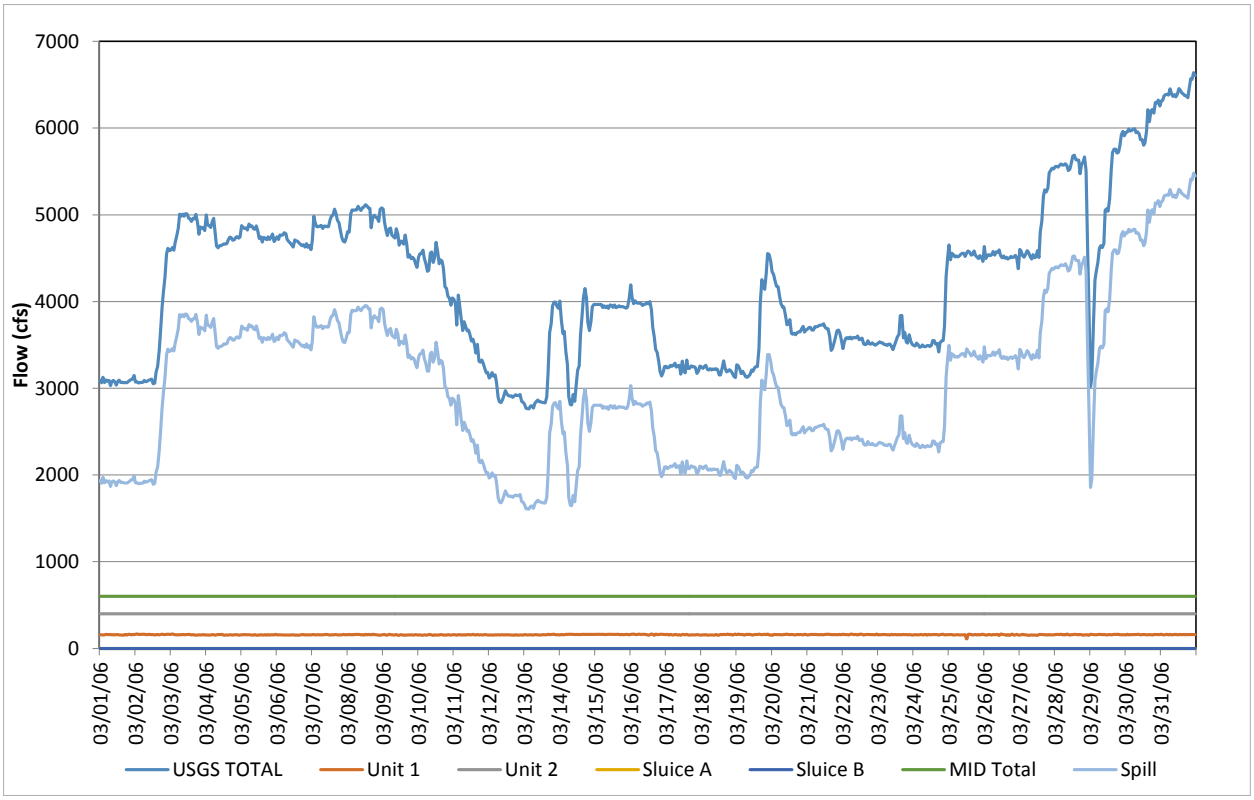

Figure D-15. Flow record in March 2006, based on hourly discharges.

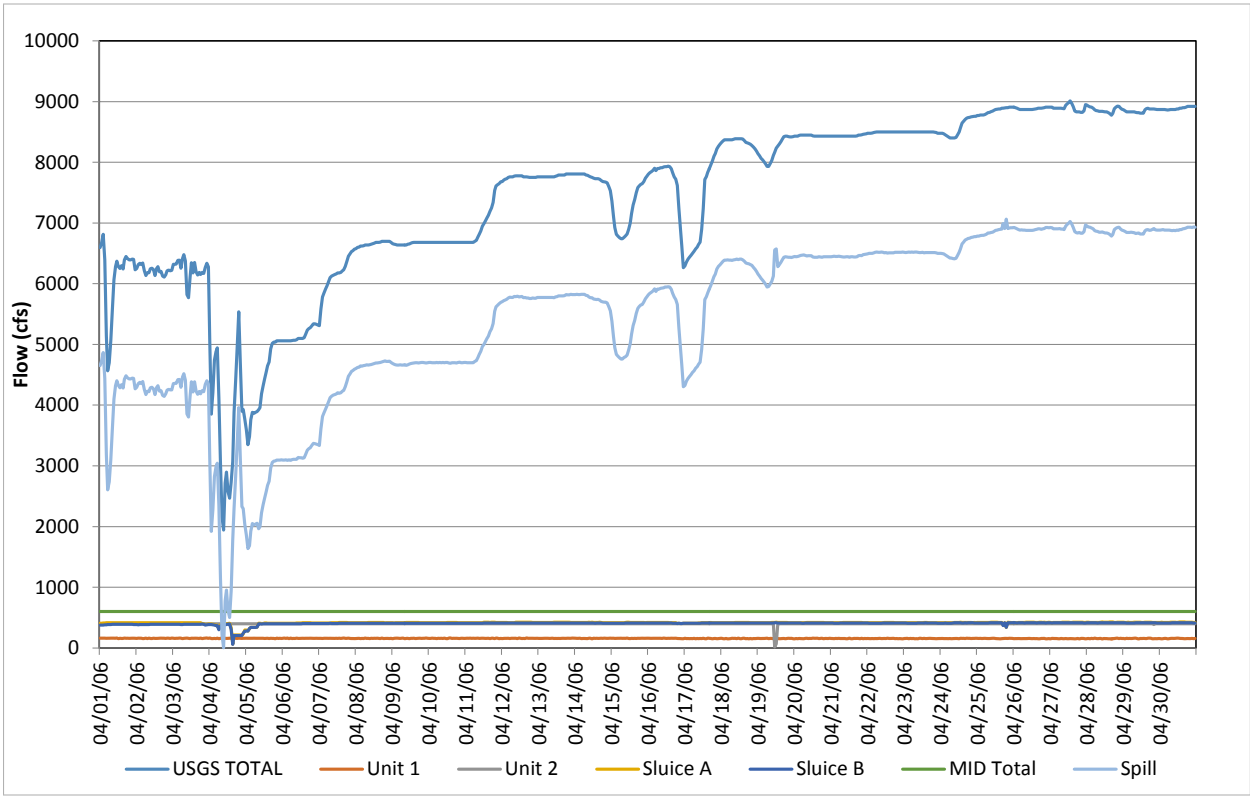

Figure D-16. Flow record in April 2006, based on hourly discharges.

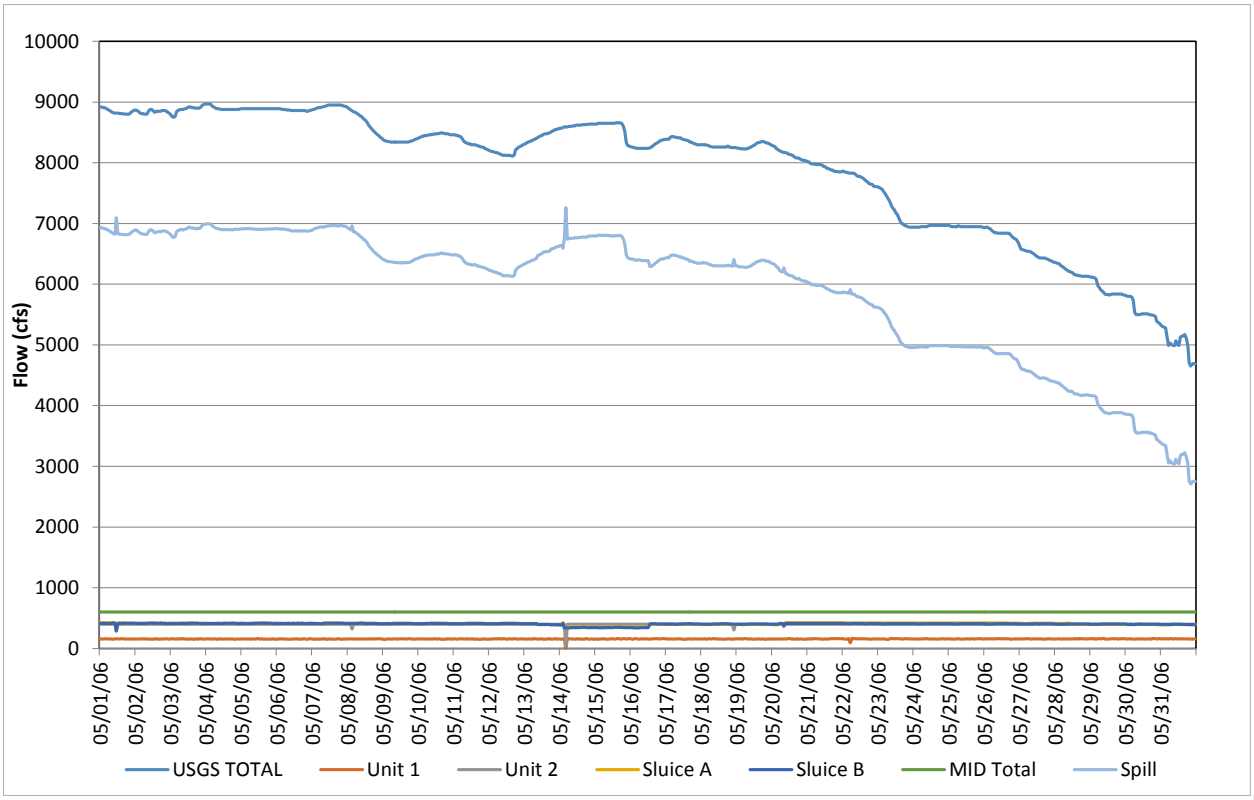

Figure D-17. Flow record in May 2006, based on hourly discharges.

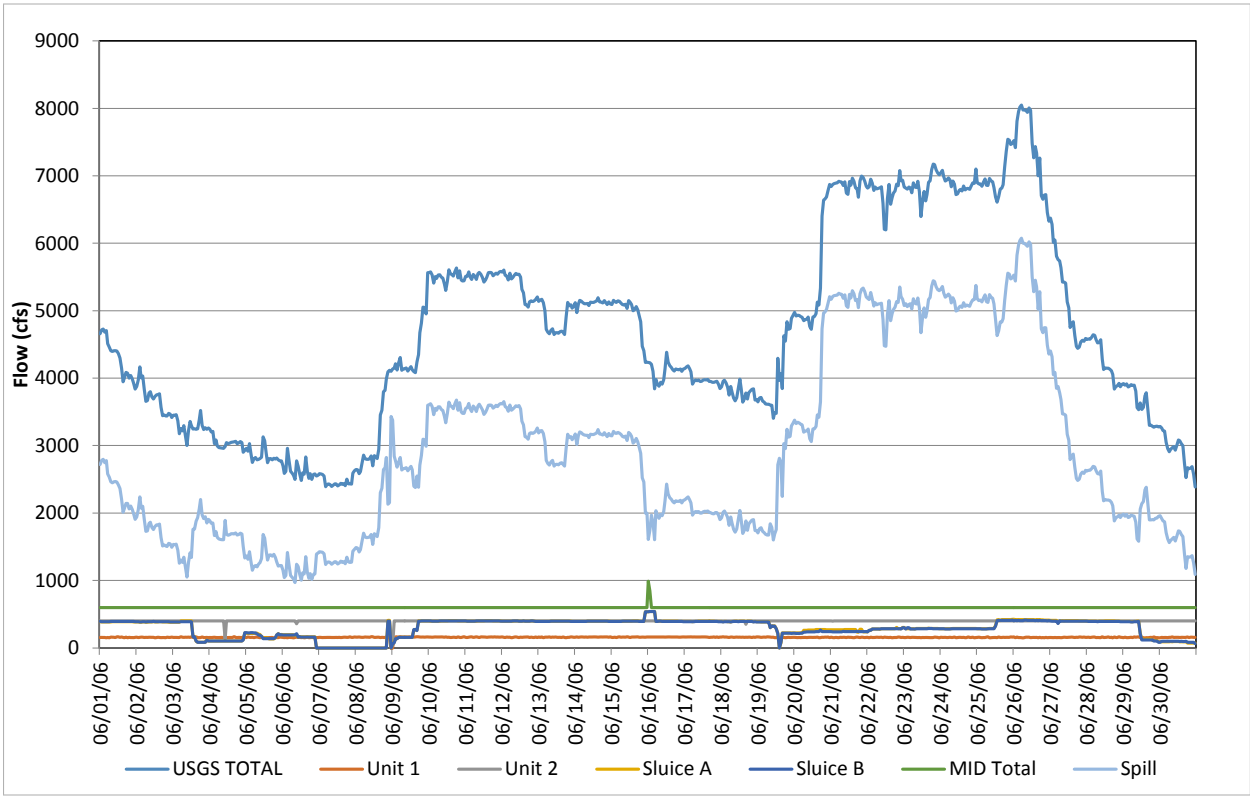

Figure D-18. Flow record in June 2006, based on hourly discharges.

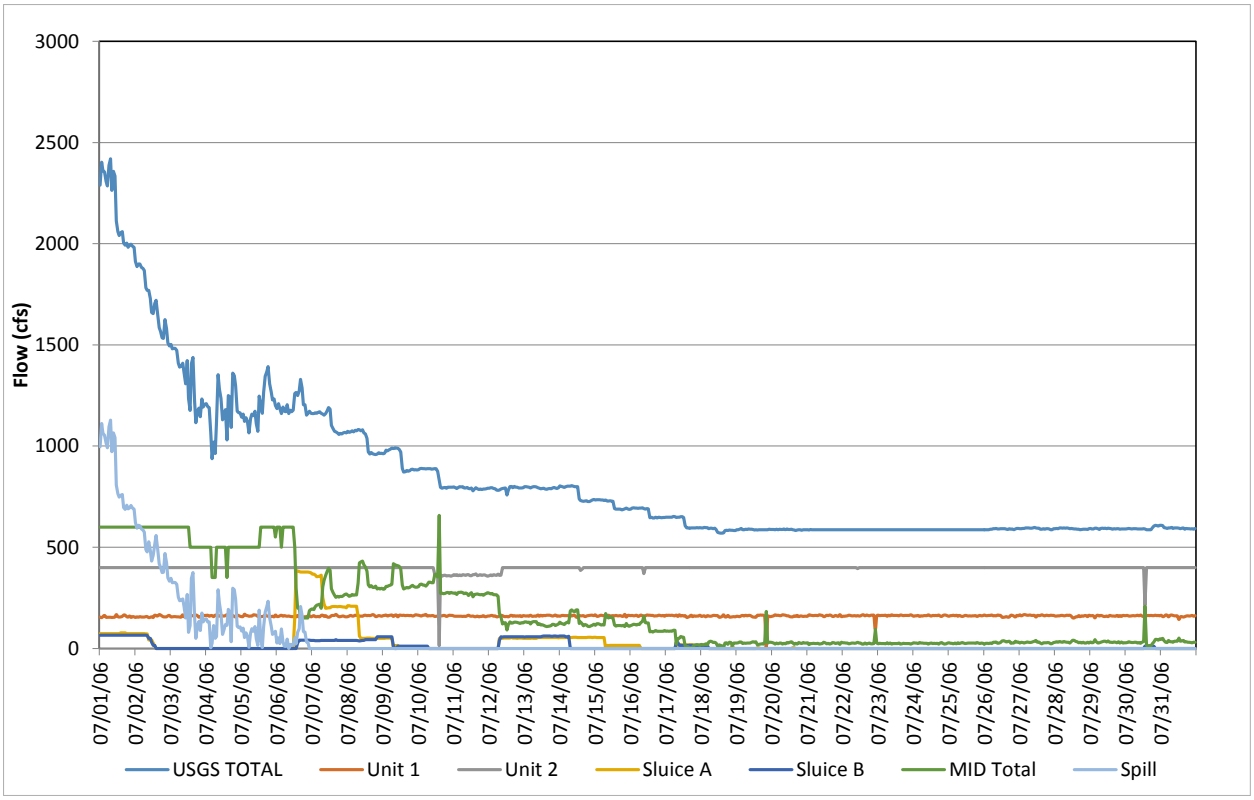

Figure D-19. Flow record in July 2006, based on hourly discharges.

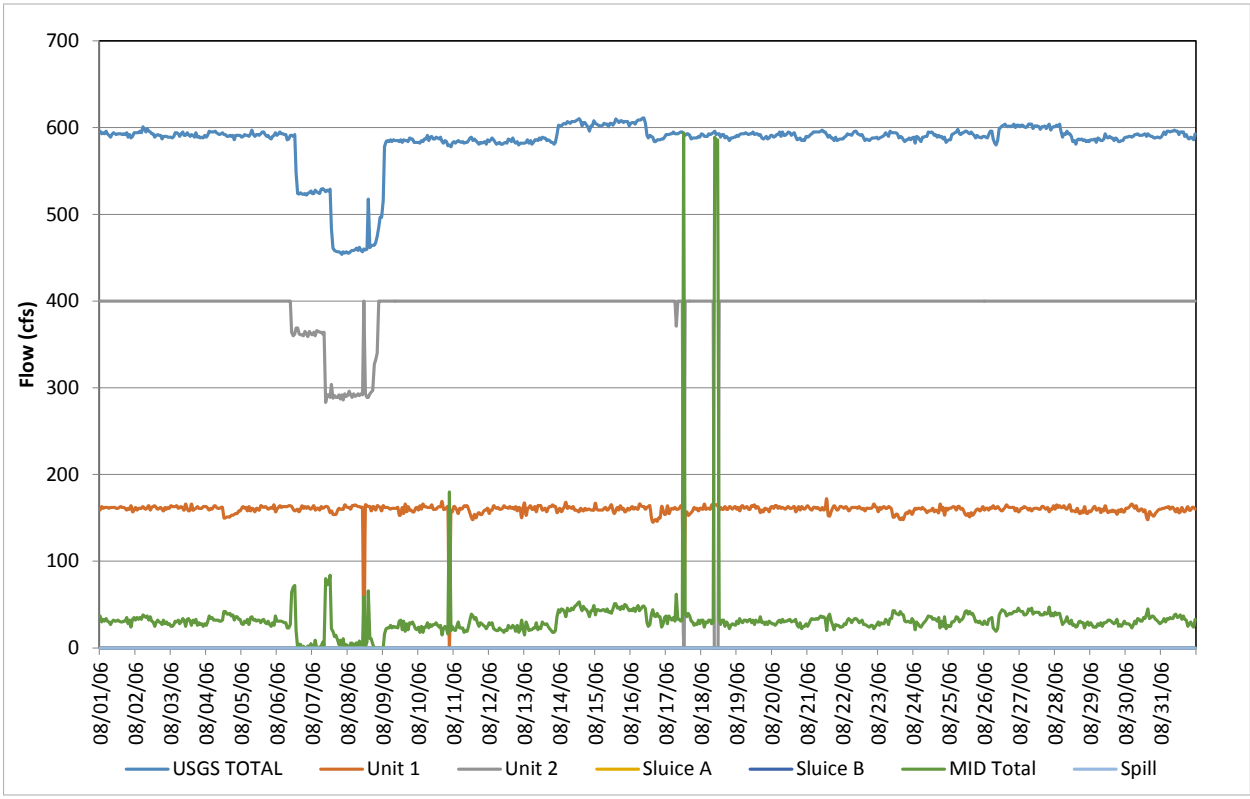

Figure D-20. Flow record in August 2006, based on hourly discharges.

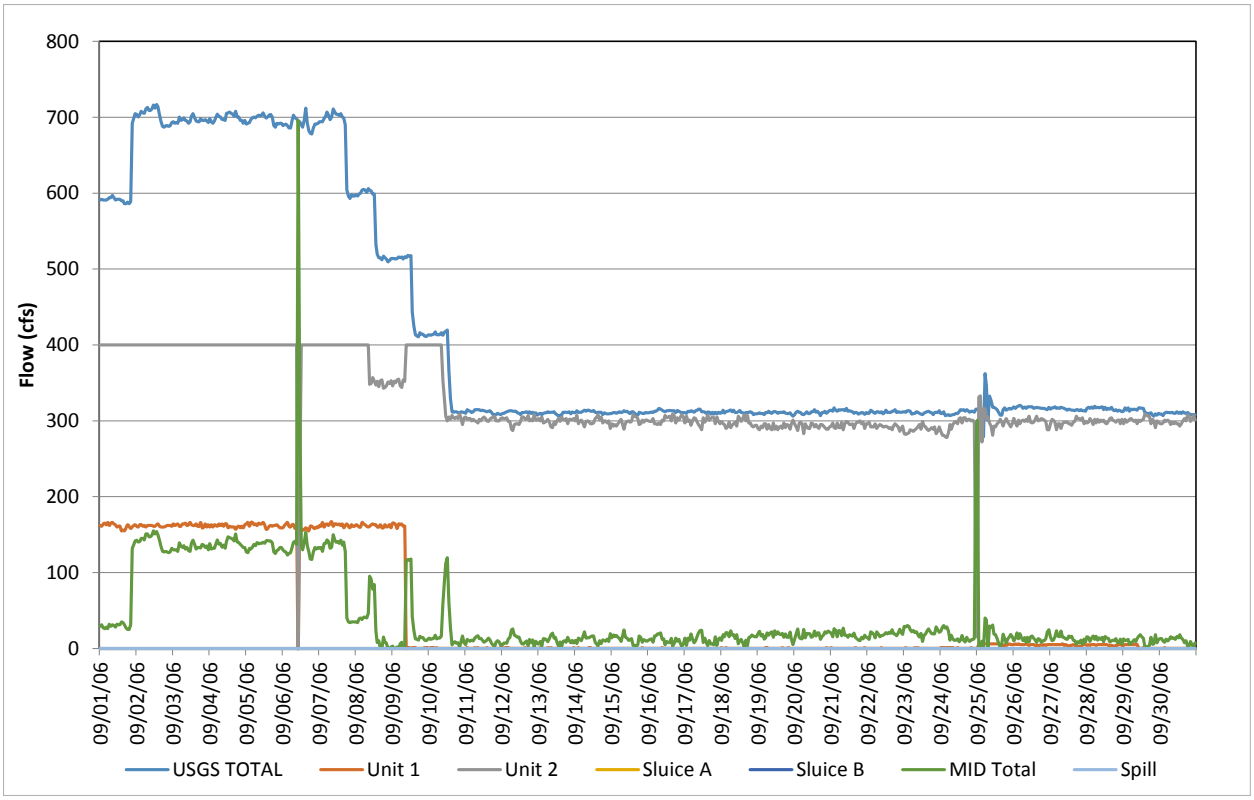

Figure D-21. Flow record in September 2006, based on hourly discharges.

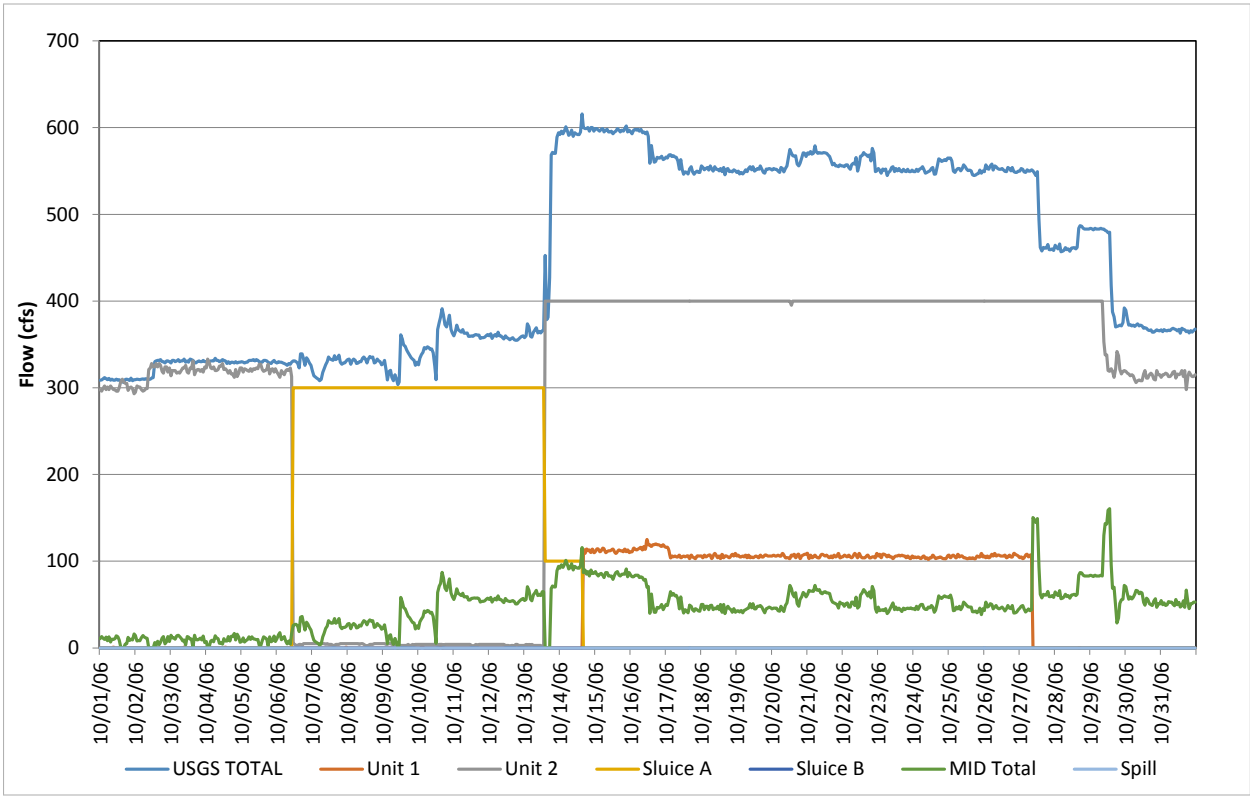

Figure D-22. Flow record in October 2006, based on hourly discharges.

Figure D-23. Flow record in November 2006, based on hourly discharges.

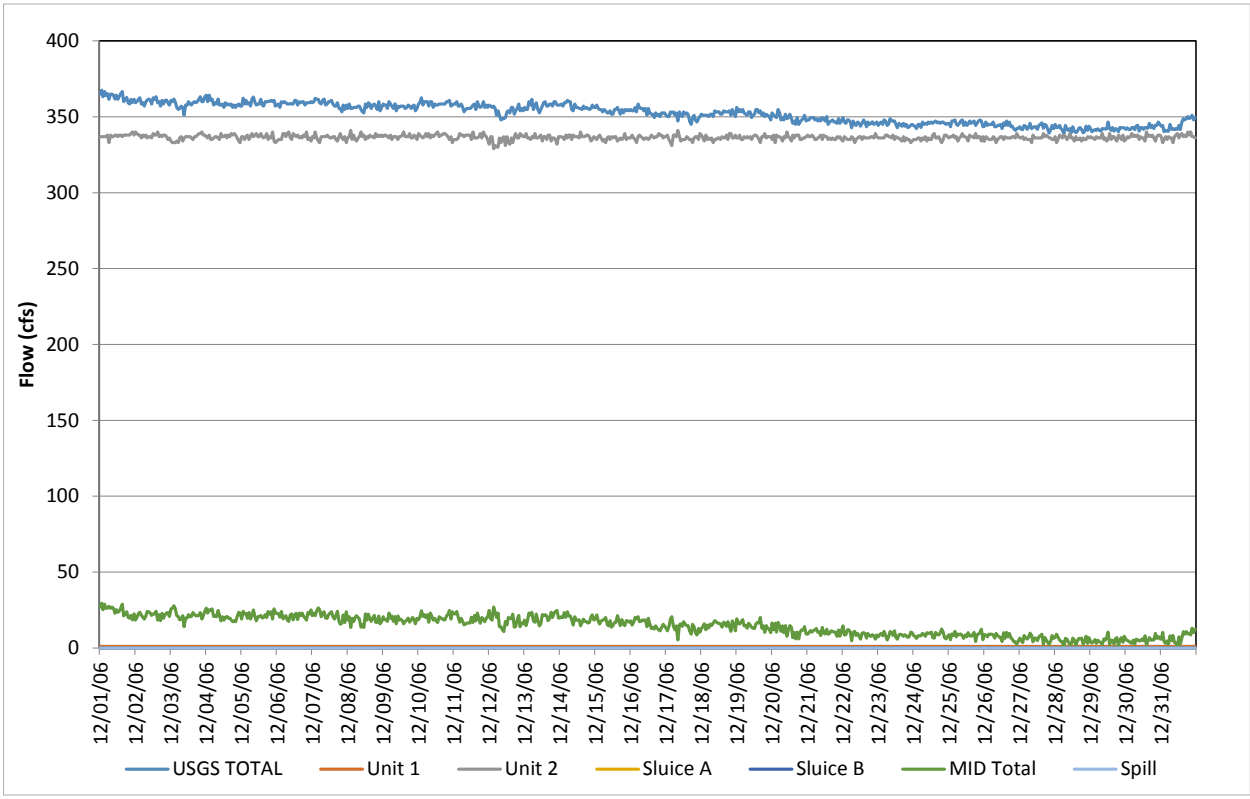

Figure D-24 Flow record in December 2006, based on hourly discharges.

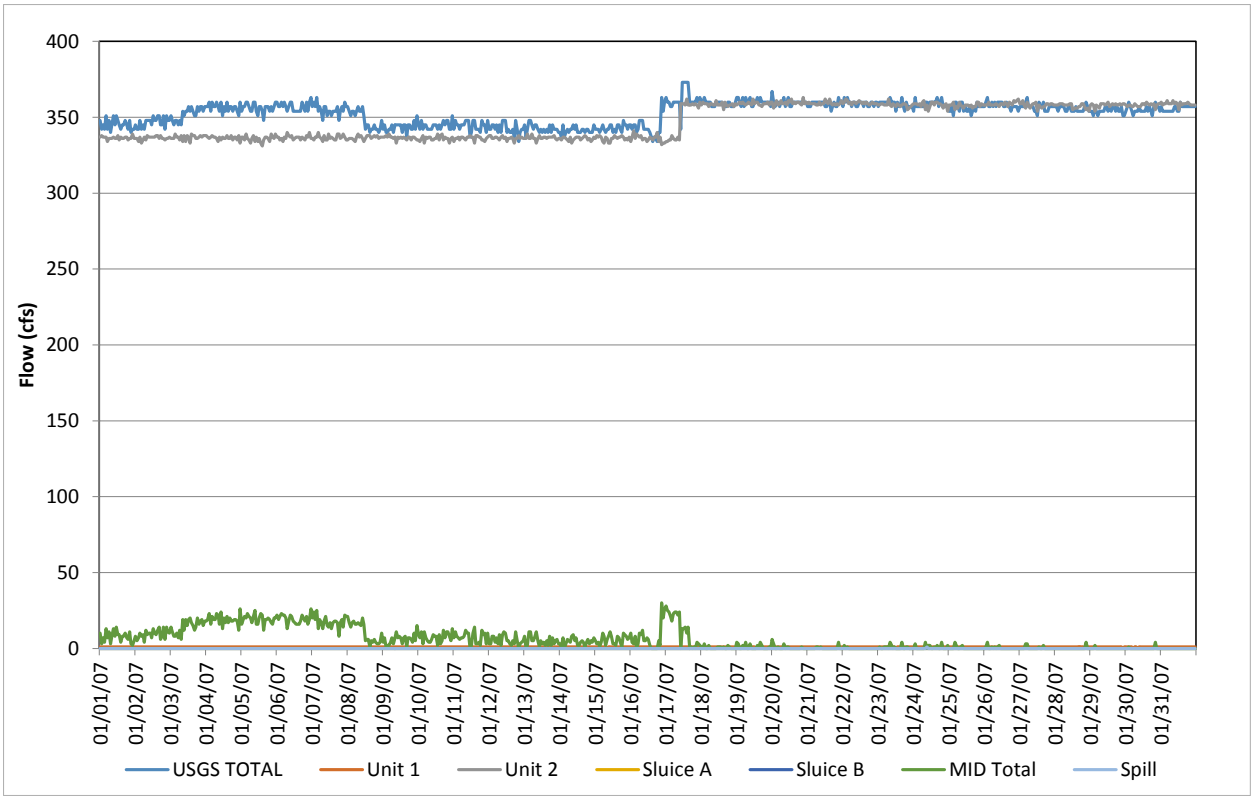

Figure D-25. Flow record in January 2007, based on hourly discharges.

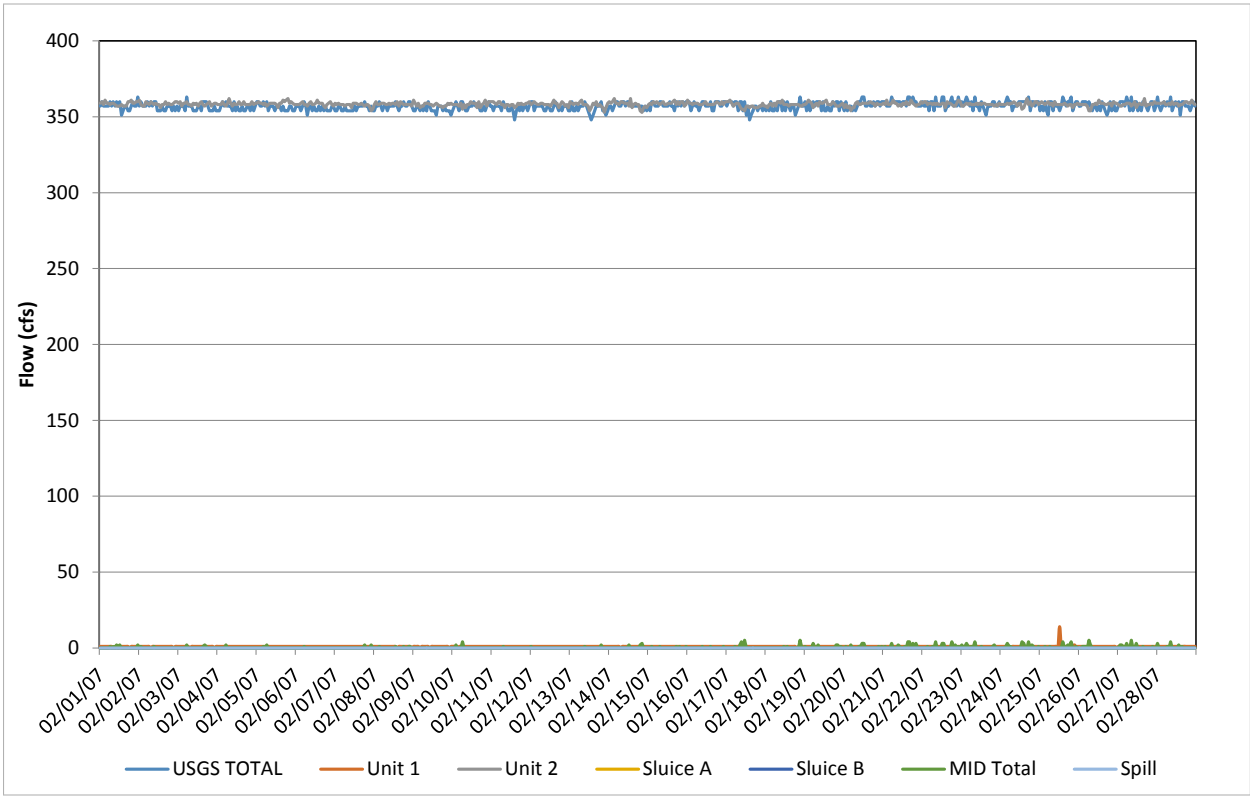

Figure D-26. Flow record in February 2007, based on hourly discharges.

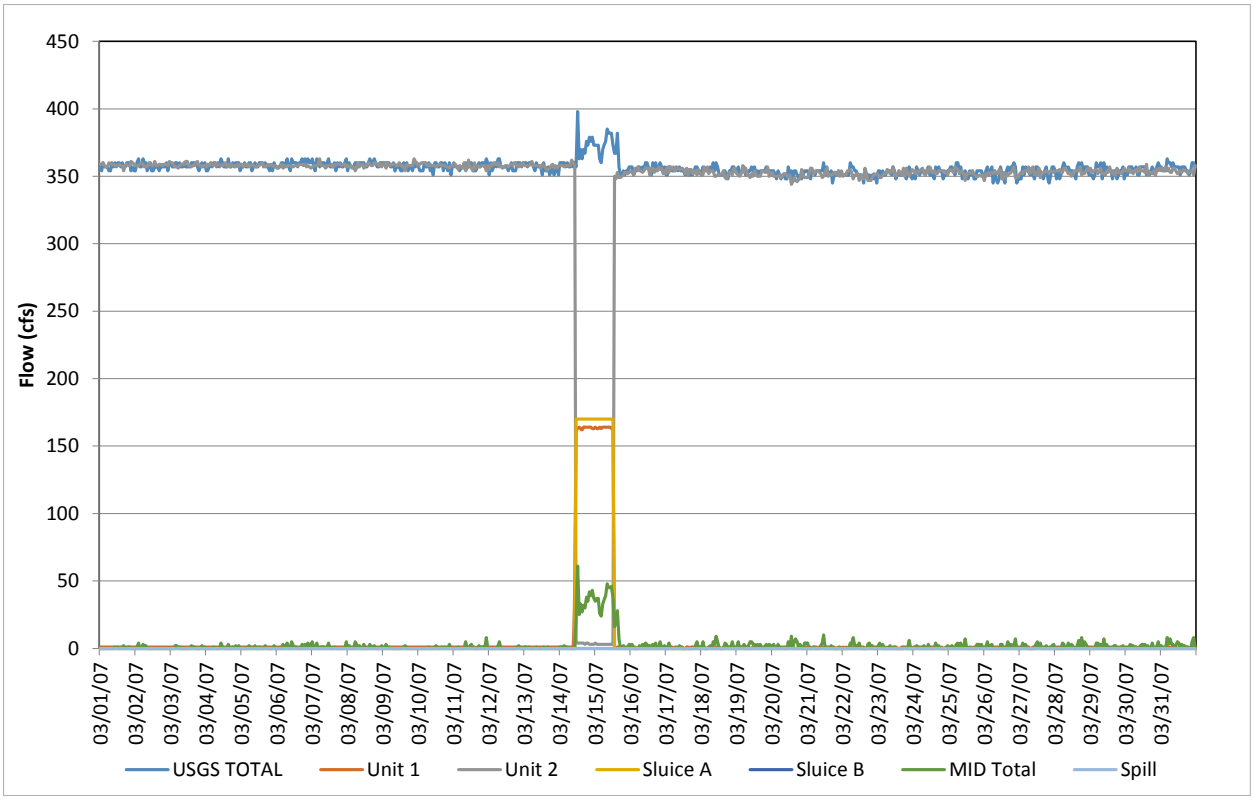

Figure D-27. Flow record in March 2007, based on hourly discharges.

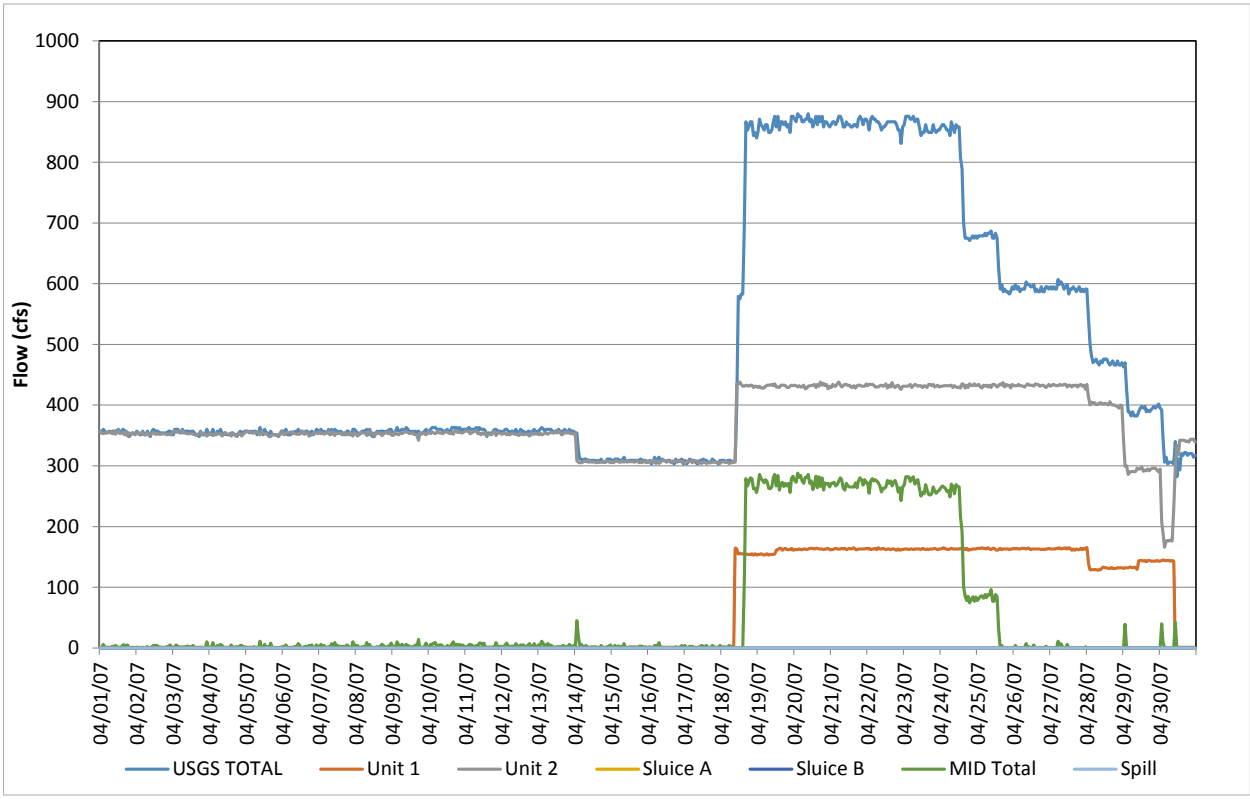

Figure D-27. Flow record in April 2007, based on hourly discharges.

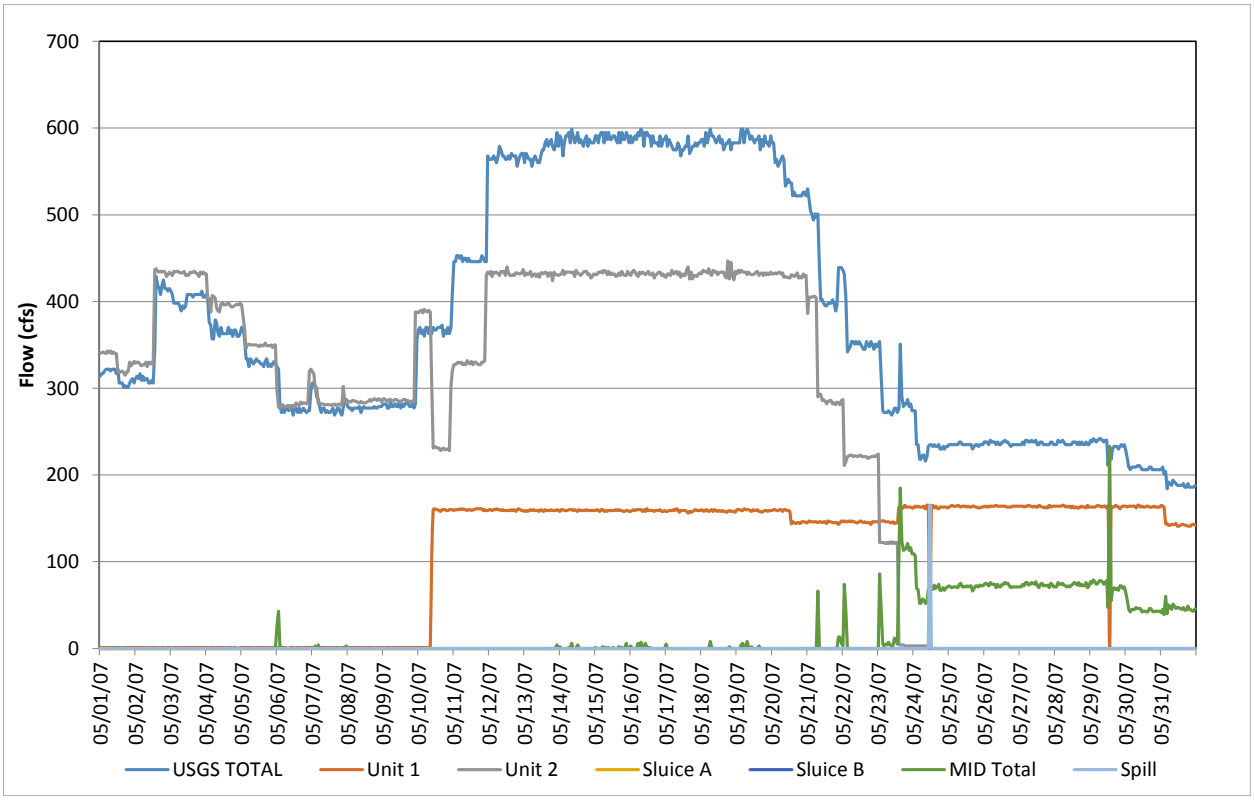

Figure D-29. Flow record in May 2007, based on hourly discharges.

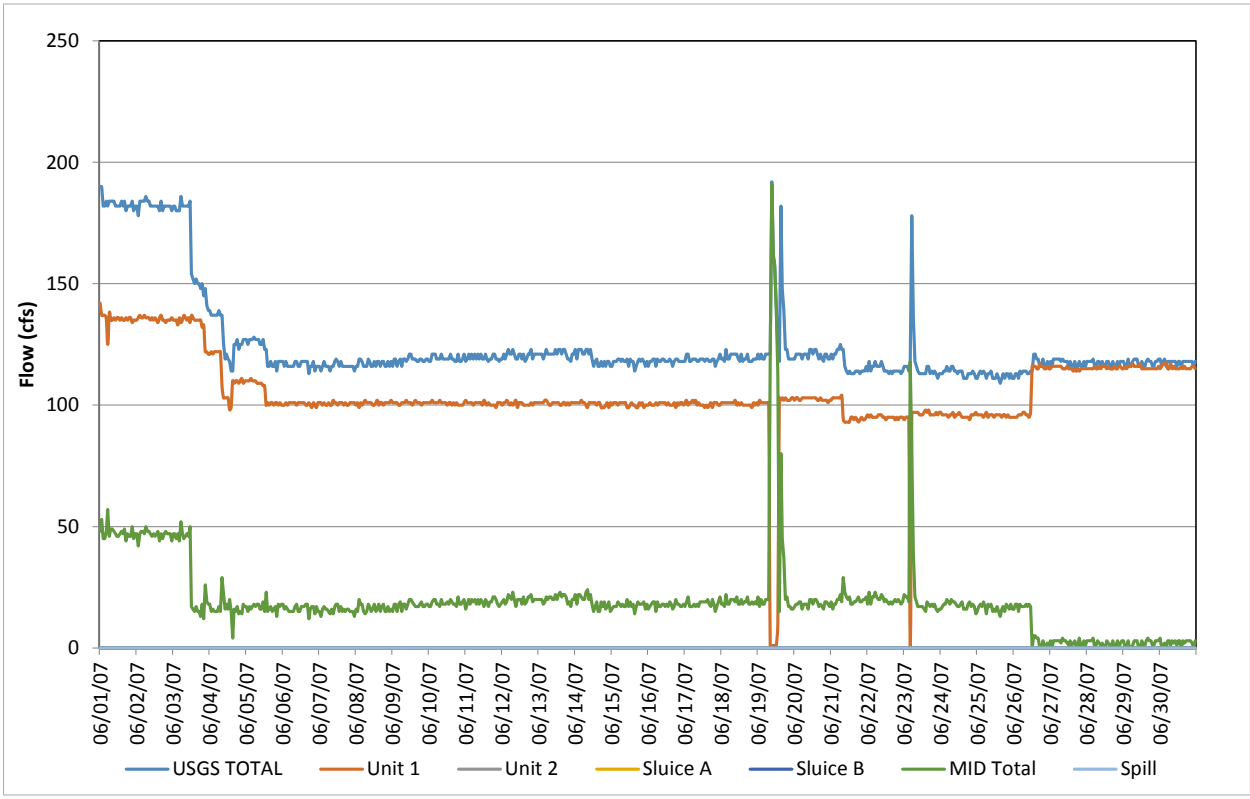

Figure D-30. Flow record in June 2007, based on hourly discharges.

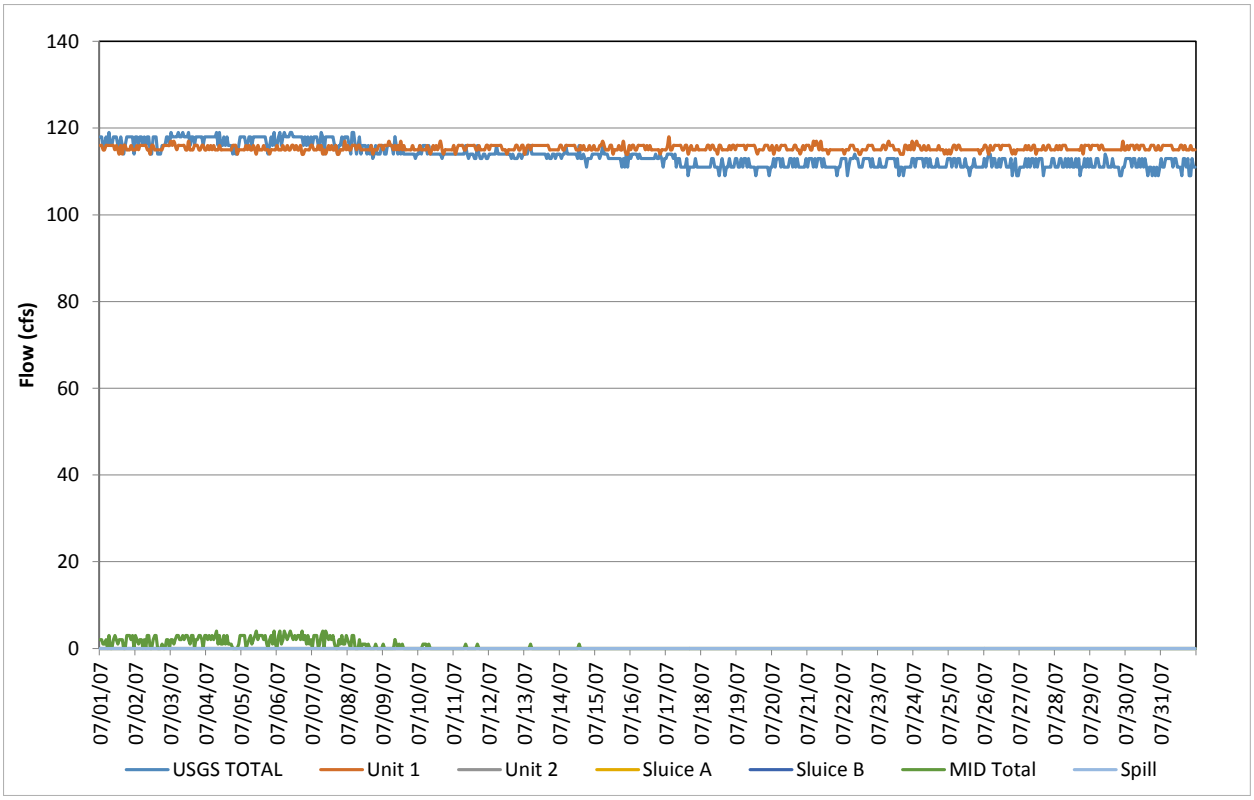

Figure D-31. Flow record in July 2007, based on hourly discharges.

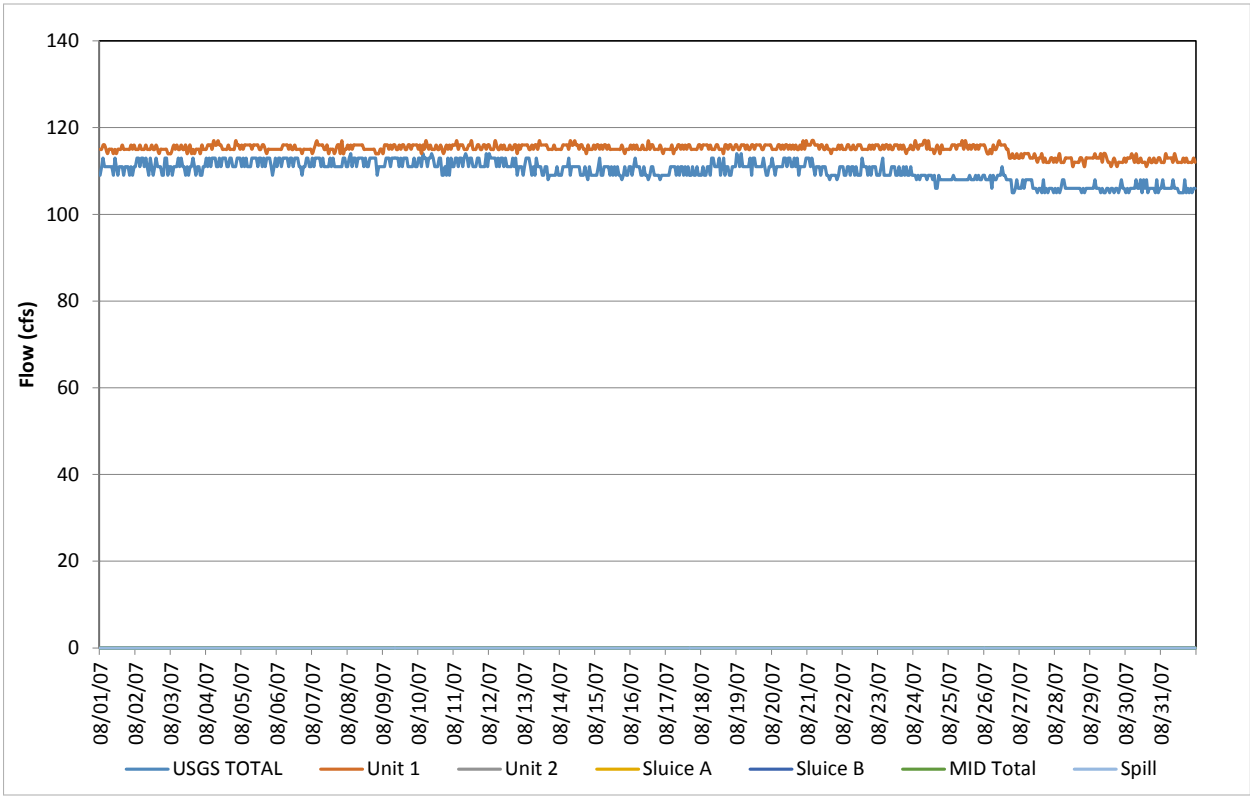

Figure D-32. Flow record in August 2007, based on hourly discharges.

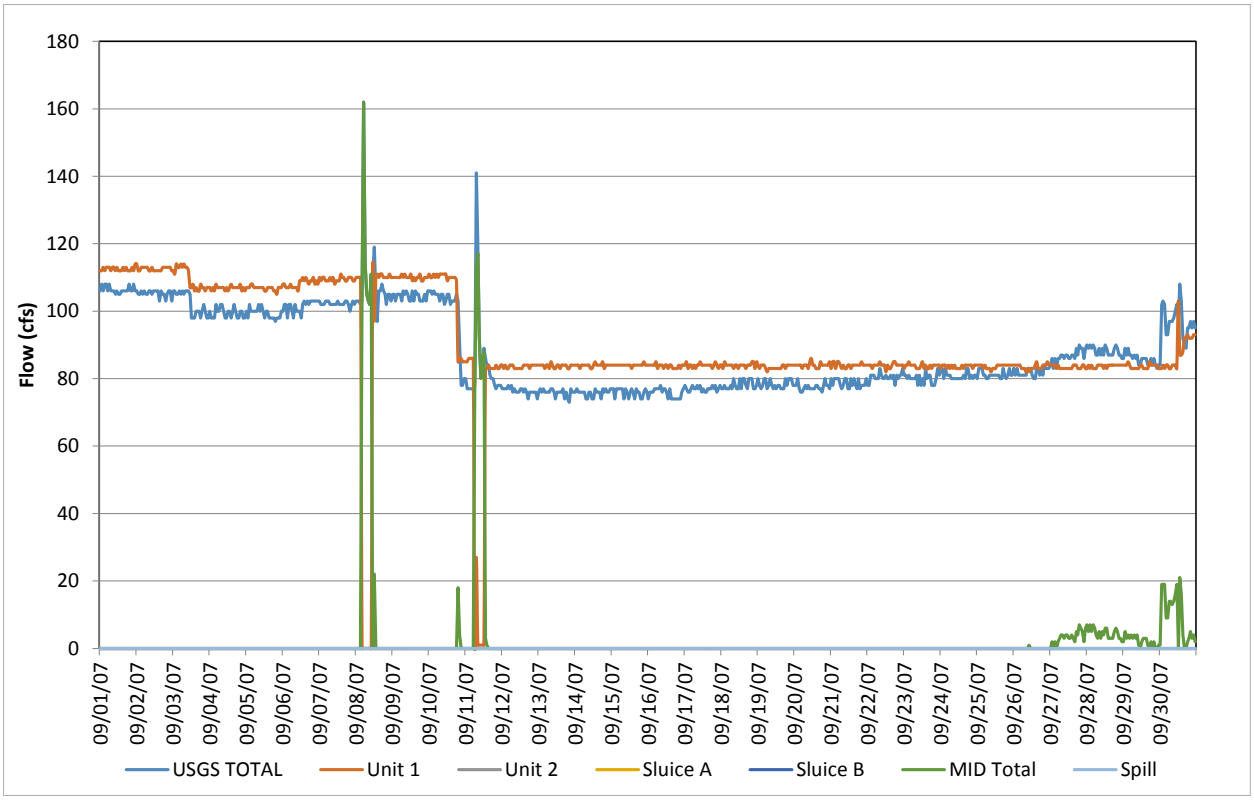

Figure D-33. Flow record in September 2007, based on hourly discharges.

Figure D-34. Flow record in October 2007, based on hourly discharges.

Figure D-35. Flow record in November 2007, based on hourly discharges.

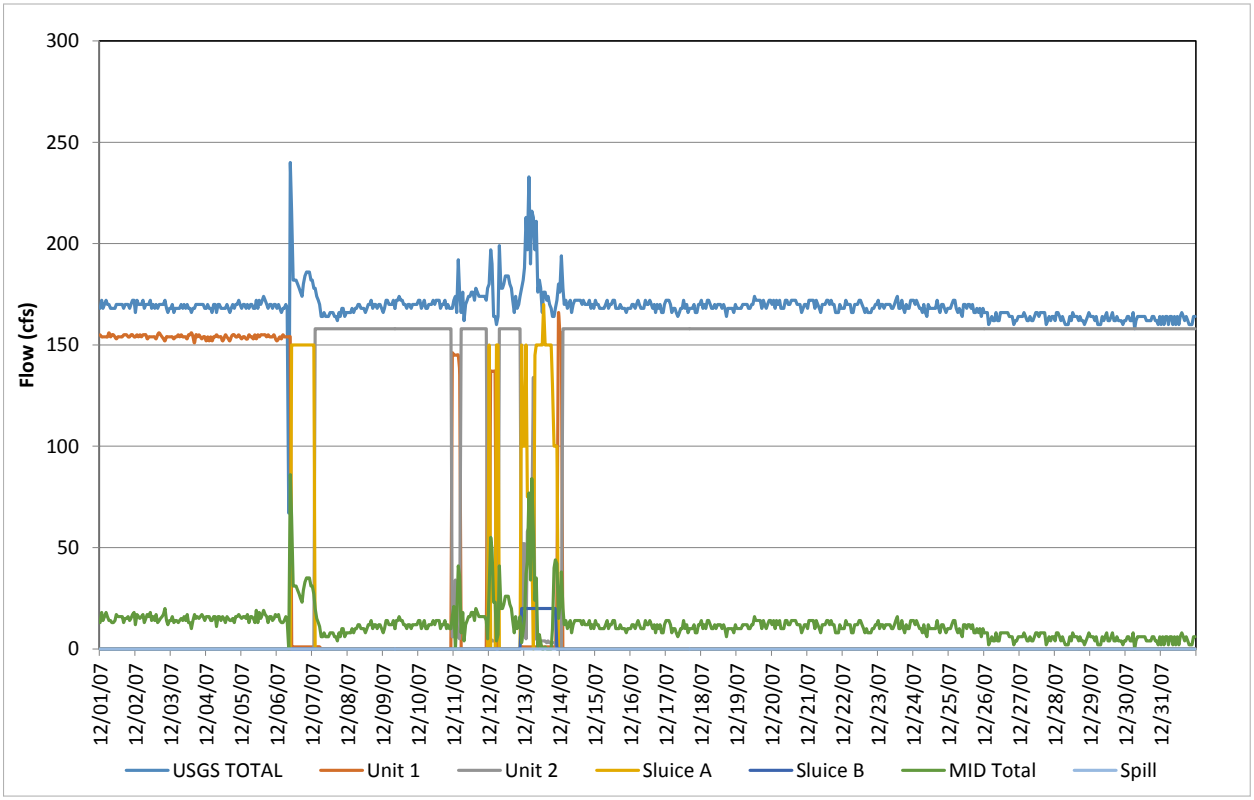

Figure D-36. Flow record in December 2007, based on hourly discharges.

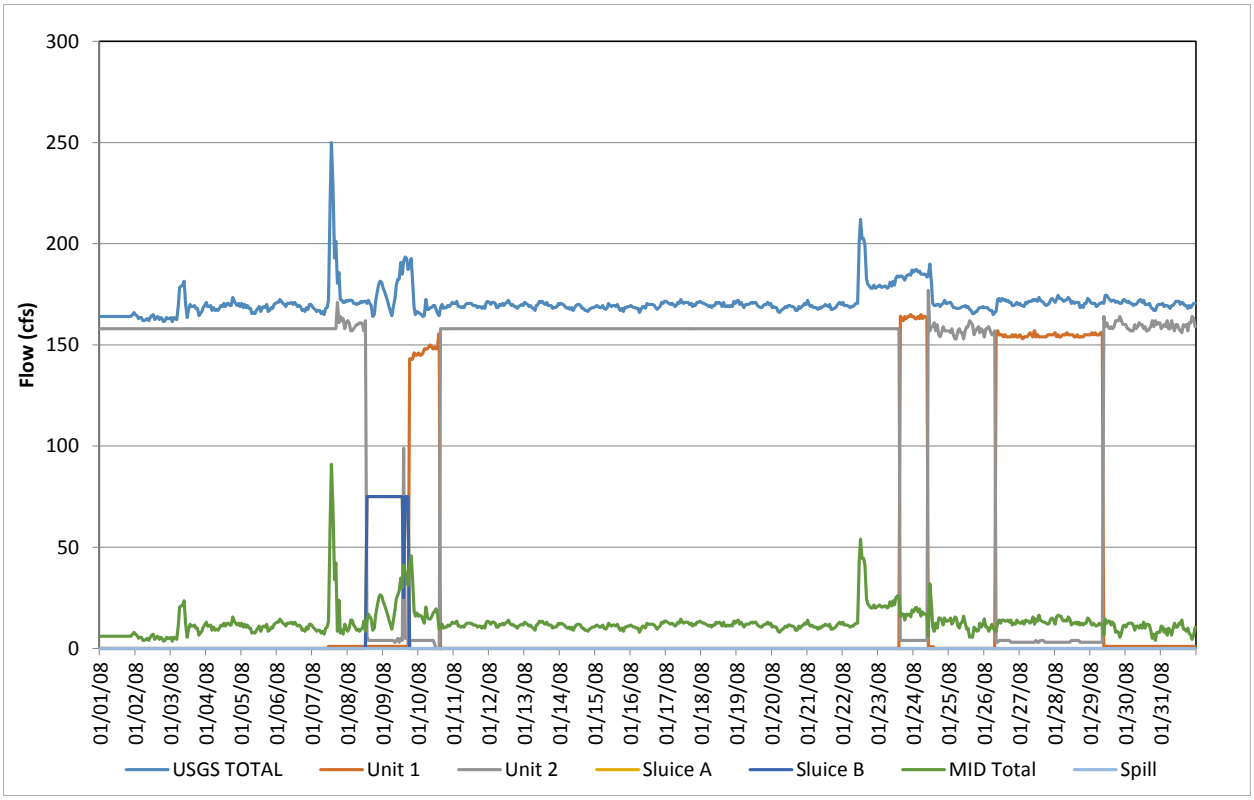

Figure D-37. Flow record in January 2008, based on hourly discharges.

Figure D-38. Flow record in February 2008, based on hourly discharges.

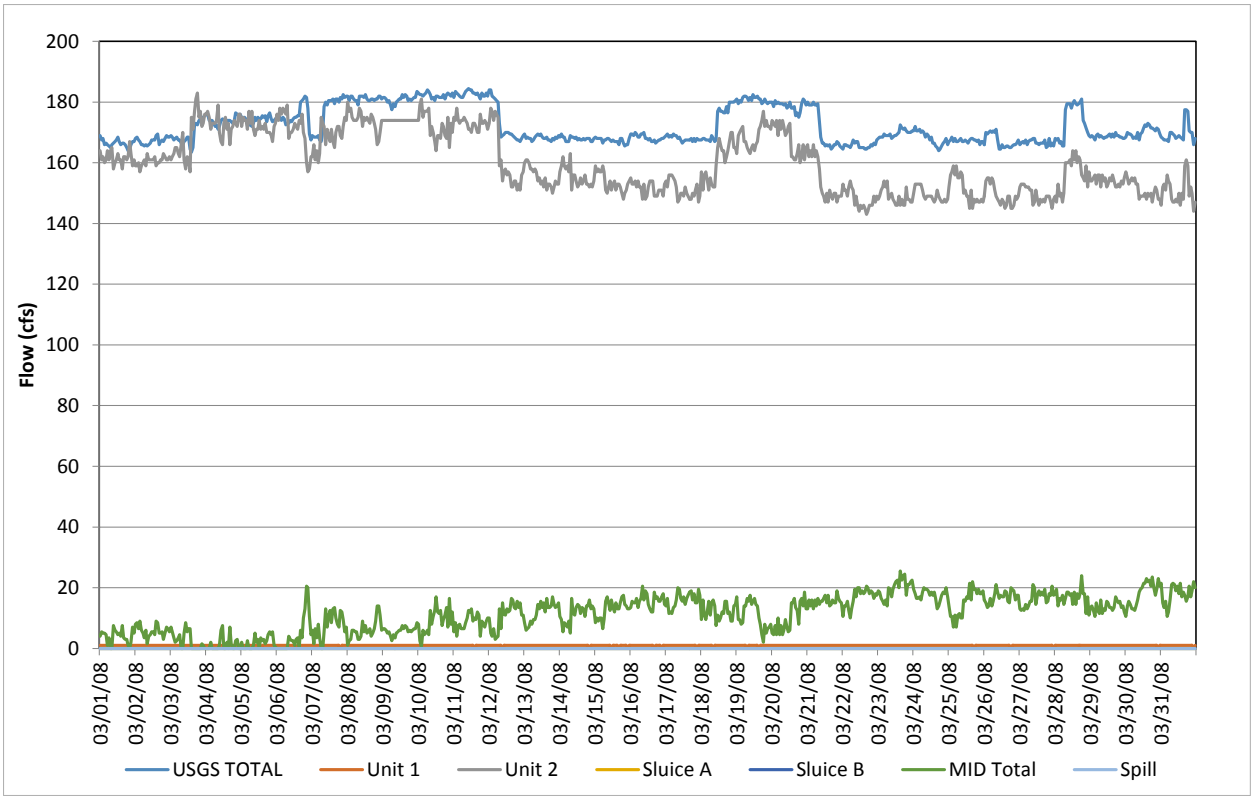

Figure D-39. Flow record in March 2008, based on hourly discharges.

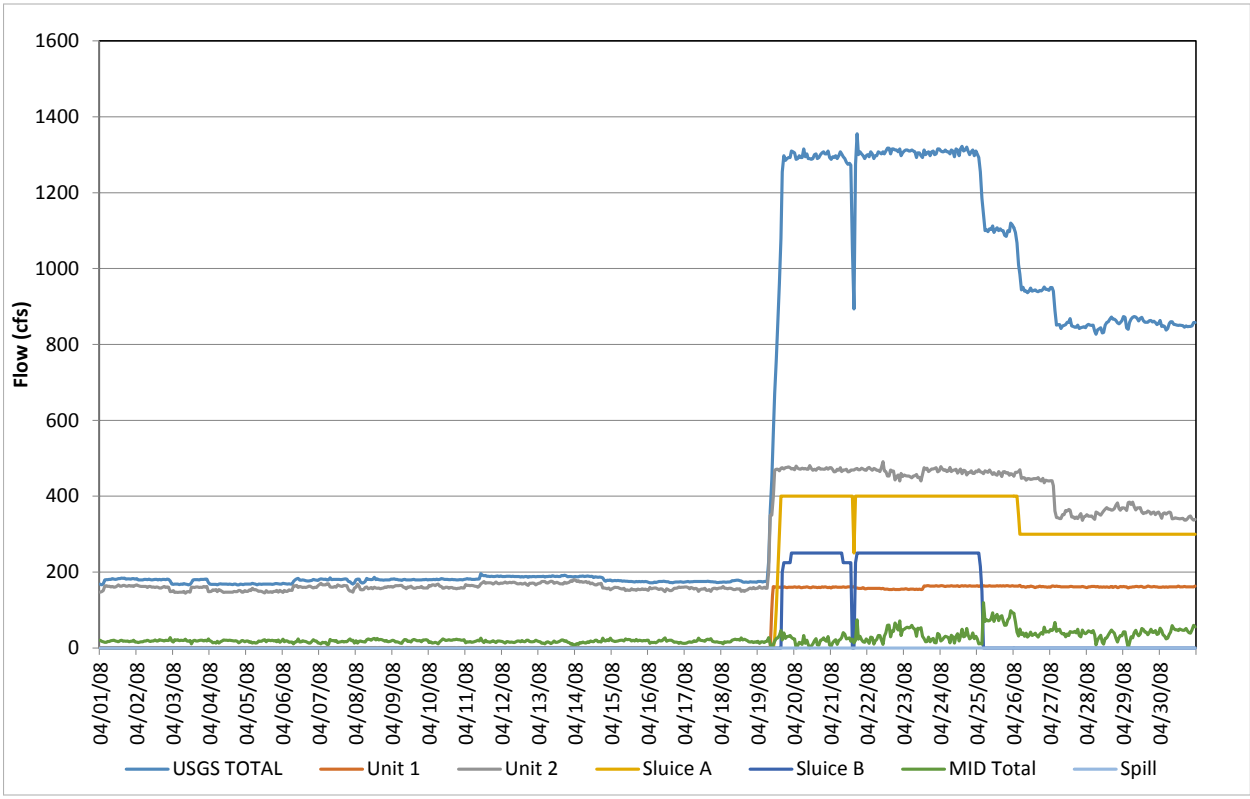

Figure D-40. Flow record in April 2008, based on hourly discharges.

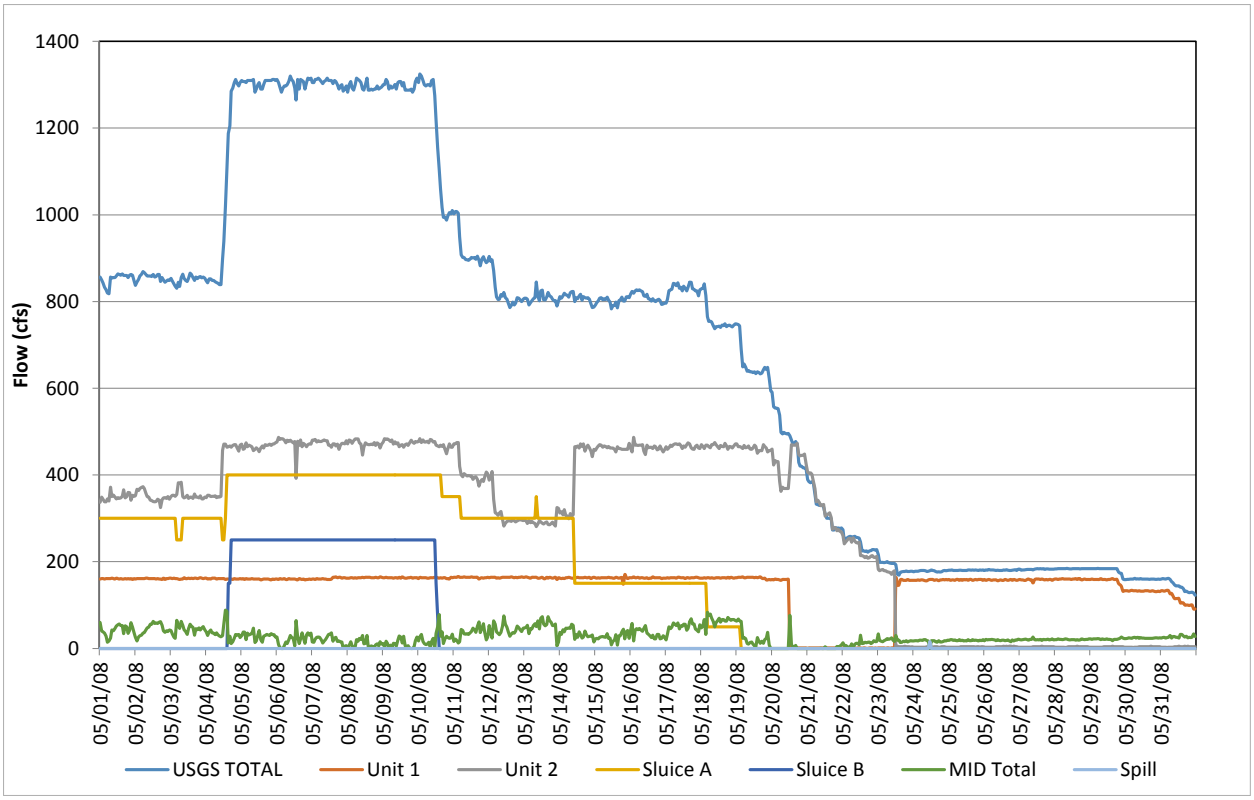

Figure D-41. Flow record in May 2008, based on hourly discharges.

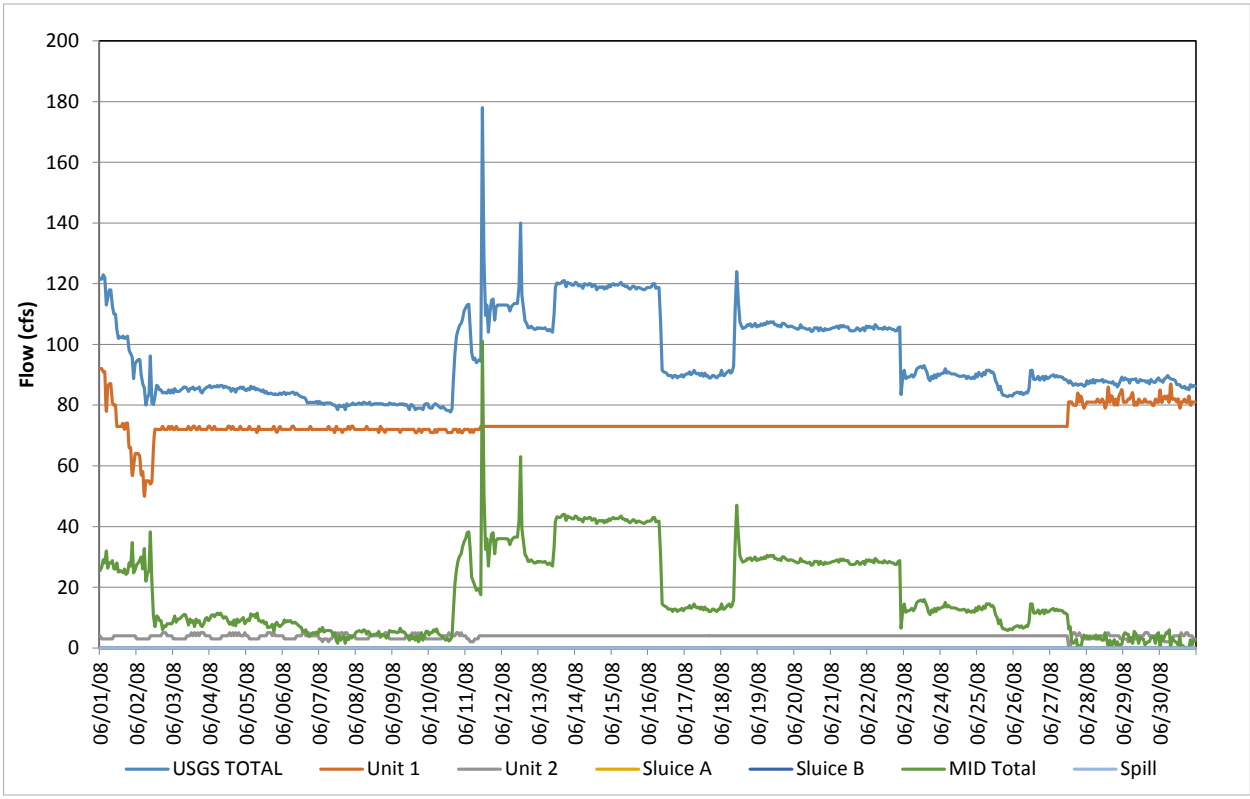

Figure D-42. Flow record in June 2008, based on hourly discharges.

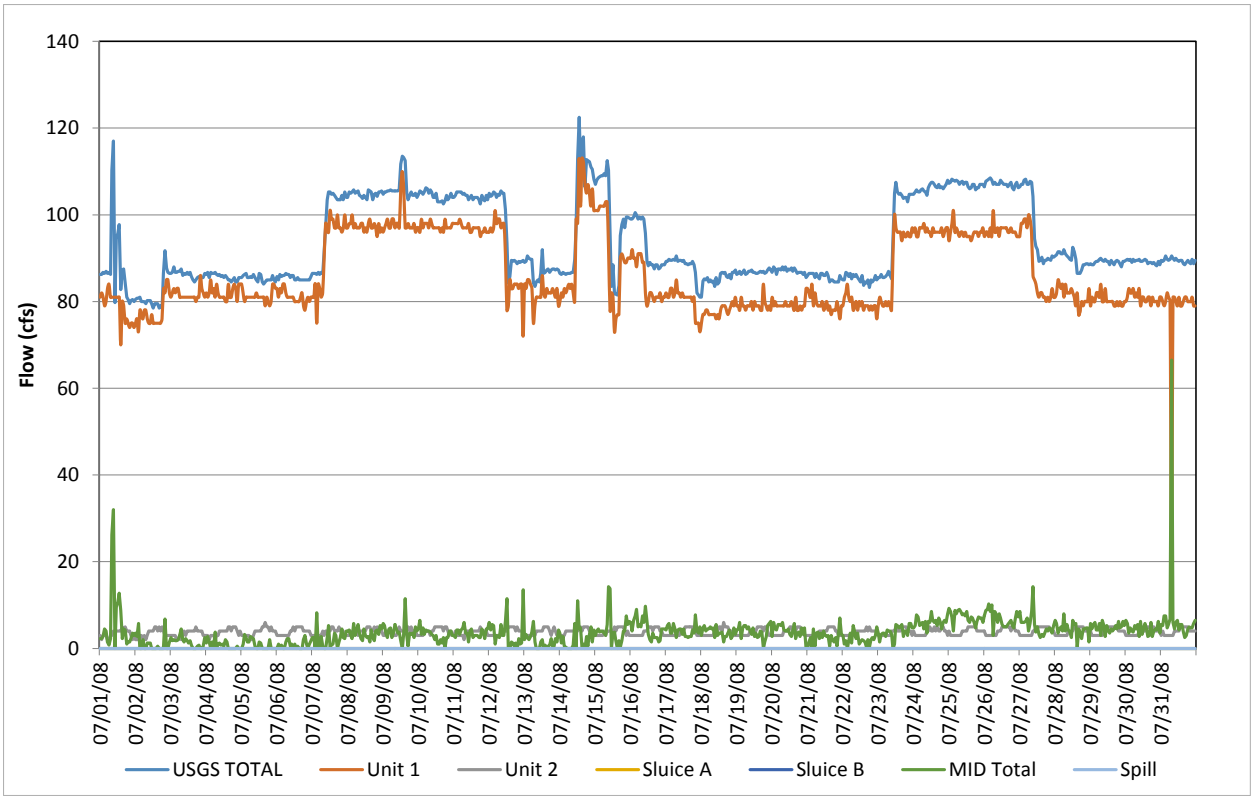

Figure D-43. Flow record in July 2008, based on hourly discharges.

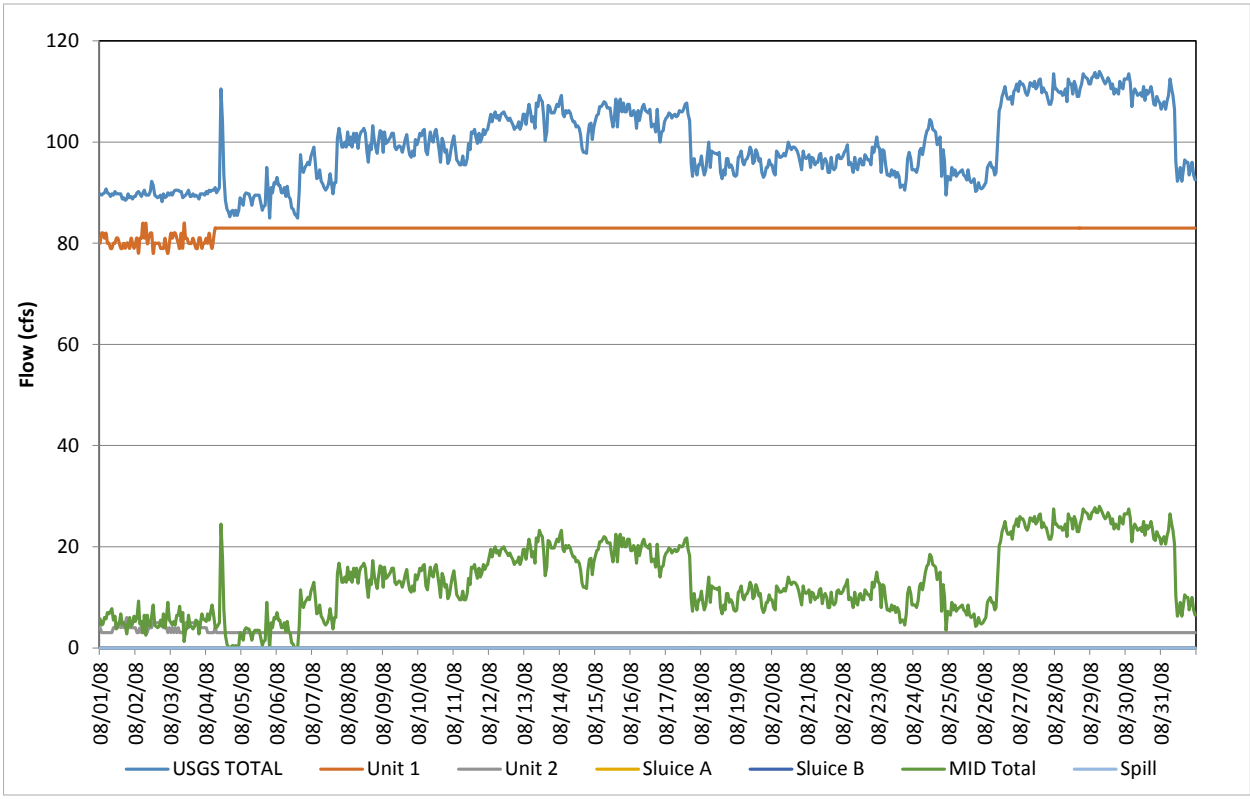

Figure D-44. Flow record in August 2008, based on hourly discharges.

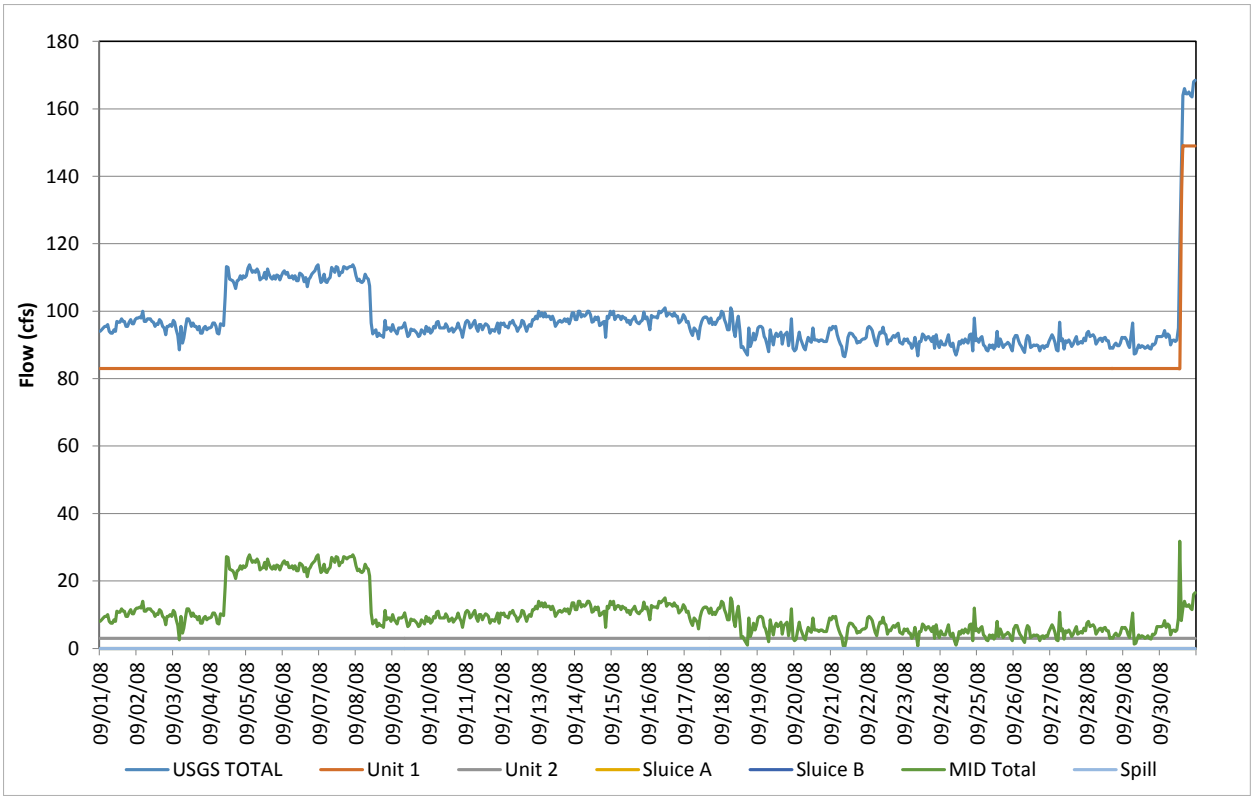

Figure D-45. Flow record in September 2008, based on hourly discharges.

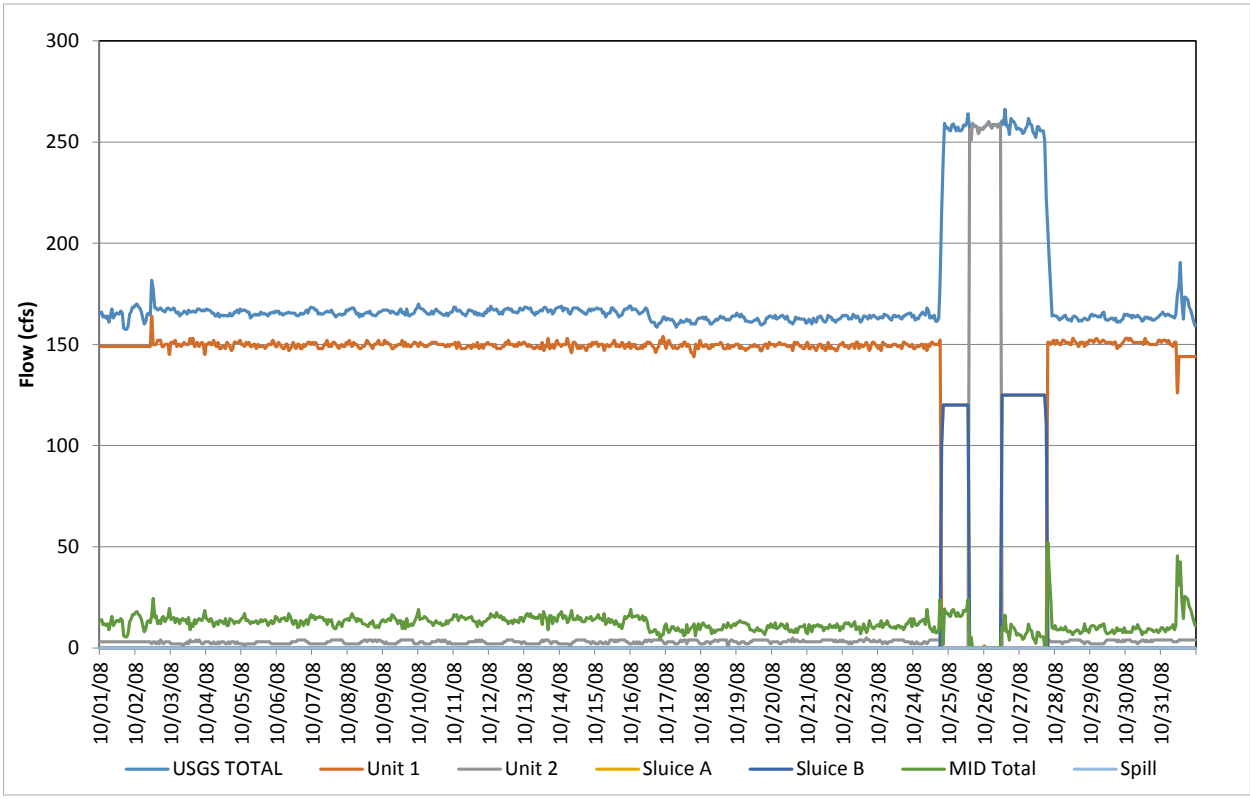

Figure D-46. Flow record in October 2008, based on hourly discharges.

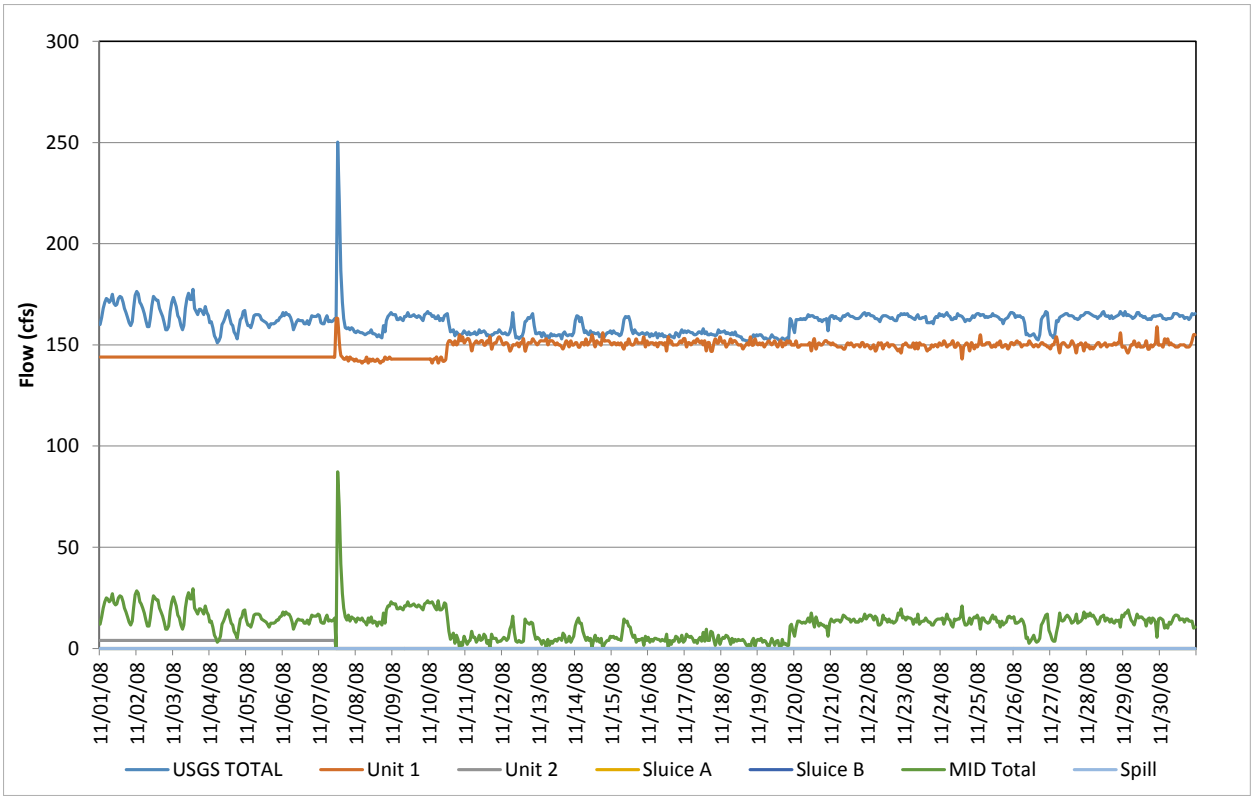

Figure D-47. Flow record in November 2008, based on hourly discharges.

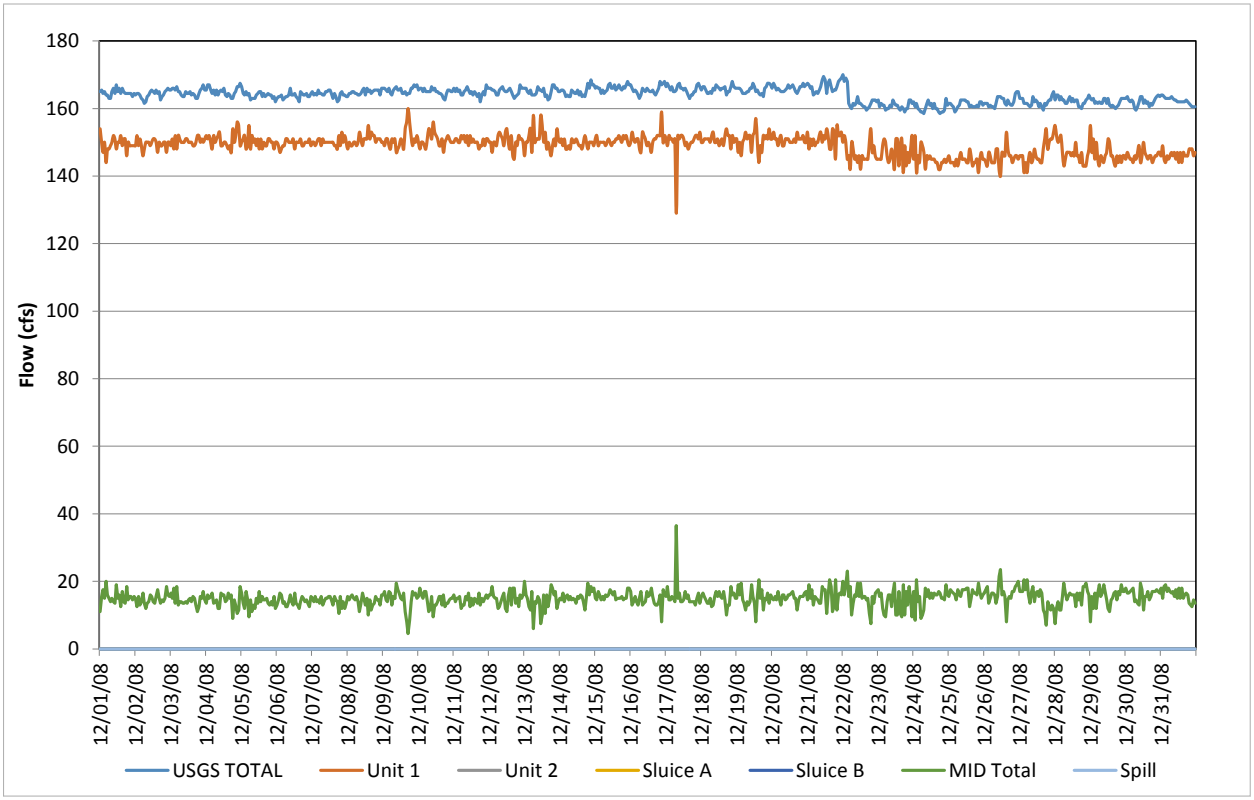

Figure D-48. Flow record in December 2008, based on hourly discharges.

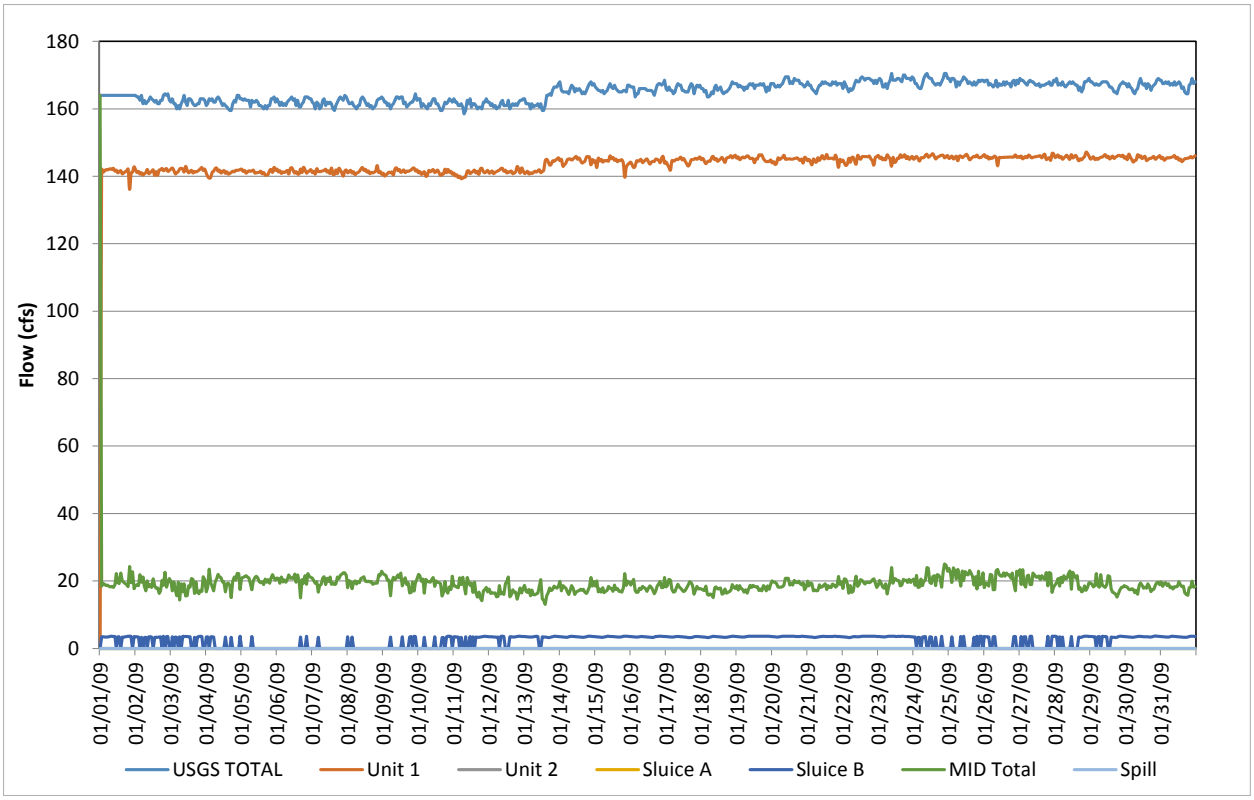

Figure D-49. Flow record in January 2009, based on hourly discharges.

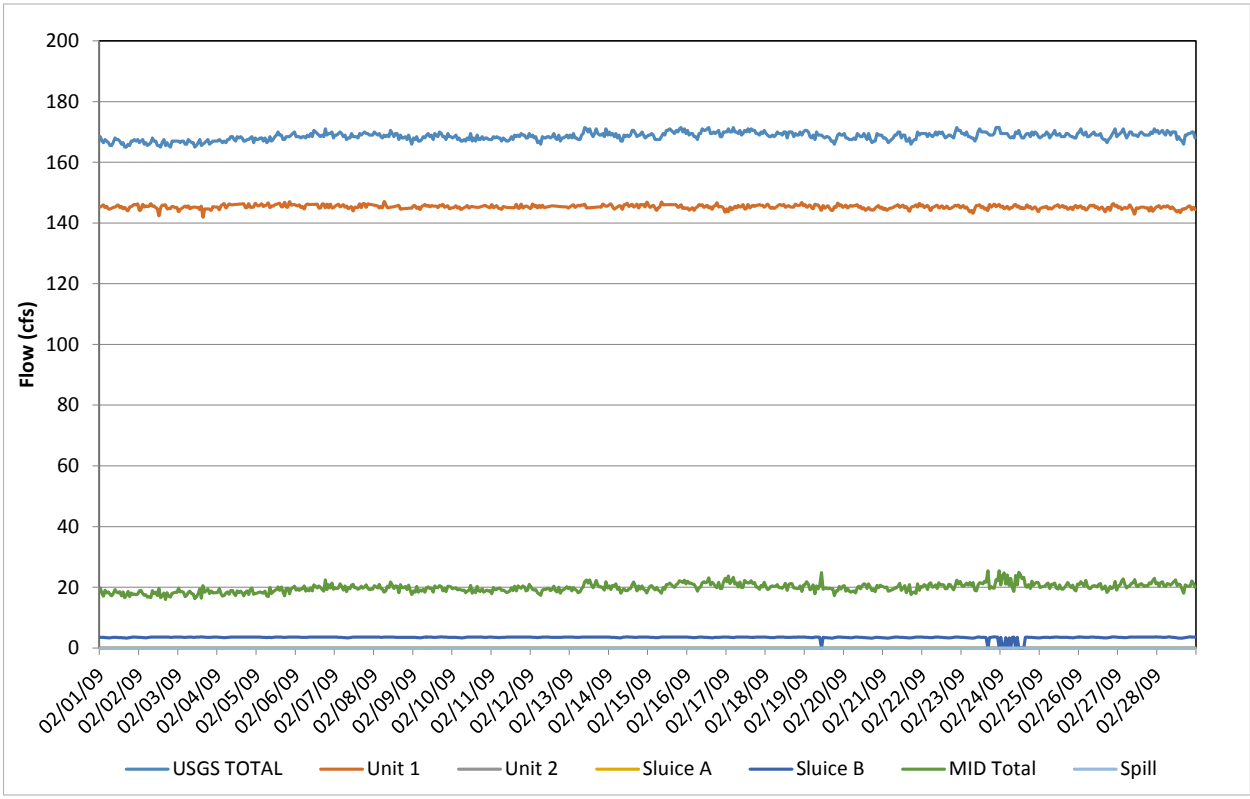

Figure D-50. Flow record in February 2009, based on hourly discharges.

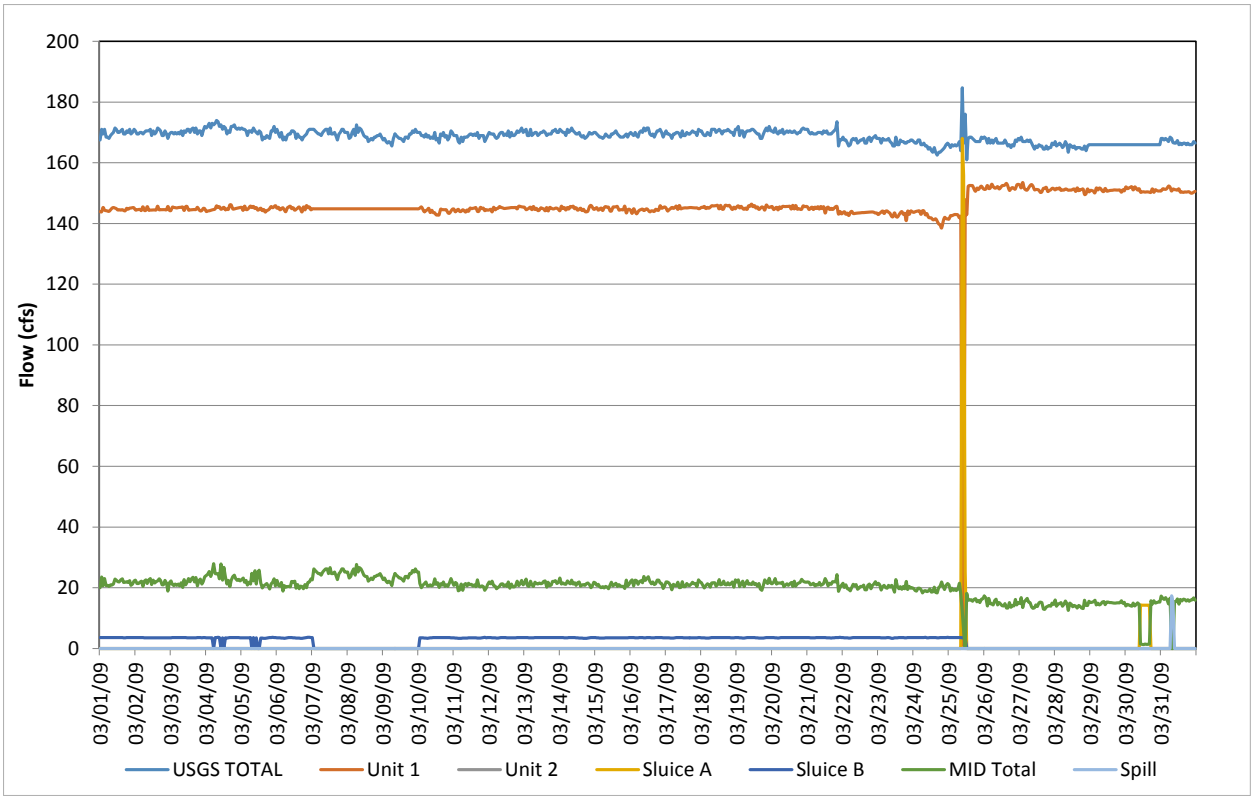

Figure D-51. Flow record in March 2009, based on hourly discharges.

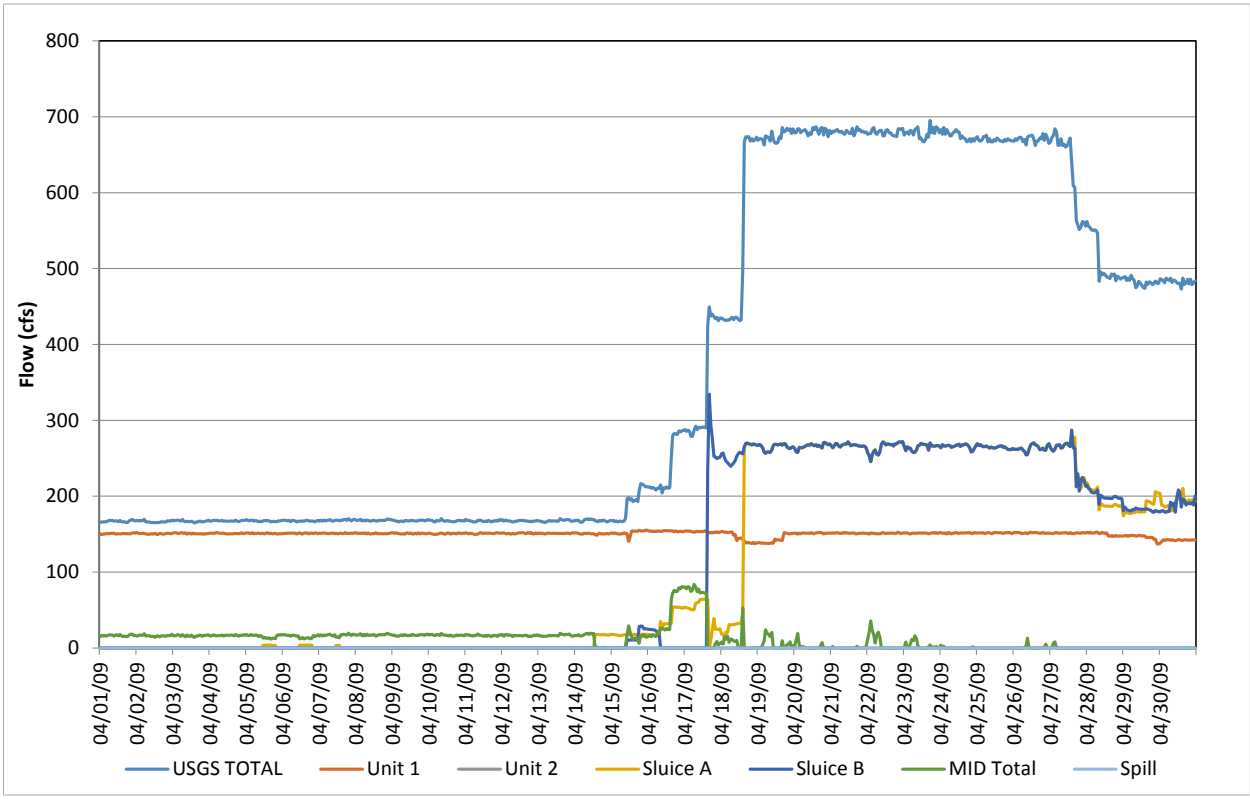

Figure D-52. Flow record in April 2009, based on hourly discharges.

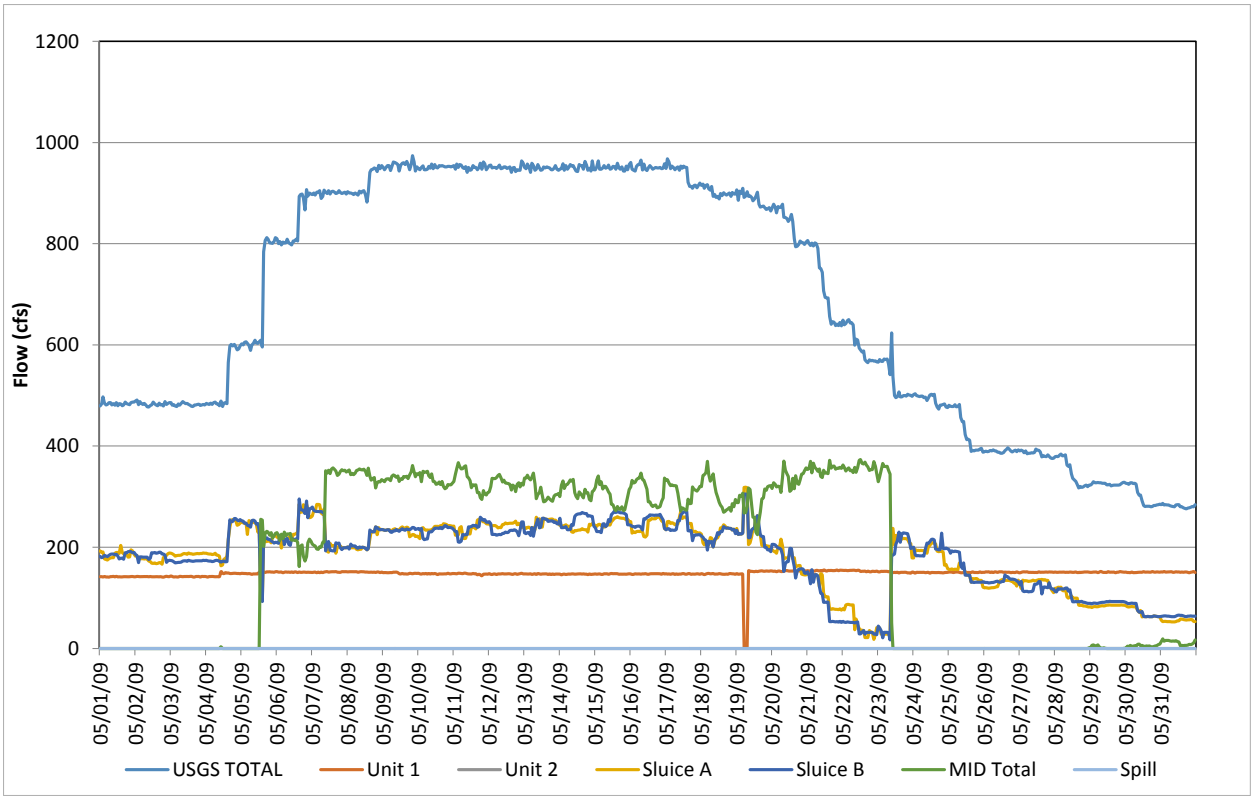

Figure D-53. Flow record in May 2009, based on hourly discharges.

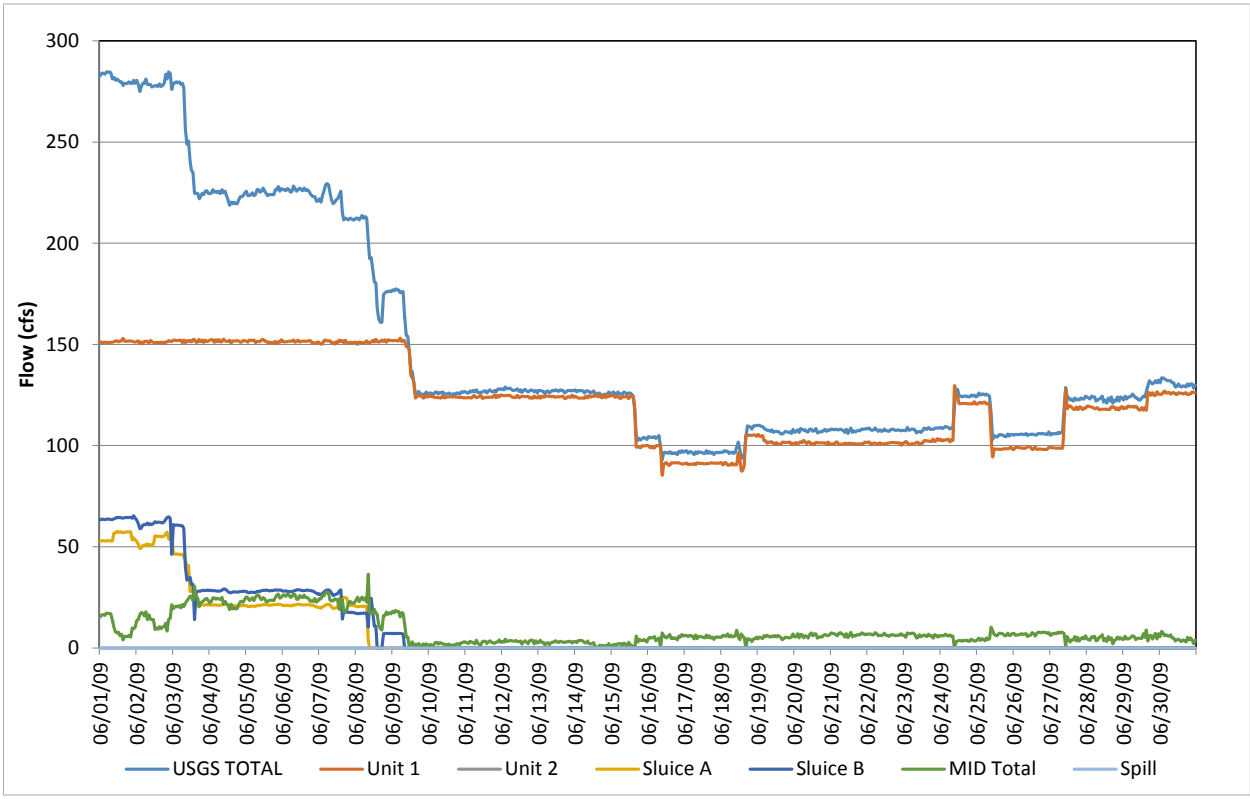

Figure D-54. Flow record in June 2009, based on hourly discharges.

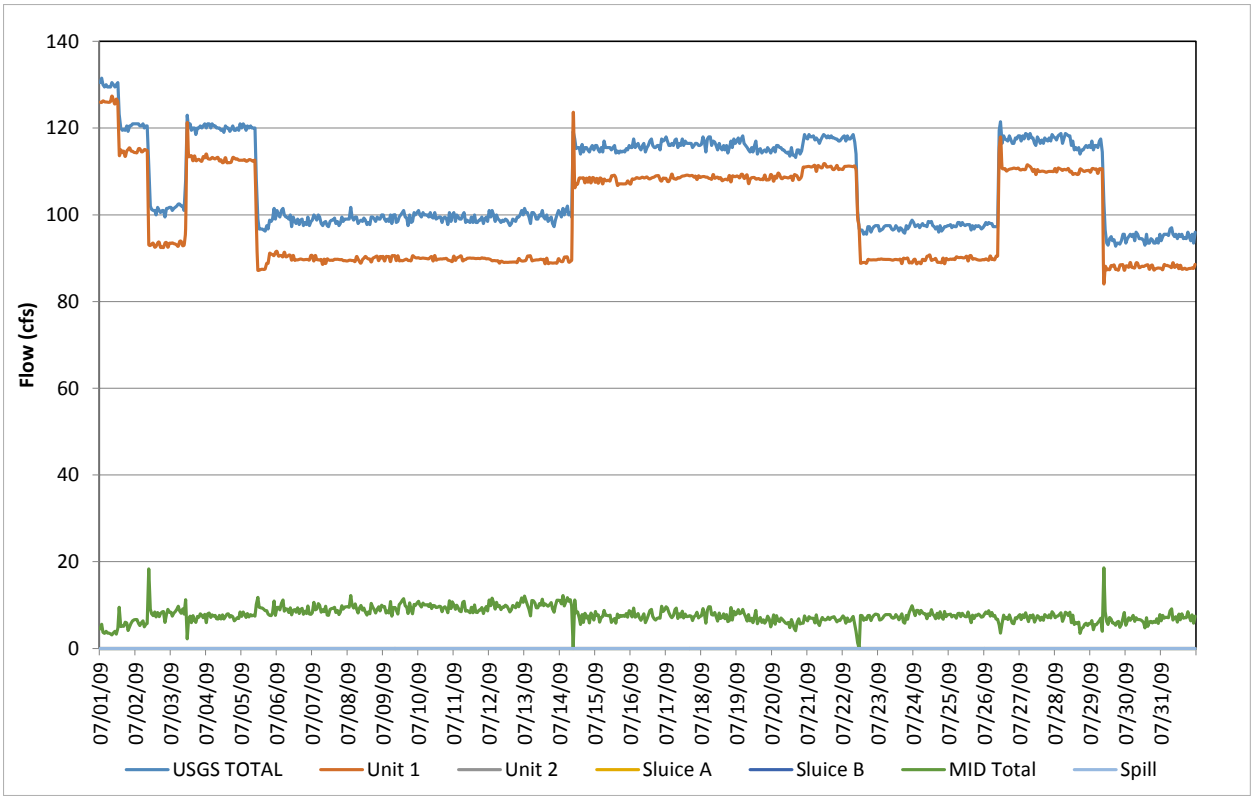

Figure D-55. Flow record in July 2009, based on hourly discharges.

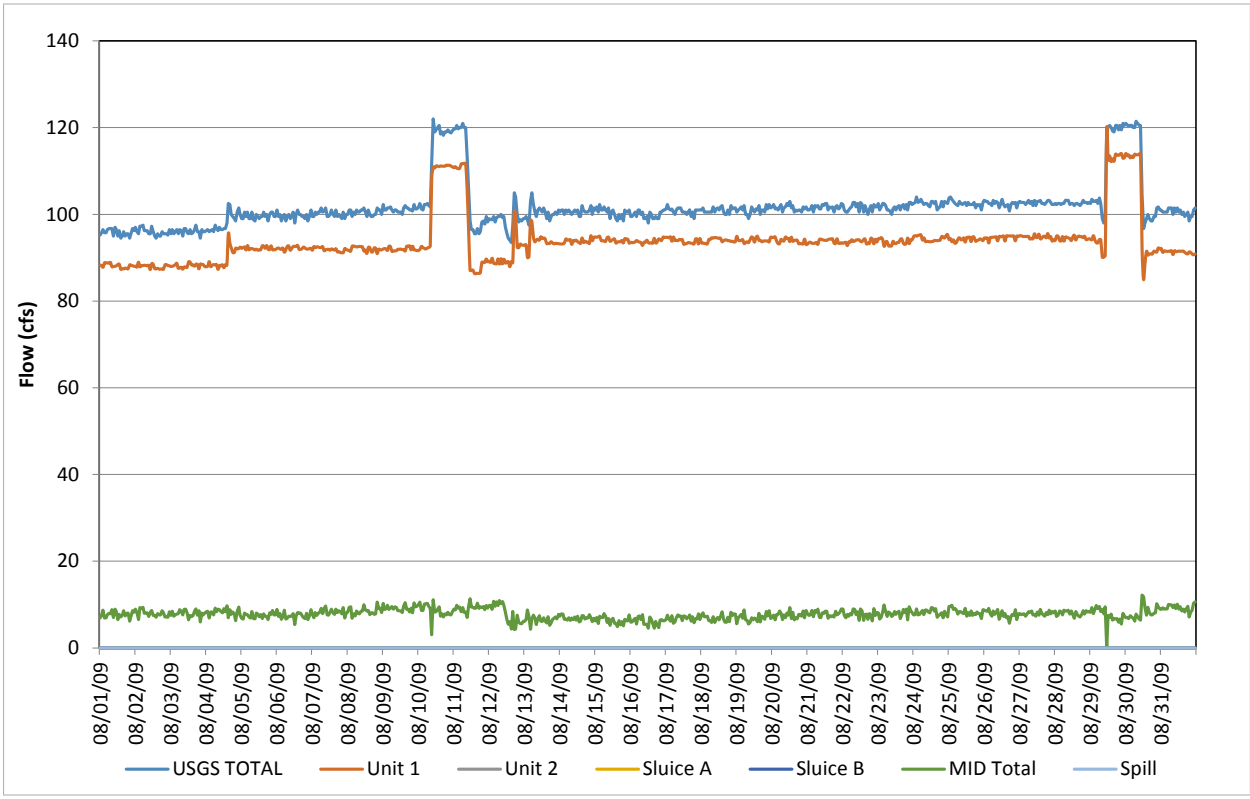

Figure D-56. Flow record in August 2009, based on hourly discharges.

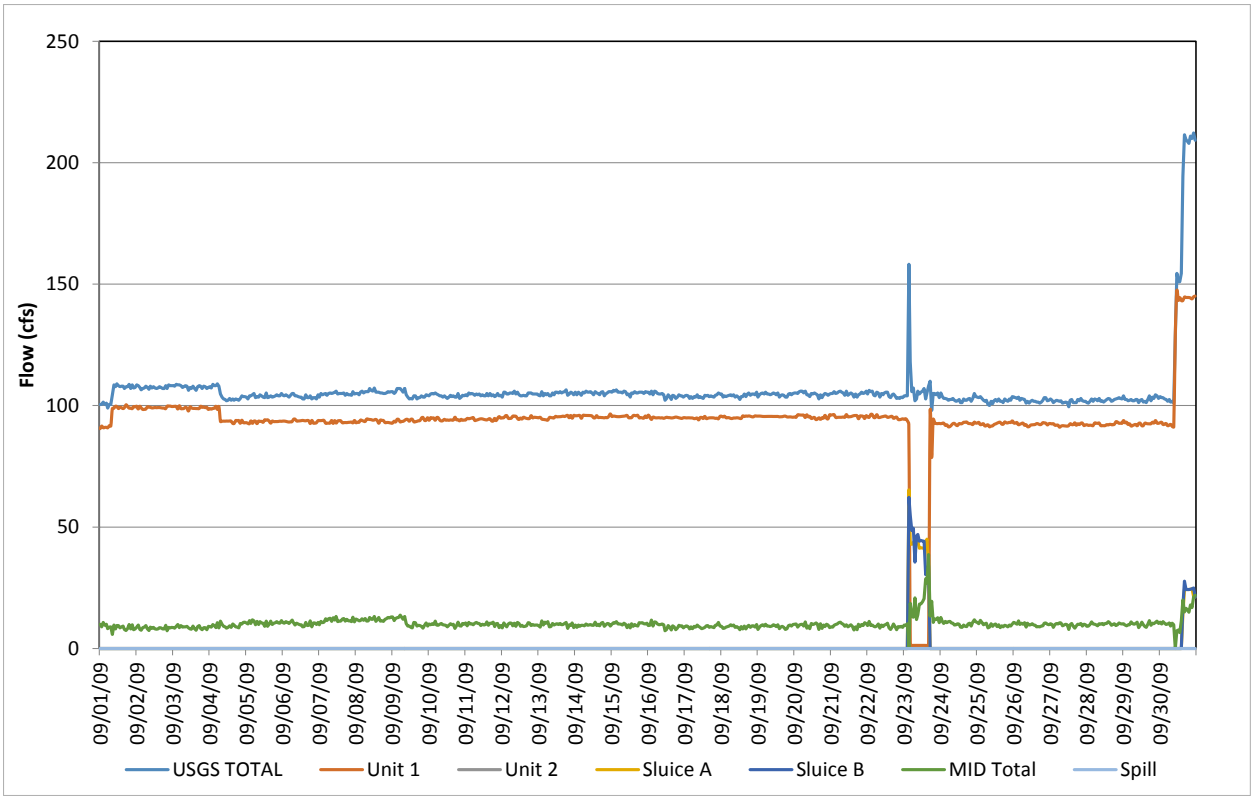

Figure D-57. Flow record in September 2009, based on hourly discharges.

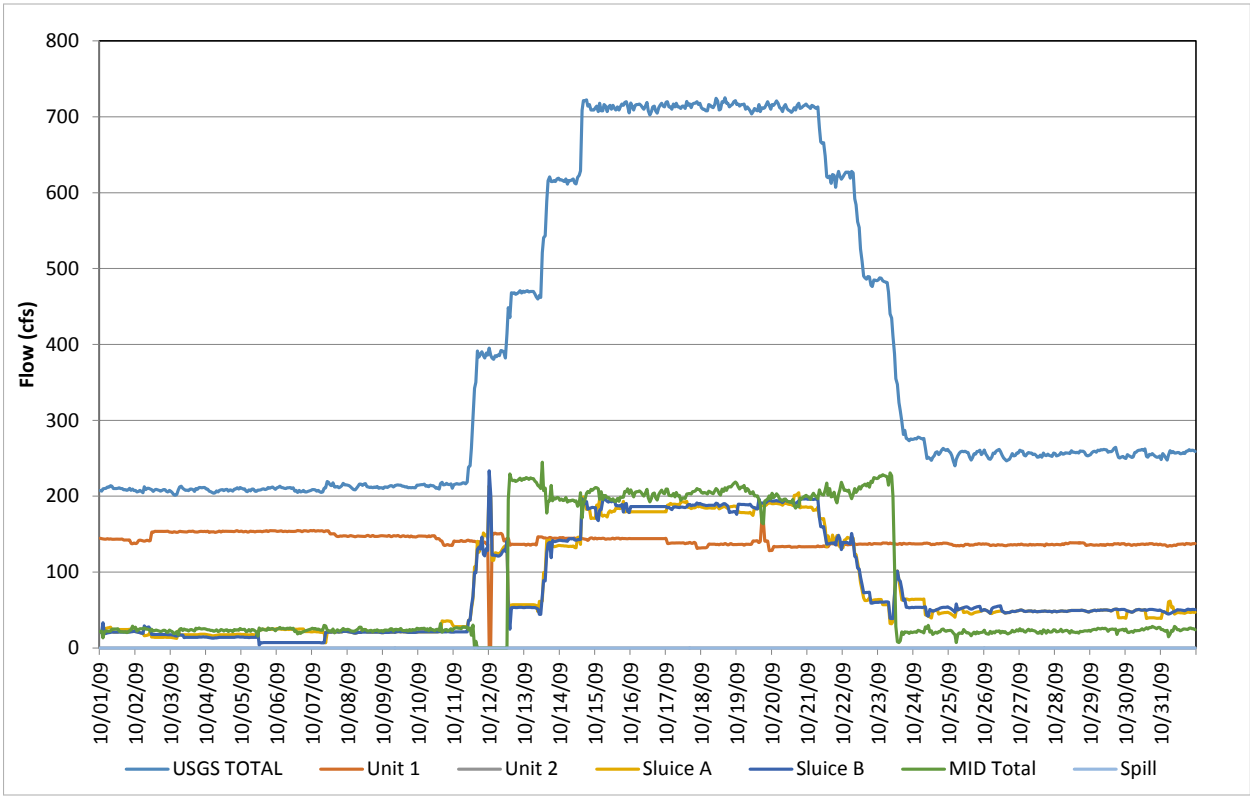

Figure D-58. Flow record in October 2009, based on hourly discharges.

Figure D-59. Flow record in November 2009, based on hourly discharges.

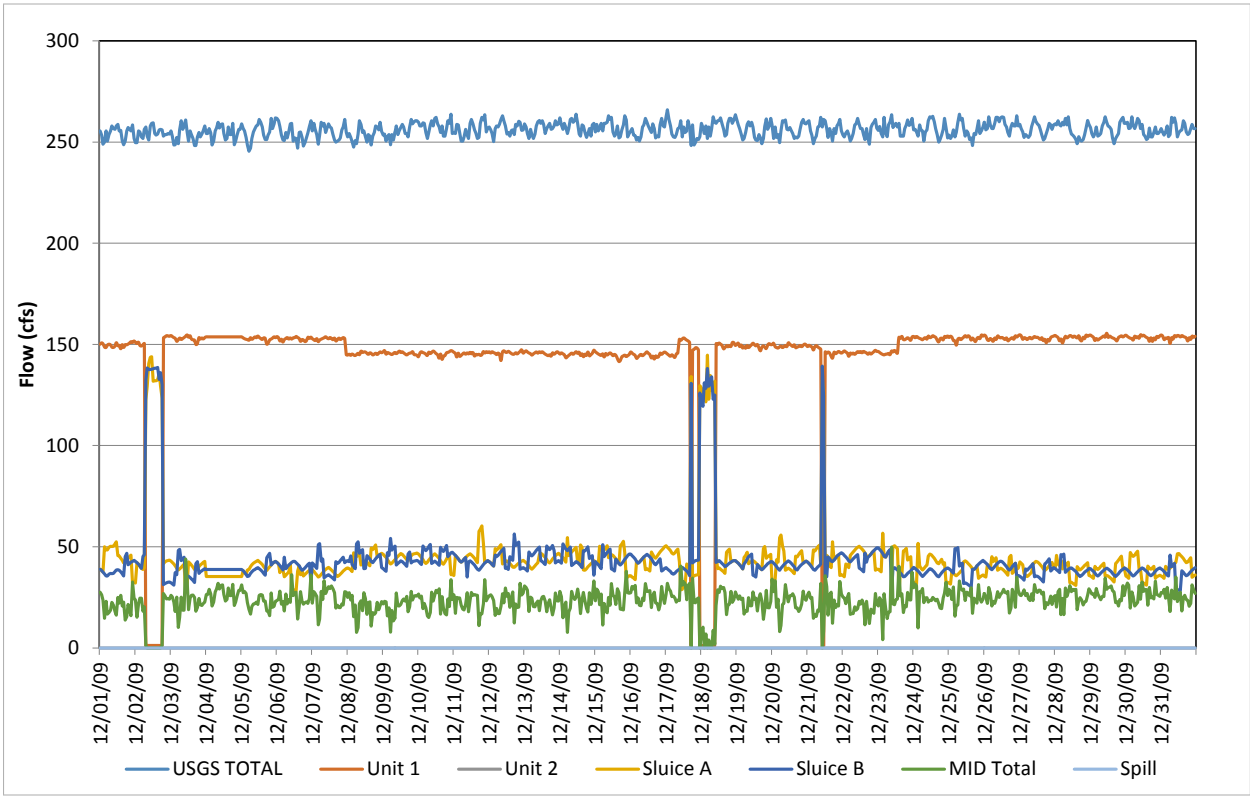

Figure D-60. Flow record in December 2009, based on hourly discharges.

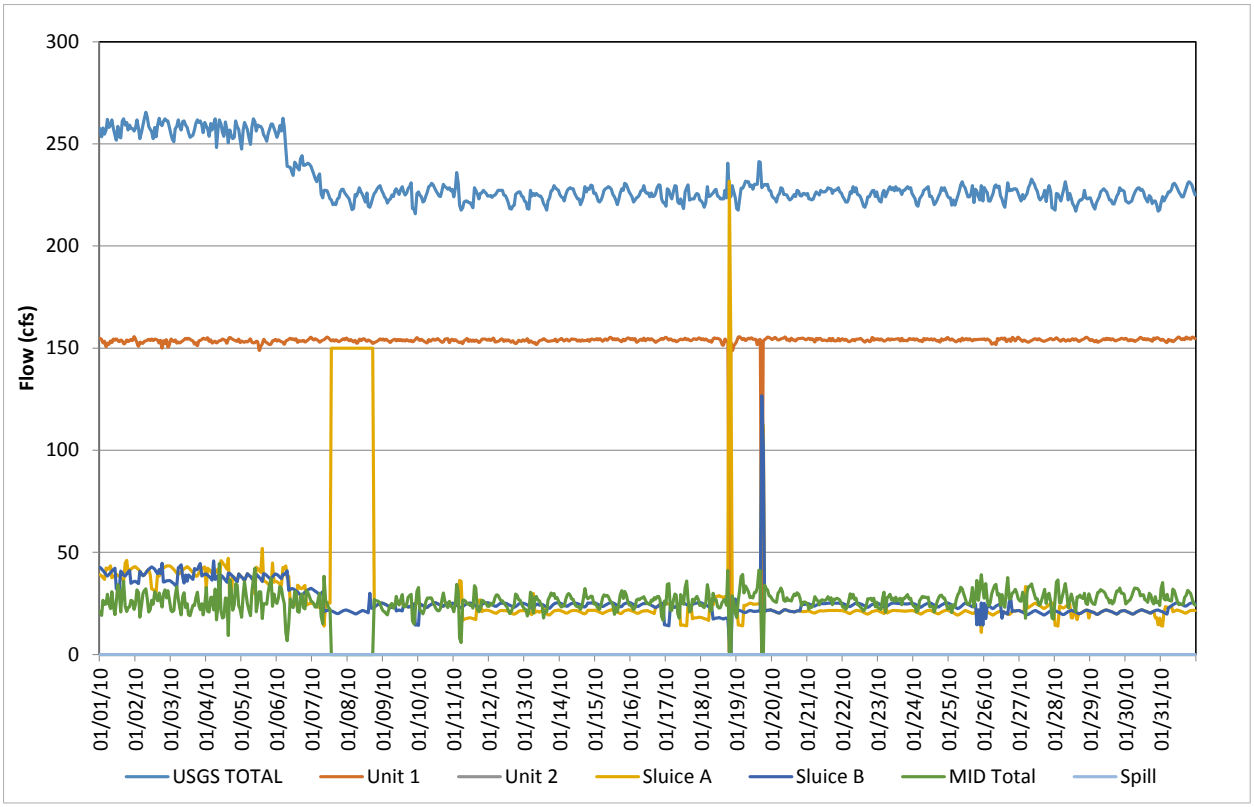

Figure D-61. Flow record in January 2010, based on hourly discharges.

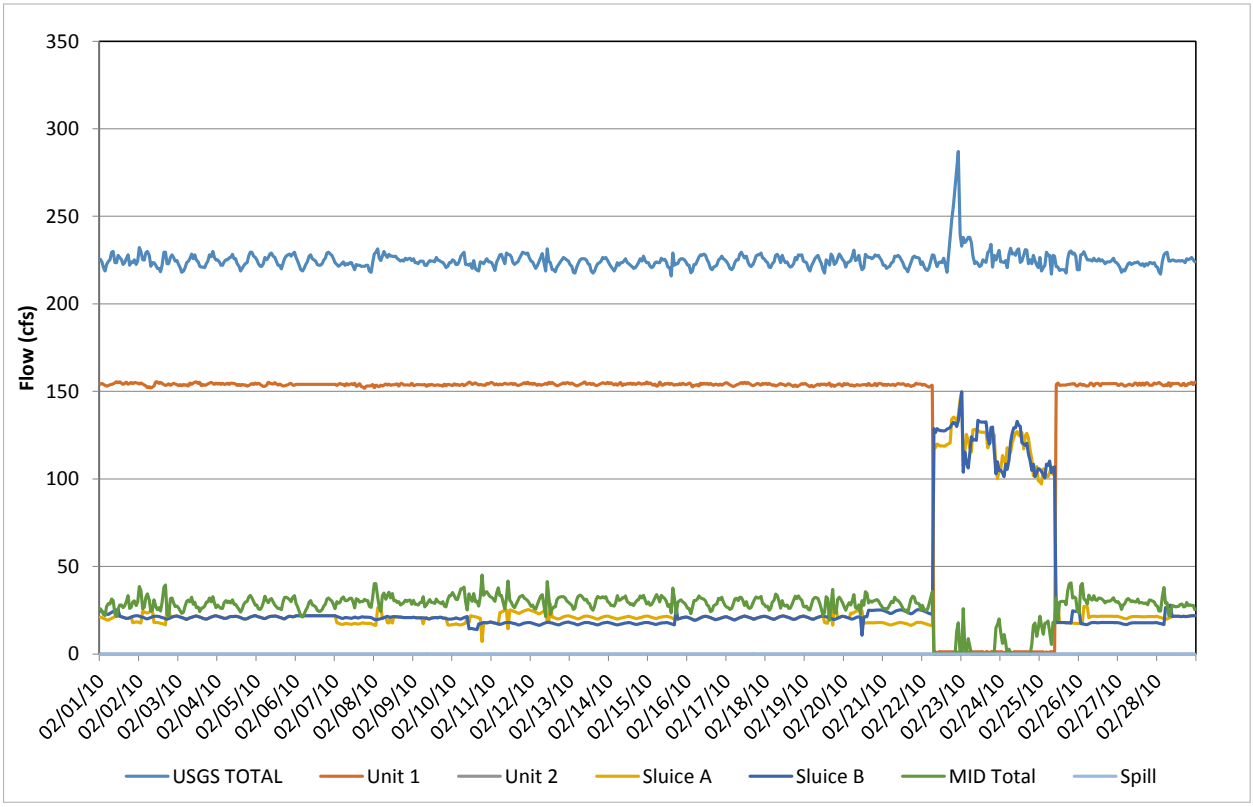

Figure D-62. Flow record in February 2010, based on hourly discharges.

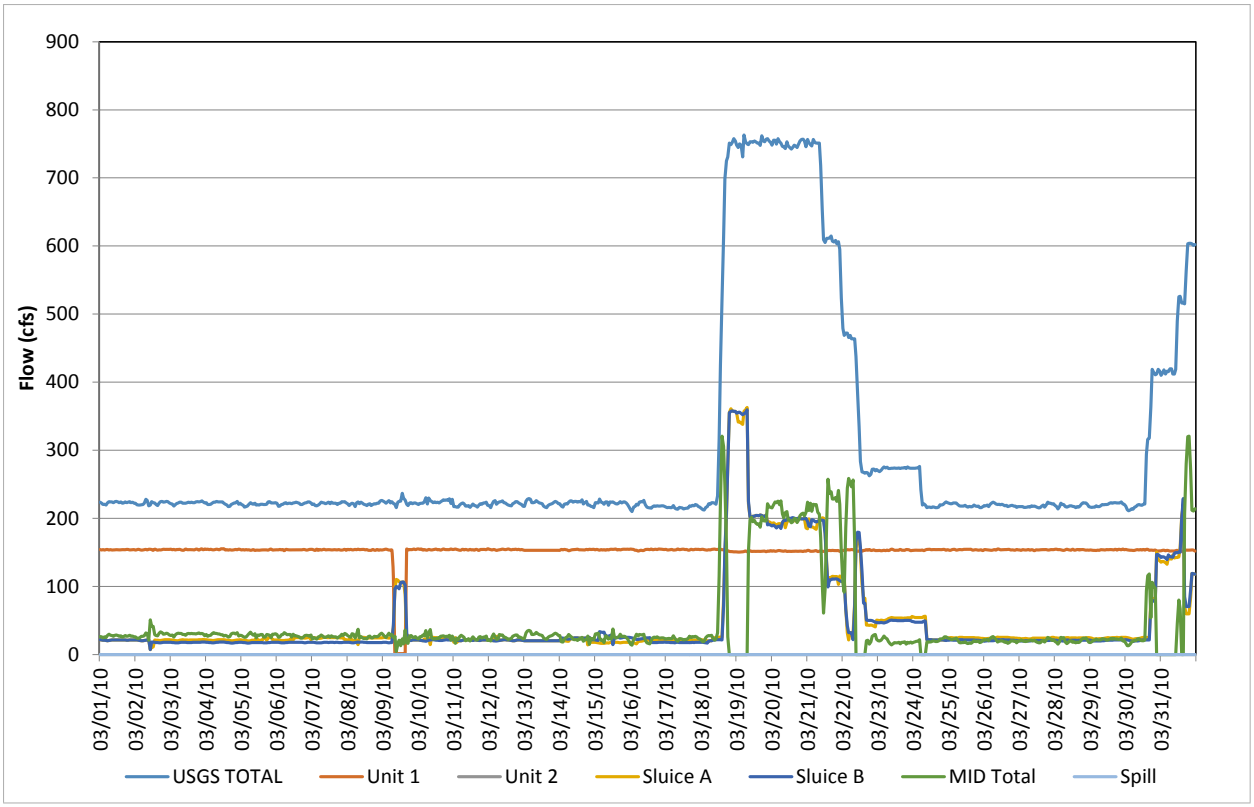

Figure D-63. Flow record in March 2010, based on hourly discharges.

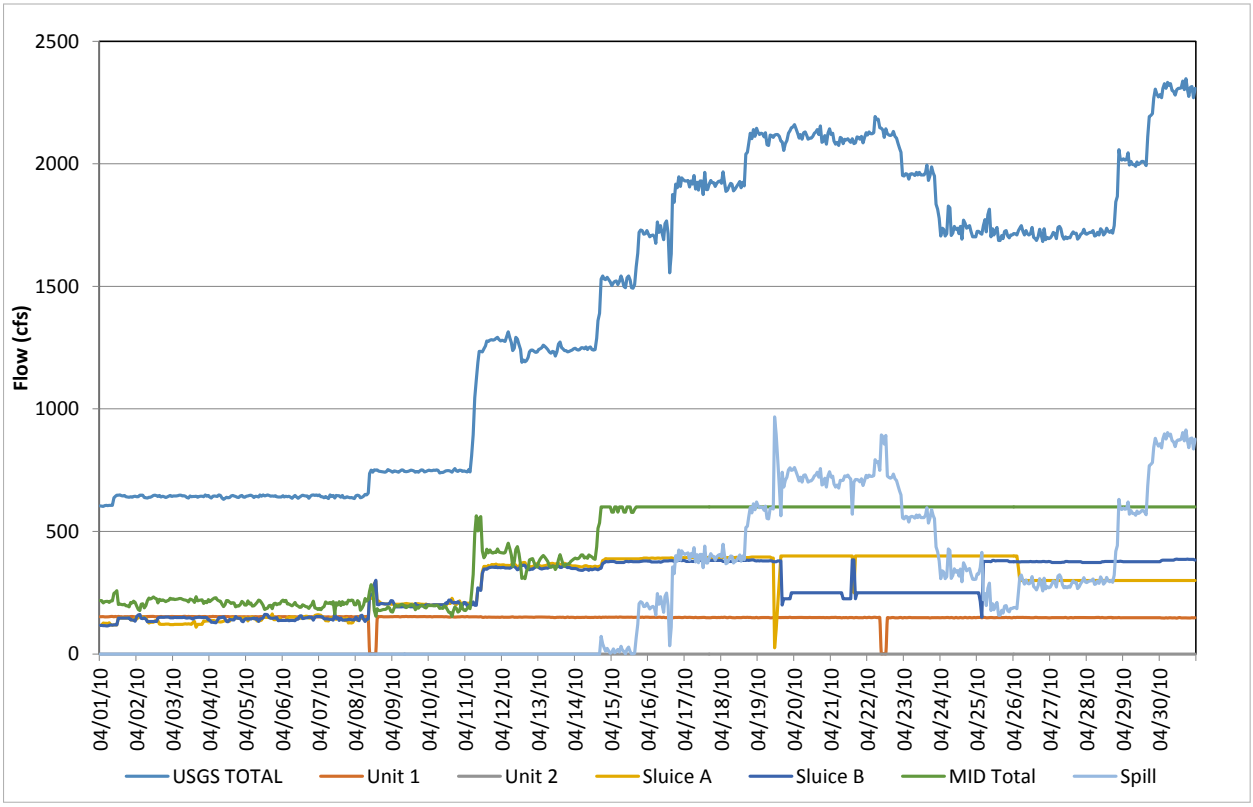

Figure D-64. Flow record in April 2010, based on hourly discharges.

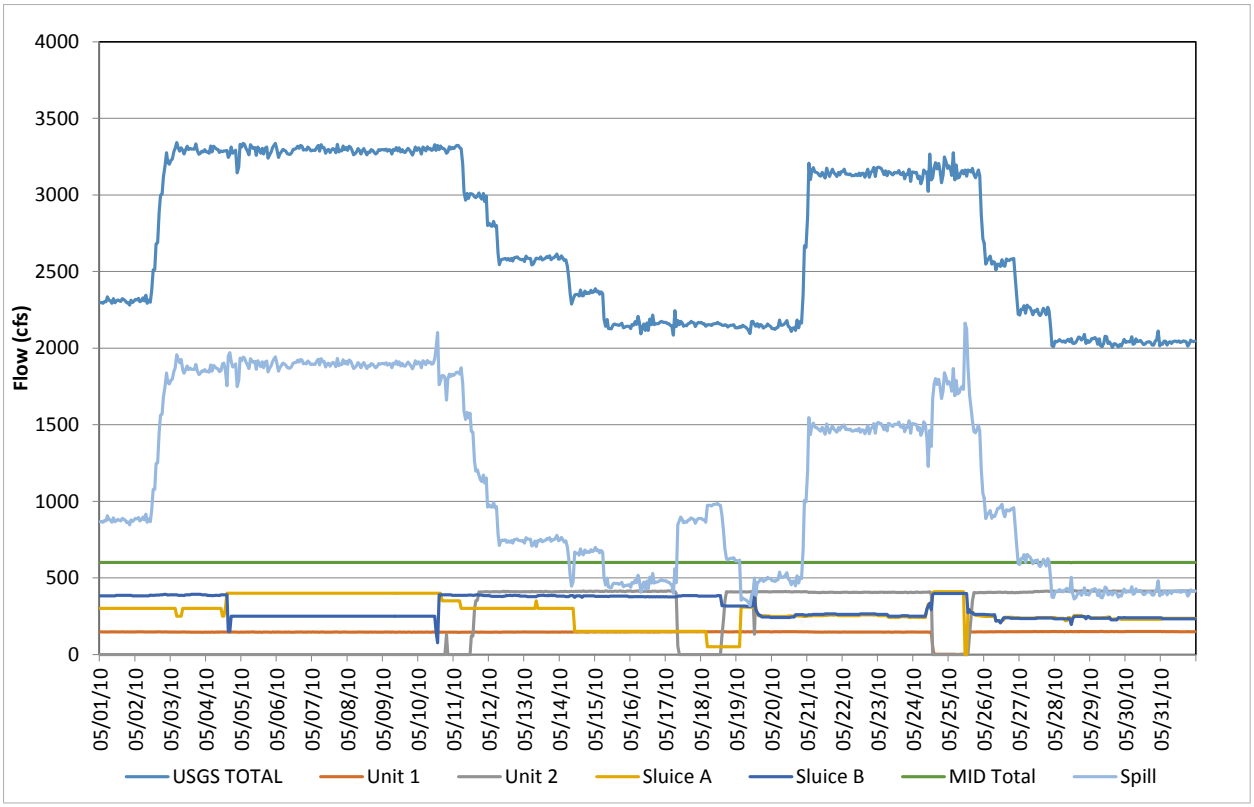

Figure D-65. Flow record in May 2010, based on hourly discharges.

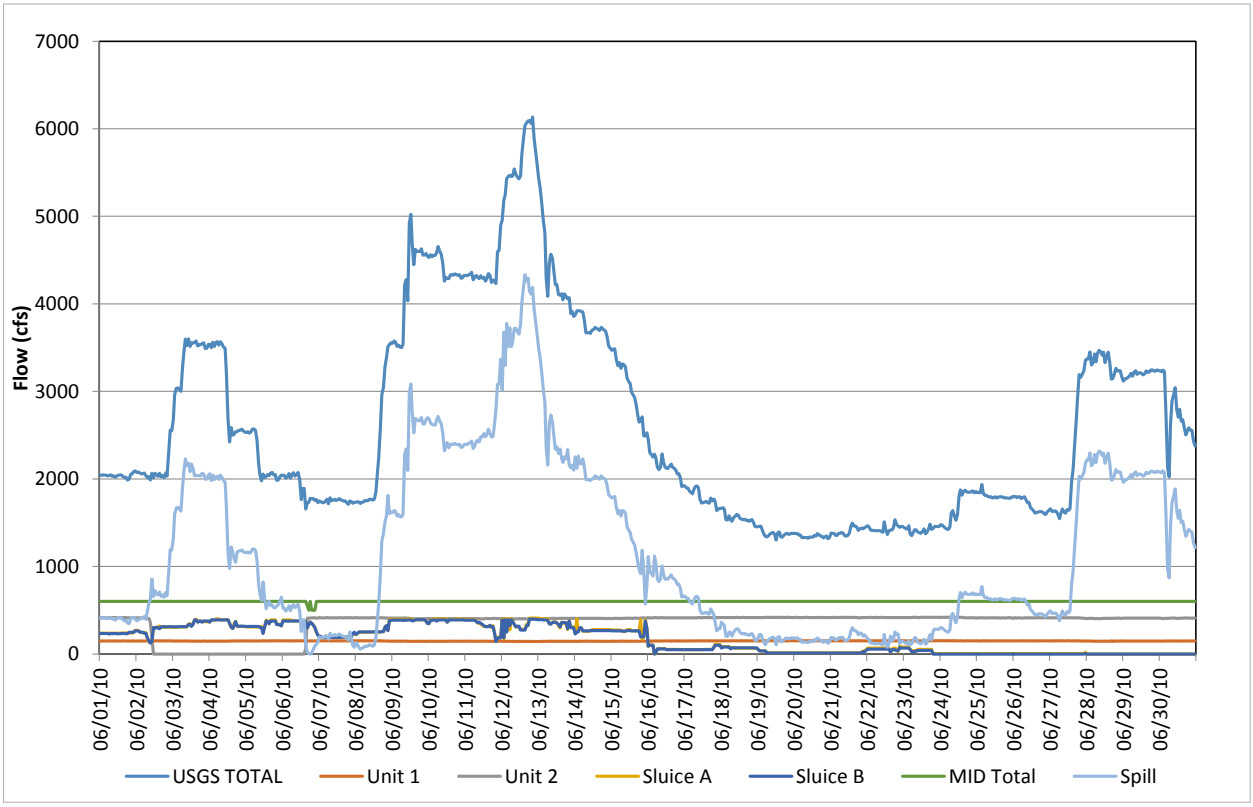

Figure D-66. Flow record in June 2010, based on hourly discharges.

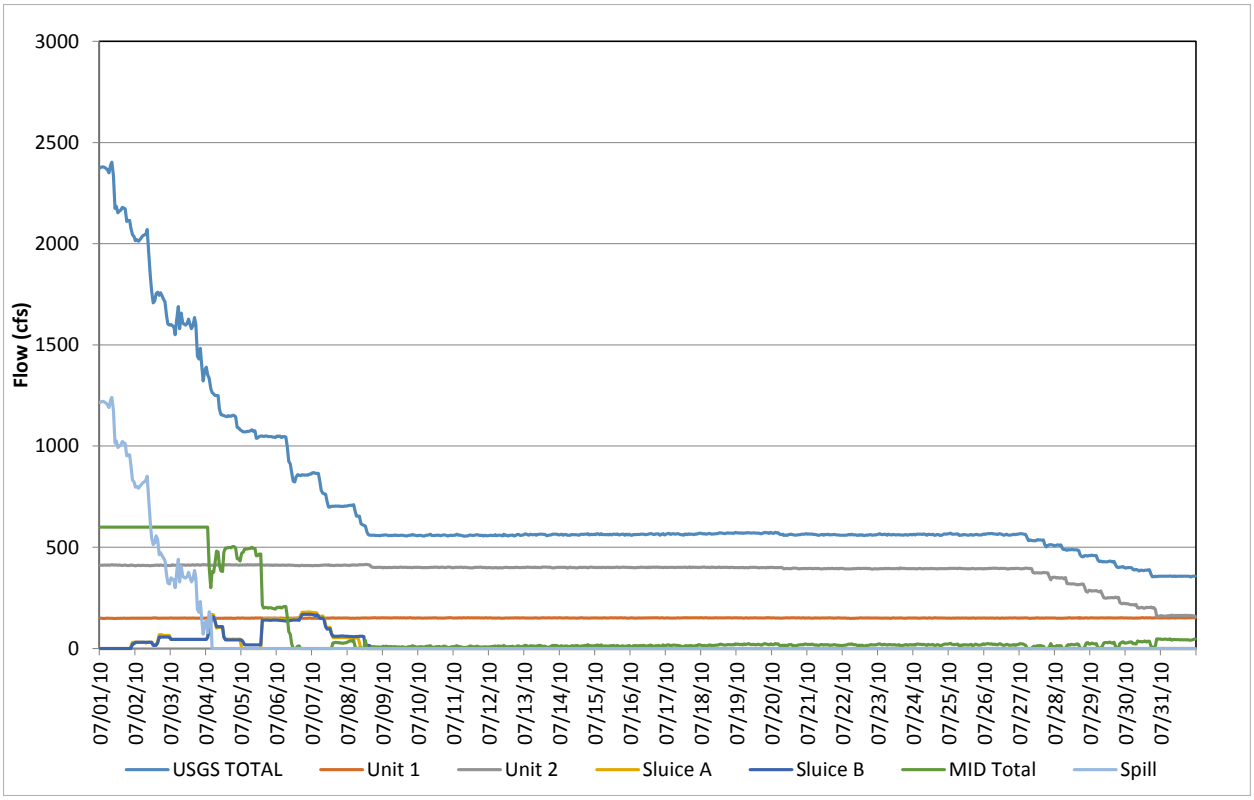

Figure D-67. Flow record in July 2010, based on hourly discharges.

Figure D-68. Flow record in August 2010, based on hourly discharges.

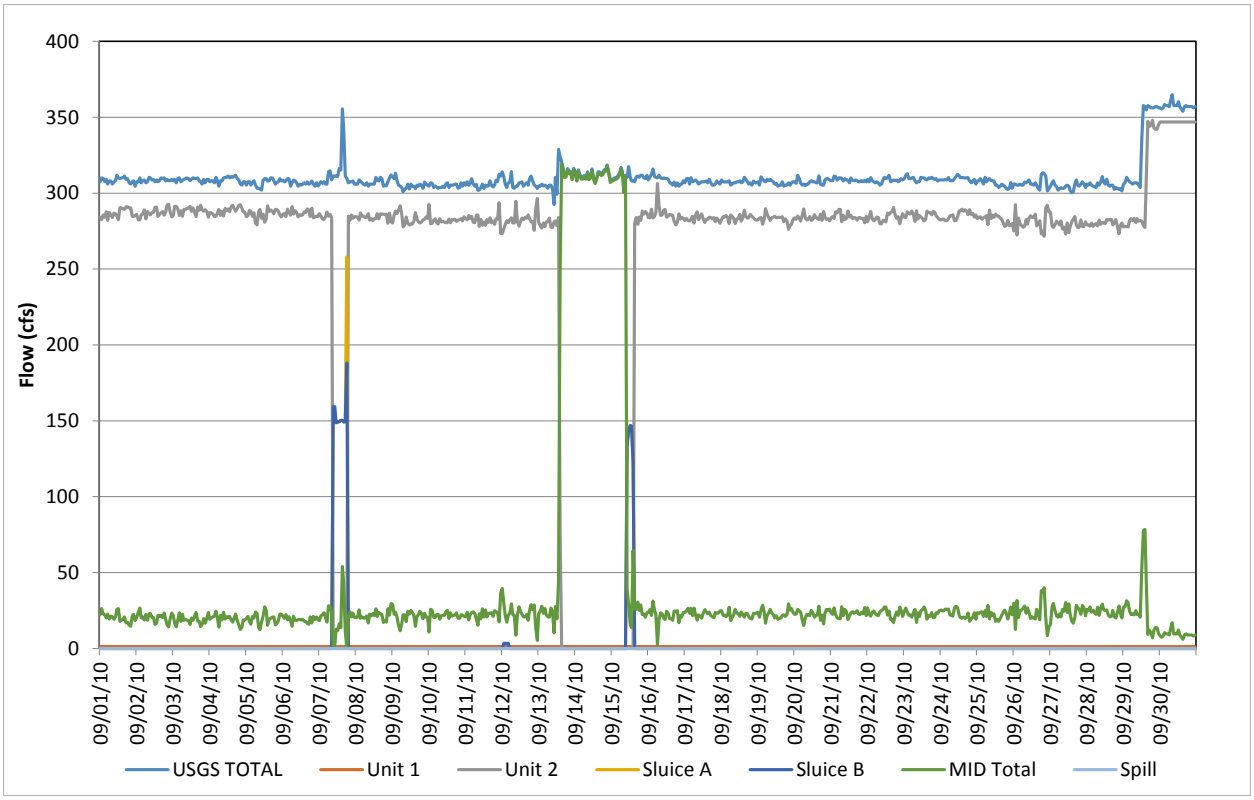

Figure D-69. Flow record in September 2010, based on hourly discharges.

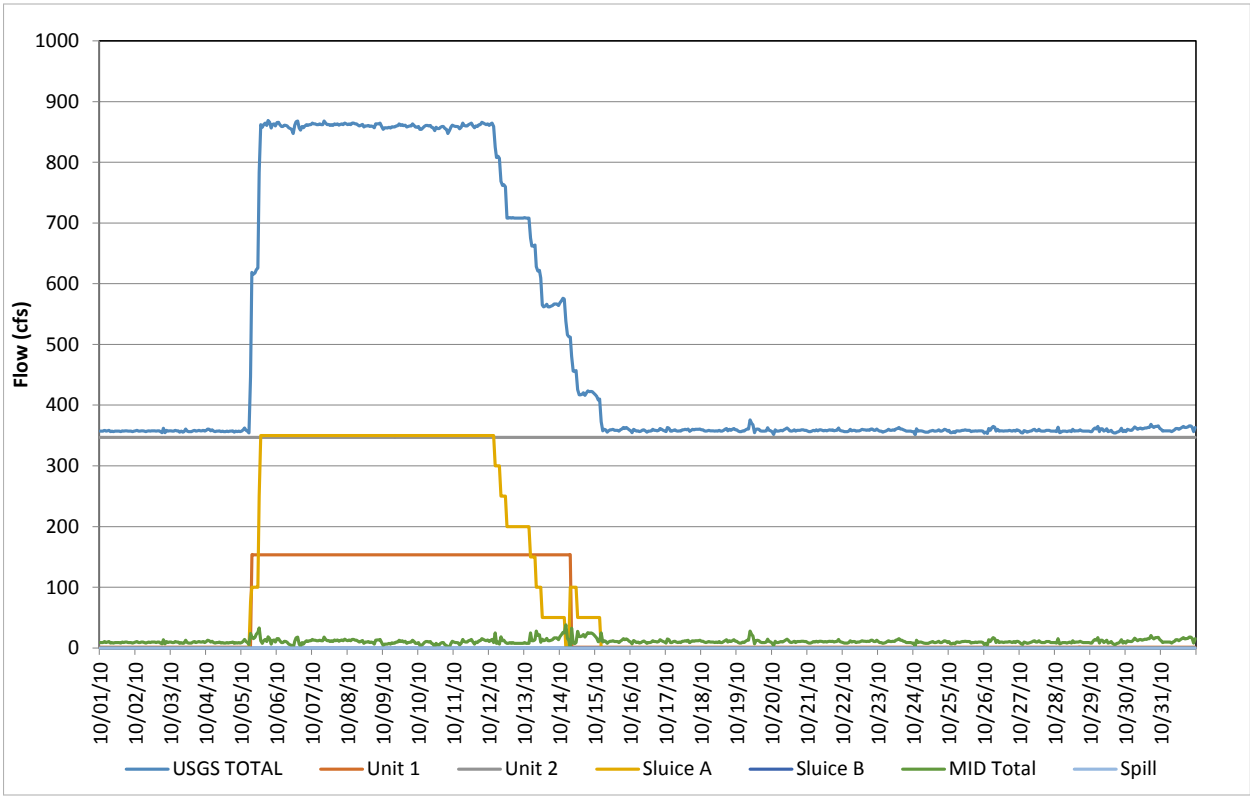

Figure D-70. Flow record in October 2010, based on hourly discharges.

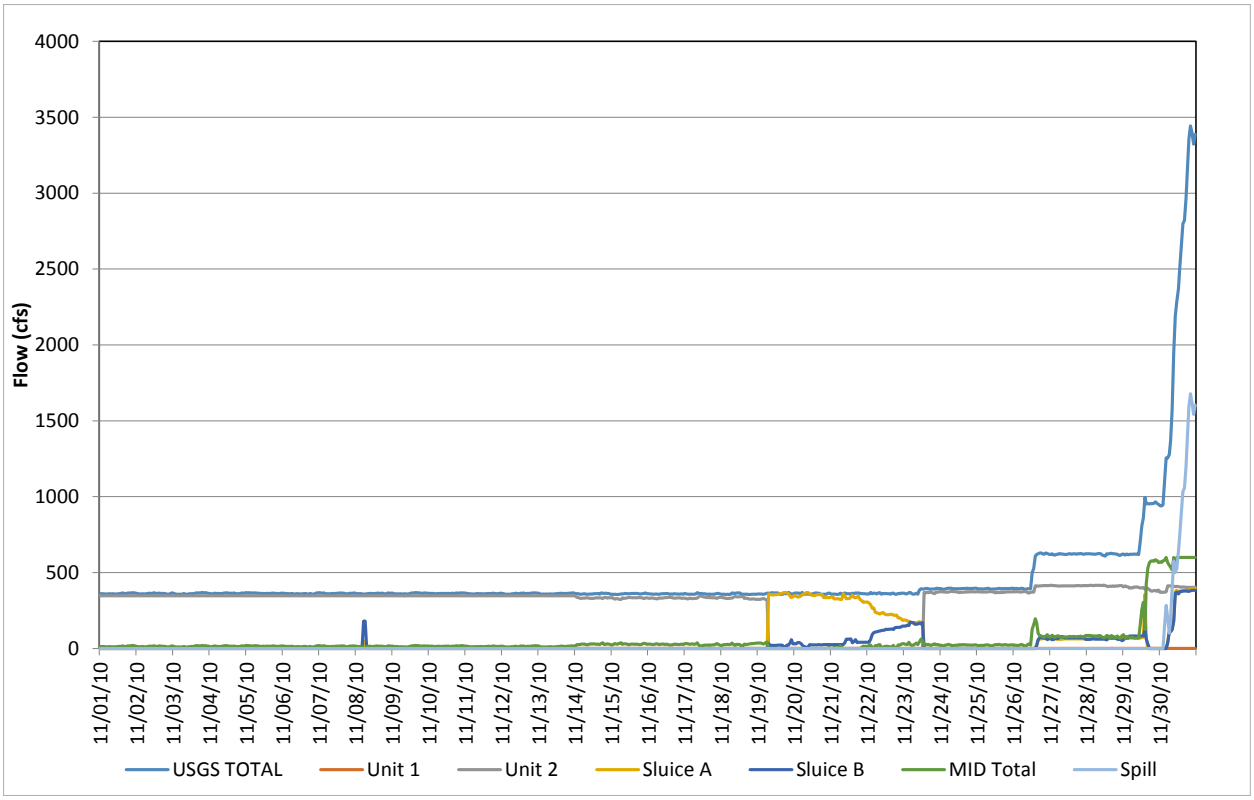

Figure D-71. Flow record in November 2010, based on hourly discharges.

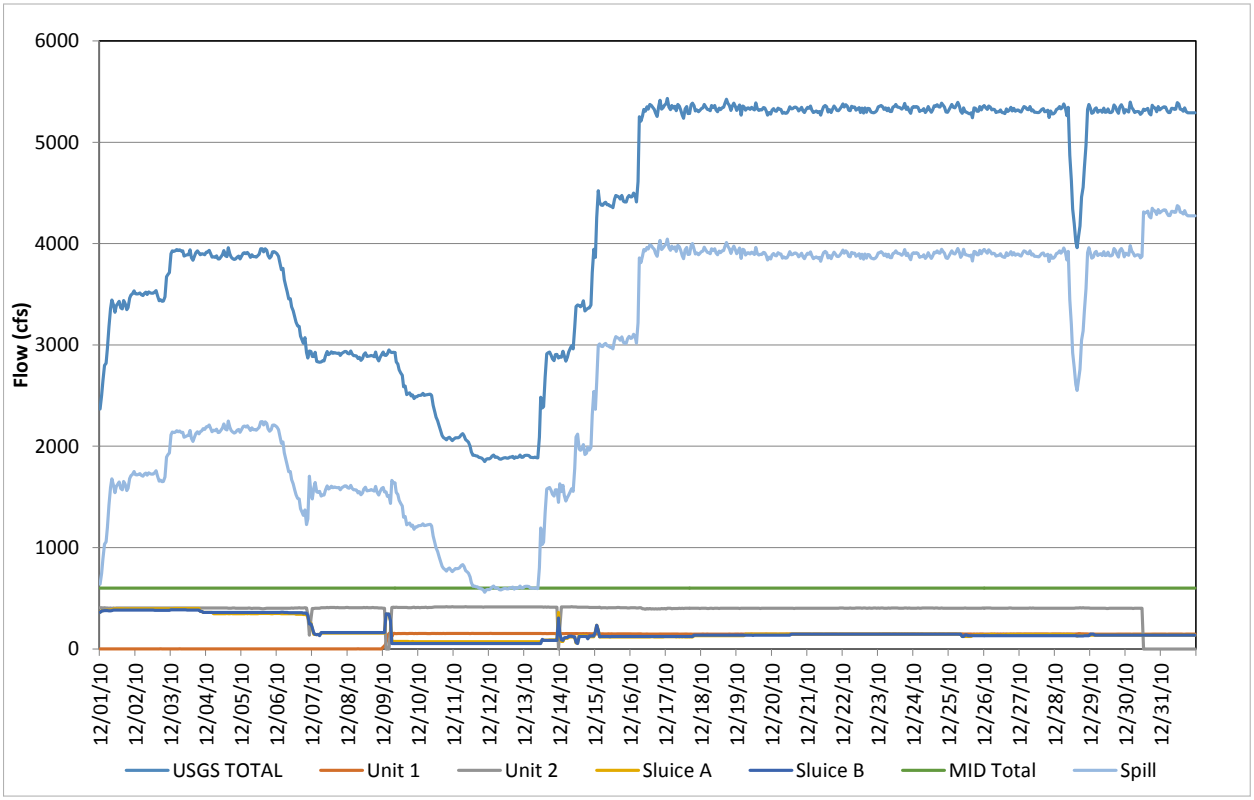

Figure D-72. Flow record in December 2010, based on hourly discharges.

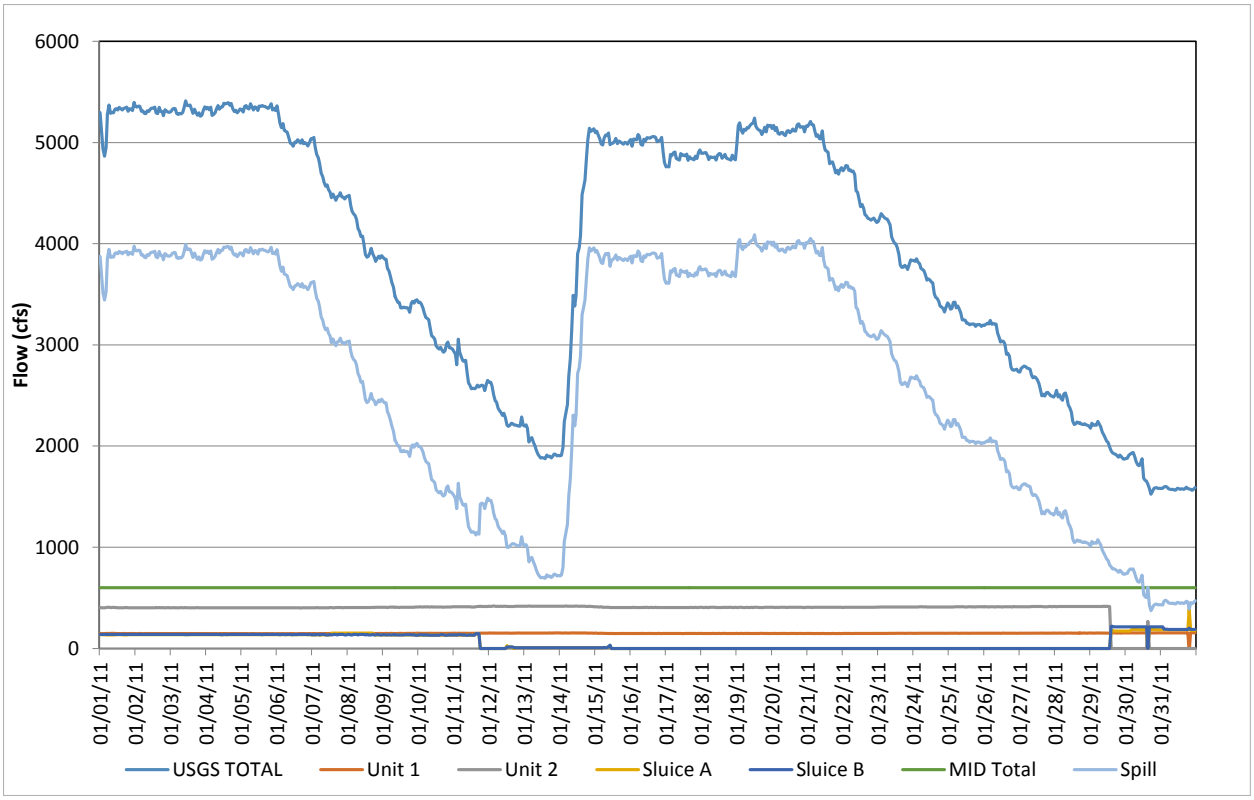

Figure D-73. Flow record in January 2011, based on hourly discharges.

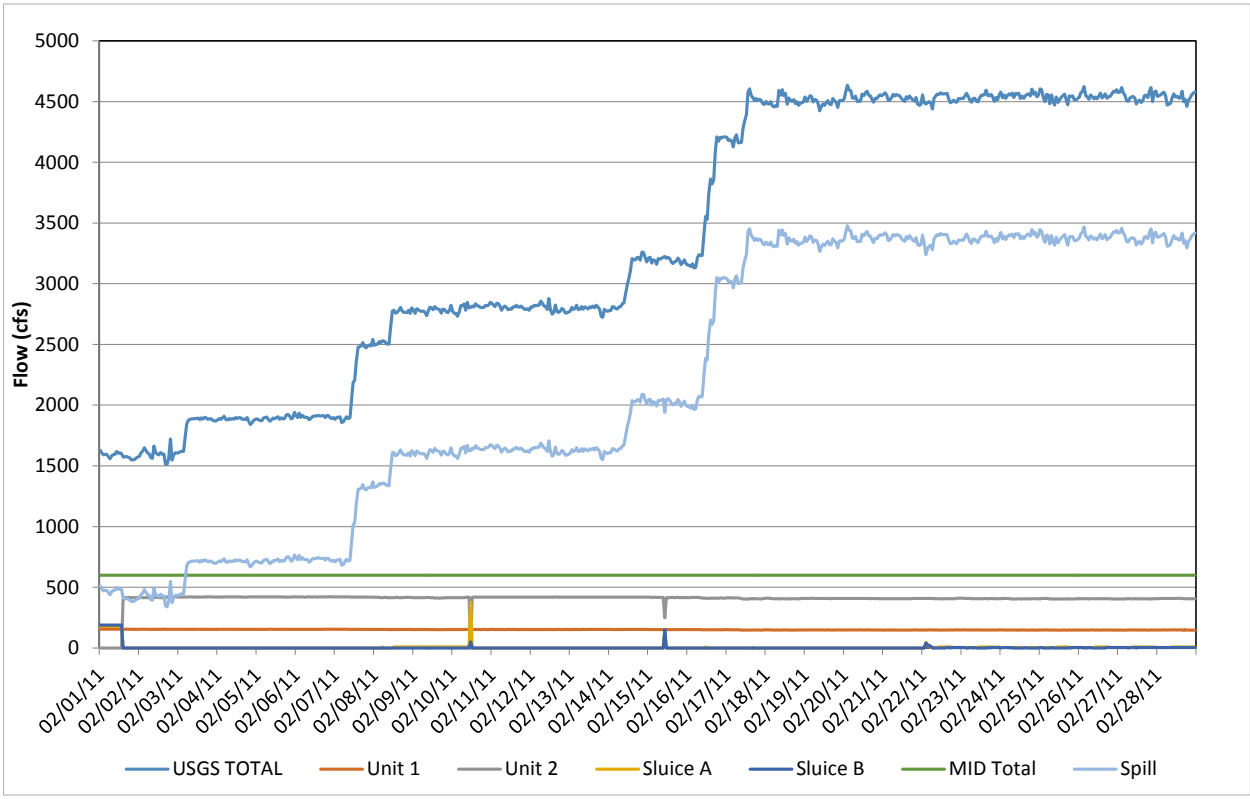

Figure D-74. Flow record in February 2011, based on hourly discharges.

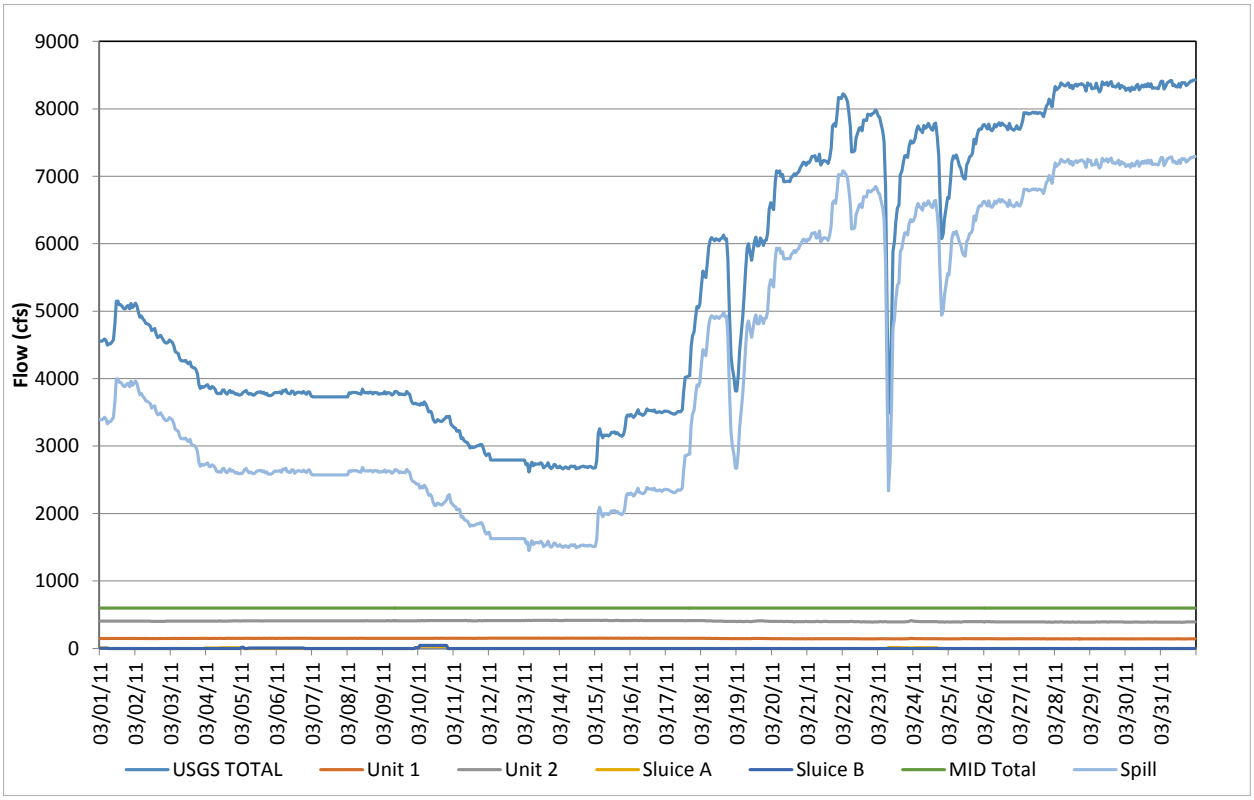

Figure D-75. Flow record in March 2011, based on hourly discharges.

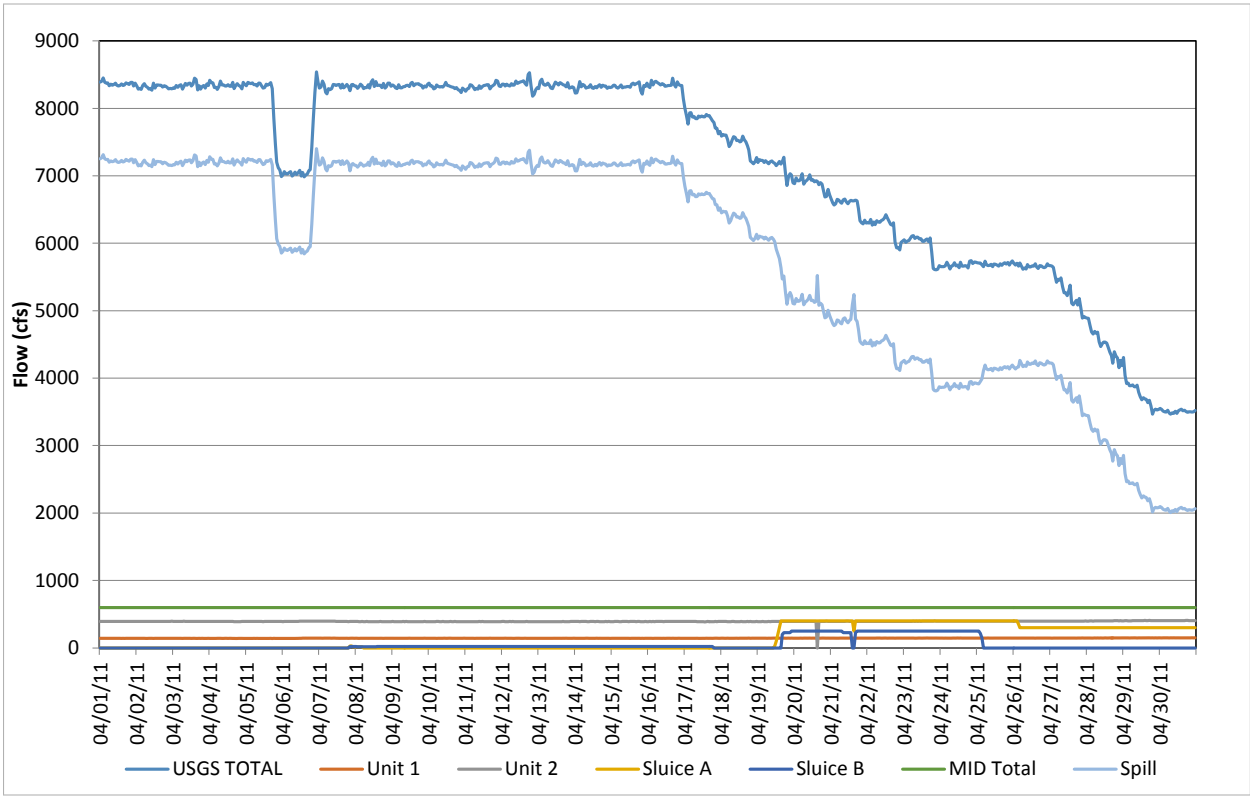

Figure D-76. Flow record in April 2011, based on hourly discharges.

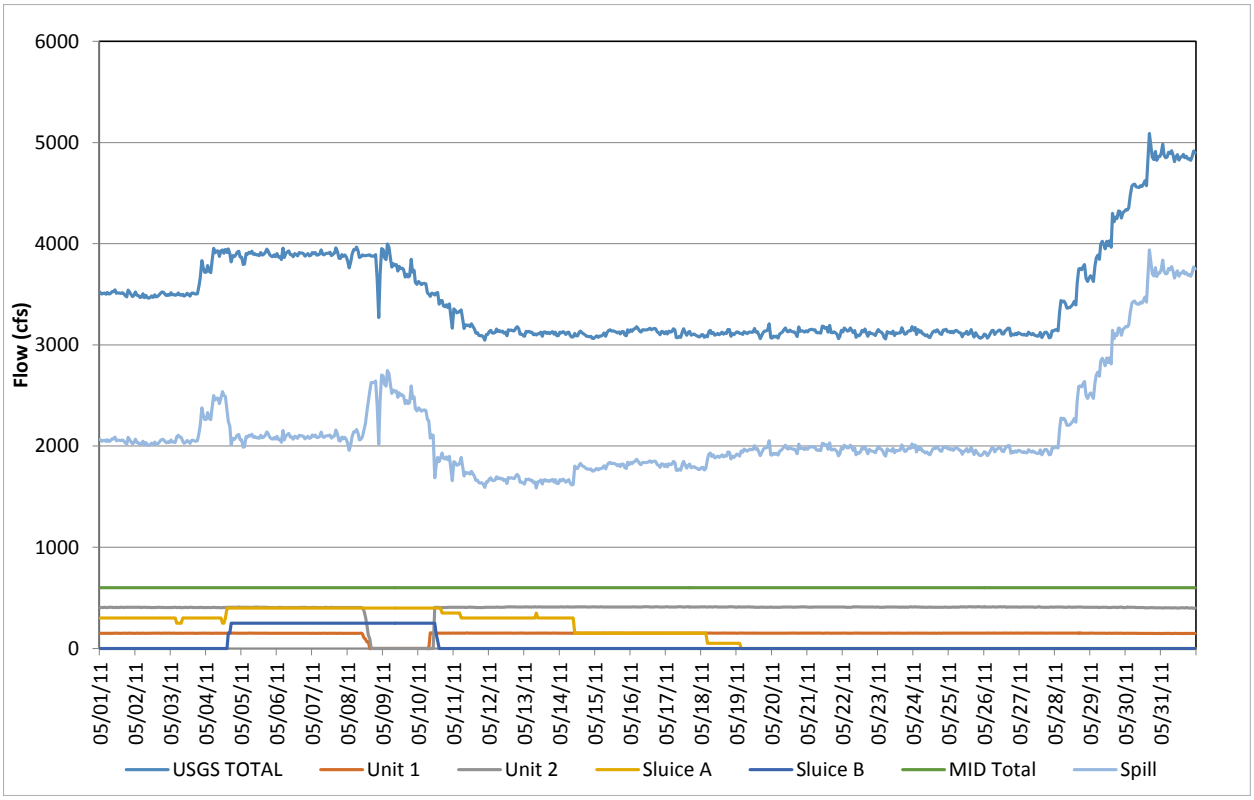

Figure D-77. Flow record in May 2011, based on hourly discharges.

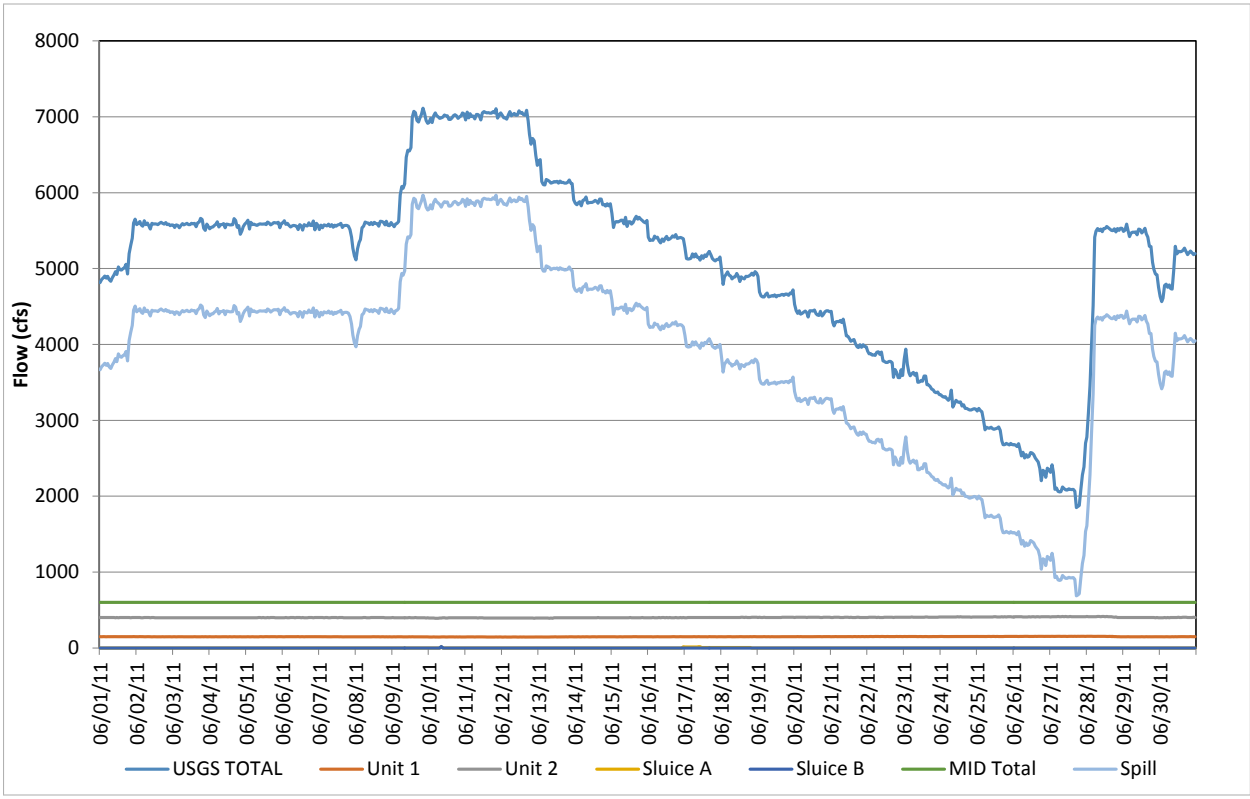

Figure D-78. Flow record in June 2011, based on hourly discharges.

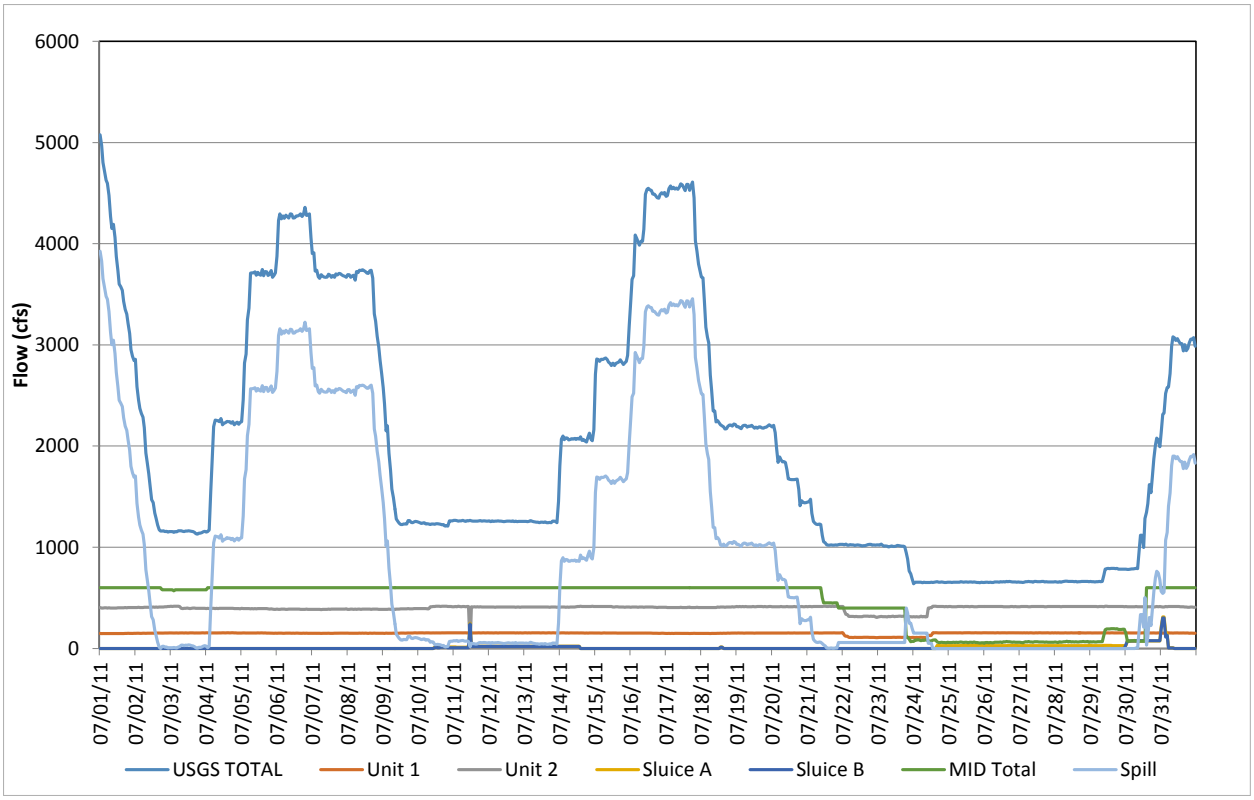

Figure D-79. Flow record in July 2011, based on hourly discharges.

Figure D-80. Flow record in August 2011, based on hourly discharges.

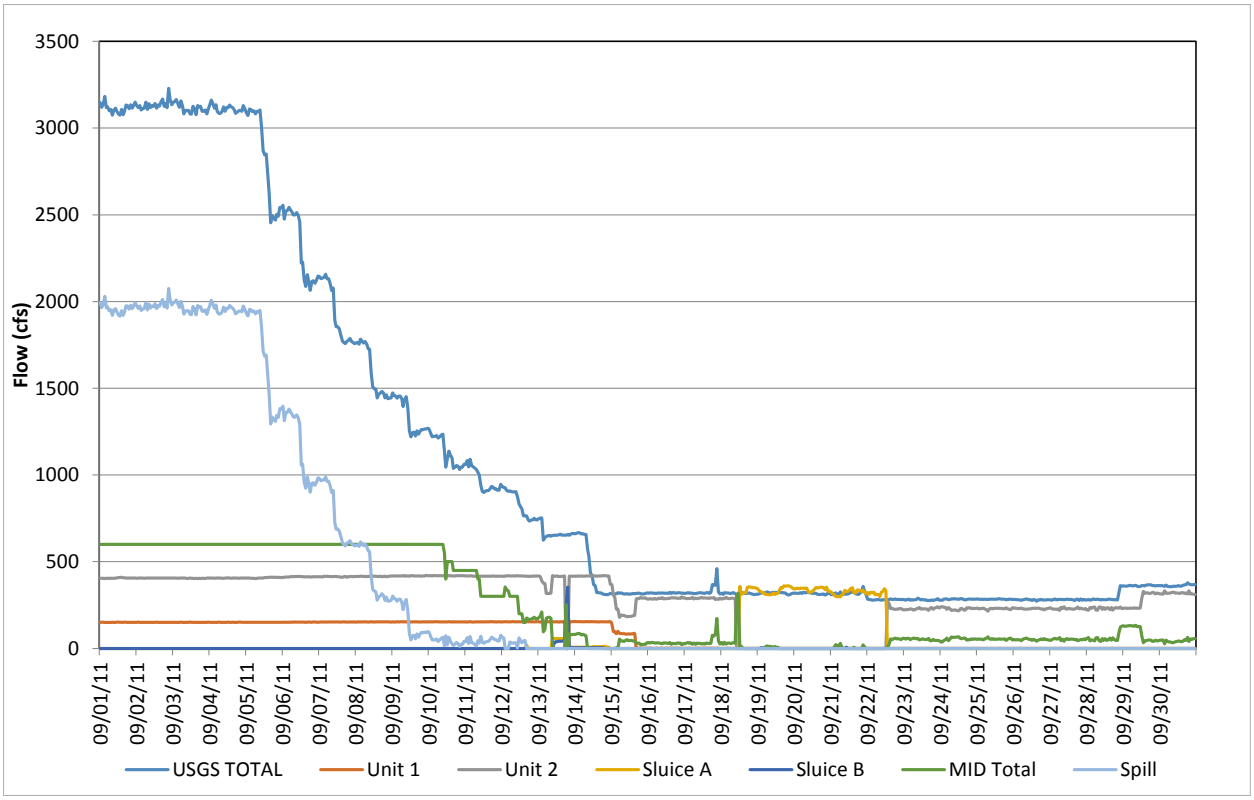

Figure D-81. Flow record in September 2011, based on hourly discharges.

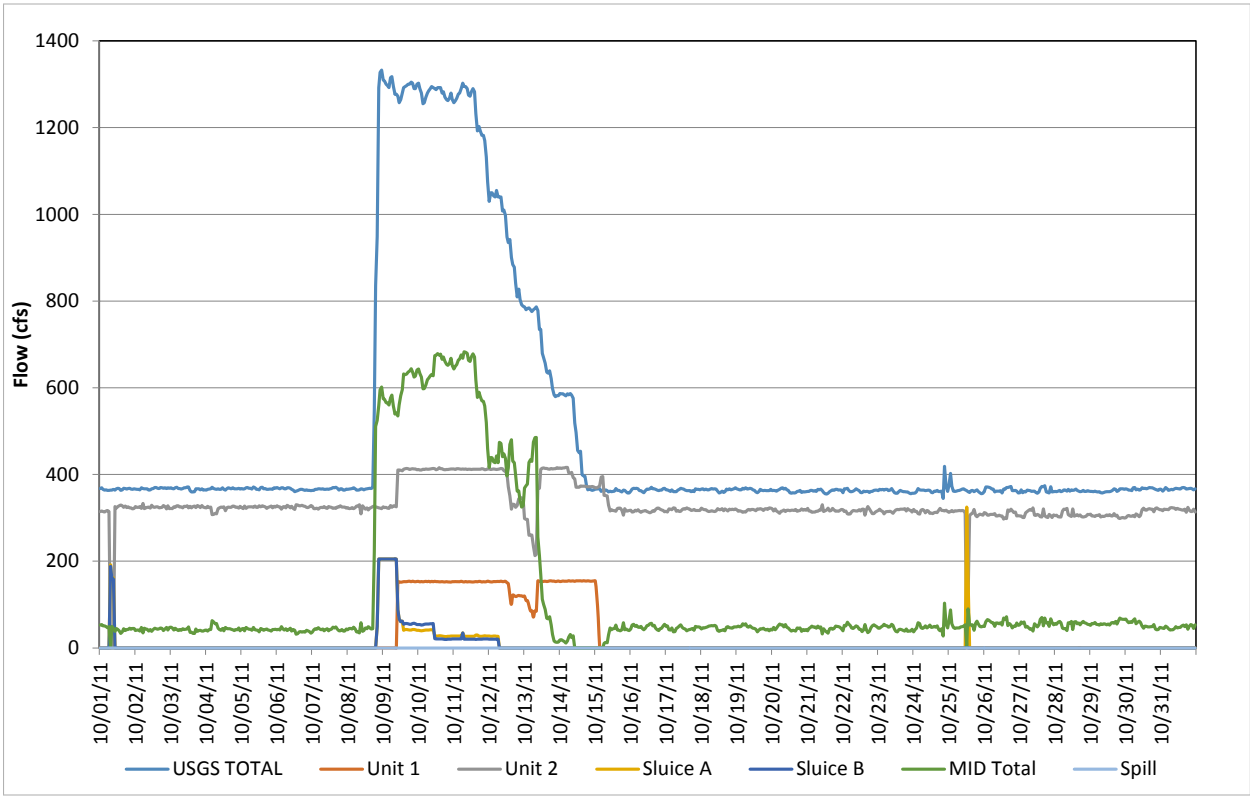

Figure D-82. Flow record in October 2011, based on hourly discharges.

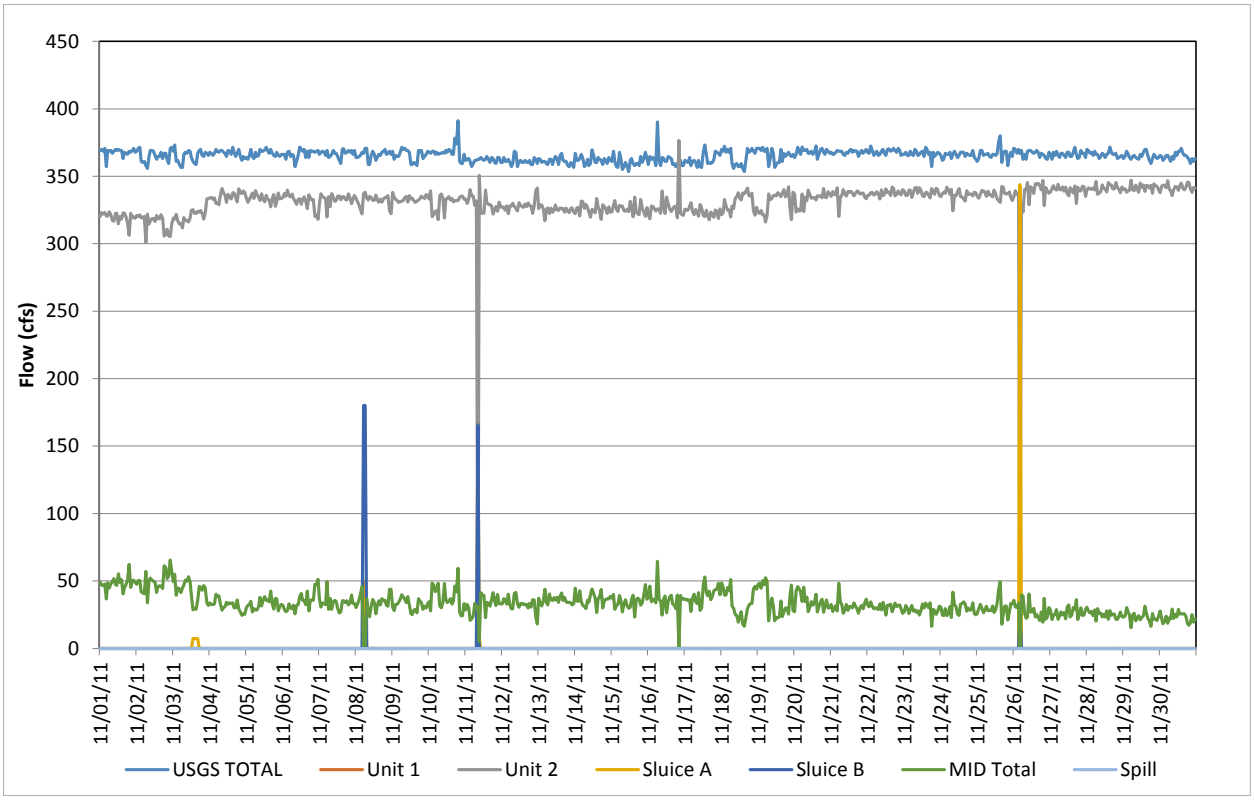

Figure D-83. Flow record in November 2011, based on hourly discharges.

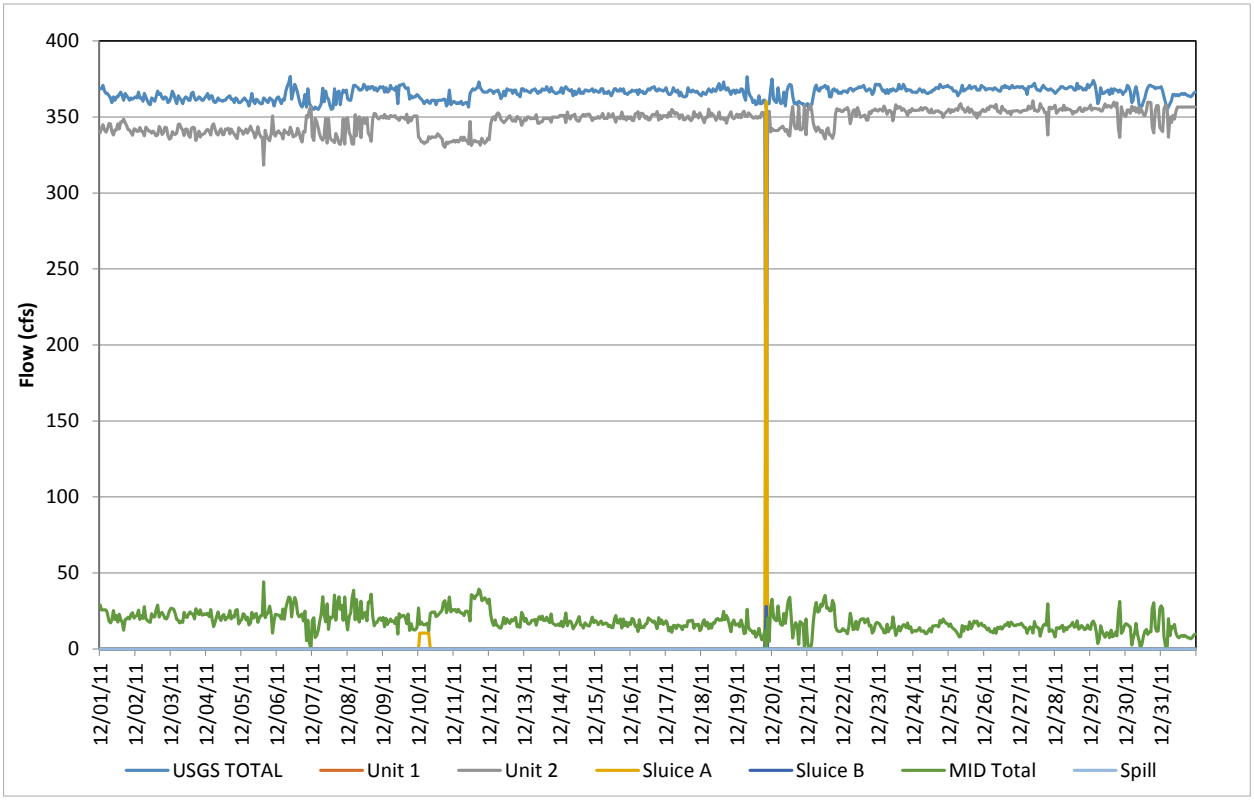

Figure D-84 Flow record in December 2011, based on hourly discharges.

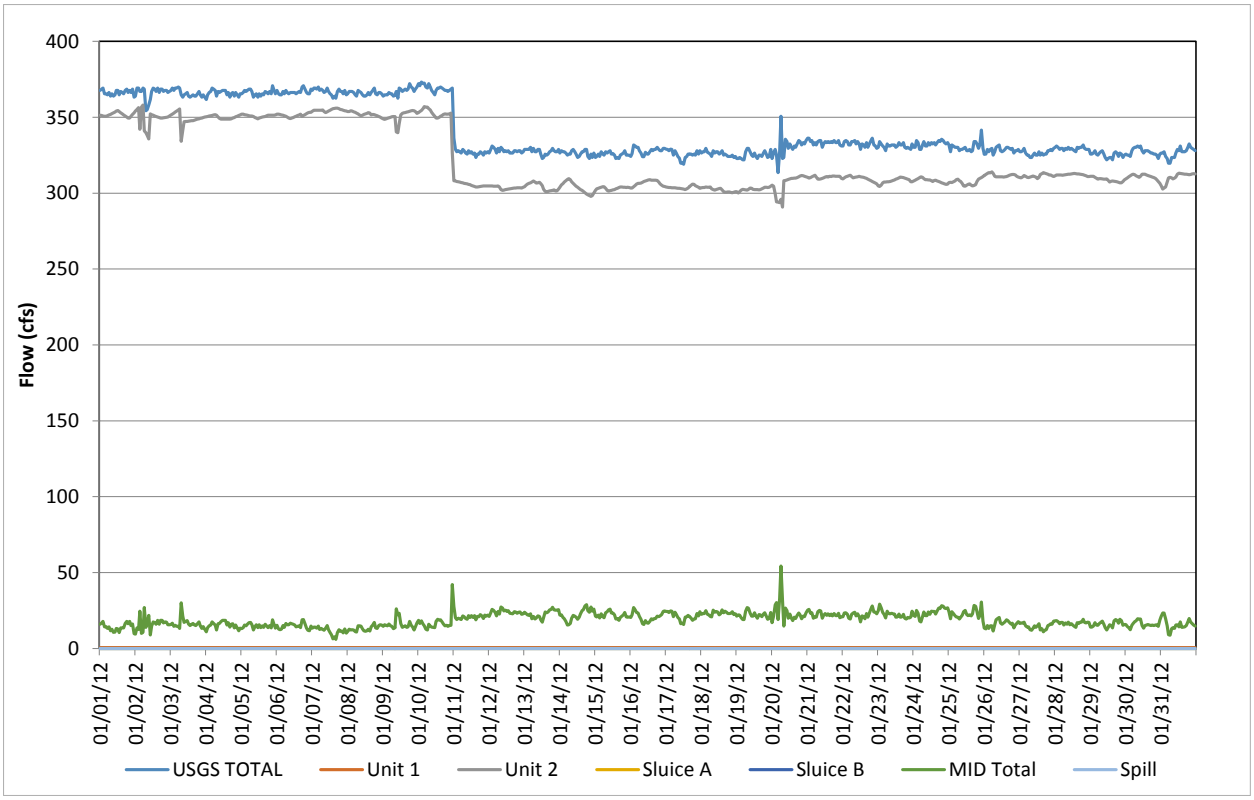

Figure D-85. Flow record in January 2012, based on hourly discharges.

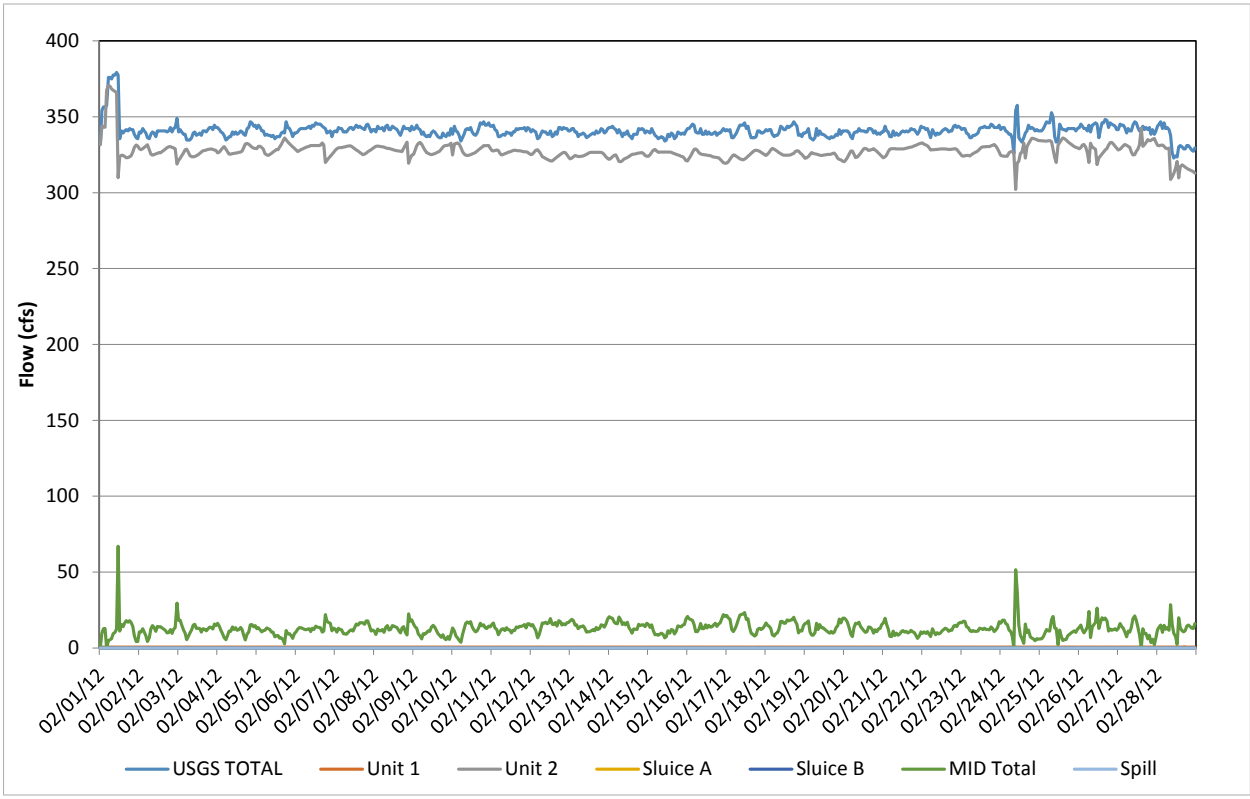

Figure D-86. Flow record in February 2012, based on hourly discharges.

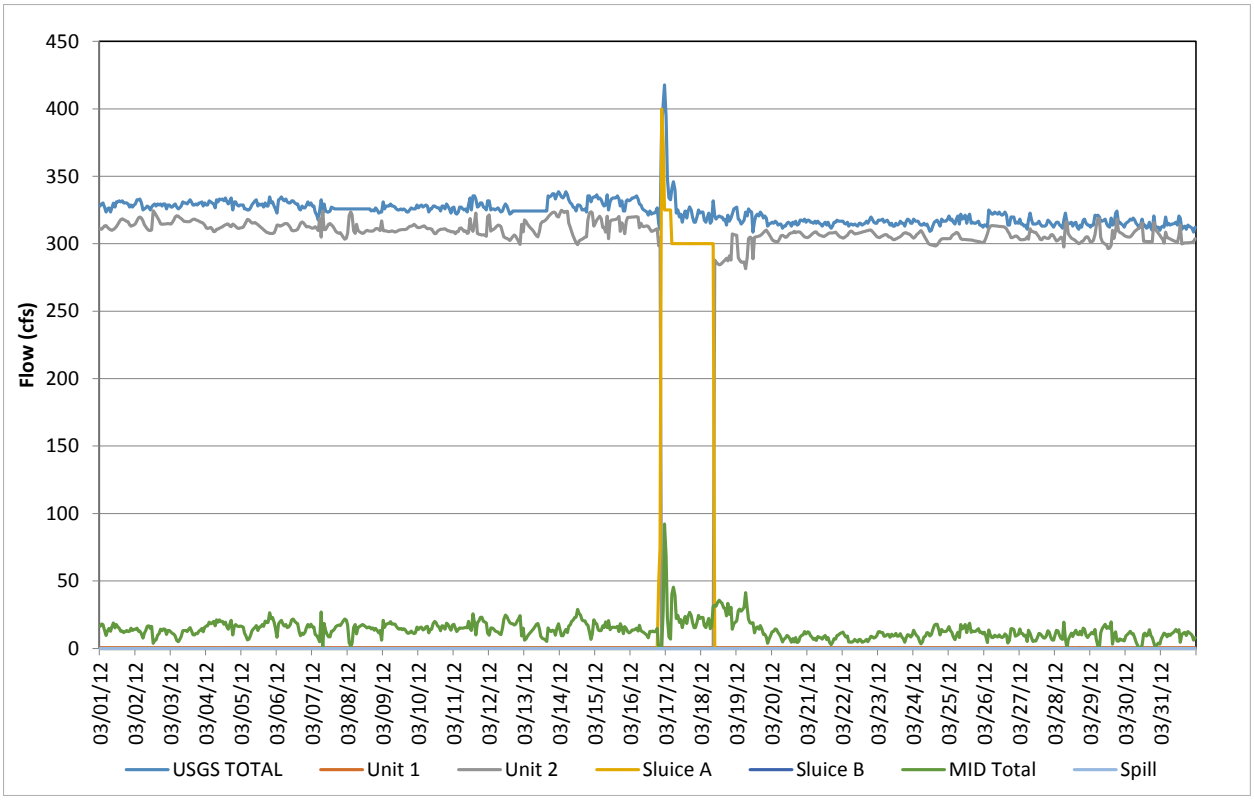

Figure D-87. Flow record in March 2012, based on hourly discharges.

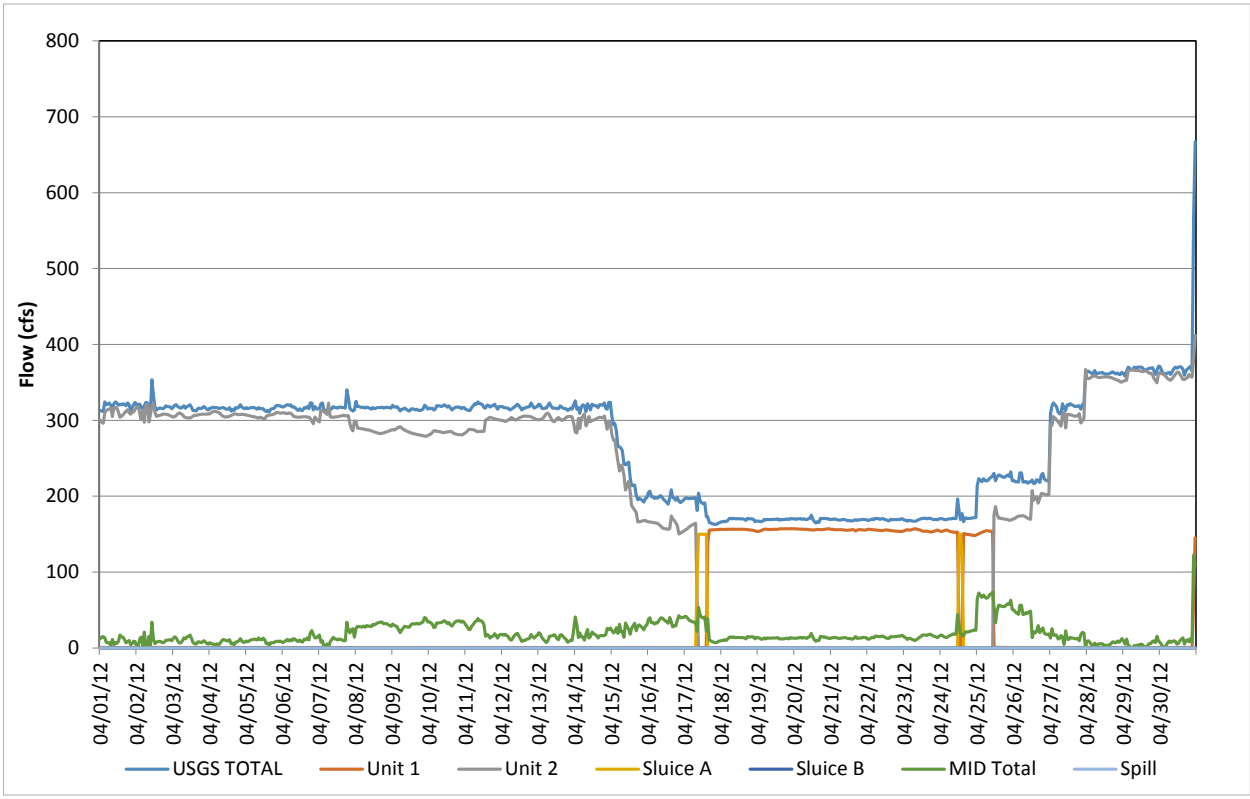

Figure D-88. Flow record in April 2012, based on hourly discharges.

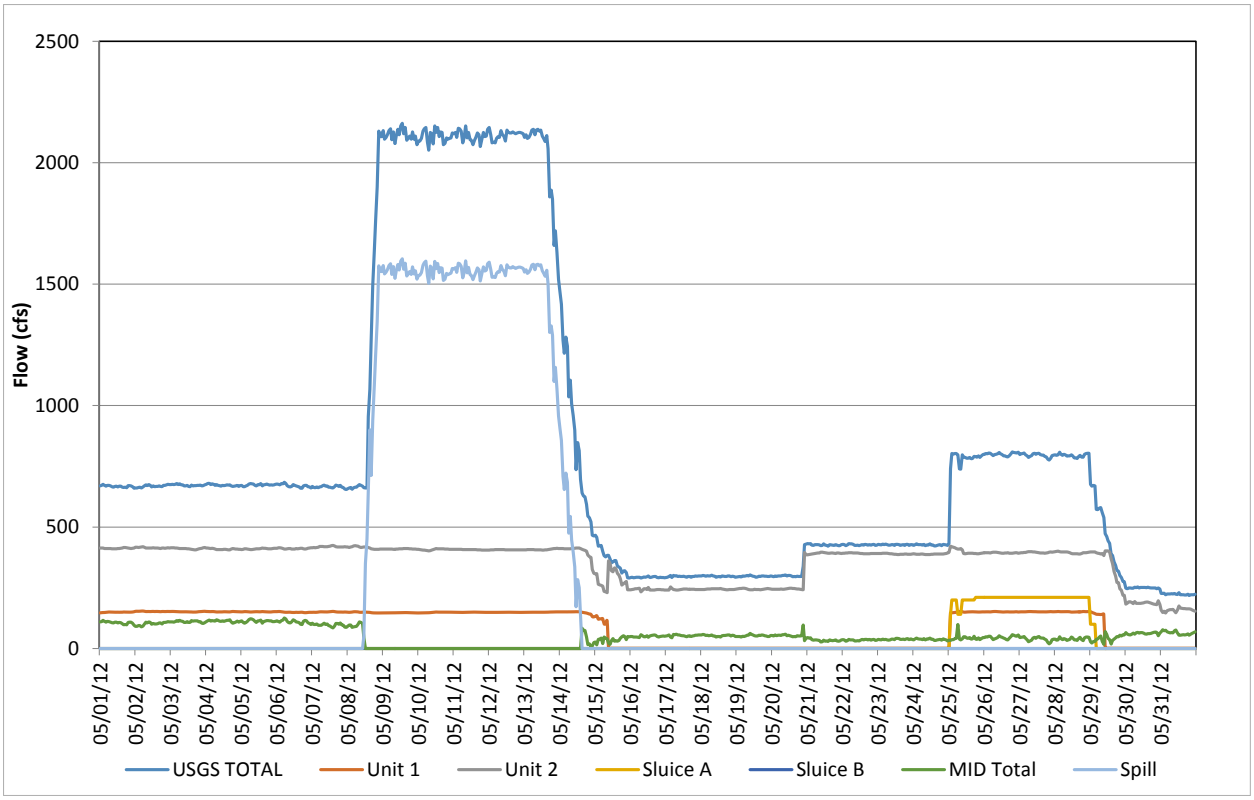

Figure D-89. Flow record in May 2012, based on hourly discharges.

Figure D-90. Flow record in June 2012, based on hourly discharges.

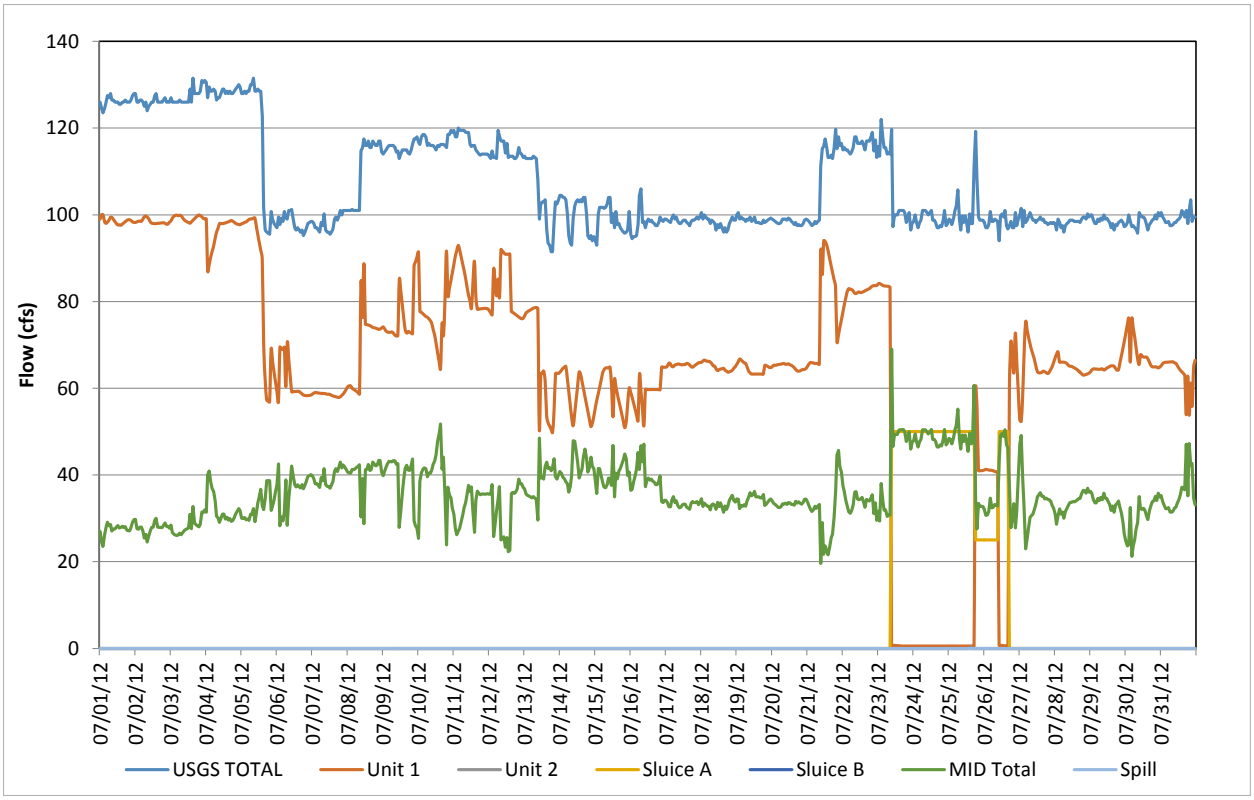

Figure D-91. Flow record in July 2012, based on hourly discharges.

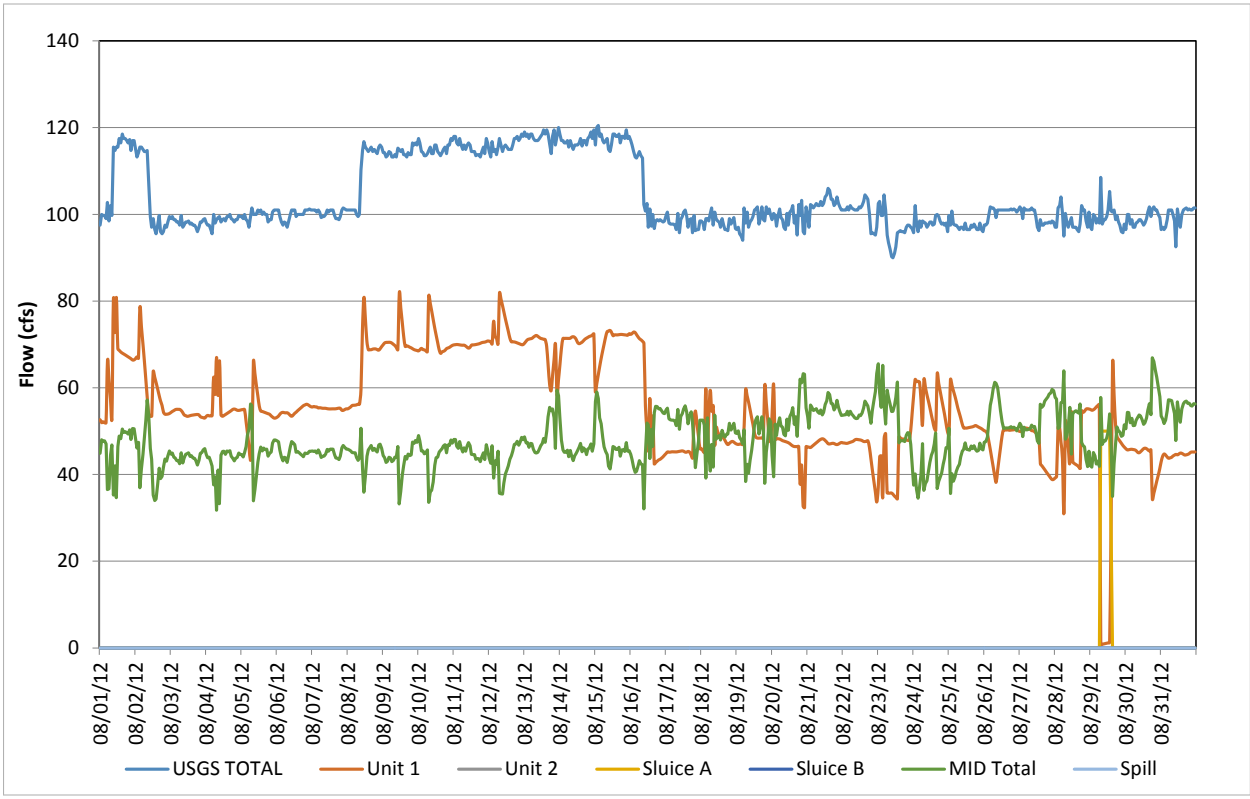

Figure D-92. Flow record in August 2012, based on hourly discharges.

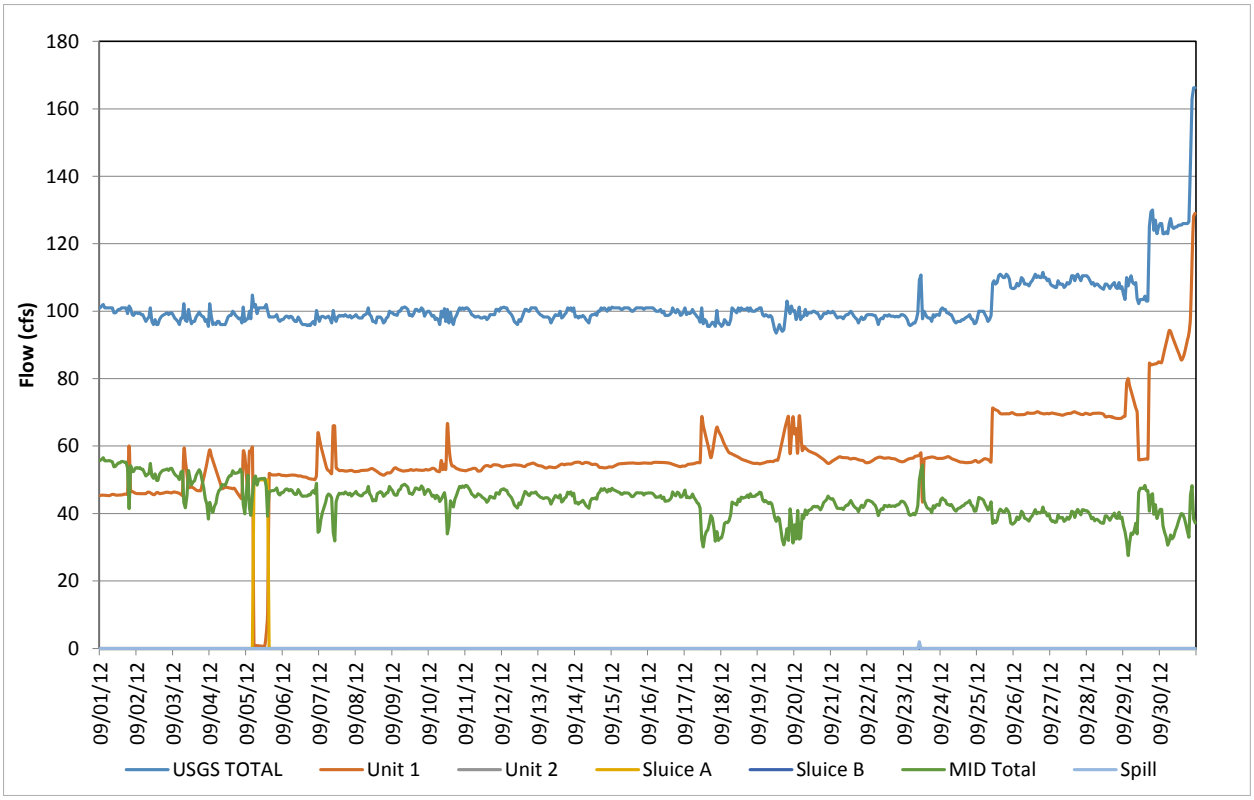

Figure D-93. Flow record in September 2012, based on hourly discharges.

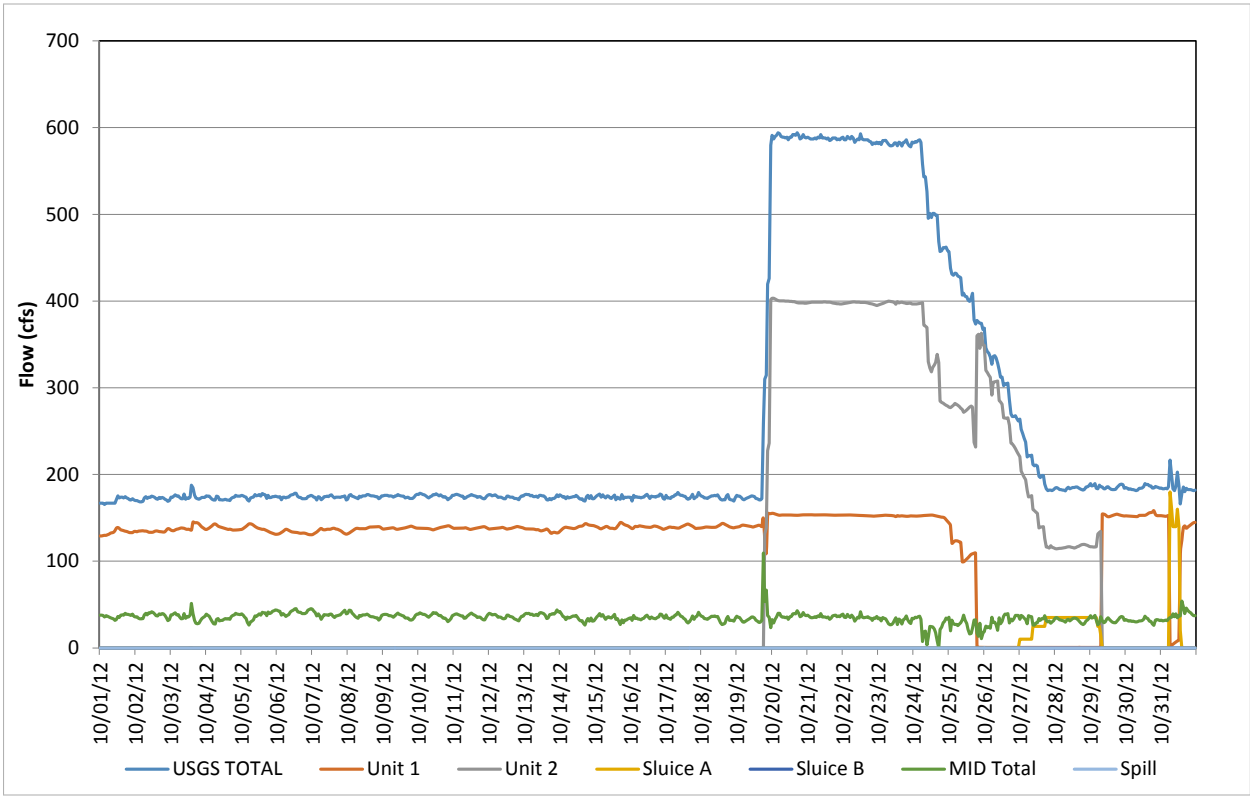

Figure D-94. Flow record in October 2012, based on hourly discharges.

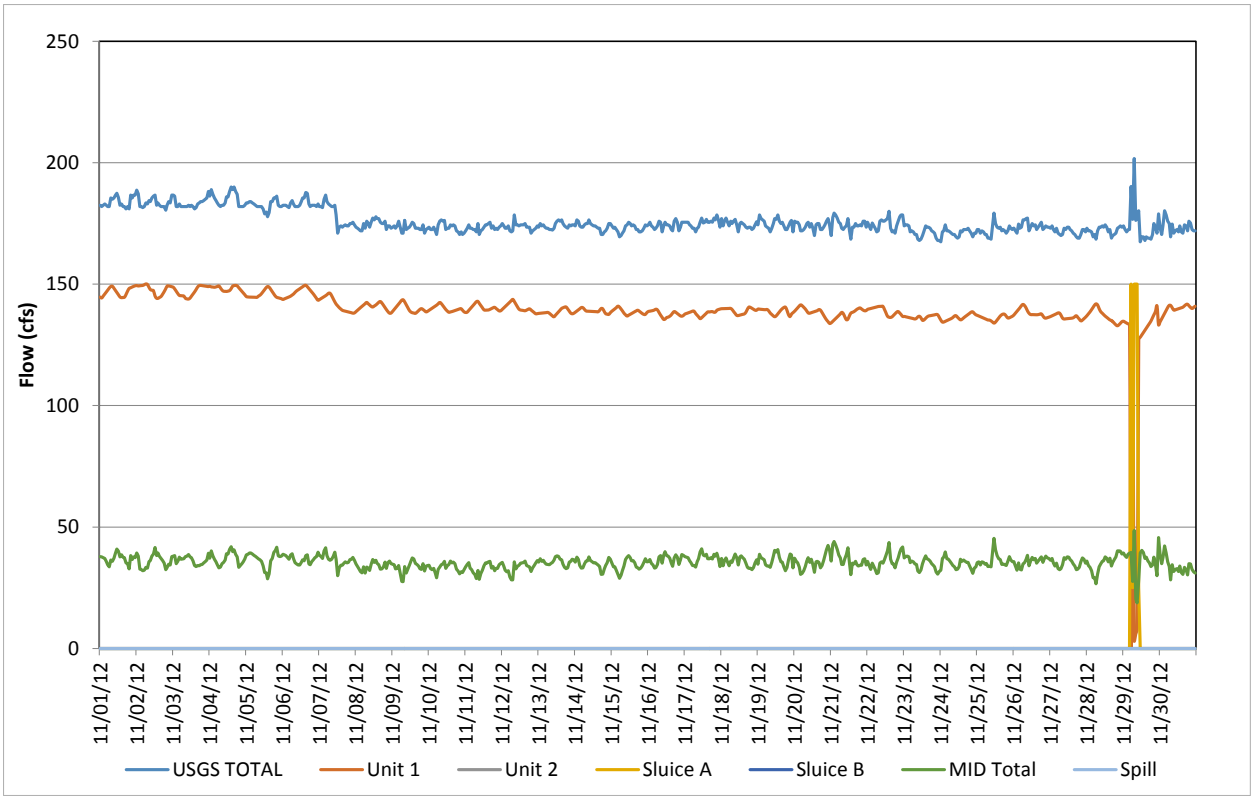

Figure D-95. Flow record in November 2012, based on hourly discharges.

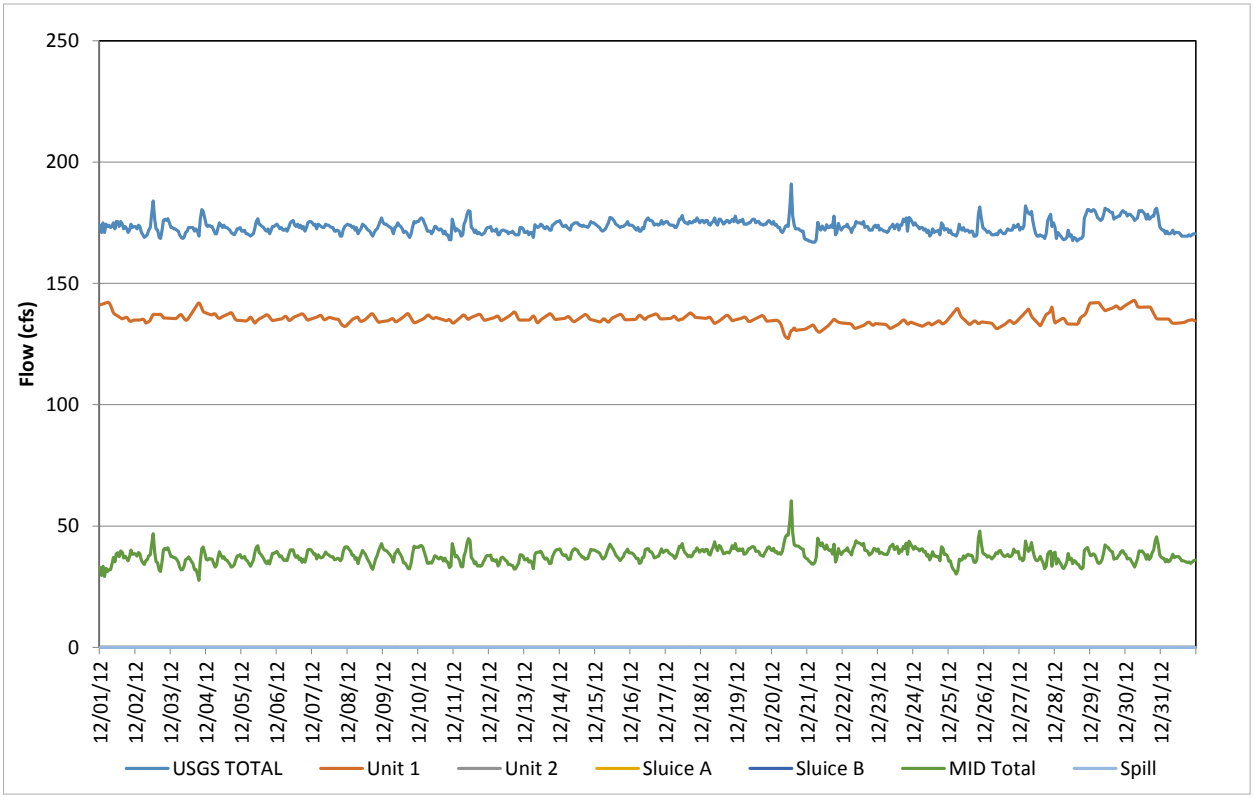

Figure D-96. Flow record in December 2012, based on hourly discharges.

Figure D-97. Flow record in January 2013, based on hourly discharges.

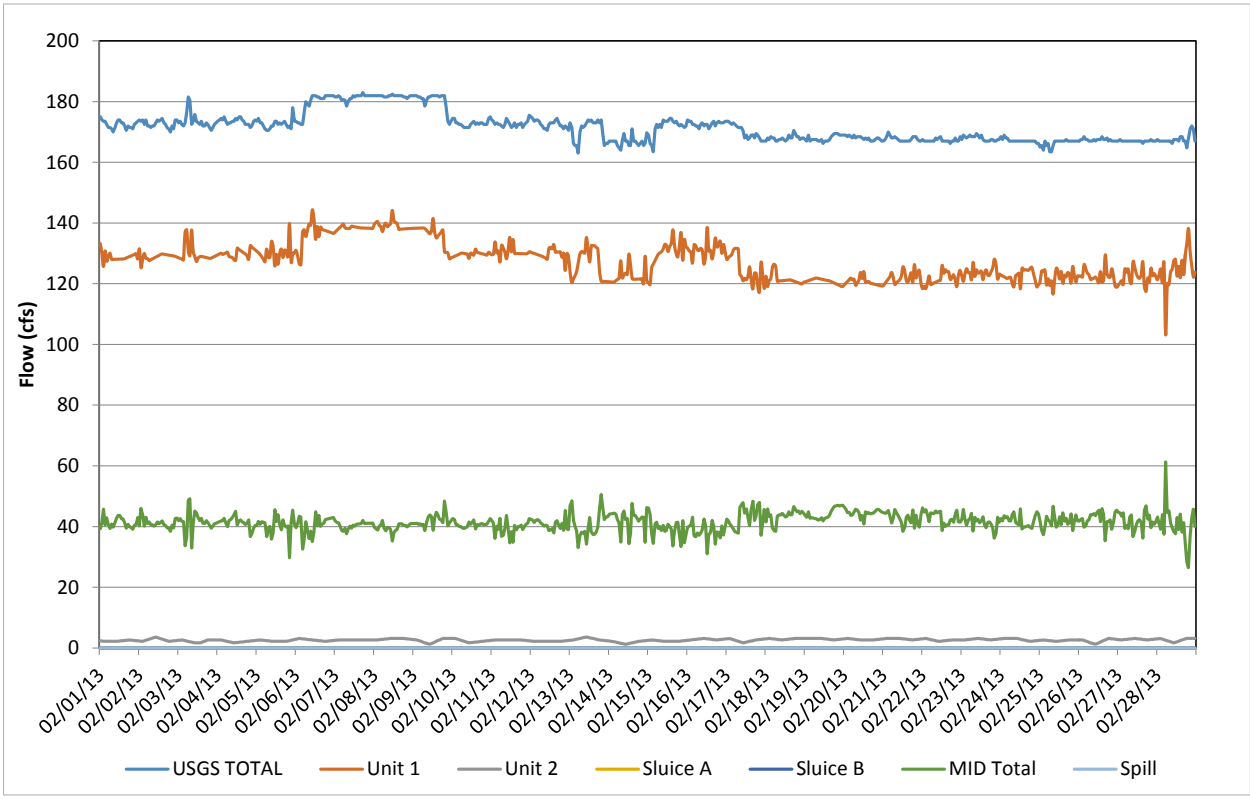

Figure D-98. Flow record in February 2013, based on hourly discharges.

Figure D-99. Flow record in March 2013, based on hourly discharges.

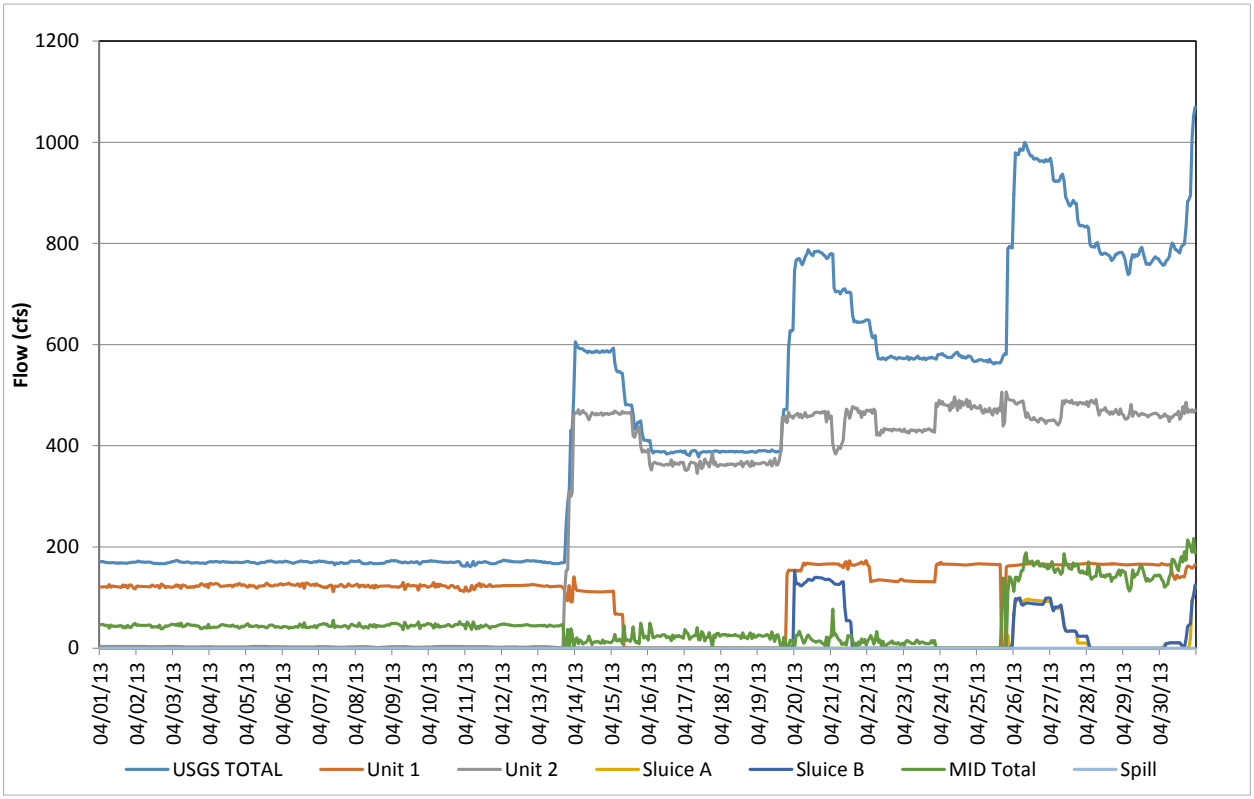

Figure D-100. Flow record in April 2013, based on hourly discharges.

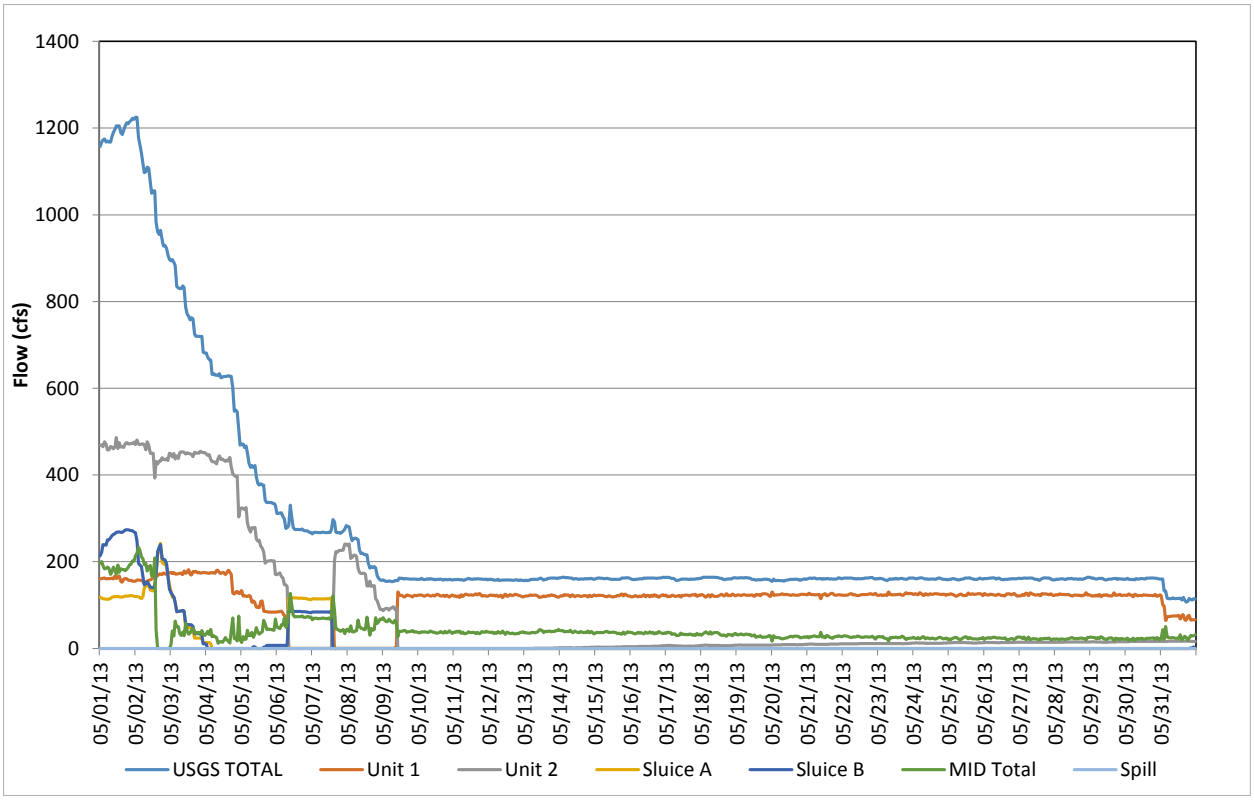

Figure D-101. Flow record in May 2013, based on hourly discharges.

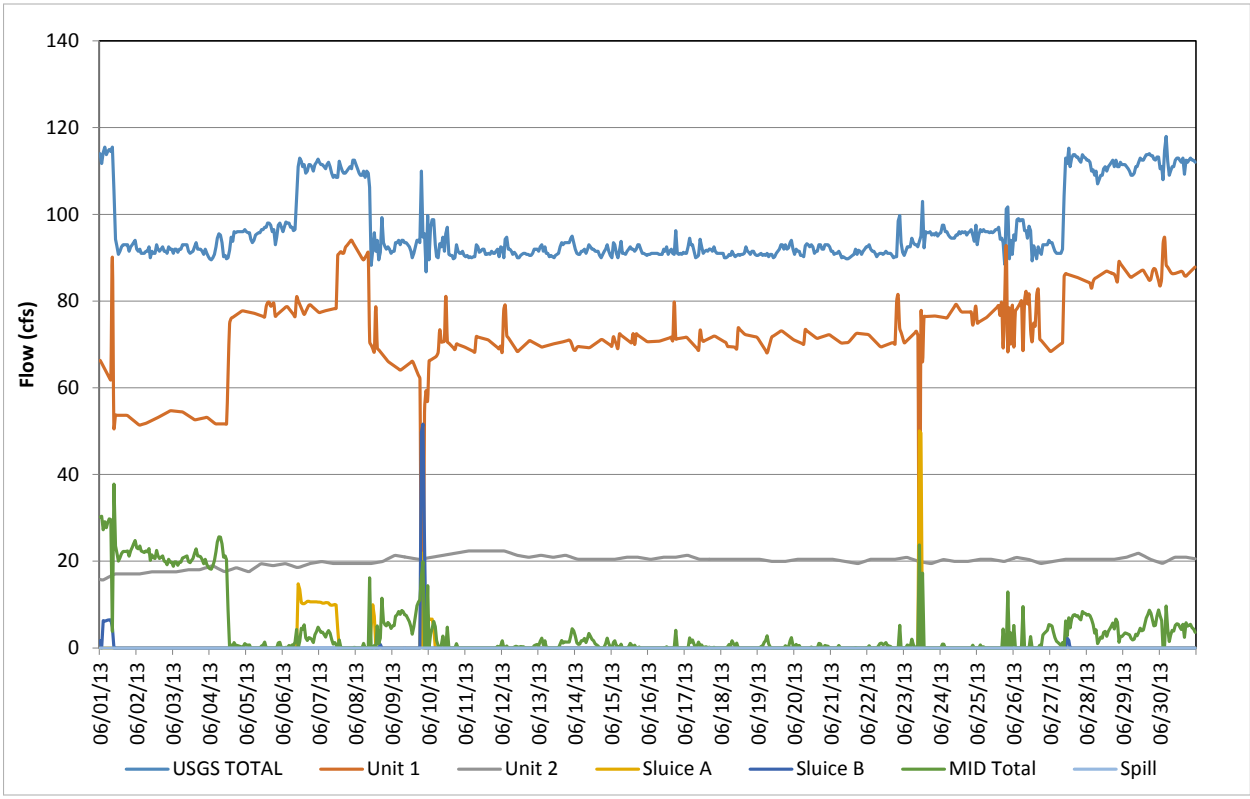

Figure D-102. Flow record in June 2013, based on hourly discharges.

Figure D-103. Flow record in July 2013, based on hourly discharges.

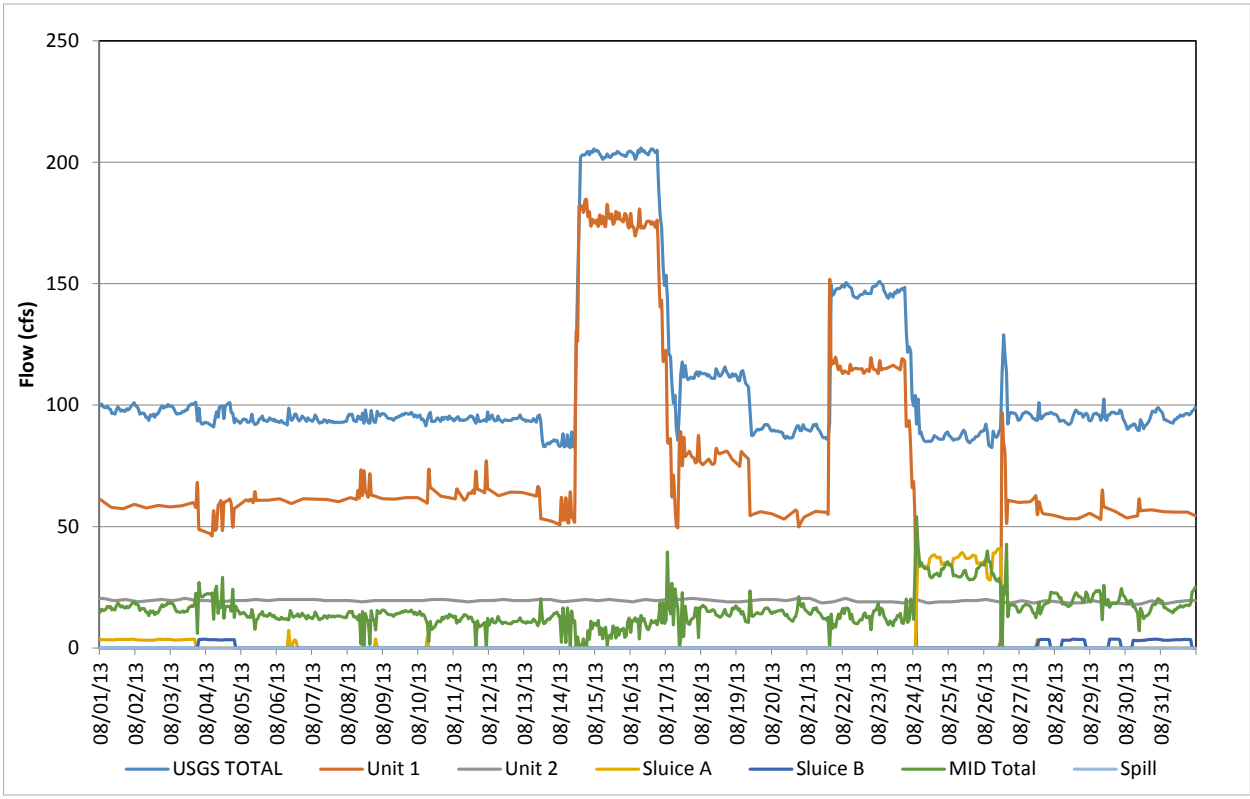

Figure D-104. Flow record in August 2013, based on hourly discharges.

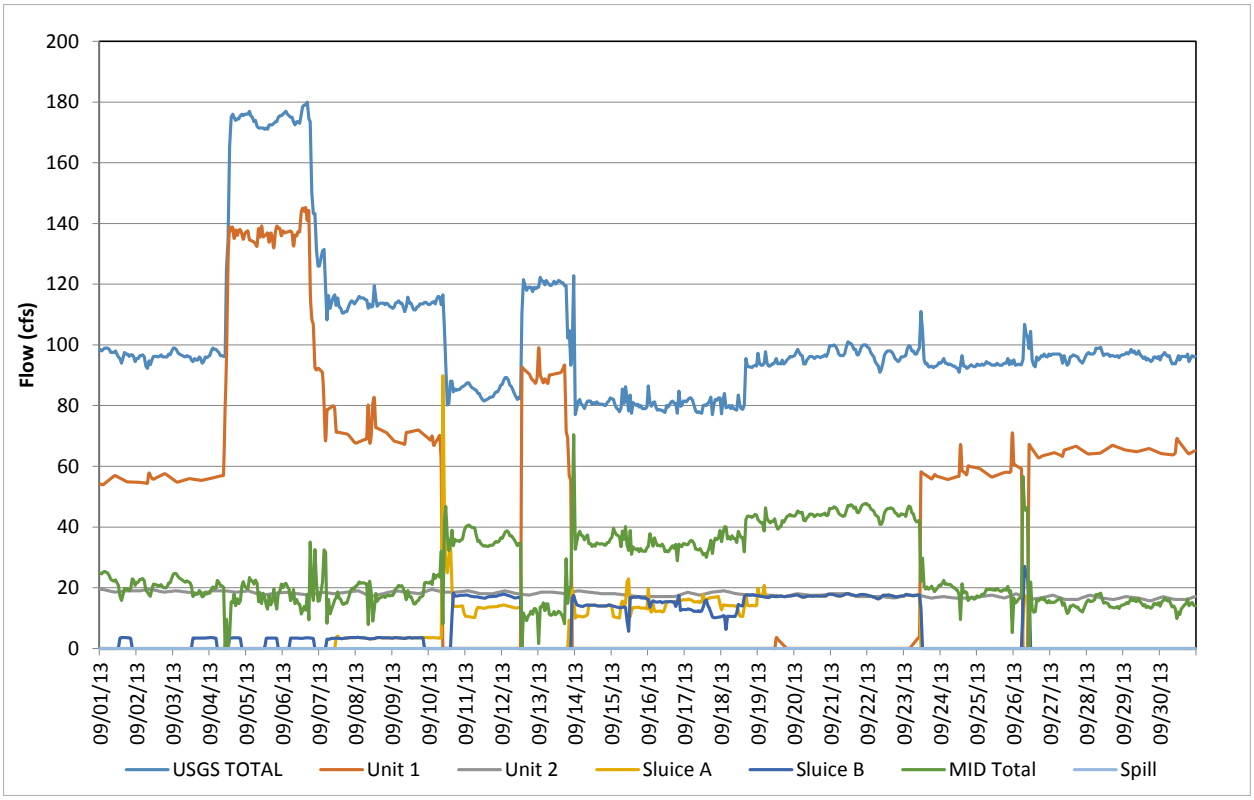

Figure D-105. Flow record in September 2013, based on hourly discharges.

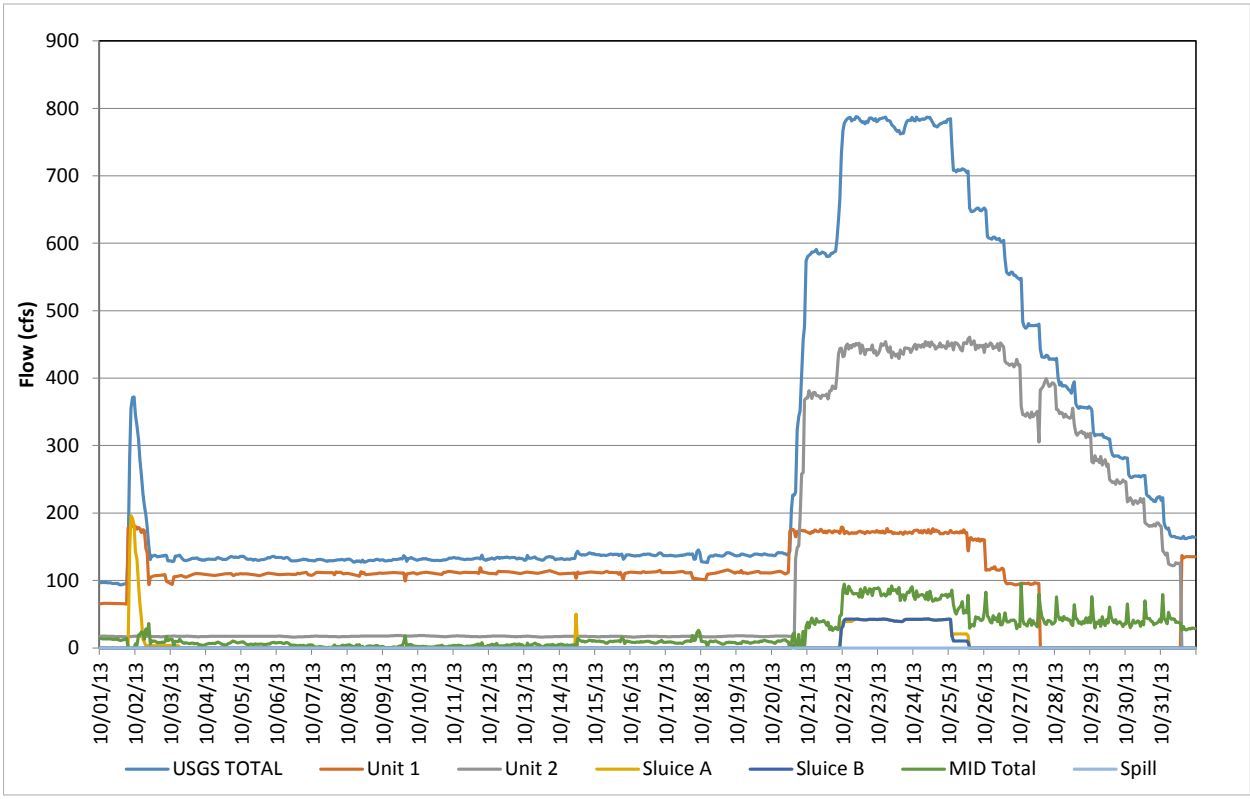

Figure D-106. Flow record in October 2013, based on hourly discharges.

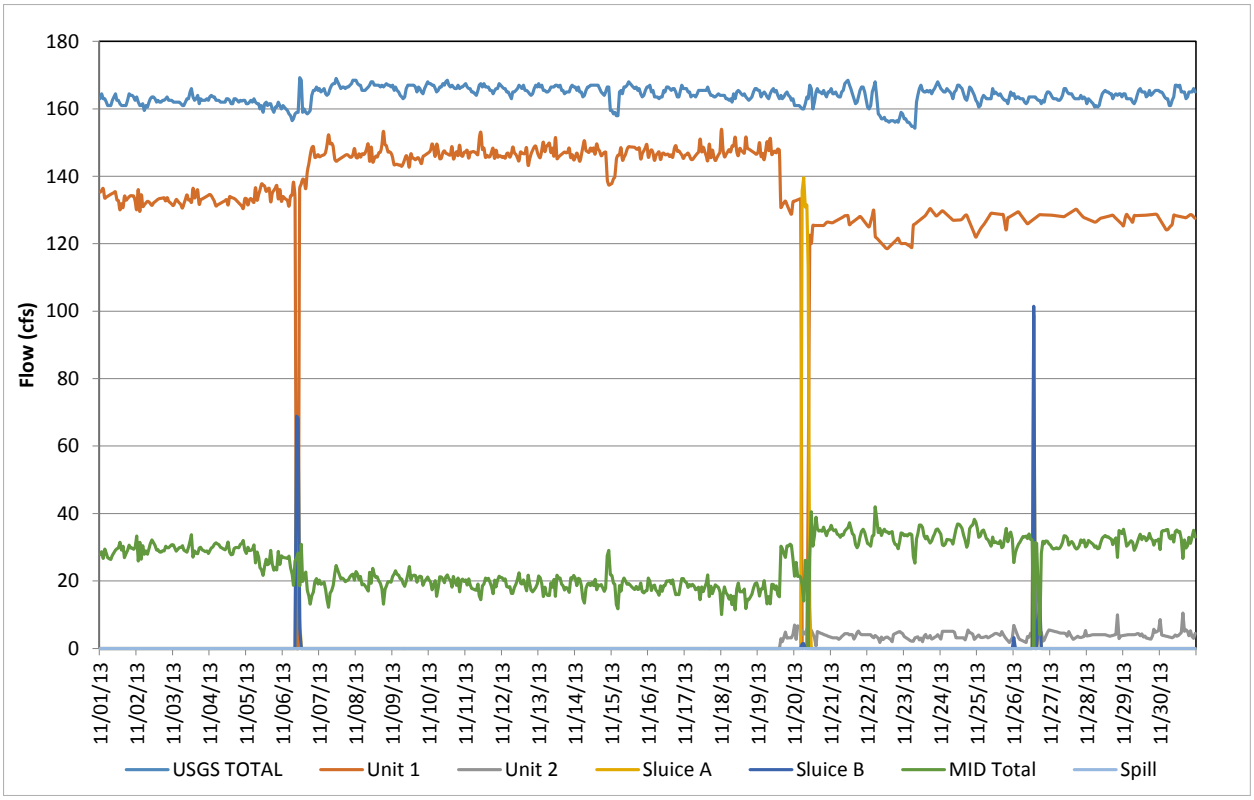

Figure D-107. Flow record in November 2013, based on hourly discharges.

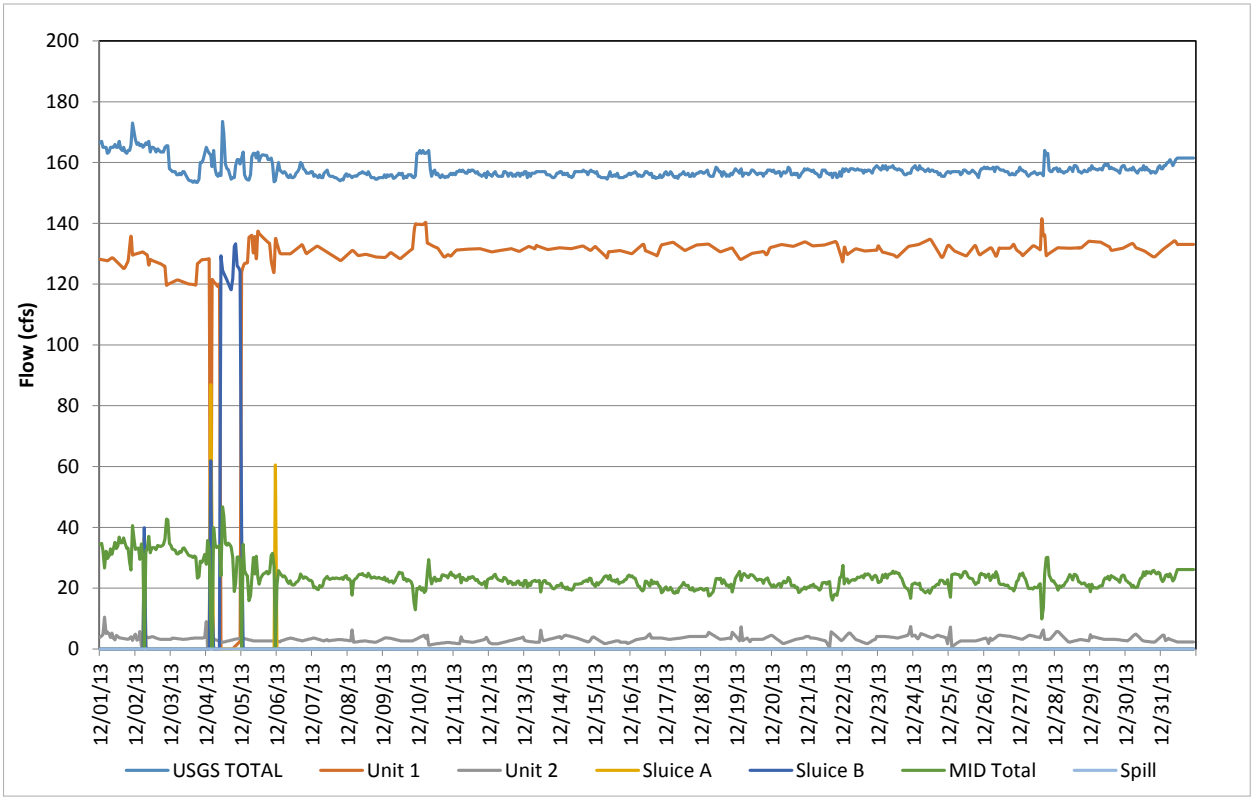

Figure D-108. Flow record in December 2013, based on hourly discharges.