INITIAL STUDY REPORT

APPENDIX H

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

This Page Intentionally Left Blank.

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 2016

This Page Intentionally Left Blank.

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.

The flow records included herein are provided per 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).

Per FERC's SPD, the Districts will continue flow monitoring in 2016. Upon the availability of this data, the Districts will update and provide this document for licensing participant review and comment.

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.

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. When the Tainter gates that control flow to the hillside gates are closed, a 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: 2014/2015 and 2005 to 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 flows were in place.

The data analysis for 2014/2015 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. The resulting flow record for the 2014/2015 period, based on hourly discharges, is provided in Figures 3.0-2 and 3.0-3. In Figures 3.0-2 and 3.0-3, "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 and B contain records of discharges by month in years 2014 and 2015 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 C 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 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.

FERC indicated in its 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.

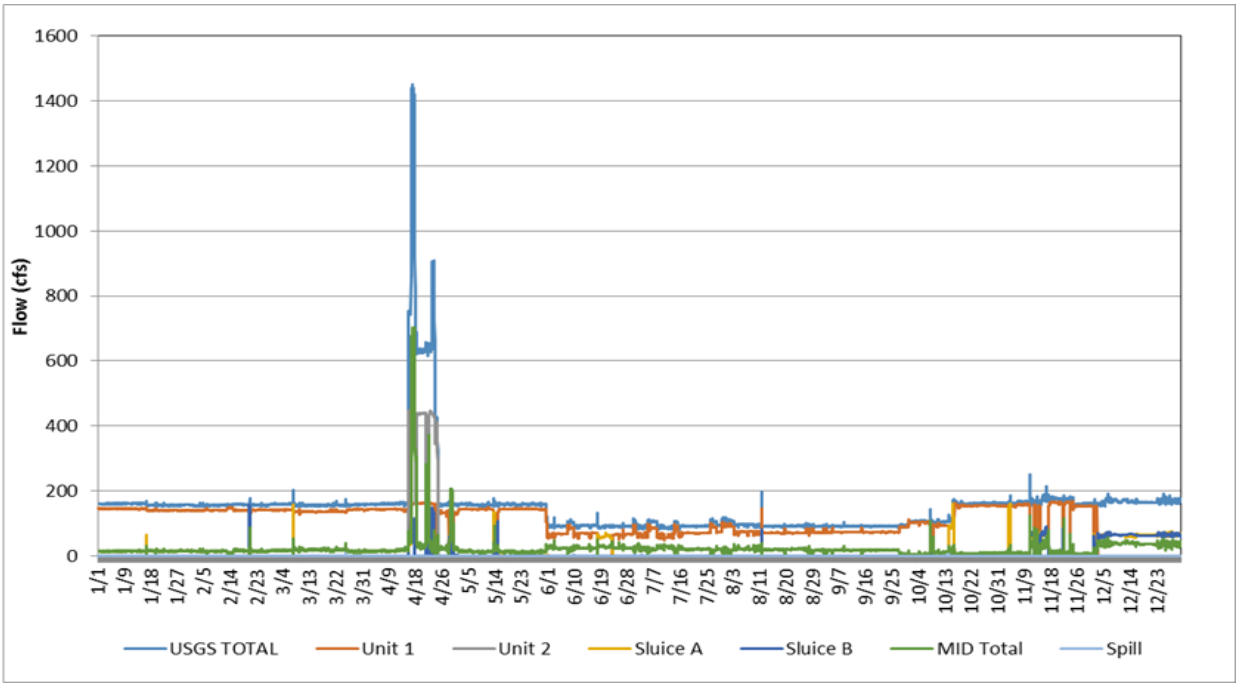

Figure 3.0-2. Flow record for year 2014, based on hourly discharges.

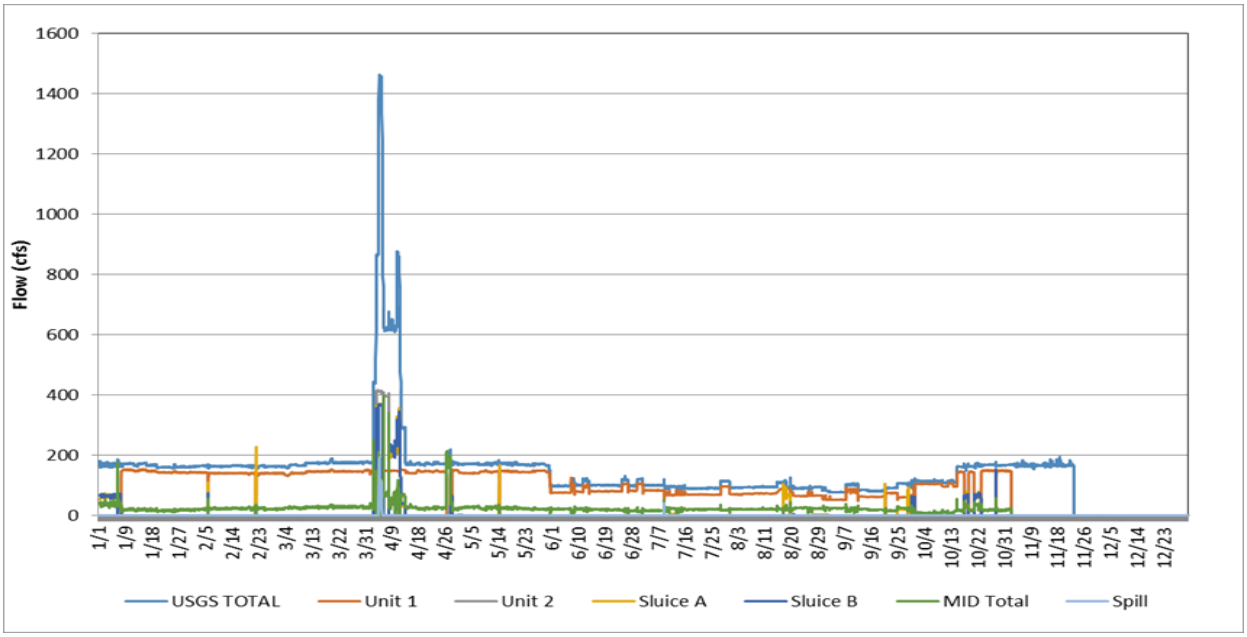

Figure 3.0-3. Flow records for year 2015, based on hourly discharges.

4.0 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

ATTACHMENT A

2014 MONTHLY FLOW RECORDS

This Page Intentionally Left Blank.

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.

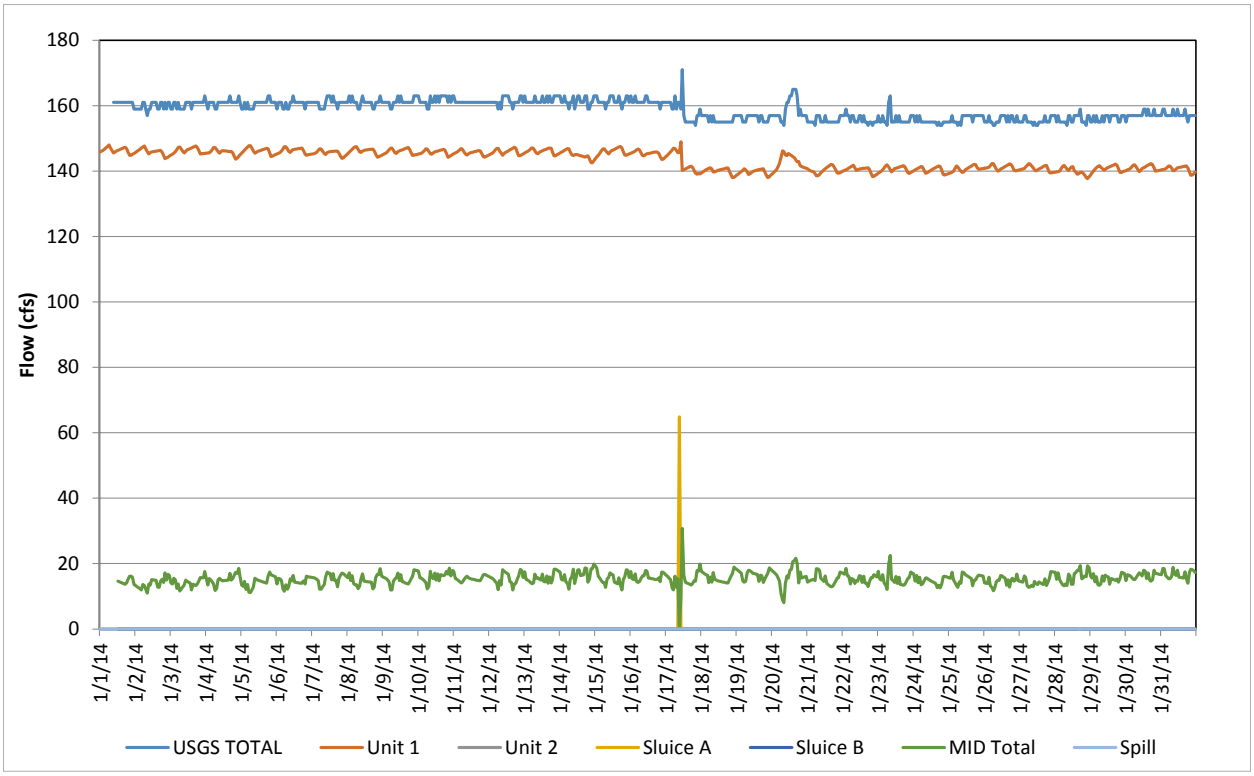

Figure A-1. Flow record in January 2014, based on hourly discharges.

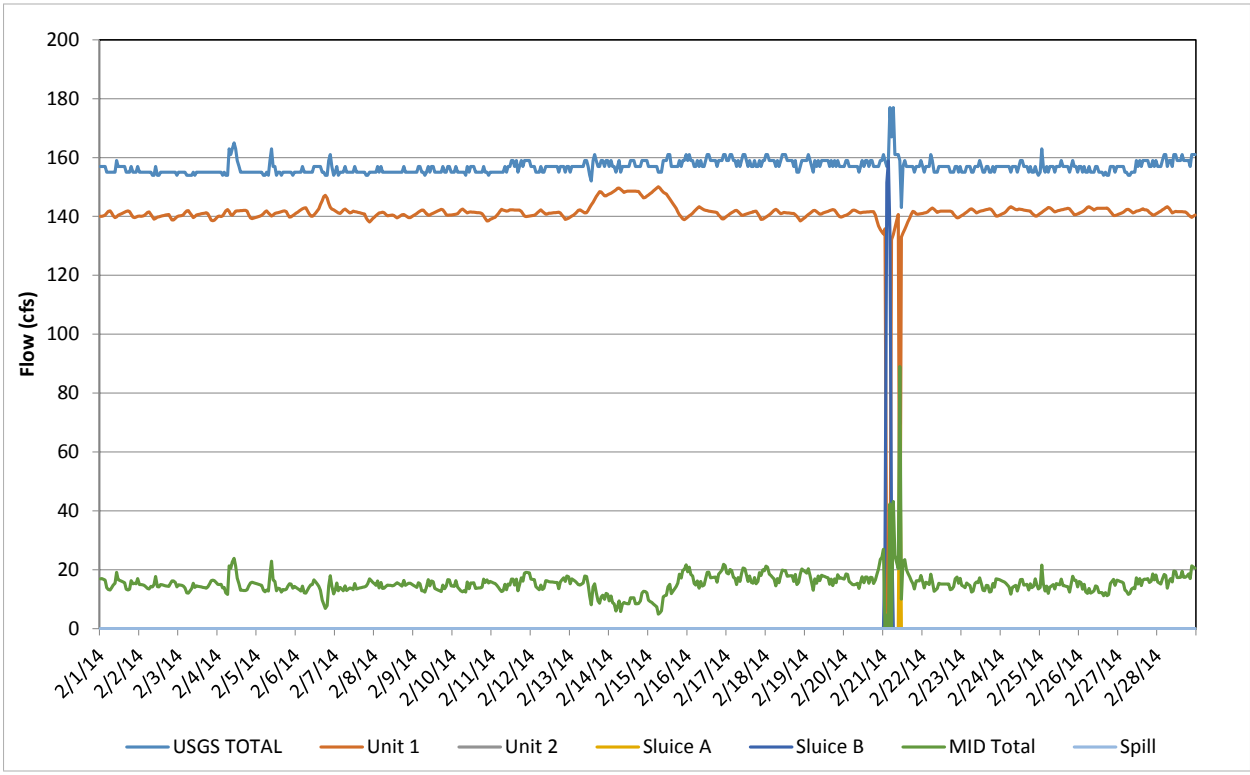

Figure A-2. Flow record in February 2014, based on hourly discharges.

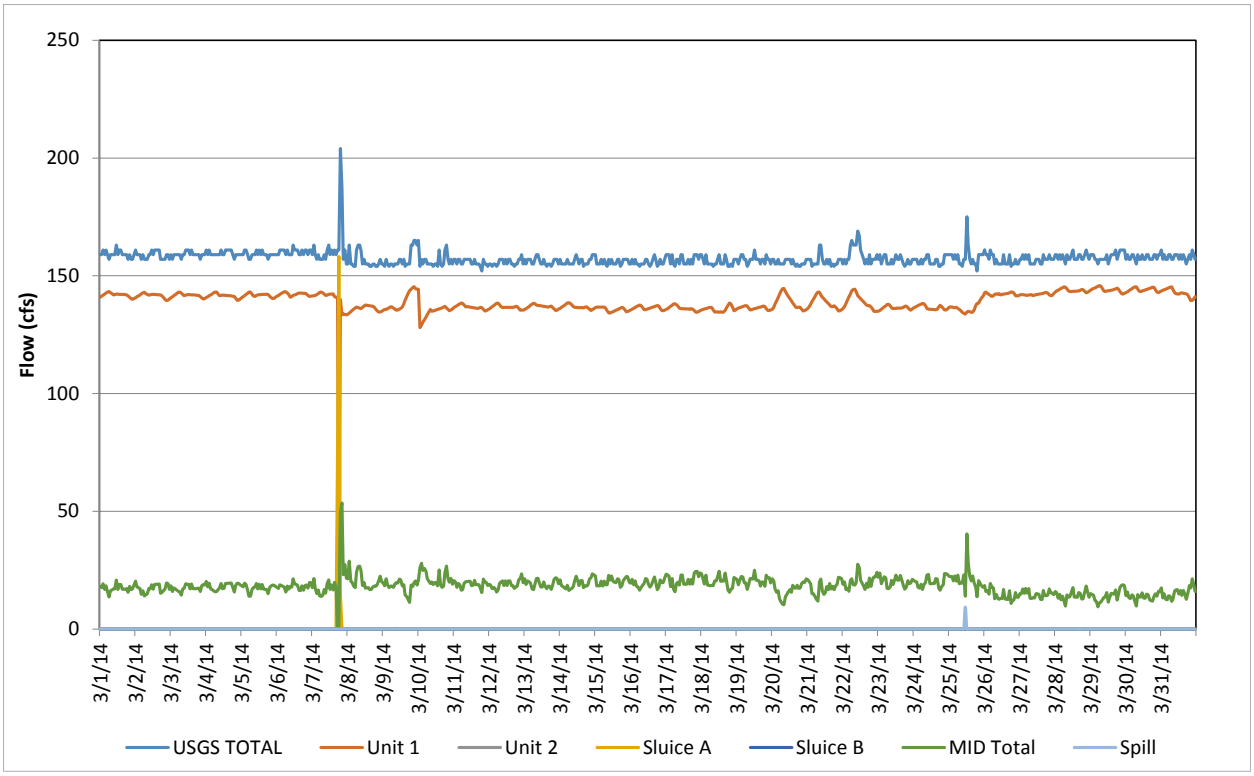

Figure A-3. Flow record in March 2014, based on hourly discharges.

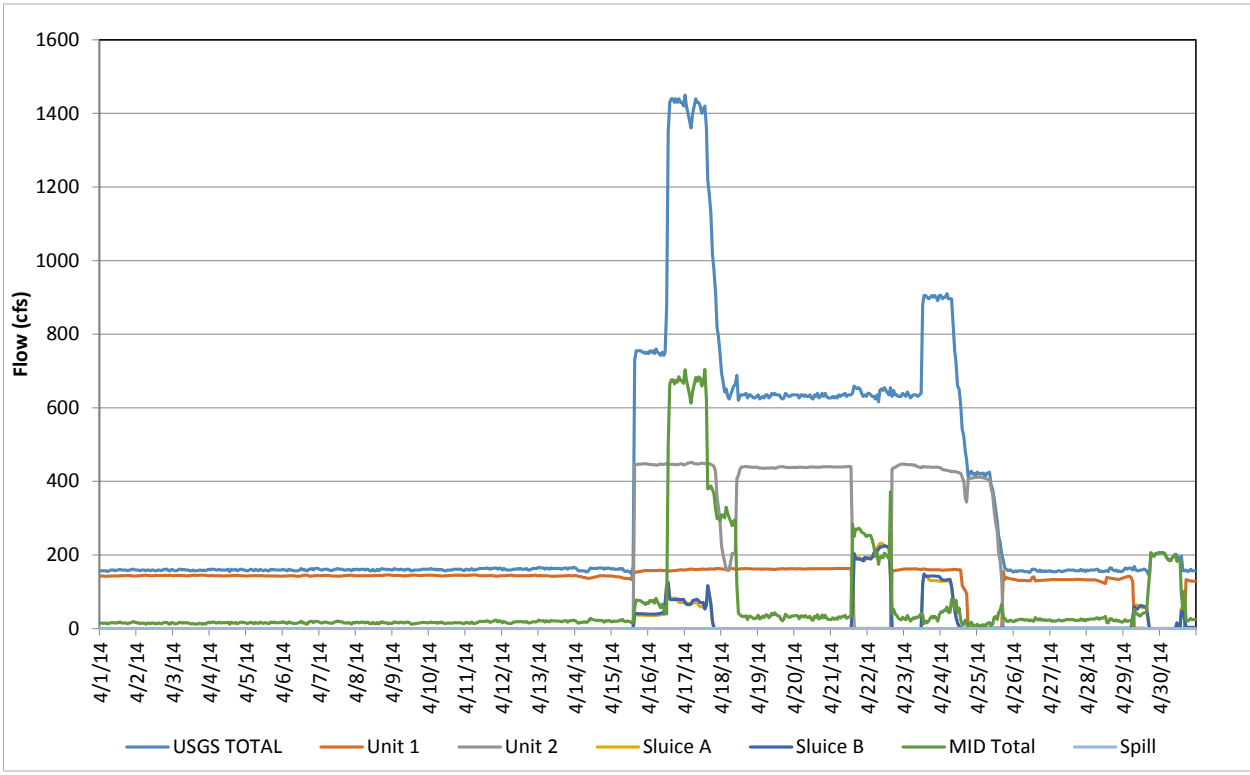

Figure A-4. Flow record in April 2014, based on hourly discharges.

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

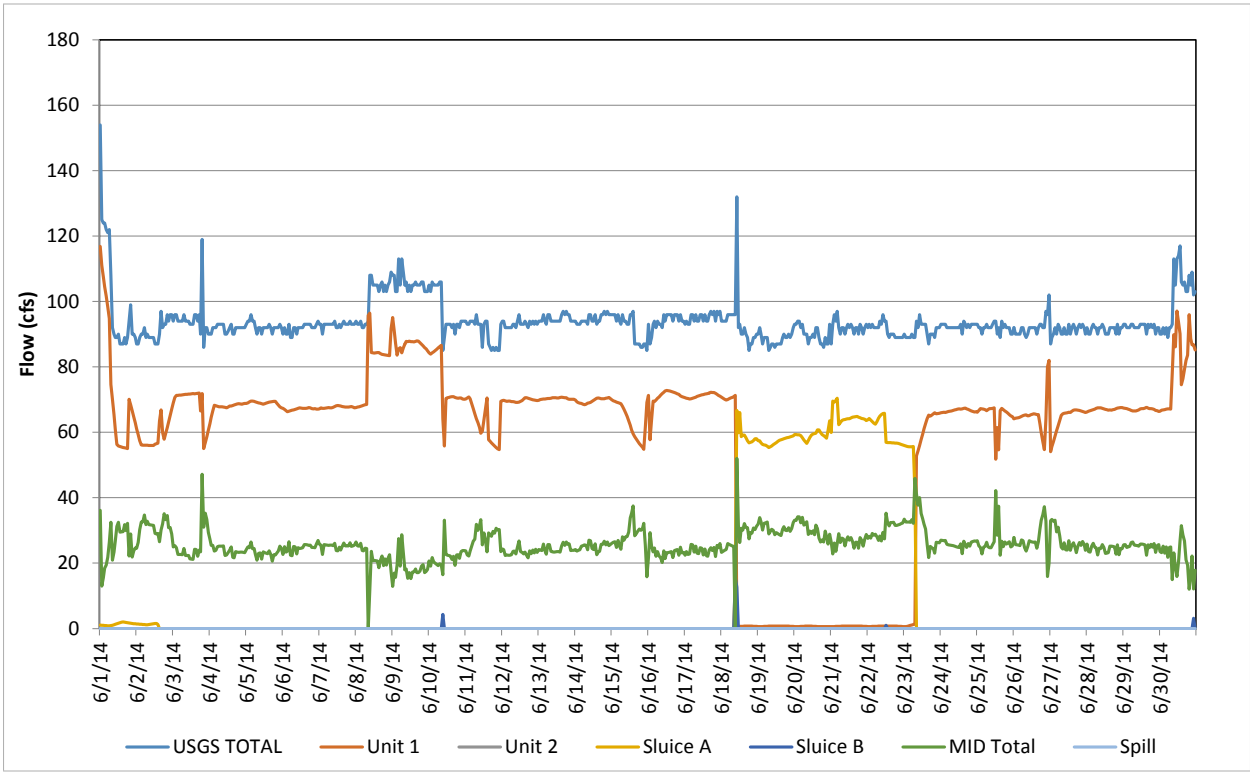

Figure A-6. Flow record in June 2014, based on hourly discharges.

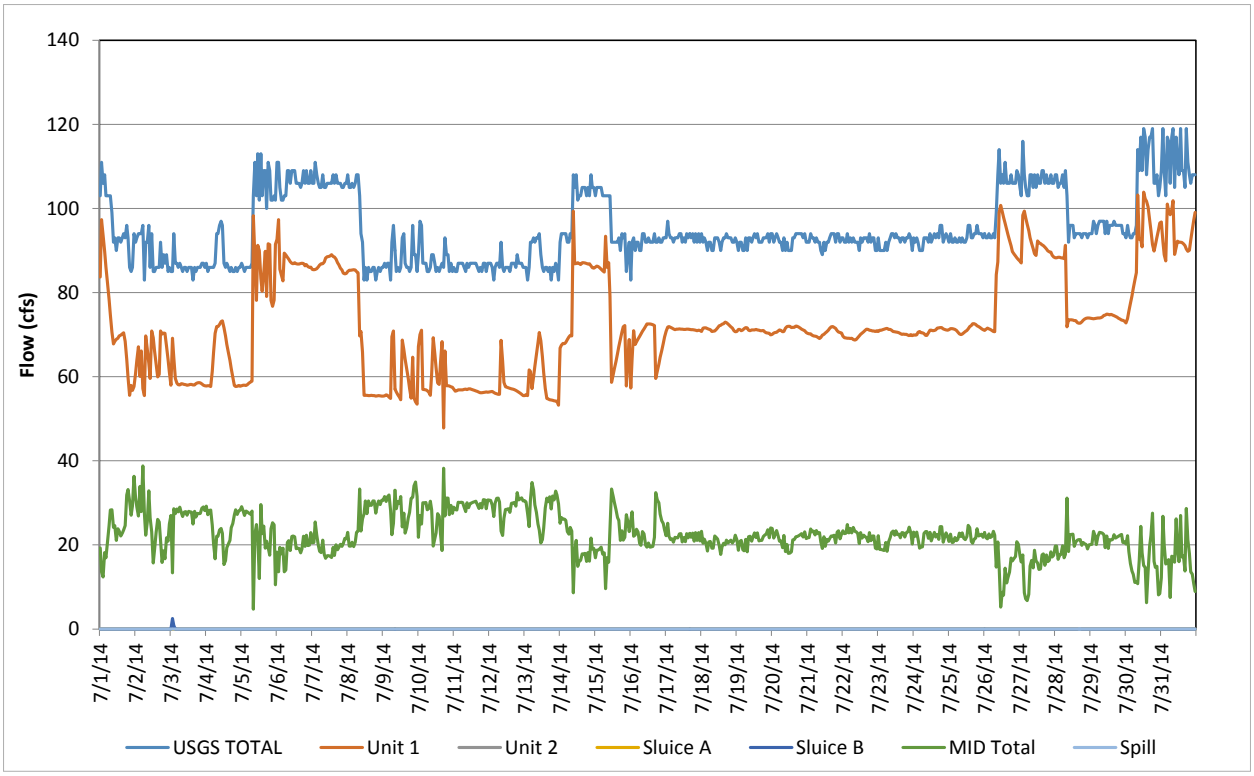

Figure A-7. Flow record in July 2014, based on hourly discharges.

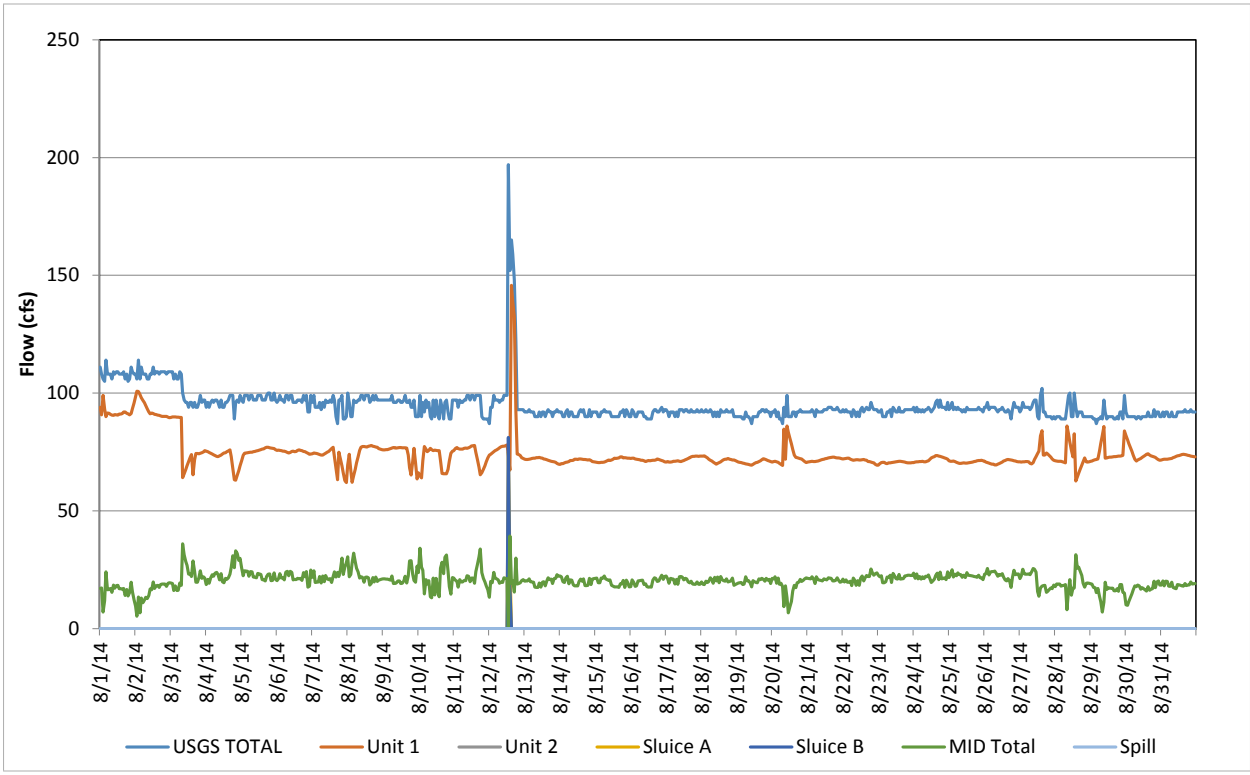

Figure A-8. Flow record in August 2014, based on hourly discharges.

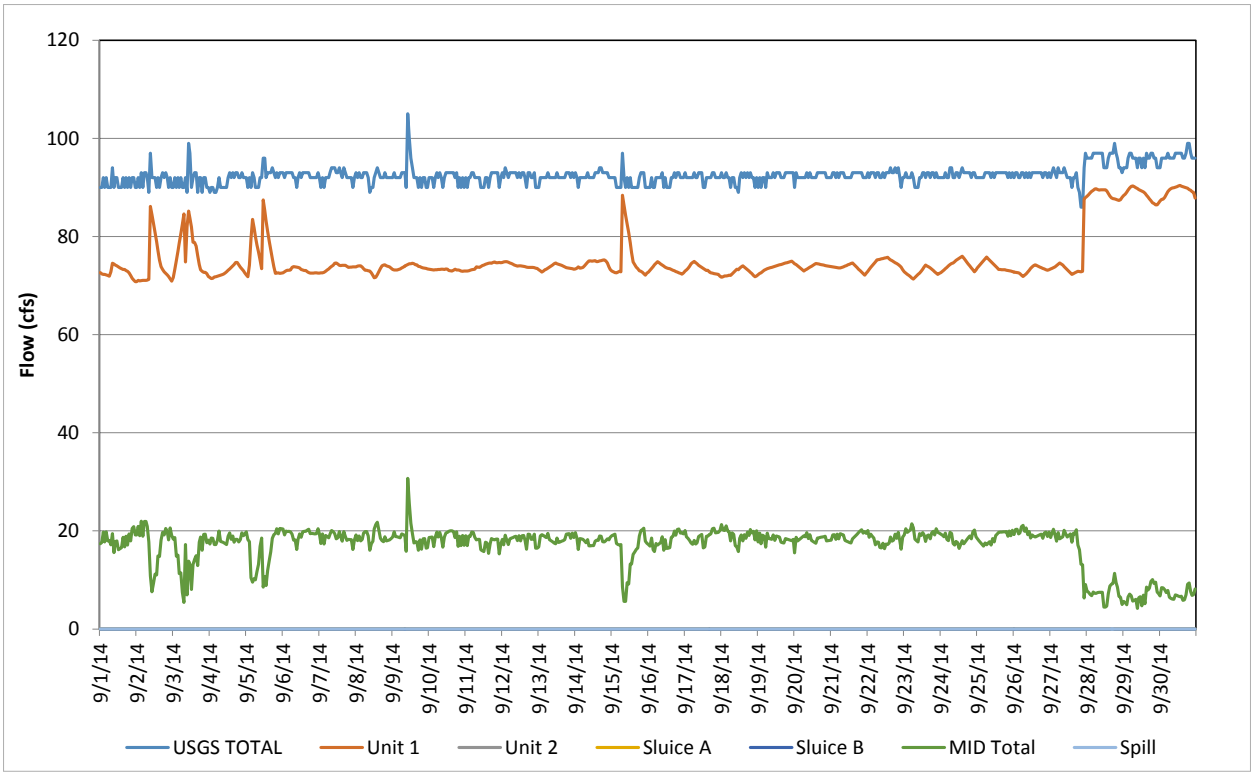

Figure A-9. Flow record in September 2014, based on hourly discharges.

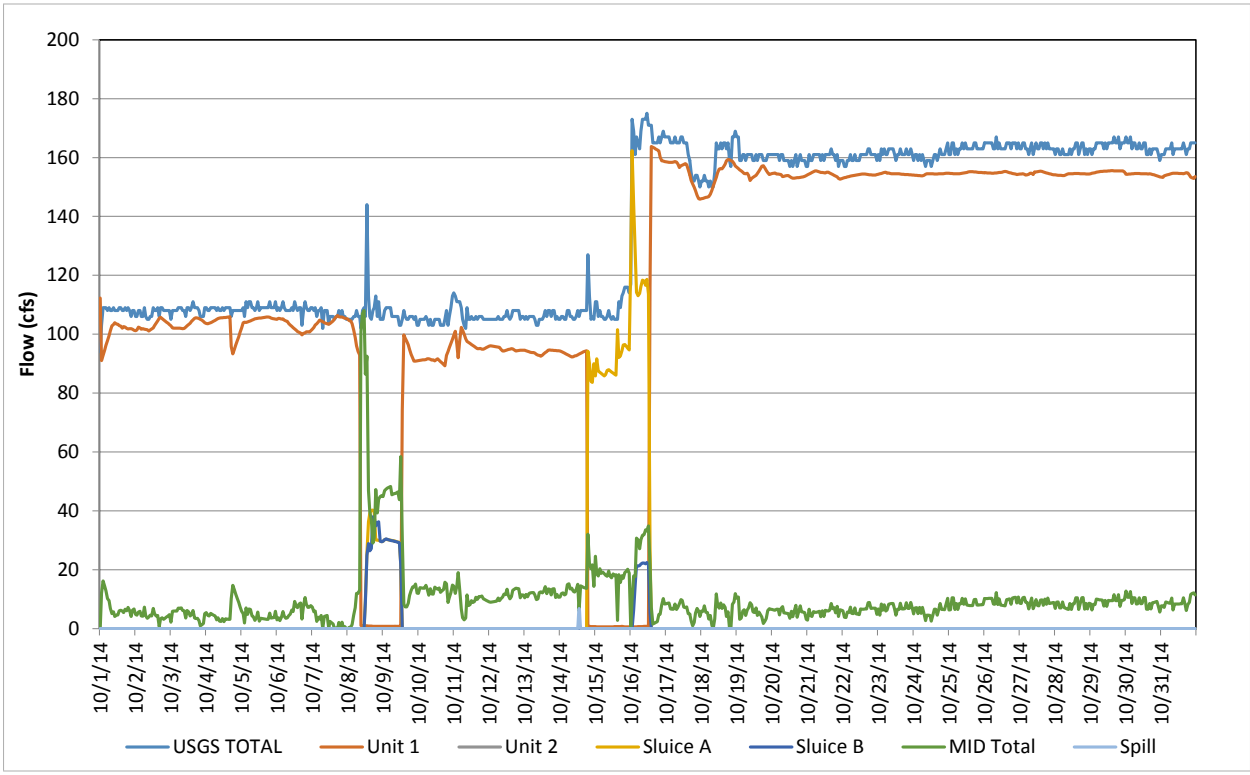

Figure A-10. Flow record in October 2014, based on hourly discharges.

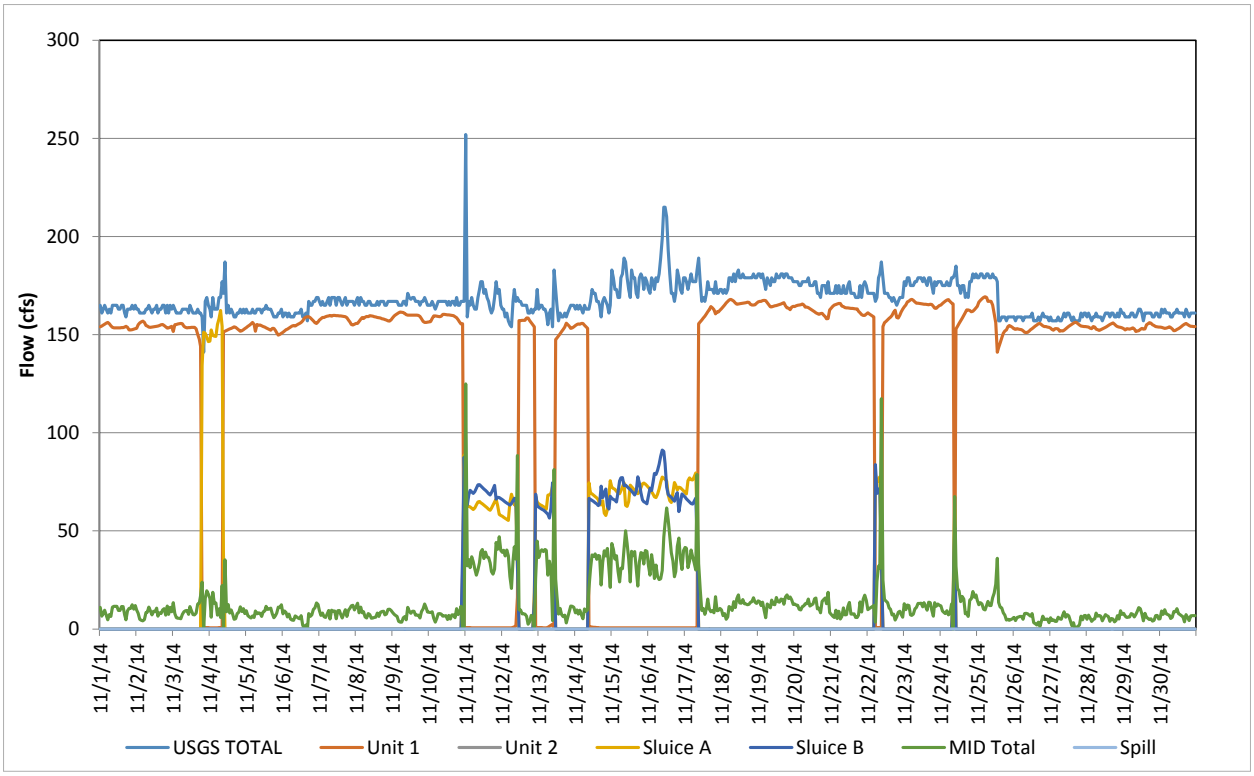

Figure A-11. Flow record in November 2014, based on hourly discharges.

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 (JANUARY – OCTOBER)

This Page Intentionally Left Blank.

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.

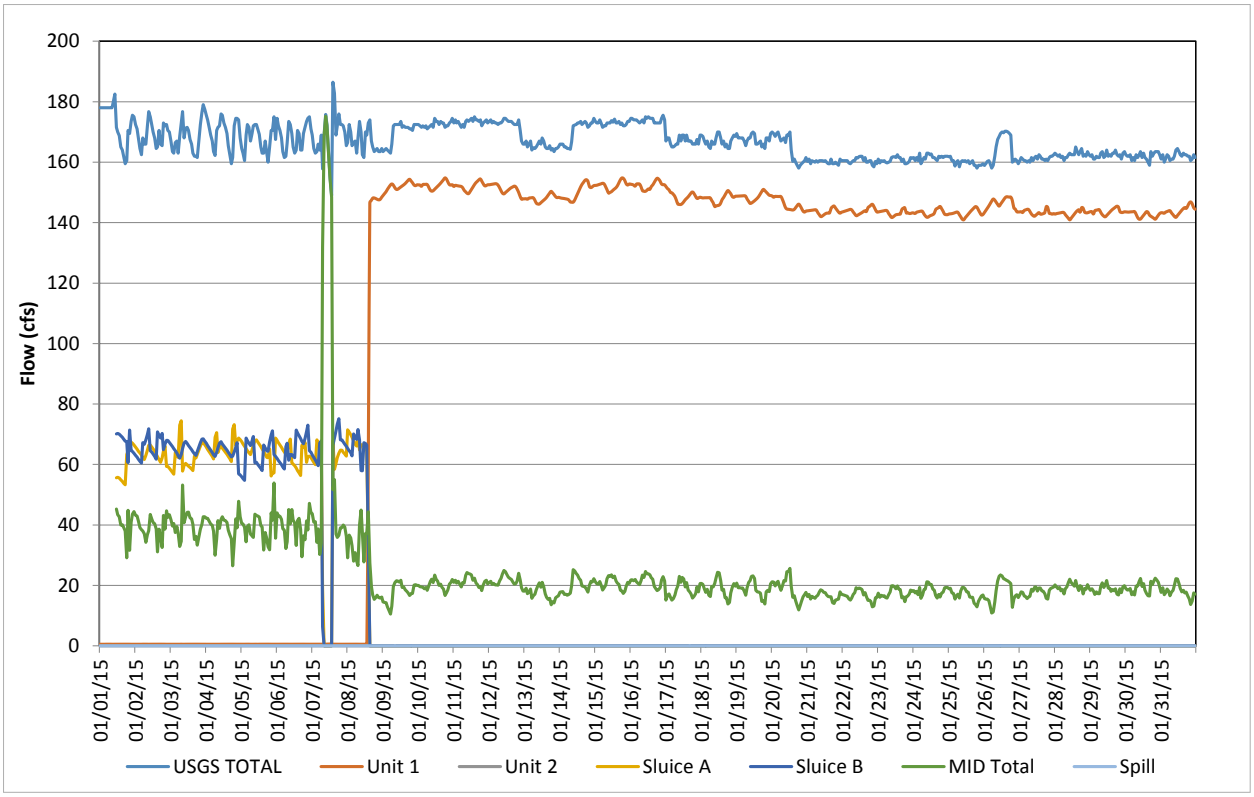

Figure B-1. Flow record in January 2015, based on hourly discharges.

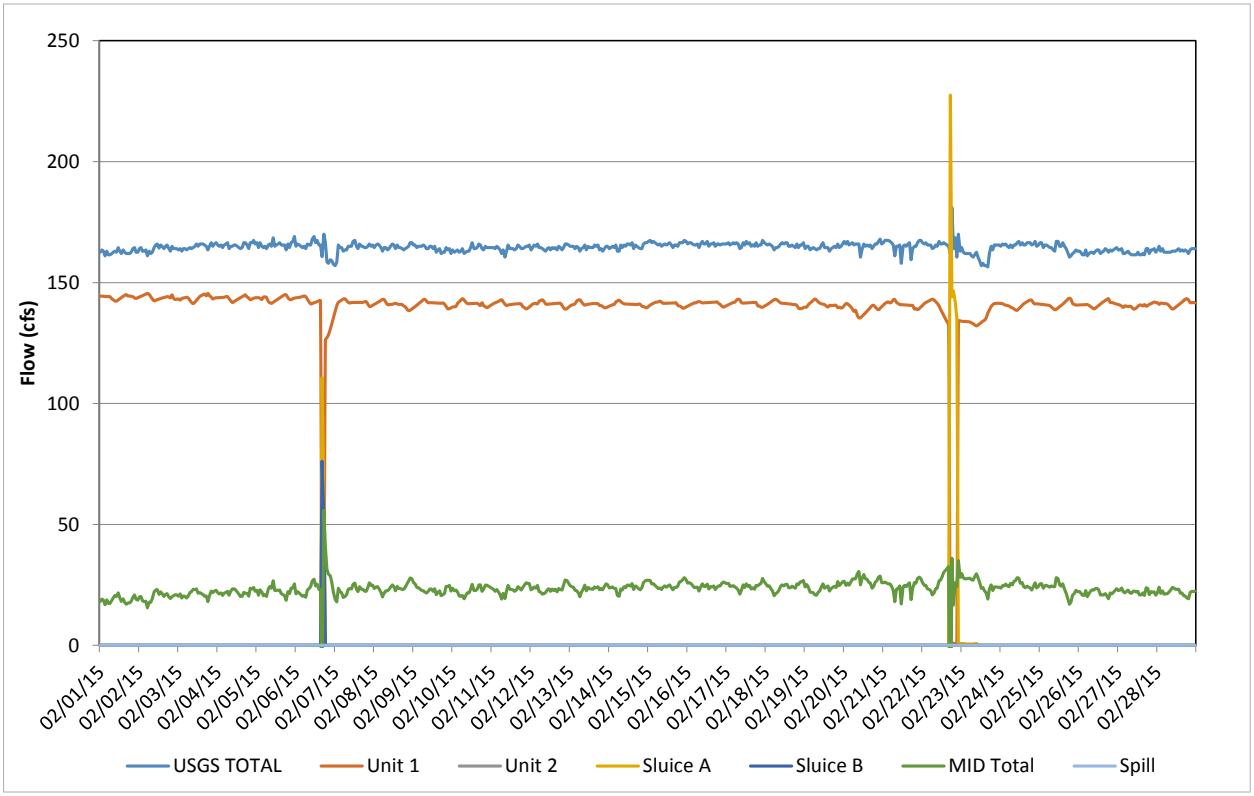

Figure B-2. Flow record in February 2015, based on hourly discharges.

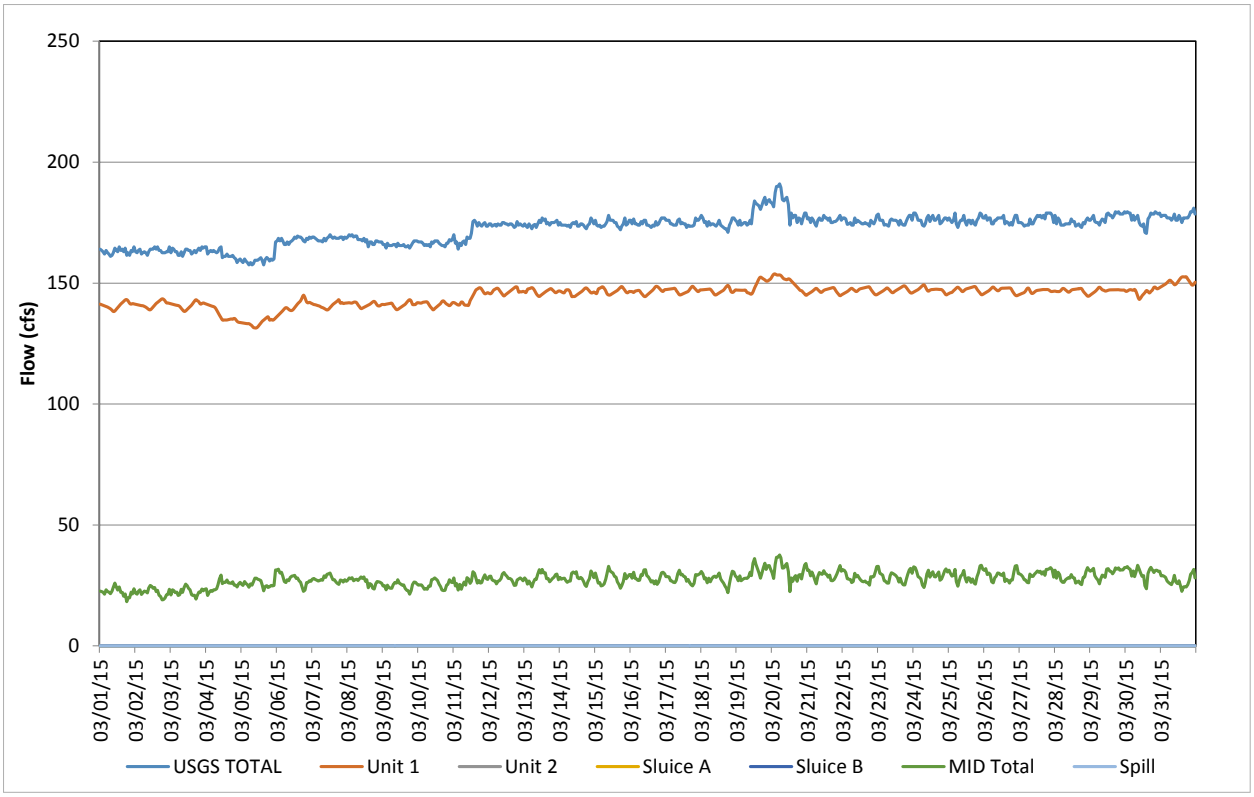

Figure B-3. Flow record in March 2015, based on hourly discharges.

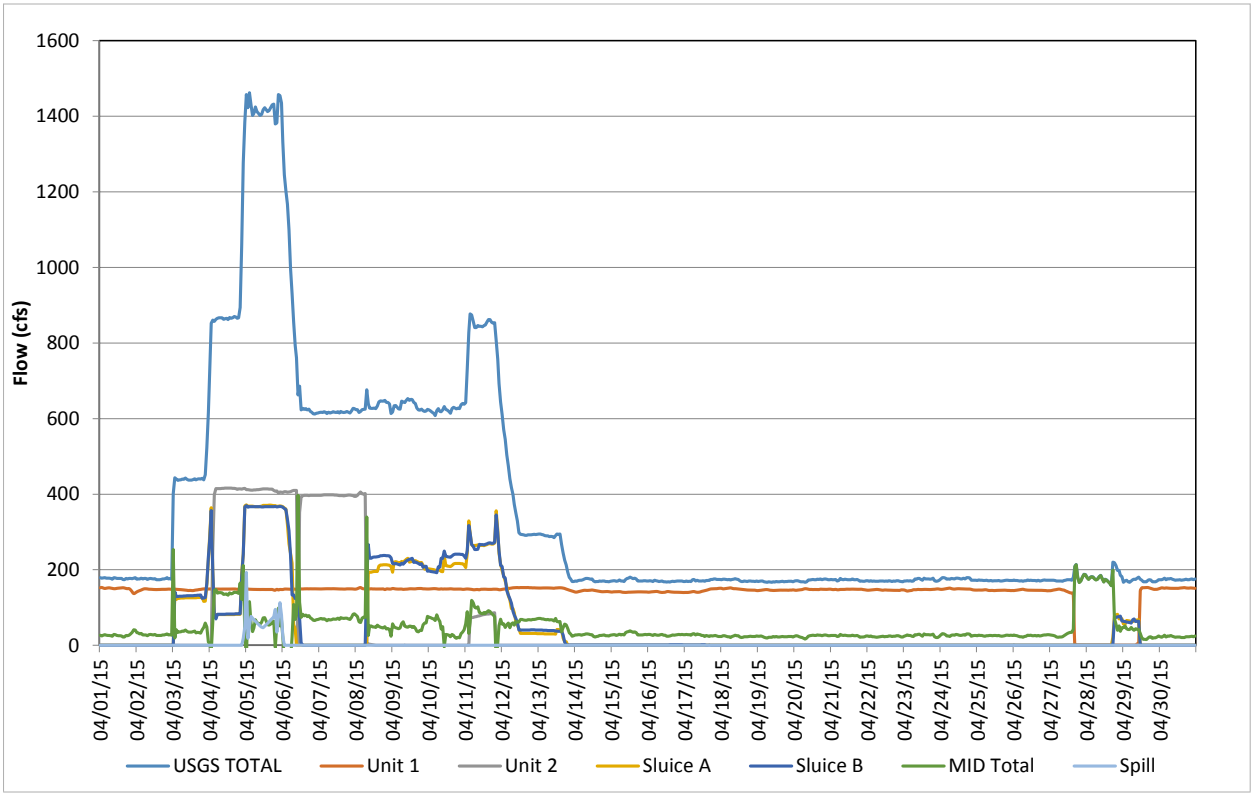

Figure B-4. Flow record in April 2015, based on hourly discharges.

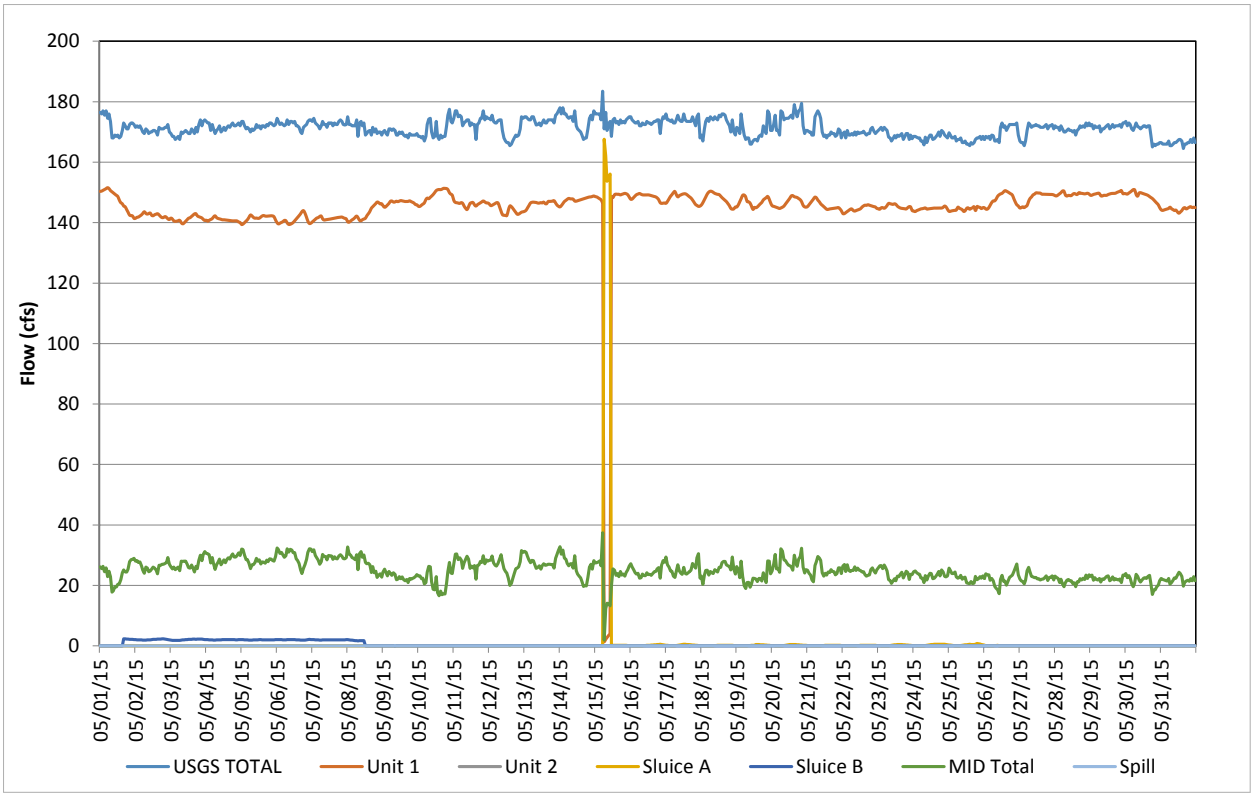

Figure B-5. Flow record in May 2015, based on hourly discharges.

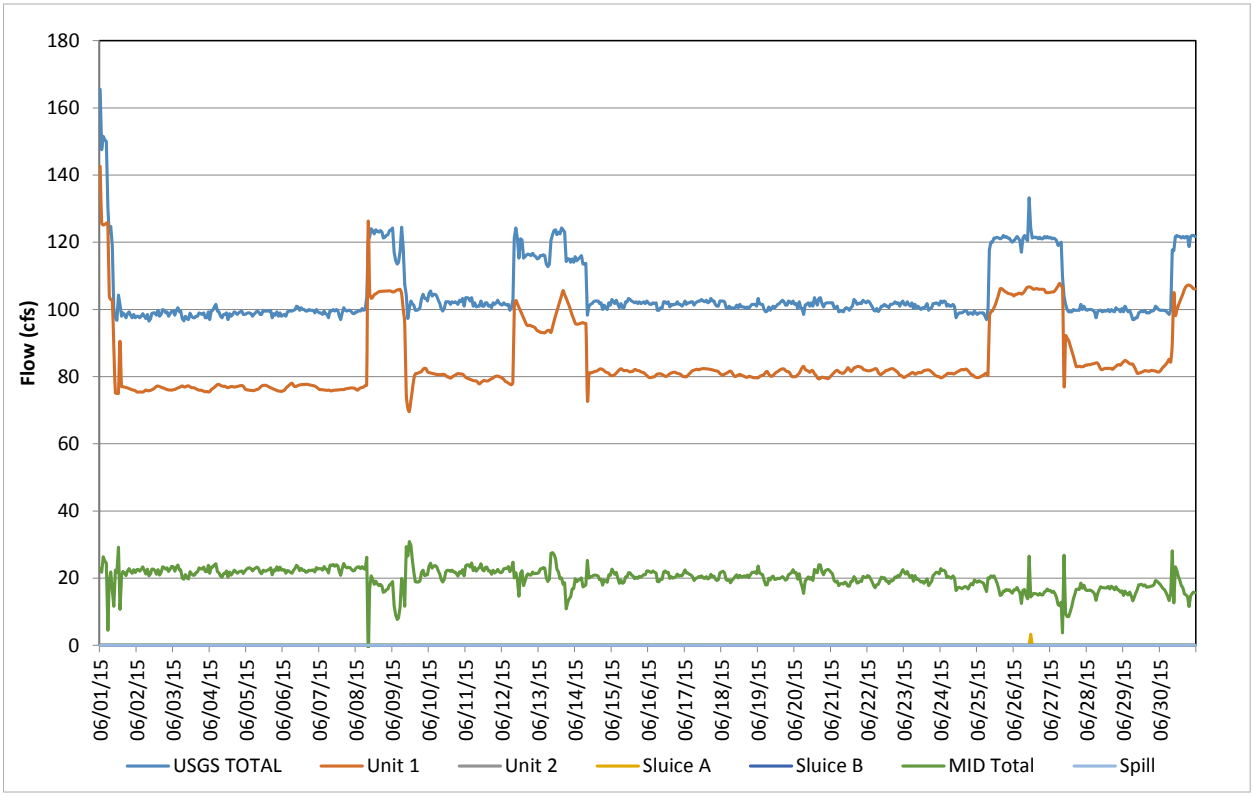

Figure B-6. Flow record in June 2015, based on hourly discharges.

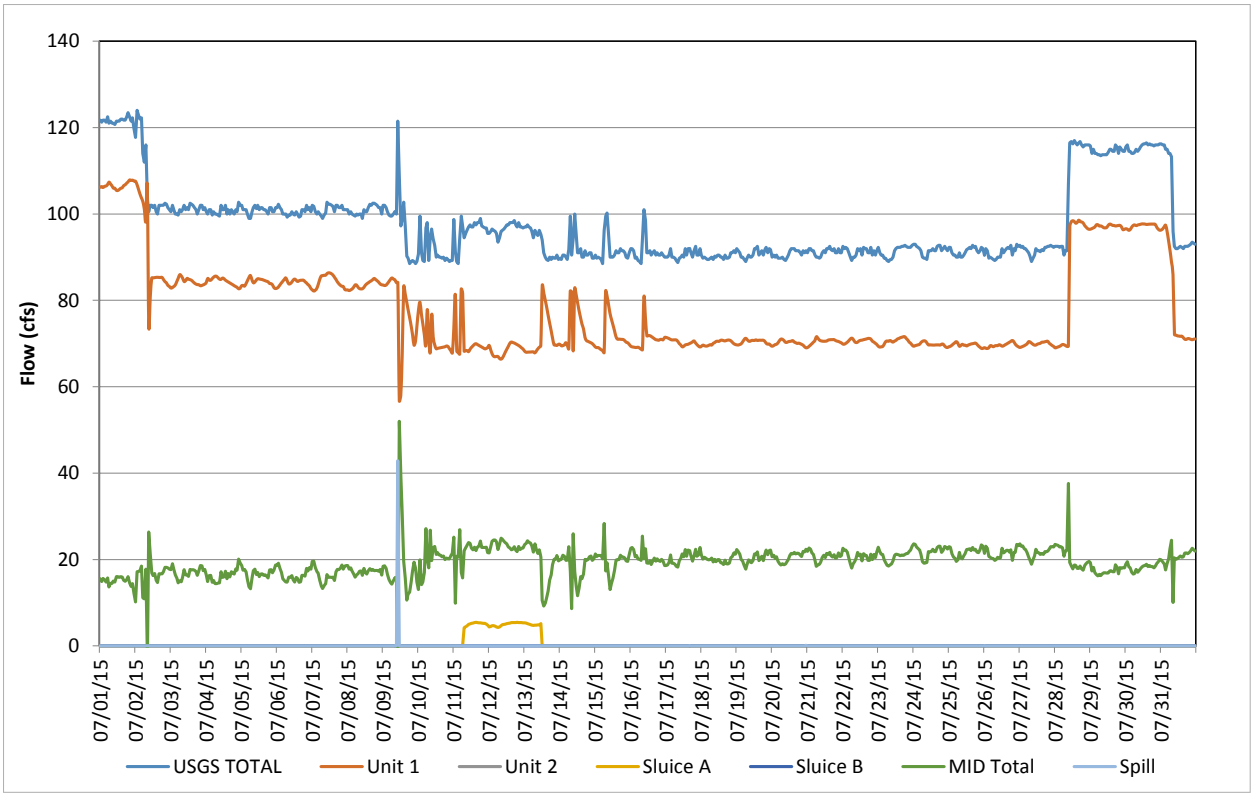

Figure B-7. Flow record in July 2015, based on hourly discharges.

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

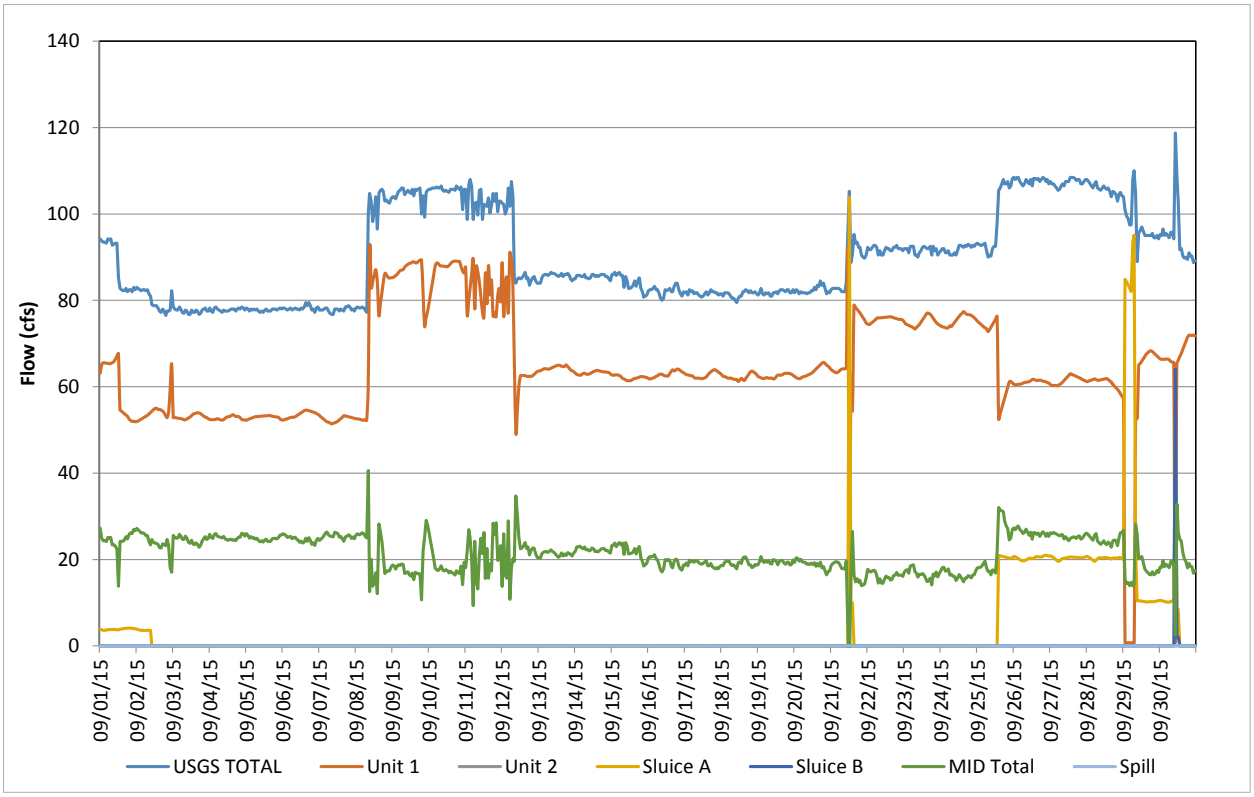

Figure B-9. Flow record in September 2015, based on hourly discharges.

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

FLOW RECORDS FOR FIVE DISCHARGE STRUCTURES AT THE LA GRANGE PROJECT

ATTACHMENT C

2005 – 2013 FLOW RECORDS

This Page Intentionally Left Blank.

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.

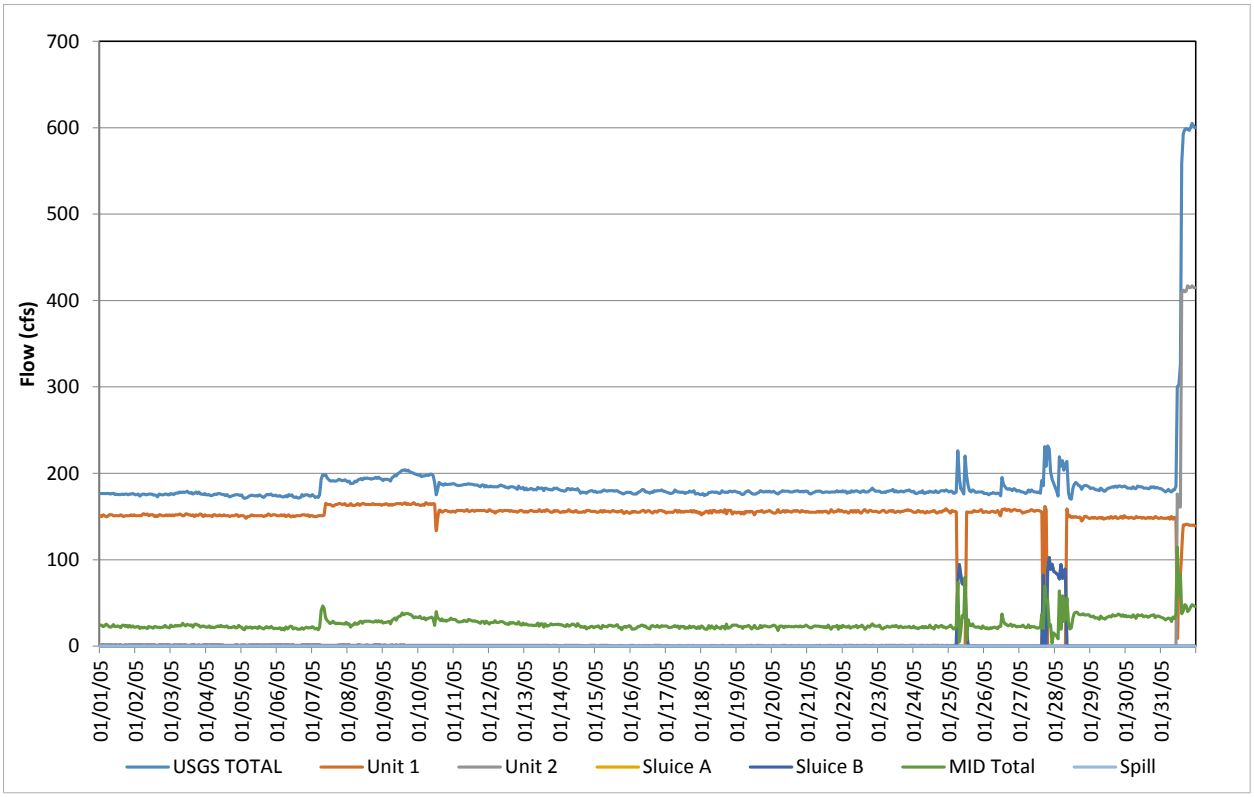

Figure C-1. Flow record in January 2005, based on hourly discharges.

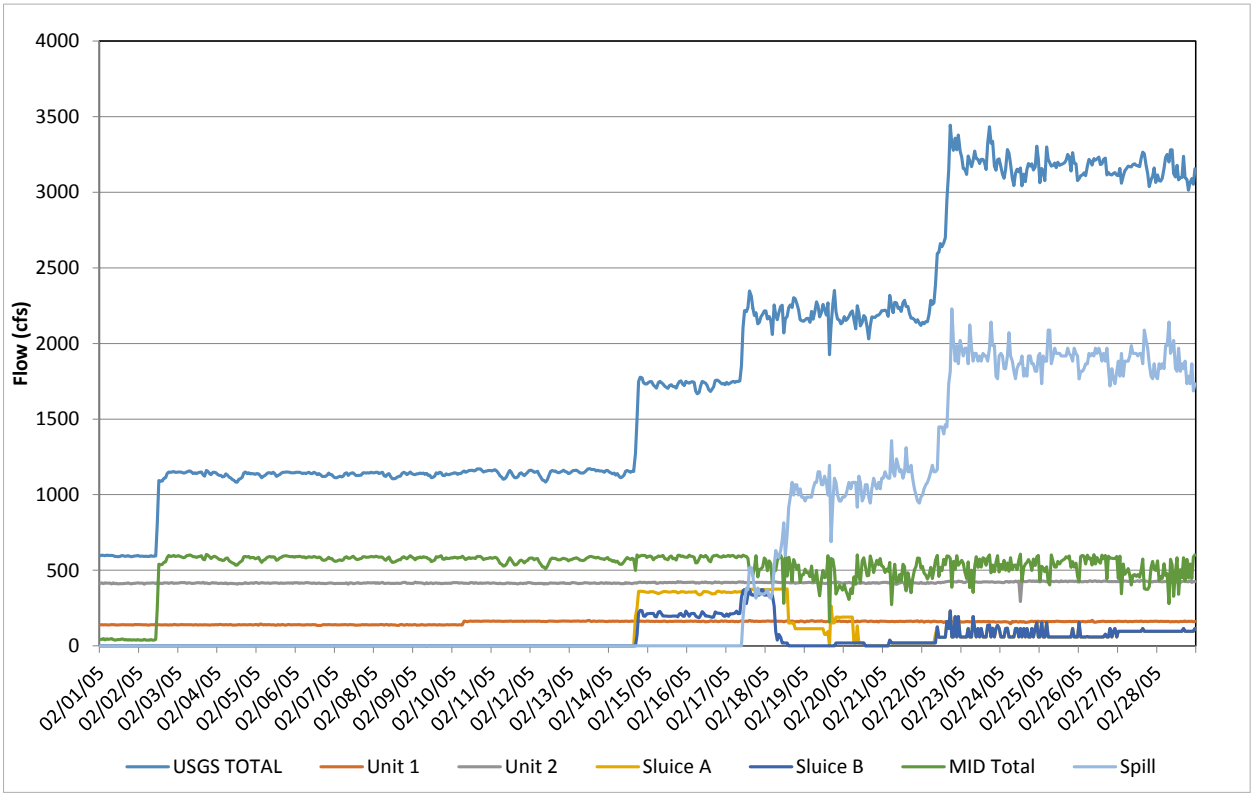

Figure C-2. Flow record in February 2005, based on hourly discharges.

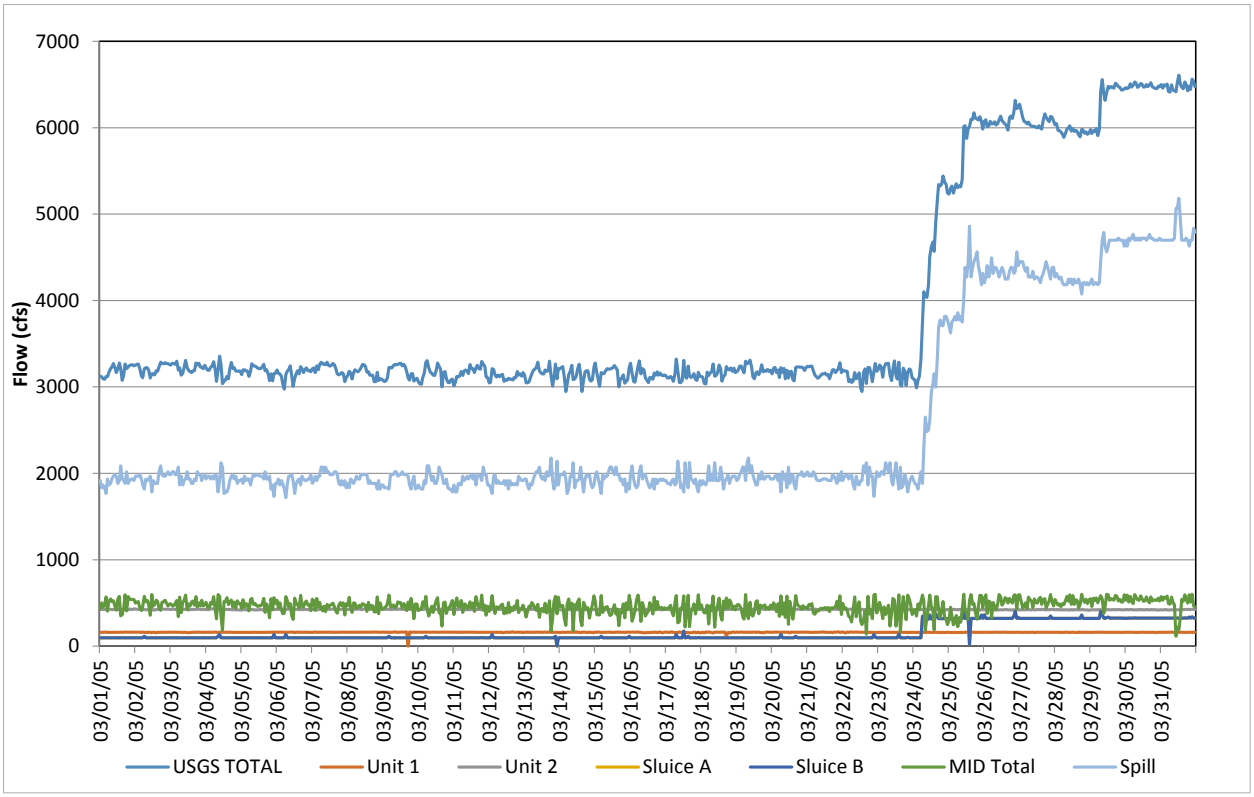

Figure C-3. Flow record in March 2005, based on hourly discharges.

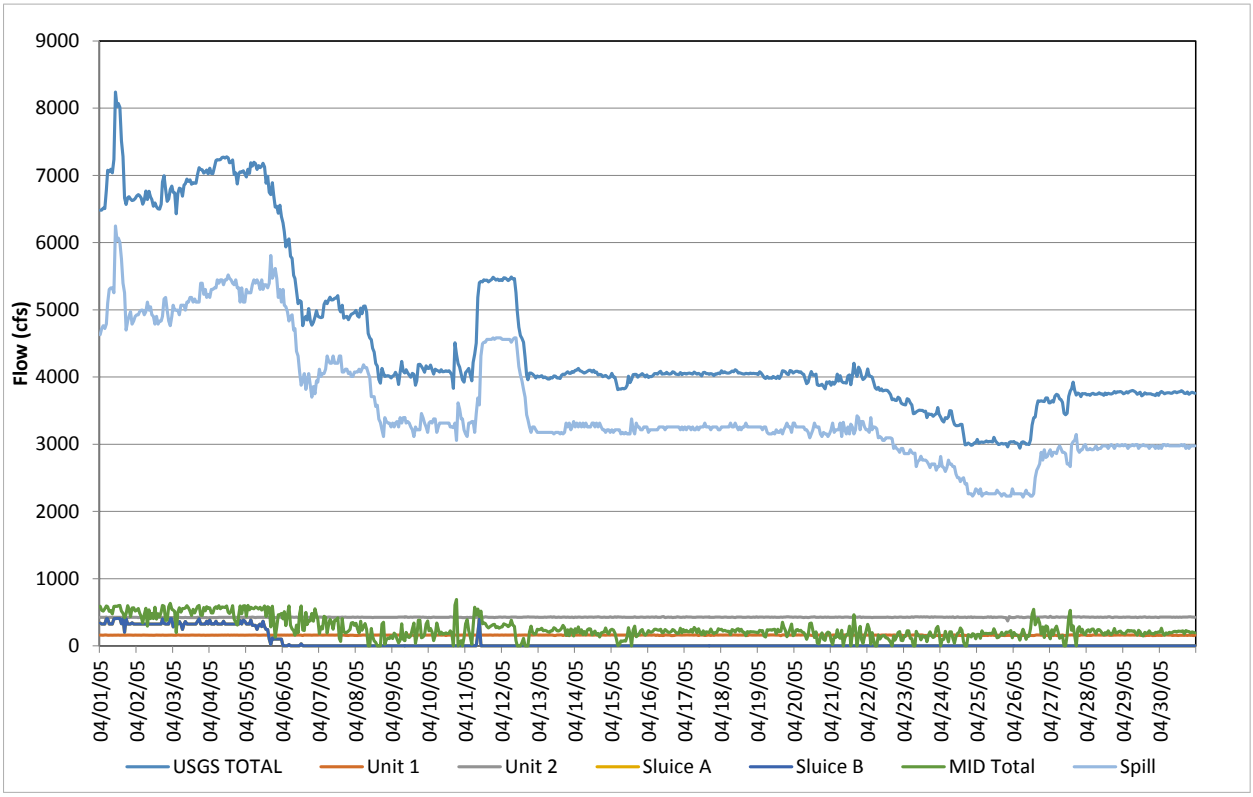

Figure C-4. Flow record in April 2005, based on hourly discharges.

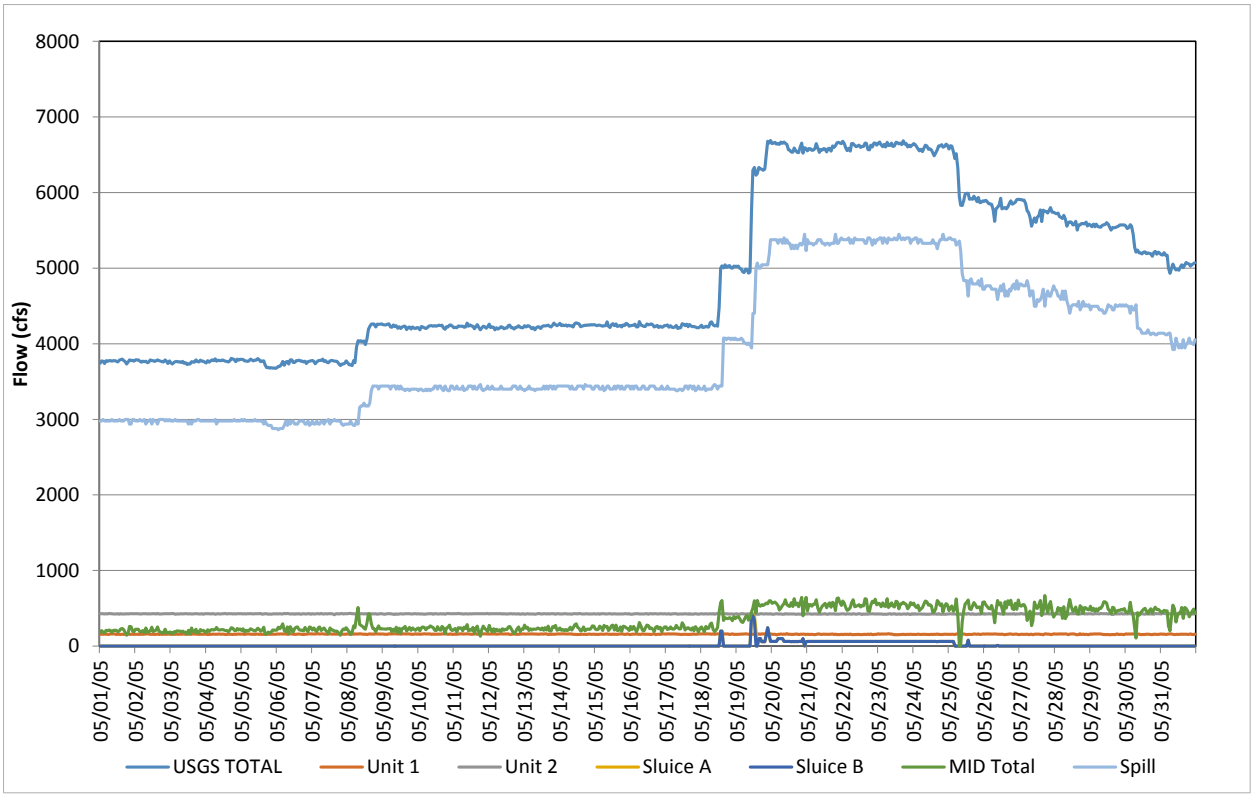

Figure C-5. Flow record in May 2005, based on hourly discharges.

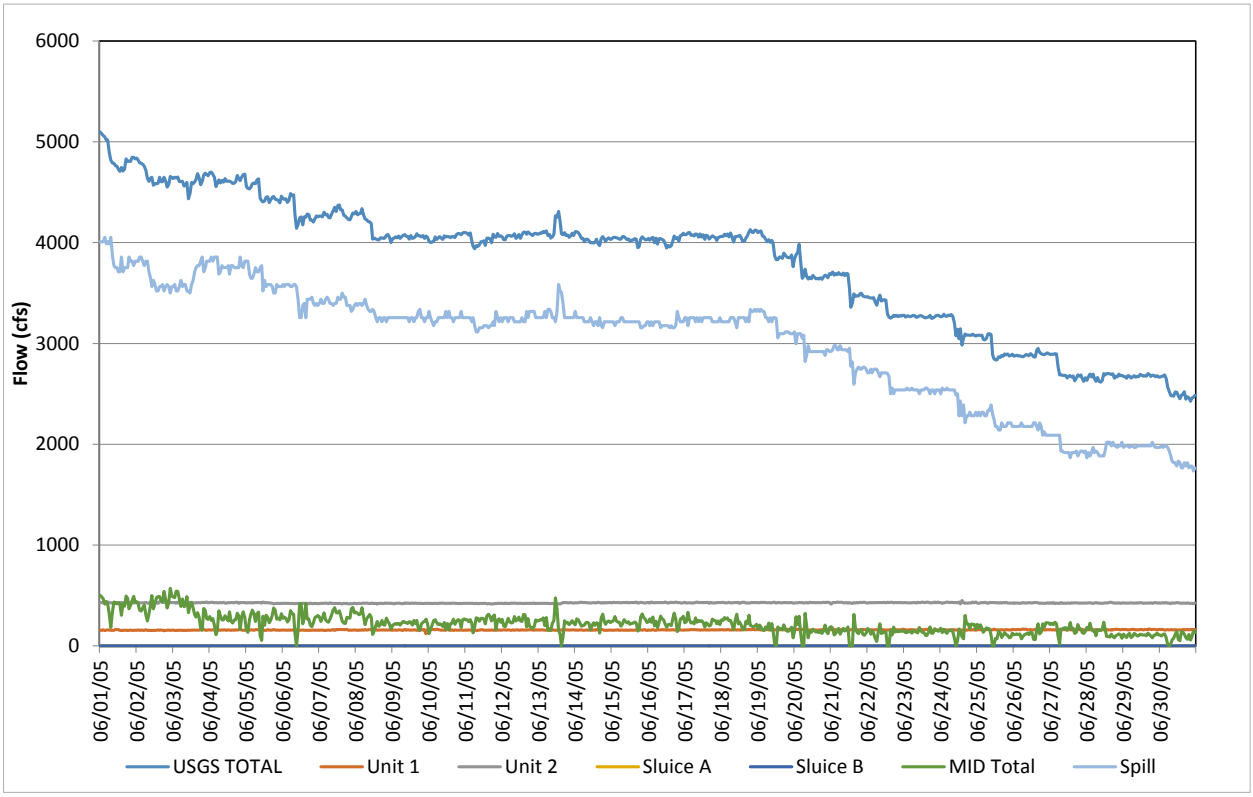

Figure C-6. Flow record in June 2005, based on hourly discharges.

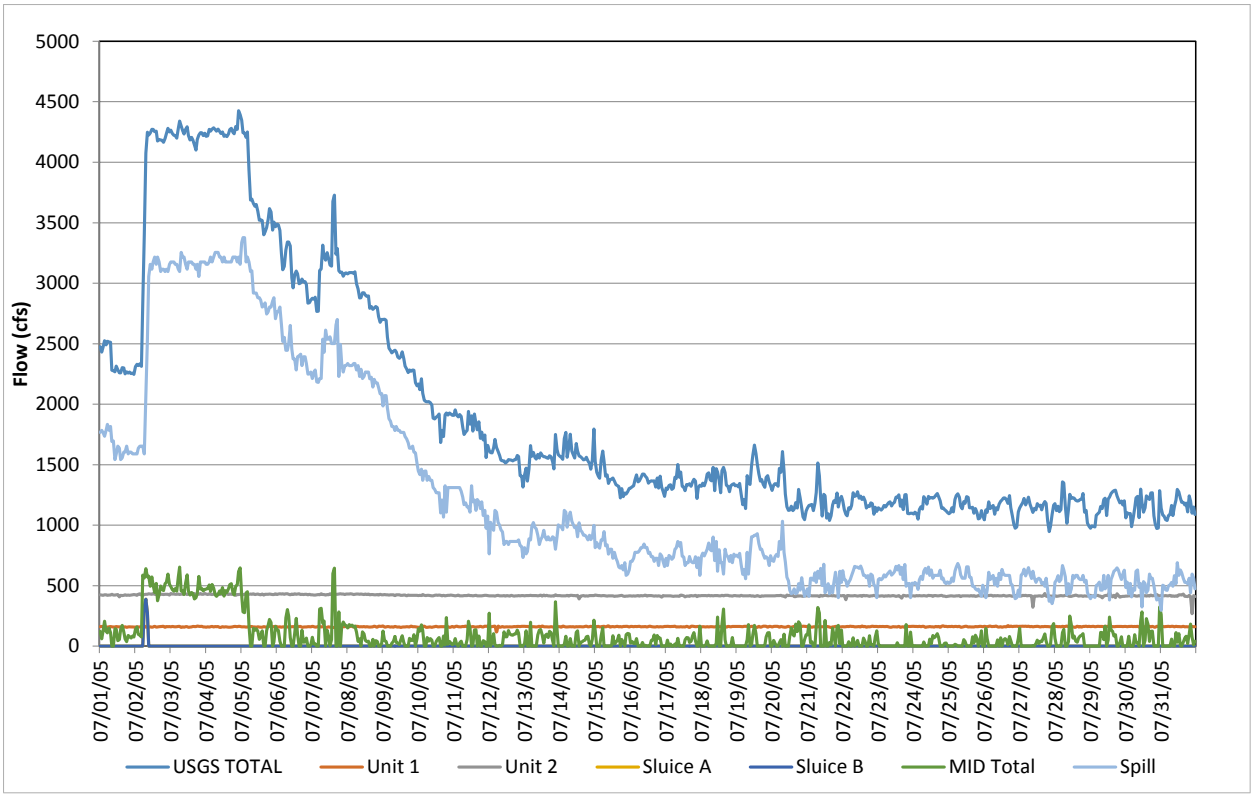

Figure C-7. Flow record in July 2005, based on hourly discharges.

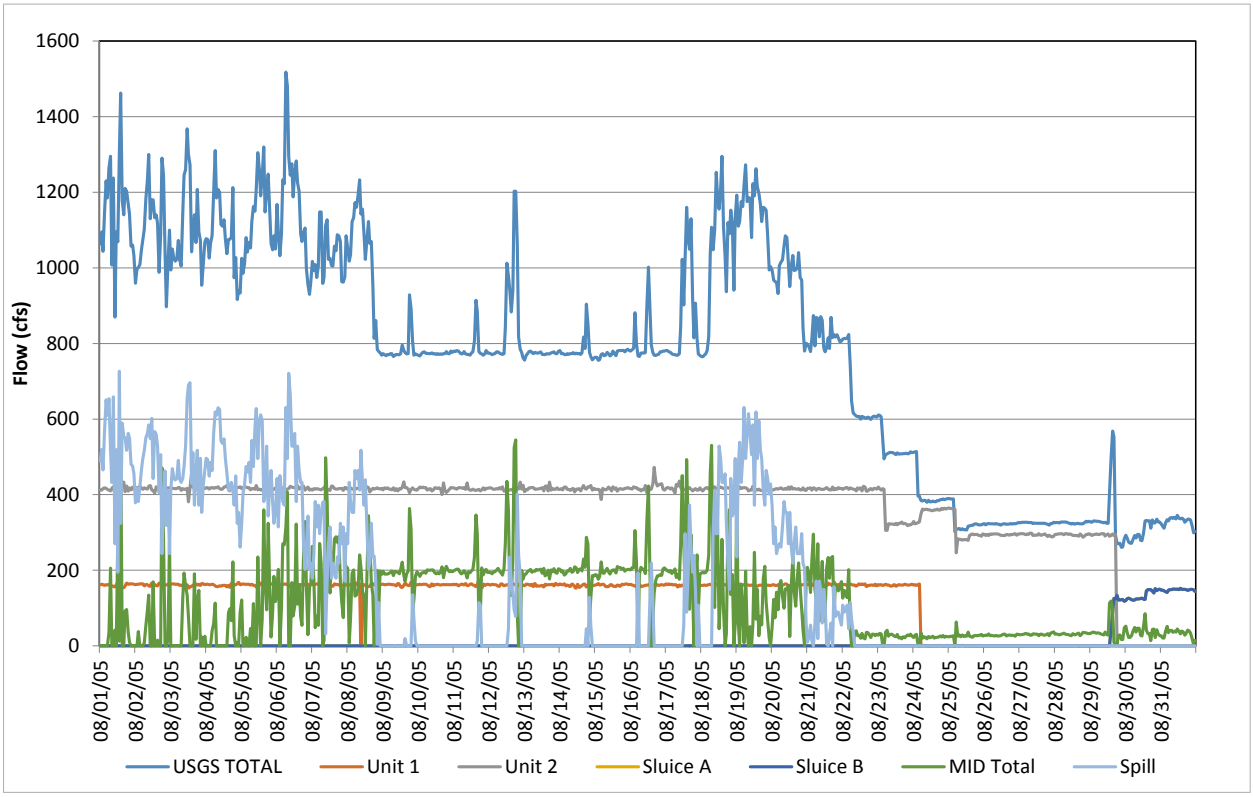

Figure C-8. Flow record in August 2005, based on hourly discharges.

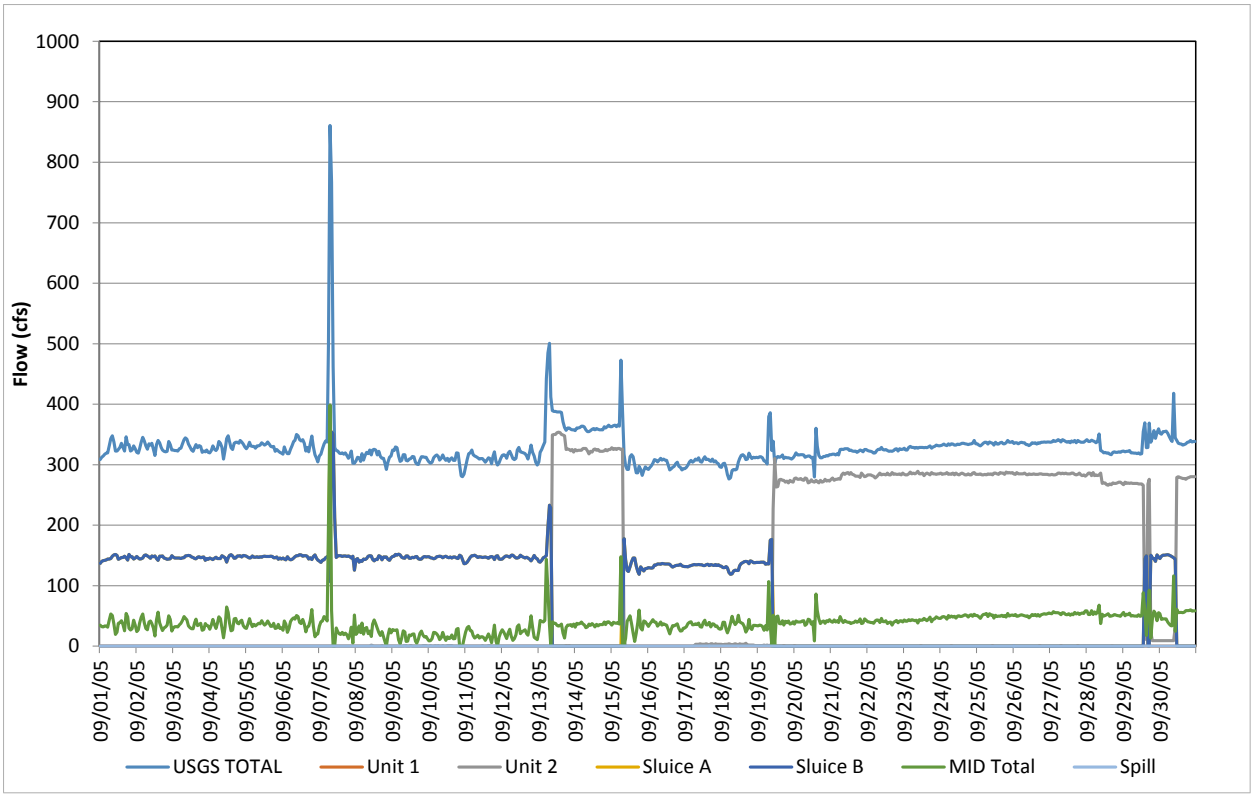

Figure C-9. Flow record in September 2005, based on hourly discharges.

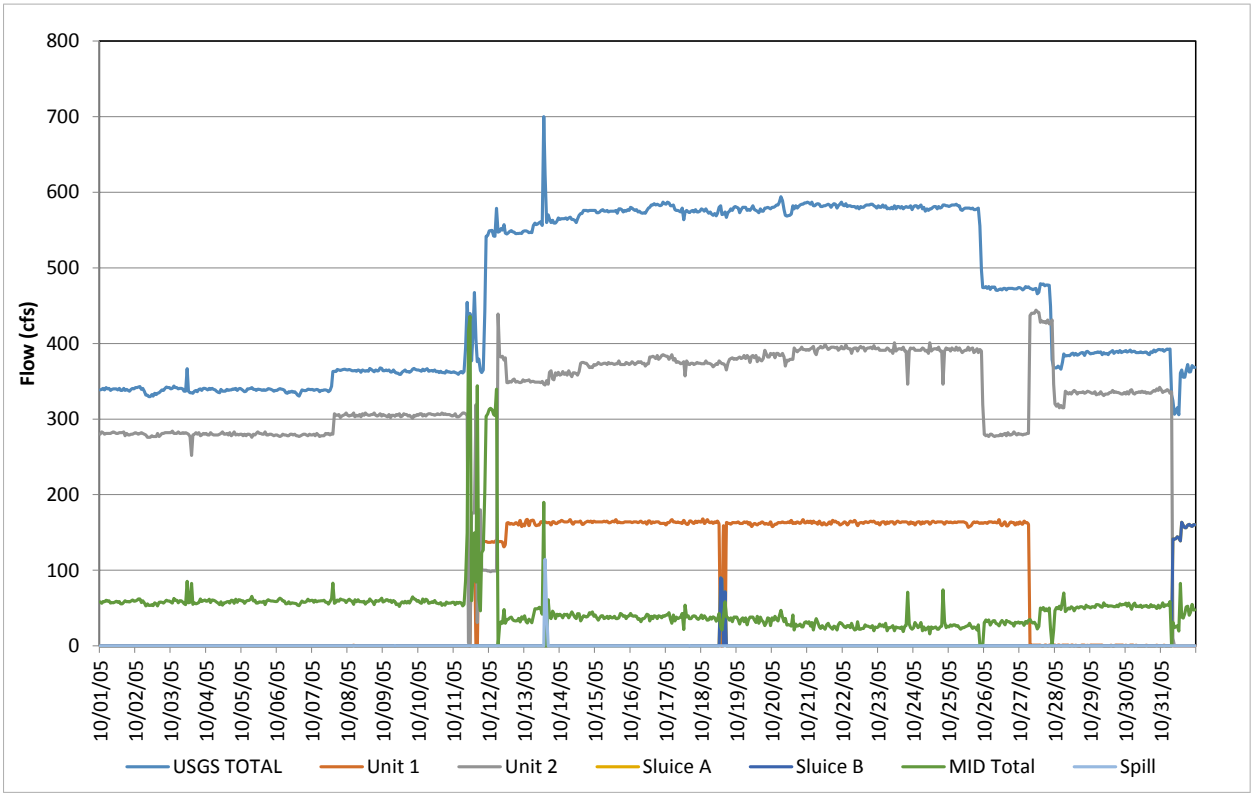

Figure C-10. Flow record in October 2005, based on hourly discharges.

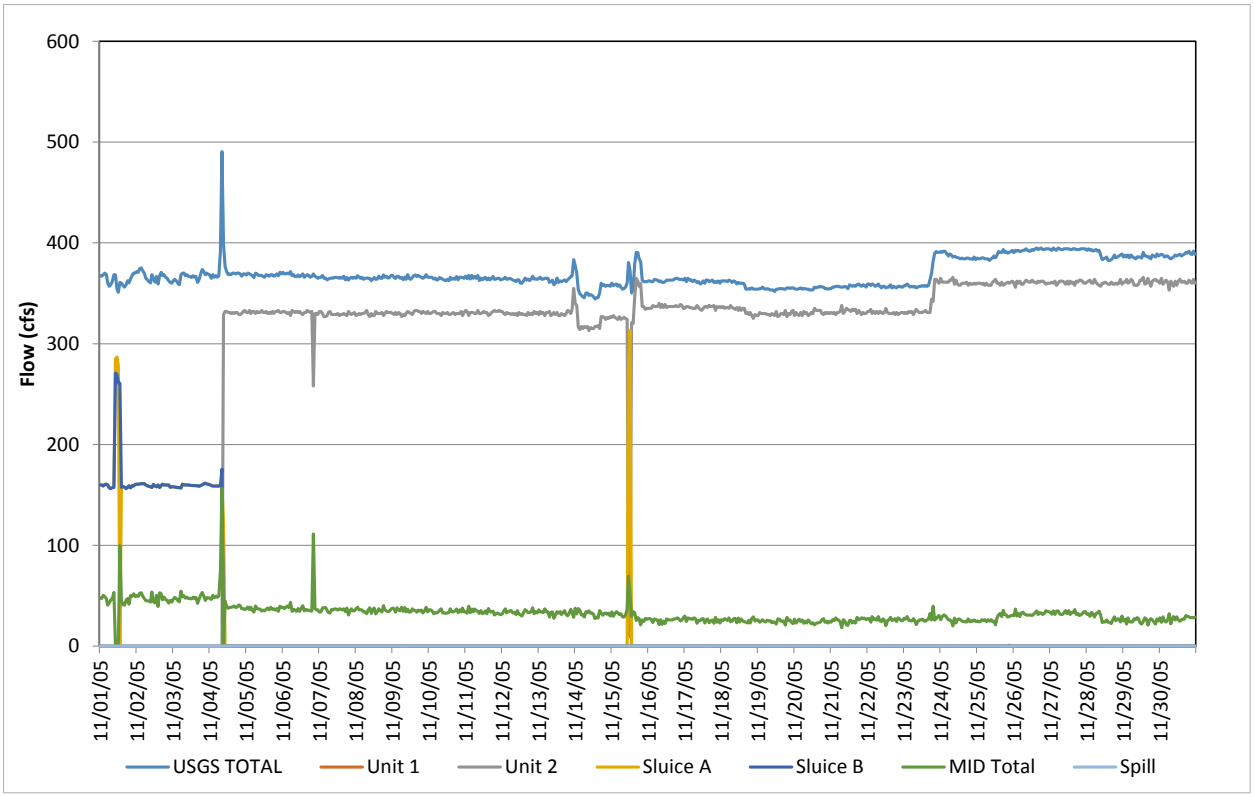

Figure C-11. Flow record in November 2005, based on hourly discharges.

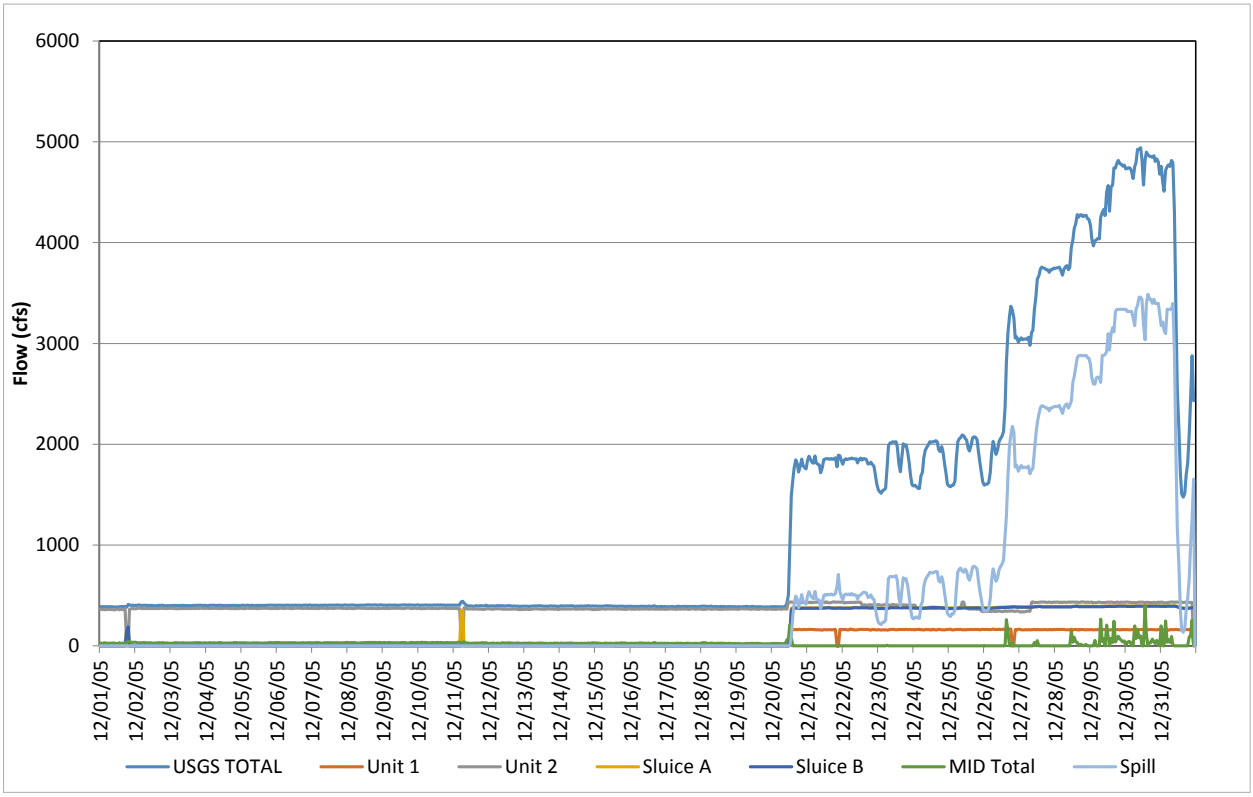

Figure C-12. Flow record in December 2005, based on hourly discharges.

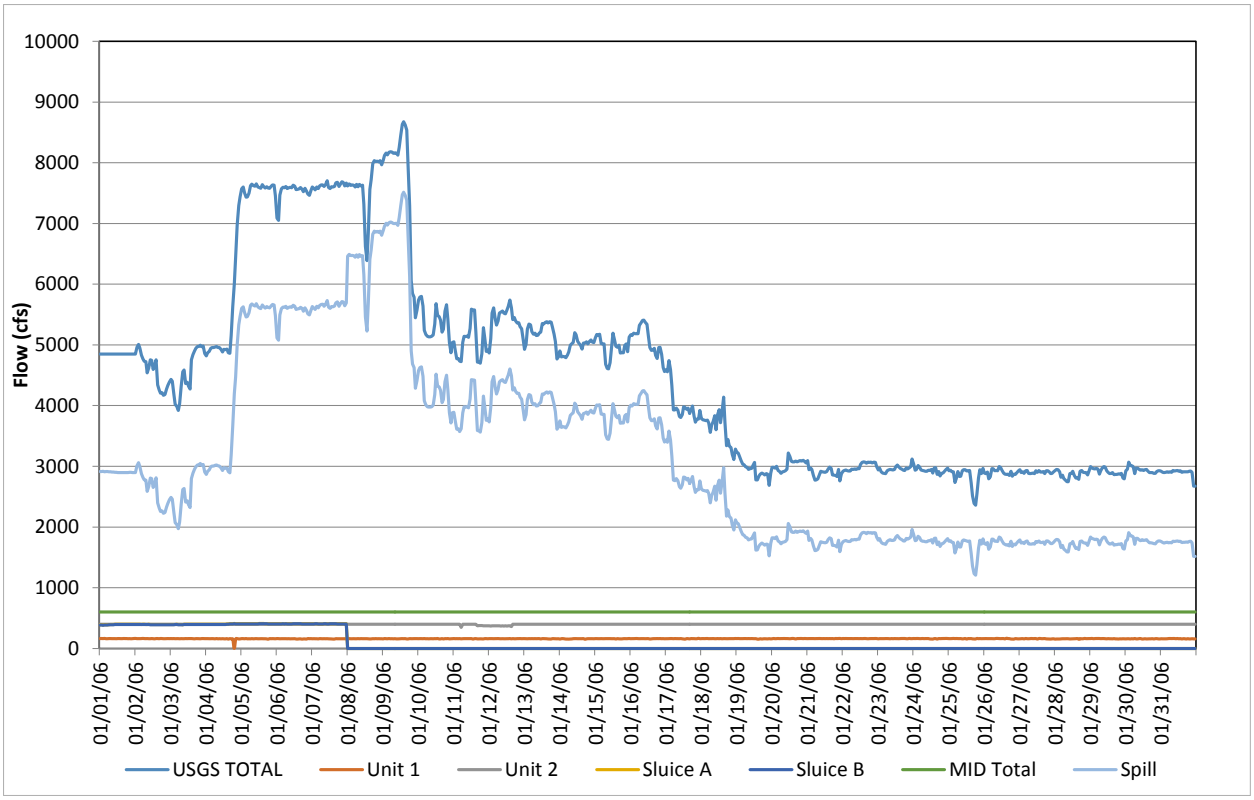

Figure C-13. Flow record in January 2006, based on hourly discharges.

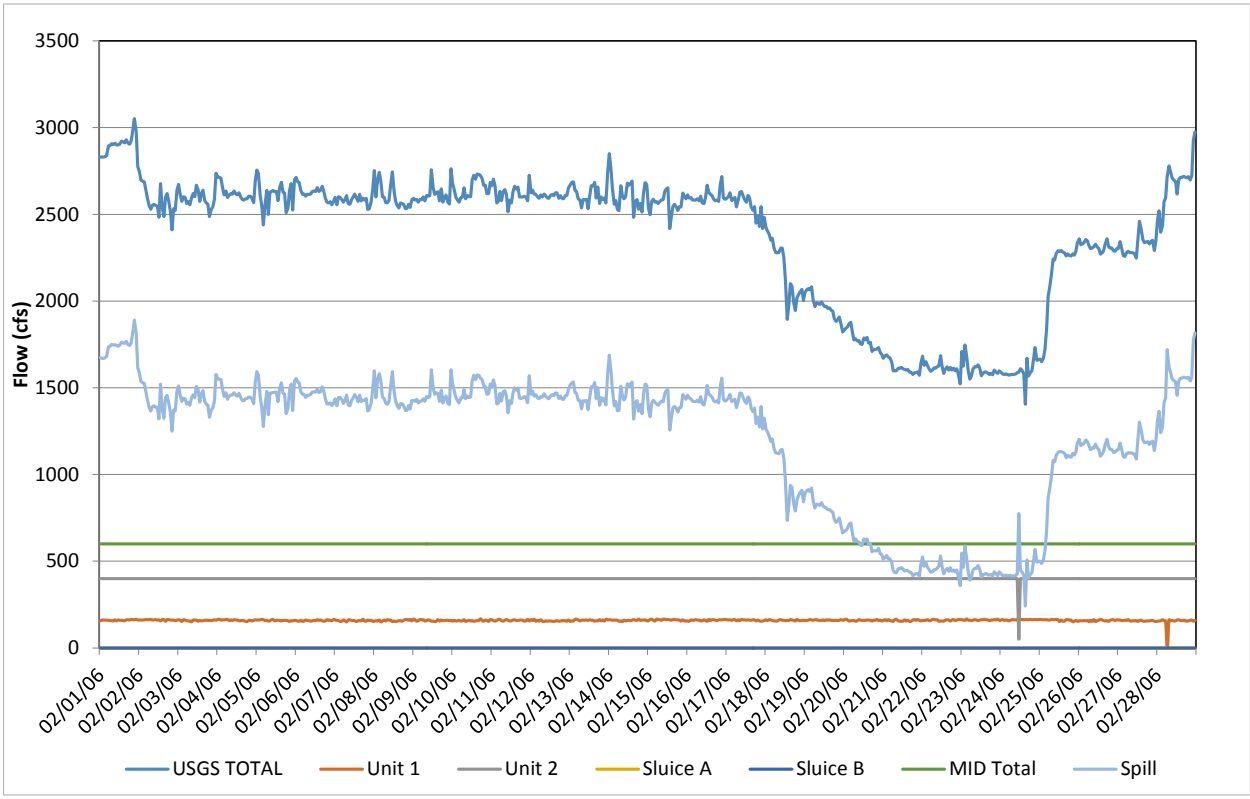

Figure C-14. Flow record in February 2006, based on hourly discharges.

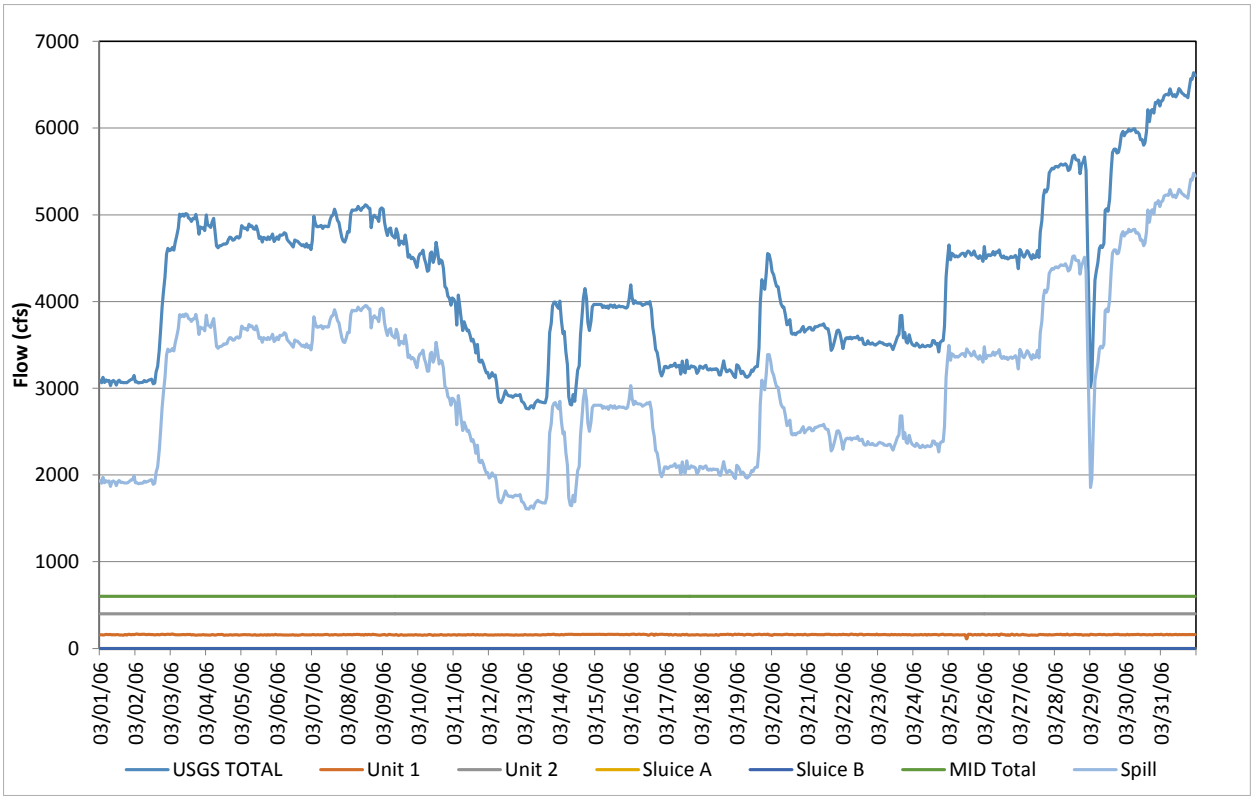

Figure C-15. Flow record in March 2006, based on hourly discharges.

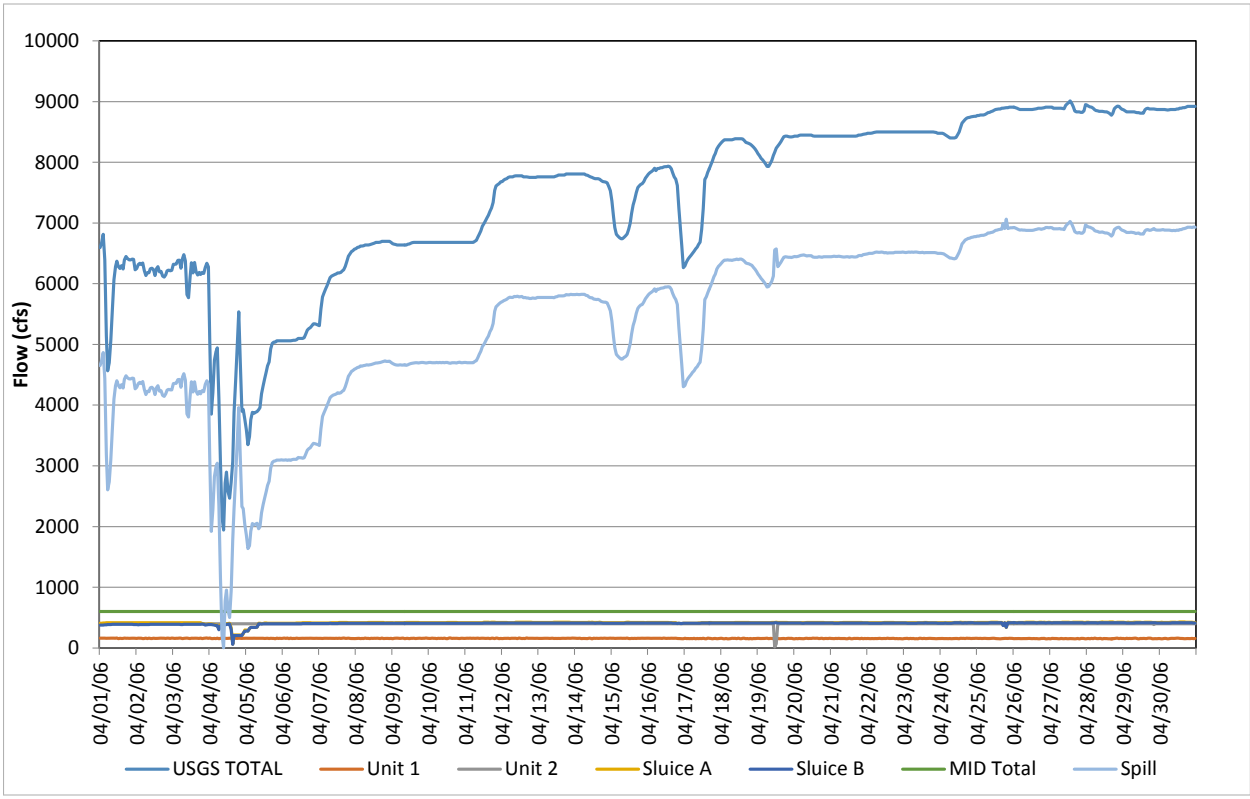

Figure C-16. Flow record in April 2006, based on hourly discharges.

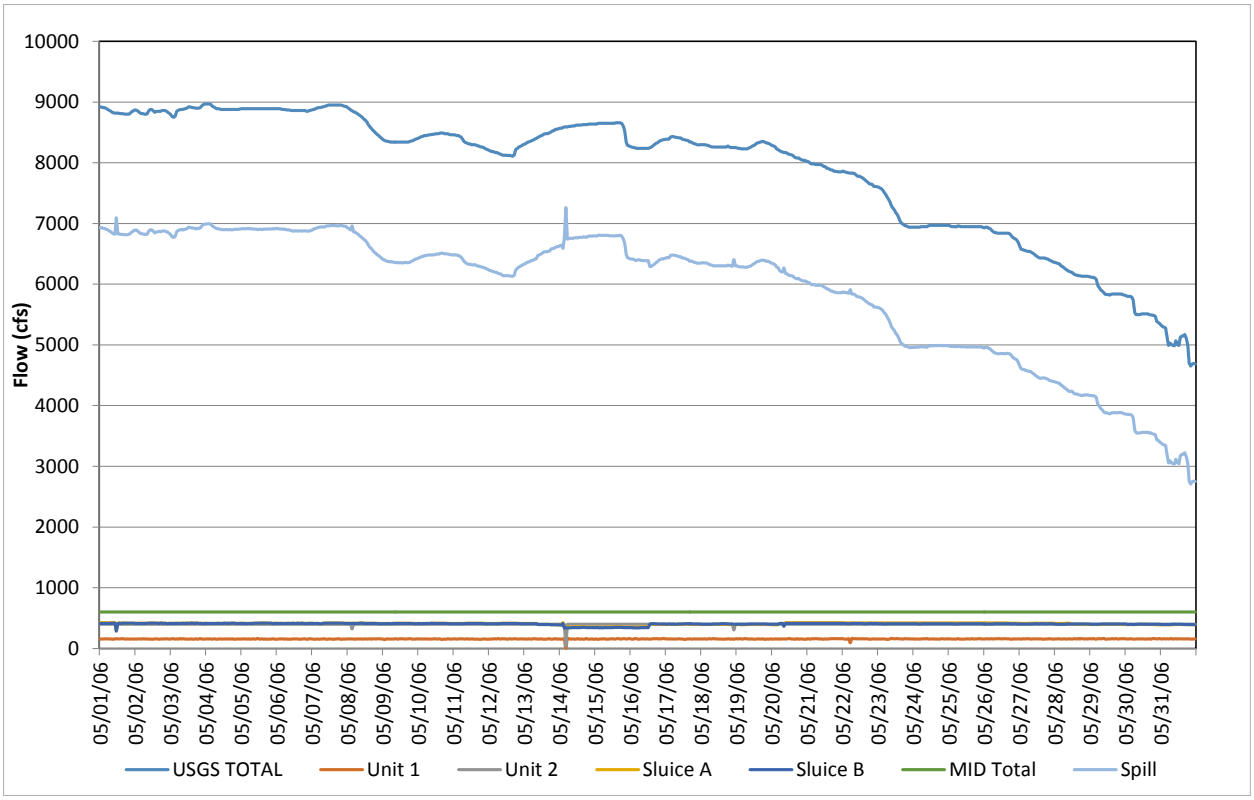

Figure C-17. Flow record in May 2006, based on hourly discharges.

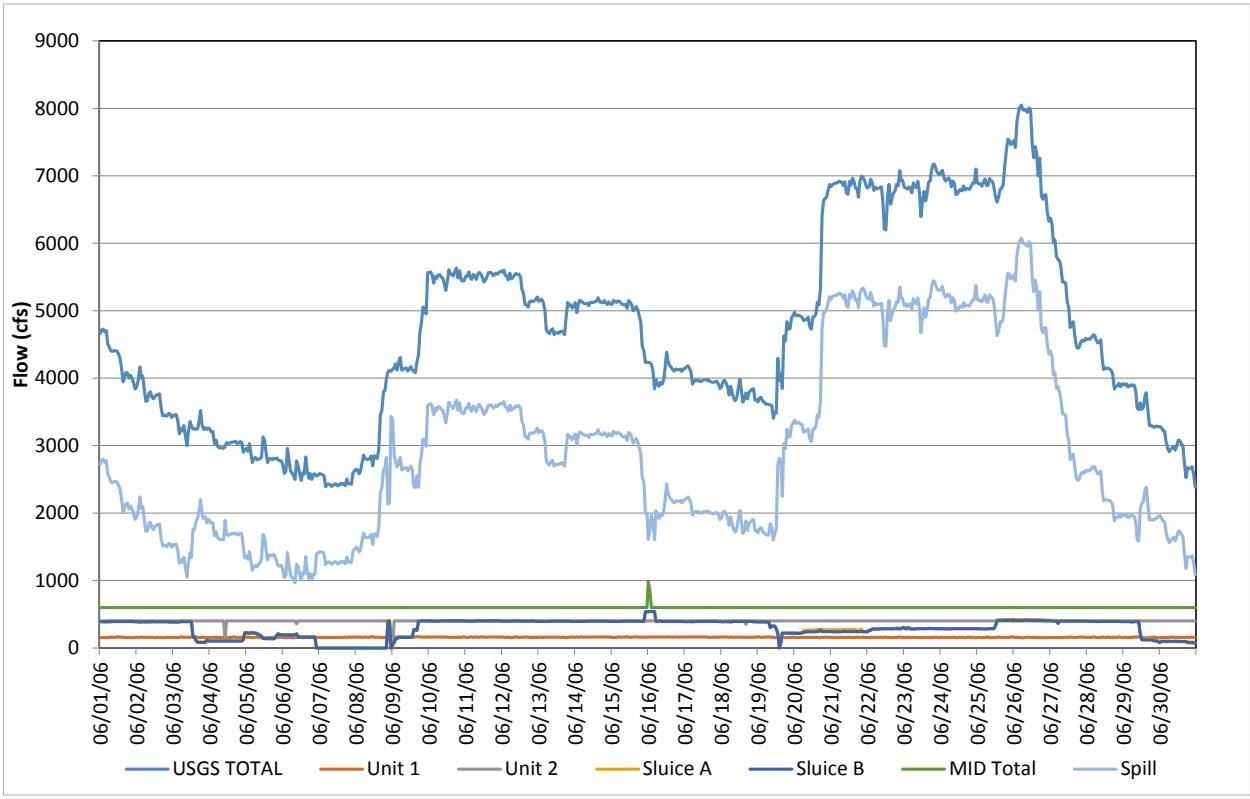

Figure C-18. Flow record in June 2006, based on hourly discharges.

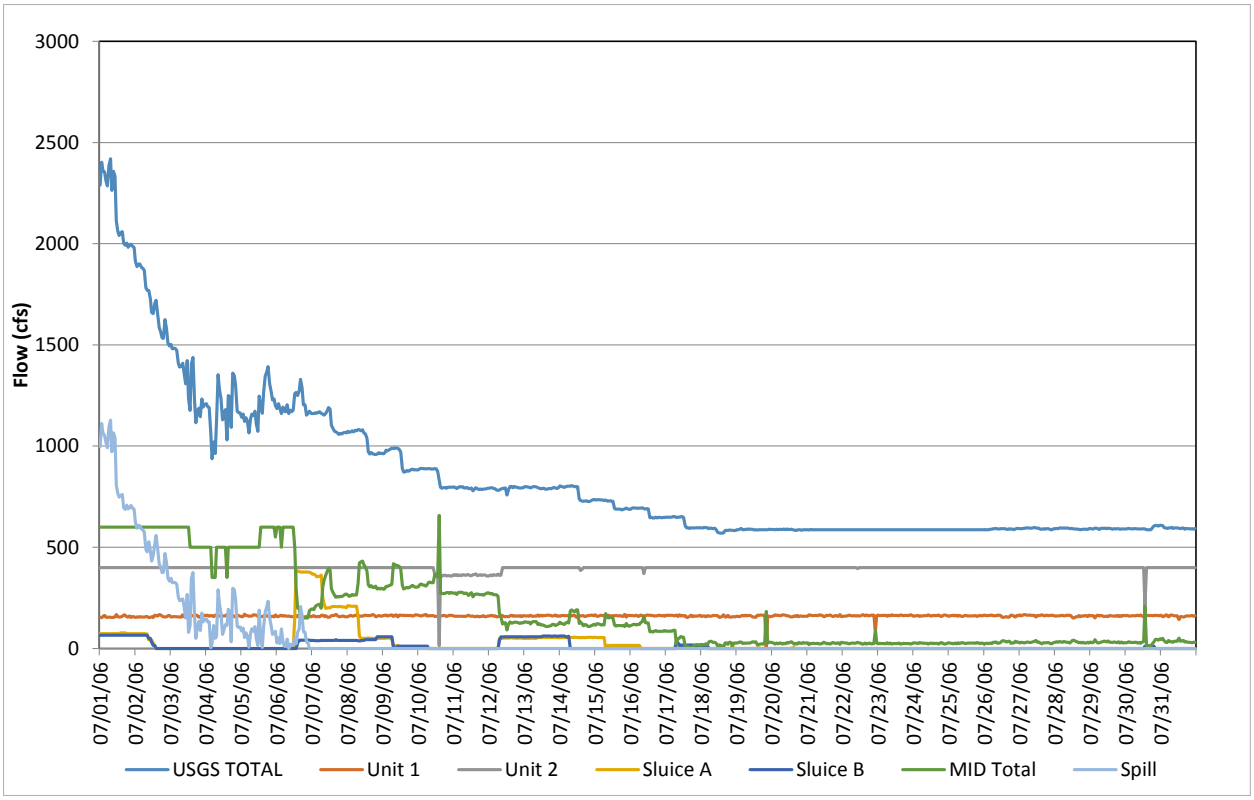

Figure C-19. Flow record in July 2006, based on hourly discharges.

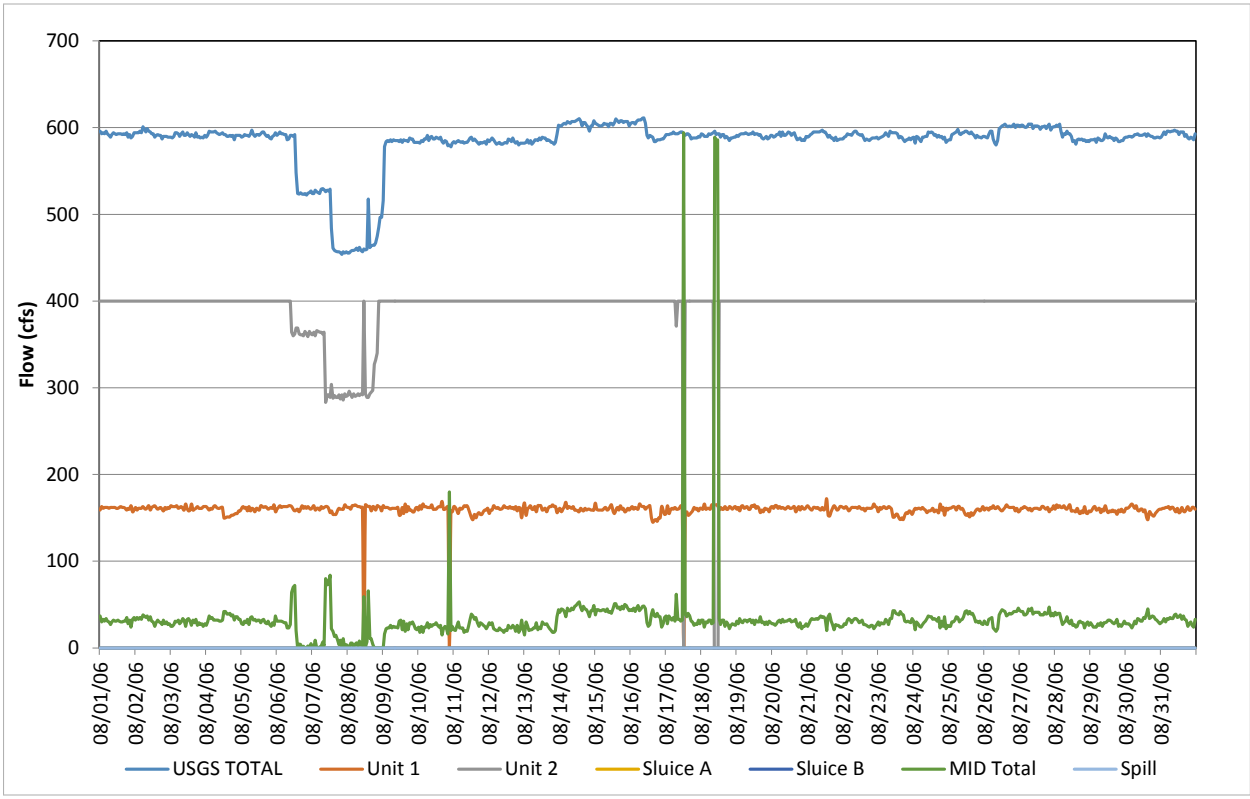

Figure C-20. Flow record in August 2006, based on hourly discharges.

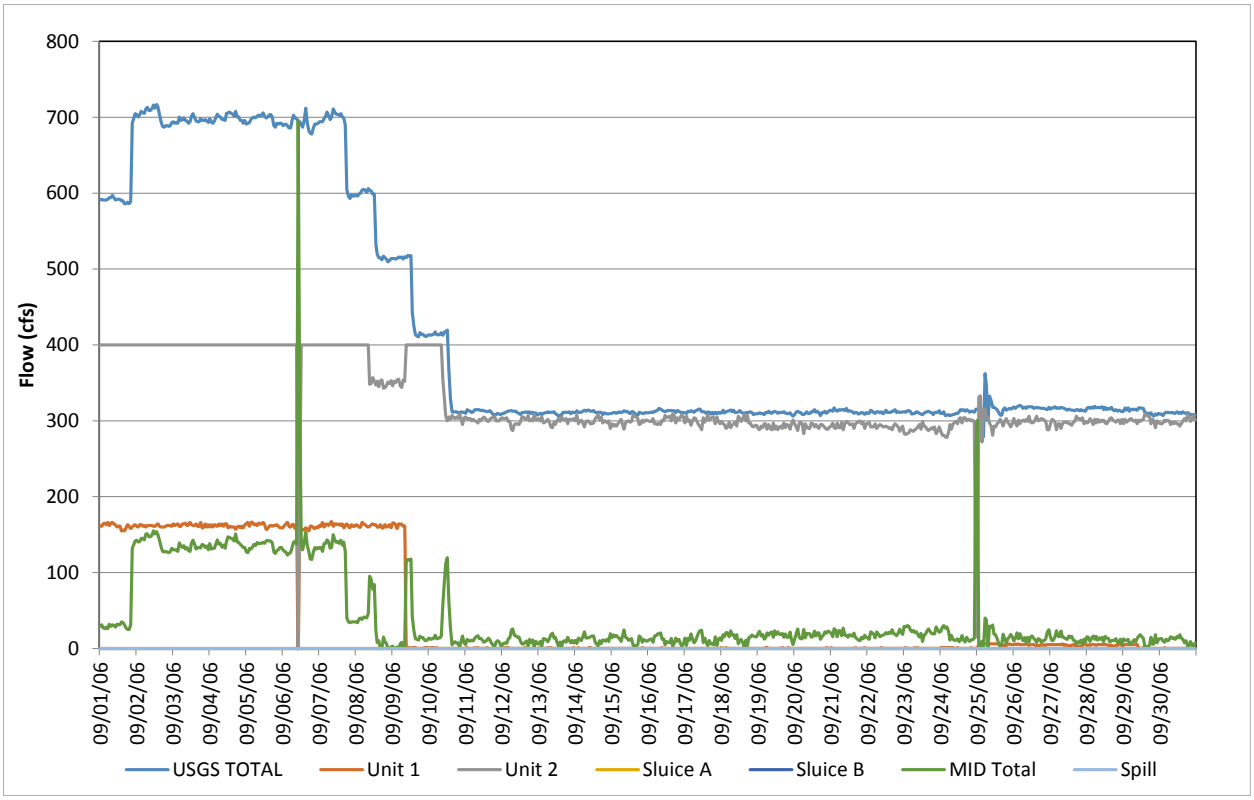

Figure C-21. Flow record in September 2006, based on hourly discharges.

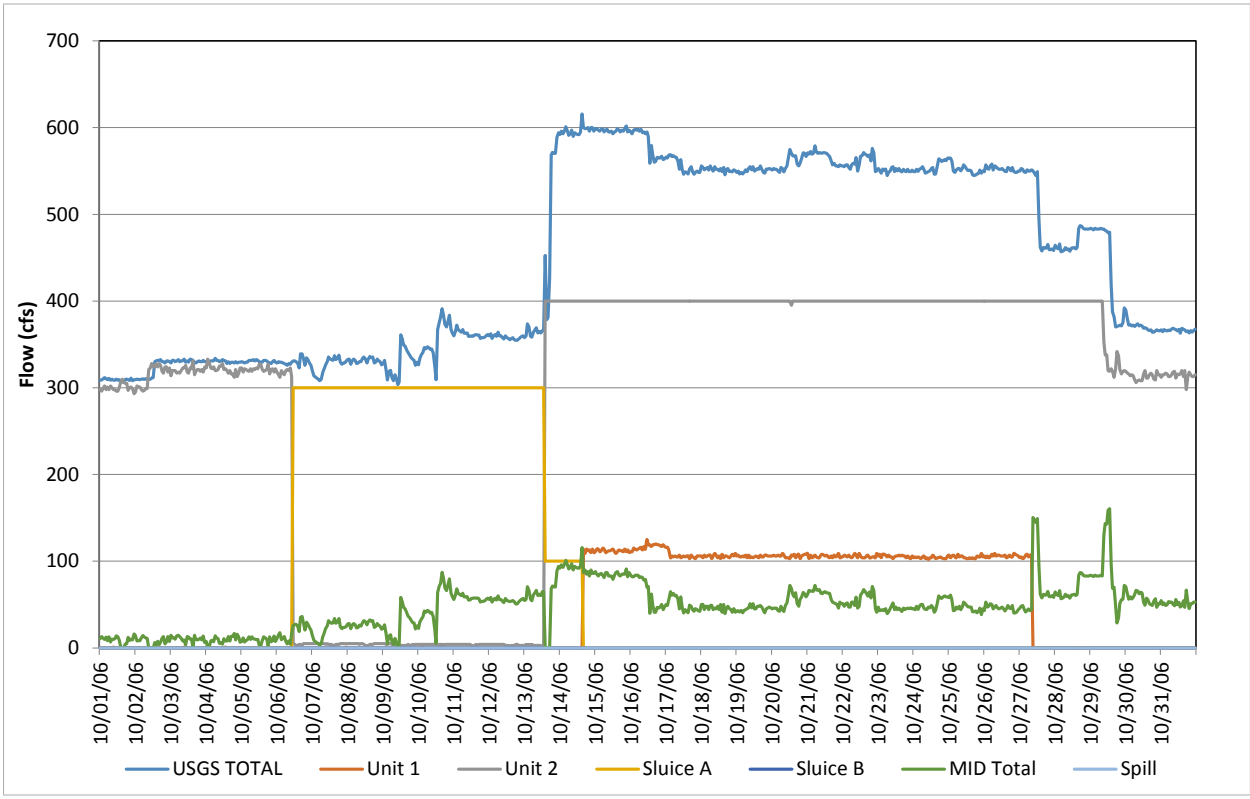

Figure C-22. Flow record in October 2006, based on hourly discharges.

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

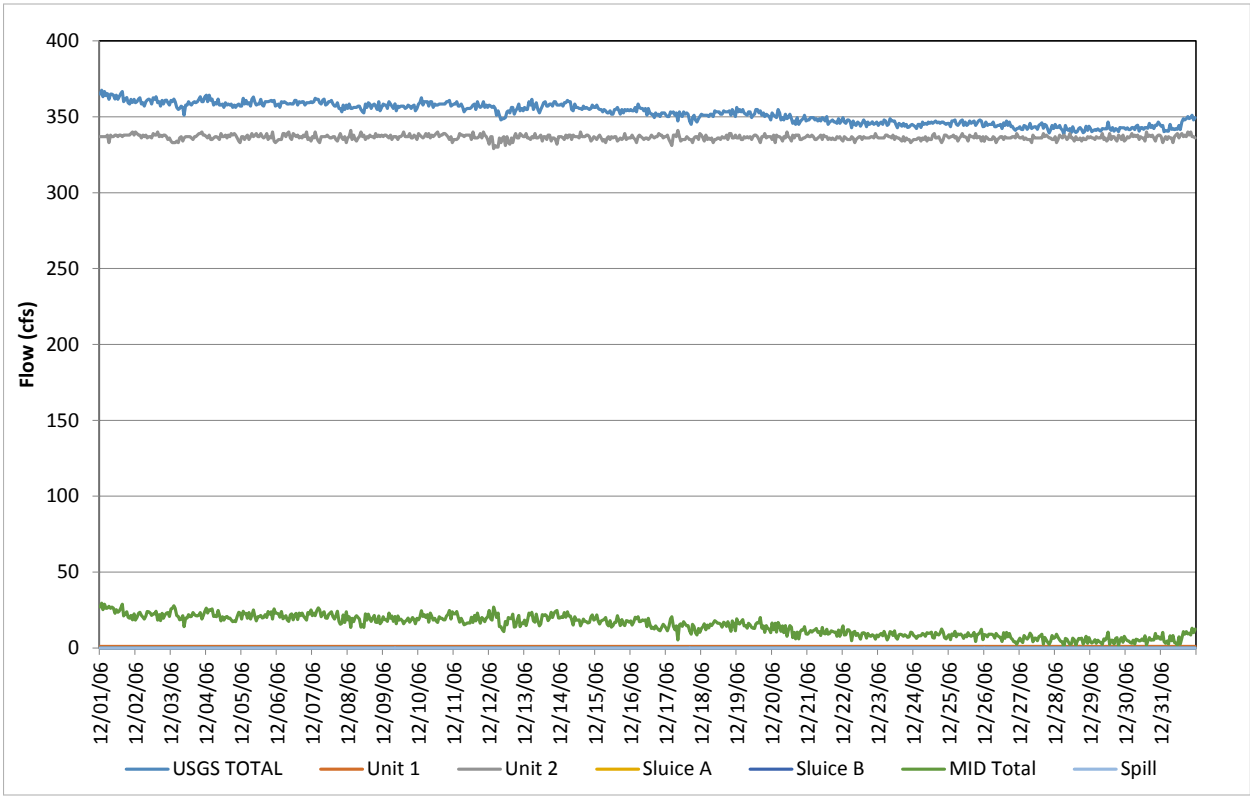

Figure C-24 Flow record in December 2006, based on hourly discharges.

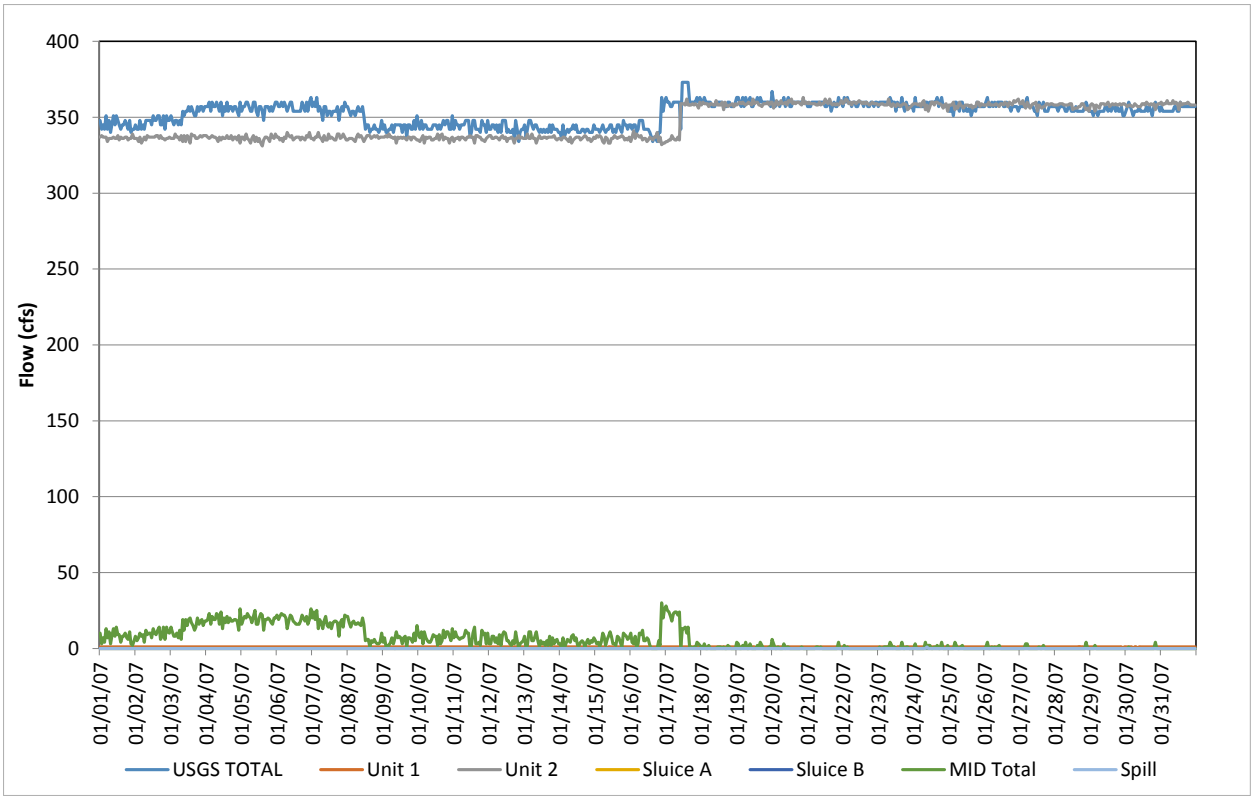

Figure C-25. Flow record in January 2007, based on hourly discharges.

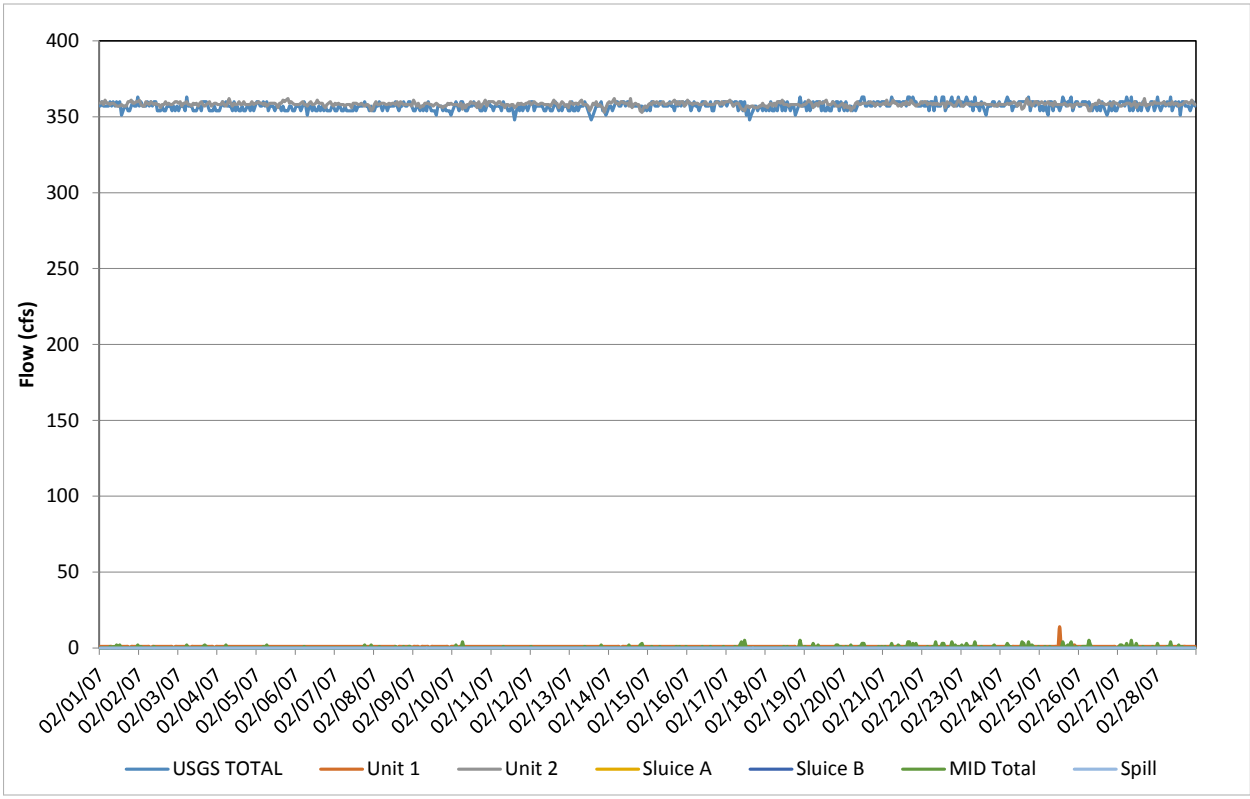

Figure C-26. Flow record in February 2007, based on hourly discharges.

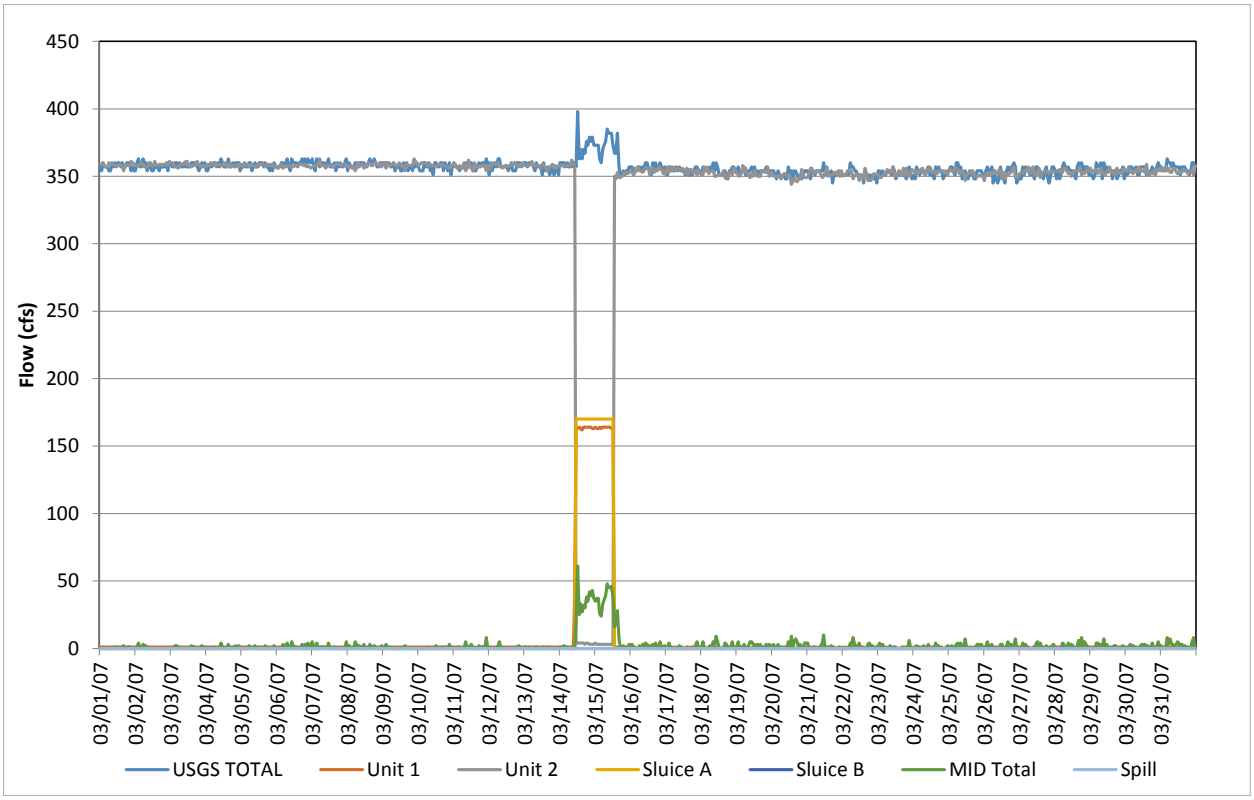

Figure C-27. Flow record in March 2007, based on hourly discharges.

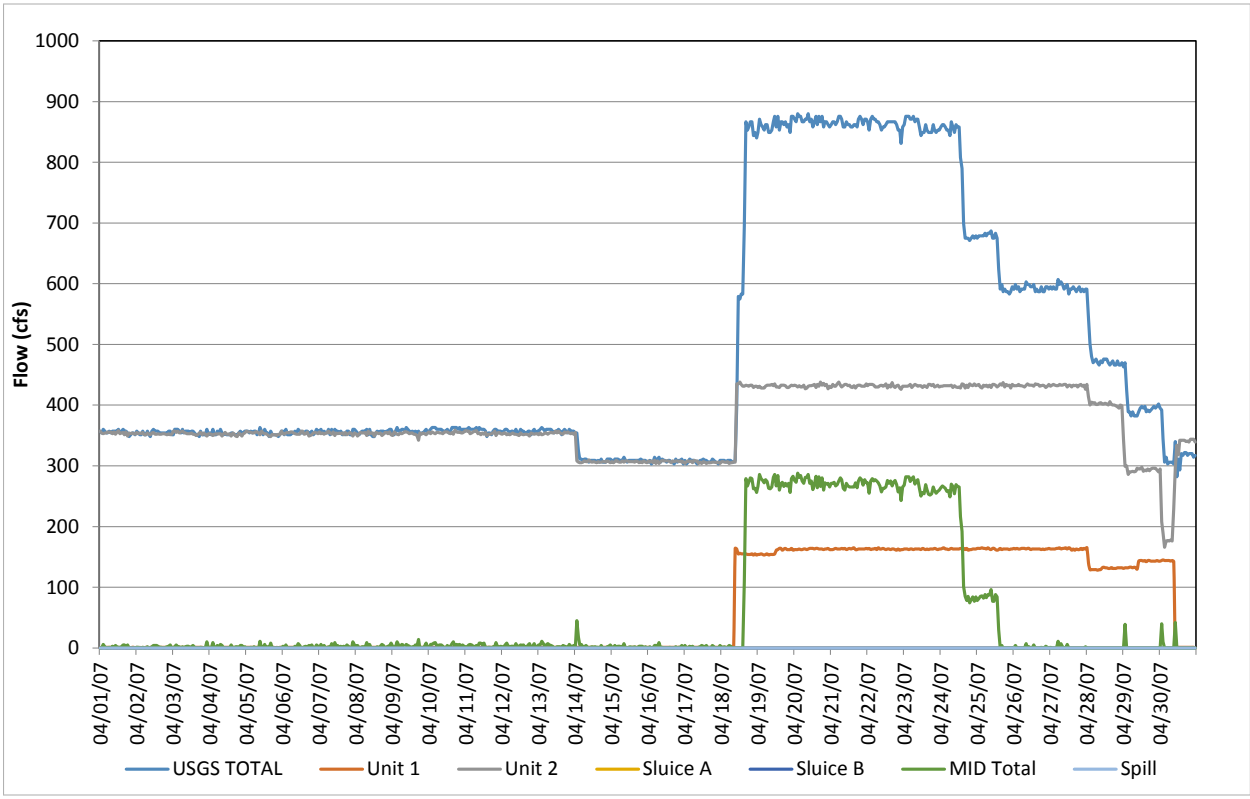

Figure C-27. Flow record in April 2007, based on hourly discharges.

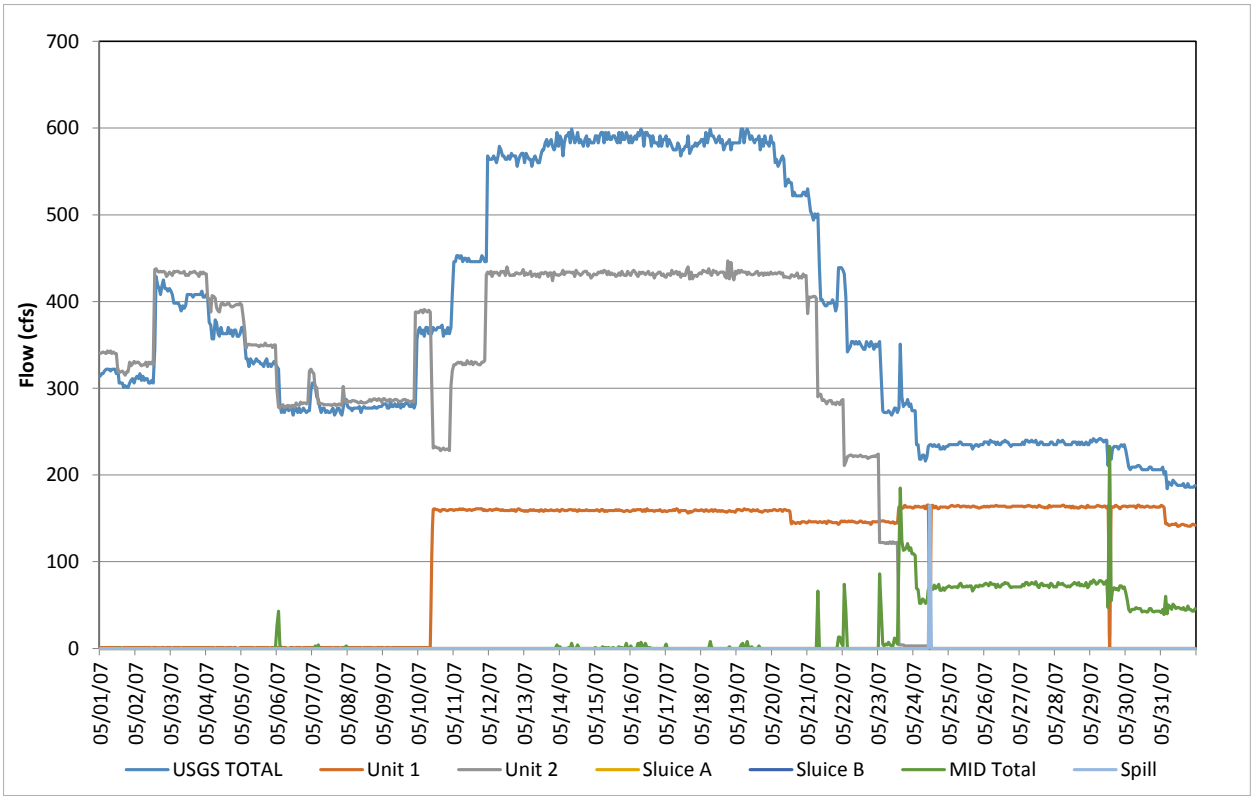

Figure C-29. Flow record in May 2007, based on hourly discharges.

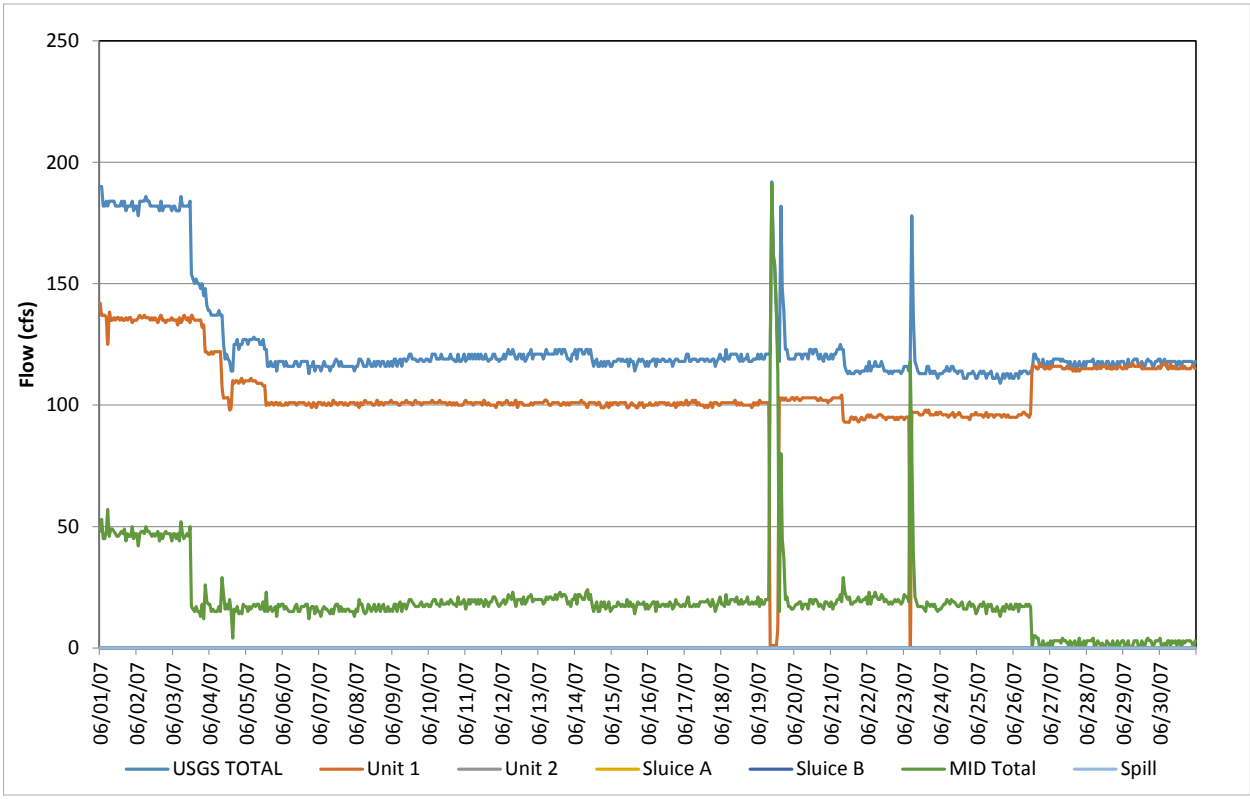

Figure C-30. Flow record in June 2007, based on hourly discharges.

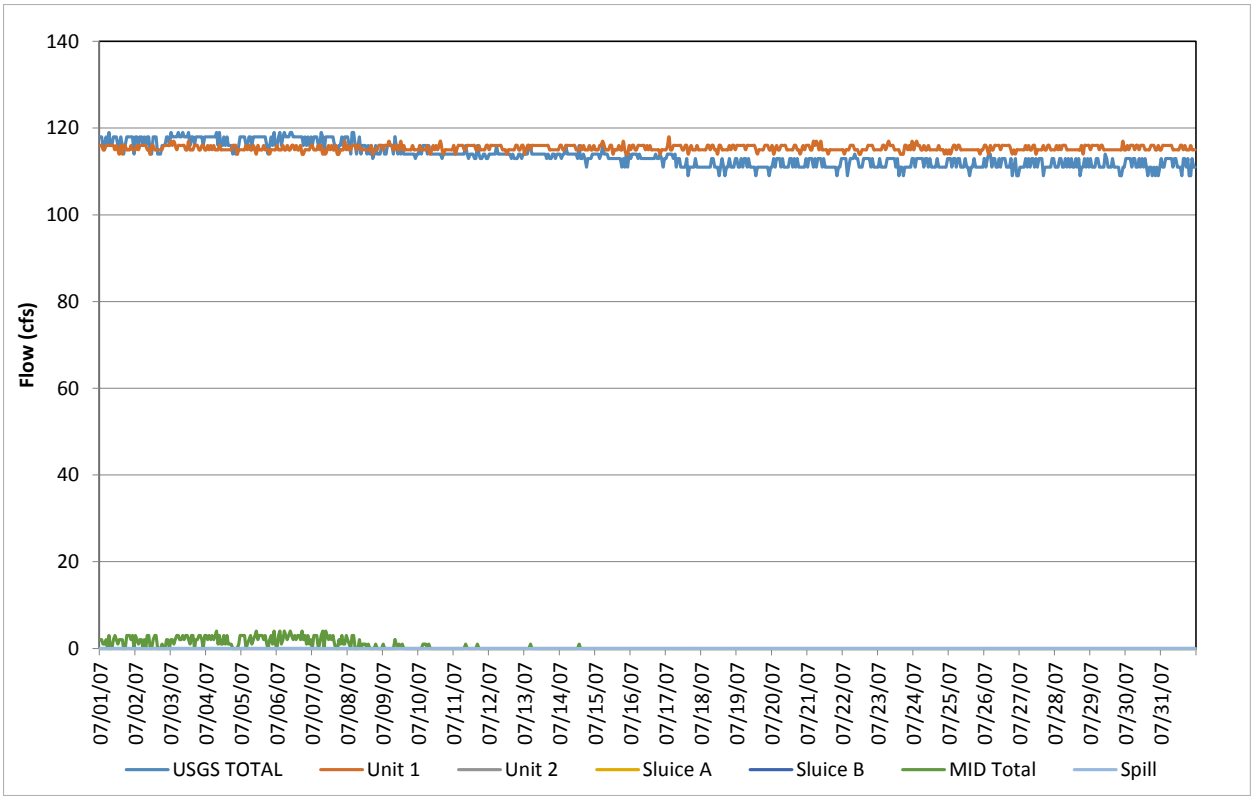

Figure C-31. Flow record in July 2007, based on hourly discharges.

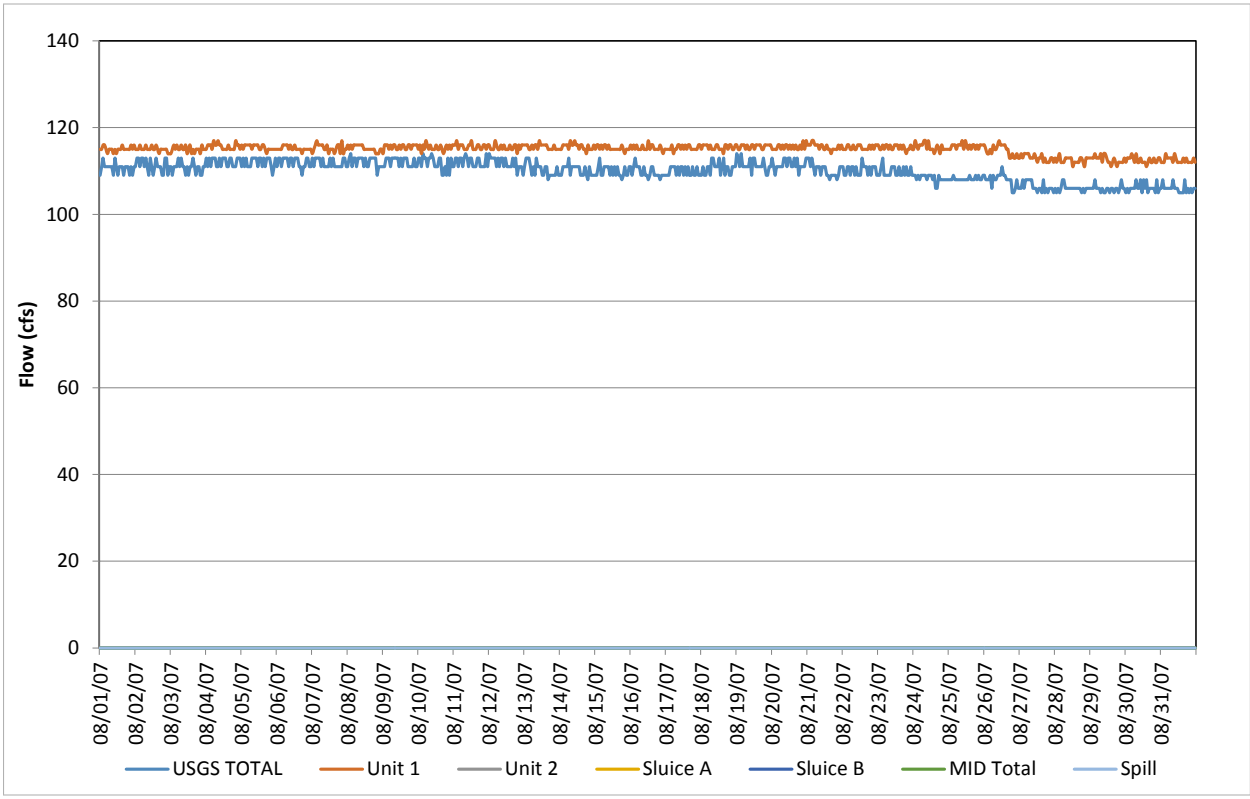

Figure C-32. Flow record in August 2007, based on hourly discharges.

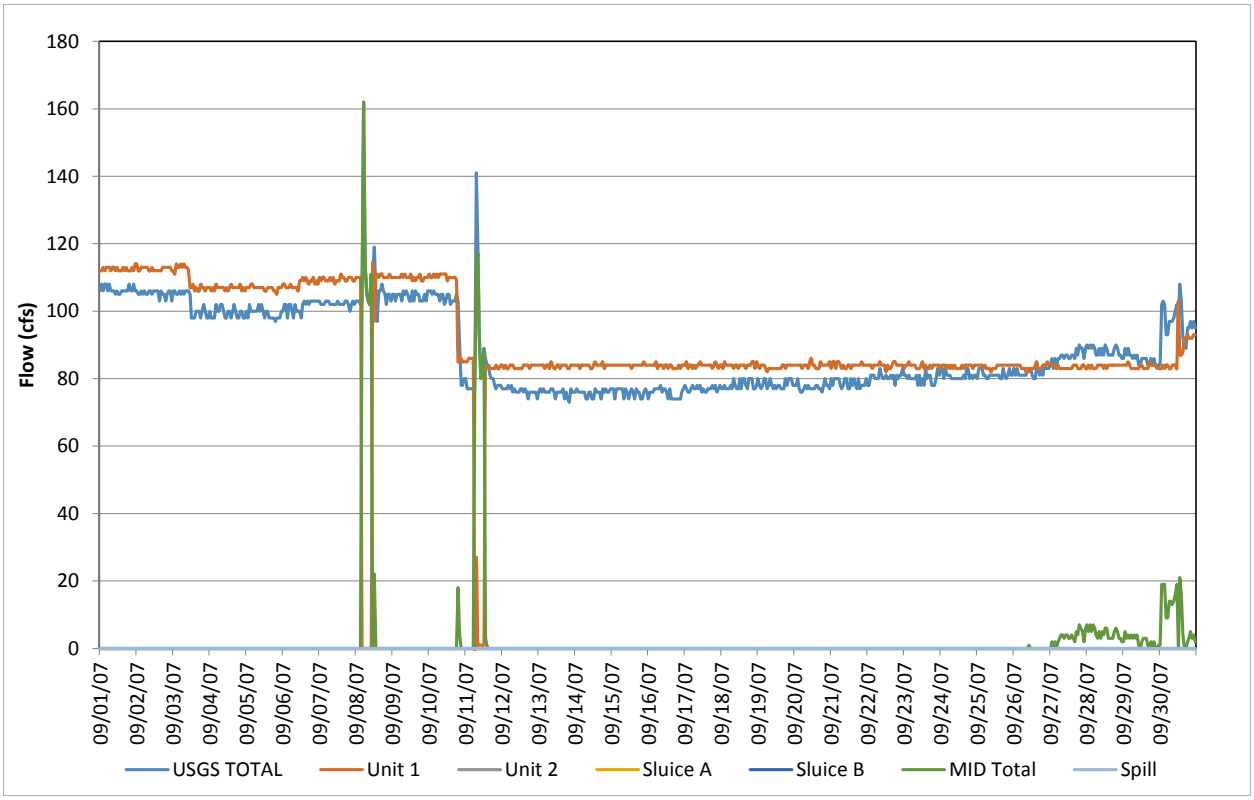

Figure C-33. Flow record in September 2007, based on hourly discharges.

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

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

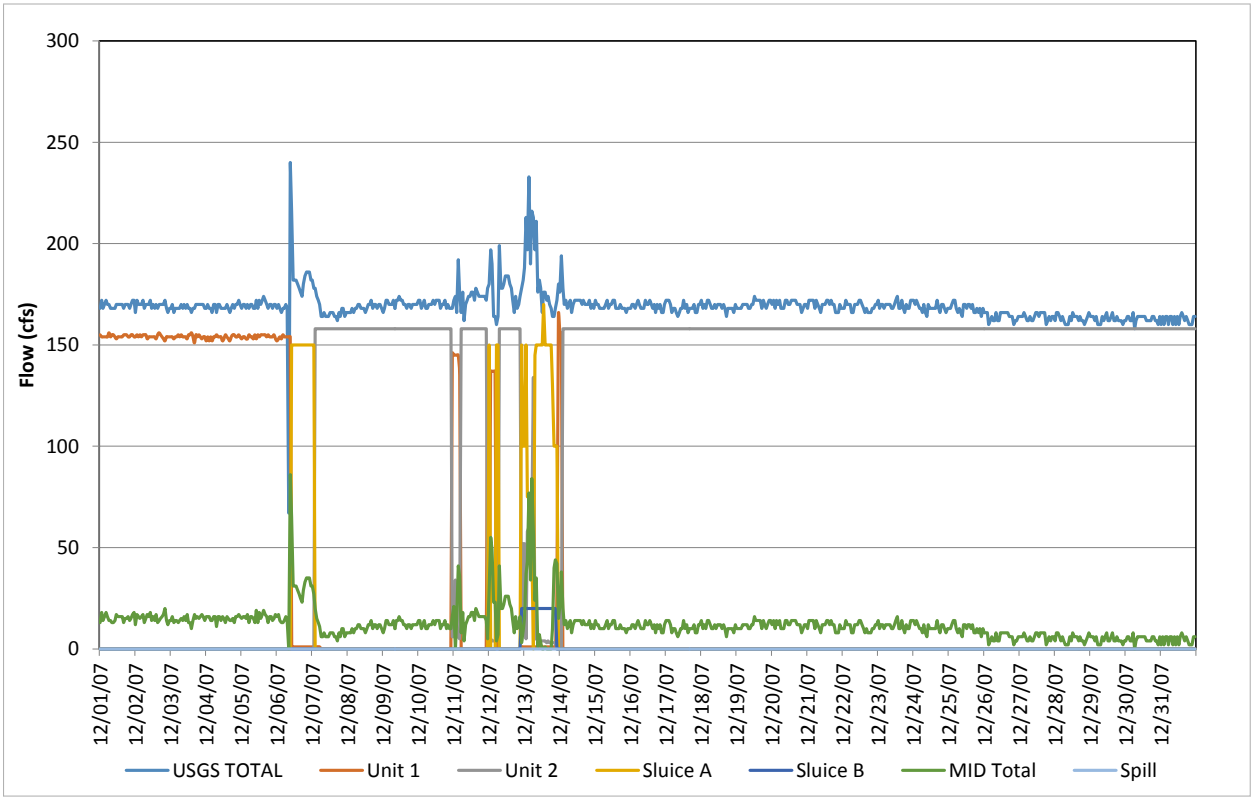

Figure C-36. Flow record in December 2007, based on hourly discharges.

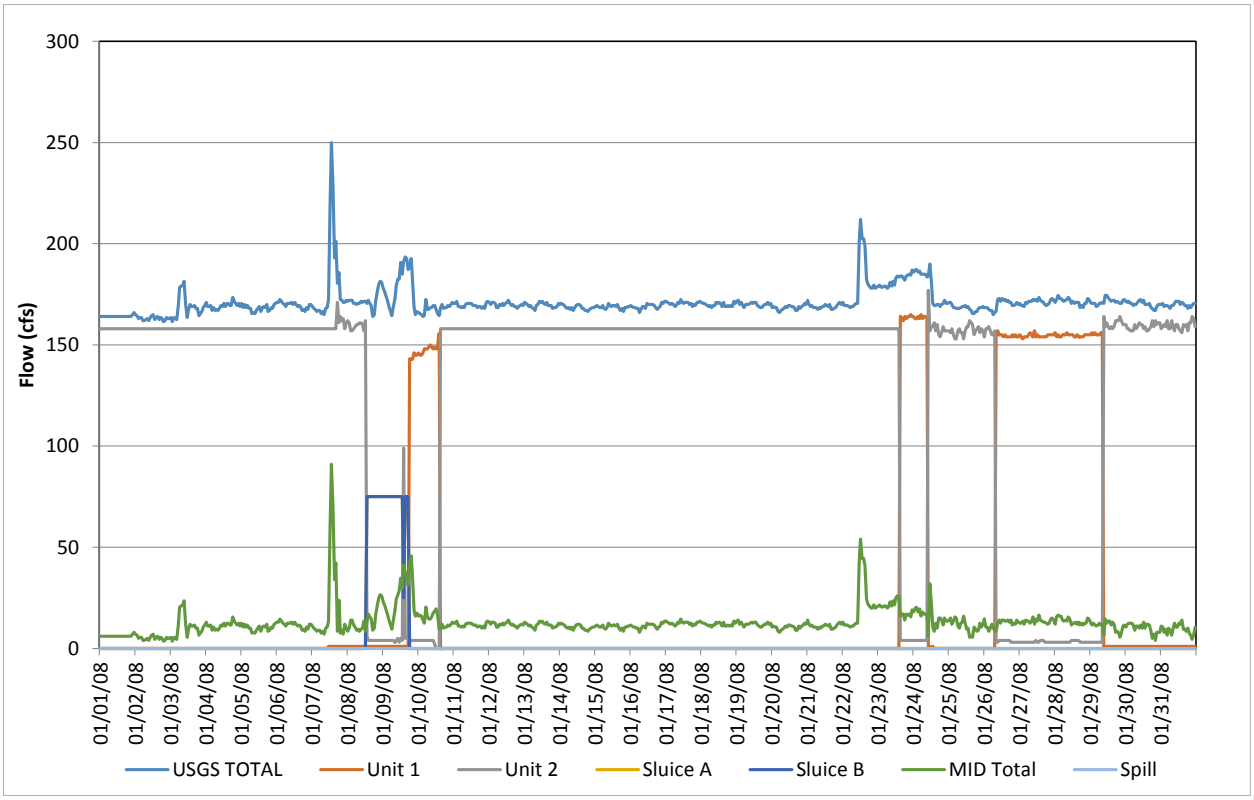

Figure C-37. Flow record in January 2008, based on hourly discharges.

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

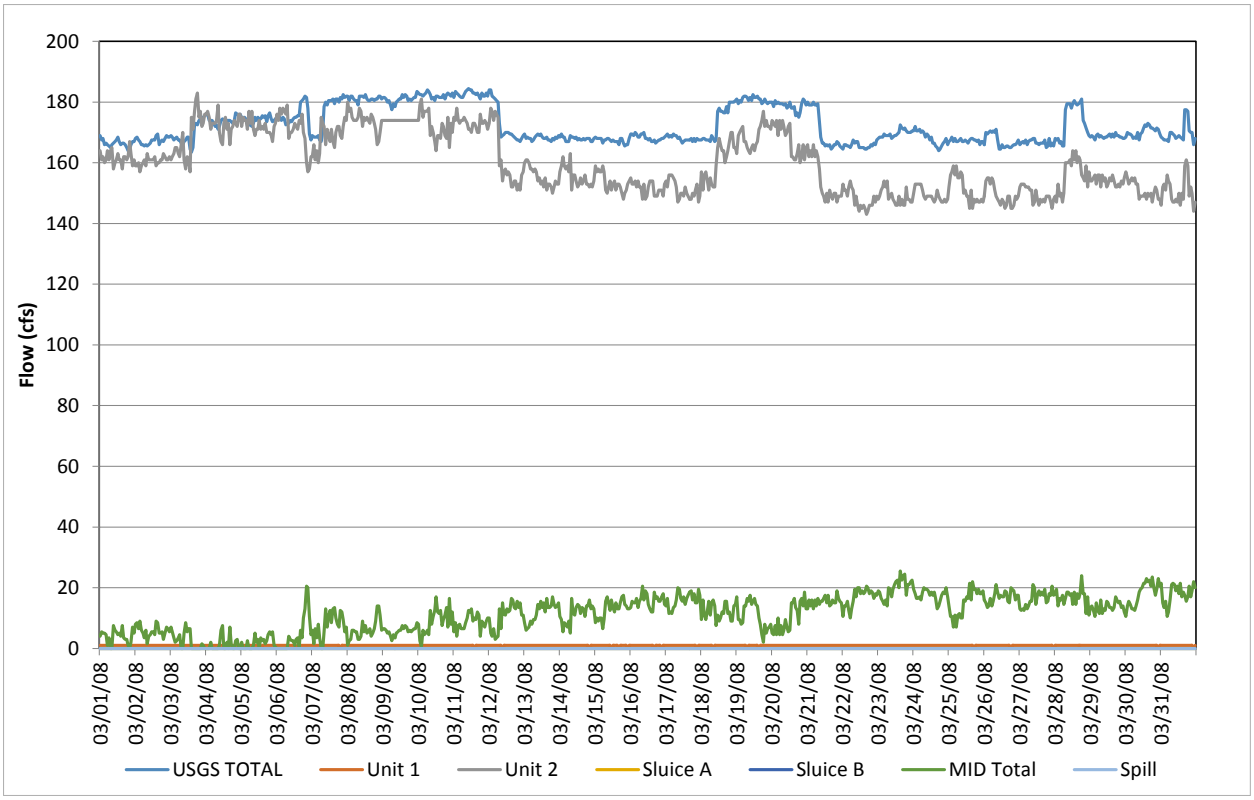

Figure C-39. Flow record in March 2008, based on hourly discharges.

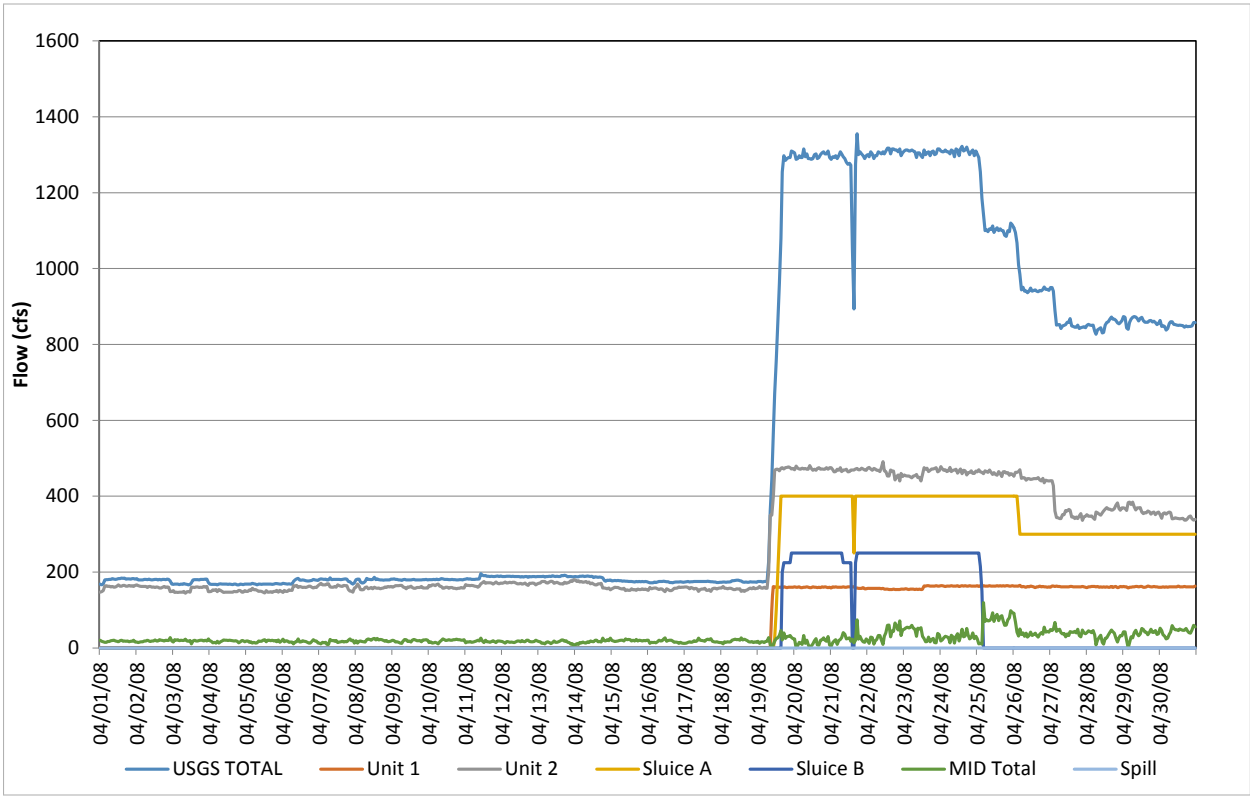

Figure C-40. Flow record in April 2008, based on hourly discharges.

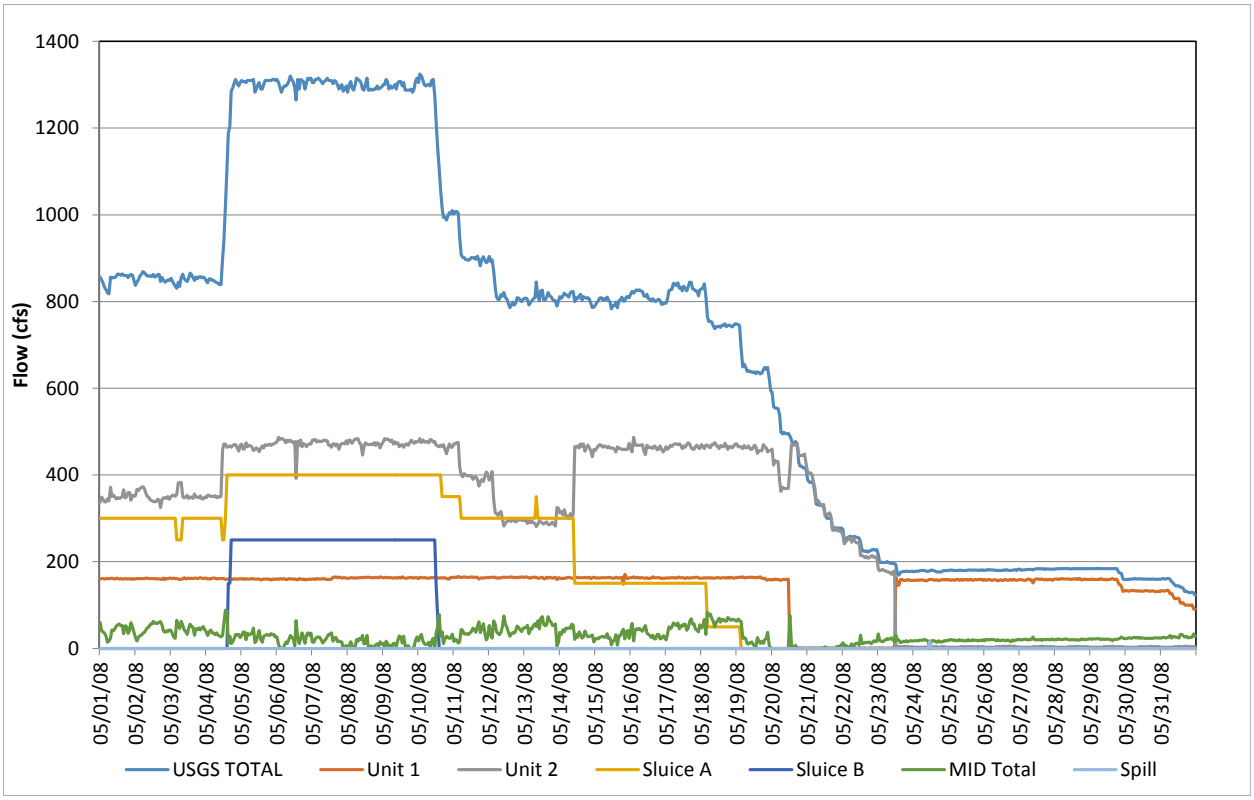

Figure C-41. Flow record in May 2008, based on hourly discharges.

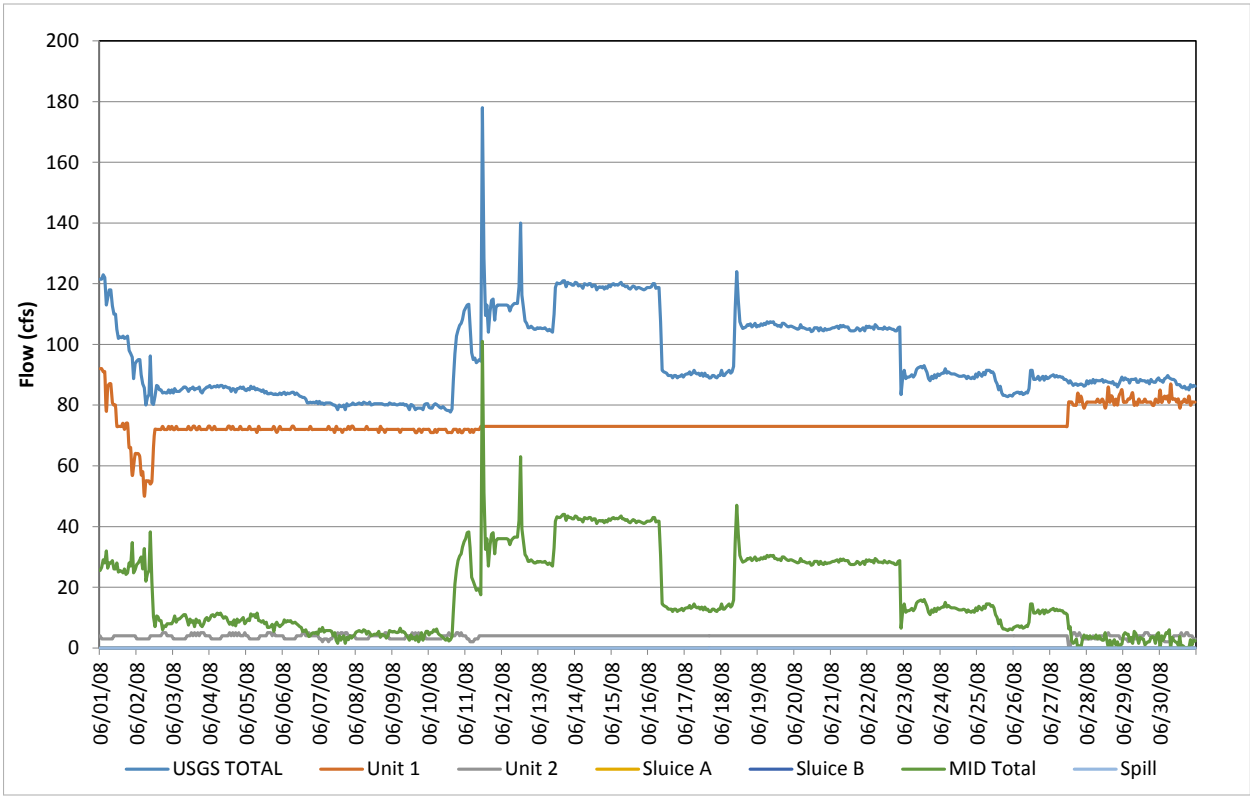

Figure C-42. Flow record in June 2008, based on hourly discharges.

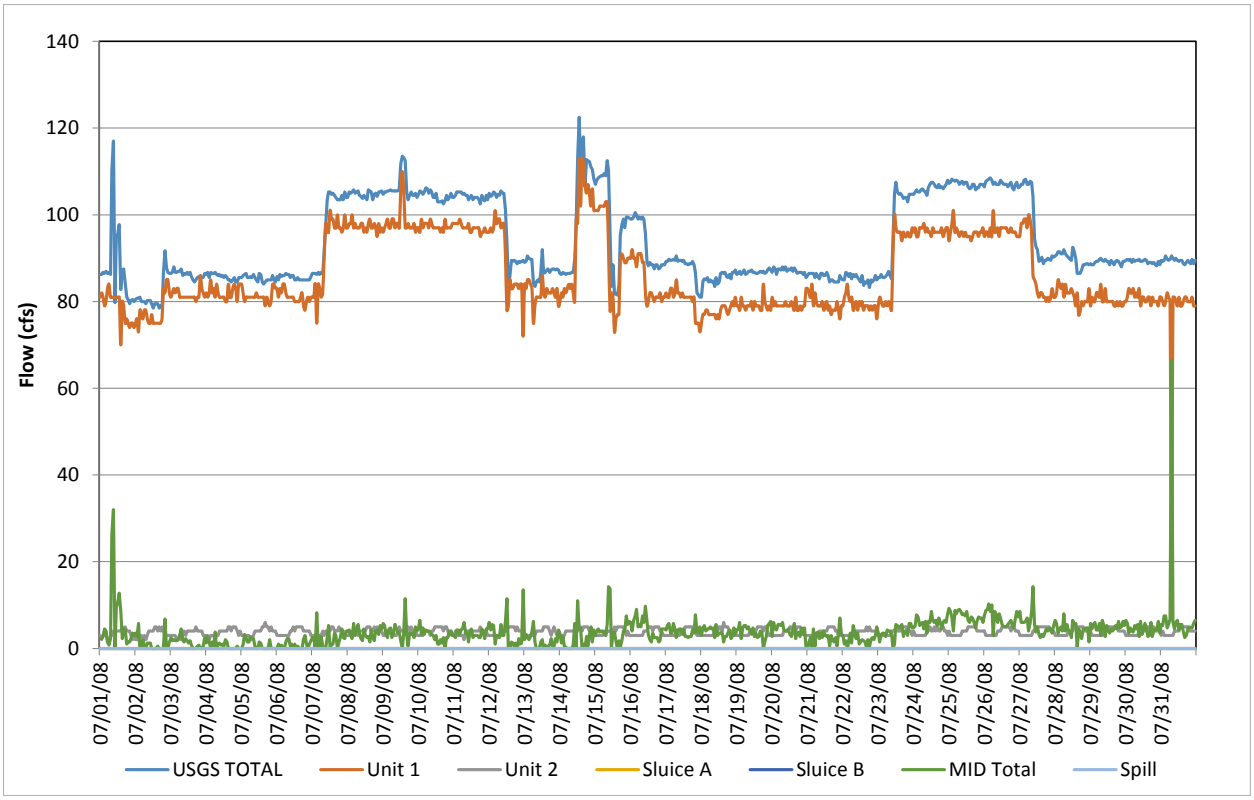

Figure C-43. Flow record in July 2008, based on hourly discharges.

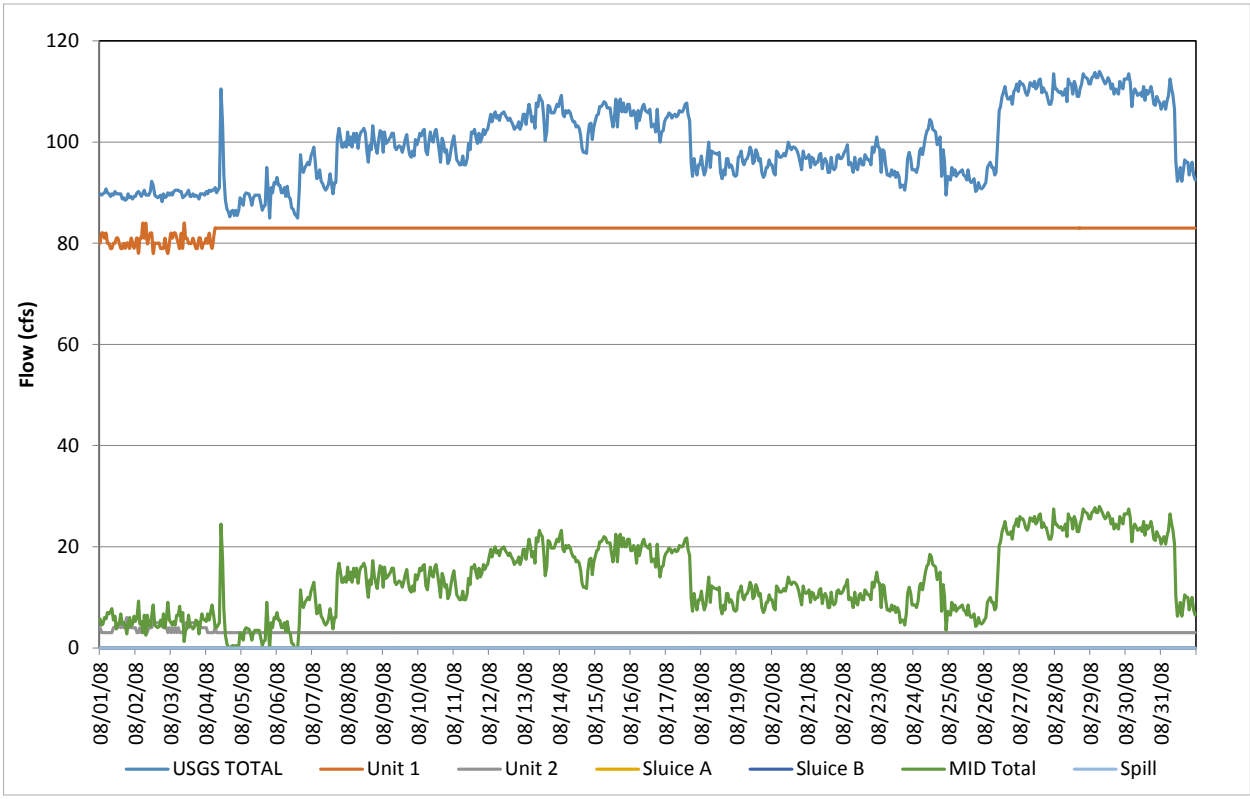

Figure C-44. Flow record in August 2008, based on hourly discharges.

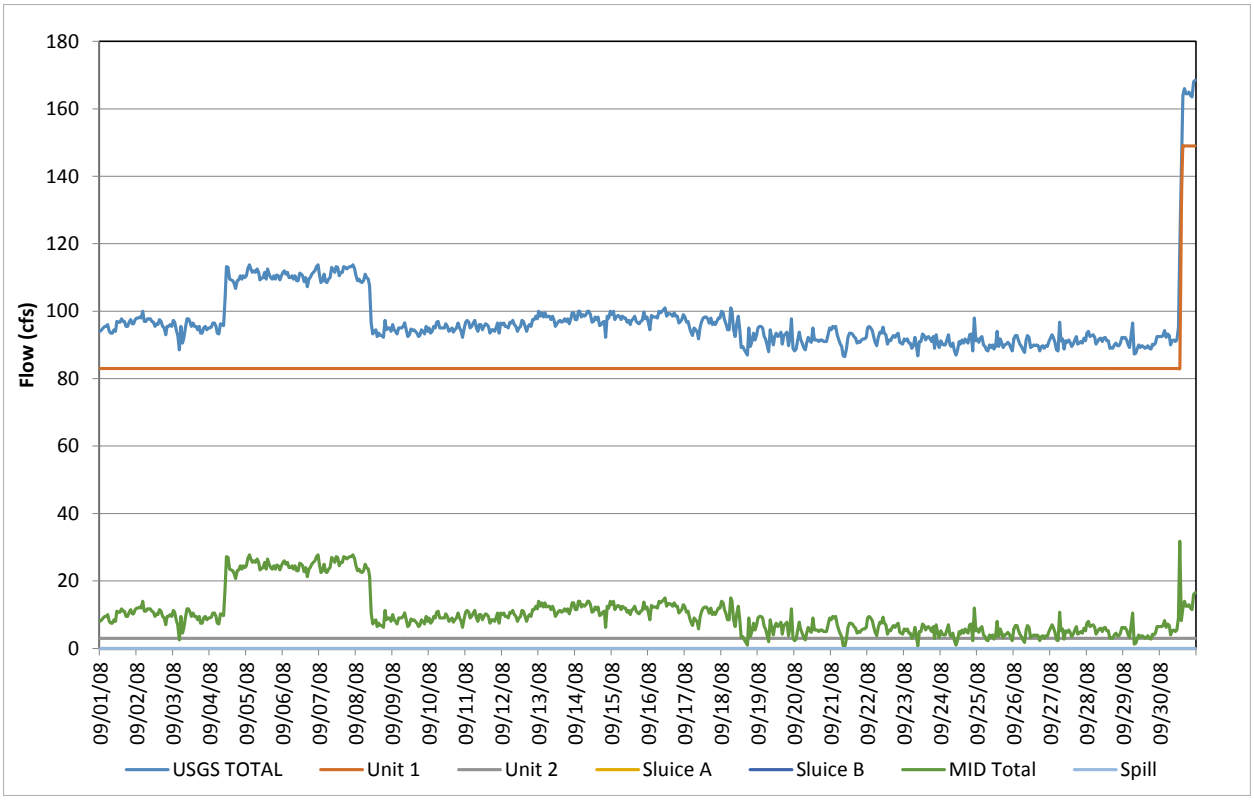

Figure C-45. Flow record in September 2008, based on hourly discharges.

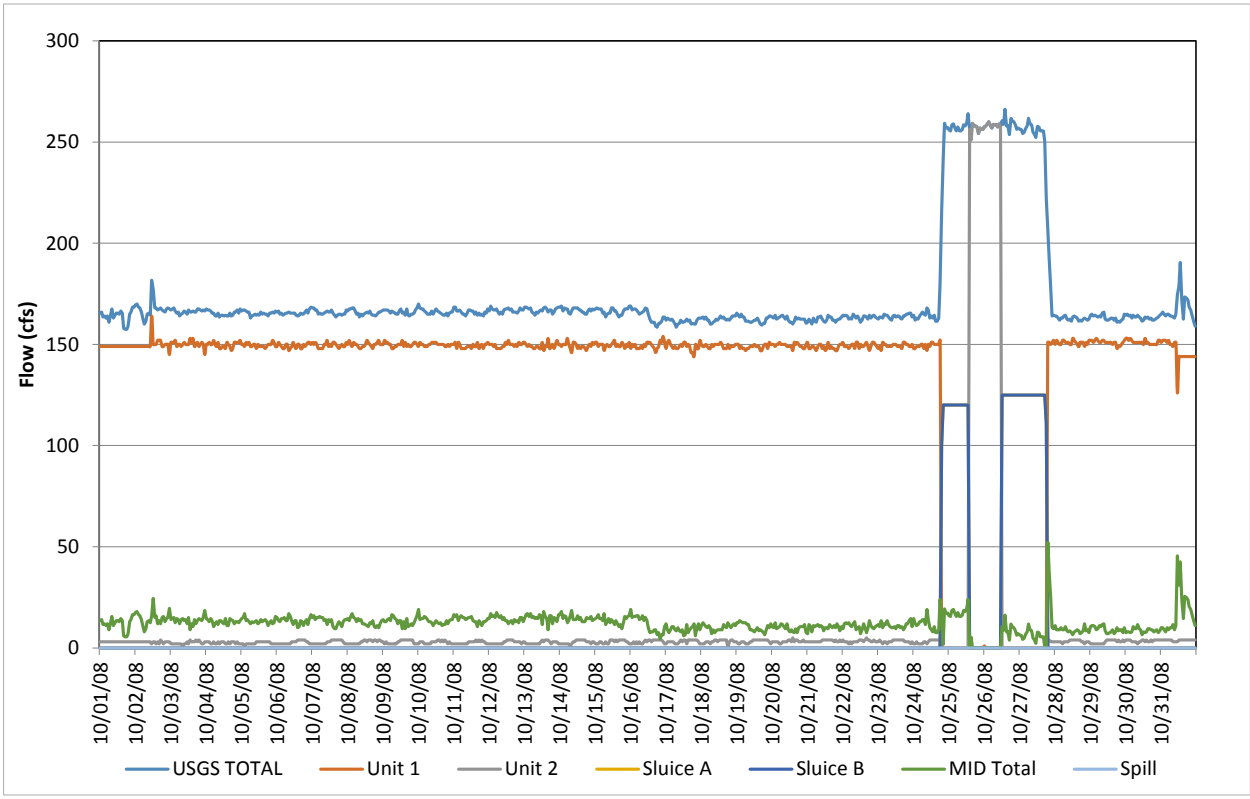

Figure C-46. Flow record in October 2008, based on hourly discharges.

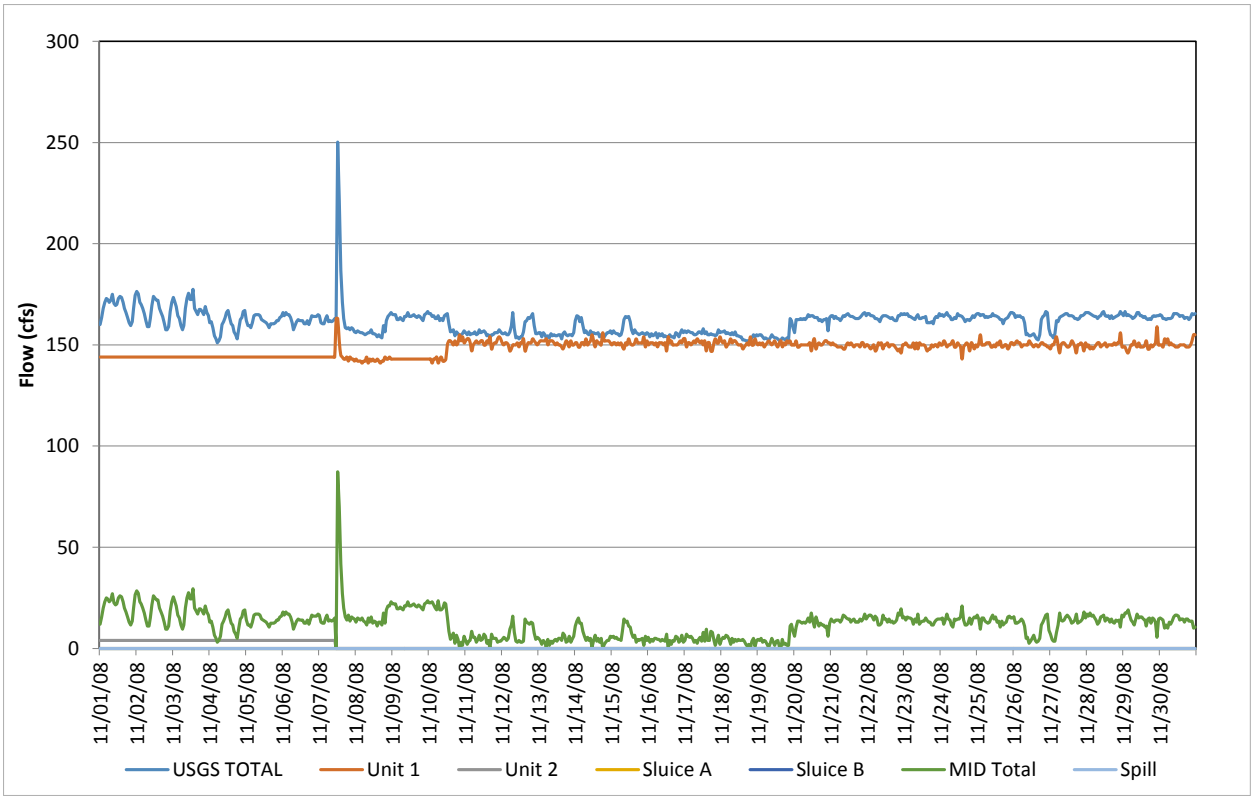

Figure C-47. Flow record in November 2008, based on hourly discharges.

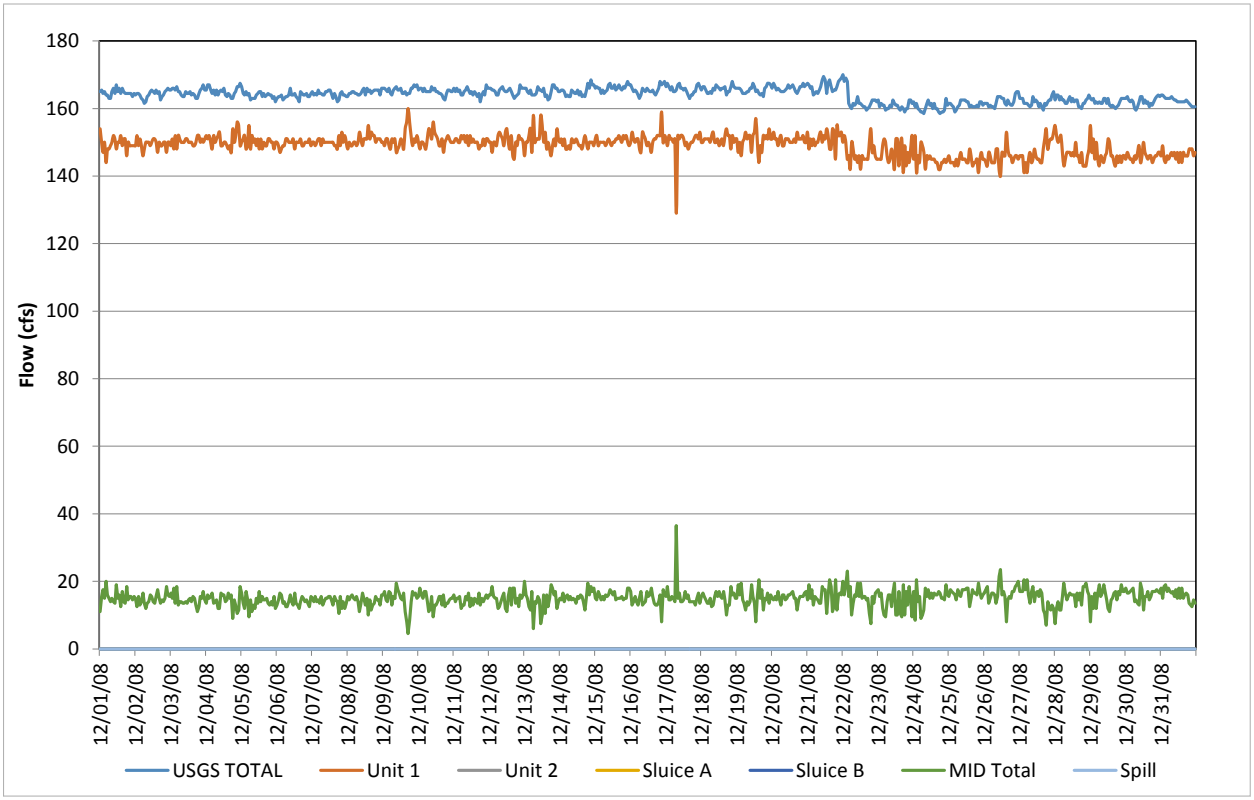

Figure C-48. Flow record in December 2008, based on hourly discharges.

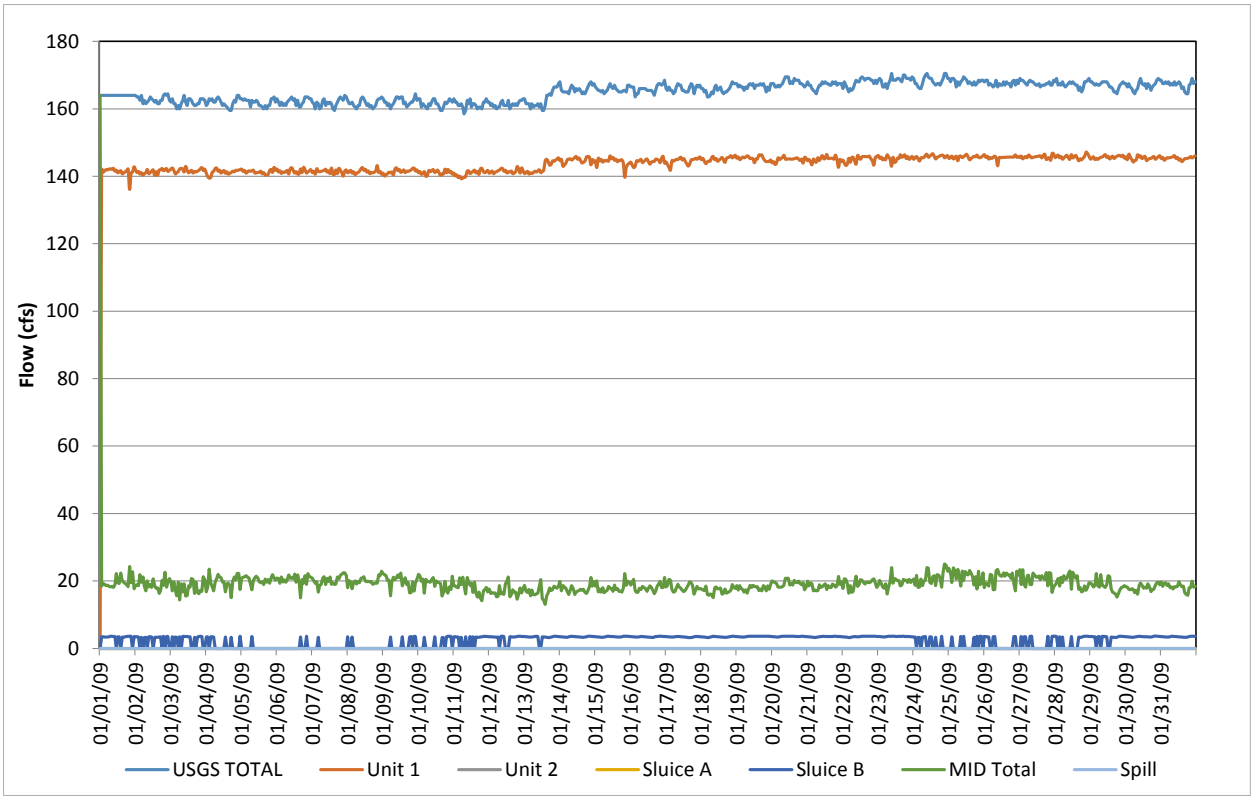

Figure C-49. Flow record in January 2009, based on hourly discharges.

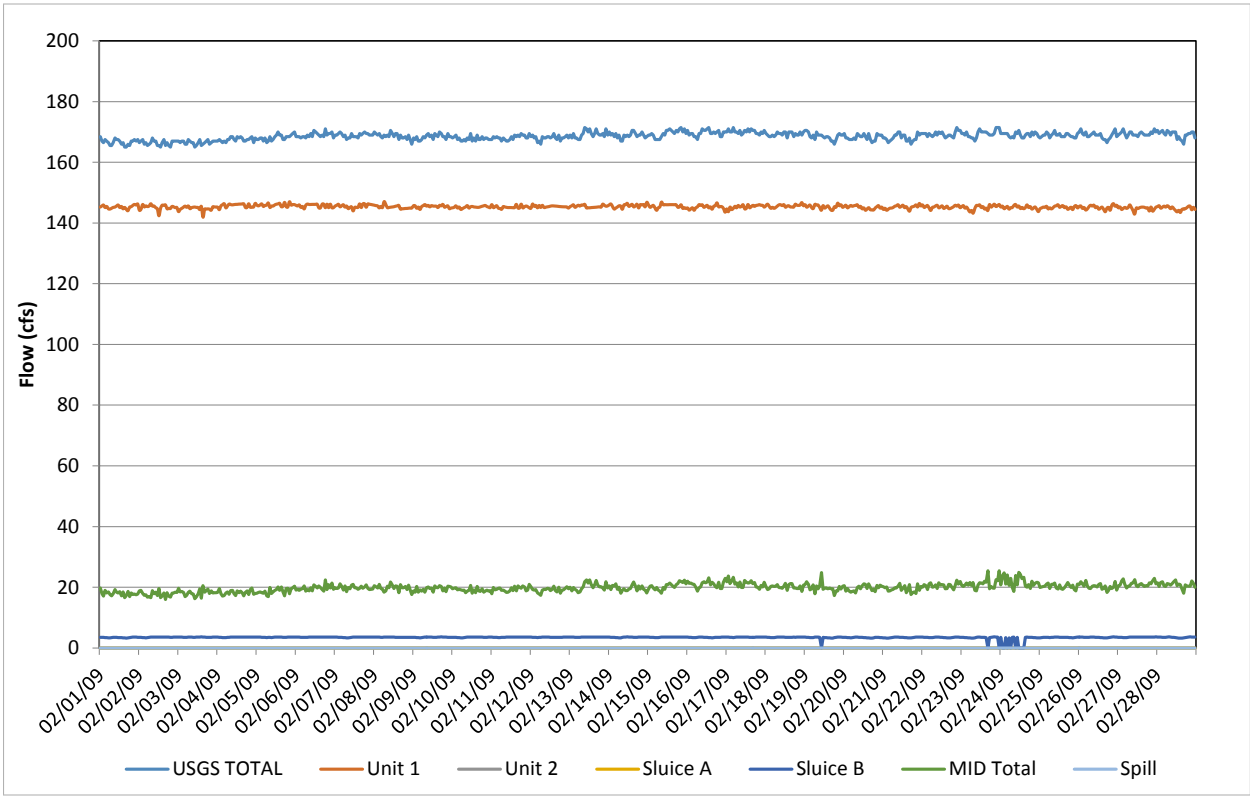

Figure C-50. Flow record in February 2009, based on hourly discharges.

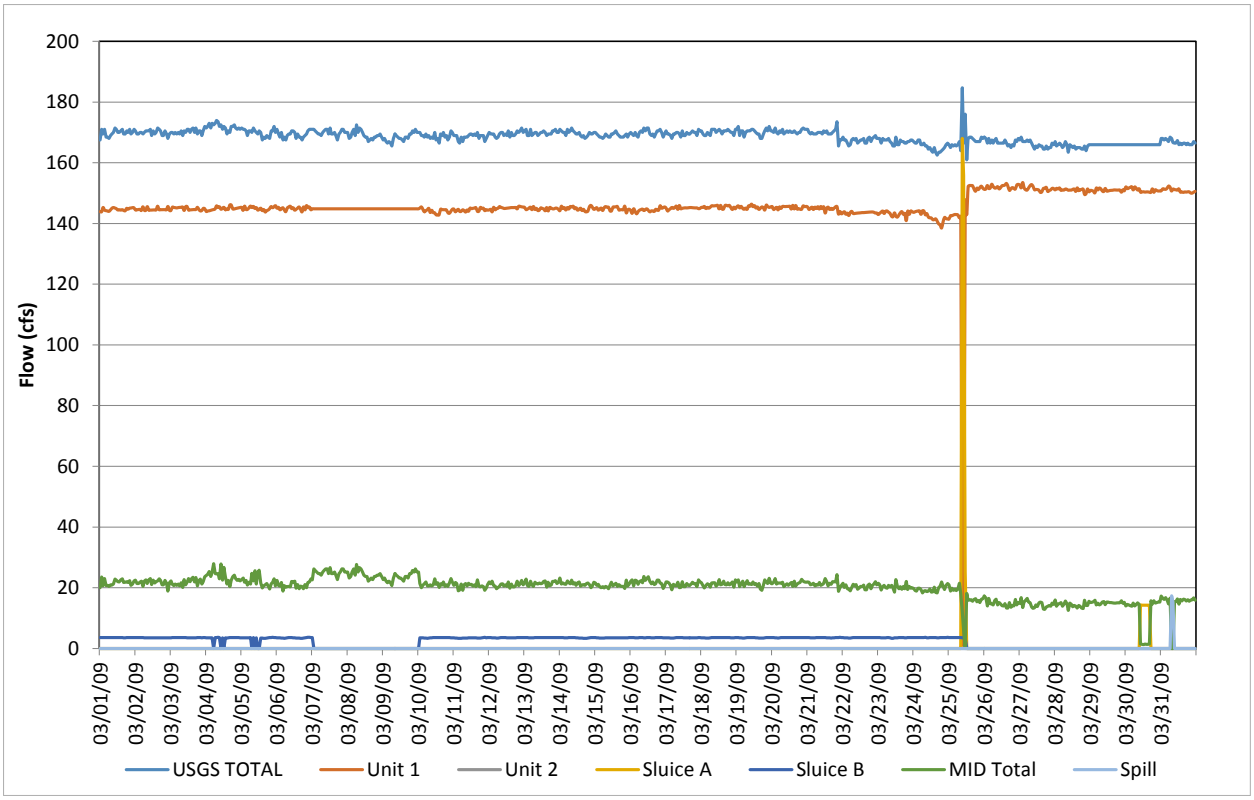

Figure C-51. Flow record in March 2009, based on hourly discharges.

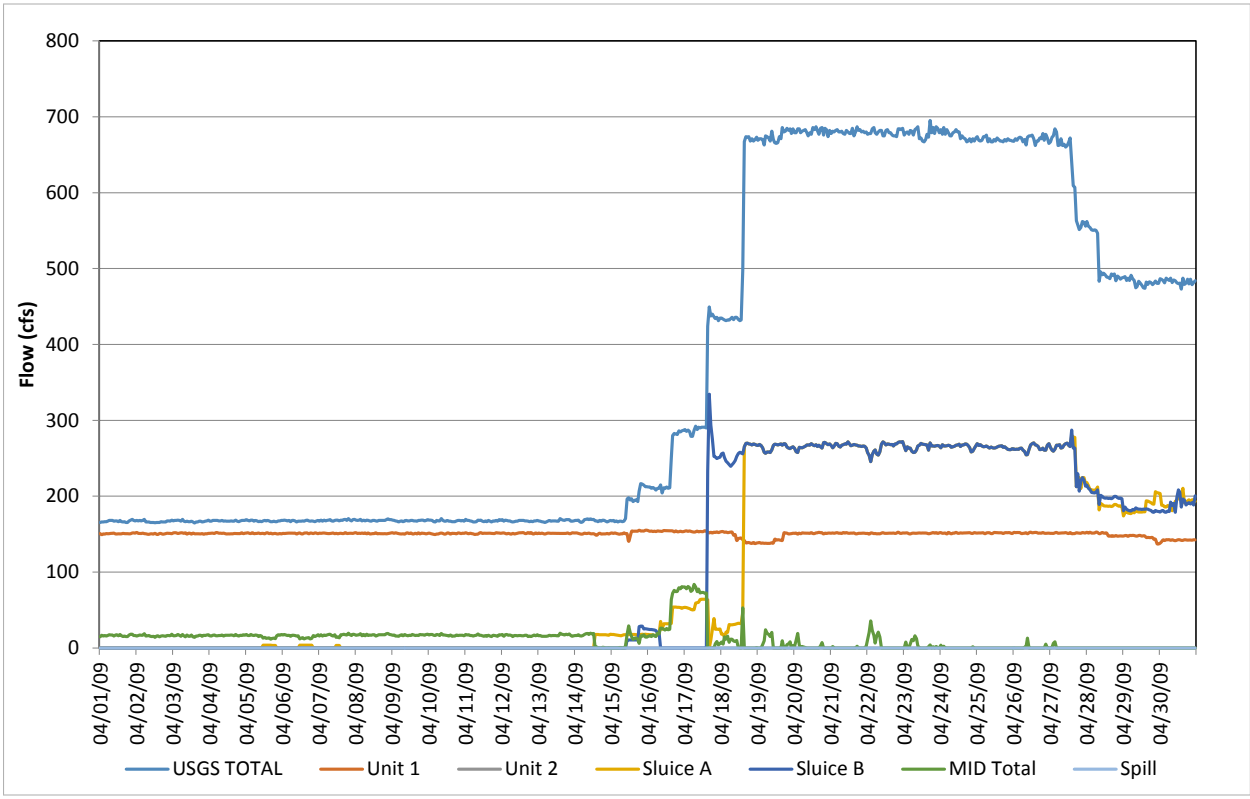

Figure C-52. Flow record in April 2009, based on hourly discharges.

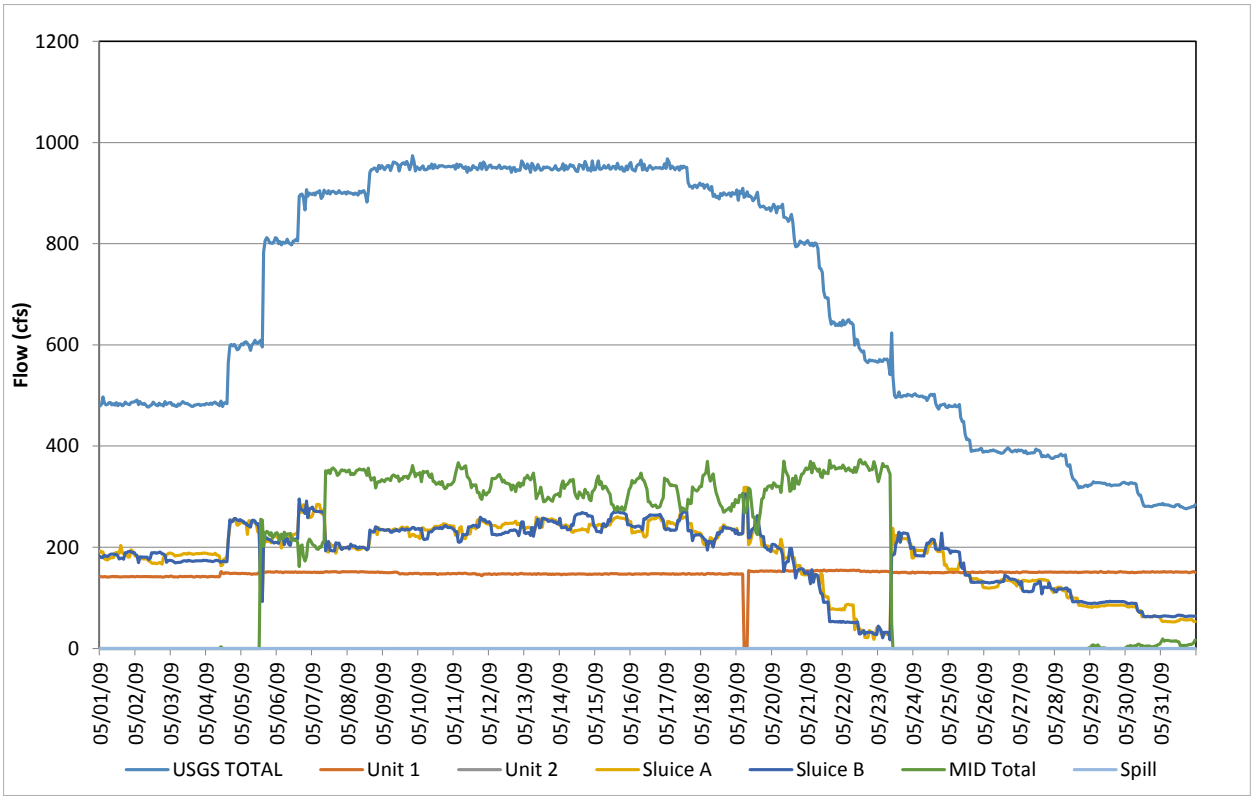

Figure C-53. Flow record in May 2009, based on hourly discharges.

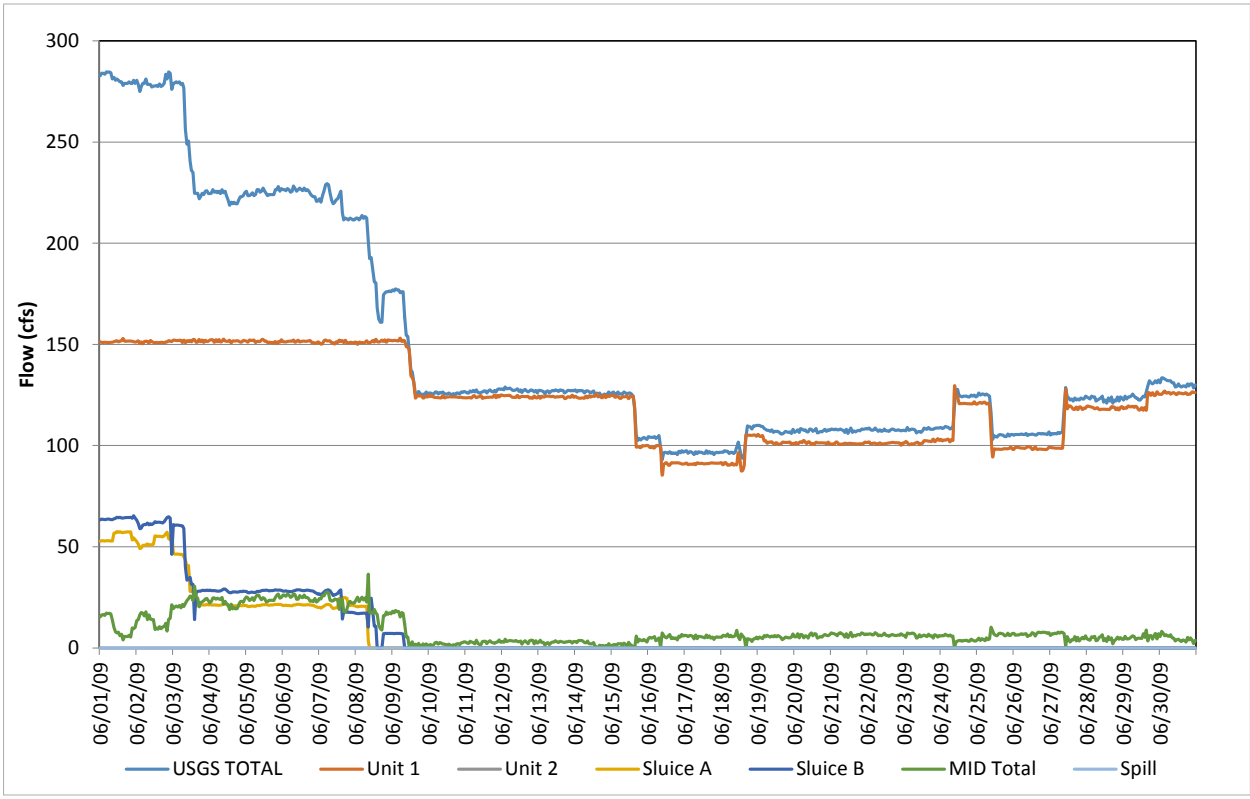

Figure C-54. Flow record in June 2009, based on hourly discharges.

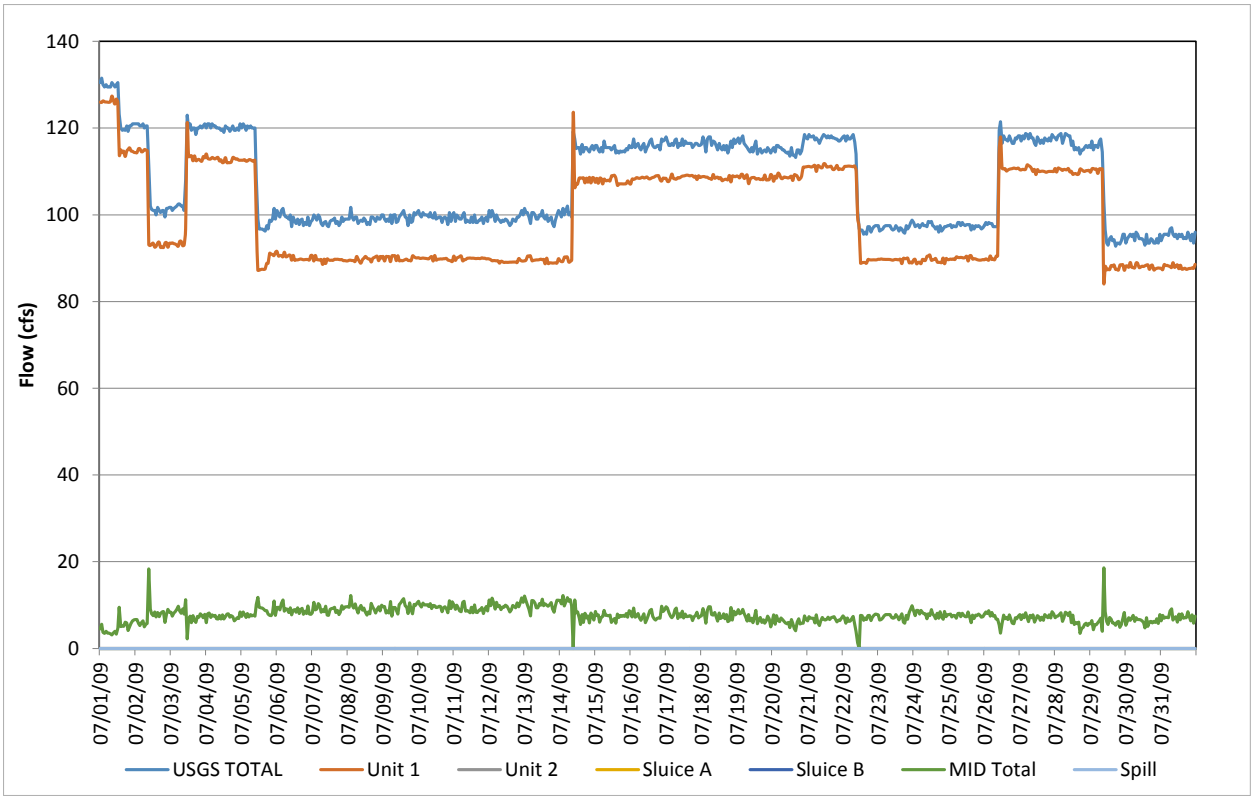

Figure C-55. Flow record in July 2009, based on hourly discharges.

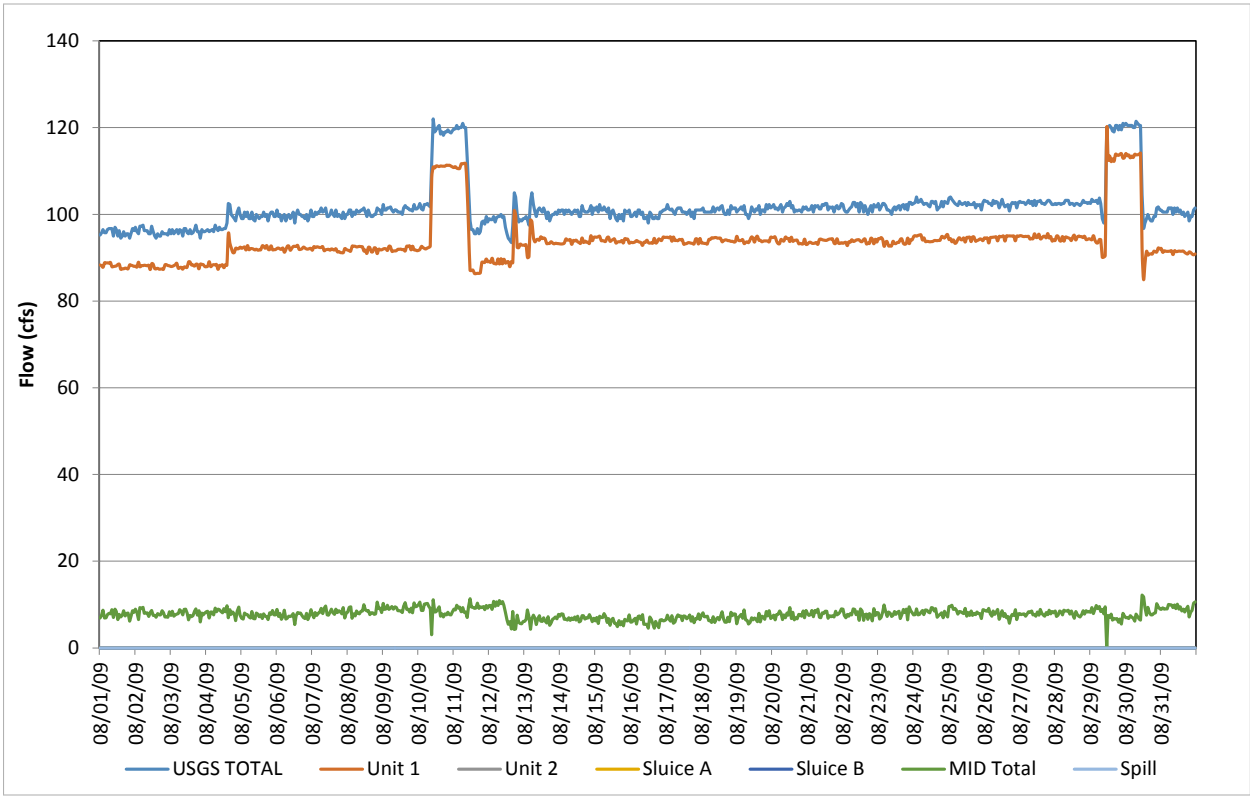

Figure C-56. Flow record in August 2009, based on hourly discharges.

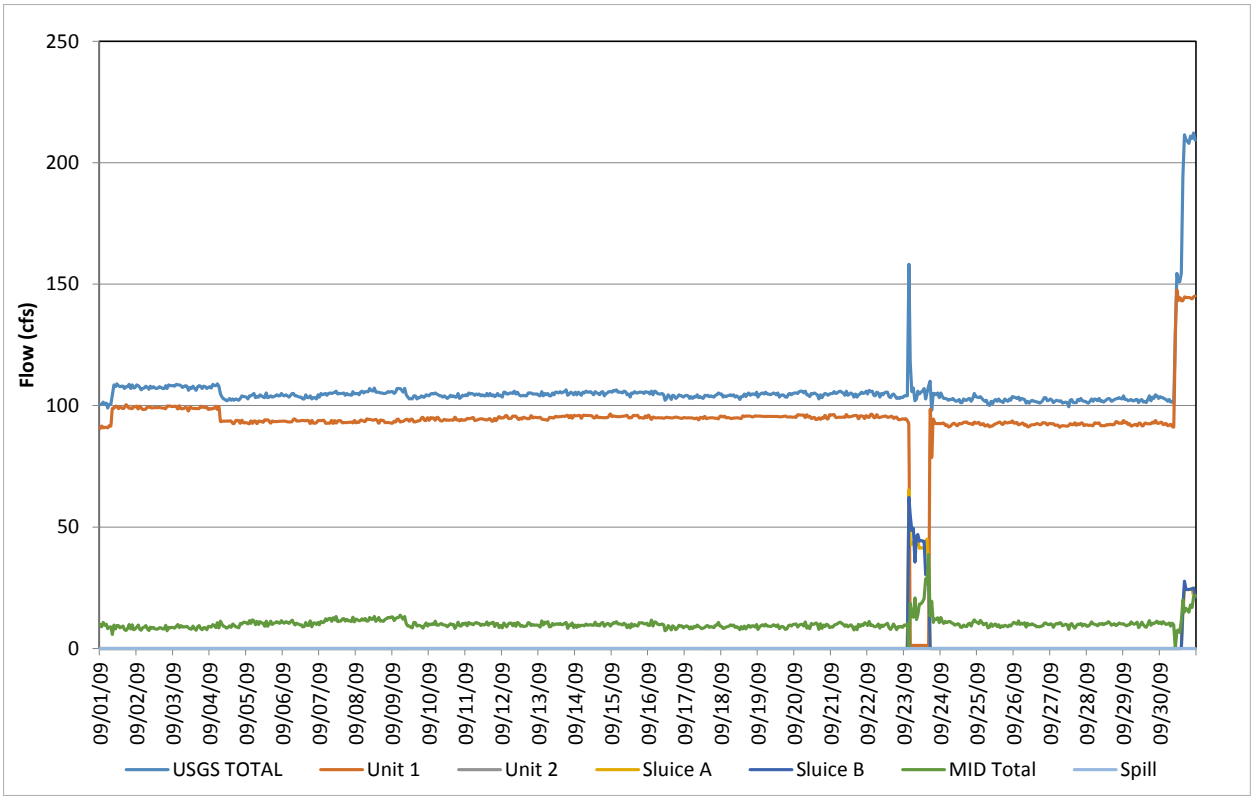

Figure C-57. Flow record in September 2009, based on hourly discharges.

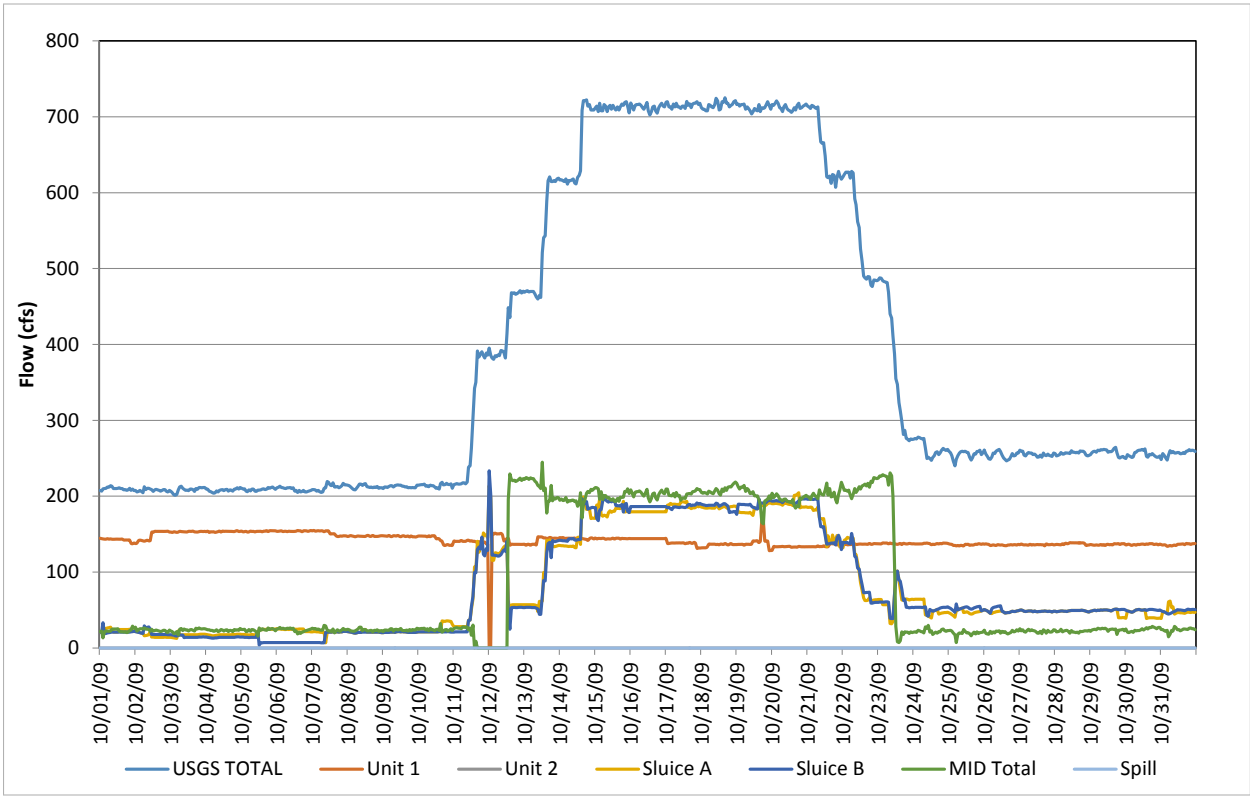

Figure C-58. Flow record in October 2009, based on hourly discharges.

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

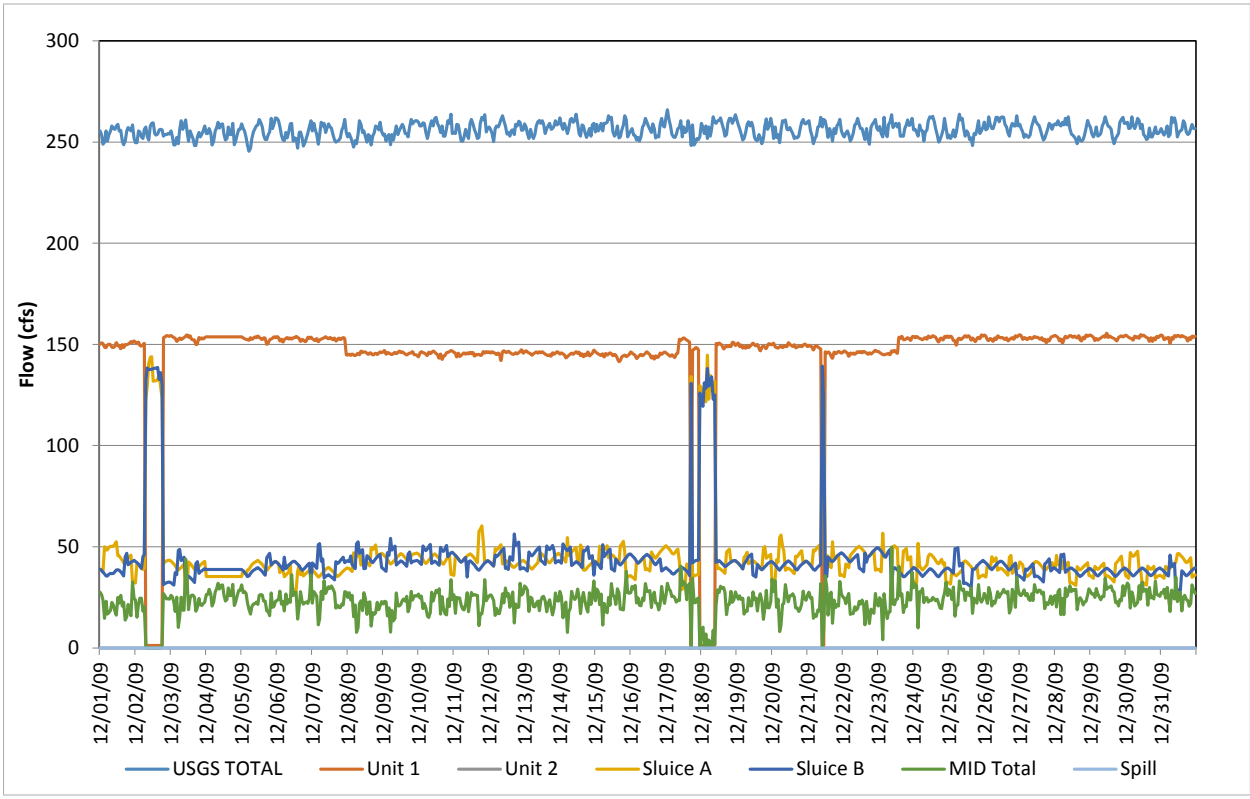

Figure C-60. Flow record in December 2009, based on hourly discharges.

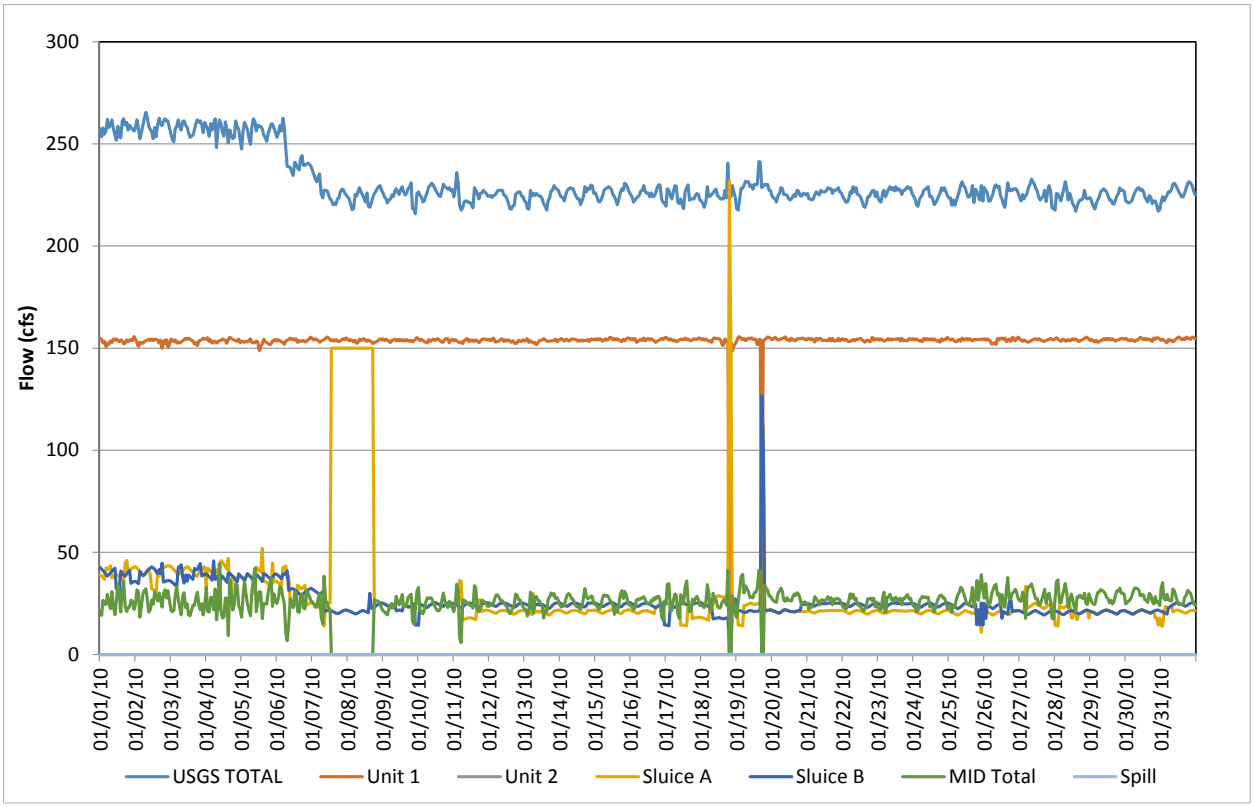

Figure C-61. Flow record in January 2010, based on hourly discharges.

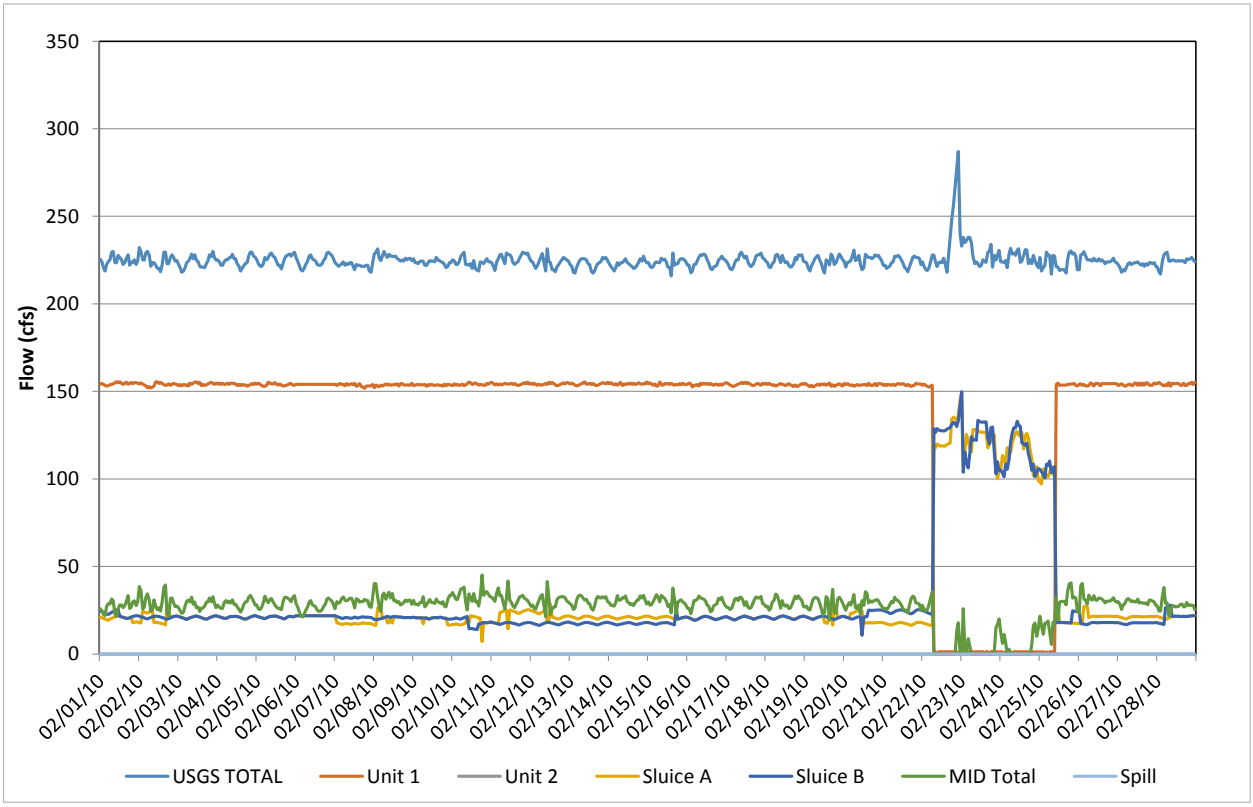

Figure C-62. Flow record in February 2010, based on hourly discharges.

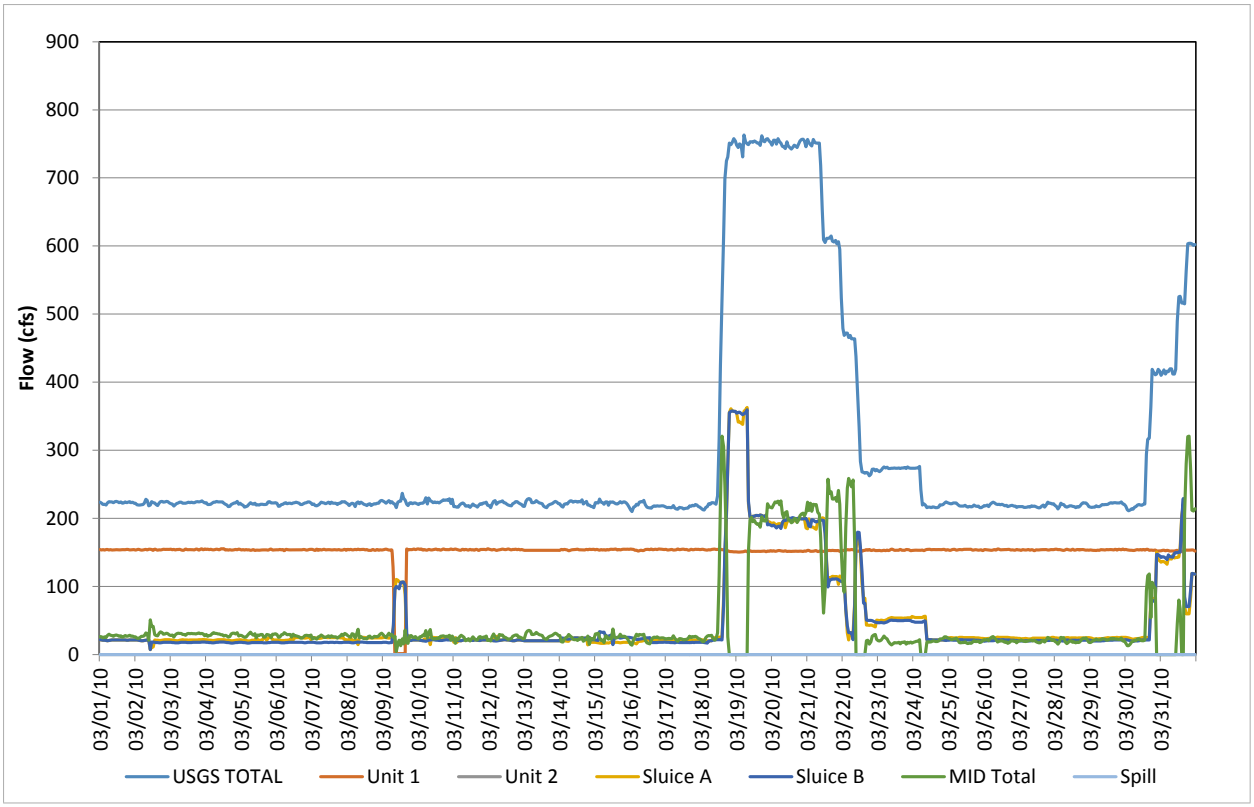

Figure C-63. Flow record in March 2010, based on hourly discharges.

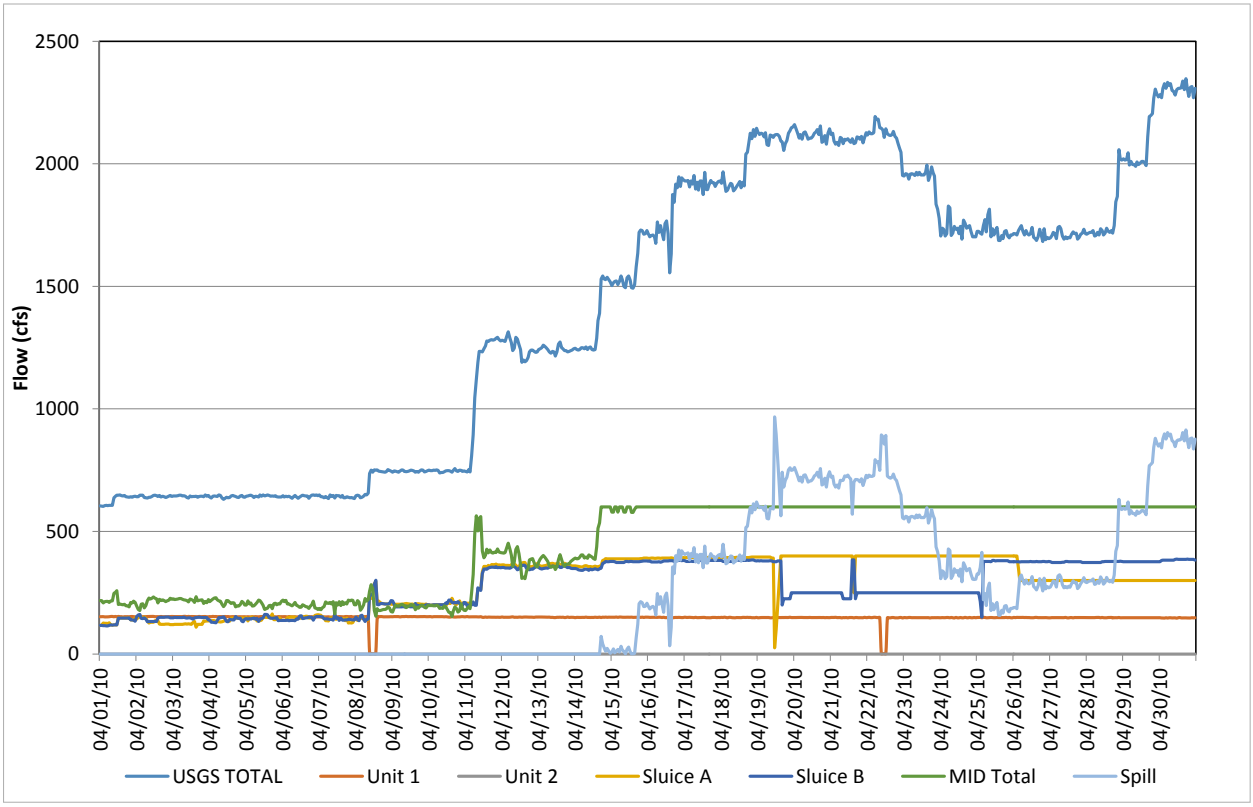

Figure C-64. Flow record in April 2010, based on hourly discharges.

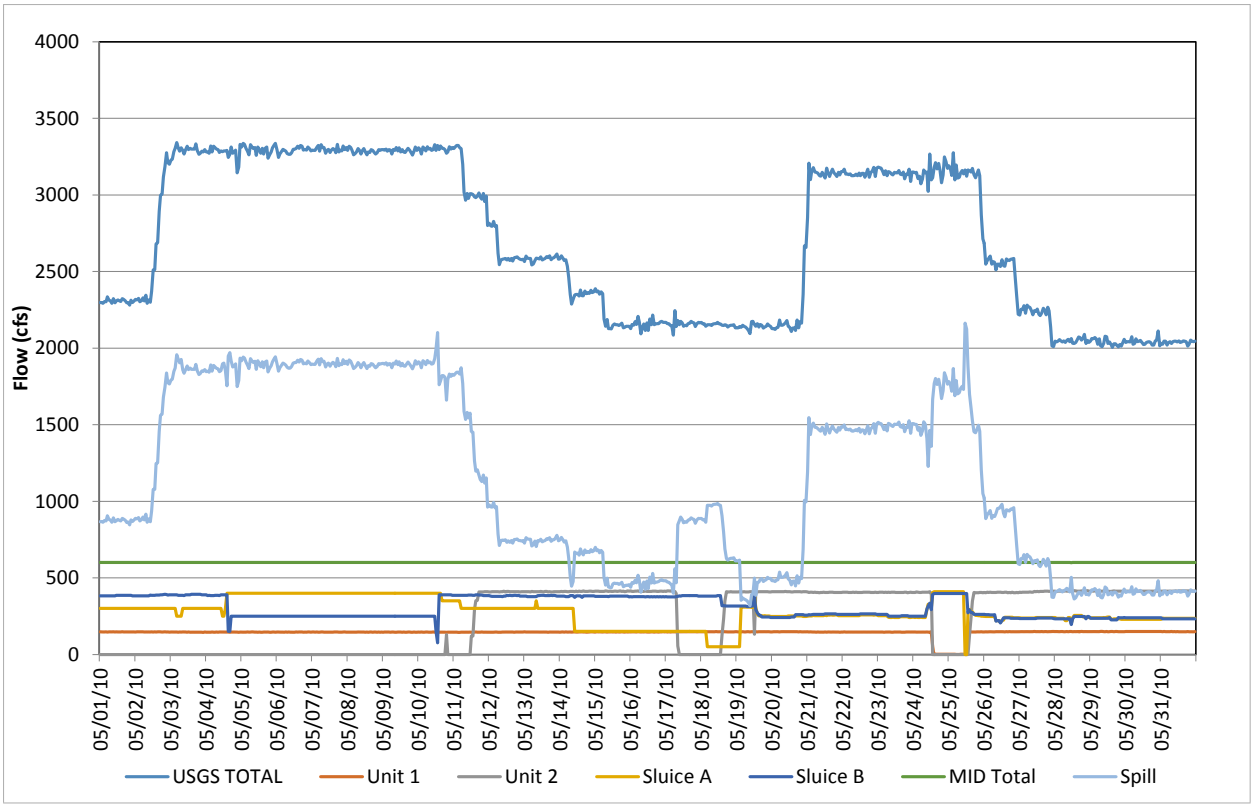

Figure C-65. Flow record in May 2010, based on hourly discharges.

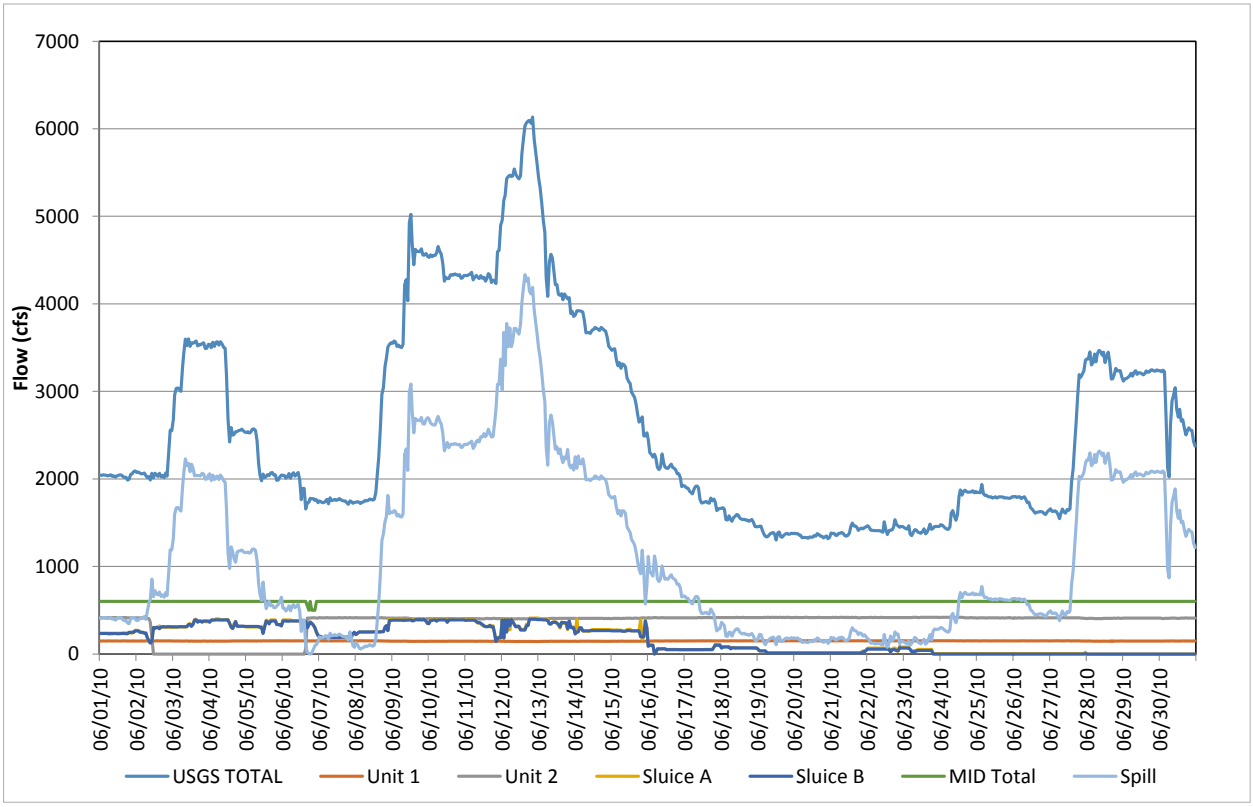

Figure C-66. Flow record in June 2010, based on hourly discharges.

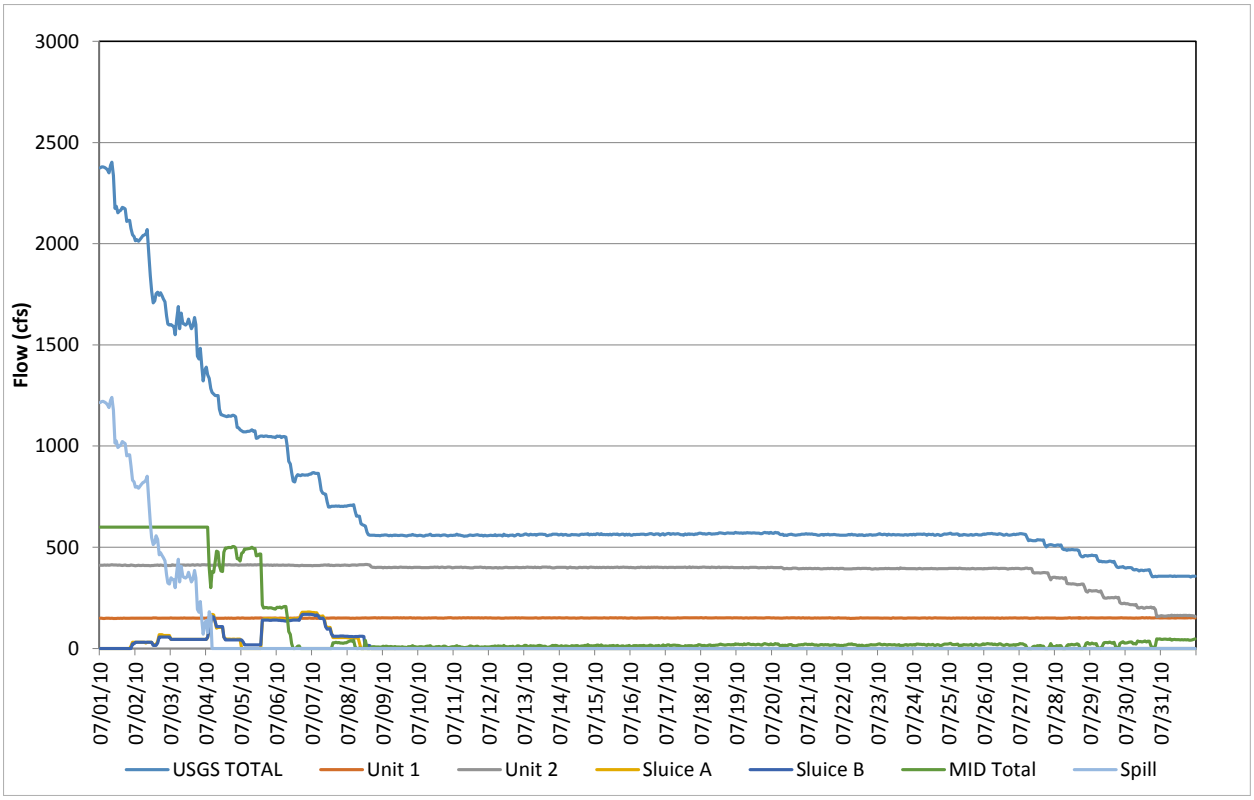

Figure C-67. Flow record in July 2010, based on hourly discharges.

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

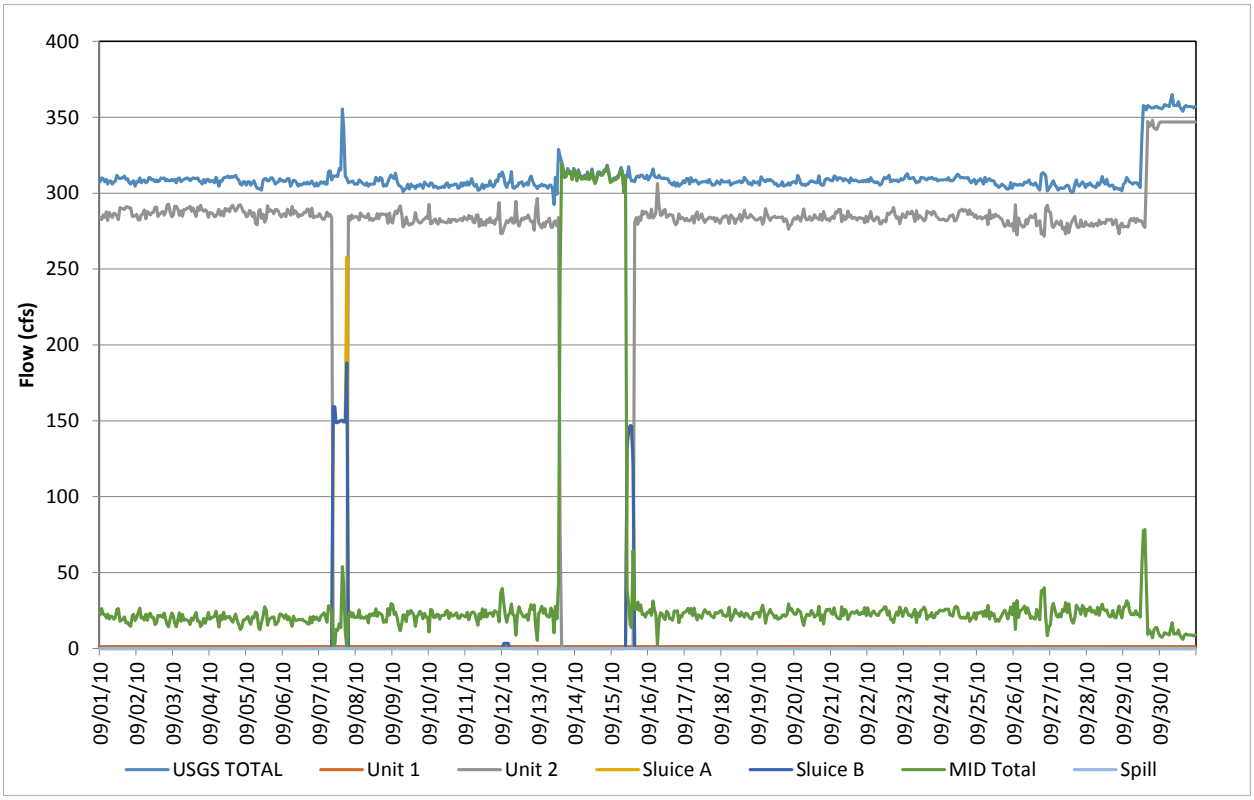

Figure C-69. Flow record in September 2010, based on hourly discharges.

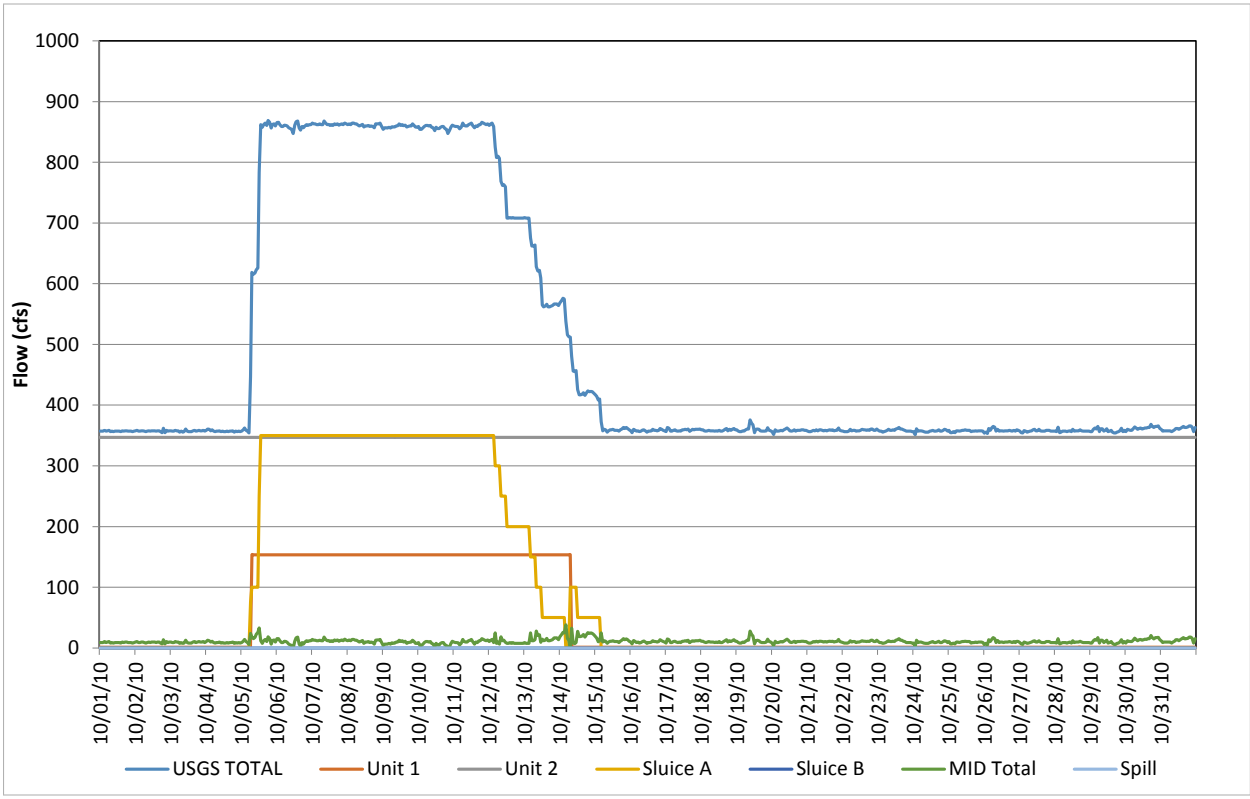

Figure C-70. Flow record in October 2010, based on hourly discharges.

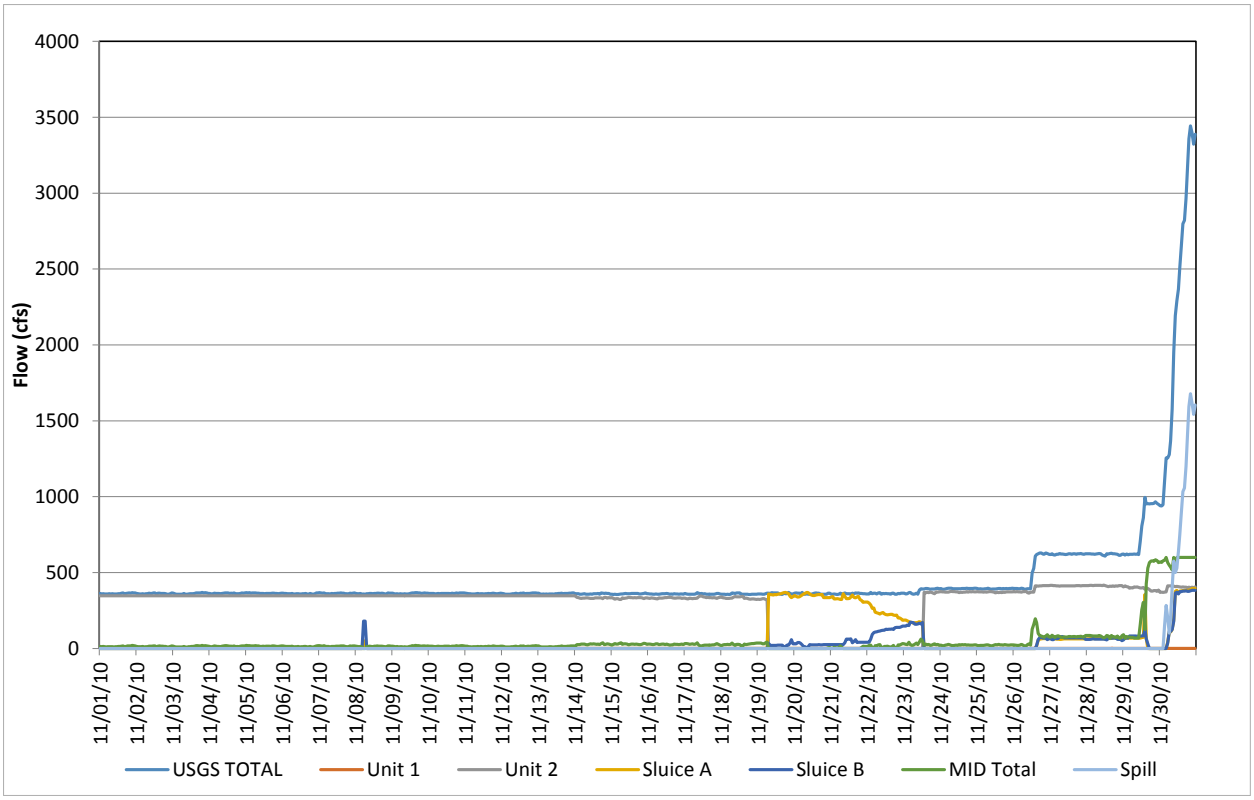

Figure C-71. Flow record in November 2010, based on hourly discharges.

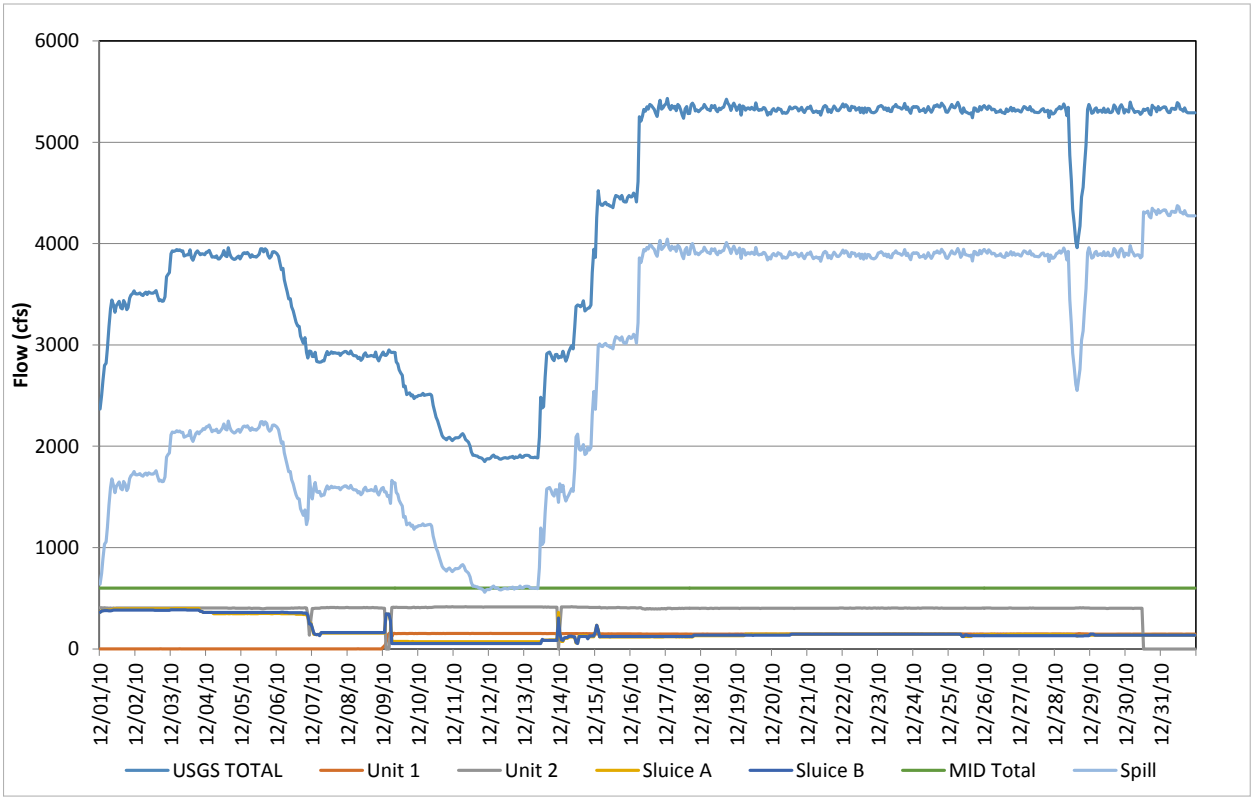

Figure C-72. Flow record in December 2010, based on hourly discharges.

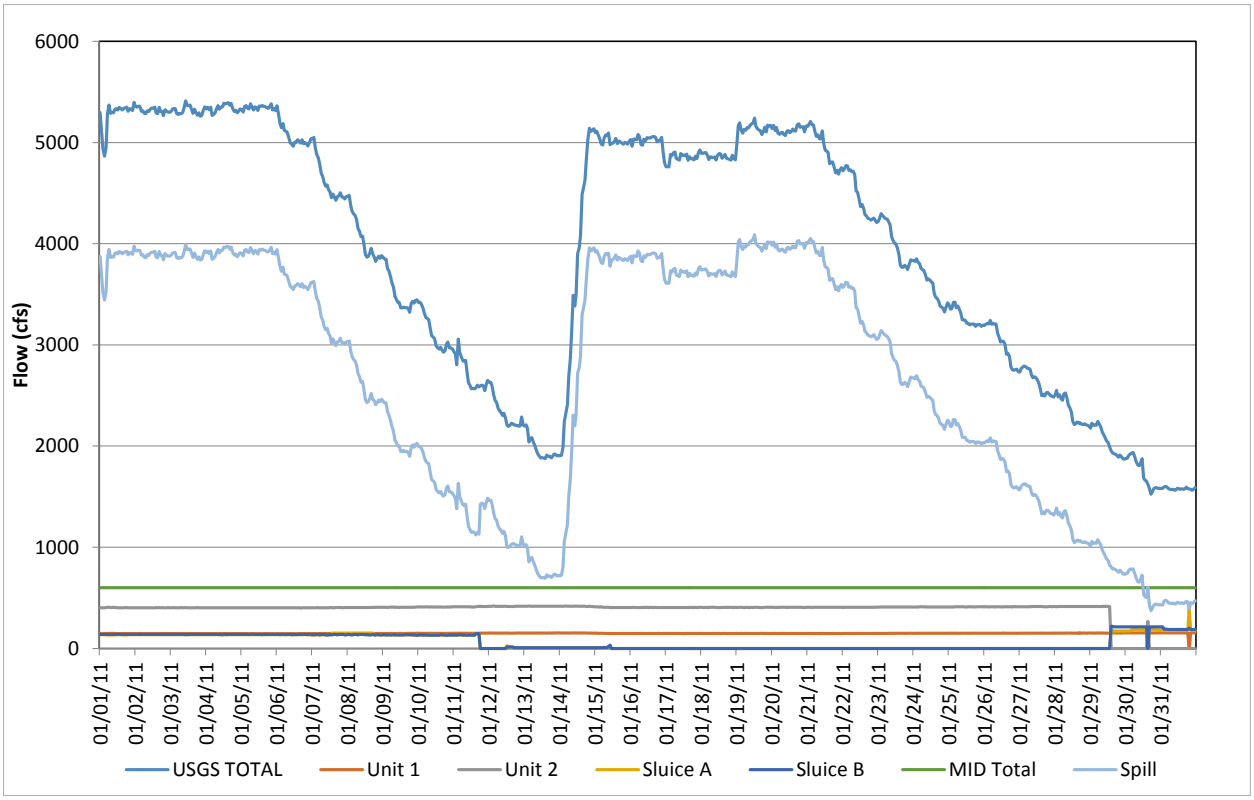

Figure C-73. Flow record in January 2011, based on hourly discharges.

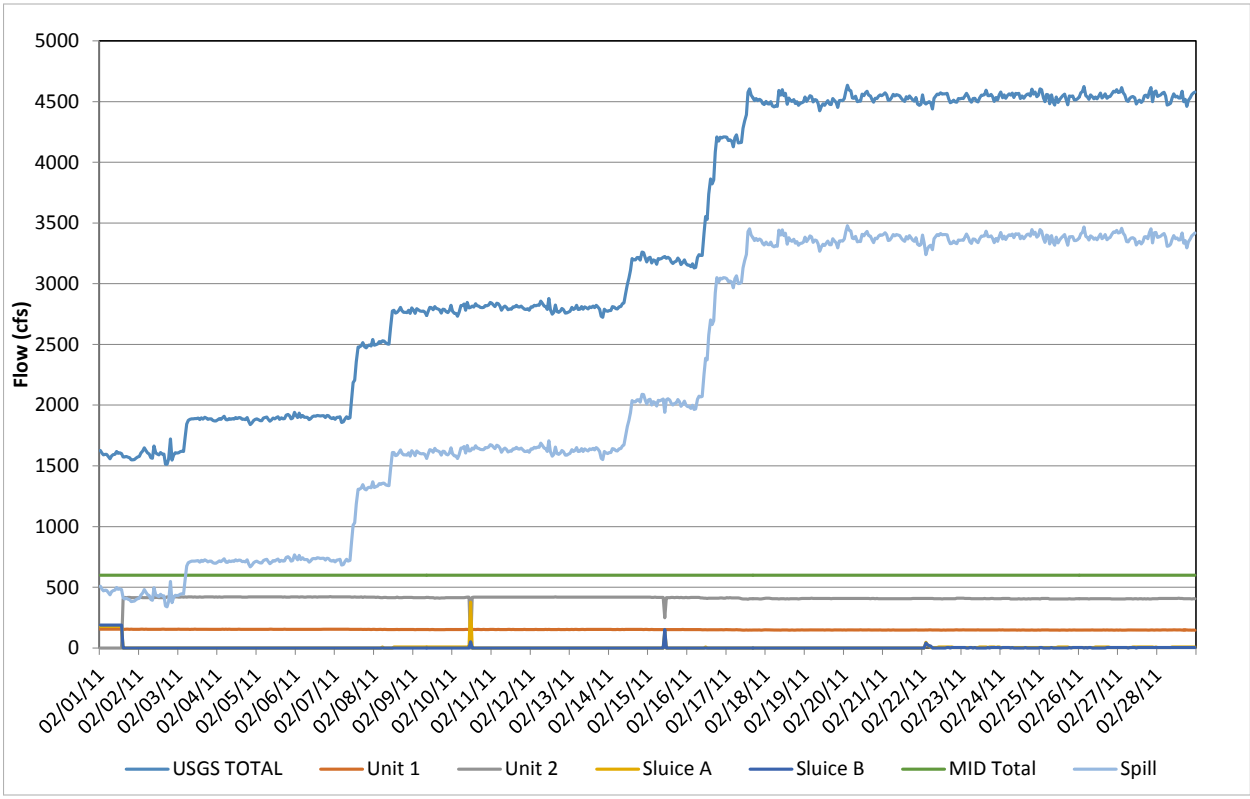

Figure C-74. Flow record in February 2011, based on hourly discharges.

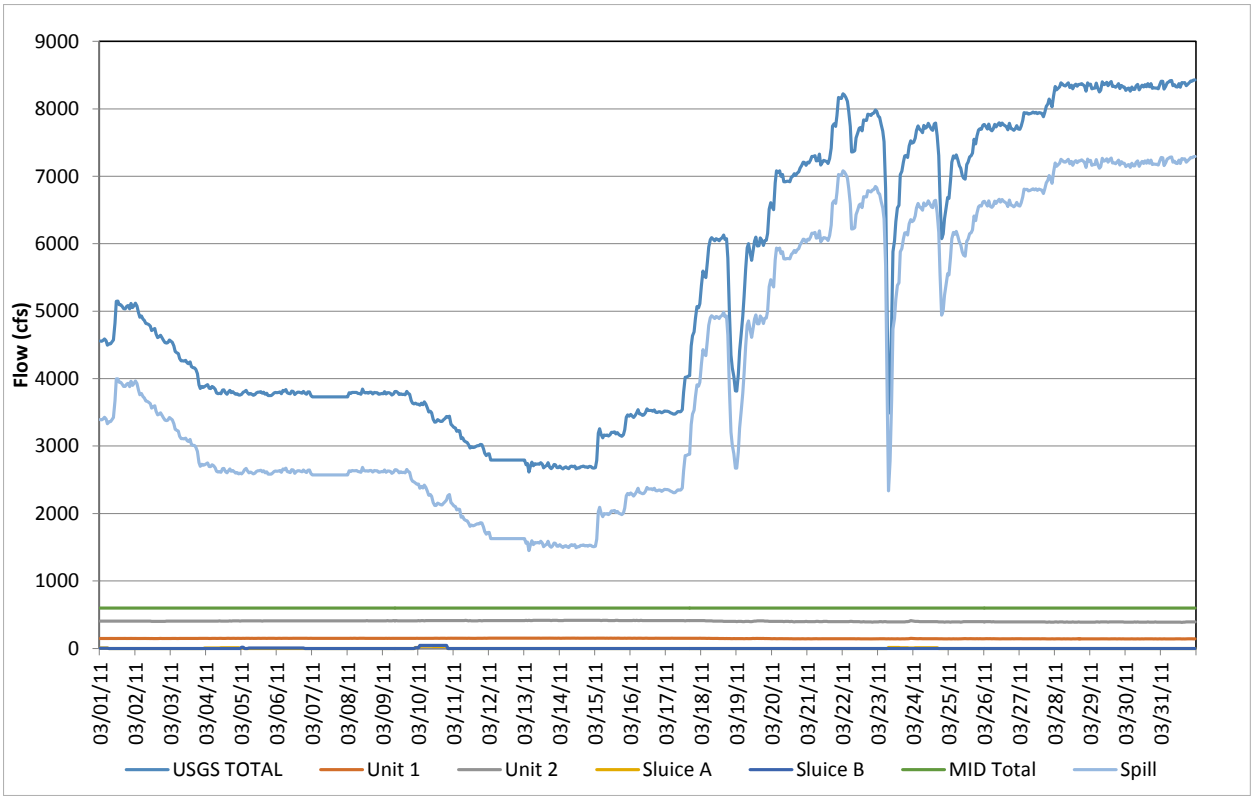

Figure C-75. Flow record in March 2011, based on hourly discharges.

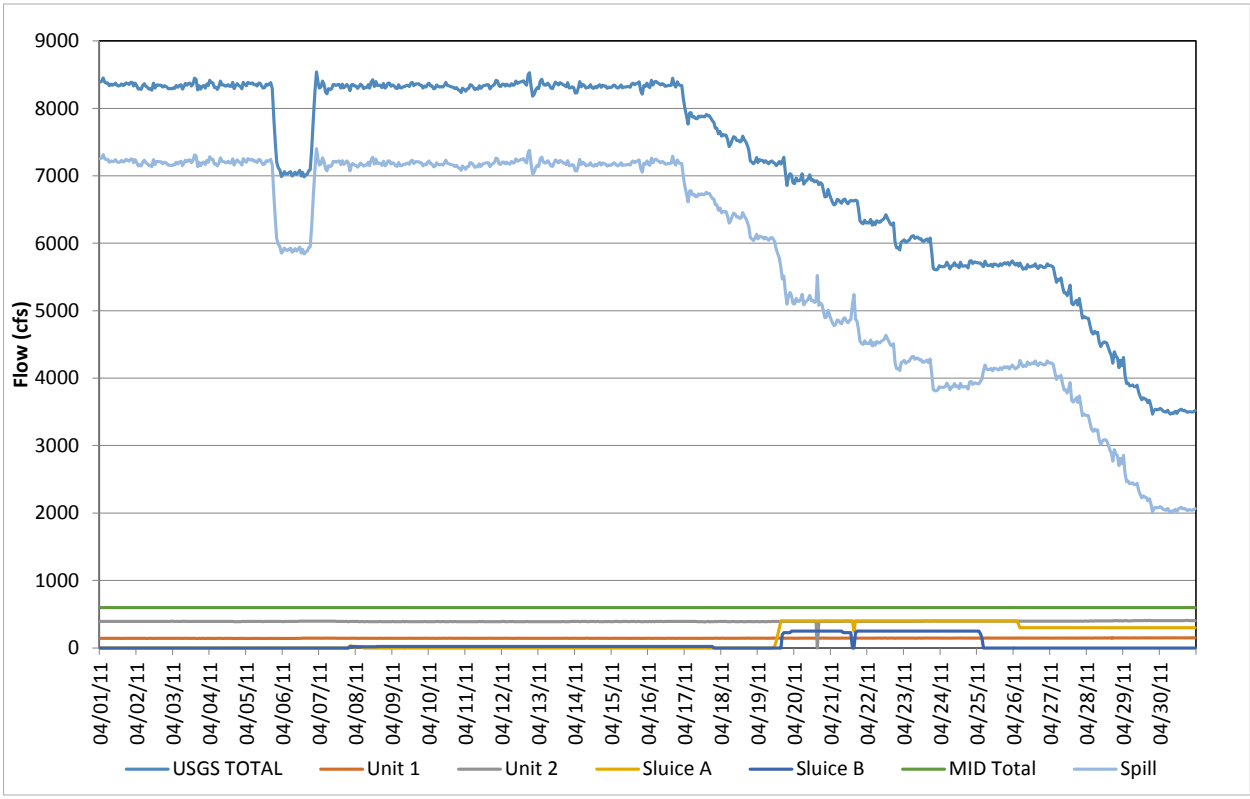

Figure C-76. Flow record in April 2011, based on hourly discharges.

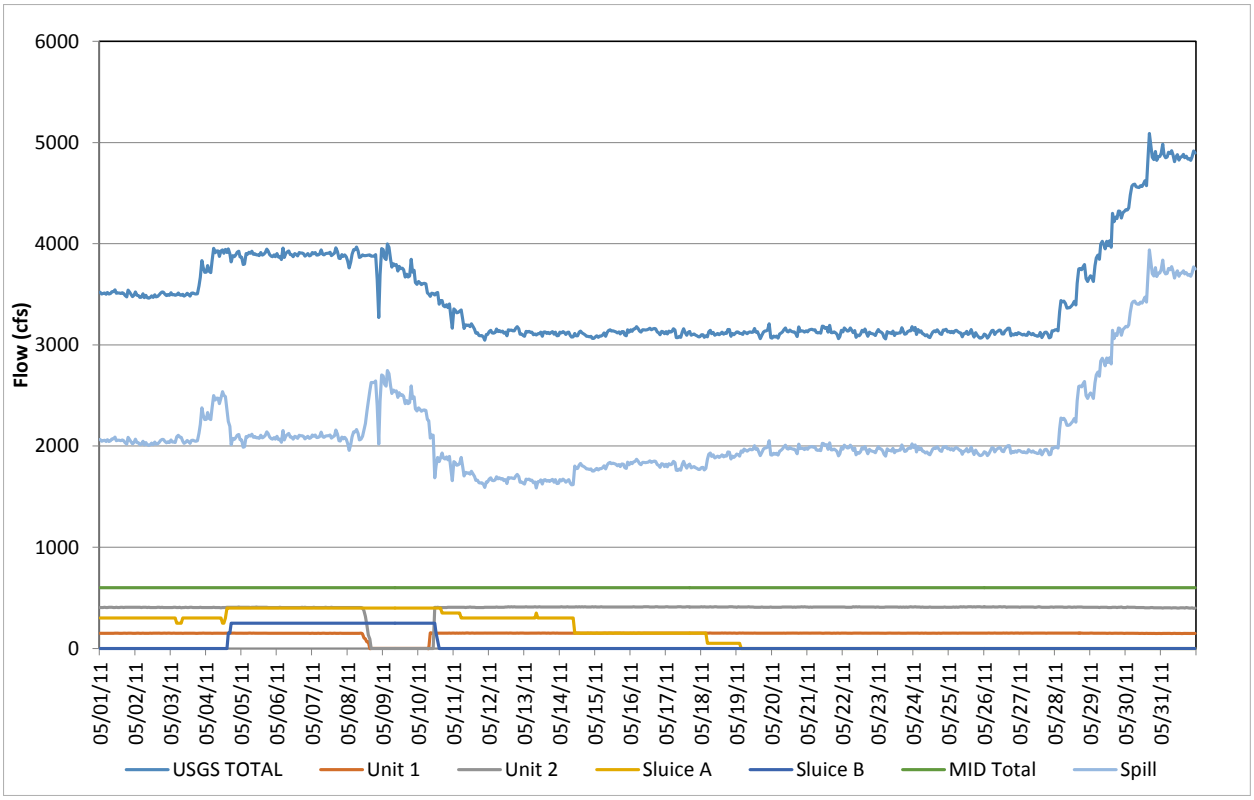

Figure C-77. Flow record in May 2011, based on hourly discharges.

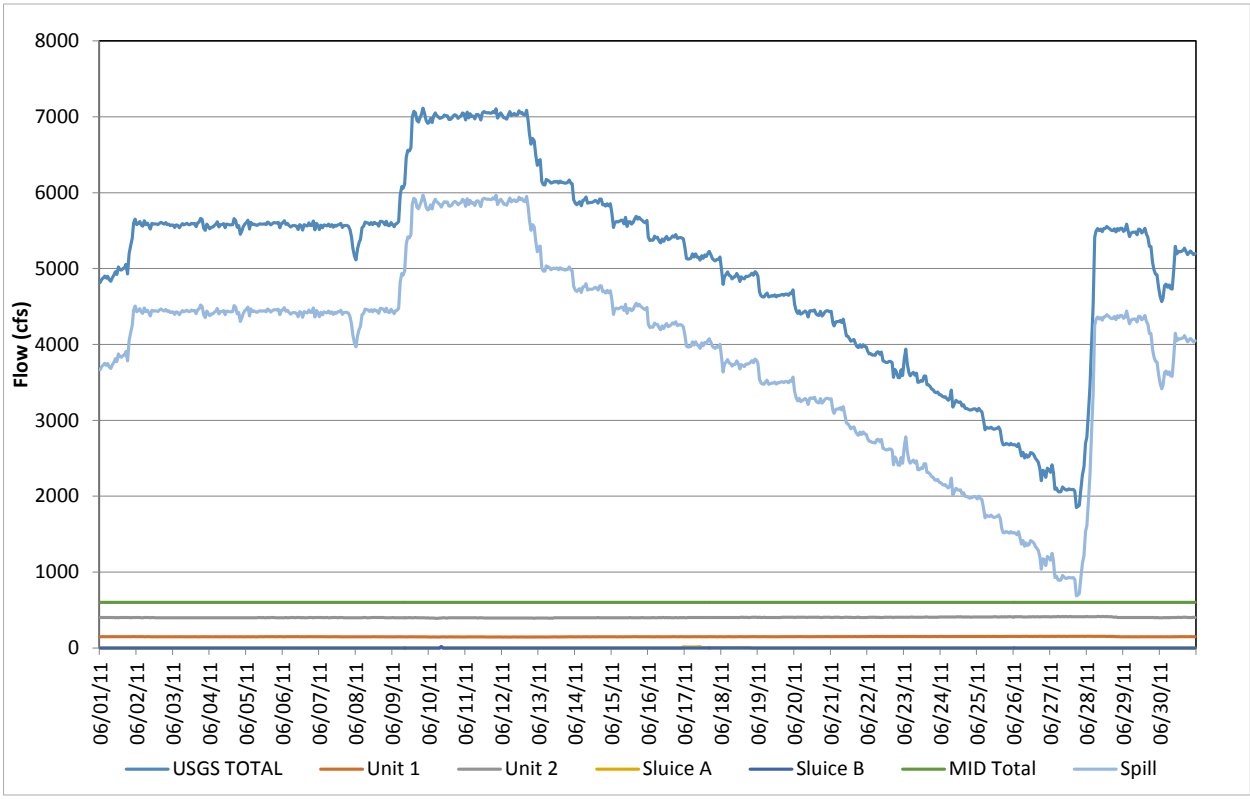

Figure C-78. Flow record in June 2011, based on hourly discharges.

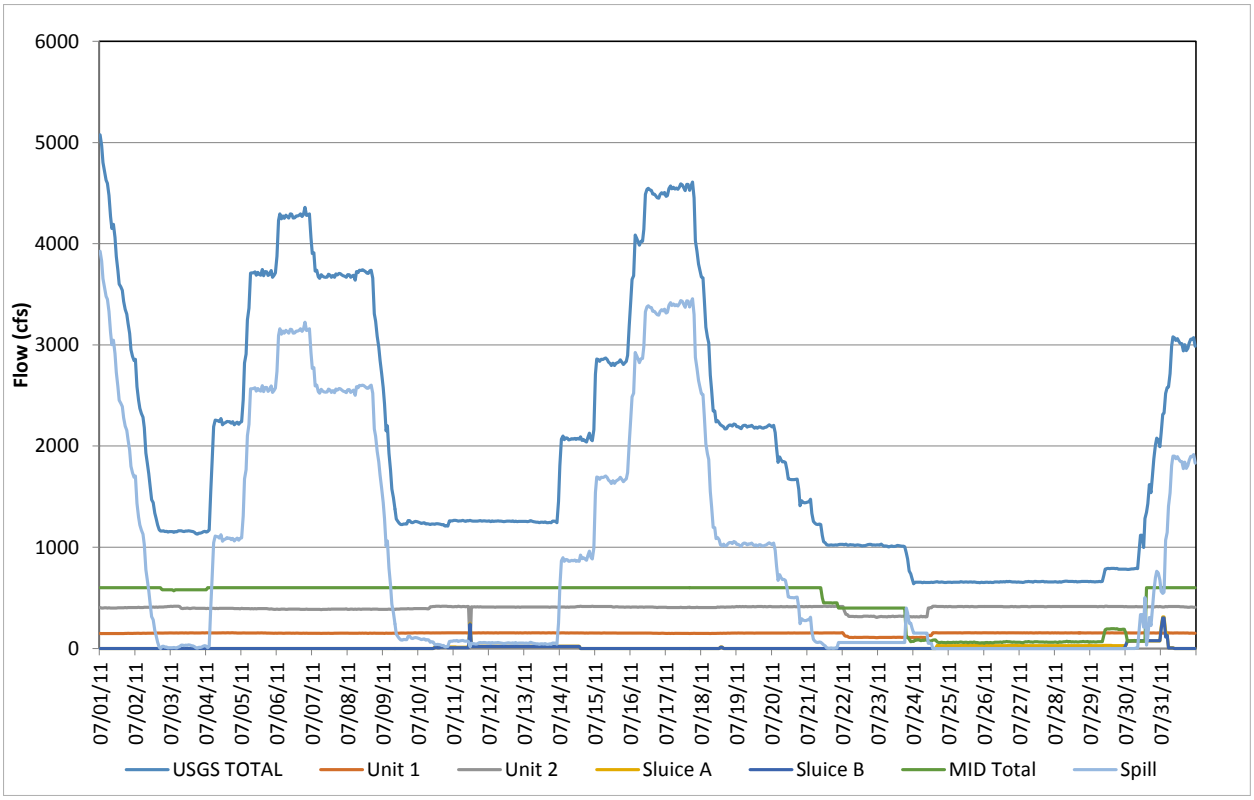

Figure C-79. Flow record in July 2011, based on hourly discharges.

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

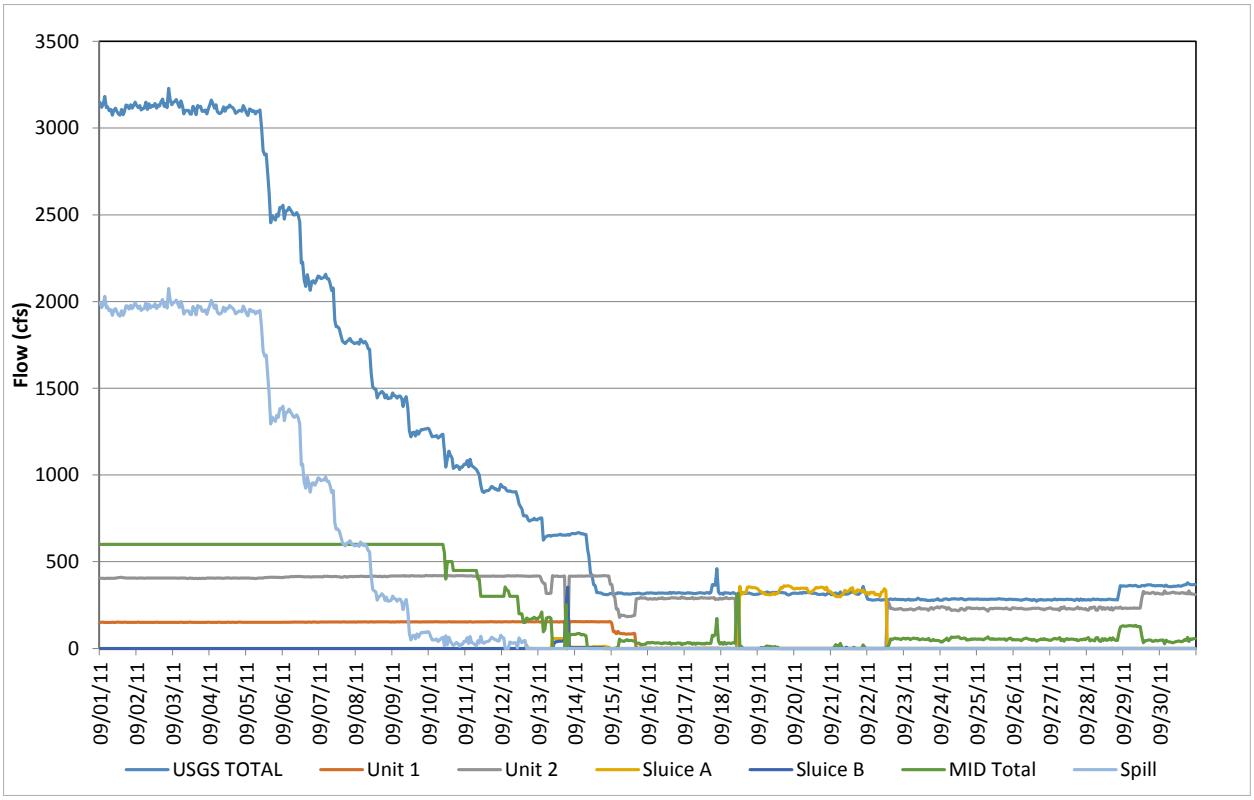

Figure C-81. Flow record in September 2011, based on hourly discharges.

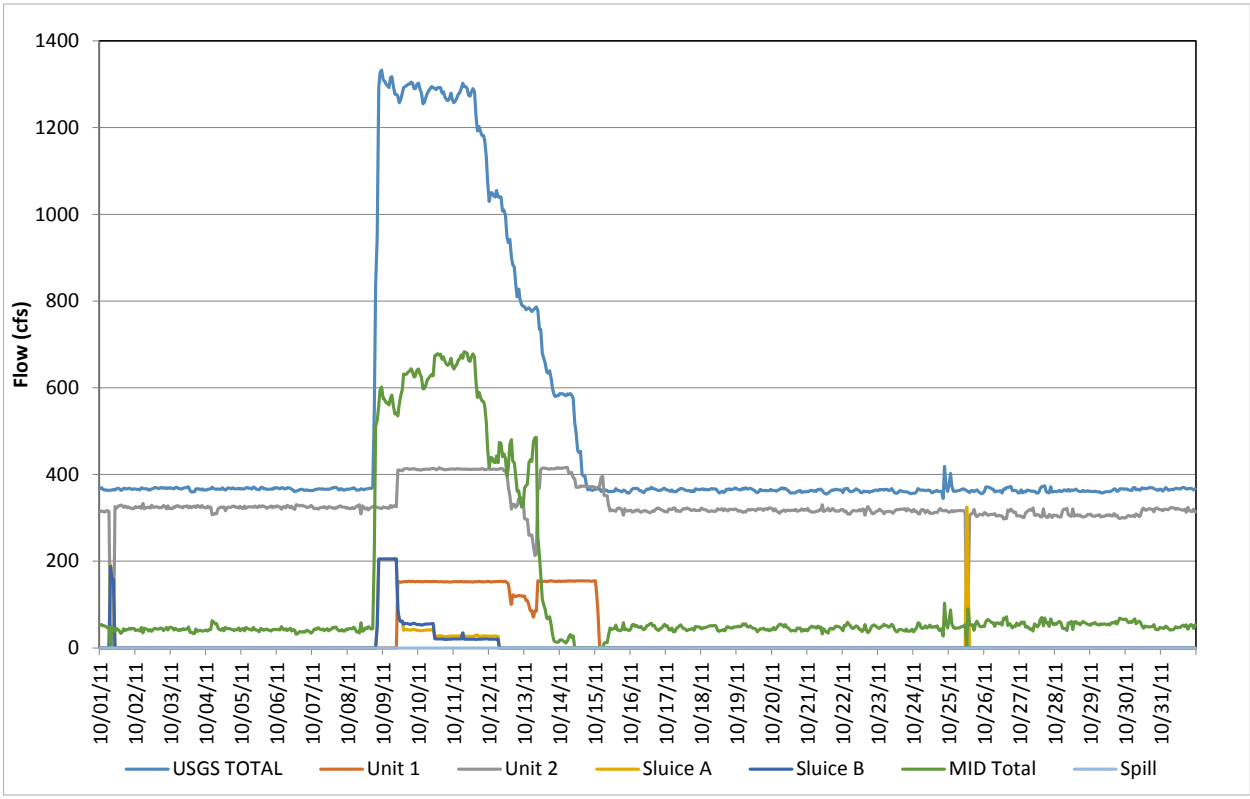

Figure C-82. Flow record in October 2011, based on hourly discharges.

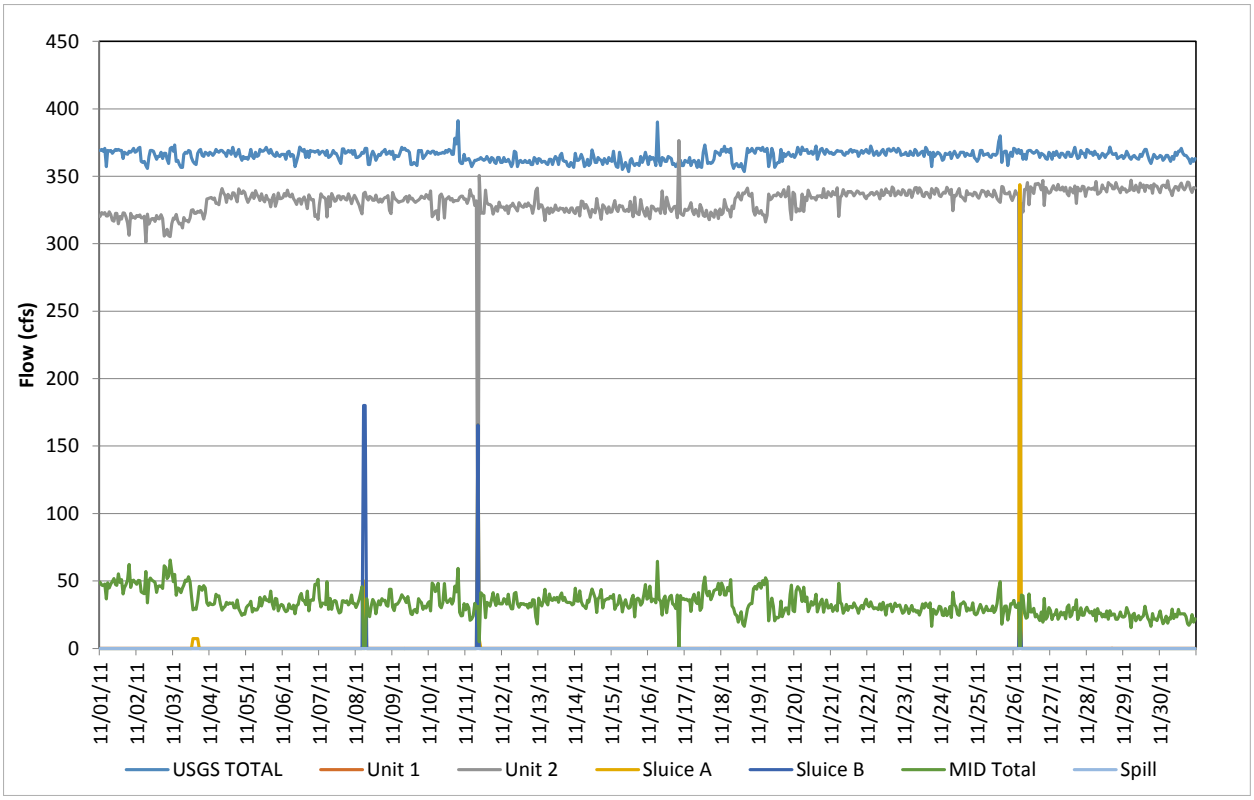

Figure C-83. Flow record in November 2011, based on hourly discharges.

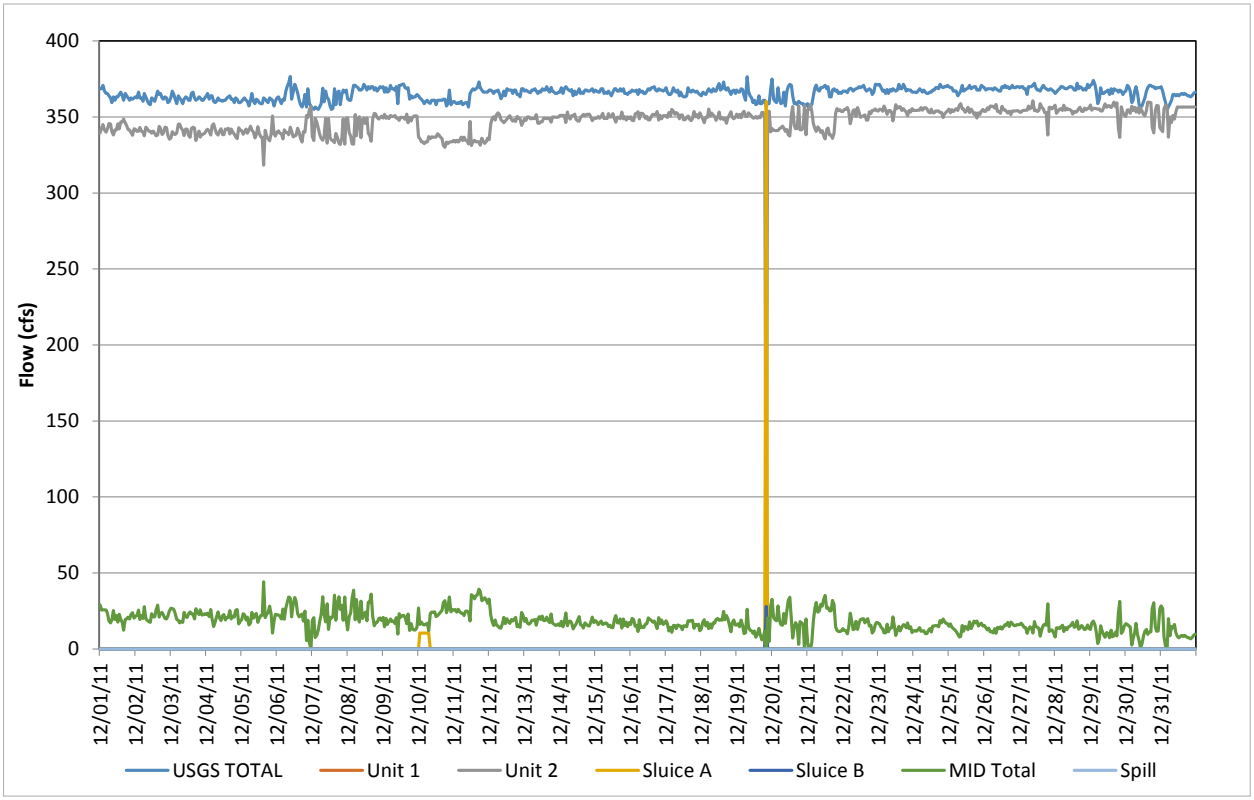

Figure C-84 Flow record in December 2011, based on hourly discharges.

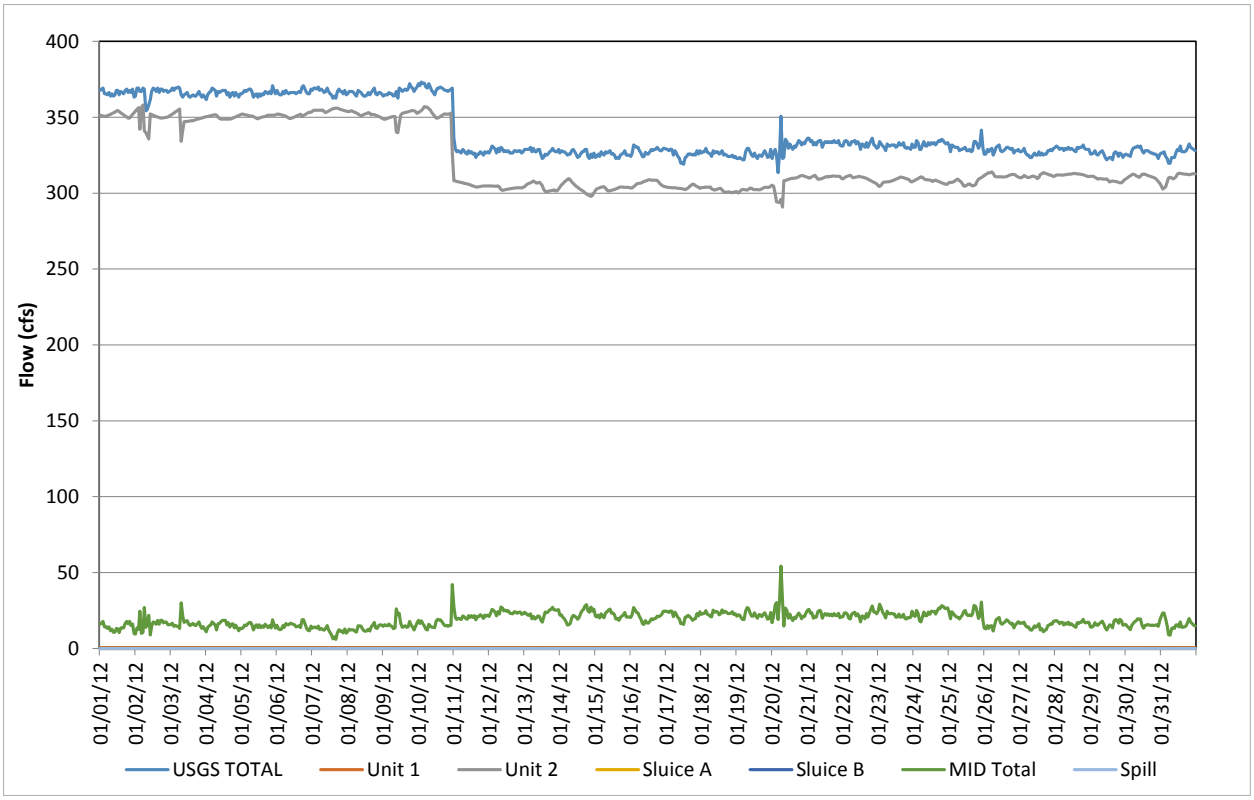

Figure C-85. Flow record in January 2012, based on hourly discharges.

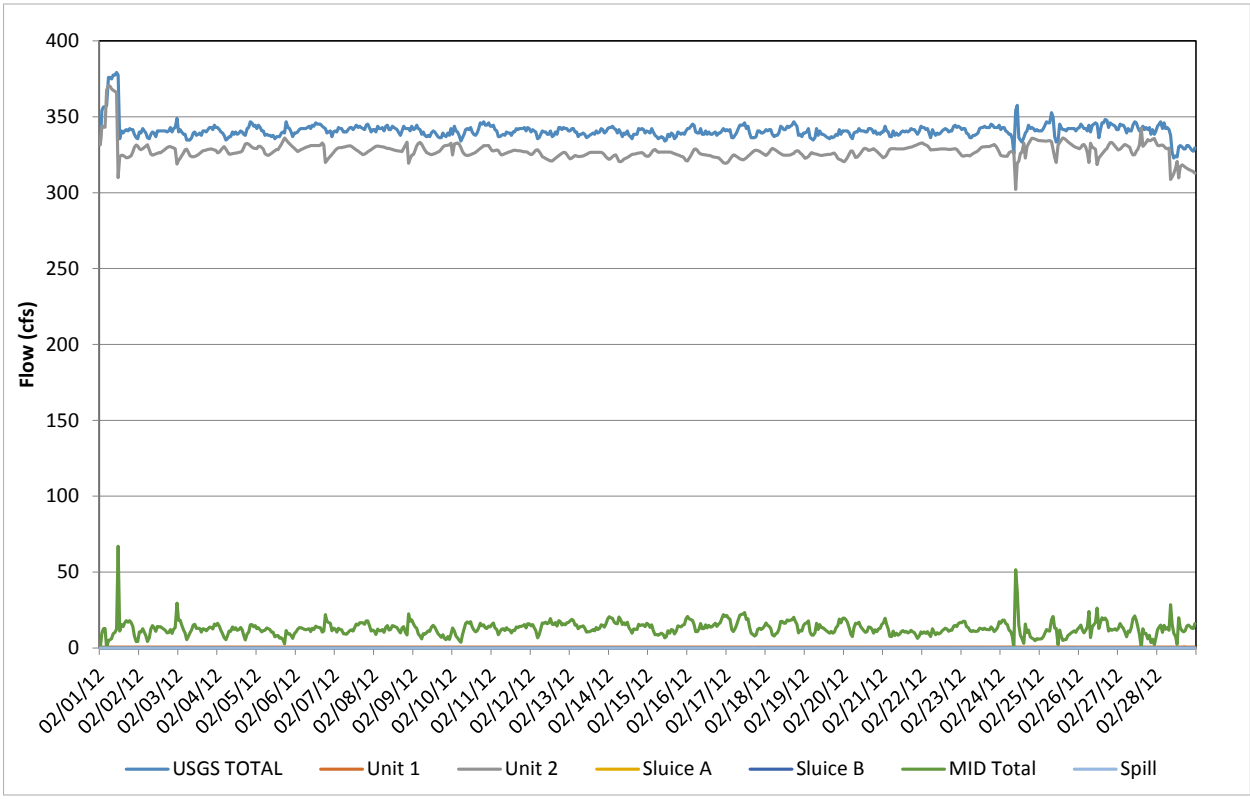

Figure C-86. Flow record in February 2012, based on hourly discharges.

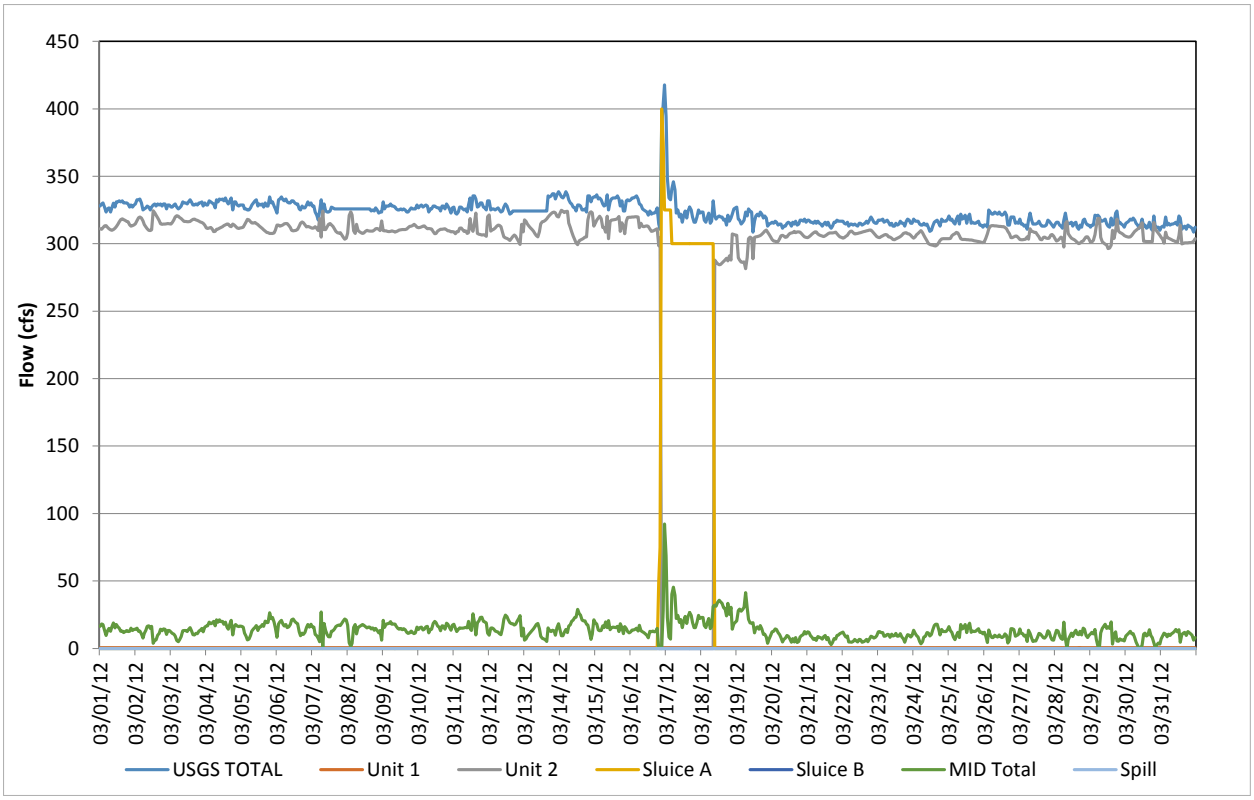

Figure C-87. Flow record in March 2012, based on hourly discharges.

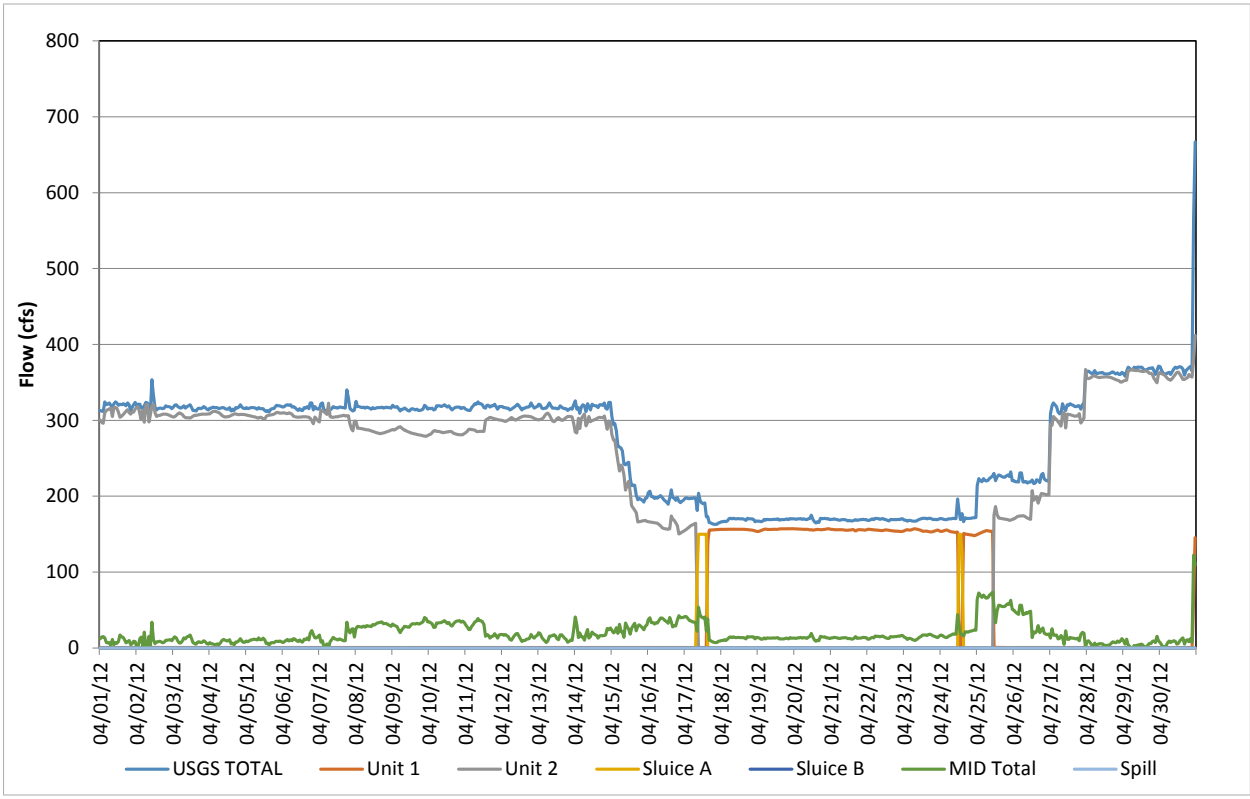

Figure C-88. Flow record in April 2012, based on hourly discharges.

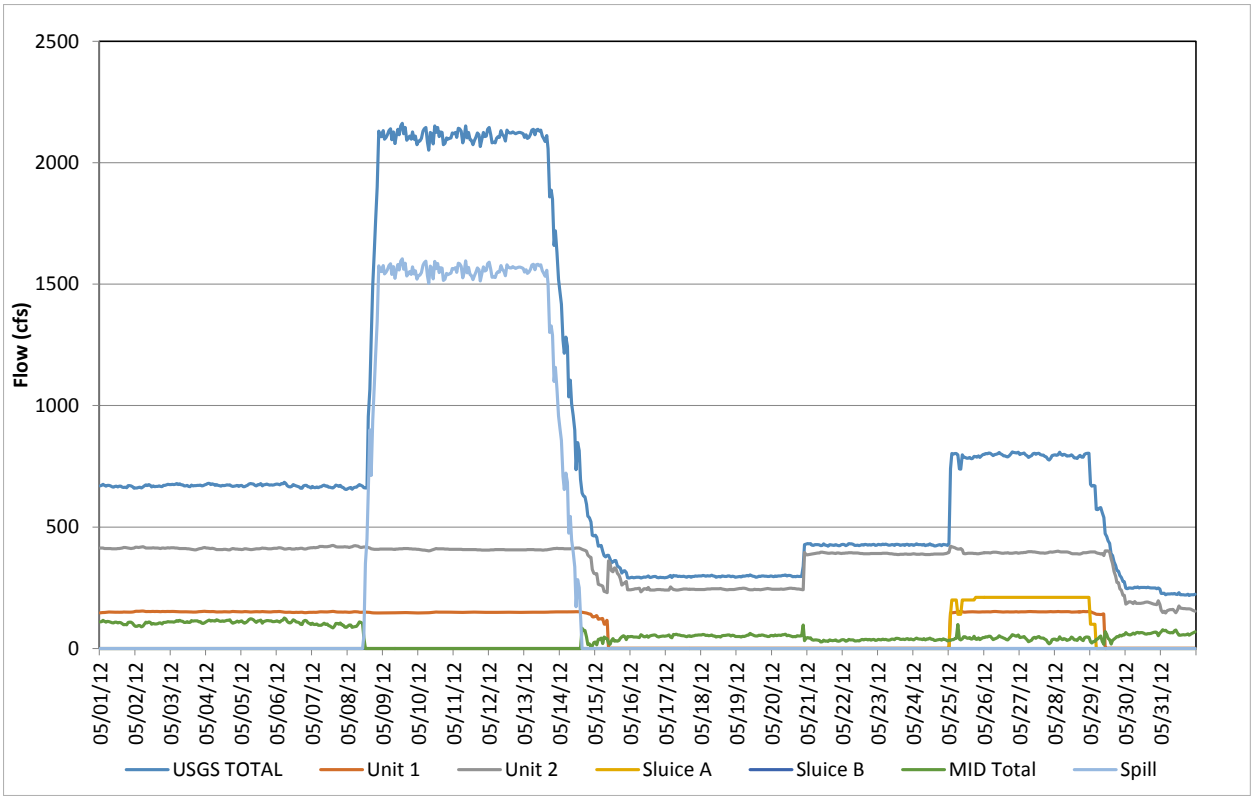

Figure C-89. Flow record in May 2012, based on hourly discharges.

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

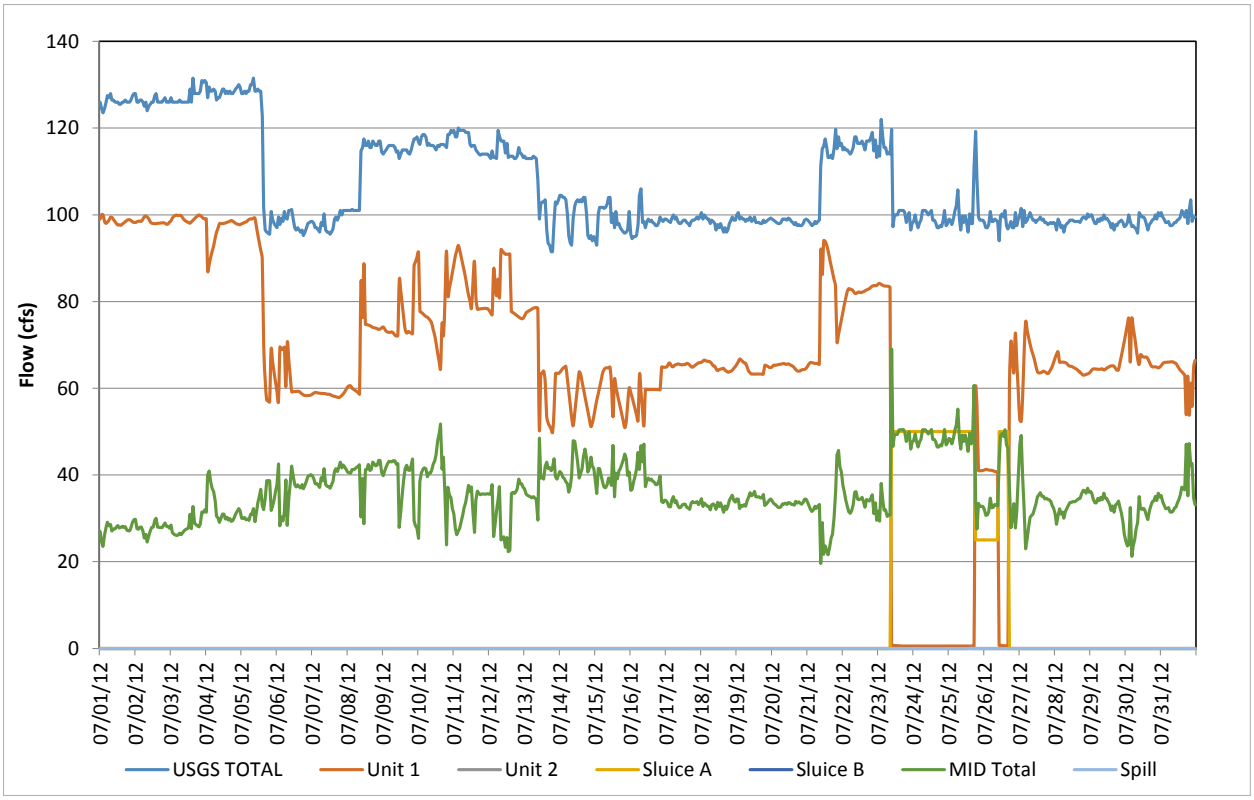

Figure C-91. Flow record in July 2012, based on hourly discharges.

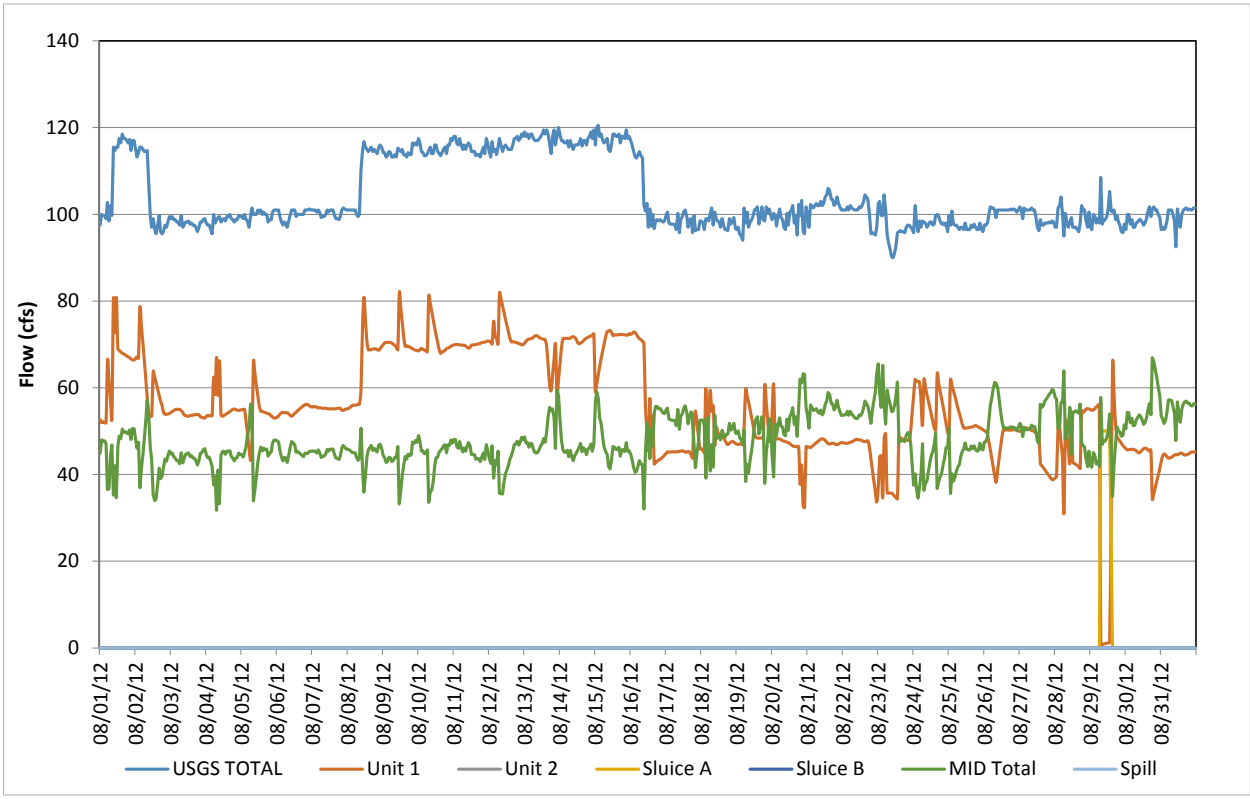

Figure C-92. Flow record in August 2012, based on hourly discharges.

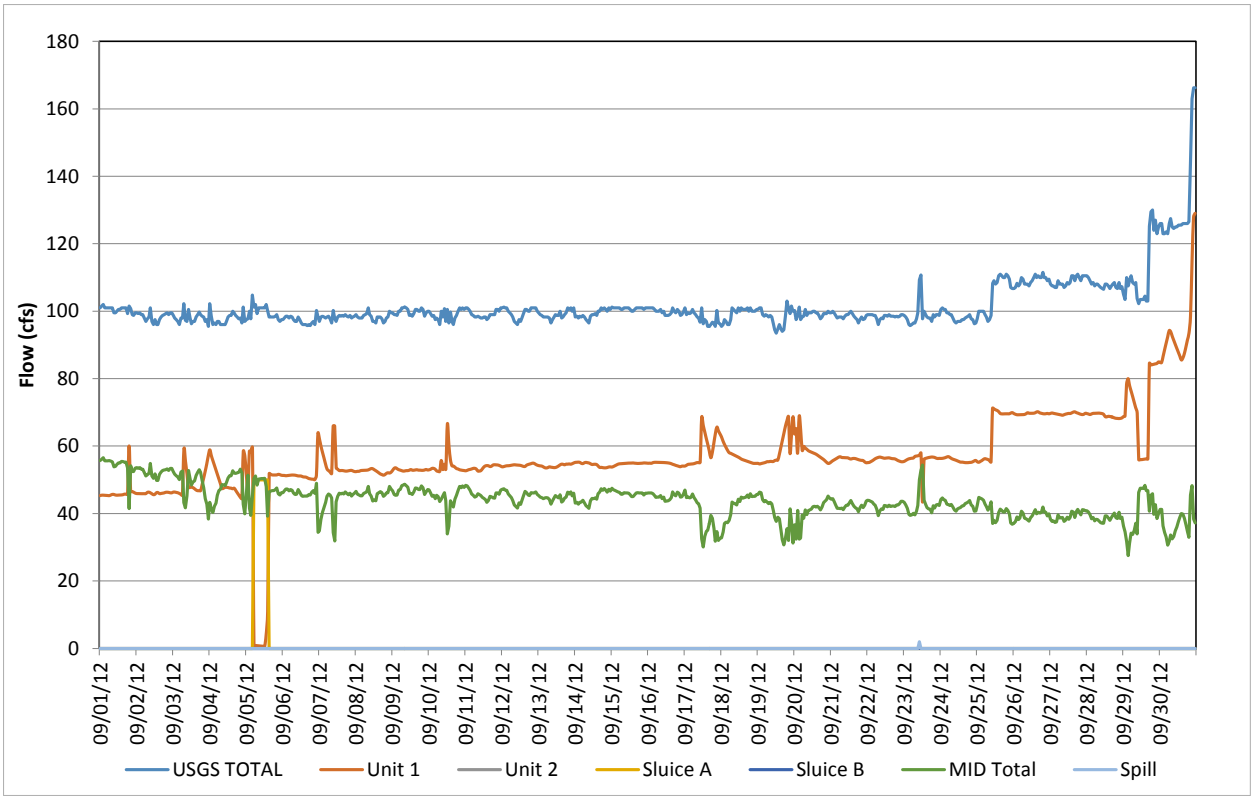

Figure C-93. Flow record in September 2012, based on hourly discharges.

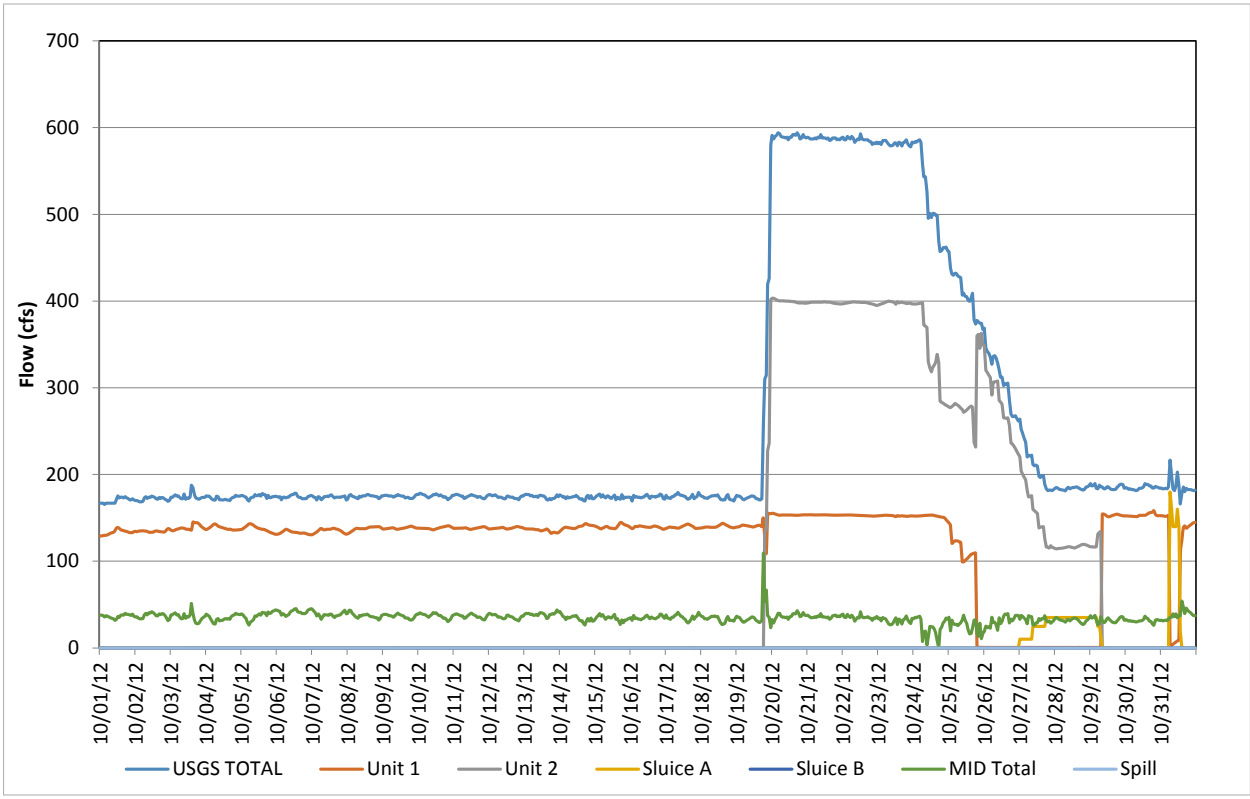

Figure C-94. Flow record in October 2012, based on hourly discharges.

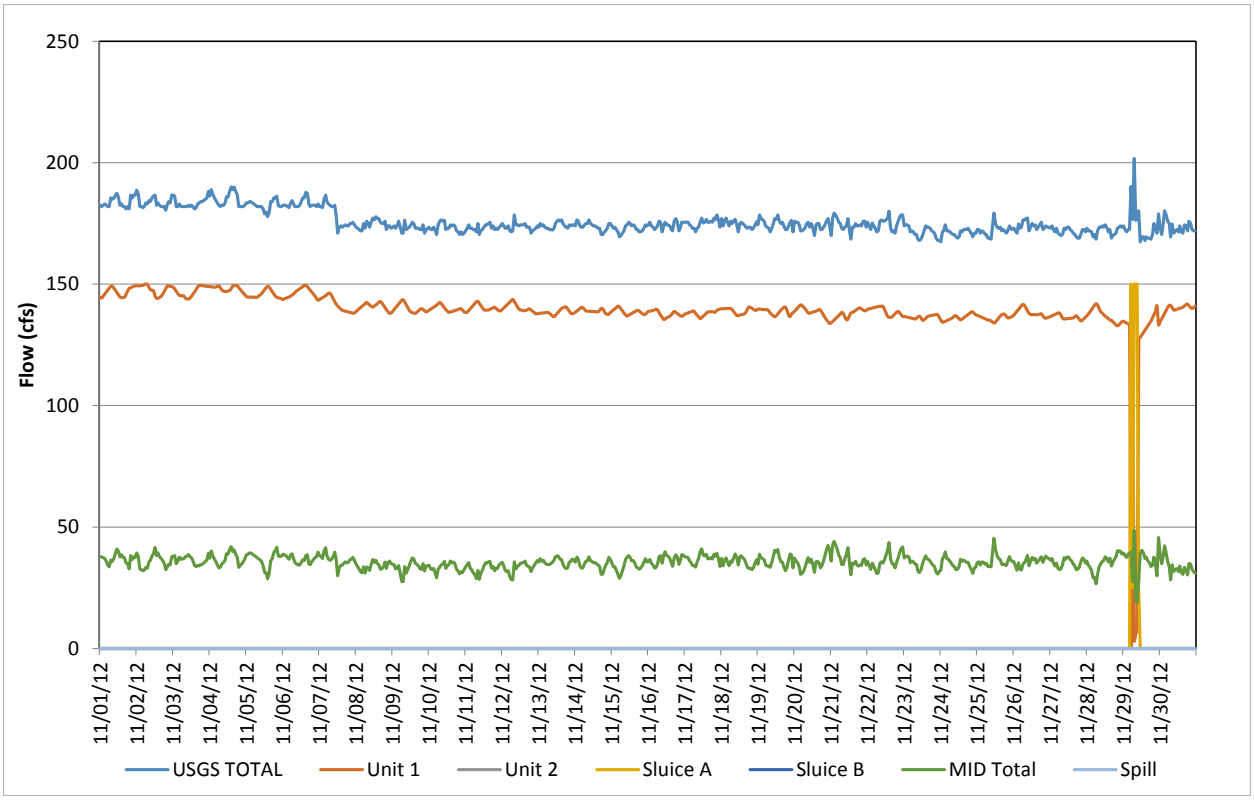

Figure C-95. Flow record in November 2012, based on hourly discharges.

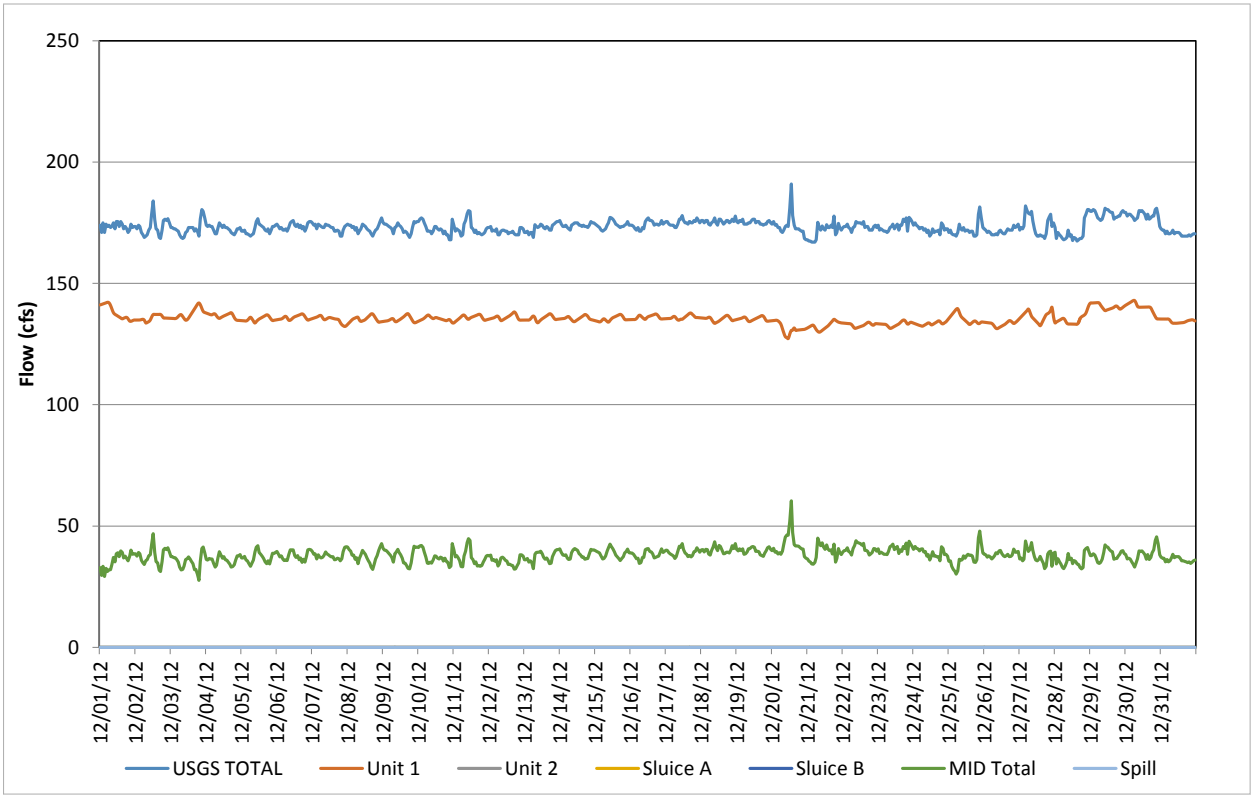

Figure C-96. Flow record in December 2012, based on hourly discharges.

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

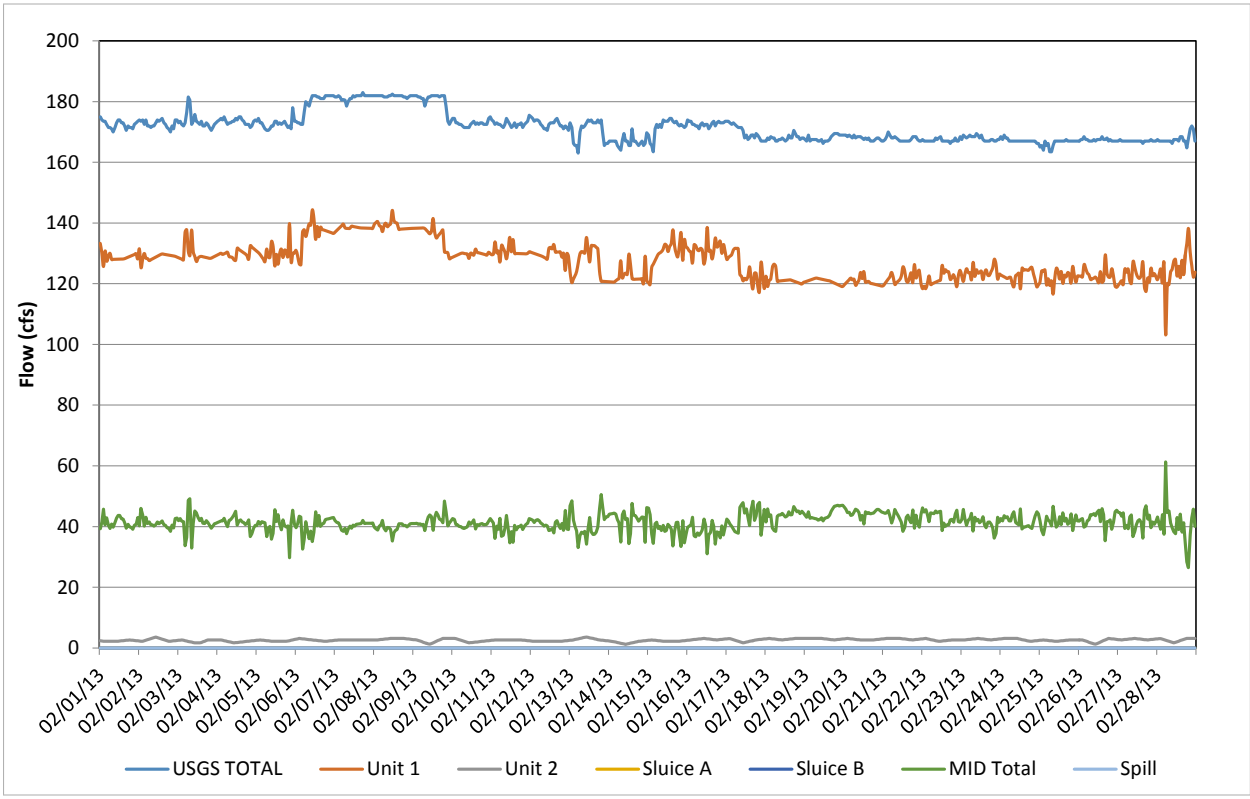

Figure C-98. Flow record in February 2013, based on hourly discharges.

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

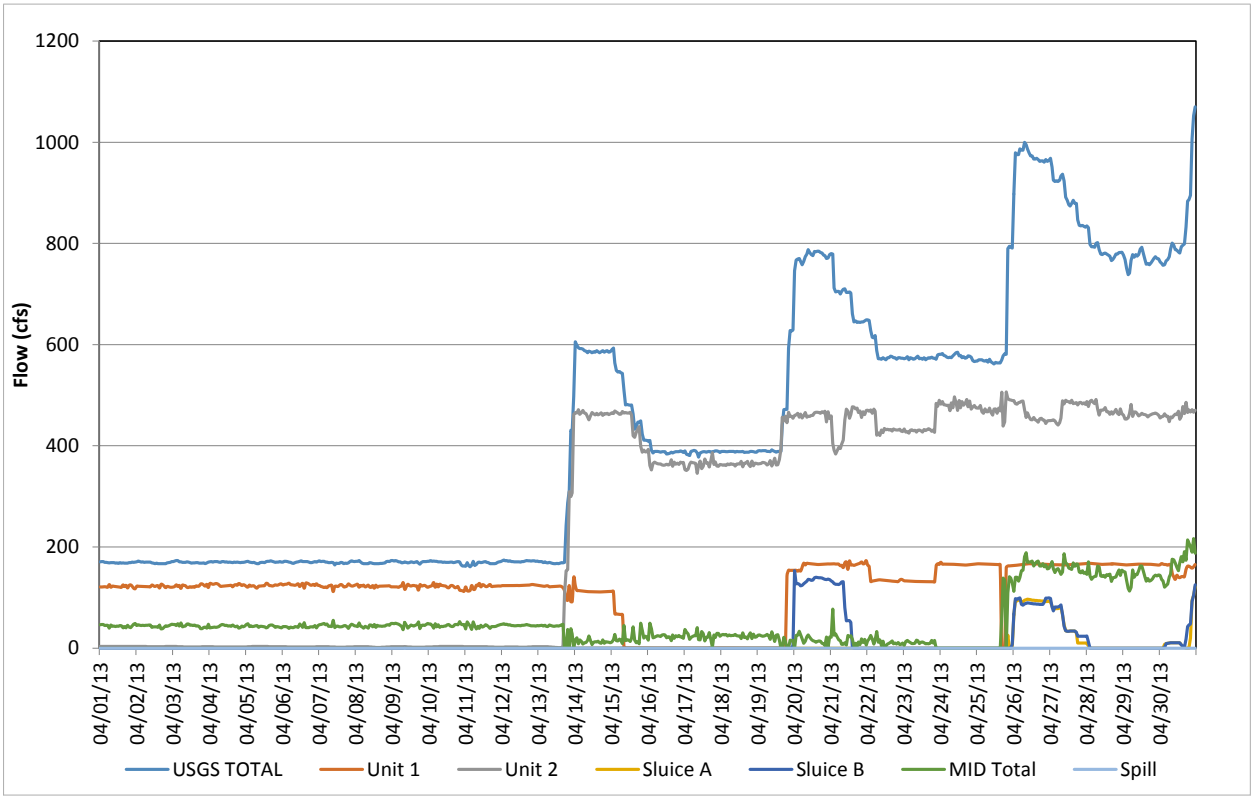

Figure C-100. Flow record in April 2013, based on hourly discharges.

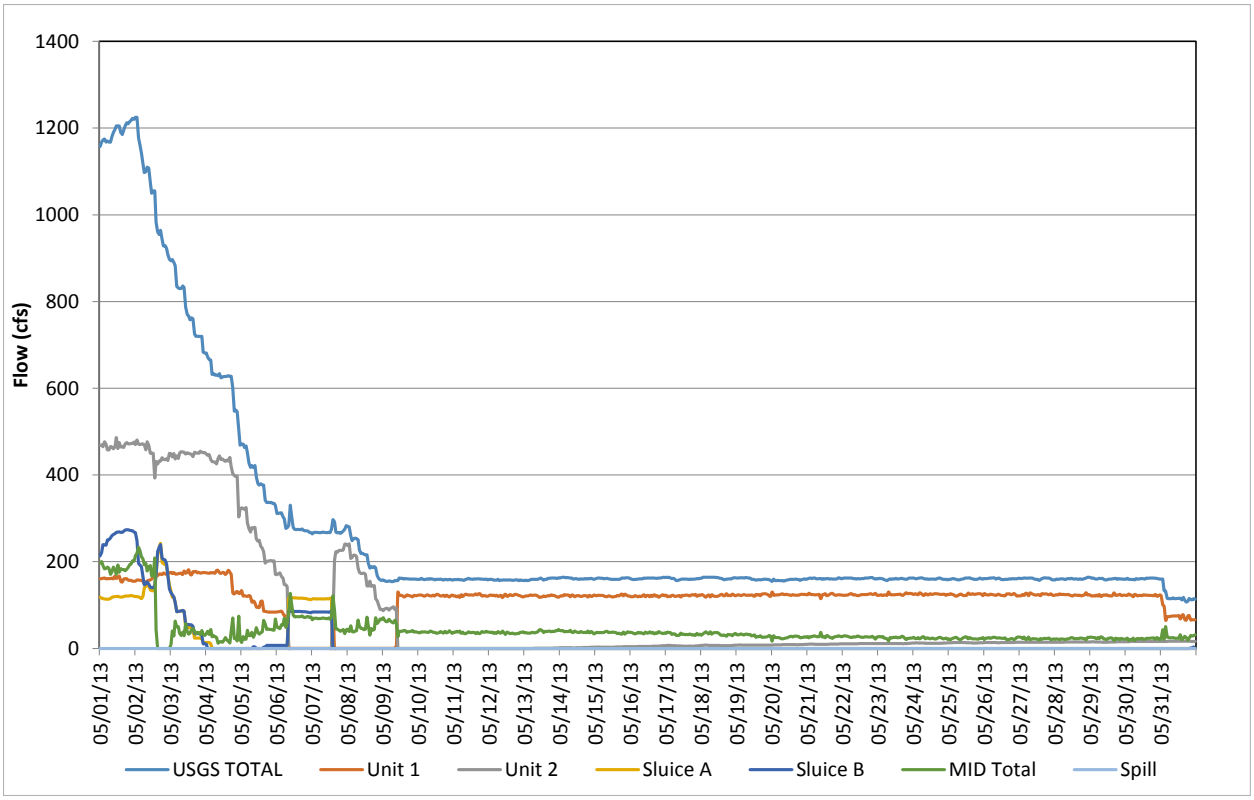

Figure C-101. Flow record in May 2013, based on hourly discharges.

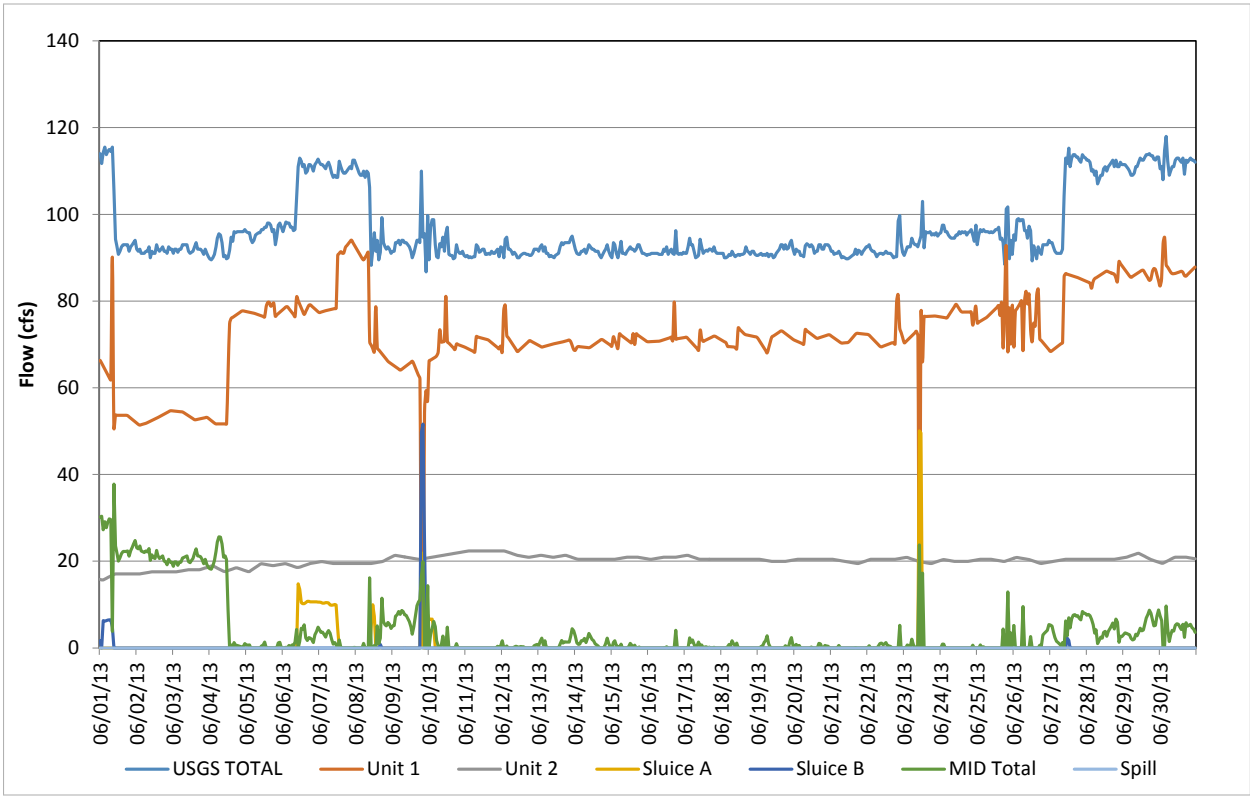

Figure C-102. Flow record in June 2013, based on hourly discharges.

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

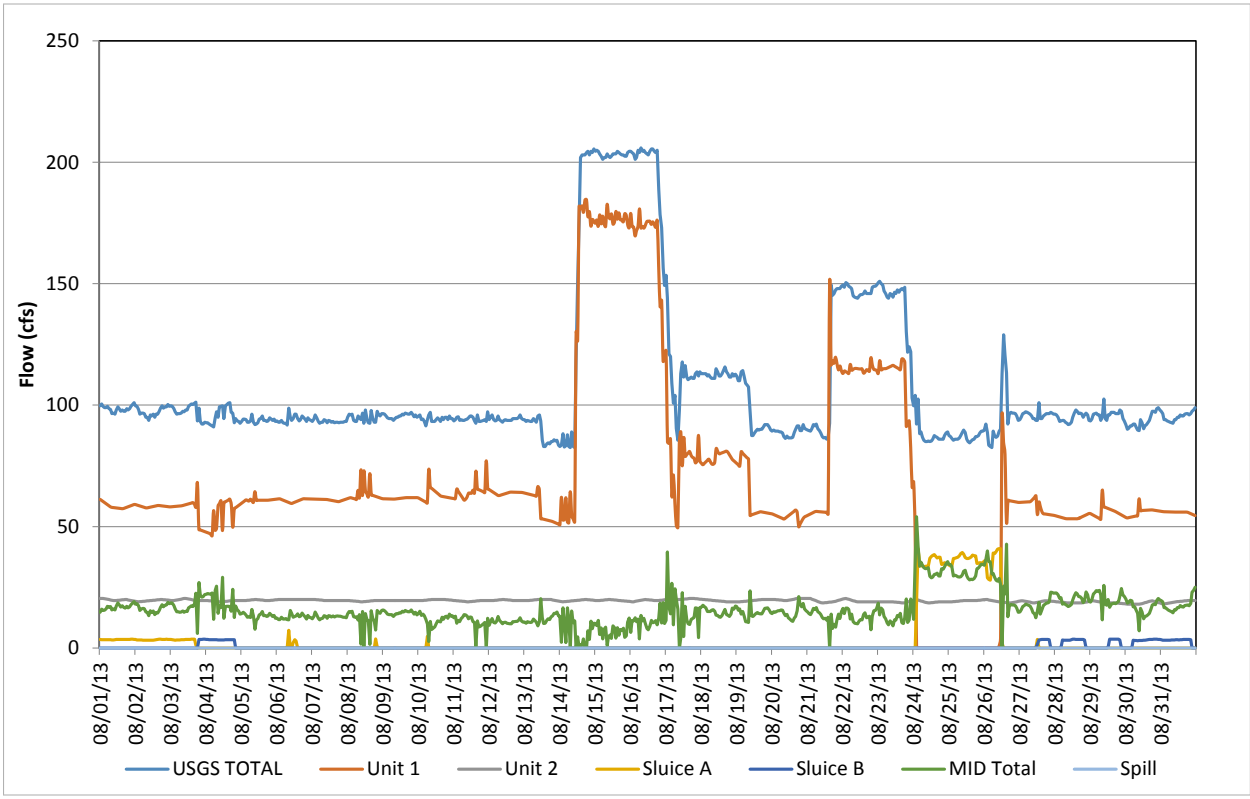

Figure C-104. Flow record in August 2013, based on hourly discharges.

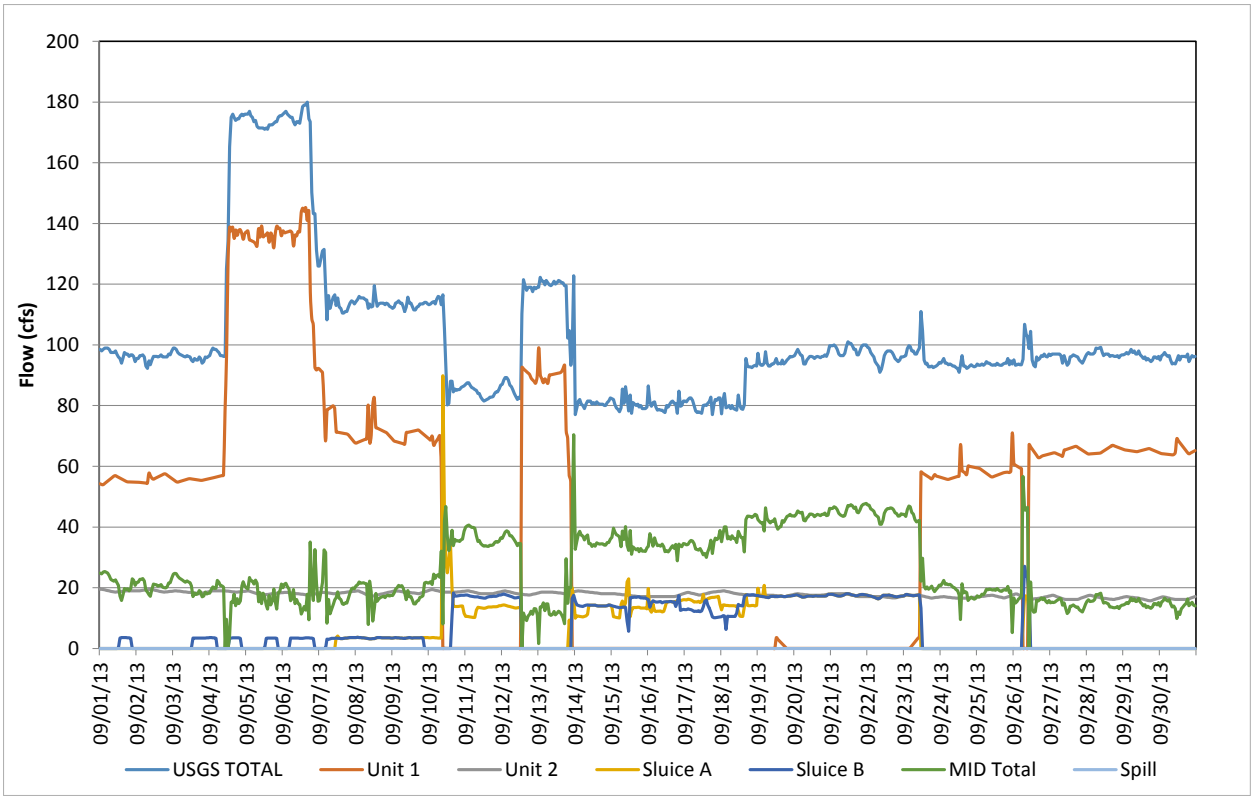

Figure C-105. Flow record in September 2013, based on hourly discharges.

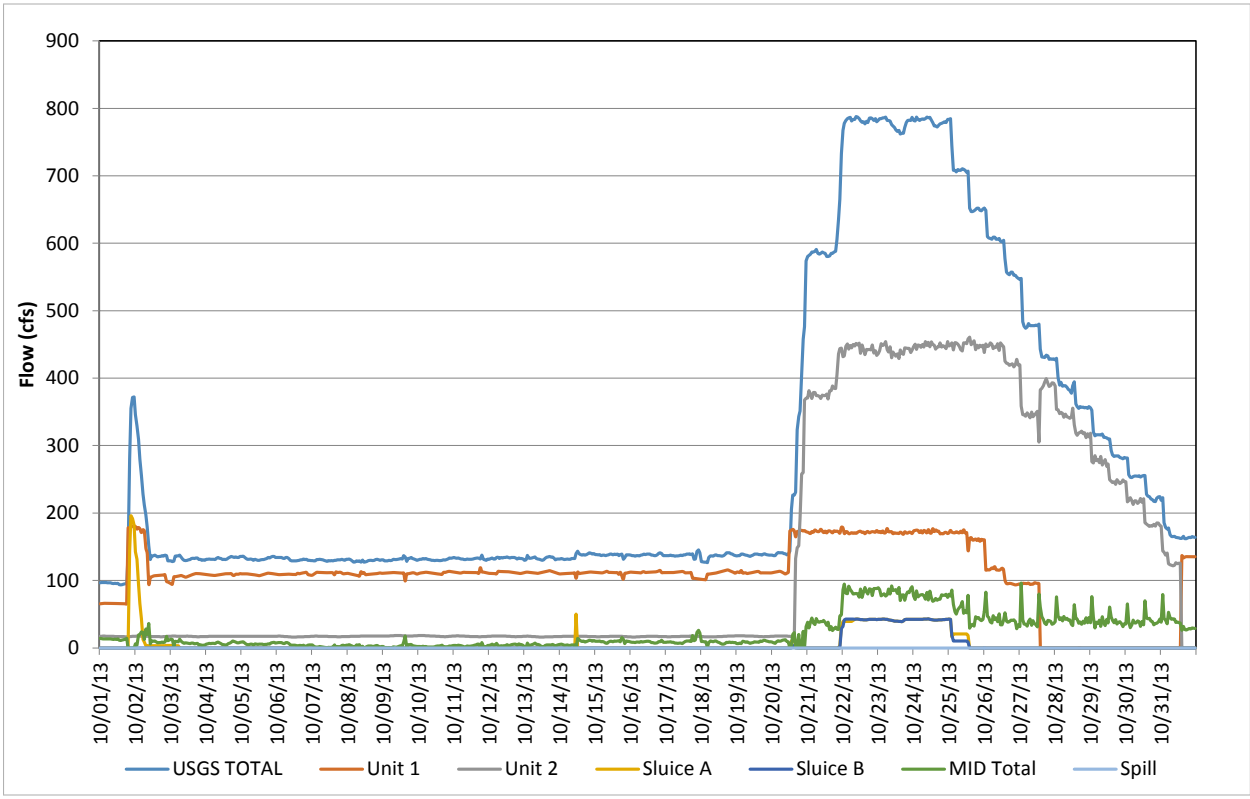

Figure C-106. Flow record in October 2013, based on hourly discharges.

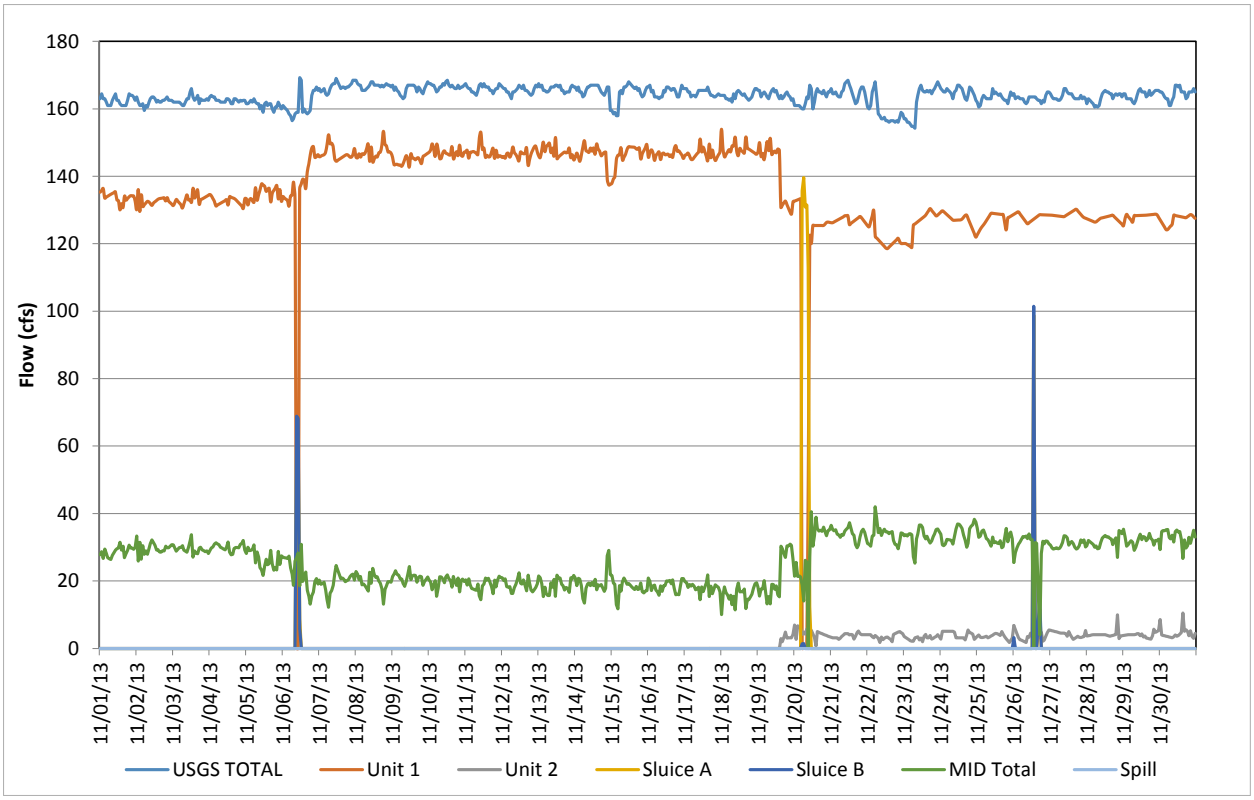

Figure C-107. Flow record in November 2013, based on hourly discharges.

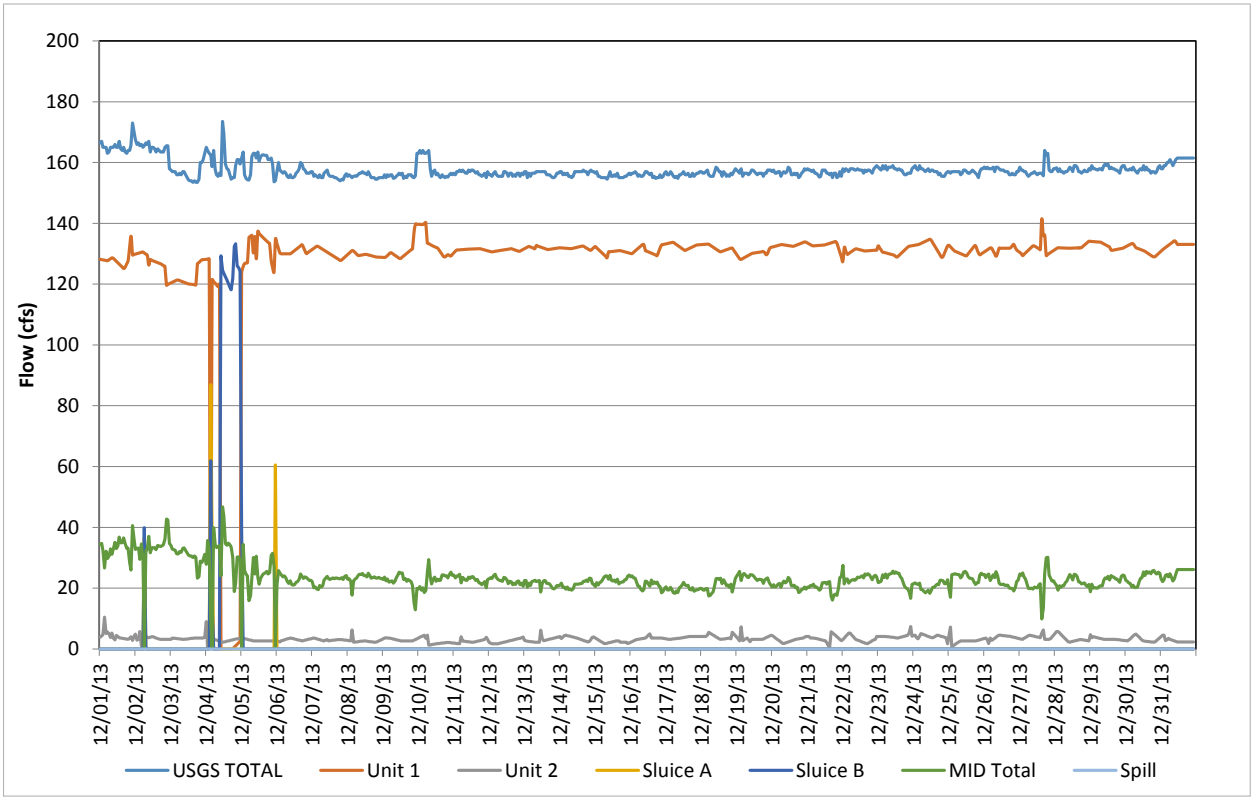

Figure C-108. Flow record in December 2013, based on hourly discharges.