Memo

Date:	Monday, February 13, 2017
Project:	Lower Platte River Basin-wide Water Management Plan
To:	Lower Platte River Basin Coalition
From:	HDR Team
Subject:	Evaluation of Historic Streamflows on the Loup, Elkhorn, and Lower Platte Rivers in Excess of State Protected Flows

1.0 Introduction and Background

The Lower Platte River Basin Coalition (Coalition) was formed through an Interlocal Cooperation Act agreement among the Nebraska Department of Natural Resources (NDNR) and the following seven Natural Resources Districts (NRDs) that encompass the Lower Platte River Basin:

- Upper Loup Natural Resources District (ULNRD)
- Lower Loup Natural Resources District (LLNRD)
- Upper Elkhorn Natural Resources District (UENRD)
- Lower Elkhorn Natural Resources District (LENRD)
- Lower Platte North Natural Resources District (LPNNRD)
- Lower Platte South Natural Resources District (LPSNRD)
- Papio-Missouri River Natural Resources District (PMRNRD)

The Lower Platte River Basin includes the Elkhorn River, Loup River, and Lower Platte River below Duncan, as shown in Figure 1 at the end of this section.

The first action taken by the Coalition is the development of the Lower Platte River Basin-wide Water Management Plan. In accordance with LB1098, §15[1] and Nebraska Revised Statute 46-755[2], the purpose of the basin-wide water management plan is to maintain a balance between current and future water supplies and demands. The HDR Team, consisting of HDR, JEO Consulting Group, Inc., and The Flatwater Group, is assisting the Coalition with this effort.

One of the tasks of the Lower Platte River Basin-wide Water Management Plan is to identify historic streamflows in excess of state protected flows (or simply “excess flow”) in the Lower Platte River Basin, including location, flow rate, flow volumes, duration of excess flows, and frequency of excess flow availability. The Lower Platte River Basin was divided into the following eight subbasins for the purpose of this analysis:

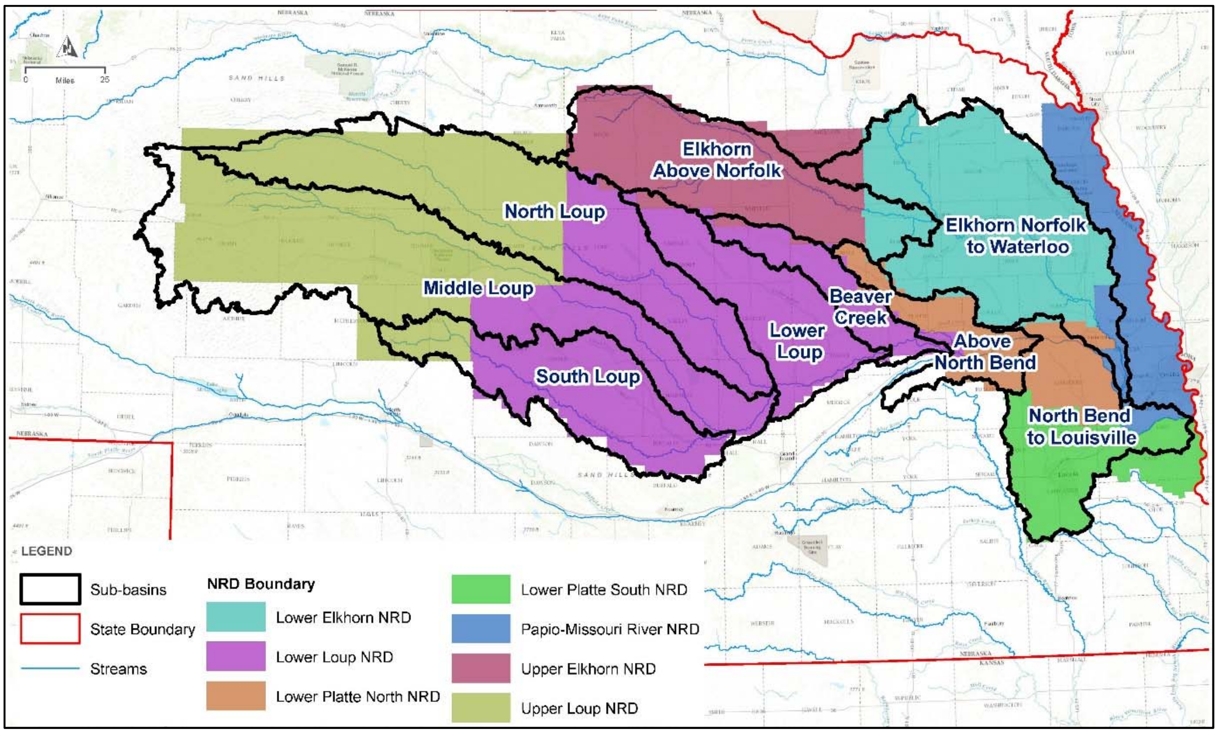
1. Lower Loup

[1] http://nebraskalegislature.gov/FloorDocs/103/PDF/Slip/LB1098.pdf
[2] http://nebraskalegislature.gov/laws/statutes.php?statute=46-755

2. South Loup
3. Middle Loup
4. North Loup
5. Elkhorn Above Norfolk
6. Elkhorn Norfolk to Waterloo
7. Lower Platte Above North Bend
8. Lower Platte North Bend to Louisville

These subbasins were chosen for consistency with NDNR's Integrated Network of Scientific Information and GeoHydrologic Tools (INSIGHT) analysis (see Figure 1). This technical memorandum describes the analysis conducted to evaluate the historic quantity of excess flow in the Lower Platte River Basin.

Figure 1: INSIGHT Basins in the Lower Platte River Basin Overlaid by NRD Boundaries



In December 2010, HDR and The Flatwater Group conducted a study/report entitled "Evaluation of Historic Plate River Streamflow in Excess of State Protected Flows and Target Flows" (HDR, 2010). The purpose of this study was to:

- Evaluate the historic quantity of excess flow in the Platte River;
- Develop a planning tool to estimate the rate of flow and duration and frequency of water in excess of state protected flows by reach; and
- Determine the quantity of water in excess of target flows based on wet, dry, and normal hydrologic classification.

The study included the area from the North Platte River just below Lake McConaughy and the South Platte River at Julesburg, Colorado, to the Platte River near Louisville, Nebraska. The study compared the amount of natural flow available in various specified reaches and then compared those flows to the computed demands for natural flow in the same specified reaches. The following builds on this study by carrying this analysis upstream into the Elkhorn and Loup Basins.

This analysis did not address future conditions and is not intended to provide a potential applicant with an analysis sufficient to establish whether excess flow is available for a specific project (new use). Any applicant seeking a surface water permit will need to provide to NDNR a comprehensive package at the time the application or variance is filed. This technical memorandum describes the methodology used to evaluate excess flow and provides plots of the results at several points in the Lower Platte River Basin in support of Task 420 of the Scope of Work.

The results summarize excess flow and the number of days that excess flow has been available. It should be noted that the number of days with excess flow may or may not be consecutive, and operational constraints that limit the ability to divert short-duration occurrences of excess flows were not considered.

Additionally, care should be taken when reading the tables and charts associated with the Loup subbasin because three demand scenarios were considered. The first demand scenario considers the full Loup River Public Power District hydropower appropriation placed on the Loup subbasin. The second demand scenario considers the historic Loup Power Canal diversion. This demand scenario is considered to be the historic demand that was actually placed on the basin. The final demand scenario is simply the instream flow demand downstream and ignores the hydropower demand altogether. This third scenario was considered at the request of the technical committee to understand what excess flows in the basin would have been if no hydropower demand existed.

2.0 Data Inputs

Data used to compute excess flow include the mean daily discharge recorded by Platte River, Loup River, and Elkhorn River gages for the period beginning with Water Year (WY) 1988 (10/1/1988) through the end of WY 2011 (9/30/2011); the Platte River instream flow appropriations; and the INSIGHT[3] instream flow demands (which differ from the Platte River instream flow appropriations[4]). The INSIGHT documentation describes instream flow demands as flows that correspond to the level of development (both surface water and groundwater) that was in place at the time an appropriation was granted.

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[3] As INSIGHT is a web-tool for displaying the data used in the draft NDNR methodology, those demands referred to as "INSIGHT" demands are the same as the demands used in the draft NDNR methodology.

[4] Because the instream flow demand is a non-consumptive use demand, the draft NDNR methodology compares the daily instream flow demand to the daily undepleted streamflow similar to the way that the hydropower demands are evaluated. Consistent with the draft NDNR methodology, if daily undepleted streamflow is greater than the daily instream flow appropriation, the demand is capped at the daily instream flow appropriation because the demand cannot exceed what is legally permitted. Conversely, if the daily undepleted streamflow is less than the daily instream appropriation, the demand is capped at the daily undepleted streamflow.

Historical gage data were obtained from the United States Geological Survey (USGS). Table 1 lists the gages used in this evaluation. The Platte River instream flow appropriations are water appropriations granted for recreational use or the needs of existing fish and wildlife, and vary through specific stream reaches and time of year. The Platte River instream flow appropriations for North Bend and Louisville are shown in Table 2.

Table 1: USGS Gages Used in Analysis

Gage Number	Gage
06805500	Platte River at Louisville, Nebr.
06796000	Platte River at North Bend, Nebr.
06792500	Loup River Power Canal near Genoa, Nebr.
06793000	Loup River near Genoa, Nebr.
06790500	North Loup River near Saint Paul, Nebr.
06785000	Middle Loup River at Saint Paul, Nebr.
06784000	South Loup River at Saint Michael, Nebr.
06800500	Elkhorn River at Waterloo, Nebr.
06799000	Elkhorn River at Norfolk, Nebr.

Table 2: Platte River Instream Flow Appropriations (cfs)

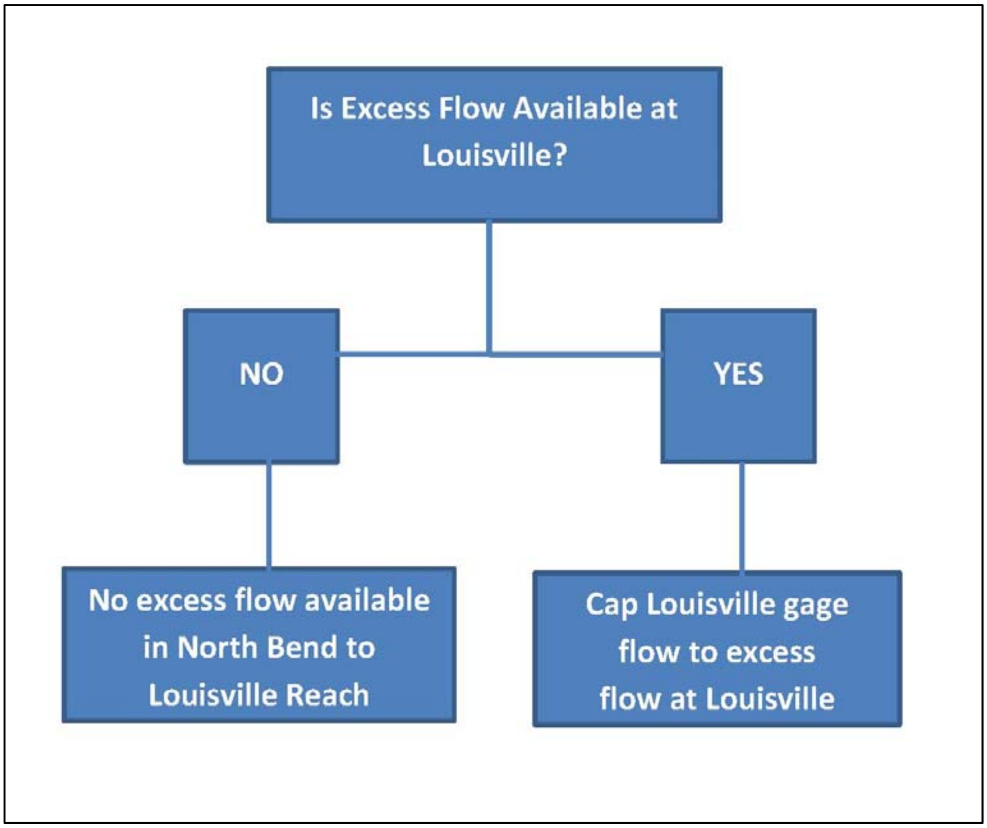
Period	North Bend	Louisville
January 1 – January 31	1,800	3,100
February 1 – July 31	1,800	3,700
August 1 – August 31	1,800	3,500
September 1 – September 30	1,800	3,200
October 1 – December 31	1,800	3,700

3.0 Methodology for Determining Excess Flows

When evaluating whether excess flow in an upstream reach is available, the downstream reach must first be evaluated. If flows in a downstream reach are insufficient to satisfy state protected flows in the Platte River on any given day, then not only is there no excess flow in the downstream reach for that day but the upstream reach, similarly, would not have any available excess flow on that day. For this reason, the analysis takes two paths as it moves upstream. The first path begins at the Platte River at Louisville and moves upstream to the Platte River at North Bend followed by the Loup River near Genoa and finally the three subbasin gages above Genoa (North Loup River near Saint Paul, Middle Loup River at Saint Paul, and South Loup River at Saint Michael). As we move upstream, we check to see if any downstream reach has available excess flow on that day (essentially, if the state protected flows are satisfied). If there is, we continue our analysis upstream. If not, then there is no excess flow at any of the reaches upstream of the analysis point. The second path begins at the Platte River at Louisville and then moves upstream to the Elkhorn River at Waterloo and finally the Elkhorn River at Norfolk. The same methodology applies. This process is described in more detail in the following paragraphs.

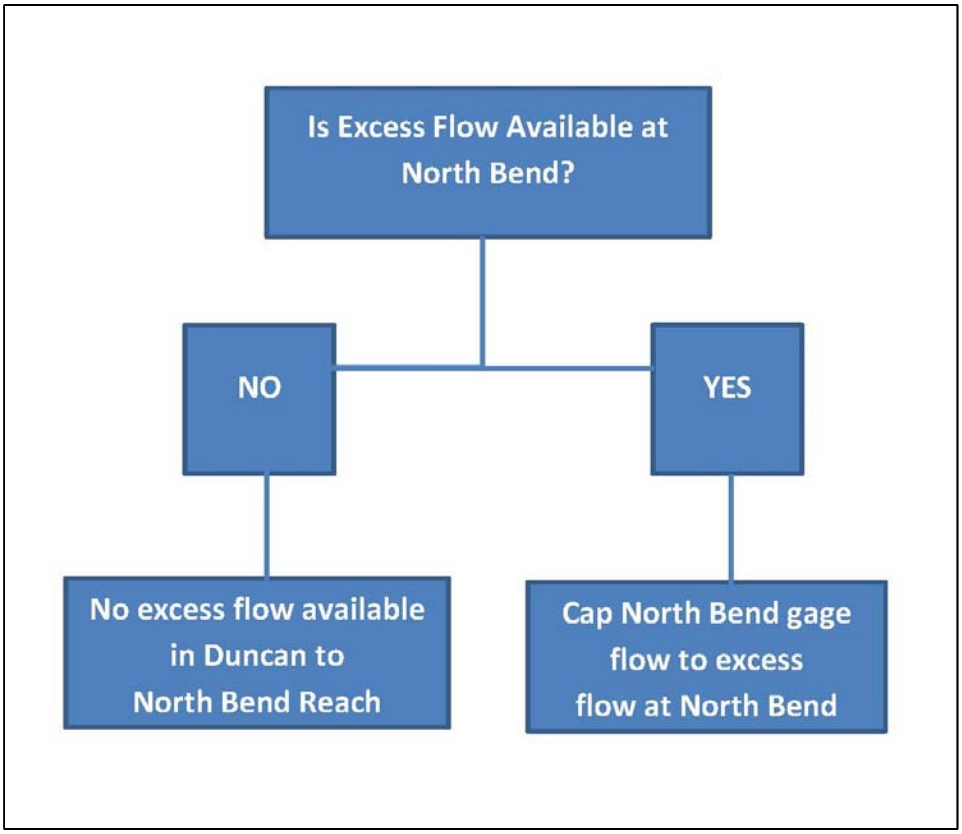
For the Lower Platte North Bend to Louisville subbasin, if the daily gage flow at Louisville exceeds both the Platte River instream flow appropriation at Louisville and the INSIGHT instream flow demand, then excess flow is available for the Lower Platte North Bend to Louisville subbasin on that day. The excess flow amount is equal to the gage flow less the INSIGHT instream flow demand. If the daily gage flow does not satisfy both the Platte River instream flow appropriation and the INSIGHT instream flow demand, then no excess flow is available for not only the Lower Platte North Bend to Louisville subbasin, but no excess flow is available for the entirety of the Lower Platte River Basin (including the Loup and Elkhorn Basins) on that day either.

Figure 2: Steps to Calculate Excess Flow in Lower Platte North Bend to Louisville Subbasin



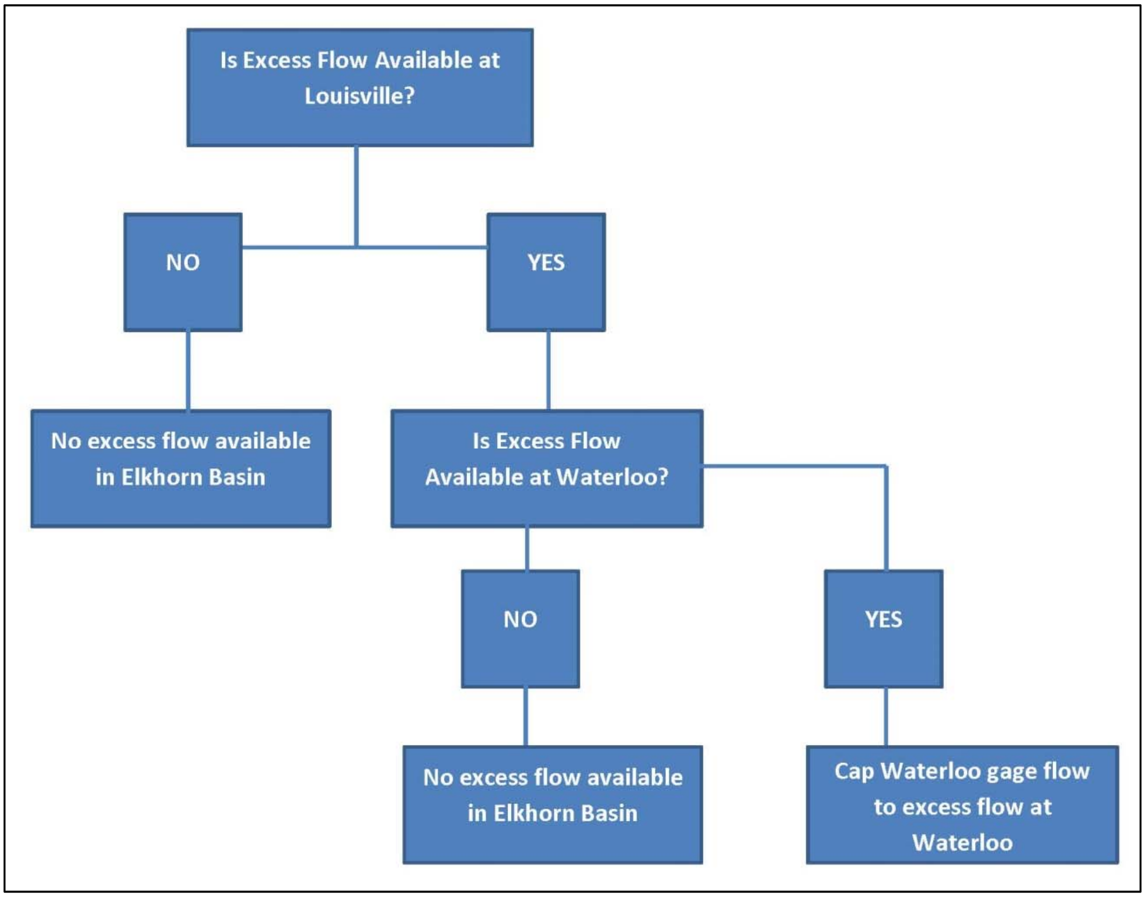
For the Lower Platte Above North Bend subbasin, if the daily gage flow at North Bend exceeds both the Platte River instream flow appropriations at North Bend and Louisville, and the INSIGHT instream flow demand, then excess flow is available for the Lower Platte Above North Bend subbasin on that day. The excess flow amount is equal to the gage flow less the INSIGHT instream flow demand. If the daily gage flow does not satisfy both the Platte River instream flow appropriations at North Bend and Louisville, and the INSIGHT instream flow demand, then no excess flow is available for not only the Lower Platte Above North Bend subbasin, but no excess flow is available for the Lower Platte River Basin upstream of this analysis point (including the Loup and Elkhorn Basins) on that day either.

Figure 3: Steps to Calculate Excess Flow in Lower Platte Above North Bend Subbasin



For the Elkhorn Norfolk to Waterloo subbasin, if excess flow is available in the Lower Platte North Bend to Louisville subbasin and the daily gage flow for the Elkhorn River at Waterloo exceeds the INSIGHT instream flow demand for the Elkhorn Norfolk to Waterloo subbasin, then excess flow is available for the Elkhorn Norfolk to Waterloo subbasin on that day. The excess flow amount is equal to the gage flow less the INSIGHT instream flow demand. If the daily gage flow does not satisfy the INSIGHT instream flow demand, then no excess flow is available for not only the Elkhorn Norfolk to Waterloo subbasin, but no excess flow is available for the Elkhorn Above Norfolk subbasin on that day either. If excess flow is available in the Elkhorn Norfolk to Waterloo subbasin, then excess flow is also available in the Elkhorn Above Norfolk subbasin in the amount equal to the gage flow at the upstream analysis point on that day capped to the excess flow available at Waterloo.

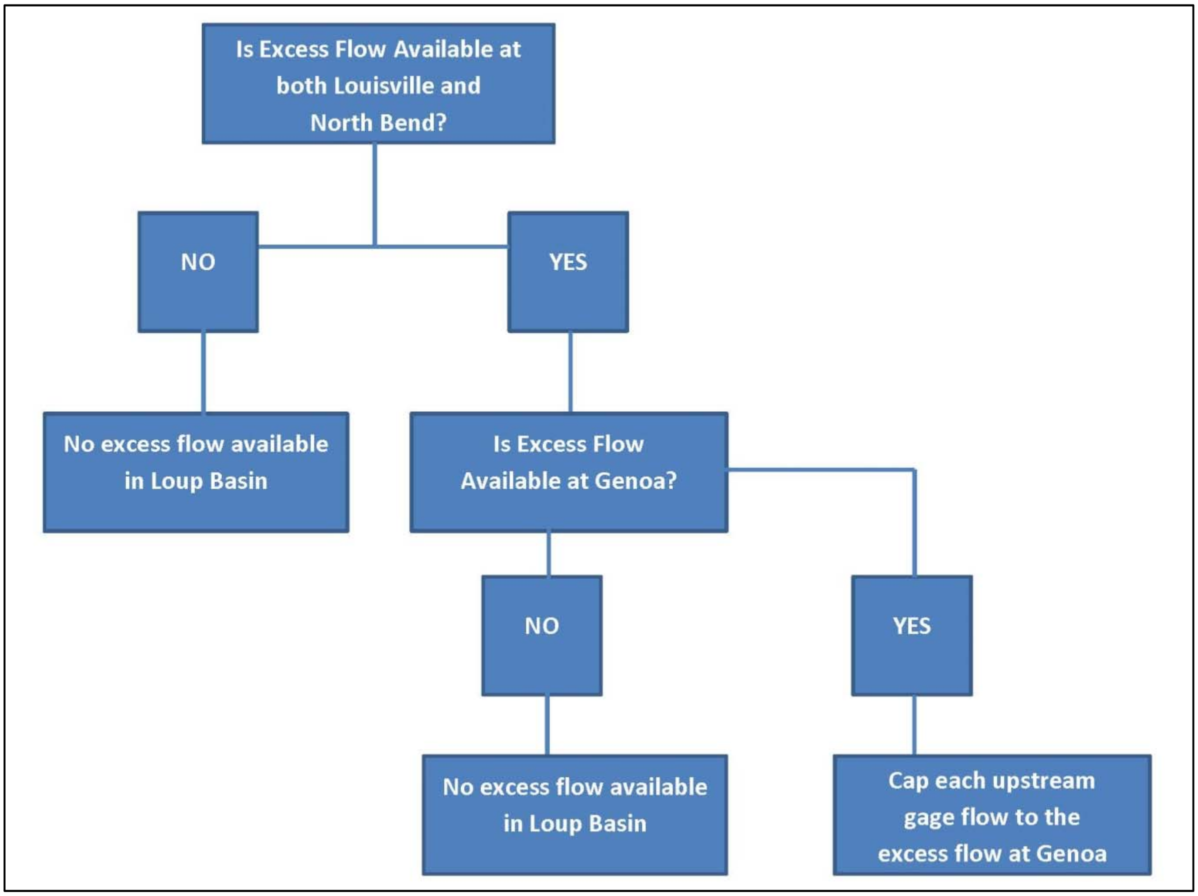
Figure 4: Steps to Calculate Excess Flow in Elkhorn Subbasins



For the Loup River near Genoa, the excess flow check was performed above the Loup River Public Power District's hydropower diversion. The daily gage flow for this analysis point was calculated as the sum of the daily gage flow for the Loup River near Genoa gage and the Loup River Power Canal near Genoa gage.

For the Lower Loup subbasin, if excess flow is available at both North Bend and Louisville and the daily gage flow for the Loup River near Genoa plus the Loup River Power Canal near Genoa exceeds the Loup hydropower demand, then excess flow is available in the Lower Loup subbasin. The excess flow amount is equal to the gage flow less the Loup hydropower demand. If the daily gage flow does not satisfy the Loup hydropower demand, then no excess flow is available for not only the Lower Loup subbasin, but no excess flow is available for the upstream basins (South Loup, Middle Loup, or North Loup) on that day either. If excess flow is available in the Loup River near Genoa, then excess flow is also available in upstream Loup basins in the amount equal to the gage flow at the upstream analysis points on that day capped to the excess flow available at Genoa.

Figure 5: Steps to Calculate Excess Flow in Loup Subbasins



The draft NDNR methodology uses the full Loup hydropower right of 3,500 cfs for its evaluation. For the purposes of this analysis, we used two other scenarios to supplement the full hydropower right in order to understand what the quantity and availability of excess flows in the basin would have been without this hydropower demand or based on historically available flow. The first additional scenario included comparing the daily gage flow (Loup River near Genoa + Loup River Power Canal near Genoa) against the historic Loup Power Canal diversion. The second additional scenario included comparing the daily gage flow (Loup River near Genoa + Loup River Power Canal near Genoa) against the INSIGHT instream flow demand.[5] In both scenarios, if the calculated daily flow exceeds the demands for the respective scenario, then excess flow is available in the Loup River near Genoa, and analysis of the upstream basins remains unchanged.

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5 The INSIGHT website does not currently report the instream flow demand because NDNR used the full Loup hydropower demand in its analysis. Because this Loup hydropower demand exceeds the NDNR calculated instream flow demand, and the hydropower and instream flow demands are both non-consumptive uses (i.e., not additive), the hydropower demand would satisfy the instream flow demand. For the case of the instream flow scenario, instream flow demands were provided by NDNR separately for purposes of this analysis.

4.0 Results

Tables 3 through 18 show the results of this analysis by subbasin, including the average number of days of excess flow by month for the period of analysis as well as the number of years within the period of analysis with no excess flow.

Table 3: Summary of North Loup Subbasin with Full Hydropower Demand

Summary of WY 1988 - 2011	January	February	March	April	May	June	July	August	September	October	November	December
Maximum Flow Volume (AF)	55,697	74,139	111,771	90,050	92,492	203,128	120,879	64,287	63,558	71,044	84,091	65,128
Minimum Flow Volume (AF)	0	0	0	0	0	0	0	0	0	0	0	0
Average Flow Volume (AF)	9,381	20,180	31,573	24,874	22,992	35,398	15,252	8,373	7,108	11,186	10,534	6,851
Average # of Days with Excess Flow	7	10	13	11	9	11	6	5	4	6	6	5
Number of Years with Zero (0) Excess Flow	9	6	2	8	5	5	12	15	11	12	12	9

Table 4: Summary of North Loup Subbasin with Historic Diversion

Summary of WY 1988 - 2011	January	February	March	April	May	June	July	August	September	October	November	December
Maximum Flow Volume (AF)	74,285	76,733	116,860	130,462	93,308	203,128	119,453	67,149	77,516	83,250	84,091	68,851
Minimum Flow Volume (AF)	0	15,921	35,102	18,510	0	1,084	0	0	0	0	2,617	3,537
Average Flow Volume (AF)	31,459	46,066	64,934	68,684	58,911	63,683	25,712	18,354	19,859	26,687	32,619	24,488
Average # of Days with Excess Flow	22	24	30	29	28	25	12	11	12	18	23	19
Number of Years with Zero (0) Excess Flow	1	0	0	0	1	0	5	9	6	3	0	0

Table 5: Summary of North Loup Subbasin with Instream Flow Demand

Summary of WY 1988 - 2011	January	February	March	April	May	June	July	August	September	October	November	December
Maximum Flow Volume (AF)	72,695	81,934	116,860	125,935	104,552	203,128	148,965	90,713	81,358	84,333	84,091	72,164
Minimum Flow Volume (AF)	0	6,320	20,853	13,438	0	3,160	0	0	0	0	2,960	3,537
Average Flow Volume (AF)	31,804	44,340	64,282	57,923	47,415	57,811	41,843	33,500	41,397	30,150	33,764	30,576
Average # of Days with Excess Flow	21	23	29	28	24	24	20	16	19	20	24	20
Number of Years with Zero (0) Excess Flow	1	0	0	0	1	0	3	6	4	3	0	0

Table 6: Summary of South Loup Subbasin with Full Hydropower Demand

Summary of WY 1988 - 2011	January	February	March	April	May	June	July	August	September	October	November	December
Maximum Flow Volume (AF)	16,097	17,119	19,256	22,105	17,178	29,645	24,283	8,320	6,273	9,318	10,569	9,029
Minimum Flow Volume (AF)	0	0	0	0	0	0	0	0	0	0	0	0
Average Flow Volume (AF)	2,444	4,737	7,455	6,086	4,835	6,265	2,628	1,058	876	1,779	2,066	1,699
Average # of Days with Excess Flow	7	10	13	11	9	11	6	5	4	6	6	5
Number of Years with Zero (0) Excess Flow	9	6	2	8	5	5	12	15	11	12	12	9

Table 7: Summary of South Loup Subbasin with Historic Diversion

Summary of WY 1988 - 2011	January	February	March	April	May	June	July	August	September	October	November	December
Maximum Flow Volume (AF)	16,533	22,241	36,271	22,924	32,537	38,564	32,381	11,890	10,030	11,916	13,086	11,076
Minimum Flow Volume (AF)	0	5,154	8,983	9,430	0	444	0	0	0	0	1,038	1,489
Average Flow Volume (AF)	7,687	11,936	17,328	15,313	15,644	16,275	5,173	2,764	3,143	5,756	8,490	6,070
Average # of Days with Excess Flow	22	24	30	29	28	25	12	11	12	18	23	19
Number of Years with Zero (0) Excess Flow	1	0	0	0	1	0	5	9	6	3	0	0

Table 8: Summary of South Loup Subbasin with Instream Flow Demand

Summary of WY 1988 - 2011	January	February	March	April	May	June	July	August	September	October	November	December
Maximum Flow Volume (AF)	16,533	22,463	38,691	22,924	32,429	29,645	32,623	12,565	12,050	11,916	13,086	12,199
Minimum Flow Volume (AF)	0	2,461	8,983	8,839	0	1,325	0	0	0	0	1,038	1,489
Average Flow Volume (AF)	7,279	11,082	16,908	14,676	12,503	14,281	8,118	4,112	5,375	6,200	8,620	6,728
Average # of Days with Excess Flow	21	23	29	28	24	24	20	16	19	20	24	20
Number of Years with Zero (0) Excess Flow	1	0	0	0	1	0	3	6	4	3	0	0

Table 9: Summary of Middle Loup Subbasin with Full Hydropower Demand

Summary of WY 1988 - 2011	January	February	March	April	May	June	July	August	September	October	November	December
Maximum Flow Volume (AF)	65,617	113,216	118,166	80,566	88,882	103,037	45,279	62,186	41,893	89,041	114,187	75,105
Minimum Flow Volume (AF)	0	0	0	0	0	0	0	0	0	0	0	0
Average Flow Volume (AF)	10,151	23,003	30,691	22,622	18,706	22,734	5,276	5,644	4,704	12,473	13,327	7,994
Average # of Days with Excess Flow	7	10	13	11	9	11	6	5	4	6	6	5
Number of Years with Zero (0) Excess Flow	9	6	2	8	5	5	12	15	11	12	12	9

Table 10: Summary of Middle Loup Subbasin with Historic Diversion

Summary of WY 1988 - 2011	January	February	March	April	May	June	July	August	September	October	November	December
Maximum Flow Volume (AF)	86,684	124,918	124,819	114,583	147,692	103,037	45,279	65,560	64,951	128,074	114,206	90,886
Minimum Flow Volume (AF)	0	14,734	34,961	18,510	0	1,084	0	0	0	0	2,617	3,537
Average Flow Volume (AF)	34,654	55,854	75,471	77,923	67,082	53,120	11,396	12,042	12,925	30,853	38,535	27,238
Average # of Days with Excess Flow	22	24	30	29	28	25	12	11	12	18	23	19
Number of Years with Zero (0) Excess Flow	1	0	0	0	1	0	5	9	6	3	0	0

Table 11: Summary of Middle Loup Subbasin with Instream Flow Demand

Summary of WY 1988 - 2011	January	February	March	April	May	June	July	August	September	October	November	December
Maximum Flow Volume (AF)	89,641	128,242	124,705	119,429	135,563	103,037	45,279	65,560	83,940	135,644	114,206	90,327
Minimum Flow Volume (AF)	0	5,926	20,447	13,438	0	5,375	0	0	0	0	2,960	3,537
Average Flow Volume (AF)	33,655	51,828	67,430	57,593	43,054	43,692	21,520	21,344	28,448	34,389	40,030	33,459
Average # of Days with Excess Flow	21	23	29	28	24	24	20	16	19	20	24	20
Number of Years with Zero (0) Excess Flow	1	0	0	0	1	0	3	6	4	3	0	0

Table 12: Summary of Full Loup Subbasin with Full Hydropower Demand

Summary of WY 1988 - 2011	January	February	March	April	May	June	July	August	September	October	November	December
Maximum Flow Volume (AF)	102,980	188,476	302,801	255,856	355,628	1,084,703	357,192	190,991	121,592	246,668	158,994	121,948
Minimum Flow Volume (AF)	0	0	0	0	0	0	0	0	0	0	0	0
Average Flow Volume (AF)	14,041	49,345	67,276	41,421	54,655	121,154	45,674	15,957	10,169	23,553	17,160	10,256
Average # of Days with Excess Flow	7	10	13	11	9	11	6	5	4	6	6	5
Number of Years with Zero (0) Excess Flow	9	6	2	8	5	5	12	15	11	12	12	9

Table 13: Summary of Full Loup Subbasin with Historic Diversion

Summary of WY 1988 - 2011	January	February	March	April	May	June	July	August	September	October	November	December
Maximum Flow Volume (AF)	196,172	251,005	367,126	410,242	501,043	854,265	525,827	377,509	315,796	431,141	351,812	207,825
Minimum Flow Volume (AF)	0	15,921	37,204	18,510	0	1,084	0	0	0	0	2,617	3,537
Average Flow Volume (AF)	51,700	83,963	119,497	146,895	152,083	172,640	62,614	39,057	33,334	54,440	56,045	37,216
Average # of Days with Excess Flow	22	24	30	29	28	25	12	11	12	18	23	19
Number of Years with Zero (0) Excess Flow	1	0	0	0	1	0	5	9	6	3	0	0

Table 14: Summary of Full Loup Basin with Instream Flow Demand

Summary of WY 1988 - 2011	January	February	March	April	May	June	July	August	September	October	November	December
Maximum Flow Volume (AF)	184,228	246,407	384,981	346,808	453,467	1,180,050	501,117	384,297	293,566	330,025	238,522	204,127
Minimum Flow Volume (AF)	0	6,320	20,853	13,438	0	5,375	0	0	0	0	2,960	3,537
Average Flow Volume (AF)	50,320	95,050	126,642	100,207	105,145	177,024	118,506	85,759	75,990	58,706	53,842	45,123
Average # of Days with Excess Flow	21	23	29	28	24	24	20	16	19	20	24	20
Number of Years with Zero (0) Excess Flow	1	0	0	0	1	0	3	6	4	3	0	0

Table 15: Summary of Elkhorn Above Norfolk Subbasin with Instream Flow Demand

Summary of WY 1988 - 2011		January	February	March	April	May	June	July	August	September	October	November	December
Maximum Flow Volume (AF)		29,688	45,764	139,249	213,682	273,475	417,911	224,438	68,352	43,375	50,744	51,449	28,988
Minimum Flow Volume (AF)		0	0	0	0	0	704	0	0	0	0	0	0
Average Flow Volume (AF)		4,071	14,750	38,470	56,483	58,221	70,587	32,386	16,782	11,978	10,452	11,260	6,708
Average # of Days with Excess Flow		7	14	22	25	26	26	21	17	17	11	11	9
Number of Years with Zero (0) Excess Flow		10	4	1	1	1	0	3	5	4	12	11	10

Table 16: Summary of Full Elkhorn Subbasin with Instream Flow Demand

Summary of WY 1988 - 2011	January	February	March	April	May	June	July	August	September	October	November	December
Maximum Flow Volume (AF)	30,972	146,671	418,797	244,828	386,956	1,101,495	621,850	290,268	124,623	154,450	90,909	36,973
Minimum Flow Volume (AF)	0	0	0	0	0	704	0	0	0	0	0	0
Average Flow Volume (AF)	4,913	32,603	83,724	91,888	114,755	192,461	121,702	75,726	32,327	21,519	17,864	7,647
Average # of Days with Excess Flow	7	14	22	25	26	26	21	17	17	11	11	9
Number of Years with Zero (0) Excess Flow	10	4	1	1	1	0	3	5	4	12	11	10

Table 17: Summary of Lower Platte Above North Bend Subbasin with Instream Flow Demand

Summary of WY 1988 - 2011	January	February	March	April	May	June	July	August	September	October	November	December
Maximum Flow Volume (AF)	339,966	499,554	1,035,302	626,076	602,072	1,279,836	1,026,646	405,821	386,179	461,498	422,730	392,931
Minimum Flow Volume (AF)	0	89,886	207,066	139,294	0	10,247	0	0	0	0	22,702	40,673
Average Flow Volume (AF)	202,047	263,690	372,677	313,583	308,013	403,381	229,315	146,422	153,535	211,518	233,516	207,283
Average # of Days with Excess Flow	26	26	31	30	28	26	20	16	19	23	26	25
Number of Years with Zero (0) Excess Flow	1	0	0	0	1	0	3	6	4	3	0	0

Table 18: Summary of Lower Platte Subbasin with Instream Flow Demand

Summary of WY 1988 - 2011	January	February	March	April	May	June	July	August	September	October	November	December
Maximum Flow Volume (AF)	585,982	712,918	1,592,256	1,067,778	1,272,281	2,965,930	2,593,138	820,631	720,725	650,302	548,541	497,496
Minimum Flow Volume (AF)	15,080	108,464	274,538	181,987	0	19,214	0	0	0	0	25,446	64,328
Average Flow Volume (AF)	288,230	400,804	576,952	512,818	558,448	756,990	453,467	265,111	227,478	282,504	310,730	278,863
Average # of Days with Excess Flow	27	26	31	30	28	27	21	17	20	23	27	25
Number of Years with Zero (0) Excess Flow	0	0	0	0	1	0	3	5	4	3	0	0

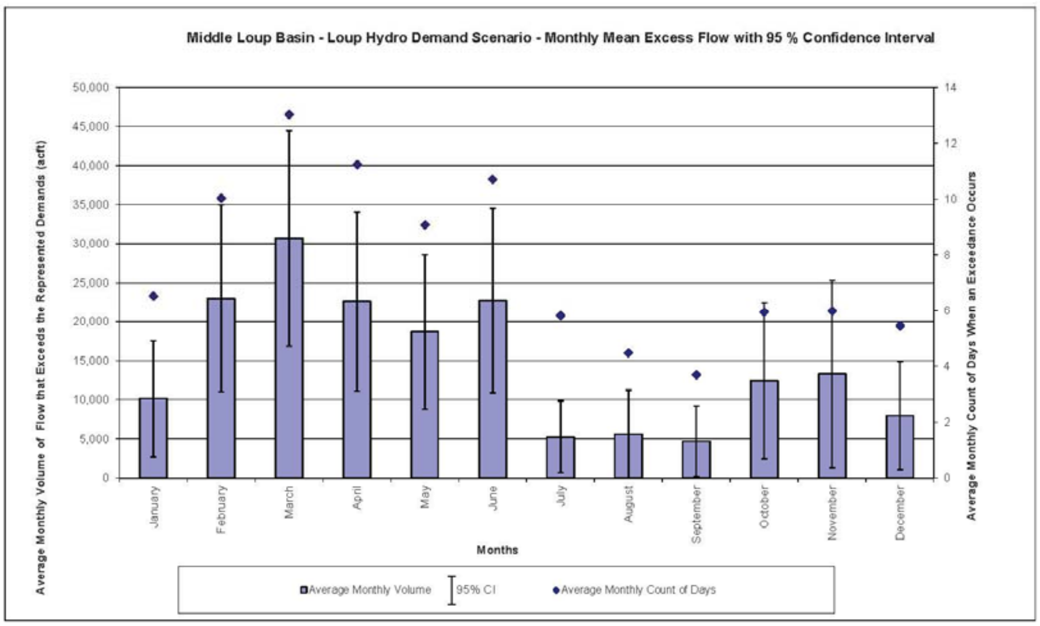
The following illustration shows one potential use of the excess flow analysis to assess the interaction of and impacts on calculated excess flow for a potential project.

Steps to Reading Excess Flow Analysis Plots

The first step involves evaluation of the excess flow analysis and resulting plots to define the project's physical and operational characteristics.

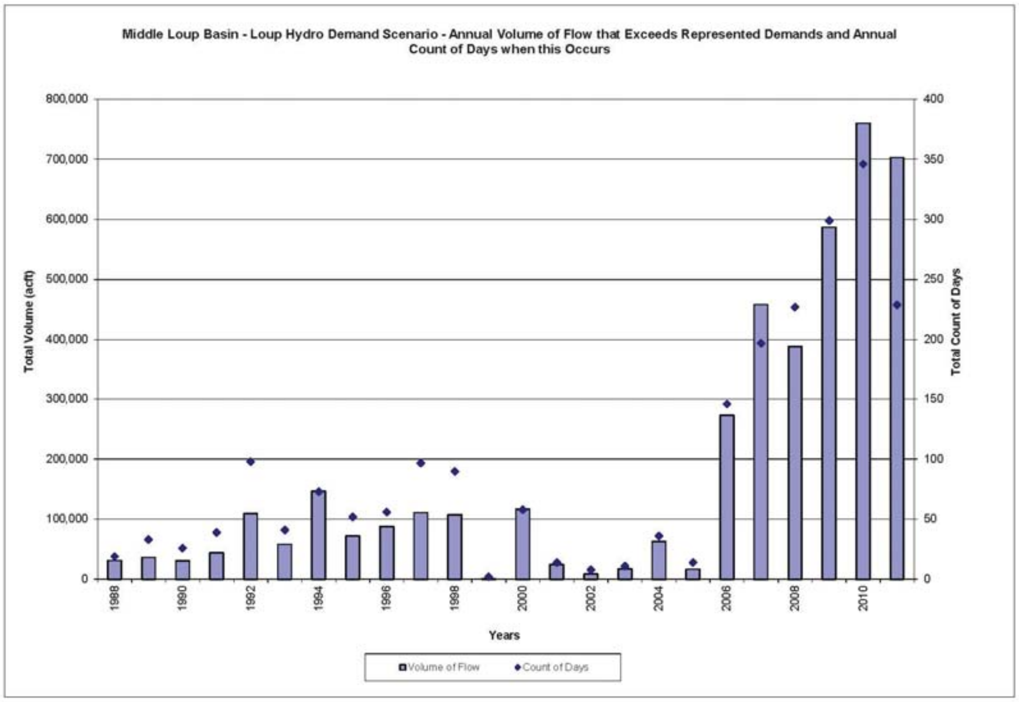
The plot of annual excess flow volumes in the Middle Loup subbasin, shown below, indicates that sufficient excess flow volumes are likely present for project feasibility when considering both instream flow demands as well as historic Loup hydropower diversions.

Figure 6: Middle Loup Subbasin,
Annual Volume of Flow that Exceeds both Instream Flow Demands as well as Historic Loup Hydropower Diversions and Annual Count of Days when this Occurs



The monthly mean excess flow plot is then evaluated to determine the seasonal variations of excess flows that can be expected. The monthly mean excess flow plot shows that there is considerable variability; however, excess flows have been available throughout the year.

Figure 7: Middle Loup Subbasin, Monthly Mean Flows in Excess of both Instream Flow Demands as well as Historic Loup Hydropower Diversions with 95% Confidence Interval



Next, the computed volumes for each month through the period of record are evaluated.

Figure 8: Middle Loup Subbasin,
January Volume of Excess Flow and Count of Days that are above both Instream Flow Demands as well as Historic Loup Hydropower Diversions

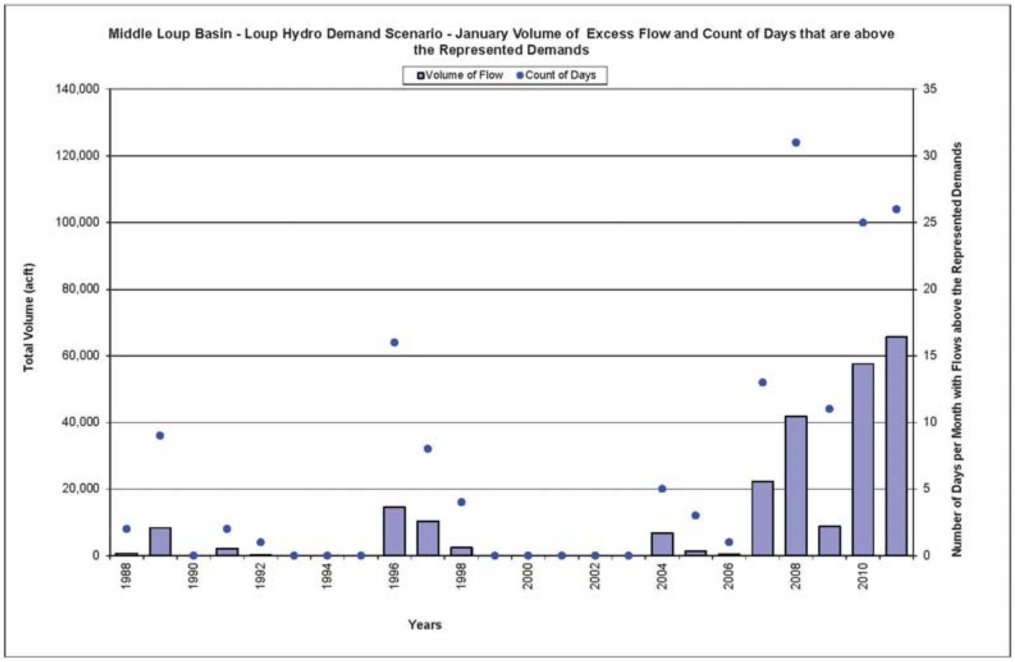


Figure 9: Middle Loup Subbasin,
February Volume of Excess Flow and Count of Days that are both Instream Flow Demands as well as Historic Loup Hydropower Diversions

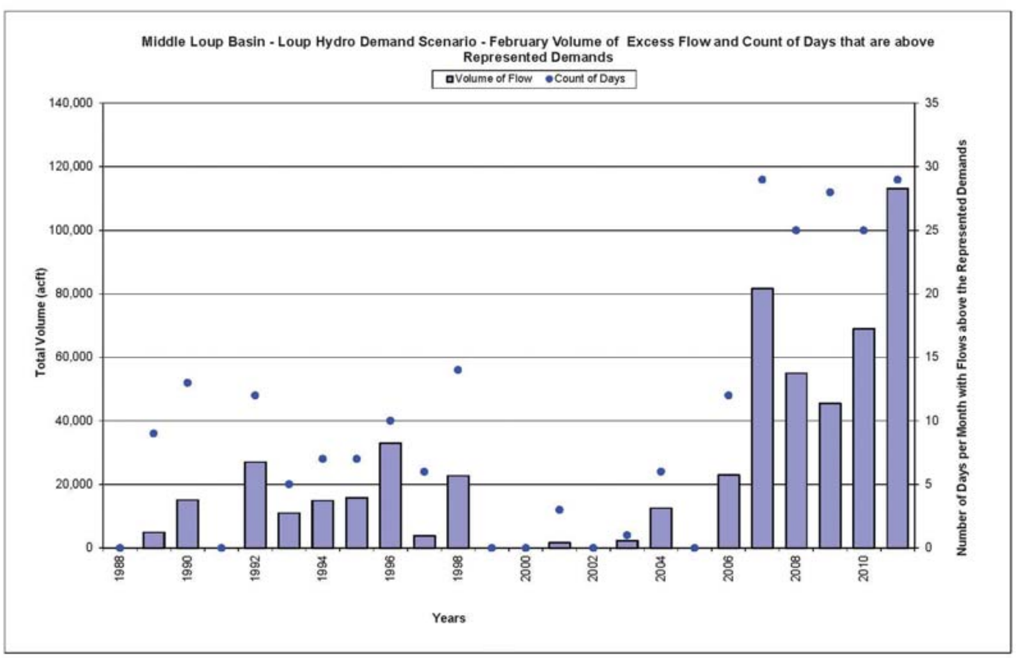


Figure 10: Middle Loup Subbasin,
March Volume of Excess Flow and Count of Days that are above both Instream Flow Demands as well as Historic Loup Hydropower Diversions

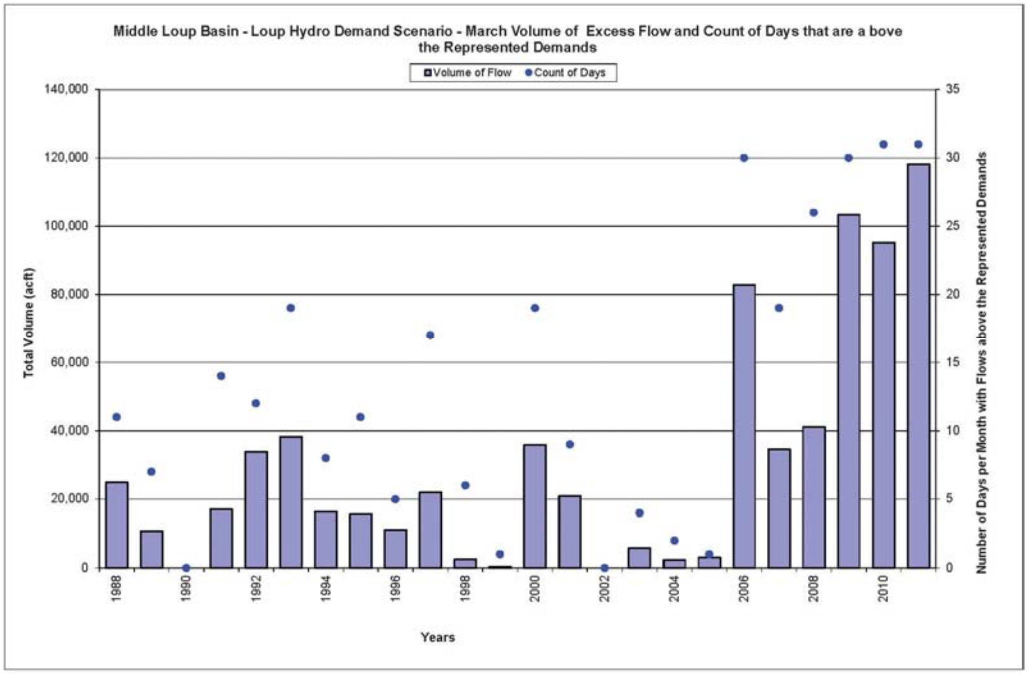


Figure 11: Middle Loup Subbasin,
April Volume of Excess Flow and Count of Days that are above both Instream Flow Demands as well as Historic Loup Hydropower Diversions

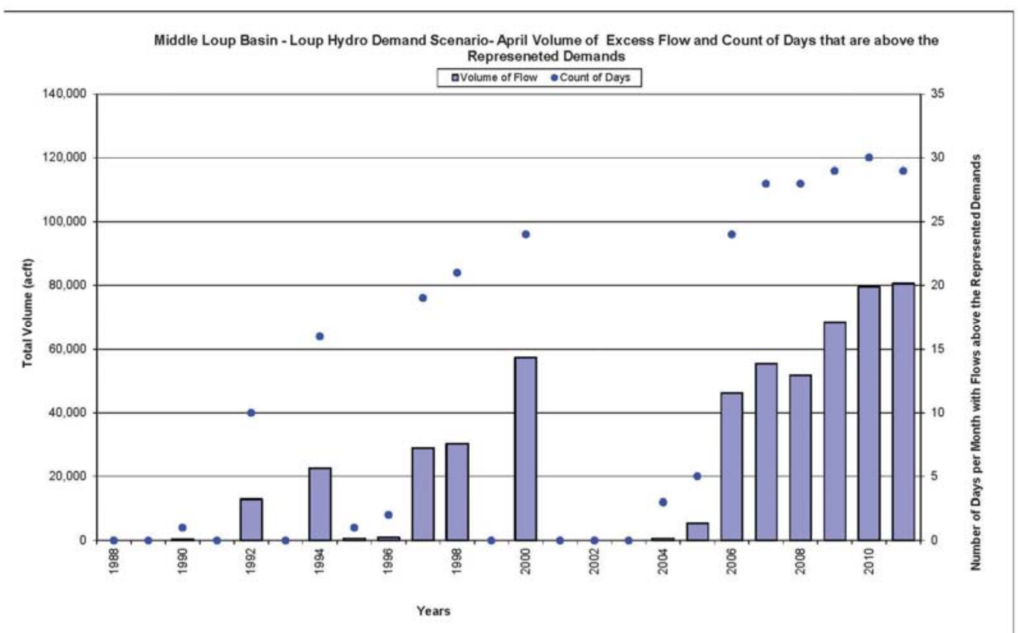


Figure 12: Middle Loup Subbasin,
May Volume of Excess Flow and Count of Days that are above both Instream Flow Demands as well as Historic Loup Hydropower Diversions

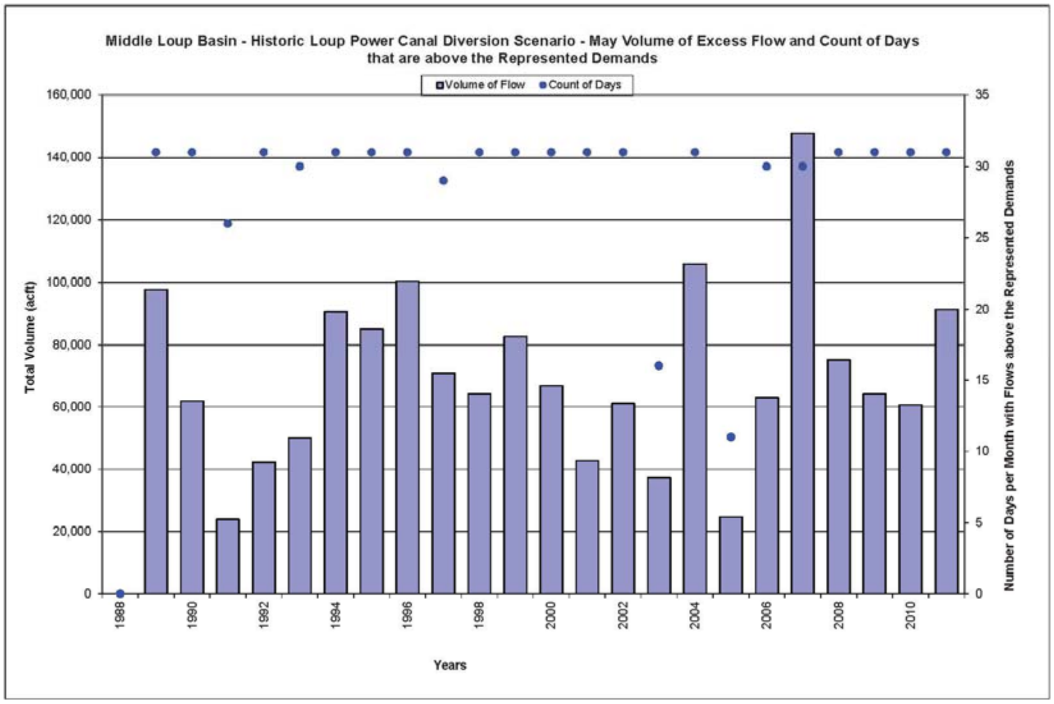


Figure 13: Middle Loup Subbasin,
June Volume of Excess Flow and Count of Days that are above both Instream Flow Demands as well as Historic Loup Hydropower Diversions

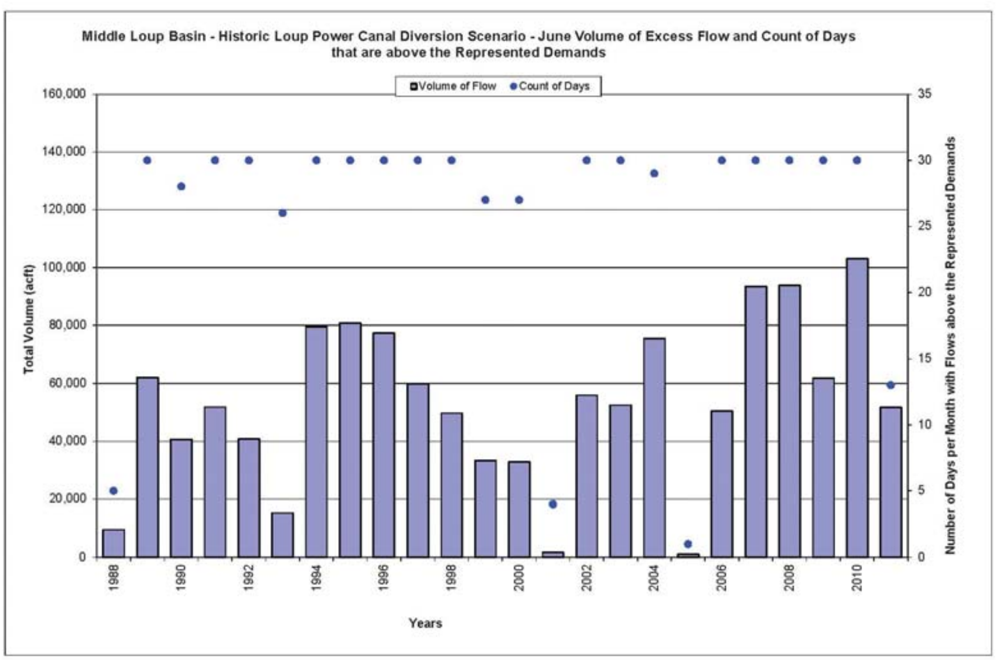


**Figure 14: Middle Loup Subbasin,
July Volume of Excess Flow and Count of Days that are above both Instream Flow Demands as well as Historic Loup Hydropower Diversions**

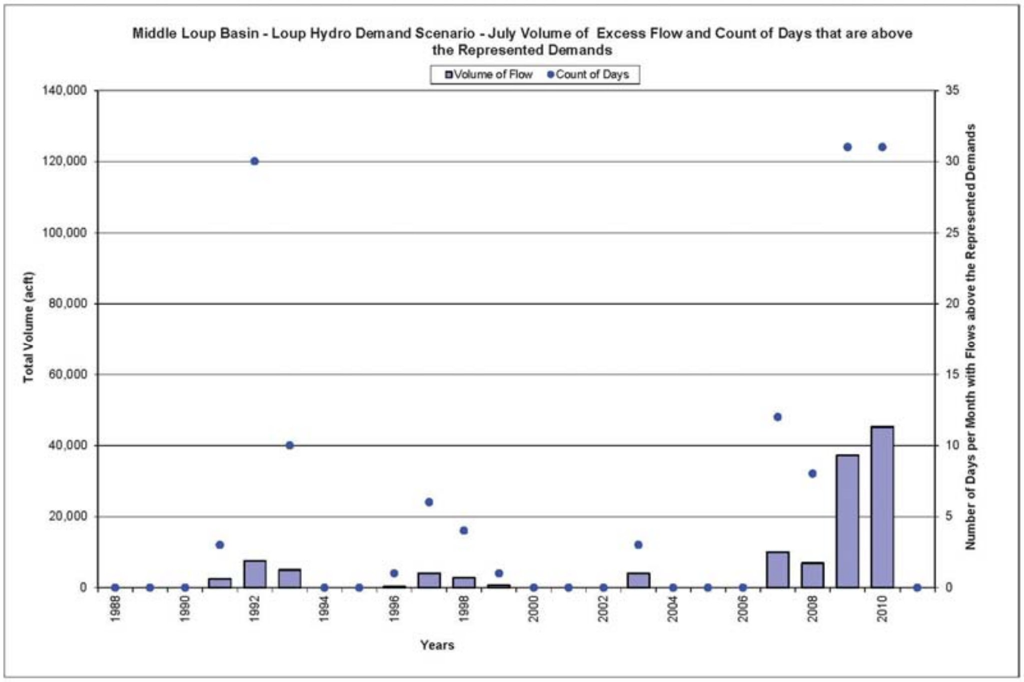


**Figure 15: Middle Loup Subbasin,
August Volume of Excess Flow and Count of Days that are above both Instream Flow Demands as well as Historic Loup Hydropower Diversions**

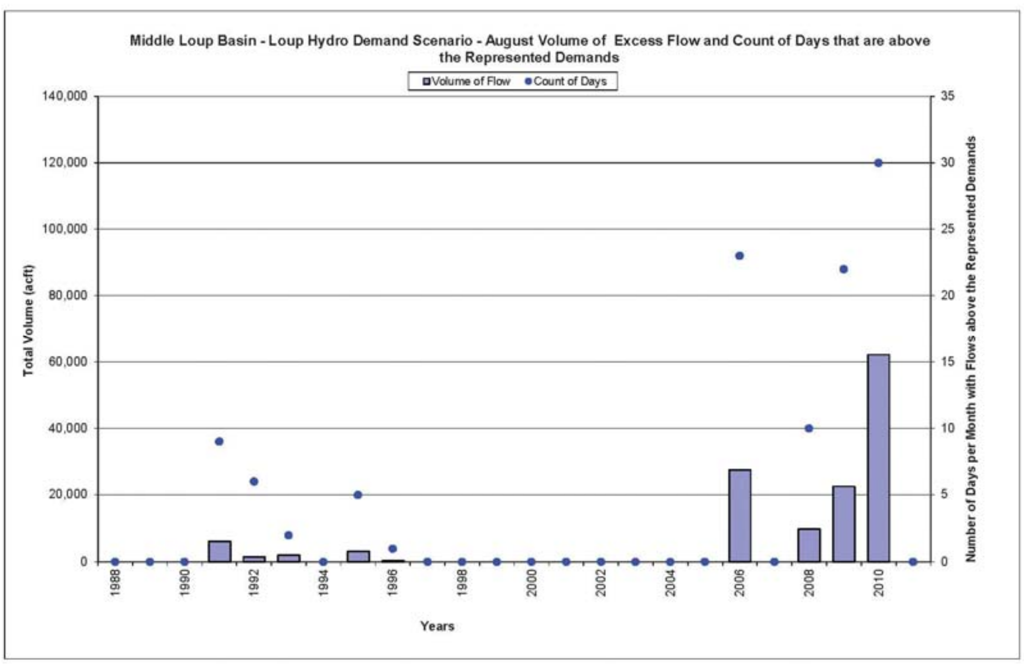


Figure 16: Middle Loup Subbasin,
September Volume of Excess Flow and Count of Days that are above both Instream Flow Demands as well as Historic Loup Hydropower Diversions

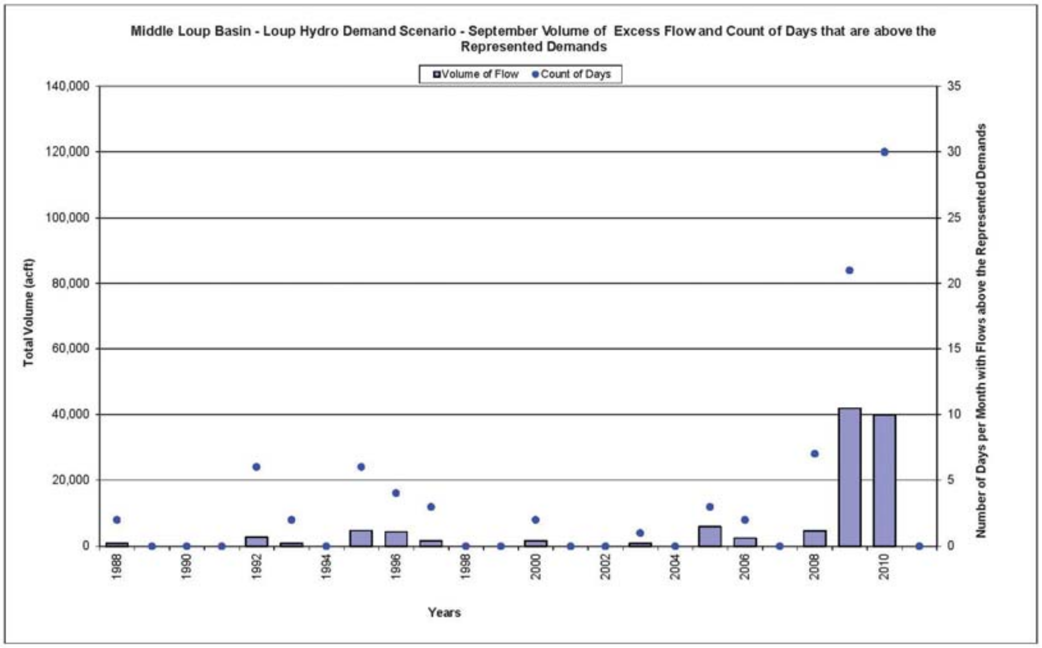


Figure 17: Middle Loup Subbasin,
October Volume of Excess Flow and Count of Days that are above both Instream Flow Demands as well as Historic Loup Hydropower Diversions

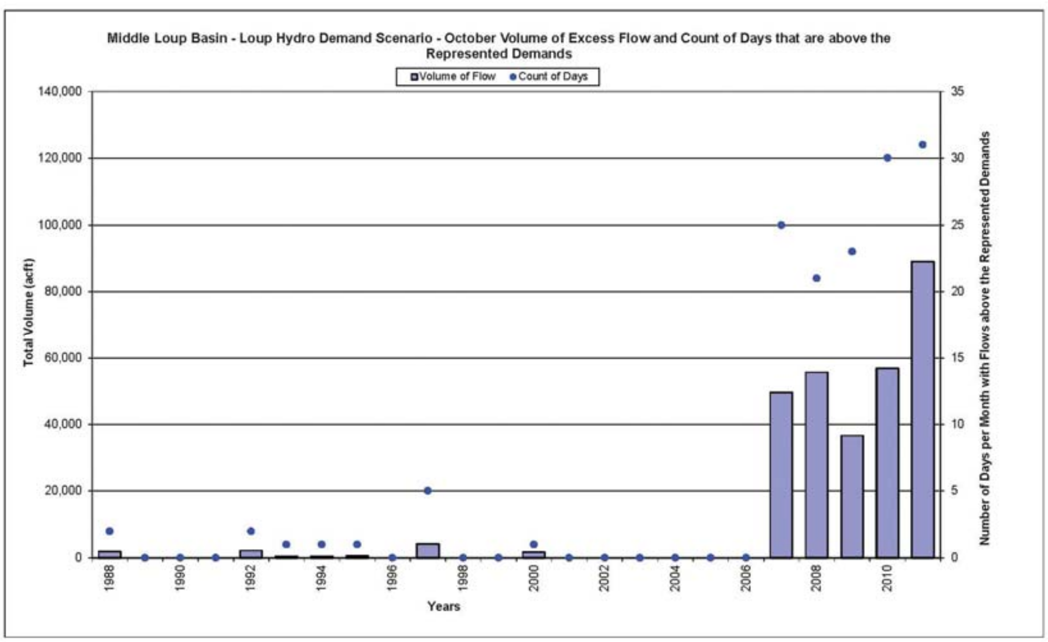


**Figure 18: Middle Loup Subbasin,
November Volume of Excess Flow and Count of Days that are above both Instream Flow Demands as well as Historic Loup Hydropower Diversions**

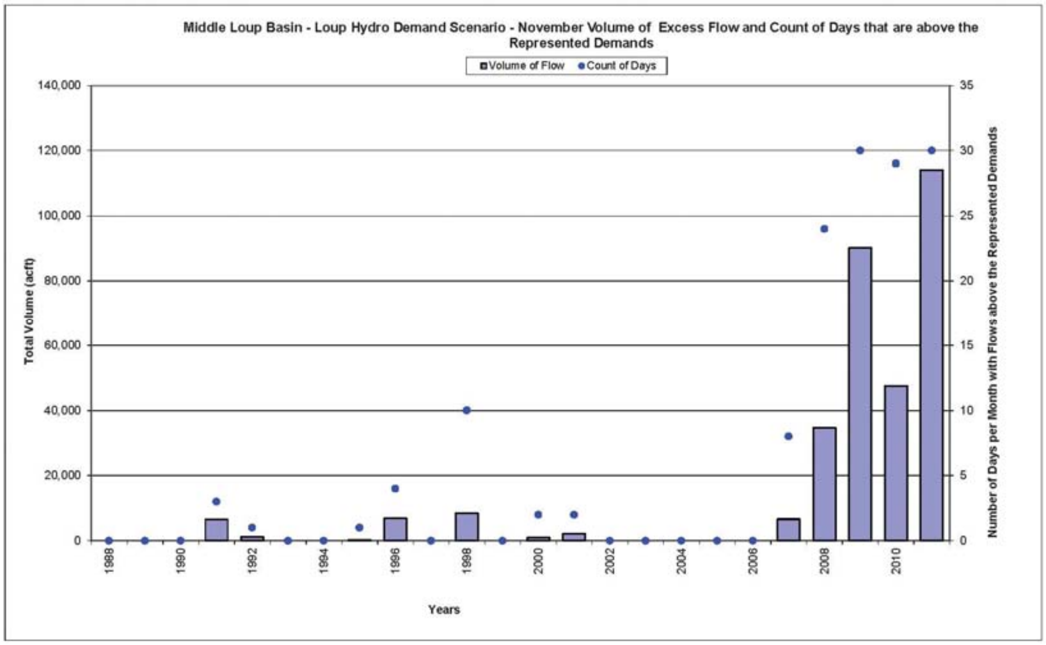
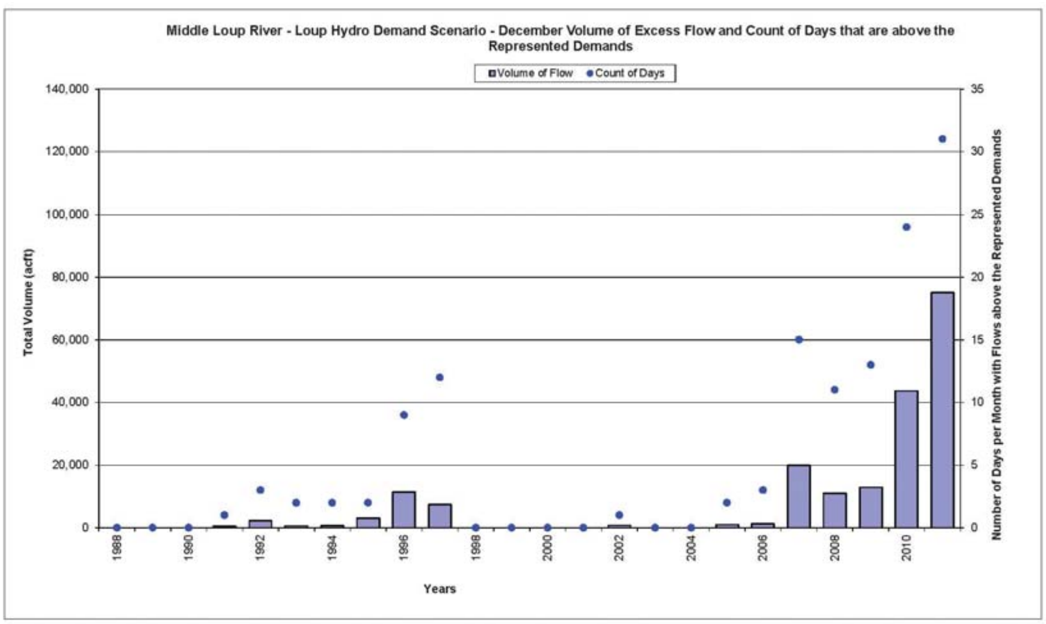


**Figure 19: Middle Loup Subbasin,
December Volume of Excess Flow and Count of Days that are above both Instream Flow Demands as well as Historic Loup Hydropower Diversions**



As shown in Figures 8 through 19, with the exception of the months of July through September, excess flows are available in the Middle Loup subbasin when both instream flow demands and historic Loup hydropower diversions are considered. This excess flow availability during the non-irrigation season indicates that the project could potentially use existing diversion infrastructure without interfering with existing irrigation season use. July and August are the heart of the irrigation season, with little excess flow available.

These plots give insight into the potential project's overall feasibility as well as to evaluate operational constraints and their impact on the amount of excess flow that may be used for a project.

The remainder of the excess flow plots shown in the example above are provided in Appendices A and B. Appendix A contains plots of the monthly excess flow volumes for the period of record at each analysis point. Appendix B contains plots of the average monthly excess flow volumes over the period of record. In addition, the average number of days each month during which excess flow is available is also plotted.

Figures 20 through 24 provide an overview of the data provided in Appendices A and B in less detail. Figures 20, 21, and 22 show the three demand scenarios previously described for the Loup subbasin. In general, the full hydropower appropriation is more conservative than the other two demand scenarios, and there is less excess flow available under this scenario.

When comparing Figures 21 and 22, the reader will notice that there is more excess flow available under the historic Loup Power Canal diversion scenario for the months of January, April, May, and November than under the instream flow demand scenario. The purpose of the analysis was to quantify flows in excess of state protected flows (instream flow demand); therefore, the instream flow demand scenario should always be given higher priority than the other two demand scenarios, and the user should perform a check against the instream flow demand and use the most conservative value for excess flow (whichever is less).

The results for the Elkhorn subbasin and the Lower Platte River reaches are shown in Figures 23 and 24.

Figure 20: Loup Subbasin, Average Monthly Flow Volume (1988-2011) based on Loup Hydropower Appropriation

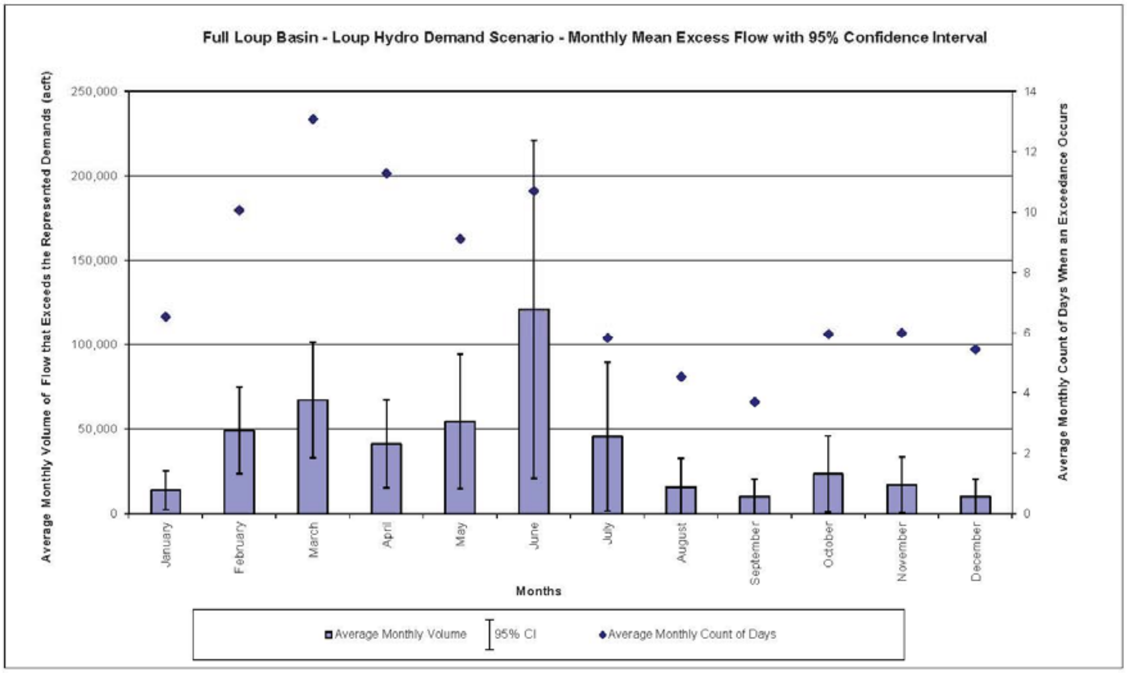


Figure 21: Loup Subbasin, Average Monthly Flow Volume (1988-2011) based on Historic Loup Power Canal Diversion

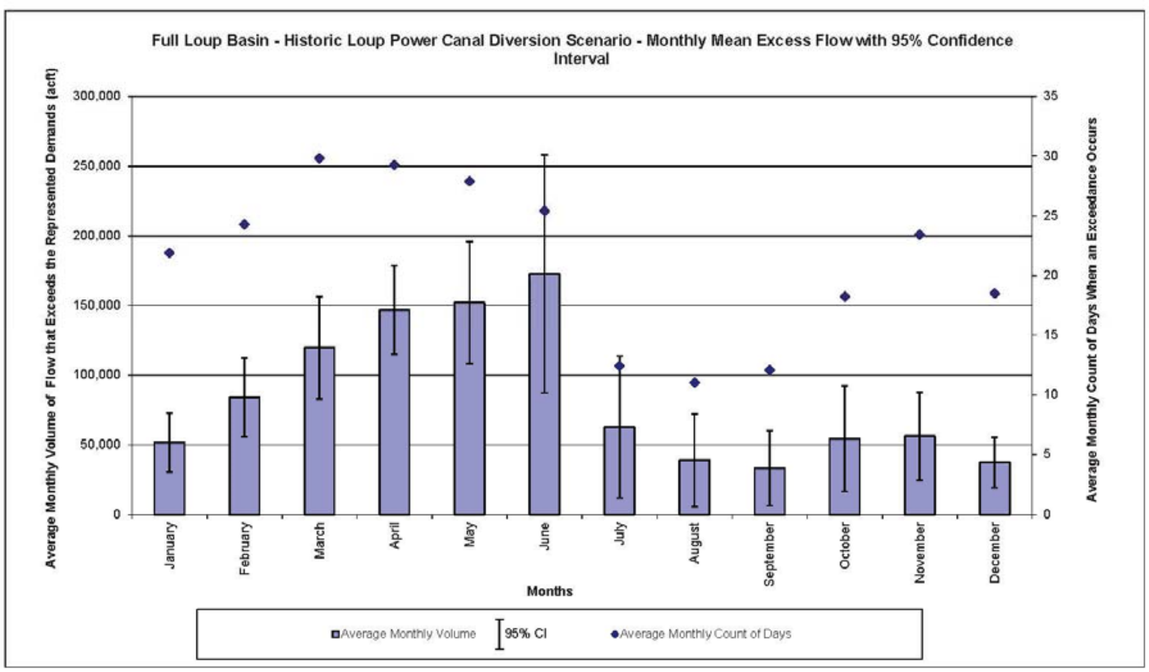


Figure 22: Loup Subbasin, Average Monthly Flow Volume (1988-2011) based on Platte River Instream Flow Appropriations

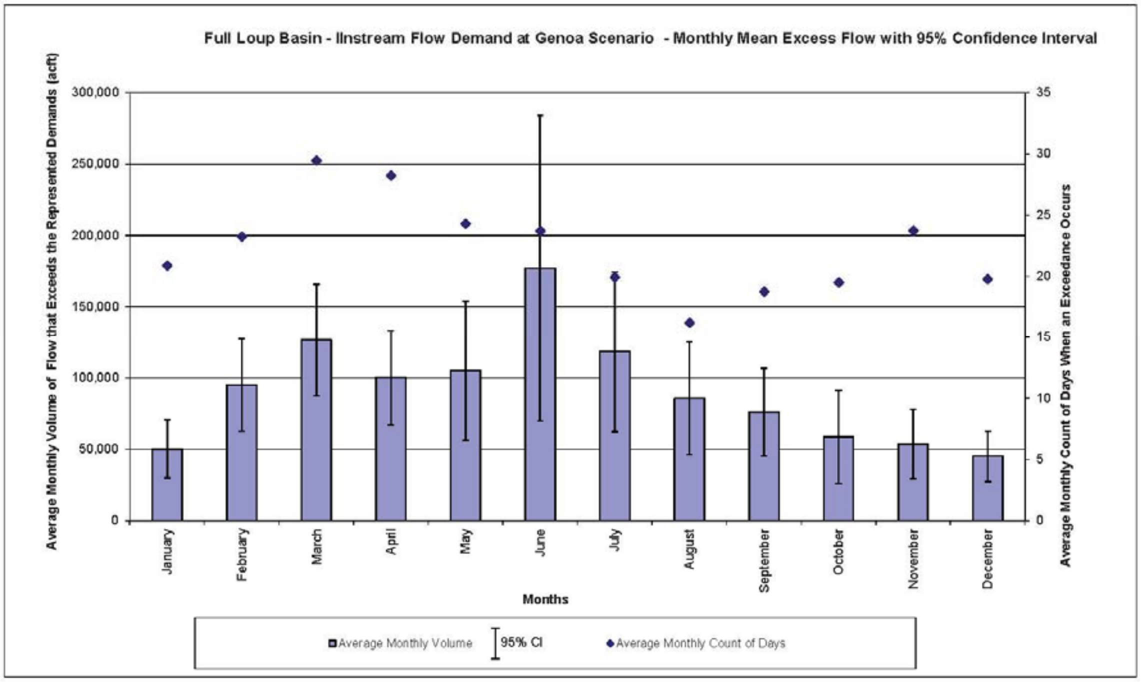


Figure 23: Elkhorn Subbasin, Average Monthly Flow Volume (1988-2011) based on Platte River Instream Flow Appropriations

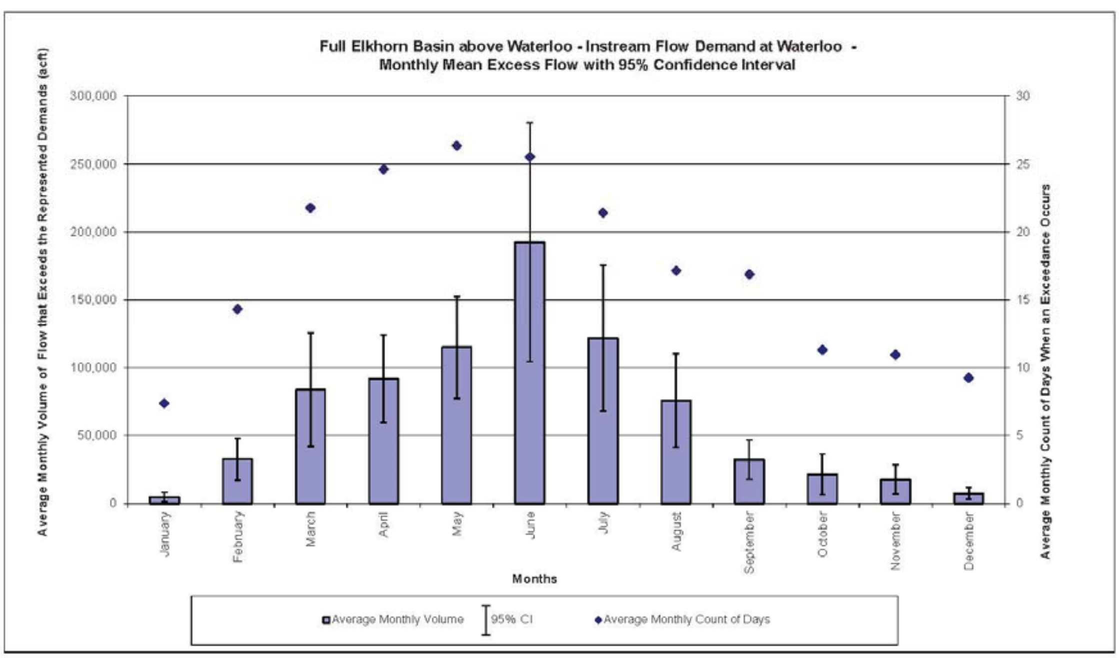
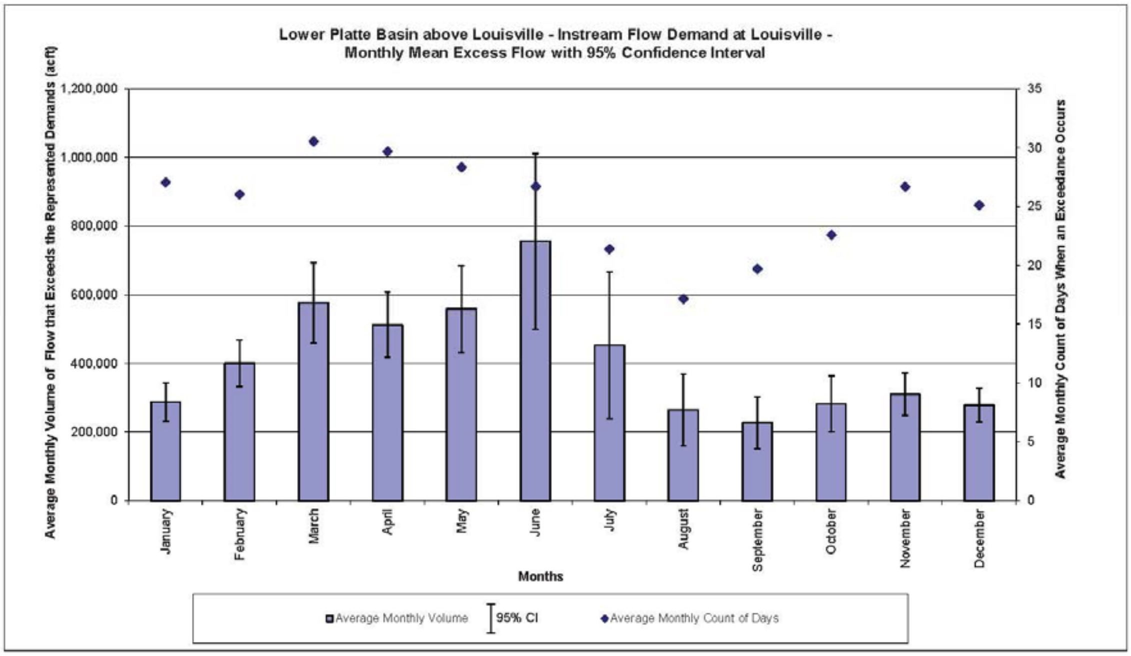


Figure 24: Lower Platte River Subbasins, Average Monthly Flow Volume (1988-2011) based on Platte River Instream Flow Appropriations



Appendix A: Output Plots for Monthly Mean Excess Flow Volumes (Period of Record) at Each Analysis Point

Appendix A contains plots of the monthly mean excess flow volumes for the period of record at each analysis point.

Figure A1: Lower Platte North Bend to Louisville Subbasin, January Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

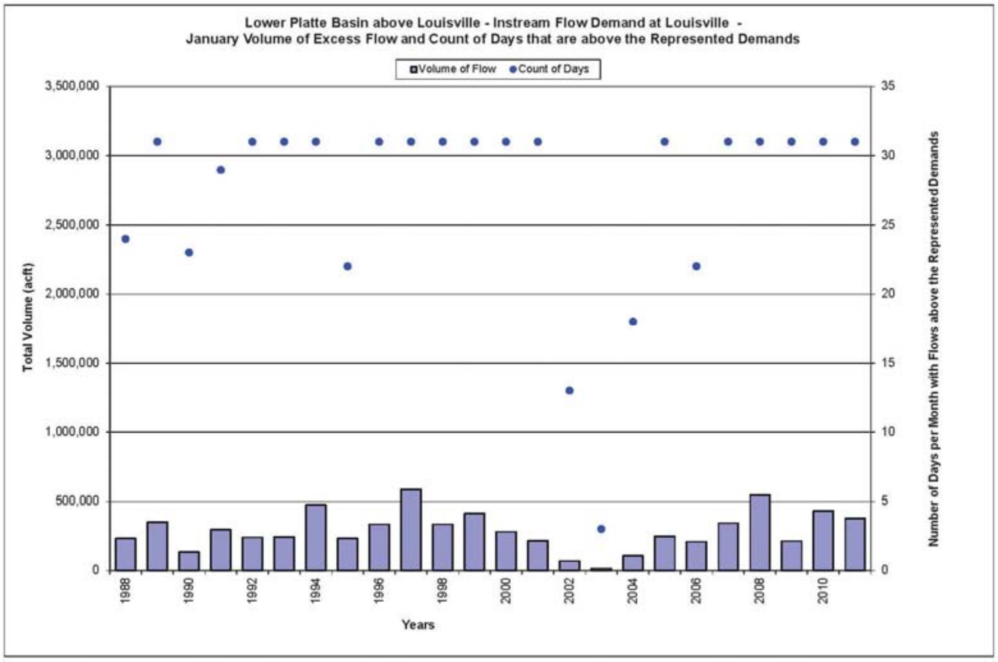


Figure A2: Lower Platte North Bend to Louisville Subbasin, February Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

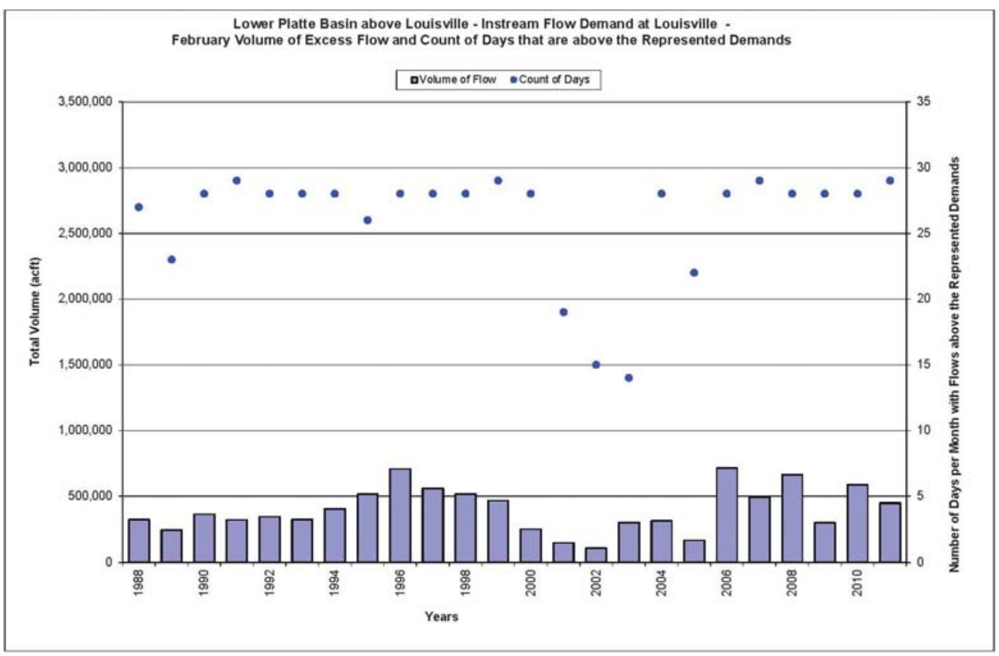


Figure A3: Lower Platte North Bend to Louisville Subbasin, March Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

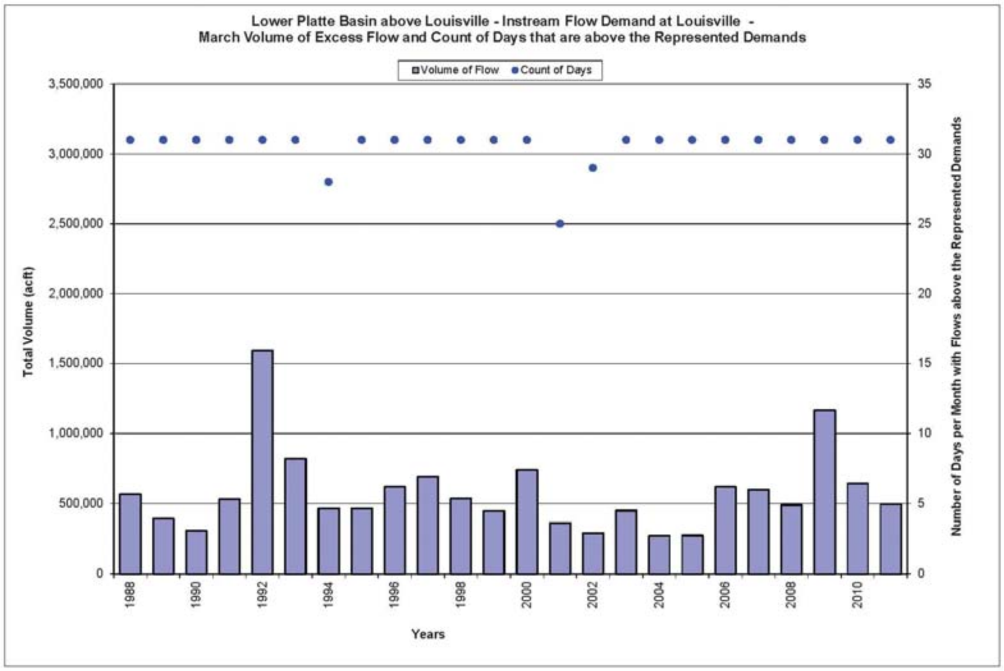


Figure A4: Lower Platte North Bend to Louisville Subbasin, April Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

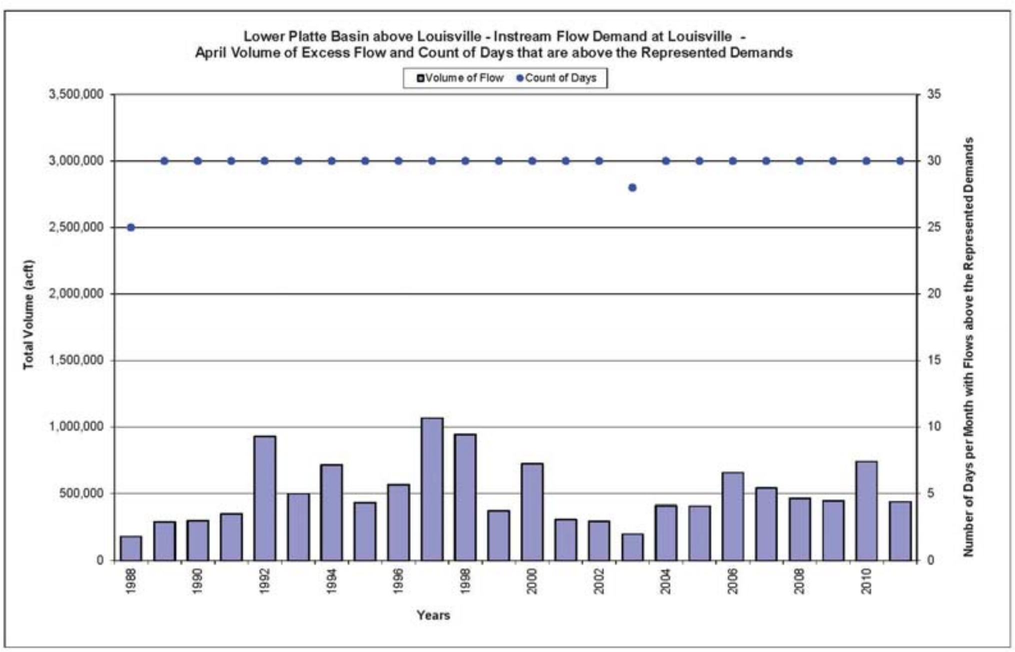


Figure A5: Lower Platte North Bend to Louisville Subbasin, May Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

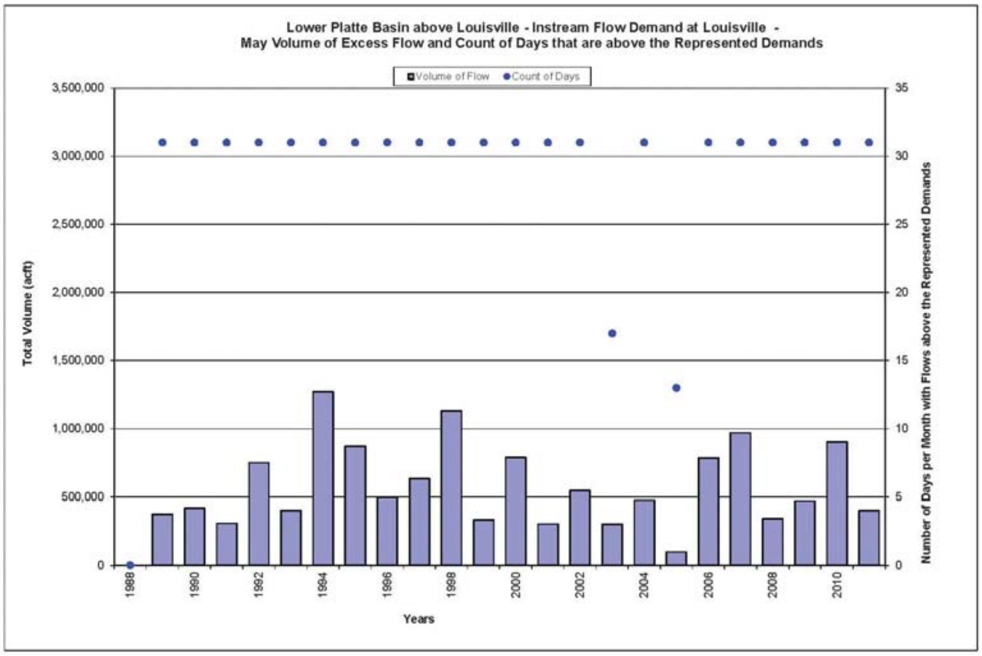


Figure A6: Lower Platte North Bend to Louisville Subbasin, June Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

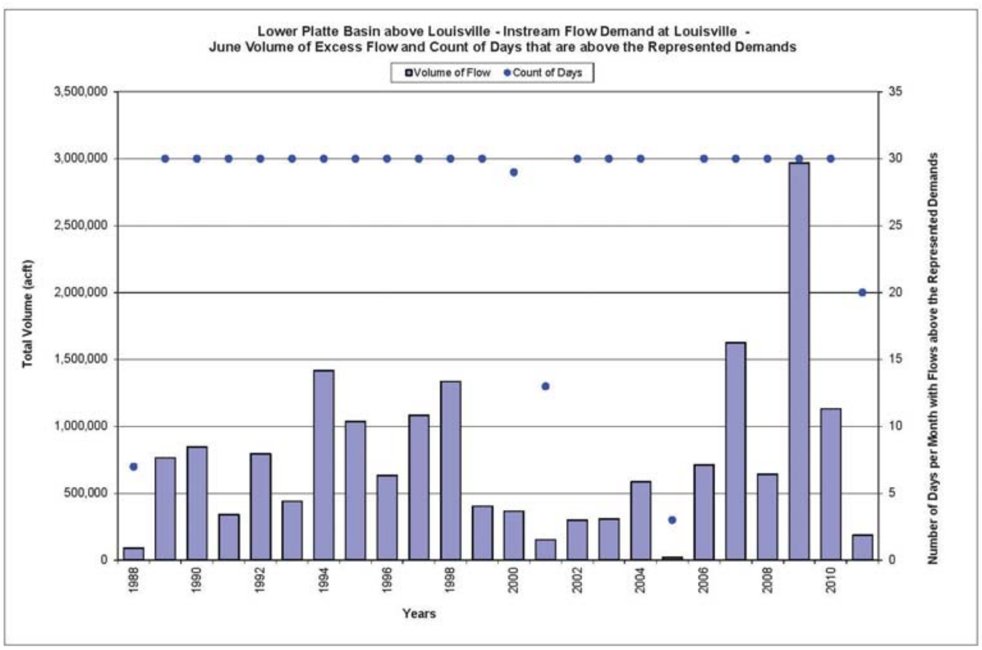


Figure A7: Lower Platte North Bend to Louisville Subbasin,
July Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

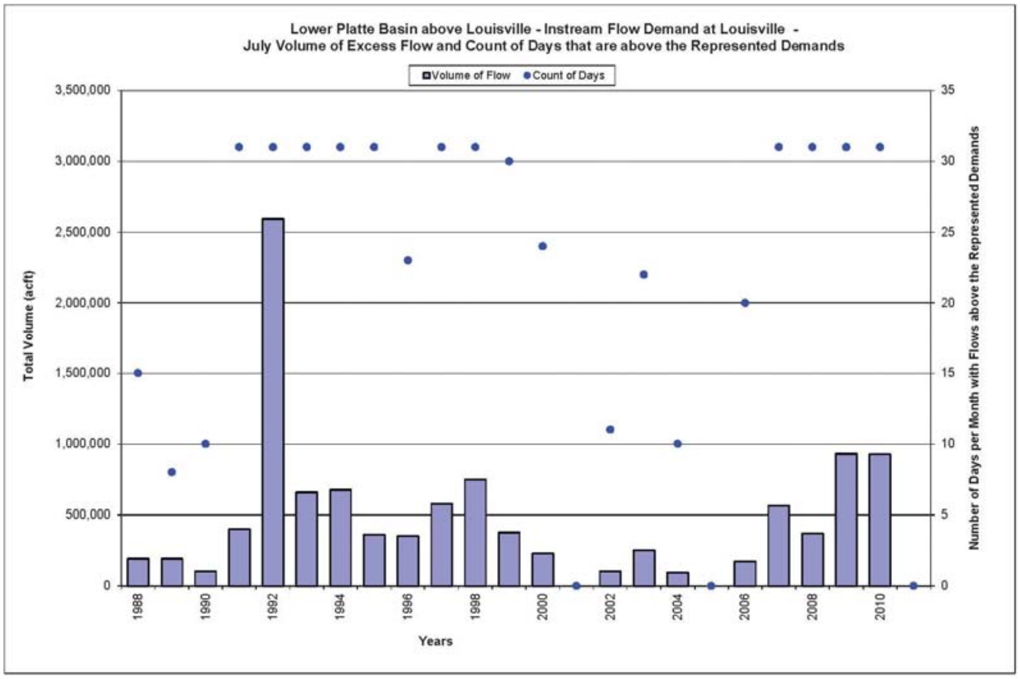


Figure A8: Lower Platte North Bend to Louisville Subbasin,
August Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

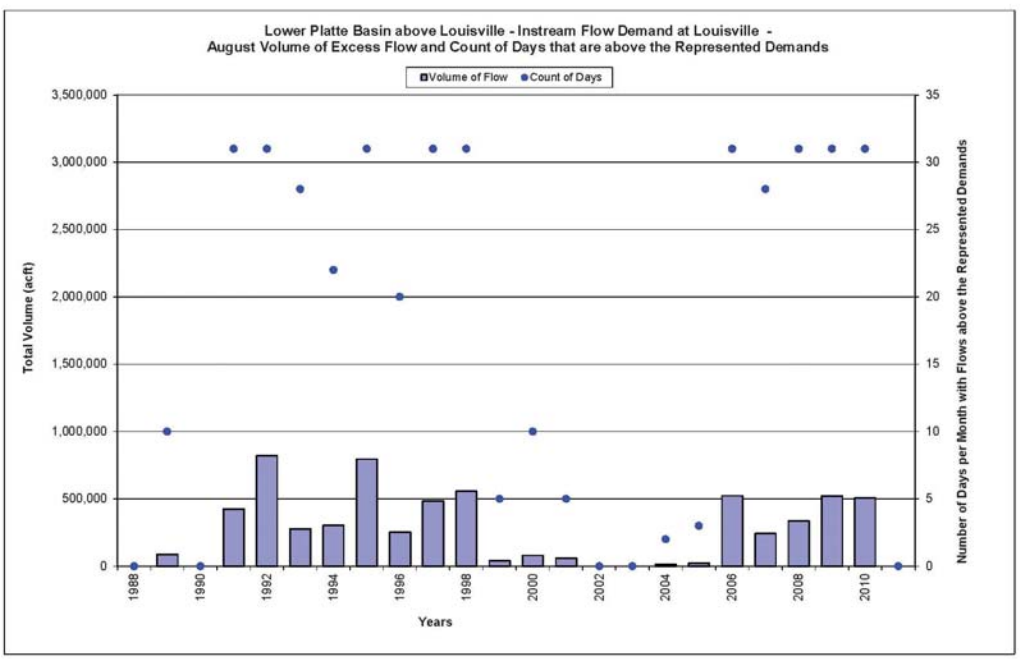


Figure A9: Lower Platte North Bend to Louisville Subbasin, September Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

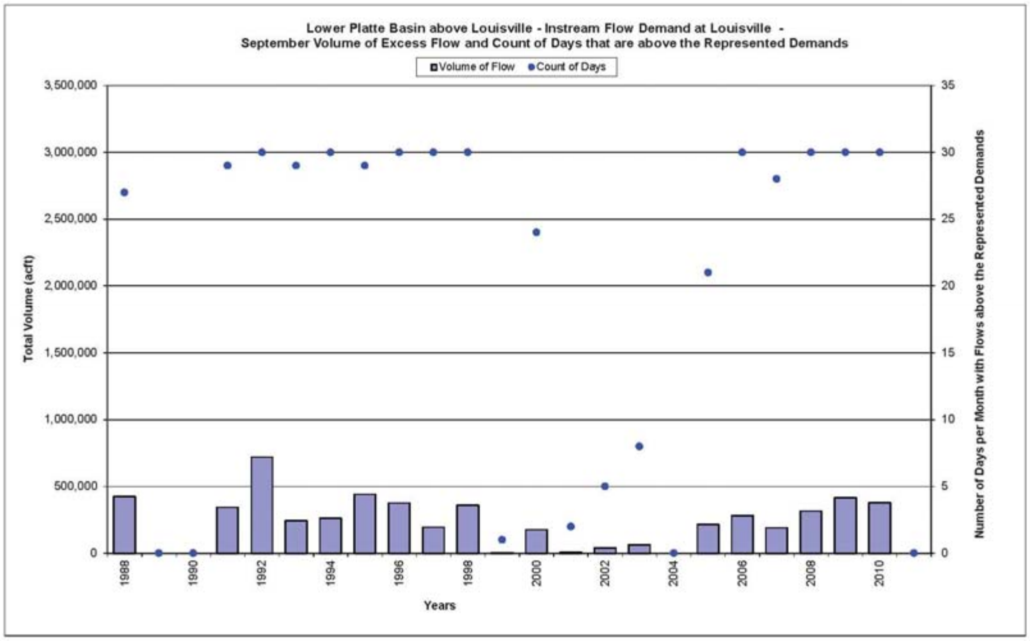


Figure A10: Lower Platte North Bend to Louisville Subbasin, October Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

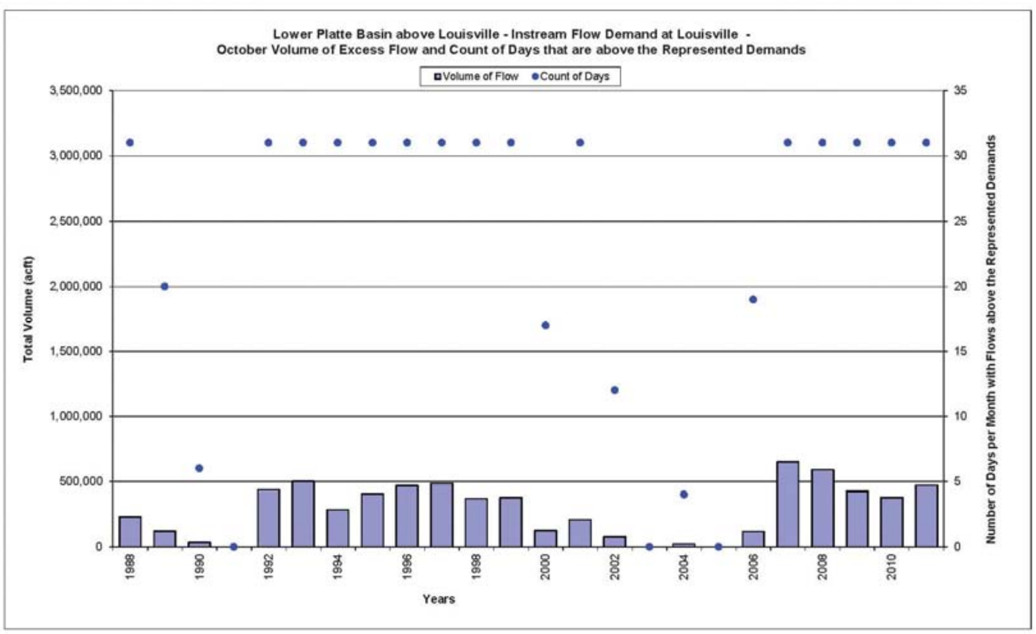


Figure A11: Lower Platte North Bend to Louisville Subbasin, November Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

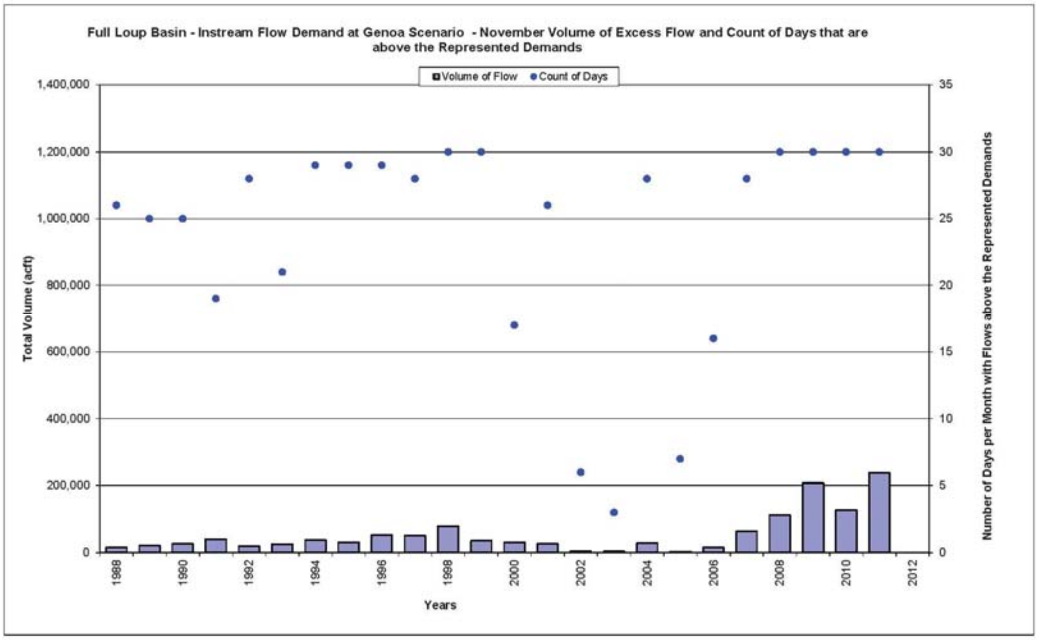


Figure A12: Lower Platte North Bend to Louisville Subbasin, December Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

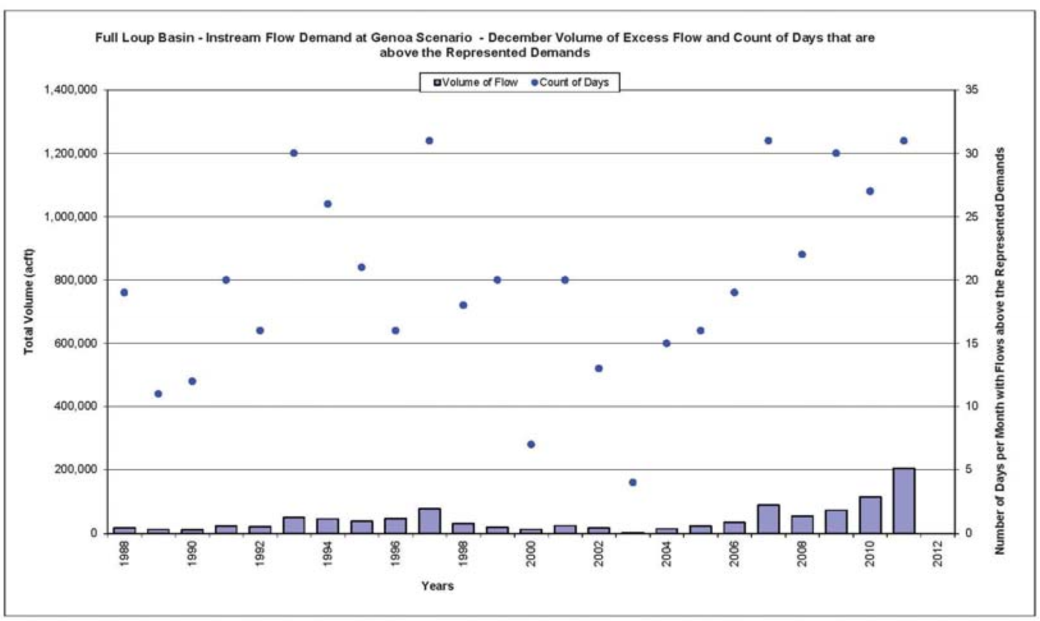


**Figure A13: Lower Platte Above North Bend Subbasin,
January Volume of Excess Flow and Count of Days that are above the Instream Flow Demands**

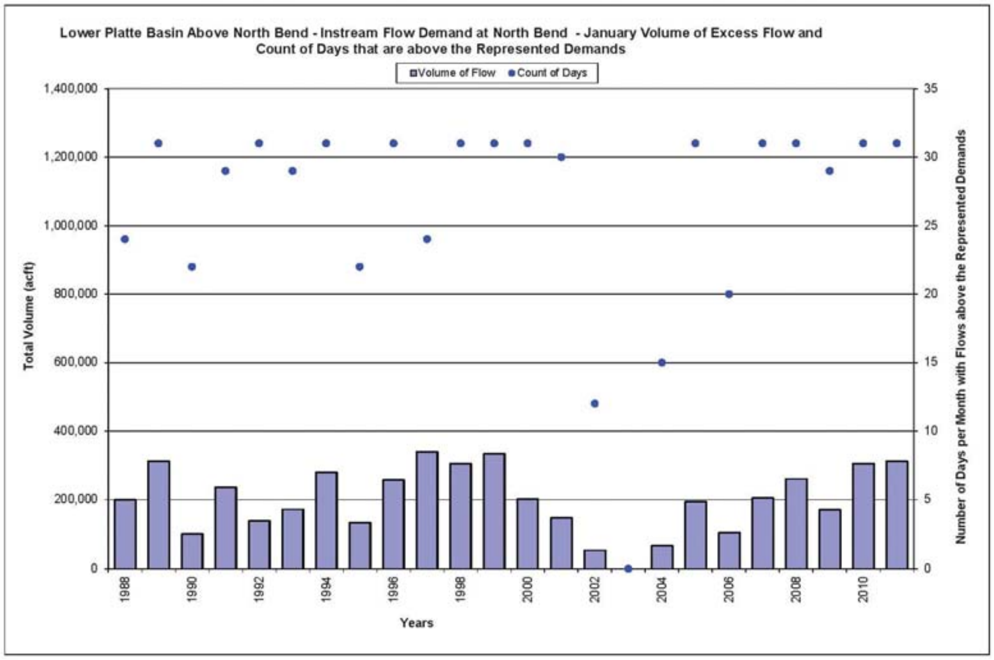


**Figure A14: Lower Platte Above North Bend Subbasin,
February Volume of Excess Flow and Count of Days that are above the Instream Flow Demands**

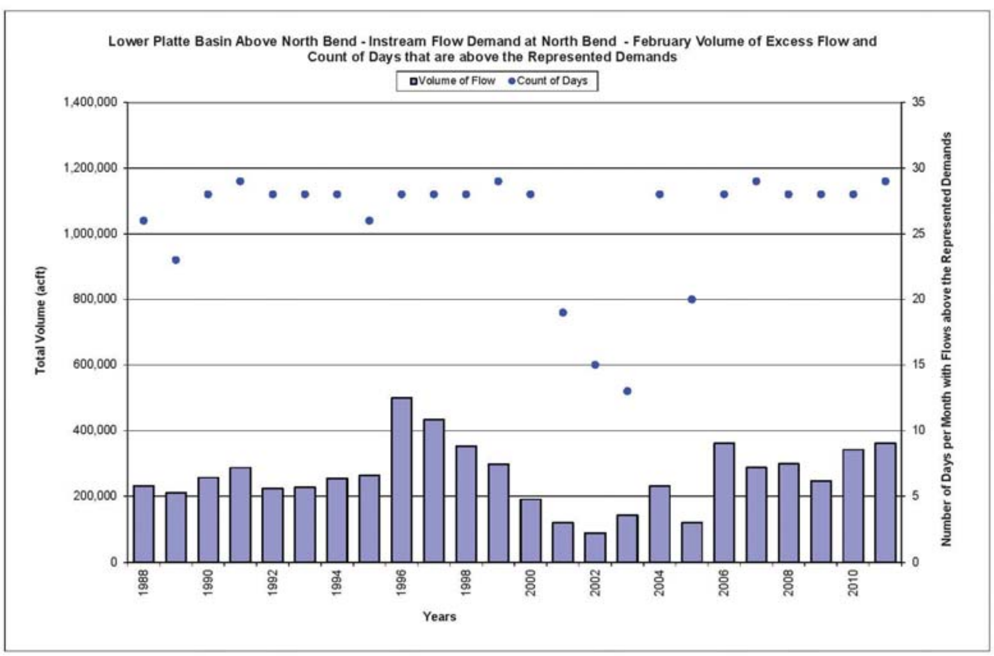


Figure A15: Lower Platte Above North Bend Subbasin,
March Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

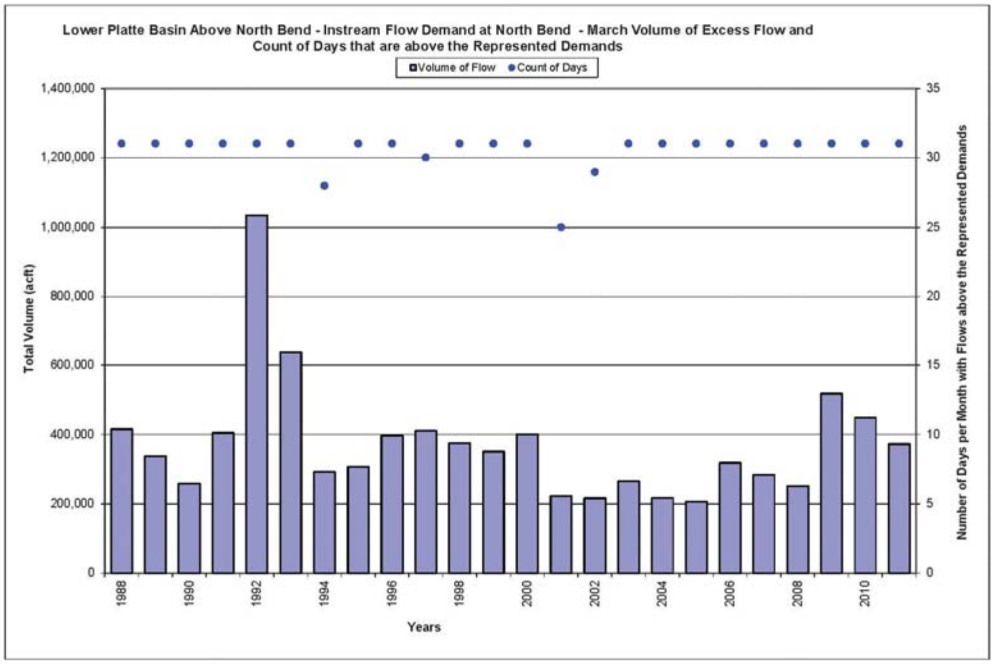


Figure A16: Lower Platte Above North Bend Subbasin,
April Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

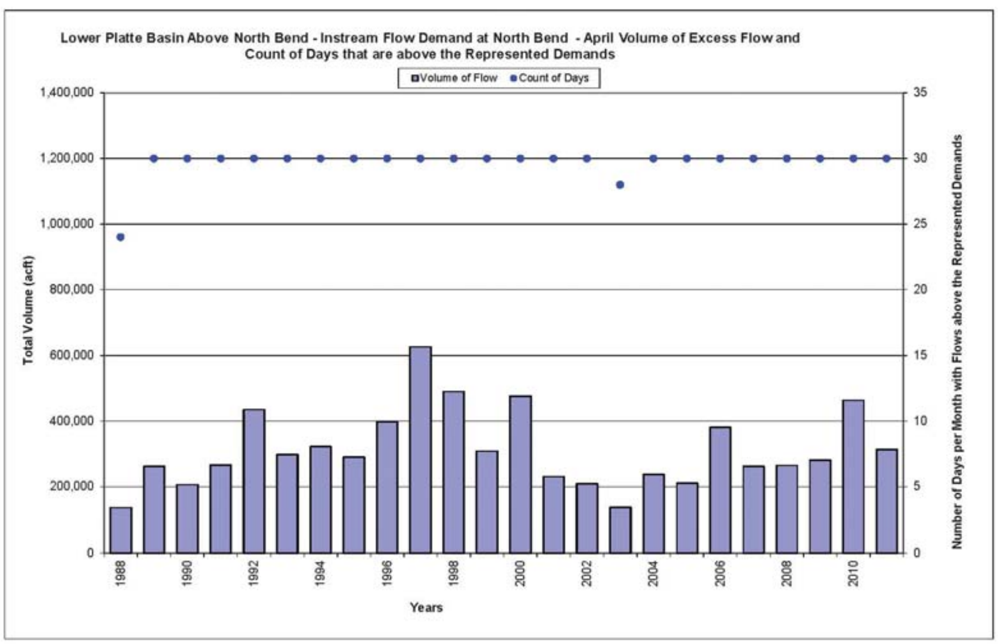


Figure A17: Lower Platte Above North Bend Subbasin,
May Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

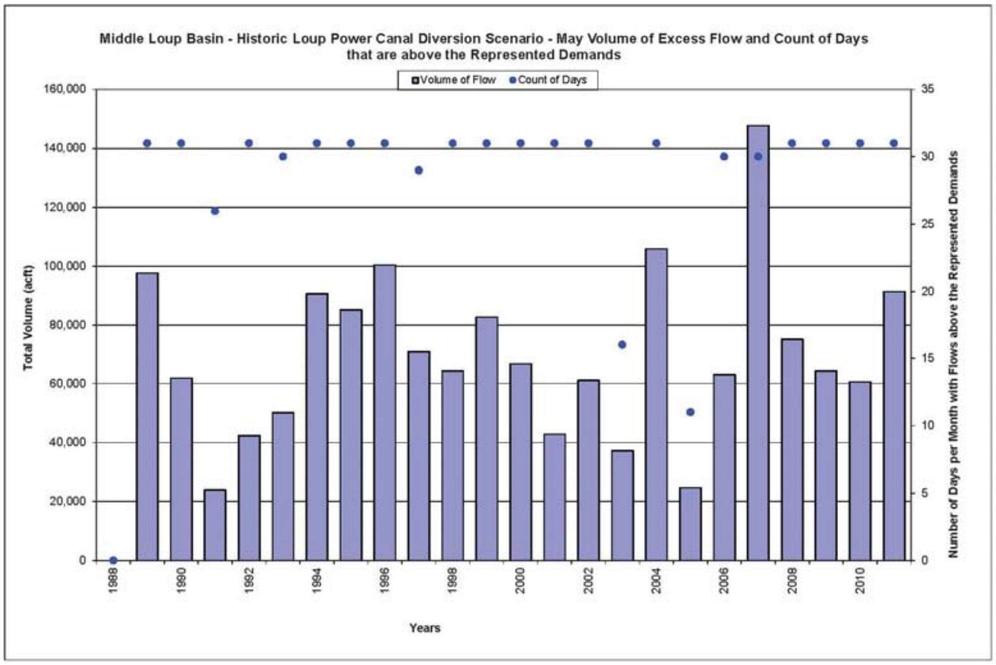


Figure A18: Lower Platte Above North Bend Subbasin,
June Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

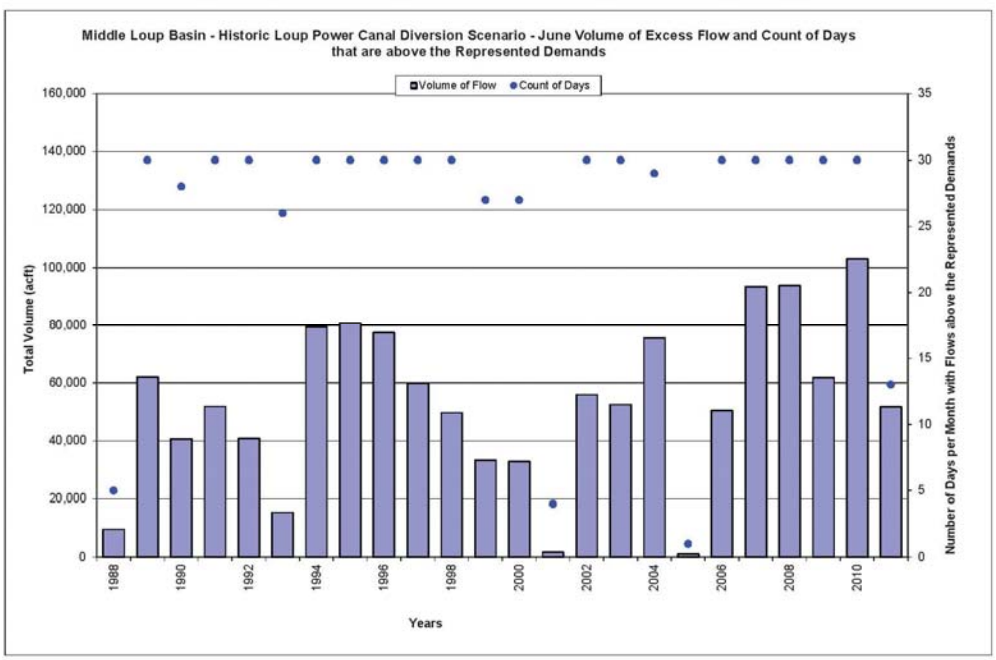


Figure A19: Lower Platte Above North Bend Subbasin,
July Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

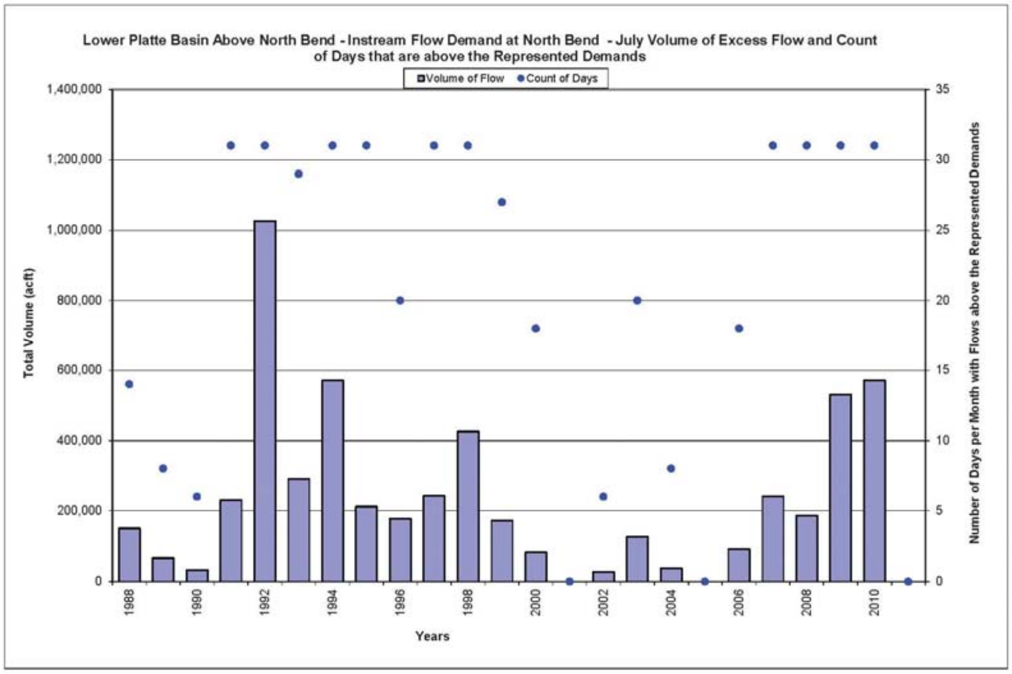


Figure A20: Lower Platte Above North Bend Subbasin,
August Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

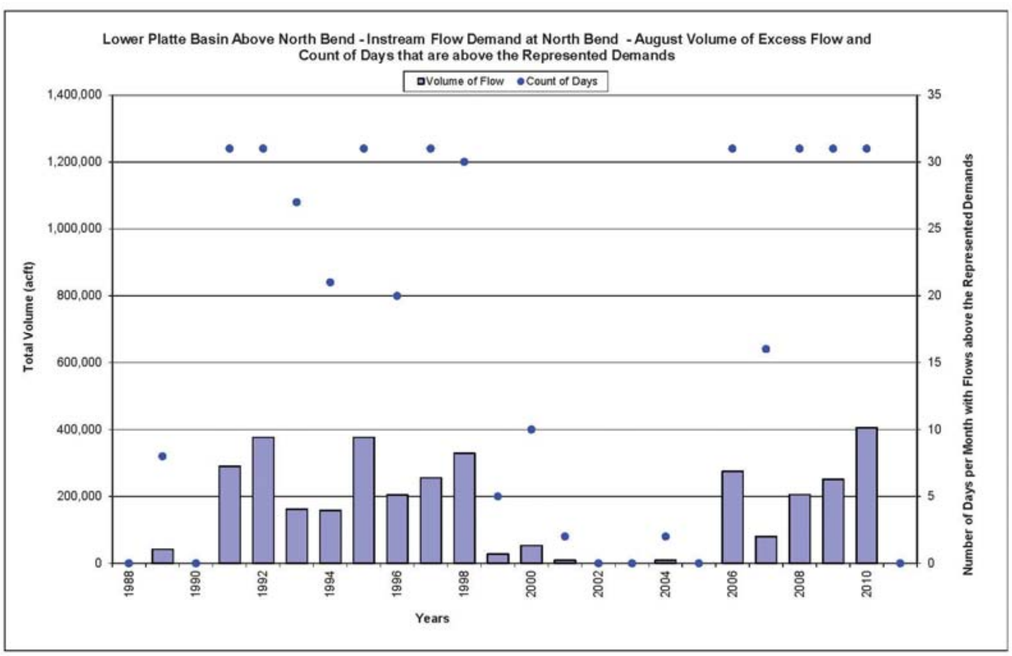


Figure A21: Lower Platte Above North Bend Subbasin, September Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

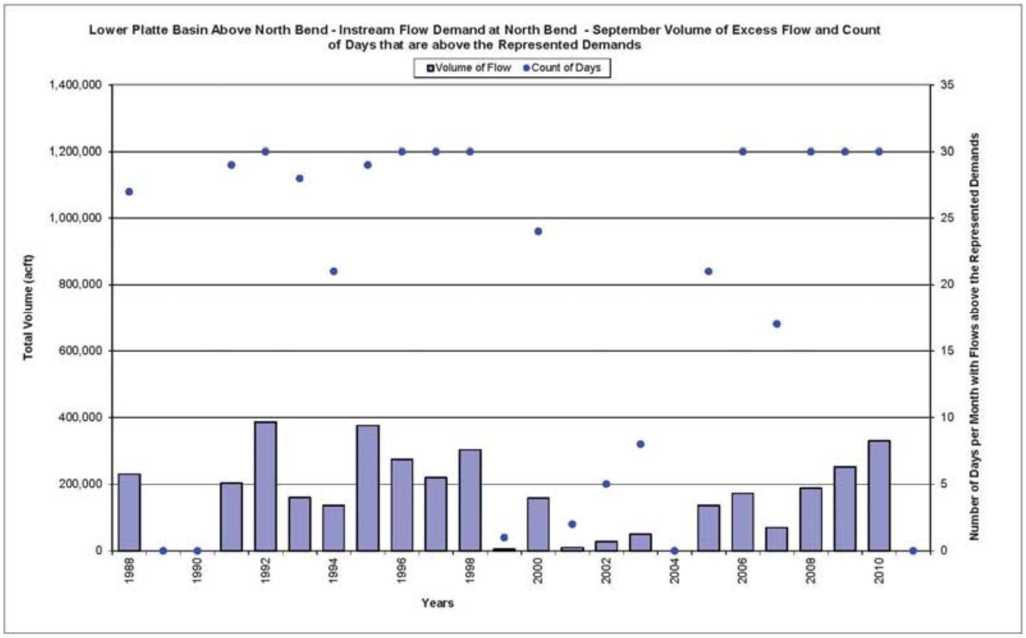


Figure A22: Lower Platte Above North Bend Subbasin, October Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

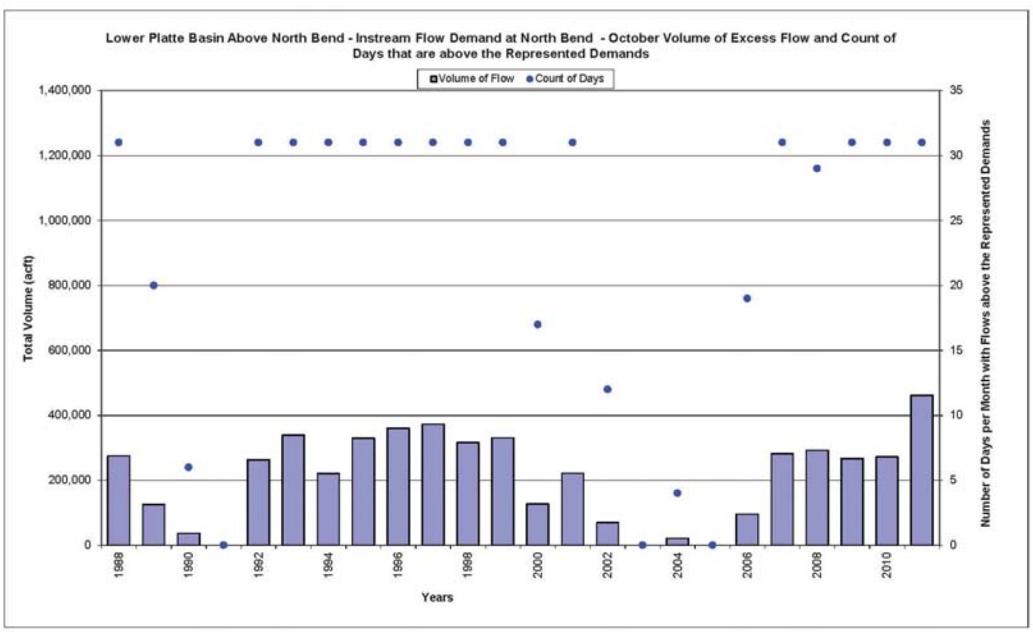


Figure A23: Lower Platte Above North Bend Subbasin,
November Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

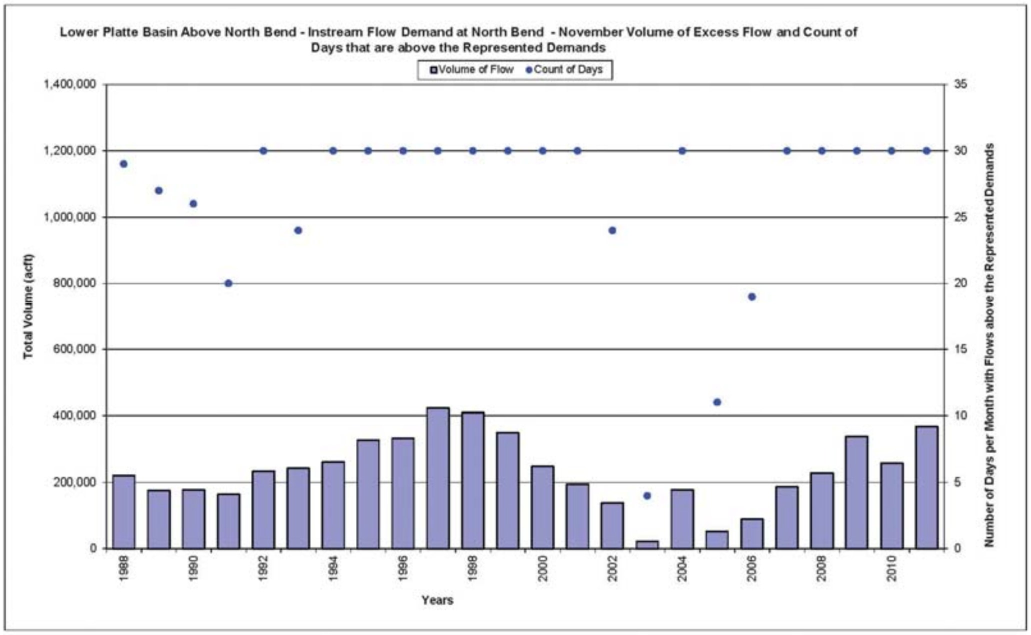


Figure A24: Lower Platte Above North Bend Subbasin,
December Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

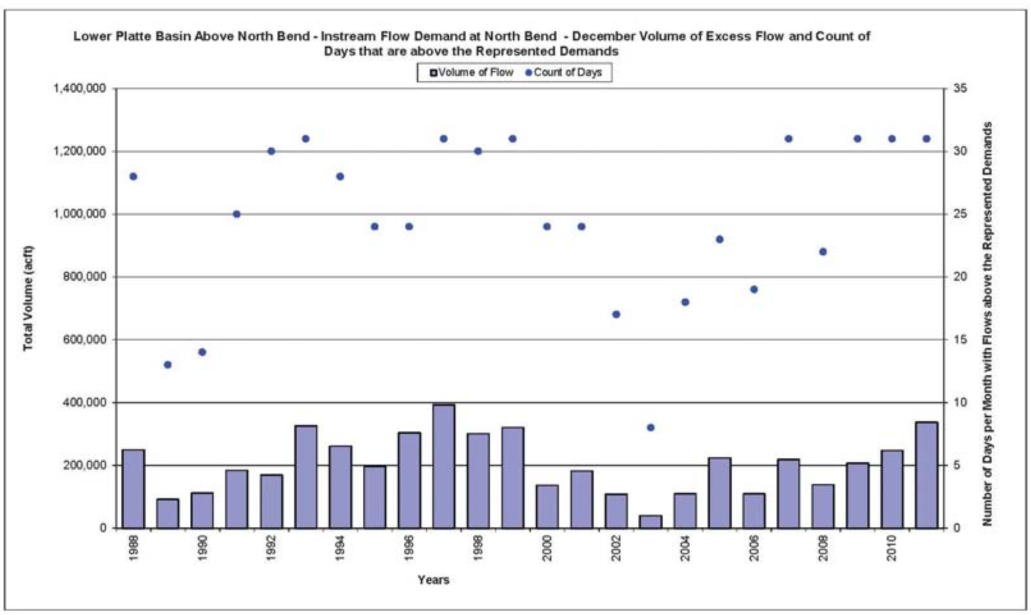


Figure A25: Elkhorn Norfolk to Waterloo Subbasin,
January Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

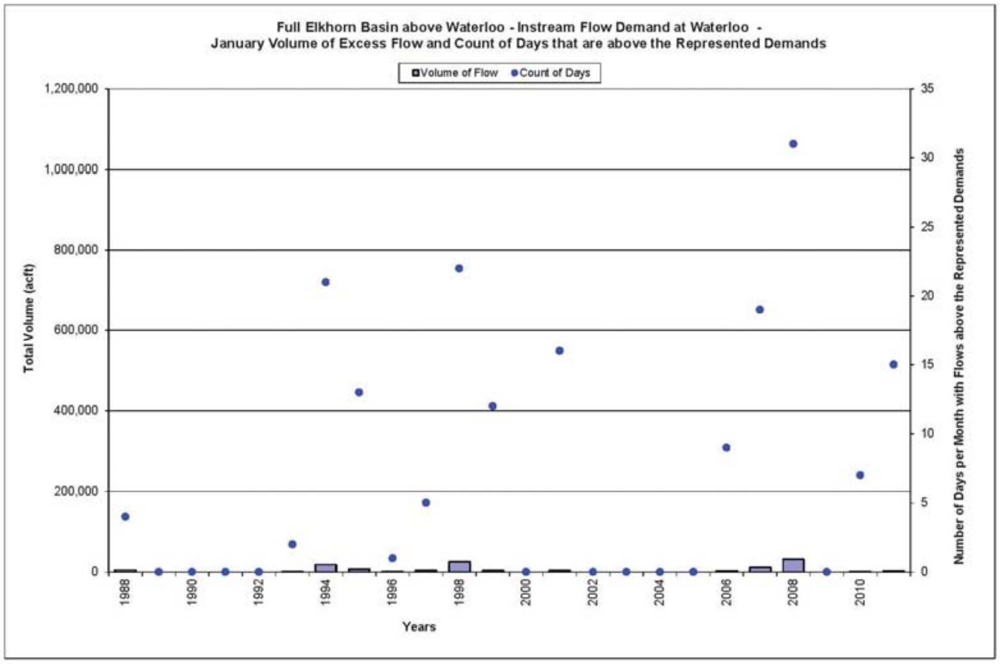


Figure A26: Elkhorn Norfolk to Waterloo Subbasin,
February Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

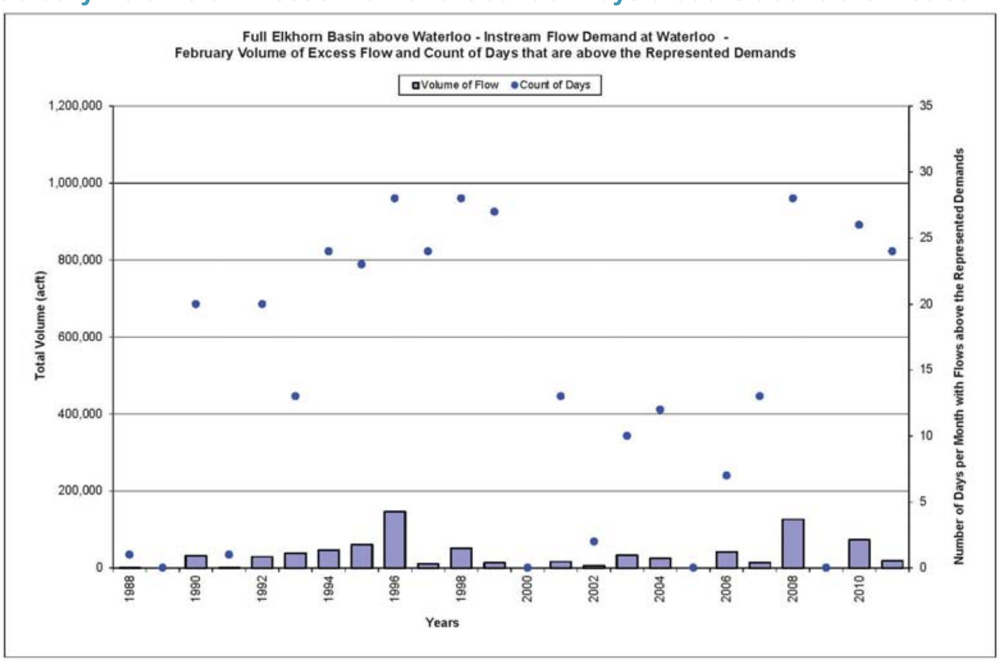


Figure A27: Elkhorn Norfolk to Waterloo Subbasin,
March Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

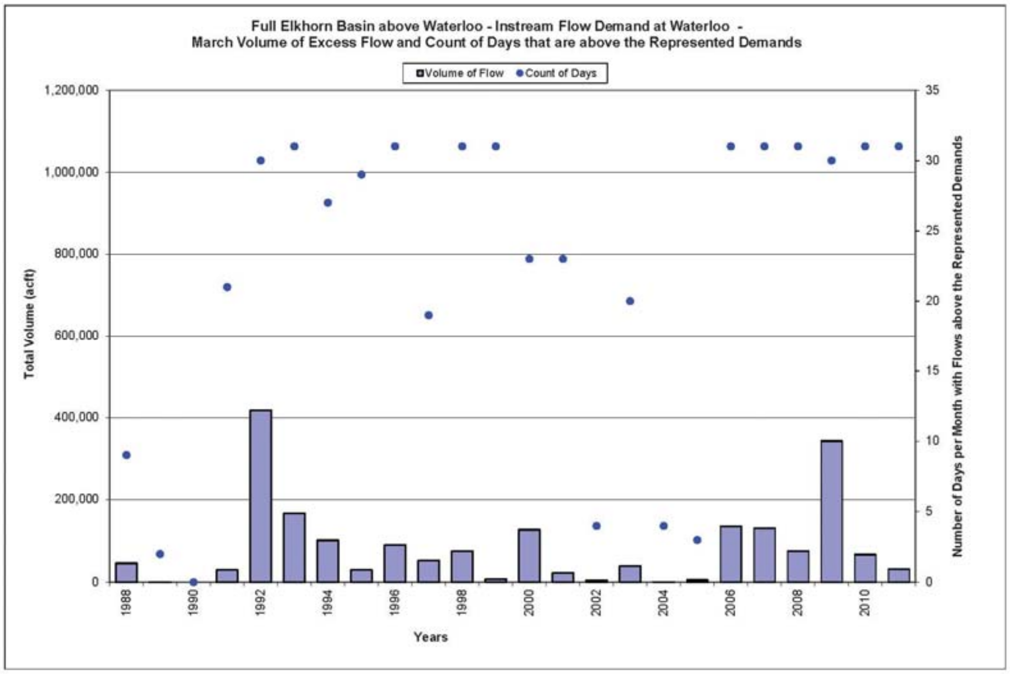


Figure A28: Elkhorn Norfolk to Waterloo Subbasin,
April Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

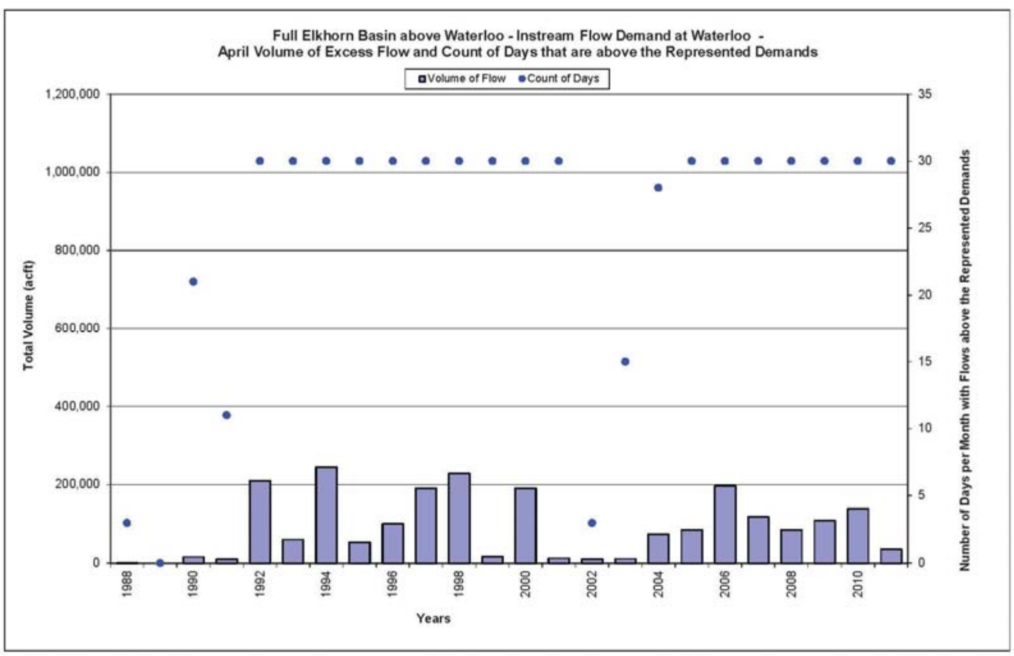


Figure A29: Elkhorn Norfolk to Waterloo Subbasin, May Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

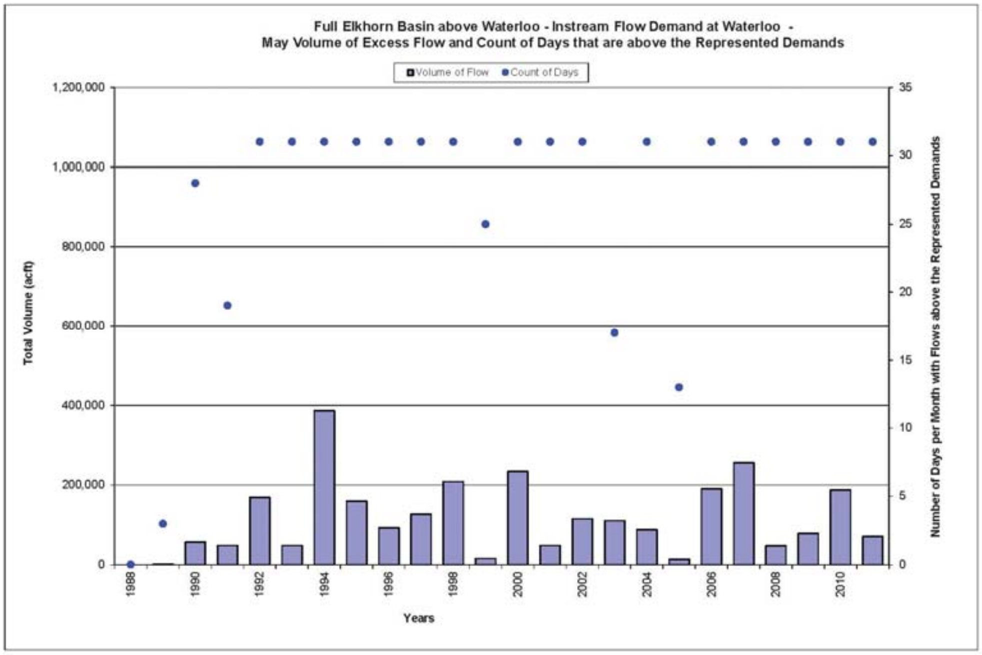


Figure A30: Elkhorn Norfolk to Waterloo Subbasin, June Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

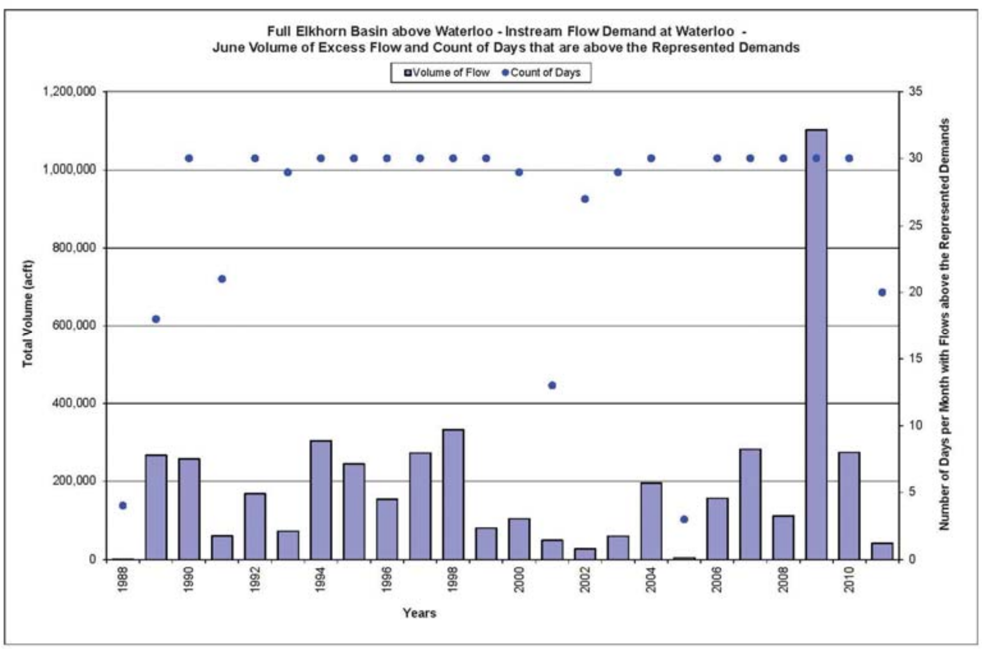


Figure A31: Elkhorn Norfolk to Waterloo Subbasin, July Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

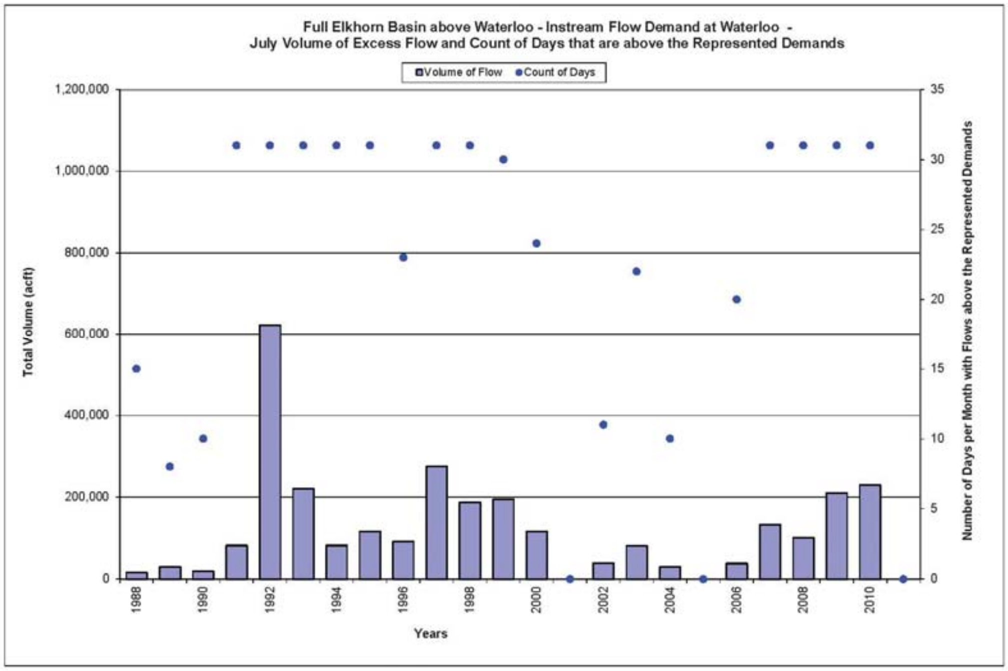


Figure A32: Elkhorn Norfolk to Waterloo Subbasin, August Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

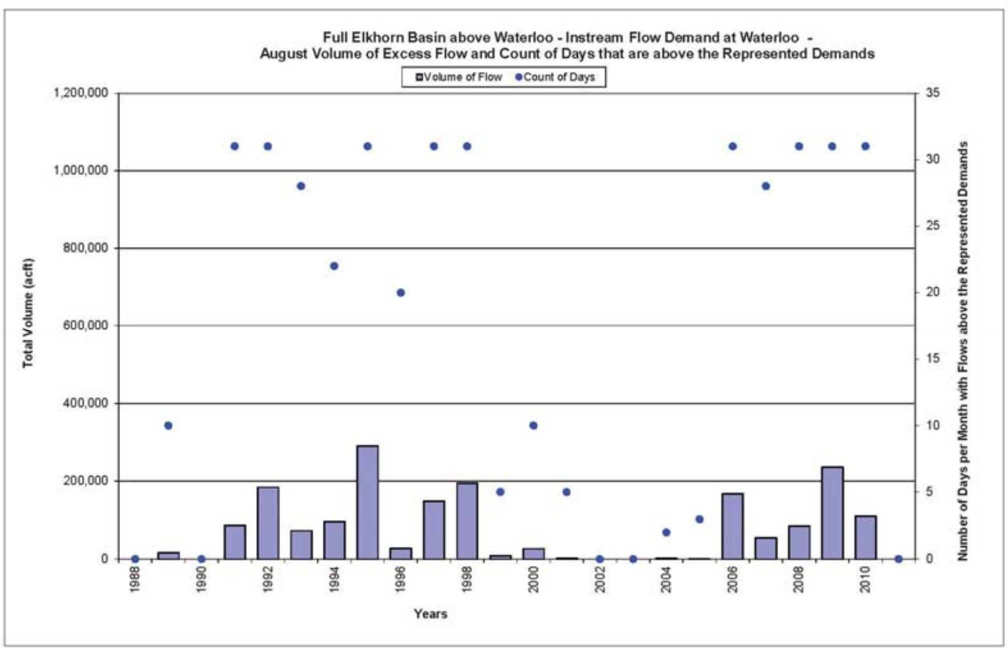


Figure A33: Elkhorn Norfolk to Waterloo Subbasin,
September Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

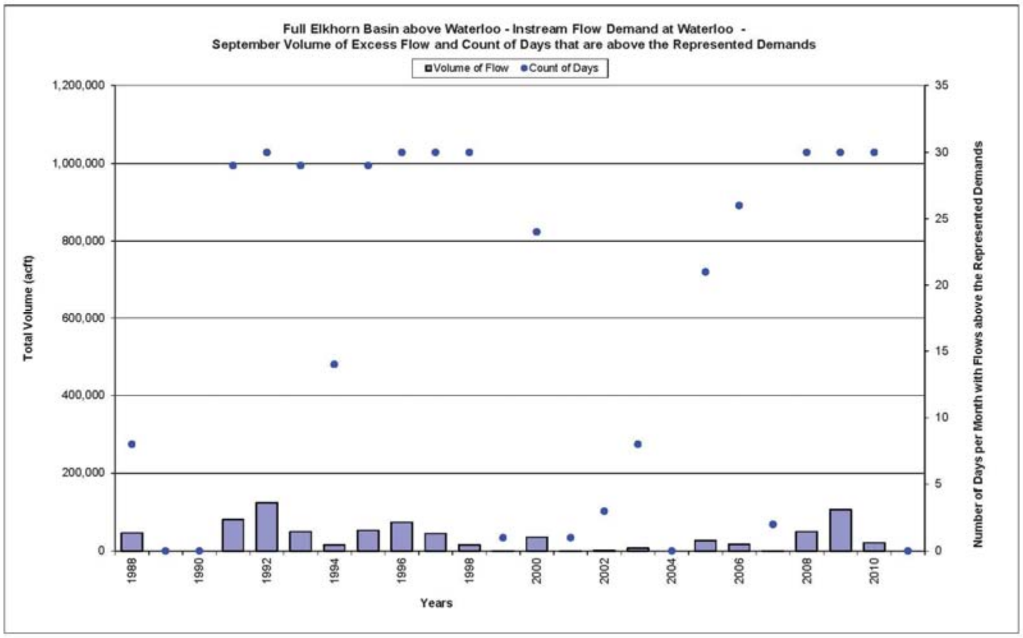


Figure A34: Elkhorn Norfolk to Waterloo Subbasin,
October Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

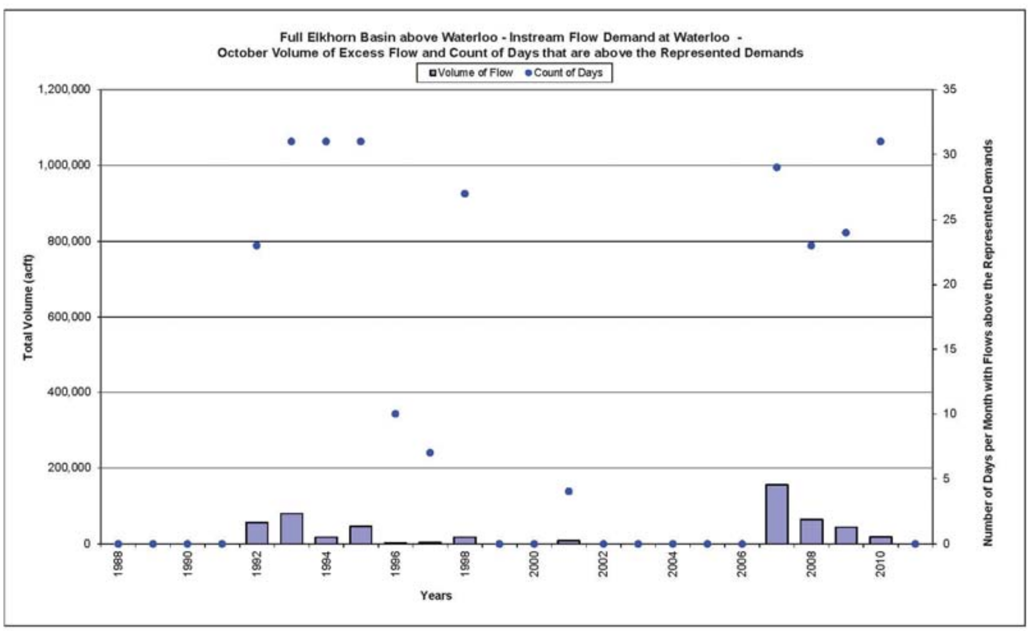


Figure A35: Elkhorn Norfolk to Waterloo Subbasin,
November Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

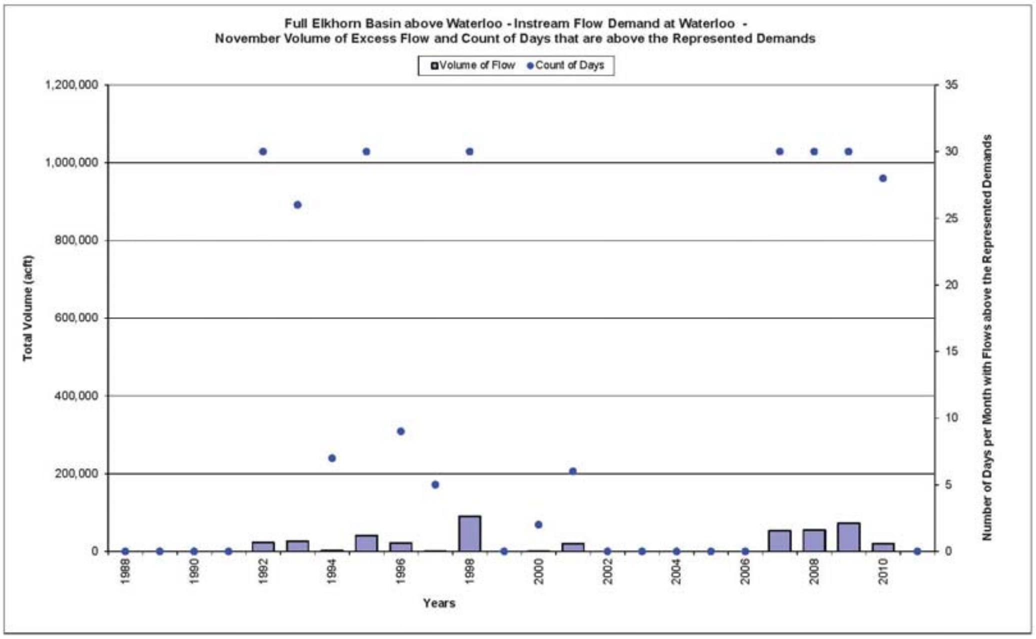


Figure A36: Elkhorn Norfolk to Waterloo Subbasin,
December Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

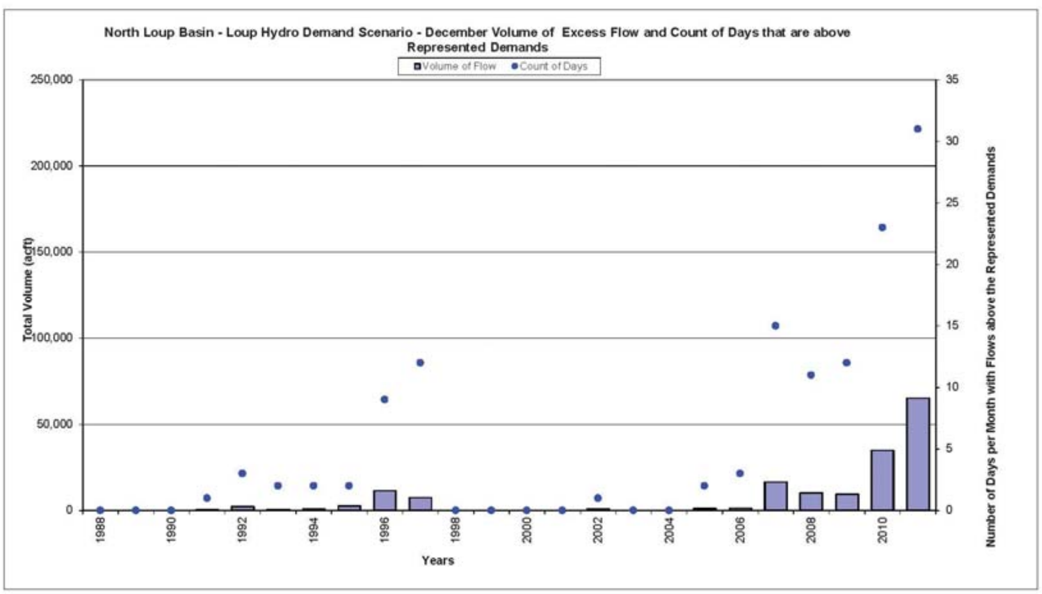


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Figure A37: Elkhorn Above Norfolk Subbasin,
January Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

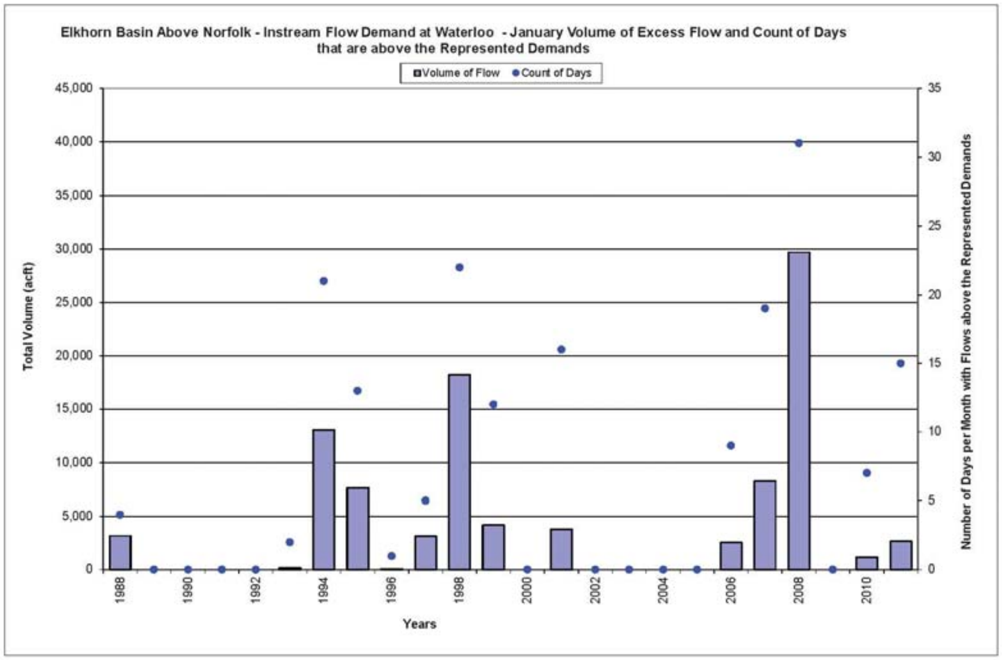


Figure A38: Elkhorn Above Norfolk Subbasin,
February Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

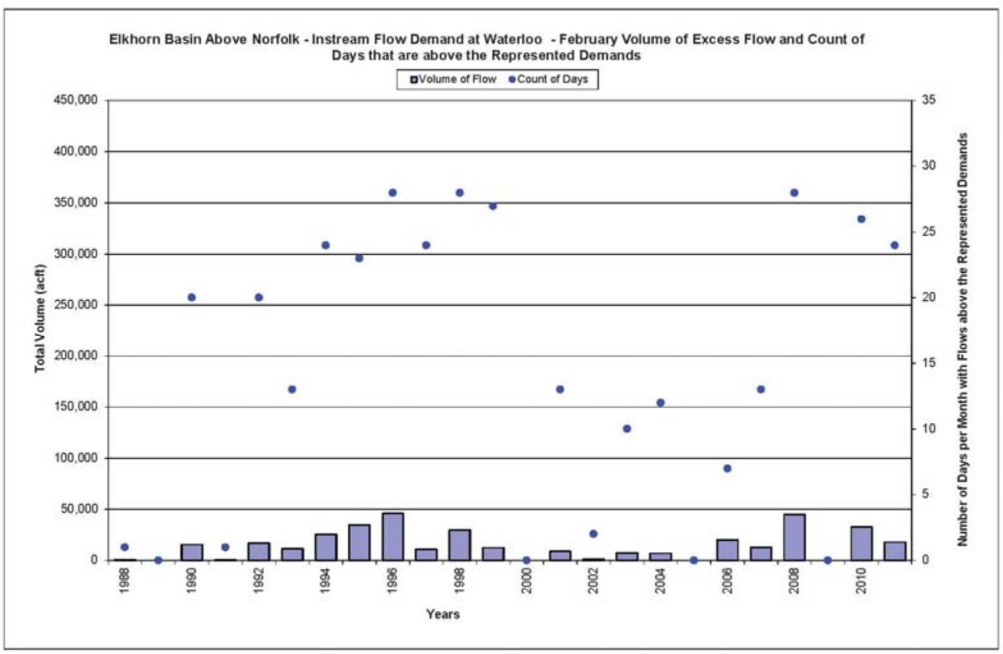


**Figure A39: Elkhorn Above Norfolk Subbasin,
March Volume of Excess Flow and Count of Days that are above the Instream Flow Demands**

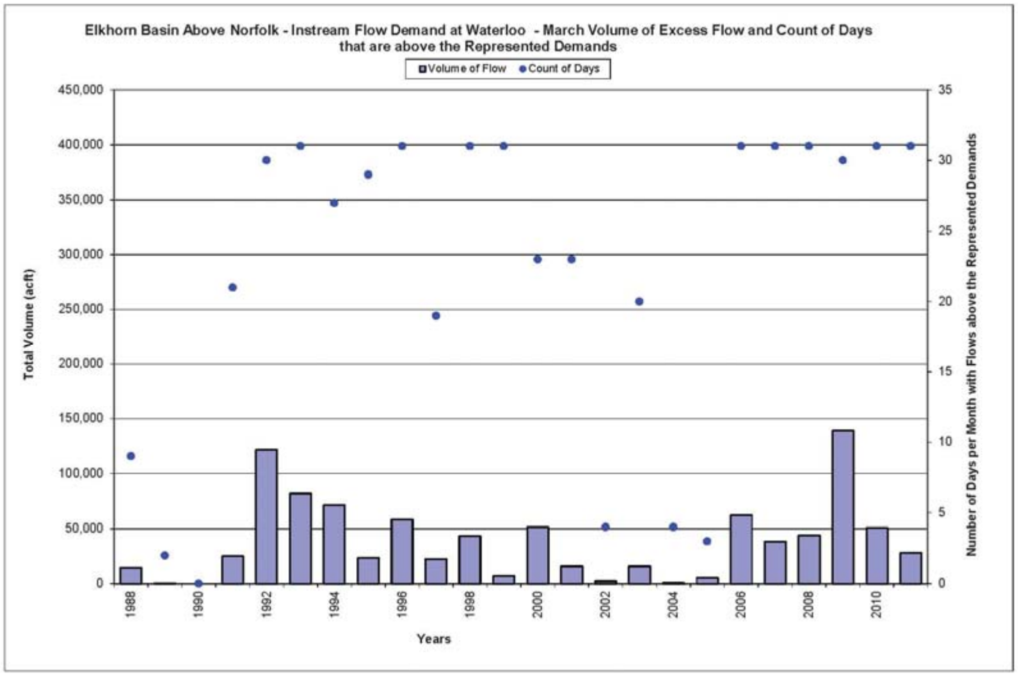


**Figure A40: Elkhorn Above Norfolk Subbasin,
April Volume of Excess Flow and Count of Days that are above the Instream Flow Demands**

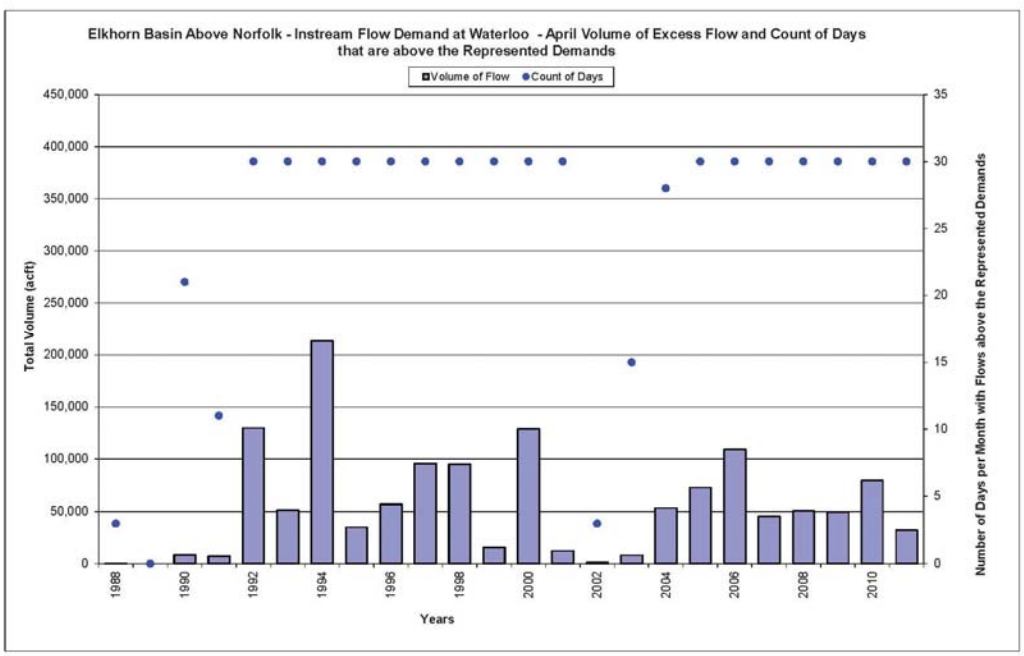


Figure A41: Elkhorn Above Norfolk Subbasin,
May Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

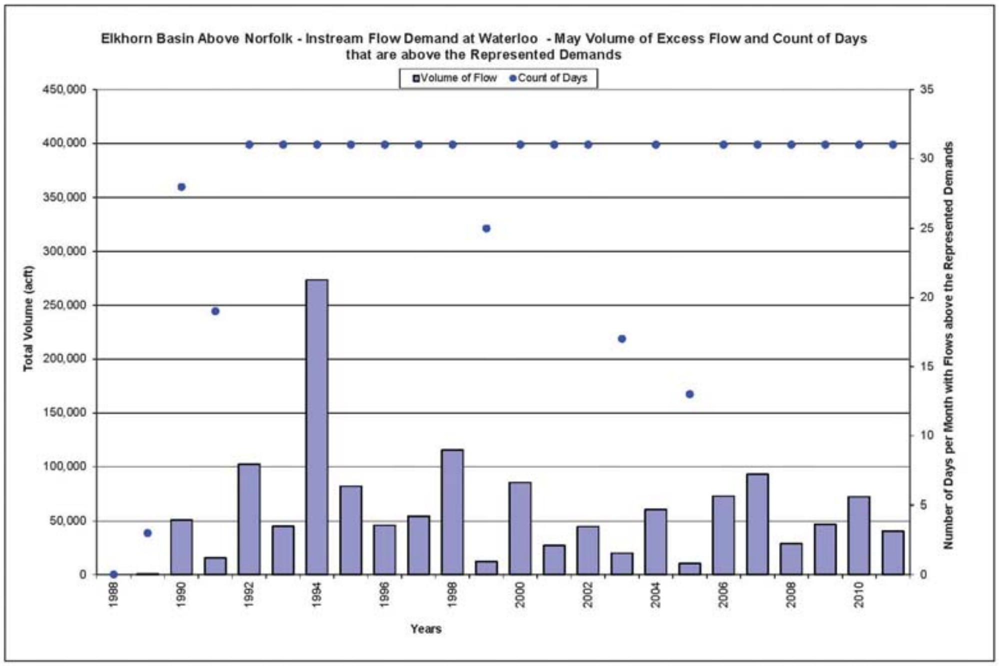


Figure A42: Elkhorn Above Norfolk Subbasin,
June Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

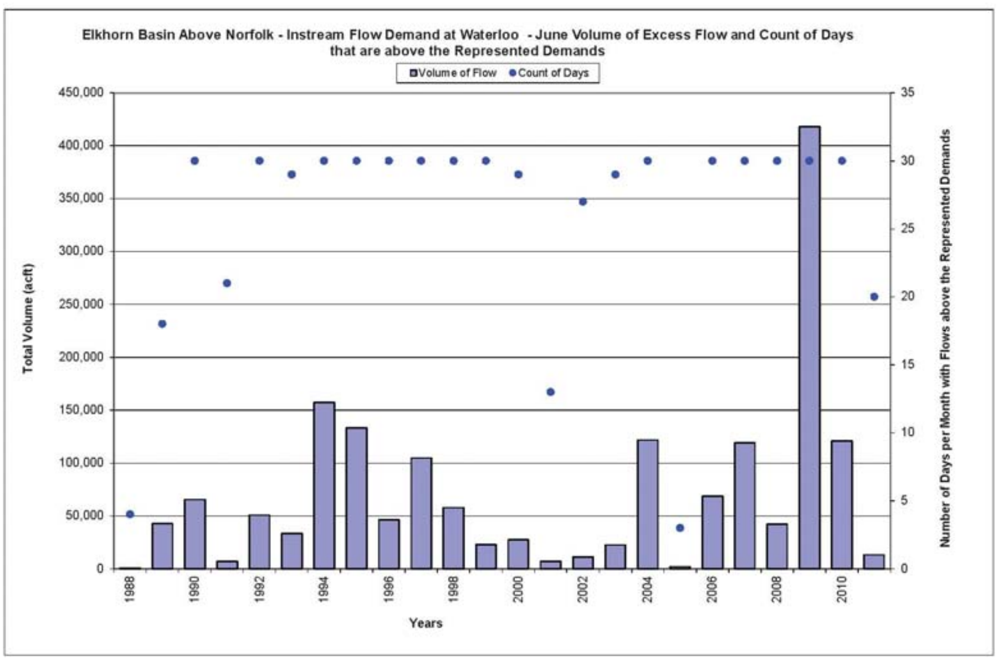


Figure A43: Elkhorn Above Norfolk Subbasin,
July Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

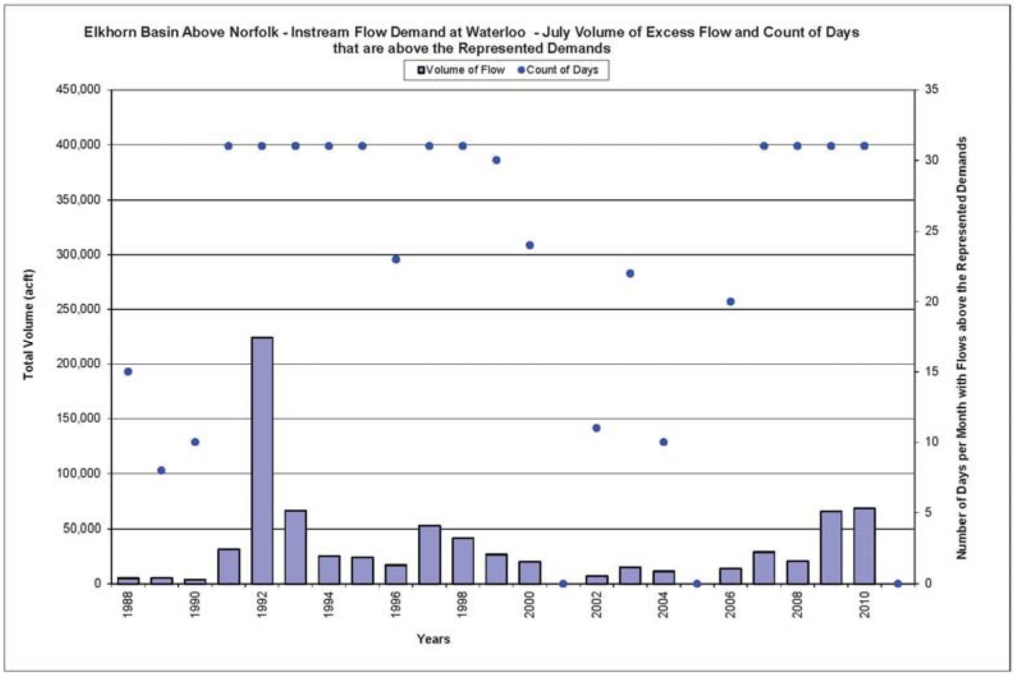


Figure A44: Elkhorn Above Norfolk Subbasin,
August Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

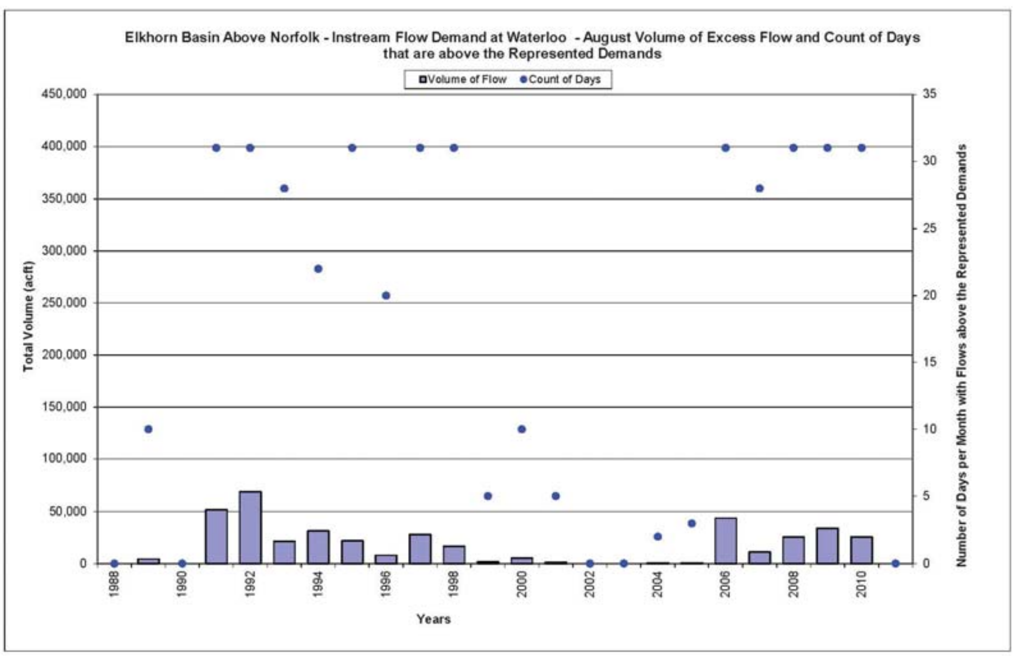


**Figure A45: Elkhorn Above Norfolk Subbasin,
September Volume of Excess Flow and Count of Days that are above the Instream Flow Demands**

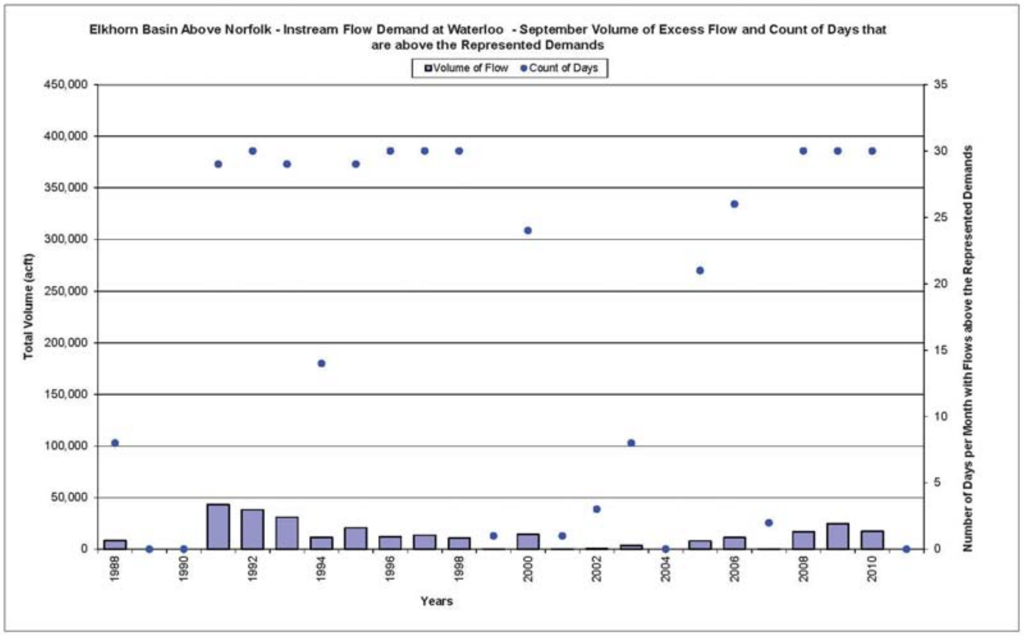


**Figure A46: Elkhorn Above Norfolk Subbasin,
October Volume of Excess Flow and Count of Days that are above the Instream Flow Demands**

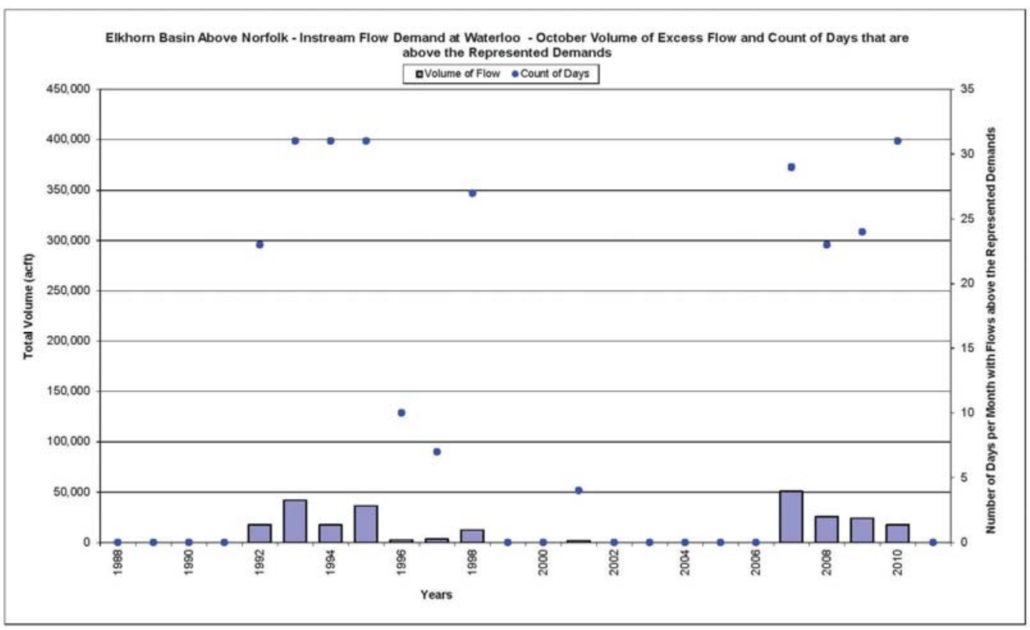


Figure A47: Elkhorn Above Norfolk Subbasin,
November Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

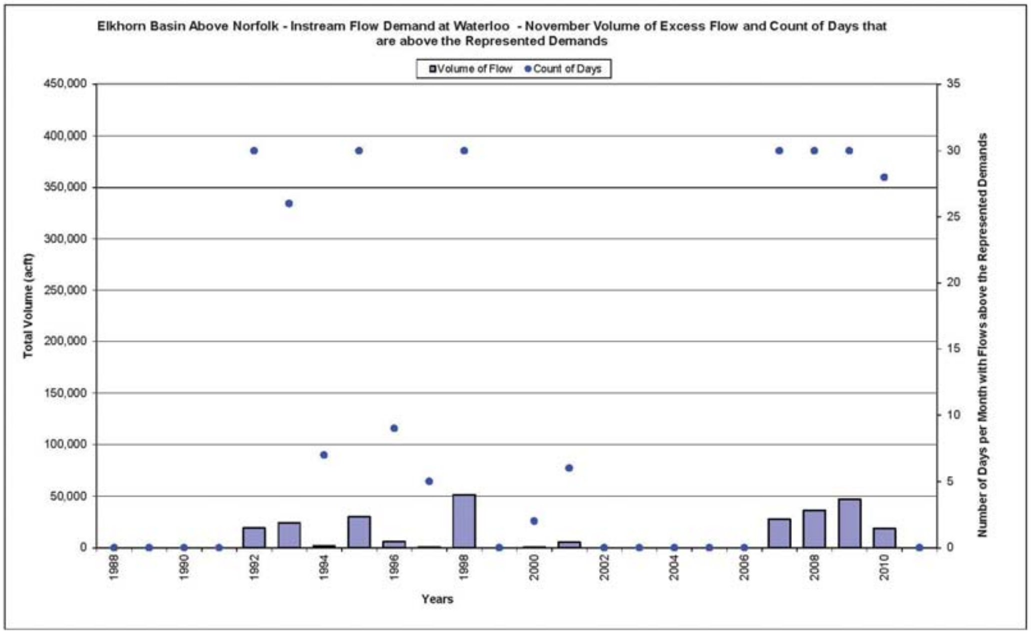


Figure A48: Elkhorn Above Norfolk Subbasin,
December Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

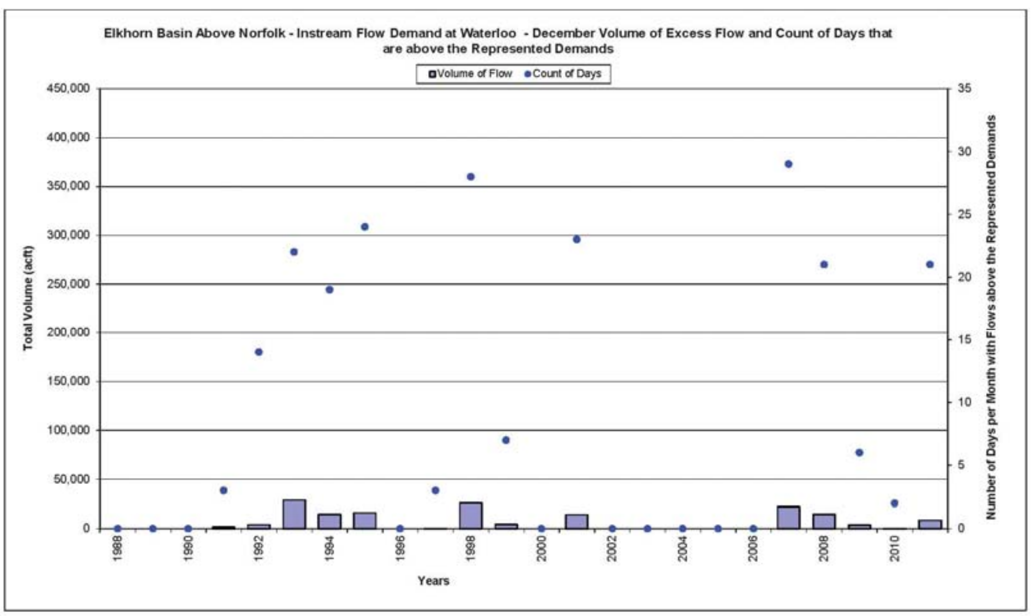


Figure A49: Lower Loup Subbasin,
January Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

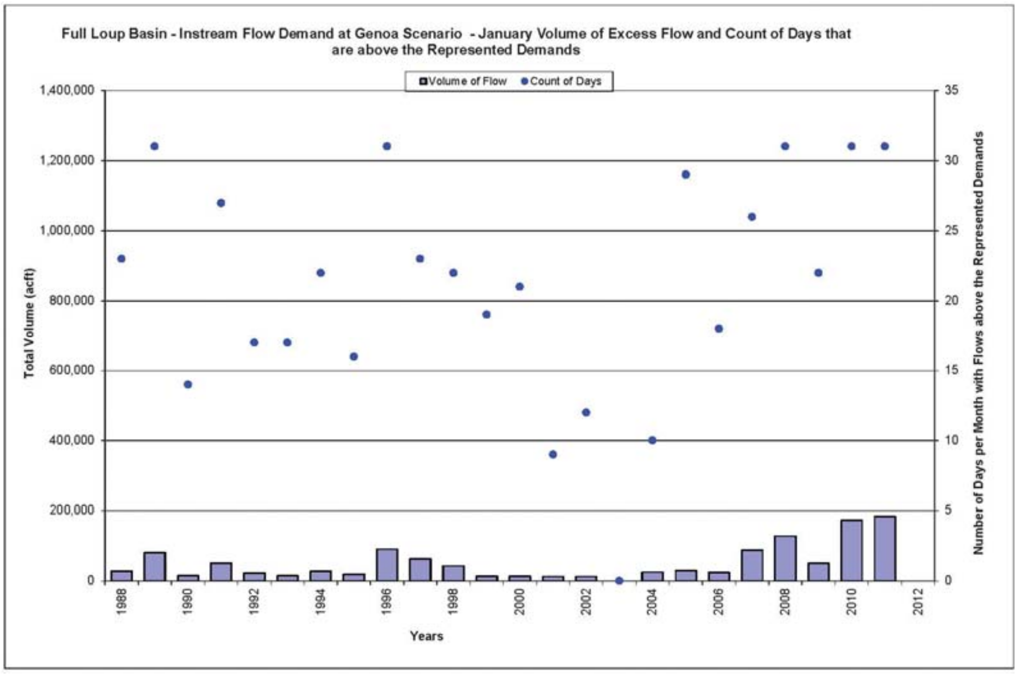


Figure A50: Lower Loup Subbasin,
February Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

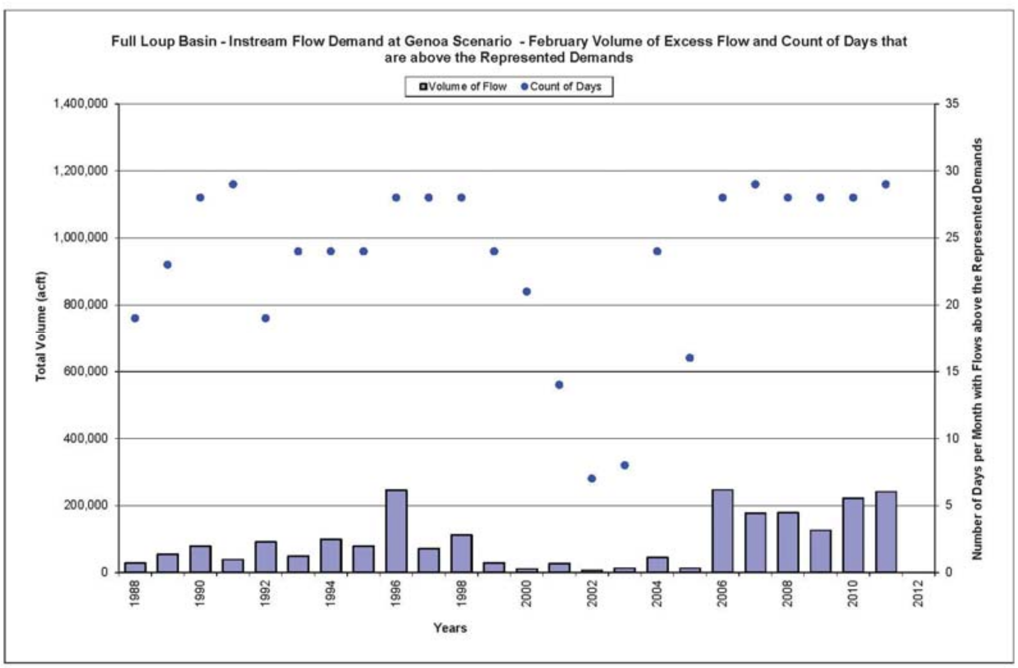


**Figure A51: Lower Loup Subbasin,
March Volume of Excess Flow and Count of Days that are above the Instream Flow Demands**

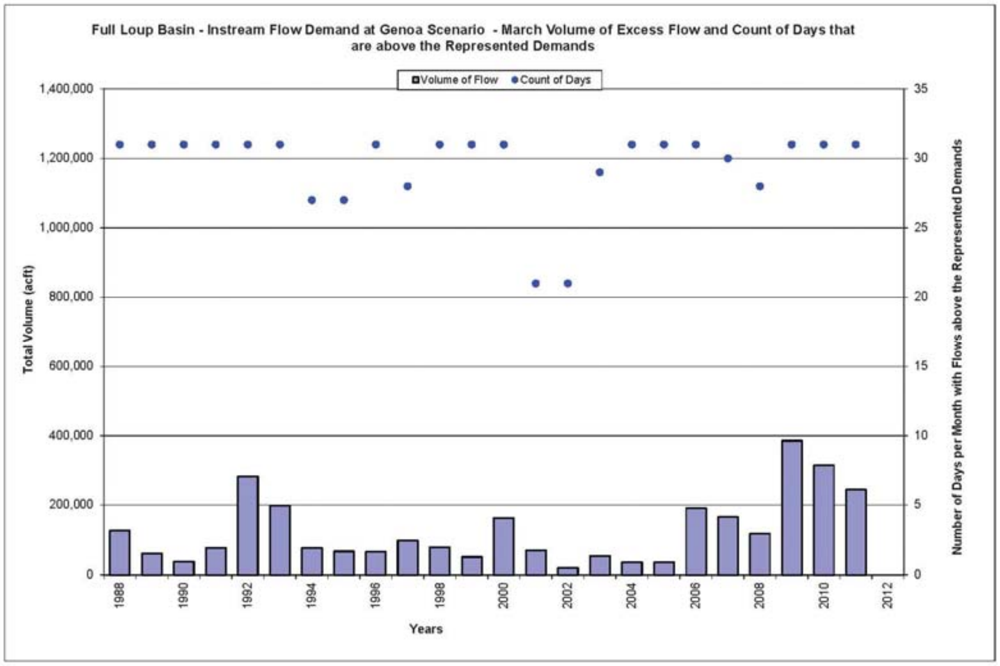


**Figure A52: Lower Loup Subbasin,
April Volume of Excess Flow and Count of Days that are above the Instream Flow Demands**

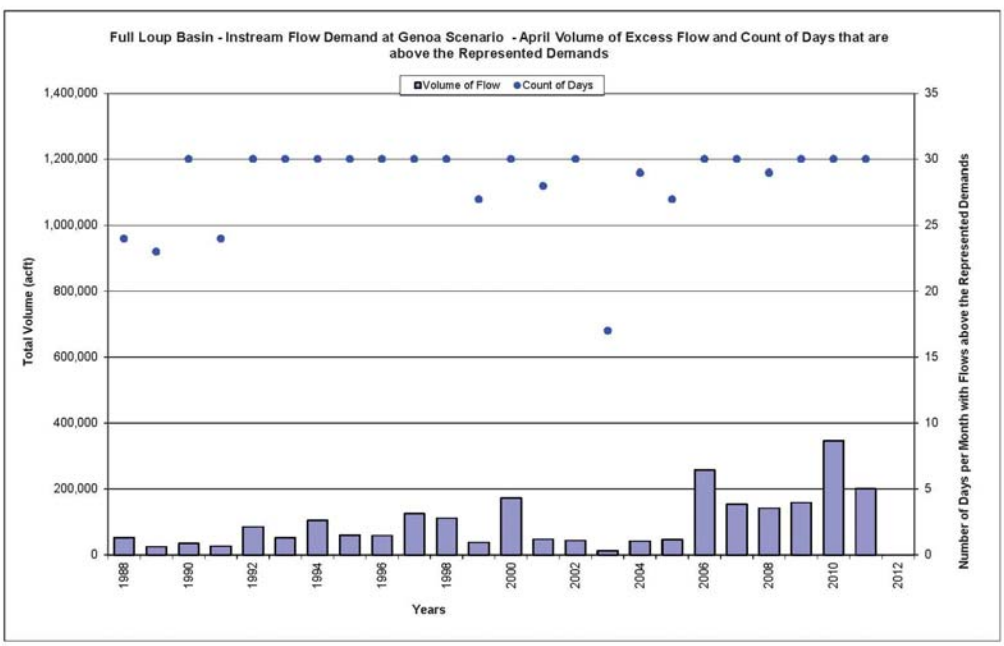


Figure A53: Lower Loup Subbasin,
May Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

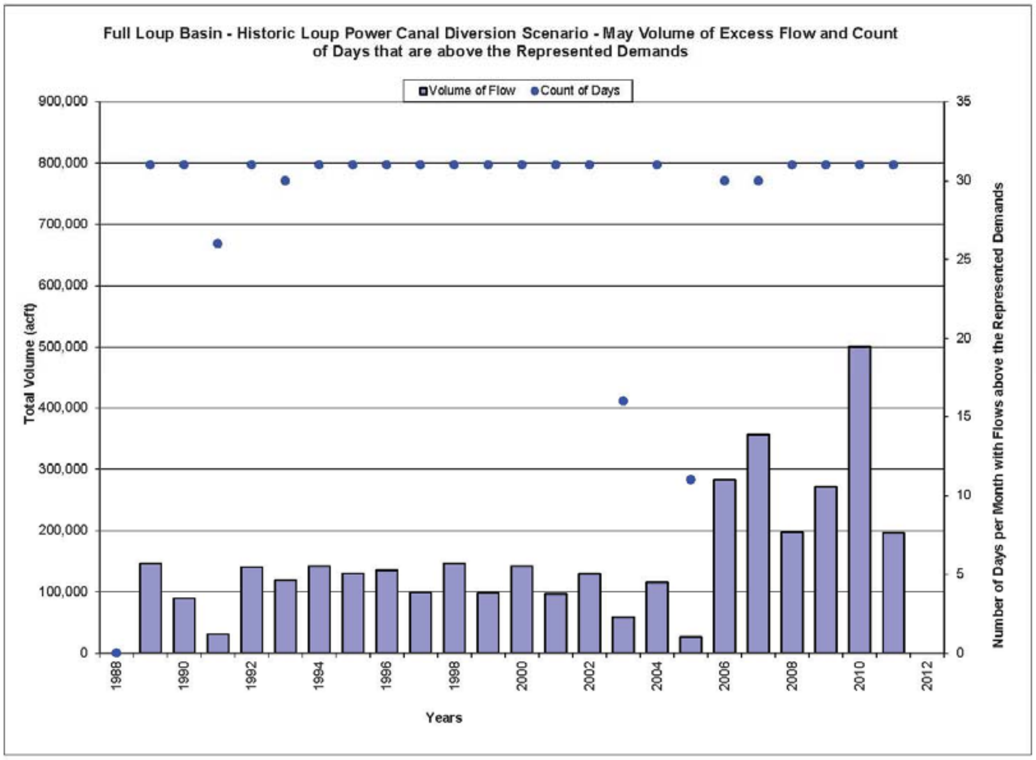


Figure A54: Lower Loup Subbasin,
June Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

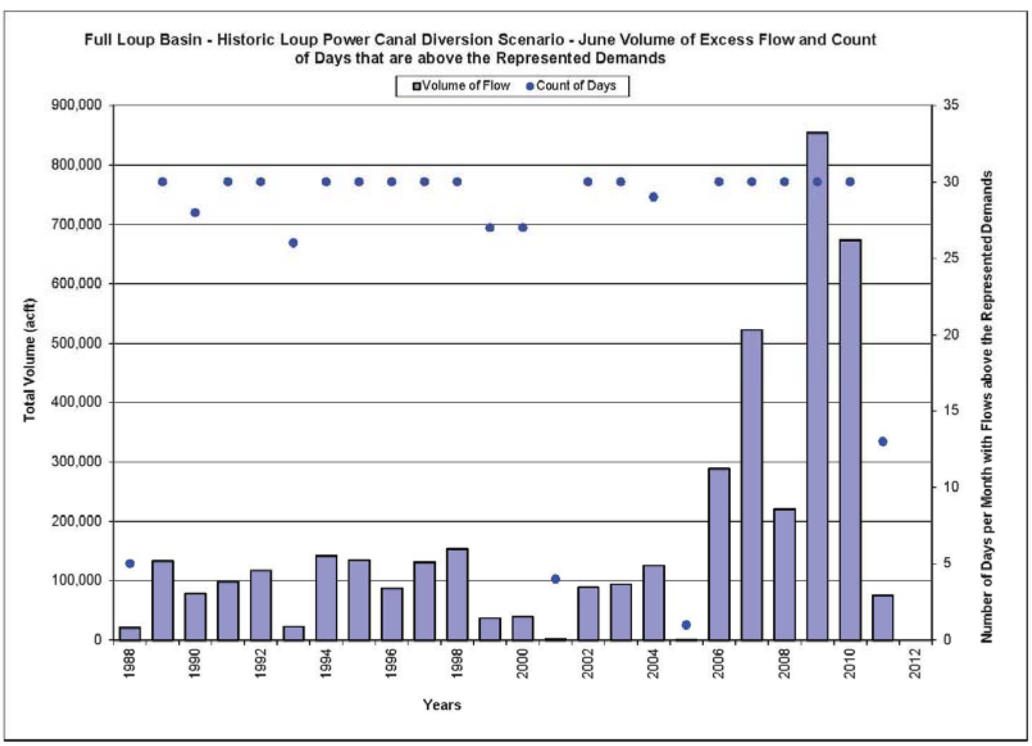


Figure A55: Lower Loup Subbasin, July Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

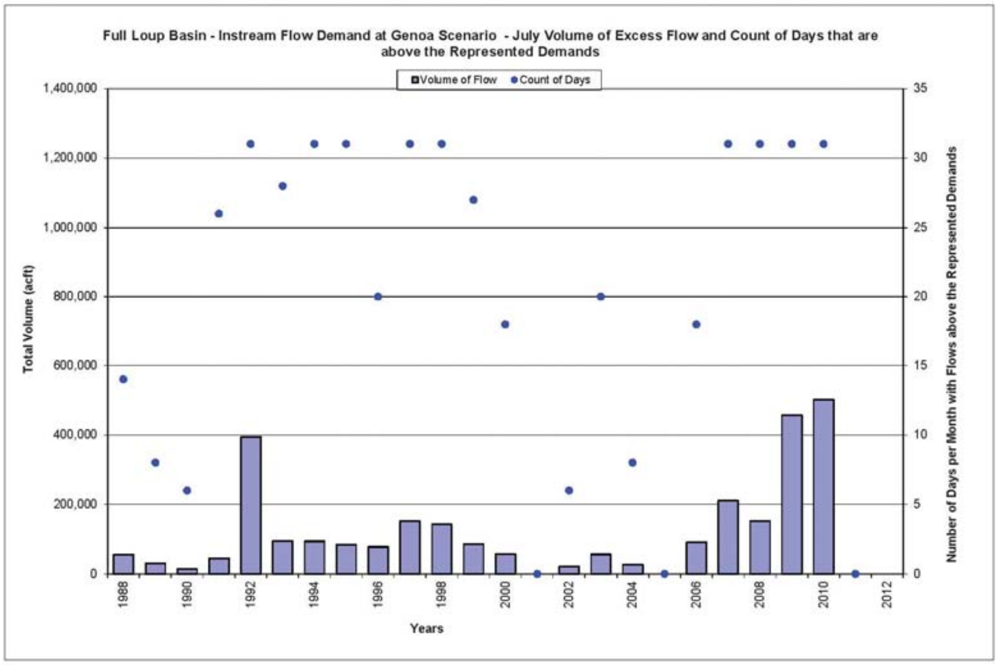


Figure A56: Lower Loup Subbasin, August Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

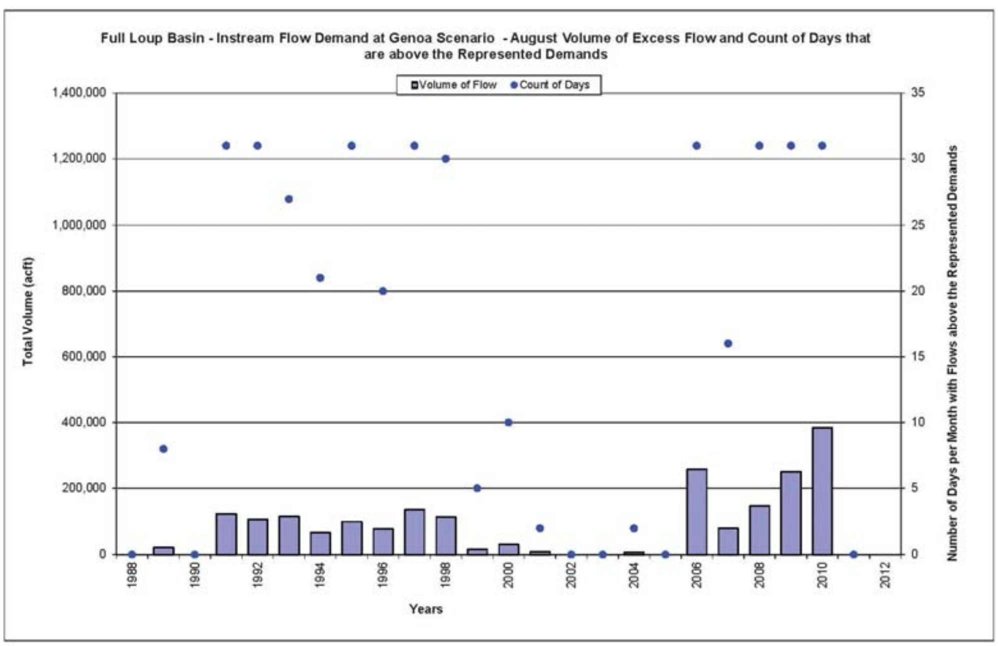


Figure A57: Lower Loup Subbasin,
September Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

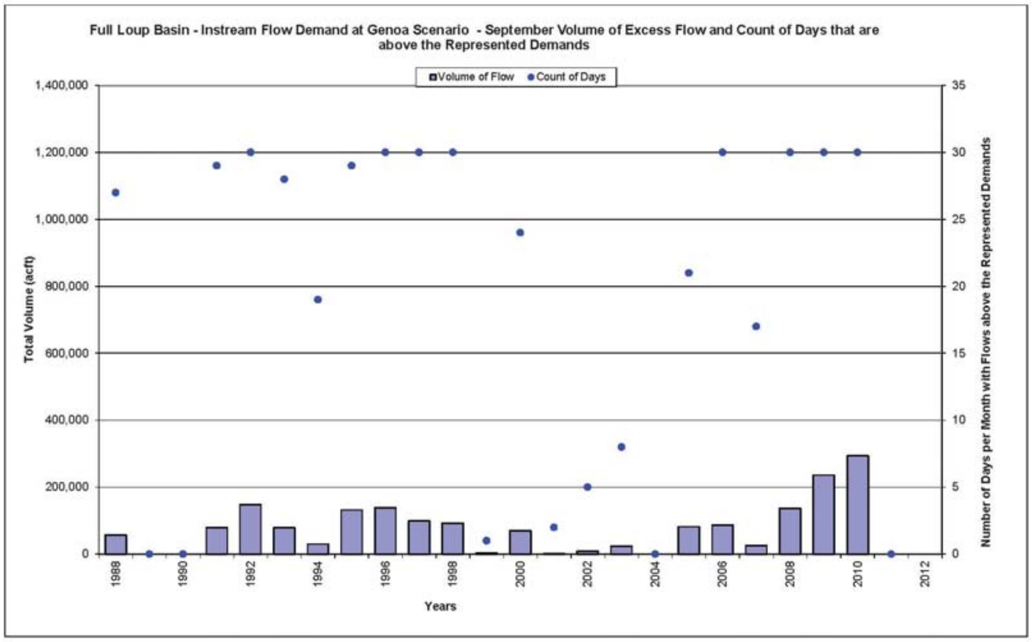


Figure A58: Lower Loup Subbasin,
October Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

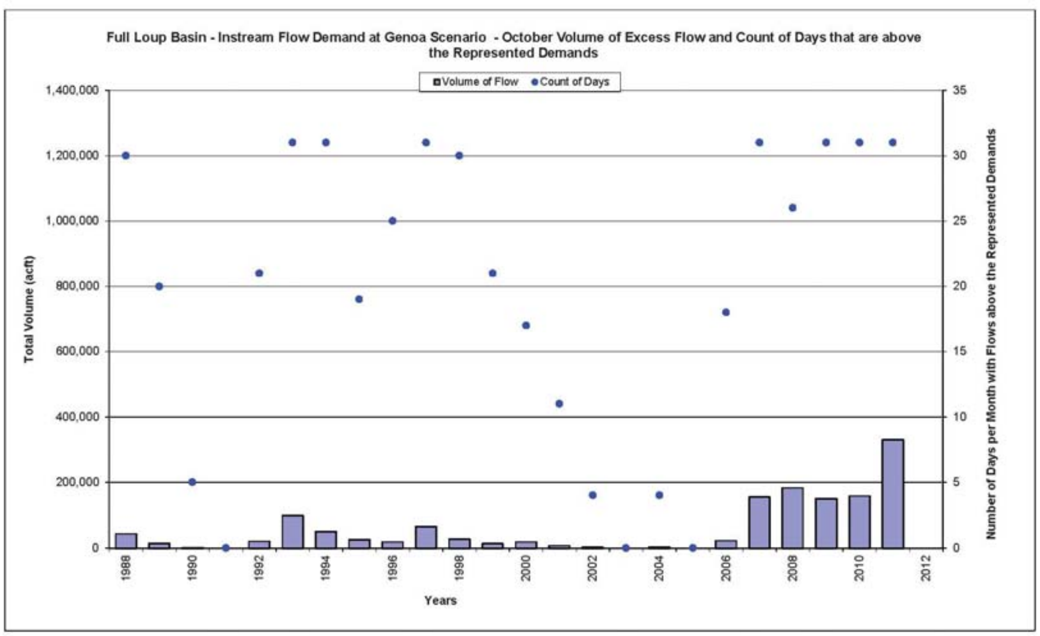


Figure A59: Lower Loup Subbasin,
November Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

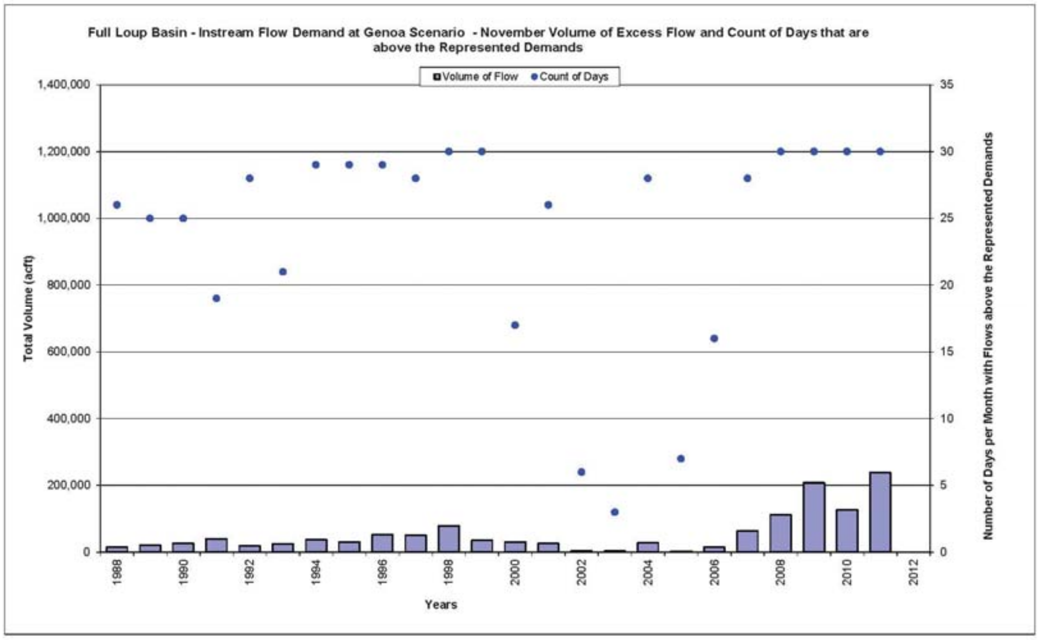


Figure A60: Lower Loup Subbasin,
December Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

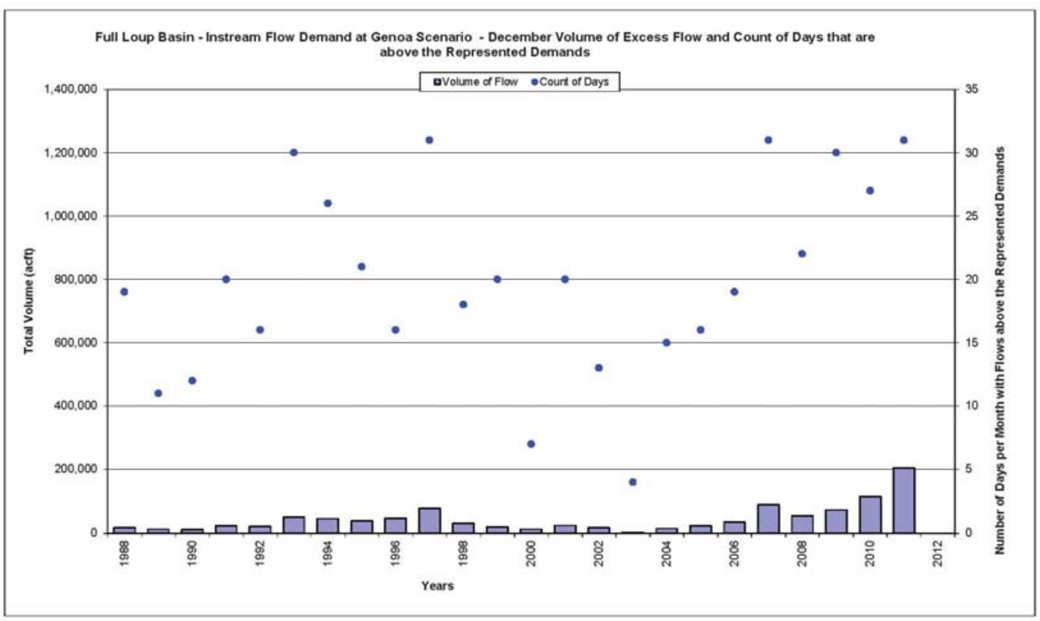


**Figure A61: Middle Loup Subbasin,
January Volume of Excess Flow and Count of Days that are above the Instream Flow Demands**

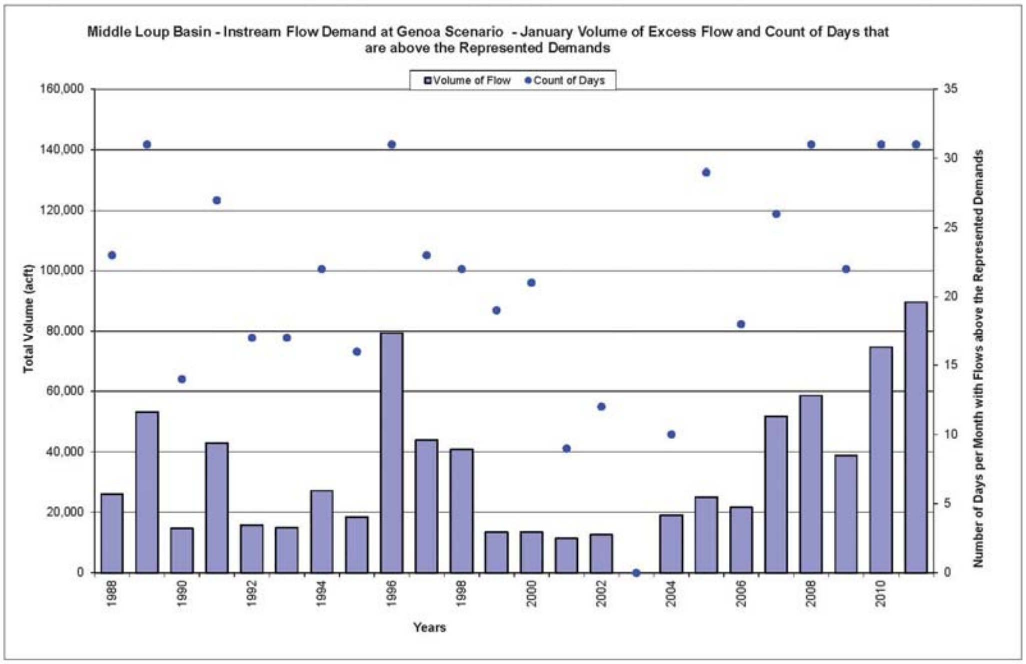


**Figure A62: Middle Loup Subbasin,
February Volume of Excess Flow and Count of Days that are above the Instream Flow Demands**

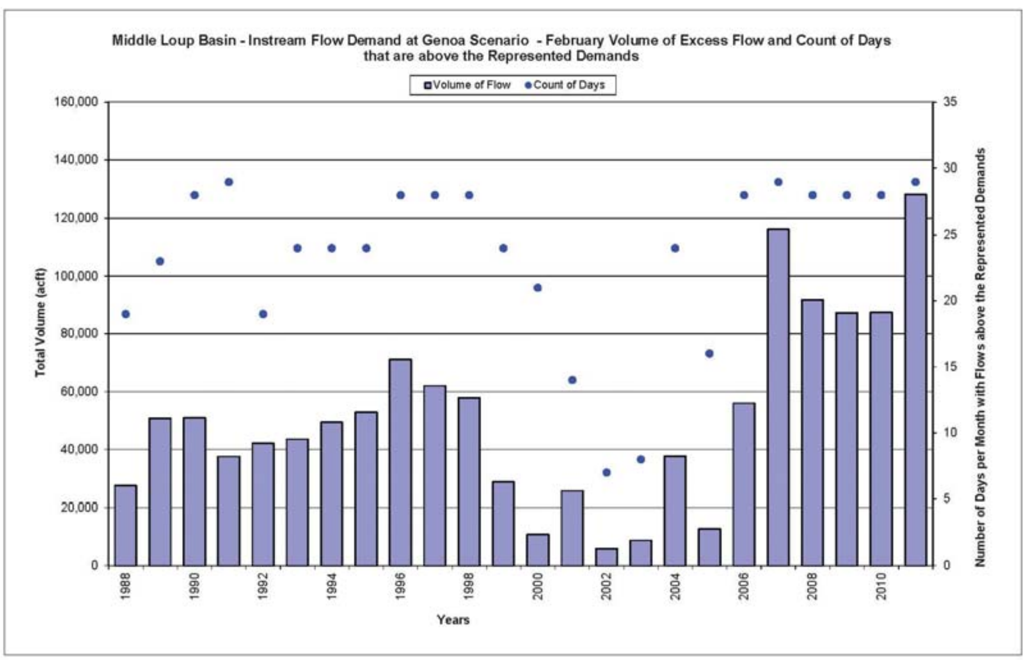


Figure A63: Middle Loup Subbasin,
March Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

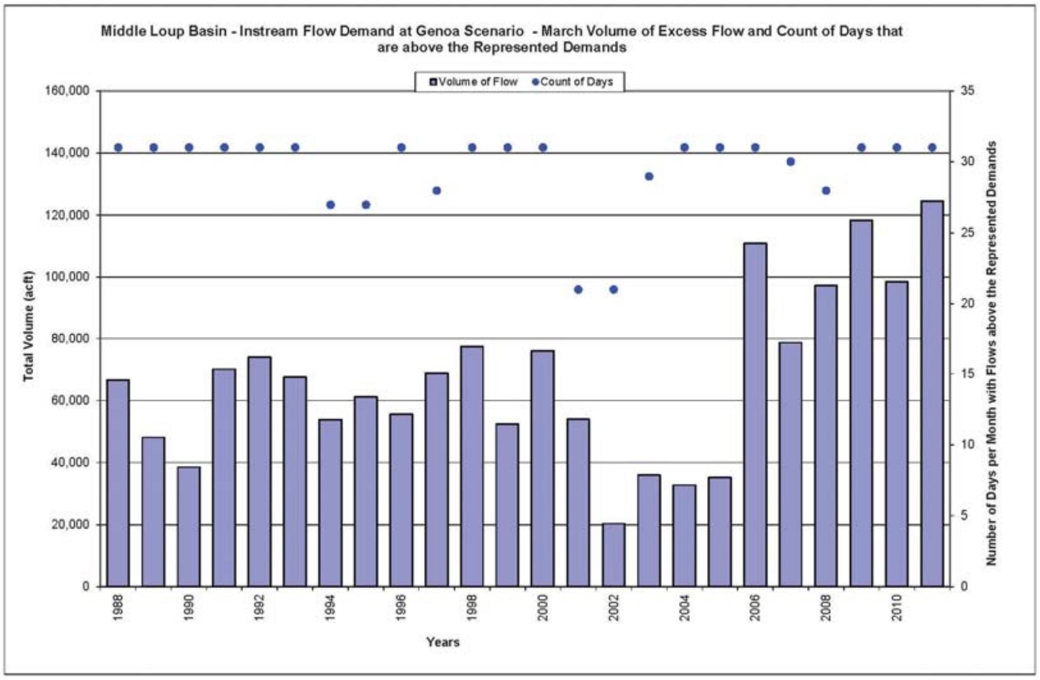


Figure A64: Middle Loup Subbasin,
April Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

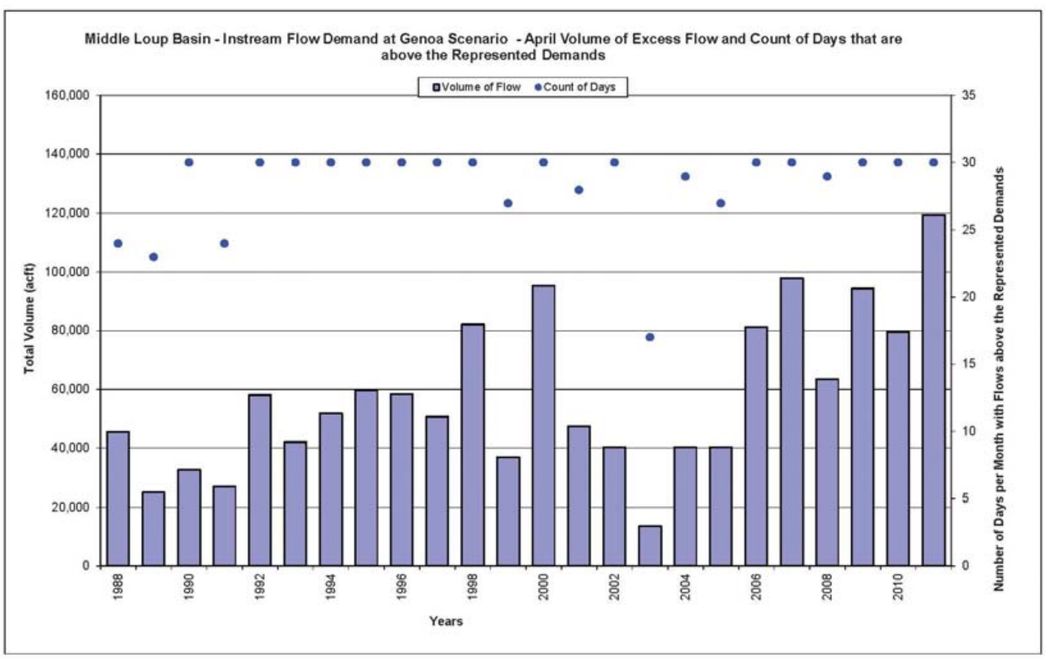


**Figure A65: Middle Loup Subbasin,
May Volume of Excess Flow and Count of Days that are above the Instream Flow Demands**

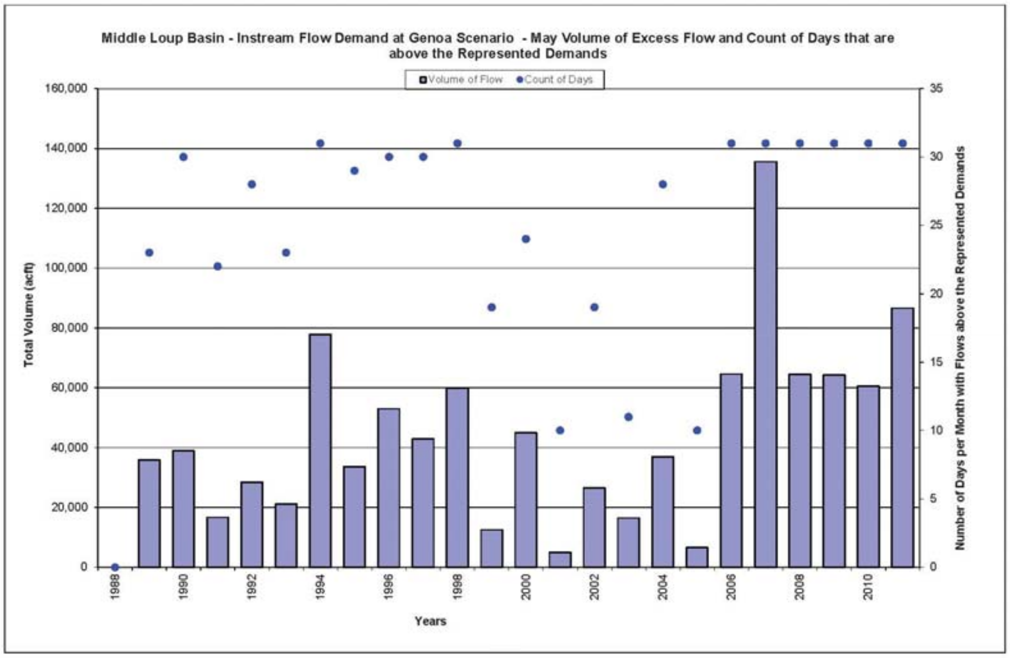


**Figure A66: Middle Loup Subbasin,
June Volume of Excess Flow and Count of Days that are above the Instream Flow Demands**

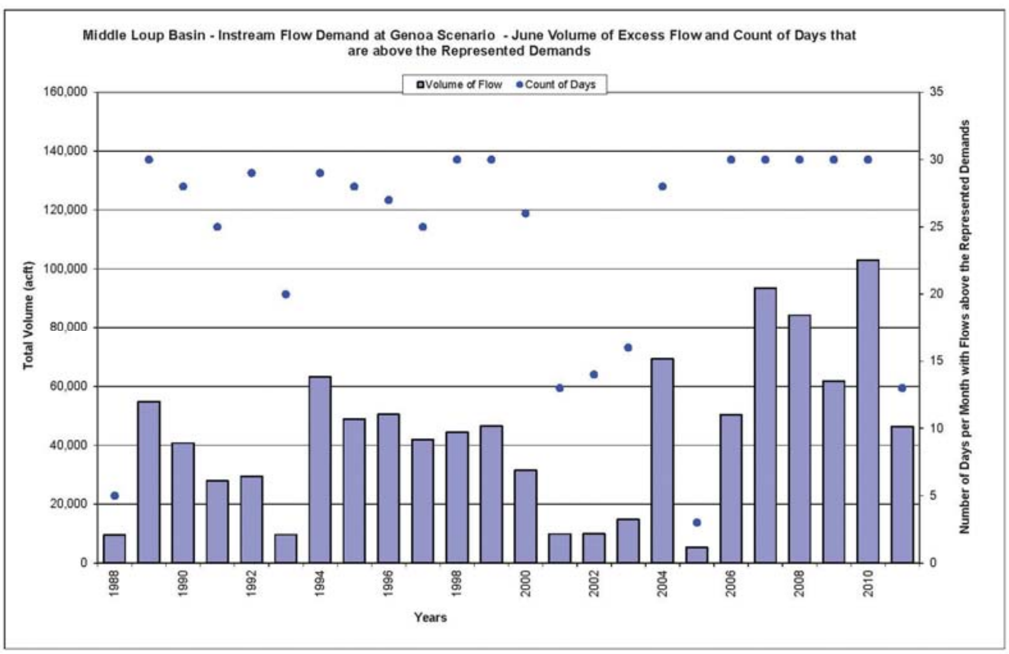


Figure A67: Middle Loup Subbasin, July Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

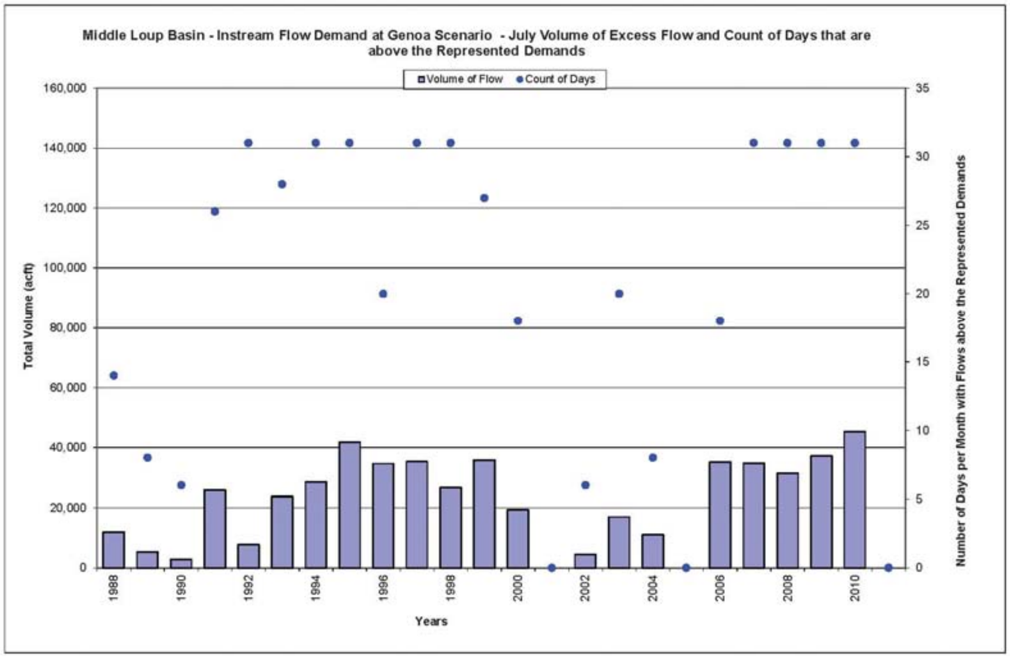


Figure A68: Middle Loup Subbasin, August Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

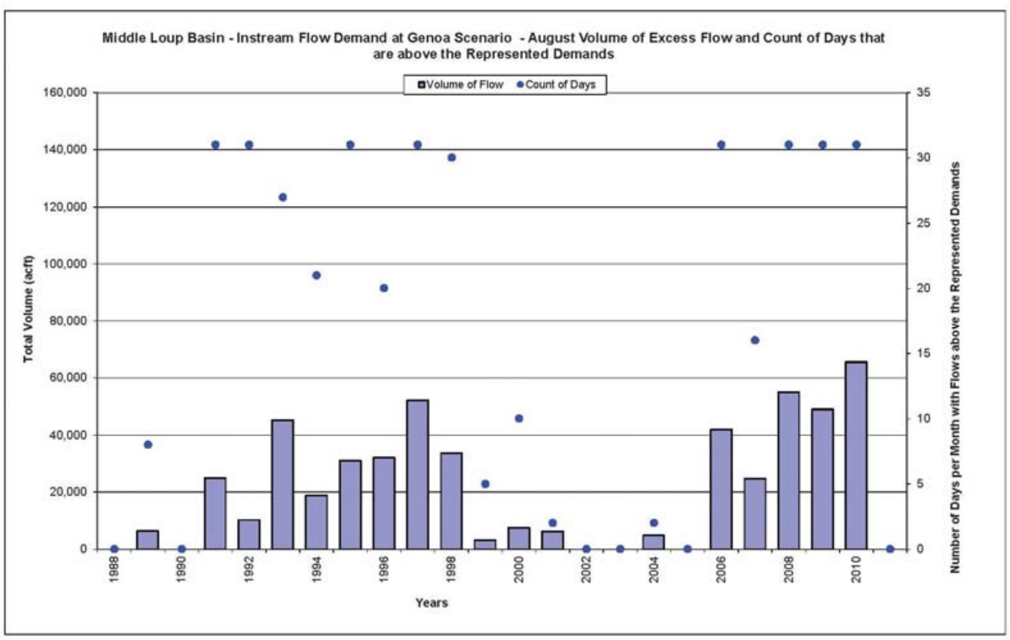


Figure A69: Middle Loup Subbasin, September Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

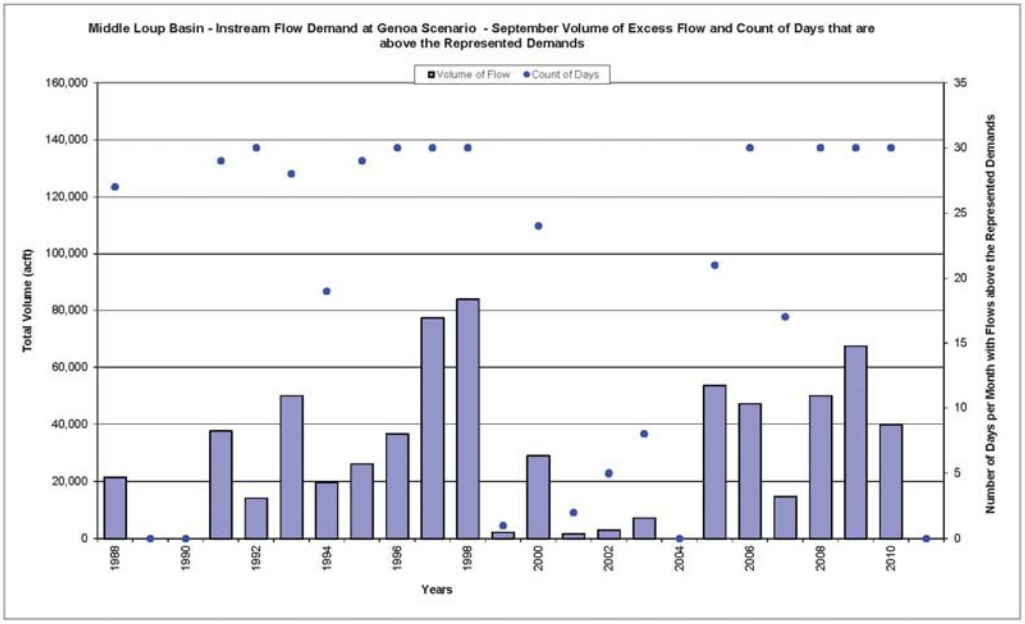


Figure A70: Middle Loup Subbasin, October Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

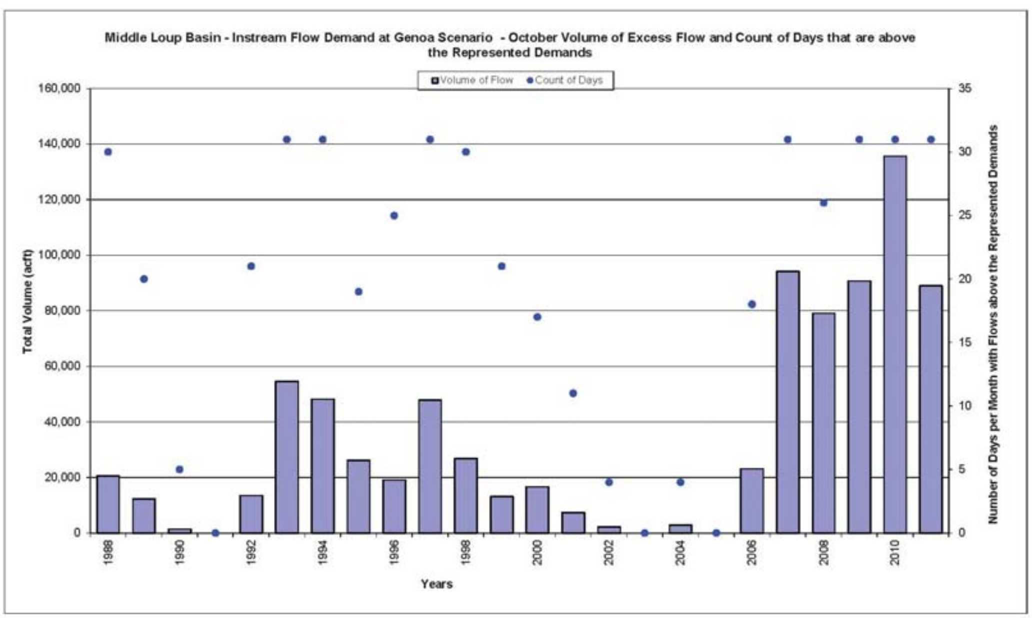


Figure A71: Middle Loup Subbasin,
November Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

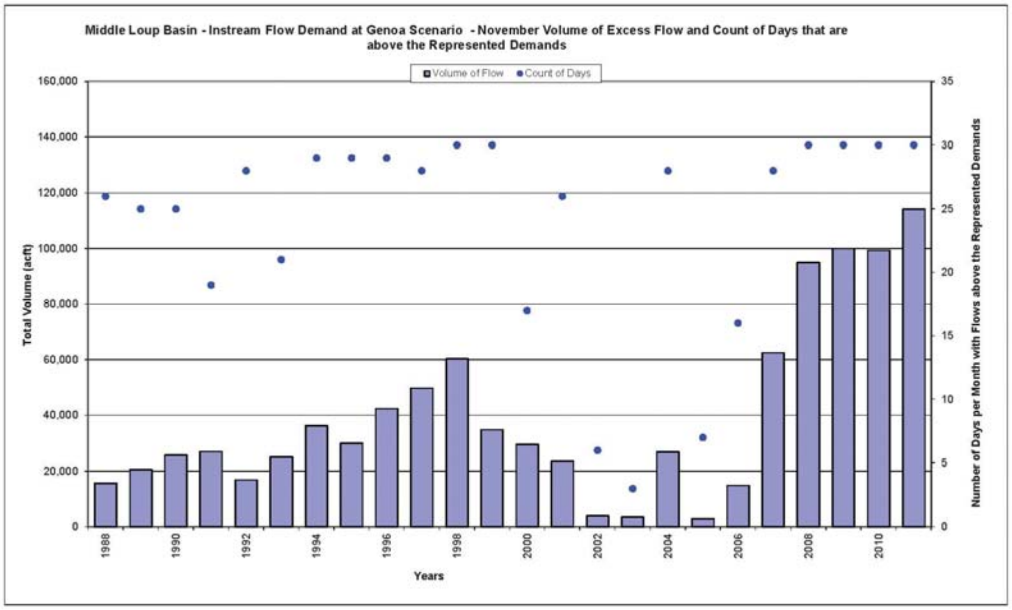


Figure A72: Middle Loup Subbasin,
December Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

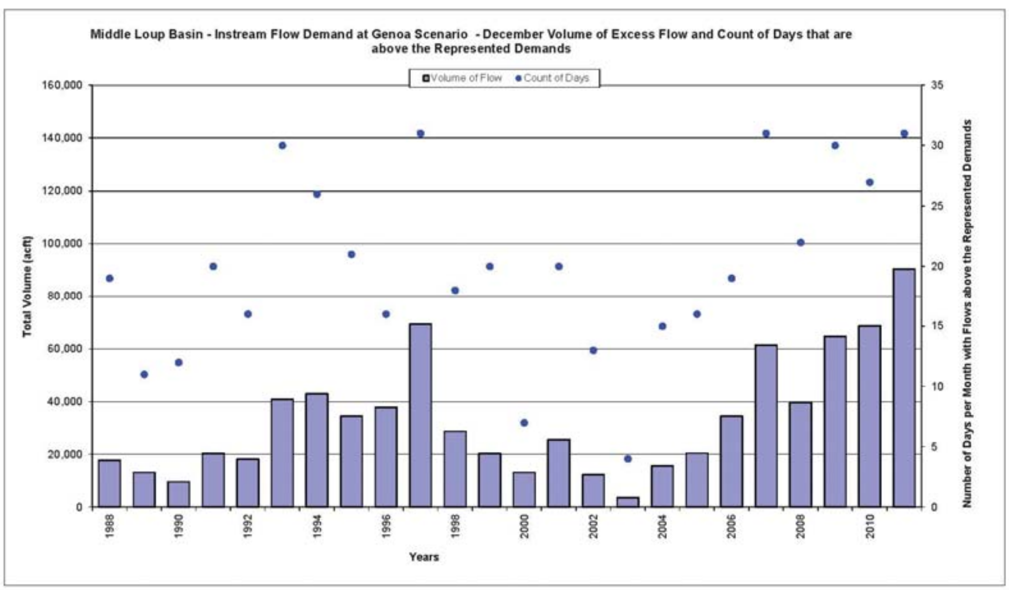


Figure A73: South Loup Subbasin,
January Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

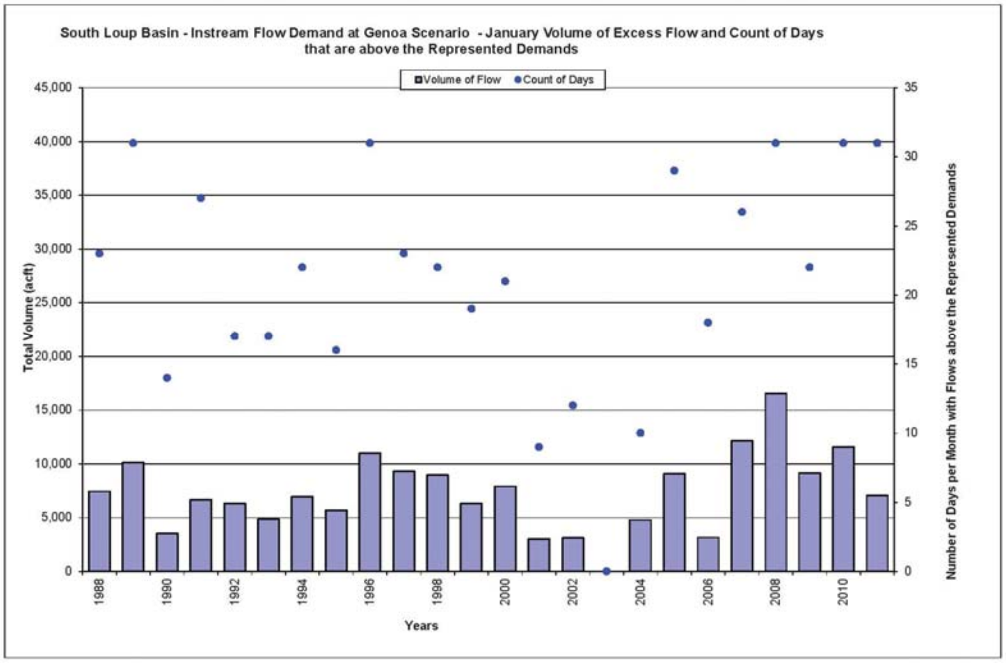


Figure A74: South Loup Subbasin,
February Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

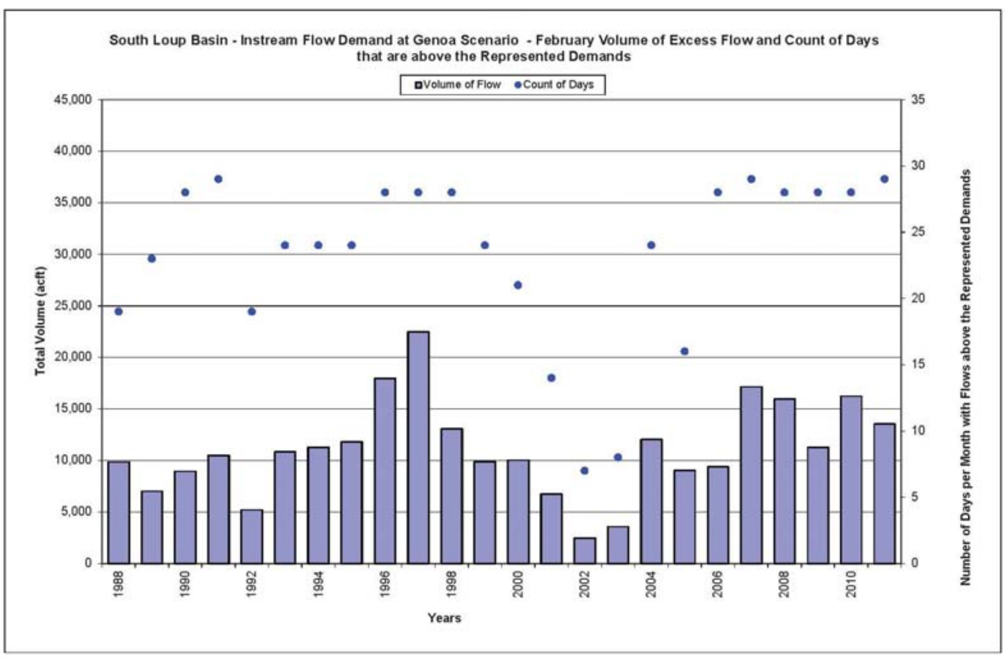


Figure A75: South Loup Subbasin, March Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

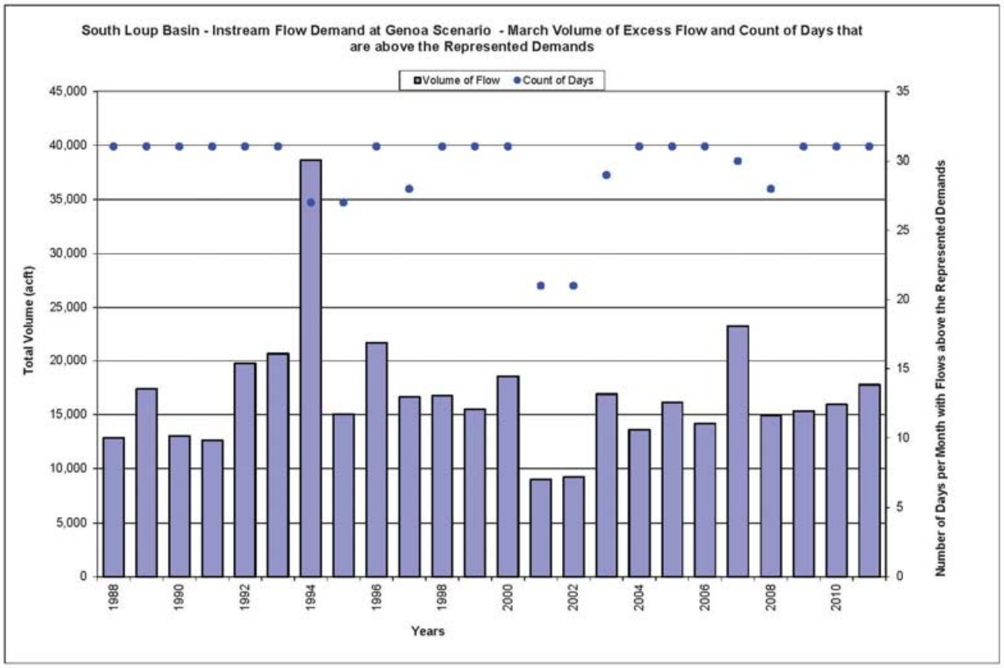


Figure A76: South Loup Subbasin, April Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

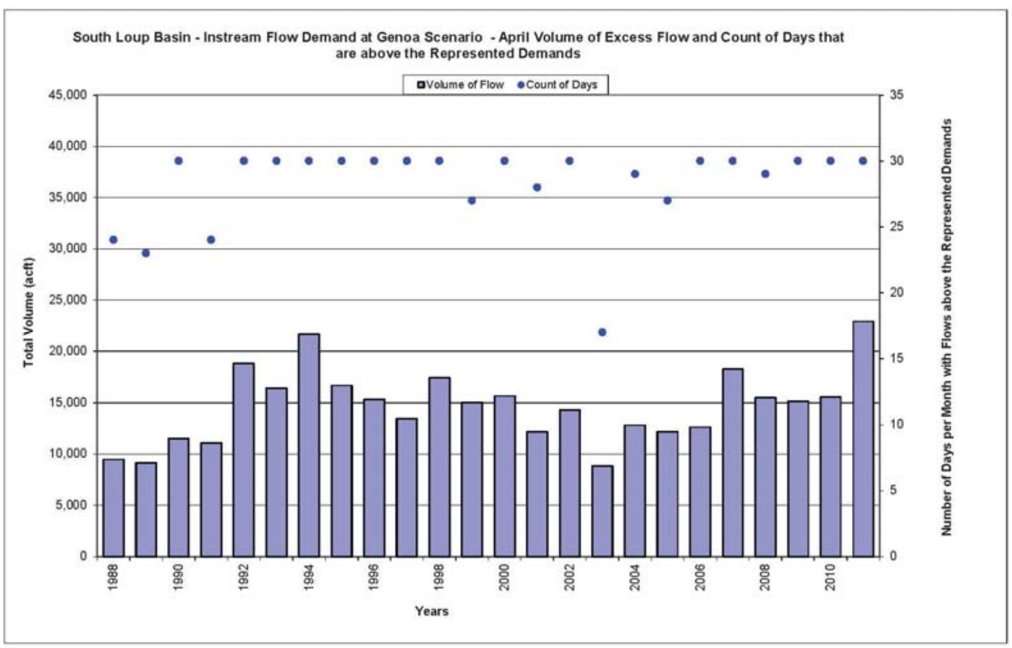


Figure A77: South Loup Subbasin, May Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

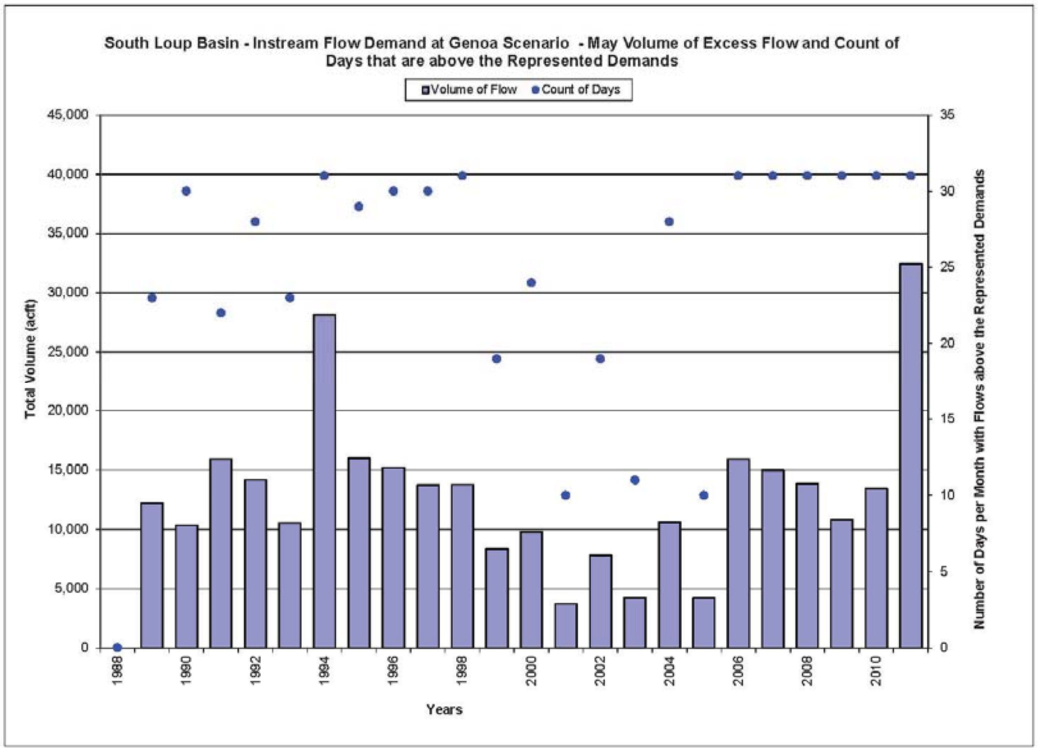


Figure A78: South Loup Subbasin, June Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

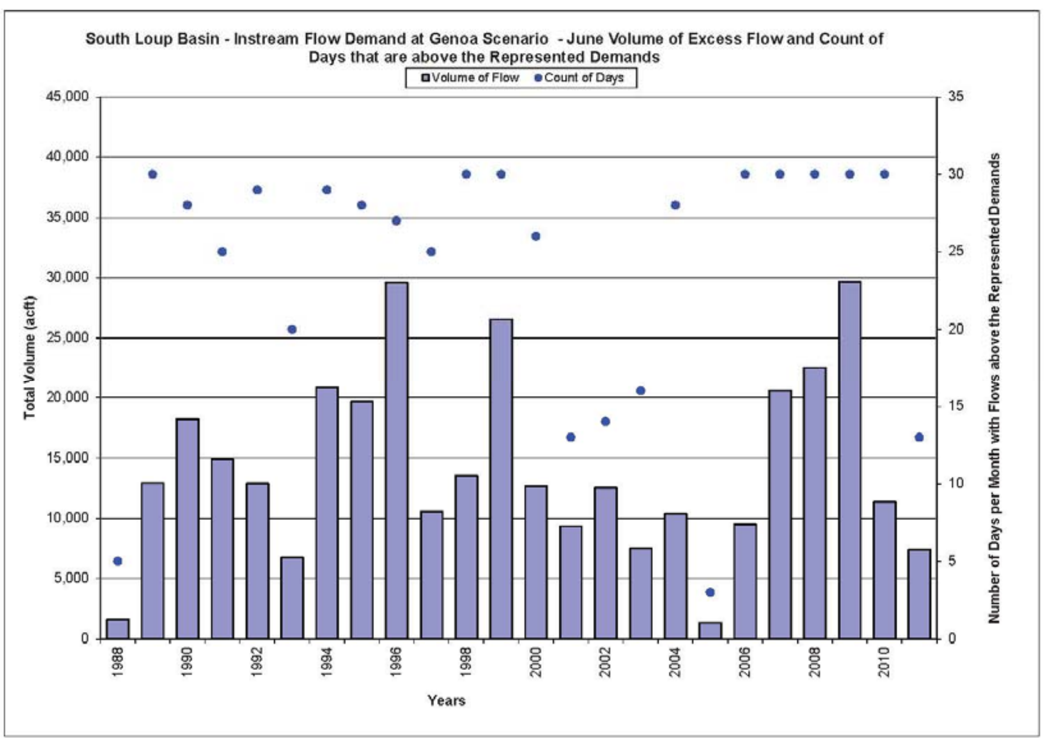


Figure A79: South Loup Subbasin,
July Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

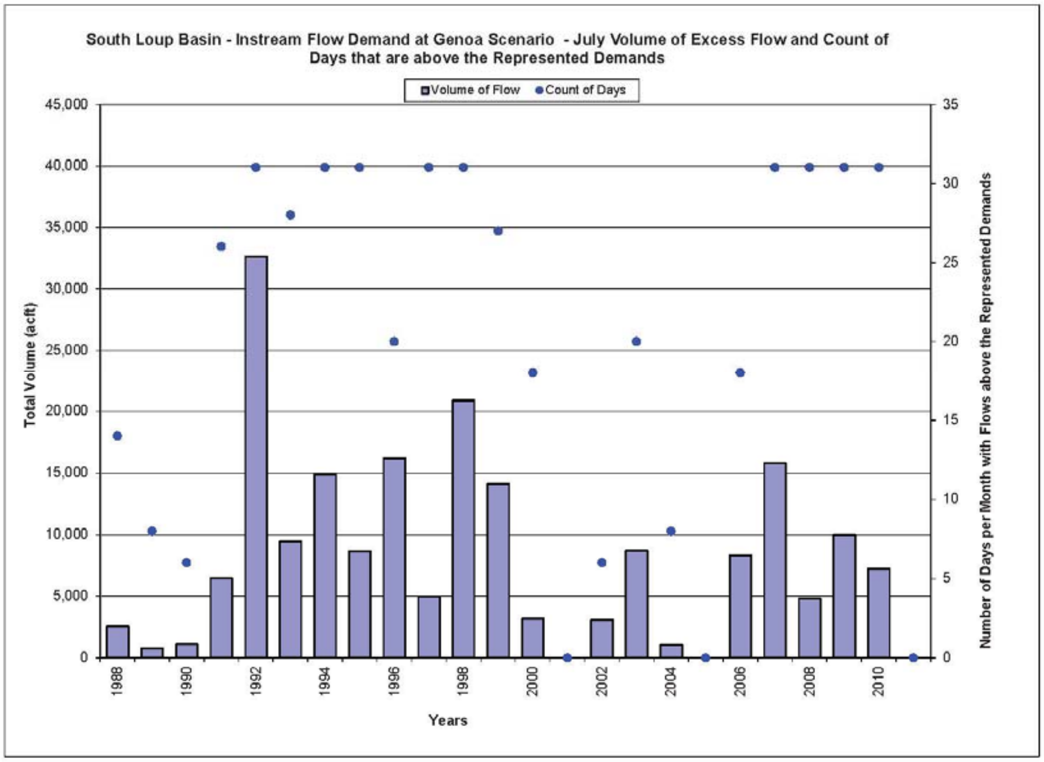


Figure A80: South Loup Subbasin,
August Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

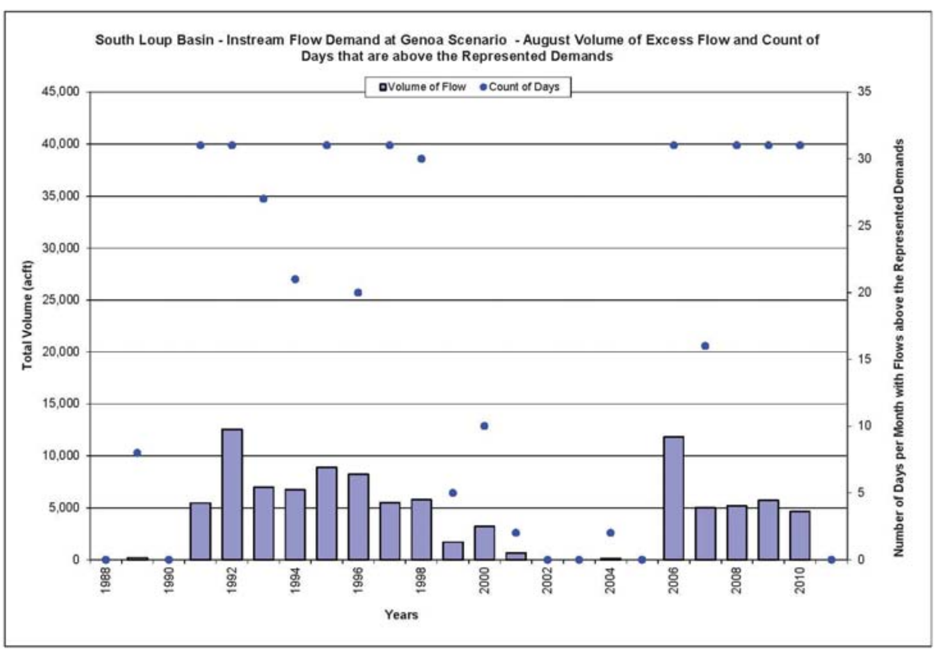


Figure A81: South Loup Subbasin,
September Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

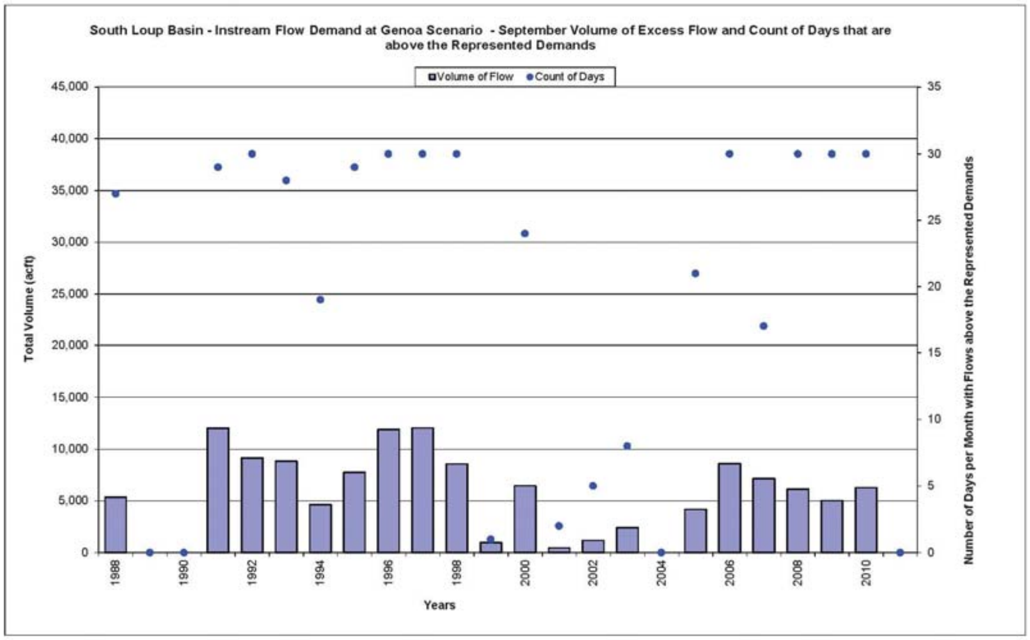


Figure A82: South Loup Subbasin,
October Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

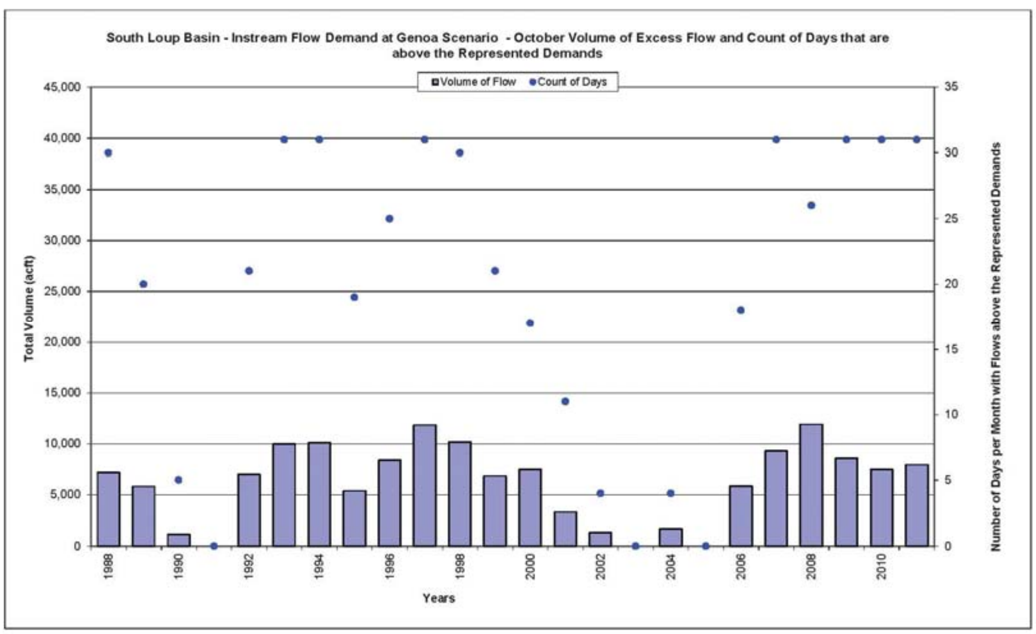


Figure A83: South Loup Subbasin,
November Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

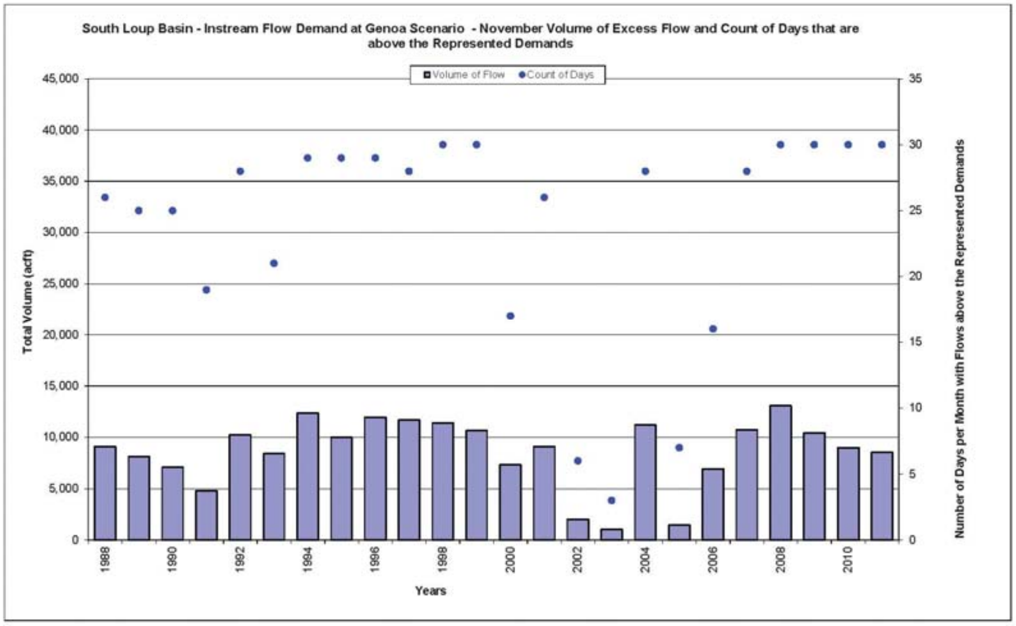


Figure A84: South Loup Subbasin,
December Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

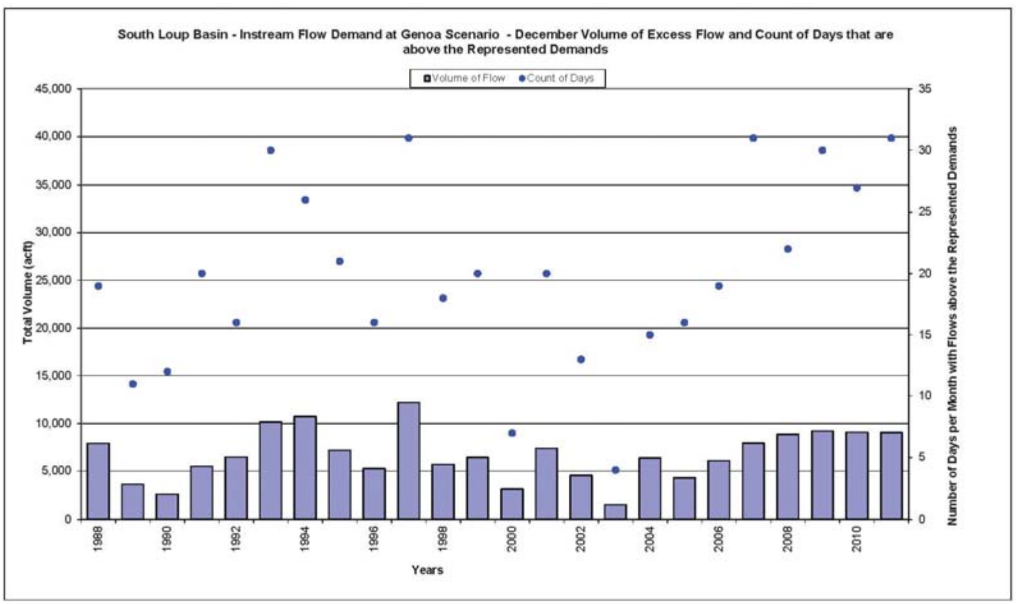


Figure A85: North Loup Subbasin,
January Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

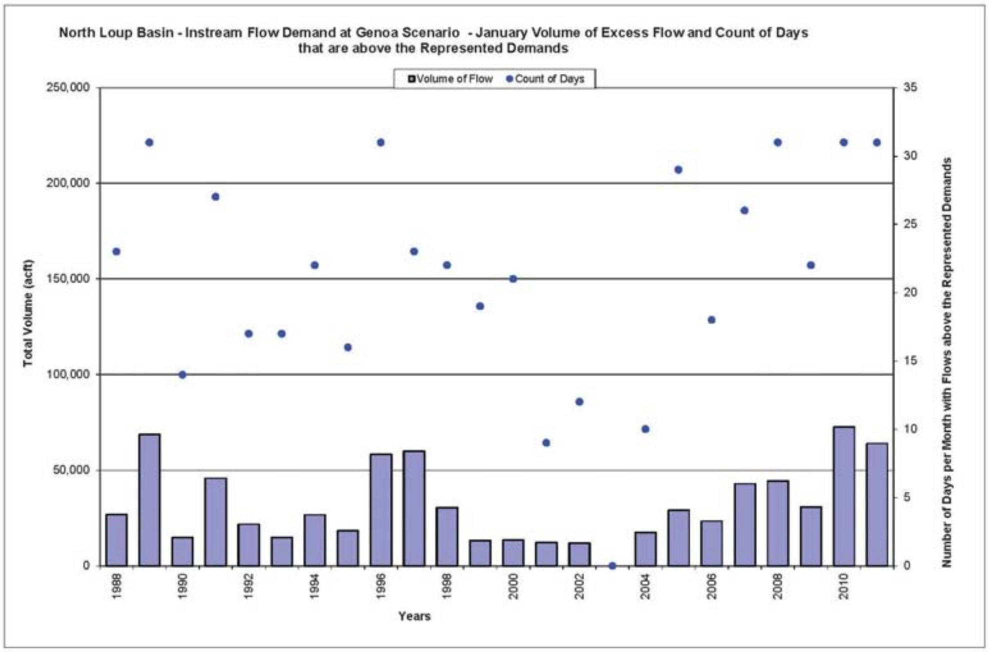


Figure A86: North Loup Subbasin,
February Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

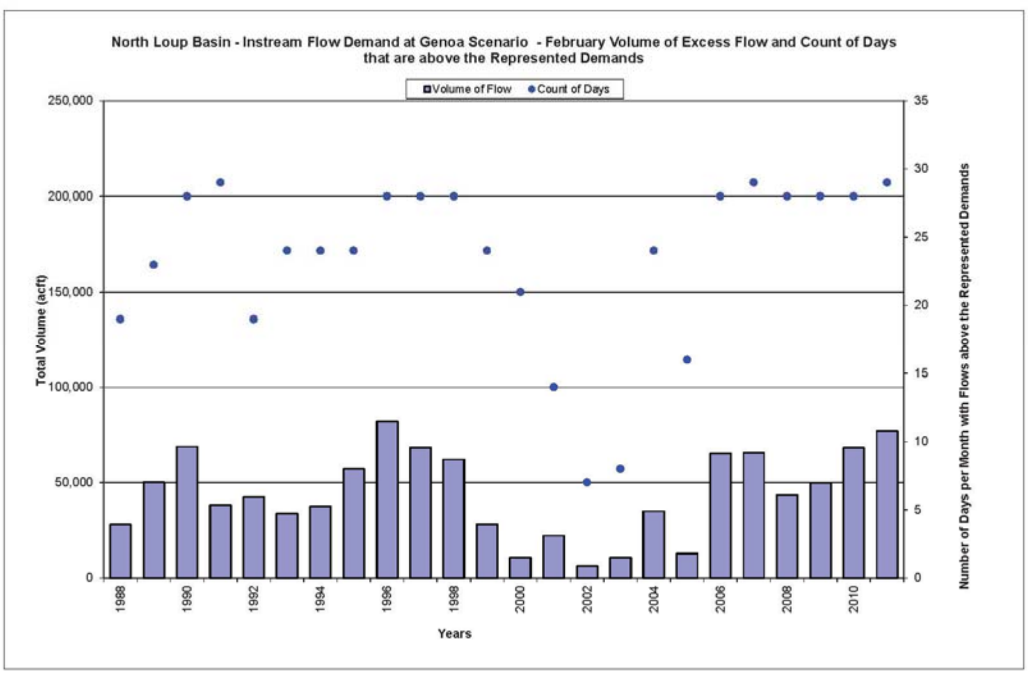


Figure A87: North Loup Subbasin,
March Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

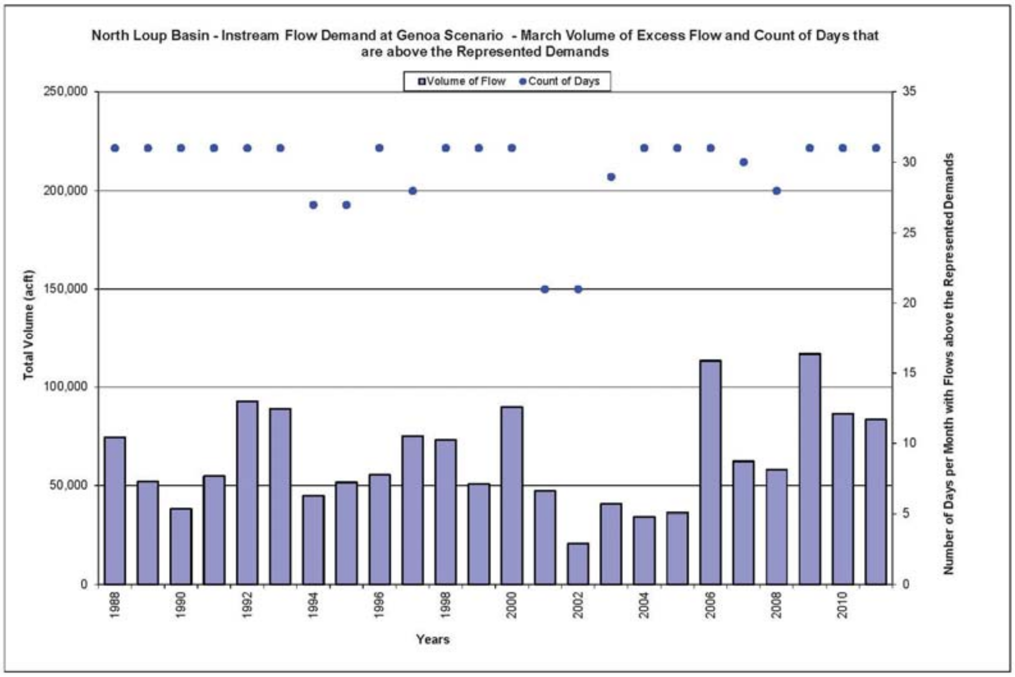


Figure A88: North Loup Subbasin,
April Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

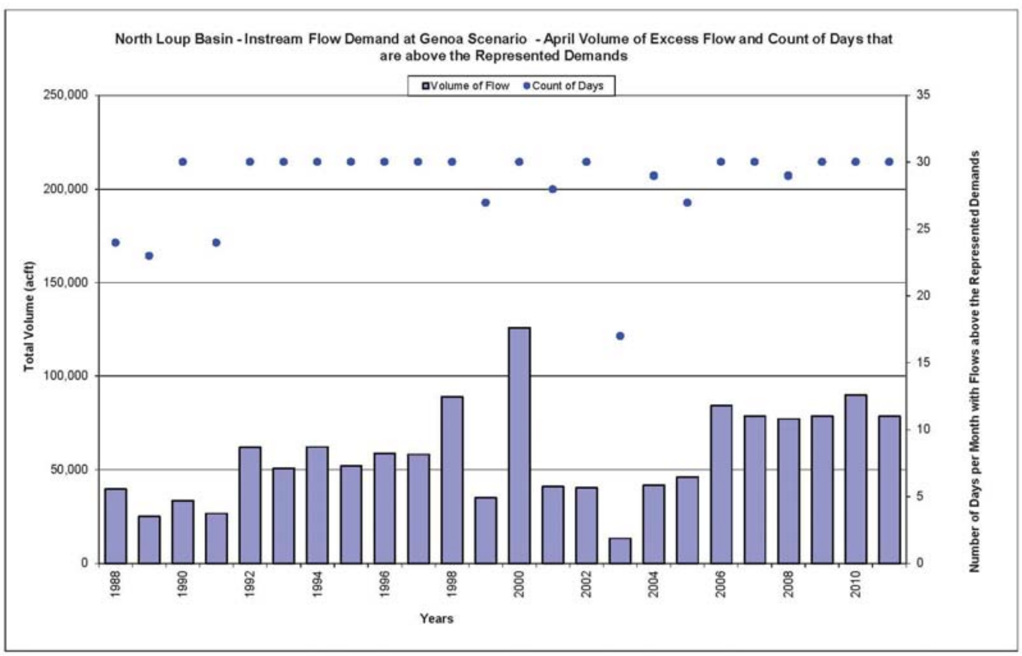


Figure A89: North Loup Subbasin,
May Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

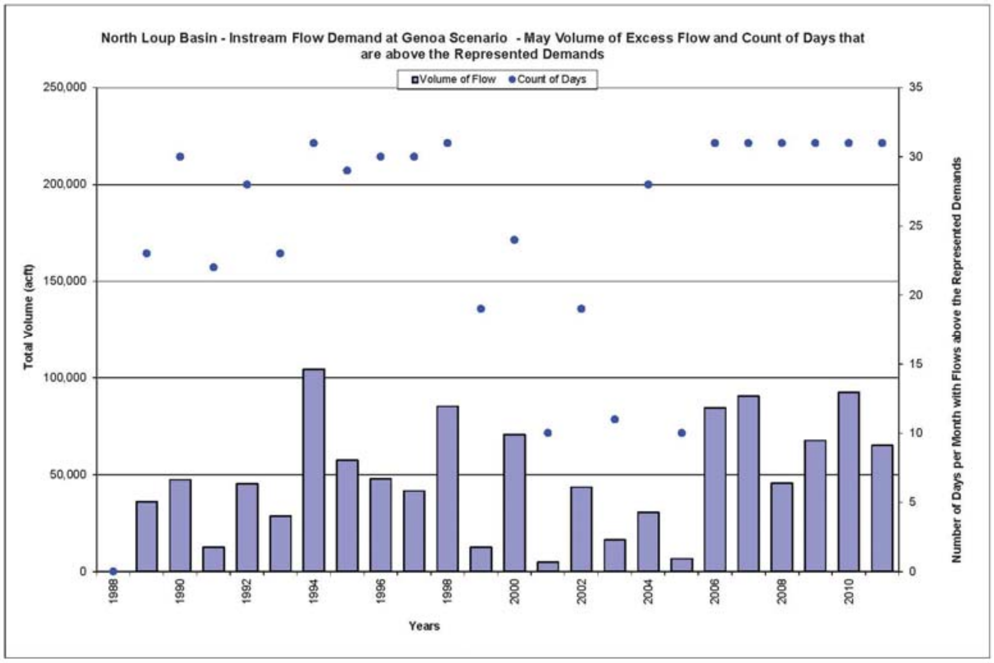


Figure A90: North Loup Subbasin,
June Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

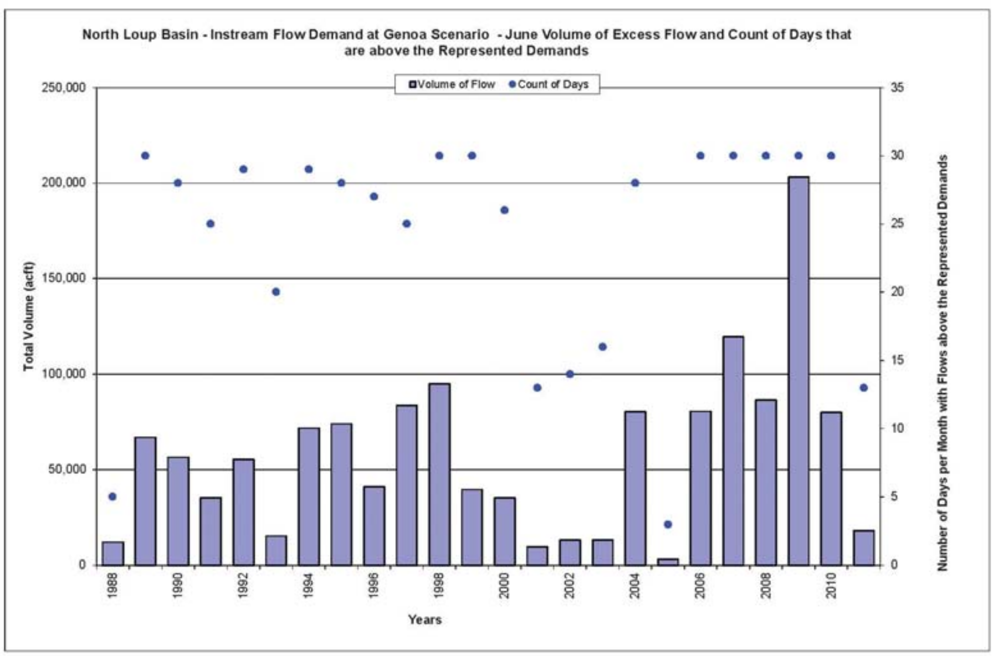


Figure A91: North Loup Subbasin,
July Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

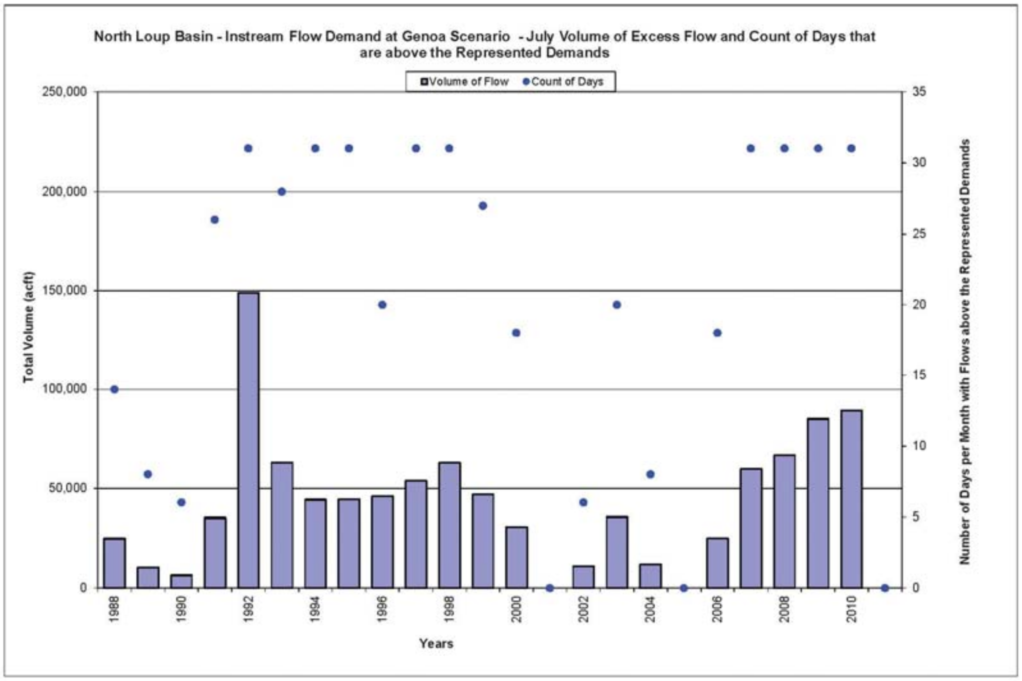


Figure A92: North Loup Subbasin,
August Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

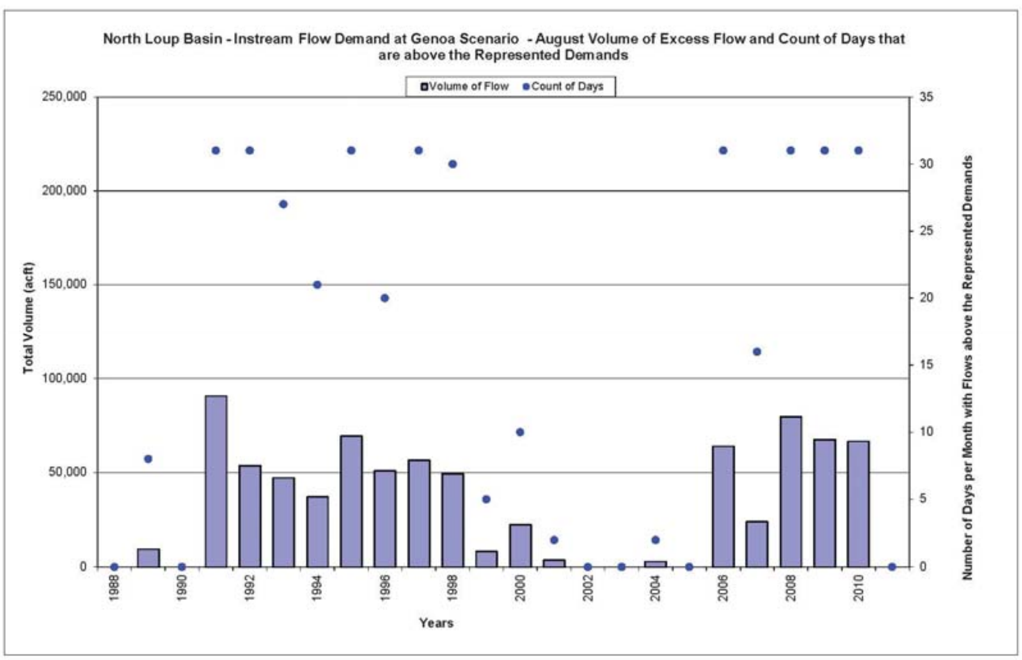


Figure A93: North Loup Subbasin,
September Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

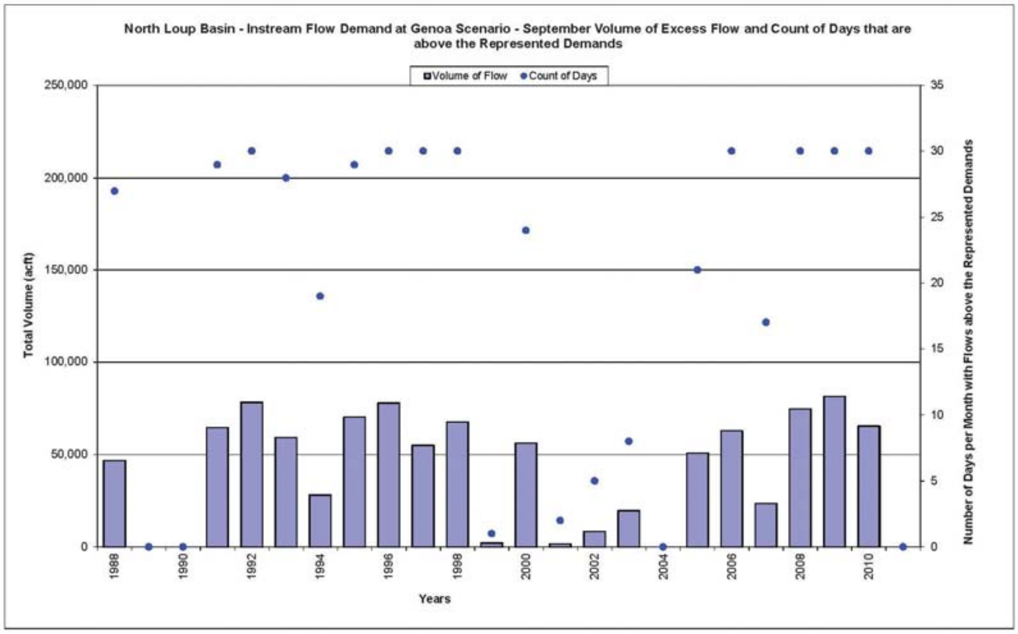


Figure A94: North Loup Subbasin,
October Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

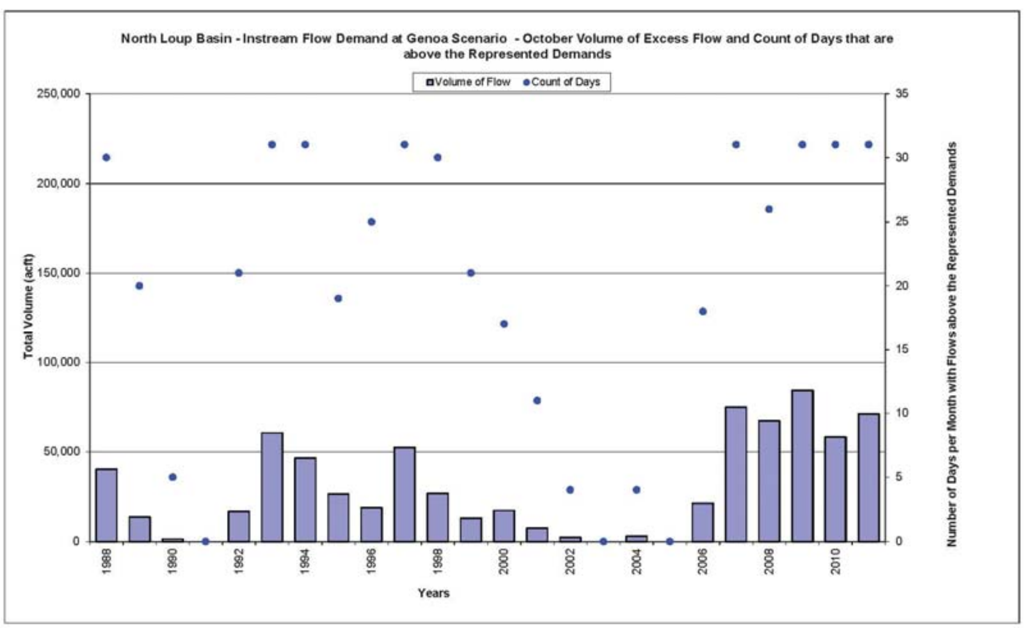


Figure A95: North Loup Subbasin, November Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

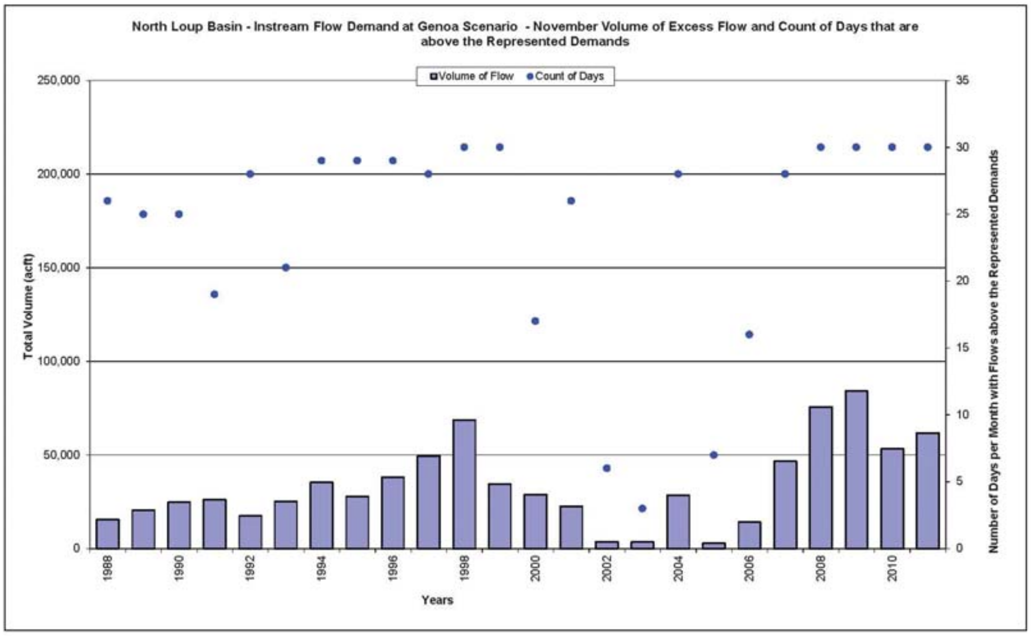


Figure A96: North Loup Subbasin, December Volume of Excess Flow and Count of Days that are above the Instream Flow Demands

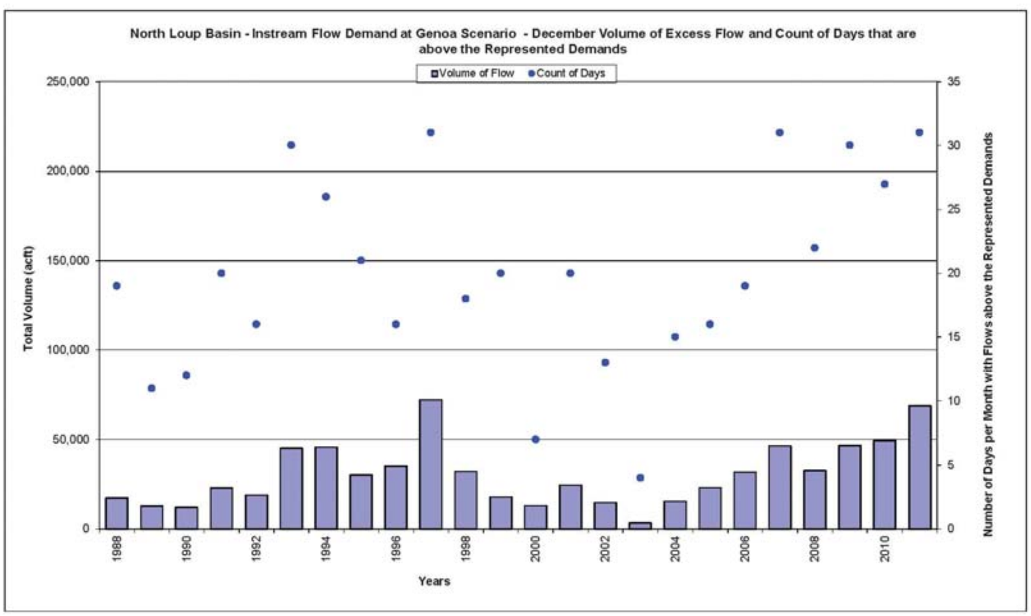


Figure A97: Lower Loup Subbasin,
January Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

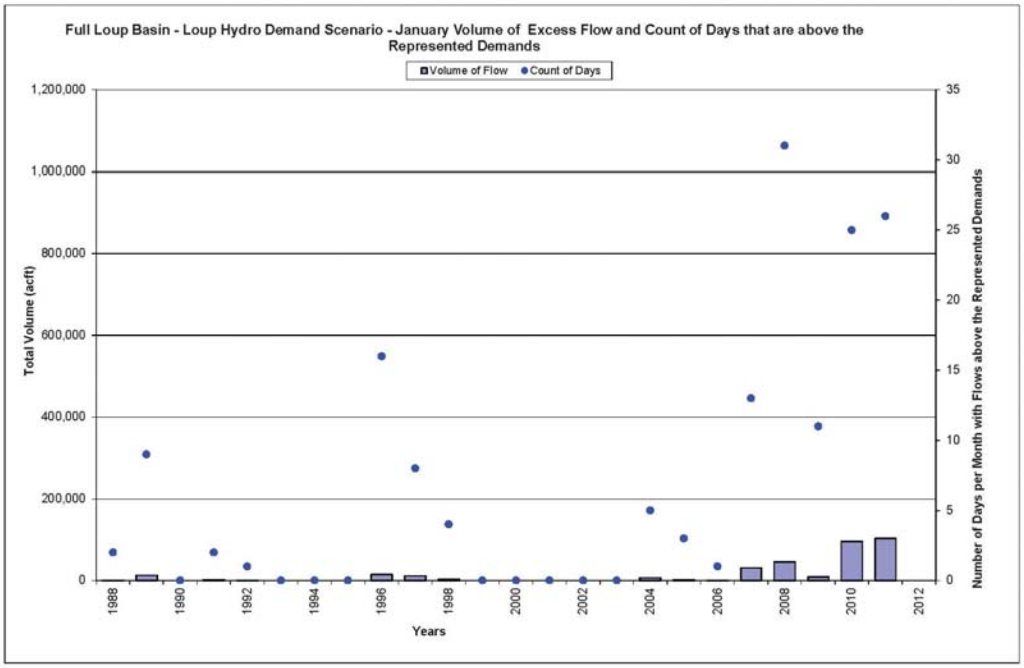


Figure A98: Lower Loup Subbasin,
February Volume of Excess Flow and Count of Days that are above the Instream Demands as well as Historic Loup Hydropower Diversion

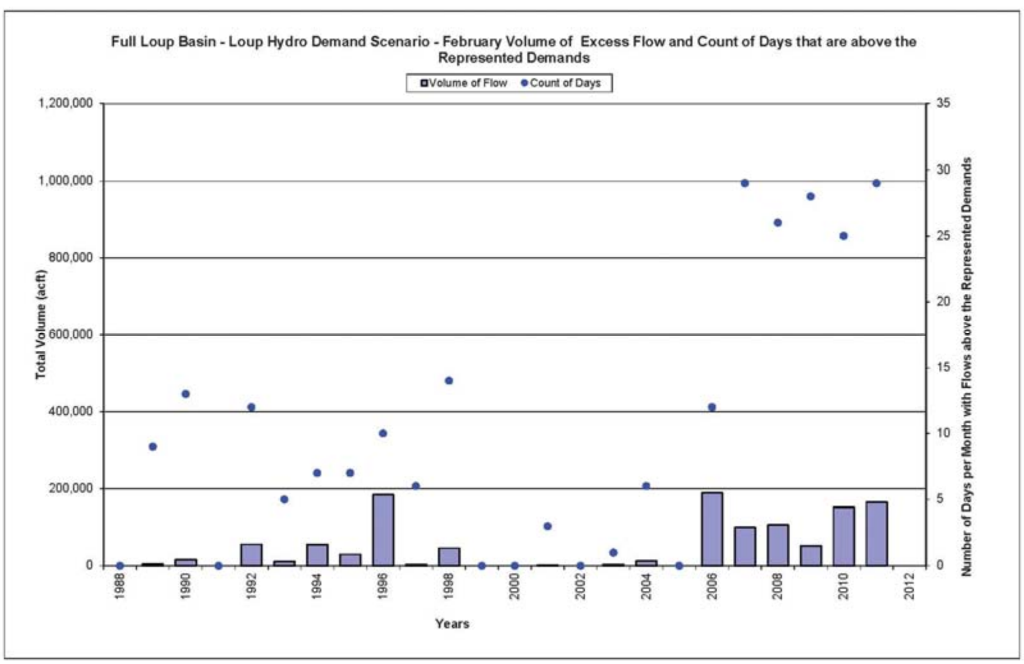


Figure A99: Lower Loup Subbasin,
March Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

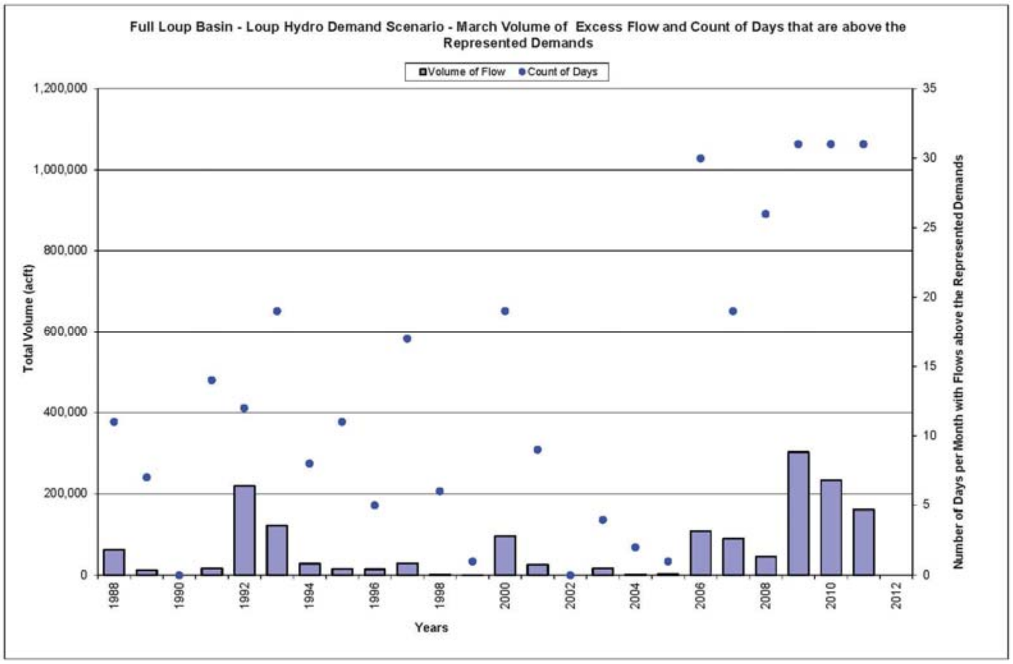


Figure A100: Lower Loup Subbasin,
April Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

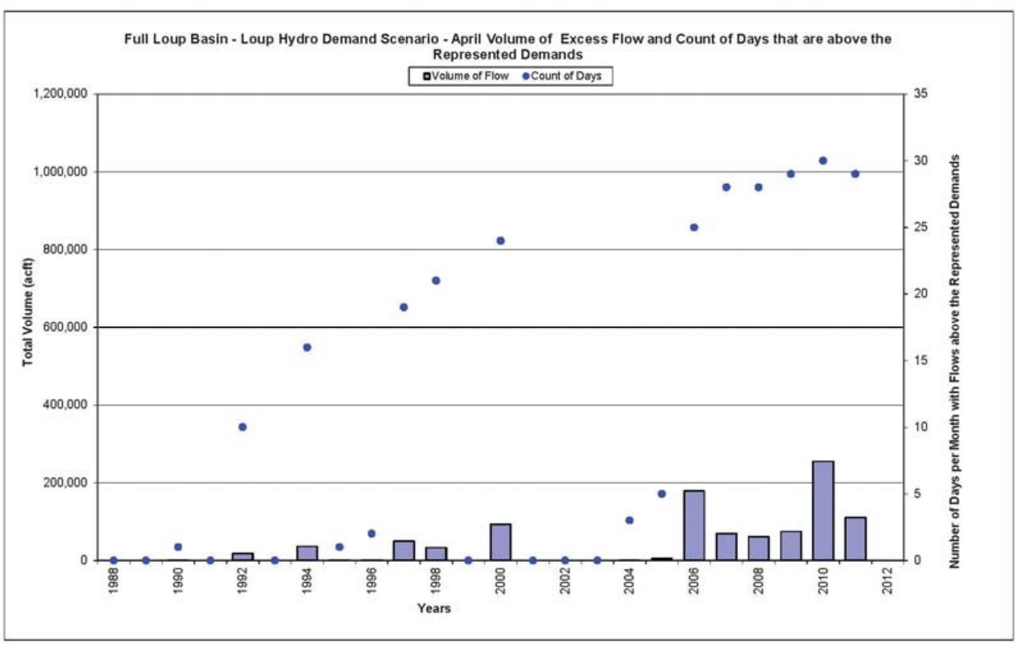


Figure A101: Lower Loup Subbasin,
May Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

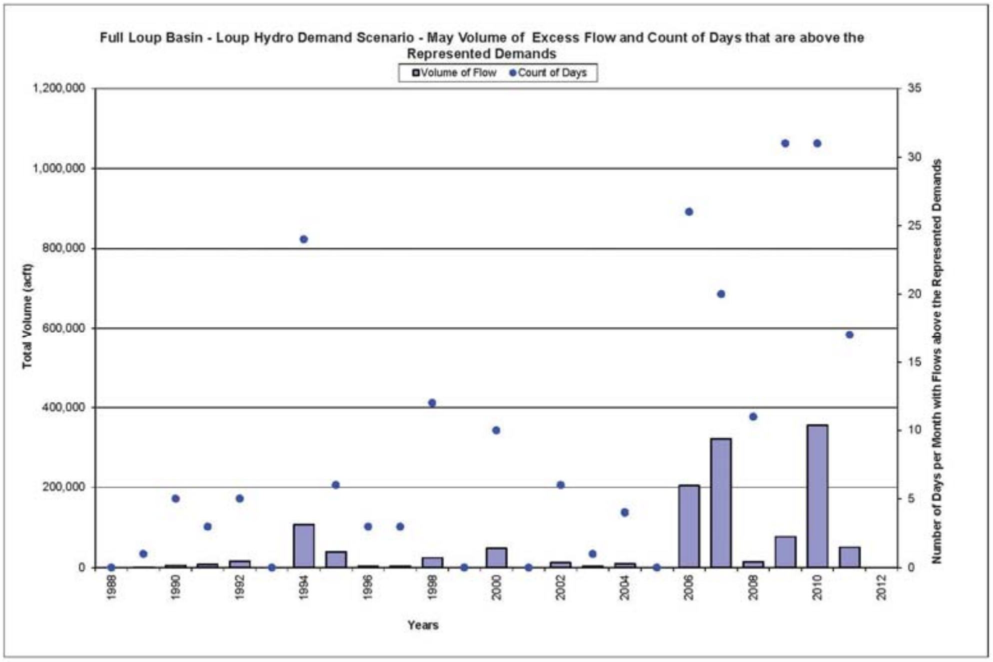


Figure A102: Lower Loup Subbasin,
June Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

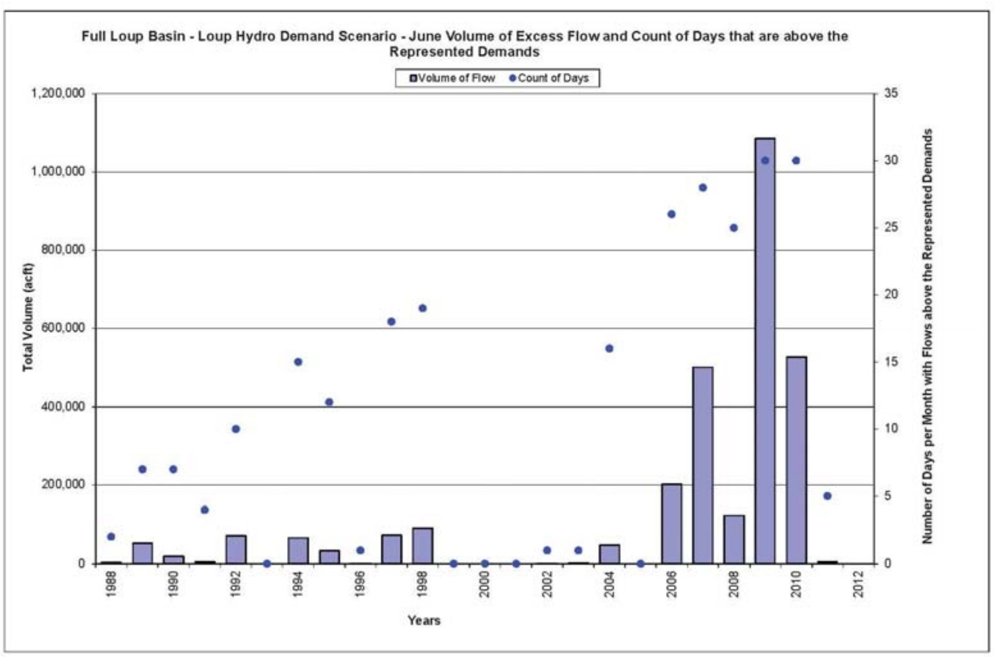


Figure A103: Lower Loup Subbasin,
July Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

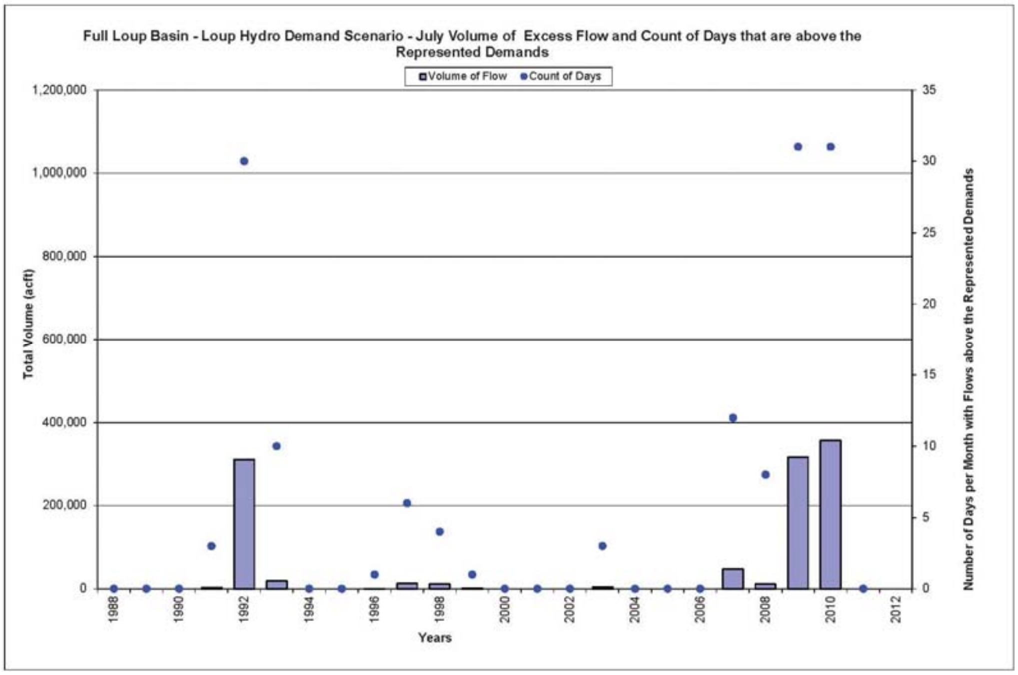


Figure A104: Lower Loup Subbasin,
August Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

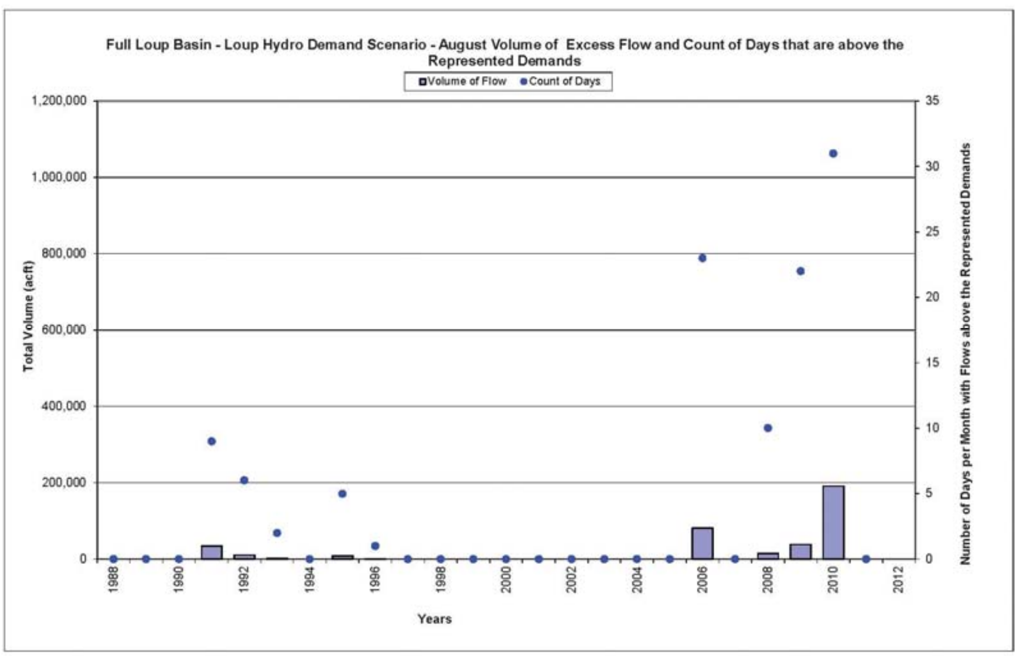


Figure A105: Lower Loup Subbasin, September Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

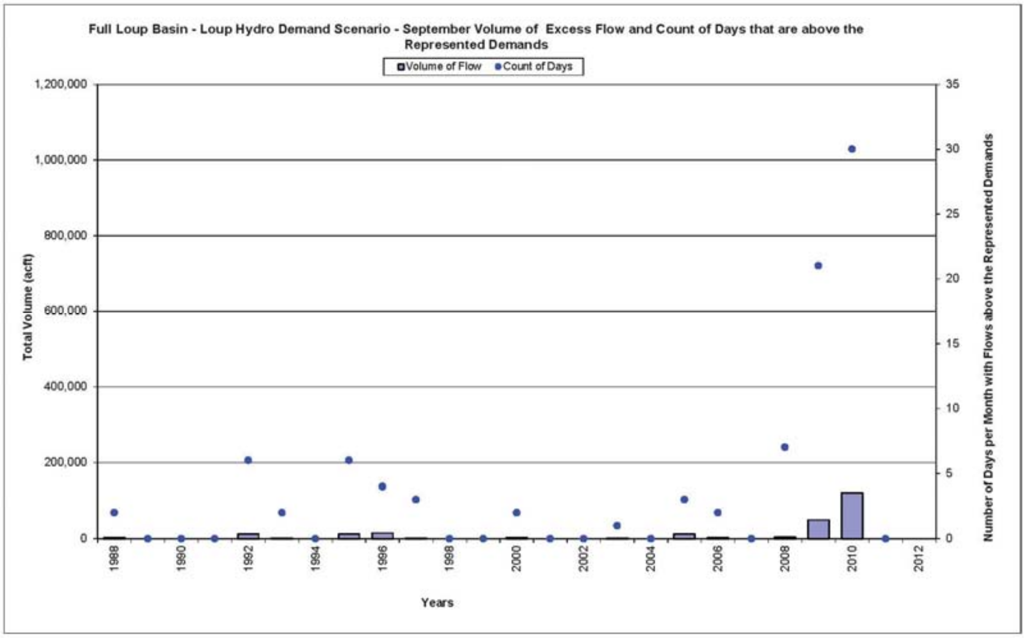


Figure A106: Lower Loup Subbasin, October Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

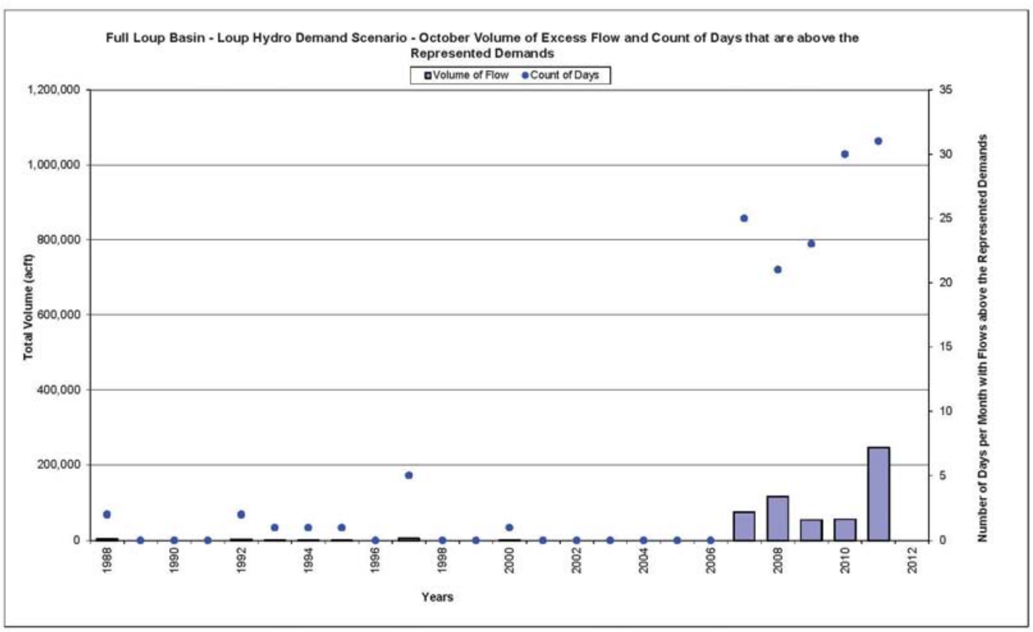


Figure A107: Lower Loup Subbasin,
November Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

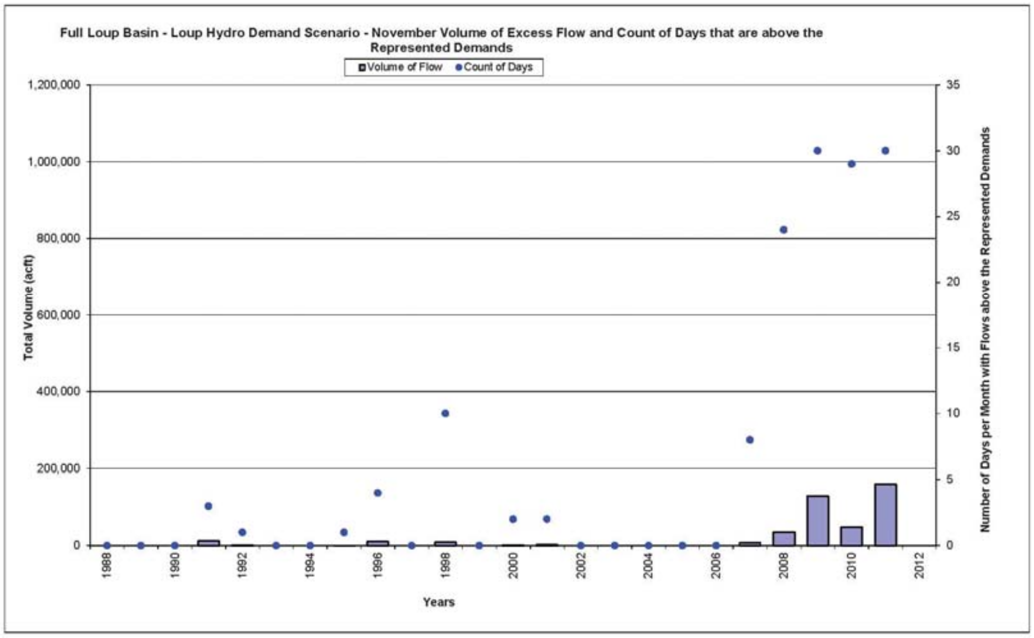


Figure A108: Lower Loup Subbasin,
December Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

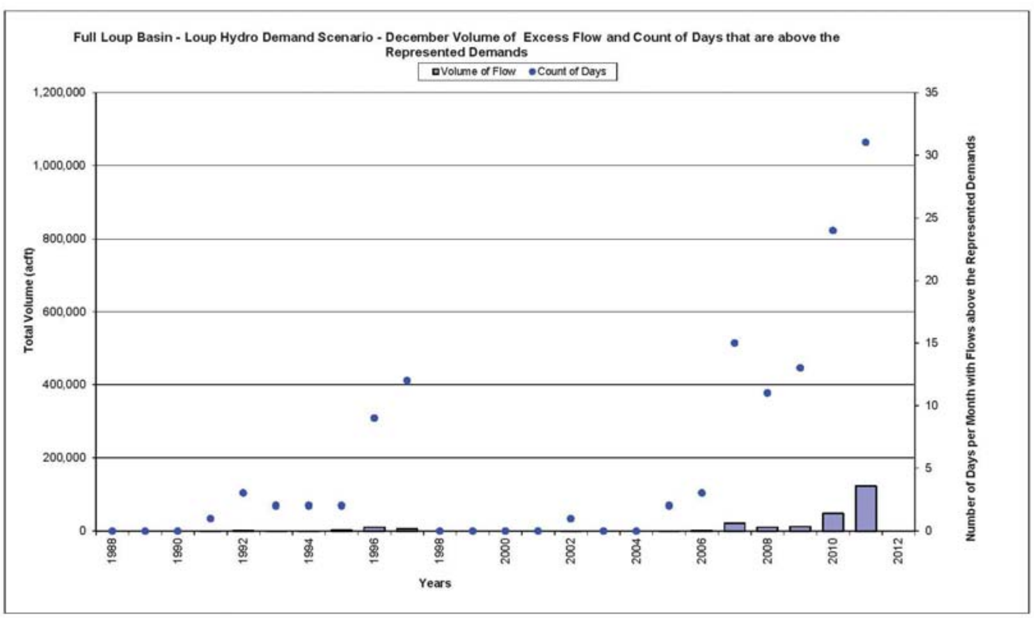


Figure A109: Middle Loup Subbasin,
January Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

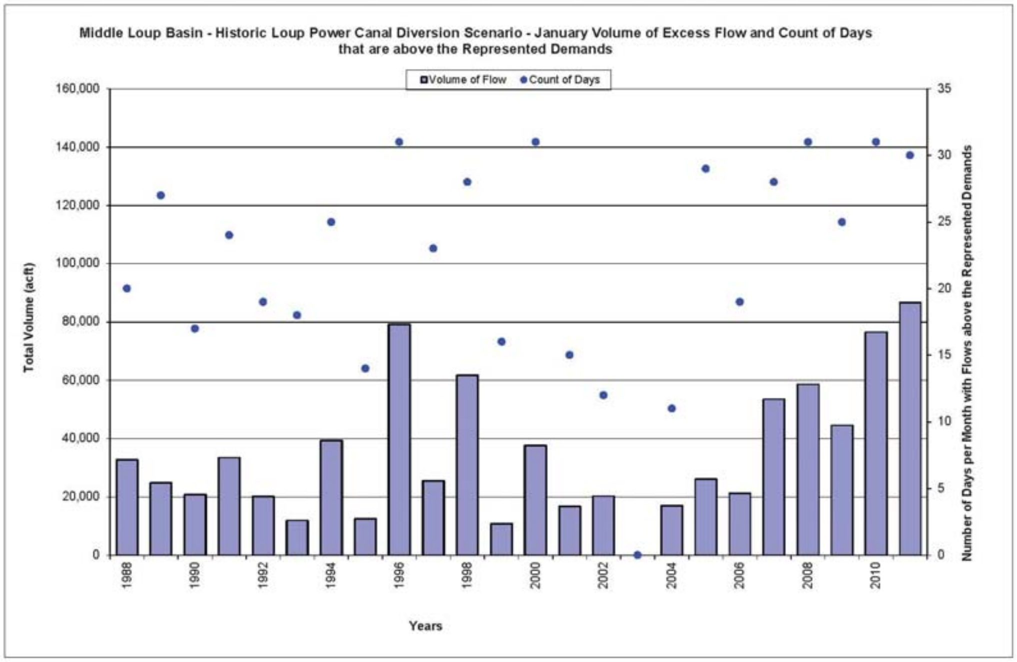


Figure A110: Middle Loup Subbasin,
February Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

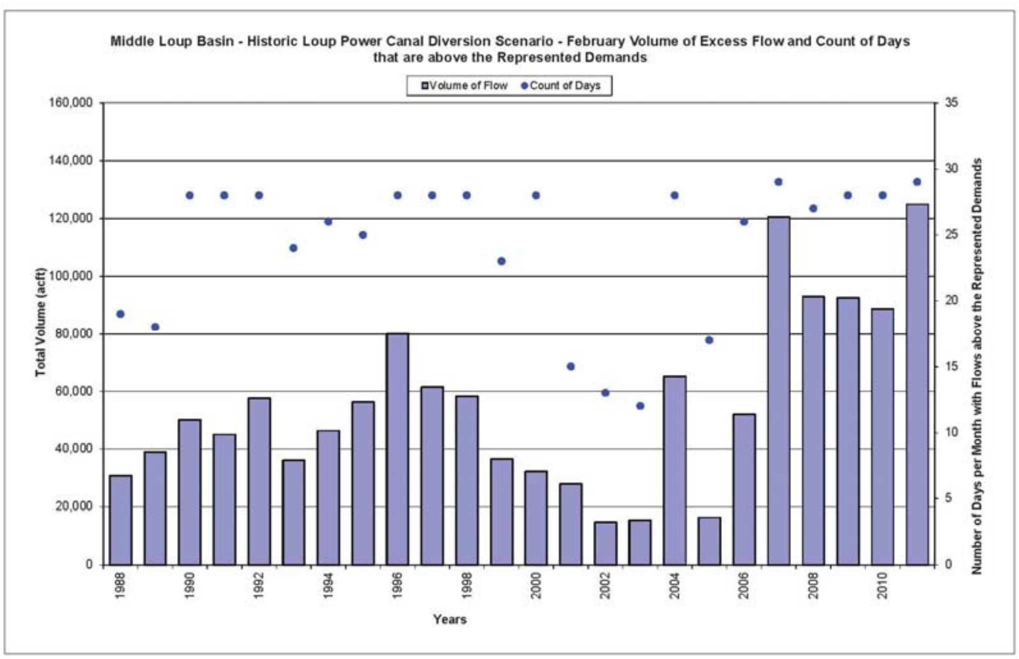


Figure A111: Middle Loup Subbasin,
March Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

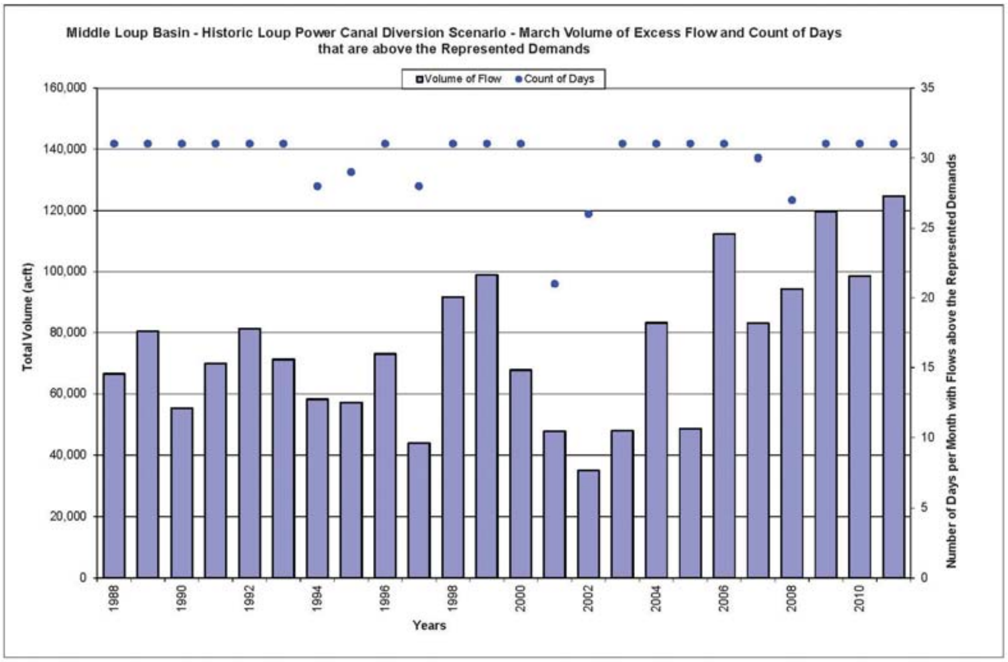


Figure A112: Middle Loup Subbasin,
April Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

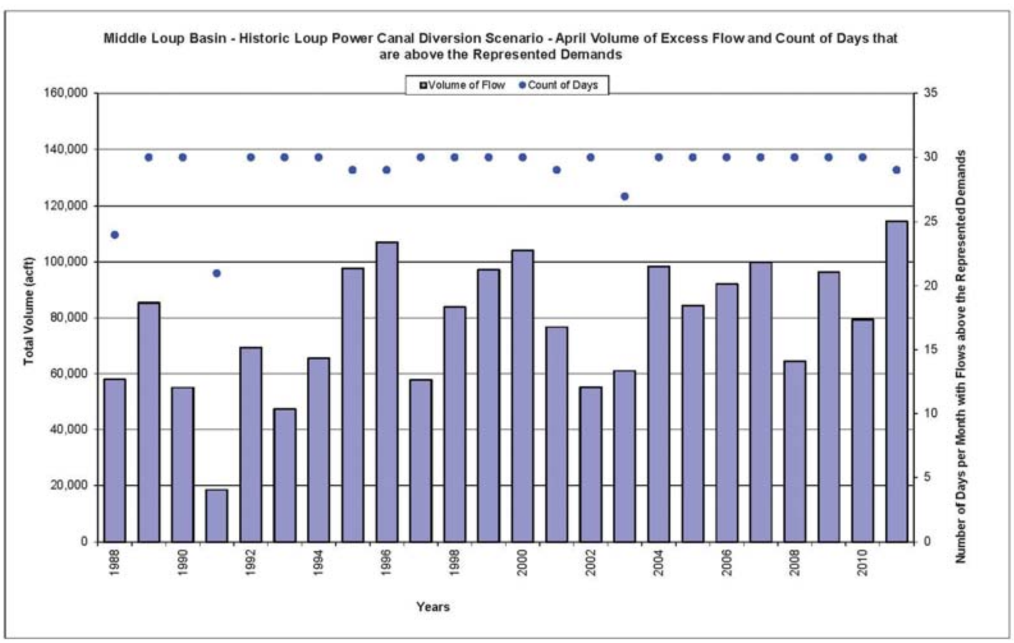


**Figure A113: Middle Loup Subbasin,
May Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion**

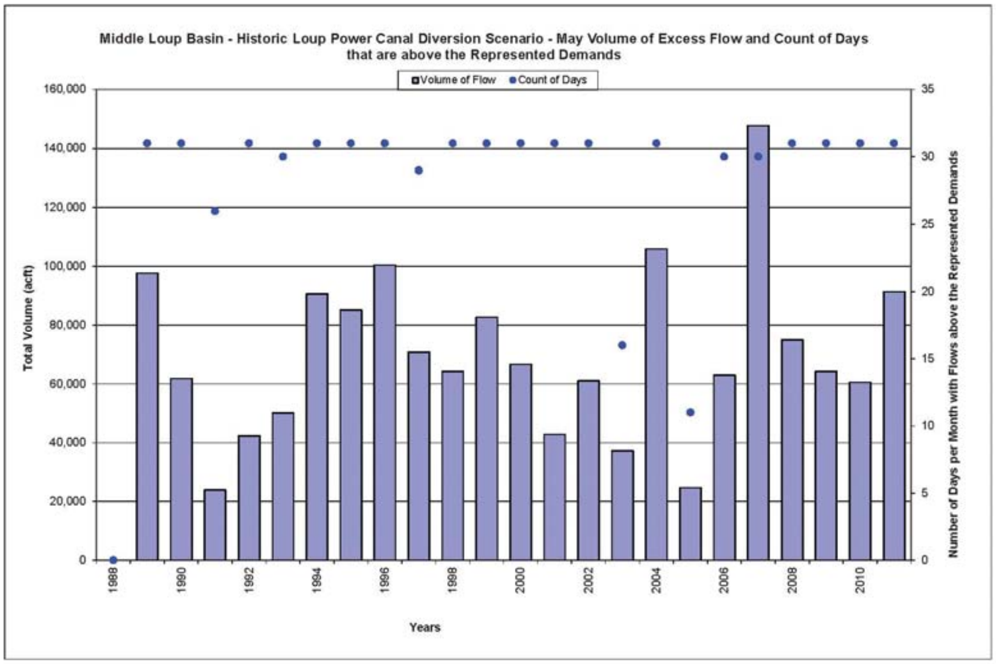


**Figure A114: Middle Loup Subbasin,
June Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion**

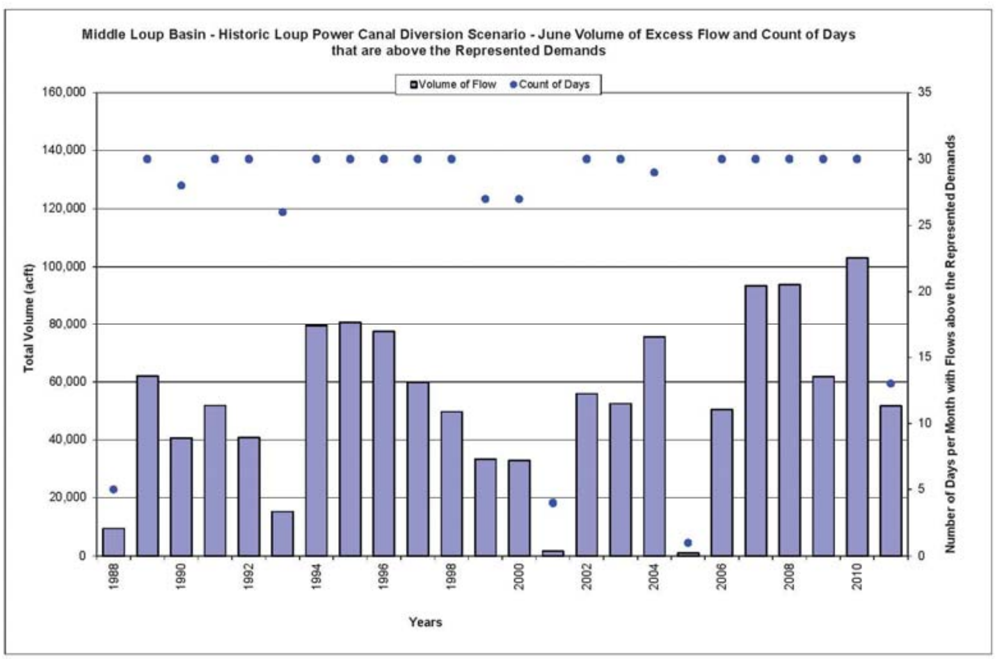


Figure A115: Middle Loup Subbasin,
July Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

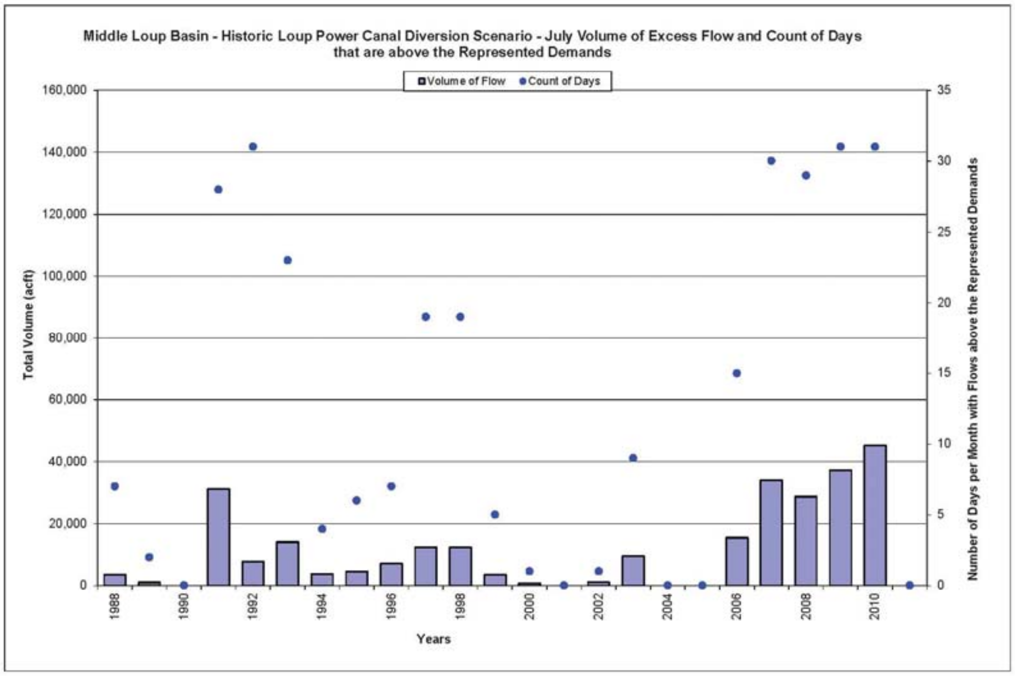


Figure A116: Middle Loup Subbasin,
August Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

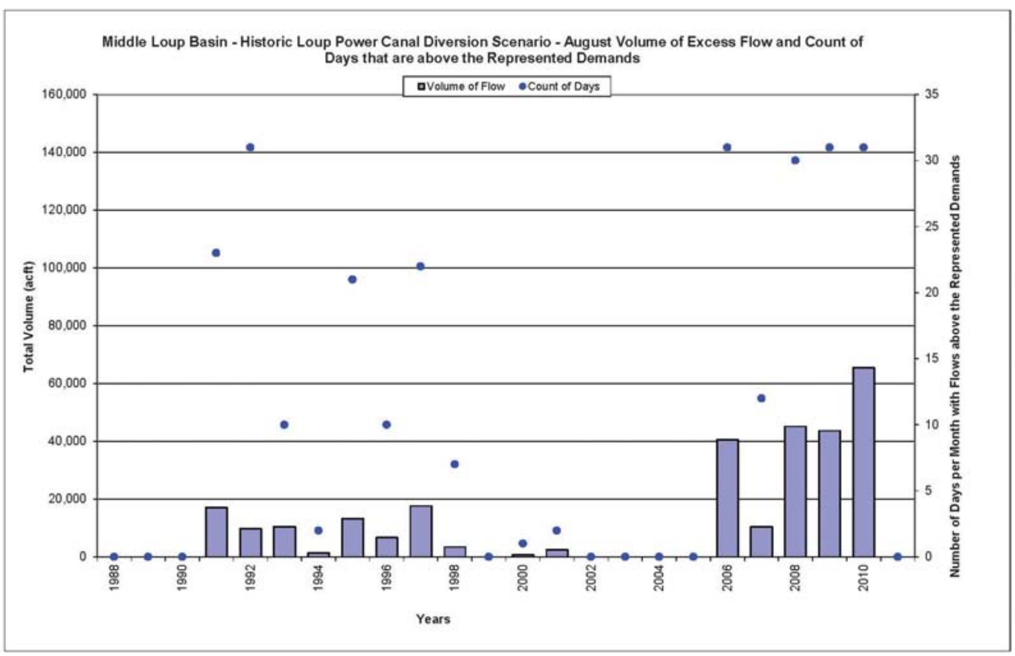


Figure A117: Middle Loup Subbasin,
September Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

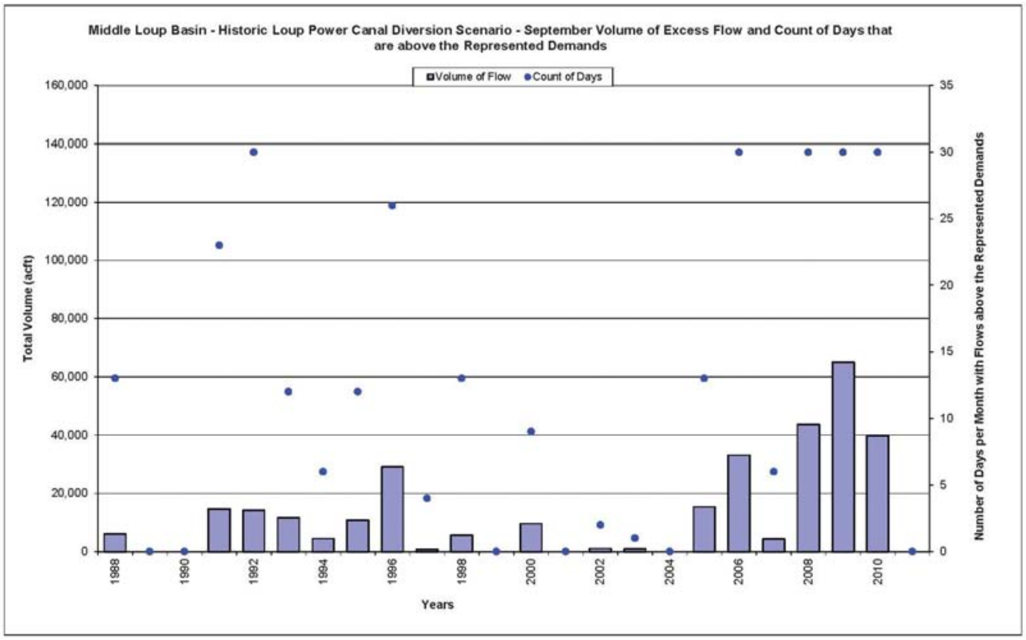


Figure A118: Middle Loup Subbasin,
October Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

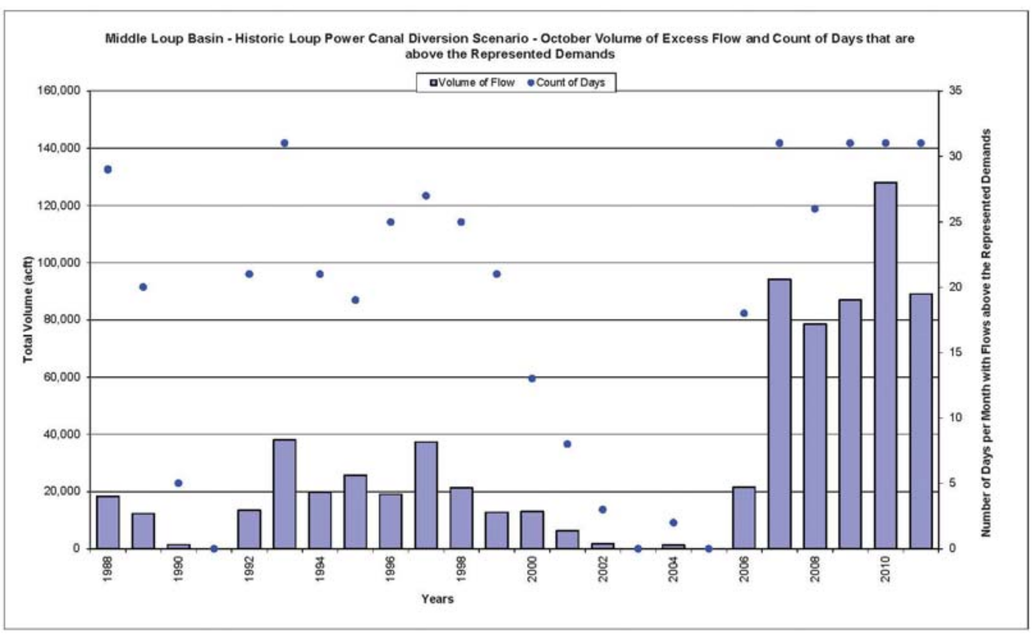


Figure A119: Middle Loup Subbasin,
November Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

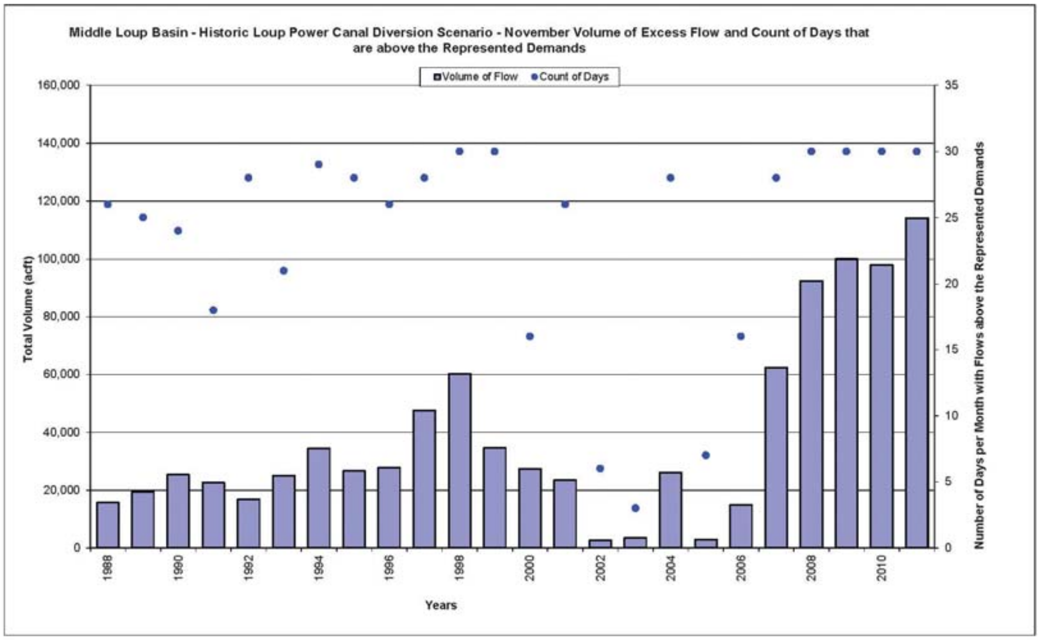


Figure A120: Middle Loup Subbasin,
December Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

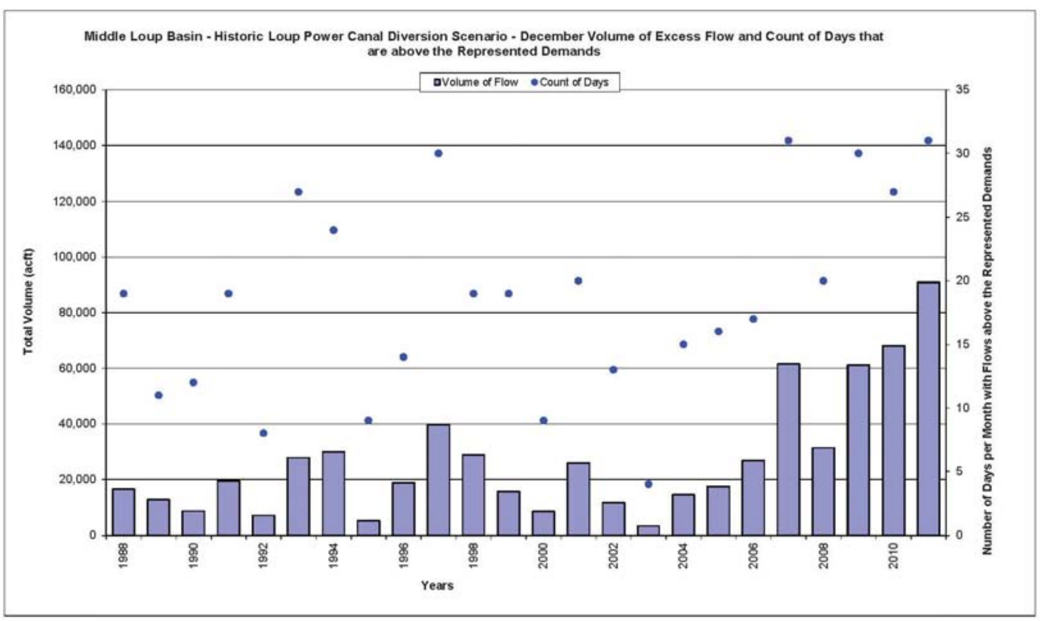


Figure A121: South Loup Subbasin, January Volume of Excess Flow and Count of Days that are above the Instream Demands as well as Historic Loup Hydropower Diversion

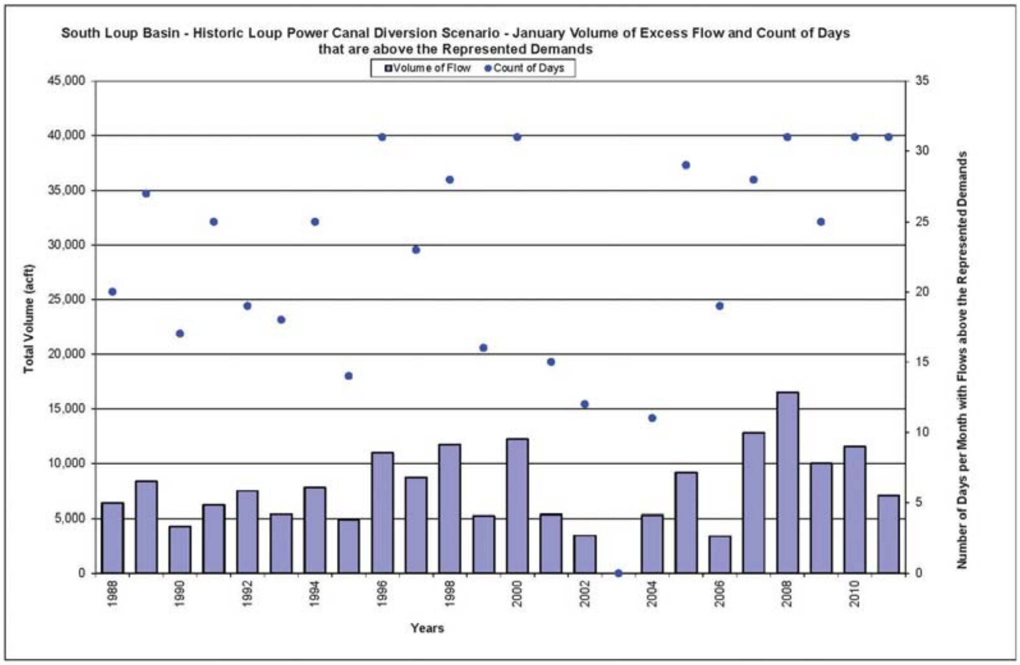


Figure A122: South Loup Subbasin, February Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

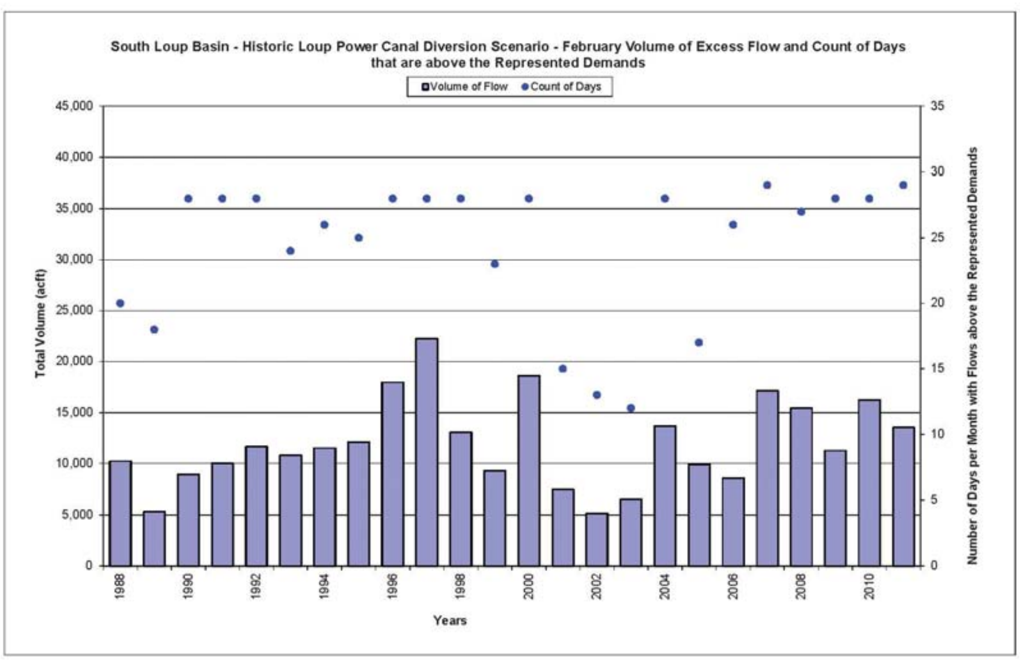


Figure A123: South Loup Subbasin,
March Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

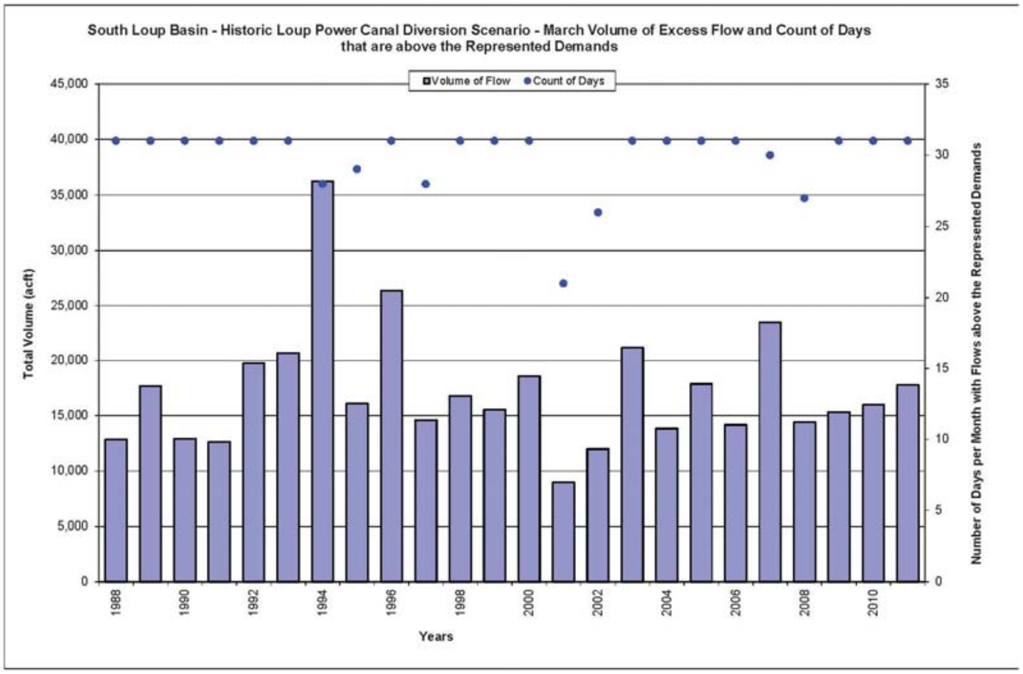


Figure A124: South Loup Subbasin,
April Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

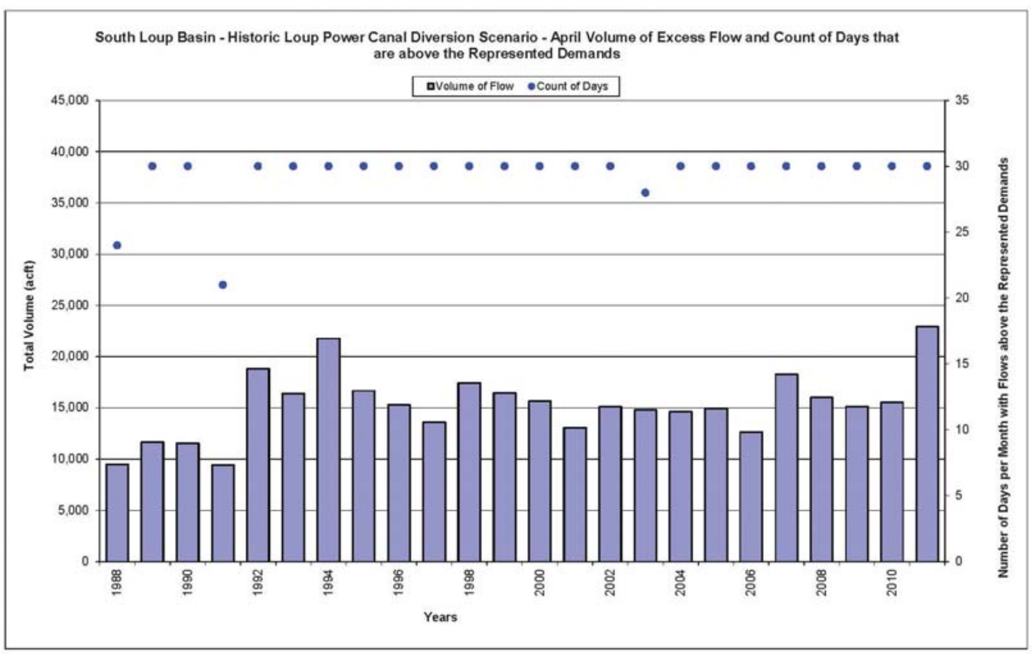


Figure A125: South Loup Subbasin,
May Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

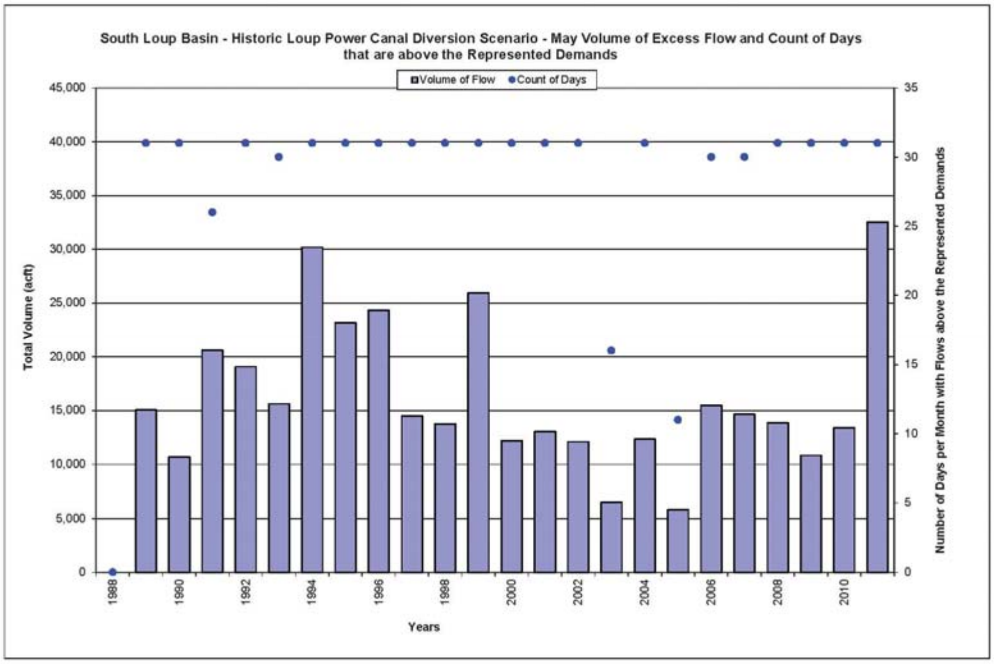


Figure A126: South Loup Subbasin,
June Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

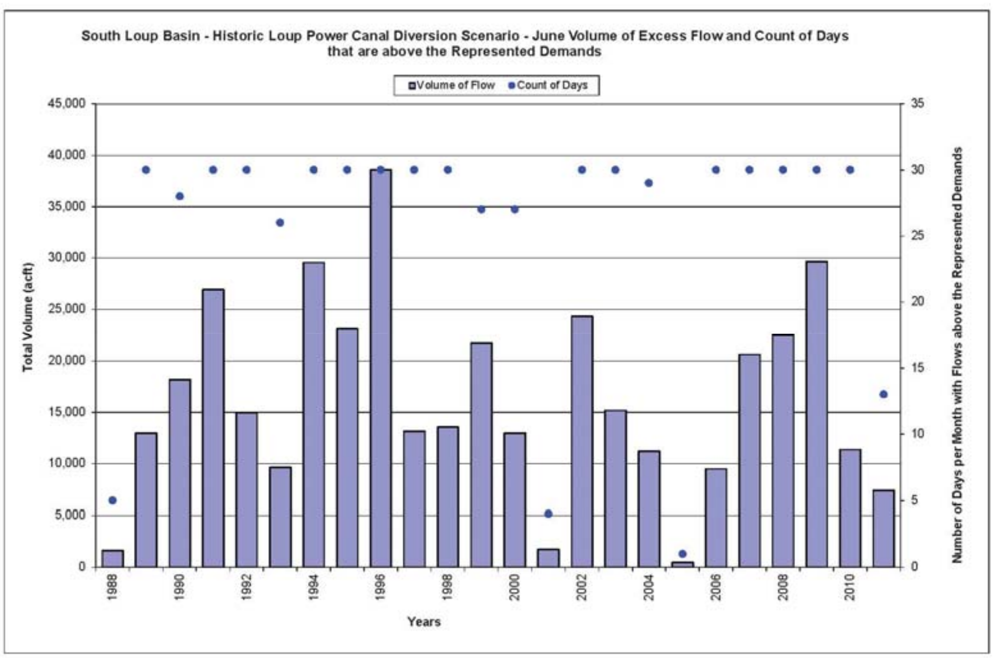


Figure A127: South Loup Subbasin, July Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

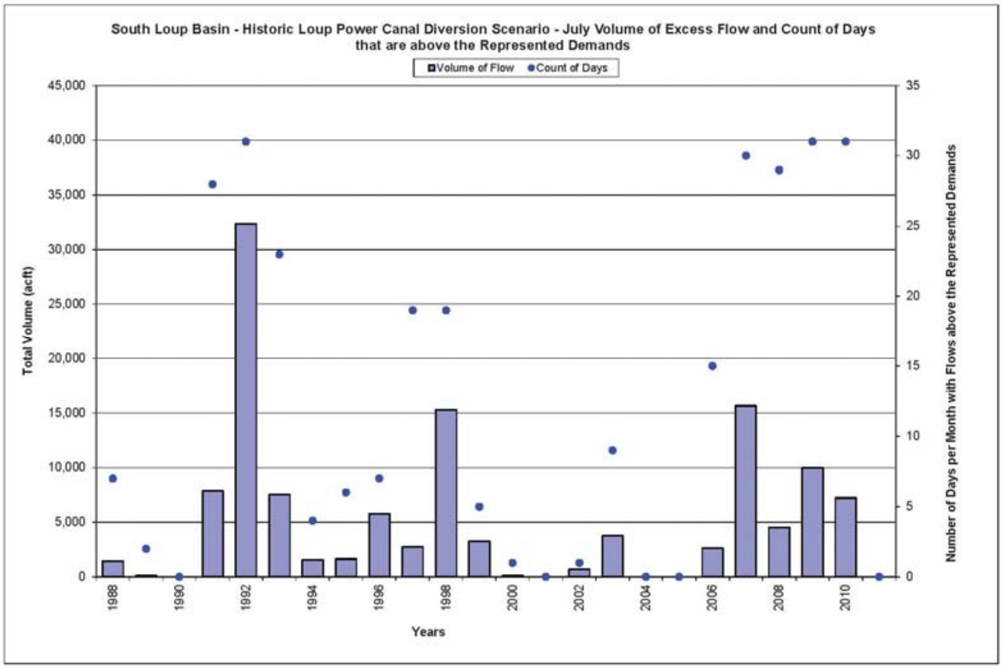


Figure A128: South Loup Subbasin, August Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

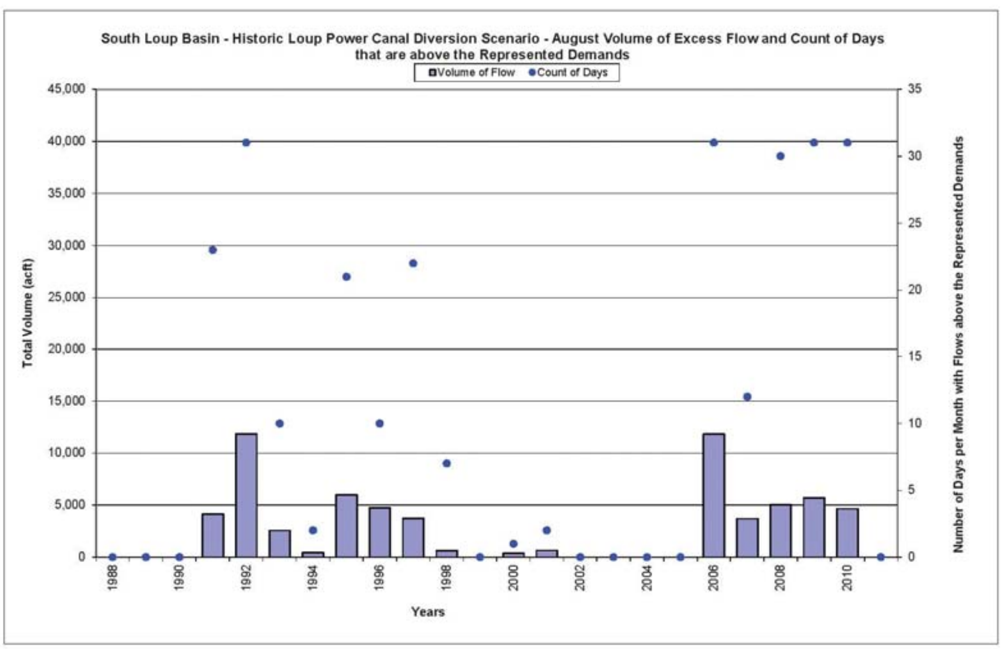


**Figure A129: South Loup Subbasin,
September Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion**

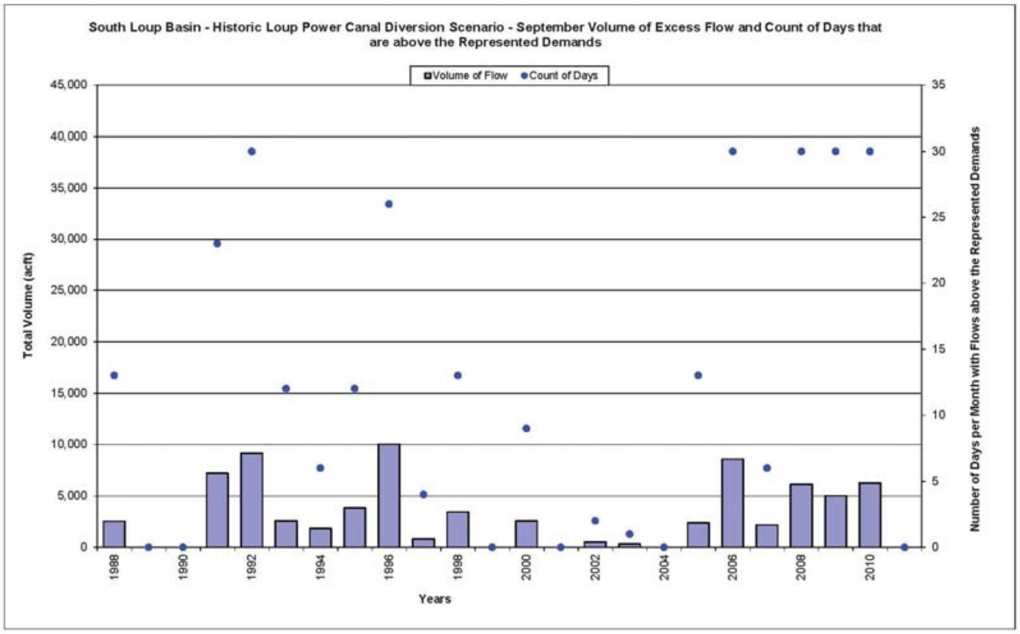


**Figure A130: South Loup Subbasin,
October Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion**

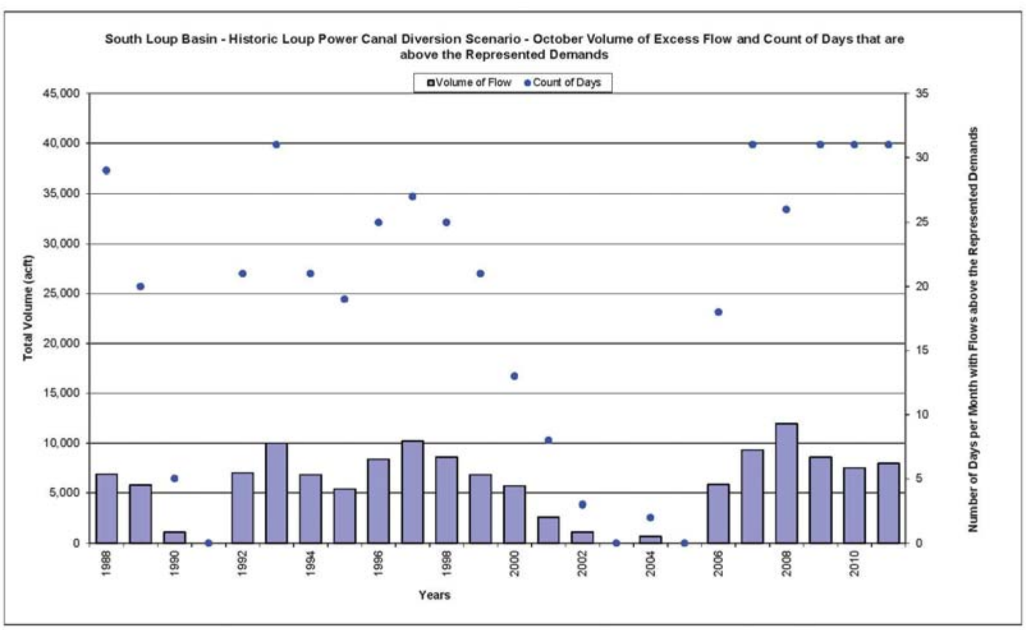


Figure A131: South Loup Subbasin,
November Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

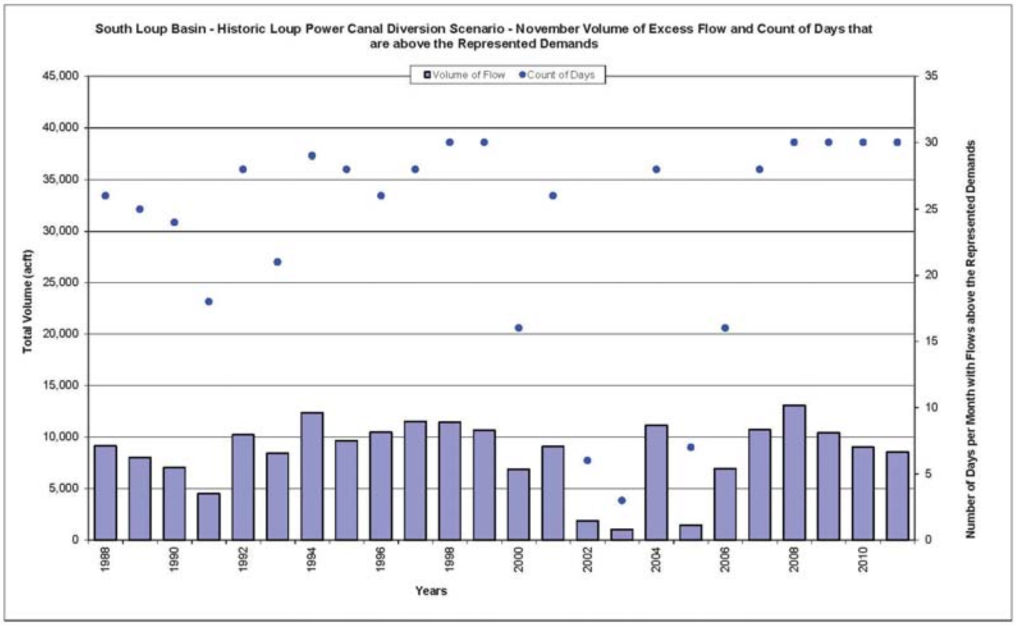


Figure A132: South Loup Subbasin,
December Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

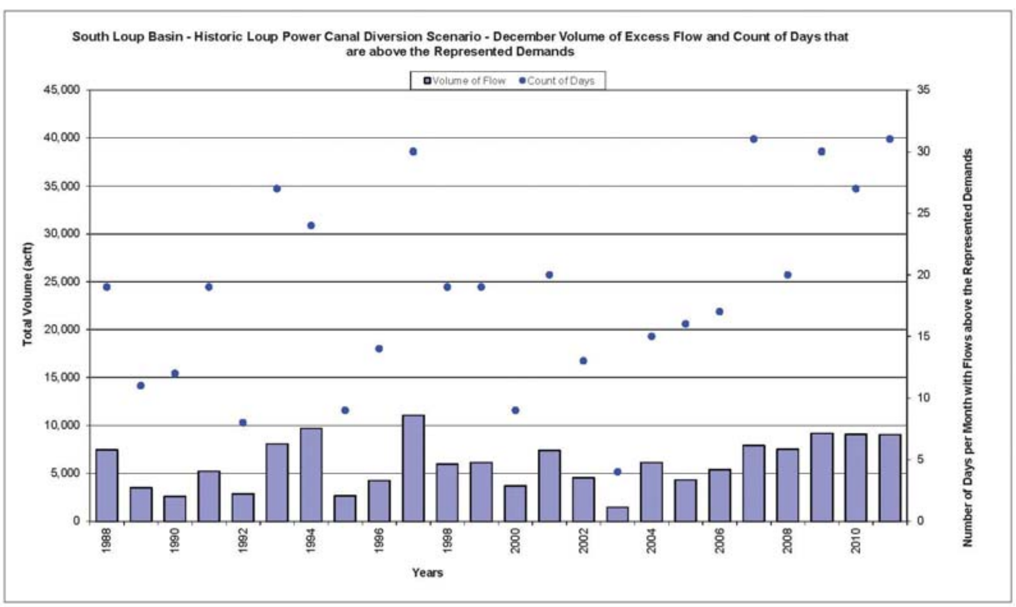


Figure A133: North Loup Subbasin,
January Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

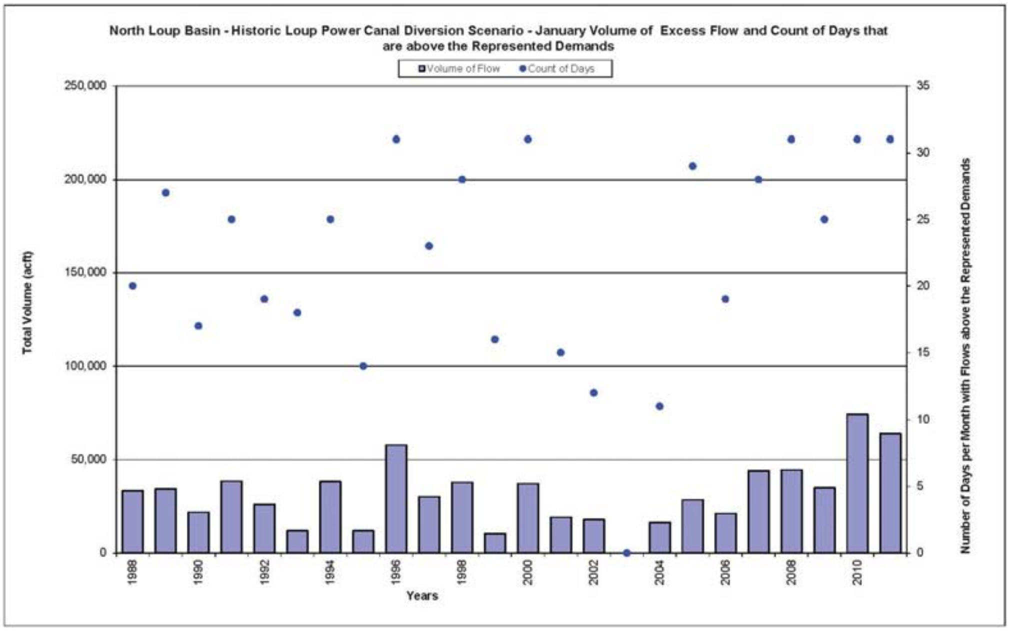


Figure A134: North Loup Subbasin,
February Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

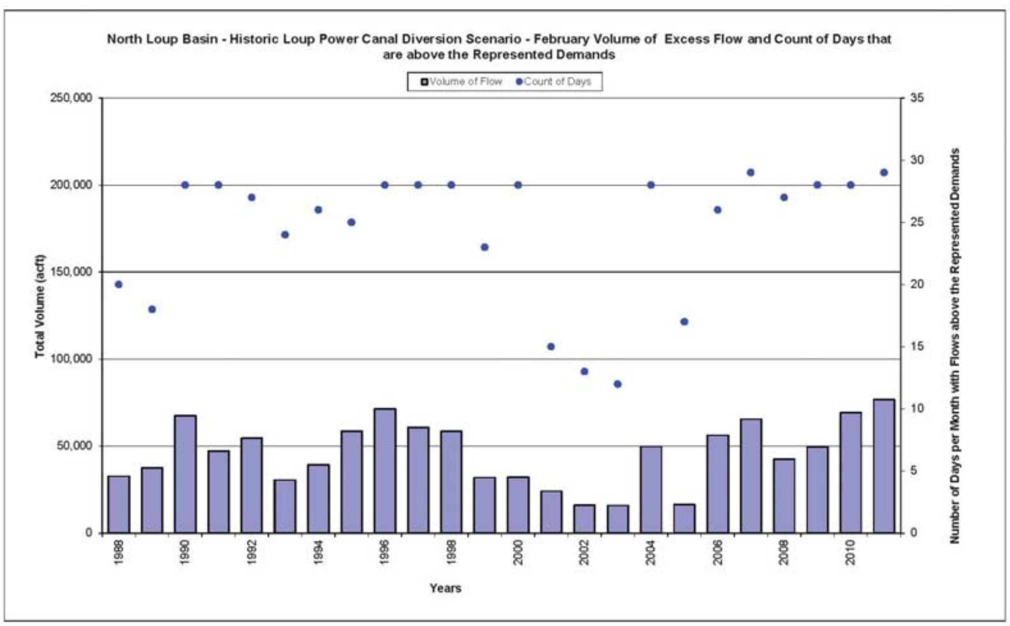


Figure A135: North Loup Subbasin,
March Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

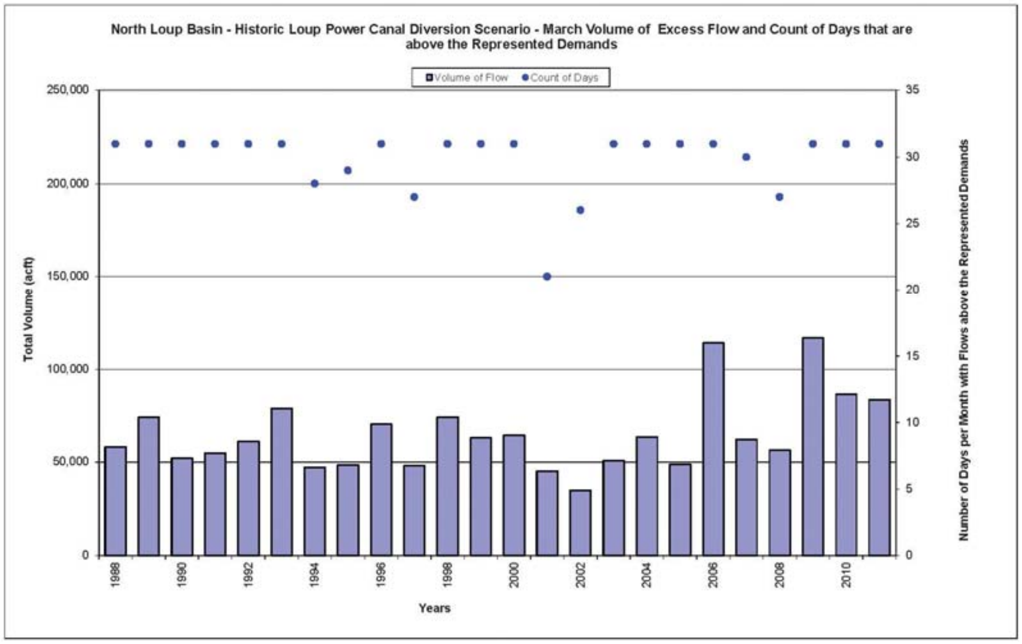


Figure A136: North Loup Subbasin,
April Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

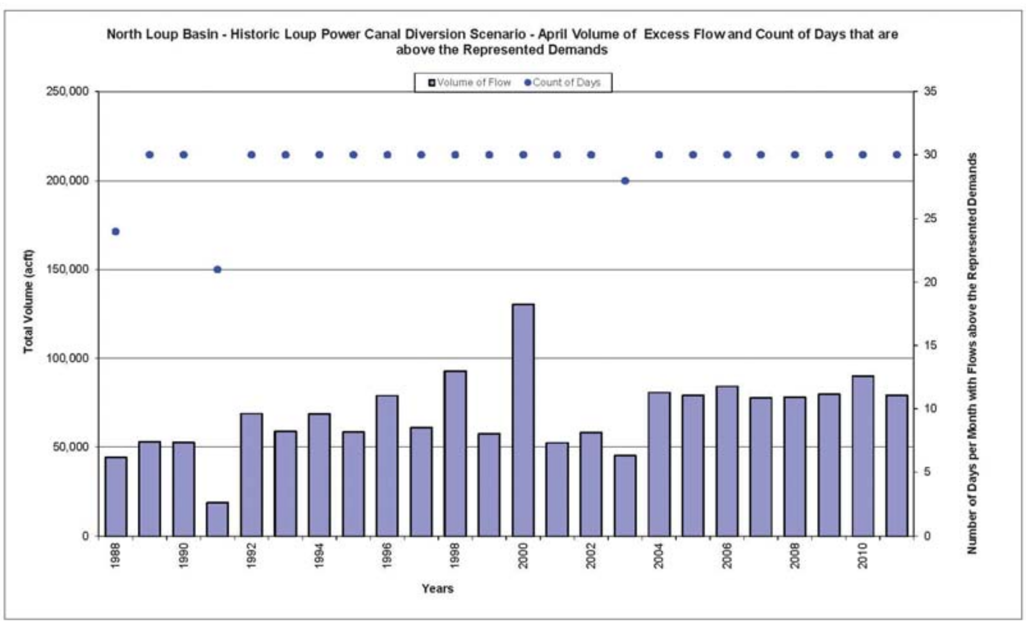


Figure A137: North Loup Subbasin,
May Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

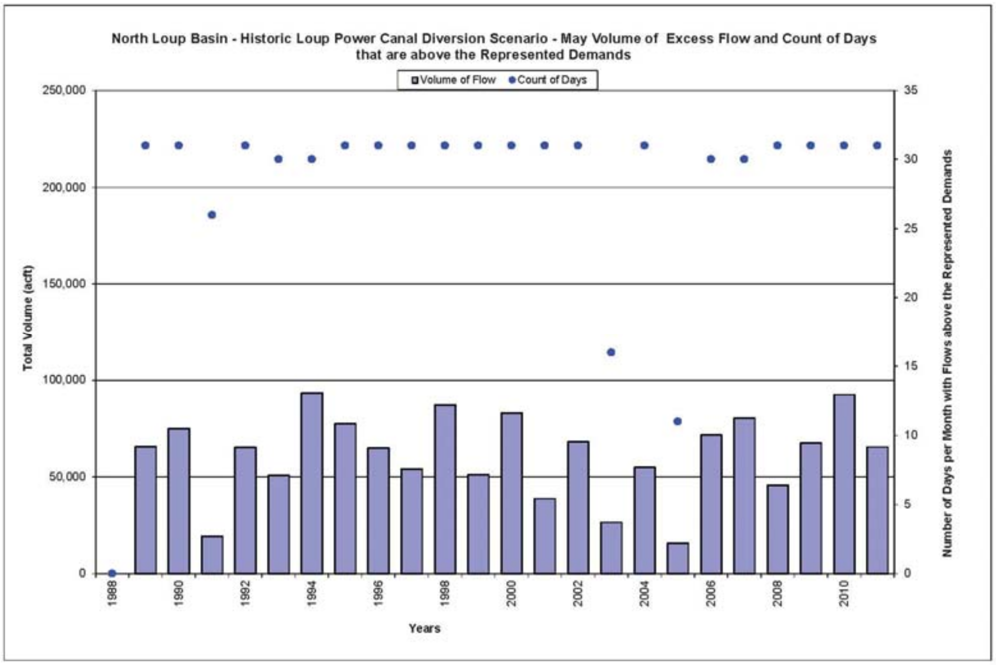


Figure A138: North Loup Subbasin,
June Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

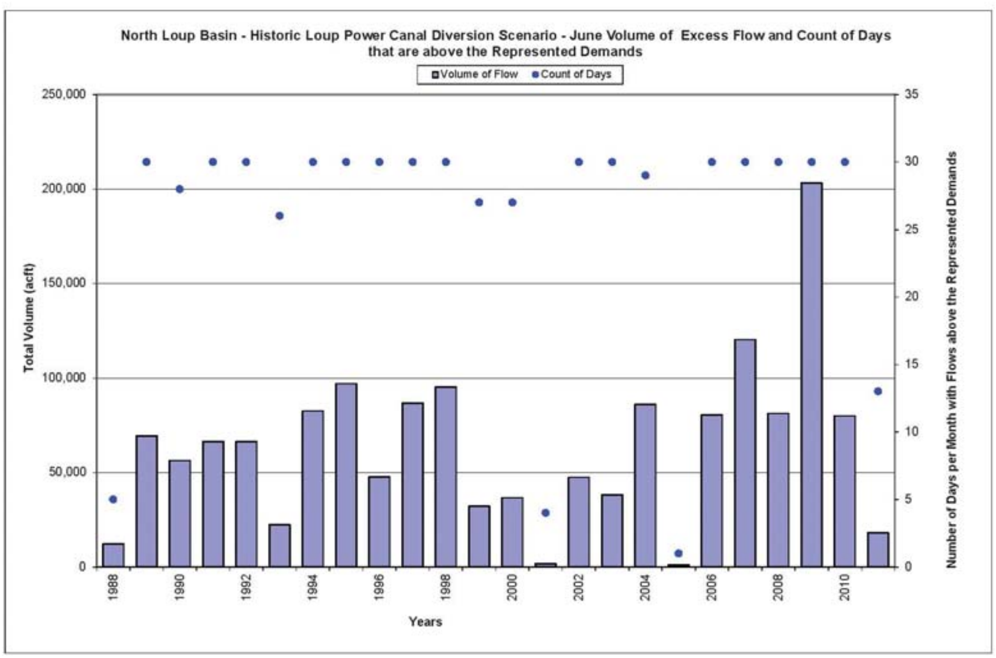


**Figure A139: North Loup Subbasin,
July Volume of Excess Flow and Count of Days that are above the Instream Flow Demands
as well as Historic Loup Hydropower Diversion**

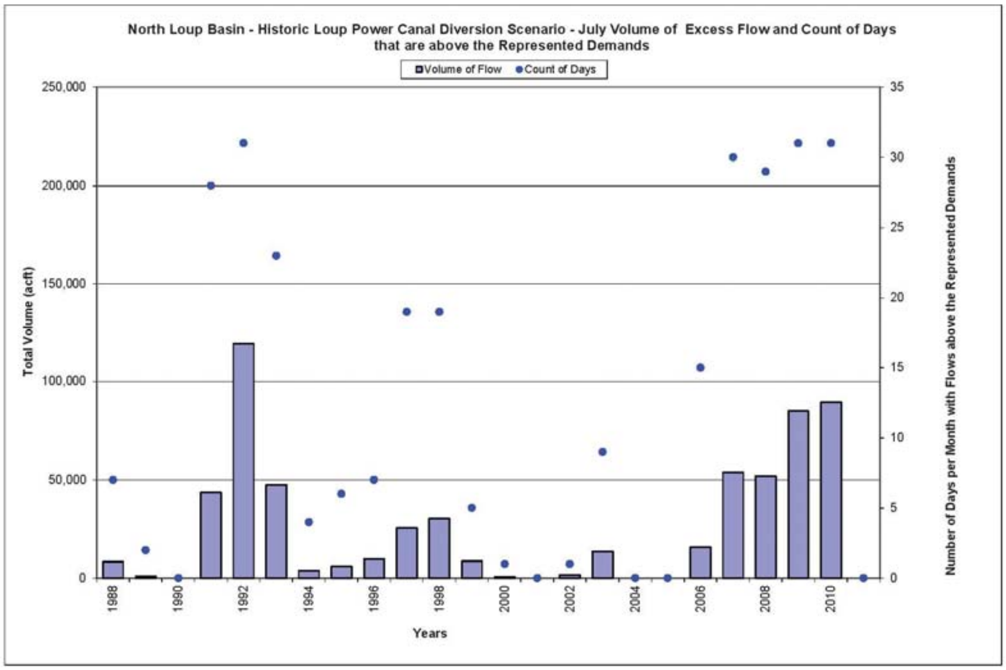


**Figure A140: North Loup Subbasin,
August Volume of Excess Flow and Count of Days that are above the Instream Flow Demands
as well as Historic Loup Hydropower Diversion**

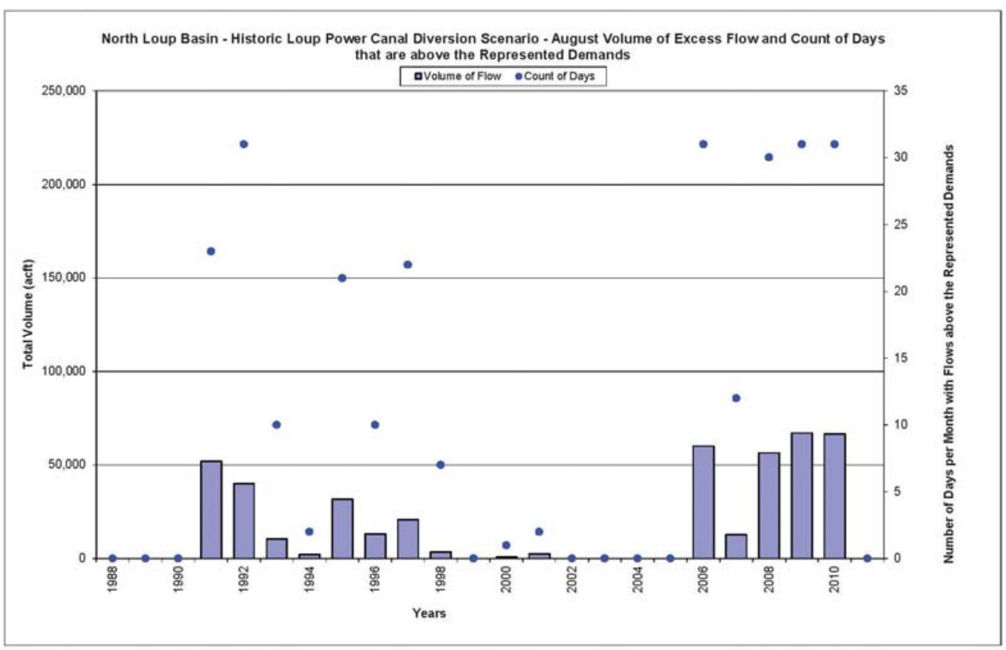


Figure A141: North Loup Subbasin, September Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

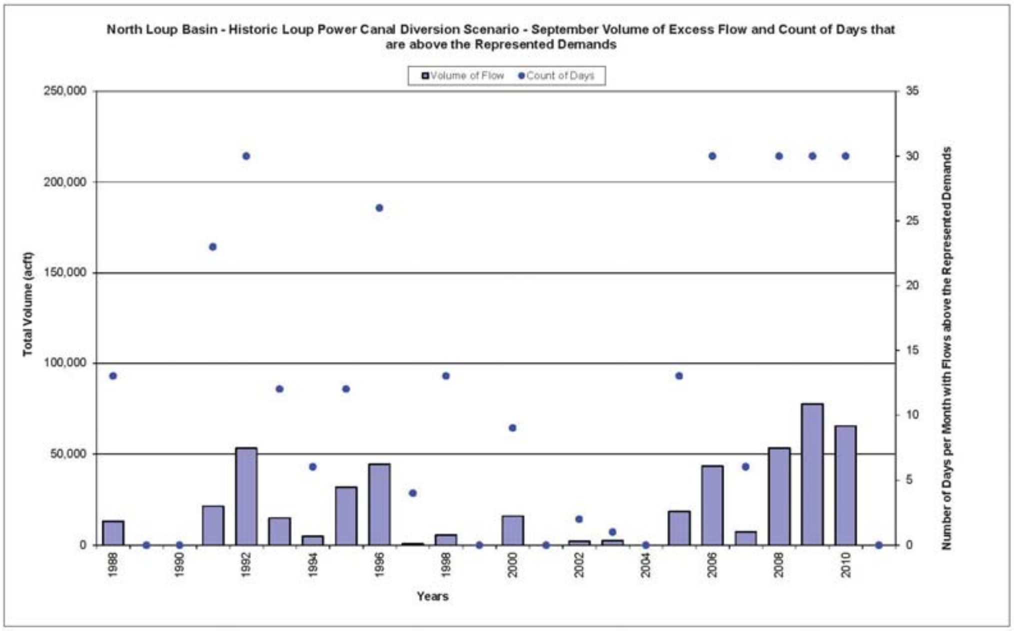


Figure A142: North Loup Subbasin, October Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

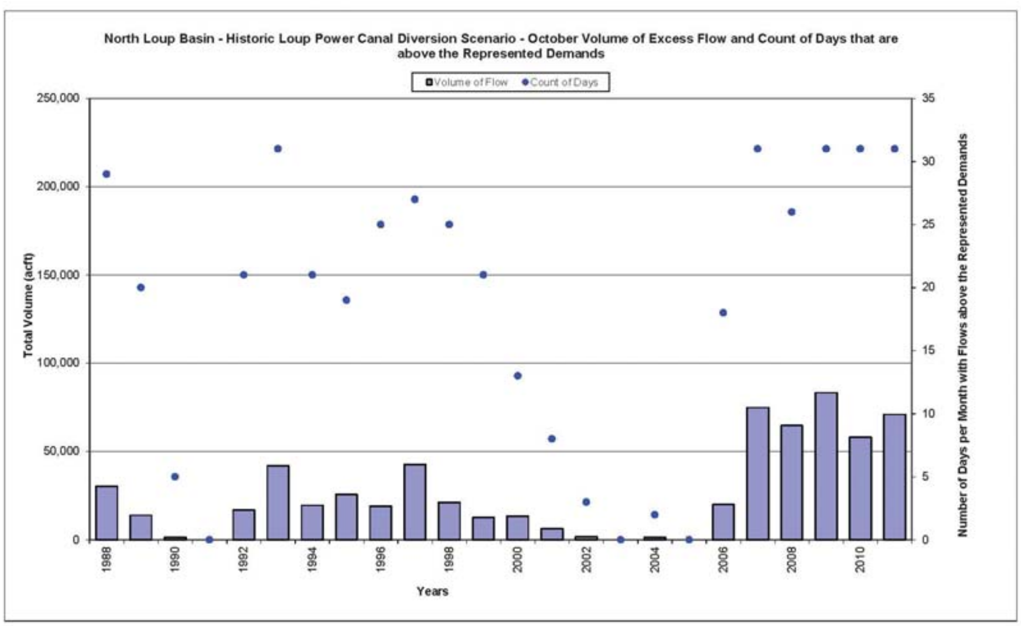


Figure A143: North Loup Subbasin,
November Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

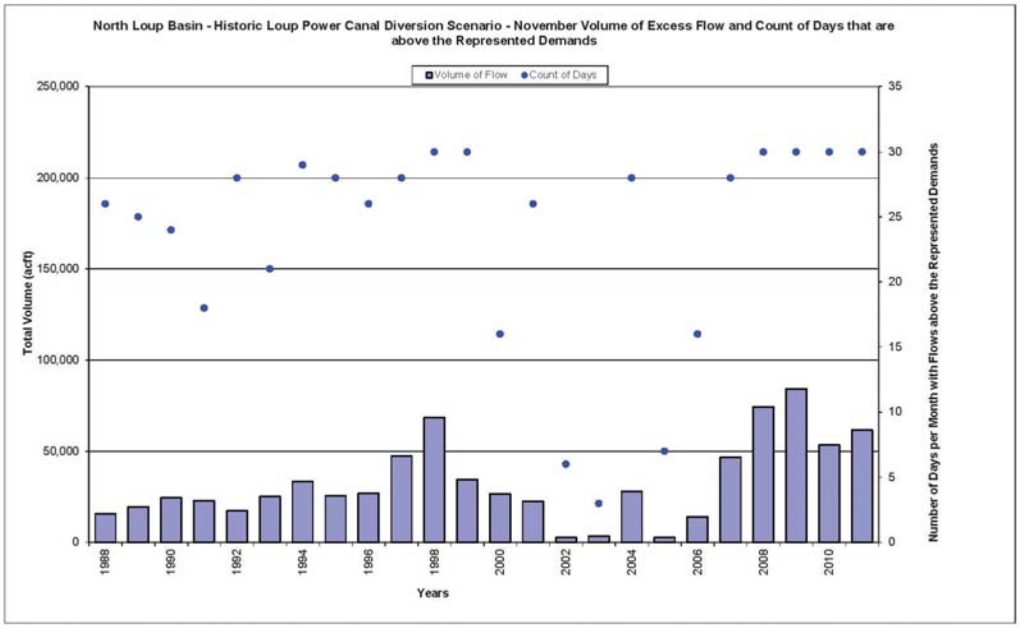


Figure A144: North Loup Subbasin,
December Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Historic Loup Hydropower Diversion

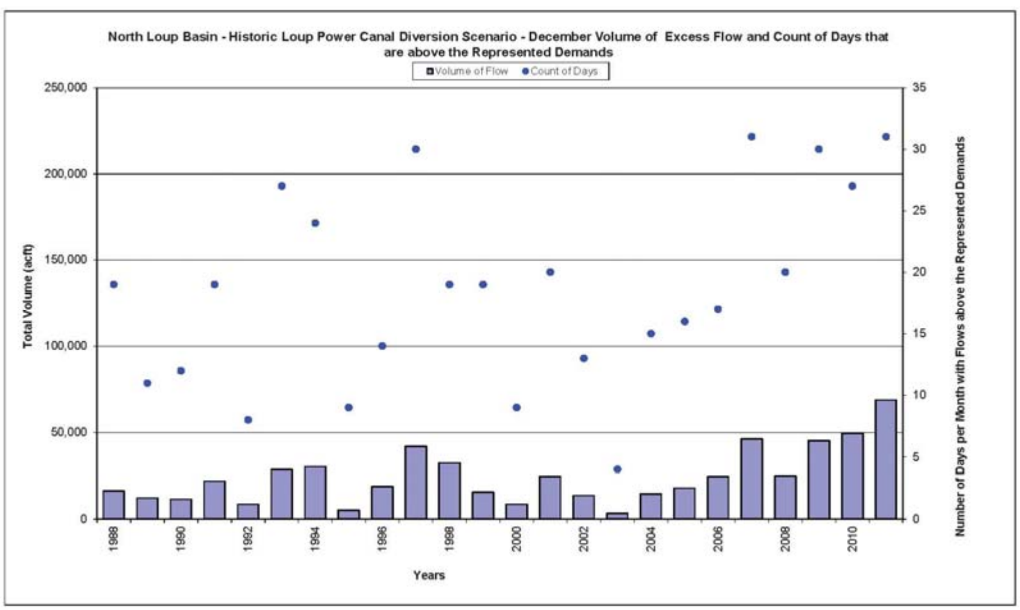


Figure A145: Lower Loup Subbasin,
January Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

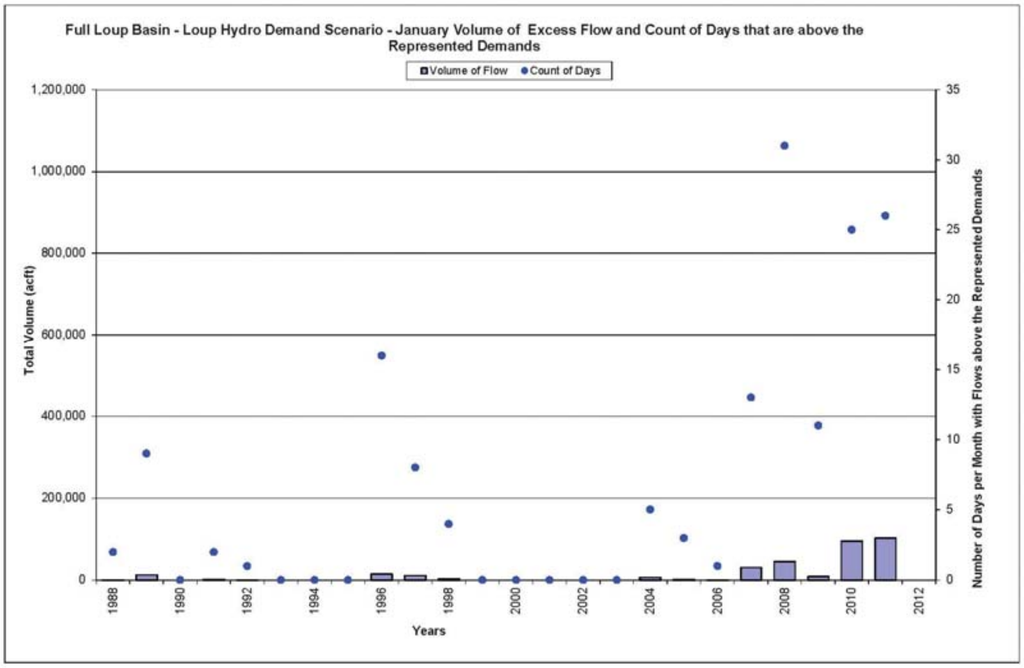


Figure A146: Lower Loup Subbasin,
February Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

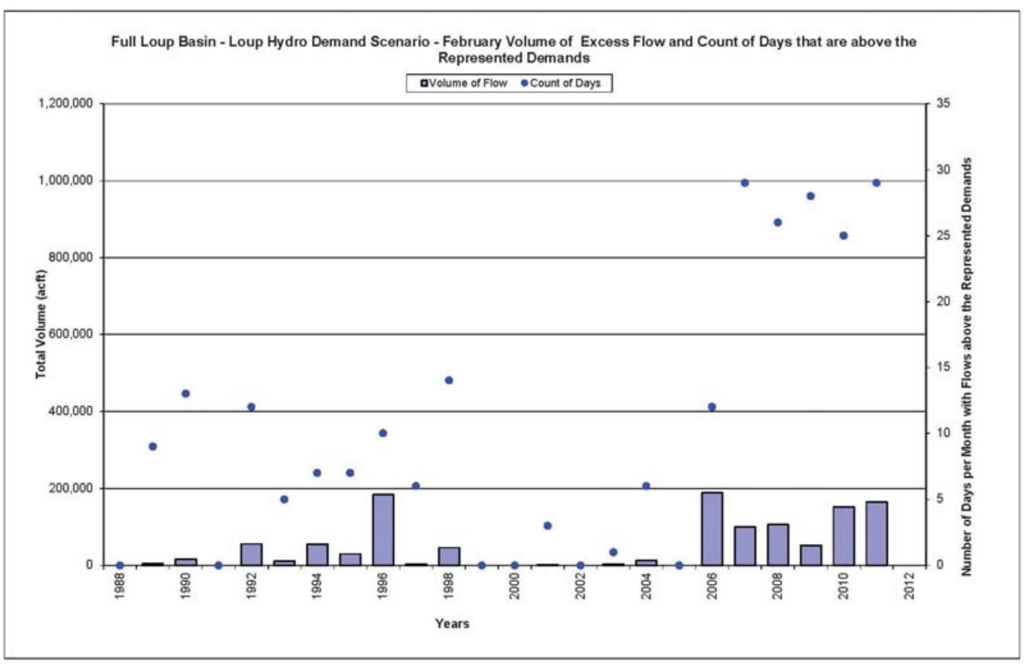


**Figure A147: Lower Loup Subbasin,
March Volume of Excess Flow and Count of Days that are above the Instream Flow Demands
as well as Full Loup Hydropower Demand**

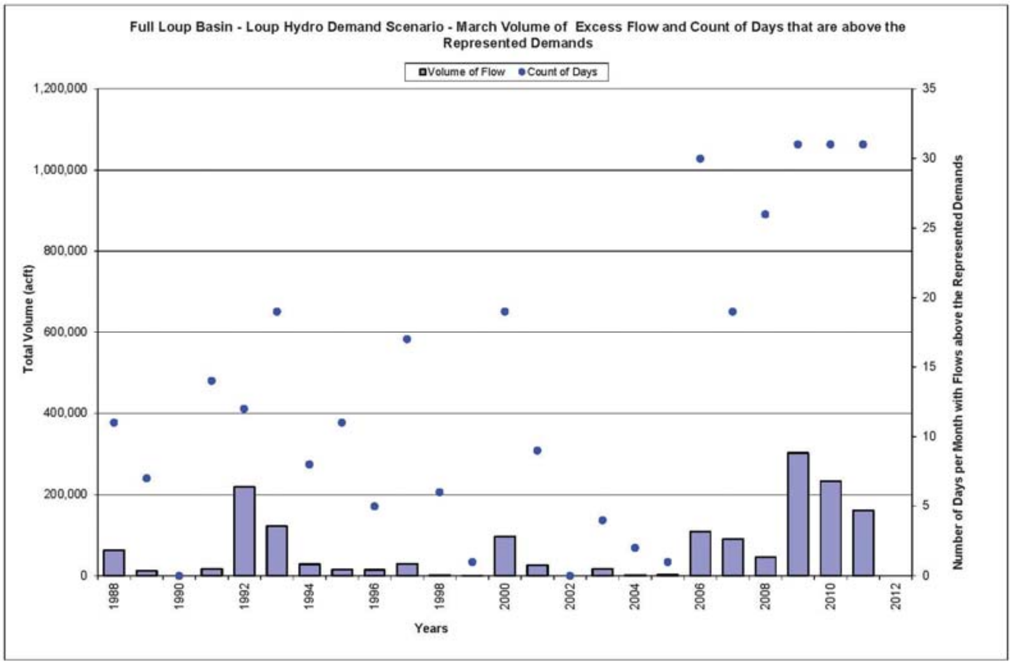


**Figure A148: Lower Loup Subbasin,
April Volume of Excess Flow and Count of Days that are above the Instream Flow Demands
as well as Full Loup Hydropower Demand**

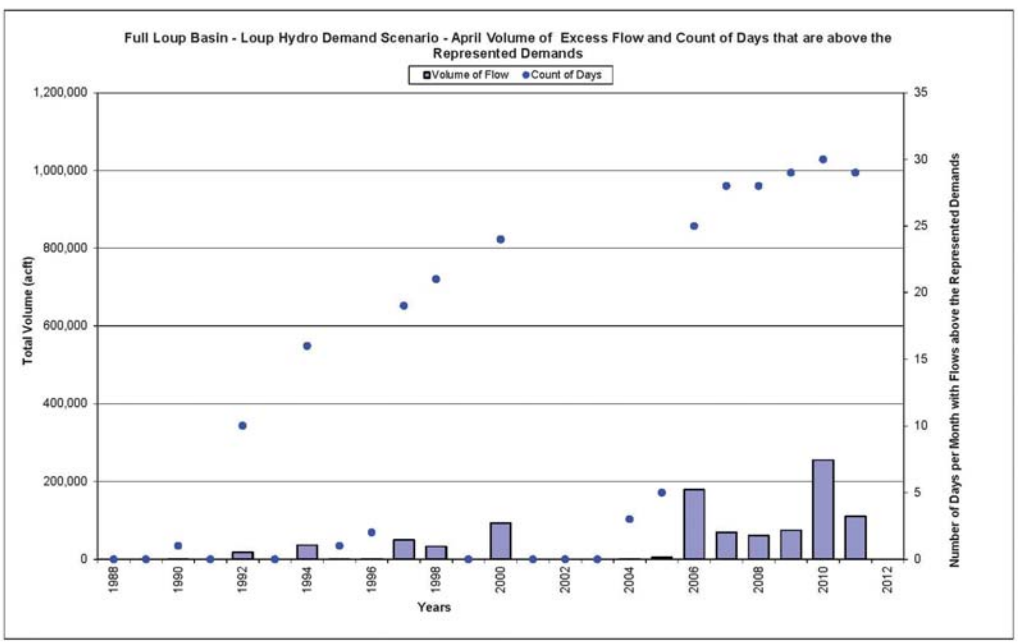


Figure A149: Lower Loup Subbasin,
May Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

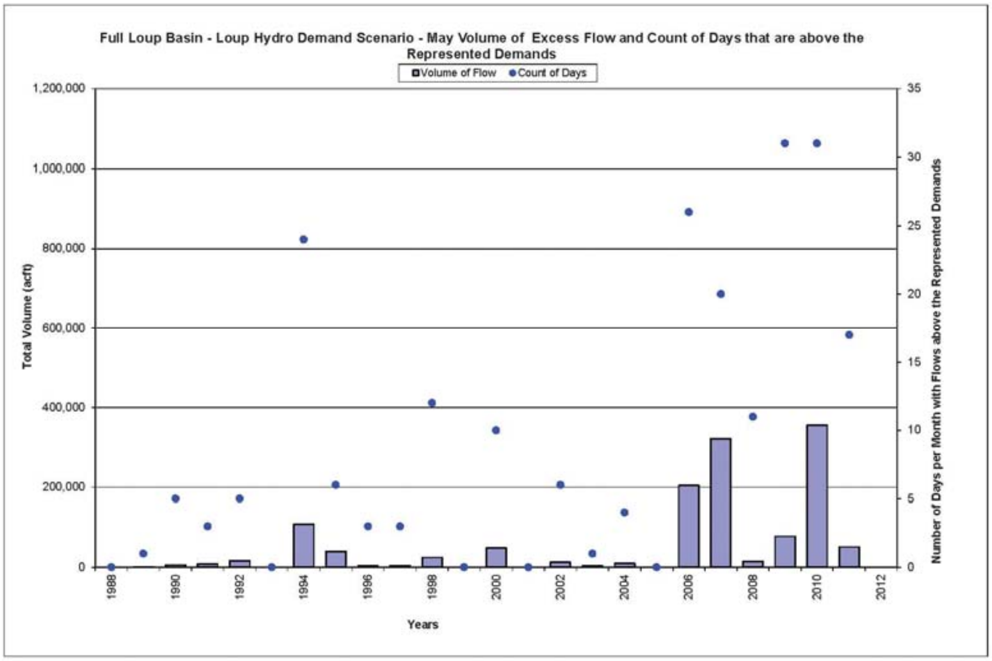


Figure A150: Lower Loup Subbasin,
June Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

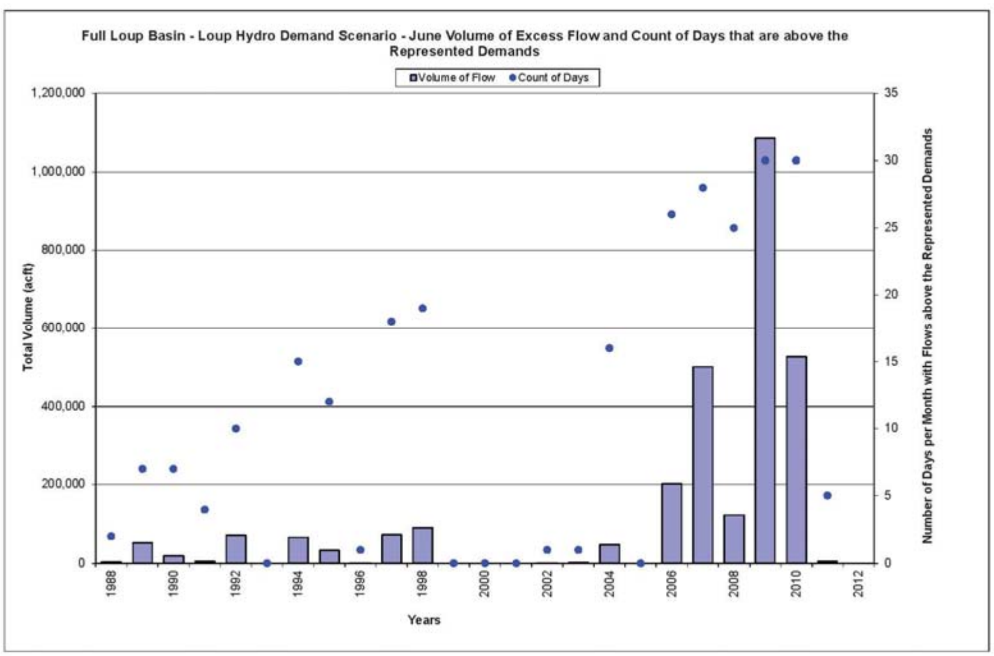


Figure A151: Lower Loup Subbasin,
July Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

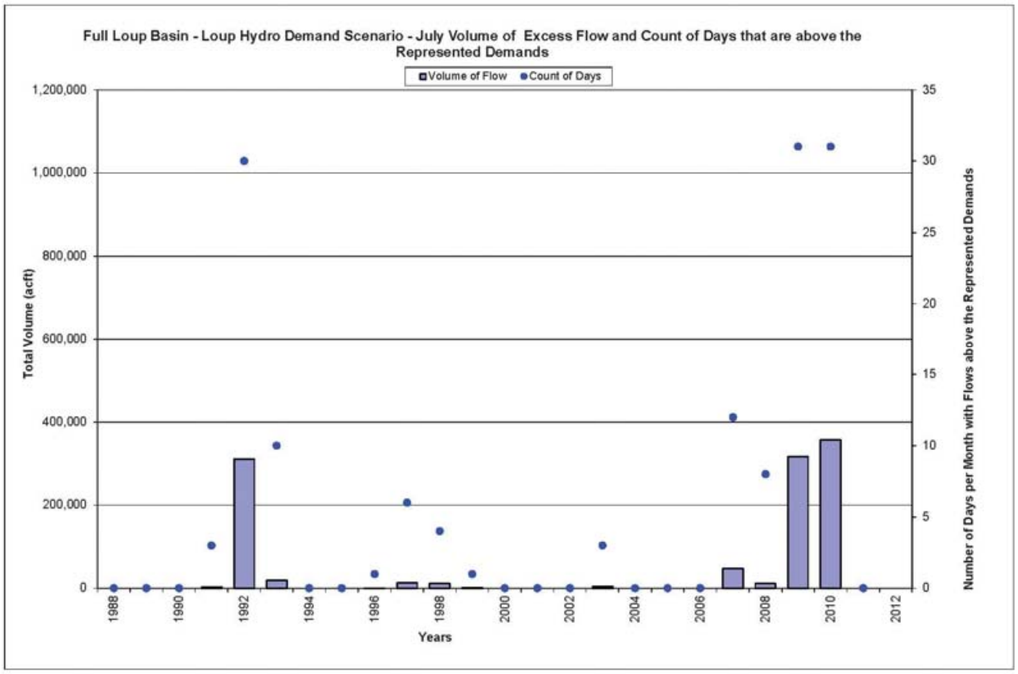


Figure A152: Lower Loup Subbasin,
August Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

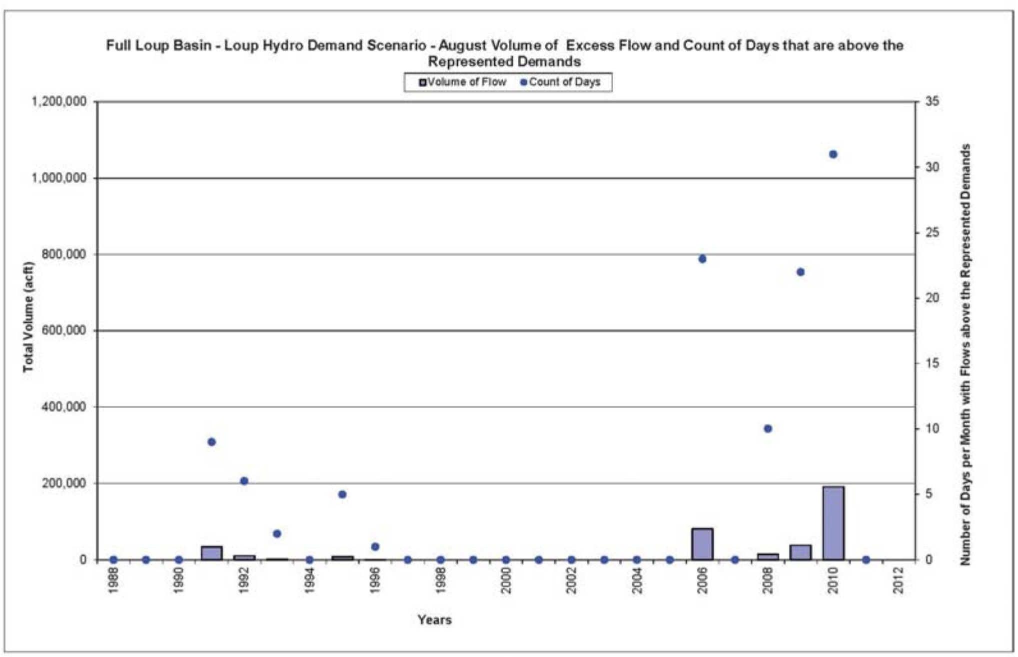


Figure A153: Lower Loup Subbasin,
September Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

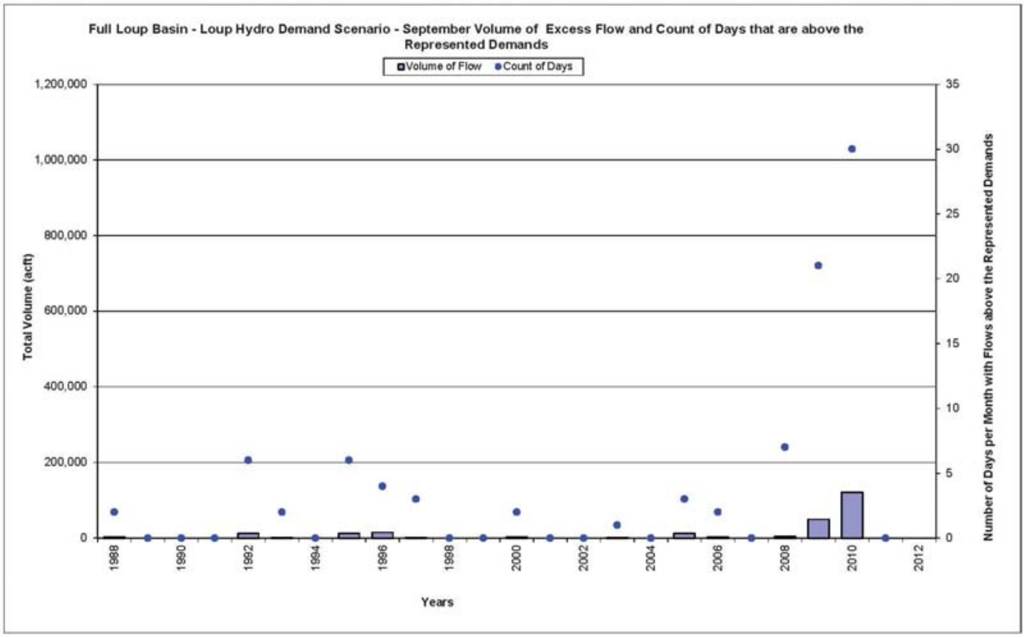


Figure A154: Lower Loup Subbasin,
October Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

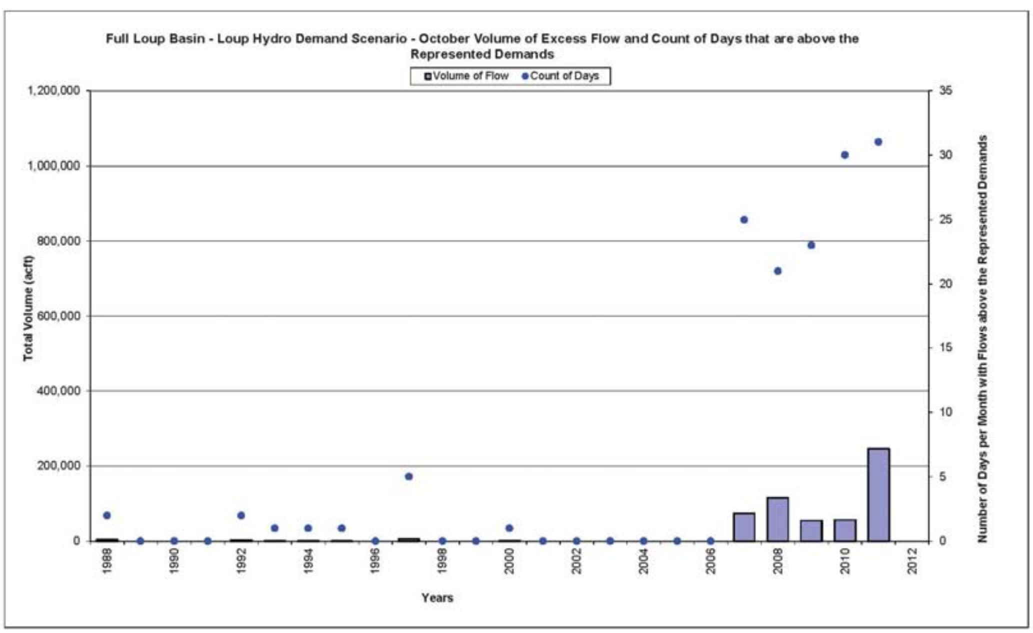


Figure A155: Lower Loup Subbasin,
November Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

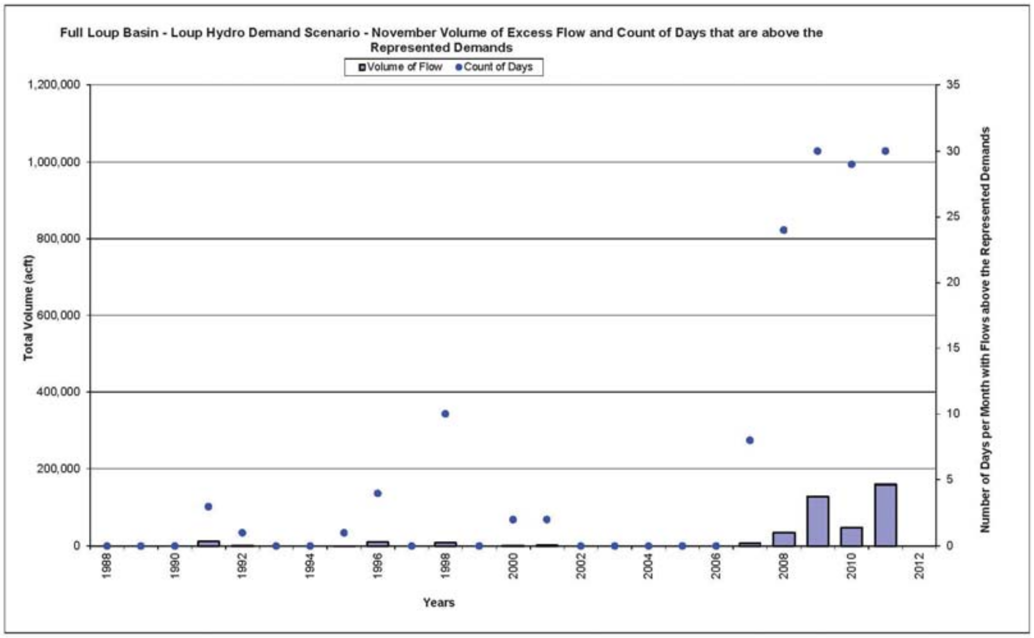


Figure A156: Lower Loup Subbasin,
December Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

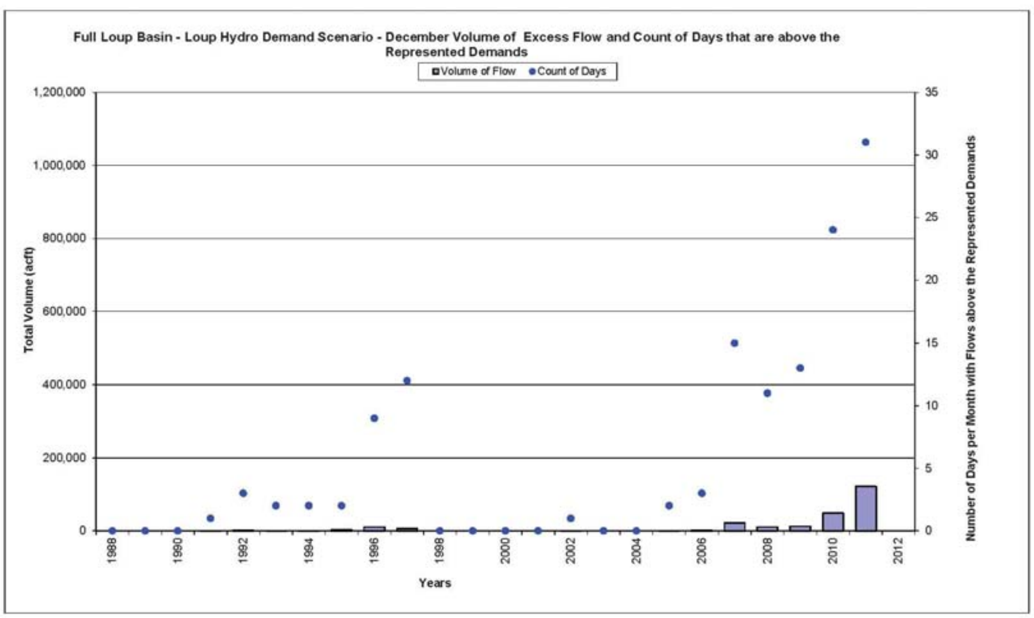


Figure A157: Middle Loup Subbasin,
January Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

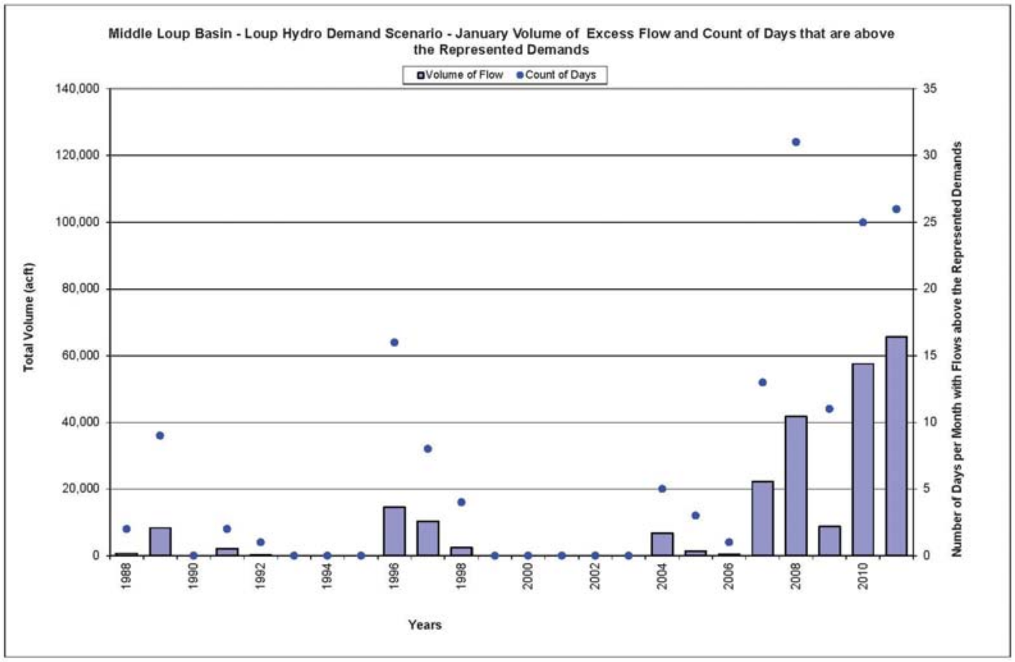


Figure A158: Middle Loup Subbasin,
February Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

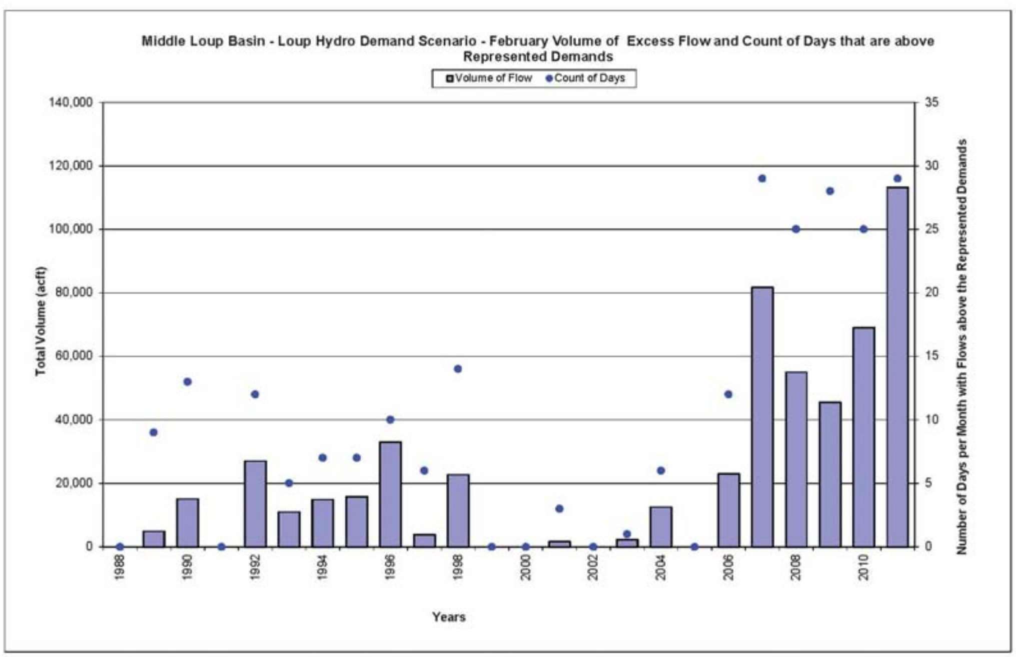


Figure A159: Middle Loup Subbasin,
March Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

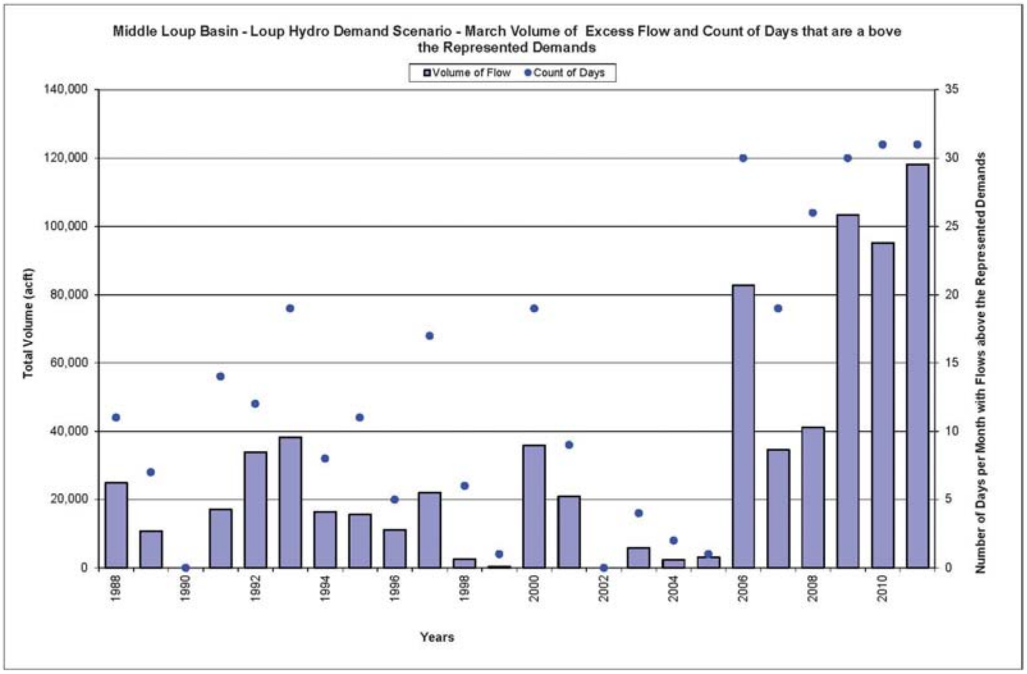


Figure A160: Middle Loup Subbasin,
April Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

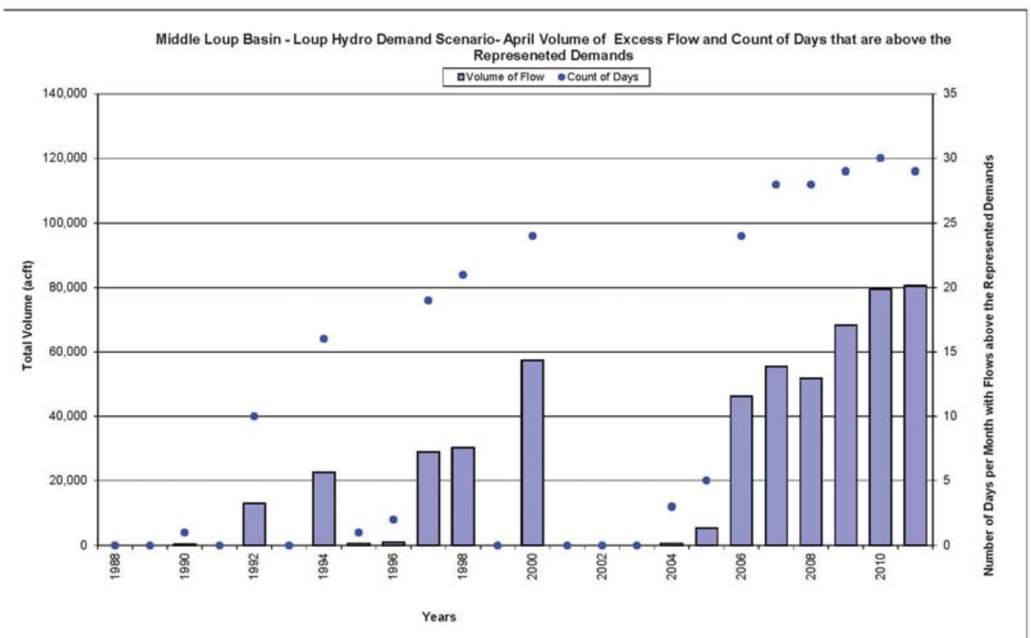


**Figure A161: Middle Loup Subbasin,
May Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand**

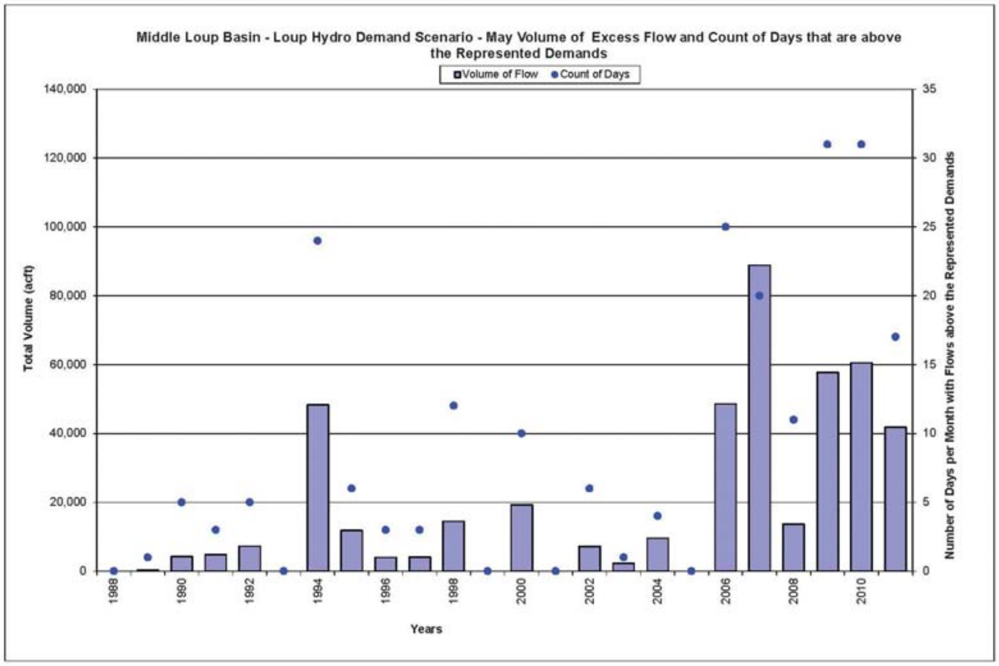


**Figure A162: Middle Loup Subbasin,
June Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand**

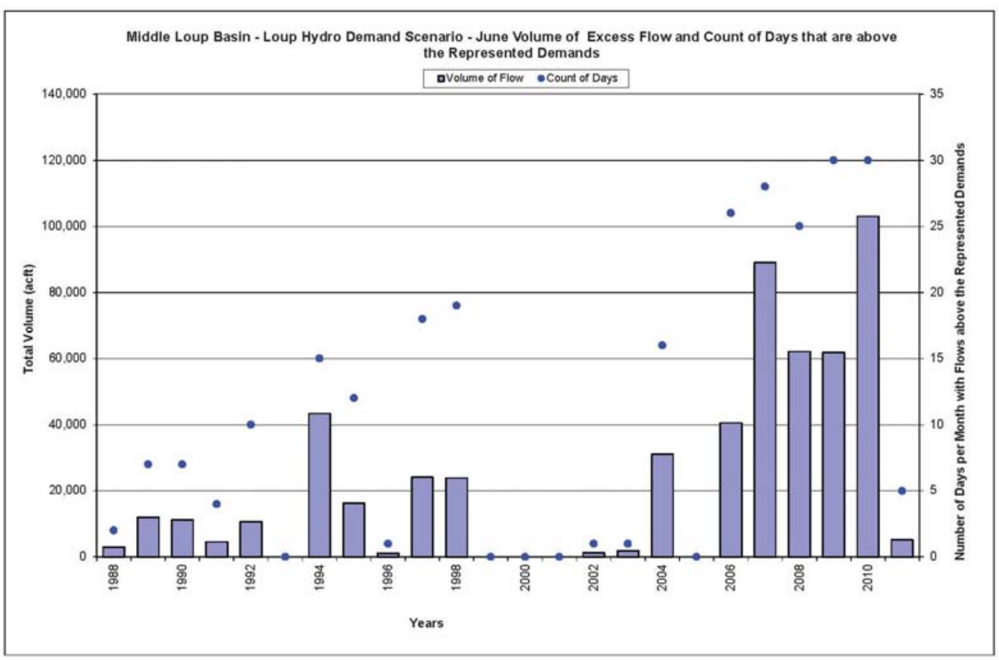


Figure A163: Middle Loup Subbasin,
July Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

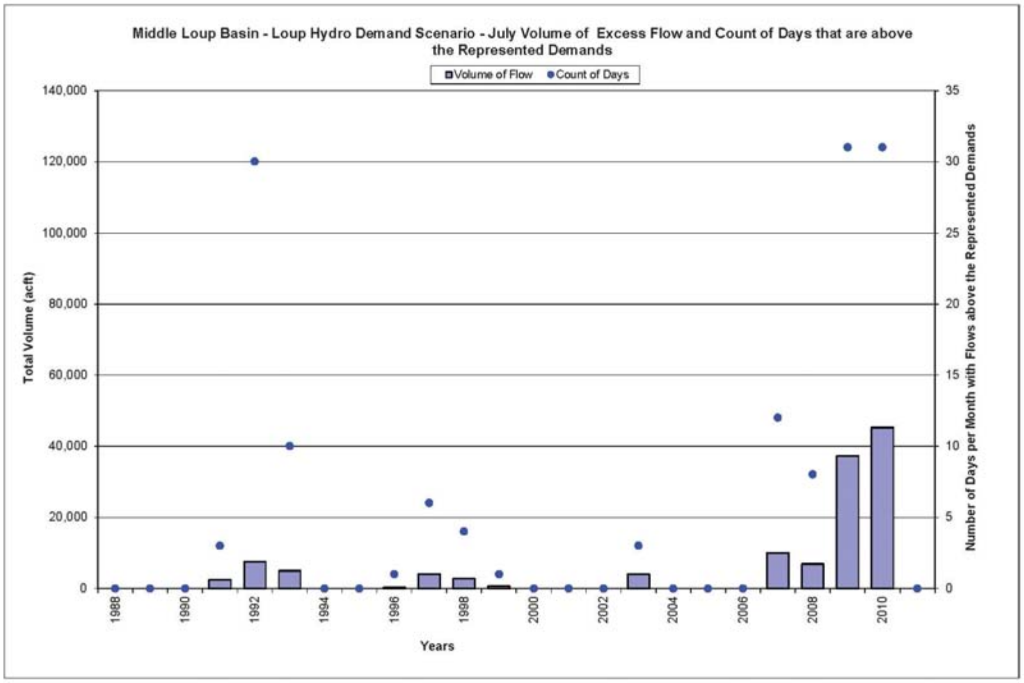


Figure A164: Middle Loup Subbasin,
August Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

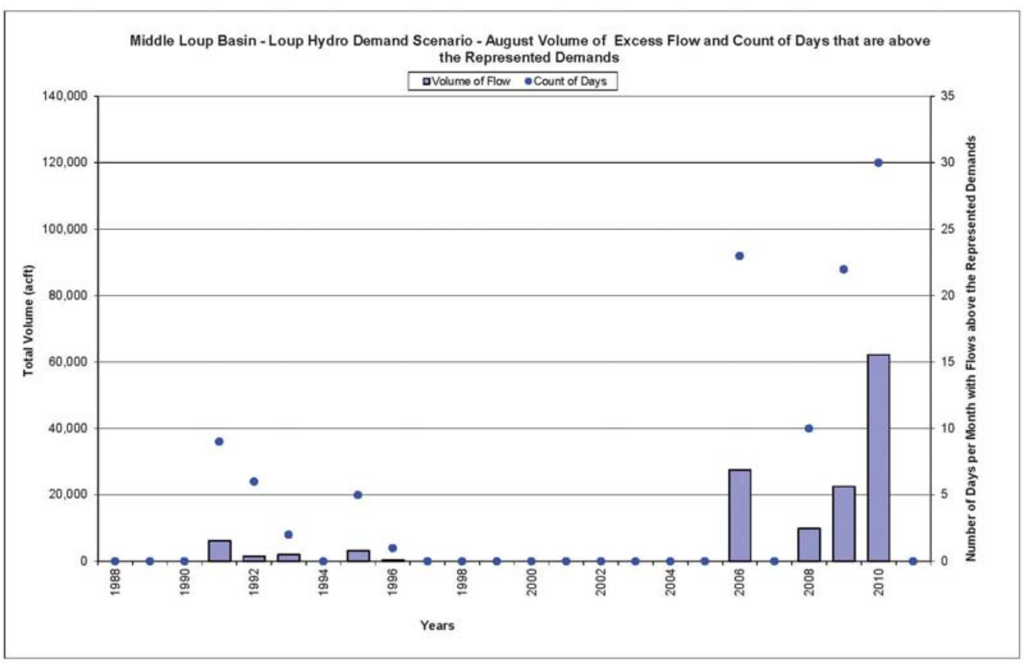


Figure A165: Middle Loup Subbasin, September Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

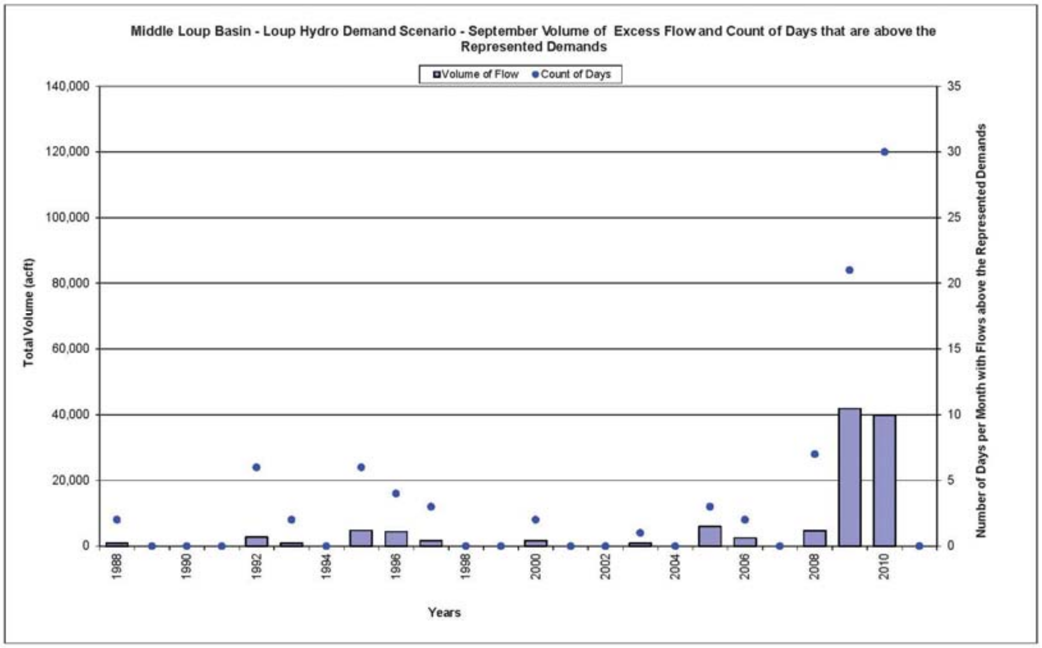


Figure A166: Middle Loup Subbasin, October Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

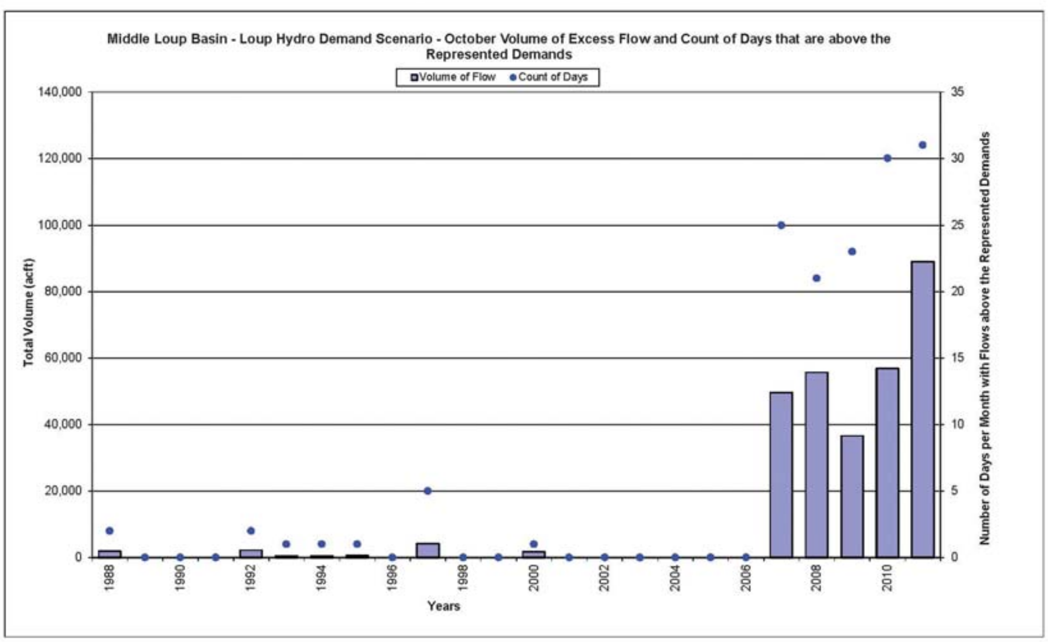


Figure A167: Middle Loup Subbasin,
November Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

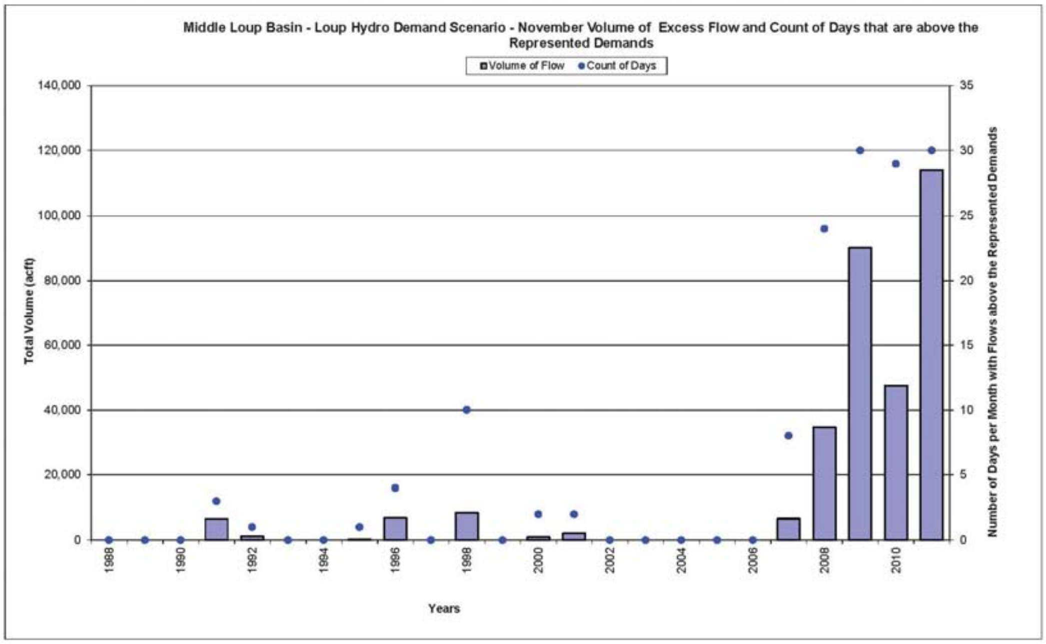


Figure A168: Middle Loup Subbasin,
December Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

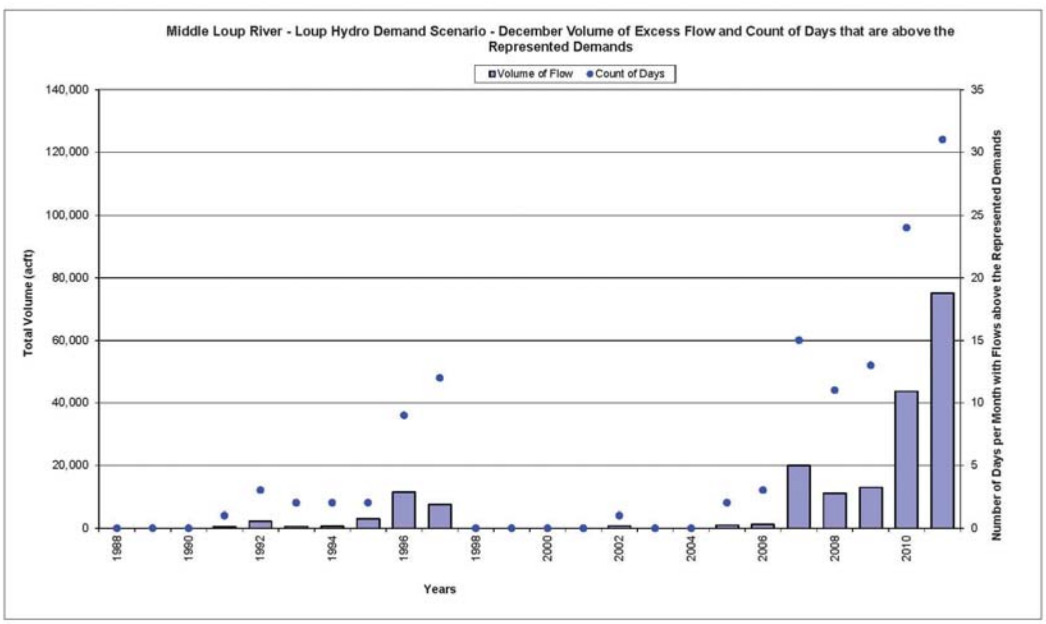


Figure A169: South Loup Subbasin, January Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

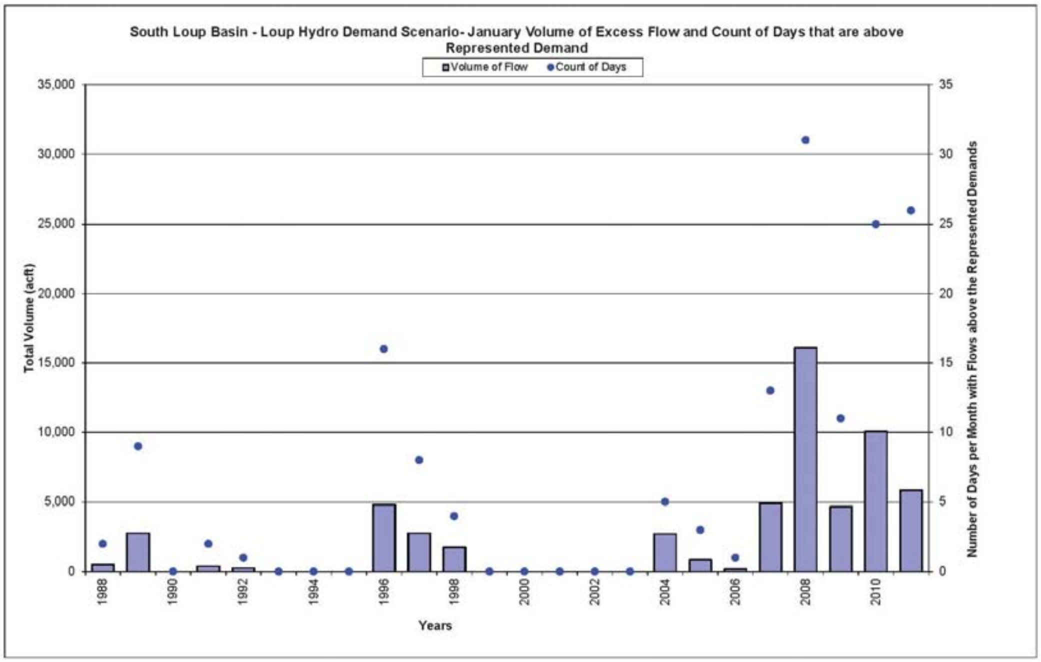


Figure A170: South Loup Subbasin, February Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

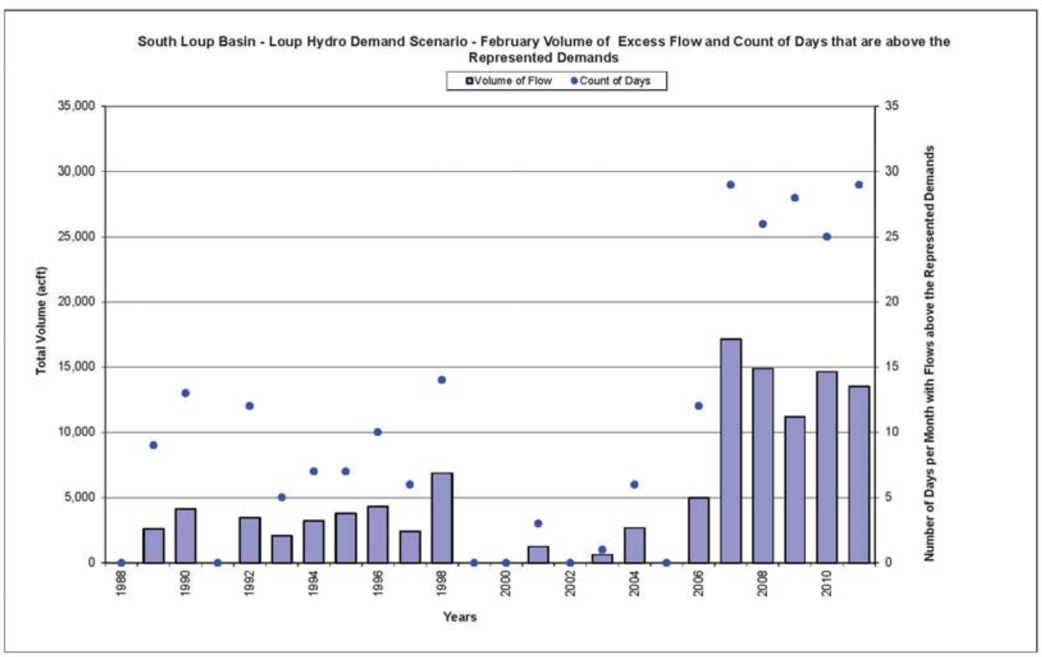


Figure A171: South Loup Subbasin,
March Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

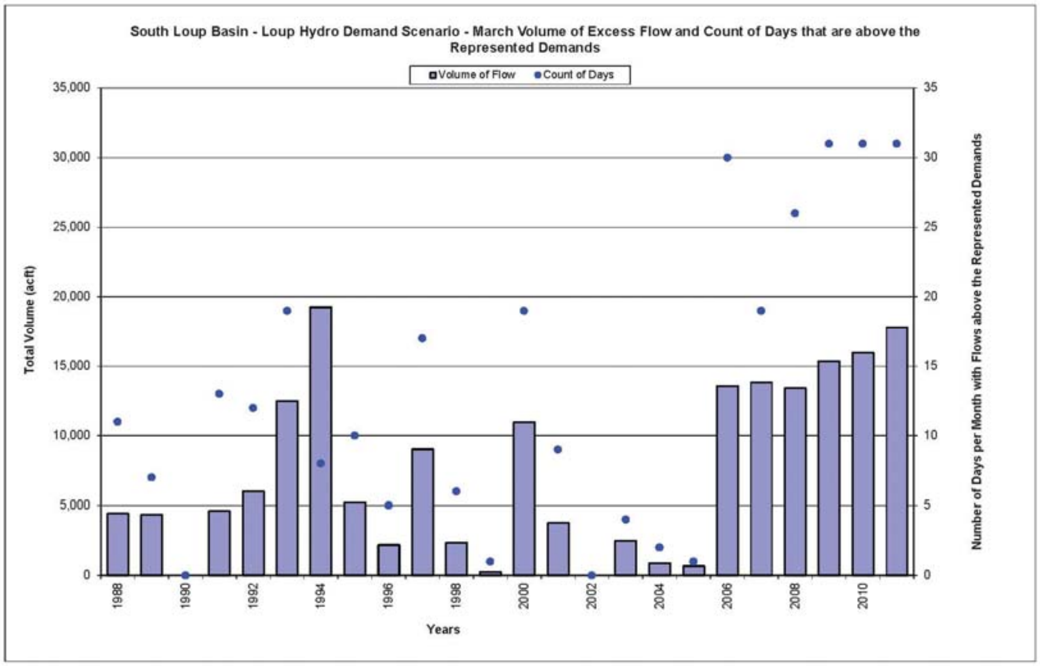


Figure A172: South Loup Subbasin,
April Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

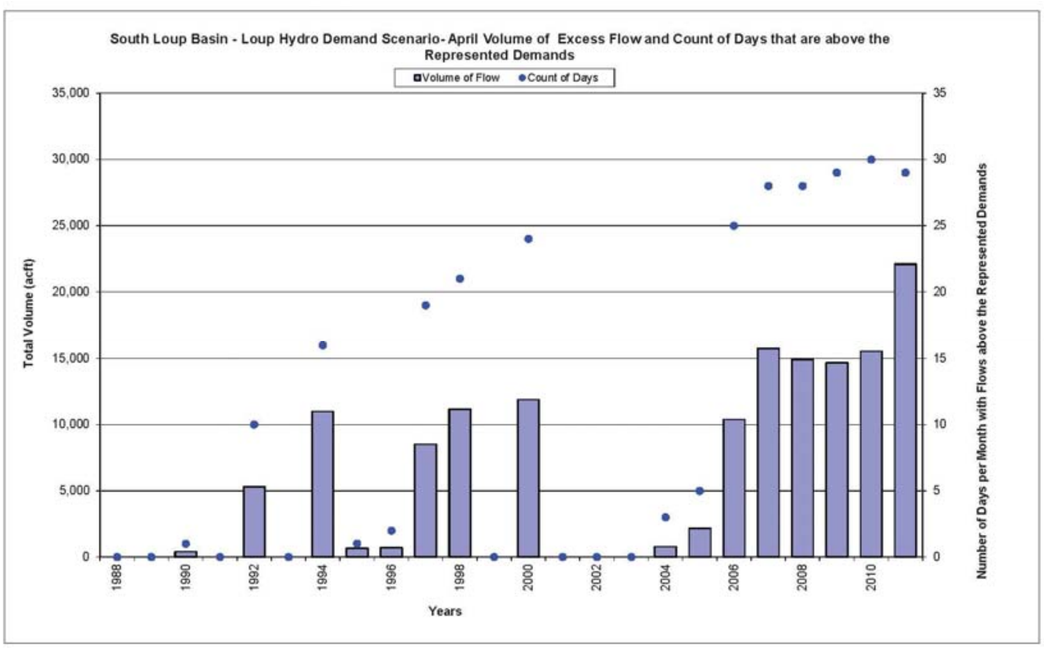


Figure A173: South Loup Subbasin,
May Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

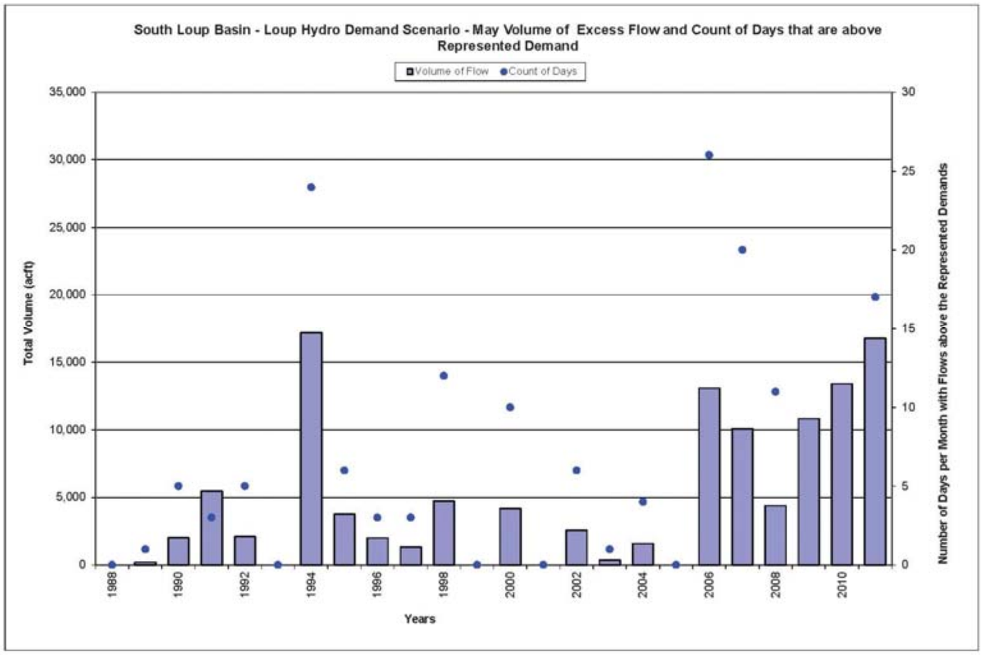


Figure A174: South Loup Subbasin,
June Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

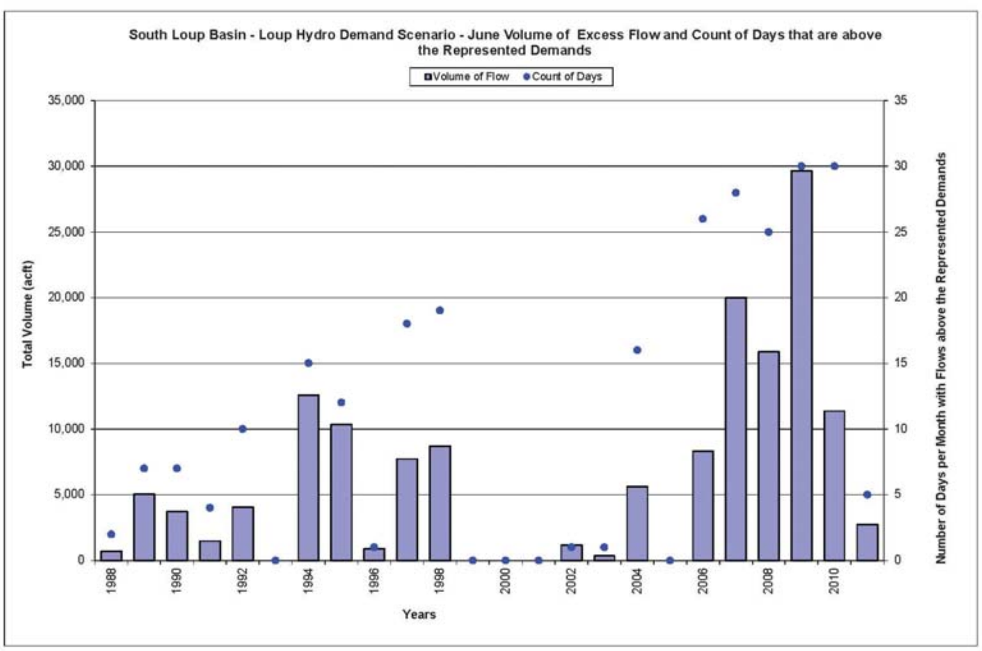


Figure A175: South Loup Subbasin,
July Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

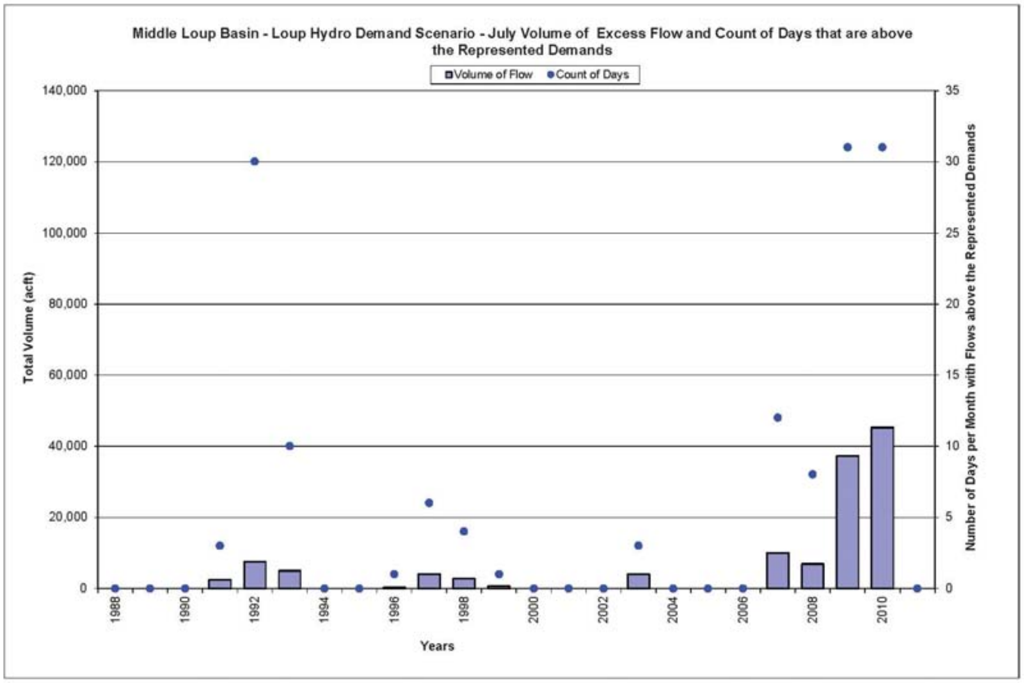


Figure A176: South Loup Subbasin,
August Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

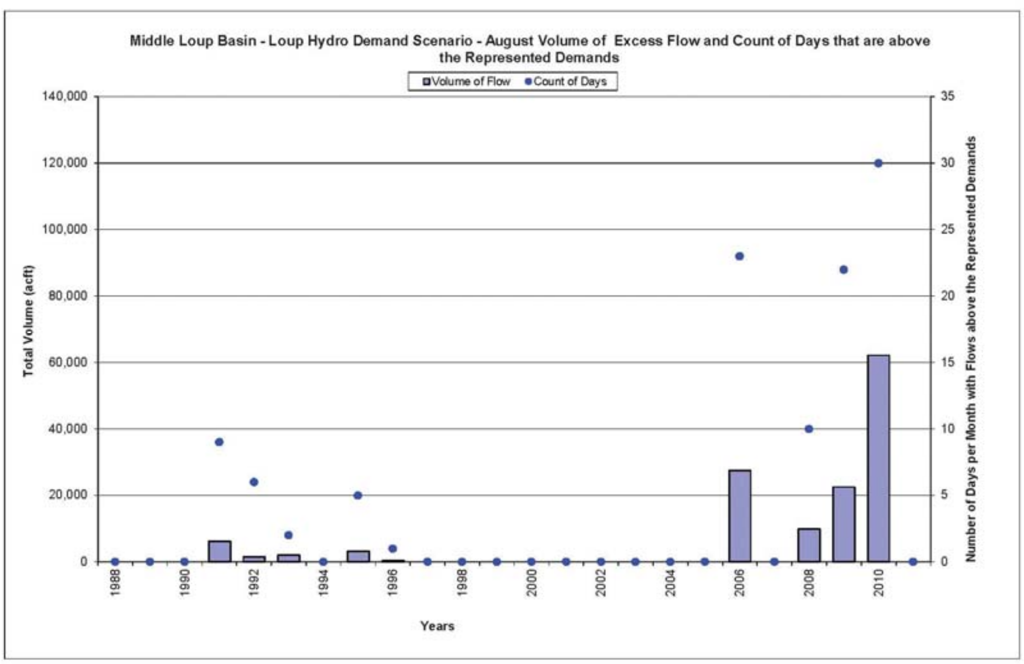


Figure A177: South Loup Subbasin,
September Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

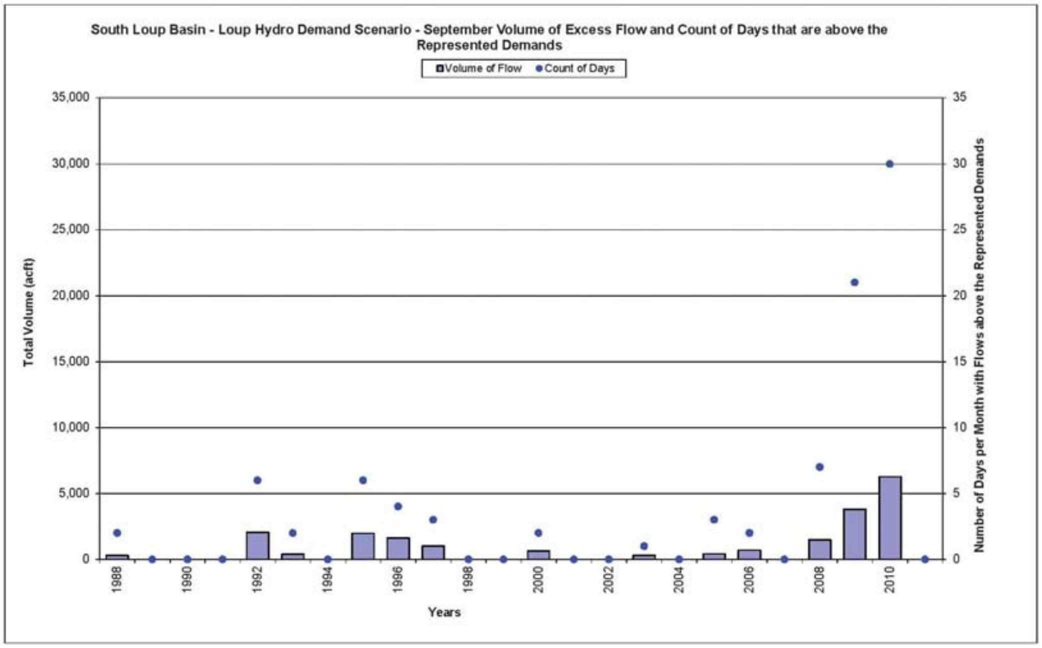


Figure A178: South Loup Subbasin,
October Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

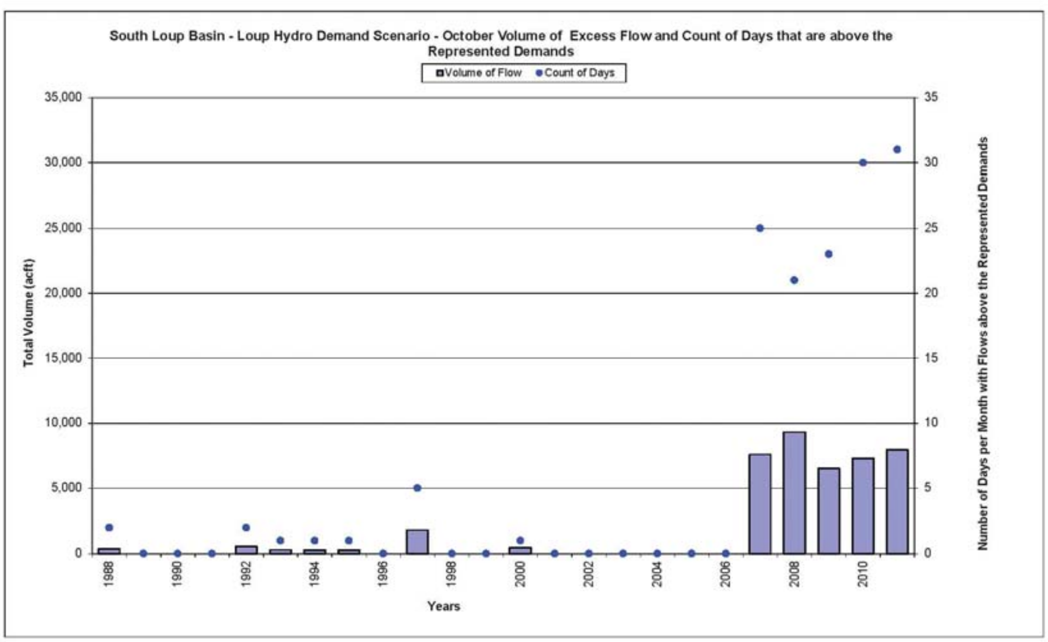


Figure A179: South Loup Subbasin,
November Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

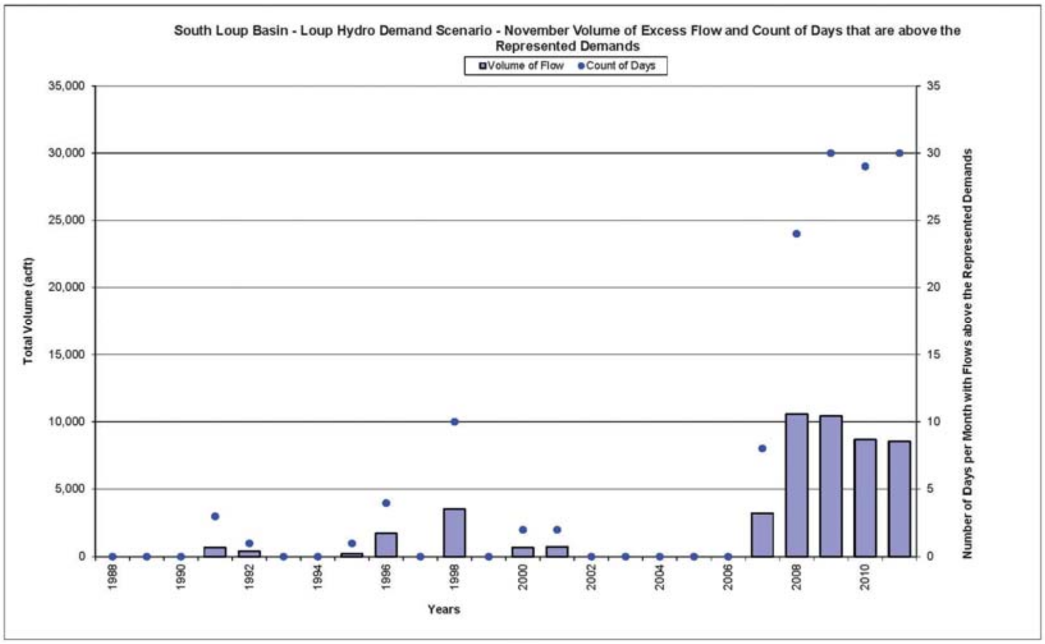


Figure A180: South Loup Subbasin,
December Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

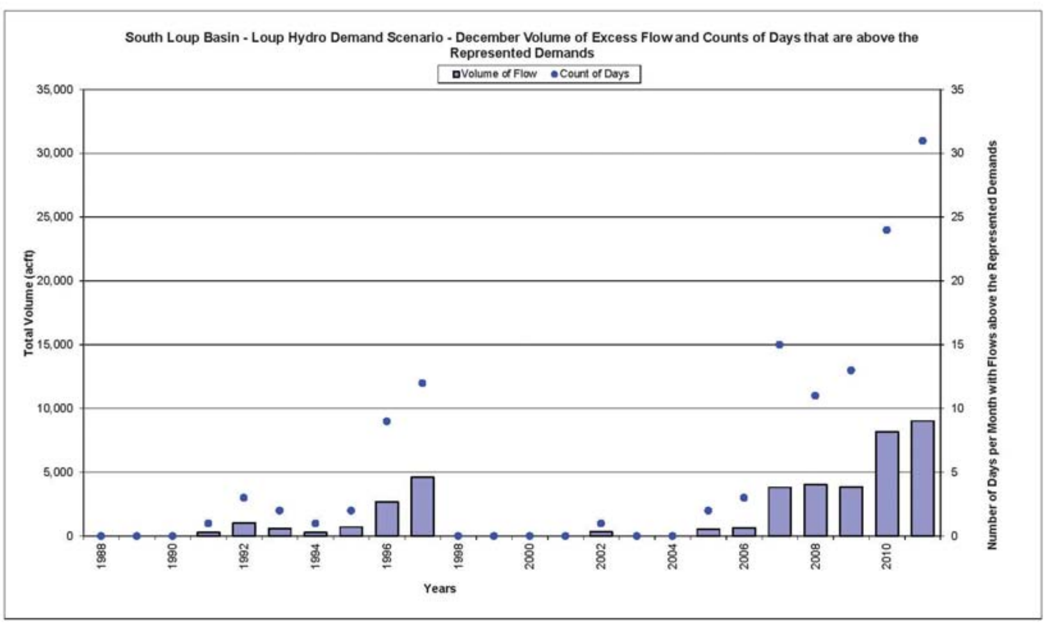


Figure A181: North Loup Subbasin,
January Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

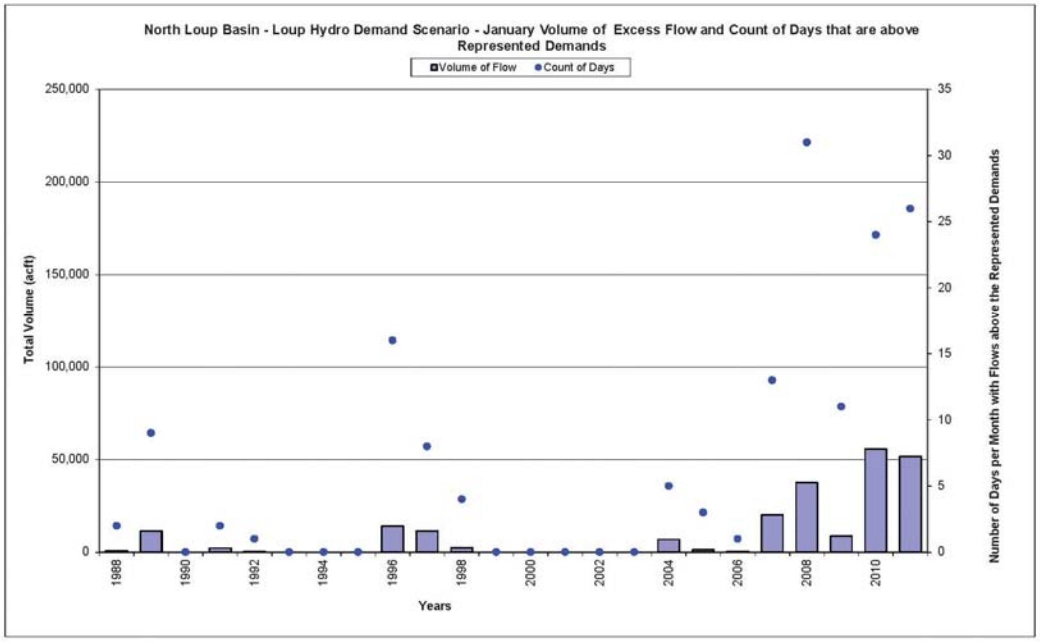


Figure A182: North Loup Subbasin,
February Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

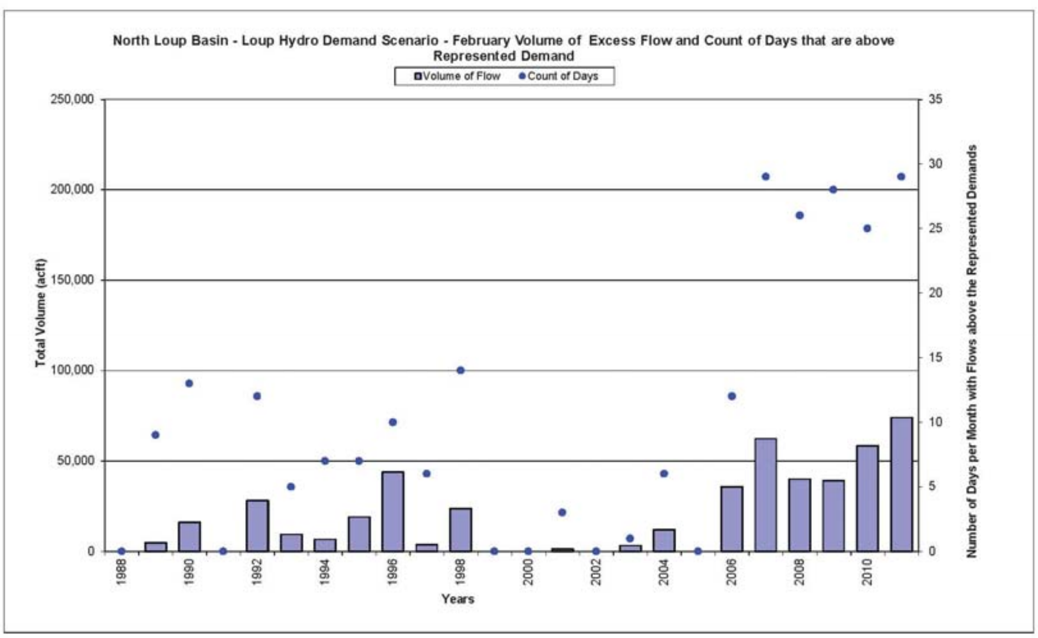


Figure A183: North Loup Subbasin, March Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

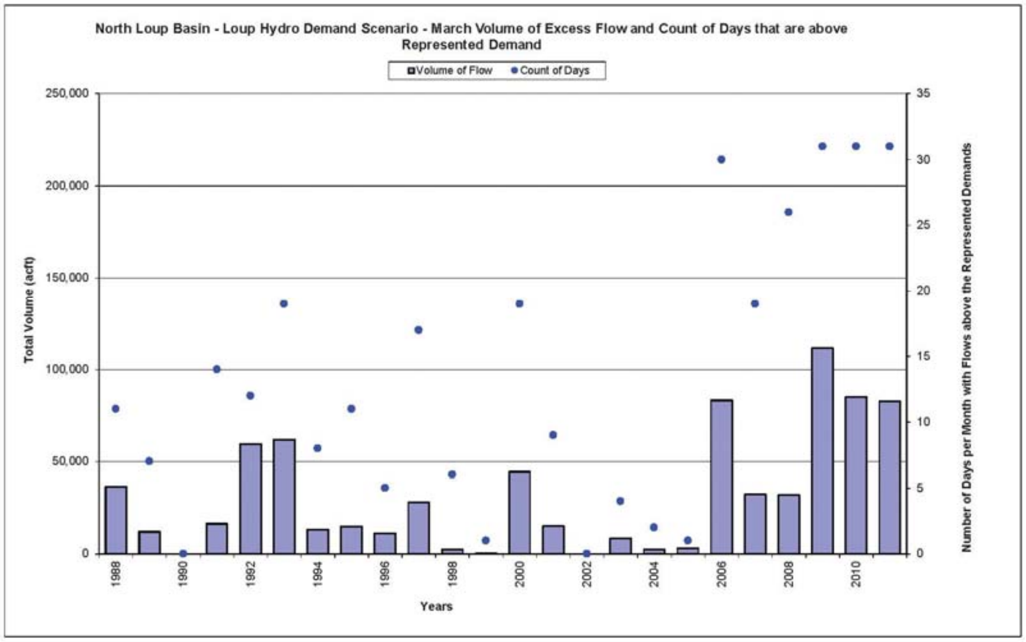


Figure A184: North Loup Subbasin, April Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

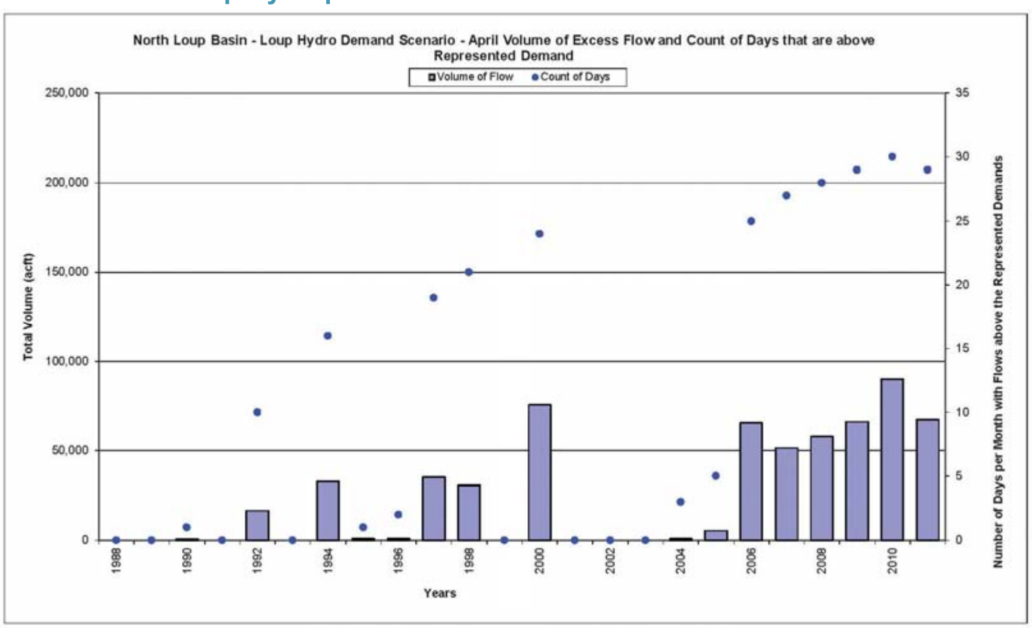


**Figure A185: North Loup Subbasin,
May Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand**

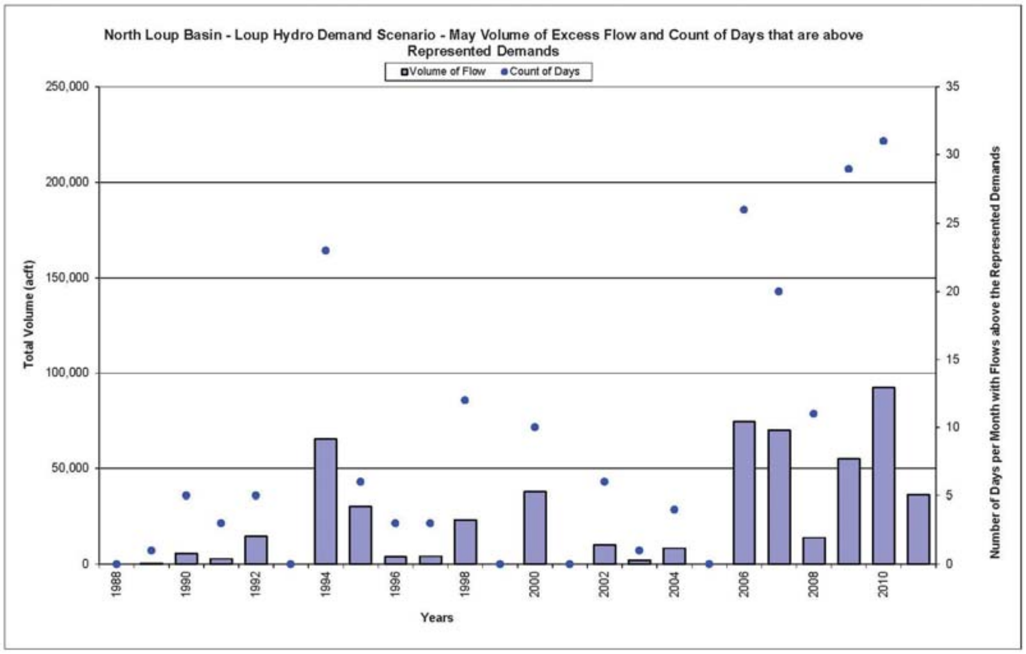


**Figure A186: North Loup Subbasin,
June Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand**

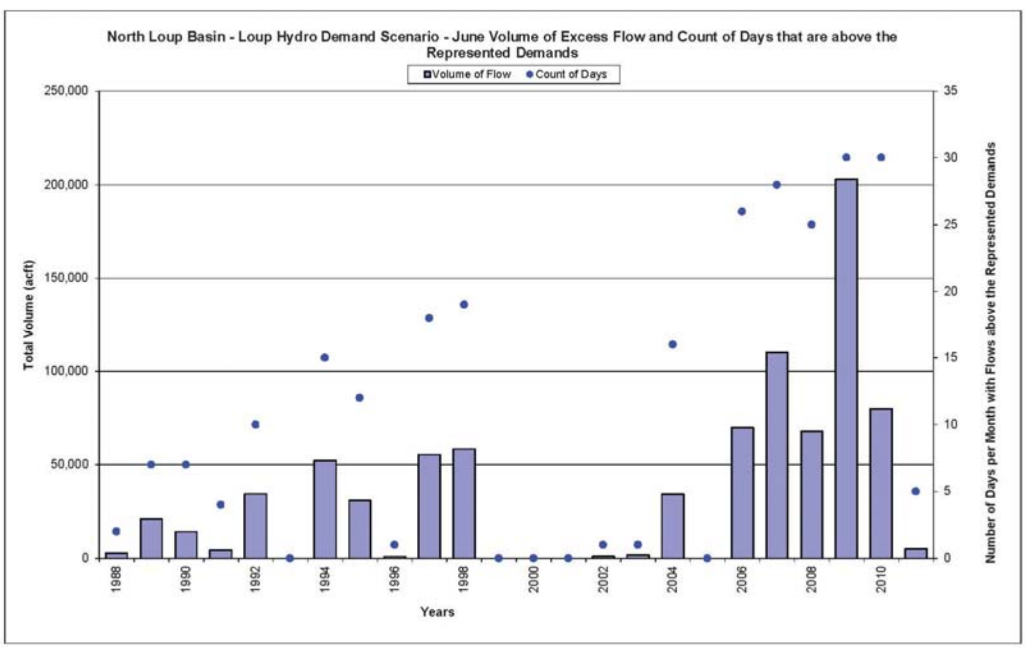


**Figure A187: North Loup Subbasin,
July Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand**

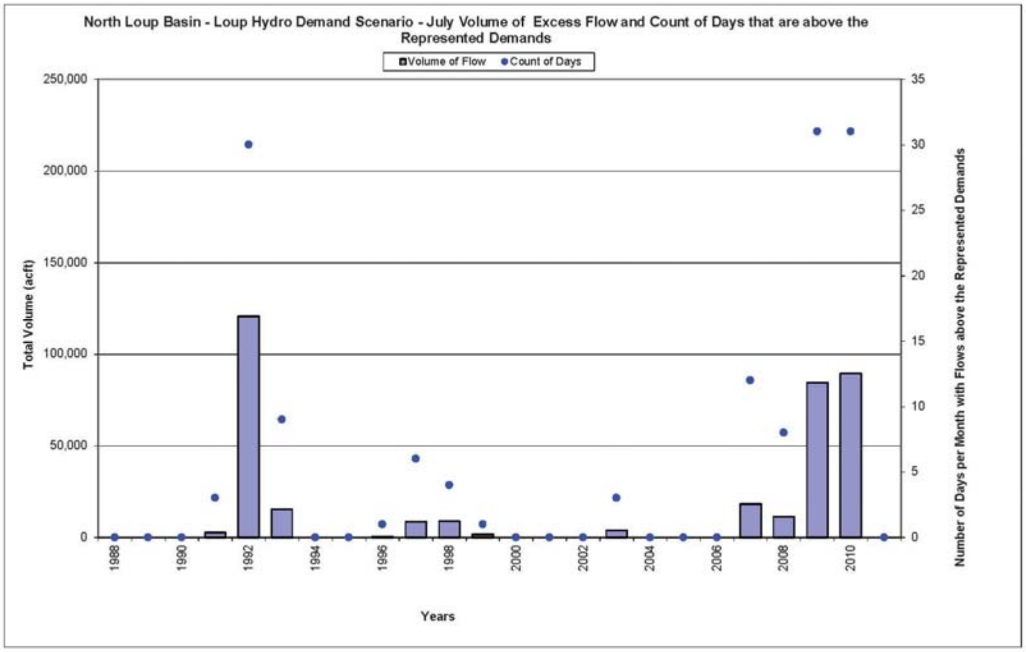


**Figure A188: North Loup Subbasin,
August Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand**

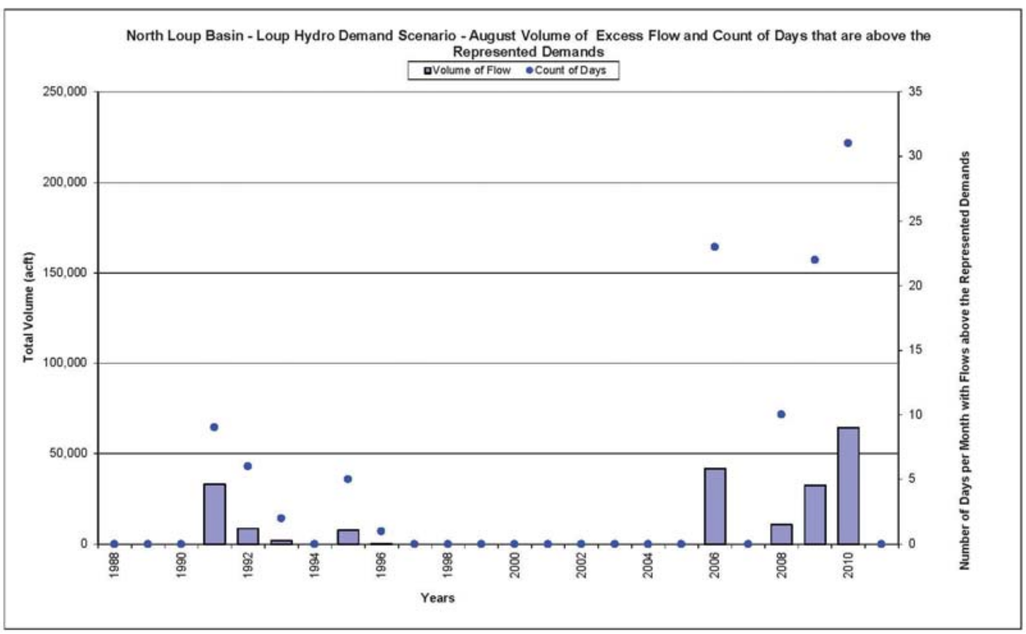


Figure A189: North Loup Subbasin,
September Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

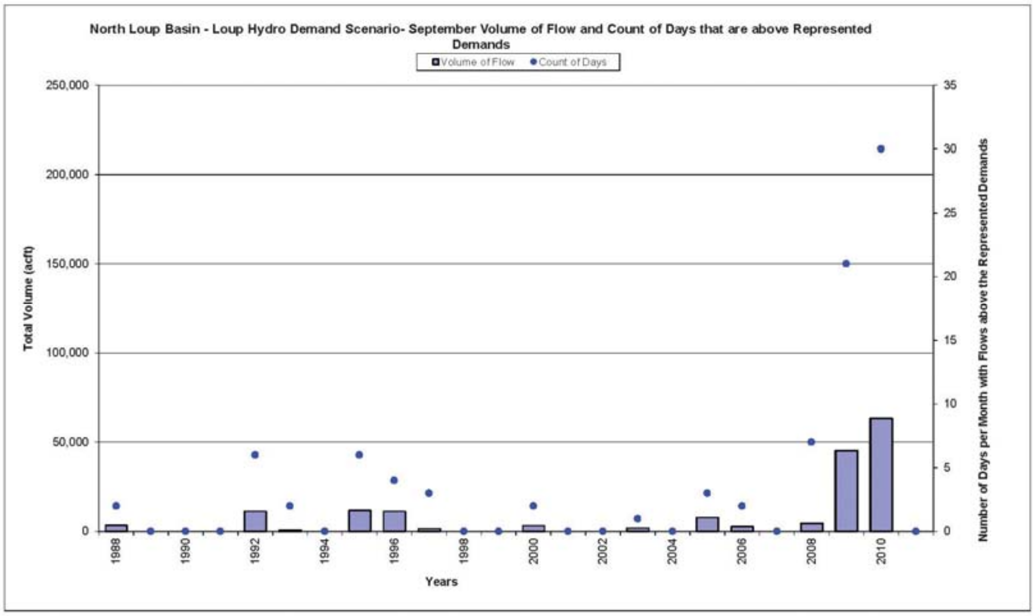


Figure A190: North Loup Subbasin,
October Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand

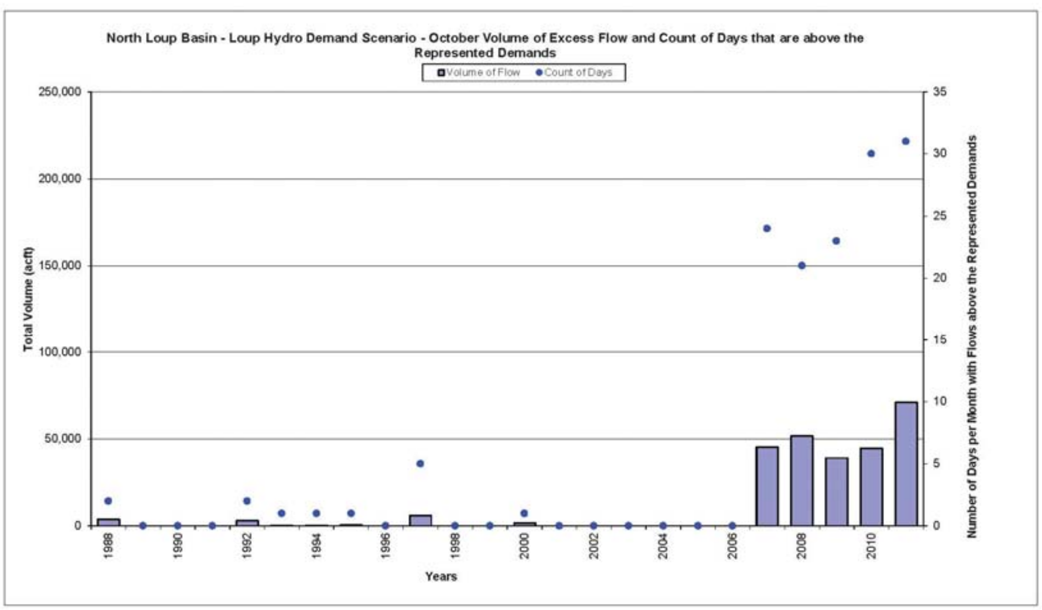


**Figure A191: North Loup Subbasin,
November Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand**

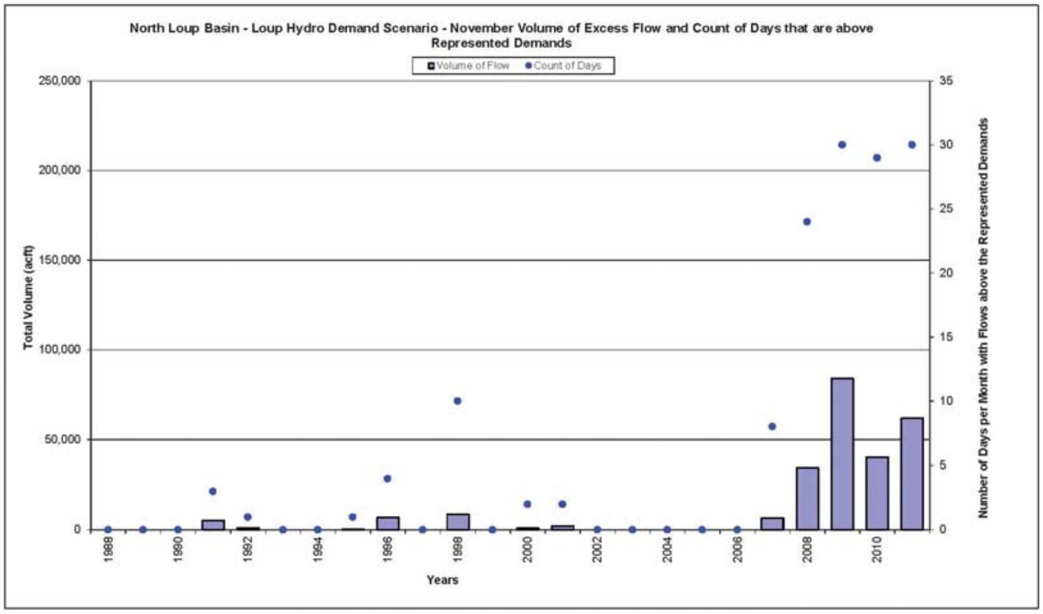
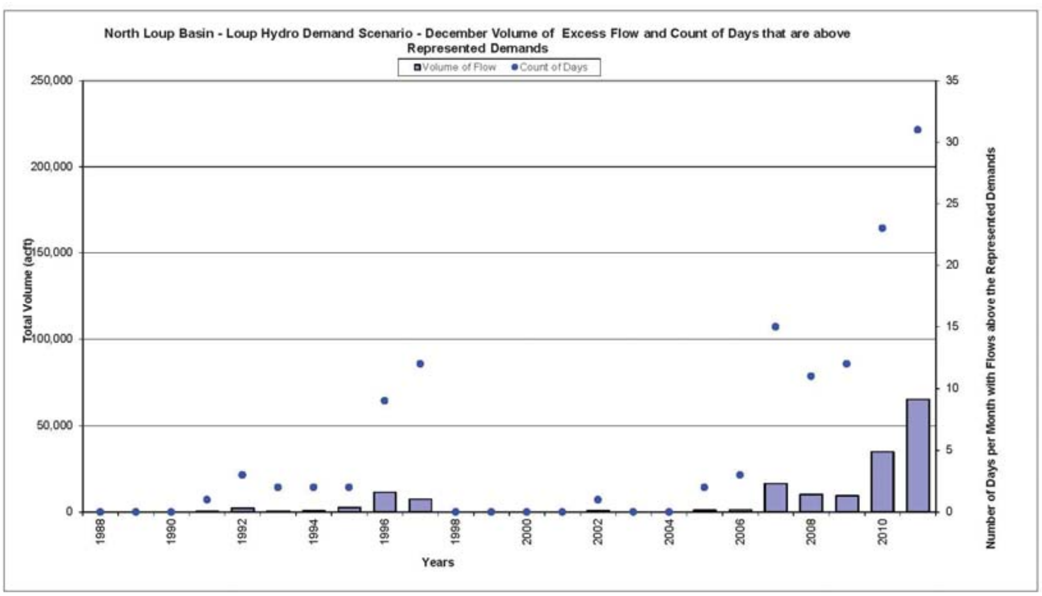


**Figure A192: North Loup Subbasin,
December Volume of Excess Flow and Count of Days that are above the Instream Flow Demands as well as Full Loup Hydropower Demand**



Appendix B: Output Plots for Average Monthly Mean Excess Flows

Appendix B contains plots of the average monthly mean excess flow volumes over the period of record. Also plotted is the average number of days each month during which excess flows are available.

Figure B1: Lower Platte North Bend to Louisville Subbasin, Monthly Mean Flow in Excess of Instream Flow Demands with 95% Confidence Interval

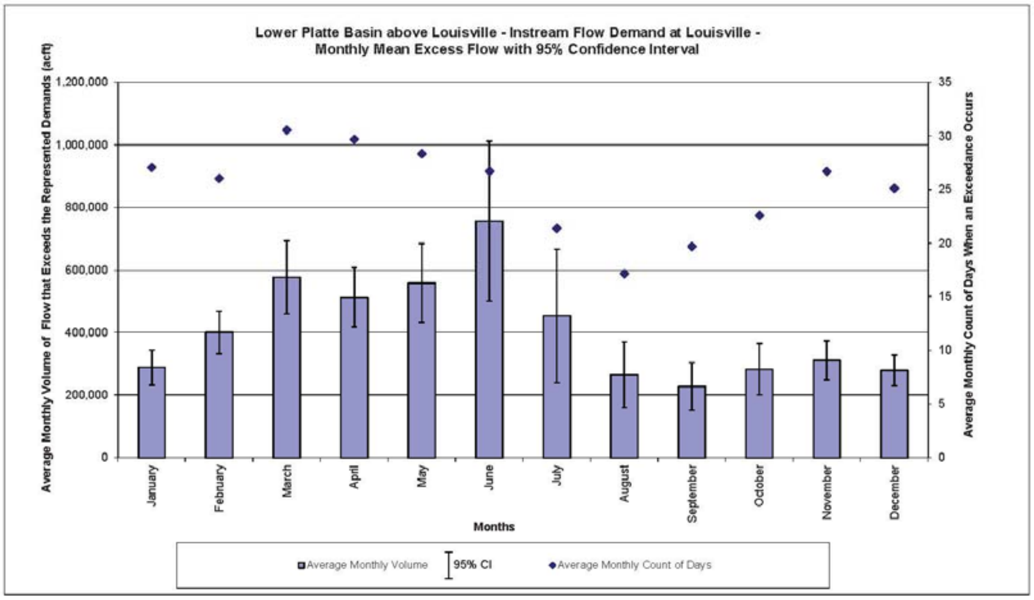


Figure B2: Lower Platte North Bend to Louisville Subbasin, Annual Volume of Flow that Exceeds Instream Flow Demands and Annual Count of Days when this Occurs

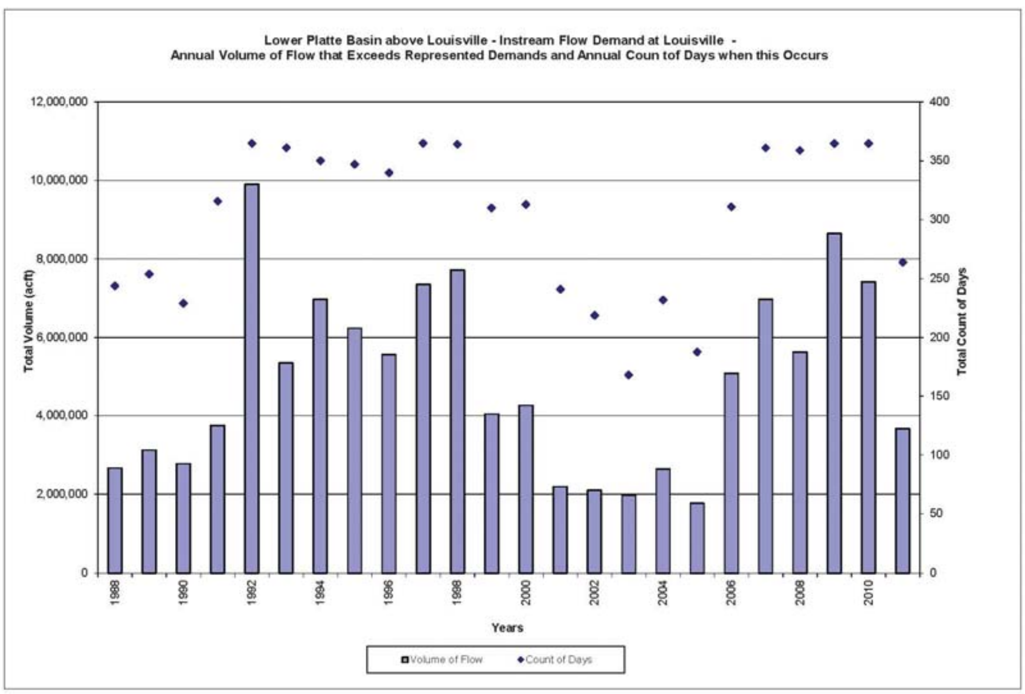


Figure B3: Lower Platte Above North Bend Subbasin, Monthly Mean Flow in Excess of Instream Flow Demands with 95% Confidence Interval

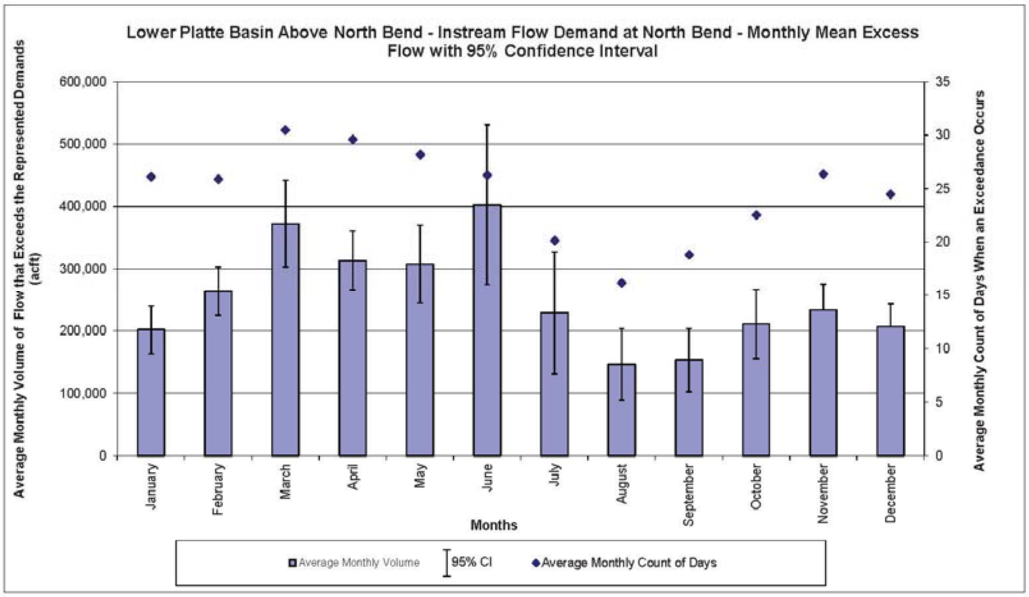


Figure B4: Lower Platte Above North Bend Subbasin, Annual Volume of Flow that Exceeds Instream Flow Demands and Annual Count of Days when this Occurs

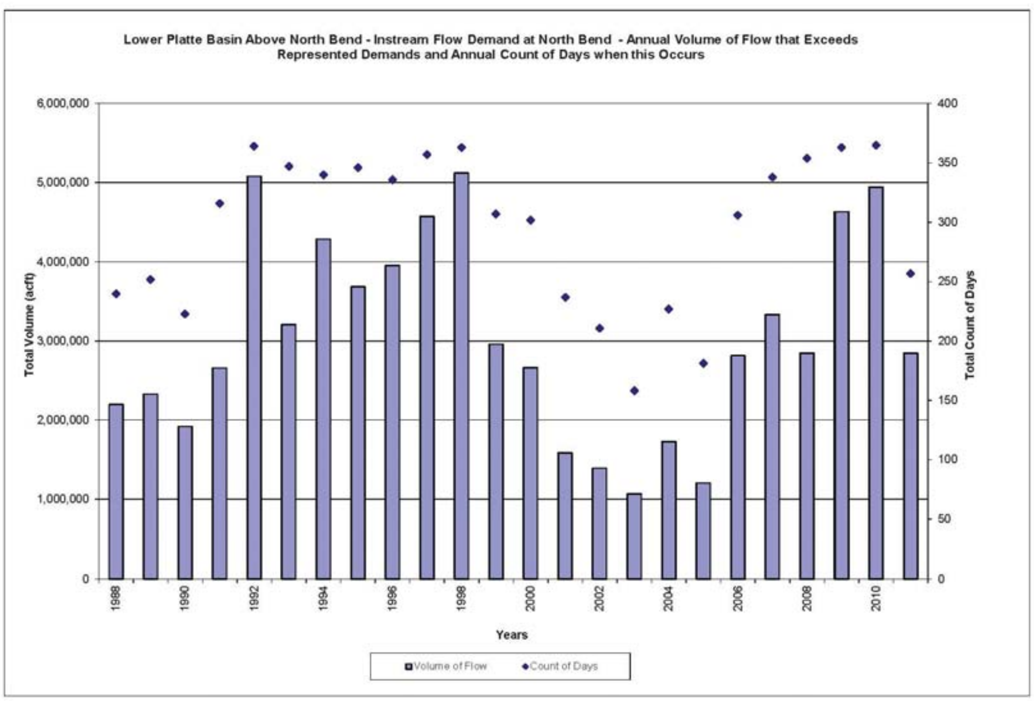


Figure B5: Elkhorn Norfolk to Waterloo Subbasin,
Monthly Mean Flow in Excess of Instream Flow Demands with 95% Confidence Interval

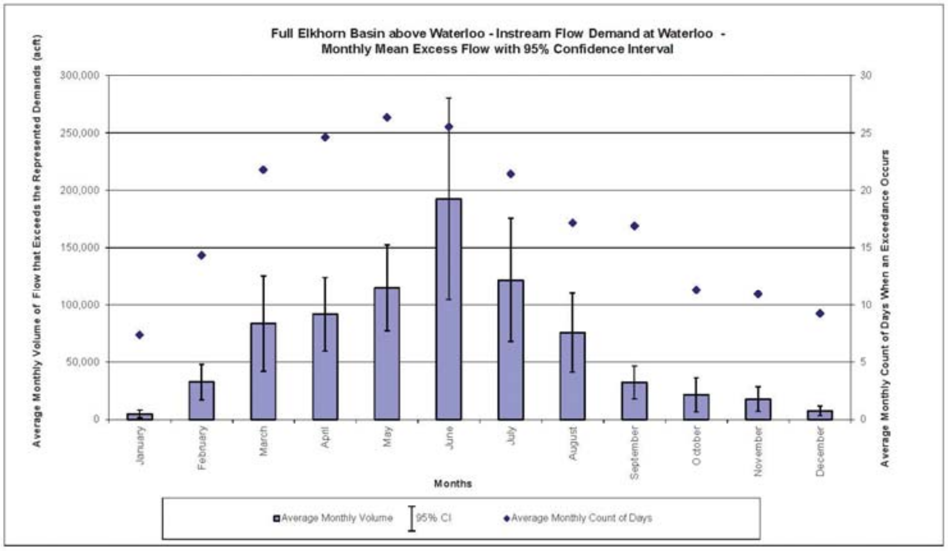


Figure B6: Elkhorn Norfolk to Waterloo Subbasin,
Annual Volume of Flow that Exceeds Instream Flow Demands and
Annual Count of Days when this Occurs

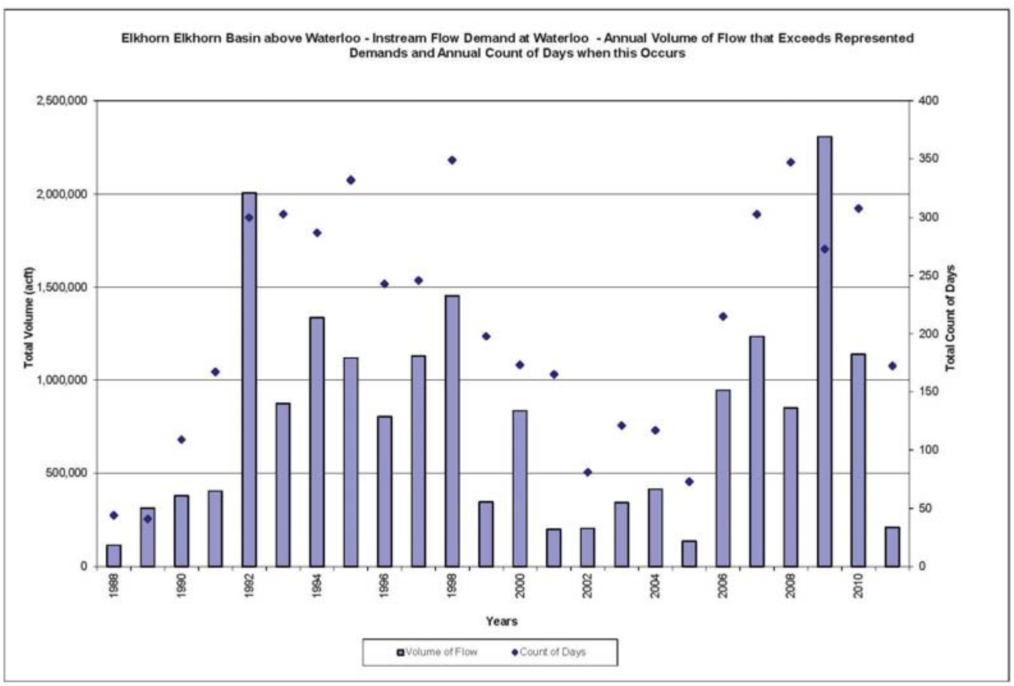


Figure B7: Elkhorn Above Norfolk Subbasin,
Monthly Mean Flow in Excess of Instream Flow Demands with 95% Confidence Interval

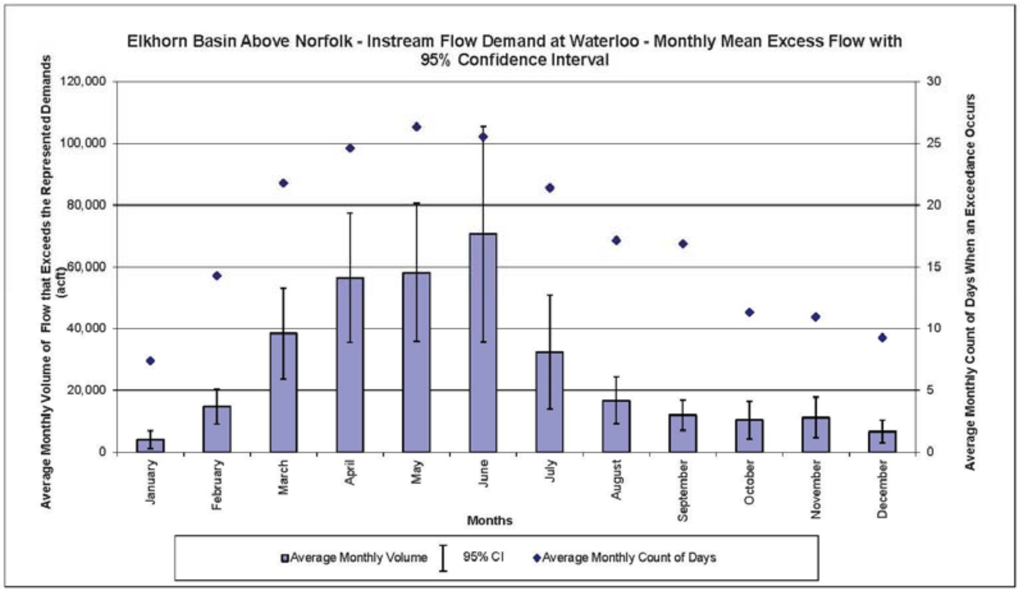


Figure B8: Elkhorn Above Norfolk Subbasin,
Annual Volume of Flow that Exceeds Instream Flow Demands and
Annual Count of Days when this Occurs

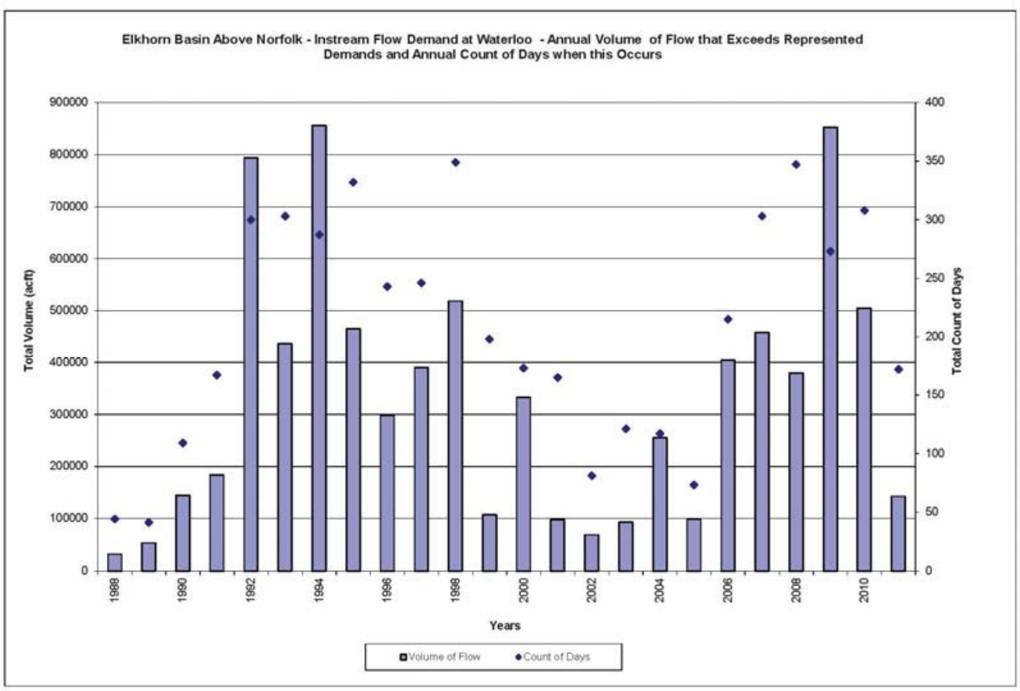


**Figure B9: Lower Loup Subbasin,
Monthly Mean Flow in Excess of Instream Flow Demands with 95% Confidence Interval**

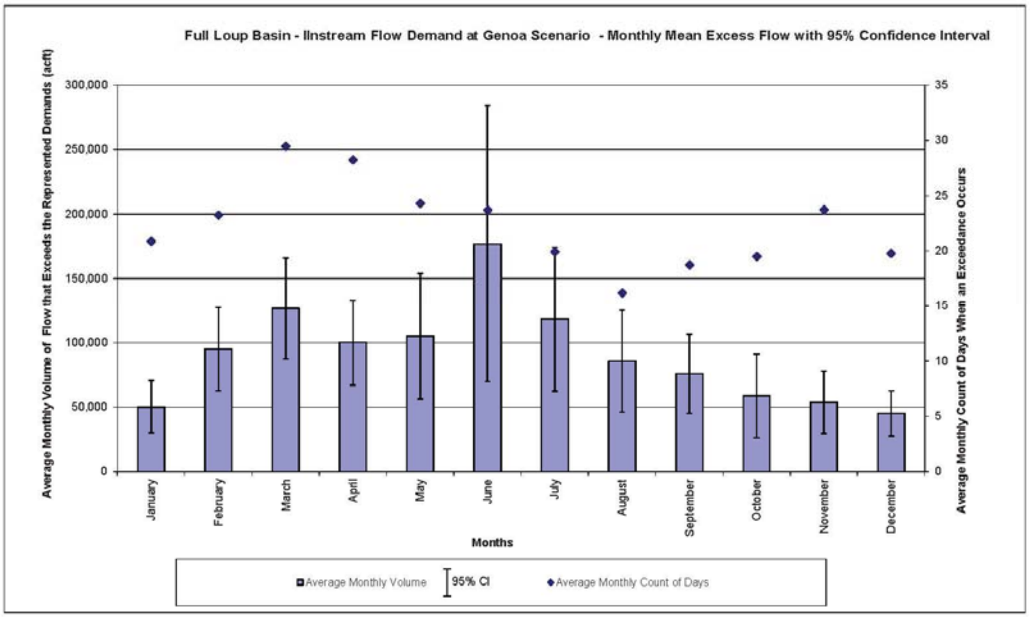


**Figure B10: Lower Loup Subbasin,
Annual Volume of Flow that Exceeds Instream Flow Demands and
Annual Count of Days when this Occurs**

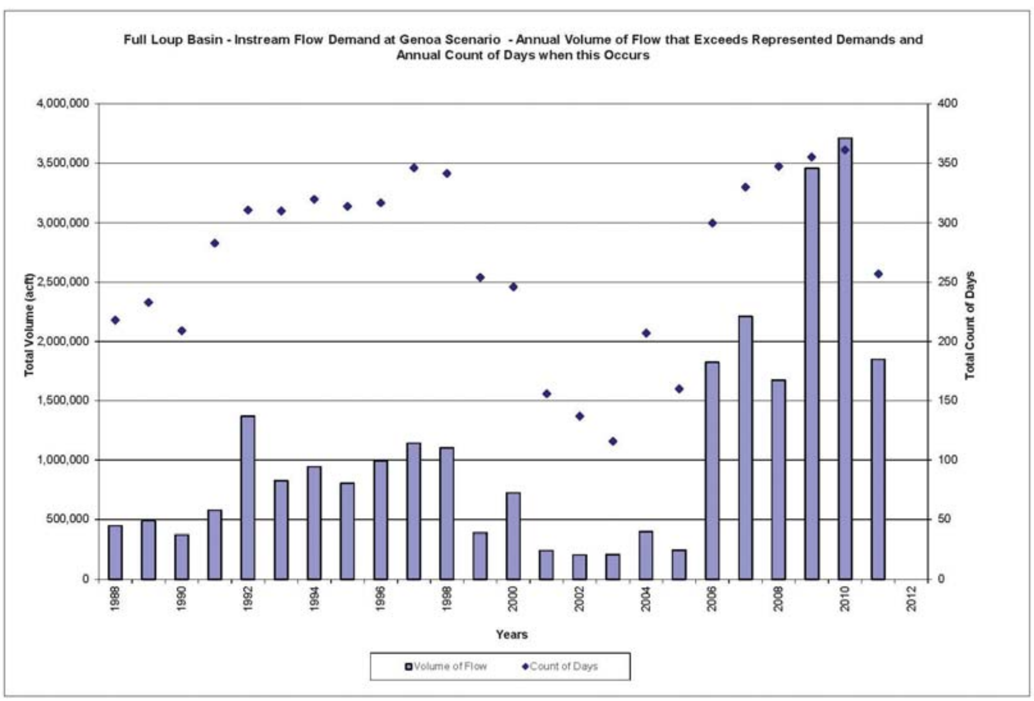


Figure B11: Middle Loup Subbasin,
Monthly Mean Flow in Excess of Instream Flow Demands with 95% Confidence Interval

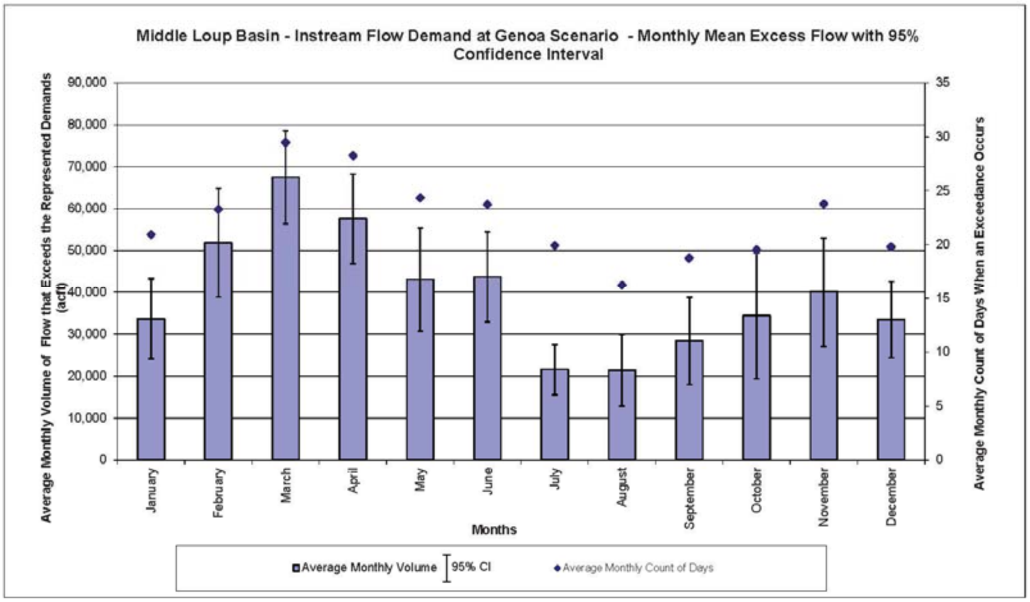


Figure B12: Middle Loup Subbasin,
Annual Volume of Flow that Exceeds Instream Flow Demands and
Annual Count of Days when this Occurs

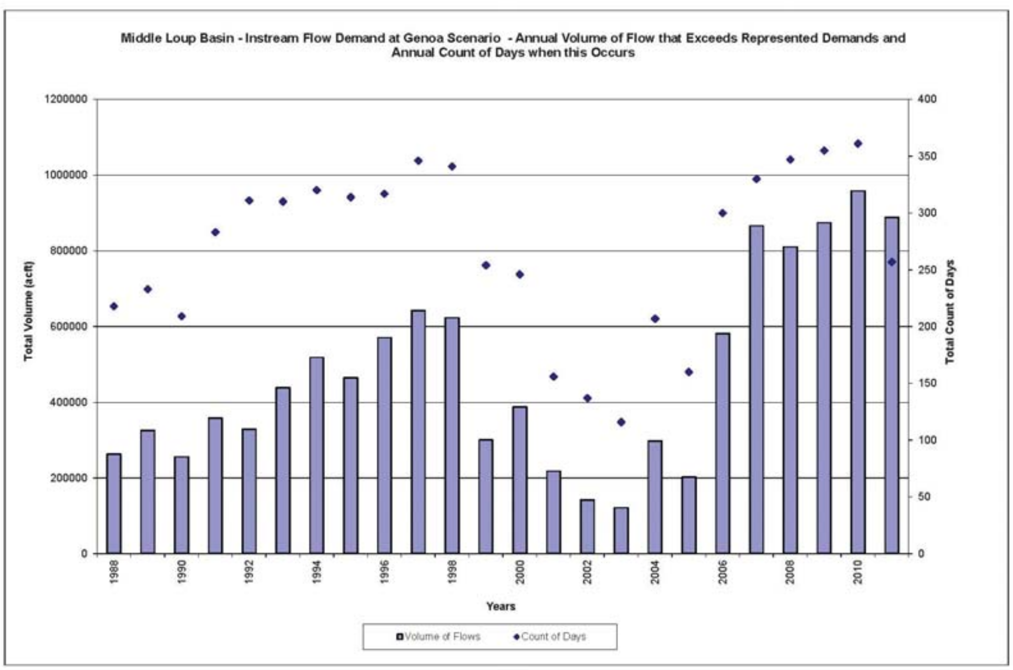


Figure B13: South Loup Subbasin,
Monthly Mean Flow in Excess of Instream Flow Demands with 95% Confidence Interval

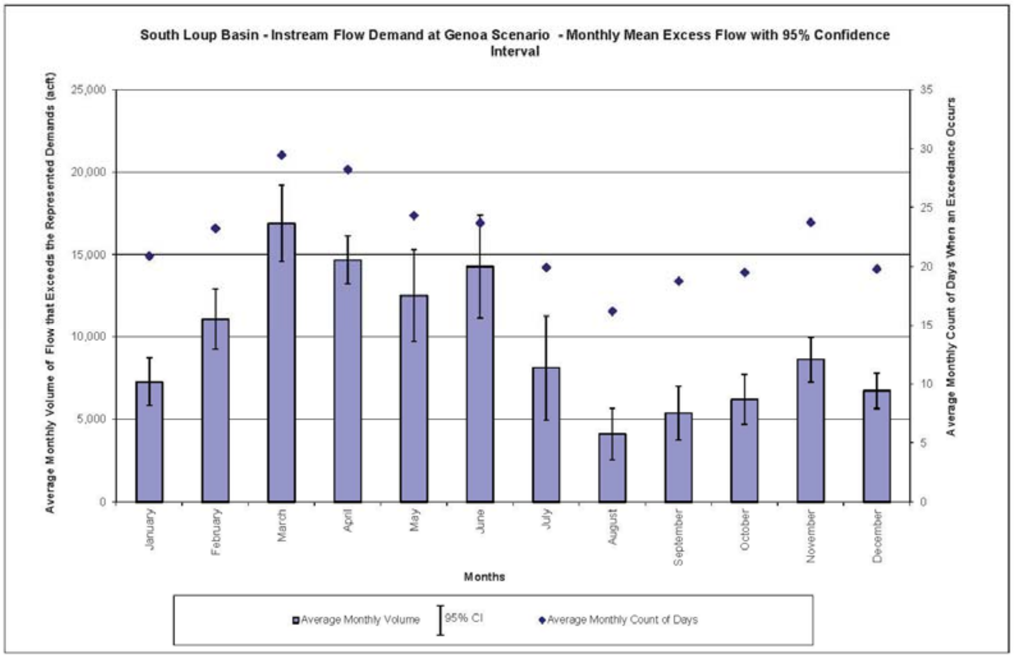


Figure B14: South Loup Subbasin,
Annual Volume of Flow that Exceeds Instream Flow Demands and Annual Count of Days when this Occurs

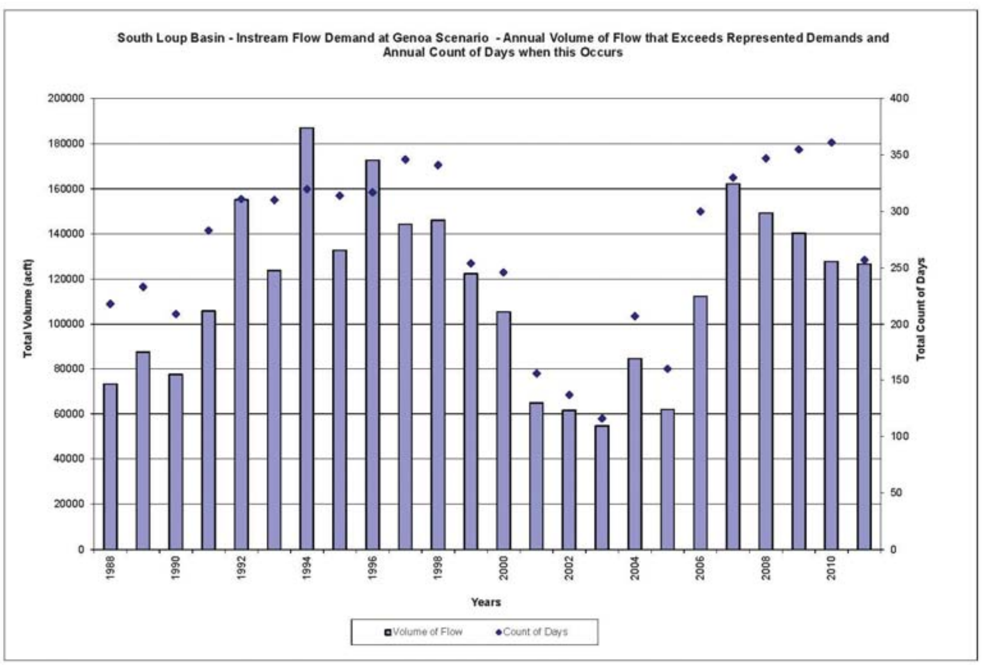


Figure B15: North Loup Subbasin,
Monthly Mean Flow in Excess of Instream Flow Demands with 95% Confidence Interval

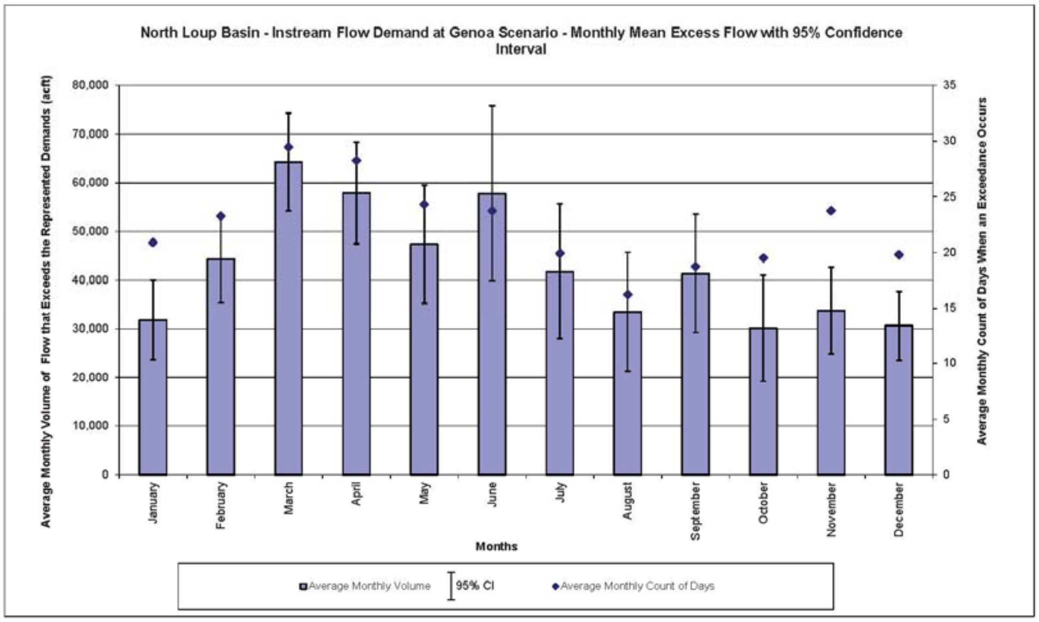


Figure B16: North Loup Subbasin,
Annual Volume of Flow that Exceeds Instream Flow Demands and
Annual Count of Days when this Occurs

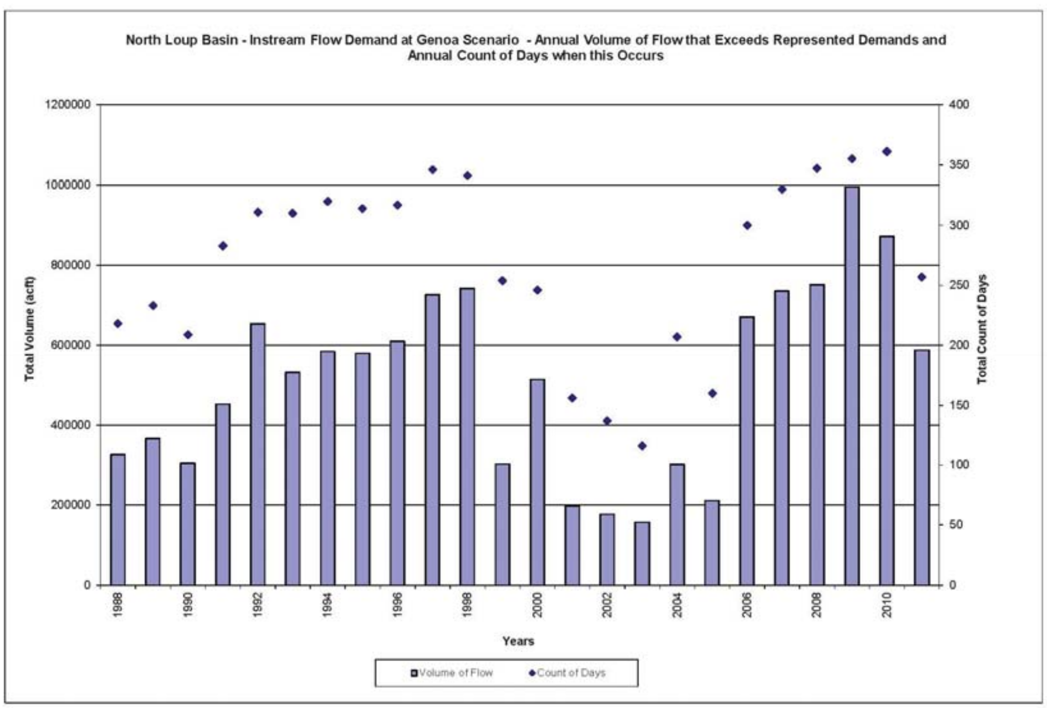


Figure B17: Lower Loup Subbasin,
Monthly Mean Flow in Excess of Instream Flow Demands as well as Historic Loup Hydropower Diversion with 95% Confidence Interval

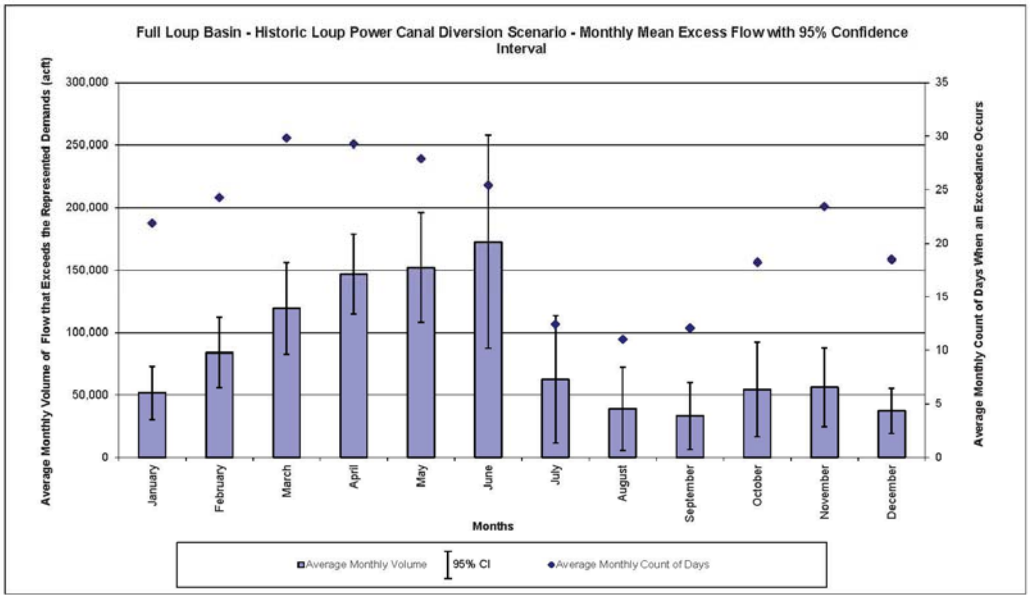


Figure B18: Lower Loup Subbasin,
Annual Volume of Flow that Exceeds both Instream Flow Demands and Historic Loup Hydropower Diversions and Annual Count of Days when this Occurs

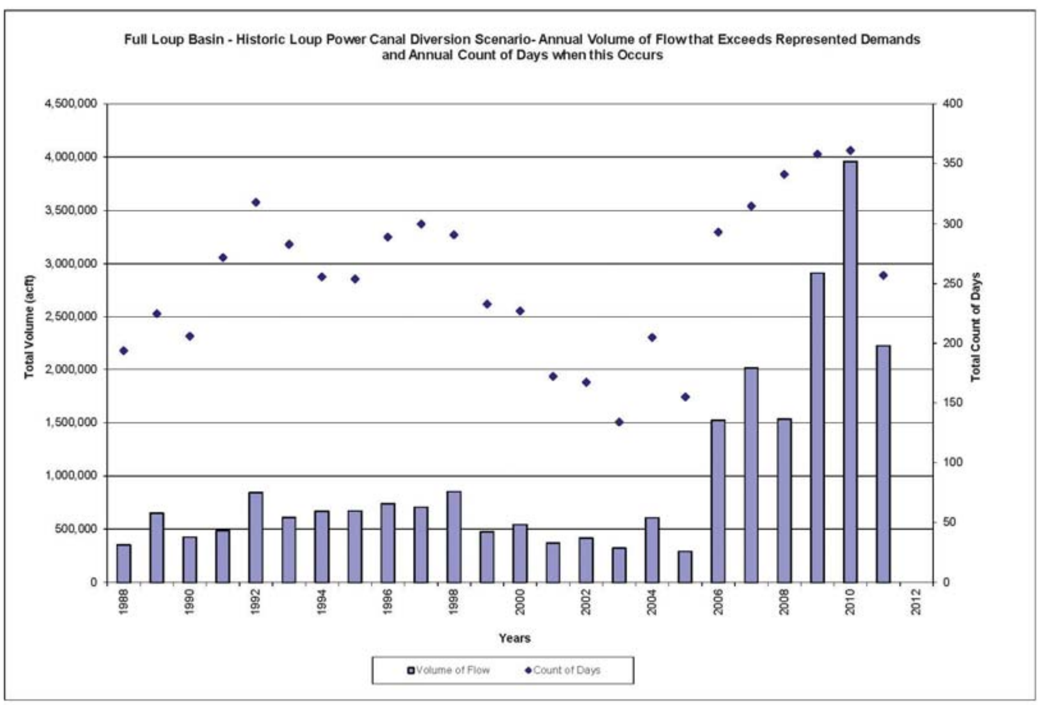


Figure B19: Middle Loup Subbasin,
Monthly Mean Flow in Excess of Instream Flow Demands as well as Historic Loup Hydropower Diversion with 95% Confidence Interval

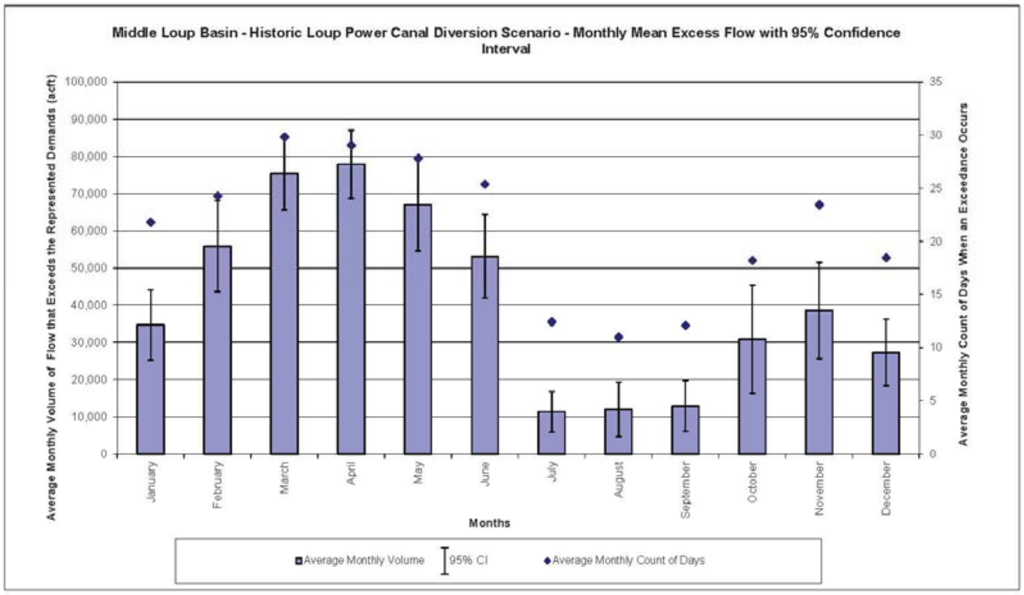


Figure B20: Middle Loup Subbasin,
Annual Volume of Flow that Exceeds both Instream Flow Demands and Historic Loup Hydropower Diversions and Annual Count of Days when this Occurs

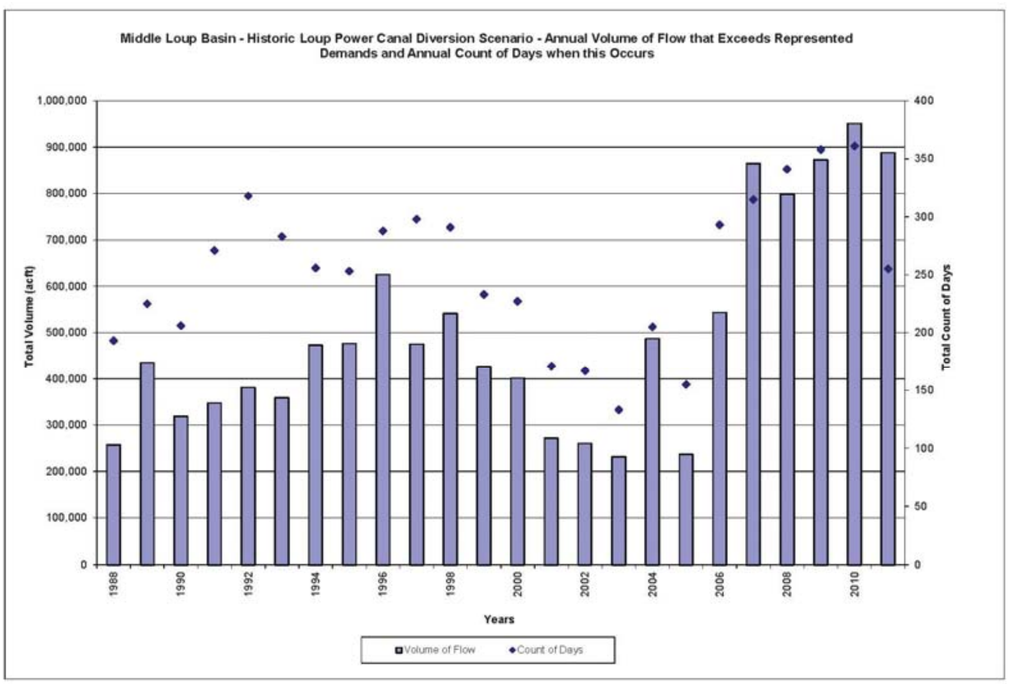


Figure B21: South Loup Subbasin,
Monthly Mean Flow in Excess of Instream Flow Demands as well as Historic Loup Hydropower Diversion with 95% Confidence Interval

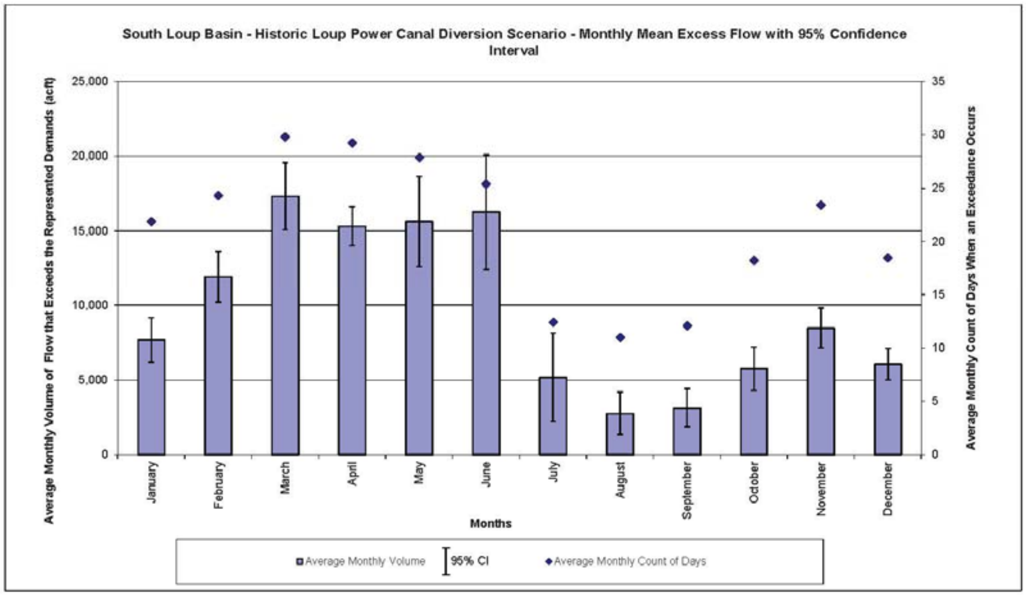


Figure B22: South Loup Subbasin,
Annual Volume of Flow that Exceeds both Instream Flow Demands and Historic Loup Hydropower Diversions and Annual Count of Days when this Occurs

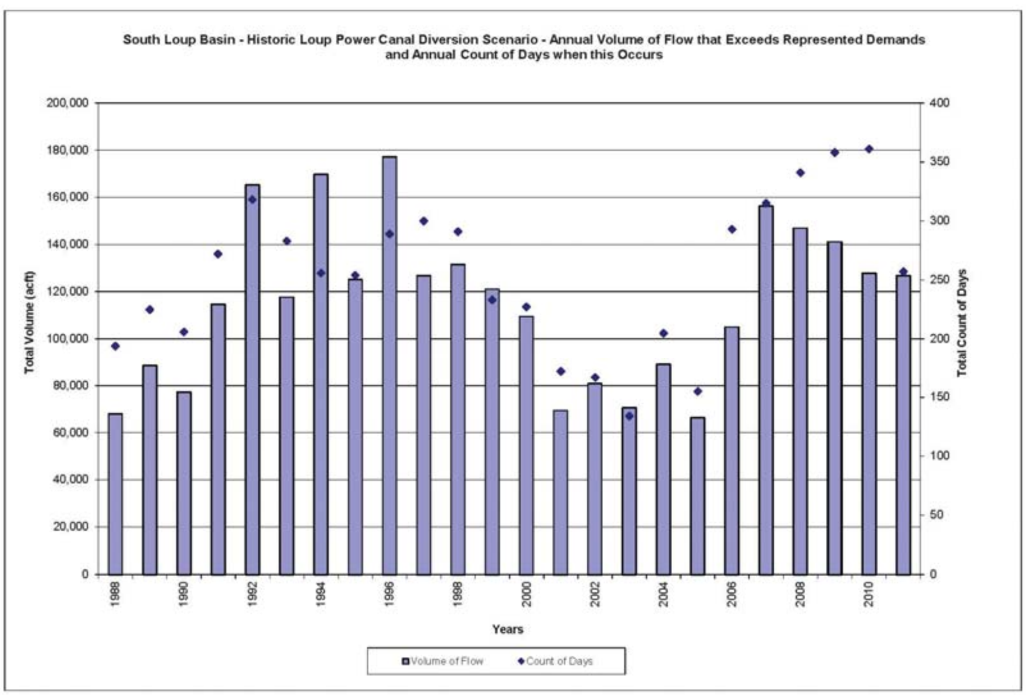


Figure B23: North Loup Subbasin, Monthly Mean Flow in Excess of Instream Flow Demands as well as Historic Loup Hydropower Diversion with 95% Confidence Interval

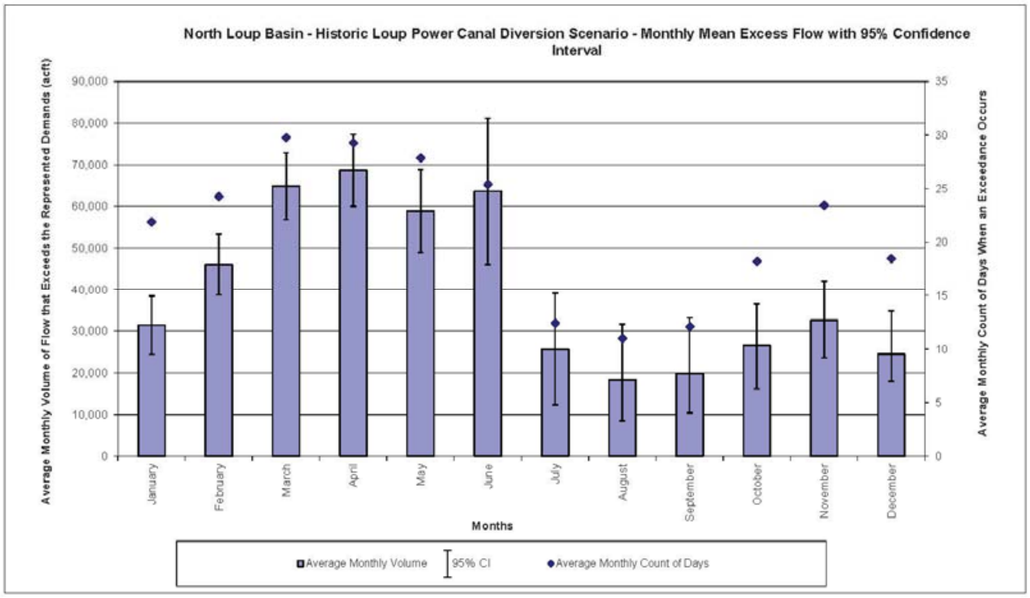


Figure B24: North Loup Subbasin, Annual Volume of Flow that Exceeds both Instream Flow Demands and Historic Loup Hydropower Diversions and Annual Count of Days when this Occurs

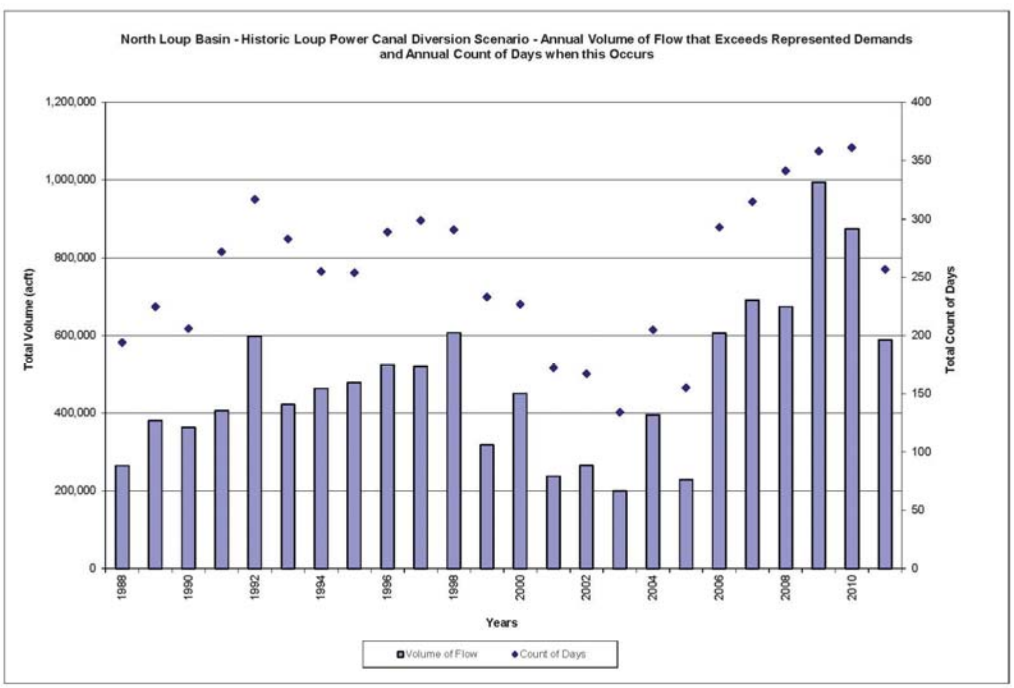


Figure B25: Lower Loup Subbasin,
Monthly Mean Flow in Excess of Instream Flow Demands as well as Full Loup Hydropower Demand with 95% Confidence Interval

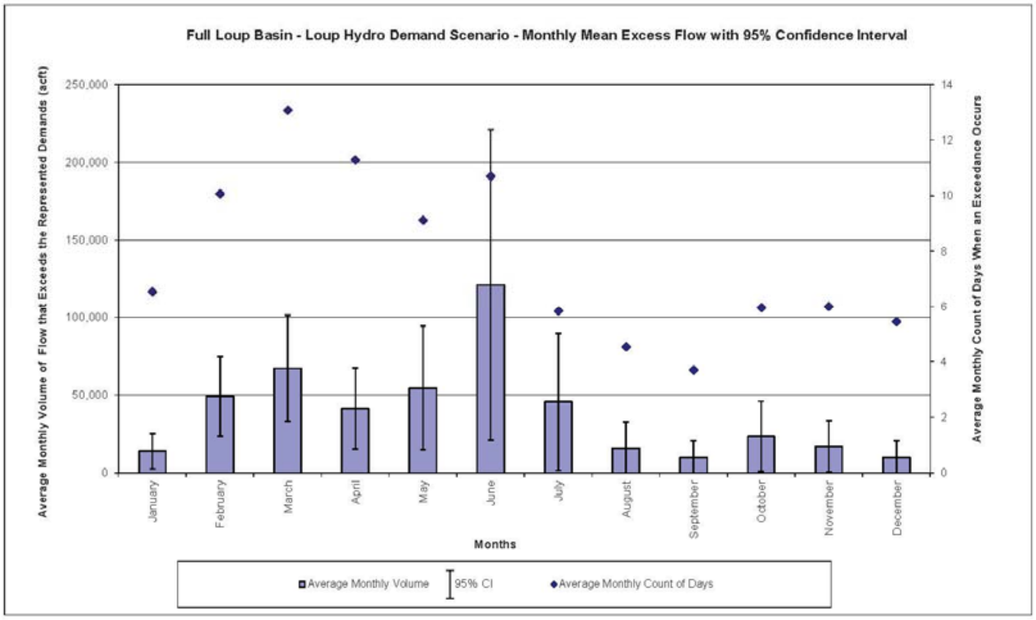


Figure B26: Lower Loup Subbasin,
Annual Volume of Flow that Exceeds both Instream Flow Demands and Full Loup Hydropower Demand and Annual Count of Days when this Occurs

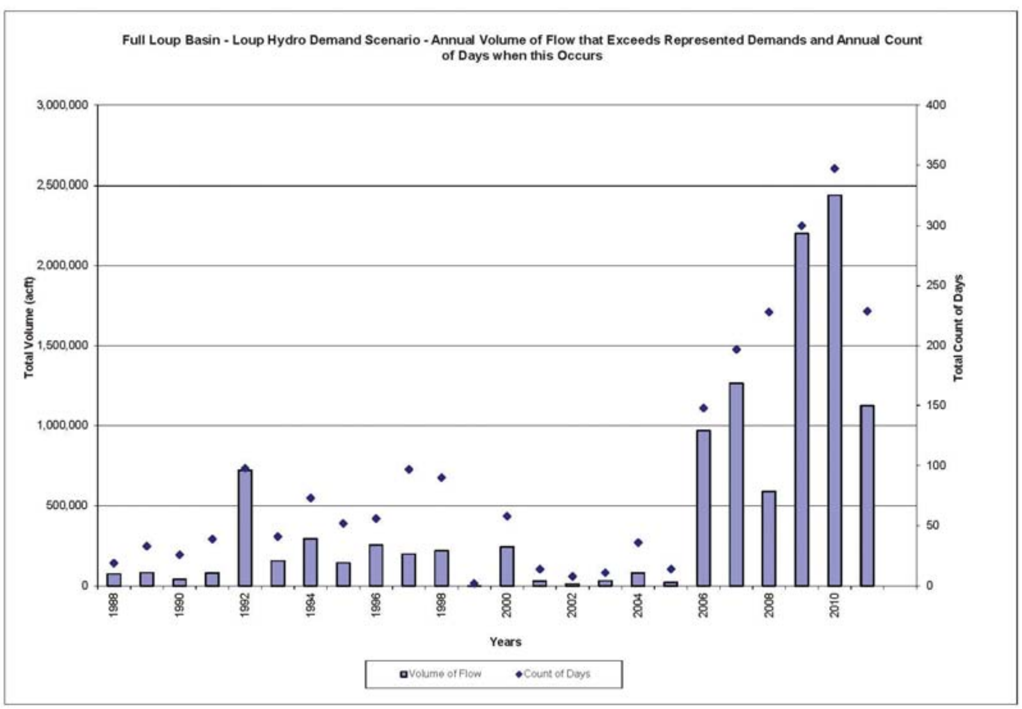


**Figure B27: Middle Loup Subbasin,
Monthly Mean Flow in Excess of Instream Flow Demands as well as Full Loup Hydropower Demand with 95% Confidence Interval**

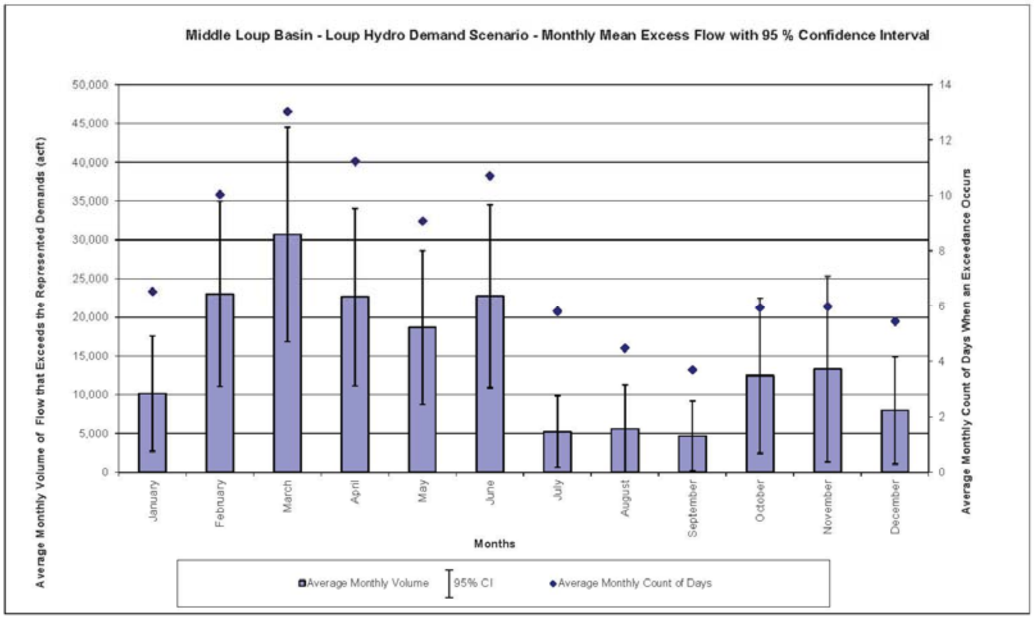


**Figure B28: Middle Loup Subbasin,
Annual Volume of Flow that Exceeds both Instream Flow Demands and Full Loup Hydropower Demand and Annual Count of Days when this Occurs**

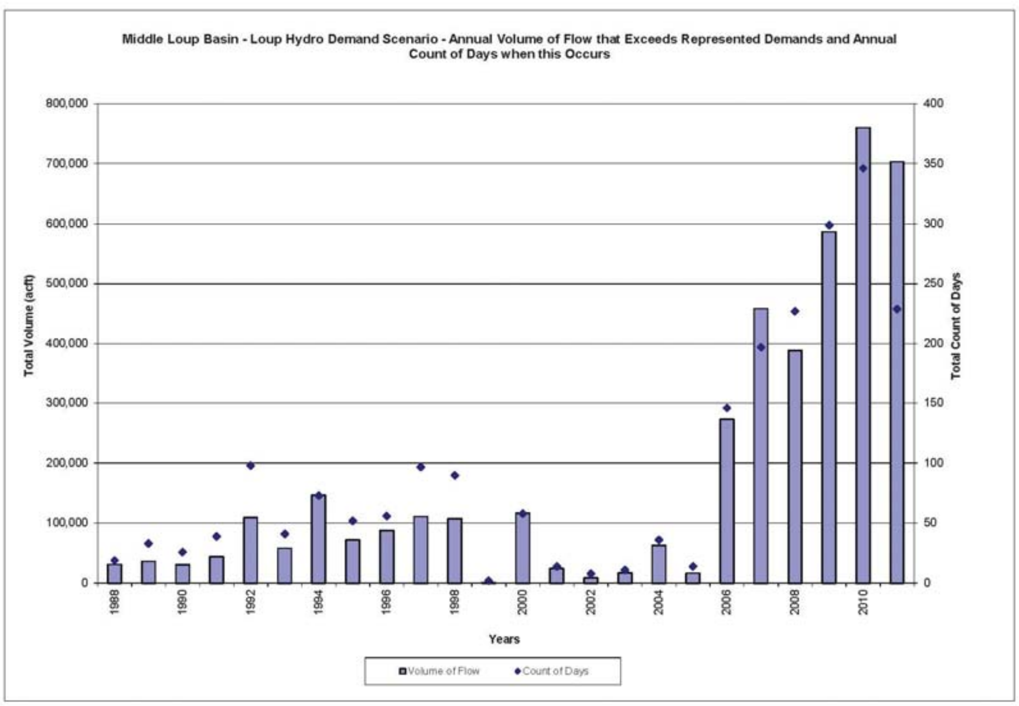


Figure B29: South Loup Subbasin,
Monthly Mean Flow in Excess of Instream Flow Demands as well as Full Loup Hydropower Demand with 95% Confidence Interval

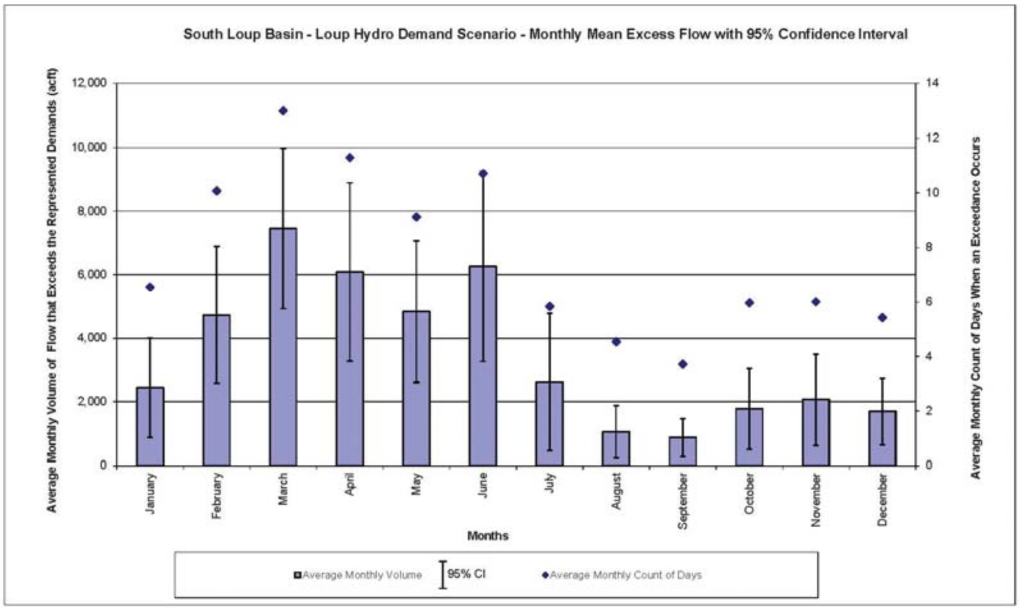


Figure B30: South Loup Subbasin,
Annual Volume of Flow that Exceeds both Instream Flow Demands and Full Loup Hydropower Demand and Annual Count of Days when this Occurs

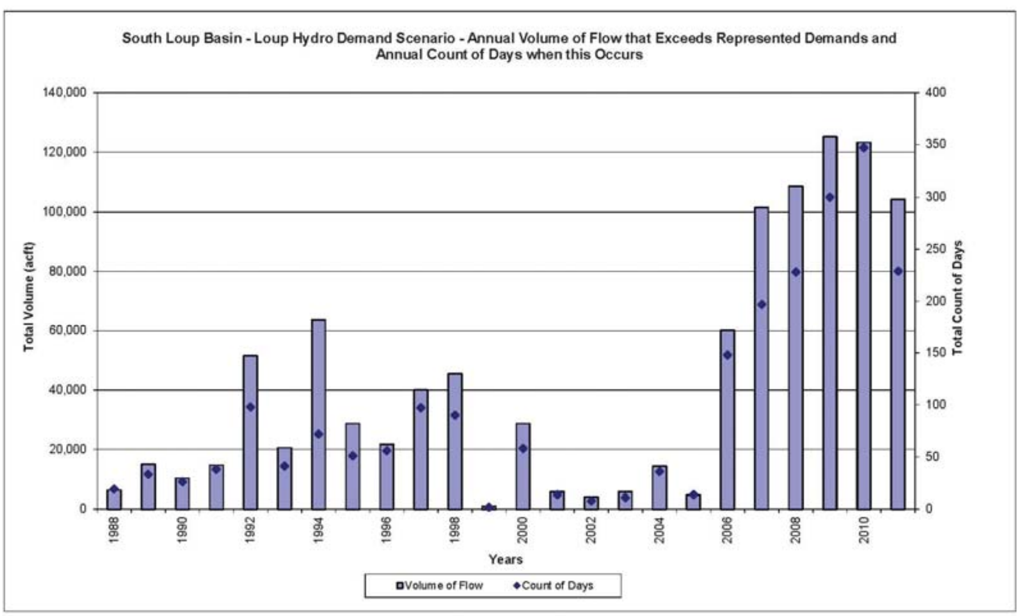


Figure B31: North Loup Subbasin,
Monthly Mean Flow in Excess of Instream Flow Demands as well as Full Loup Hydropower Demand with 95% Confidence Interval

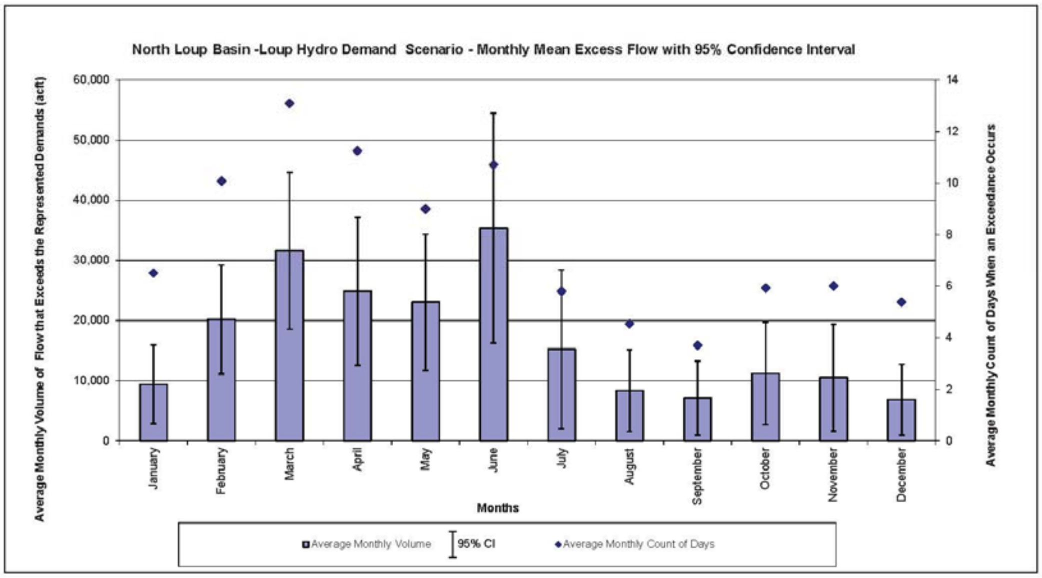


Figure B32: North Loup Subbasin,
Annual Volume of Flow that Exceeds both Instream Flow Demands and Full Loup Hydropower Demand and Annual Count of Days when this Occurs