WATER BALANCE CONSULTING

MEMO

To: Michael Cohen, Pacific Institute
From: Kevin Wheeler, Water Balance Consulting LLC
Date: 26-Oct-11
Re: Colorado River Limitrophe Analysis

Message

Pacific Institute contracted with Water Balance Consulting LLC to analyze existing data related to the flows in the Colorado River between the Northerly International Boundary (NIB) and Southerly International Boundary (SIB). This memo describes the analysis of these flows and provides suggestions for further study of this region.

This reach, commonly referred as the Limitrophe, is approximately 24 miles long, flows generally north to south and forms a portion of the border between the United States on the east and Mexico on the west. The reach is characterized by a meandering channel bed with extremely irregular geometry and variation in channel sinuosity and slope. The limitrophe is directly below Morelos Dam which is the last control structure on the Colorado River. Waters flowing within the channel are typically irregular and are the result of either:

- Non-Storable Flows (NSF's) that are released from Morelos Dam that occur due to releases from Parker Dam that are in excess of the diversion capacity of both the United States and Mexico.
- Seepage from the Morelos Dam
- Discharges from the MODE#3 outlet (Wellton-Mohawk Drainage Water Discharge to Colorado River)
- Discharges from the Eleven Mile Wasteway
- Discharges from the Twenty-One Mile Wasteway

Flow measurements taken at approximately 7 locations that are relevant to the limitrophe and are published by the International Boundary and Water Commission. These locations are:

- Colorado River at Northerly International Boundary
- Cooper Wasteway (Valley Diversion, Yuma Project)
- Intake Canal at Morelos Diversion Structure
- Wellton-Mohawk Drainage Water Discharged to Colorado River
- Eleven Mile Wasteway (Valley Division, Yuma Project)
- Twenty-One Mile Wasteway (Valley Division, Yuma Project)
- Colorado River at Southerly International Boundary

The primary purpose of was to review the data provided by IBWC and to understand the methods used to determine the flows at the SIB. This consisted of 3 phases including:

1. Conversations with IBWC staff to understand these methods and the unique challenges that exist to develop data at this location.
2. Review of the rating curve and shift methods reported by the IBWC for the SIB
3. Comparative Analysis of the calculated inflows to the Limitrophe to the reported flows at the SIB

Southerly International Boundary Gage Methods

Conversations with IBWC staff focused on the methods used to measure flows at the SIB. It is known that historical flow records were developed in the past with use of a traditional stream gage, however IBWC staff indicated that the SIB Gage is at continuous risk of vandalism, therefore no recording devices are currently left in place. Alternatively IBWC staff performs manual flow and stage measurements if and when flows occur at the SIB gage site. Due to the manual nature of these measurements, it is probable that some quantity of flows is not captured due to the practical aspects of staff scheduling and timing of changes in flows.

Rating Curve Shift Methods

The second part of this analysis focused on understanding the methods used by IBWC to calculate stream gage shifts and the potential impacts on the reported flow measurements at the SIB. A rating table was provided that was labeled as water year 2005 and related gage height to discharge. In addition, a stage computation sheet and hand-drawn diagrams were provided that appears to show linear interpolations of stream gage shifts. The method for determining rating curve shifts was determined by analyzing these plots. It was observed that points were plotted representing known gage heights of the water surface and calculated shifts based on periodic measurements. Specifically the measured flows, observed depth on a staff gage, and the depth of zero flow (value of a staff gage at the sediment bed and water interface) were compared to the values on the 2005 rating table. With this information, shifts at the two end points could be plotted and shifts at intermediate depths could be estimated. Although this method is technically credible, some misplotted values were noted and no rationale for various

inflection points could be determined, particularly when extrapolations beyond measured shifts were used. More detailed communication with the IBWC staff that produced these hand-drawn plots would be required to explain these anomalies and would clarify the detailed decisions that were made but not obvious from the plots themselves.

Comparative Analysis of Limitrophe Inflows to SIB Gage

The third part of this analysis consisted of a comparison between the calculated amount of water entering the limitrophe and the amount of water that is reported at the SIB. It is assumed that some amount of loss would occur into the subsurface and this phase attempted to estimate the quantity of these losses.

The basic equation used to determine the amount of water entering the limitrophe included the following:

Colorado River at Northerly International Boundary
+ Cooper Wasteway (Valley Diversion, Yuma Project)
- Intake Canal at Morelos Diversion Structure
+ Wellton-Mohawk Drainage Water Discharged to Colorado River
+ Eleven Mile Wasteway (Valley Division, Yuma Project)
+ Twenty-One Mile Wasteway (Valley Division, Yuma Project)

If the calculated flows exiting Morelos Dam (NIB + Cooper – Morelos Diversion) resulted in a negative flow, it was assumed that this contribution to the limitrophe was zero.

The results derived from the above equation were plotted against the flows reported at the SIB gage (Colorado River at Southerly International Boundary). A year-by-year analysis of this comparison provided a visual understanding of the seepage losses in the limitrophe. However it is also noted that the basis on which this comparison is made is potentially flawed due to the indirect nature of the values being compared. For example the equation described above is dominated by the subtraction of two comparatively large numbers (Colorado River at Northerly International Boundary - Intake Canal at Morelos Diversion Structure) therefore small errors in either of these two numbers can results in large uncertainties in the amount of contribution to the limitrophe through Morelos Dam. Since no permanent systematic errors were known to exist with any of the data provided by IBWC, the comparison over the period for which data from all these elements were available (1977-2005) yielded valuable information. Conclusions could be drawn that average daily flows entering the limitrophe of less than 2 cubic meters per second (cms) or approximately 70 cubic feet per second (cfs), rarely resulted in any noticeable flows at the SIB gage.

Numerical methods for determining loss rates were explored. With limited information on the physical properties of the channel, three simplified methods were explored: Constant Gain/Loss, Flow Variable Gain/Loss and Percolation Gain/Loss

The Constant Gain/Loss method uses an empirical relationship to calculate channel loss using a fixed flow rate reduction and a ratio of the flow. A fixed flow rate is subtracted from the routed flow and the remainder is multiplied by a ratio.

Outflow = (Inflow – X)* (1-Y)

X = Fixed Value; Y = Loss Fraction (0 to 1)

The Variable Gain/Loss method is similar to the Constant Gain/Loss Method, but the Loss Fraction is a variable and depends on the average flow rate for a fixed prior period. In addition,

a fixed threshold value can be selected that assumes a zero flow if the inflow is below this value.
Outflow = If (Inflow < X then 0, else Inflow)* (1-Y_z)
X = Fixed Threshold Value; Y_z = Variable Loss Fraction (0 to 1) as a function of z previous days

Percolation Loss/Gain method uses a constant infiltration rate in combination with the inundated area in the reach to compute channel loss. This requires an elevation-discharge function and percolation rate.

The Constant Gain/Loss method was deemed too simplified because it did not account for the large variability of seepage losses due to the effects of antecedent moisture conditions in the limitrophe. The Percolation Loss/Gain method was also infeasible without acquiring additional data on the hydraulics of the channel. The Variable Gain/Loss method was applied through a spreadsheet model and optimization function.

To apply the Variable Gain/Loss method, the calculated inflows to the Limitrophe were compared to a fixed threshold value. If the inflows were below this threshold, the outflow was assumed to be zero. If the inflow were greater than this threshold, the inflows were multiplied by a percentage loss fraction that is selected from a table based on the value of the average flow over a selected period of days. An estimated threshold value of 2 cms was determined through visual inspection of the data and a period of 20 days was selected to represent the maximum period of influence from antecedent conditions. An objective function was constructed that represented the sum of the absolute values of the differences between the reduced calculated inflows and the gaged flows at the SIB. A Generalized Reduced Gradient (GRG) Nonlinear optimization algorithm was used to minimize the result of this objective function by modifying the percent loss values for each flow over the averaging period.

The results are a distribution of flow losses ranging from 70% for 20 day average flow to less than 5% losses for flows greater than 50 cms as shown in Figure 1.

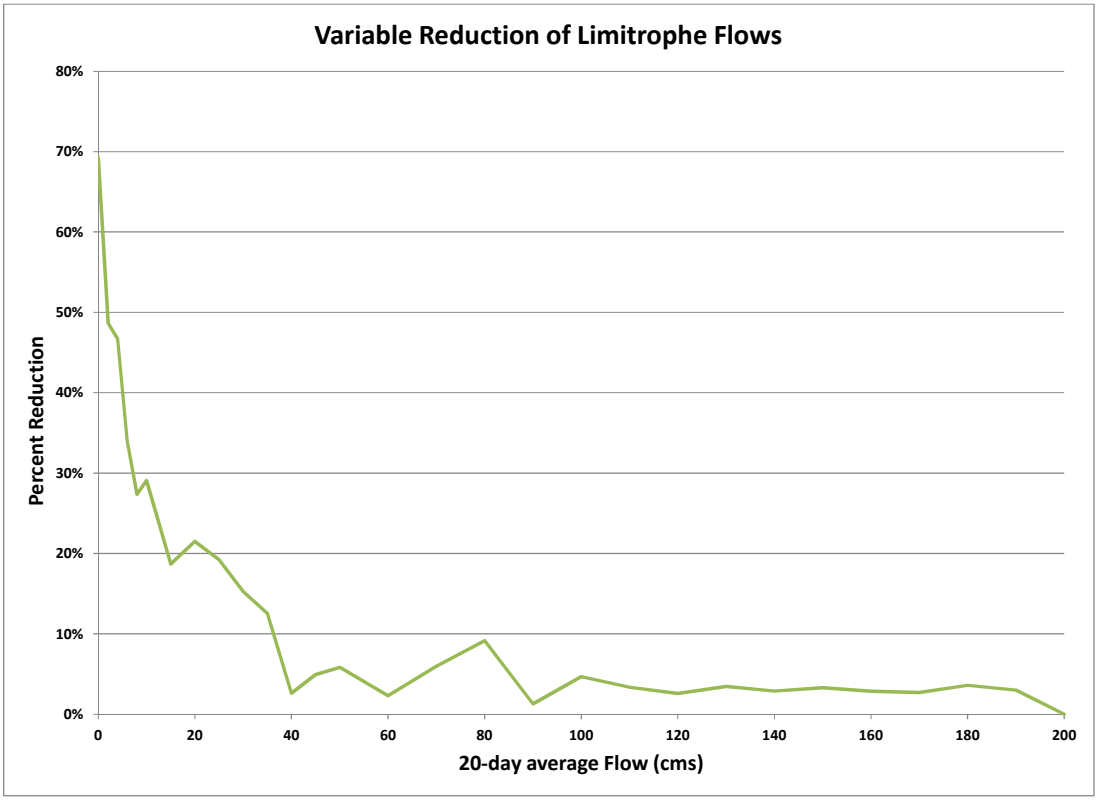


Figure 1. Modeled variable reduction of flows between the Inflows to the limitrophe and the flows reported at the SIB

A lag of 1 day was assumed in the model based on visual observation of peak inflows into the limitrophe and peak flows passing through the SIB. Several more sophisticated lag methods could be applied, but with increased assumption requirements.

Additional Analysis Possibilities

The model descried above applies a simple lag and gain/loss method to the inflows to the limitrophe to calculate an outflow from the limitrophe. Many potential improvements can be made to this analysis including a more thorough understanding of the quality of the input data, modifying the above analysis to reflect any erroneous data reported by IBWC, and applying alternative methods to better estimate the quantity and timing of flows through the limitrophe.

Ungaged Flows through the SIB

The utility of this analysis is limited by the accuracy of the data itself. Through this analysis, it became apparent that various methods for collecting gage data at the SIB have been used throughout the years. Comparing the inflows into the limitrophe to the flows reported at the SIB, it appears as though some flows are not captured at the SIB gage. An example of potentially missed flows is shown in Figure 2. This is expected due to the manual methods used to collect data at the SIB which is necessary according to IBWC. The above analysis can be modified to extract such occurances and to refine the loss estimates.

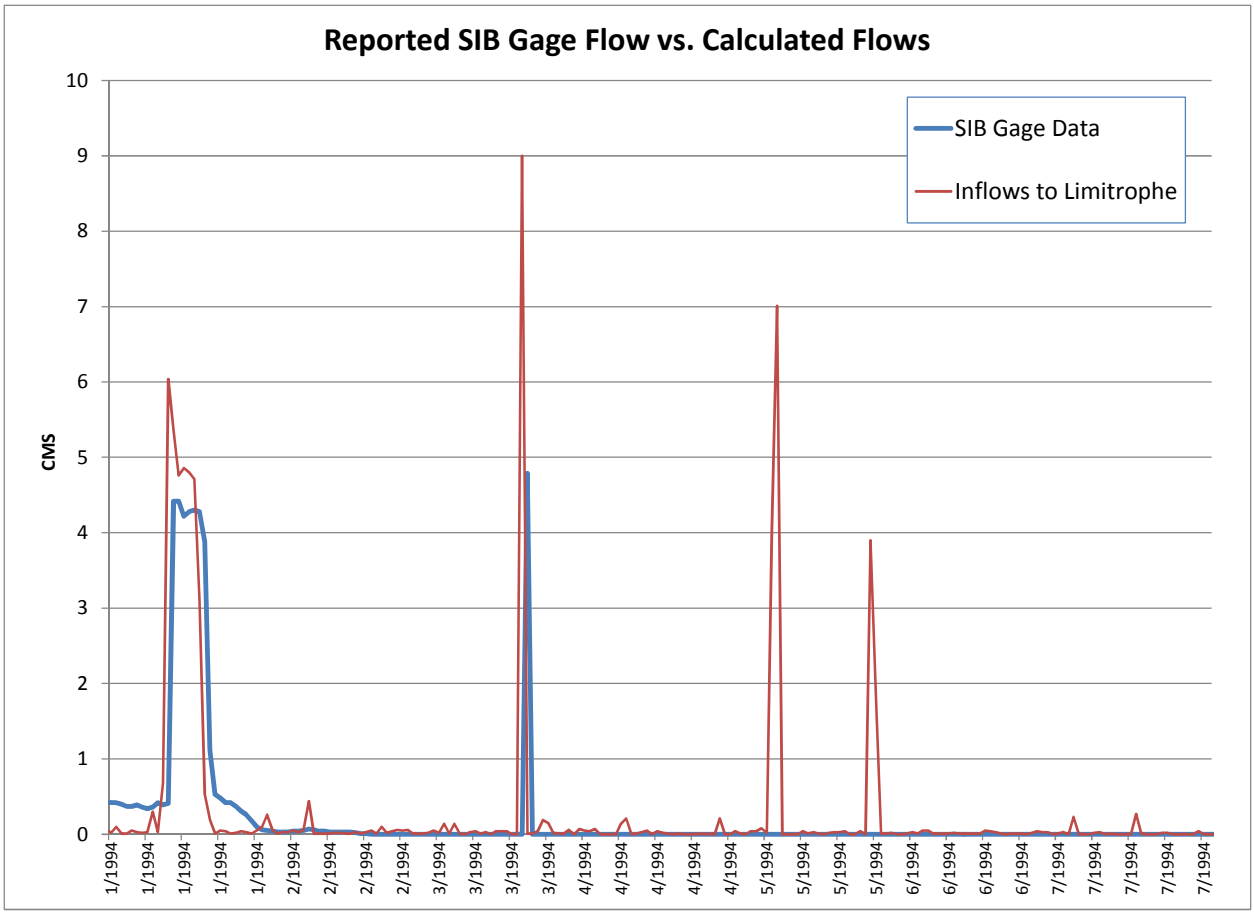


Figure 2. Example of Apparent Inflows into the Limitrophe not captured by the SIB Gage measurement

Additional uncertainly exists in the data used to calculate the inflows into the limitrophe. During the period of record, the methods and equipment that were used to measure flows likely varied and therefore anomolies may exist that affect the results of this analysis. No efforts were made in this study to analyze the quality of the the data for flows entering the limitrophe.

Possible Routing Method Improvements

Improvements to the routing method could be performed with additional information and resources. A list of various routing methods and the information required to apply these methods are provided below:

Lag Routing

- Simple Time

Straddle Stagger Routing

- Lag – Travel Time through Reach
- Duration – Amount of spreading in a flood peak

Muskingum Routing

- Muskingham K = Travel Time
- Muskingham X = Weighting between inflow and outflow influence (attenuation)

Modified Puls Routing (Storage Routing)

- Storage-Discharge Function

Kinematic Wave Routing

- Reach Length
- Slope
- Manning's n
- Channel Geometry

Muskingum-Cunge Routing

- Length
- Slope
- Manning's n
- Channel Geometry

Bank storage

Although modification of loss rates were considered in the analysis described above, there is no consideration for the effects of bank storage allowing flows to occur after flood flows in the channel have subsided. Observations such as Figure 3 in the comparative analysis demonstrate examples when this potentially occurs or other sources or sinks of water may exist.

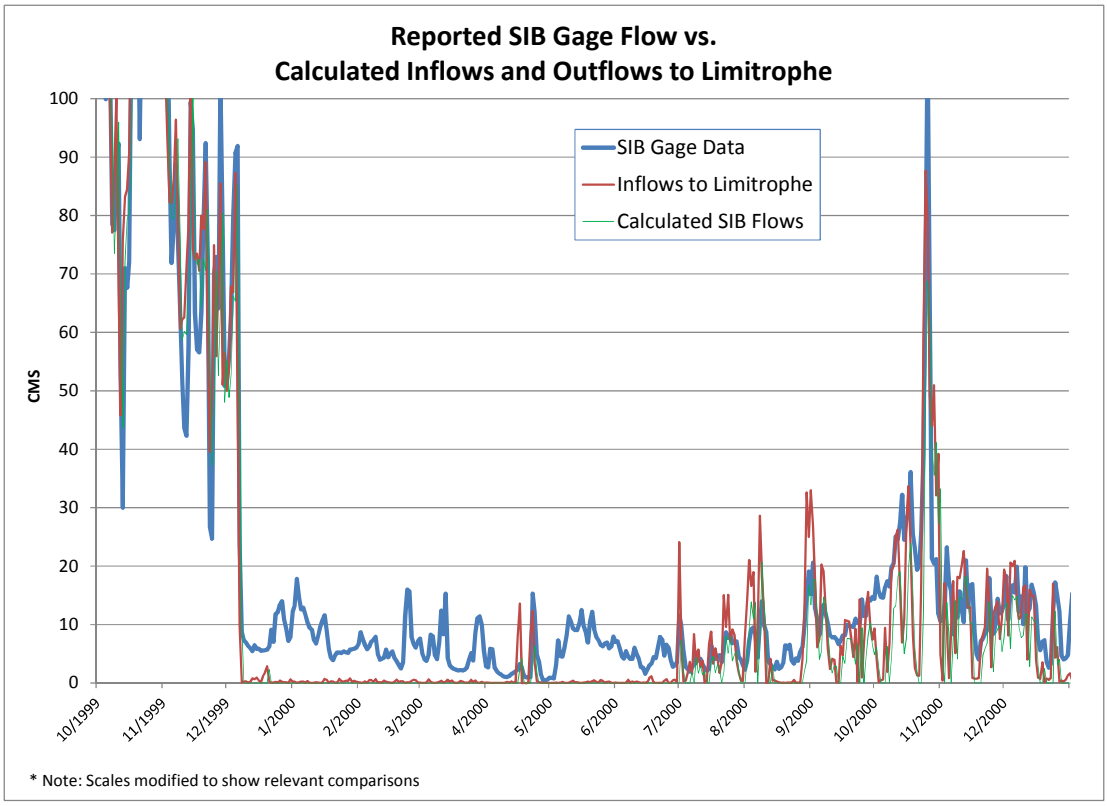


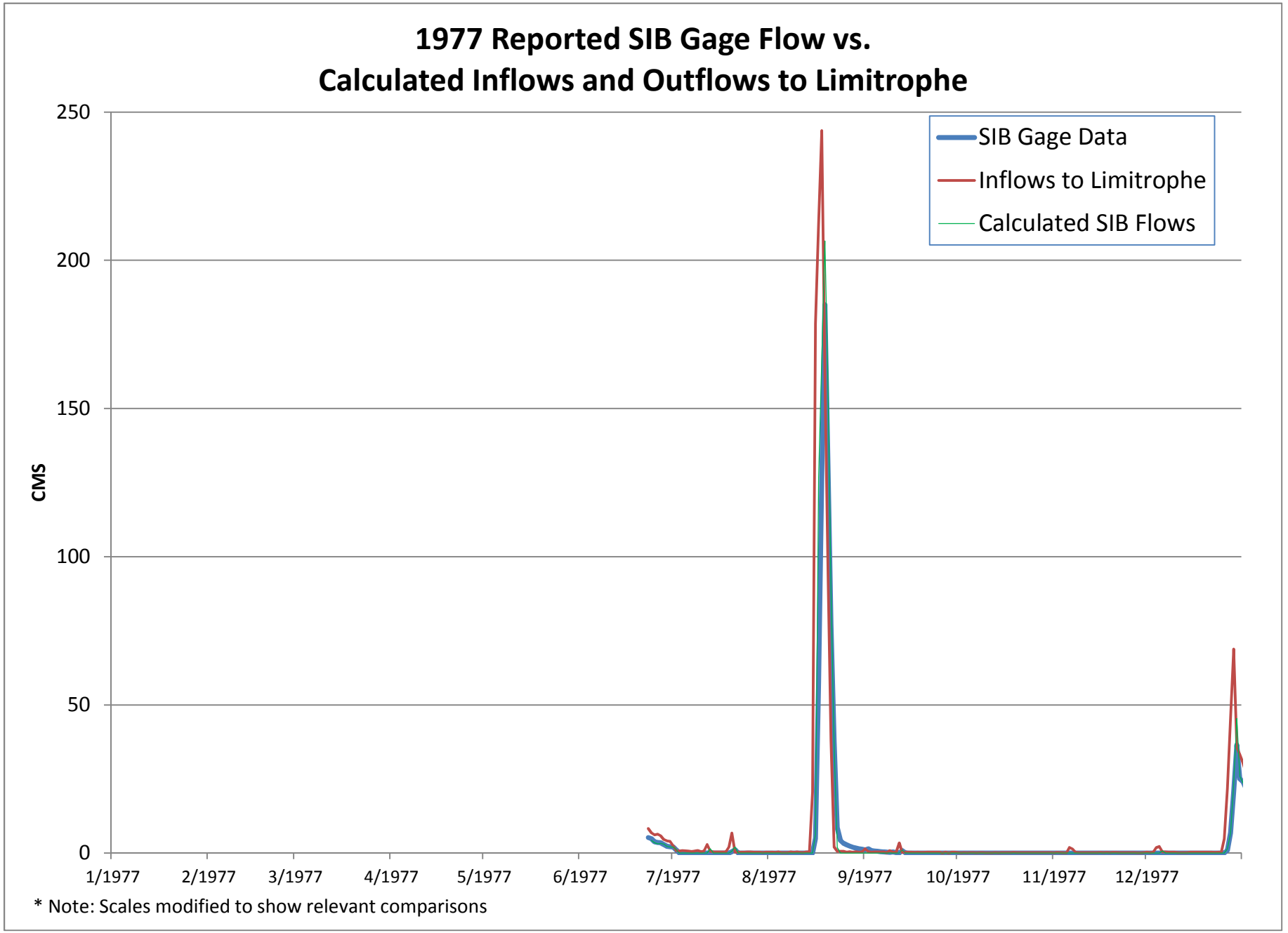
Figure 3. Flows recorded at the SIB and not directly accounted for through known inflows

Conclusion

The analysis presented above attempts to create an understanding of the data published by IBWC that affects flows in the limitrophe region of the Colorado River. The methods for data collection at the SIB are challenging due to the circumstances which precludes a more traditional stream gage equipment to be used. A comparative analysis of the flows entering the limitrophe with the flows reported at the SIB demonstrate the level of similarity between these datasets. Differences between these datasets are potentially the result of physical processes such as seepage losses, attenuation, bank storage, or data issues such as unmeasured or mismeasured flows. Techniques were used to estimate seepage losses and a simplified routing method was applied. Suggestions for further analysis are also presented in this memo.

Included is an appendix of annual plots comparing SIB Gage Data, inflows to the limitrophe and calculated flows at the SIB after accounting for lags and losses as described above.

Appendix


1977 Reported SIB Gage Flow vs.
Calculated Inflows and Outflows to Limitrophe
250
200
150
100
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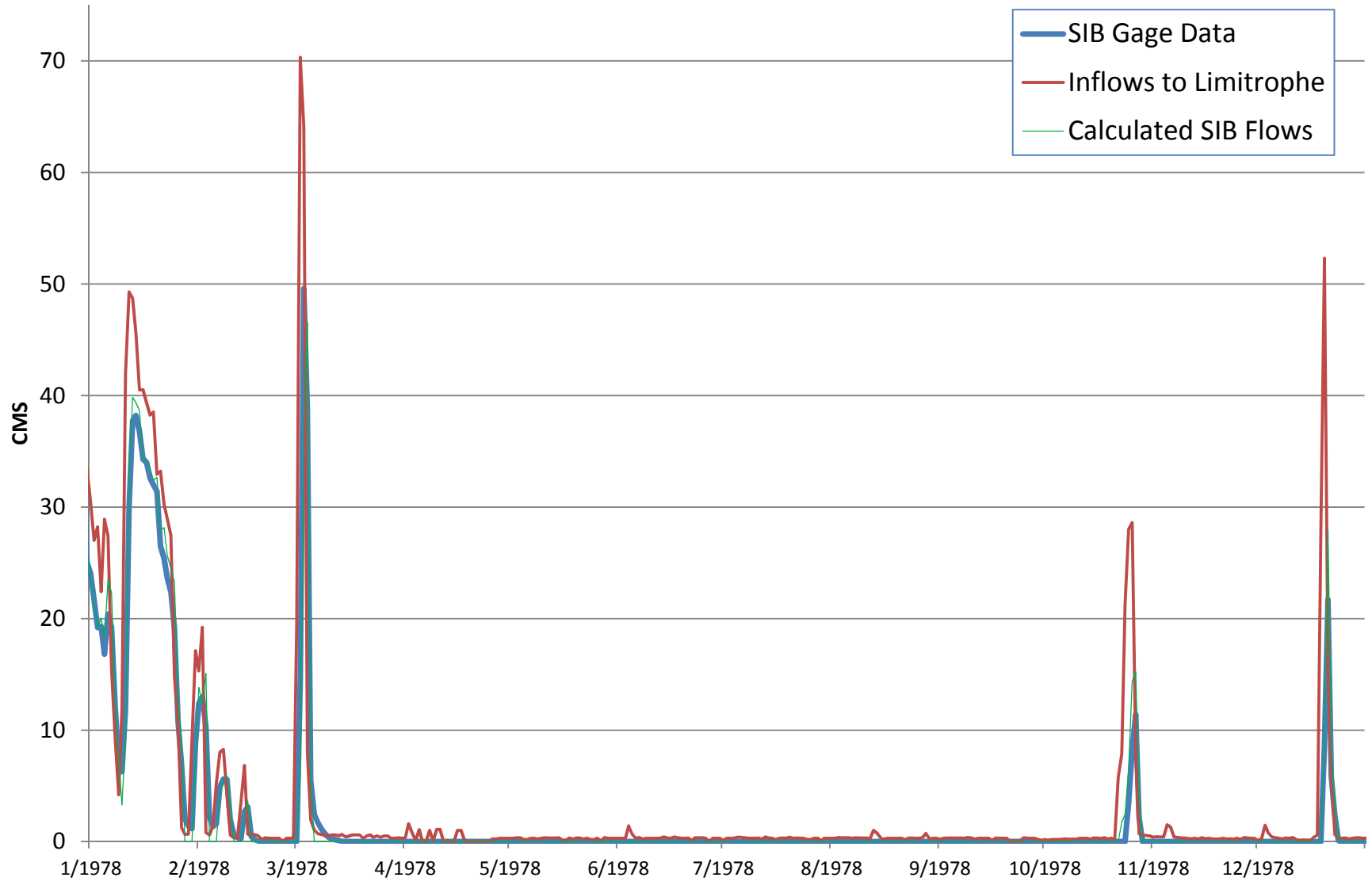
0
CMS
SIB Gage Data
Inflows to Limitrophe
Calculated SIB Flows
1/1977
2/1977
3/1977
4/1977
5/1977
6/1977
7/1977
8/1977
9/1977
10/1977
11/1977
12/1977
* Note: Scales modified to show relevant comparisons

1978 Reported SIB Gage Flow vs. Calculated Inflows and Outflows to Limitrophe



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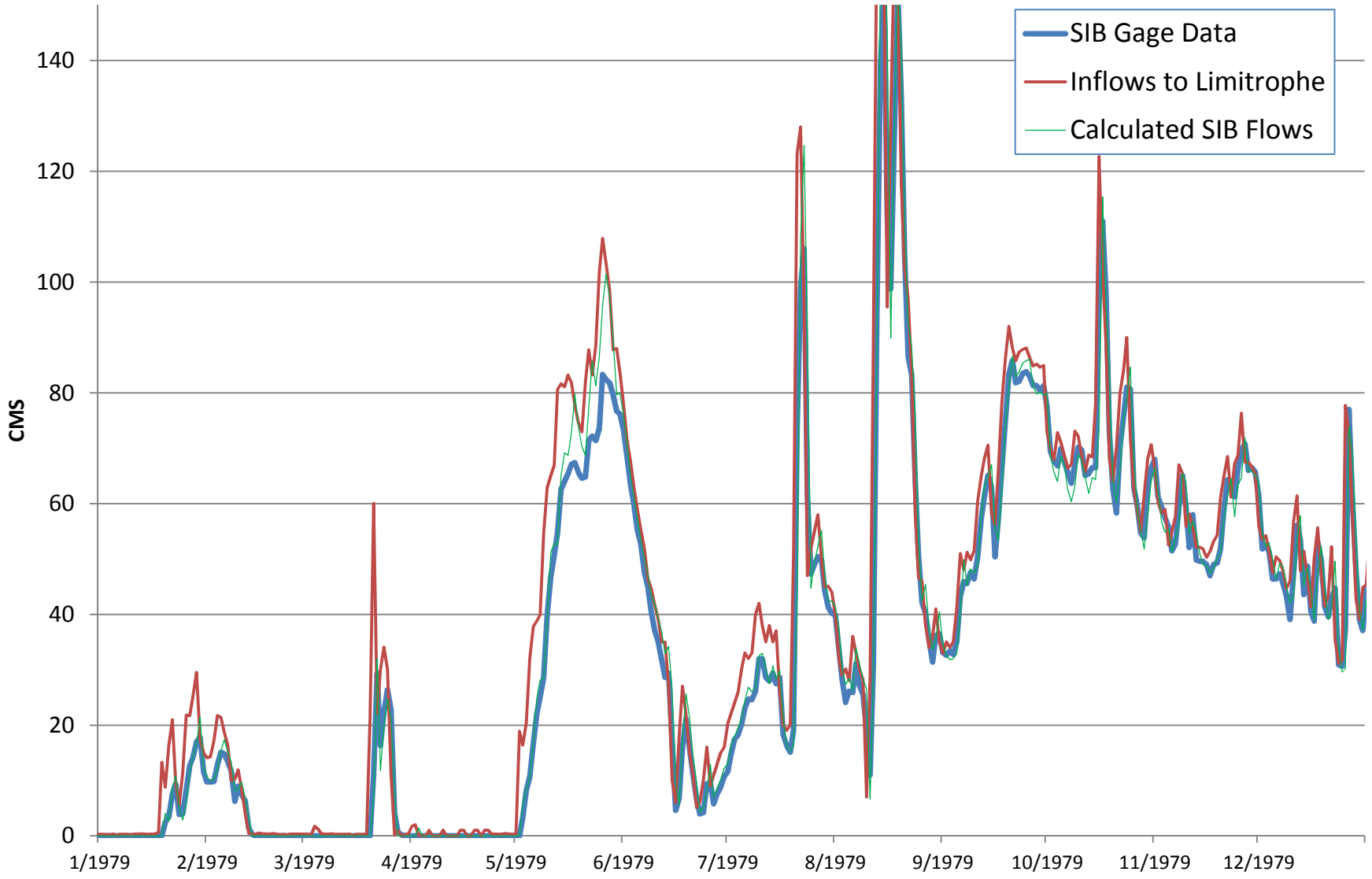
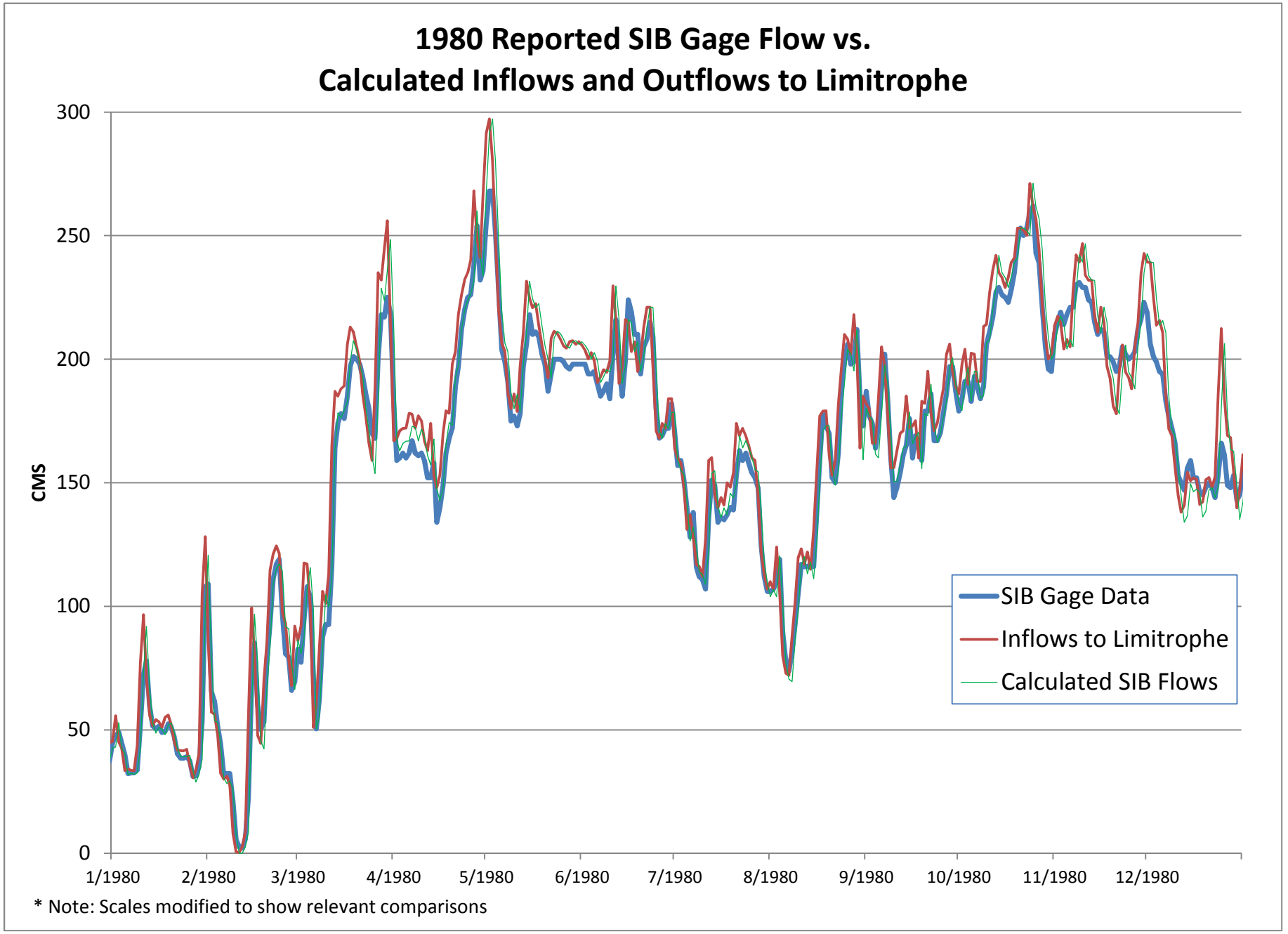
1979 Reported SIB Gage Flow vs. Calculated Inflows and Outflows to Limitrophe



* Note: Scales modified to show relevant comparisons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Calculated Inflows and Outflows to Limitrophe
CMS
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3/1980
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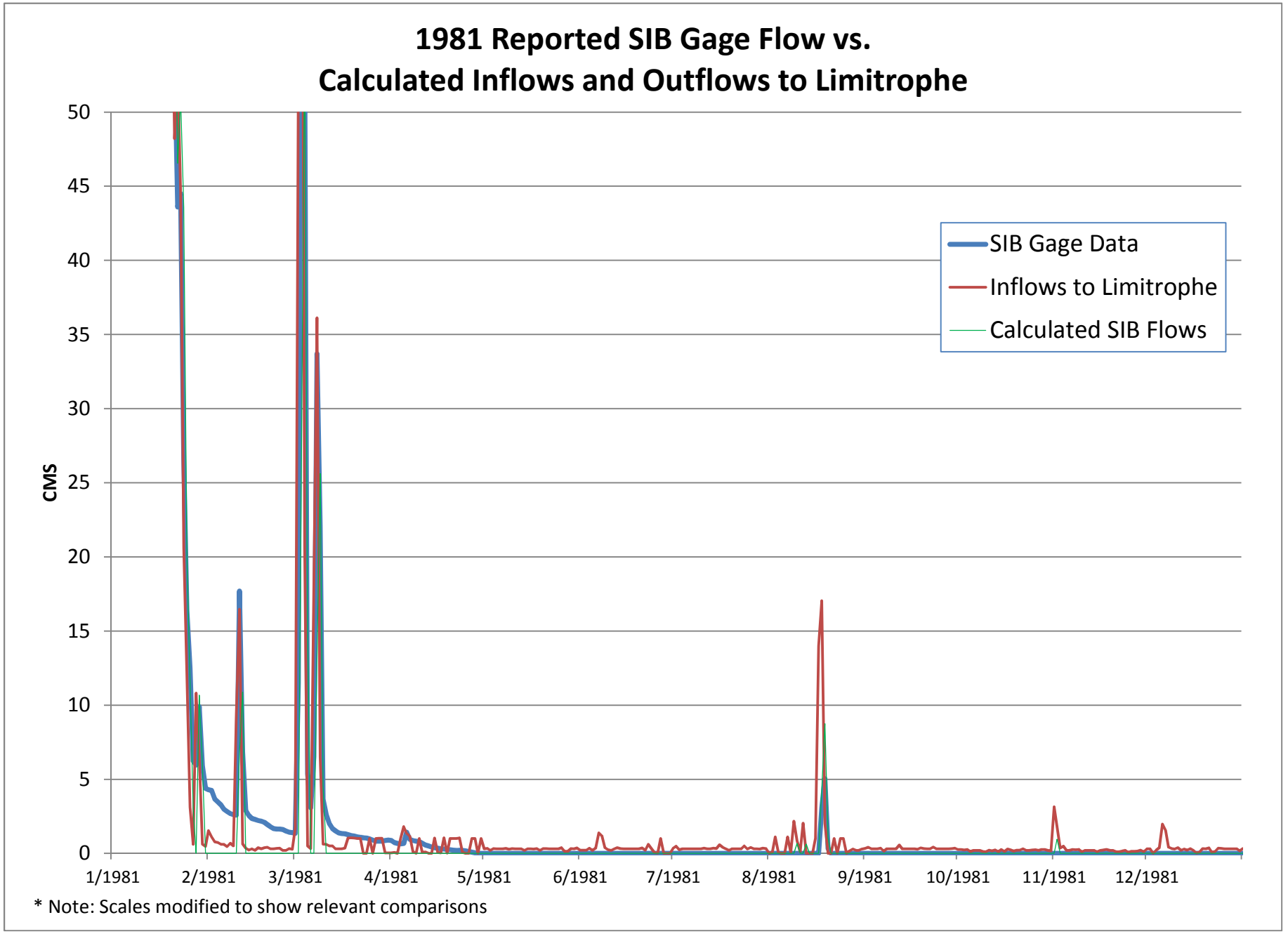
12/1980
SIB Gage Data
Inflows to Limitrophe
Calculated SIB Flows
* Note: Scales modified to show relevant comparisons


1981 Reported SIB Gage Flow vs.
Calculated Inflows and Outflows to Limitrophe
CMS
50
45
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1/1981
2/1981
3/1981
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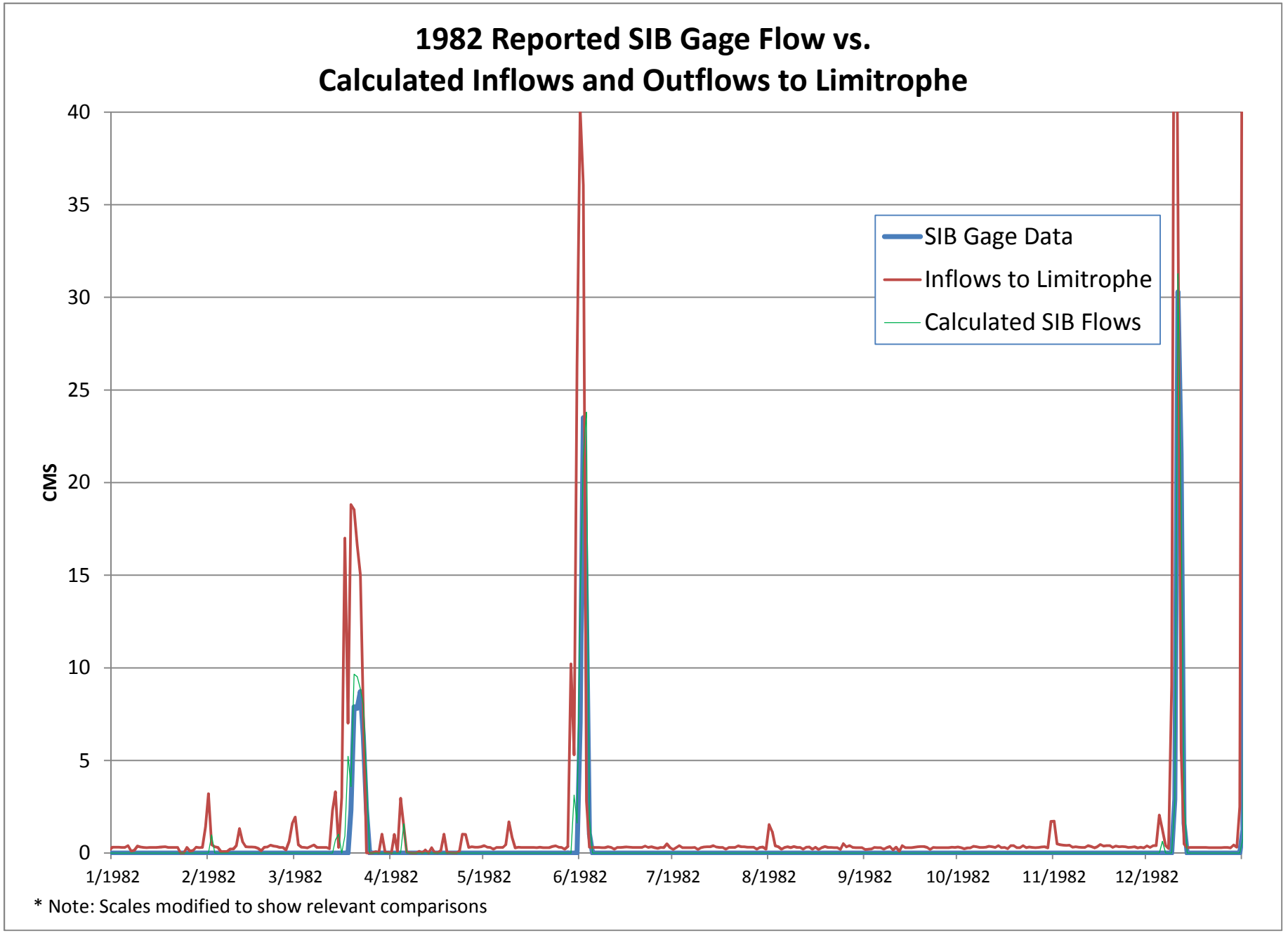
12/1981
SIB Gage Data
Inflows to Limitrophe
Calculated SIB Flows
* Note: Scales modified to show relevant comparisons


1982 Reported SIB Gage Flow vs.
Calculated Inflows and Outflows to Limitrophe
CMS
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35
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1/1982
2/1982
3/1982
4/1982
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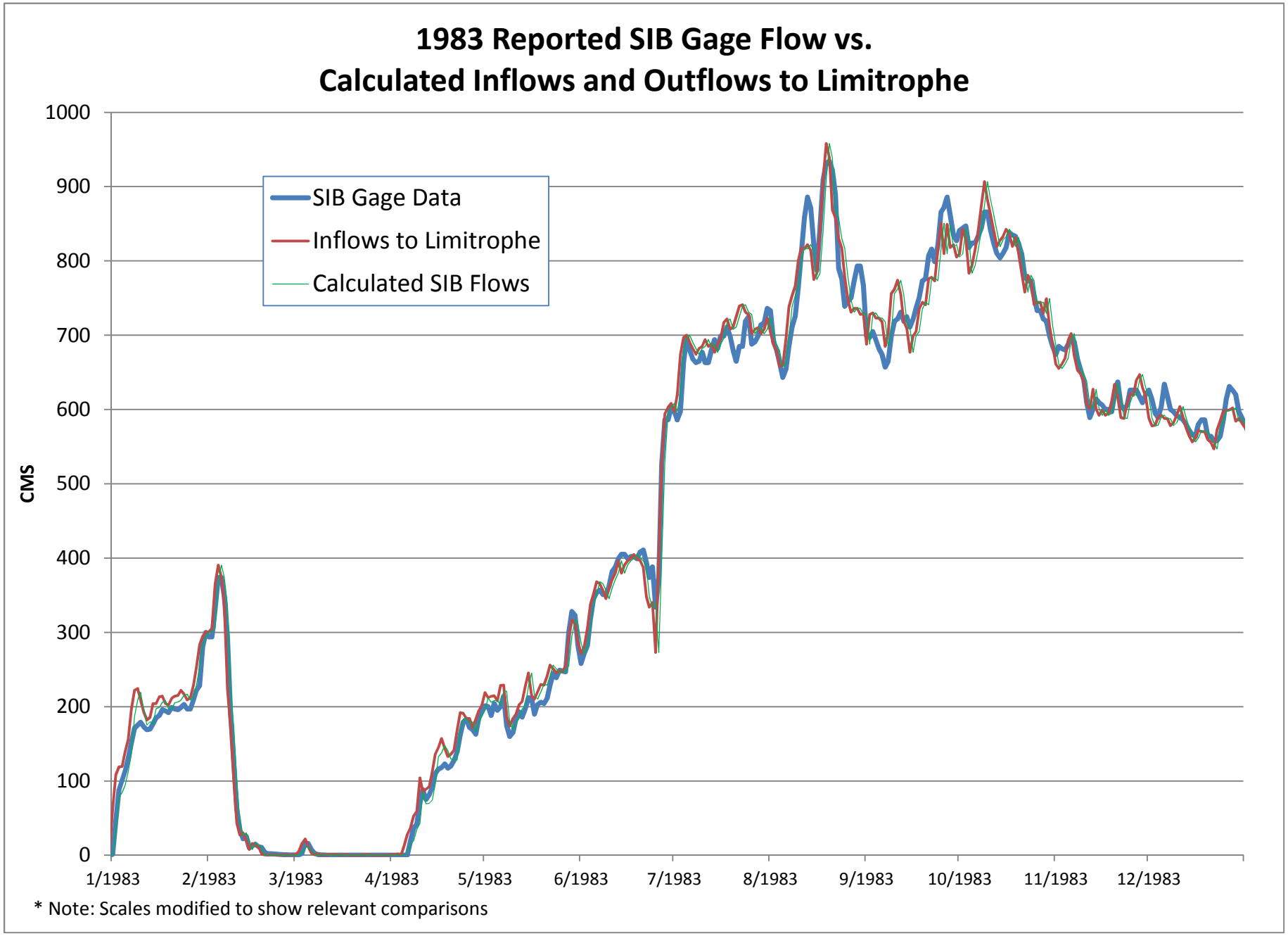
SIB Gage Data
Inflows to Limitrophe
Calculated SIB Flows
* Note: Scales modified to show relevant comparisons


1983 Reported SIB Gage Flow vs.
Calculated Inflows and Outflows to Limitrophe
SIB Gage Data
Inflows to Limitrophe
Calculated SIB Flows
CMS
1000
900
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1/1983
2/1983
3/1983
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9/1983
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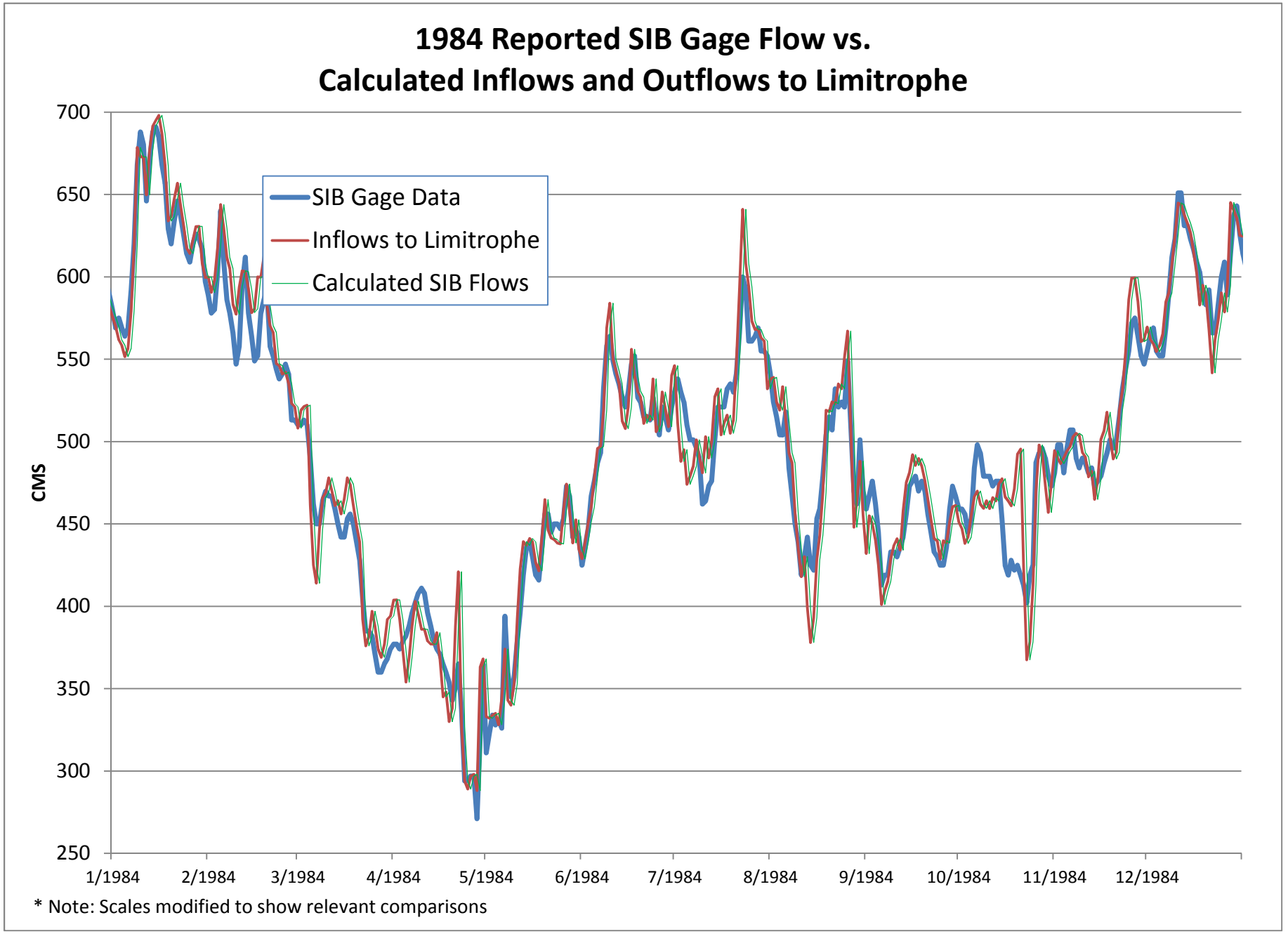
11/1983
12/1983
* Note: Scales modified to show relevant comparisons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Calculated Inflows and Outflows to Limitrophe
SIB Gage Data
Inflows to Limitrophe
Calculated SIB Flows
CMS
700
650
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300
250
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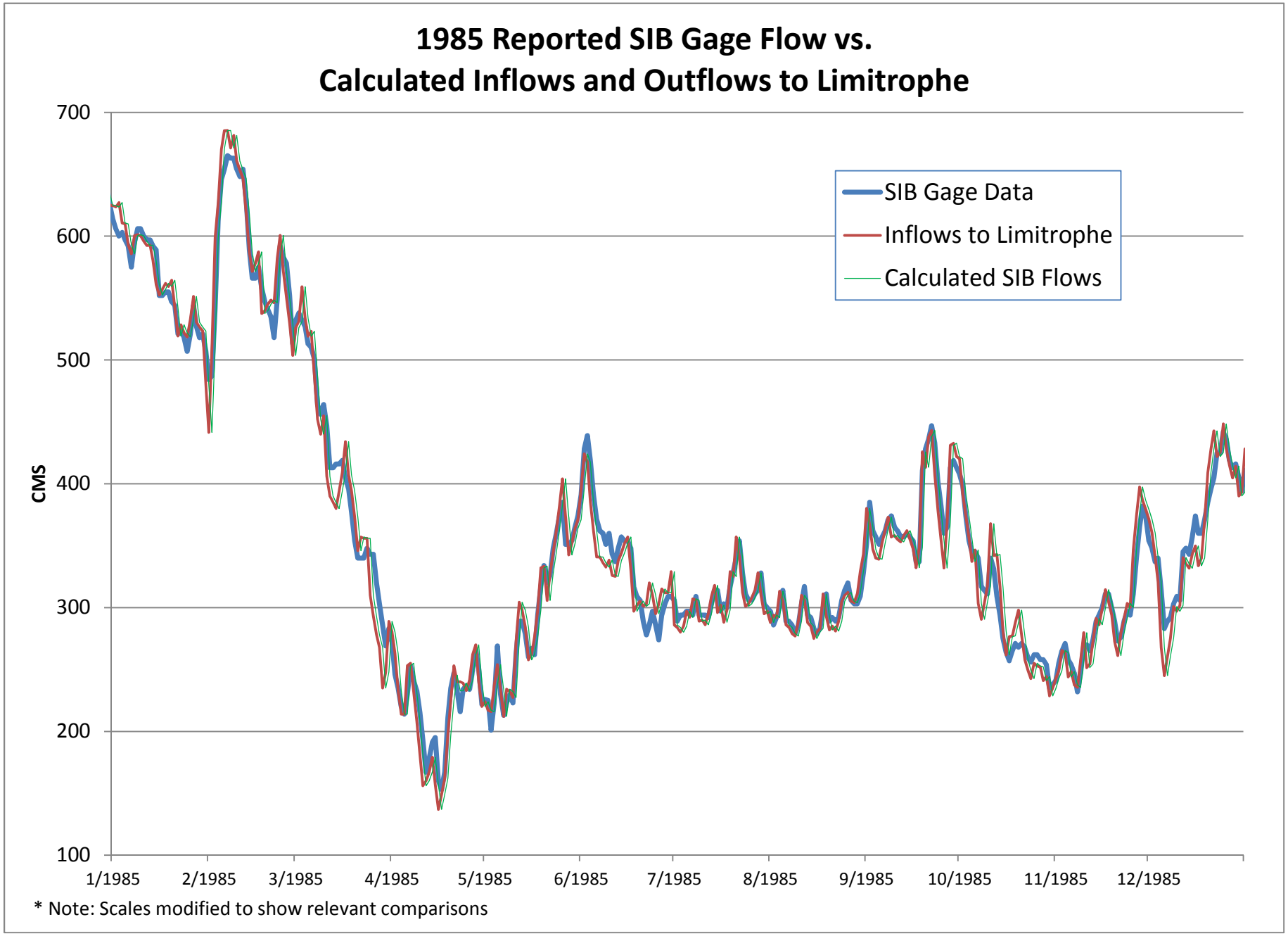
* Note: Scales modified to show relevant comparisons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Calculated Inflows and Outflows to Limitrophe
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SIB Gage Data
Inflows to Limitrophe
Calculated SIB Flows
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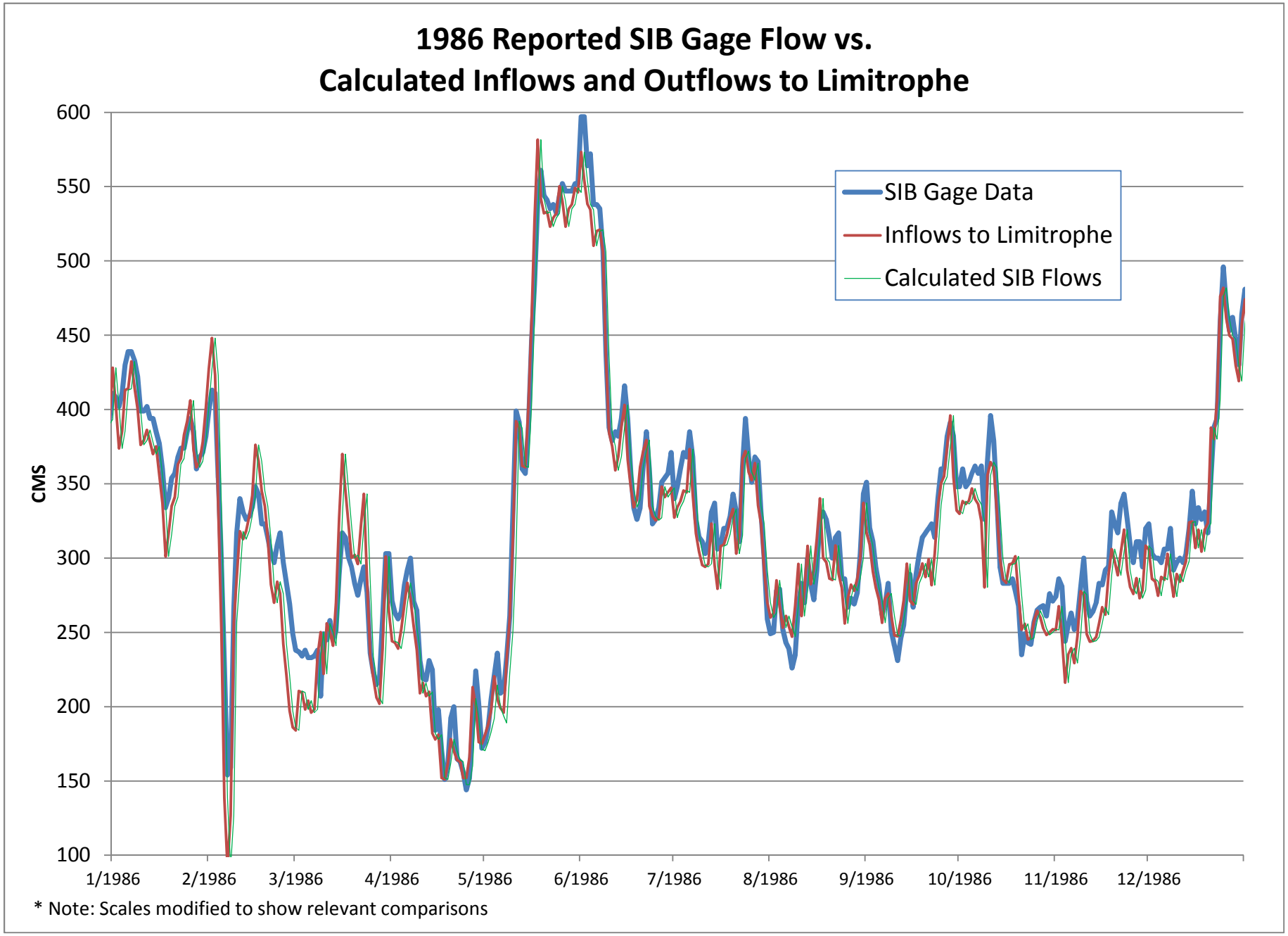
* Note: Scales modified to show relevant comparisons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Calculated Inflows and Outflows to Limitrophe
600
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300
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SIB Gage Data
Inflows to Limitrophe
Calculated SIB Flows
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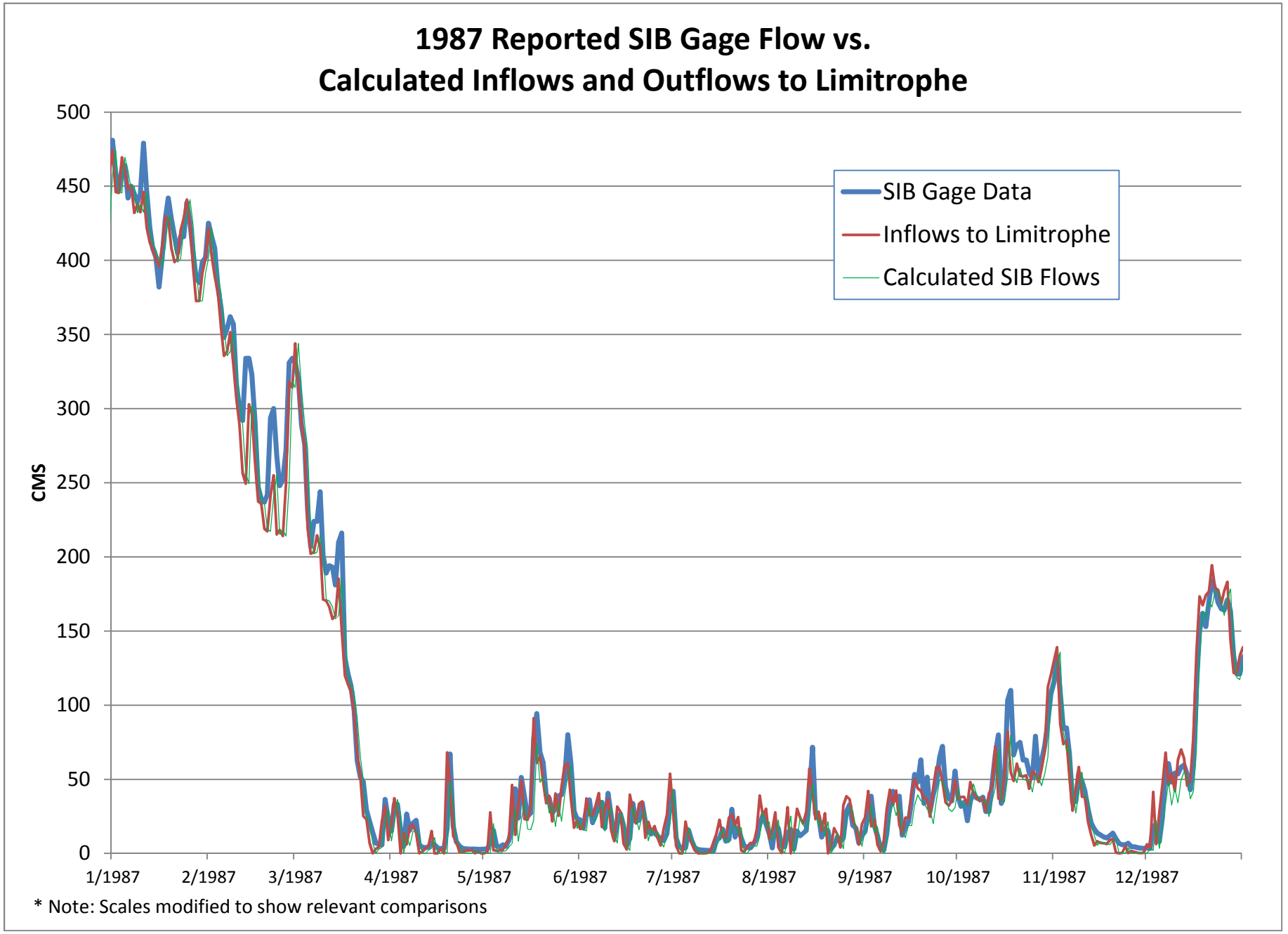
* Note: Scales modified to show relevant comparisons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CMS
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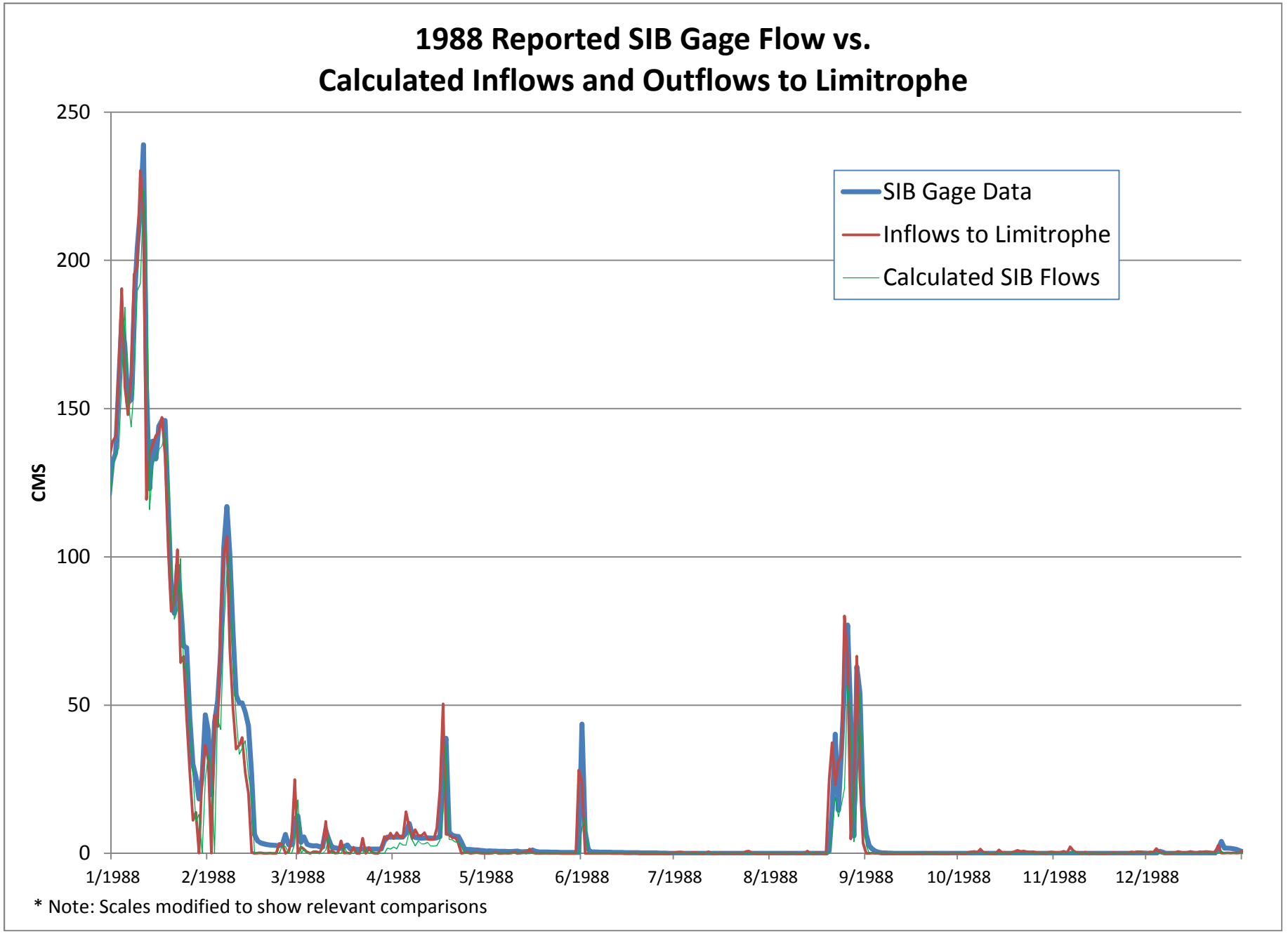
Inflows to Limitrophe
Calculated SIB Flows
* Note: Scales modified to show relevant comparisons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SIB Gage Data
Inflows to Limitrophe
Calculated SIB Flows
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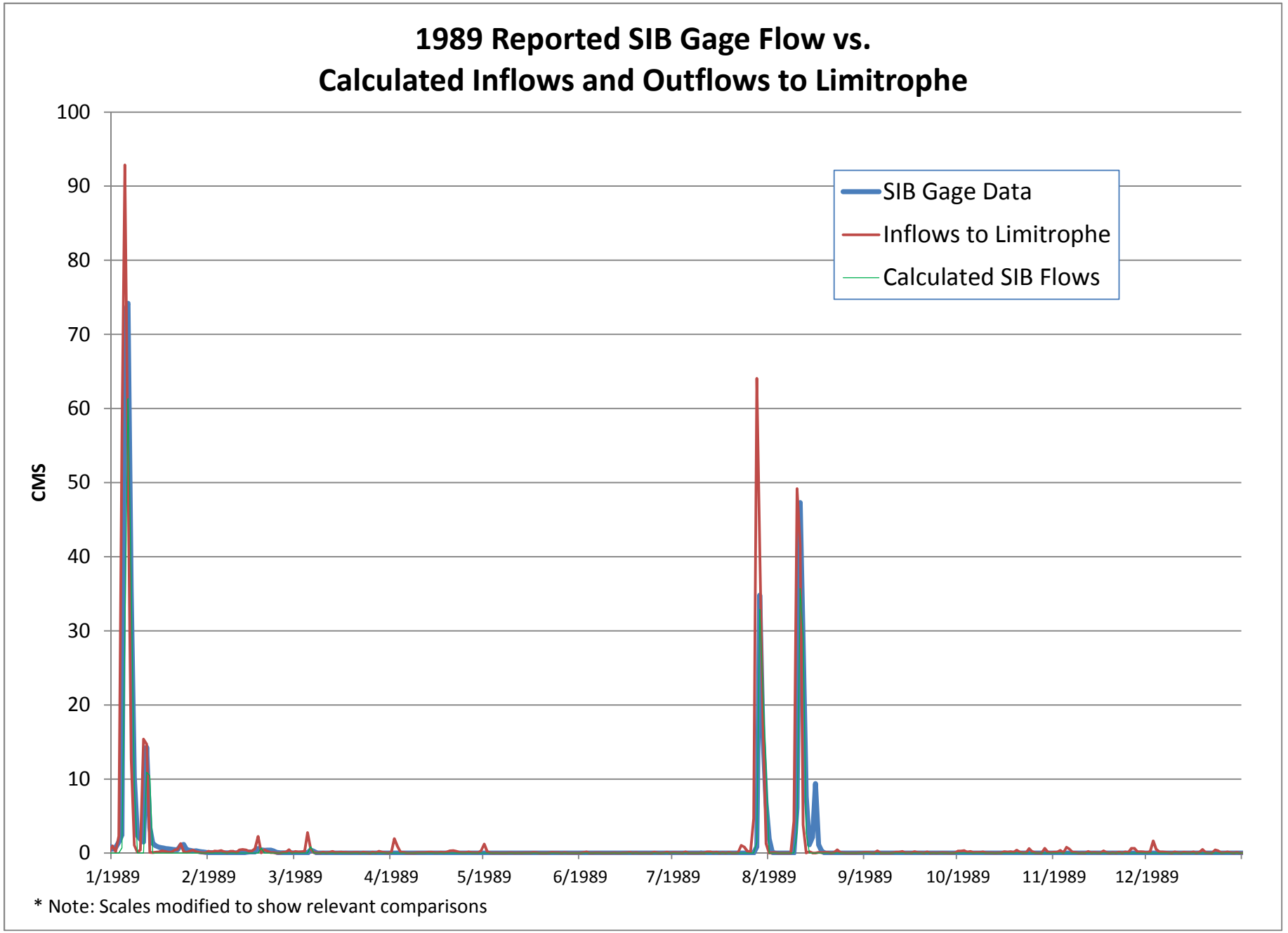
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CMS
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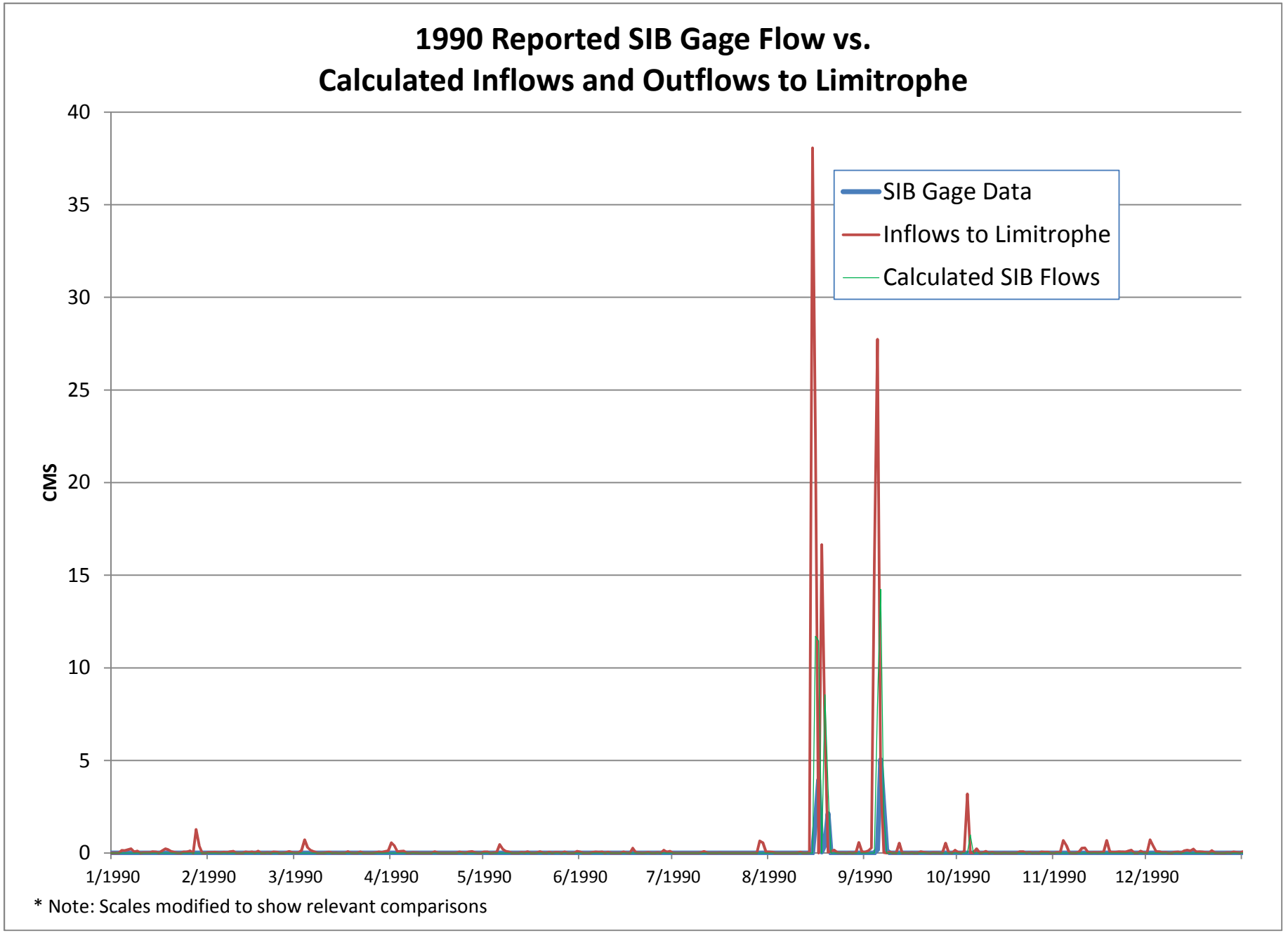
Inflows to Limitrophe
Calculated SIB Flows
* Note: Scales modified to show relevant comparisons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CMS
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Inflows to Limitrophe
Calculated SIB Flows
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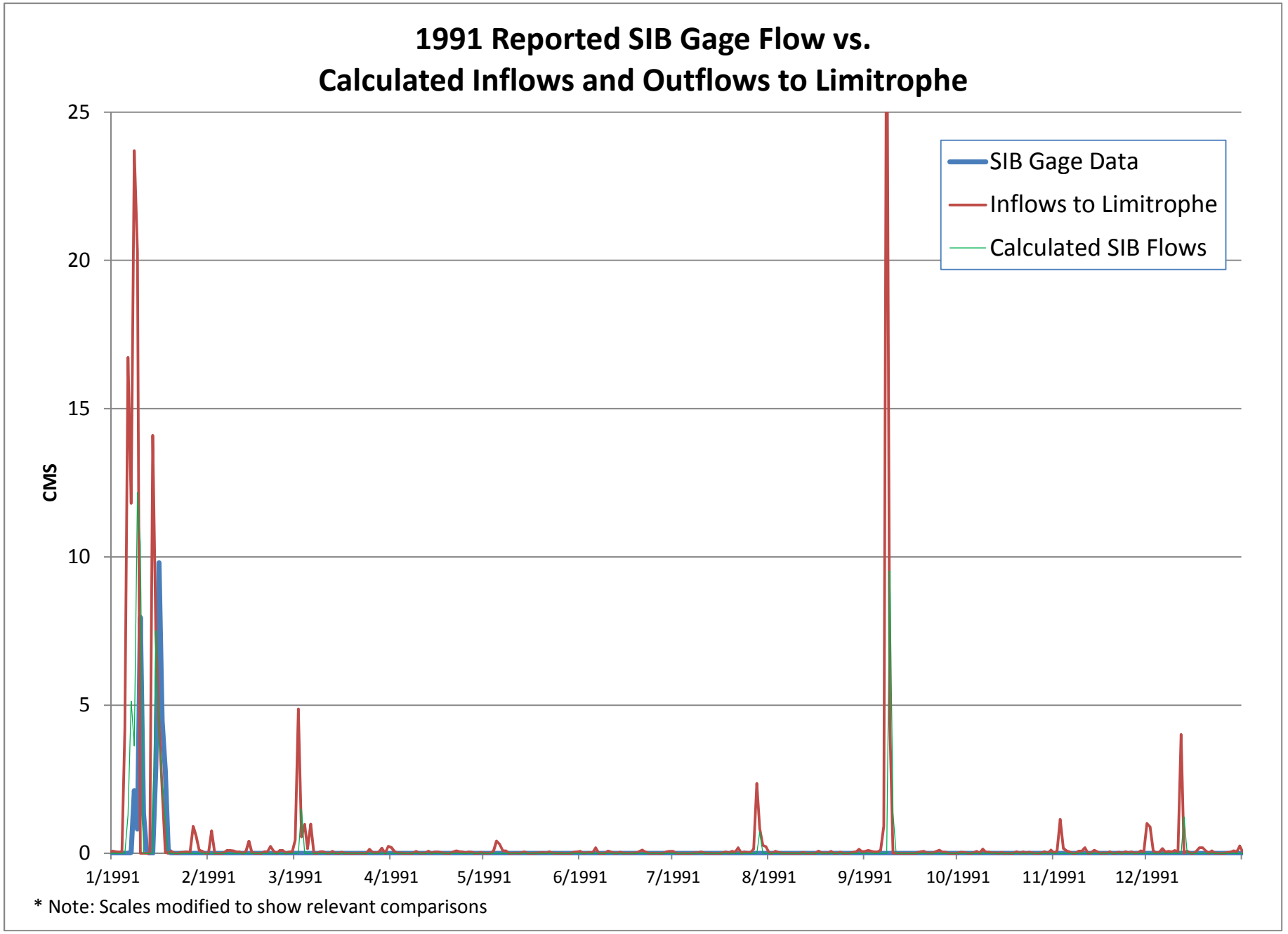
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Calculated SIB Flows
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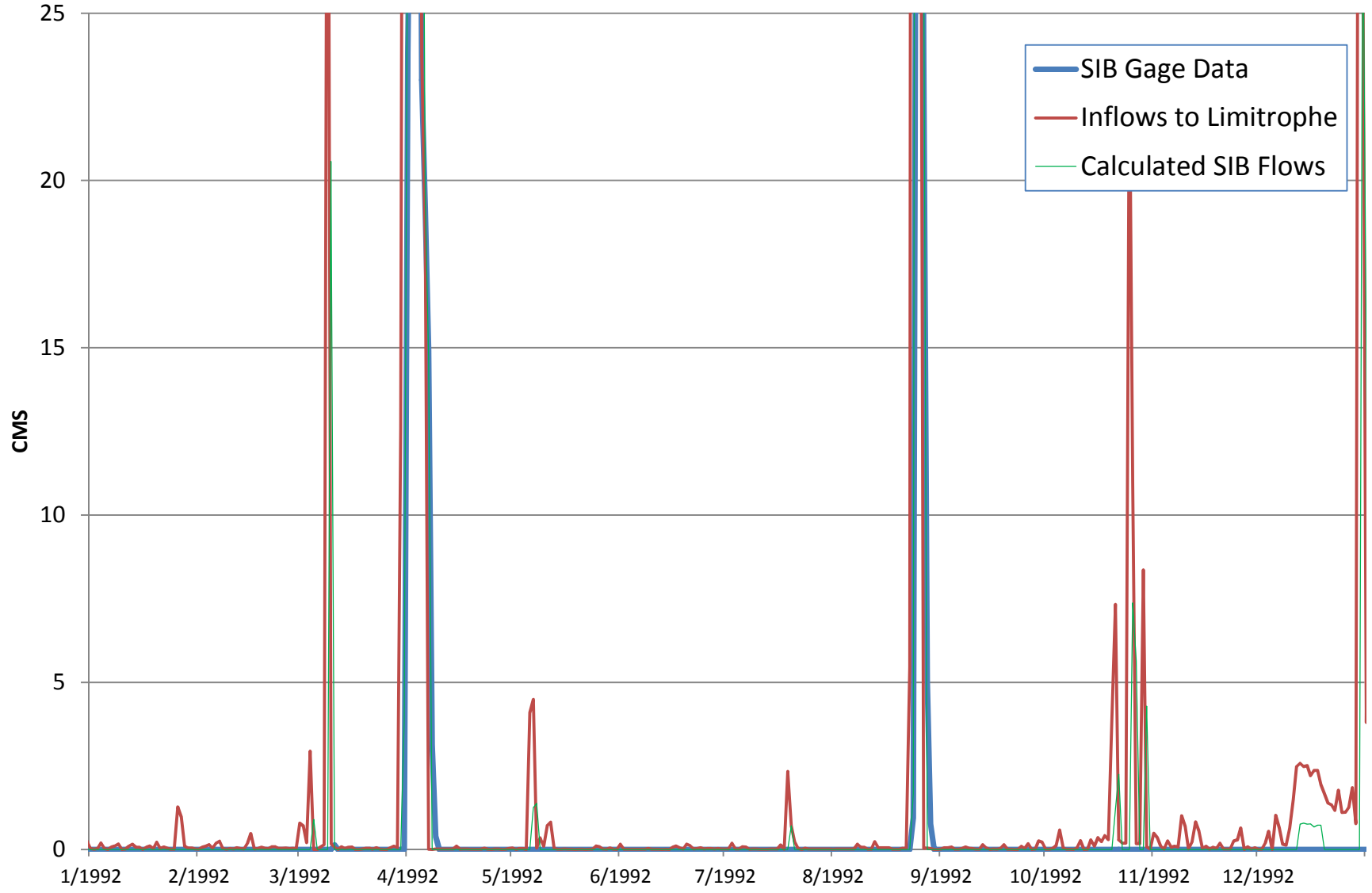
* Note: Scales modified to show relevant comparisons

1992 Reported SIB Gage Flow vs. Calculated Inflows and Outflows to Limitrophe



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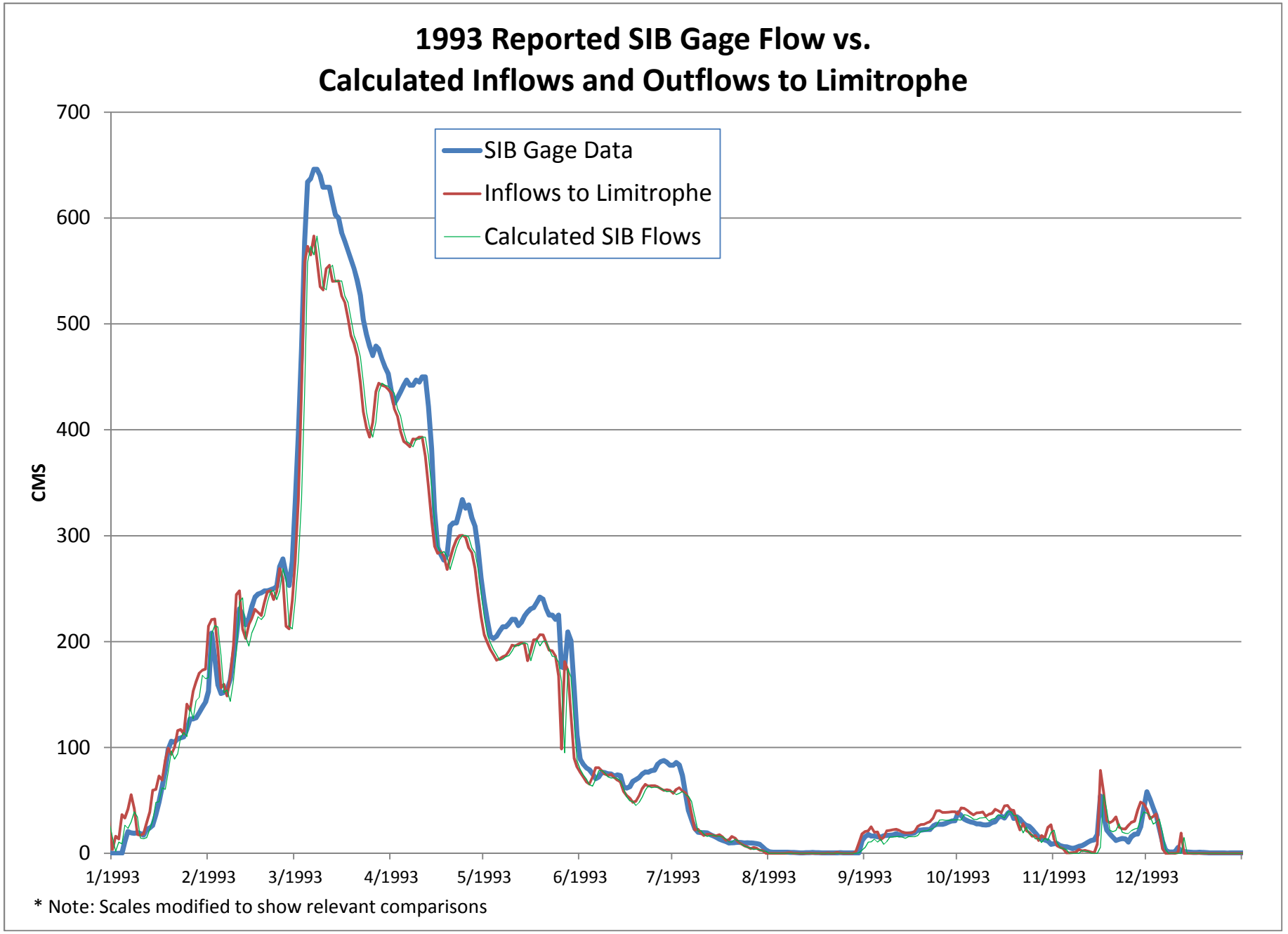
1993 Reported SIB Gage Flow vs.
Calculated Inflows and Outflows to Limitrophe
SIB Gage Data
Inflows to Limitrophe
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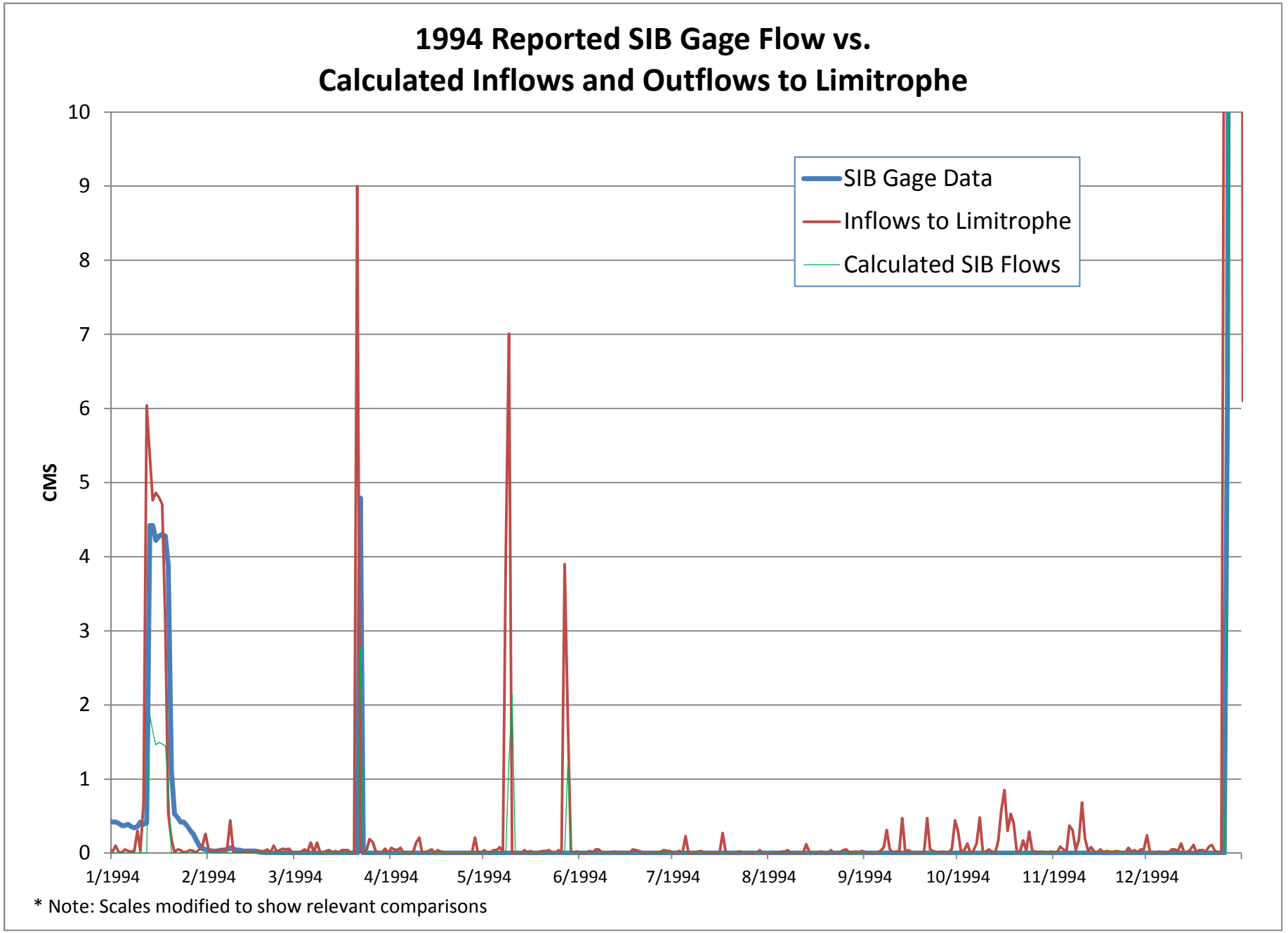
12/1993
* Note: Scales modified to show relevant comparisons


1994 Reported SIB Gage Flow vs.
Calculated Inflows and Outflows to Limitrophe
CMS
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1/1994
2/1994
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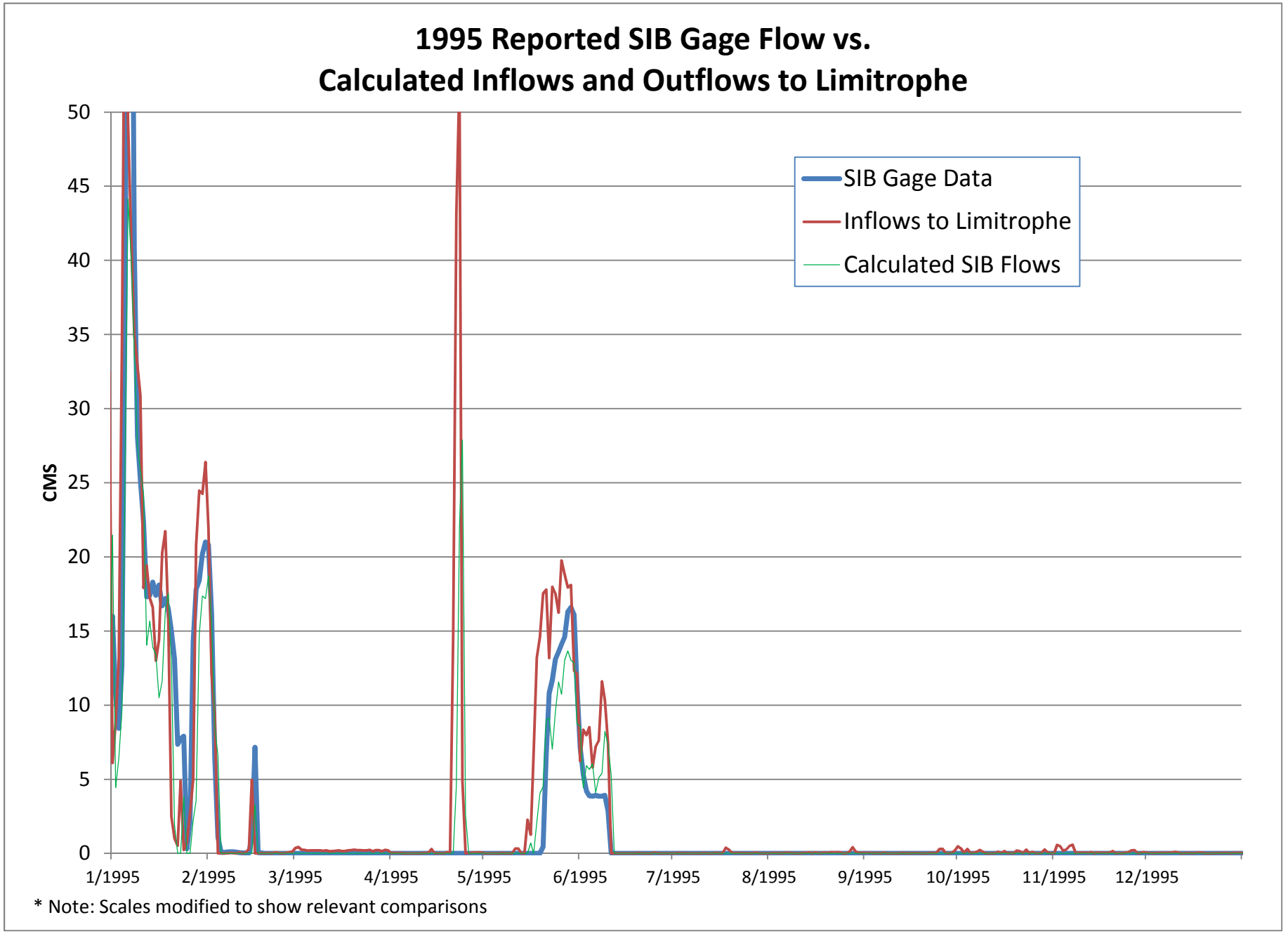
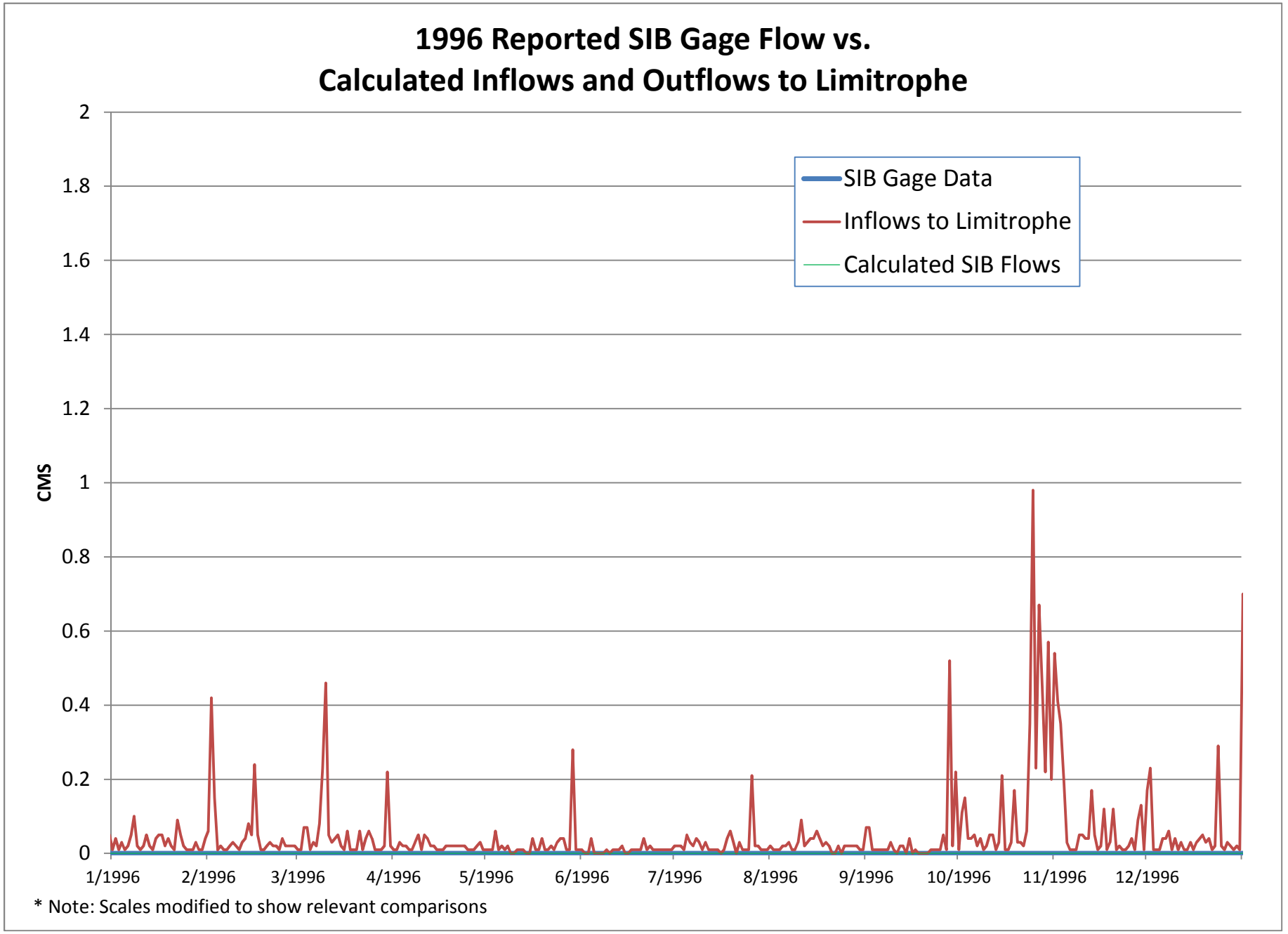
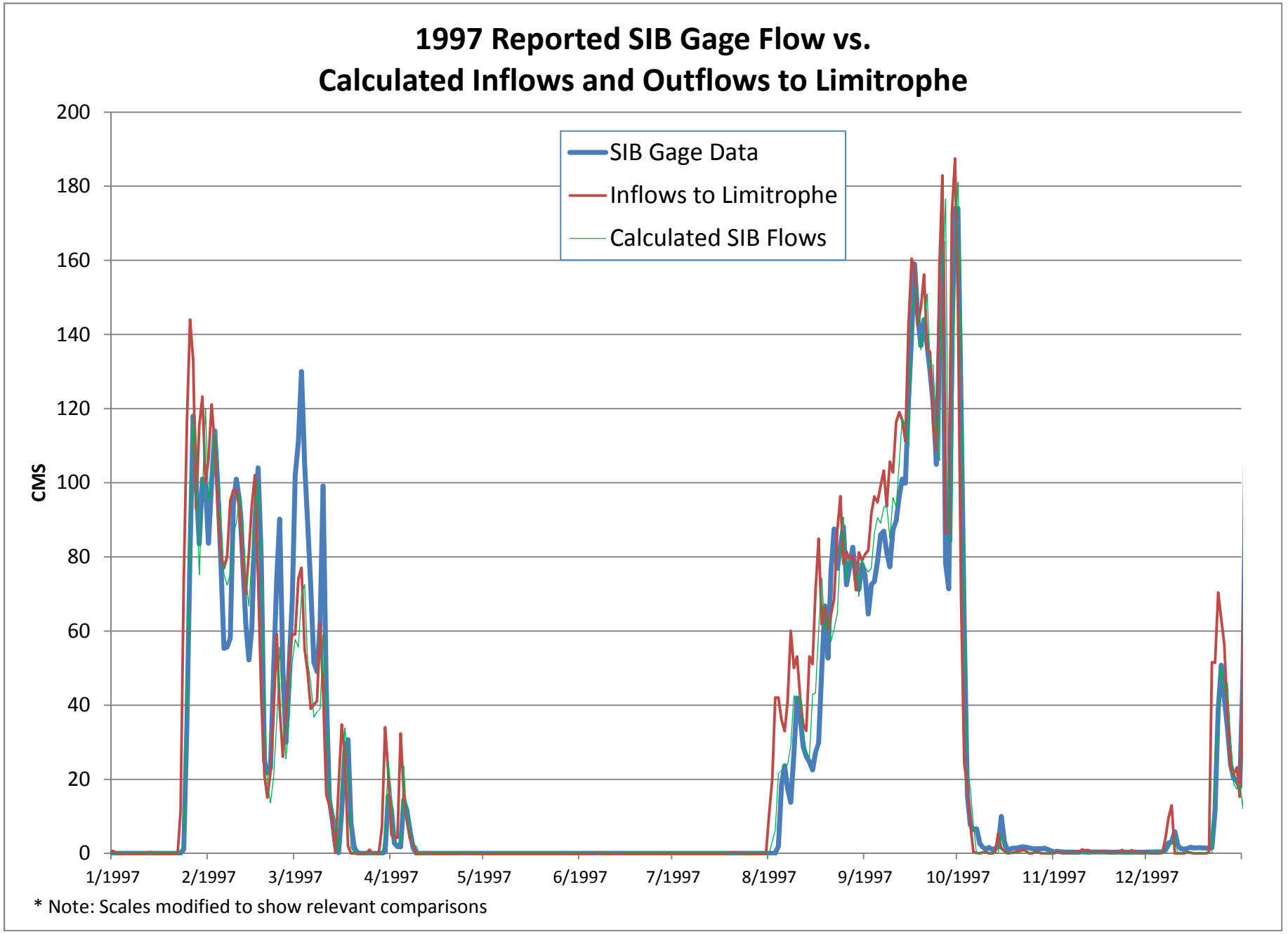
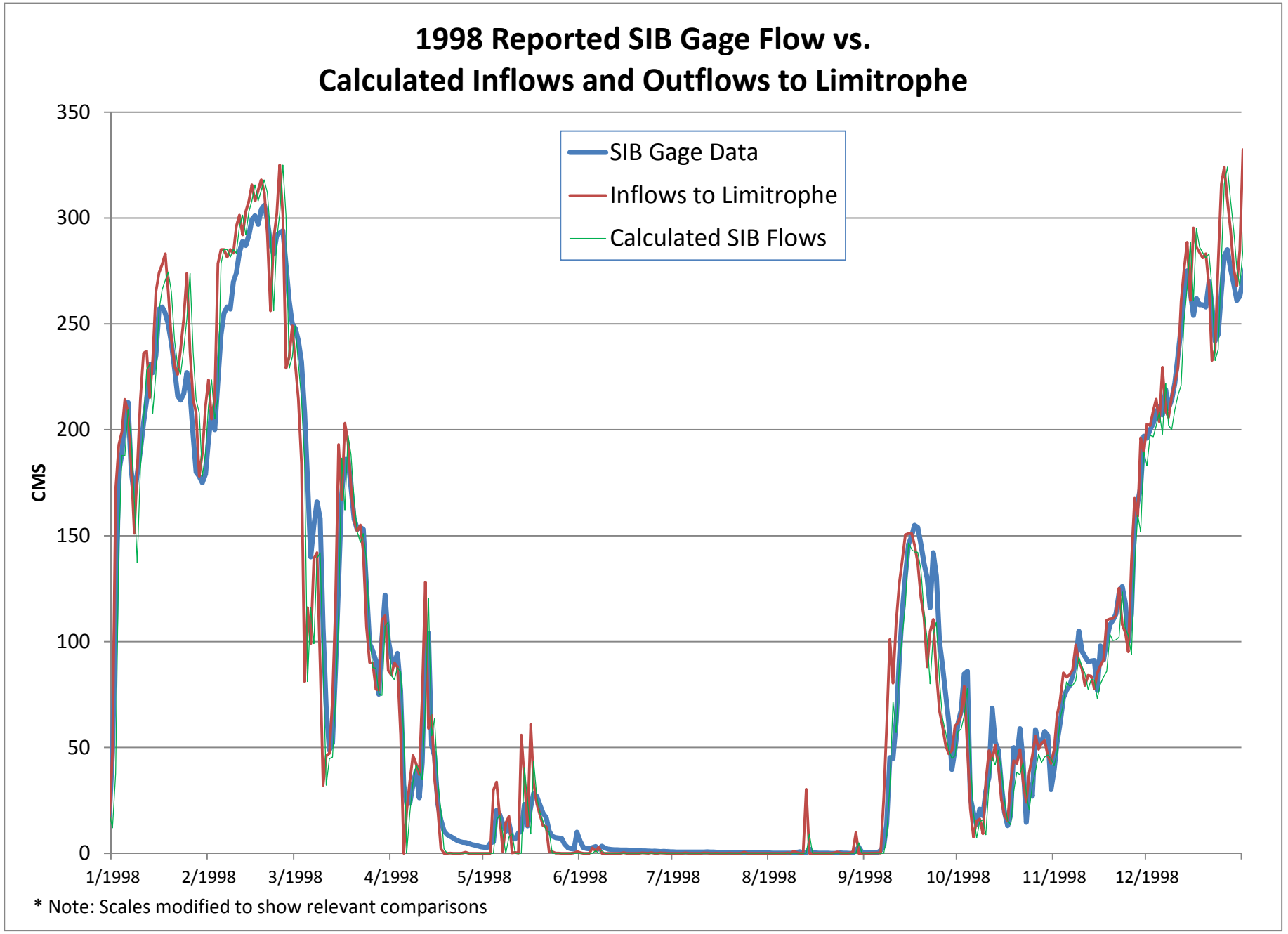
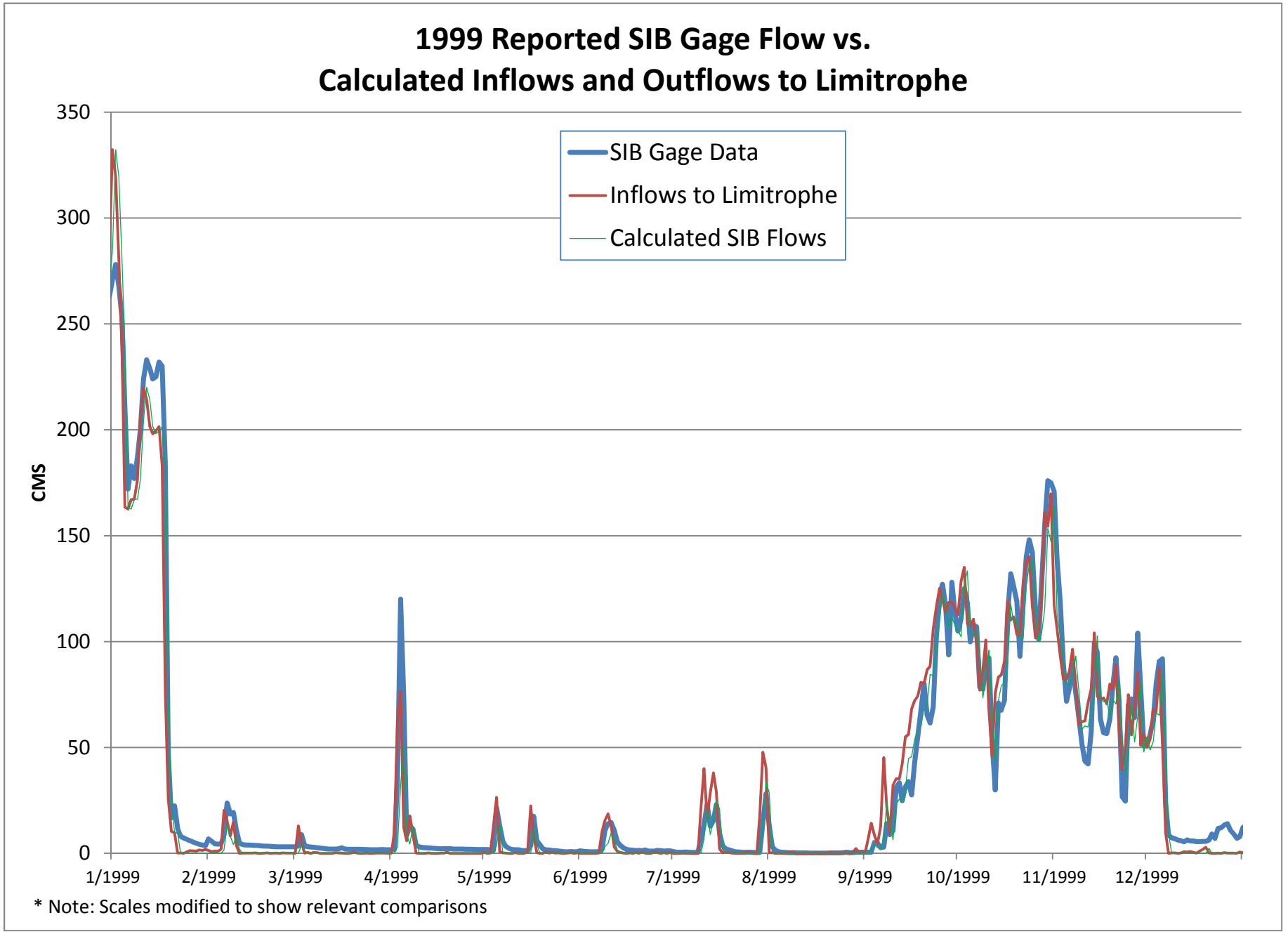
SIB Gage Data
Inflows to Limitrophe
Calculated SIB Flows
* Note: Scales modified to show relevant comparisons

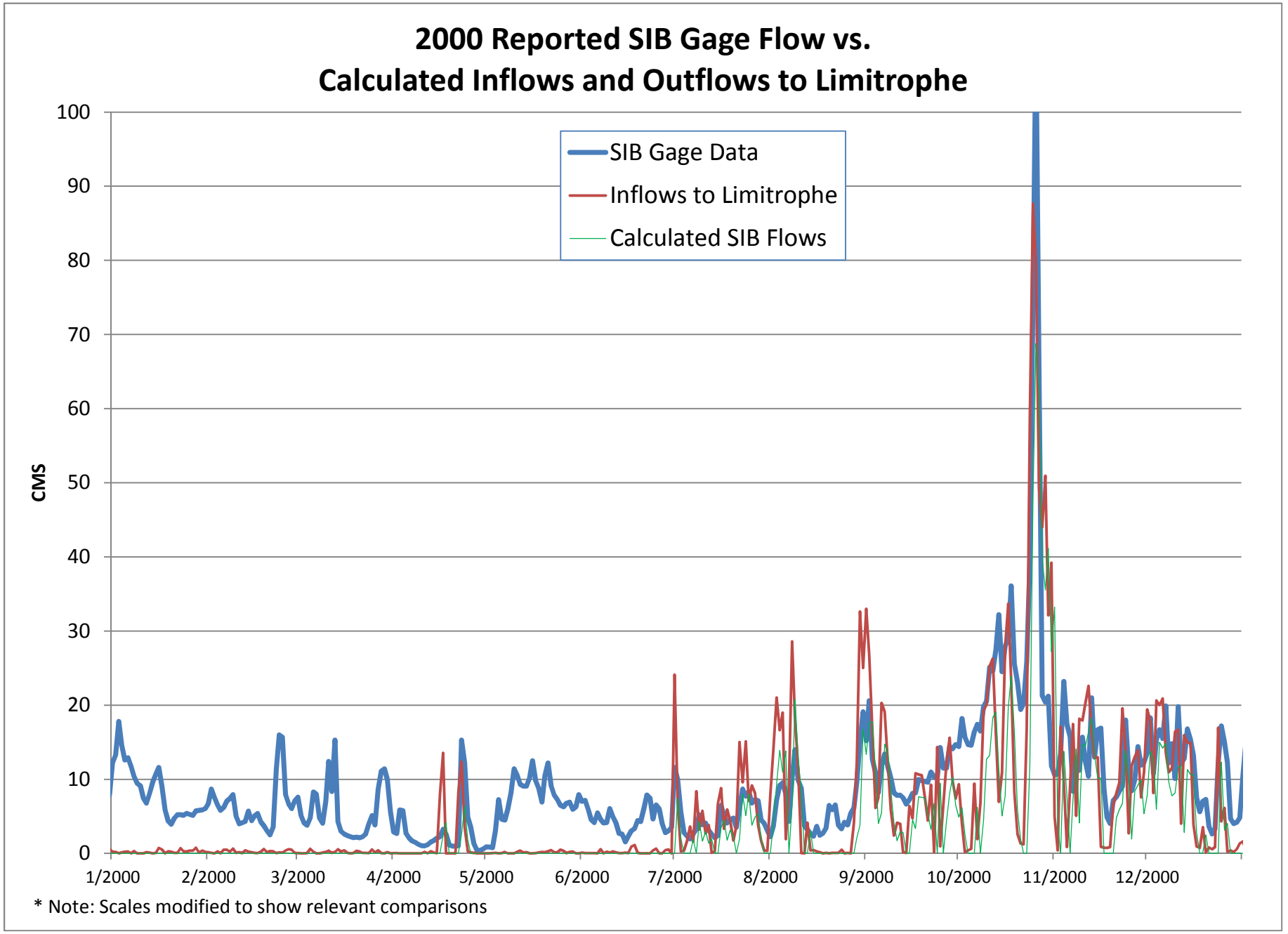

1995 Reported SIB Gage Flow vs.
Calculated Inflows and Outflows to Limitrophe
CMS
50
45
40
35
30
25
20
15
10
5
0
1/1995
2/1995
3/1995
4/1995
5/1995
6/1995
7/1995
8/1995
9/1995
10/1995
11/1995
12/1995
SIB Gage Data
Inflows to Limitrophe
Calculated SIB Flows
* Note: Scales modified to show relevant comparisons

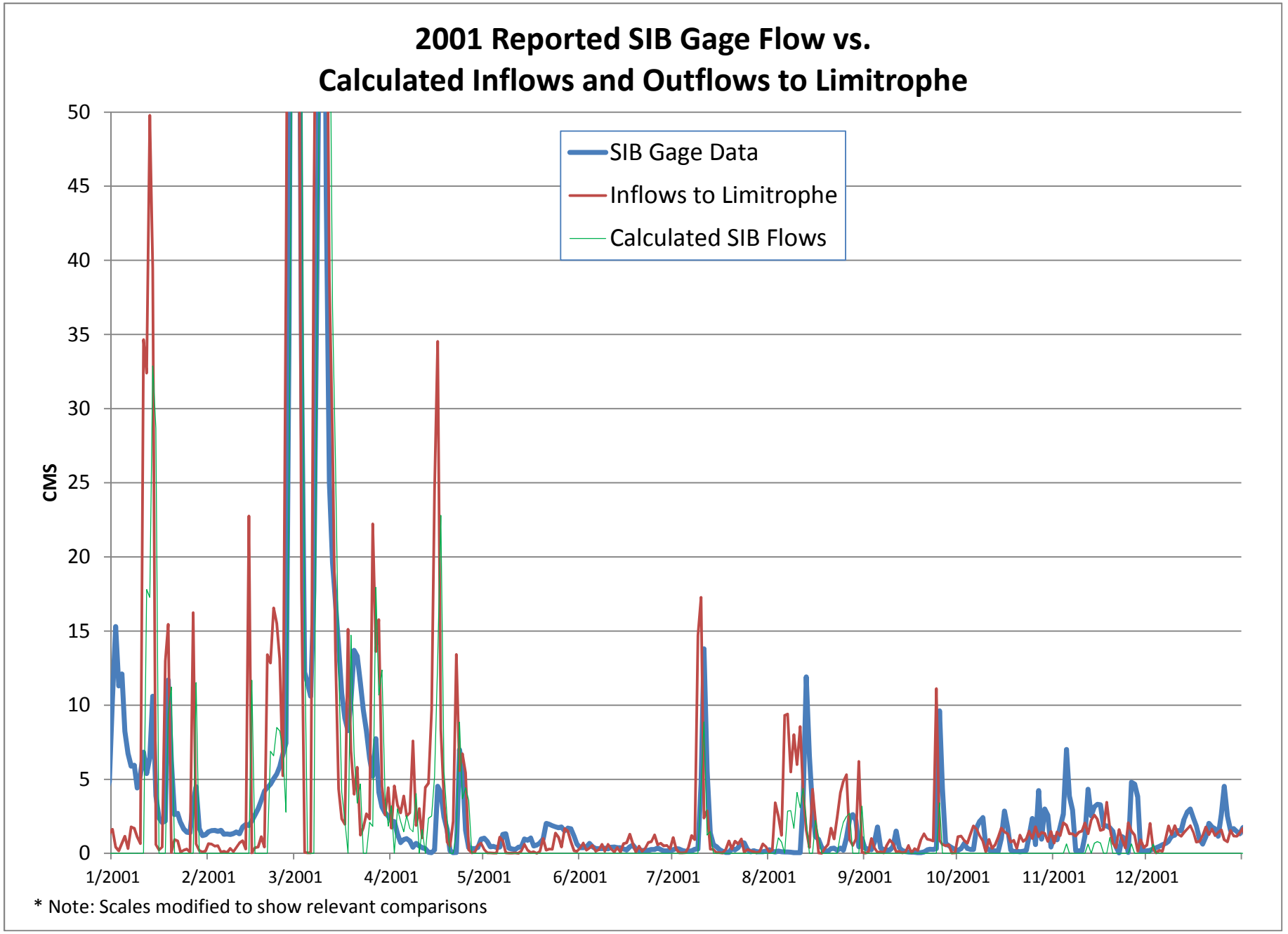

1996 Reported SIB Gage Flow vs.
Calculated Inflows and Outflows to Limitrophe
SIB Gage Data
Inflows to Limitrophe
Calculated SIB Flows
CMS
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1/1996
2/1996
3/1996
4/1996
5/1996
6/1996
7/1996
8/1996
9/1996
10/1996
11/1996
12/1996
* Note: Scales modified to show relevant comparisons

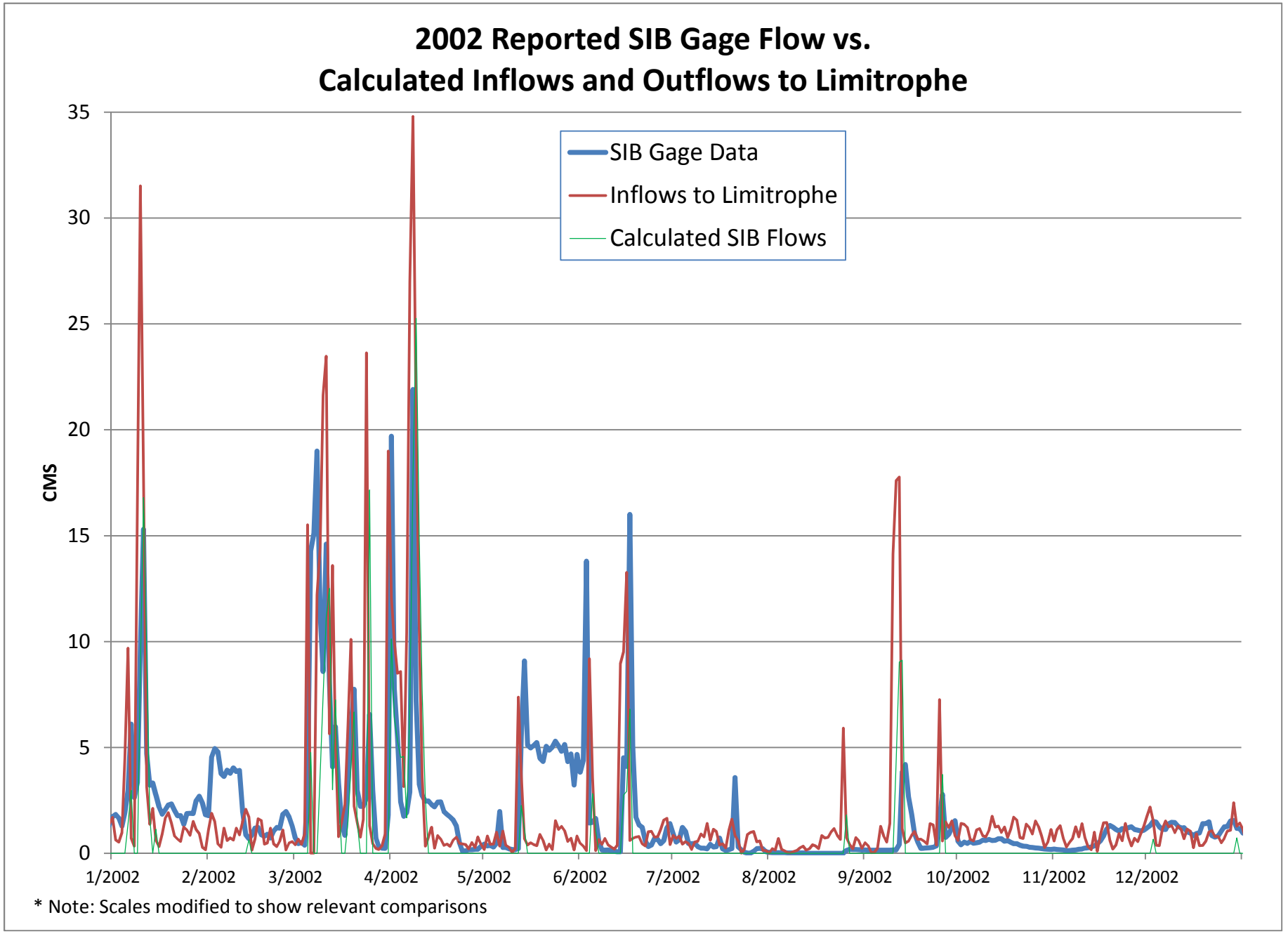

1997 Reported SIB Gage Flow vs.
Calculated Inflows and Outflows to Limitrophe
SIB Gage Data
Inflows to Limitrophe
Calculated SIB Flows
CMS
200
180
160
140
120
100
80
60
40
20
0
1/1997
2/1997
3/1997
4/1997
5/1997
6/1997
7/1997
8/1997
9/1997
10/1997
11/1997
12/1997
* Note: Scales modified to show relevant comparisons

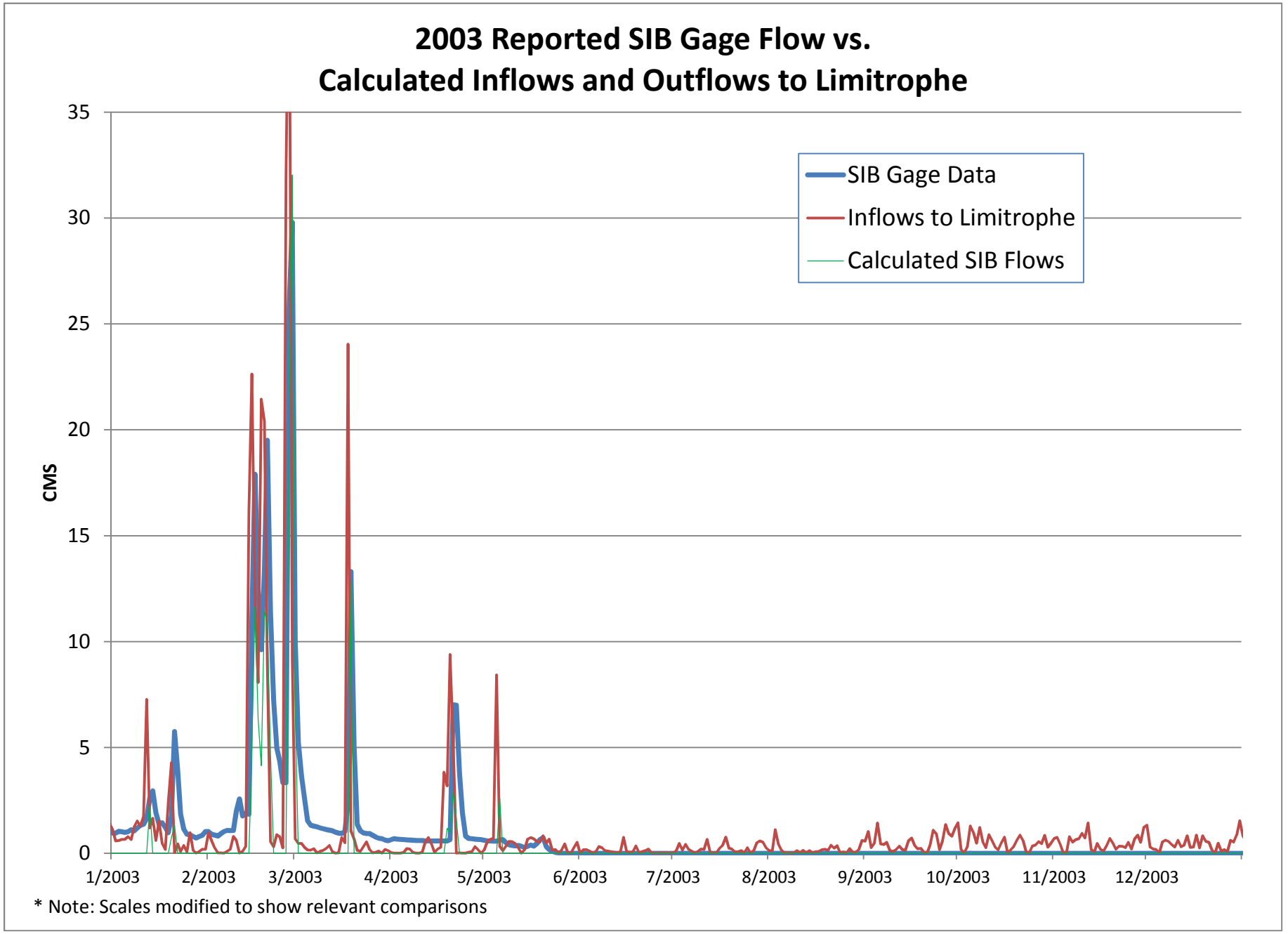

1998 Reported SIB Gage Flow vs.
Calculated Inflows and Outflows to Limitrophe
SIB Gage Data
Inflows to Limitrophe
Calculated SIB Flows
CMS
350
300
250
200
150
100
50
0
1/1998
2/1998
3/1998
4/1998
5/1998
6/1998
7/1998
8/1998
9/1998
10/1998
11/1998
12/1998
* Note: Scales modified to show relevant comparisons

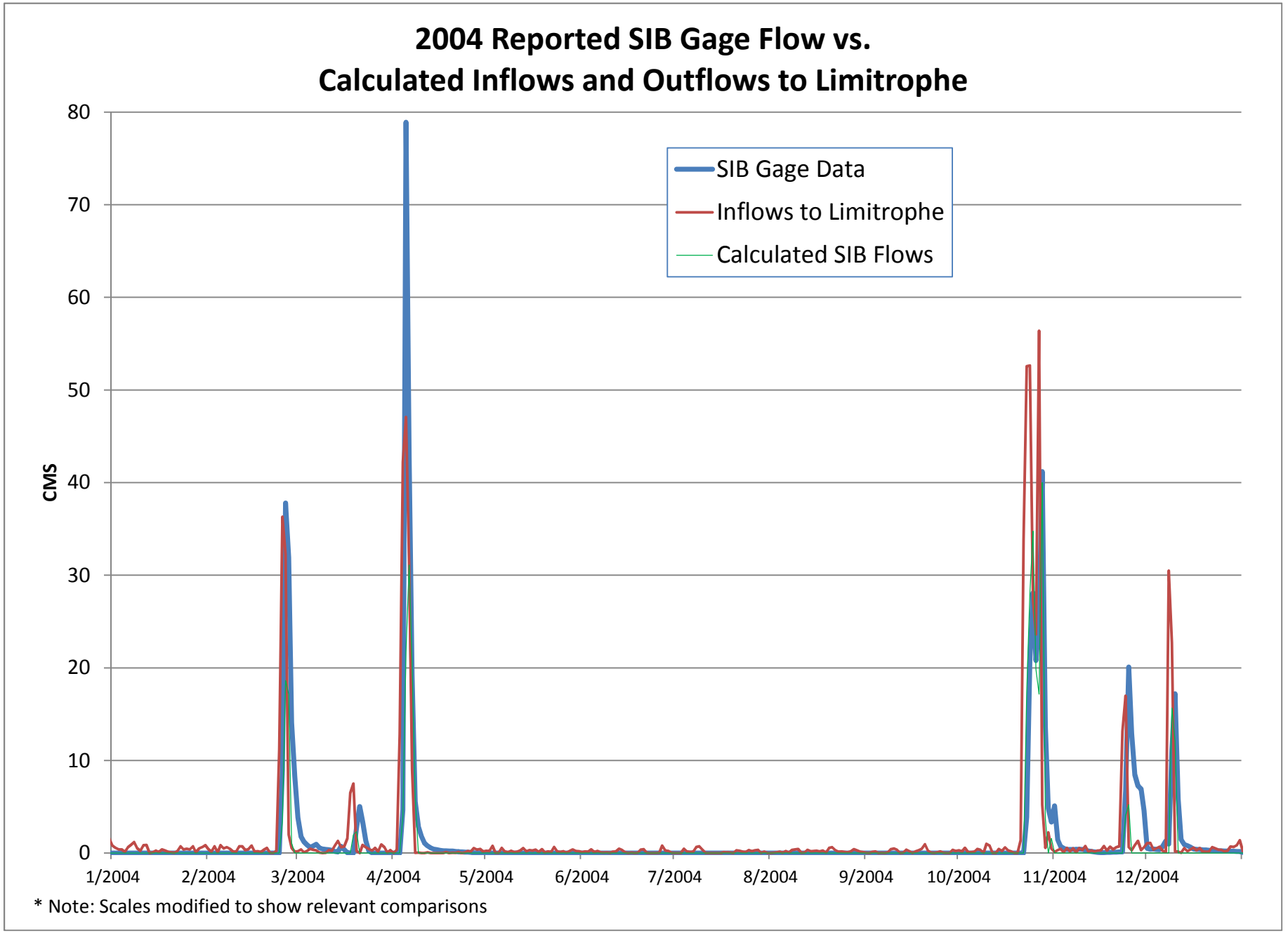

1999 Reported SIB Gage Flow vs.
Calculated Inflows and Outflows to Limitrophe
SIB Gage Data
Inflows to Limitrophe
Calculated SIB Flows
CMS
350
300
250
200
150
100
50
0
1/1999
2/1999
3/1999
4/1999
5/1999
6/1999
7/1999
8/1999
9/1999
10/1999
11/1999
12/1999
* Note: Scales modified to show relevant comparisons

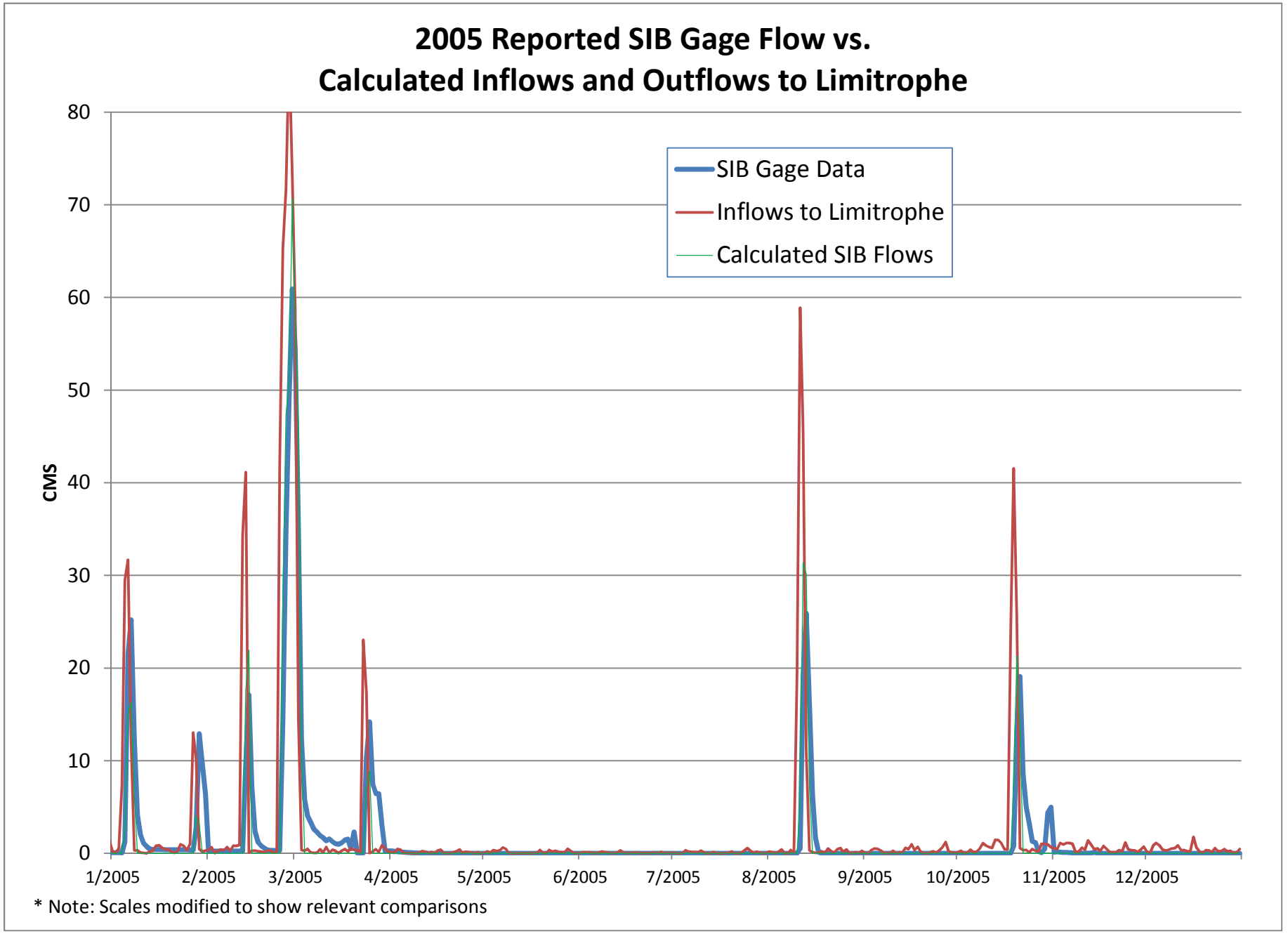

2000 Reported SIB Gage Flow vs.
Calculated Inflows and Outflows to Limitrophe
SIB Gage Data
Inflows to Limitrophe
Calculated SIB Flows
CMS
100
90
80
70
60
50
40
30
20
10
0
1/2000
2/2000
3/2000
4/2000
5/2000
6/2000
7/2000
8/2000
9/2000
10/2000
11/2000
12/2000
* Note: Scales modified to show relevant comparisons


2001 Reported SIB Gage Flow vs.
Calculated Inflows and Outflows to Limitrophe
SIB Gage Data
Inflows to Limitrophe
Calculated SIB Flows
CMS
50
45
40
35
30
25
20
15
10
5
0
1/2001
2/2001
3/2001
4/2001
5/2001
6/2001
7/2001
8/2001
9/2001
10/2001
11/2001
12/2001
* Note: Scales modified to show relevant comparisons


2002 Reported SIB Gage Flow vs.
Calculated Inflows and Outflows to Limitrophe
SIB Gage Data
Inflows to Limitrophe
Calculated SIB Flows
CMS
35
30
25
20
15
10
5
0
1/2002
2/2002
3/2002
4/2002
5/2002
6/2002
7/2002
8/2002
9/2002
10/2002
11/2002
12/2002
* Note: Scales modified to show relevant comparisons


2003 Reported SIB Gage Flow vs.
Calculated Inflows and Outflows to Limitrophe
CMS
35
30
25
20
15
10
5
0
1/2003
2/2003
3/2003
4/2003
5/2003
6/2003
7/2003
8/2003
9/2003
10/2003
11/2003
12/2003
SIB Gage Data
Inflows to Limitrophe
Calculated SIB Flows
* Note: Scales modified to show relevant comparisons


2004 Reported SIB Gage Flow vs.
Calculated Inflows and Outflows to Limitrophe
SIB Gage Data
Inflows to Limitrophe
Calculated SIB Flows
CMS
80
70
60
50
40
30
20
10
0
1/2004
2/2004
3/2004
4/2004
5/2004
6/2004
7/2004
8/2004
9/2004
10/2004
11/2004
12/2004
* Note: Scales modified to show relevant comparisons


2005 Reported SIB Gage Flow vs.
Calculated Inflows and Outflows to Limitrophe
CMS
80
70
60
50
40
30
20
10
0
1/2005
2/2005
3/2005
4/2005
5/2005
6/2005
7/2005
8/2005
9/2005
10/2005
11/2005
12/2005
SIB Gage Data
Inflows to Limitrophe
Calculated SIB Flows
* Note: Scales modified to show relevant comparisons

23.300
-0.380

4-8-10

Colorado River @ SIB
4-29-10

22.500
-0.330

4-13-11

4-13-10

Ght. in Meters

23.3
.2
.1
23.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
22.0
.9
21.8

-0.8 -0.7 -0.6 -0.5 -0.4 -0.3 -0.2 -0.1 -0 +0.1 +0.2

Shift in Meters

F2F = 21.882
- 0.164
21.718 = first occurance of flow on the rating Table

F2F = 21.827
- 0.109
21.718

Colorado River at SIB
9-11-08

Ght. in Meters

-0.780
23.180
-0.700
3-9-10

-0.300

1-22-10

1-25-10

9-4-08

22.590
-0.159
3-9-10

3-9-10

22.570
-0.600

22.600
-0.200

22.560
0.00

23.300
-1.100

23.320
-1.000

9-2-08

9-5-08 PZF=22.217=Ght.
-0.499=Shift
21.718

PZF=22.783
-1.065
21.718

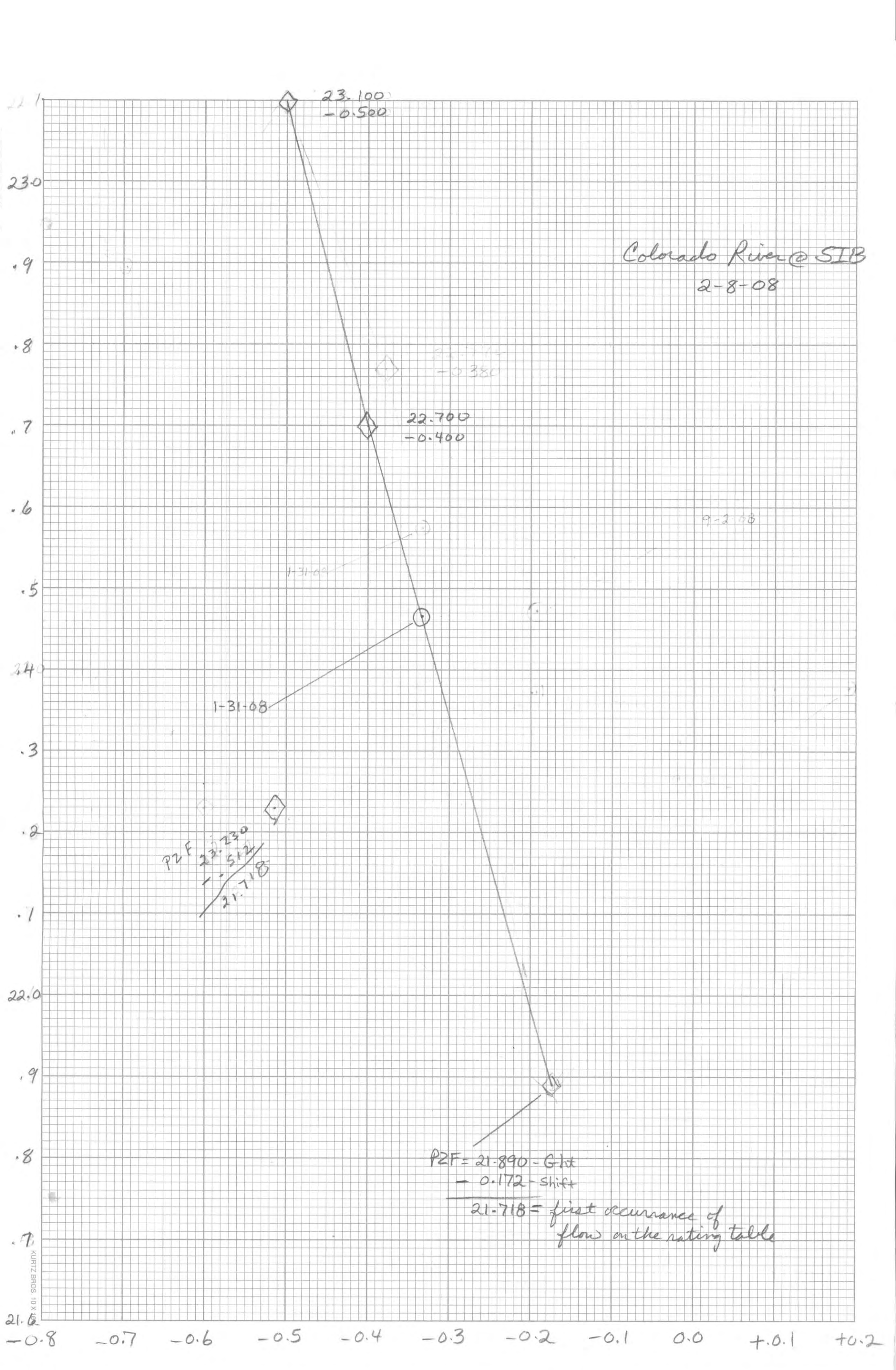
PZF=21.890=Ght.
-0.172=Shift
21.718=0 flow
ON Rating Table

0.8 -0.7 -0.6
PZF=21.860=Ght 3-9-10
-0.142=Shift
21.718=0 flow

PZF=22.531=GHT
-0.813=SHIFT
21.718=0 flow
ON RATING TABLE

-1.4 -1.3 -1.2 -1.1 -1.0 -0.9 -0.8 -0.7 -0.6 -0.5 -0.4 -0.3 -0.2 -0.1 0.0 +0.1 +0.2

Shift in Meters


23.100
-0.500
22.700
-0.400
1-31-08
PZF 22.230
-.512
21.718
Colorado River @ SIB
2-8-08
9-2-08
PZF = 21.890 - Gkt
- 0.172 - shift
21.718 = first occurrance of flow on the rating table
23.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
22.0
.9
.8
.7
21.6
-0.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0.0
+0.1
+0.2

Colorado River @ SIB
11-17-05

24.000
-0.750

24.000
-0.670

24.000
-0.500

24.000
-0.300

23.460
-0.660

23.320
-0.370

23.200
-0.090

10-21-05

12-23-08

23.053
-.128

22.800
-0.720

22.700
-0.340

22.460
-0.530

22.480
-0.540

P2F
23.230
-.512
22.718

= latest curves for 12-12-05 meas.

11-1-05

10-25-05

11-15-05

12-12-05

21.981
-.263
11-15-05
NEW P2F

21.859
-0.141

NEW P2F based on 12-12-05 meas.
21.878
-.160
21.718 = first occurrence of flow on the rating table

24.0
.8
.6
.4
.3
.2
23.0
.8
.6
.4
.3
.2
22.0
.8
.6
.4
21.2

-0.8 -0.7 -0.6 -0.5 -0.4 -0.3 -0.2 -0.1 0.0 +0.1 +0.2

COLORADO RIVER @ [redacted] SIS
SHIFT COMPUTATION SHEET

Meas #	Date 20	Stage meters	Disch CFS	Disch CMS	Table Stage	Shift	Shift Used	% Diff	Remarks
	2-16-05	22.324	81.2	2.30	22.124	-.200	-.198	-2.1%	
	3-1-05	23.706	1921	54.4	23.110	-.596	-.596	∅	
	3-15-05	22.189	31.8	0.901	22.069	-.120	-.120	+0.1%	
	4-1-05	22.112	8.88	0.251	21.986	-.126	-.120	-3.5%	
	8-16-05	22.232	55.5	1.57	22.096	-.136	-.135	-2.5%	
↓	10-21-05	23.374	754	21.3	22.742	-.632			
	10-25-05	22.193	29.7	.841	22.066	-.127			
	11-1-05	22.123	5.37	.152	21.940	-.183	-.183	+1.3%	
	11-15-05	22.106	.820	.023	21.762	-.344	-.334		
	12-12-05	22.140	13.3	0.378	21.825	-.315	-.316	+2.2%	
				2008					
	1-31-08	22.466	89.6	2.54	22.134	-.332	-.332	∅	
	9-2-08	22.371	129.47	3.67	22.179	-.192	-.192	∅	
	9-4-08	22.896	148	4.19	22.199	-.697	-.697	-0.2%	
	12-23-08	23.053	278	7.86	22.325	-.728			
	1-22-10	23.879	751	21.3	22.744	-1.135			
	1-25-10	23.822	499	14.14	22.527	-1.295			
	3-9-10	22.590	388	11.0	22.431	-.159			
	4-8-10	23.250	1,000	28.3	22.880	-.370			
	4-13-10	22.403	61.1	1.73	22.102	-.301			
	4-13-11	22.433	122	3.46	22.171	-.262	-.262	∅	
	4-15-11	22.049	28.2	0.799	22.064	+.015	+.015	-0.1%	
Meas #	Date 20	Stage meters	Disch CFS	Disch CMS	Table Stage	Shift	Shift Used	% Diff	Remarks

COLORADO RIVER @ [redacted] SIB
SHIFT COMPUTATION SHEET

Meas #	Date 20	Stage meters	Disch CFS	Disch CMS	Table Stage	Shift	Shift Used	% Diff	Remarks
	12-4-02	22.747	52.0	1.47	22.093	-.654			
2002	12-17	22.592	31.2	0.882	22.068	-.524	-.523	-2.0%	2002
2003	1-8-03	22.582	36.168	1.02	22.075	-.507	-.507	ϕ	2003
	1-21	23.134	229	6.48	22.279	-0.855	-0.855	ϕ	
	2-4	22.516	29.2	.828	22.065	-0.451	-0.451	+1.0%	
	2-18	22.936	110	3.11	22.157	-.779			
	3-5	22.916	56.2	1.59	22.096	-.820			
	4-1	22.547	21.7	0.613	22.052	-.495	-.495	+0.5%	
	4-15	22.078	21.1	0.597	22.051	-.027	-.027	+1.2%	
	5-7	22.422	23.7	0.672	22.057	-.365	-.365	-1.2%	
	5-20	22.101	33.2	0.940	22.071	-.030	-.031	+2.2%	
	6-2	21.571	Θ	Θ					
				2004					
	2-26	23.770	1090	30.9	22.917	-.853	-.853	Θ %	
	3-2	22.773	63.1	1.79	22.105	-.668	-.668	-0.6%	
	3-16	22.196	14.2	.402	22.032	-.164	-.164	+0.5%	
	4-6-04	23.423	1225	34.7	22.962	-.461	-.461	Θ %	
	4-20	22.026	8.52	.241	21.983	-.093			
	10-26	23.087	733	20.8	22.729	-358	-361	+0.5%	
	11-2	22.368	70.2	1.99	22.113	-.255	-255	Θ	
	11-10	22.138	15.8	0.449	22.039	-.099	-.100	+2.0%	
	11-16	22.043	2.32	0.0657	21.873	-.170	-.170	-5.7%	
	12-1	22.133	16.5	0.467	22.041	-.092	-.094	+3.8%	
	12-15	22.161	22.0	0.623	22.053	-.108	-.107	-1.1%	
2004	12-9	22.713	417	11.8	22.456	-.257	-.258	+0.8%	2004
2005	1-3-05	22.159	3.27	0.093	21.902	-.257	-.256	+3.3%	2005
	1-11-05	22.214	36.0	1.02	22.075	-.139	-.140	+2.0%	
	1-25-05	22.137	14.3	0.405	22.032	-.105	-.106	+1.2%	
	2-1-05	22.136	10.9	0.308	22.006	-.130	-.130	-0.6%	
Meas #	Date 20	Stage meters	Disch CFS	Disch CMS	Table Stage	Shift	Shift Used	% Diff	Remarks

12/07/05 06:41

INTERNATIONAL BOUNDARY AND WATER COMMISSION

#95222.00 COLORADO RIVER AT SOUTHERLY INTERNATIONAL BOUNDARY 2005 WY

Rating Table 1 from 01/01/2005 00:00 Scale Offset = 1.000

DISCHARGE IN CUBIC METRES PER SECOND

ght	.000	.001	.002	.003	.004	.005	.006	.007	.008	.009	1st diff	2nd diff
1.70			0*	0	.001	.001	.001	.002	.002	.002		
1.71	.002	.003	.003	.003	.004	.004	.004	.005	.005	.005	.003	
1.72	.006	.006	.006	.006	.007	.007	.007	.008	.008	.008	.003	0
1.73	.009	.009	.009	.009	.010	.010	.010	.011	.011	.011	.003	-0
1.74	.012	.012	.012	.013	.013	.013	.013	.014	.014	.014	.003	0
1.75	.015	.015	.015	.016	.016	.016	.017	.017	.017	.017	.003	0
1.76	.018	.018	.018	.019	.019	.019	.020	.020	.020	.021	.003	0
1.77	.021	.021	.021	.022	.022	.022	.023	.023	.023	.024	.003	-0
1.78	.024	.024	.024	.025	.025	.025	.026	.026	.026	.027	.003	0
1.79	.027	.027	.028	.028	.028	.028	.029	.029	.029	.030	.003	0
1.80	.030	.030	.031	.031	.031	.032	.032	.032	.032	.033	.003	-0
1.81	.033	.033	.034	.034	.034	.035	.035	.035	.035	.036	.003	0
1.82	.036	.036	.037	.037	.037	.038	.038	.038	.039	.039	.003	0
1.83	.039	.039	.040	.040	.040	.041	.041*	.042	.042	.043	.004	.001
1.84	.043	.044	.044	.045	.045	.046	.047	.047	.048	.048	.006	.002
1.85	.049	.050	.050	.051	.052	.052	.053	.054	.054	.055	.007	.001
1.86	.056	.056	.057	.058	.059	.059	.060	.061	.062	.062	.007	.001
1.87	.063	.064	.065	.065	.066	.067	.068	.069	.070	.071	.008	.001
1.88	.071	.072	.073	.074	.075	.076	.077	.078	.079	.080	.009	.001
1.89	.081	.082	.083	.084	.085	.086	.087	.088	.089	.090	.010	.001
1.90	.091	.092	.093	.094	.095	.097	.098	.099	.100	.101	.012	.001
1.91	.103	.104	.105	.106	.108	.109	.110	.111	.113	.114	.013	.001
1.92	.115	.117	.118	.120	.121	.122	.124	.125	.127	.128	.014	.001
1.93	.130	.131	.133	.134	.136	.137	.139	.141	.142	.144	.016	.002
1.94	.146	.147	.149	.151	.152	.154	.156*	.158	.160	.161	.018	.002
1.95	.163	.165	.167	.169	.171	.173	.175	.177	.179	.181	.020	.002
1.96	.183	.185	.187	.189	.192	.194	.196	.198	.200	.203	.022	.002
1.97	.205	.207	.210	.212	.214	.217	.219	.222	.224	.227	.024	.002

ght	.000	.001	.002	.003	.004	.005	.006	.007	.008	.009	1st diff	2nd diff
1.98	.229	.232	.234	.237	.240	.242	.245	.248	.251	.253	.027	.003
1.99	.256	.259	.262	.265	.268	.271	.274	.277	.280	.283	.030	.003
2.00	.286	.289	.292	.295	.299	.302	.305	.309	.312	.315	.033	.003
2.01	.319	.322	.326	.329	.333	.336	.340	.344	.347	.351	.036	.003
2.02	.355	.359	.363	.366	.370	.374	.378	.382	.386	.391	.040	.004
2.03	.395	.399	.403	.407	.412	.416	.421	.425*	.435	.446	.062	.022
2.04	.456	.467	.478	.490	.502	.514	.526	.538	.551	.564	.121	.060
2.05	.578	.591	.605	.620	.634	.649	.665	.680	.696	.713	.152	.031
2.06	.730	.747	.764	.782	.800	.819	.838	.858	.878*	.897	.186	.034
2.07	.916	.935	.955	.976	.996	1.02	1.04	1.06	1.08	1.11	.214	.028
2.08	1.13	1.15	1.18	1.20	1.23	1.25	1.28	1.31	1.33	1.36	.261	.047
2.09	1.39	1.42	1.45	1.48	1.51	1.54	1.57	1.61	1.64*	1.66	.293	.032
2.10	1.68	1.71	1.73	1.75	1.77	1.80	1.82	1.84	1.87	1.89	.232	-.060
2.11	1.92	1.94	1.97	1.99	2.02	2.04	2.07	2.10	2.12	2.15	.262	.030
2.12	2.18	2.21	2.23	2.26	2.29	2.32	2.35	2.38	2.41*	2.43	.276	.015
2.13	2.45	2.48	2.50	2.52	2.54	2.57	2.59	2.61	2.63	2.66	.229	-.048
2.14	2.68	2.71	2.73	2.75	2.78	2.80	2.83	2.85	2.88	2.90	.248	.019
2.15	2.93	2.96	2.98	3.01	3.03	3.06	3.09	3.12	3.14	3.17*	.264	.016
2.16	3.19	3.22	3.24	3.26	3.29	3.31	3.34	3.36	3.39	3.41	.242	-.022
2.17	3.44	3.46	3.49	3.51	3.54	3.56	3.59	3.61	3.64	3.67	.258	.016
2.18	3.69	3.72	3.75	3.77	3.80	3.83	3.86	3.88	3.91	3.94*	.272	.014
2.19	3.97	3.99	4.02	4.04	4.07	4.09	4.12	4.15	4.17	4.20	.260	-.012
2.20	4.23	4.25	4.28	4.31	4.33	4.36	4.39	4.42	4.44	4.47	.275	.015
2.21	4.50	4.53	4.56	4.59	4.61	4.64	4.67	4.70	4.73	4.76	.290	.015
2.22	4.79*	4.82	4.84	4.87	4.90	4.92	4.95	4.98	5.01	5.03	.270	-.020
2.23	5.06	5.09	5.12	5.14	5.17	5.20	5.23	5.26	5.29	5.31	.283	.013
2.24	5.34	5.37	5.40	5.43	5.46	5.49	5.52	5.55	5.58	5.61	.297	.013
2.25	5.64*	5.67	5.69	5.72	5.75	5.78	5.81	5.83	5.86	5.89	.278	-.018
2.26	5.92	5.95	5.98	6.00	6.03	6.06	6.09	6.12	6.15	6.18	.290	.011
2.27	6.21	6.24	6.27	6.30	6.33	6.36	6.39	6.42	6.45	6.48	.301	.012
2.28	6.51	6.54*	6.57	6.60	6.63	6.66	6.68	6.71	6.74	6.77	.294	-.008
2.29	6.80	6.83	6.86	6.89	6.92	6.95	6.98	7.01	7.04	7.07	.302	.009
2.30	7.10	7.14	7.17	7.20	7.23	7.26	7.29	7.32	7.35	7.39	.313	.011
2.31	7.42	7.45*	7.48	7.51	7.53	7.56	7.59	7.62	7.65	7.67	.285	-.028

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ght	.000	.001	.002	.003	.004	.005	.006	.007	.008	.009	1st diff	2nd diff
2.32	7.70	7.73	7.76	7.79	7.82	7.85	7.88	7.90	7.93	7.96	.289	.004
2.33	7.99	8.02	8.05	8.08	8.11	8.14	8.17	8.20	8.23	8.26	.298	.009
2.34	8.29	8.32	8.35*	8.38	8.41	8.44	8.47	8.50	8.53	8.56	.296	-.002
2.35	8.59	8.62	8.65	8.68	8.71	8.74	8.77	8.80	8.83	8.86	.302	.006
2.36	8.89	8.92	8.95	8.98	9.01	9.04	9.07	9.10	9.13	9.17	.310	.008
2.37	9.20	9.23	9.26*	9.29	9.32	9.35	9.38	9.41	9.44	9.47	.299	-.011
2.38	9.50	9.53	9.56	9.59	9.62	9.65	9.68	9.71	9.74	9.77	.301	.002
2.39	9.80	9.83	9.86	9.89	9.92	9.95	9.98	10.0	10.0	10.1	.309	.007
2.40	10.1	10.1	10.2	10.2*	10.2	10.3	10.3	10.3	10.3	10.4	.299	-.010
2.41	10.4	10.4	10.5	10.5	10.5	10.6	10.6	10.6	10.6	10.7	.298	-.001
2.42	10.7	10.7	10.8	10.8	10.8	10.9	10.9	10.9	10.9	11.0	.304	.006
2.43	11.0	11.0	11.1	11.1*	11.1	11.2	11.2	11.2	11.2	11.3	.291	-.013
2.44	11.3	11.3	11.4	11.4	11.4	11.4	11.5	11.5	11.5	11.6	.288	-.003
2.45	11.6	11.6	11.6	11.7	11.7	11.7	11.8	11.8	11.8	11.9	.294	.005
2.46	11.9	11.9	11.9	12.0	12.0*	12.0	12.1	12.1	12.1	12.2	.314	.020
2.47	12.2	12.2	12.3	12.3	12.3	12.4	12.4	12.4	12.5	12.5	.331	.016
2.48	12.5	12.6	12.6	12.6	12.7	12.7	12.7	12.8	12.8	12.8	.337	.007
2.49	12.9	12.9	12.9	13.0	13.0*	13.0	13.1	13.1	13.1	13.2	.326	-.011
2.50	13.2	13.2	13.3	13.3	13.3	13.3	13.4	13.4	13.4	13.5	.320	-.006
2.51	13.5	13.5	13.6	13.6	13.6	13.7	13.7	13.7	13.8	13.8	.326	.006
2.52	13.8	13.9	13.9	13.9	14.0	14.0*	14.0	14.1	14.1	14.1	.328	.003
2.53	14.2	14.2	14.2	14.3	14.3	14.3	14.4	14.4	14.4	14.5	.331	.002
2.54	14.5	14.5	14.6	14.6	14.6	14.7	14.7	14.7	14.8	14.8	.336	.006
2.55	14.8	14.9	14.9	14.9	15.0	15.0*	15.0	15.1	15.1	15.1	.328	-.008
2.56	15.2	15.2	15.2	15.3	15.3	15.3	15.3	15.4	15.4	15.4	.320	-.008
2.57	15.5	15.5	15.5	15.6	15.6	15.6	15.7	15.7	15.7	15.8	.325	.005
2.58	15.8	15.8	15.9	15.9	15.9	16.0	16.0*	16.0	16.1	16.1	.328	.003
2.59	16.1	16.2	16.2	16.2	16.3	16.3	16.3	16.4	16.4	16.4	.331	.003
2.60	16.5	16.5	16.5	16.6	16.6	16.6	16.7	16.7	16.7	16.8	.335	.005
2.61	16.8	16.8	16.9	16.9	16.9	17.0	17.0*	17.0	17.1	17.1	.330	-.005
2.62	17.1	17.2	17.2	17.2	17.3	17.3	17.3	17.4	17.4	17.4	.320	-.010
2.63	17.4	17.5	17.5	17.5	17.6	17.6	17.6	17.7	17.7	17.7	.324	.004
2.64	17.8	17.8	17.8	17.9	17.9	17.9	18.0	18.0*	18.0	18.1	.328	.004
2.65	18.1	18.1	18.2	18.2	18.2	18.3	18.3	18.3	18.4	18.4	.331	.003
2.66	18.4	18.5	18.5	18.5	18.6	18.6	18.6	18.7	18.7	18.7	.335	.004

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ght	.000	.001	.002	.003	.004	.005	.006	.007	.008	.009	1st diff	2nd diff
2.67	18.8	18.8	18.8	18.9	18.9	18.9	19.0	19.0*	19.0	19.1	.332	-.003
2.68	19.1	19.1	19.2	19.2	19.2	19.3	19.3	19.3	19.4	19.4	.320	-.012
2.69	19.4	19.4	19.5	19.5	19.5	19.6	19.6	19.6	19.7	19.7	.323	.003
2.70	19.7	19.8	19.8	19.8	19.9	19.9	19.9	20.0	20.0*	20.0	.333	.010
2.71	20.1	20.1	20.1	20.2	20.2	20.3	20.3	20.3	20.4	20.4	.363	.030
2.72	20.4	20.5	20.5	20.5	20.6	20.6	20.7	20.7	20.7	20.8	.368	.004
2.73	20.8	20.8	20.9	20.9	21.0	21.0	21.0	21.1	21.1*	21.1	.379	.012
2.74	21.2	21.2	21.3	21.3	21.3	21.4	21.4	21.5	21.5	21.6	.415	.035
2.75	21.6	21.6	21.7	21.7	21.8	21.8	21.8	21.9	21.9	22.0	.420	.006
2.76	22.0	22.1	22.1	22.1	22.2	22.2	22.3	22.3	22.4	22.4*	.429	.009
2.77	22.4	22.5	22.5	22.6	22.6	22.7	22.7	22.8	22.8	22.9	.461	.032
2.78	22.9	23.0	23.0	23.0	23.1	23.1	23.2	23.2	23.3	23.3	.467	.007
2.79	23.4	23.4	23.5	23.5	23.6	23.6	23.7	23.7	23.8	23.8*	.474	.006
2.80	23.8	23.9	23.9	24.0	24.0	24.1	24.1	24.2	24.2	24.3	.477	.004
2.81	24.3	24.4	24.4	24.5	24.5	24.6	24.6	24.7	24.7	24.8	.484	.007
2.82	24.8	24.9	24.9	25.0	25.0	25.1	25.1	25.2	25.2	25.3	.491	.007
2.83	25.3*	25.4	25.4	25.5	25.5	25.6	25.6	25.7	25.7	25.8	.557	.066
2.84	25.9	25.9	26.0	26.0	26.1	26.1	26.2	26.3	26.3	26.4	.567	.009
2.85	26.4	26.5	26.5	26.6	26.7	26.7	26.8	26.8	26.9	26.9	.576	.009
2.86	27.0*	27.1	27.1	27.2	27.3	27.3	27.4	27.5	27.5	27.6	.654	.078
2.87	27.7	27.7	27.8	27.9	27.9	28.0	28.1	28.1	28.2	28.3	.667	.012
2.88	28.3	28.4	28.5	28.5	28.6	28.7	28.7	28.8	28.9	28.9	.679	.012
2.89	29.0*	29.1	29.1	29.2	29.3	29.3	29.4	29.5	29.6	29.6	.696	.017
2.90	29.7	29.8	29.8	29.9	30.0	30.0	30.1	30.2	30.3	30.3	.709	.013
2.91	30.4	30.5	30.5	30.6	30.7	30.8	30.8	30.9	31.0	31.1	.722	.013
2.92	31.1	31.2*	31.3	31.4	31.4	31.5	31.6	31.7	31.8	31.9	.807	.085
2.93	31.9	32.0	32.1	32.2	32.3	32.3	32.4	32.5	32.6	32.7	.832	.025
2.94	32.8	32.8	32.9	33.0	33.1	33.2	33.3	33.4	33.4	33.5	.849	.017
2.95	33.6	33.7*	33.8	33.9	34.0	34.1	34.2	34.2	34.3	34.4	.908	.060
2.96	34.5	34.6	34.7	34.8	34.9	35.0	35.1	35.2	35.3	35.4	.933	.025
2.97	35.5	35.6	35.6	35.7	35.8	35.9	36.0	36.1	36.2	36.3	.953	.020
2.98	36.4	36.5	36.6	36.7	36.8	36.9	37.0	37.1	37.2	37.3	.974	.021
2.99	37.4	37.5	37.6	37.7	37.8	37.9	38.0	38.1	38.2	38.3	.995	.021
3.00	38.4	38.5	38.6	38.7	38.8	38.9	39.0	39.1	39.2	39.3	1.02	.021

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ght	.000	.001	.002	.003	.004	.005	.006	.007	.008	.009	1st diff	2nd diff
3.01	39.4	39.5	39.6*	39.7	39.9	40.0	40.1	40.3	40.4	40.5	1.27	.253
3.02	40.7	40.8	40.9	41.1	41.2	41.3	41.5	41.6	41.8	41.9	1.36	.094
3.03	42.0	42.2	42.3	42.4	42.6	42.7	42.9	43.0	43.1	43.3	1.40	.039
3.04	43.4	43.6	43.7	43.9	44.0	44.1	44.3	44.4	44.6	44.7	1.44	.040
3.05	44.9	45.0	45.2	45.3	45.5	45.6	45.8	45.9	46.1	46.2	1.48	.040
3.06	46.4	46.5	46.7	46.8	47.0	47.1	47.3	47.4	47.6	47.7	1.52	.041
3.07	47.9	48.0	48.2	48.3	48.5	48.7	48.8	49.0	49.1	49.3	1.57	.042
3.08	49.4	49.6	49.8	49.9	50.1	50.2	50.4	50.6	50.7	50.9	1.61	.043
3.09	51.0	51.2	51.4	51.5	51.7	51.9	52.0	52.2	52.4	52.5	1.65	.044
3.10	52.7	52.9	53.0	53.2	53.4	53.5	53.7	53.9	54.1	54.2	1.70	.045
3.11	54.4	54.6	54.7	54.9	55.1	55.3	55.4	55.6	55.8	56.0	1.74	.046
3.12	56.1	56.3	56.5	56.7	56.9	57.0	57.2	57.4	57.6	57.8	1.79	.047
3.13	57.9	58.1	58.3	58.5	58.7	58.9	59.0	59.2	59.4	59.6	1.84	.048
3.14	59.8	60.0	60.2	60.3	60.5	60.7	60.9	61.1	61.3	61.5	1.89	.049
3.15	61.7	61.9	62.1	62.2	62.4	62.6	62.8	63.0	63.2	63.4	1.94	.051
3.16	63.6	63.8	64.0	64.2	64.4	64.6*	64.7	64.9	65.0	65.2	1.71	-.231
3.17	65.3	65.5	65.6	65.8	65.9	66.0	66.2	66.3	66.5	66.6	1.46	-.251
3.18	66.8	66.9	67.1	67.2	67.4	67.5	67.7	67.8	68.0	68.1	1.48	.026
3.19	68.3	68.4	68.6	68.7	68.9	69.0	69.2	69.3	69.5	69.6	1.51	.026
3.20	69.8	69.9	70.1	70.2	70.4	70.5	70.7	70.8	71.0	71.2	1.54	.026
3.21	71.3	71.5	71.6	71.8	71.9	72.1	72.2	72.4	72.6	72.7	1.56	.027
3.22	72.9	73.0	73.2	73.3	73.5	73.7	73.8	74.0	74.1	74.3	1.59	.027
3.23	74.5	74.6	74.8	74.9	75.1	75.3	75.4	75.6	75.8	75.9	1.62	.027
3.24	76.1	76.2	76.4	76.6	76.7	76.9	77.1	77.2	77.4	77.6	1.65	.028
3.25	77.7	77.9	78.1	78.2	78.4	78.6	78.7	78.9	79.1	79.2	1.67	.028
3.26	79.4	79.6	79.7	79.9	80.1	80.3	80.4	80.6	80.8	80.9	1.70	.028
3.27	81.1	81.3	81.5	81.6	81.8	82.0	82.1	82.3	82.5	82.7	1.73	.029
3.28	82.8	83.0	83.2	83.4	83.5	83.7	83.9	84.1	84.2	84.4	1.76	.029
3.29	84.6	84.8	85.0	85.1	85.3	85.5	85.7	85.8	86.0	86.2	1.79	.029
3.30	86.4	86.6	86.8	86.9	87.1	87.3	87.5	87.7	87.8	88.0	1.82	.030
3.31	88.2	88.4	88.6	88.8	88.9	89.1	89.3	89.5*	89.6	89.8	1.73	-.089
3.32	89.9	90.1	90.2	90.4	90.5	90.7	90.8	91.0	91.1	91.3	1.48	-.255
3.33	91.4	91.6	91.7	91.9	92.0	92.2	92.3	92.5	92.6	92.8	1.49	.018
3.34	92.9	93.1	93.2	93.4	93.5	93.7	93.8	94.0	94.1	94.3	1.51	.018
3.35	94.4	94.6	94.7	94.9	95.0	95.2	95.3	95.5	95.6	95.8	1.53	.018

ght	.000	.001	.002	.003	.004	.005	.006	.007	.008	.009	1st diff	2nd diff
3.36	95.9	96.1	96.3	96.4	96.6	96.7	96.9	97.0	97.2	97.3	1.55	.018
3.37	97.5	97.7	97.8	98.0	98.1	98.3	98.4	98.6	98.7	98.9	1.57	.018
3.38	99.1	99.2	99.4	99.5	99.7	99.9	100	100	100	100	1.58	.018
3.39	101	101	101	101	101	101	102	102	102	102	1.60	.019
3.40	102	102	103	103	103	103	103	103	104	104	1.62	.019
3.41	104	104	104	104	105	105	105	105	105	105	1.64	.019
3.42	106	106	106	106	106	106	107	107	107	107	1.66	.019
3.43	107	107	108	108	108	108	108	108	109	109	1.68	.019
3.44	109	109	109	109	110	110	110	110	110	110	1.70	.019
3.45	111	111	111	111	111	111	112	112	112	112	1.72	.019
3.46	112	112	113	113	113	113	113	113	114	114	1.74	.020
3.47	114*	114	114	114	115	115	115	115	115	115	1.60	-.141
3.48	116	116	116	116	116	116	117	117	117	117	1.61	.016
3.49	117	117	118	118	118	118	118	118	119	119	1.63	.016
3.50	119	119	119	119	119	120	120	120	120	120	1.64	.016
3.51	120	121	121	121	121	121	121	122	122	122	1.66	.016
3.52	122	122	122	123	123	123	123	123	123	124	1.68	.016
3.53	124	124	124	124	124	125	125	125	125	125	1.69	.016
3.54	126	126	126	126	126	126	127	127	127	127	1.71	.016
3.55	127	127	128	128	128	128	128	128	129	129	1.72	.016
3.56	129	129	129	129	130	130	130	130	130	131	1.74	.017
3.57	131	131	131	131	131	132	132	132	132	132	1.76	.017
3.58	132	133	133	133	133	133	133	134	134	134	1.77	.017
3.59	134	134	135	135	135	135	135	135	136	136	1.79	.017
3.60	136	136	136	137	137	137	137	137	137	138	1.81	.017
3.61	138	138	138	138	139	139	139	139	139	139	1.82	.017
3.62	140	140	140*	140	140	140	141	141	141	141	1.66	-.163
3.63	141	141	142	142	142	142	142	142	143	143	1.63	-.032
3.64	143	143	143	143	144	144	144	144	144	144	1.64	.013
3.65	145	145	145	145	145	145	146	146	146	146	1.66	.013
3.66	146	146	147	147	147	147	147	147	148	148	1.67	.013
3.67	148	148	148	148	149	149	149	149	149	149	1.68	.013
3.68	150	150	150	150	150	150	151	151	151	151	1.69	.013
3.69	151	151	152	152	152	152	152	152	153	153	1.71	.013
3.70	153	153	153	153	154	154	154	154	154	155	1.72	.013

ght	.000	.001	.002	.003	.004	.005	.006	.007	.008	.009	1st diff	2nd diff
3.71	155	155	155	155	155	156	156	156	156	156	1.73	.013
3.72	156	157	157	157	157	157	157	158	158	158	1.74	.013
3.73	158	158	159	159	159	159	159	159	160	160	1.76	.013
3.74	160	160	160	160	161	161	161	161	161	162	1.77	.013
3.75	162	162	162	162	162	163	163	163	163	163	1.78	.013
3.76	163	164	164	164	164	164	165	165	165	165	1.80	.013
3.77	165	165	166	166	166*	166	166	166	167	167	1.66	-.135
3.78	167	167	167	167	168	168	168	168	168	168	1.57	-.089
3.79	169	169	169	169	169	169	169	170	170	170	1.58	.009
3.80	170	170	170	171	171	171	171	171	171	172	1.59	.009
3.81	172	172	172	172	172	172	173	173	173	173	1.60	.009
3.82	173	173	174	174	174	174	174	174	175	175	1.61	.009
3.83	175	175	175	175	176	176	176	176	176	176	1.62	.009
3.84	177	177	177	177	177	177	177	178	178	178	1.63	.009
3.85	178	178	178	179	179	179	179	179	179	180	1.64	.009
3.86	180	180	180	180	180	181	181	181	181	181	1.65	.009
3.87	181	182	182	182	182	182	182	183	183	183	1.66	.009
3.88	183	183	183	184	184	184	184	184	184	185	1.67	.009
3.89	185	185	185	185	185	186	186	186	186	186	1.68	.009
3.90	186	187	187	187	187	187	187	188	188	188	1.68	.009
3.91	188	188	188	189	189	189	189	189	189	190	1.69	.009
3.92	190	190	190	190	190	191	191	191*	191	191	1.69	-.009
3.93	191	192	192	192	192	192	192	193	193	193	1.65	-.033
3.94	193	193	193	194	194	194	194	194	194	195	1.66	.009
3.95	195	195	195	195	195	196	196	196	196	196	1.67	.009
3.96	196	197	197	197	197	197	197	198	198	198	1.68	.009
3.97	198	198	198	199	199	199	199	199	200	200	1.69	.009
3.98	200	200	200	200	201	201	201	201	201	201	1.69	.009
3.99	202	202	202	202	202	202	203	203	203	203	1.70	.009
4.00	203	203	204	204	204	204	204	204	205	205	1.71	.009
4.01	205	205	205	205	206	206	206	206	206	206	1.72	.009
4.02	207	207	207	207	207	208	208	208	208	208	1.73	.009
4.03	208	209	209	209	209	209	209	210	210	210	1.74	.009
4.04	210	210	210	211	211	211	211	211	212	212	1.75	.009
4.05	212	212	212	212	213	213	213	213	213	213	1.76	.009

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ght	.000	.001	.002	.003	.004	.005	.006	.007	.008	.009	1st diff	2nd diff
4.06	214	214	214	214	214	215	215	215	215	215	1.76	.009
4.07	215	216	216	216	216	216	216	217	217	217*	1.76	-.004
4.08	217	217	217	218	218	218	218	218	218	219	1.65	-.111
4.09	219	219	219	219	219	220	220	220	220	220	1.66	.007
4.10	220	221	221	221	221	221	221	222	222	222	1.66	.007
4.11	222	222	222	223	223	223	223	223	223	224	1.67	.007
4.12	224	224	224	224	224	225	225	225	225	225	1.68	.007
4.13	225	226	226	226	226	226	226	227	227	227	1.68	.007
4.14	227	227	228	228	228	228	228	228	229	229	1.69	.007
4.15	229	229	229	229	230	230	230	230	230	230	1.70	.007
4.16	231	231	231	231	231	231	232	232	232	232	1.71	.007
4.17	232	232	233	233	233	233	233	233	234	234	1.71	.007
4.18	234	234	234	234	235	235	235	235	235	236	1.72	.007
4.19	236	236	236	236	236	237	237	237	237	237	1.73	.007
4.20	237	238	238	238	238	238	238	239	239	239	1.73	.007
4.21	239	239	240	240	240	240	240	240	241	241	1.74	.007
4.22	241	241	241	241	242	242	242	242	242	242	1.75	.007
4.23	243	243	243*	243	243	243	244	244	244	244	1.68	-.066
4.24	244	244	245	245	245	245	245	246	246	246	1.67	-.012
4.25	246	246	246	247	247	247	247	247	247	248	1.68	.006
4.26	248	248	248	248	248	249	249	249	249	249	1.68	.006
4.27	249	250	250	250	250	250	250	251	251	251	1.69	.006
4.28	251	251	251	252	252	252	252	252	252	253	1.70	.006
4.29	253	253	253	253	253	254	254	254	254	254	1.70	.006
4.30	254	255	255	255	255	255	255	256	256	256	1.71	.006
4.31	256	256	257	257	257	257	257	257	258	258	1.71	.006
4.32	258	258	258	258	259	259	259	259	259	259	1.72	.006
4.33	260	260	260	260	260	260	261	261	261	261	1.73	.006
4.34	261	261	262	262	262	262	262	263	263	263	1.73	.006
4.35	263	263	263	264	264	264	264	264	264	265	1.74	.006
4.36	265	265	265	265	265	266	266	266	266	266	1.75	.006
4.37	267	267	267	267	267	267	268	268	268	268	1.75	.006
4.38	268	268	269	269	269*	269	269	269	270	270	1.68	-.074
4.39	270	270	270	270	271	271	271	271	271	271	1.63	-.049
4.40	272	272	272	272	272	272	273	273	273	273	1.63	.005

ght	.000	.001	.002	.003	.004	.005	.006	.007	.008	.009	1st diff	2nd diff
4.41	273	273	274	274	274	274	274	274	275	275	1.64	.005
4.42	275	275	275	275	276	276	276	276	276	276	1.64	.005
4.43	277	277	277	277	277	277	278	278	278	278	1.65	.005
4.44	278	278	279	279	279	279*	279	279	280	280	1.72	.070
4.45	280	280	280	280	281	281	281	281	281	282	1.79	.071
4.46	282	282	282	282	282	283	283	283	283	283	1.80	.006
4.47	283	284	284	284	284	284	285	285	285	285	1.80	.006
4.48	285	285	286	286	286	286	286	287	287	287	1.81	.006
4.49	287	287	287	288	288	288	288	288	289	289	1.82	.006
4.50	289	289	289	289	290	290	290*	290	290	291	1.81	-.009
4.51	291	291	291	291	291	292	292	292	292	292	1.79	-.016
4.52	293	293	293	293	293	293	294	294	294	294	1.80	.006
4.53	294	294	295	295	295	295	295	296	296	296	1.80	.006
4.54	296	296	296	297	297	297	297	297	298	298	1.81	.006
4.55	298	298	298	298	299	299	299	299	299	300	1.81	.006
4.56	300	300	300	300	300	301	301	301*	301	302	2.05	.233
4.57	302	302	302	303	303	303	303	304	304	304	2.59	.542
4.58	304	305	305	305	305	306	306	306	306	307	2.60	.015
4.59	307	307	307	308	308	308	309	309	309	309	2.62	.015
4.60	310	310	310	310	311	311	311	311	312	312	2.63	.015
4.61	312	312	313	313	313	314	314	314	314	315	2.65	.015
4.62	315	315	315	316	316	316	316	317	317*	317	2.83	.185
4.63	318	318	318	319	319	319	320	320	321	321	3.54	.703
4.64	321	322	322	322	323	323	323	324	324	324	3.57	.030
4.65	325	325	326	326	326	327	327	327	328	328	3.60	.030
4.66	328	329	329	329	330	330	331	331	331	332	3.63	.030
4.67	332	332	333	333	333	334	334	335	335	335	3.66	.030
4.68	336	336	336	337	337	338	338	338	339	339*	3.71	.059
4.69	339	340	340	341	341	341	342	342	343	343	4.01	.294
4.70	343	344	344	345	345	345	346	346	347	347	4.04	.036
4.71	347	348	348	349	349	349	350	350	351	351	4.08	.037
4.72	352	352	352	353	353	354	354	354	355	355	4.12	.037
4.73	356	356	356	357	357	358	358	359	359	359	4.16	.037
4.74	360	360	361	361	361	362	362	363	363	364	4.19	.037
4.75	364*	365	365	366	366	367	368	368	369	369	6.01	1.82

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ght	.000	.001	.002	.003	.004	.005	.006	.007	.008	.009	1st diff	2nd diff
4.76	370	371	371	372	372	373	374	374	375	375	6.10	.083
4.77	376	377	377	378	379	379	380	380	381	382	6.18	.084
4.78	382	383	384	384	385	385	386	387	387	388	6.27	.085
4.79	389	389	390	390	391	392	392	393	394	394	6.35	.086
4.80	395	396	396	397	397	398	399	399	400	401	6.44	.087
4.81	401	402*	403	403	404	405	405	406	406	407	6.35	-.086
4.82	408	408	409	410	410	411	412	412	413	413	6.42	.064
4.83	414	415	415	416	417	417	418	419	419	420	6.50	.084
4.84	421	421	422	423	423	424	425	425	426	427	6.59	.085
4.85	427	428	429	429	430	431	431	432	433	433	6.67	.086
4.86	434	435	435	436	437	437	438	439	439	440	6.76	.087
4.87	441	441	442*	443	443	444	445	445	446	446	6.45	-.311
4.88	447	448	448	449	450	450	451	452	452	453	6.42	-.023
4.89	454	454	455	455	456	457	457	458	459	459	6.50	.075
4.90	460	461	461	462	463	463	464	465	465	466	6.58	.076
4.91	467	467	468	469	469	470	471	471	472	473	6.65	.077
4.92	473	474	475	475	476	477	477	478	479	479	6.73	.078
4.93	480	481	481	482*	483	483	484	484	485	486	6.39	-.343
4.94	486	487	488	488	489	489	490	491	491	492	6.27	-.114
4.95	493	493	494	495	495	496	496	497	498	498	6.34	.065
4.96	499	500	500	501	502	502	503	503	504	505	6.40	.065
4.97	505	506	507	507	508	509	509	510	511	511	6.47	.066
4.98	512	512	513	514	514	515	516	516	517	518	6.53	.066
4.99	518	519	520	520	521*							

* skeletal rating point

Colorado River @ STB

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