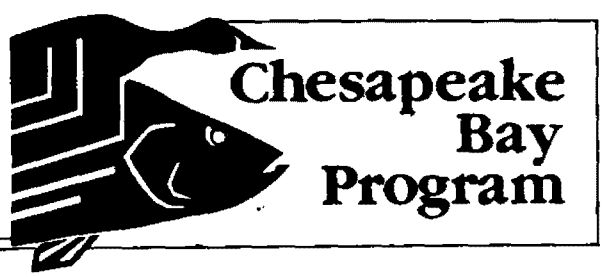
CBP/TRS 62/91
April 1991

Watershed Model Application to Calculate Bay Nutrient Loadings

Final Findings and Recommendations

Appendix A Hydrology Calibration Results



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Watershed Model Application to Calculate Bay Nutrient Loadings:

Final Findings and Recommendations

Appendix A Hydrology Calibration Results

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APPENDIX A

HYDROLOGY CALIBRATION RESULTS

Table of Contents

APPENDIX SUMMARY

Appendix A provides the results of the Watershed Model Phase II Hydrology Calibration. Presented are plots and statistical tables comparing the simulated and observed flows covering the period 1984-1987 for each of the major calibration stations of the fourteen subbasins of the Chesapeake Bay. Specifically, this appendix includes the following plots: a) time series plots of simulated and observed daily flows for 1984-1987; b) time series plots of residuals (simulated minus observed daily flows); c) time series plots of cumulative simulated and observed flows; d) plots of percent chance flow exceeded vs. streamflow; e) distribution of percent relative errors and actual errors over the percentile sample population; and e) scatter plots of the regression of log transformed simulated flows on log transformed observed flows. This Appendix also contains statistical tables, as follows: a) comparison of annual total observed and simulated flows; and, b) regression statistics including average daily, monthly and seasonal R^2's, and intercept and slope statistics.

The time series overlay plots of simulated and observed daily flows show good agreement between the model results and the monitoring data. The differences occur during the winter months when the model manifests higher flows compared with the observed flows, and in the spring periods when the simulated values are lower than the observed. These may be attributed to difficulties in simulating snowmelt. In general, the model anticipates the observed peak flows with a one to two days phasing difference as

illustrated by the residual plots which characteristically show an initial overshoot followed immediately by an undershoot of the simulated flows during major storm events.

The state of model calibration is also demonstrated by the cumulative flow plots. For most of the subbasins, the cumulative plots depict a very close tracking of the observed cumulative flows by the cumulative simulated flows. Only Rappahannock and Mattaponi show relatively poor correspondence of the simulated and observed values due to the persistent undersimulation of flows in both rivers. The percent chance flow exceeded plots affirm that the simulated and observed values favorably compare with each other.

The relative error plots (i.e., where relative error is computed as the simulated minus observed values divided by the observed values) show that over 90% of the daily simulated flows are within -100% to 100% error with respect to the observed flows. However, for most of the subbasins about 60-85% of the relative errors fall within the -50% to 50% range. Virtually all of the daily simulated flow values deviate with the observed flows within the range, -10,000 to +10,000 cfs. Almost all of the actual error plots display a flat curve about 0 cfs. The sigmoidal shape of the relative and actual eror plots indicate that the errors are normally distributed.

The scatter plots of the regression of log simulated flows on log observed flow show that generally the model has no bias, and that the subbasins, Appomattox and Mattaponi, bear the greatest difference between the log simulated and log observed values. It should be noted that the flows in the two rivers are controlled to

a high degree by reservoir water releases.

The regression results reveal that there is, in general, a linear dependence between the log simulated and log observed flows with the 1984-1987 R^2's varying from 0.59 to 0.83 for the daily flows, and from 0.76 to 0.90 for the monthly flows. The average daily and monthly R^2's for the period 1984-1987 are 0.75 and 0.84, respectively. The monthly flow R^2's are invariably higher than the daily flow R^2's due to aggregation of data. The seasonal flow regressions exhibit lower R^2's compared to the daily and monthly flow regressions. The best simulations were obtained for the summer and fall seasons due to low flows, while the overall least agreement was obtained for the winter season as the model oversimulated the high or peak flows -- that is, the seasonal regression coefficients are mostly high for Seasons 3 and 4 (or the 151st to 365th day of the Julian year), and low for Season 1 (or the 1st to the 60th day of the year).

The intercept and slope statistics show parallel results. The 1984-87 monthly flow intercept and slope coefficients are noticeably improved over the daily and seasonal coefficients with nine of the fourteen subbasins (in contrast with only one for the daily and seasonal flows) falling within the 95% confidence limits determined under the F-test (i.e., a statistical test which verifies whether the intercept and slope are significantly different from 0 and 1, respectively).

A.1 EAST BRANCH SUSQUEHANNA RIVER AT SEG. 40

Time Series Plot of Simulated and Observed Daily Flows for 1984-1987

Time Series Plot of Residual (Simulated Minus Observed) Daily Flows for 1984-1987

Time Series Plot of Cumulative Simulated and Observed Flows for 1984-1987

Plot of Percent Chance Flow Exceeded vs. Volume of Streamflow

Distribution of Percent Relative Errors Over Percentile Sample Population

Distribution of Percent Actual Errors Over Percentile Sample Population

Regression of Log Transformed Simulated Flow vs. Log Transformed Observed Flow Scatter Plot

Comparison of Annual Total Observed and Simulated Flow

Average Daily and Monthly R-Squared for 1984-1987

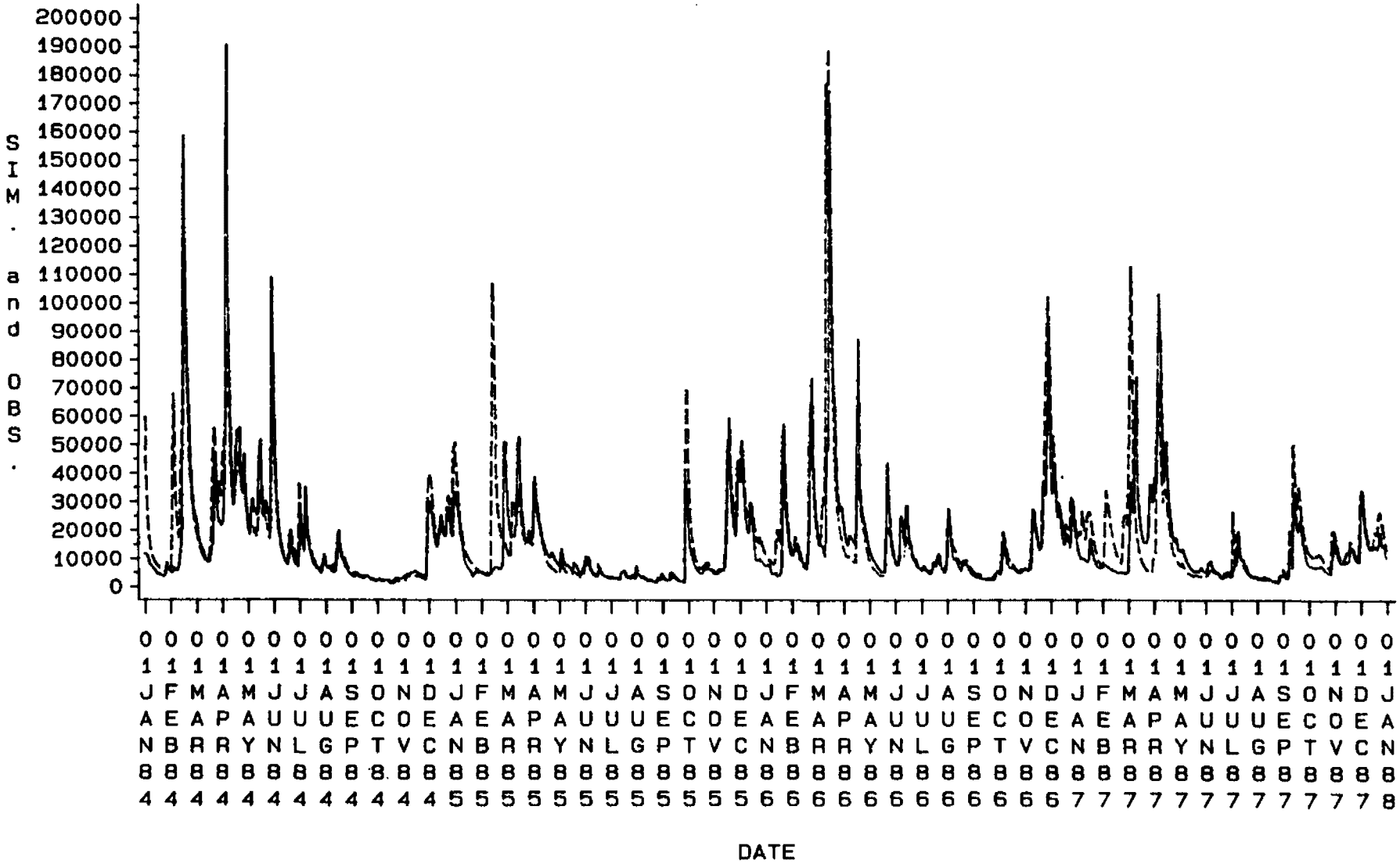
Average Seasonal R-Squared for 1984-1987

Log Transformed Simulated and Observed Flow Regression Slope and Intercept Statistics

EAST BRANCH SUSQUEHANNA RIVER AT SEG. 40

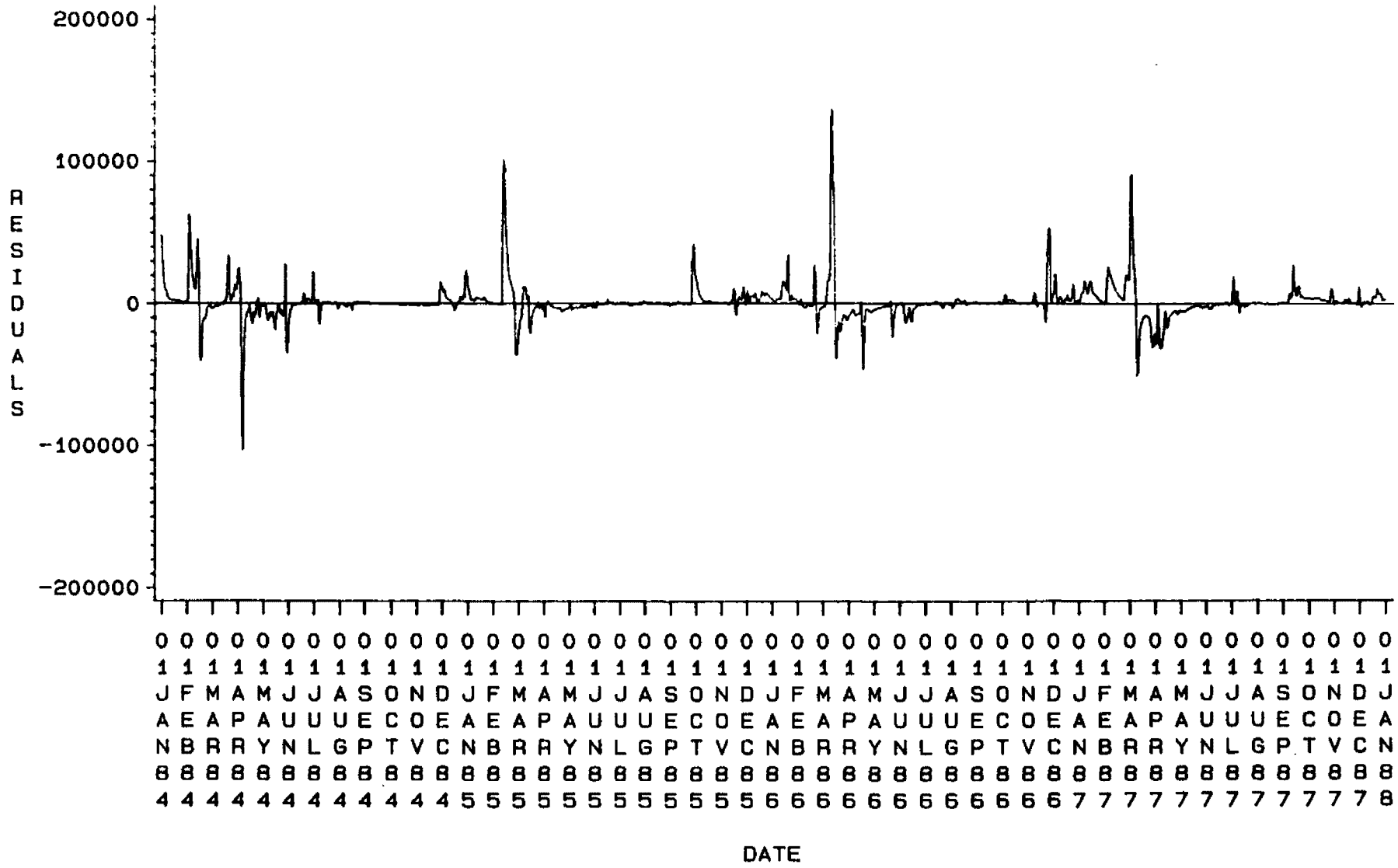
FLOW (CFS)

RED DASHED: SIM., BLUE SOLID: OBS.



EAST BRANCH SUSQUEHANNA RIVER AT SEG. 40

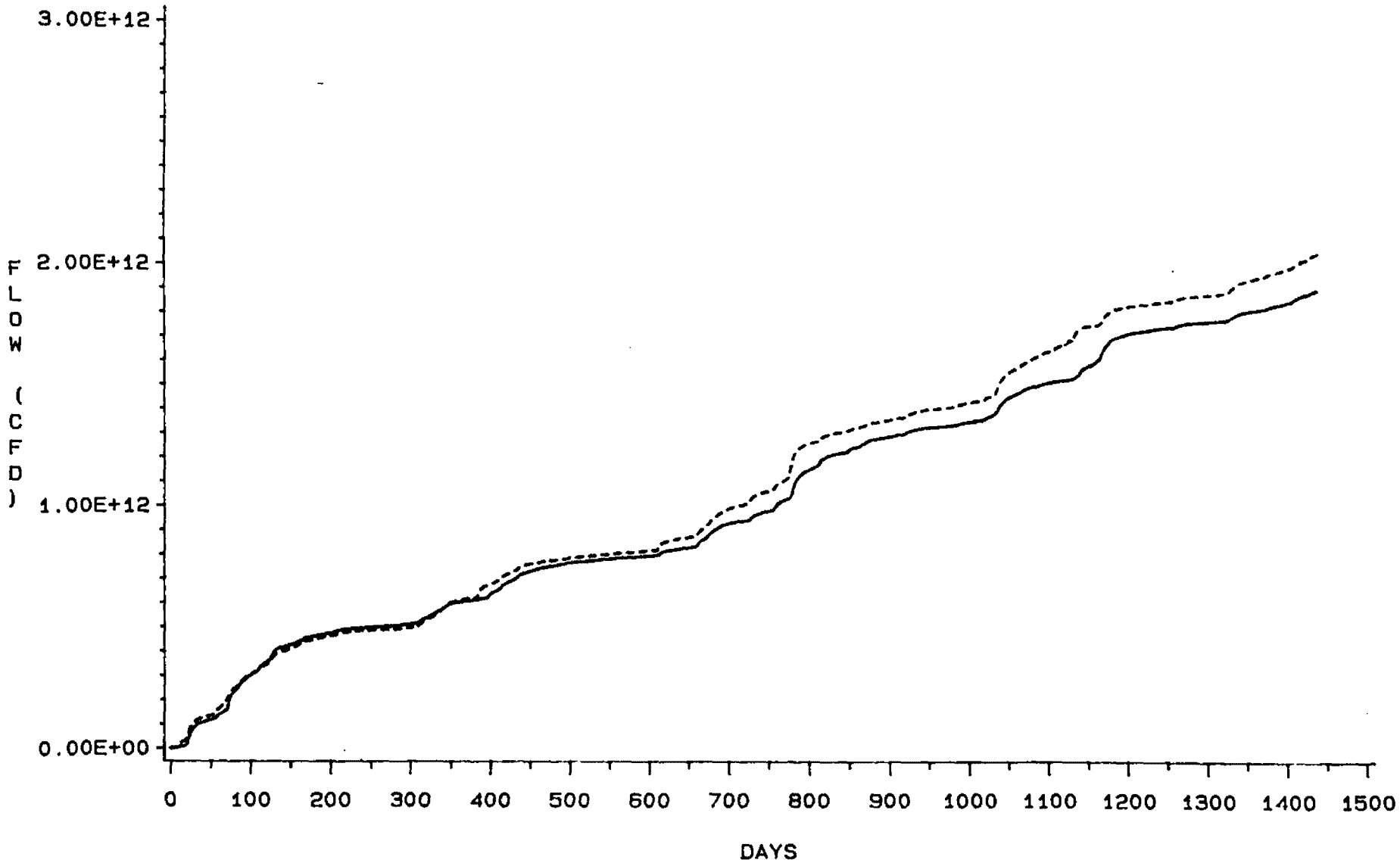
FLOW (CFS)
RESIDUALS (SIMULATED - OBSERVED)

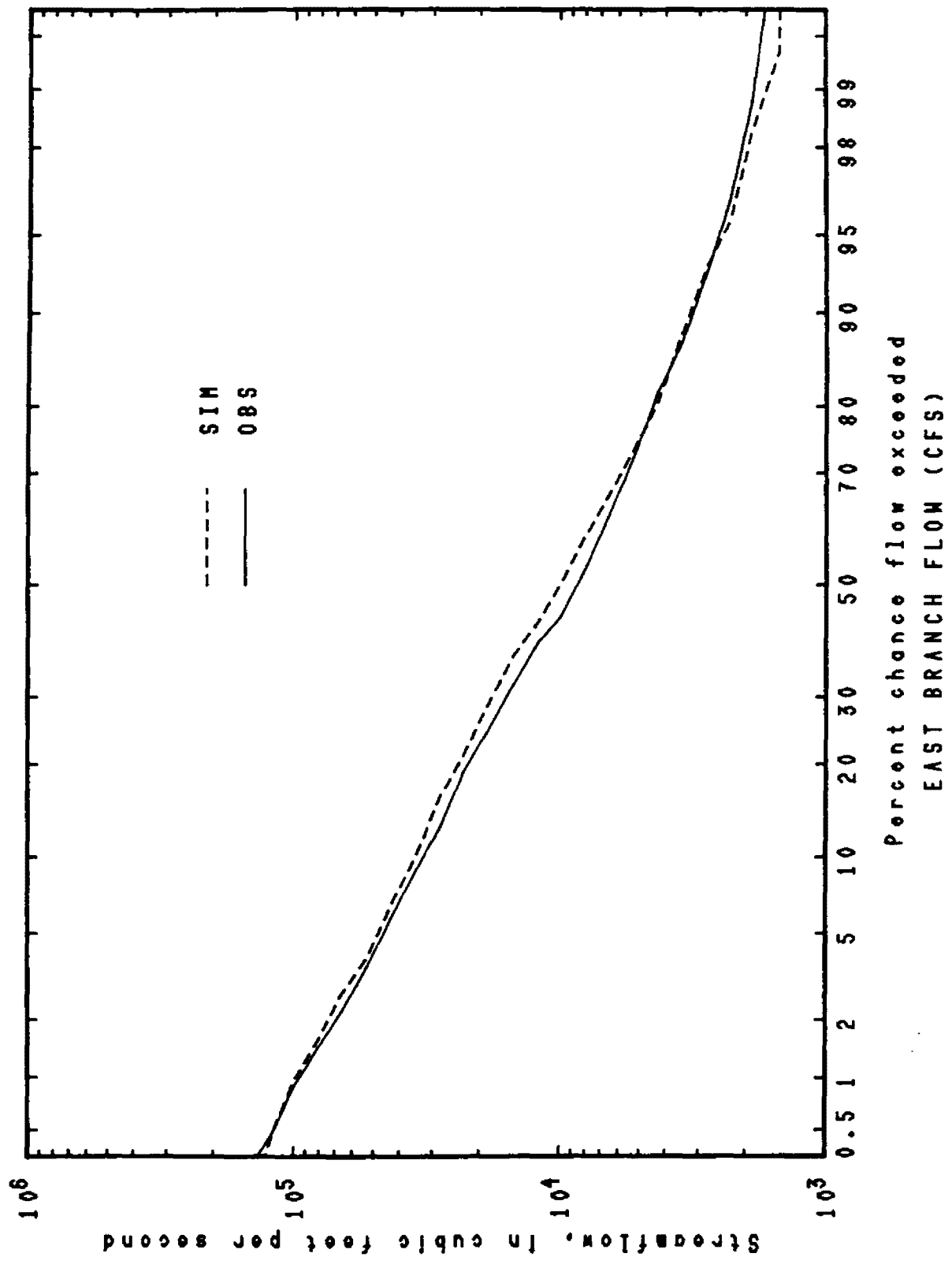


CUMULATIVE FLOWS (CFD) 1984 - 1987

EBSUS

Simulated - - - - - Observed ---------

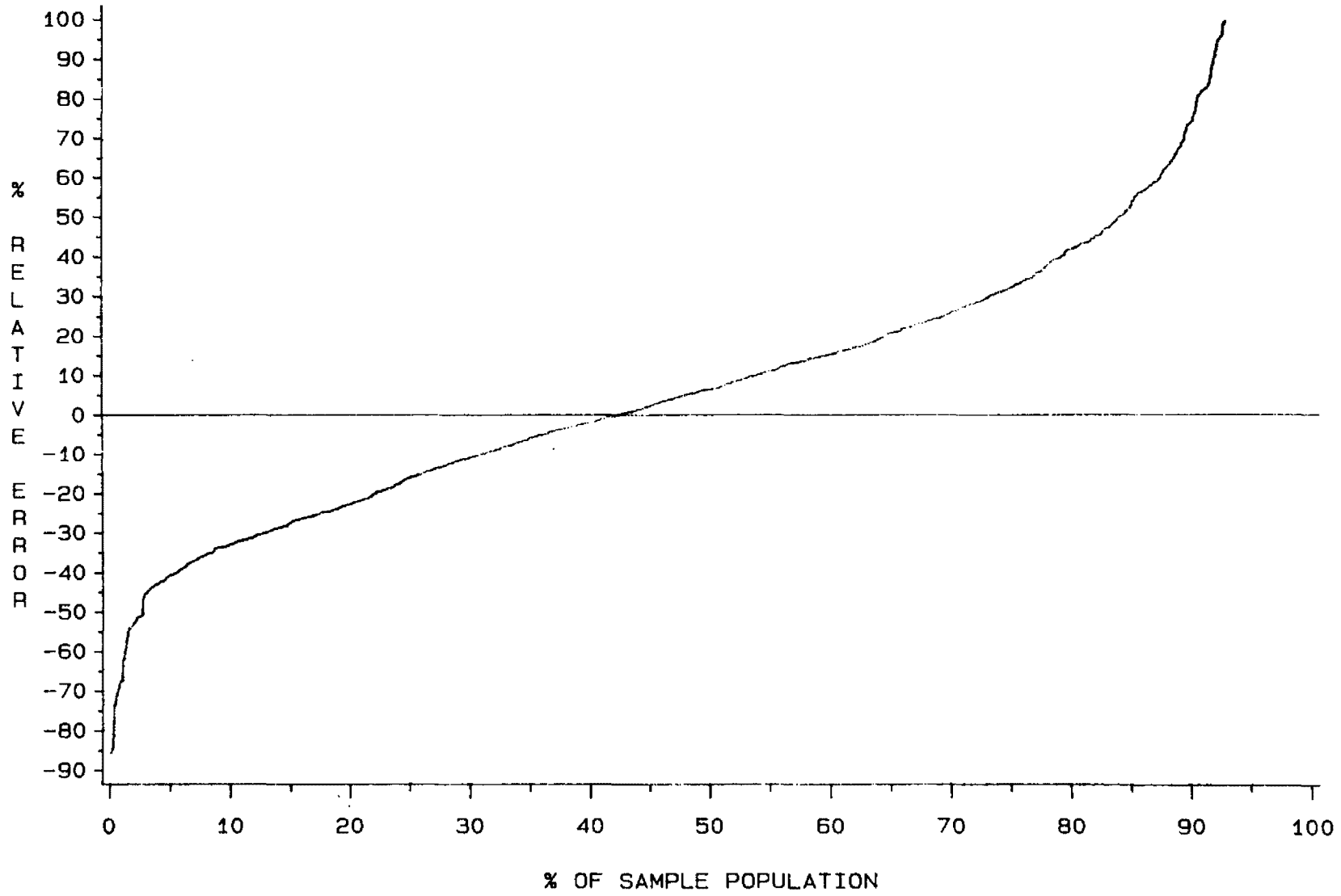



SIM
OBS
Streamflow, in cubic feet per second
10^6
10^5
10^4
10^3
0.5 1 2 5 10 20 30 50 70 80 90 95 98 99
Percent chance flow exceeded
EAST BRANCH FLOW (CFS)

EAST BRANCH SUSQUEHANNA RIVER AT SEG. 40

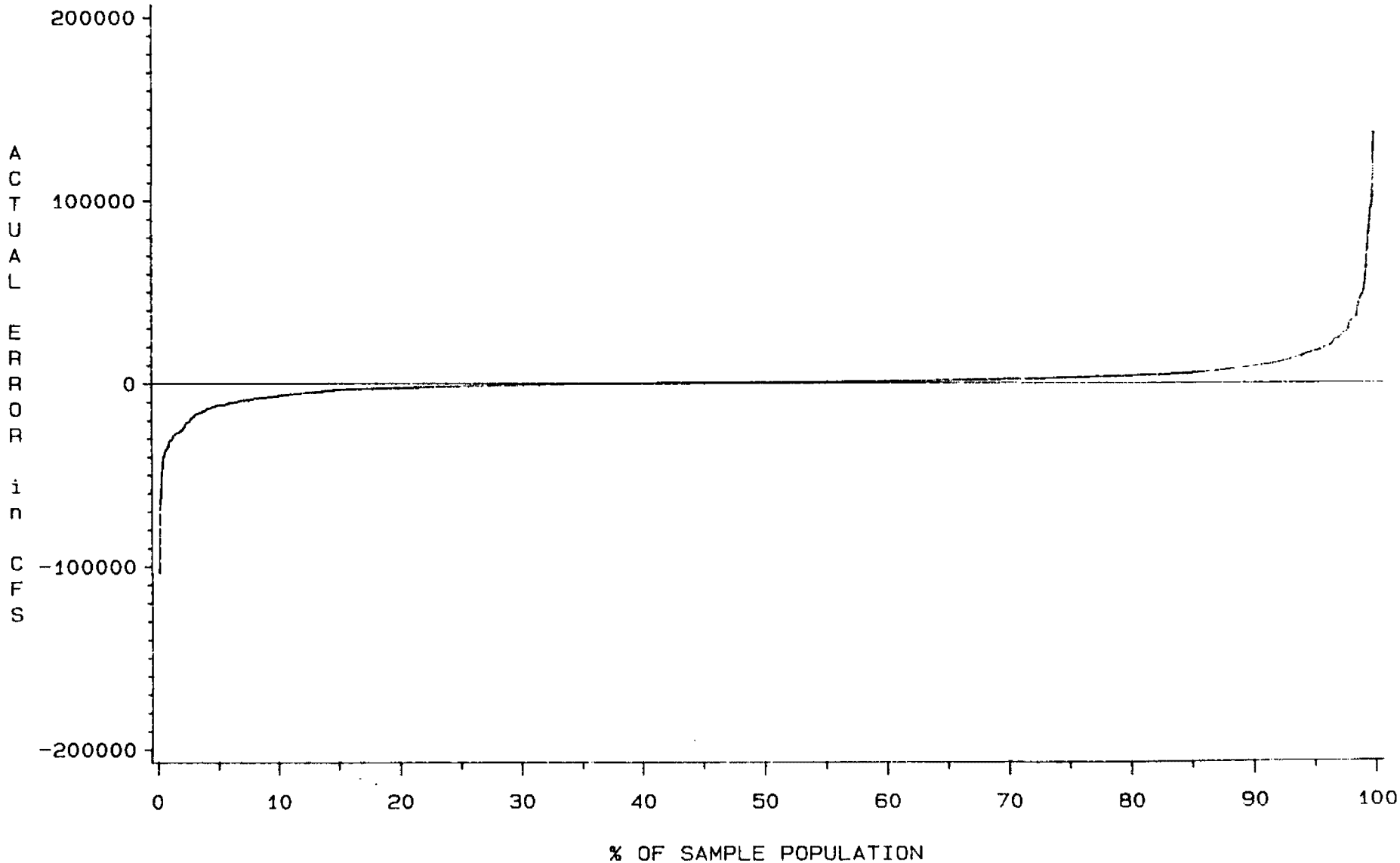
FLOW RELATIVE ERRORS

RELATIVE ERROR = (SIMULATED - OBSERVED)/OBSERVED



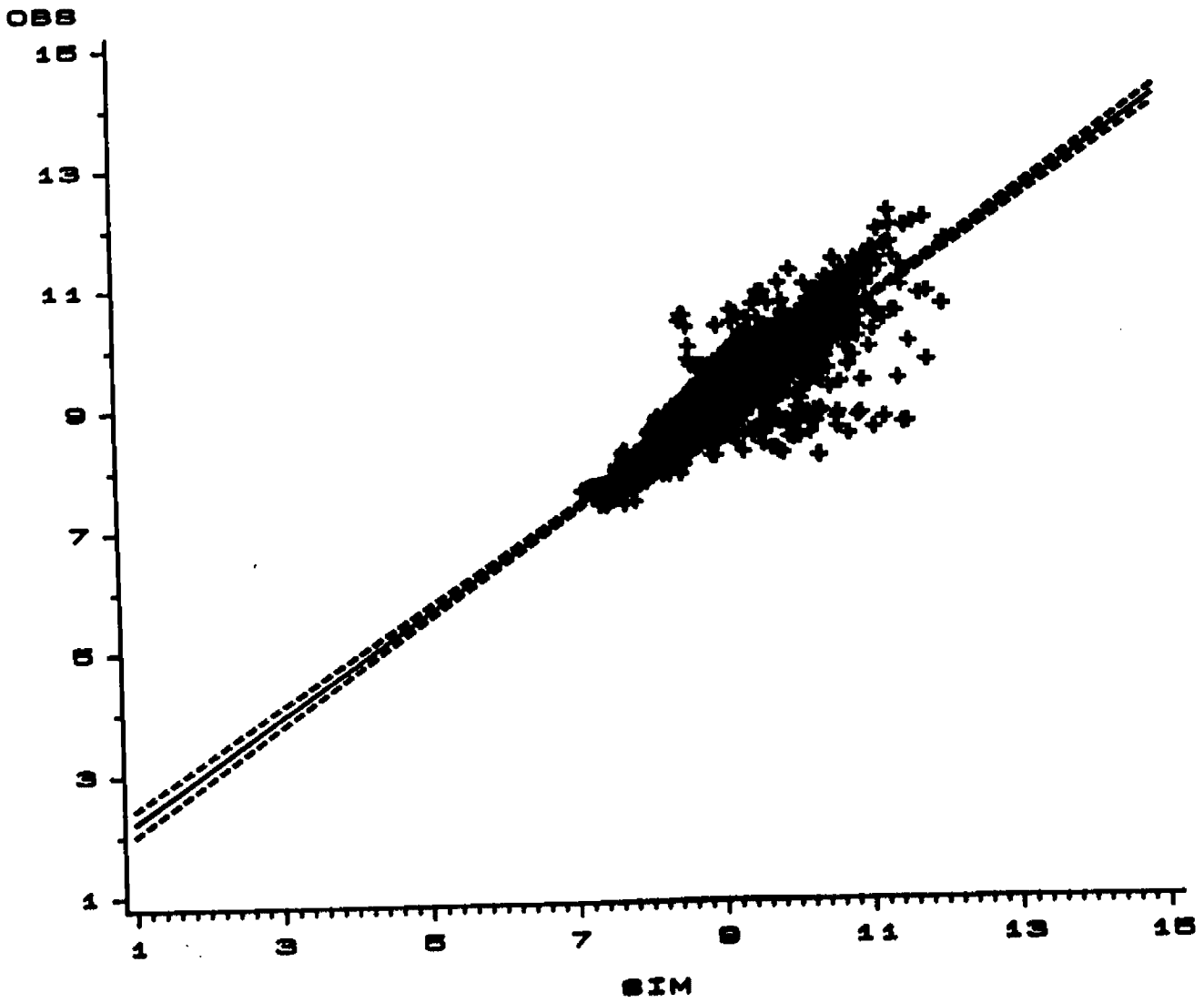
EAST BRANCH SUSQUEHANNA RIVER AT SEG. 40

FLOW ACTUAL ERRORS (CFS)



East Branch Susquehanna River at Seg. 40

Regression of Log Simulated Flow versus Log Observed Flow



Note: Dashed lines represent the 95% confidence limits around the regression line.

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
EAST BRANCH SUSQUEHANNA RIVER, PA (Segments 10, 20, 30 and 40)

COMPARISON OF ANNUAL TOTAL OBSERVED AND SIMULATED FLOWS

Year	Observed* Flow (in)	Simulated+ Flow (in)
1984	22.64	22.66
1985	13.59	15.57
1986	21.02	22.12
1987	15.59	16.59
Mean	18.21	19.24

* Observed flow Susquehanna River near Danville, PA
\+ Simulated outflow from RCH 40

REGRESSION OF LOG SIMULATED FLOW ON LOG OBSERVED FLOW
DAILY AND MONTHLY R-SQUARED

Year	Ave. Daily	Ave. Monthly
1984	0.8465	0.9349
1985	0.7382	0.7992
1986	0.7763	0.8726
1987	0.5454	0.6868
1984-87	0.7453	0.8398

SEASONAL R-SQUARED

Year	Season 1	Season 2	Season 3	Season 4
1984	0.5165	0.7085	0.9254	0.9708
1985	0.2050	0.8719	0.6493	0.9277
1986	0.5532	0.7257	0.8917	0.9280
1987	0.2975	0.6177	0.8387	0.8019

Overall Seasonal R-squared 0.7496

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

CHESAPEAKE BAY WATERSHED HYDROLOGICAL SIMULATION
EAST BRANCH SUSQUEHANNA RIVER, PA (Segments 10, 20, 30 and 40)

REGRESSION OF LOG TRANSFORMED SIMULATED AND OBSERVED FLOWS

	Intercept	Probability Intercept=0*	Slope	Probability Slope=1*
DAILY FLOWS				
1984	1.1117	0.0001	0.8748	0.0001
1985	1.8411	0.0001	0.7860	0.0001
1986	0.8204	0.0008	0.9062	0.0003
1987	2.4920	0.0001	0.7184	0.0001
1984-87	1.4577	0.0001	0.8340	0.0001
MONTHLY FLOWS				
1984	0.3610	0.6458	0.9561	0.5947
1985	1.6256	0.2024	0.8089	0.1669
1986	0.6539	0.5572	0.9266	0.5268
1987	1.3057	0.4574	0.8434	0.4048
1984-87	0.7783	0.1654	0.9065	0.1162
SEASONAL FLOWS				
1984 S1	-0.0982	0.9542	0.9604	0.8110
S2	0.8268	0.2026	0.9236	0.2294
S3	-0.2006	0.4113	1.0179	0.5022
S4	1.8281	0.0001	0.7994	0.0001
1985 S1	5.5243	0.0001	0.3693	0.0001
S2	2.5211	0.0001	0.7549	0.0001
S3	1.9768	0.0001	0.7529	0.0001
S4	1.1219	0.6521	0.9592	0.1453
1986 S1	0.6645	0.5221	0.9017	0.3594
S2	2.9919	0.0001	0.7113	0.0001
S3	-2.2777	0.0001	1.2492	0.0001
S4	0.6113	0.0200	0.9194	0.0031
1987 S1	6.6499	0.0001	0.2347	0.0001
S2	3.6432	0.0001	0.6635	0.0001
S3	1.5030	0.0001	0.8149	0.0001
S4	-0.5272	0.2982	1.0281	0.5972
1984-87	1.4403	0.0001	0.8368	0.0001

* If probability is less than .05 (95% confidence level) then intercept is significantly different from 0, or slope is significantly different from 1.

A.2 WEST BRANCH SUSQUEHANNA RIVER AT SEG. 70

Time Series Plot of Simulated and Observed Daily Flows for 1984-1987

Time Series Plot of Residual (Simulated Minus Observed) Daily Flows for 1984-1987

Time Series Plot of Cumulative Simulated and Observed Flows for 1984-1987

Plot of Percent Chance Flow Exceeded vs. Volume of Streamflow

Distribution of Percent Relative Errors Over Percentile Sample Population

Distribution of Percent Actual Errors Over Percentile Sample Population

Regression of Log Transformed Simulated Flow vs. Log Transformed Observed Flow Scatter Plot

Comparison of Annual Total Observed and Simulated Flow

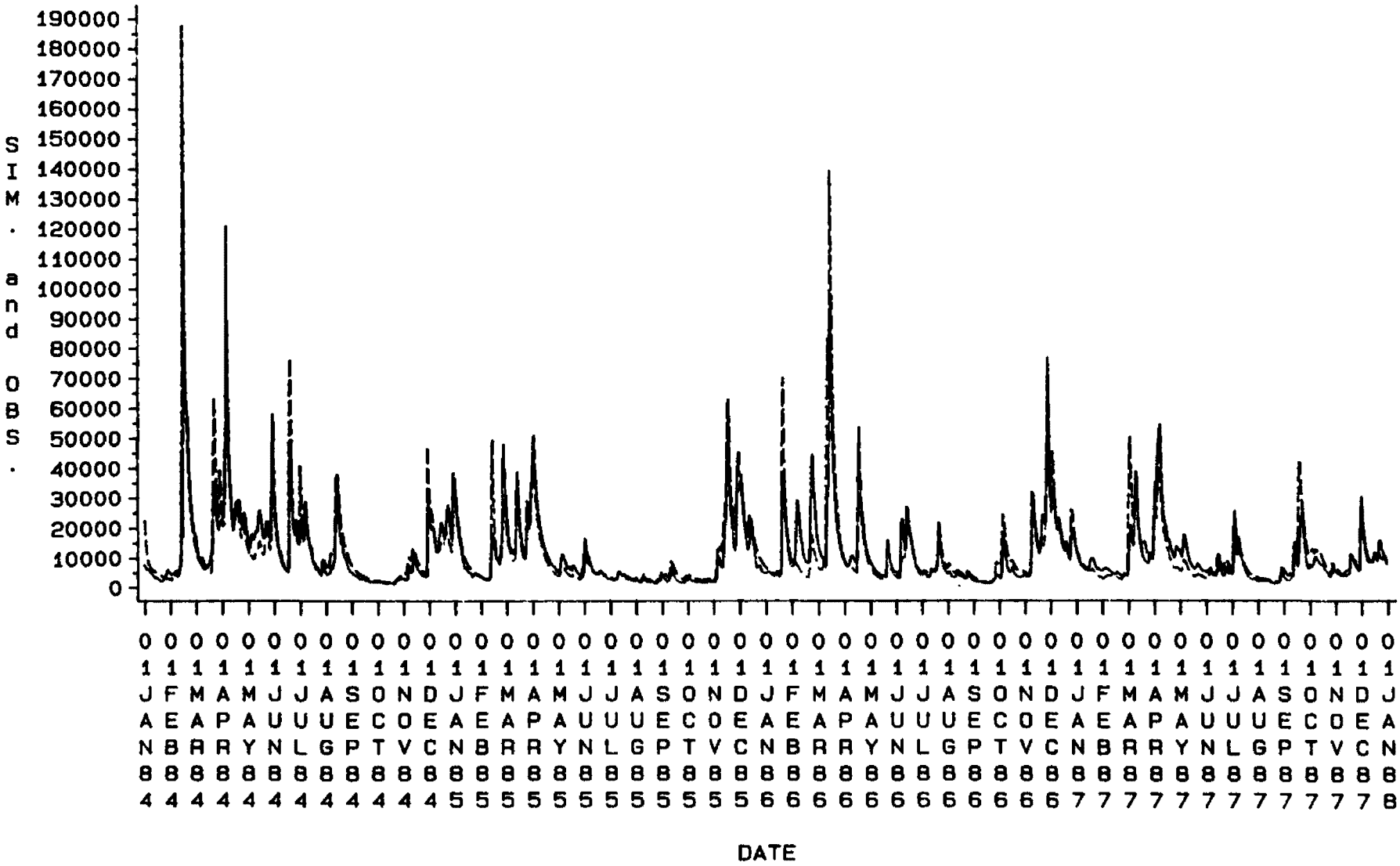
Average Daily and Monthly R-Squared for 1984-1987

Average Seasonal R-Squared for 1984-1987

Log Transformed Simulated and Observed Flow Regression Slope and Intercept Statistics

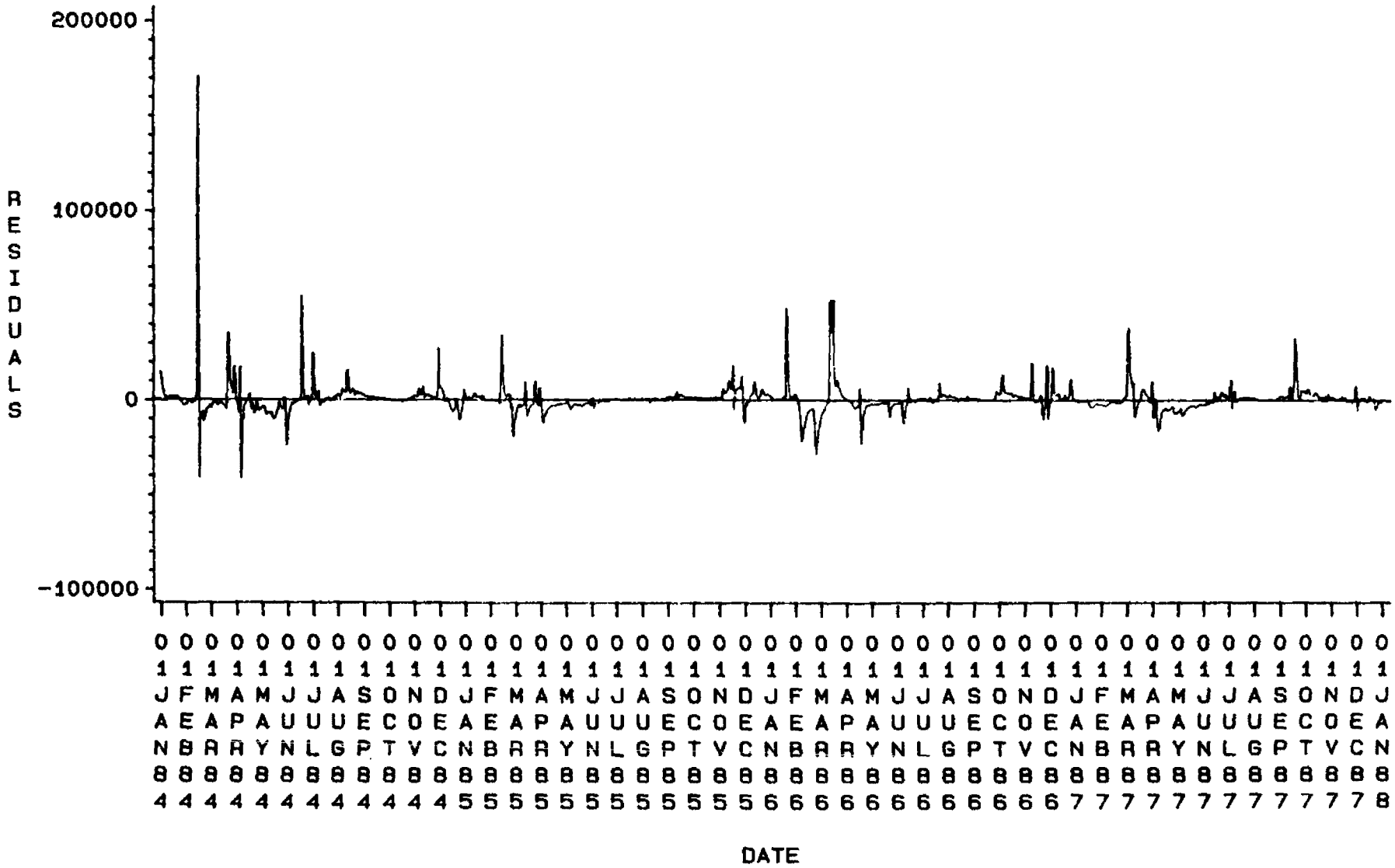
WEST BRANCH SUSQUEHANNA RIVER AT SEG. 70

FLOW (CFS)
RED DASHED: SIM., BLUE SOLID: OBS.

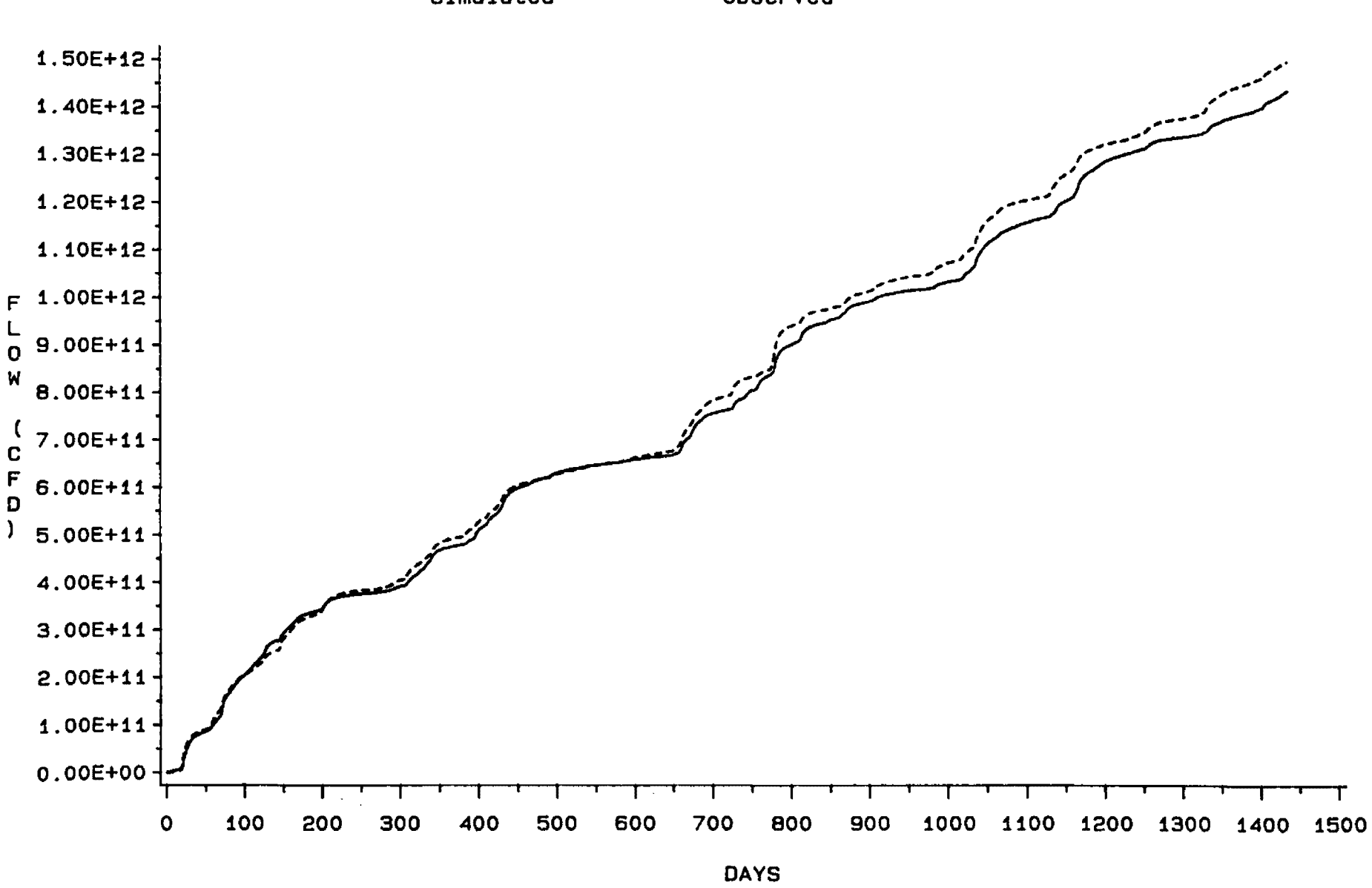


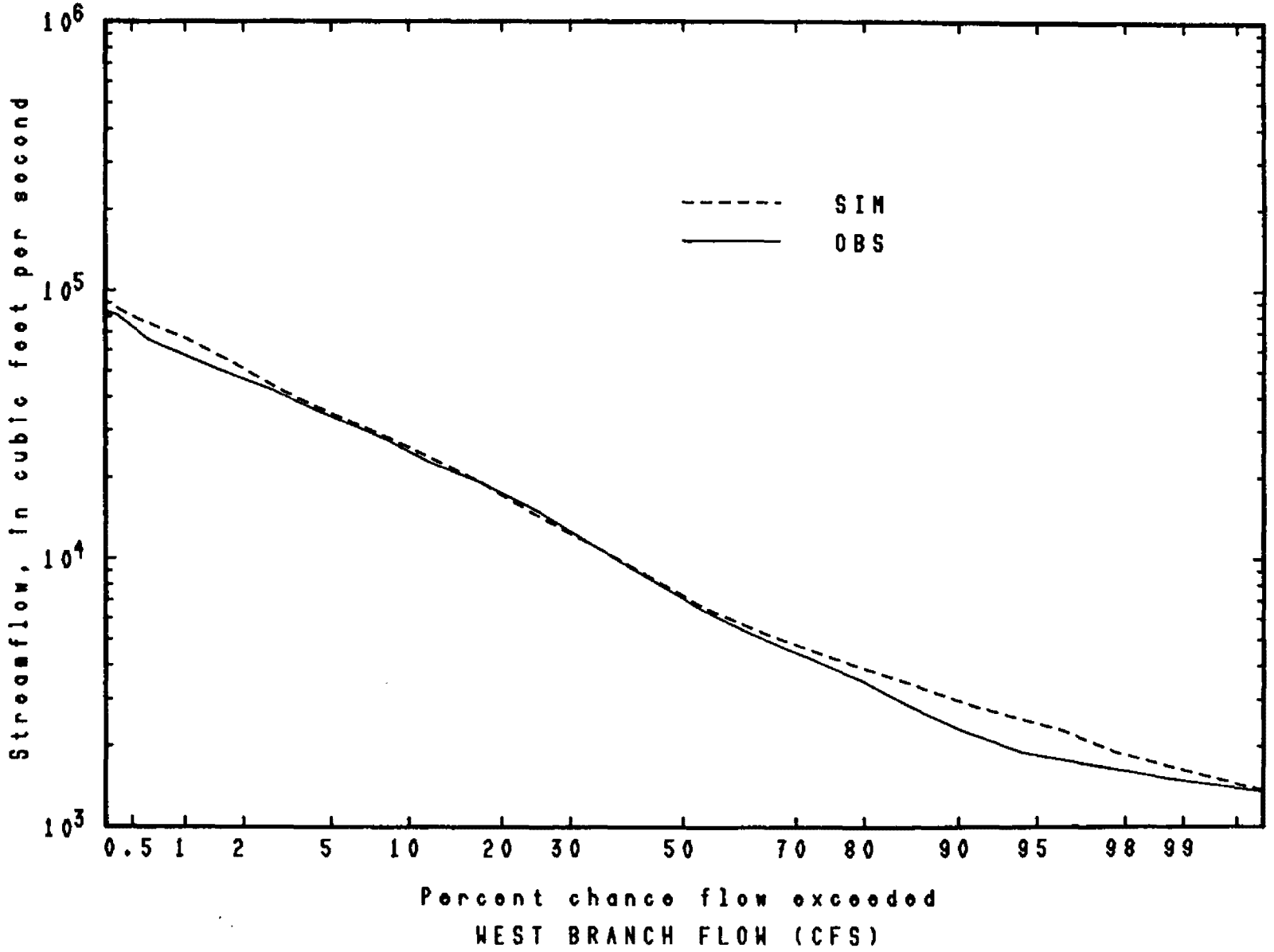
WEST BRANCH SUSQUEHANNA RIVER AT SEG. 70

FLOW (CFS)
RESIDUALS (SIMULATED - OBSERVED)



CUMULATIVE FLOWS (CFD) 1984 - 1987

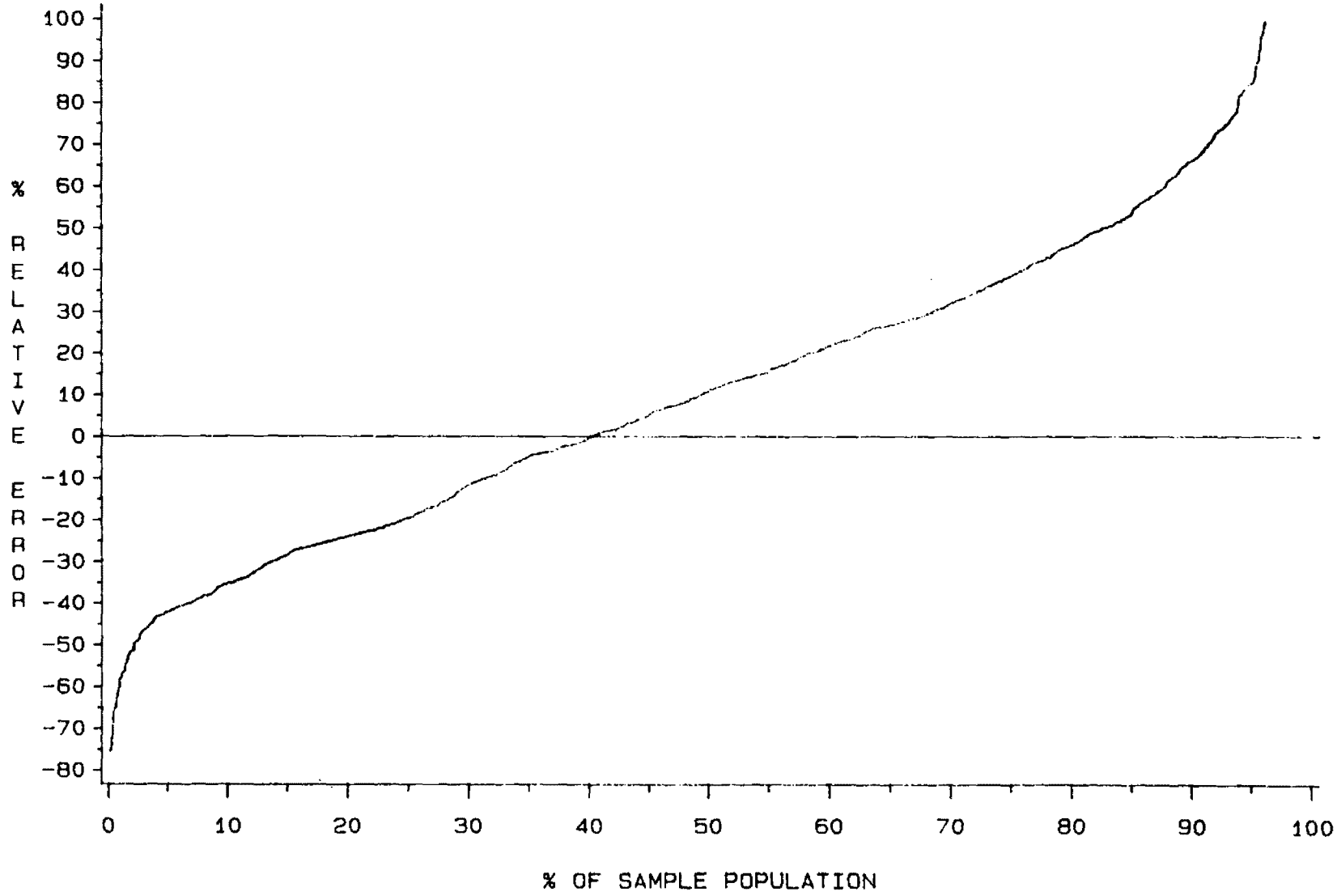



Streamflow, in cubic feet per second
10^6
10^5
10^4
10^3
SIM
OBS
0.5 1 2 5 10 20 30 50 70 80 90 95 98 99
Percent chance flow exceeded
WEST BRANCH FLOW (CFS)

WEST BRANCH SUSQUEHANNA RIVER AT SEG. 70

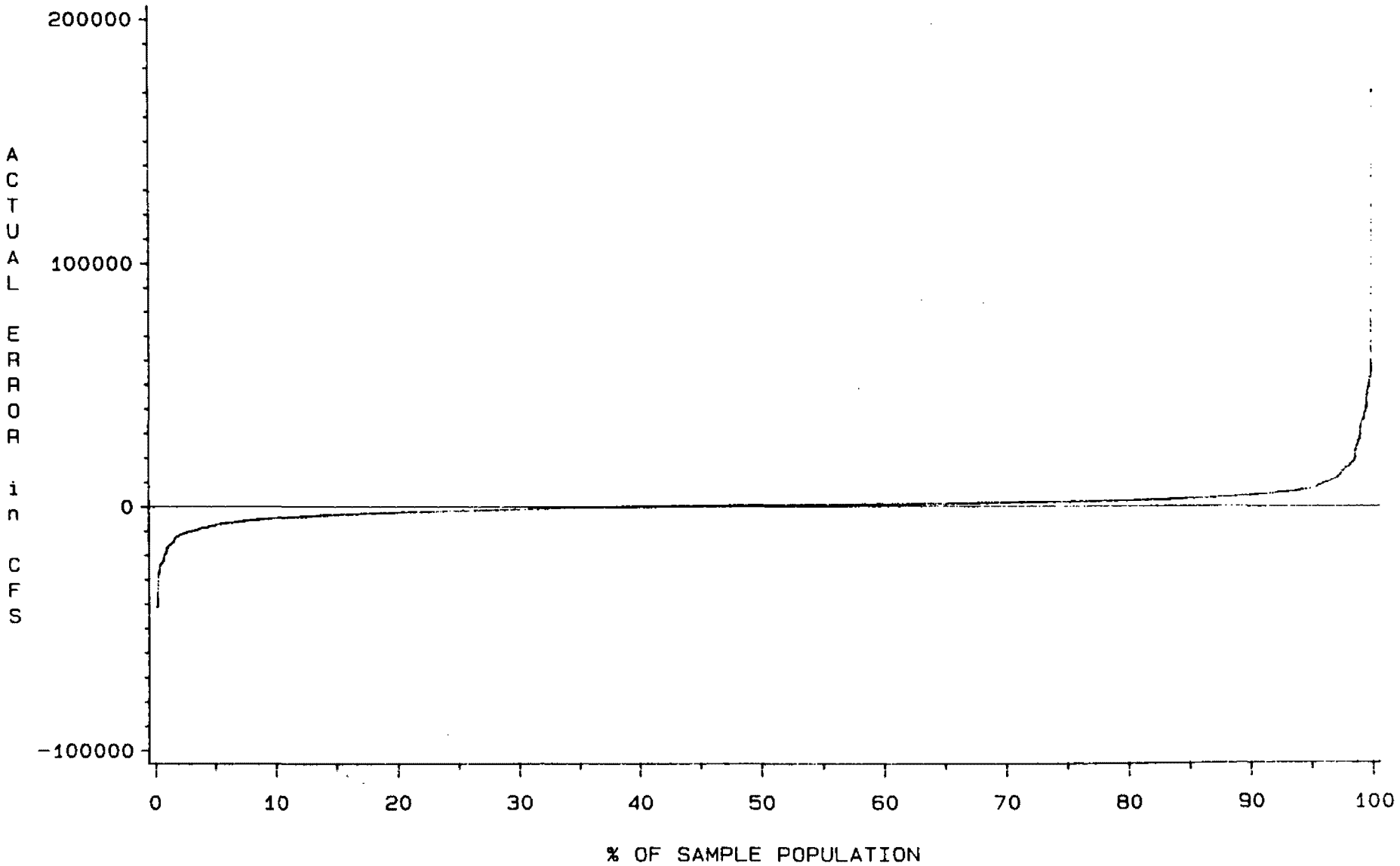
FLOW RELATIVE ERRORS

RELATIVE ERROR = (SIMULATED - OBSERVED)/OBSERVED



WEST BRANCH SUSQUEHANNA RIVER AT SEG. 70

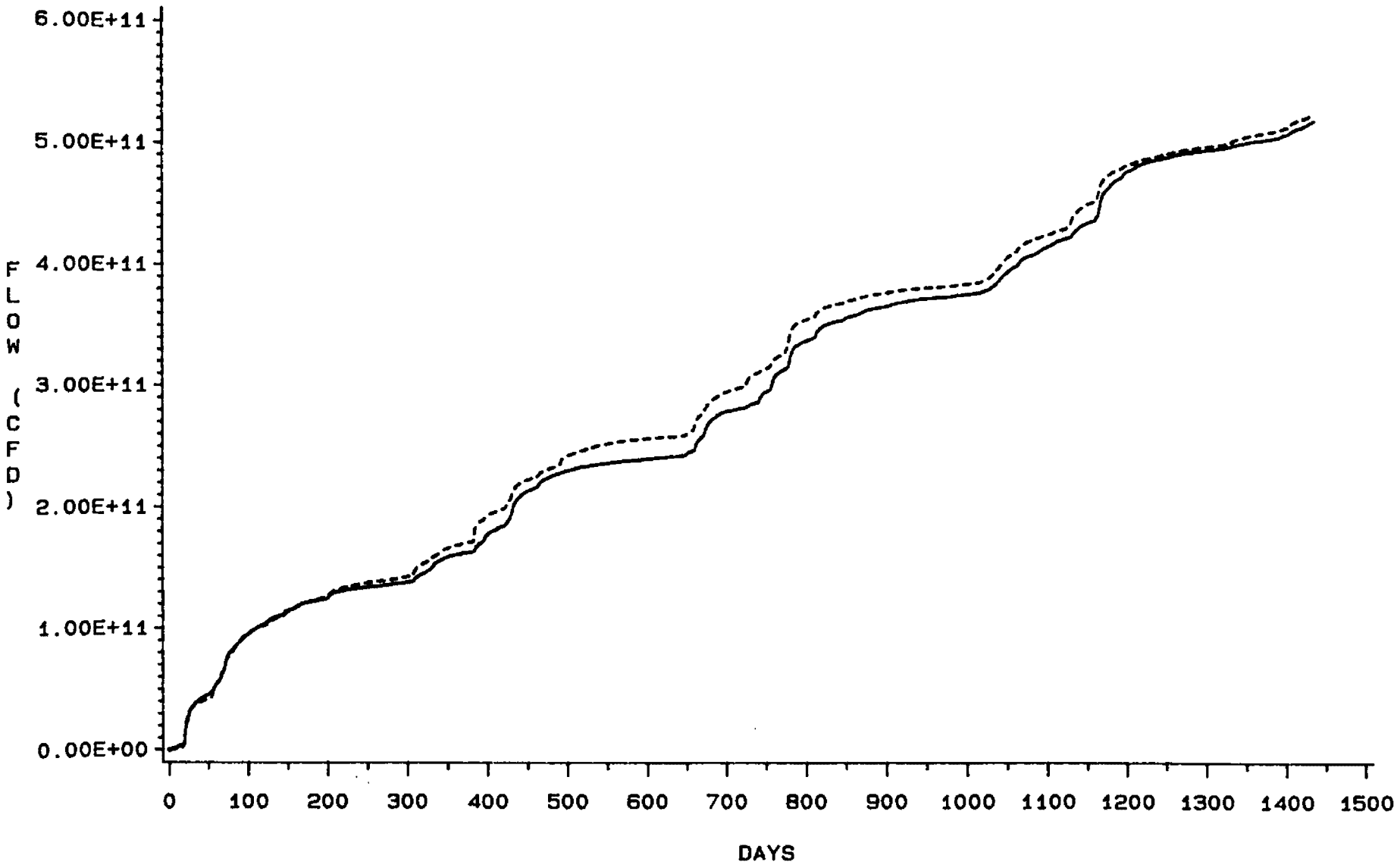
FLOW ACTUAL ERRORS (CFS)

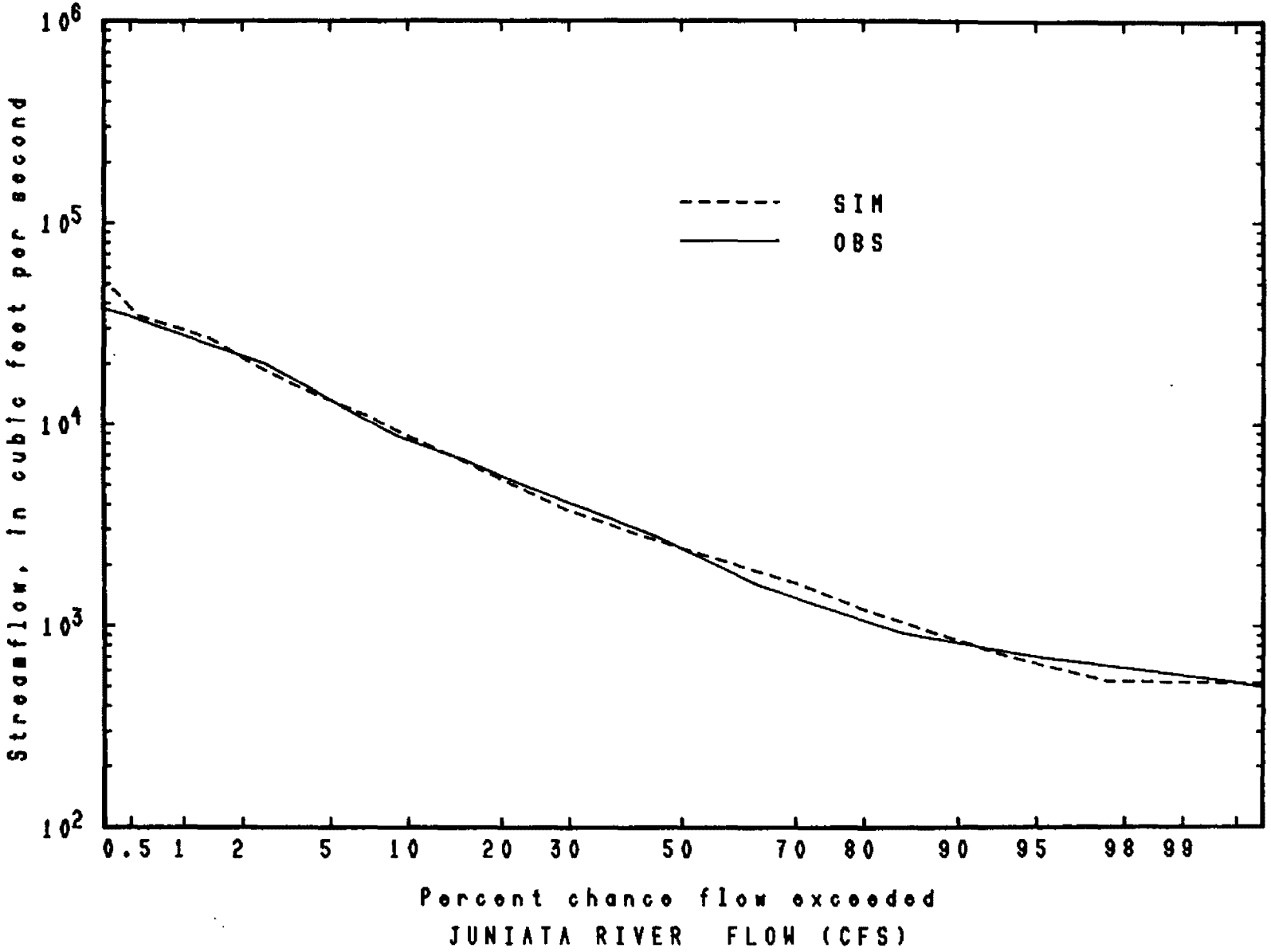


CUMULATIVE FLOWS (CFD) 1984 - 1987

JUNIA

Simulated - - - - - Observed ---------

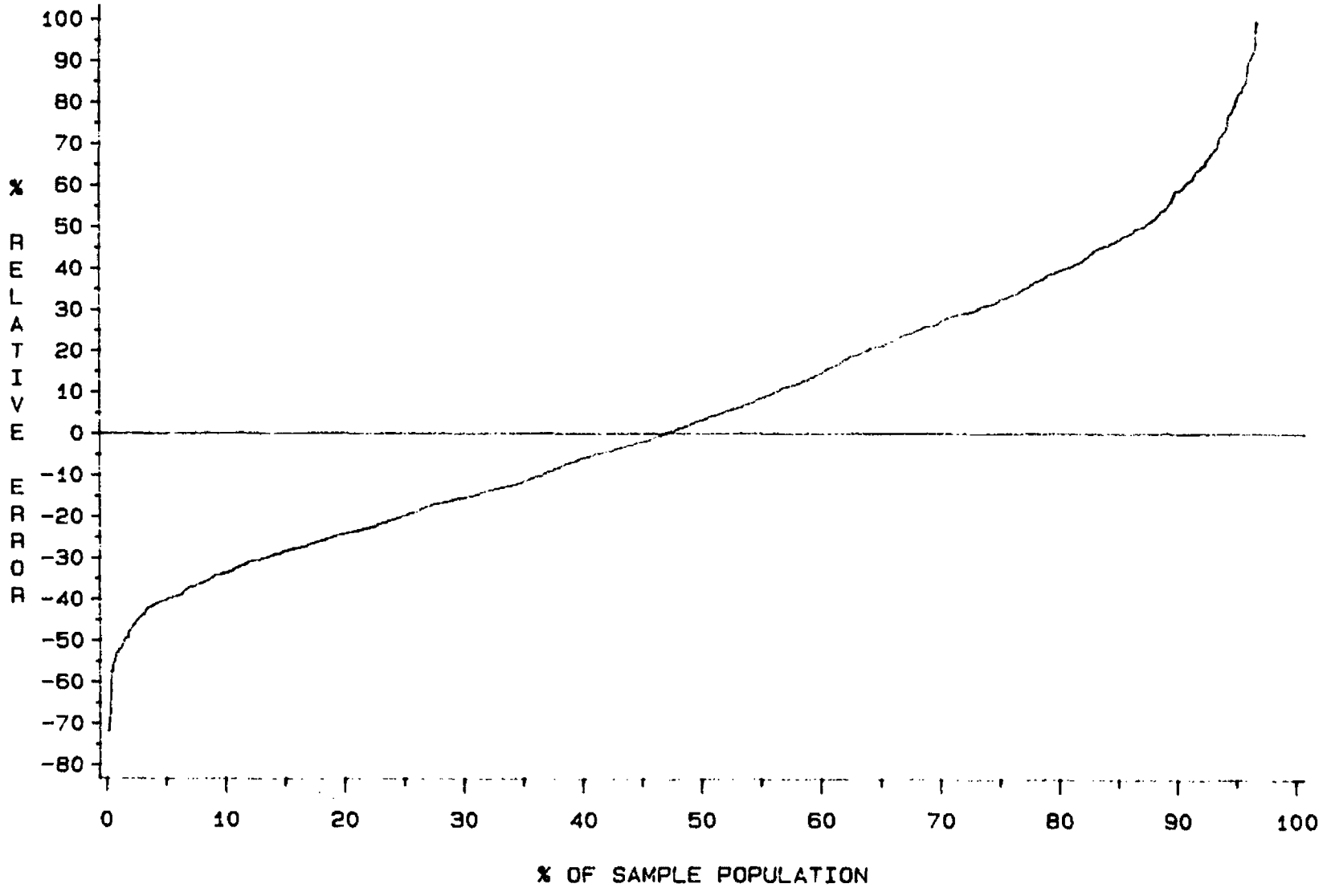



Streamflow, in cubic feet per second
10^6
10^5
10^4
10^3
10^2
SIM
OBS
0.5 1 2 5 10 20 30 50 70 80 90 95 98 99
Percent chance flow exceeded
JUNIATA RIVER FLOW (CFS)

JUNIATA RIVER AT SEG. 100

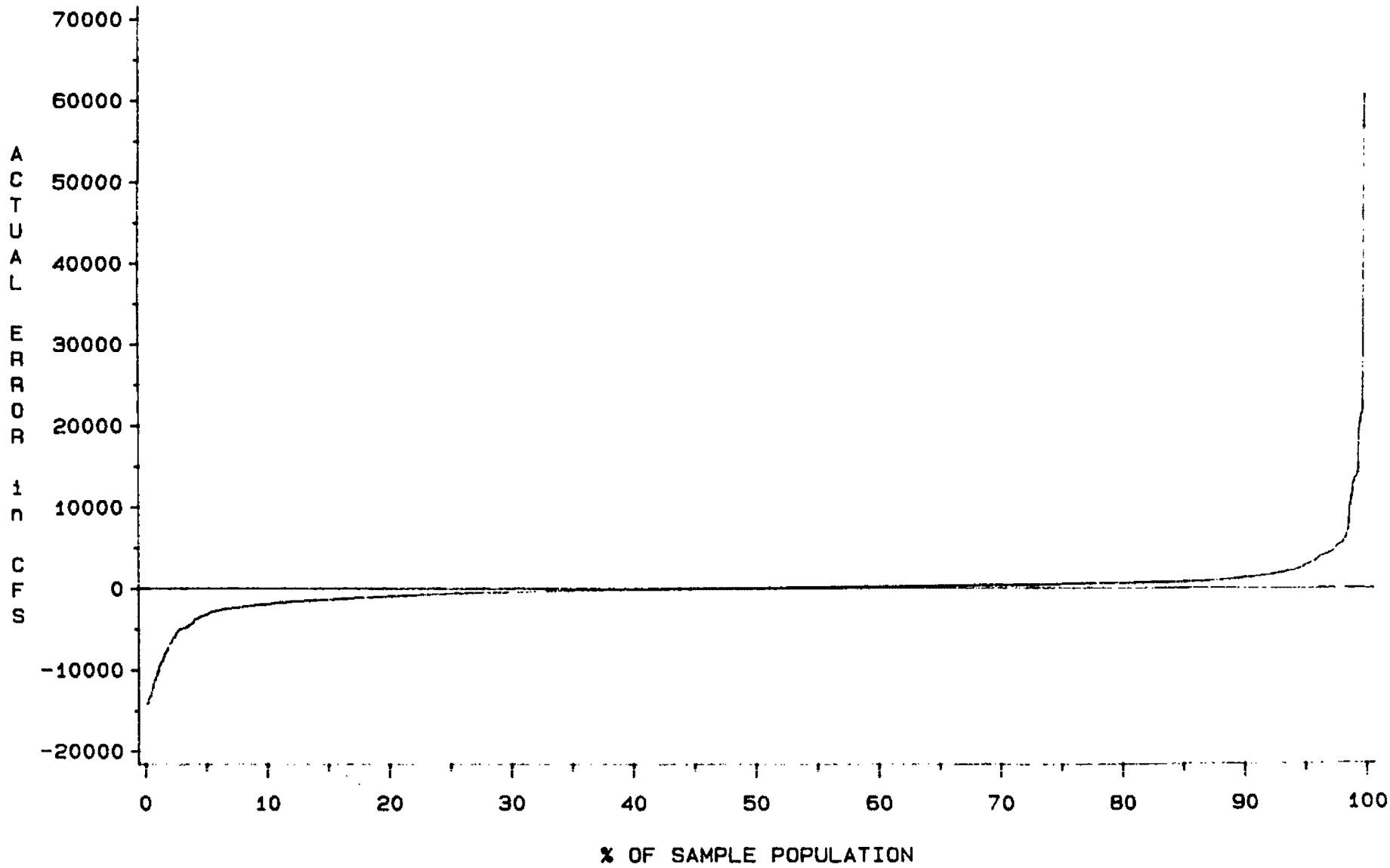
FLOW RELATIVE ERRORS

RELATIVE ERROR = (SIMULATED - OBSERVED)/OBSERVED



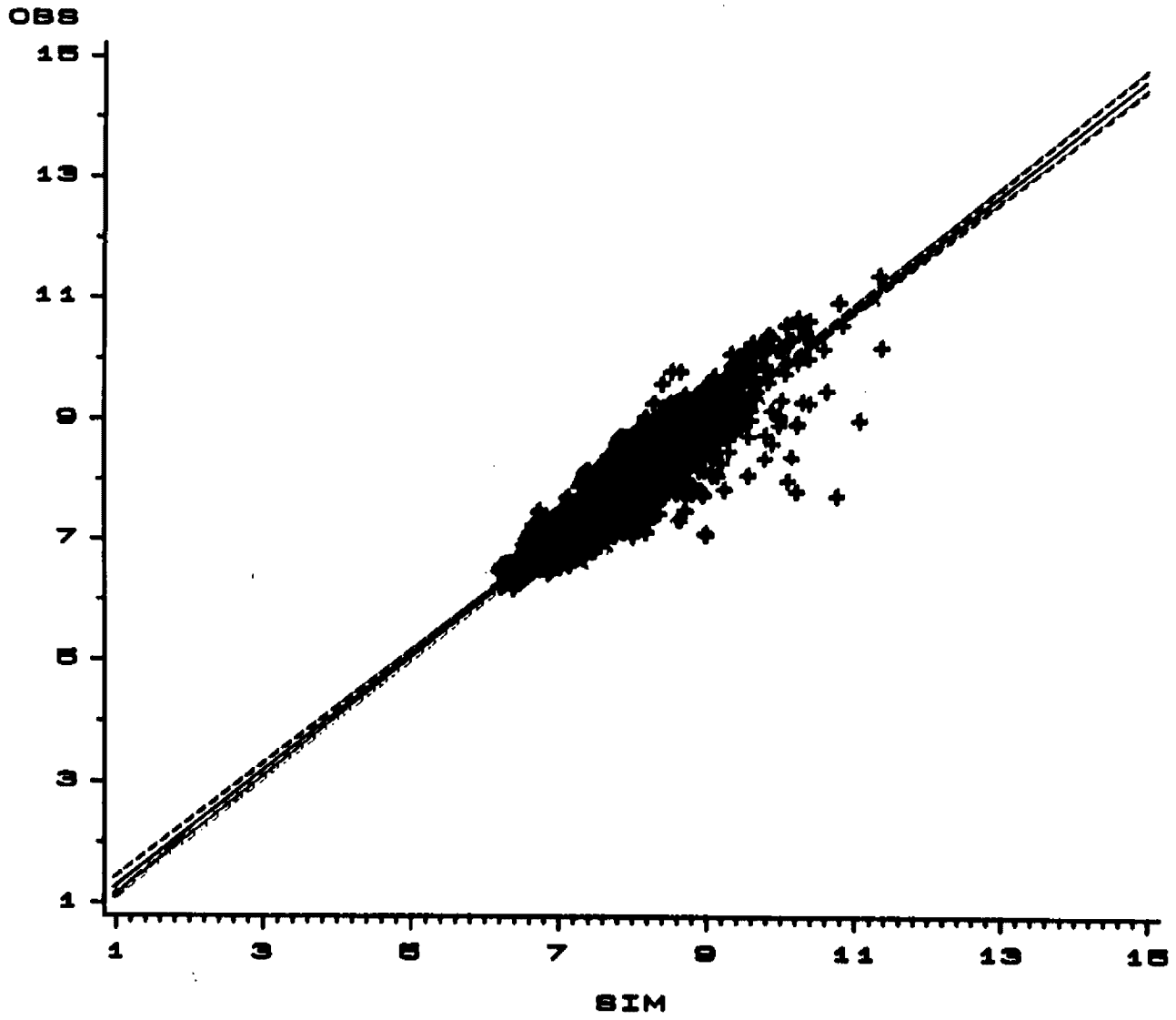
JUNIATA RIVER AT SEG. 100

FLOW ACTUAL ERRORS (CFS)



Juniata River at Seg. 100

Regression of Log Simulated Flow versus Log Observed Flow



Note: Dashed lines represent the 95% confidence limits around the regression line.

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
JUNIATA RIVER BASIN, PA (Segments 90 and 100)

COMPARISON OF ANNUAL TOTAL OBSERVED AND SIMULATED FLOWS

Year	Observed* Flow (in)	Simulated+ Flow (in)
1984	20.44	21.87
1985	15.84	17.46
1986	16.03	15.83
1987	14.50	13.81
Mean	16.70	17.24

* Observed flow Juniata River at Newport, PA
\+ Simulated outflow from RCH 100

REGRESSION OF LOG SIMULATED FLOW ON LOG OBSERVED FLOW
DAILY AND MONTHLY R-SQUARED

Year	Ave. Daily	Ave. Monthly
1984	0.8554	0.9733
1985	0.8177	0.8822
1986	0.8395	0.8637
1987	0.7861	0.8930
1984-87	0.8213	0.8841

SEASONAL R-SQUARED

Year	Season 1	Season 2	Season 3	Season 4
1984	0.8994	0.7619	0.9268	0.8669
1985	0.6546	0.8129	0.8184	0.9300
1986	0.4865	0.8061	0.8869	0.9489
1987	0.0727	0.7070	0.6645	0.8309

Overall Seasonal R-squared 0.8236

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

CHESAPEAKE BAY WATERSHED HYDROLOGICAL SIMULATION
JUNIATA RIVER, PA (Segments 90 and 100)

REGRESSION OF LOG TRANSFORMED SIMULATED AND OBSERVED FLOWS

	Intercept	Probability Intercept=0*	Slope	Probability Slope=1*
DAILY FLOWS				
1984	-0.2682	0.1357	1.0218	0.3231
1985	0.5883	0.0011	0.9132	0.0001
1986	1.0836	0.0001	0.8699	0.0001
1987	0.1742	0.4076	0.9800	0.4569
1984-87	0.5440	0.0001	0.9281	0.0001
MONTHLY FLOWS				
1984	-1.2317	0.0320	1.1332	0.0487
1985	0.2148	0.8152	0.9580	0.7124
1986	1.2098	0.1862	0.8572	0.2145
1987	-0.5743	0.5509	1.0729	0.5485
1984-87	0.2701	0.5174	0.9614	0.4554
SEASONAL FLOWS				
1984 S1	2.0441	0.0001	0.7972	0.0001
S2	3.1502	0.0001	0.6527	0.0001
S3	-2.1774	0.0001	1.2443	0.0001
S4	-0.2001	0.5225	1.0034	0.9328
1985 S1	1.5140	0.0175	0.7891	0.0069
S2	0.9714	0.0139	0.9068	0.0475
S3	2.8003	0.0001	0.5696	0.0001
S4	0.9263	0.0001	0.8867	0.0001
1986 S1	0.0332	0.9762	0.9829	0.8975
S2	1.4377	0.0002	0.8356	0.0003
S3	-0.5323	0.0382	1.1205	0.0014
S4	0.5142	0.0046	0.9251	0.0011
1987 S1	8.5792	0.0001	-0.0546	0.0001
S2	1.8174	0.0002	0.8068	0.0008
S3	1.4754	0.0001	0.7883	0.0001
S4	-0.9429	0.0201	1.1133	0.0321
1984-87	0.5463	0.0001	0.9284	0.0001

* If probability is less than .05 (95% confidence level) then intercept is significantly different from 0, or slope is significantly different from 1.

A.4 LOWER SUSQUEHANNA RIVER AT SEG. 80

Time Series Plot of Simulated and Observed Daily Flows for 1984-1987

Time Series Plot of Residual (Simulated Minus Observed) Daily Flows for 1984-1987

Time Series Plot of Cumulative Simulated and Observed Flows for 1984-1987

Plot of Percent Chance Flow Exceeded vs. Volume of Streamflow

Distribution of Percent Relative Errors Over Percentile Sample Population

Distribution of Percent Actual Errors Over Percentile Sample Population

Regression of Log Transformed Simulated Flow vs. Log Transformed Observed Flow Scatter Plot

Comparison of Annual Total Observed and Simulated Flow

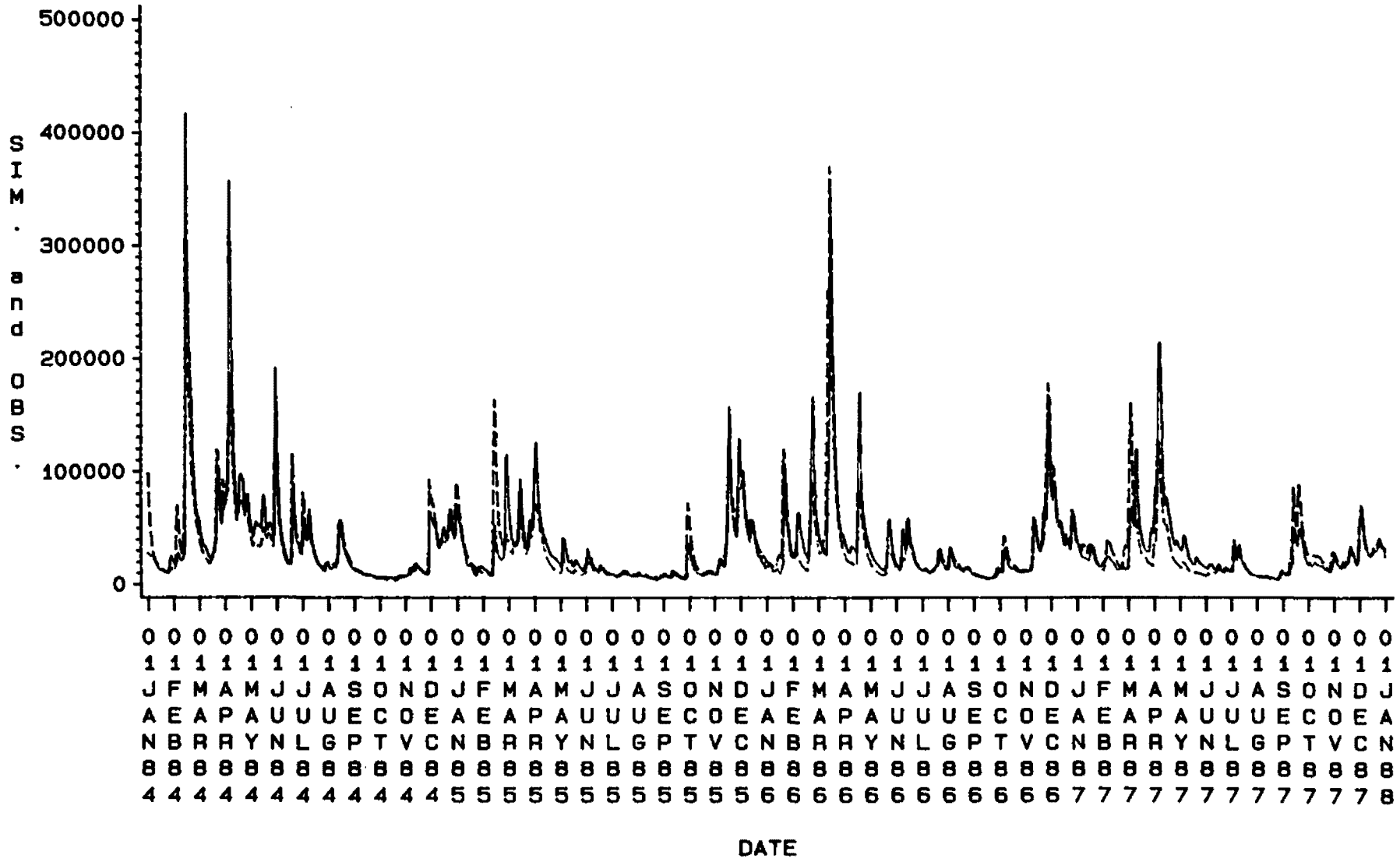
Average Daily and Monthly R-Squared for 1984-1987

Average Seasonal R-Squared for 1984-1987

Log Transformed Simulated and Observed Flow Regression Slope and Intercept Statistics

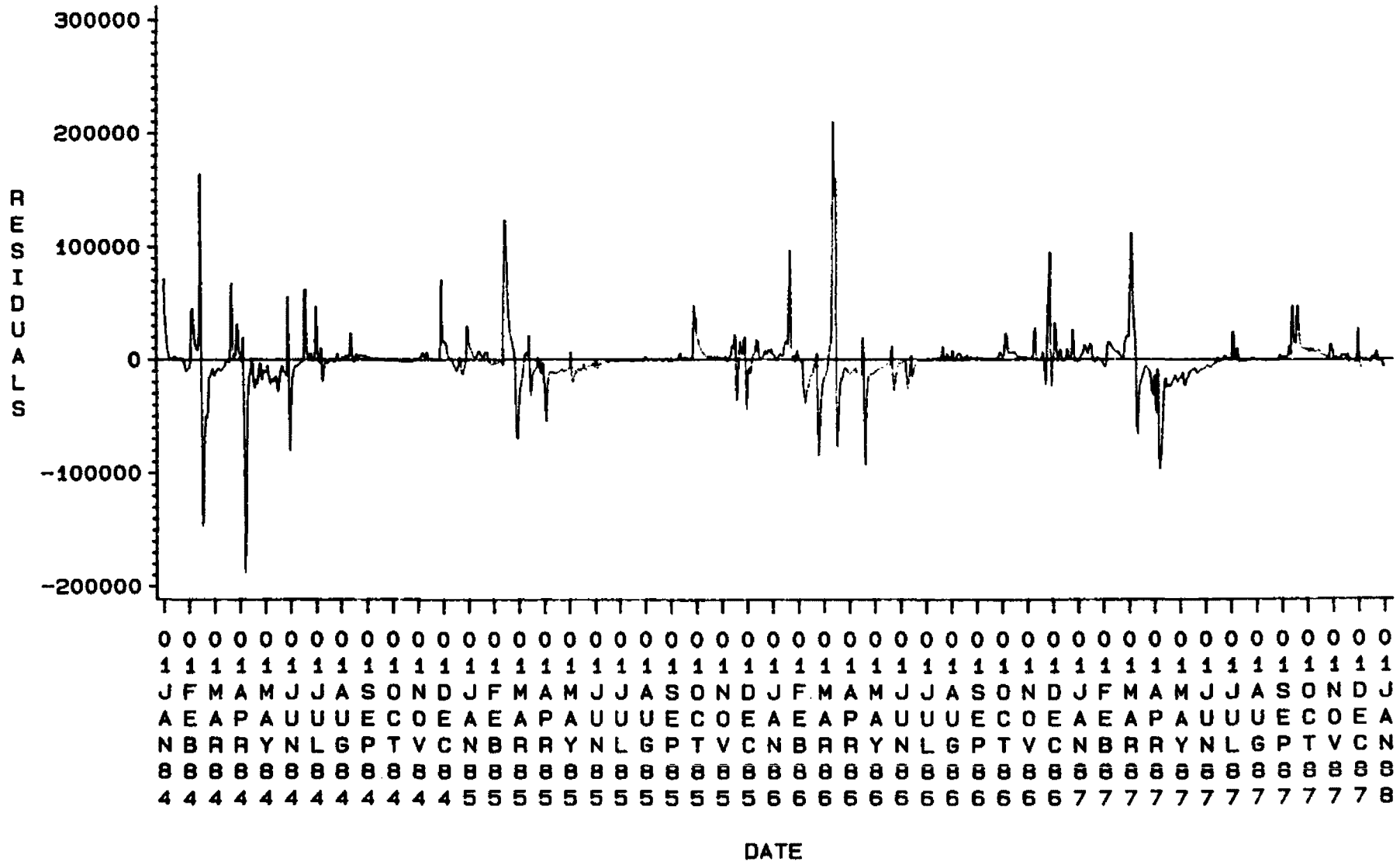
LOWER SUSQUEHANNA RIVER AT SEG. 80

FLOW (CFS)
RED DASHED: SIM., BLUE SOLID: OBS.



LOWER SUSQUEHANNA RIVER AT SEG. 80

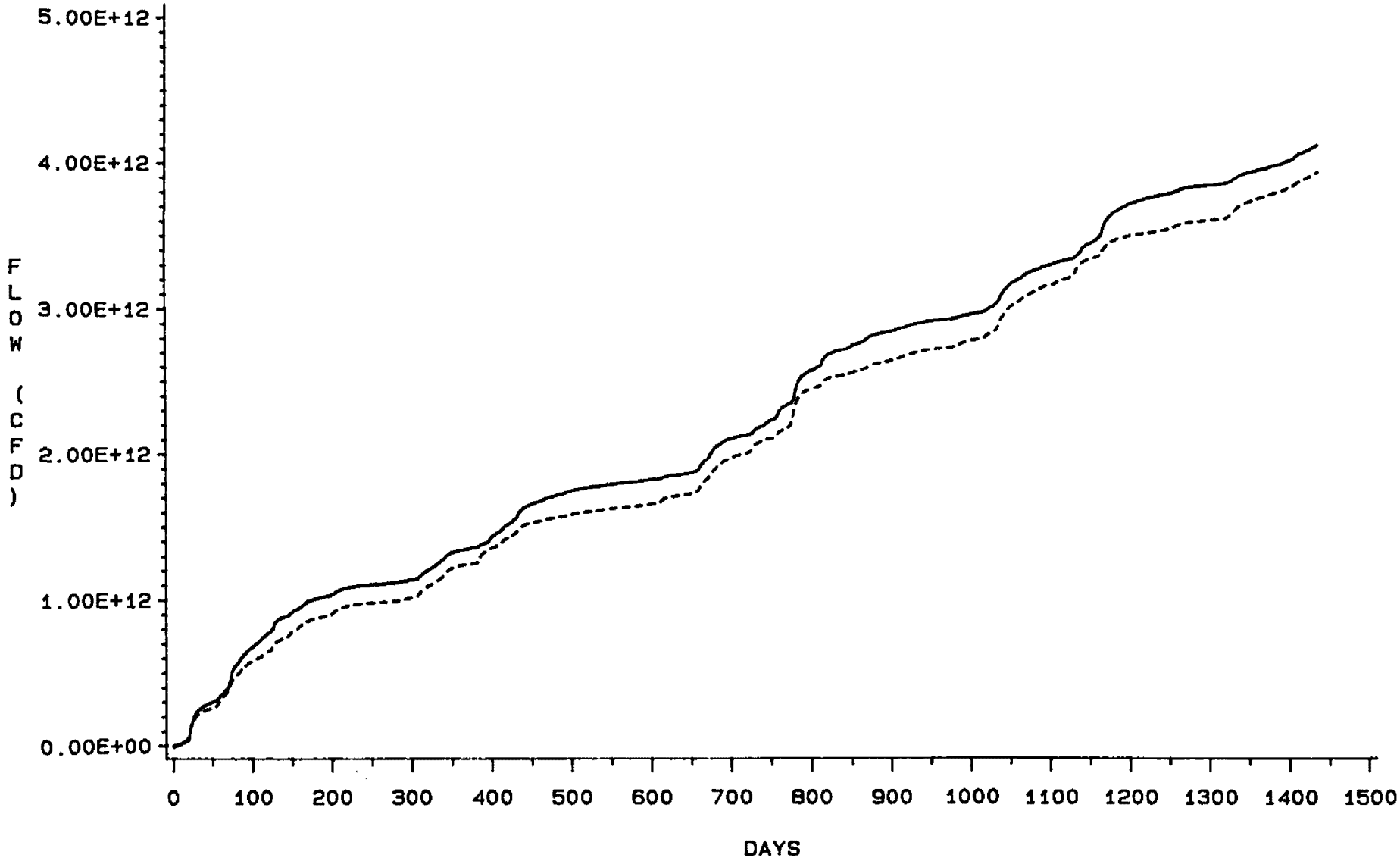
FLOW (CFS)
RESIDUALS (SIMULATED - OBSERVED)

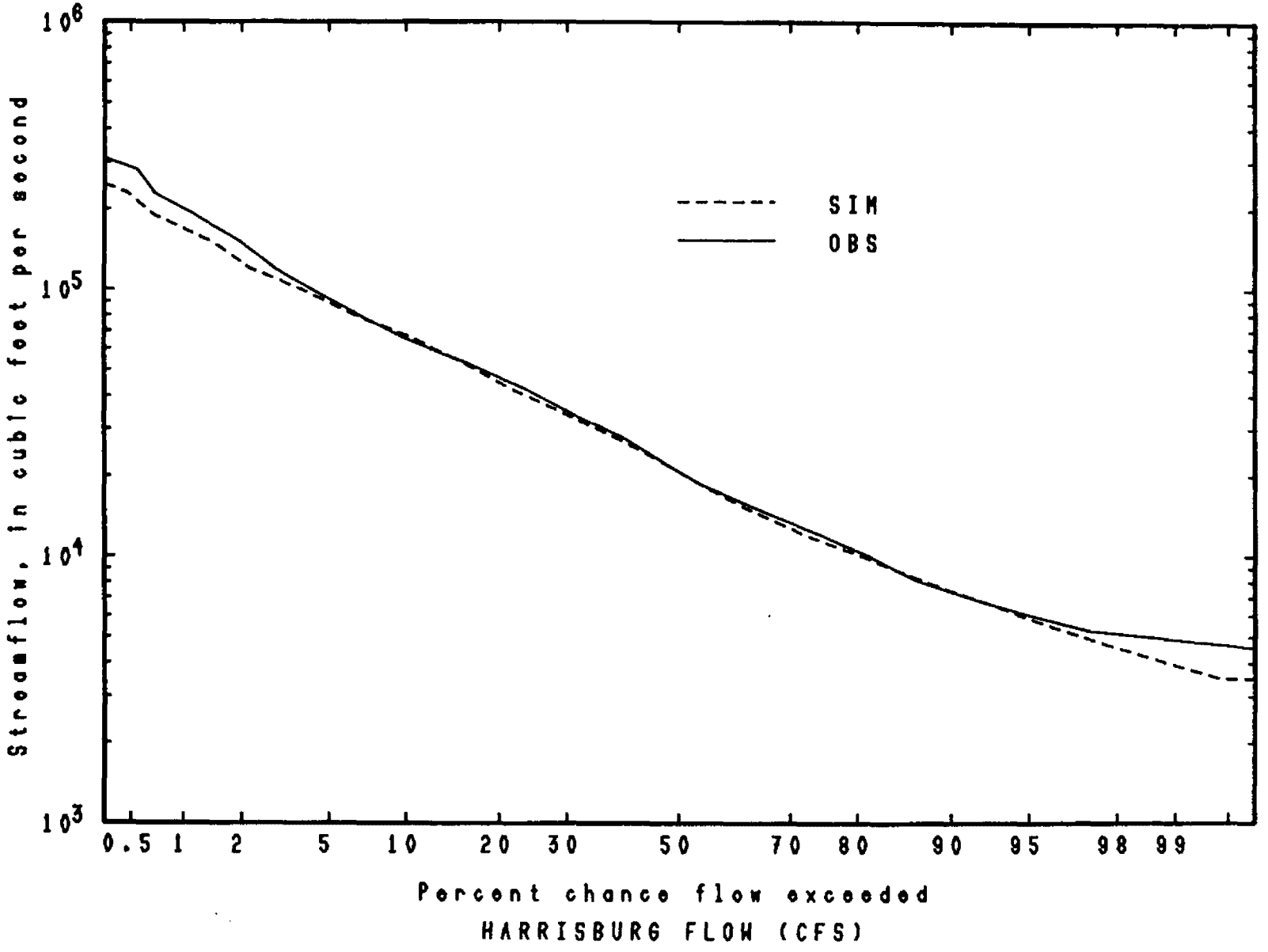


CUMULATIVE FLOWS (CFD) 1984 - 1987

LOSUS

Simulated - - - - - Observed ---------

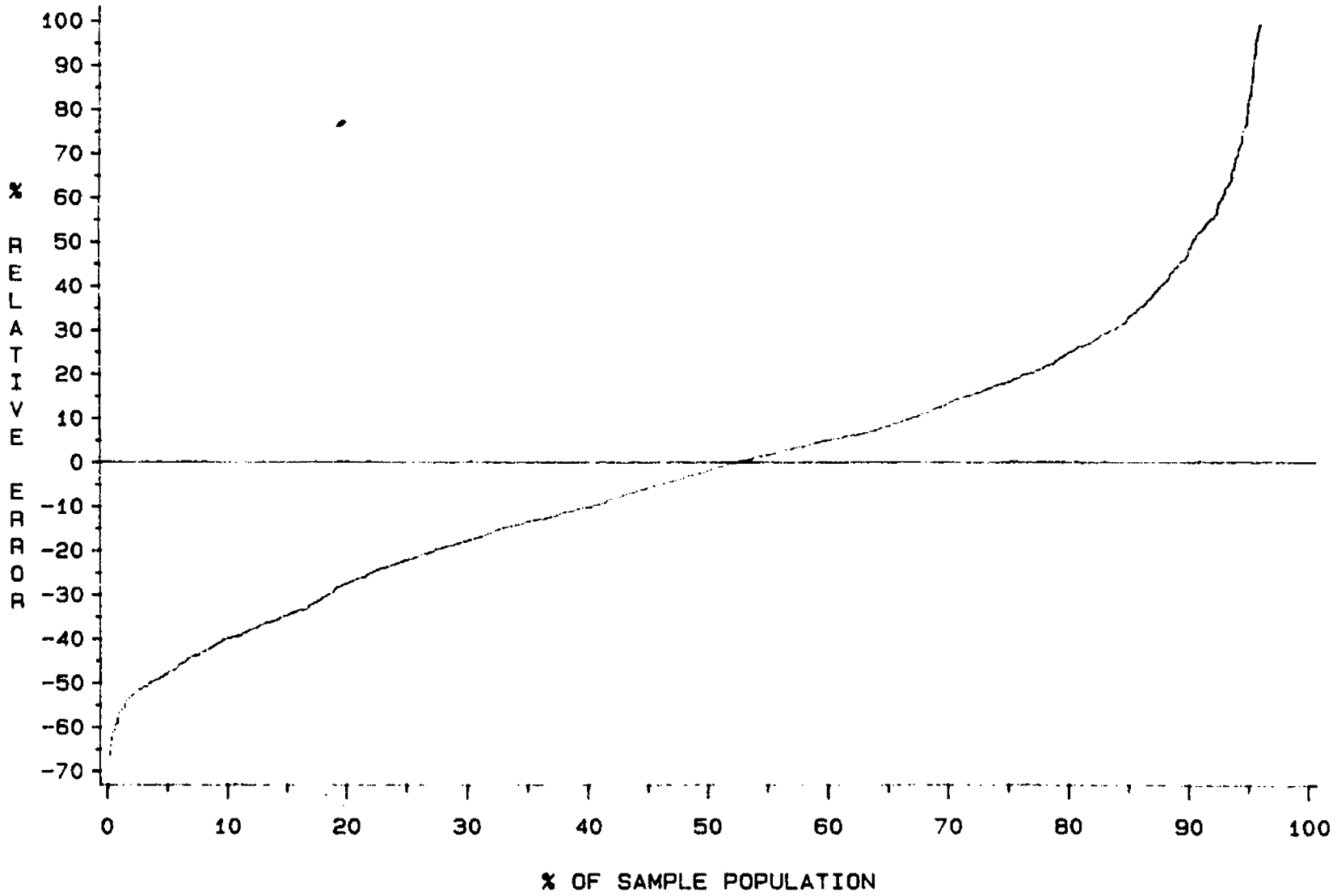



10^6
10^5
10^4
10^3
Streamflow, in cubic feet per second
SIM
OBS
0.5 1 2 5 10 20 30 50 70 80 90 95 98 99
Percent chance flow exceeded
HARRISBURG FLOW (CFS)

LOWER SUSQUEHANNA RIVER AT SEG. 80

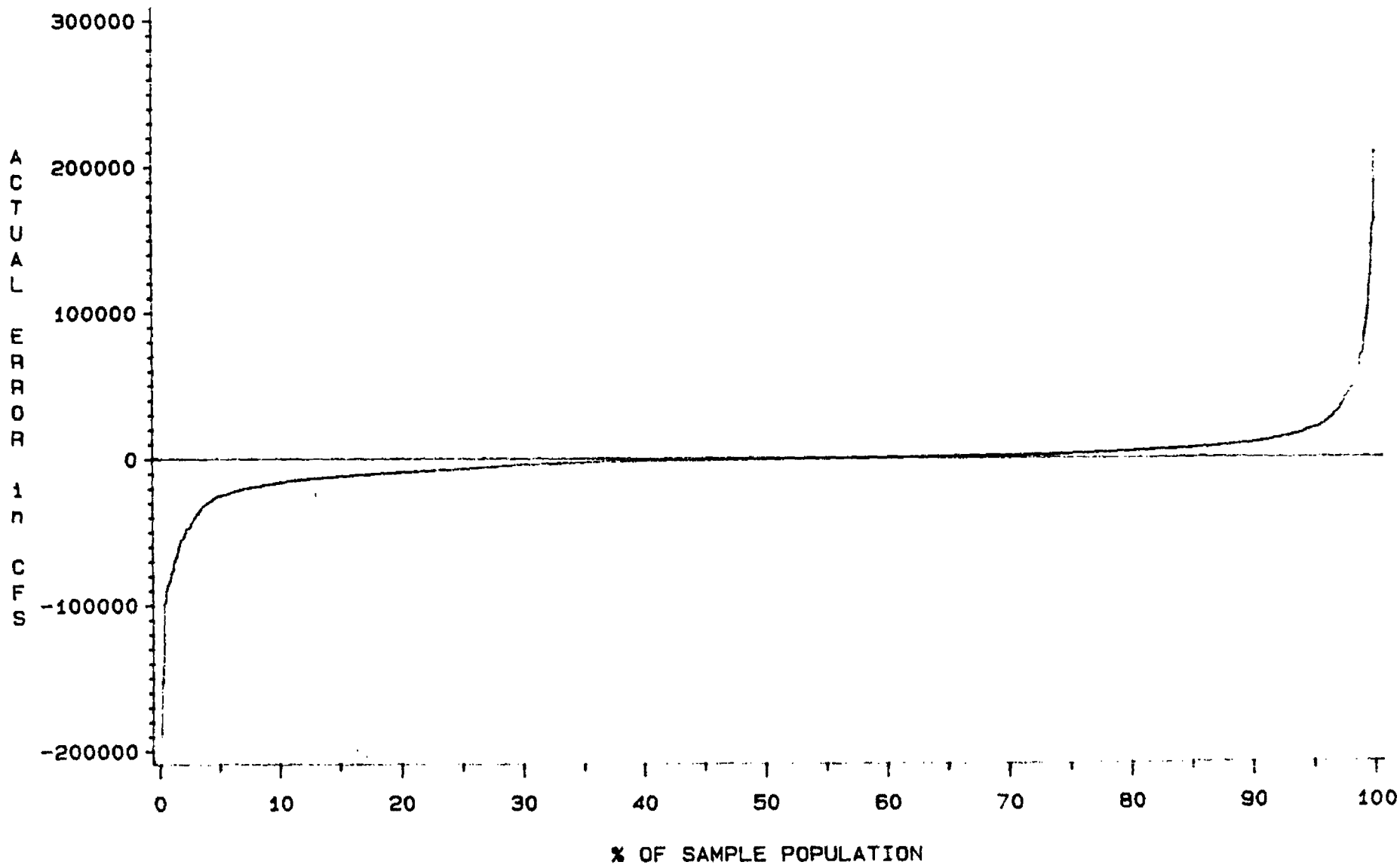
FLOW RELATIVE ERRORS

RELATIVE ERROR = (SIMULATED - OBSERVED)/OBSERVED



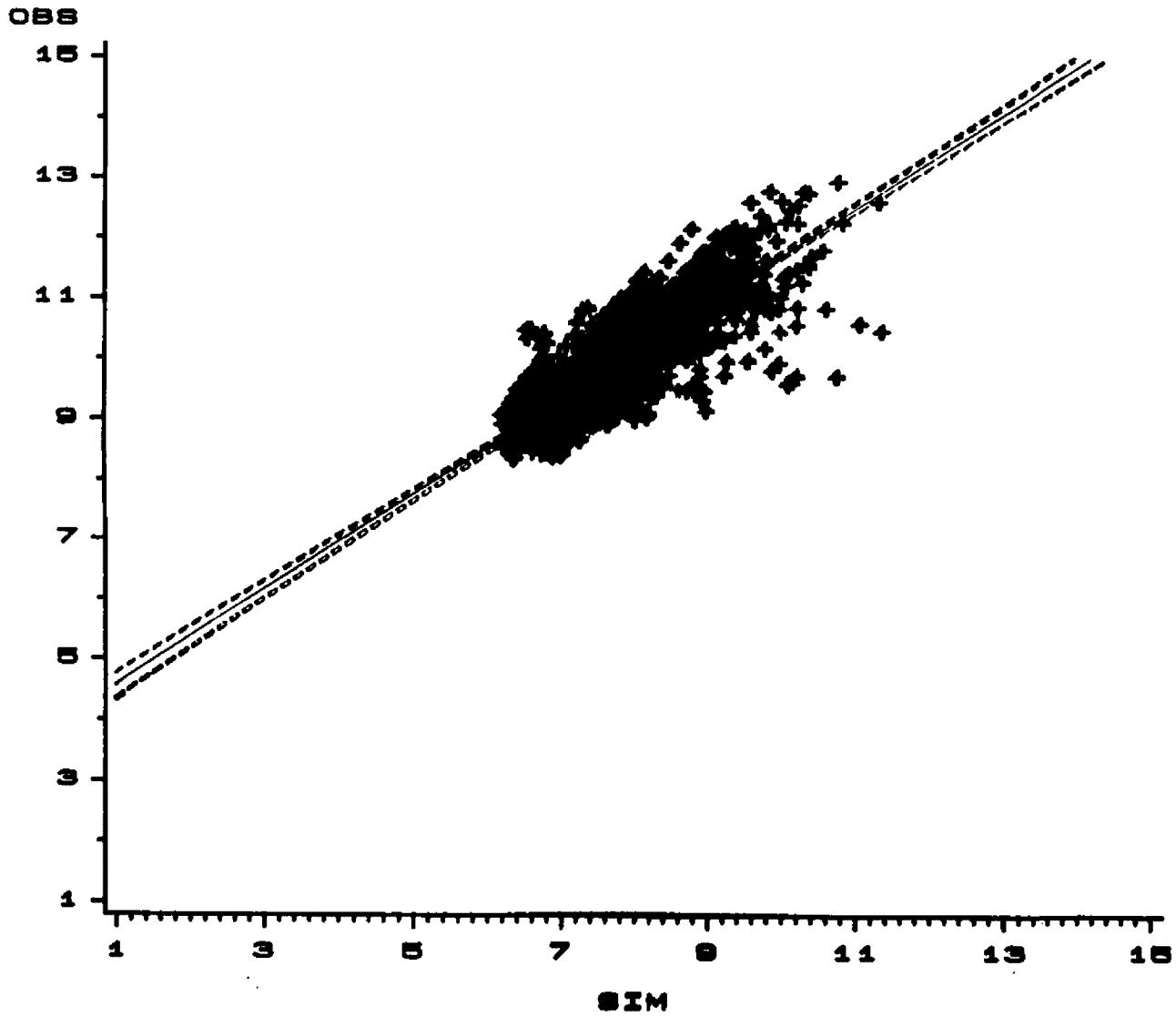
LOWER SUSQUEHANNA RIVER AT SEG. 80

FLOW ACTUAL ERRORS (CFS)



Lower Susquehanna River at Seg. 80

Regression of Log Simulated Flow versus Log Observed Flow



Note: Dashed lines represent the 95% confidence limits around the regression line.

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
LOWER SUSQUEHANNA RIVER, PA (Segments 80 and 110)

COMPARISON OF ANNUAL TOTAL OBSERVED AND SIMULATED FLOWS

Year	Observed* Flow (in)	Simulated+ Flow (in)
1984	23.60	21.84
1985	14.81	14.42
1986	19.96	19.54
1987	15.58	14.79
Mean	18.49	17.65

* Observed flow Susquehanna River at Harrisburg, PA
\+ Simulated outflow from RCH 80

REGRESSION OF LOG SIMULATED FLOW ON LOG OBSERVED FLOW
DAILY AND MONTHLY R-SQUARED

Year	Ave. Daily	Ave. Monthly
1984	0.8823	0.9547
1985	0.8018	0.8343
1986	0.7734	0.8441
1987	0.6750	0.7424
1984-87	0.8013	0.8651

SEASONAL R-SQUARED

Year	Season 1	Season 2	Season 3	Season 4
1984	0.6994	0.7595	0.9077	0.9242
1985	0.5866	0.8810	0.7427	0.8875
1986	0.4031	0.7694	0.8946	0.8976
1987	0.2474	0.7436	0.8399	0.7431

Overall Seasonal R-squared 0.8037

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

CHESAPEAKE BAY WATERSHED HYDROLOGICAL SIMULATION
LOWER SUSQUEHANNA RIVER, PA (Segments 80 and 110)

REGRESSION OF LOG TRANSFORMED SIMULATED AND OBSERVED FLOWS

	Intercept	Probability Intercept=0*	Slope	Probability Slope=1*
DAILY FLOWS				
1984	0.7292	0.0001	0.9311	0.0001
1985	1.1309	0.0001	0.8873	0.0001
1986	0.9058	0.0006	0.9119	0.0007
1987	1.8850	0.0001	0.8133	0.0001
1984-87	1.0624	0.0001	0.8963	0.0001
MONTHLY FLOWS				
1984	-0.3074	0.6840	1.0312	0.6702
1985	0.6005	0.6590	0.9401	0.6611
1986	0.2742	0.8440	0.9750	0.8540
1987	1.1195	0.5158	0.8887	0.5165
1984-87	0.2890	0.6173	0.9725	0.6290
SEASONAL FLOWS				
1984 S1	1.2273	0.2796	0.8862	0.2761
S2	1.8761	0.0009	0.8427	0.0025
S3	0.2803	0.3298	0.9690	0.2781
S4	1.6449	0.0001	0.8321	0.0001
1985 S1	3.5535	0.0001	0.6364	0.0001
S2	2.5275	0.0001	0.7847	0.0001
S3	-0.3771	0.4625	1.0468	0.4105
S4	-0.7641	0.0599	1.0533	0.1738
1986 S1	2.2337	0.0887	0.7864	0.0945
S2	3.1680	0.0001	0.7176	0.0001
S3	-0.8766	0.0088	1.0899	0.0102
S4	-0.2950	0.4266	1.0118	0.7397
1987 S1	5.7463	0.0001	0.4085	0.0001
S2	3.8656	0.0001	0.6679	0.0001
S3	2.3014	0.0001	0.7524	0.0001
S4	-0.7165	0.2761	1.0581	0.3705
1984-87	1.0350	0.0001	0.8995	0.0001

* If probability is less than .05 (95% confidence level) then intercept is significantly different from 0, or slope is significantly different from 1.

A.5 SUSQUEHANNA RIVER AT CONOWINGO AT SEG. 140

Time Series Plot of Simulated and Observed Daily Flows for 1984-1987

Time Series Plot of Residual (Simulated Minus Observed) Daily Flows for 1984-1987

Time Series Plot of Cumulative Simulated and Observed Flows for 1984-1987

Plot of Percent Chance Flow Exceeded vs. Volume of Streamflow

Distribution of Percent Relative Errors Over Percentile Sample Population

Distribution of Percent Actual Errors Over Percentile Sample Population

Regression of Log Transformed Simulated Flow vs. Log Transformed Observed Flow Scatter Plot

Comparison of Annual Total Observed and Simulated Flow

Average Daily and Monthly R-Squared for 1984-1987

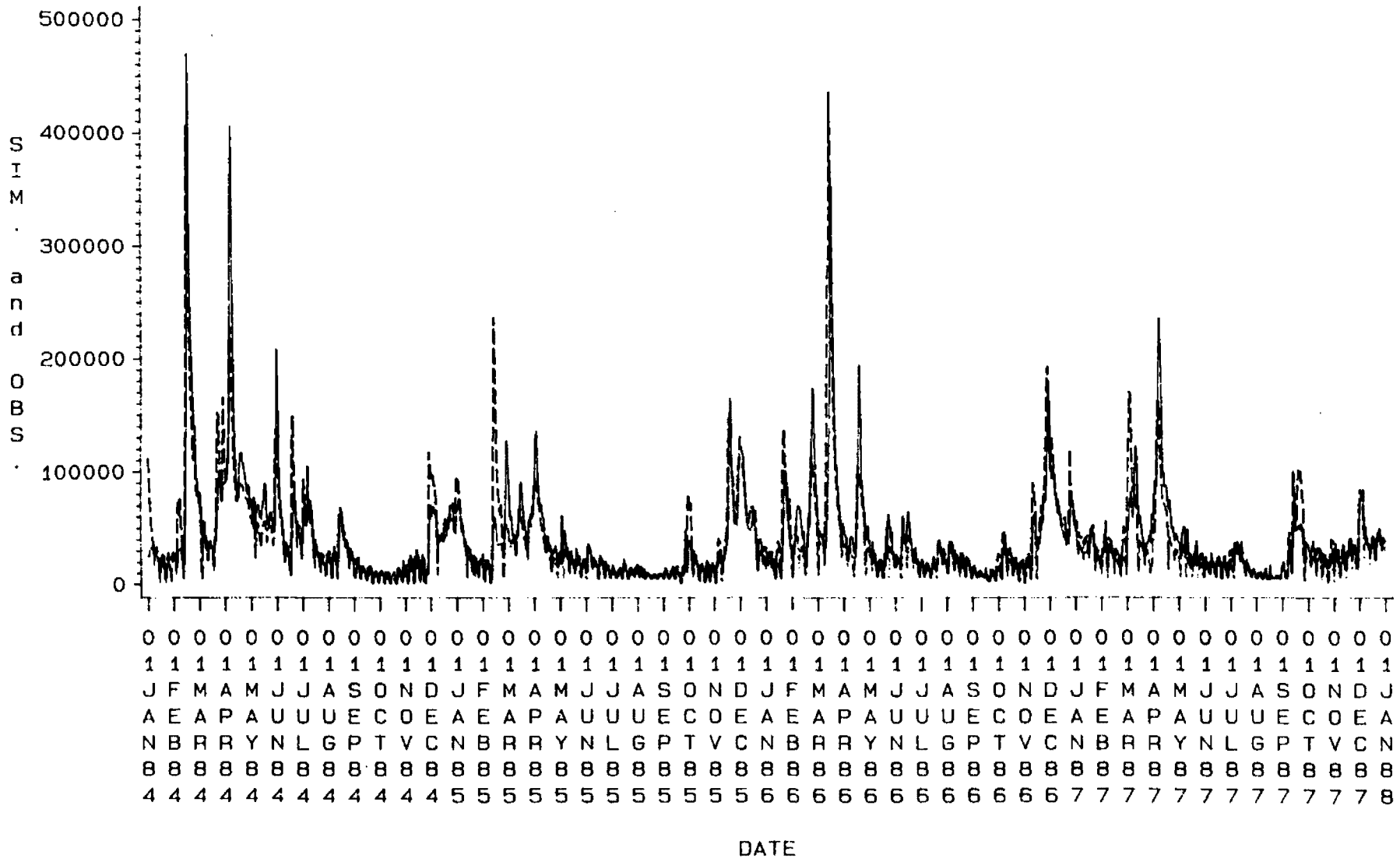
Average Seasonal R-Squared for 1984-1987

Log Transformed Simulated and Observed Flow Regression Slope and Intercept Statistics

SUSQUEHANNA RIVER AT CONOWINGO

FLOW (CFS)

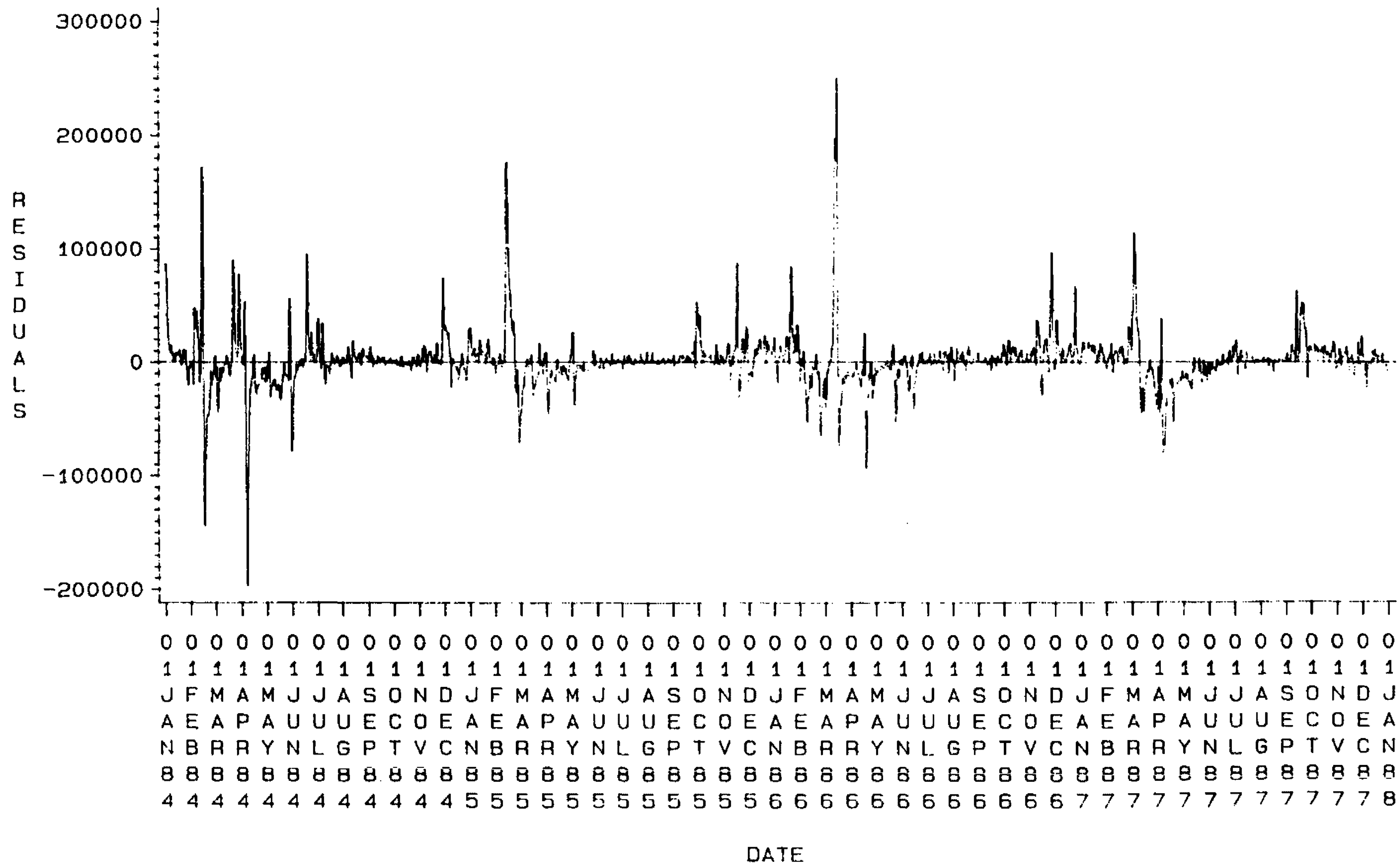
RED DASHED: SIM., BLUE SOLID: OBS.



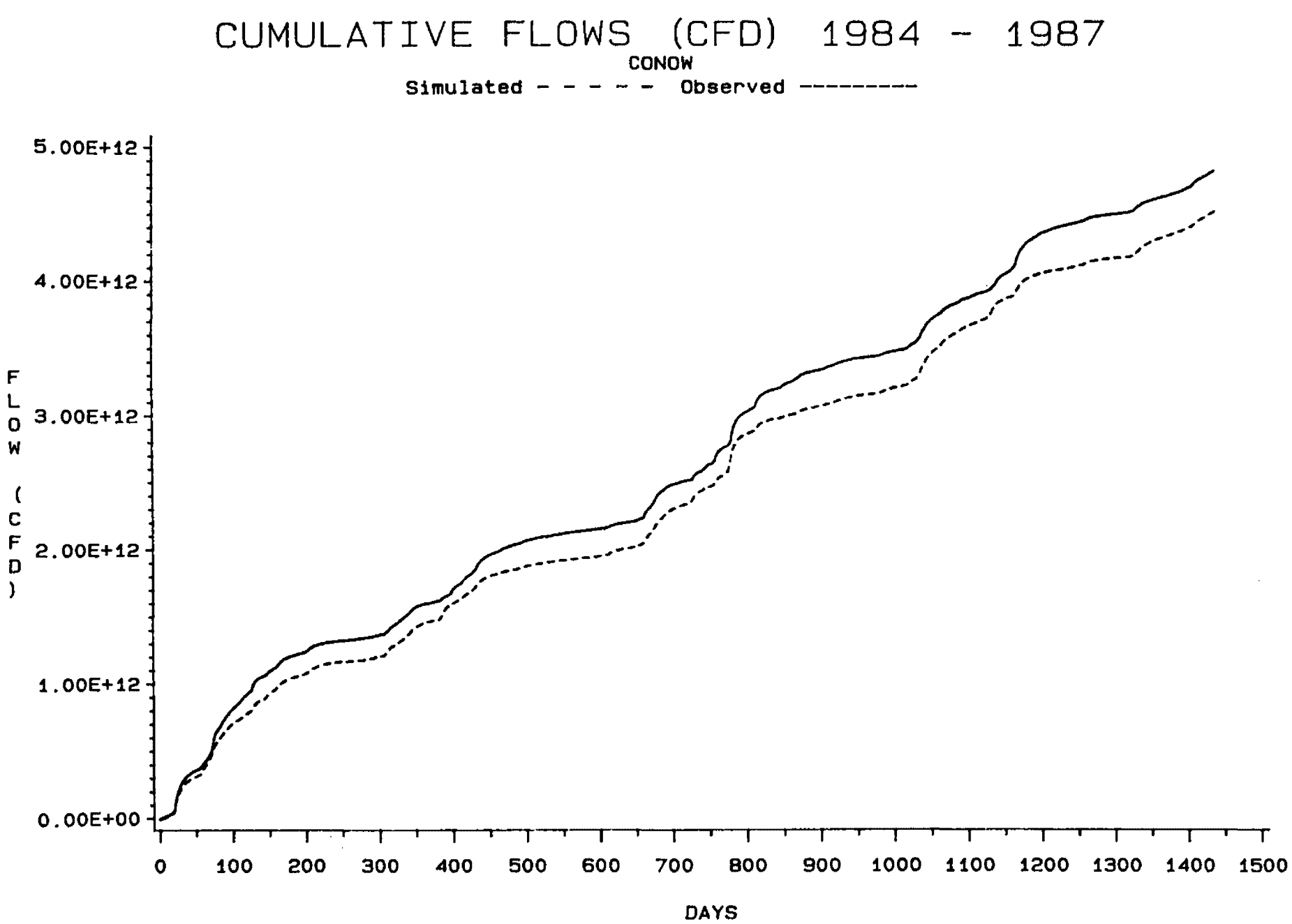
SUSQUEHANNA RIVER AT CONOWINGO

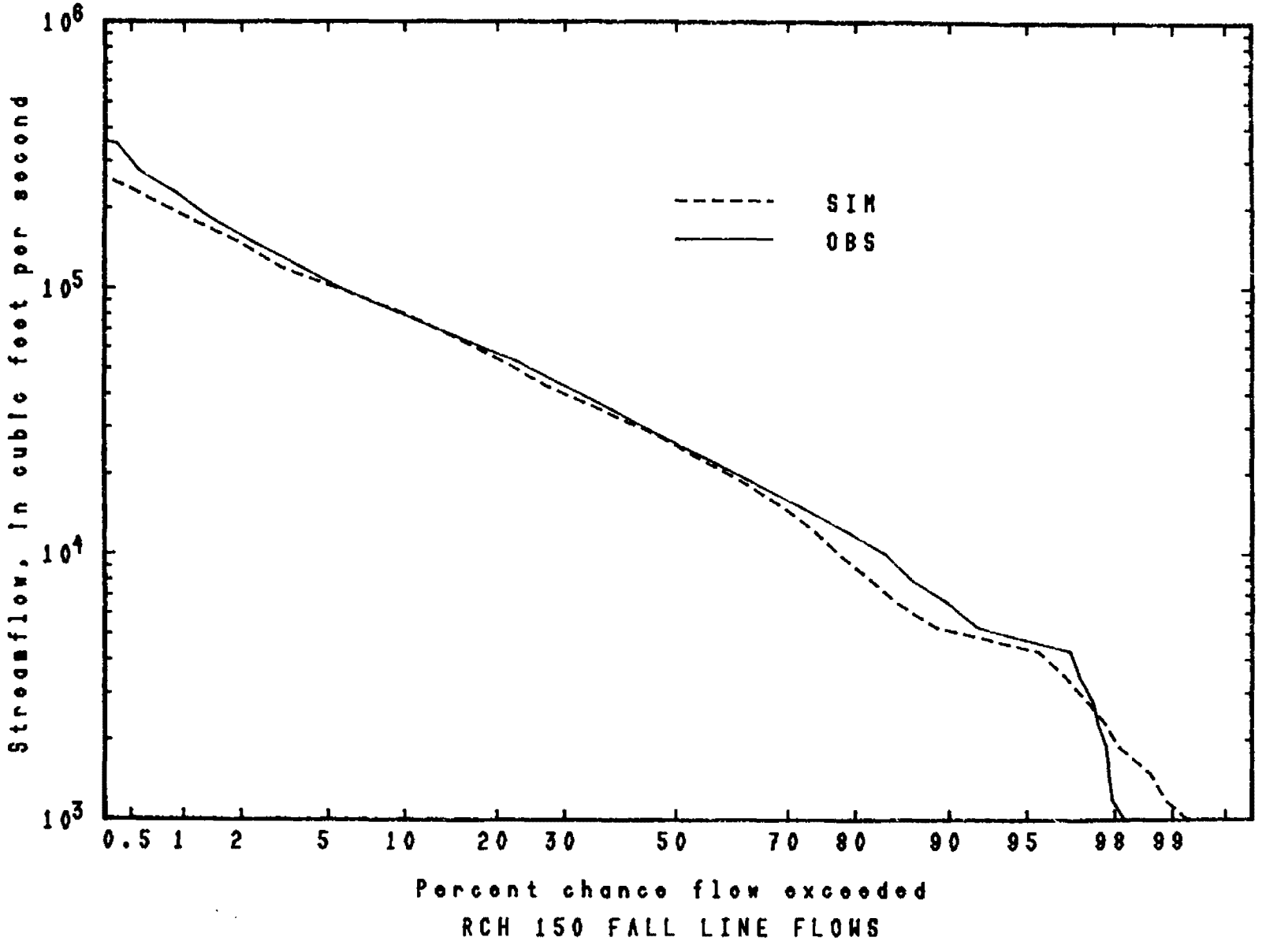
FLOW (CFS)

RESIDUALS (SIMULATED - OBSERVED)



CUMULATIVE FLOWS (CFD) 1984 - 1987

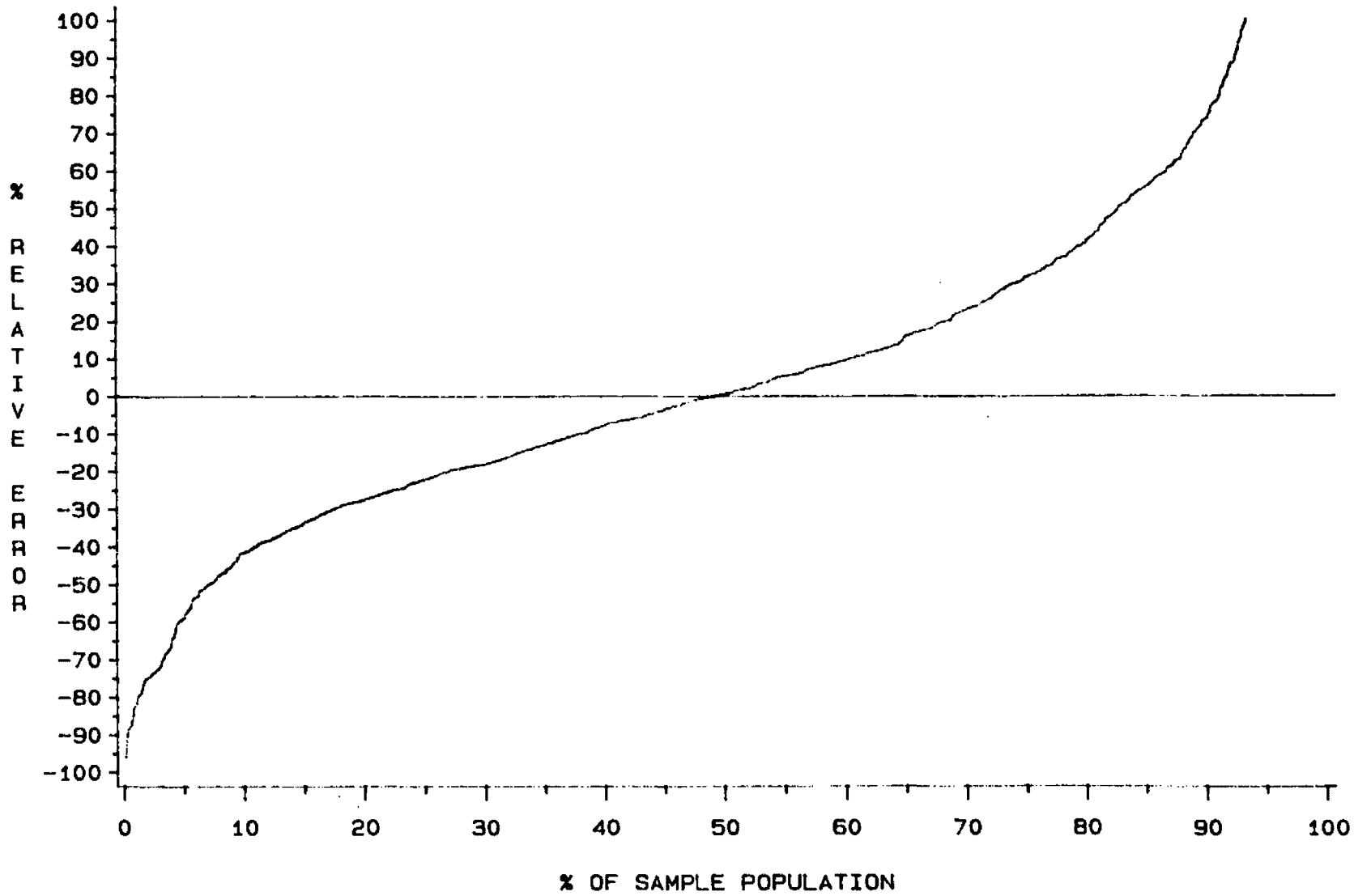



10^6
10^5
10^4
10^3
Streamflow, in cubic feet per second
SIM
OBS
0.5 1 2 5 10 20 30 50 70 80 90 95 98 99
Percent chance flow exceeded
RCH 150 FALL LINE FLOWS

SUSQUEHANNA RIVER AT CONOWINGO (SEG. 140)

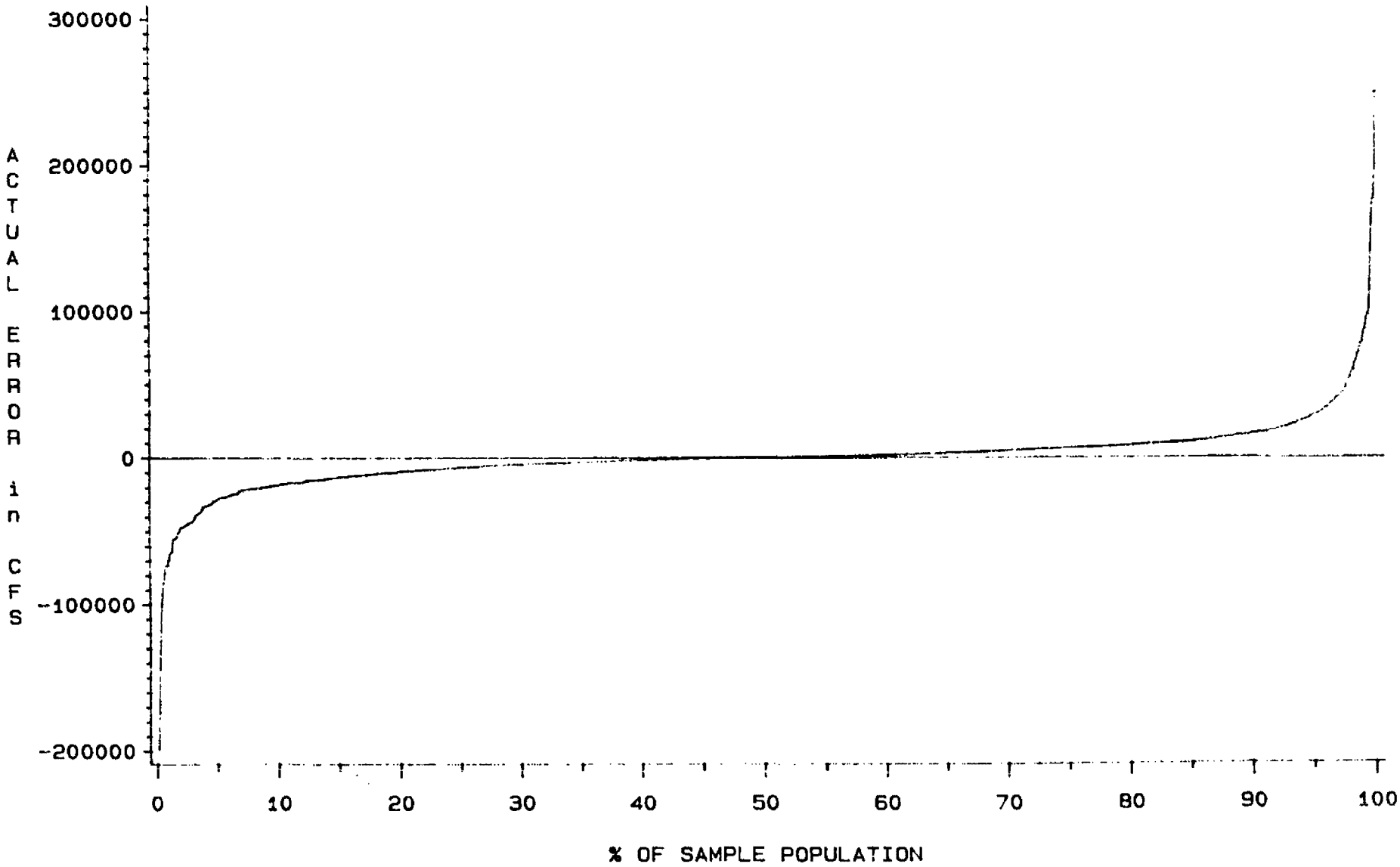
FLOW RELATIVE ERRORS

RELATIVE ERROR = (SIMULATED - OBSERVED)/OBSERVED



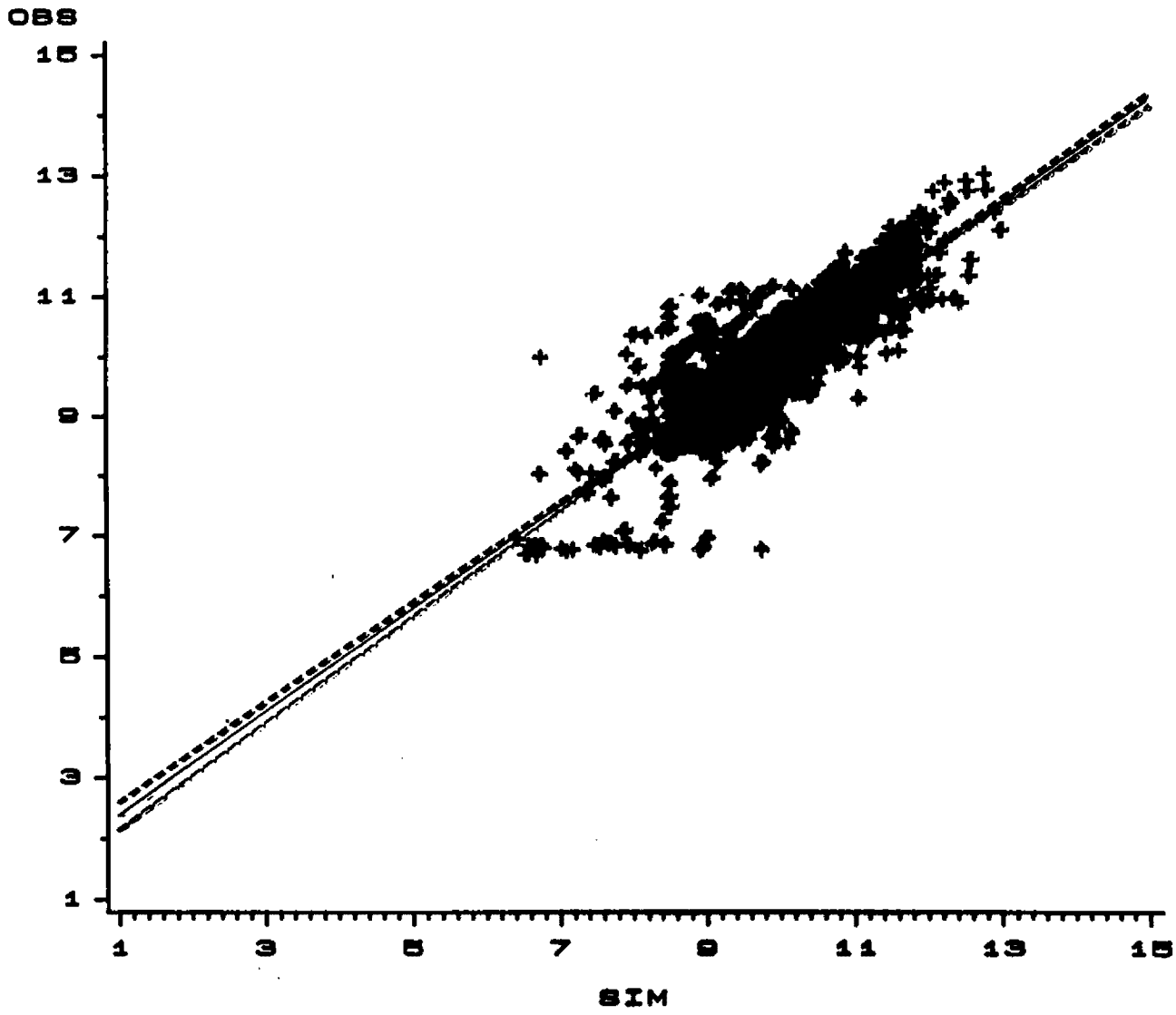
SUSQUEHANNA RIVER AT CONOWINGO (SEG. 140)

FLOW ACTUAL ERRORS (CFS)



Susquehanna River at Conowingo (Seg. 140)

Regression of Log Simulated Flow versus Log Observed Flow



Note: Dashed lines represent the 95% confidence limits around the regression line.

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
CONOWINGO RESERVOIR, MD (Segments 120 and 140)

COMPARISON OF ANNUAL TOTAL OBSERVED AND SIMULATED FLOWS

Year	Observed* Flow (in)	Simulated+ Flow (in)
1984	25.01	24.42
1985	15.27	16.16
1986	20.66	21.14
1987	16.16	16.15
Mean	19.40	19.47

* Observed flow Susquehanna River at Conowingo, MD
\+ Simulated outflow from RCH 140

REGRESSION OF LOG SIMULATED FLOW ON LOG OBSERVED FLOW
DAILY AND MONTHLY R-SQUARED

Year	Ave. Daily	Ave. Monthly
1984	0.8254	0.9536
1985	0.7805	0.9074
1986	0.7465	0.8797
1987	0.6644	0.8324
1984-87	0.7695	0.9011

SEASONAL R-SQUARED

Year	Season 1	Season 2	Season 3	Season 4
1984	0.6282	0.7755	0.8919	0.8456
1985	0.6574	0.7063	0.6636	0.8300
1986	0.6106	0.6984	0.4918	0.9090
1987	0.5232	0.6653	0.7914	0.5333

Overall Seasonal R-squared 0.7756

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

CHESAPEAKE BAY WATERSHED HYDROLOGICAL SIMULATION
CONOWINGO RESERVOIR, MD (Segments 120 and 140)

REGRESSION OF LOG TRANSFORMED SIMULATED AND OBSERVED FLOWS

	Intercept	Probability Intercept=0*	Slope	Probability Slope=1*
DAILY FLOWS				
1984	0.8370	0.0003	0.9225	0.0006
1985	1.6082	0.0001	0.8436	0.0001
1986	1.9619	0.0001	0.8165	0.0001
1987	2.1809	0.0001	0.7899	0.0001
1984-87	1.5321	0.0001	0.8550	0.0001
MONTHLY FLOWS				
1984	-0.3752	0.6321	1.0386	0.6056
1985	1.4136	0.1396	0.8648	0.1528
1986	1.0503	0.3607	0.9066	0.3992
1987	1.3145	0.3218	0.8760	0.3420
1984-87	0.7686	0.1063	0.9305	0.1332
SEASONAL FLOWS				
1984 S1	5.2219	0.0001	0.5404	0.0001
S2	1.8330	0.0010	0.8493	0.0026
S3	-0.1594	0.6308	1.0126	0.6990
S4	0.8192	0.0369	0.9197	0.0503
1985 S1	2.6312	0.0005	0.7260	0.0002
S2	3.5744	0.0001	0.6813	0.0001
S3	1.2040	0.0229	0.8822	0.0439
S4	0.8975	0.0418	0.9027	0.0238
1986 S1	1.1810	0.2316	0.8883	0.2354
S2	3.7086	0.0001	0.6713	0.0001
S3	2.4168	0.0005	0.7624	0.0012
S4	1.4017	0.0001	0.8583	0.0001
1987 S1	2.3558	0.0182	0.7458	0.0086
S2	4.7402	0.0001	0.5856	0.0001
S3	2.0184	0.0001	0.7997	0.0001
S4	0.8608	0.3383	0.9043	0.2779
1984-87	1.5377	0.0001	0.8554	0.0001

* If probability is less than .05 (95% confidence level) then intercept is significantly different from 0, or slope is significantly different from 1.

A.6 UPPER POTOMAC RIVER AT SEG. 175

Time Series Plot of Simulated and Observed Daily Flows for 1984-1987

Time Series Plot of Residual (Simulated Minus Observed) Daily Flows for 1984-1987

Time Series Plot of Cumulative Simulated and Observed Flows for 1984-1987

Plot of Percent Chance Flow Exceeded vs. Volume of Streamflow

Distribution of Percent Relative Errors Over Percentile Sample Population

Distribution of Percent Actual Errors Over Percentile Sample Population

Regression of Log Transformed Simulated Flow vs. Log Transformed Observed Flow Scatter Plot

Comparison of Annual Total Observed and Simulated Flow

Average Daily and Monthly R-Squared for 1984-1987

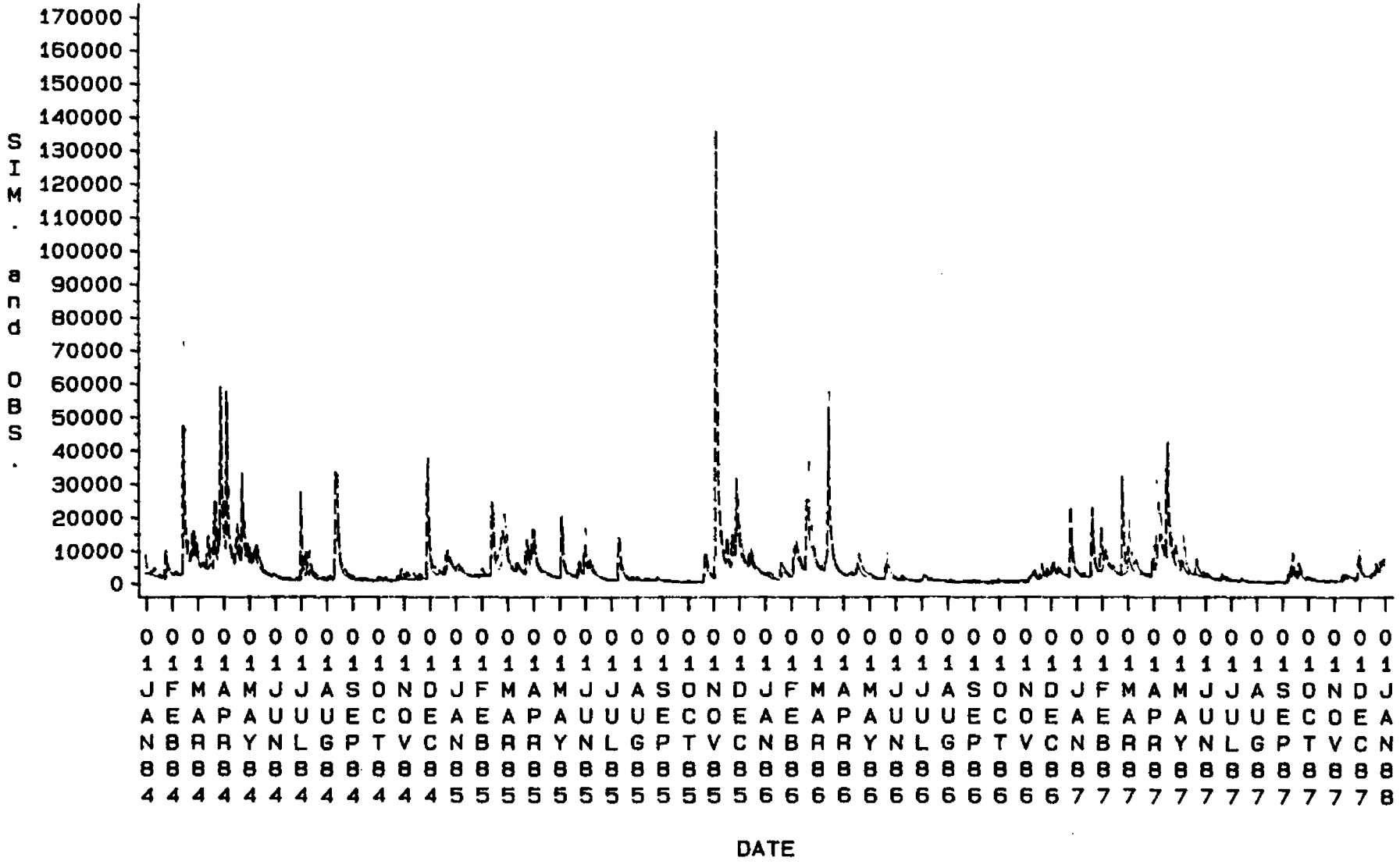
Average Seasonal R-Squared for 1984-1987

Log Transformed Simulated and Observed Flow Regression Slope and Intercept Statistics

UPPER POTOMAC RIVER AT SEG. 175

FLOW (CFS)

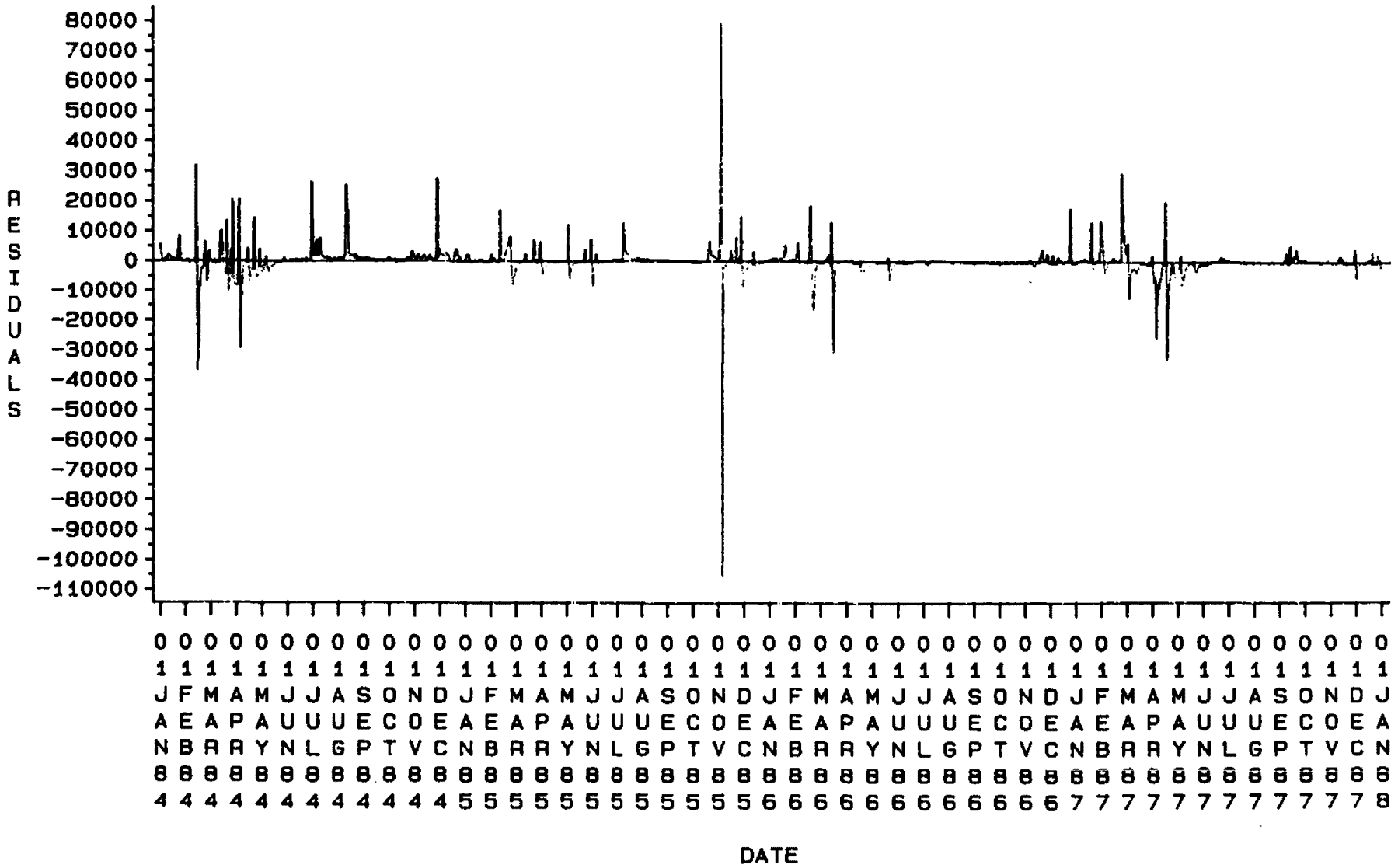
RED DASH: SIM., BLUE: OBS.



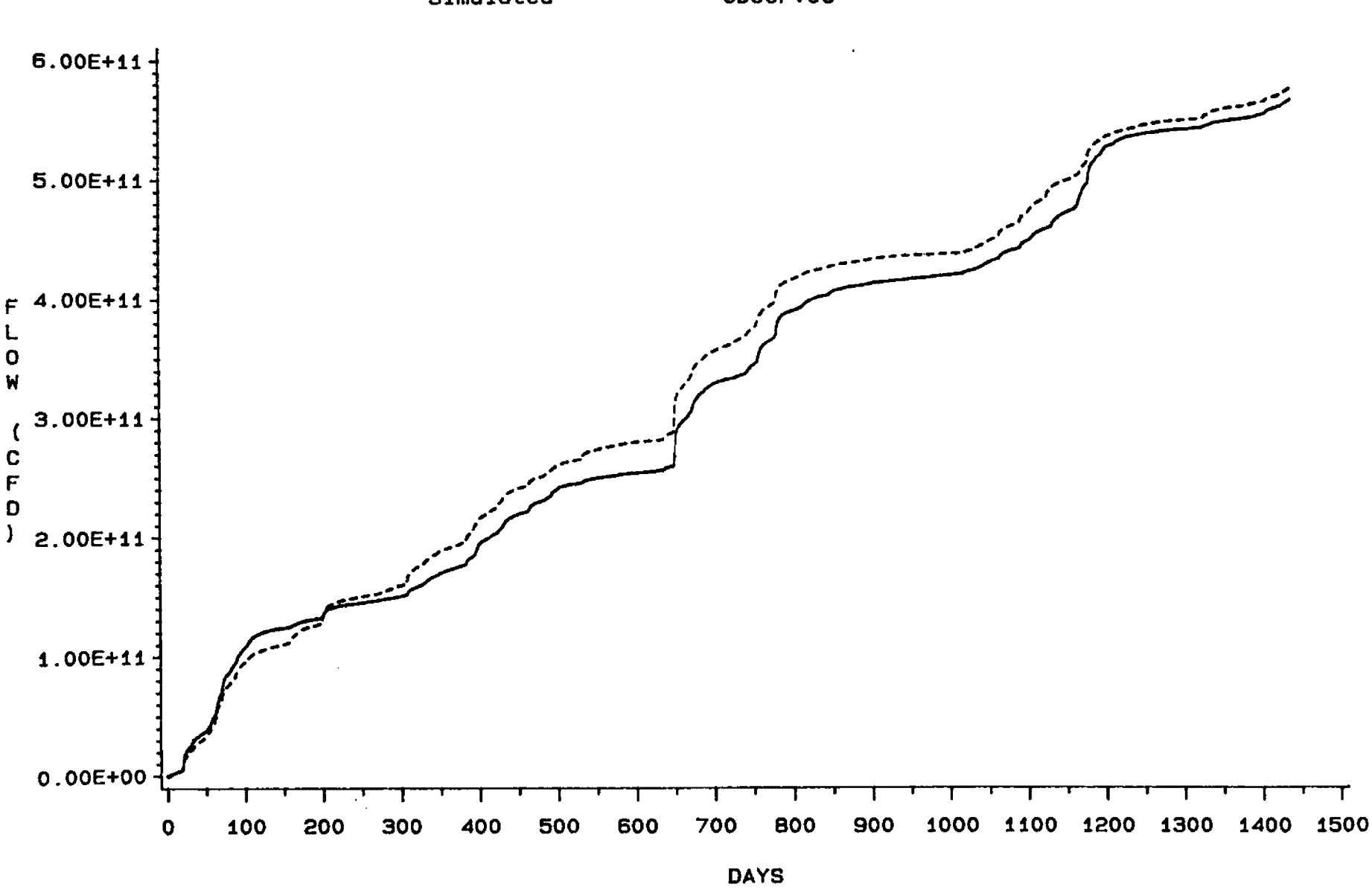
UPPER POTOMAC RIVER AT SEG. 175

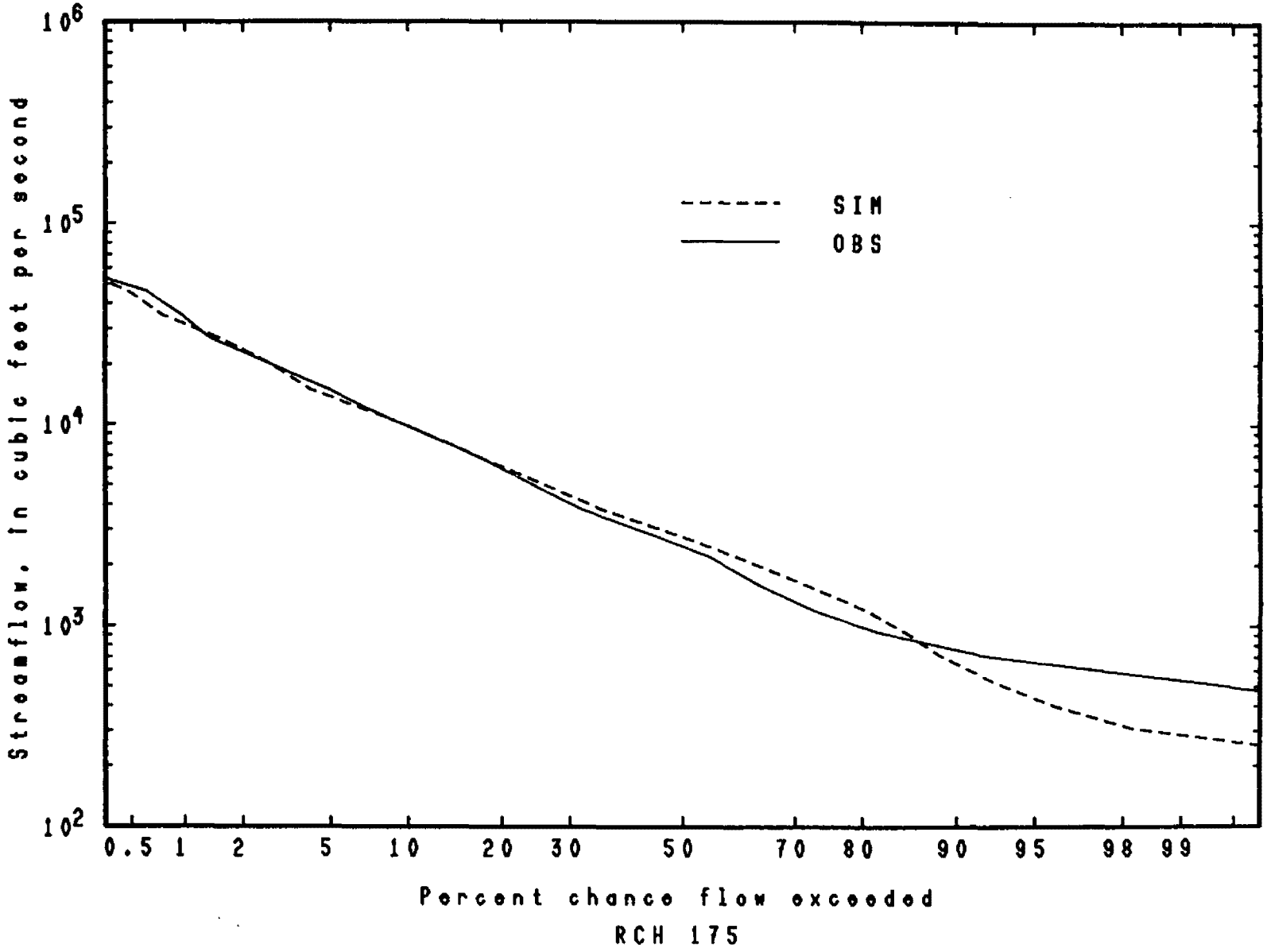
FLOW (CFS)

RESIDUALS (Simulated - Observed)



CUMULATIVE FLOWS (CFD) 1984 - 1987

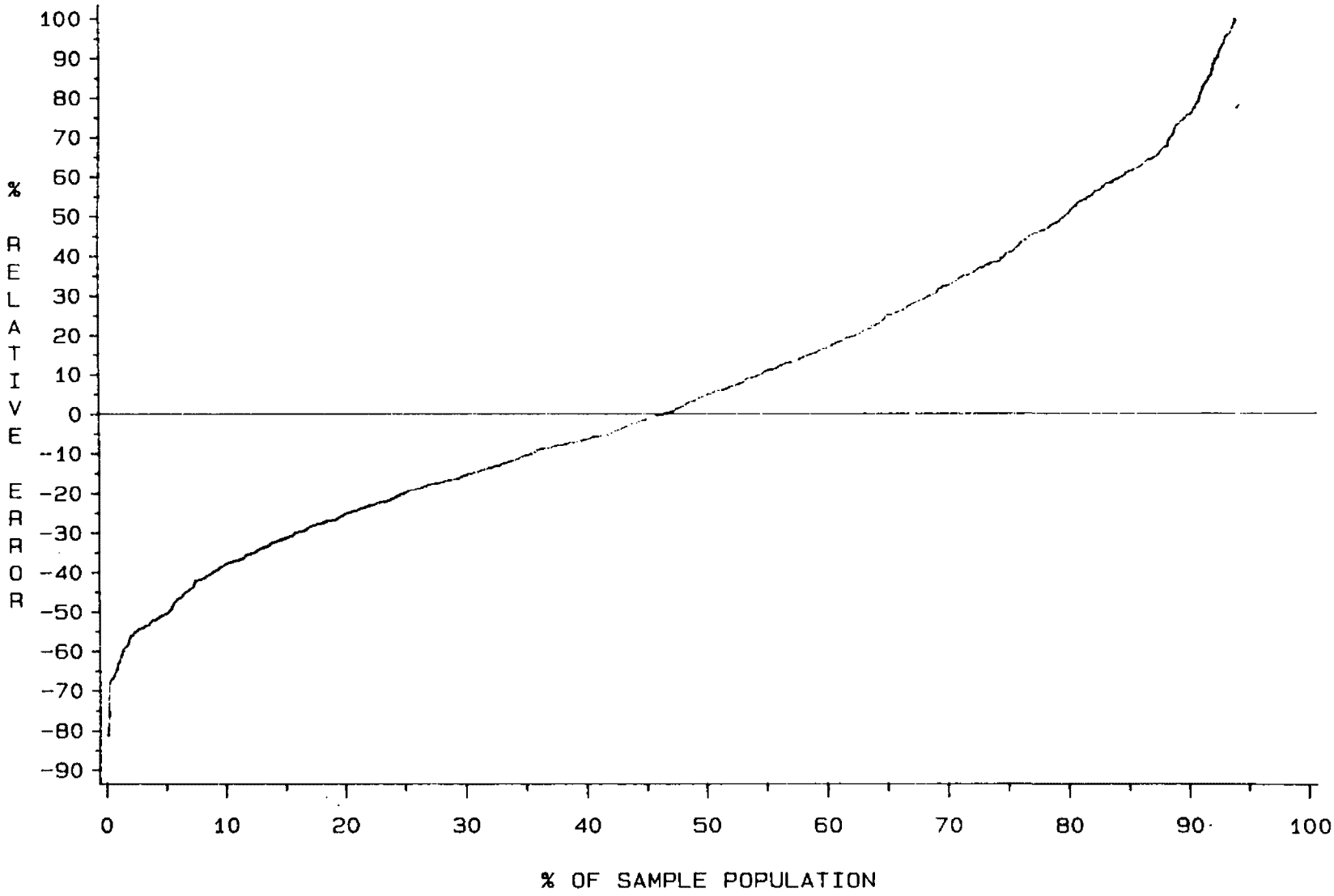



10^6
10^5
10^4
10^3
10^2
Streamflow, in cubic feet per second
SIM
OBS
0.5 1 2 5 10 20 30 50 70 80 90 95 98 99
Percent chance flow exceeded
RCH 175

UPPER POTOMAC RIVER AT SEG. 175

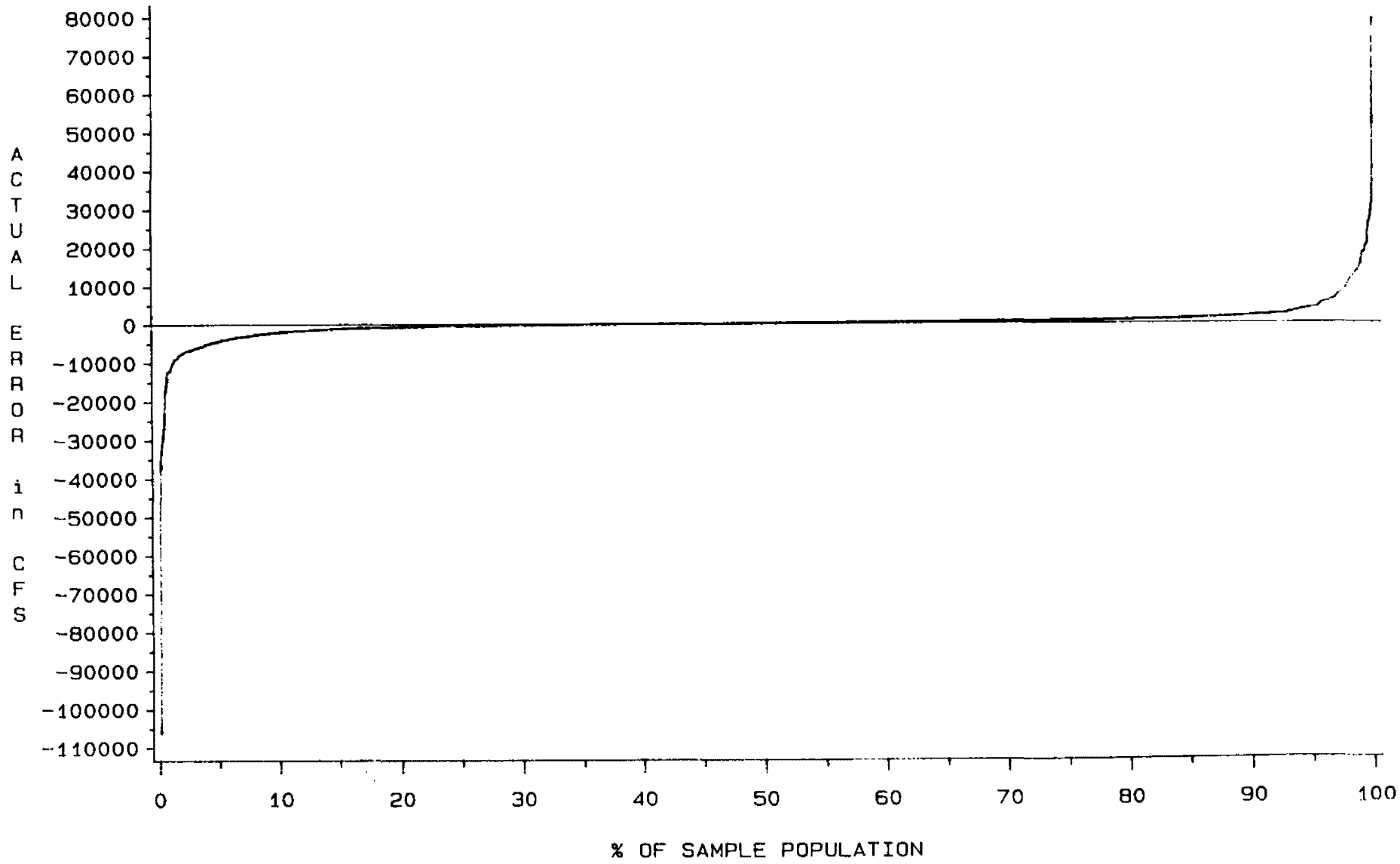
FLOW RELATIVE ERRORS

RELATIVE ERROR = (SIMULATED - OBSERVED)/OBSERVED



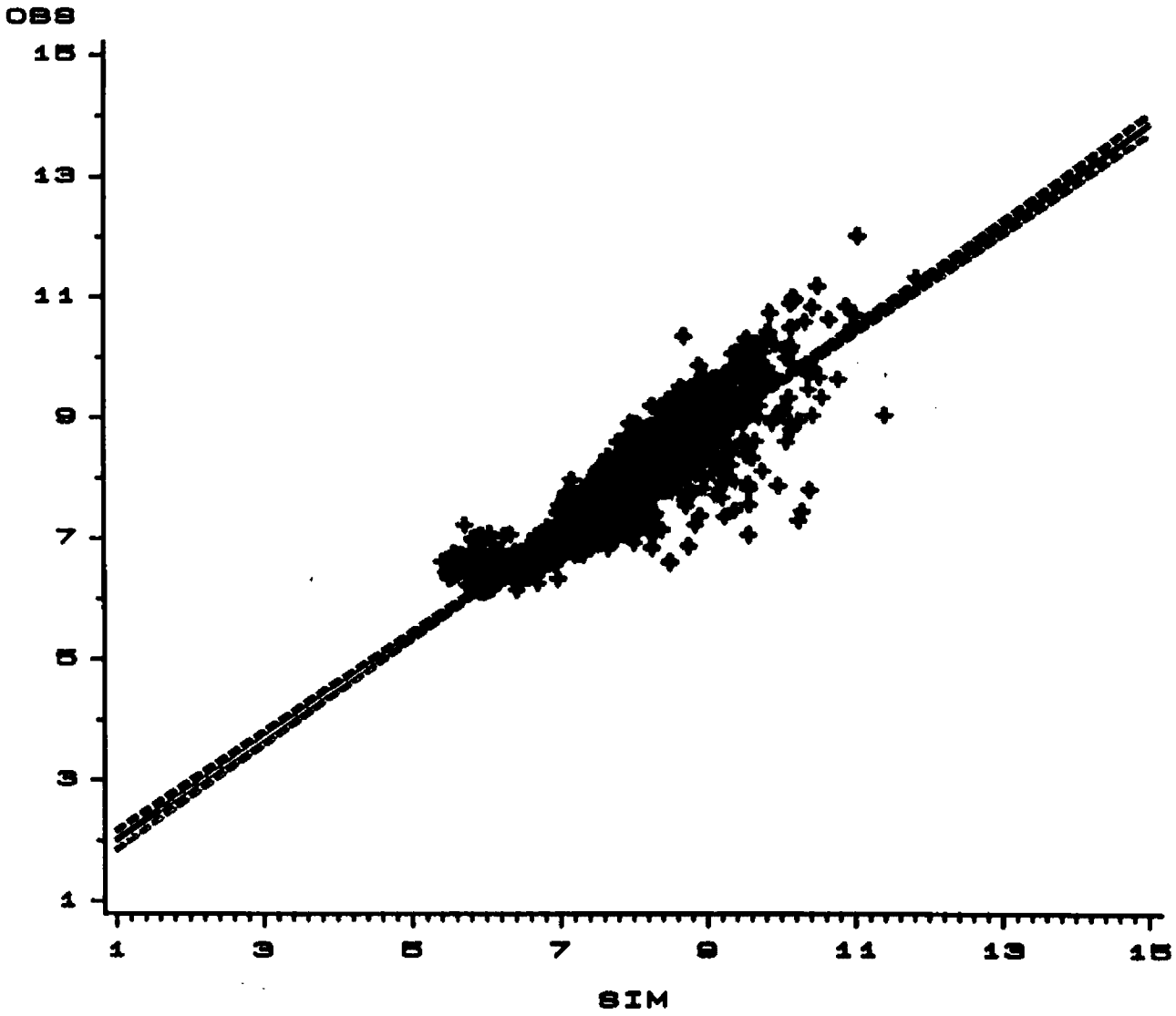
UPPER POTOMAC RIVER AT SEG. 175

FLOW ACTUAL ERRORS (CFS)



Upper Potomac River at Seg. 175

Regression of Log Simulated Flow versus Log Observed Flow



Note: Dashed lines represent the 95% confidence limits around the regression line.

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
UPPER POTOMAC RIVER, VA (Segment 160, 170 and 175)

COMPARISON OF ANNUAL TOTAL OBSERVED AND SIMULATED FLOWS

Year	Observed* Flow (in)	Simulated+ Flow (in)
1984	18.19	20.39
1985	17.30	18.22
1986	11.35	10.55
1987	13.47	12.30
Mean	15.08	15.37

* Observed flow at Upper Potomac River at Hancock, MD
\+ Simulated outflow from RCH 175

REGRESSION OF LOG SIMULATED FLOW ON LOG OBSERVED FLOW
DAILY AND MONTHLY R-SQUARED

Year	Ave. Daily	Ave. Monthly
1984	0.7730	0.8706
1985	0.8365	0.9370
1986	0.8209	0.9205
1987	0.7796	0.8884
1984-87	0.7795	0.8563

SEASONAL R-SQUARED

Year	Season 1	Season 2	Season 3	Season 4
1984	0.8187	0.6982	0.7782	0.7272
1985	0.7581	0.7551	0.7502	0.8598
1986	0.7321	0.8076	0.5378	0.8214
1987	0.2510	0.7649	0.8007	0.7338

Overall Seasonal R-squared 0.7849

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

CHESAPEAKE BAY WATERSHED HYDROLOGICAL SIMULATION
UPPER POTOMAC RIVER, VA (Segments 160, 170 and 175)

REGRESSION OF LOG TRANSFORMED SIMULATED AND OBSERVED FLOWS

	Intercept	Probability Intercept=0*	Slope	Probability Slope=1*
DAILY FLOWS				
1984	-0.5460	0.0266	1.0340	0.2479
1985	0.2712	0.1327	0.9521	0.0307
1986	2.1784	0.0001	0.7319	0.0001
1987	0.5891	0.0038	0.9251	0.0039
1984-87	1.1655	0.0001	0.8465	0.0001
MONTHLY FLOWS				
1984	-2.0439	0.1346	1.2062	0.1913
1985	-0.8655	0.2726	1.0901	0.3372
1986	1.9224	0.0055	0.7712	0.0096
1987	-0.2159	0.8180	1.0250	0.8324
1984-87	0.7716	0.0863	0.8973	0.0643
SEASONAL FLOWS				
1984 S1	0.0902	0.9022	1.0011	0.9891
S2	1.5469	0.0046	0.8419	0.0088
S3	1.5492	0.0001	0.7466	0.0001
S4	0.8742	0.0424	0.8360	0.0025
1985 S1	1.3509	0.0116	0.8250	0.0059
S2	1.2084	0.0068	0.8592	0.0084
S3	0.4745	0.1914	0.8987	0.0359
S4	0.8742	0.0067	0.8908	0.0043
1986 S1	-1.5292	0.0559	1.1504	0.1053
S2	1.1960	0.0018	0.8773	0.0086
S3	3.7912	0.0001	0.4696	0.0001
S4	3.2560	0.0001	0.5859	0.0001
1987 S1	4.7998	0.0001	0.4000	0.0001
S2	0.8591	0.0730	0.9452	0.3289
S3	1.9152	0.0001	0.7133	0.0001
S4	0.9764	0.0191	0.8706	0.0193
1984-87	1.1417	0.0001	0.8505	0.0001

* If probability is less than .05 (95% confidence level) then intercept is significantly different from 0, or slope is significantly different from 1.

A.7 SHENANDOAH RIVER AT SEG. 200

Time Series Plot of Simulated and Observed Daily Flows for 1984-1987

Time Series Plot of Residual (Simulated Minus Observed) Daily Flows for 1984-1987

Time Series Plot of Cumulative Simulated and Observed Flows for 1984-1987

Plot of Percent Chance Flow Exceeded vs. Volume of Streamflow

Distribution of Percent Relative Errors Over Percentile Sample Population

Distribution of Percent Actual Errors Over Percentile Sample Population

Regression of Log Transformed Simulated Flow vs. Log Transformed Observed Flow Scatter Plot

Comparison of Annual Total Observed and Simulated Flow

Average Daily and Monthly R-Squared for 1984-1987

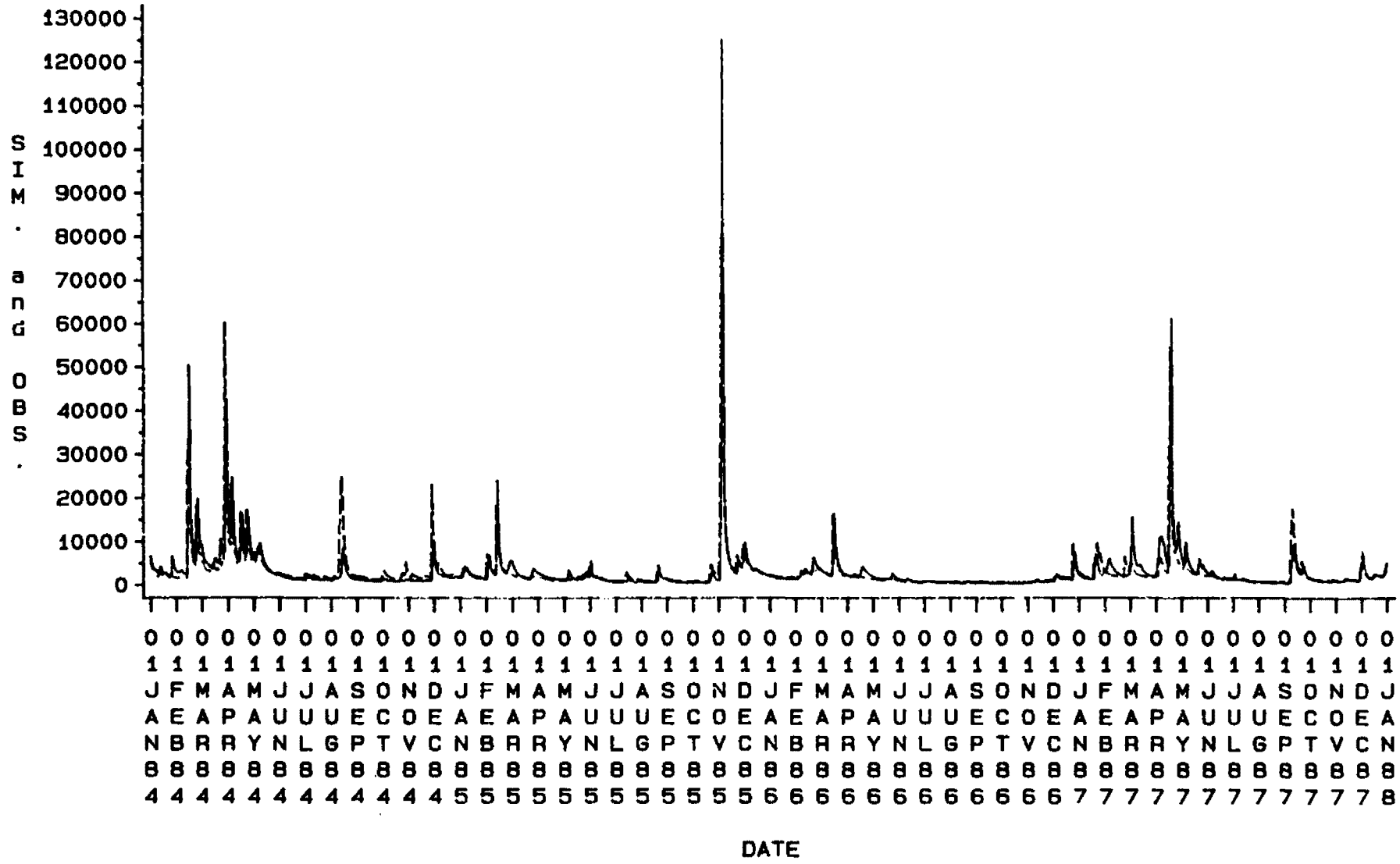
Average Seasonal R-Squared for 1984-1987

Log Transformed Simulated and Observed Flow Regression Slope and Intercept Statistics

SHENANDOAH RIVER AT SEG. 200

FLOW (CFS)

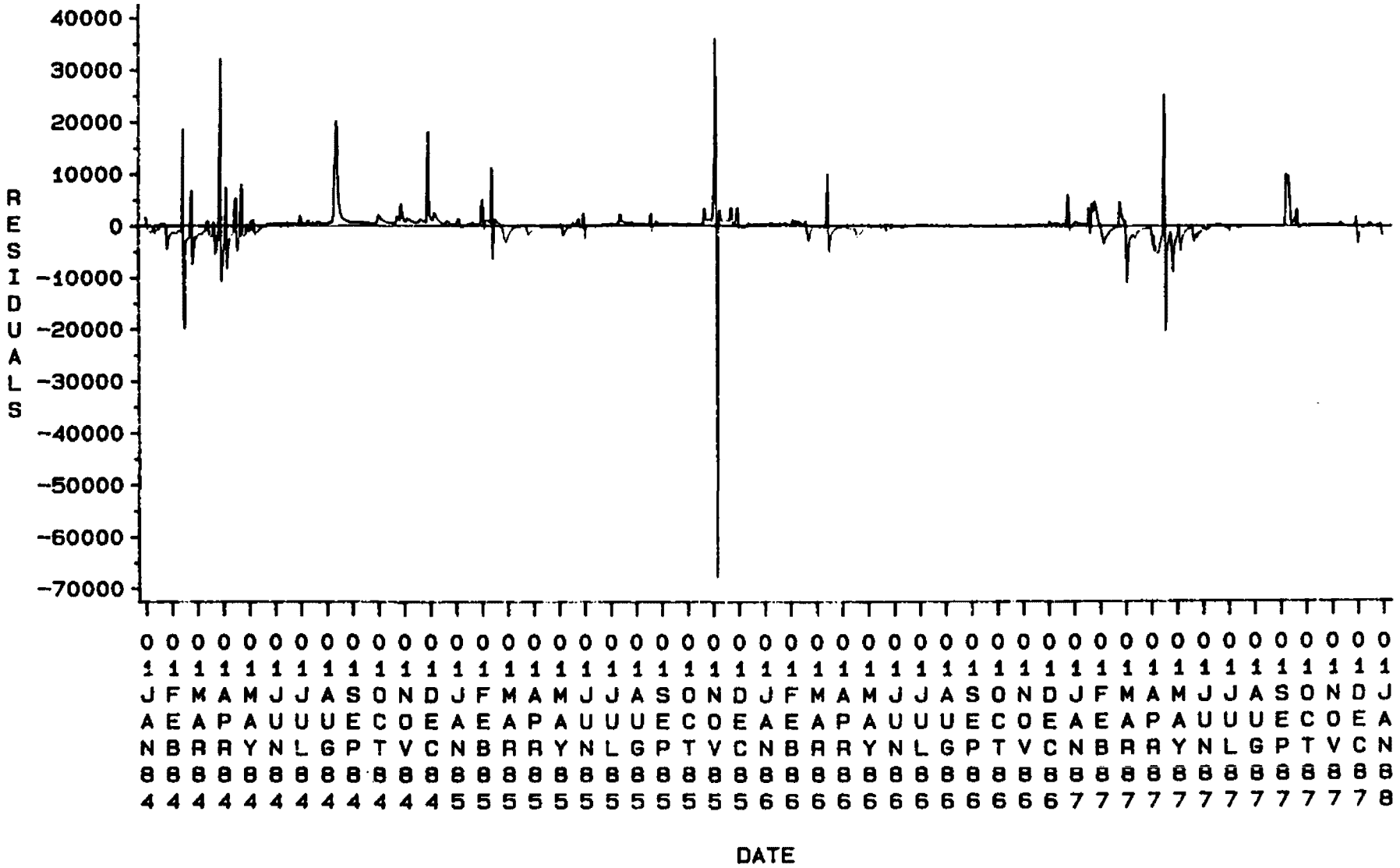
RED DASHED: SIM., BLUE SOLID: OBS.



SHENANDOAH RIVER AT SEG. 200

FLOW (CFS)

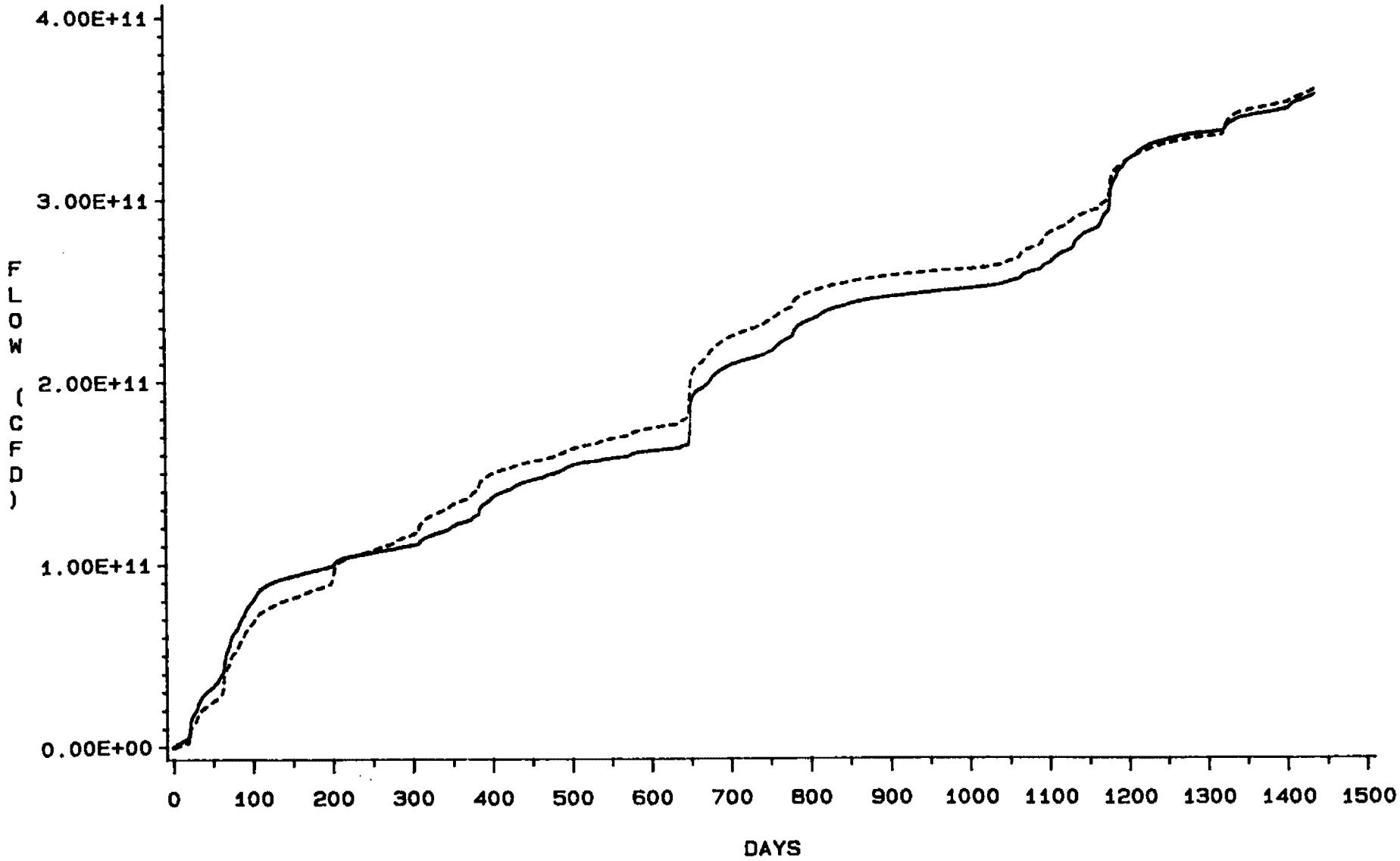
RESIDUALS (SIMULATED - OBSERVED)

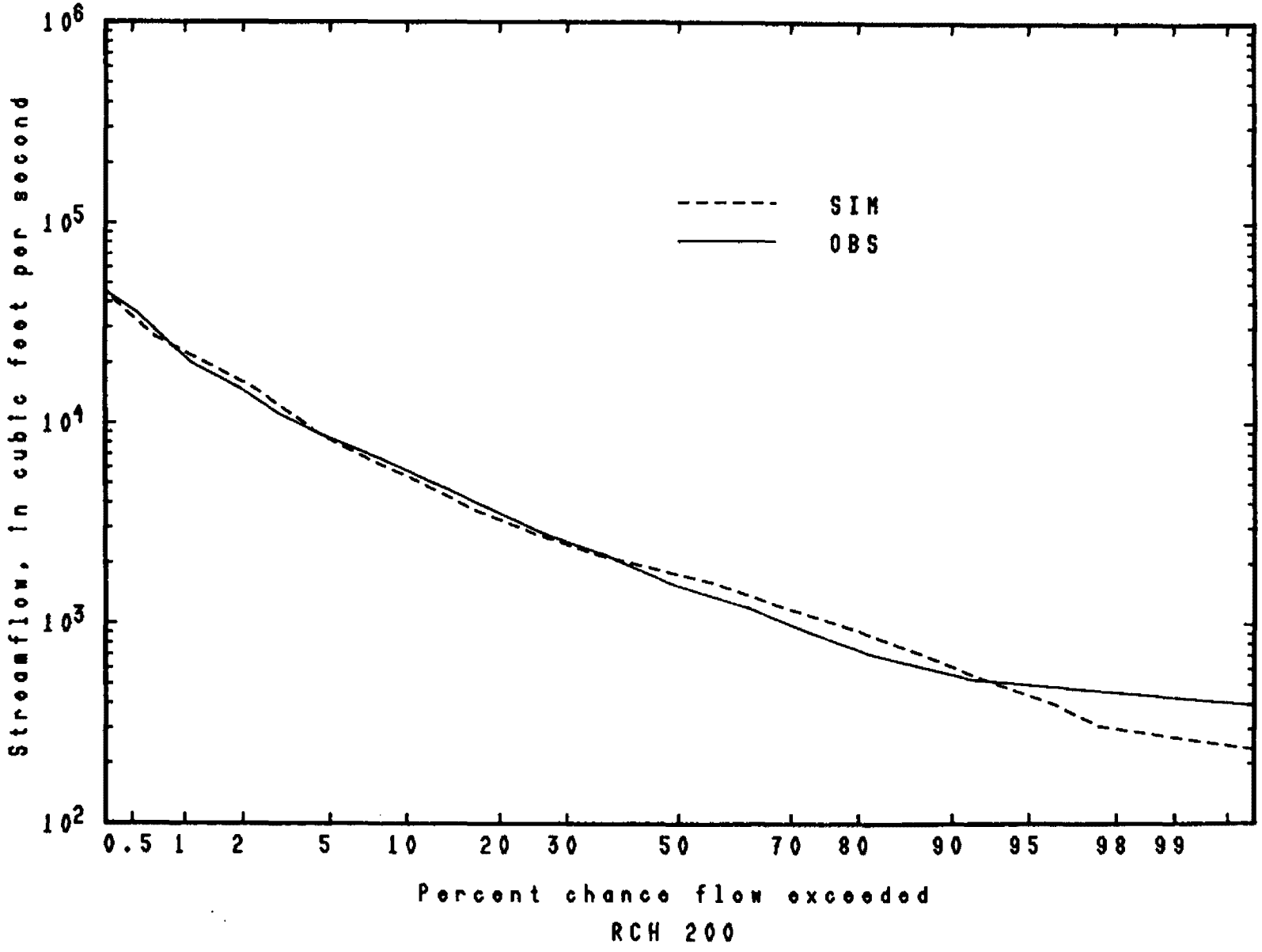


CUMULATIVE FLOWS (CFD) 1984 - 1987

SHENA

Simulated - - - - - - Observed ----------

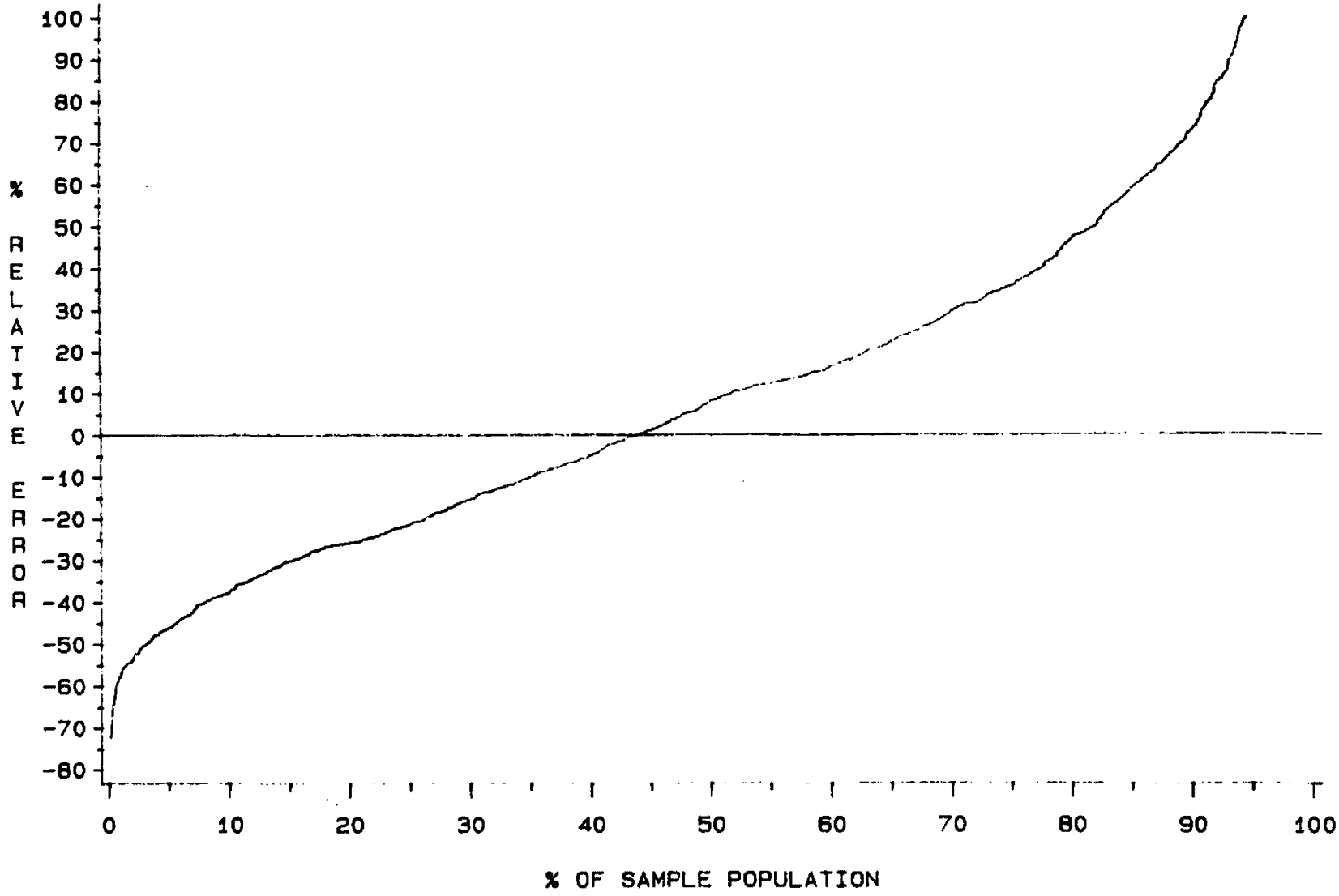



10^6
10^5
10^4
10^3
10^2
Streamflow, in cubic feet per second
SIM
OBS
0.5 1 2 5 10 20 30 50 70 80 90 95 98 99
Percent chance flow exceeded
RCH 200

SHENANDOAH RIVER AT SEG. 200

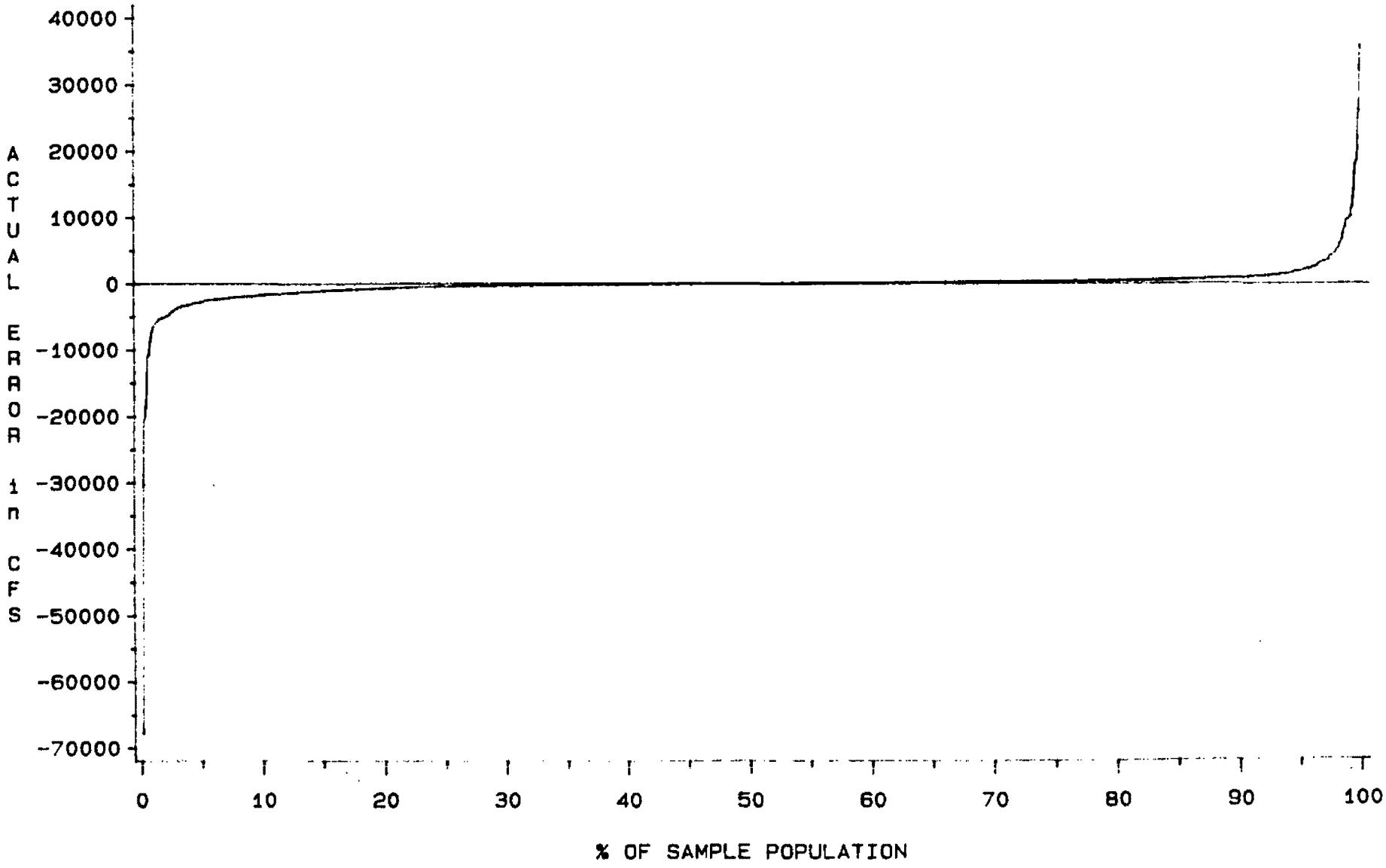
FLOW RELATIVE ERRORS

RELATIVE ERROR = (SIMULATED - OBSERVED)/OBSERVED



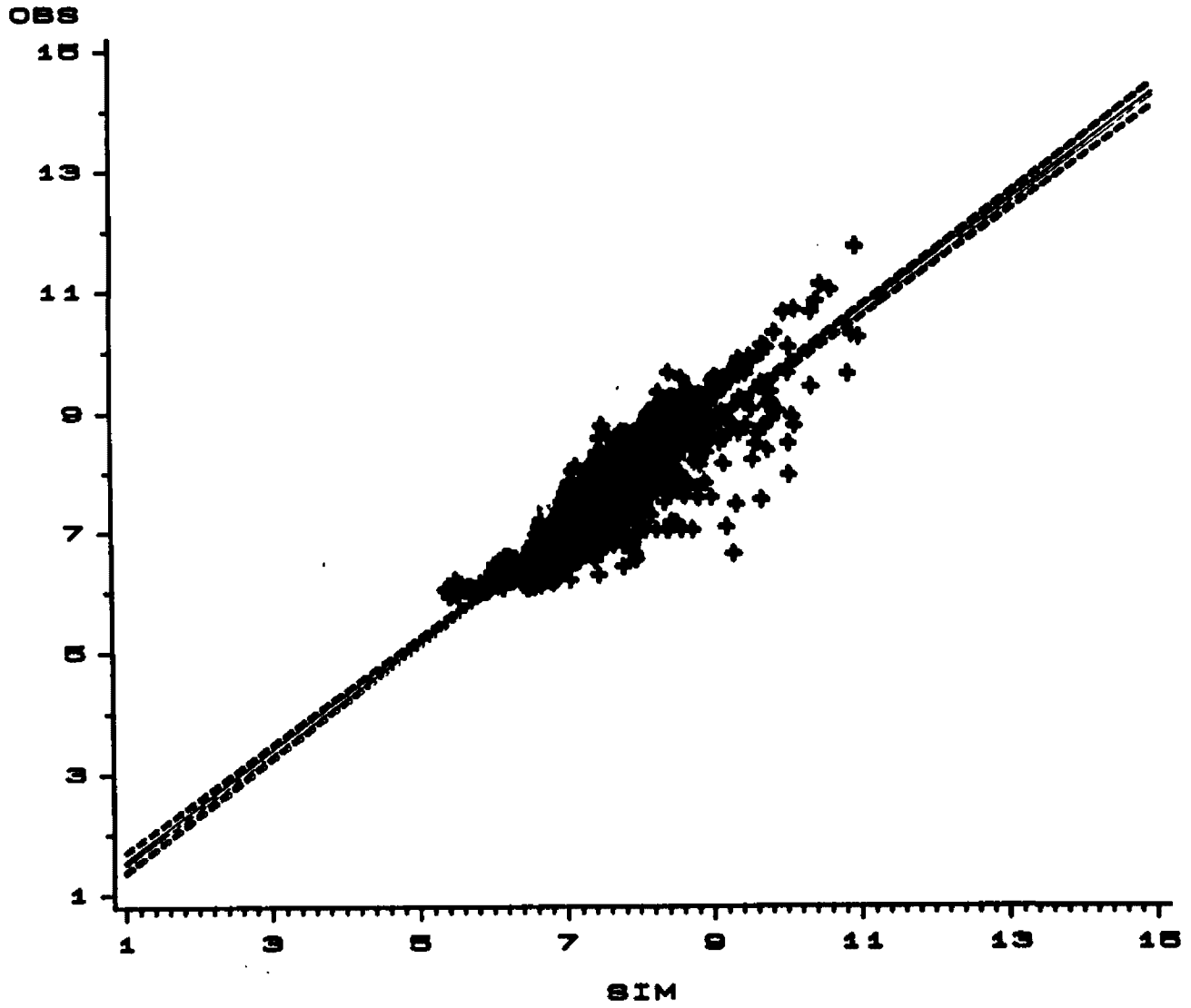
SHENANDOAH RIVER AT SEG. 200

FLOW ACTUAL ERRORS (CFS)



Shenandoah River at Seg. 200

Regression of Log Simulated Flow versus Log Observed Flow



Note: Dashed lines represent the 95% confidence limits around the regression line.

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
SHENANDOAH RIVER, VA (Segments 190 and 200)

COMPARISON OF ANNUAL TOTAL OBSERVED AND SIMULATED FLOWS

Year	Observed* Flow (in)	Simulated+ Flow (in)
1984	17.73	19.14
1985	12.93	13.43
1986	6.88	6.36
1987	13.88	12.36
Mean	12.86	12.82

* Observed flow at Shenandoah River at Millville, WV
\+ Simulated outflow from RCH 200

REGRESSION OF LOG SIMULATED FLOW ON LOG OBSERVED FLOW
DAILY AND MONTHLY R-SQUARED

Year	Ave. Daily	Ave. Monthly
1984	0.7131	0.8006
1985	0.7684	0.8786
1986	0.8712	0.9225
1987	0.7684	0.8474
1984-87	0.7770	0.8382

SEASONAL R-SQUARED

Year	Season 1	Season 2	Season 3	Season 4
1984	0.8639	0.7623	0.7458	0.6329
1985	0.5686	0.3898	0.6388	0.9035
1986	0.7897	0.7927	0.7469	0.8920
1987	0.2211	0.7861	0.8269	0.8535

Overall Seasonal R-squared 0.7775

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

CHESAPEAKE BAY WATERSHED HYDROLOGICAL SIMULATION
SHENANDOAH RIVER, VA (Segments 190 and 200)

REGRESSION OF LOG TRANSFORMED SIMULATED AND OBSERVED FLOWS

	Intercept	Probability Intercept=0*	Slope	Probability Slope=1*
DAILY FLOWS				
1984	-0.5403	0.0524	1.0408	0.2386
1985	0.0080	0.9702	0.9797	0.4726
1986	1.1241	0.0001	0.8523	0.0001
1987	0.2182	0.3075	0.9773	0.4206
1984-87	0.6311	0.0001	0.9089	0.0001
MONTHLY FLOWS				
1984	-2.4452	0.1664	1.2654	0.2134
1985	-0.5971	0.5498	1.0646	0.6171
1986	1.0173	0.0983	0.8694	0.1323
1987	-0.0880	0.9349	1.0160	0.9088
1984-87	0.4057	0.3891	0.9392	0.3226
SEASONAL FLOWS				
1984 S1	2.5127	0.0001	0.7508	0.0001
S2	1.5278	0.0007	0.8412	0.0021
S3	2.4783	0.0001	0.6186	0.0001
S4	1.1735	0.0140	0.7698	0.0003
1985 S1	1.3264	0.0853	0.8212	0.0619
S2	2.1346	0.0038	0.7413	0.0104
S3	-0.5090	0.3146	1.0220	0.7564
S4	-0.7249	0.0141	1.0548	0.1287
1986 S1	-1.7731	0.0073	1.2125	0.0122
S2	1.6731	0.0001	0.8150	0.0001
S3	0.7678	0.0126	0.8972	0.0347
S4	2.3518	0.0001	0.6521	0.0001
1987 S1	4.3141	0.0001	0.4371	0.0001
S2	1.3851	0.0008	0.8845	0.0211
S3	1.4309	0.0001	0.7885	0.0001
S4	-1.1032	0.0027	1.1451	0.0040
1984-87	0.6359	0.0001	0.9077	0.0001

* If probability is less than .05 (95% confidence level) then intercept is significantly different from 0, or slope is significantly different from 1.

A.8 LOWER POTOMAC RIVER AT SEG. 220

Time Series Plot of Simulated and Observed Daily Flows for 1984-1987

Time Series Plot of Residual (Simulated Minus Observed) Daily Flows for 1984-1987

Time Series Plot of Cumulative Simulated and Observed Flows for 1984-1987

Plot of Percent Chance Flow Exceeded vs. Volume of Streamflow

Distribution of Percent Relative Errors Over Percentile Sample Population

Distribution of Percent Actual Errors Over Percentile Sample Population

Regression of Log Transformed Simulated Flow vs. Log Transformed Observed Flow Scatter Plot

Comparison of Annual Total Observed and Simulated Flow

Average Daily and Monthly R-Squared for 1984-1987

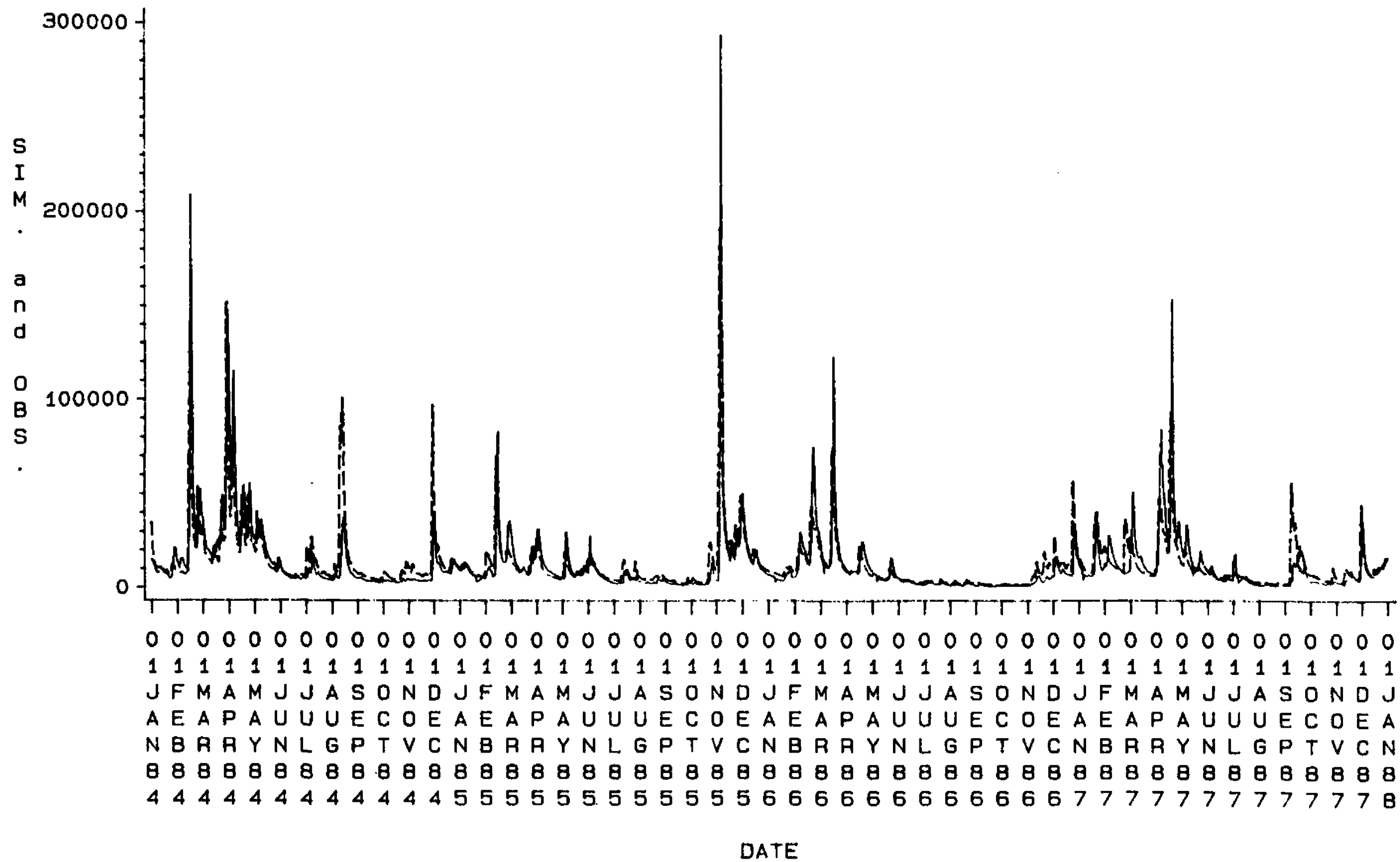
Average Seasonal R-Squared for 1984-1987

Log Transformed Simulated and Observed Flow Regression Slope and Intercept Statistics

LOWER POTOMAC RIVER AT SEG. 220

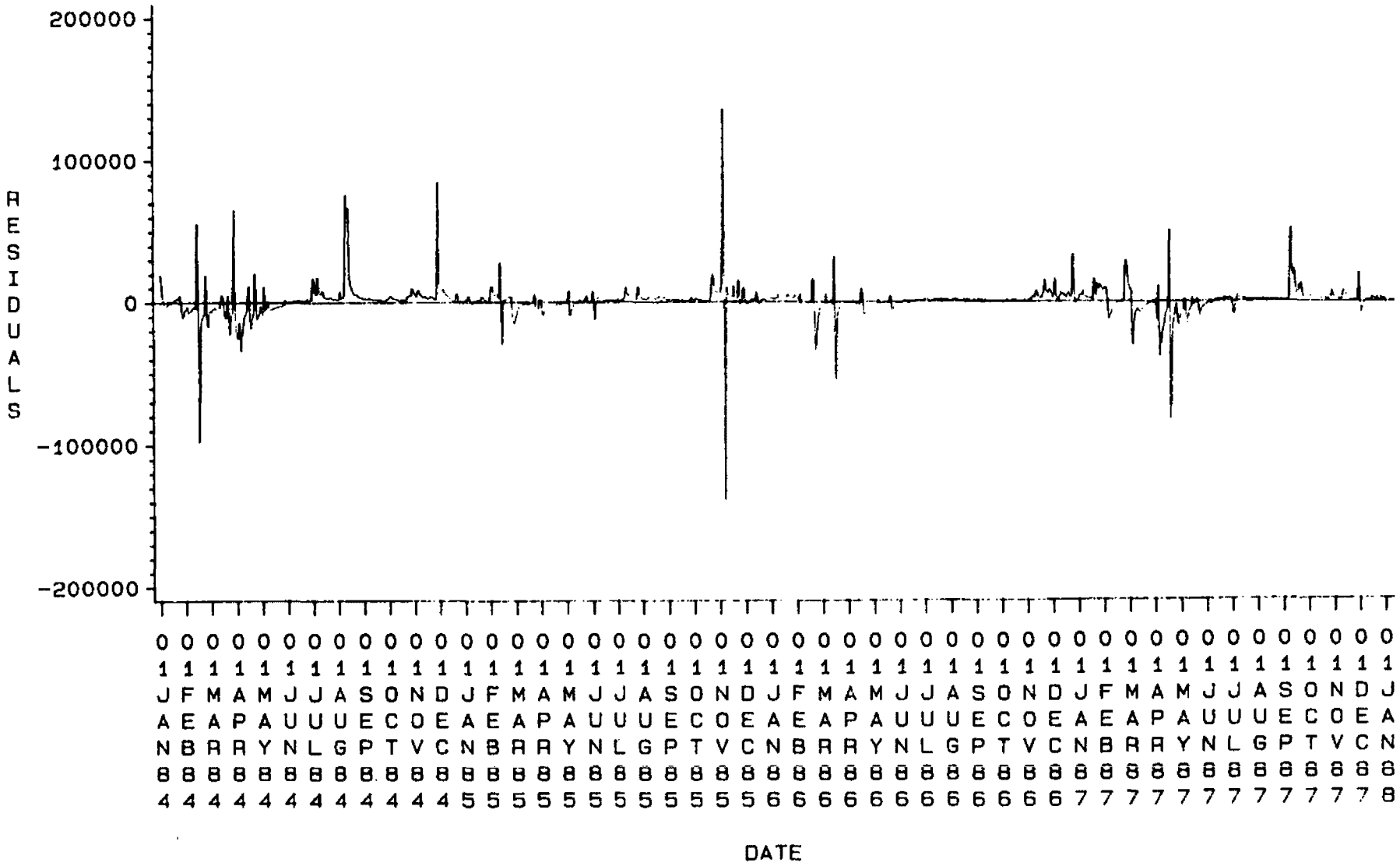
FLOW (CFS)

RED DASHED: SIM., BLUE SOLID: OBS.



LOWER POTOMAC RIVER AT SEG. 220

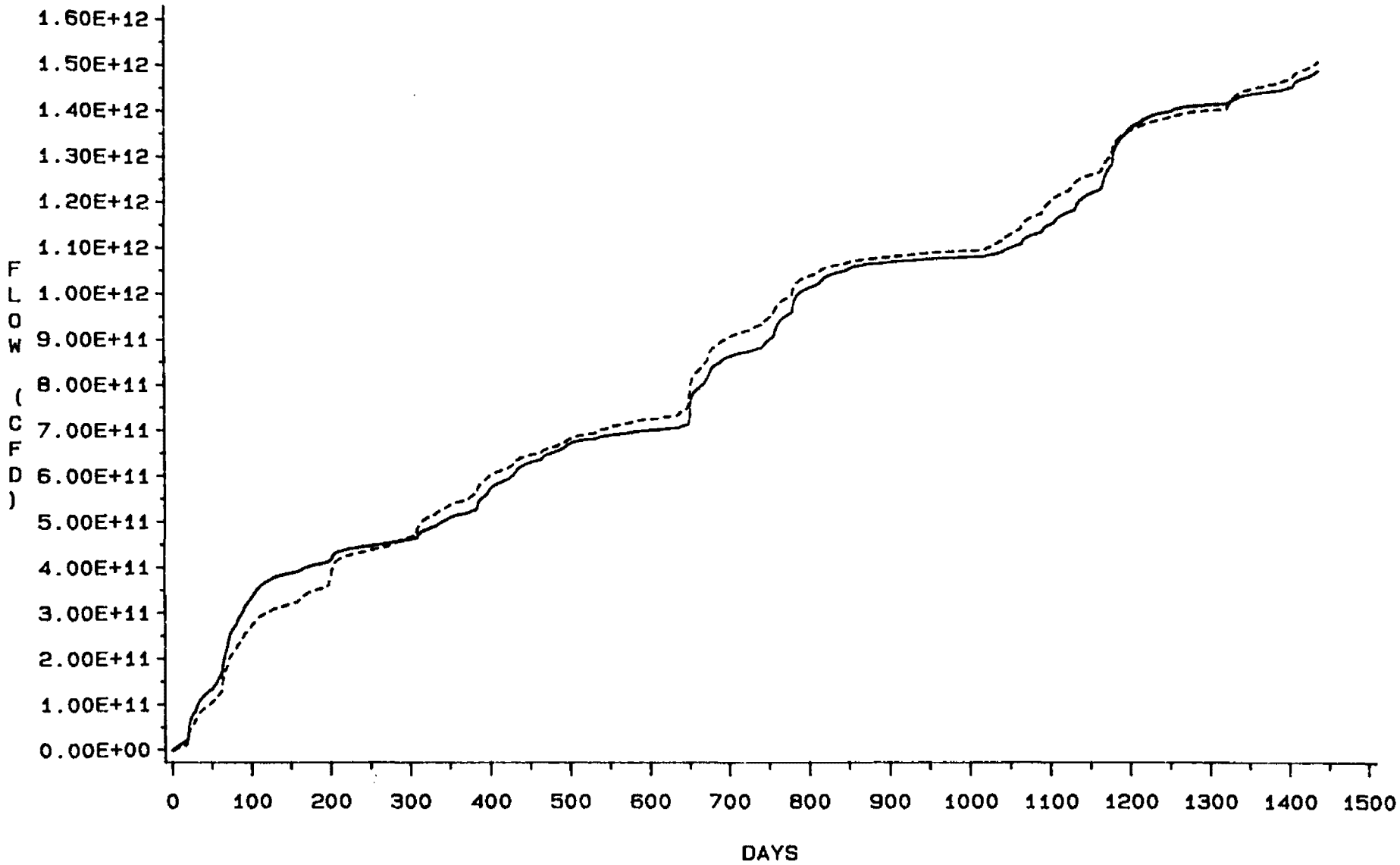
FLOW (CFS)
RESIDUALS (SIMULATED - OBSERVED)

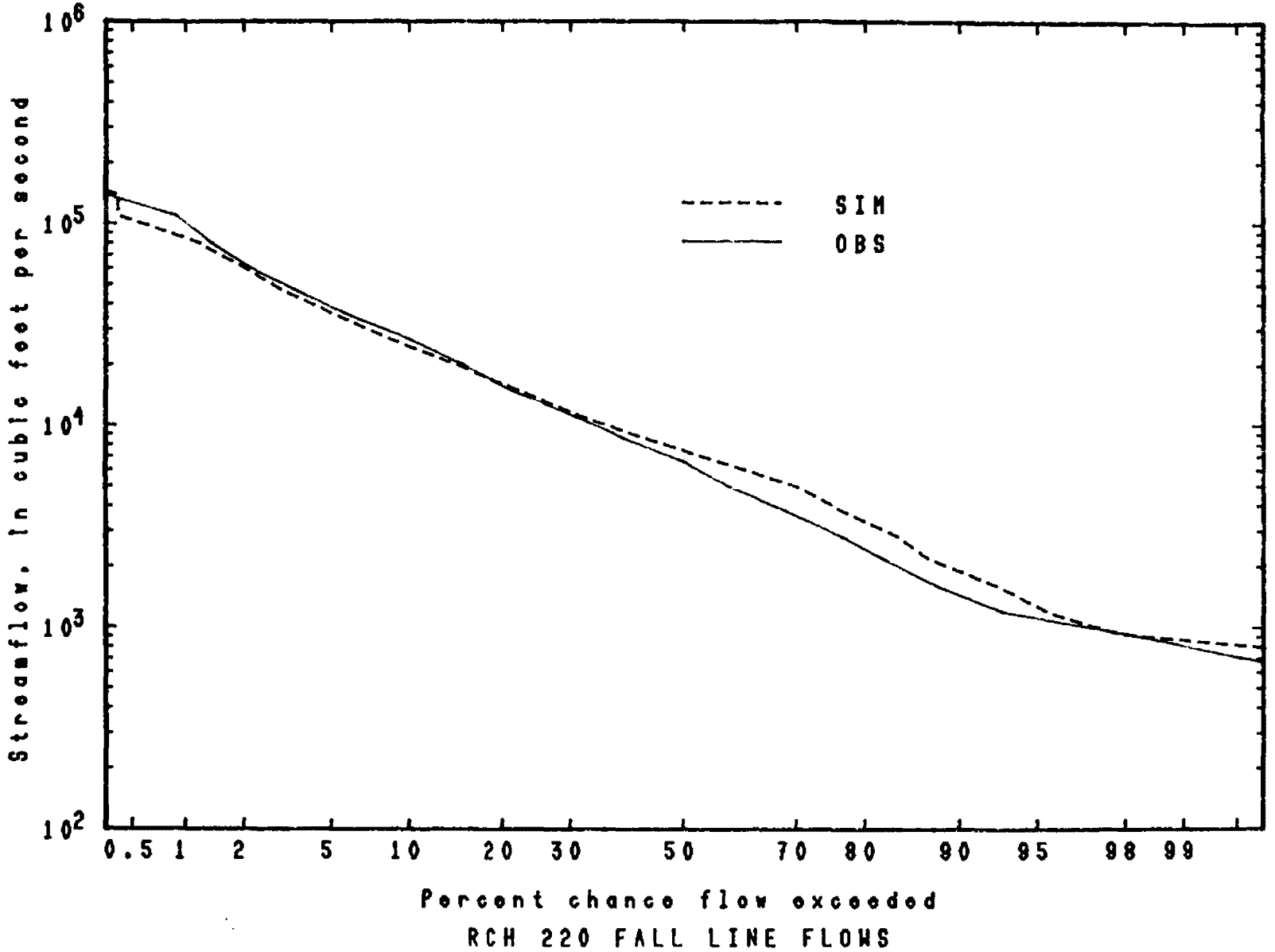


CUMULATIVE FLOWS (CFD) 1984 - 1987

LOPOT

Simulated - - - - - - Observed ---------



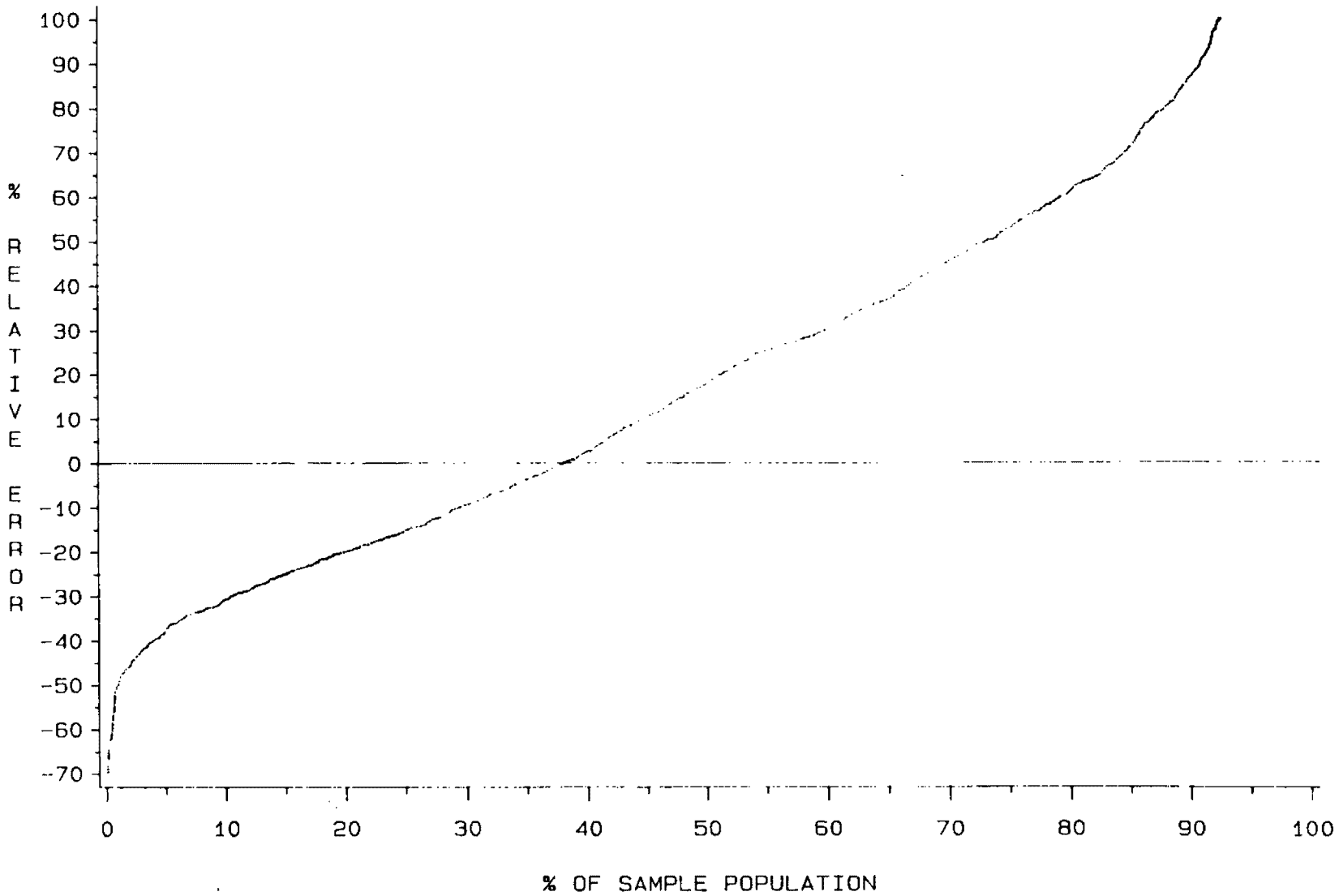


RCH 220 FALL LINE FLOWS

LOWER POTOMAC RIVER AT SEG. 220

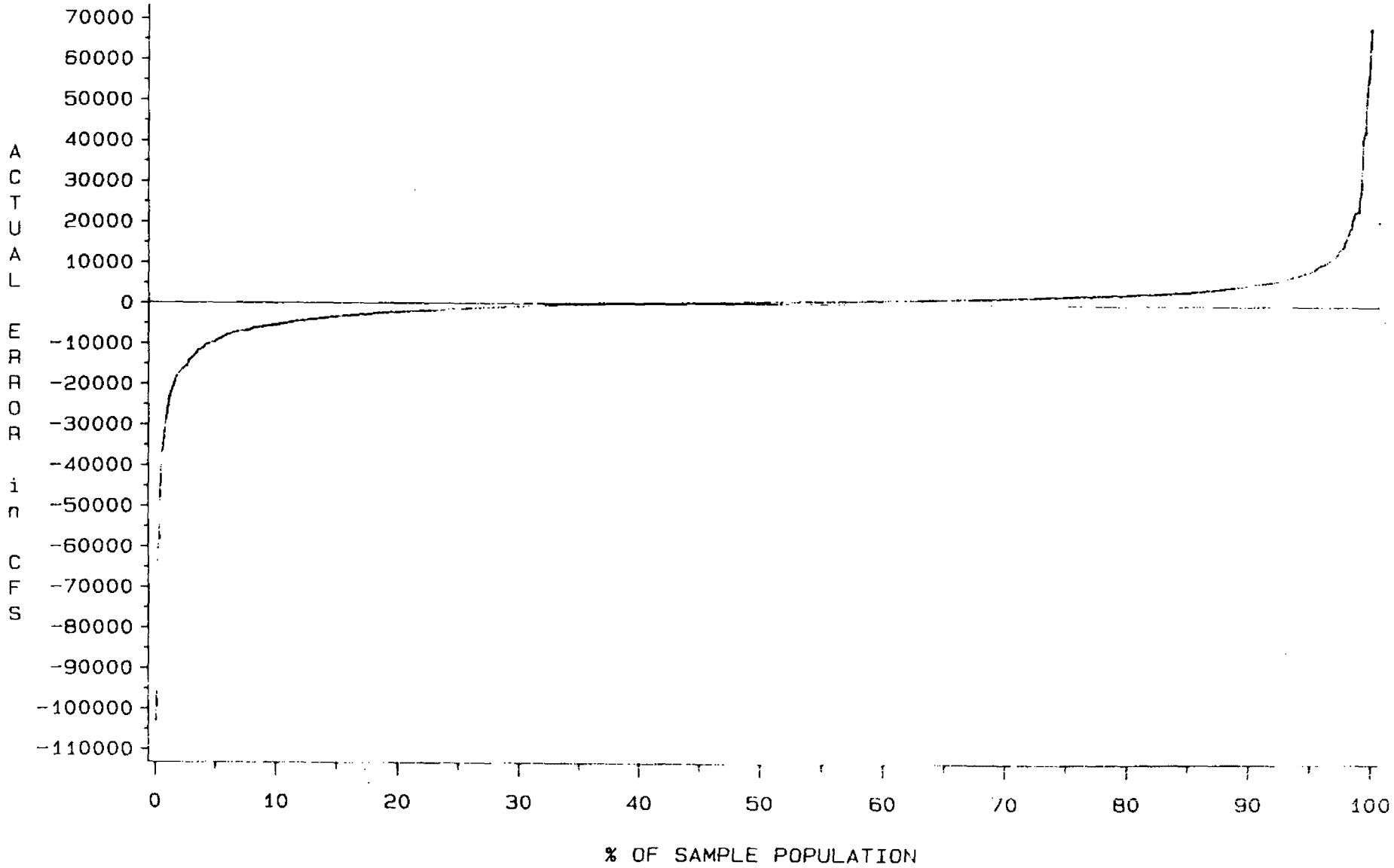
FLOW RELATIVE ERRORS

RELATIVE ERROR = (SIMULATED - OBSERVED)/OBSERVED



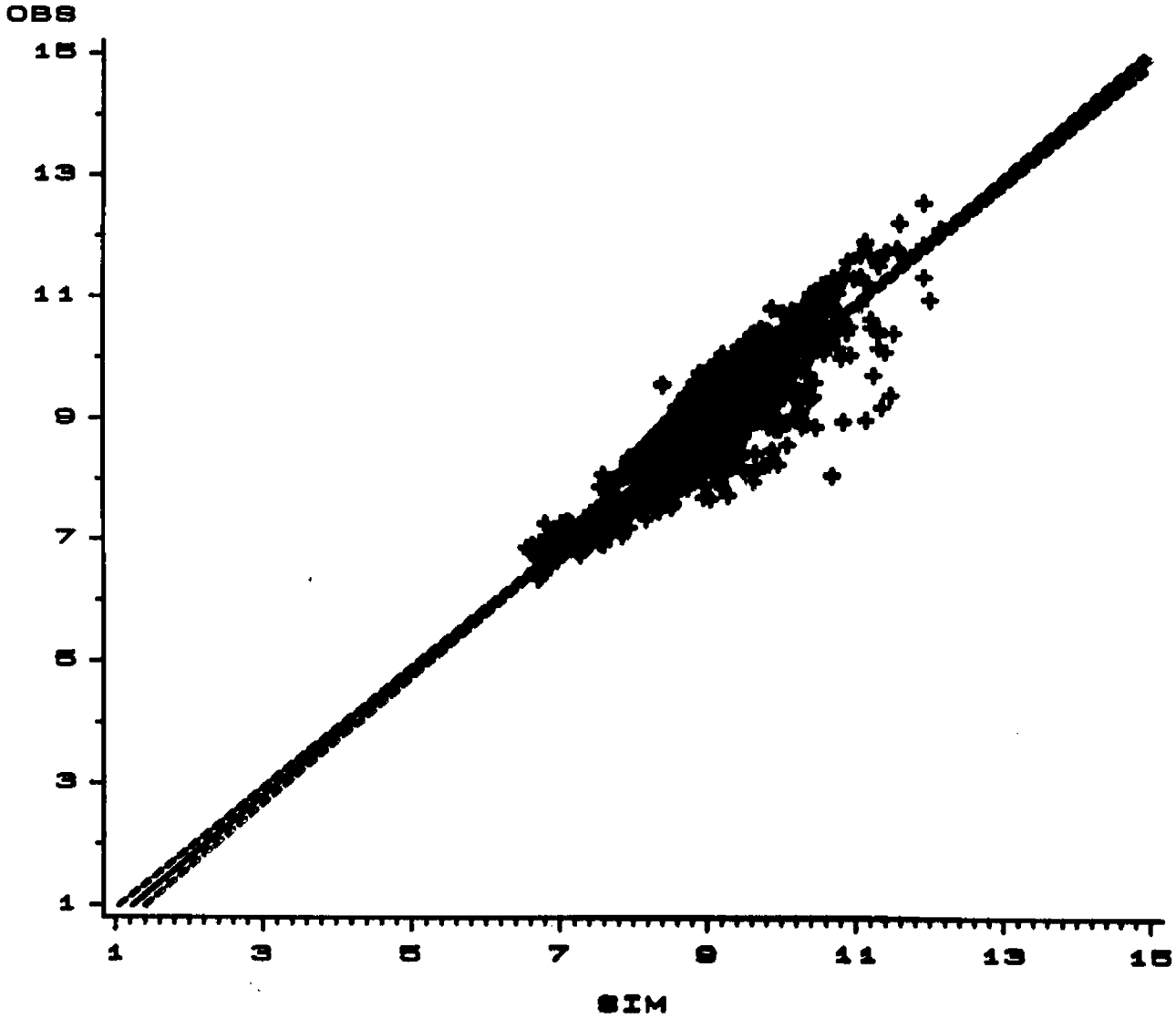
LOWER POTOMAC RIVER AT SEG. 220

FLOW ACTUAL ERRORS (CFS)



Lower Potomac River at Seg. 220

Regression of Log Simulated Flow versus Log Observed Flow



Note: Dashed lines represent the 95% confidence limits around the regression line.

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
LOWER POTOMAC RIVER (Segments 180, 210 and 220)

COMPARISON OF ANNUAL TOTAL OBSERVED AND SIMULATED FLOWS

Year	Observed* Flow (in)	Simulated+ Flow (in)
1984	20.01	20.54
1985	14.28	14.26
1986	10.27	9.42
1987	14.18	12.90
Mean	14.69	14.28

* Observed flow Potomac River at Chain Bridge near Washington, DC
\+ Simulated outflow from RCH 220

REGRESSION OF LOG SIMULATED FLOW ON LOG OBSERVED FLOW
DAILY AND MONTHLY R-SQUARED

Year	Ave. Daily	Ave. Monthly
1984	0.7788	0.8343
1985	0.8307	0.8997
1986	0.8867	0.9169
1987	0.7918	0.8323
1984-87	0.8351	0.8726

SEASONAL R-SQUARED

Year	Season 1	Season 2	Season 3	Season 4
1984	0.8537	0.8664	0.8027	0.7377
1985	0.7789	0.7644	0.7991	0.8723
1986	0.9192	0.8830	0.7502	0.9072
1987	0.2833	0.8539	0.8048	0.8116

Overall Seasonal R-squared 0.8362

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

CHESAPEAKE BAY WATERSHED HYDROLOGICAL SIMULATION
LOWER POTOMAC RIVER (Segments 180, 210 and 220)

REGRESSION OF LOG TRANSFORMED SIMULATED AND OBSERVED FLOWS

	Intercept	Probability Intercept=0*	Slope	Probability Slope=1*
DAILY FLOWS				
1984	-0.9002	0.0016	1.0745	0.0136
1985	-0.6661	0.0033	1.0550	0.0285
1986	0.0242	0.8777	0.9879	0.5132
1987	-0.2421	0.3230	1.0176	0.5218
1984-87	-0.1943	0.0645	1.0067	0.5690
MONTHLY FLOWS				
1984	-2.7102	0.1416	1.2569	0.1776
1985	-1.7322	0.1582	1.1749	0.1889
1986	-0.2858	0.7399	1.0256	0.7983
1987	-0.8520	0.5556	1.0846	0.5947
1984-87	-0.6517	0.2355	1.0569	0.3441
SEASONAL FLOWS				
1984 S1	2.3936	0.0002	0.7921	0.0011
S2	1.3401	0.0005	0.8875	0.0032
S3	2.1168	0.0001	0.7193	0.0001
S4	0.4304	0.3902	0.8943	0.0577
1985 S1	-0.8234	0.2467	1.0719	0.3418
S2	0.9255	0.0624	0.9201	0.1460
S3	-0.6215	0.1236	1.0309	0.5179
S4	-0.6980	0.0781	1.0414	0.3186
1986 S1	-3.8366	0.0001	1.3935	0.0001
S2	1.2901	0.0001	0.8876	0.0016
S3	-0.9287	0.0379	1.1069	0.0717
S4	1.4661	0.0001	0.7878	0.0001
1987 S1	4.6871	0.0001	0.4814	0.0001
S2	0.9208	0.0220	0.9472	0.2099
S3	1.2004	0.0002	0.8268	0.0001
S4	-1.0848	0.0256	1.0921	0.0949
1984-87	-0.2062	0.0511	1.0080	0.4966

* If probability is less than .05 (95% confidence level) then intercept is significantly different from 0, or slope is significantly different from 1.

A.9 PATUXENT RIVER AT SEG. 340

Time Series Plot of Simulated and Observed Daily Flows for 1984-1987

Time Series Plot of Residual (Simulated Minus Observed) Daily Flows for 1984-1987

Time Series Plot of Cumulative Simulated and Observed Flows for 1984-1987

Plot of Percent Chance Flow Exceeded vs. Volume of Streamflow

Distribution of Percent Relative Errors Over Percentile Sample Population

Distribution of Percent Actual Errors Over Percentile Sample Population

Regression of Log Transformed Simulated Flow vs. Log Transformed Observed Flow Scatter Plot

Comparison of Annual Total Observed and Simulated Flow

Average Daily and Monthly R-Squared for 1984-1987

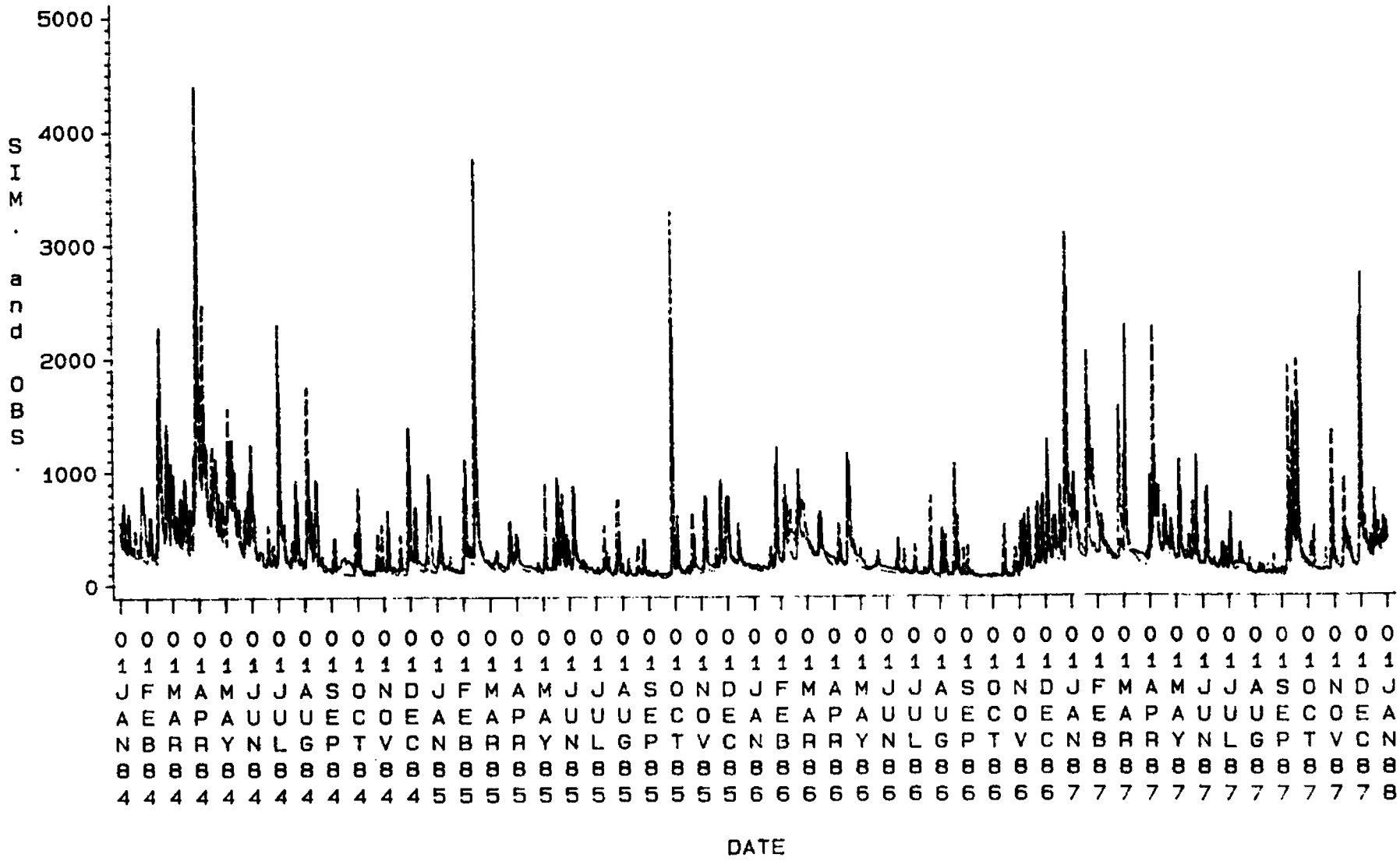
Average Seasonal R-Squared for 1984-1987

Log Transformed Simulated and Observed Flow Regression Slope and Intercept Statistics

PATUXENT RIVER AT SEG. 340

FLOW (CFS)

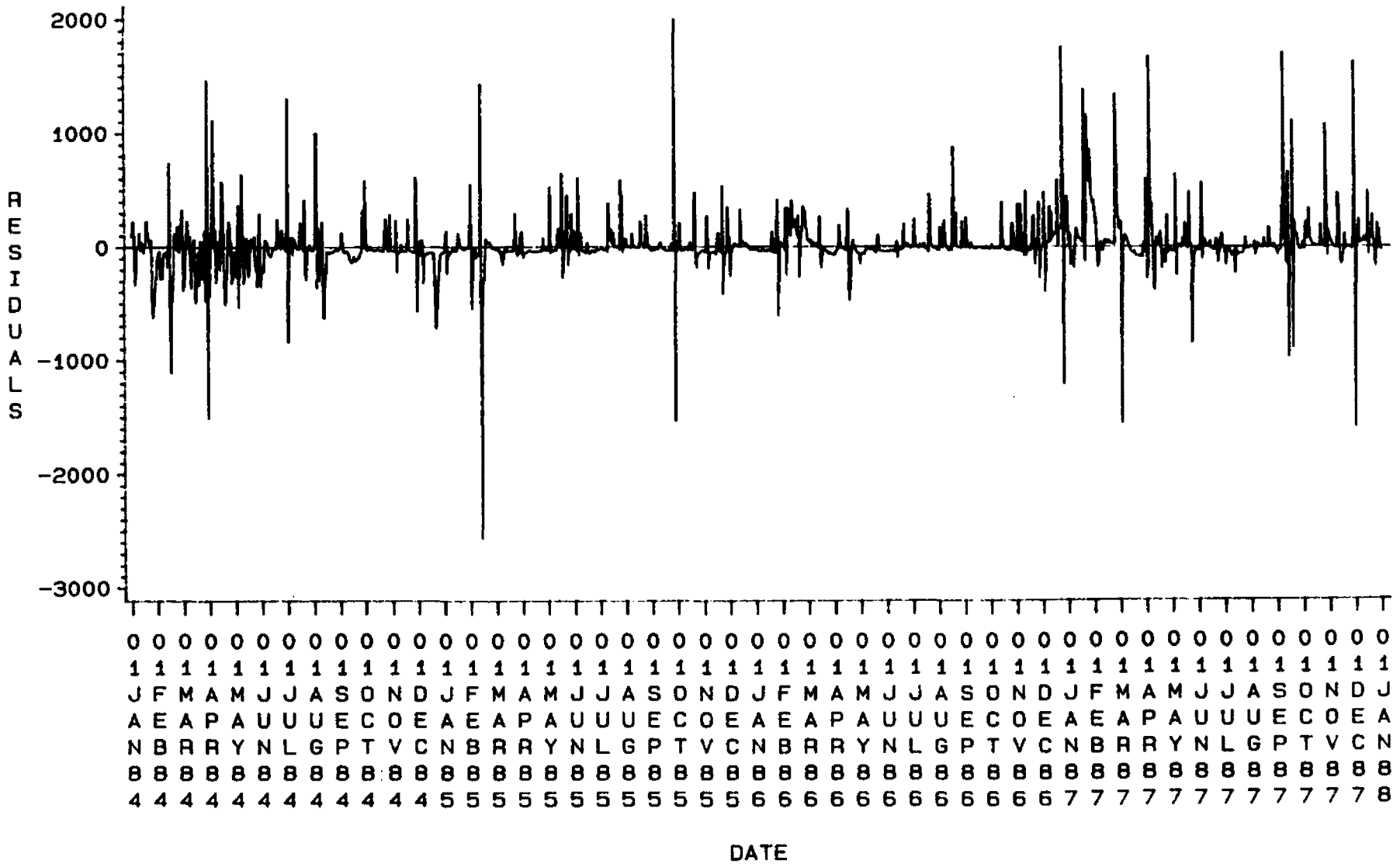
RED DASHED: SIM., BLUE SOLID: OBS.



PATUXENT RIVER AT SEG. 340

FLOW (CFS)

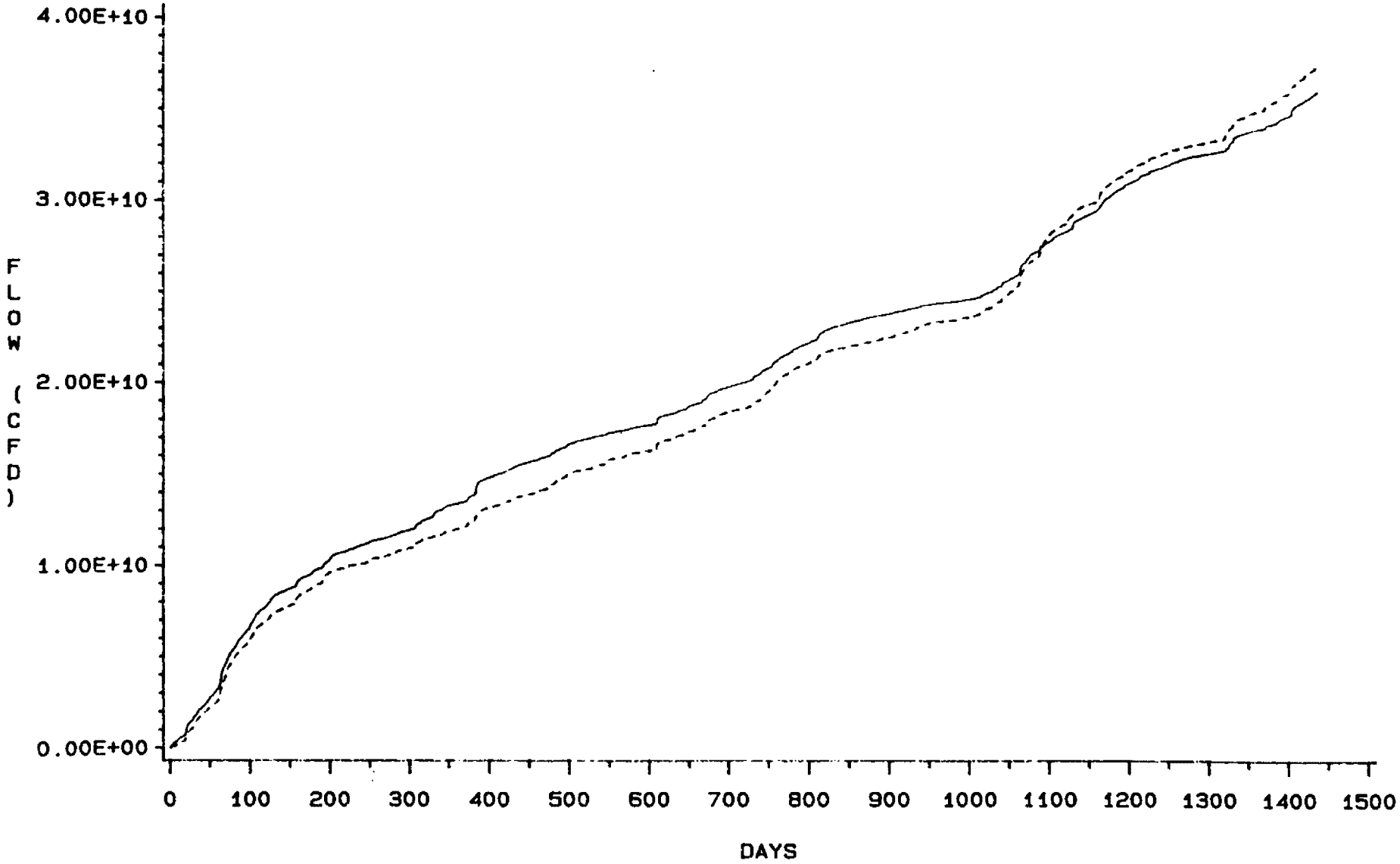
RESIDUALS (Simulated - Observed)

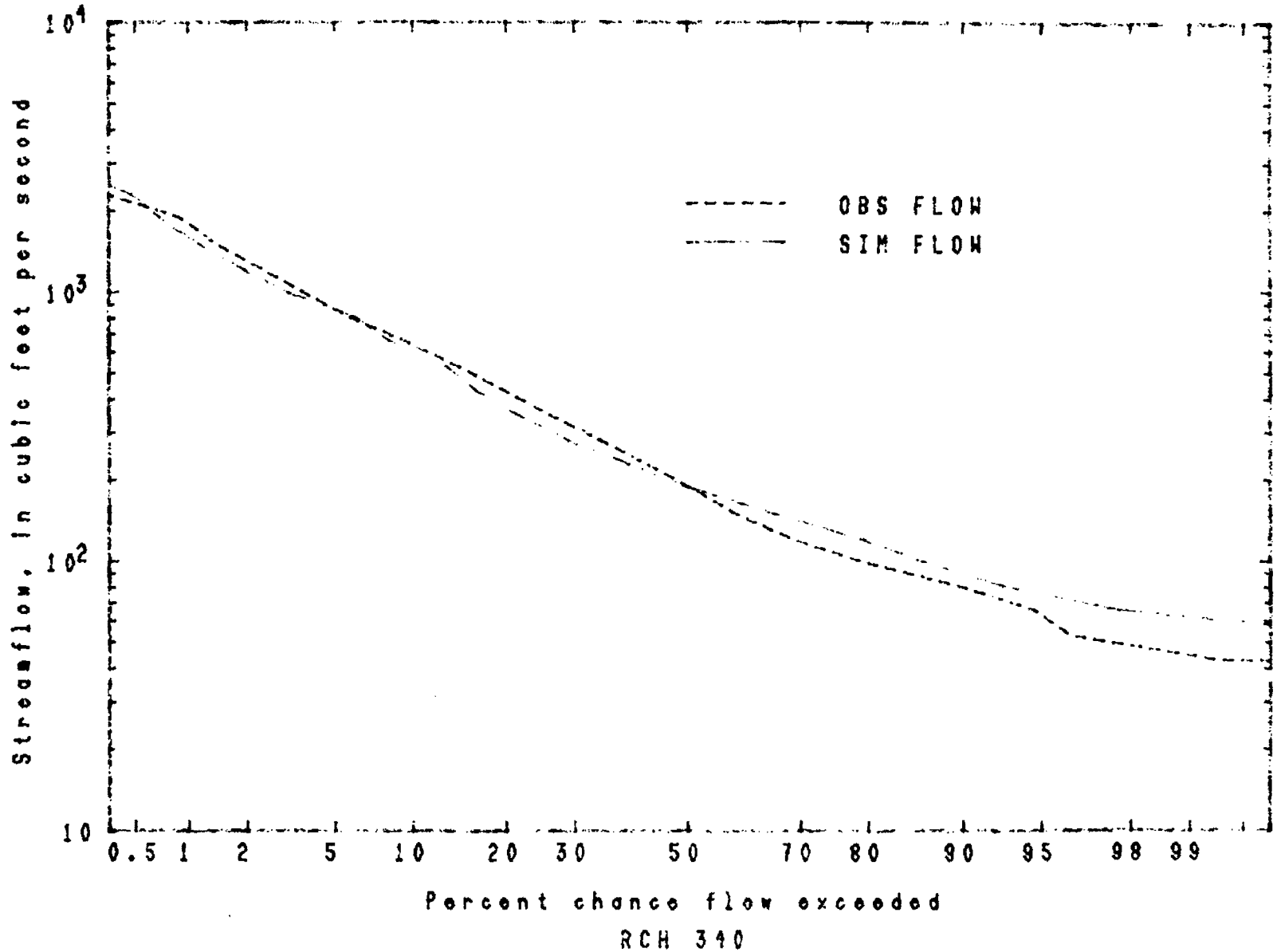


CUMULATIVE FLOWS (CFD) 1984 - 1987

PATUX

Simulated - - - - - - Observed ---------

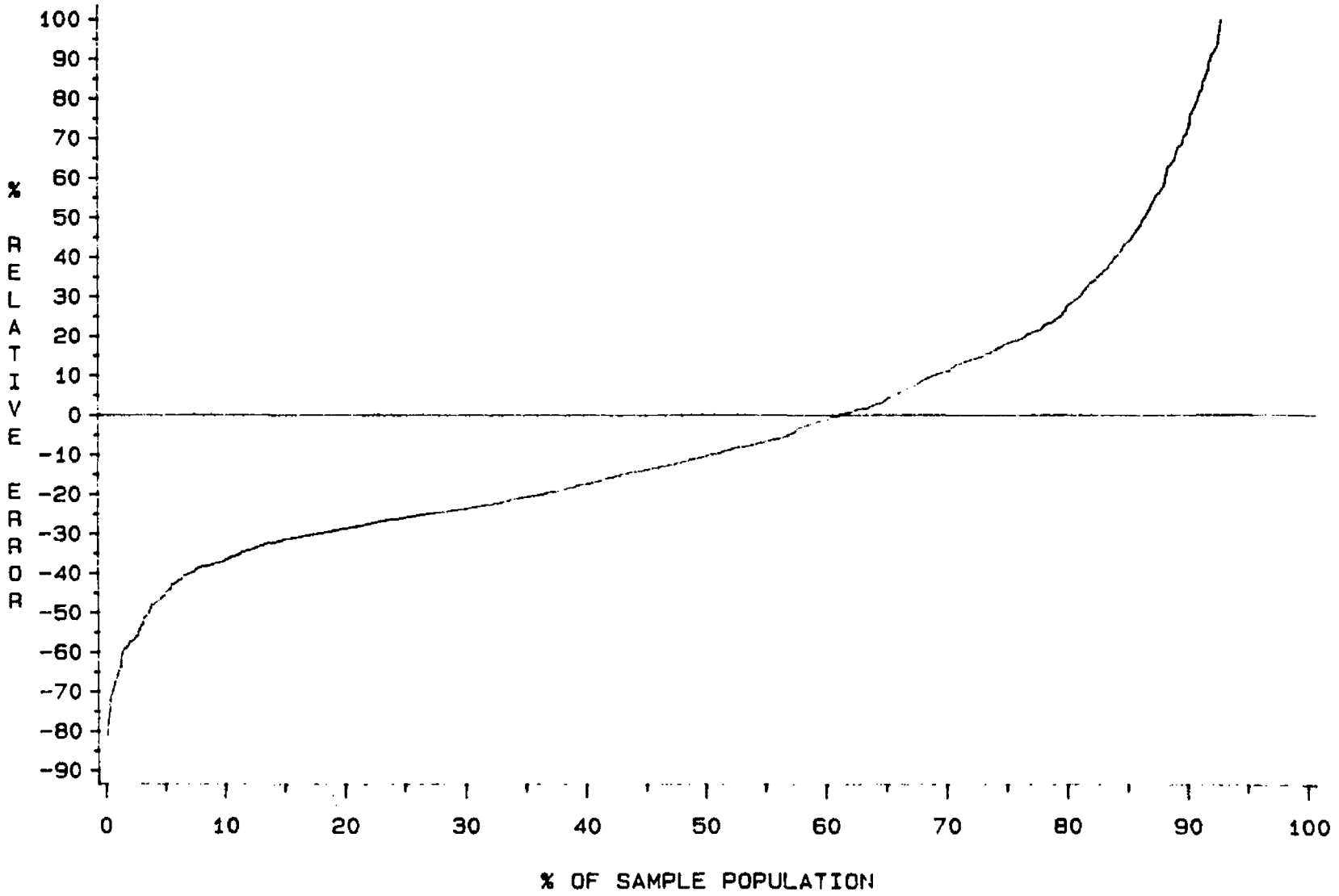



10^4
10^3
10^2
10
Streamflow, in cubic feet per second
OBS FLOW
SIM FLOW
0.5 1 2 5 10 20 30 50 70 80 90 95 98 99
Percent chance flow exceeded
RCH 340

PATUXENT RIVER AT SEG. 340

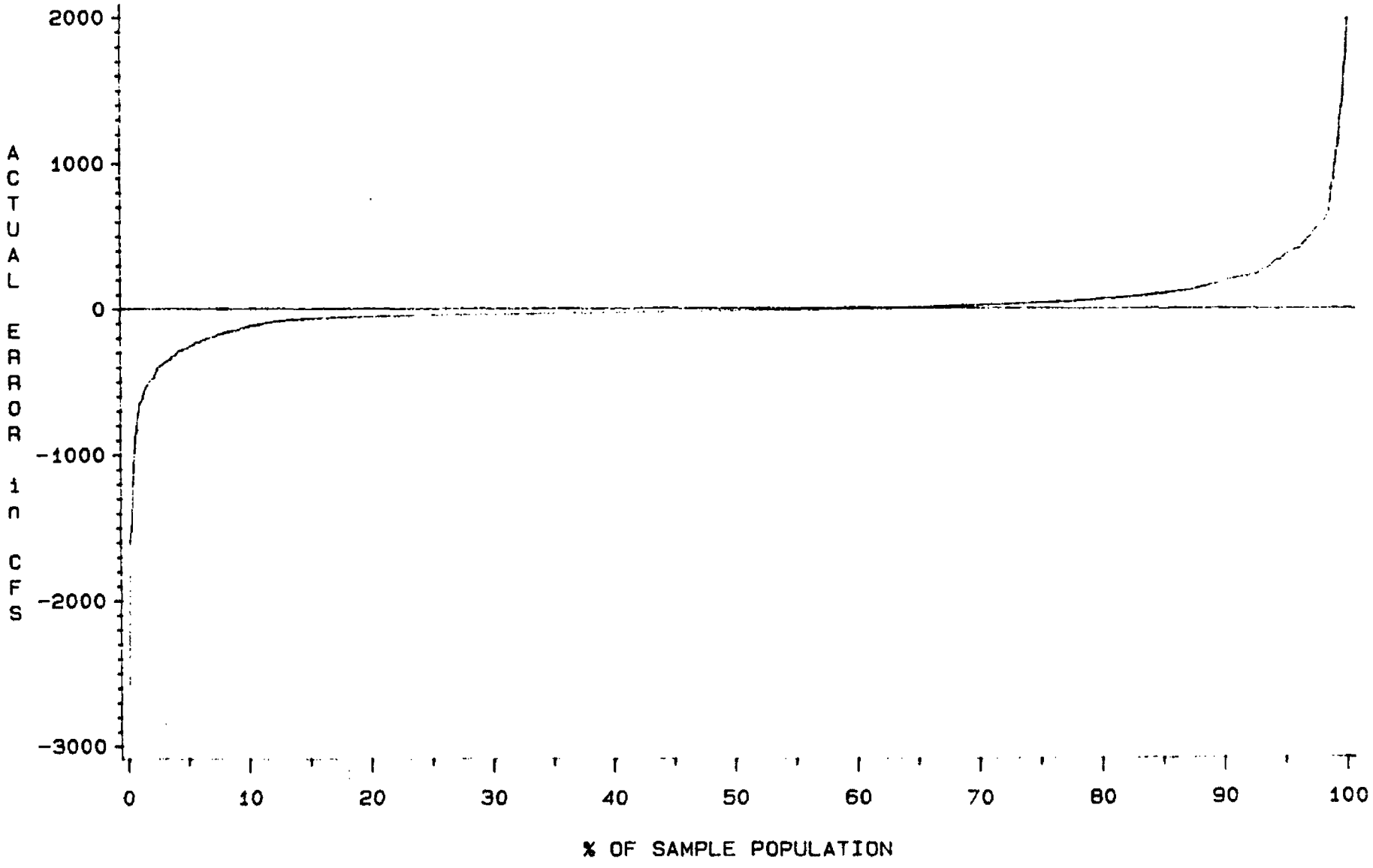
FLOW RELATIVE ERRORS

RELATIVE ERROR = (SIMULATED - OBSERVED)/OBSERVED



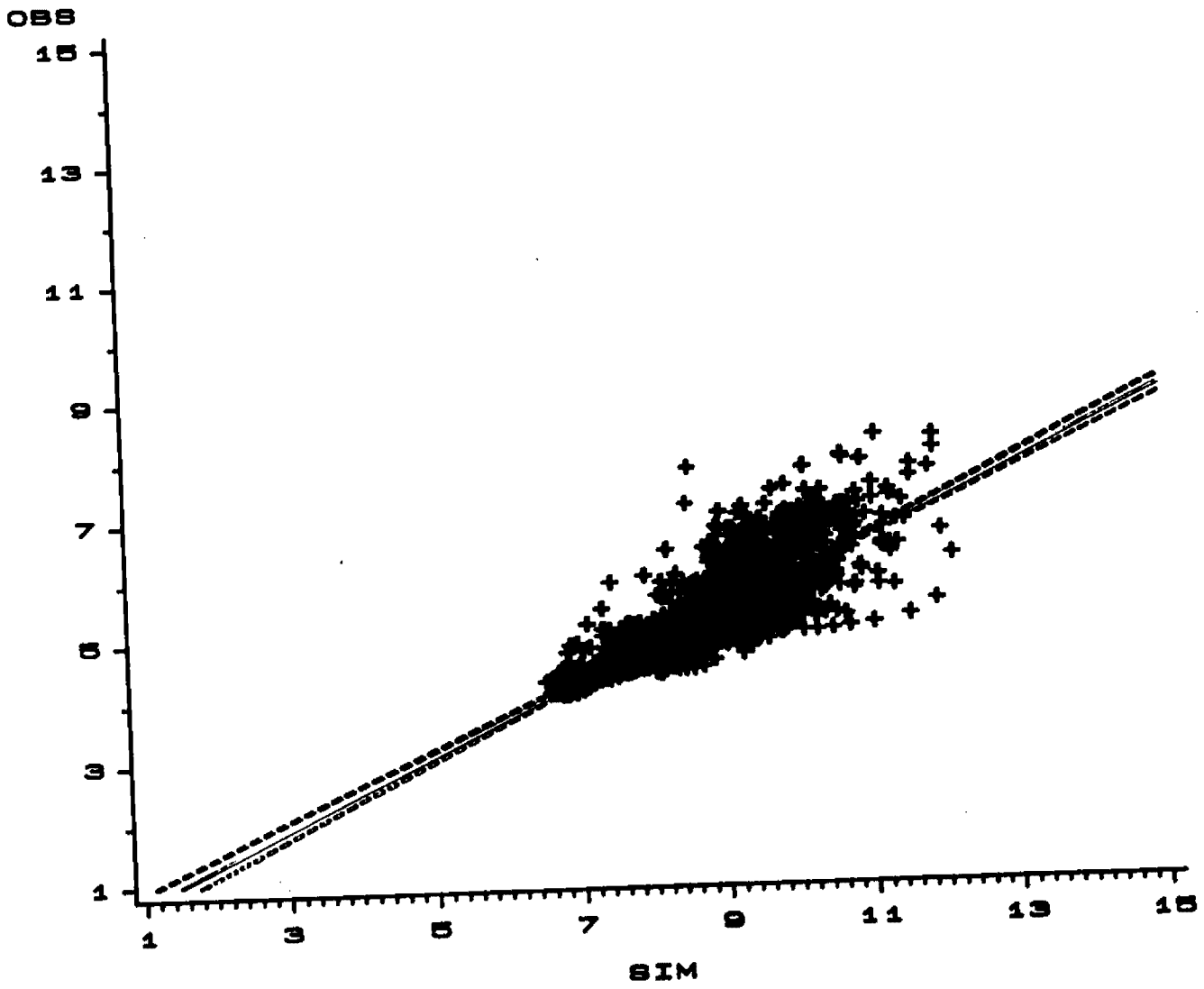
PATUXENT RIVER AT SEG. 340

FLOW ACTUAL ERRORS (CFS)



Patuxent River at Seg. 340

Regression of Log Simulated Flow versus Log Observed Flow



Note: Dashed lines represent the 95% confidence limits [illegible] line.

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
PATUXENT RIVER (Segments 330 and 340)

COMPARISON OF ANNUAL TOTAL OBSERVED AND SIMULATED FLOWS

Year	Observed* Flow (in)	Simulated+ Flow (in)
1984	17.12	14.24
1985	8.41	8.91
1986	8.42	10.46
1987	11.39	13.39
Mean	11.34	11.75

* Observed flow Patuxent River near Bowie, MD
\+ Simulated outflow from RCH 340

REGRESSION OF LOG SIMULATED FLOW ON LOG OBSERVED FLOW
DAILY AND MONTHLY R-SQUARED

Year	Ave. Daily	Ave. Monthly
1984	0.6492	0.8939
1985	0.4288	0.5142
1986	0.6495	0.8904
1987	0.5508	0.8091
Mean	0.5928	0.7729

SEASONAL R-SQUARED

Year	Season 1	Season 2	Season 3	Season 4
1984	0.3952	0.5548	0.2991	0.4183
1985	0.5542	0.1211	0.5029	0.1331
1986	0.4873	0.4494	0.1614	0.6112
1987	0.3031	0.3932	0.5198	0.7257

Overall Seasonal R-squared 0.5929

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

CHESAPEAKE BAY WATERSHED HYDROLOGICAL SIMULATION
PATUXENT RIVER (Segments 330 and 340)

REGRESSION OF LOG TRANSFORMED SIMULATED AND OBSERVED FLOWS

	Intercept	Probability Intercept=0*	Slope	Probability Slope=1*
DAILY FLOWS				
1984	2.1278	0.0001	0.7179	0.0001
1985	2.4555	0.0001	0.5961	0.0001
1986	2.3991	0.0001	1.5854	0.0001
1987	2.2773	0.0001	0.6057	0.0001
1984-87	2.2545	0.0001	0.6407	0.0001
MONTHLY FLOWS				
1984	2.5866	0.0001	0.6490	0.0006
1985	3.2137	0.0006	0.4613	0.0035
1986	2.3438	0.0001	0.6171	0.0002
1987	2.3964	0.0007	0.6032	0.0016
1984-87	2.4907	0.0001	0.6153	0.0001
SEASONAL FLOWS				
1984 S1	2.9599	0.0003	0.6038	0.0052
S2	1.6789	0.0005	0.7946	0.0082
S3	2.2679	0.0001	0.6730	0.0008
S4	0.4862	0.4017	1.1224	0.3722
1985 S1	0.2887	0.6385	1.0203	0.8667
S2	2.8116	0.0001	0.5188	0.0017
S3	1.3192	0.0001	0.9015	0.2348
S4	3.5320	0.0001	0.3635	0.0001
1986 S1	1.4806	0.0087	0.7513	0.0170
S2	1.4599	0.0025	0.7656	0.0111
S3	1.8794	0.0011	0.7164	0.0616
S4	2.6999	0.0001	0.5336	0.0001
1987 S1	1.4845	0.0890	0.6993	0.0350
S2	0.4747	0.4994	0.9480	0.6795
S3	2.1335	0.0001	0.6606	0.0001
S4	-1.0336	0.0134	1.2204	0.0057
1984-87	2.2499	0.0001	0.6414	0.0001

* If probability is less than .05 (95% confidence level) then intercept is significantly different from 0, or slope is significantly different from 1.

A.10 RAPPAHANNOCK RIVER AT SEG. 230

Time Series Plot of Simulated and Observed Daily Flows for 1984-1987

Time Series Plot of Residual (Simulated Minus Observed) Daily Flows for 1984-1987

Time Series Plot of Cumulative Simulated and Observed Flows for 1984-1987

Plot of Percent Chance Flow Exceeded vs. Volume of Streamflow

Distribution of Percent Relative Errors Over Percentile Sample Population

Distribution of Percent Actual Errors Over Percentile Sample Population

Regression of Log Transformed Simulated Flow vs. Log Transformed Observed Flow Scatter Plot

Comparison of Annual Total Observed and Simulated Flow

Average Daily and Monthly R-Squared for 1984-1987

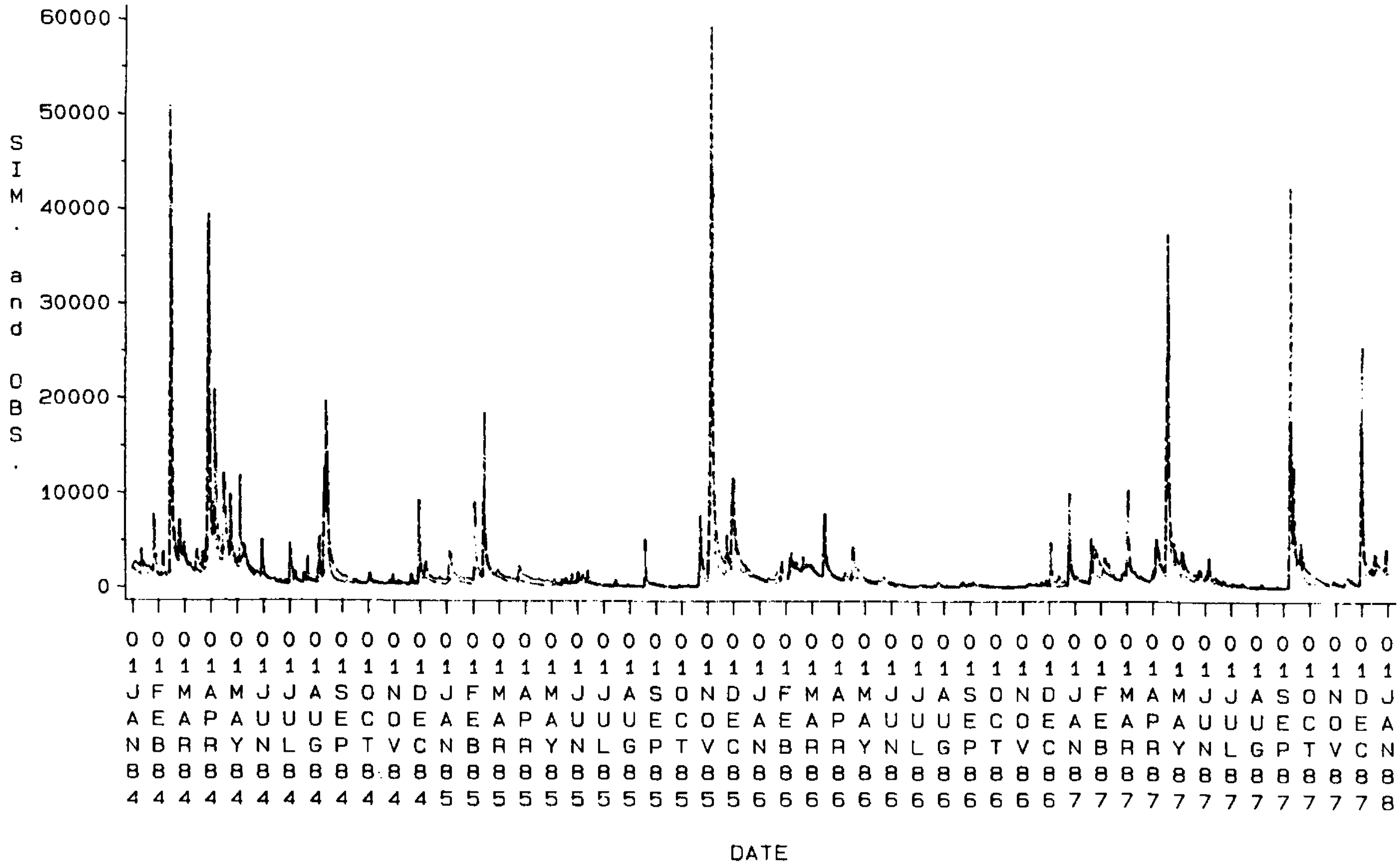
Average Seasonal R-Squared for 1984-1987

Log Transformed Simulated and Observed Flow Regression Slope and Intercept Statistics

RAPPAHANNOCK RIVER AT SEG. 230

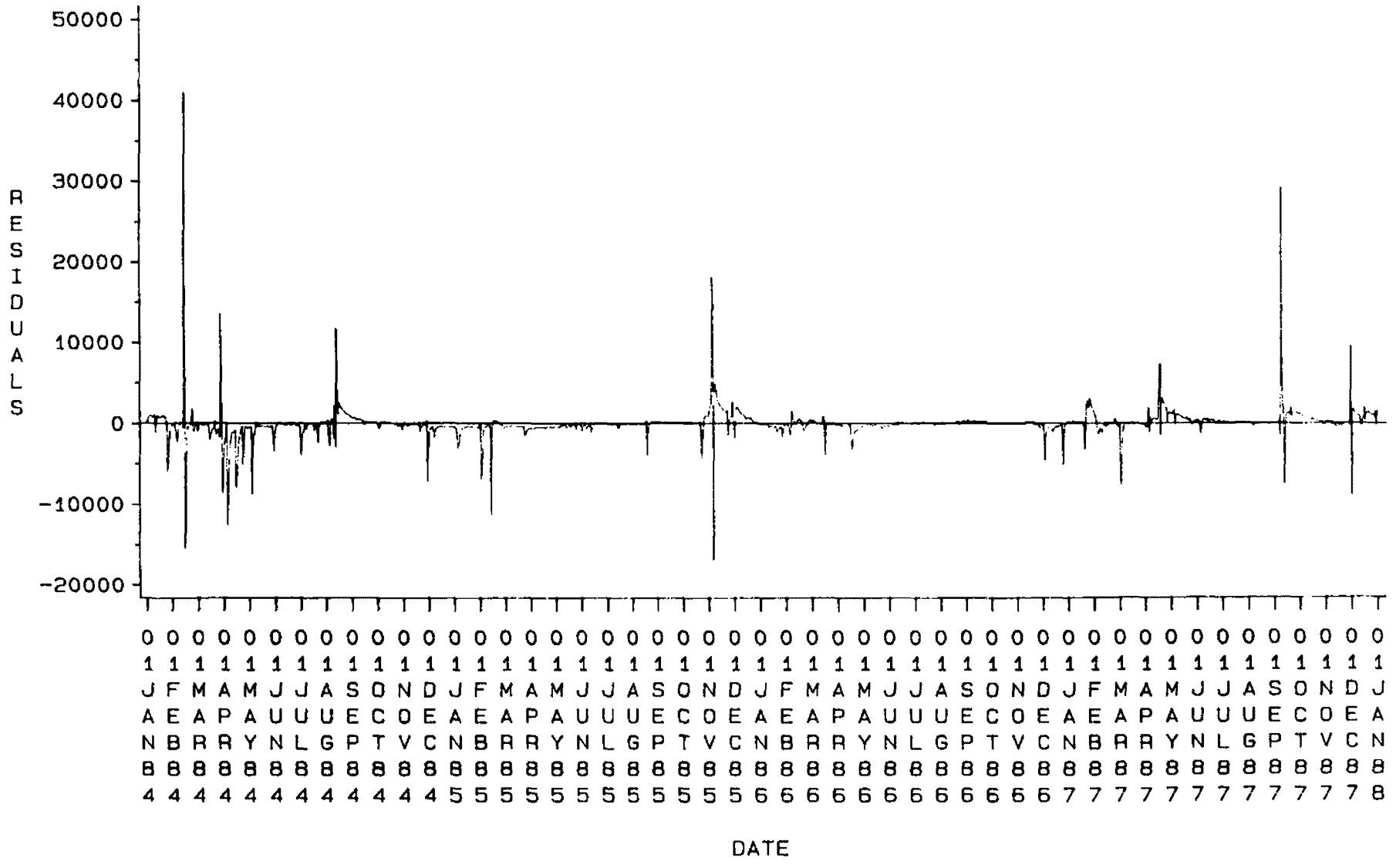
FLOW (CFS)

RED DASH: SIM., BLUE: OBS.



RAPPAHANNOCK RIVER AT SEG. 230

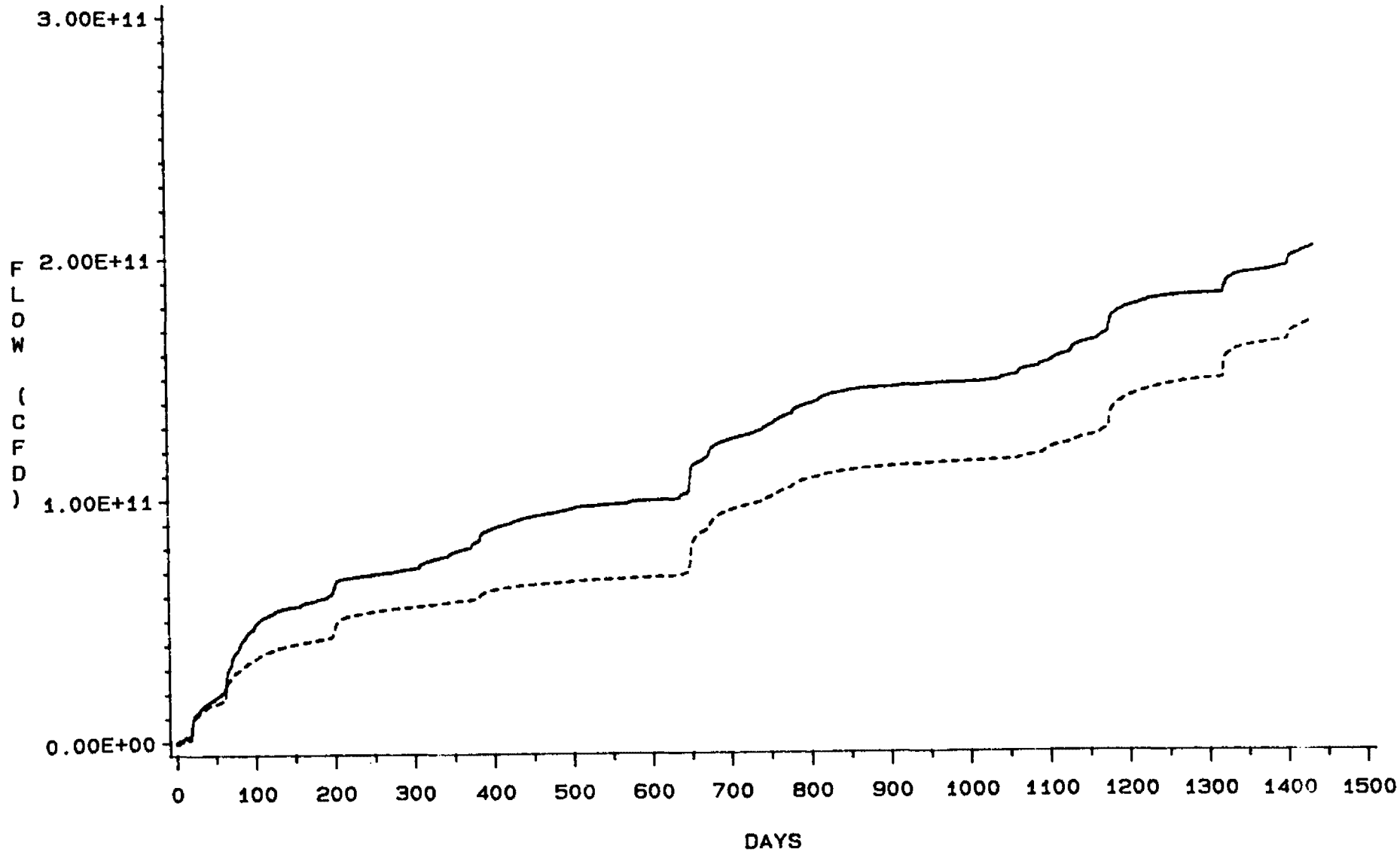
FLOW (CFS)
RESIDUALS (Simulated - Observed)

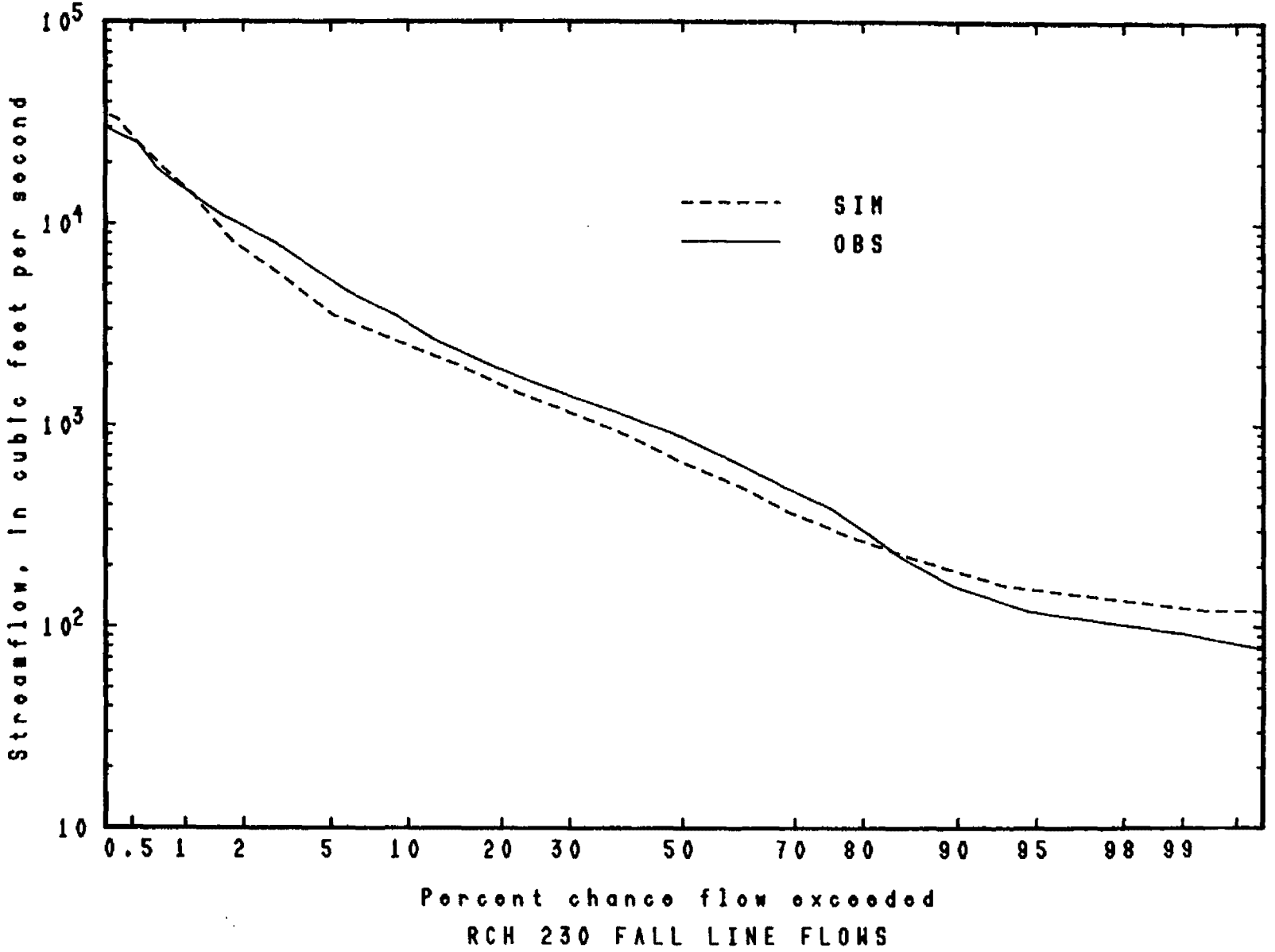


CUMULATIVE FLOWS (CFD) 1984 - 1987

RAPPA

Simulated - - - - - Observed ---------

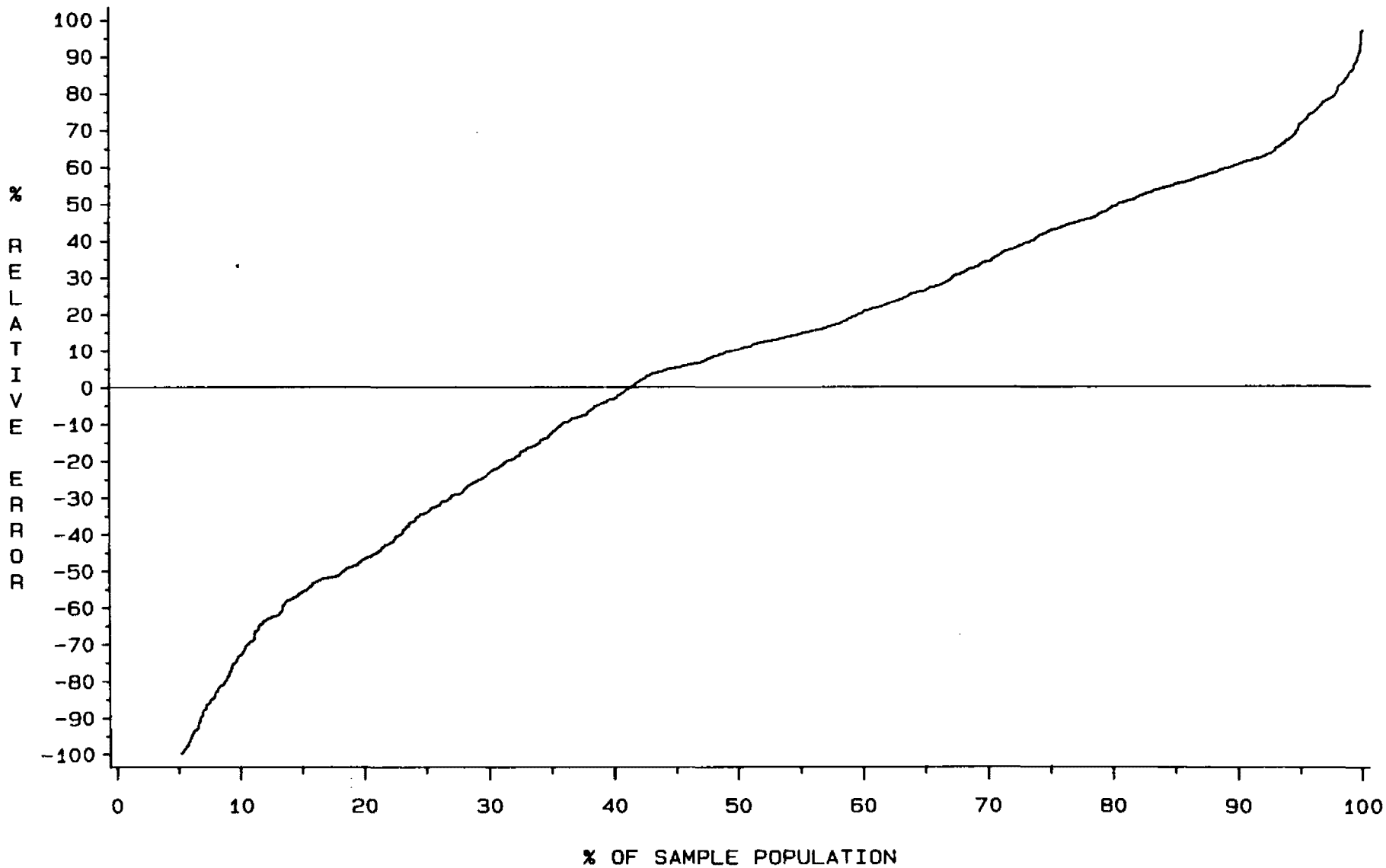




RCH 230 FALL LINE FLOWS

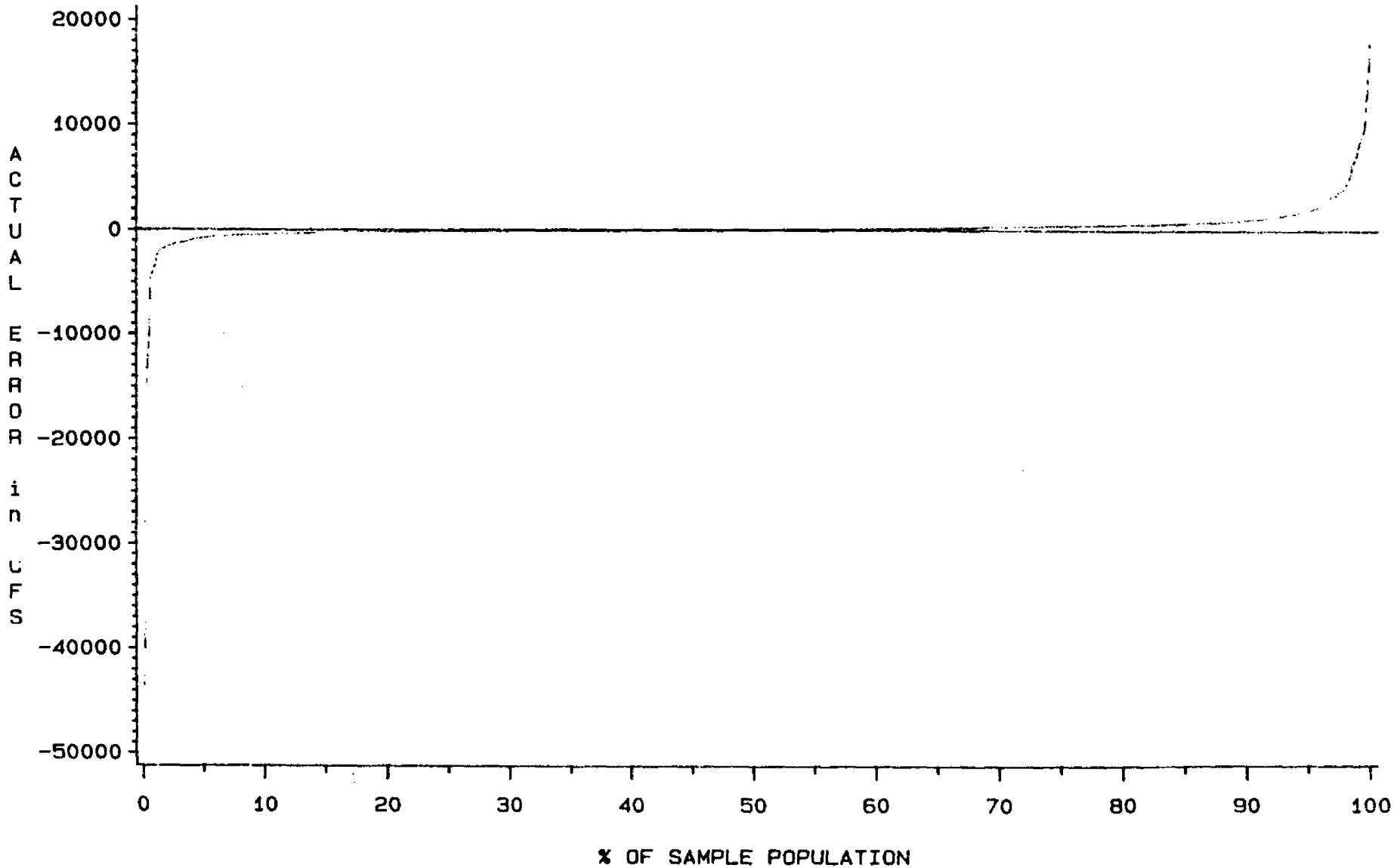
RAPPAHANNOCK RIVER AT SEG. 230

FLOW RELATIVE ERRORS



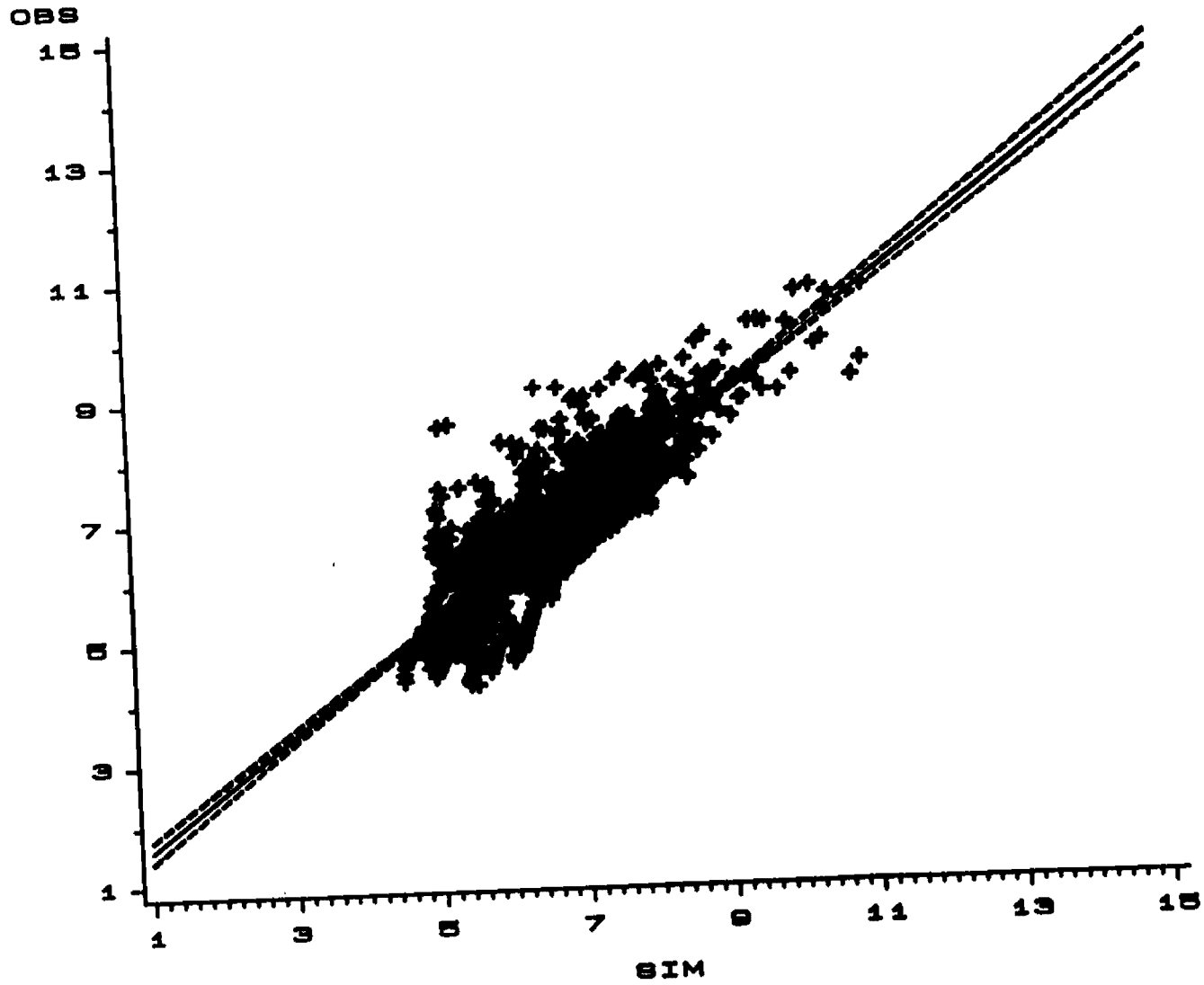
RAPPAHANNOCK RIVER AT SEG. 230

FLOW ACTUAL ERRORS (CFS)



Rappahannock River at Seg. 230

Regression of Log Simulated Flow versus Log Observed Flow



Note: Dashed lines represent the 95% confidence limits around the regression line.

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
RAPPAHANNOCK RIVER, VA (Segment 230)

COMPARISON OF ANNUAL TOTAL OBSERVED AND SIMULATED FLOWS

Year	Observed* Flow (in)	Simulated+ Flow (in)
1984	21.77	18.42
1985	13.05	12.50
1986	7.48	6.02
1987	13.43	17.36
Mean	13.93	13.58

* Observed flow Rappahannock River near Fredericksburg, VA
\+ Simulated outflow from RCH 230

REGRESSION OF LOG SIMULATED FLOW ON LOG OBSERVED FLOW
DAILY AND MONTHLY R-SQUARED

Year	Ave. Daily	Ave. Monthly
1984	0.6811	0.7890
1985	0.7332	0.8359
1986	0.6921	0.8373
1987	0.7424	0.8402
Mean	0.7019	0.7828

SEASONAL R-SQUARED

Year	Season 1	Season 2	Season 3	Season 4
1984	0.7406	0.7555	0.5430	0.1554
1985	0.5151	0.6294	0.5955	0.8977
1986	0.6110	0.6680	0.3064	0.3767
1987	0.2832	0.7568	0.8395	0.7477

Overall Seasonal R-squared 0.7018

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

CHESAPEAKE BAY WATERSHED HYDROLOGICAL SIMULATION
RAPPAHANNOCK RIVER, VA (Segment 230)

REGRESSION OF LOG TRANSFORMED SIMULATED AND OBSERVED FLOWS

	Intercept	Probability Intercept=0*	Slope	Probability Slope=1*
DAILY FLOWS				
1984	0.6844	0.0041	0.9369	0.0610
1985	1.1164	0.0001	0.8870	0.0001
1986	0.2971	0.1593	0.9799	0.5581
1987	-0.9712	0.0001	1.1097	0.0015
1984-87	0.6896	0.0001	0.9186	0.0001
MONTHLY FLOWS				
1984	1.3178	0.2243	0.8598	0.3421
1985	1.8608	0.0258	0.7959	0.0971
1986	-0.3061	0.7508	1.0840	0.5904
1987	-1.1152	0.3458	1.1329	0.4149
1984-87	1.0523	0.0274	0.8779	0.0799
SEASONAL FLOWS				
1984 S1	2.5563	0.0001	0.7162	0.0006
S2	0.4016	0.3991	1.0039	0.9490
S3	0.4628	0.3909	0.9187	0.2969
S4	-0.0692	0.0019	1.0918	0.7274
1985 S1	3.2163	0.0001	0.6393	0.0001
S2	1.5471	0.0005	0.8762	0.0876
S3	-4.3846	0.0001	1.9083	0.0001
S4	0.1478	0.5497	0.9609	0.2477
1986 S1	0.7233	0.2986	0.9147	0.3771
S2	0.9839	0.0358	0.8947	0.1210
S3	-0.9241	0.2950	1.1378	0.3836
S4	0.1444	0.8505	1.0769	0.5937
1987 S1	3.1826	0.0003	0.5697	0.0006
S2	0.8683	0.0323	0.8793	0.0255
S3	-2.2039	0.0001	1.2408	0.0001
S4	0.6474	0.0821	0.8858	0.0350
1984-87	0.6826	0.0001	0.9197	0.0001

* If probability is less than .05 (95% confidence level) then intercept is significantly different from 0, or slope is significantly different from 1.

A.11 MATTAPONI RIVER AT SEG. 240

Time Series Plot of Simulated and Observed Daily Flows for 1984-1987

Time Series Plot of Residual (Simulated Minus Observed) Daily Flows for 1984-1987

Time Series Plot of Cumulative Simulated and Observed Flows for 1984-1987

Plot of Percent Chance Flow Exceeded vs. Volume of Streamflow

Distribution of Percent Relative Errors Over Percentile Sample Population

Distribution of Percent Actual Errors Over Percentile Sample Population

Regression of Log Transformed Simulated Flow vs. Log Transformed Observed Flow Scatter Plot

Comparison of Annual Total Observed and Simulated Flow

Average Daily and Monthly R-Squared for 1984-1987

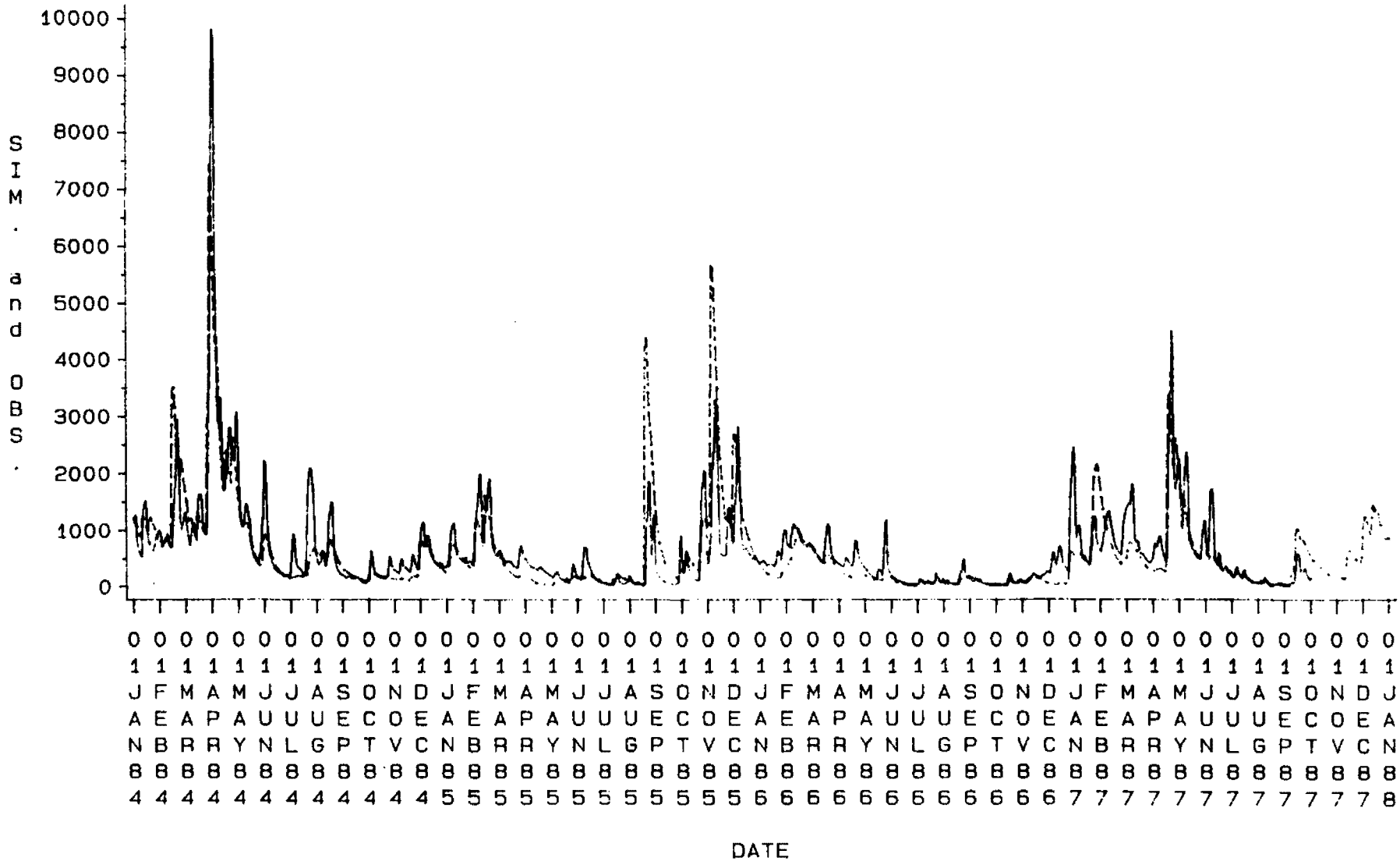
Average Seasonal R-Squared for 1984-1987

Log Transformed Simulated and Observed Flow Regression Slope and Intercept Statistics

MATTAPONI RIVER AT SEG. 240

FLOW (CFS)

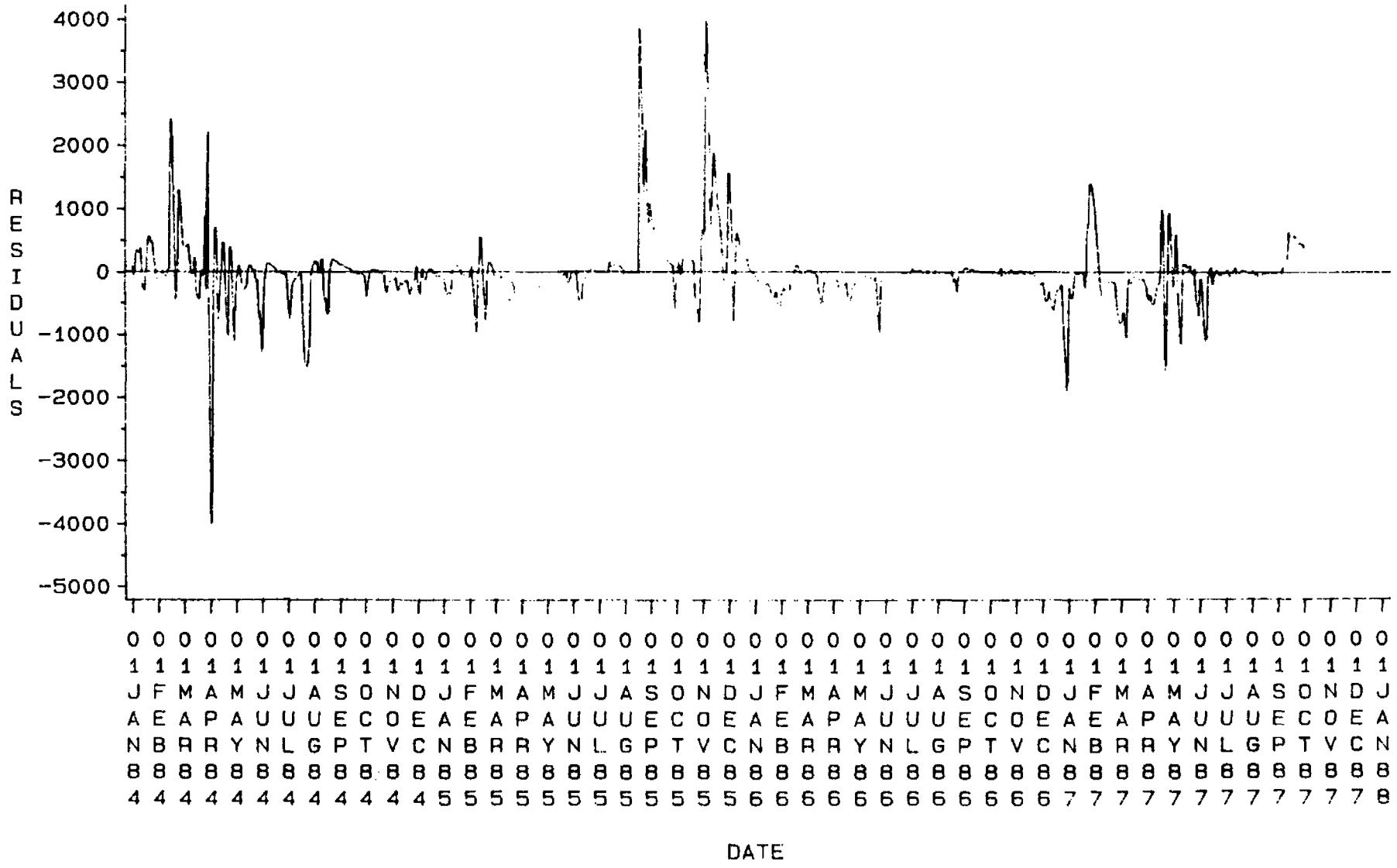
RED DASHED: SIM., BLUE SOLID: OBS.



MATTAPONI RIVER AT SEG. 240

FLOW (CFS)

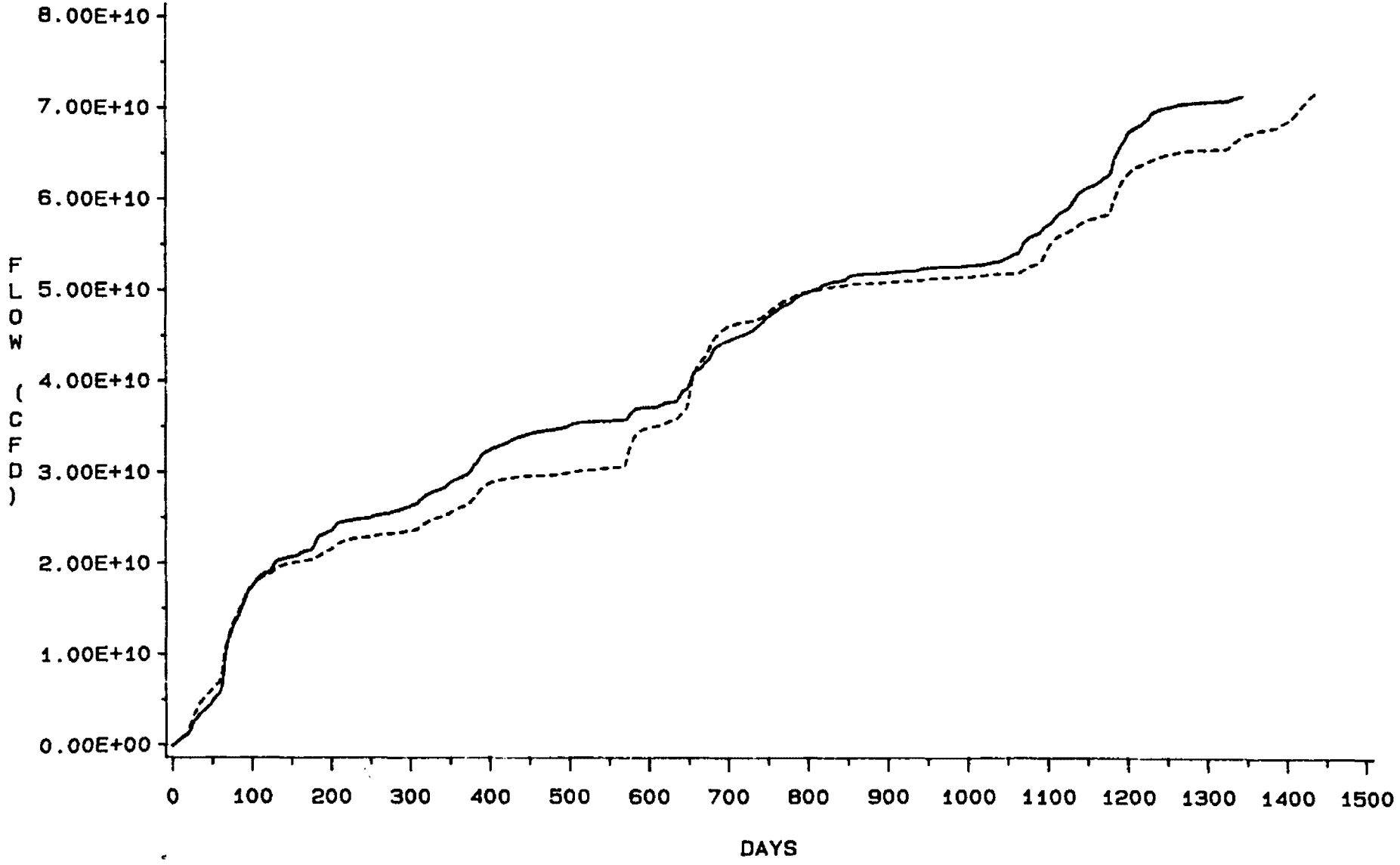
RESIDUALS (SIMULATED - OBSERVED)

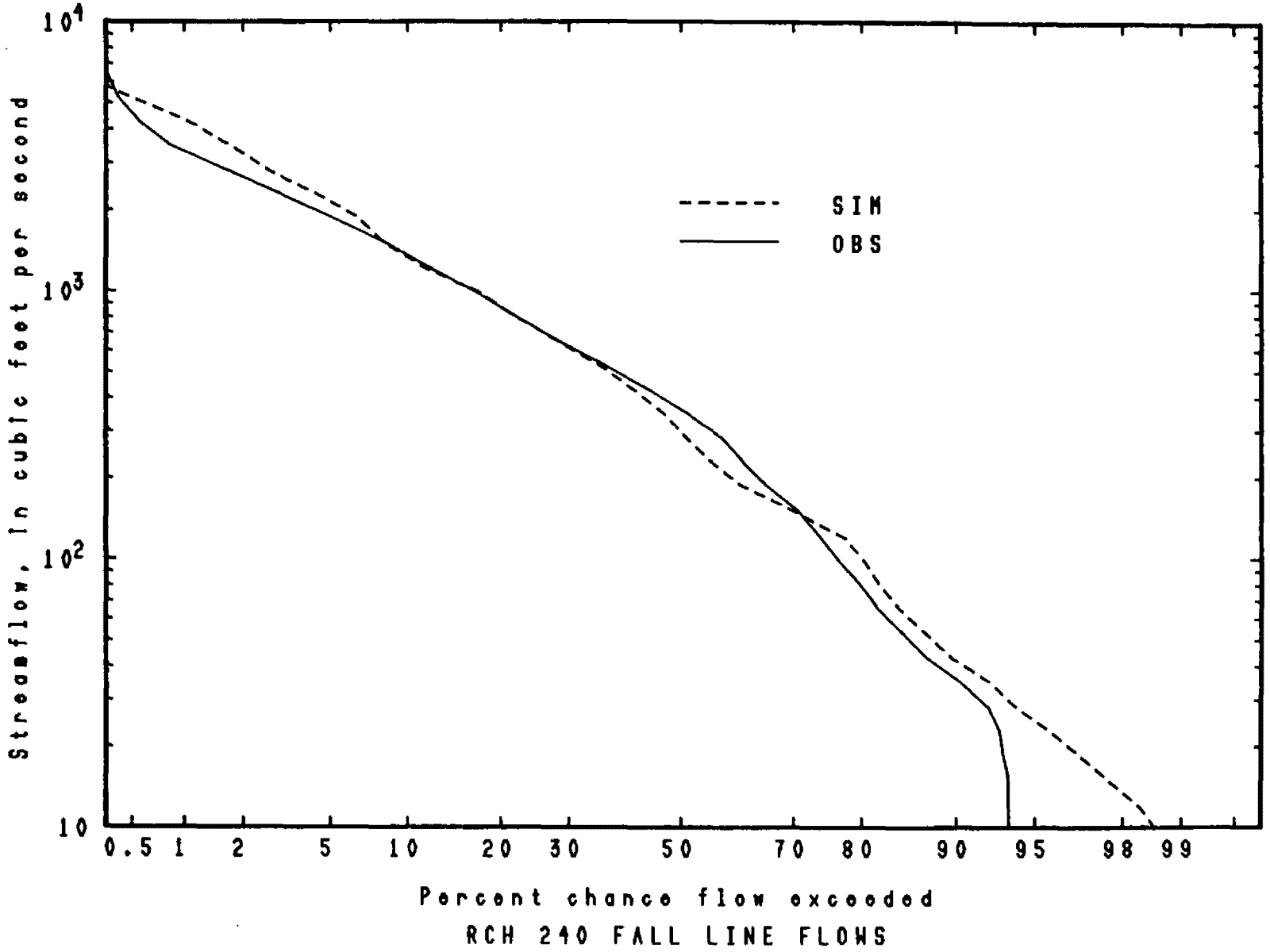


CUMULATIVE FLOWS (CFD) 1984 - 1987

YORK MATTA

Simulated - - - - - Observed ---------

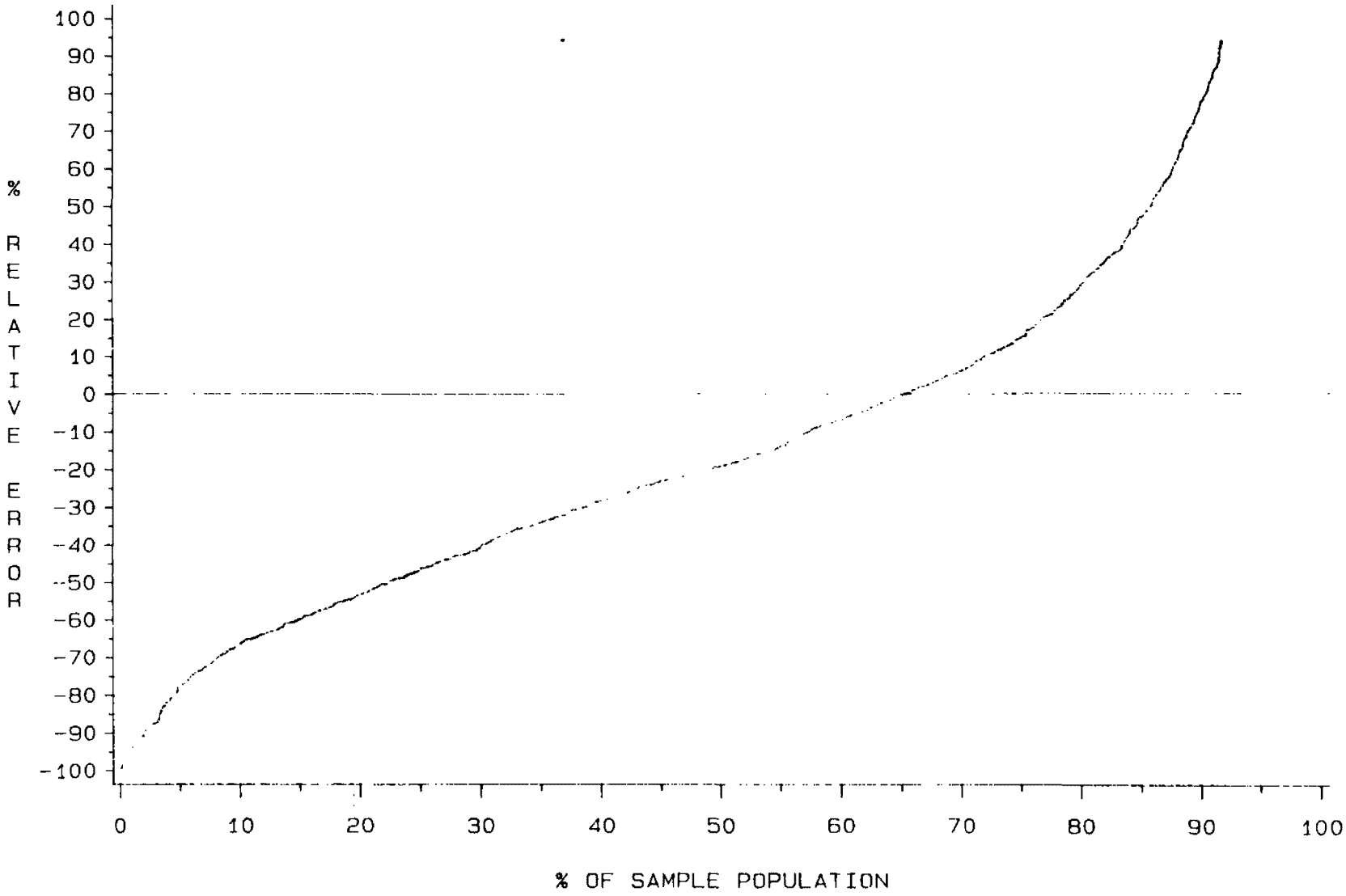



10^4
10^3
10^2
10
Streamflow, in cubic feet per second
SIM
OBS
0.5 1 2 5 10 20 30 50 70 80 90 95 98 99
Percent chance flow exceeded
RCH 240 FALL LINE FLOWS

MATTAPONI RIVER AT SEG. 240

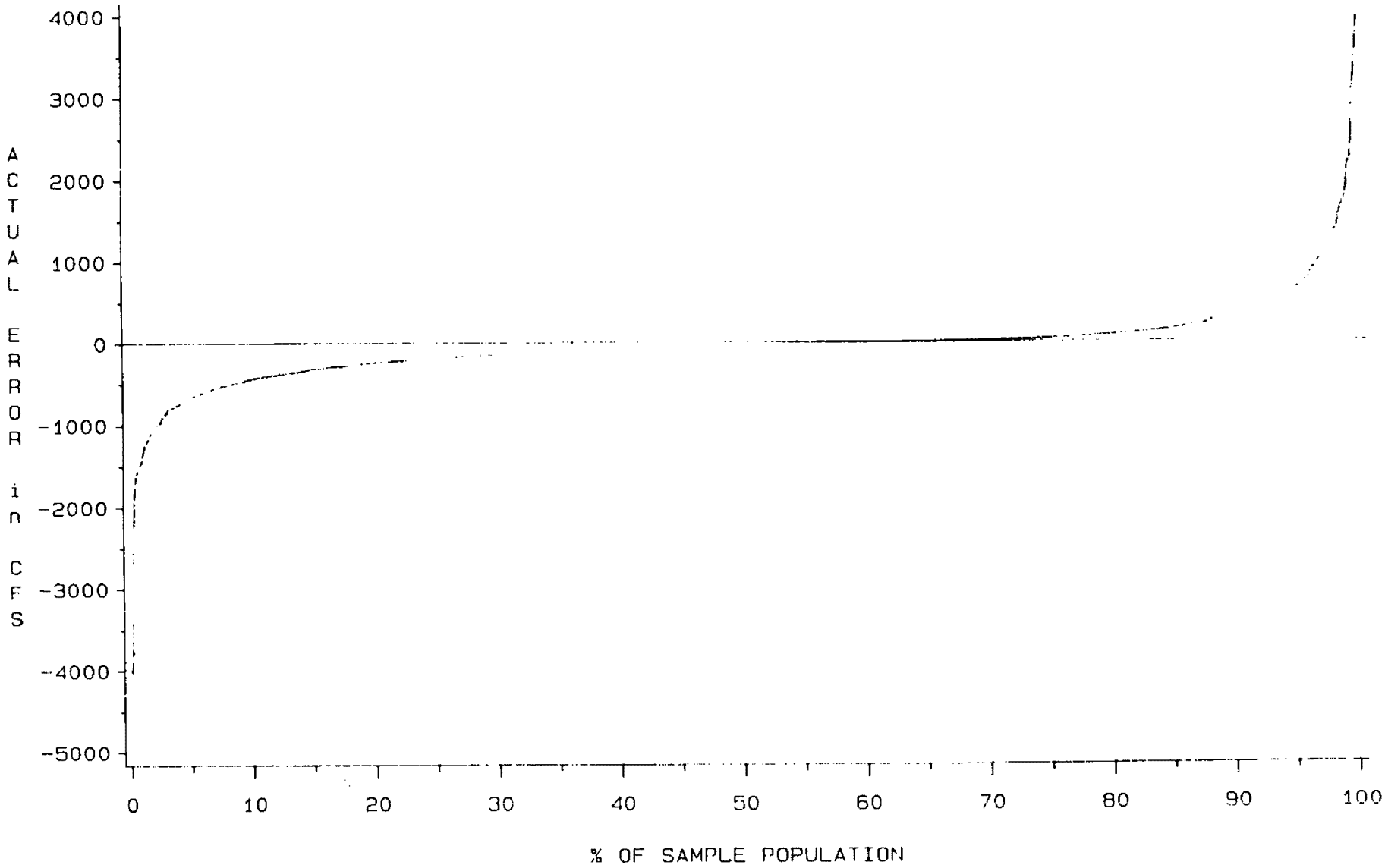
FLOW RELATIVE ERRORS

RELATIVE ERROR = (SIMULATED - OBSERVED)/OBSERVED



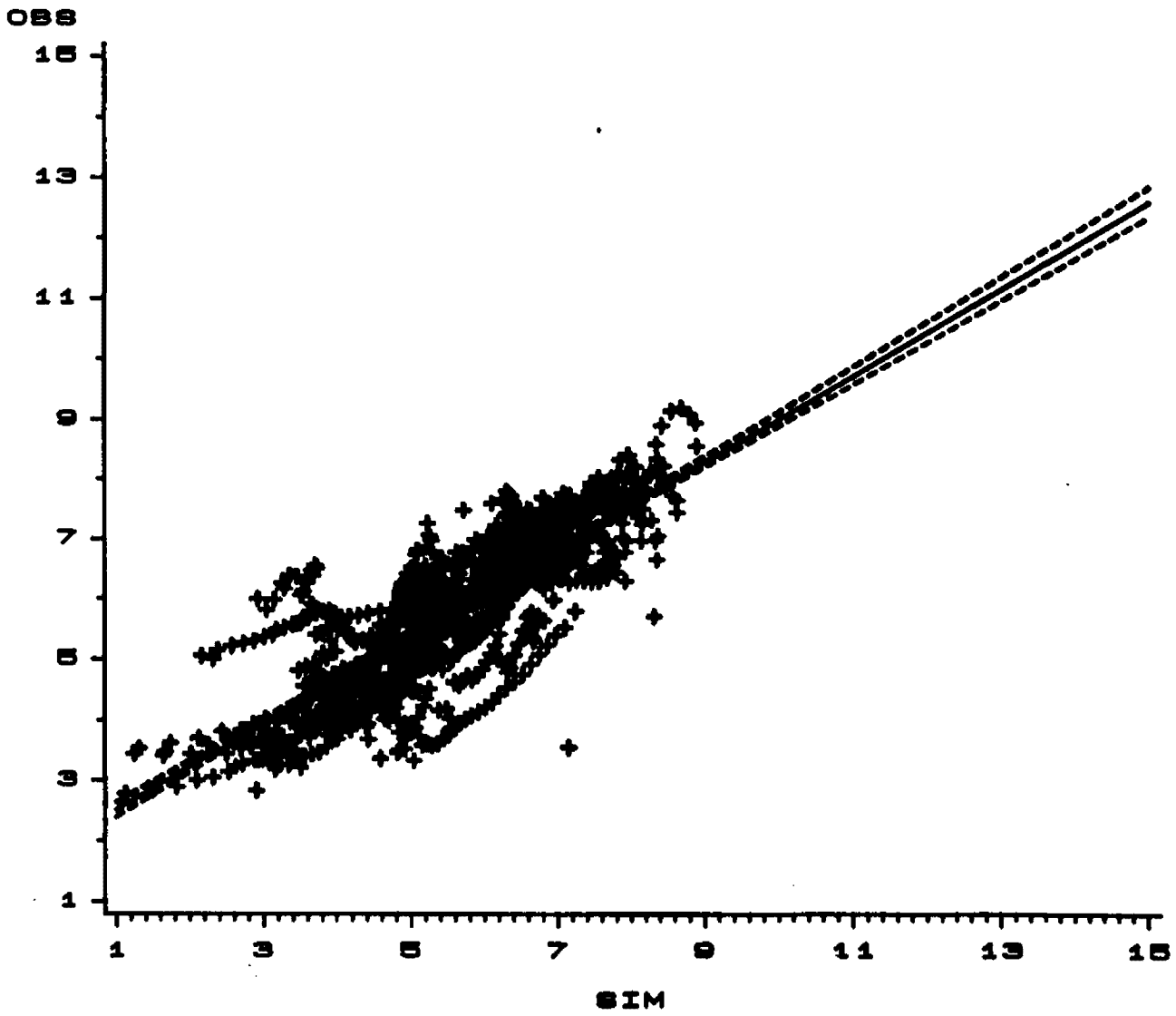
MATTAPONI RIVER AT SEG. 240

FLOW ACTUAL ERRORS (CFS)



Mattaponi River at Seg. 240

Regression of Log Simulated Flow versus Log Observed Flow



Note: Dashed lines represent the 95% confidence limits around the regression line.

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
MATTAPONI RIVER, VA (Segments 235 and 240)

COMPARISON OF ANNUAL TOTAL OBSERVED AND SIMULATED FLOWS

Year	Observed* Flow (in)	Simulated+ Flow (in)
1984	21.65	29.82
1985	11.81	15.06
1986	7.57	4.62
1987	12.42	13.78
Mean	13.36	13.32

* Observed flow Mattaponi River at Beulah, VA
\+ Simulated outflow from RCH 240

REGRESSION OF LOG SIMULATED FLOW ON LOG OBSERVED FLOW
DAILY AND MONTHLY R-SQUARED

Year	Ave. Daily	Ave. Monthly
1984	0.7677	0.8563
1985	0.5081	0.5878
1986	0.6441	0.7825
1987	0.7360	0.8274
Mean	0.6791	0.7671

SEASONAL R-SQUARED

Year	Season 1	Season 2	Season 3	Season 4
1984	0.5034	0.8535	0.5236	0.5843
1985	0.6949	0.4329	0.4927	0.6109
1986	0.5923	0.5424	0.5715	0.3967
1987	0.1132	0.7140	0.6538	0.2467

Overall Seasonal R-squared 0.6760

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

CHESAPEAKE BAY WATERSHED HYDROLOGICAL SIMULATION
MATTAPONI RIVER, VA (Segments 235 and 240)

REGRESSION OF LOG TRANSFORMED SIMULATED AND OBSERVED FLOWS

	Intercept	Probability Intercept=0*	Slope	Probability Slope=1*
DAILY FLOWS				
1984	1.4365	0.0001	0.7947	0.0001
1985	2.3103	0.0001	0.5963	0.0001
1986	1.7878	0.0001	0.7444	0.0001
1987	1.9394	0.0001	0.6983	0.0001
1984-87	1.9482	0.0001	0.6944	0.0001
MONTHLY FLOWS				
1984	1.3785	0.0684	0.8119	0.1040
1985	2.5857	0.0177	0.5684	0.0167
1986	0.3374	0.7021	1.0345	0.8455
1987	1.0922	0.2578	0.8366	0.2953
1984-87	1.5800	0.0001	0.7635	0.0006
SEASONAL FLOWS				
1984 S1	3.5911	0.0001	0.4713	0.0001
S2	0.4733	0.1233	0.9447	0.1886
S3	0.7701	0.0917	0.8970	0.1937
S4	2.4031	0.0001	0.6356	0.0001
1985 S1	1.1104	0.0236	0.8483	0.0444
S2	4.0035	0.0001	0.3580	0.0001
S3	1.6907	0.0001	0.5758	0.0001
S4	0.6664	0.1718	0.8447	0.0287
1986 S1	3.8770	0.0001	0.4301	0.0001
S2	2.3197	0.0001	0.6762	0.0001
S3	1.9536	0.0001	0.5850	0.0001
S4	2.6665	0.0001	0.5967	0.0001
1987 S1	5.2103	0.0001	0.2238	0.0001
S2	2.3758	0.0001	0.6825	0.0001
S3	2.4631	0.0001	0.5291	0.0001
S4	9.7613	0.4589	-0.7768	0.4153
1984-87	1.9456	0.0001	0.6951	0.0001

* If probability is less than .05 (95% confidence level) then intercept is significantly different from 0, or slope is significantly different from 1.

A.12 PAMUNKEY RIVER AT SEG. 260

Time Series Plot of Simulated and Observed Daily Flows for 1984-1987

Time Series Plot of Residual (Simulated Minus Observed) Daily Flows for 1984-1987

Time Series Plot of Cumulative Simulated and Observed Flows for 1984-1987

Plot of Percent Chance Flow Exceeded vs. Volume of Streamflow

Distribution of Percent Relative Errors Over Percentile Sample Population

Distribution of Percent Actual Errors Over Percentile Sample Population

Regression of Log Transformed Simulated Flow vs. Log Transformed Observed Flow Scatter Plot

Comparison of Annual Total Observed and Simulated Flow

Average Daily and Monthly R-Squared for 1984-1987

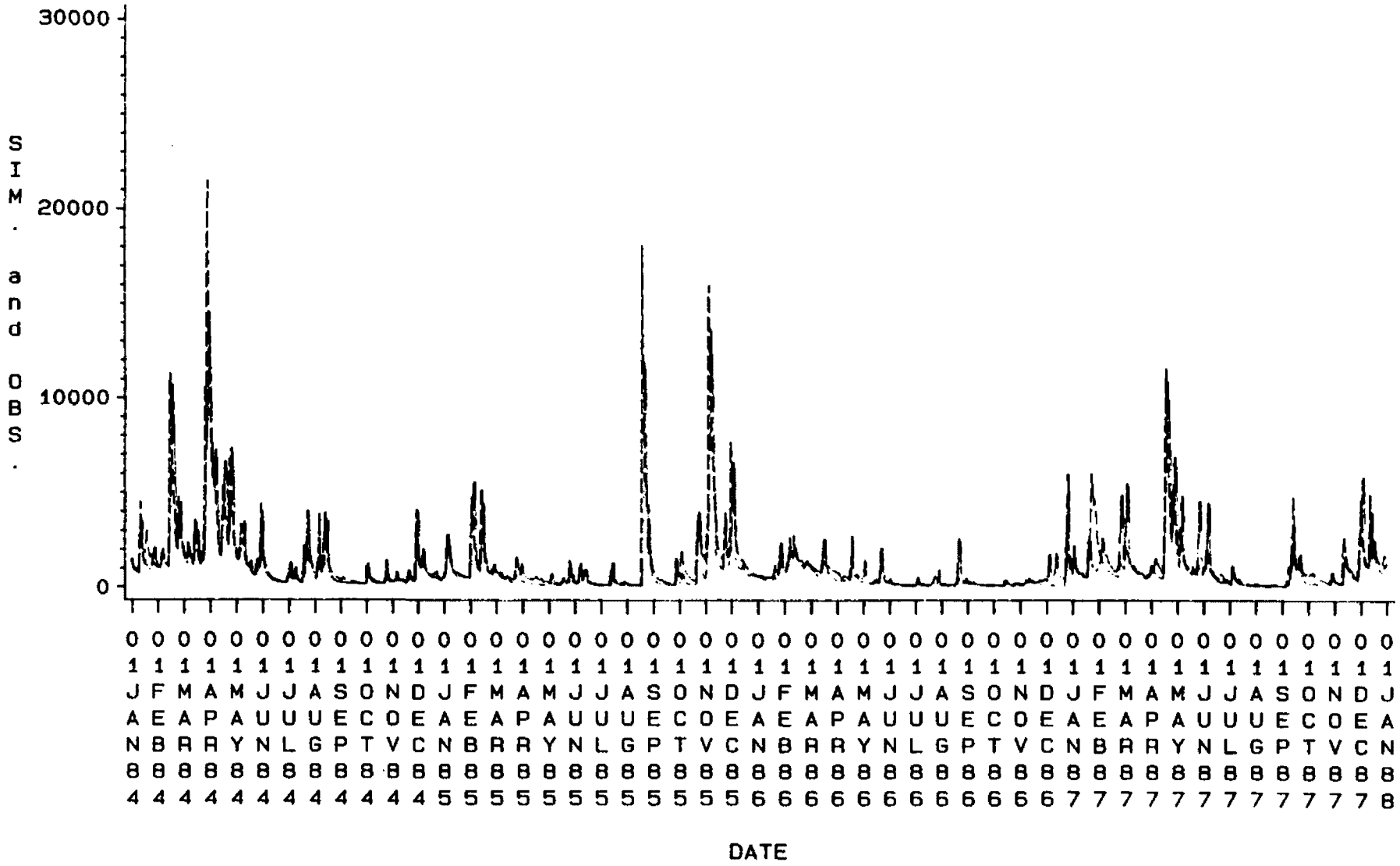
Average Seasonal R-Squared for 1984-1987

Log Transformed Simulated and Observed Flow Regression Slope and Intercept Statistics

PAMUNKEY RIVER AT SEG. 260

FLOW (CFS)

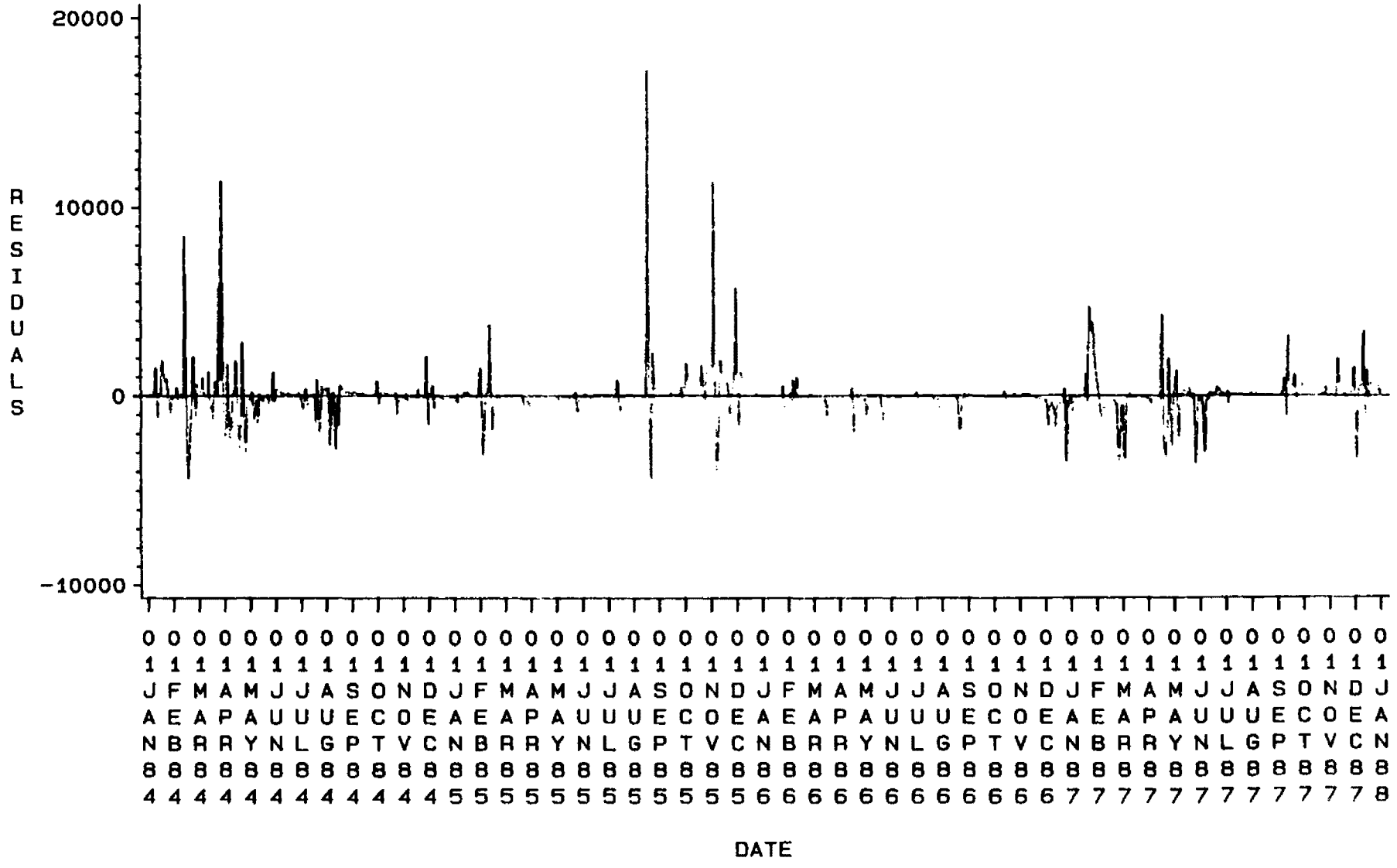
RED DASH: SIM., BLUE: OBS.



PAMUNKEY RIVER AT SEG. 260

FLOW (CFS)

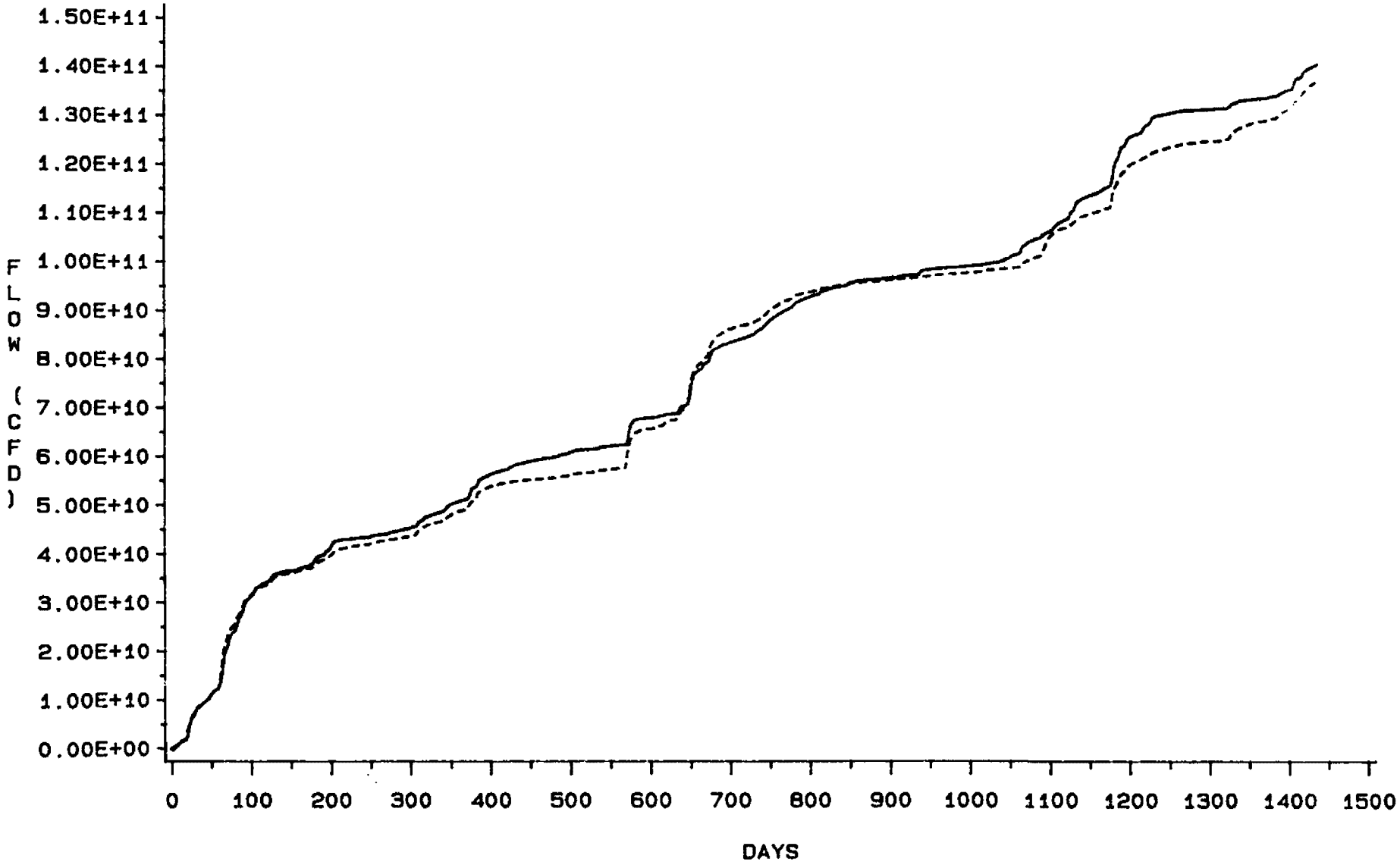
RESIDUALS (Simulated - Observed)

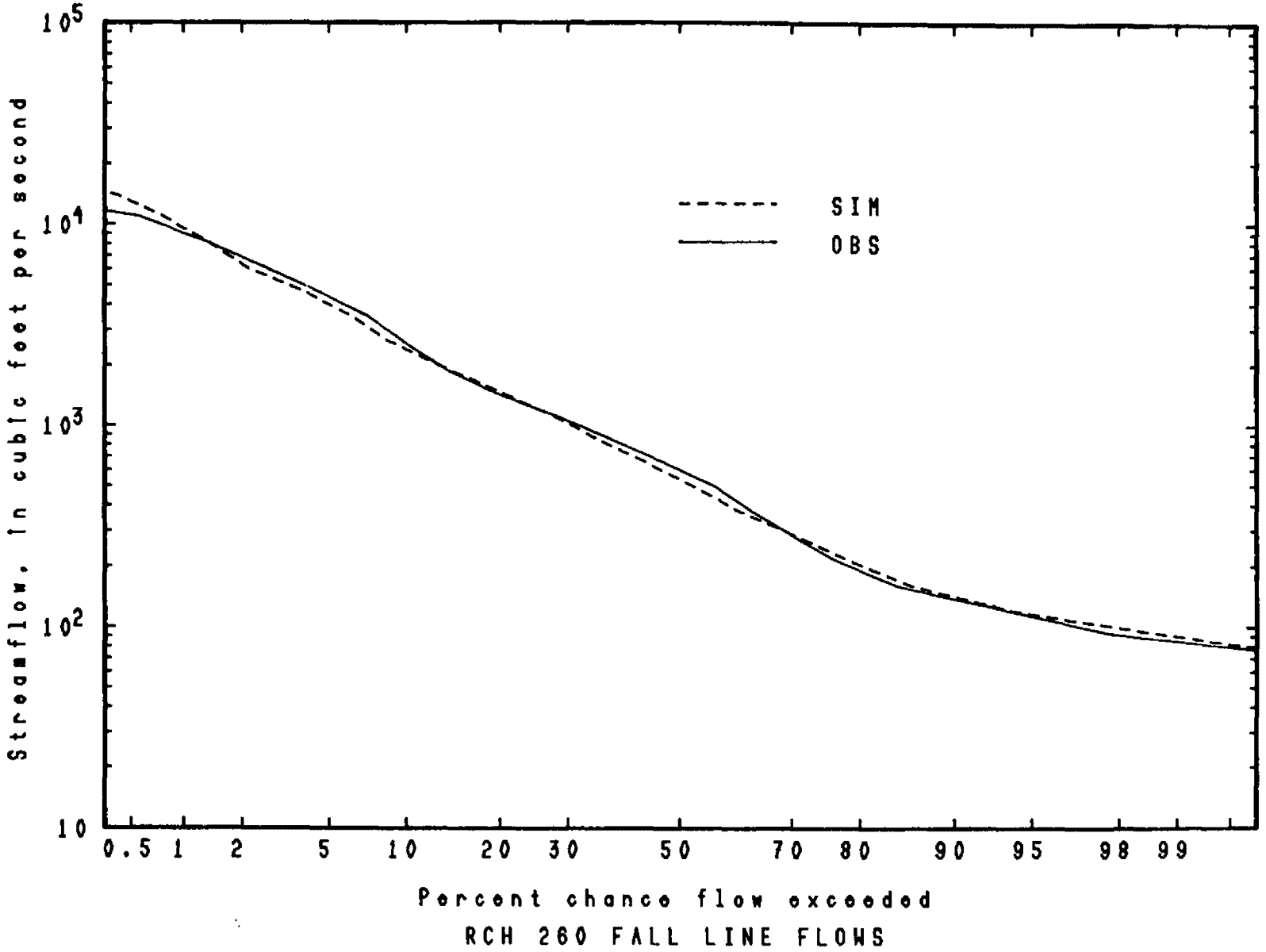


CUMULATIVE FLOWS (CFD) 1984 - 1987

YORK PAMUN

Simulated - - - - - Observed ---------

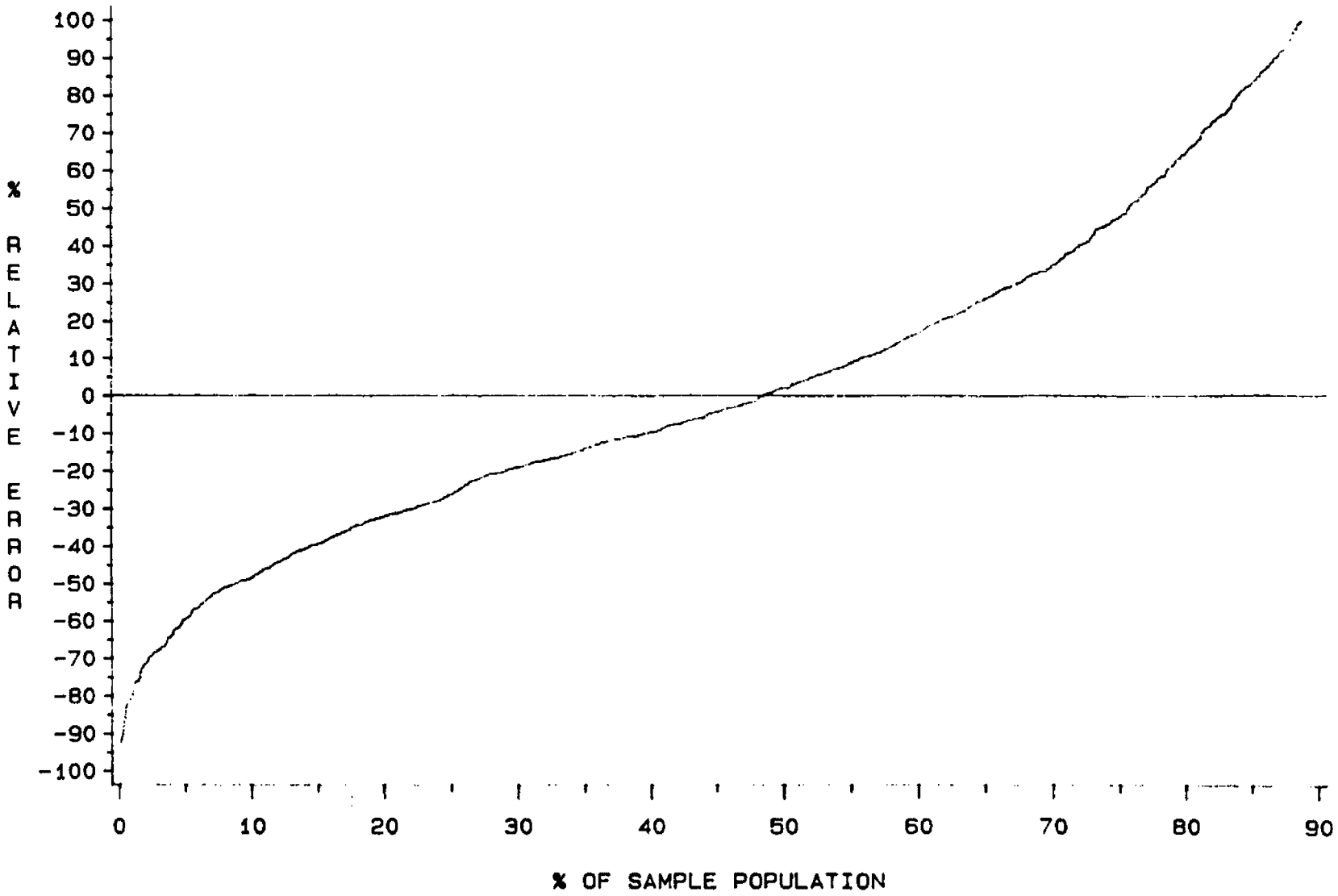



10^5
10^4
10^3
10^2
10
Streamflow, in cubic feet per second
SIM
OBS
0.5 1 2 5 10 20 30 50 70 80 90 95 98 99
Percent chance flow exceeded
RCH 260 FALL LINE FLOWS

PAMUNKEY RIVER AT SEG. 260

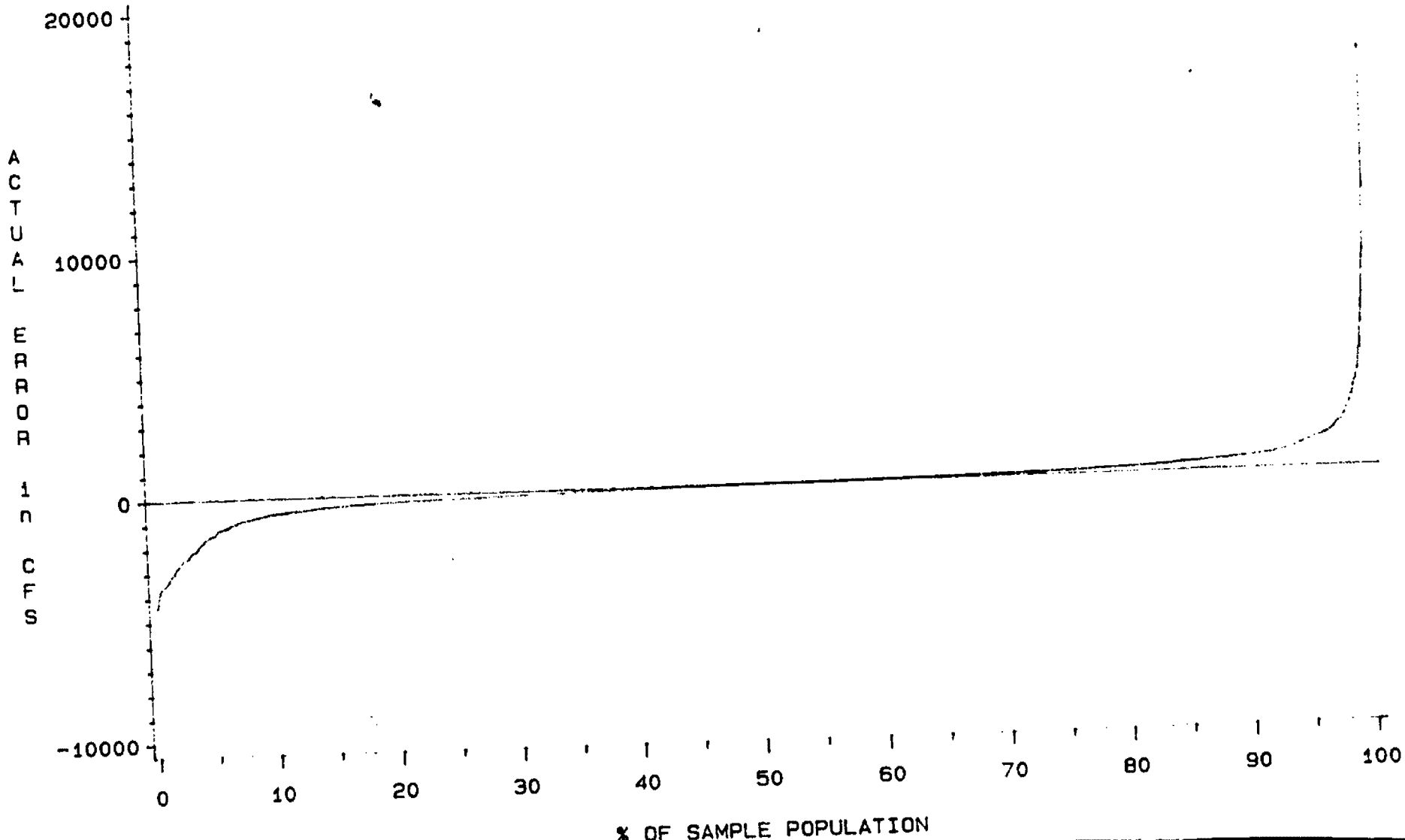
FLOW RELATIVE ERRORS

RELATIVE ERROR = (SIMULATED - OBSERVED)/OBSERVED



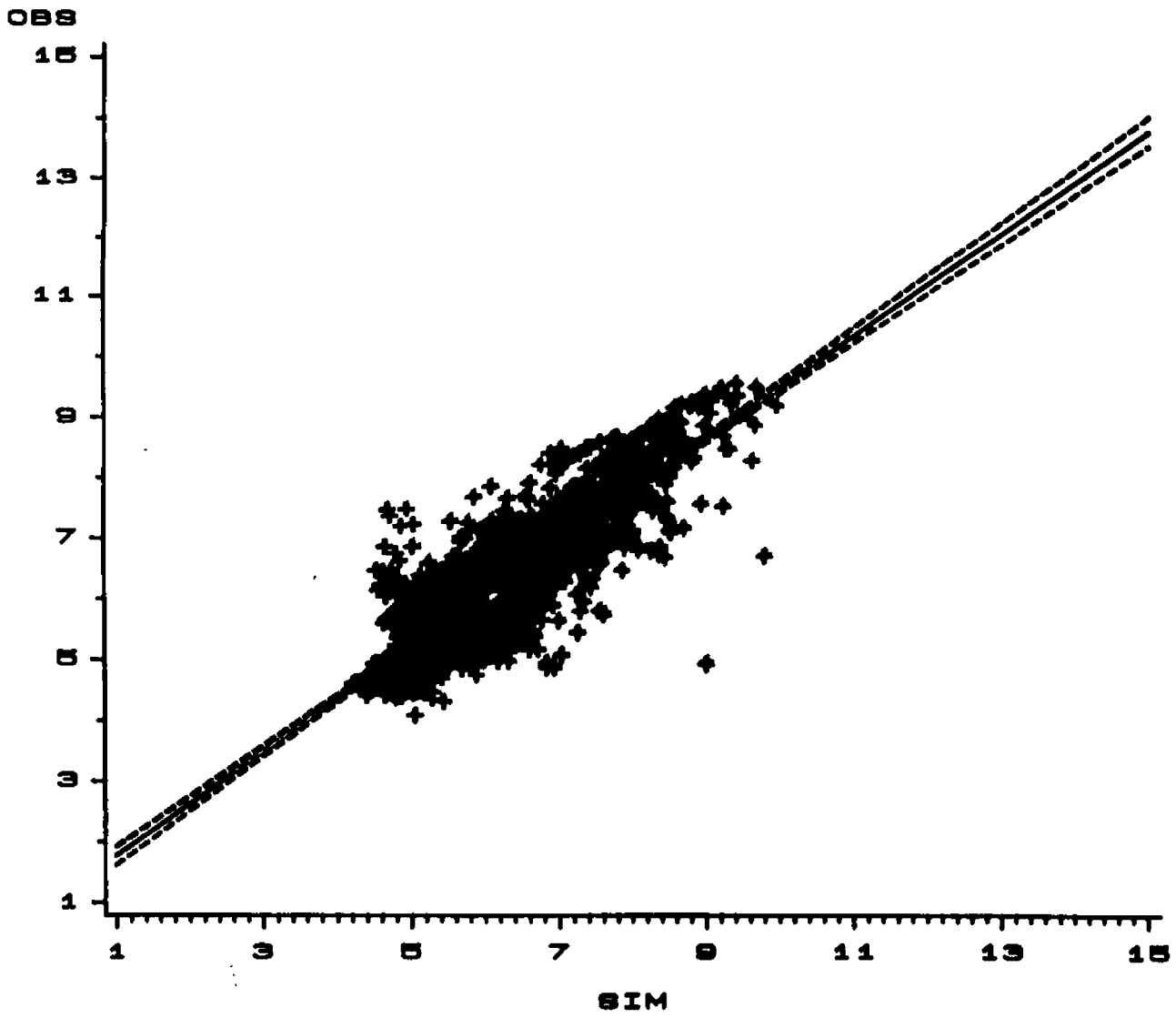
PAMUNKEY RIVER AT SEG. 260

FLOW ACTUAL ERRORS (CFS)



Pamunkey River at Seg. 260

Regression of Log Simulated Flow versus Log Observed Flow



Note: Dashed lines represent the 95% confidence limits around the regression line.

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
PAMUNKEY RIVER, VA (Segments 250 and 260)

COMPARISON OF ANNUAL TOTAL OBSERVED AND SIMULATED FLOWS

YEAR	Observed* Flow (in)	Simulated+ Flow (in)
1984	20.59	20.20
1985	13.95	15.80
1986	7.80	5.64
1987	14.71	14.74
Mean	14.26	14.10

* Observed flow Pamunkey River at Hanover, VA
\+ Simulated outflow from RCH 260

REGRESSION OF LOG SIMULATED FLOW ON LOG OBSERVED FLOW
DAILY AND MONTHLY R-SQUARED

Year	Ave. Daily	Ave. Monthly
1984	0.8367	0.9471
1985	0.6717	0.8282
1986	0.6708	0.8654
1987	0.7335	0.8414
1984-87	0.7170	0.8323

SEASONAL R-SQUARED

Year	Season 1	Season 2	Season 3	Season 4
1984	0.6291	0.8001	0.7665	0.6570
1985	0.7721	0.4892	0.6723	0.8124
1986	0.8393	0.7421	0.5129	0.3301
1987	0.0561	0.7344	0.7790	0.7335

Overall Seasonal R-squared 0.7161

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

CHESAPEAKE BAY WATERSHED HYDROLOGICAL SIMULATION
PAMUNKEY RIVER, VA (Segments 250 and 260)

REGRESSION OF LOG TRANSFORMED SIMULATED AND OBSERVED FLOWS

	Intercept	Probability Intercept=0*	Slope	Probability Slope=1*
DAILY FLOWS				
1984	-0.0017	0.9915	0.9974	0.9111
1985	1.4676	0.0001	0.7630	0.0001
1986	0.9514	0.0001	0.8952	0.0016
1987	-0.5828	0.0095	1.0572	0.0880
1984-87	0.9142	0.0001	0.8601	0.0001
MONTHLY FLOWS				
1984	-0.3076	0.5898	1.0449	0.5784
1985	1.9904	0.0156	0.7084	0.0170
1986	0.2564	0.7367	1.0205	0.8755
1987	-1.2597	0.2777	1.1649	0.3268
1984-87	0.9149	0.0210	0.8721	0.0317
SEASONAL FLOWS				
1984 S1	1.9221	0.0209	0.7552	0.0230
S2	1.2863	0.0004	0.8440	0.0008
S3	-1.2204	0.0017	1.1724	0.0045
S4	0.6350	0.1290	0.9054	0.1641
1985 S1	0.6032	0.1951	0.9206	0.2313
S2	2.4627	0.0001	0.6730	0.0001
S3	0.9603	0.0021	0.7974	0.0001
S4	-1.9164	0.0001	1.1873	0.0021
1986 S1	2.2492	0.0001	0.6963	0.0001
S2	0.8994	0.0131	0.9246	0.1978
S3	-1.1538	0.0489	1.2657	0.0210
S4	2.2261	0.0001	0.6847	0.0024
1987 S1	5.5811	0.0001	0.2153	0.0001
S2	0.9969	0.0162	0.8912	0.0602
S3	-0.5180	0.0867	1.0216	0.6672
S4	-1.4076	0.0043	1.1332	0.0631
1984-87	0.8996	0.0001	0.8627	0.0001

* If probability is less than .05 (95% confidence level) then intercept is significantly different from 0, or slope is significantly different from 1.

A.13 JAMES RIVER AT SEG. 280

Time Series Plot of Simulated and Observed Daily Flows for 1984-1987

Time Series Plot of Residual (Simulated Minus Observed) Daily Flows for 1984-1987

Time Series Plot of Cumulative Simulated and Observed Flows for 1984-1987

Plot of Percent Chance Flow Exceeded vs. Volume of Streamflow

Distribution of Percent Relative Errors Over Percentile Sample Population

Distribution of Percent Actual Errors Over Percentile Sample Population

Regression of Log Transformed Simulated Flow vs. Log Transformed Observed Flow Scatter Plot

Comparison of Annual Total Observed and Simulated Flow

Average Daily and Monthly R-Squared for 1984-1987

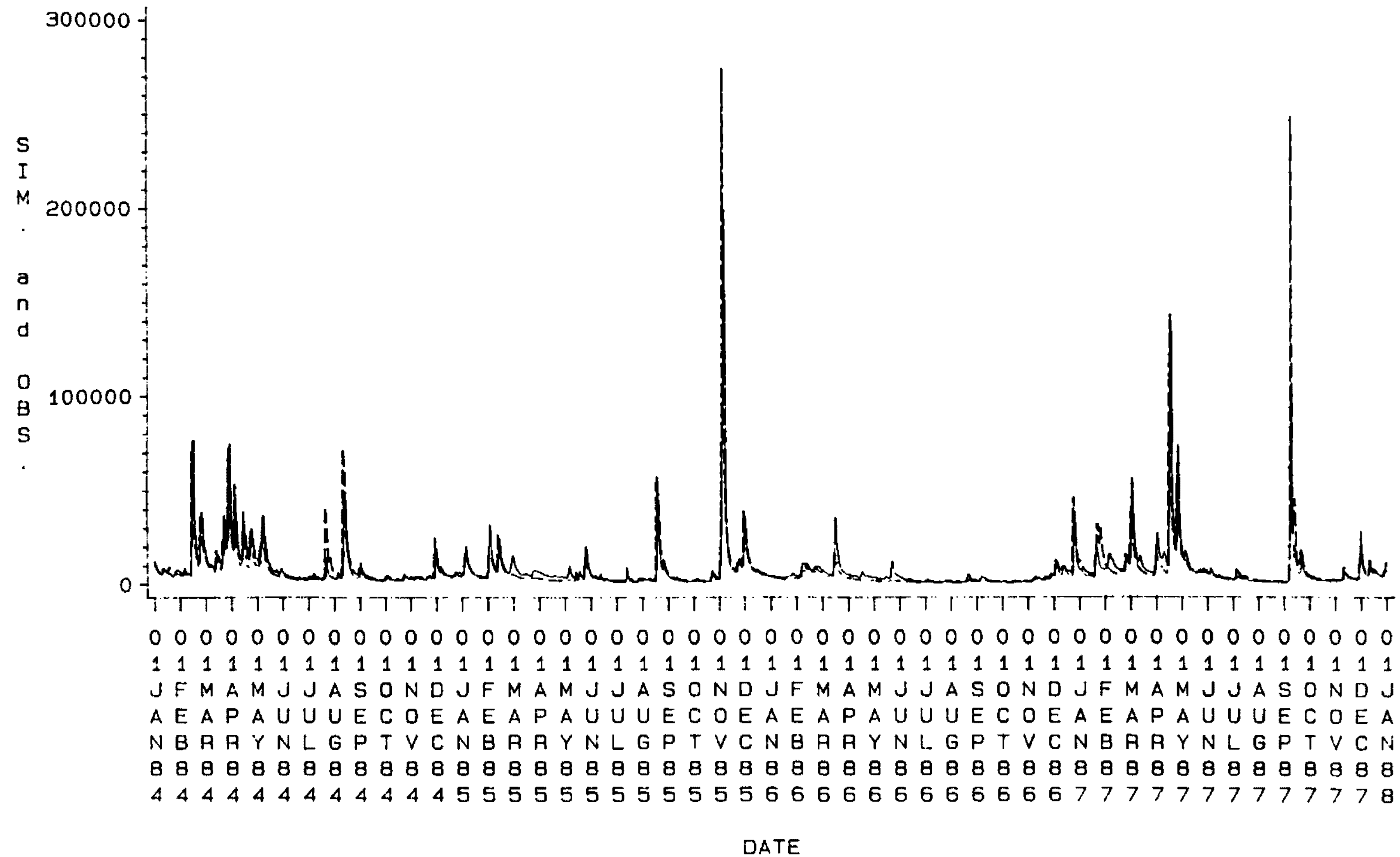
Average Seasonal R-Squared for 1984-1987

Log Transformed Simulated and Observed Flow Regression Slope and Intercept Statistics

JAMES RIVER AT SEG. 280

FLOW (CFS)

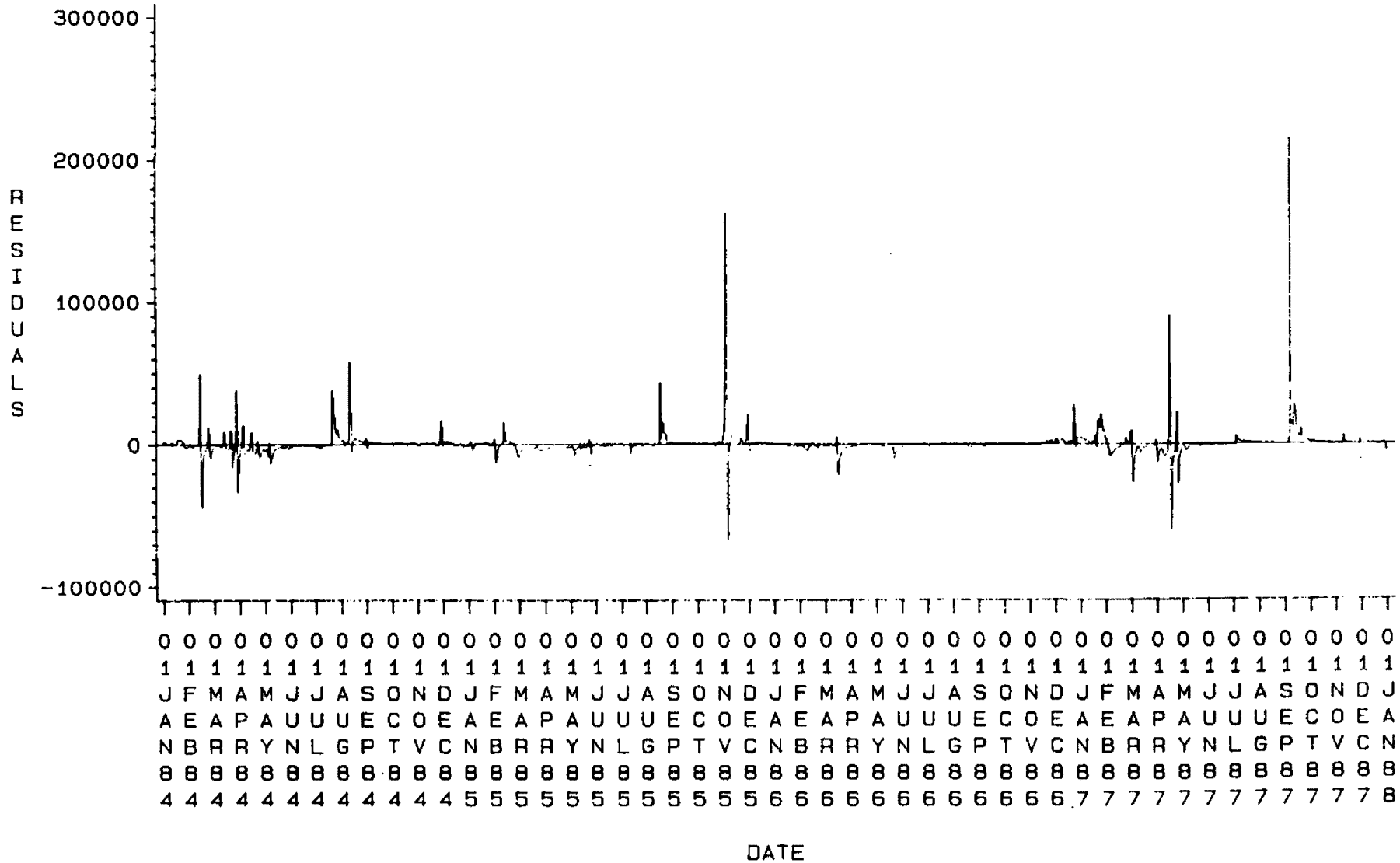
RED DASHED: SIM., BLUE SOLID: OBS.



JAMES RIVER AT SEG. 280

FLOW (CFS)

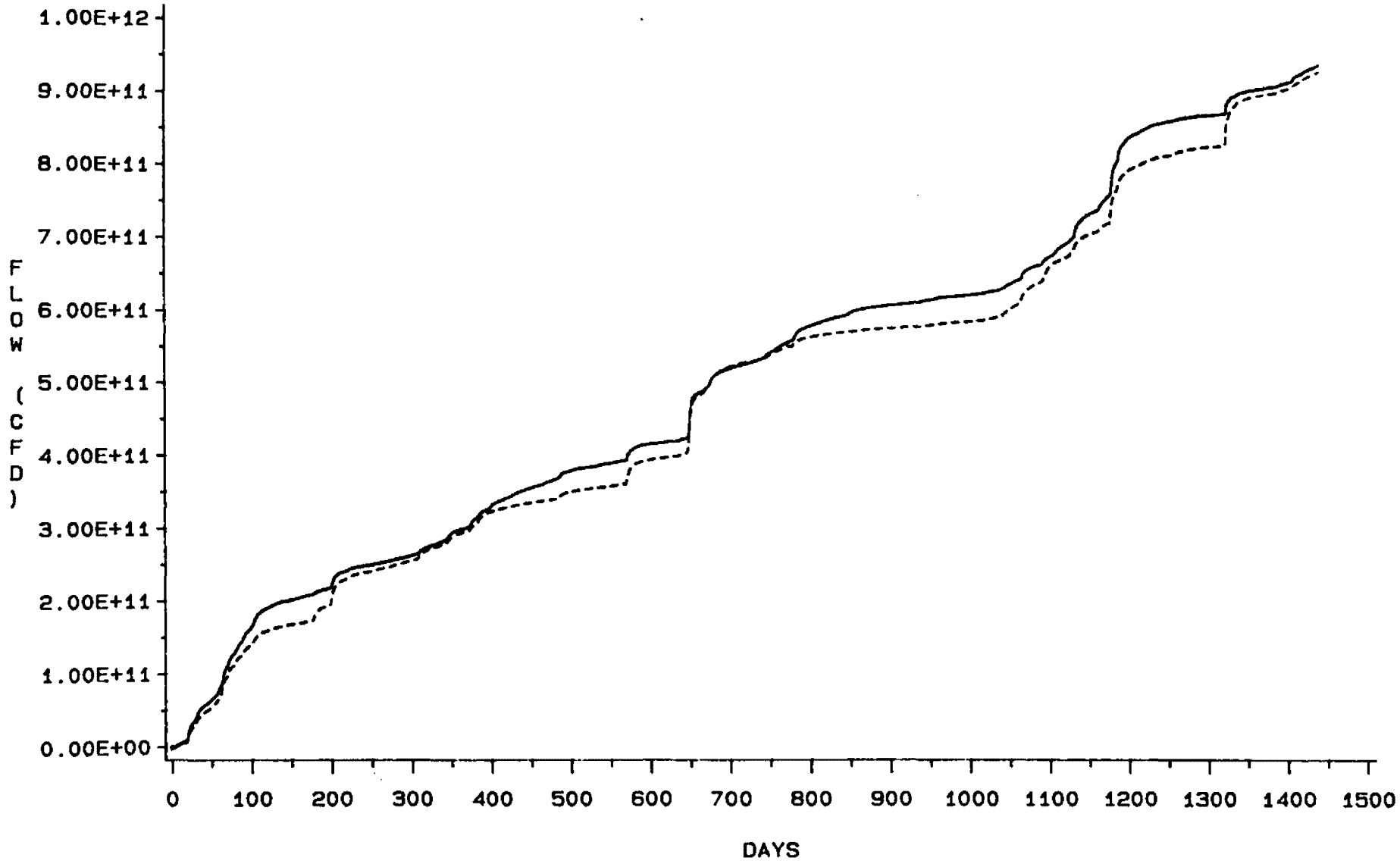
RESIDUALS (SIMULATED - OBSERVED)

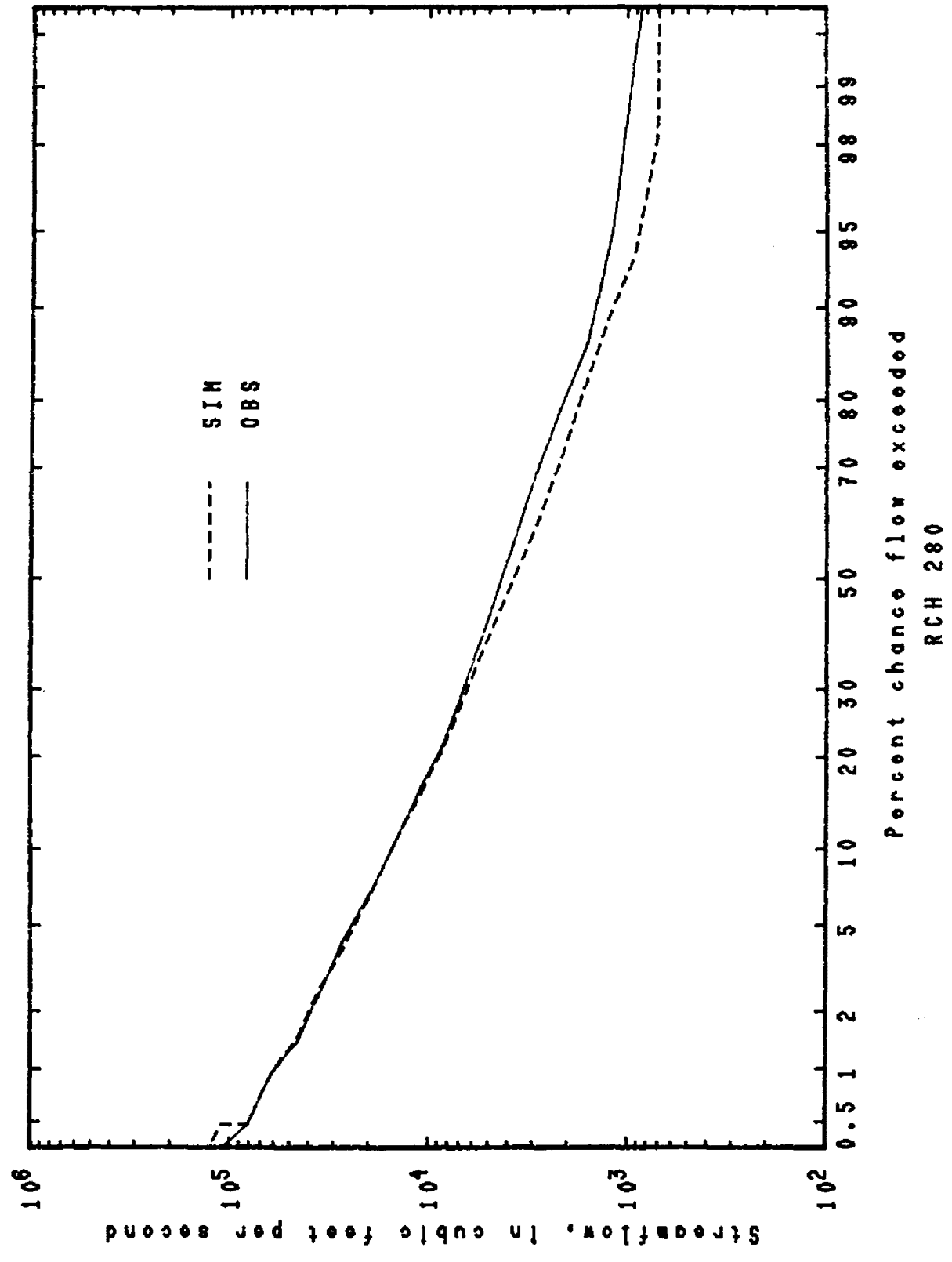


CUMULATIVE FLOWS (CFD) 1984 - 1987

JAMES

Simulated - - - - - Observed ---------

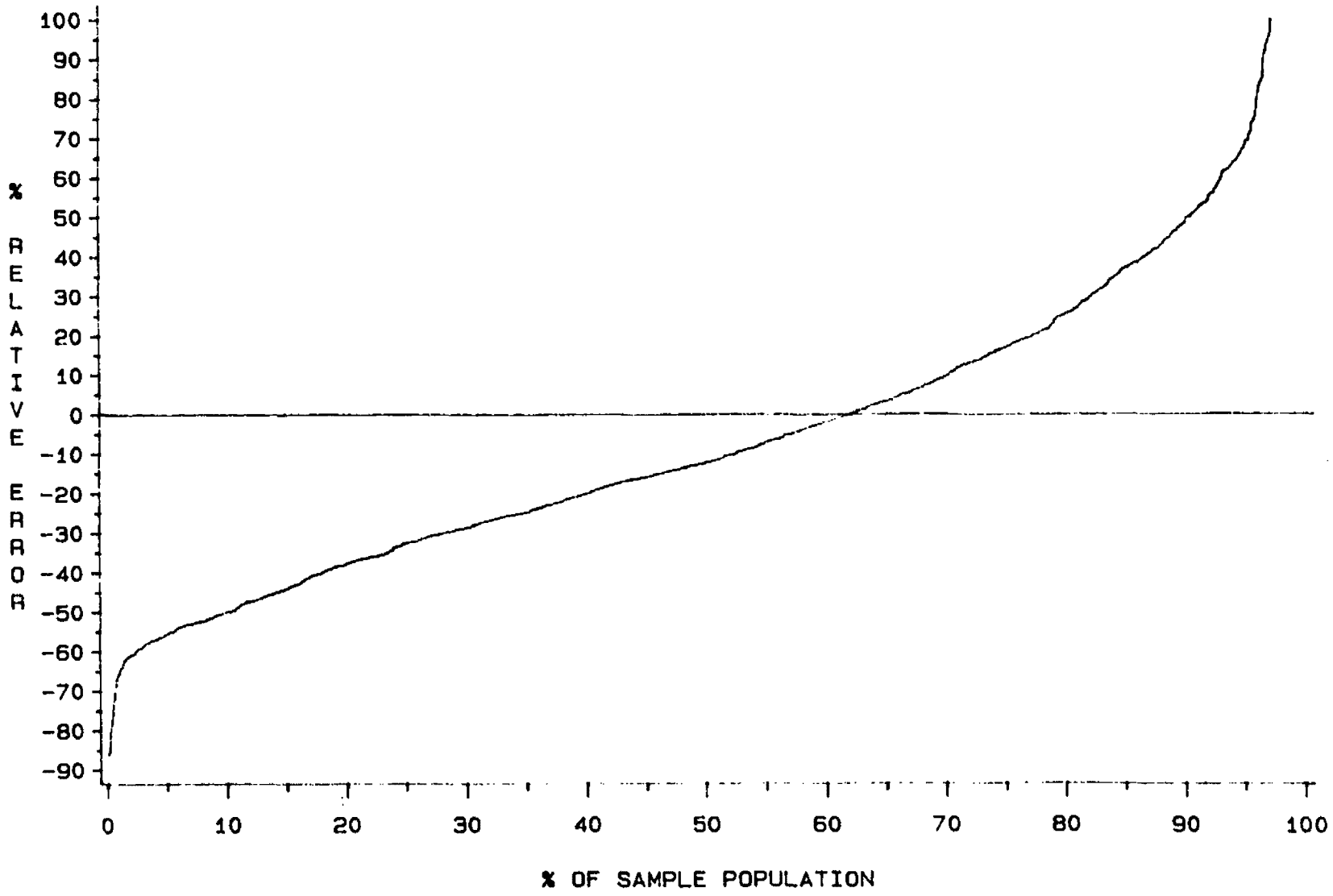



SIM
OBS
Streamflow, in cubic feet per second
10^6
10^5
10^4
10^3
10^2
0.5 1 2 5 10 20 30 50 70 80 90 95 98 99
Percent chance flow exceeded
RCH 280

JAMES RIVER AT SEG. 280

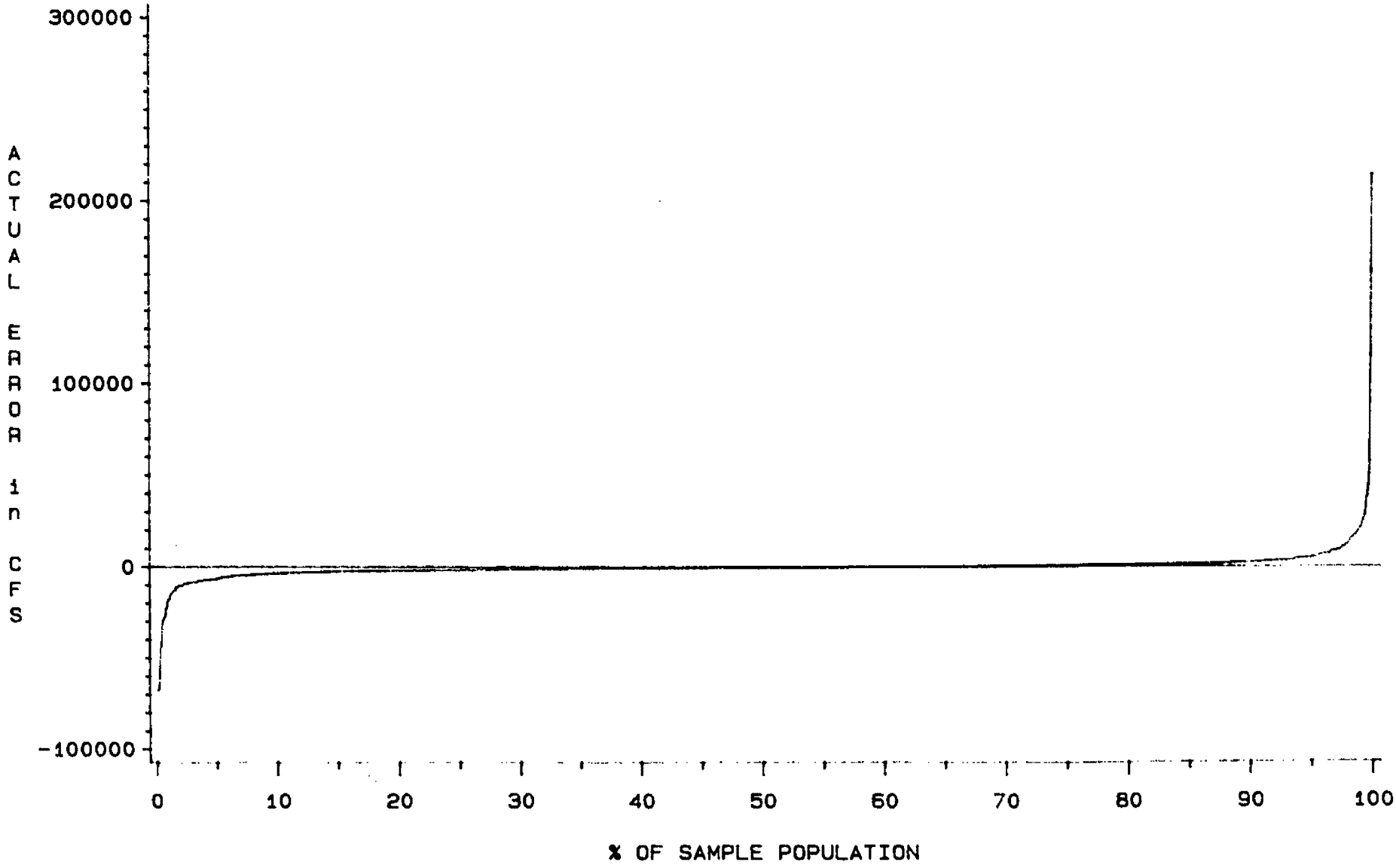
FLOW RELATIVE ERRORS

RELATIVE ERROR = (SIMULATED - OBSERVED)/OBSERVED



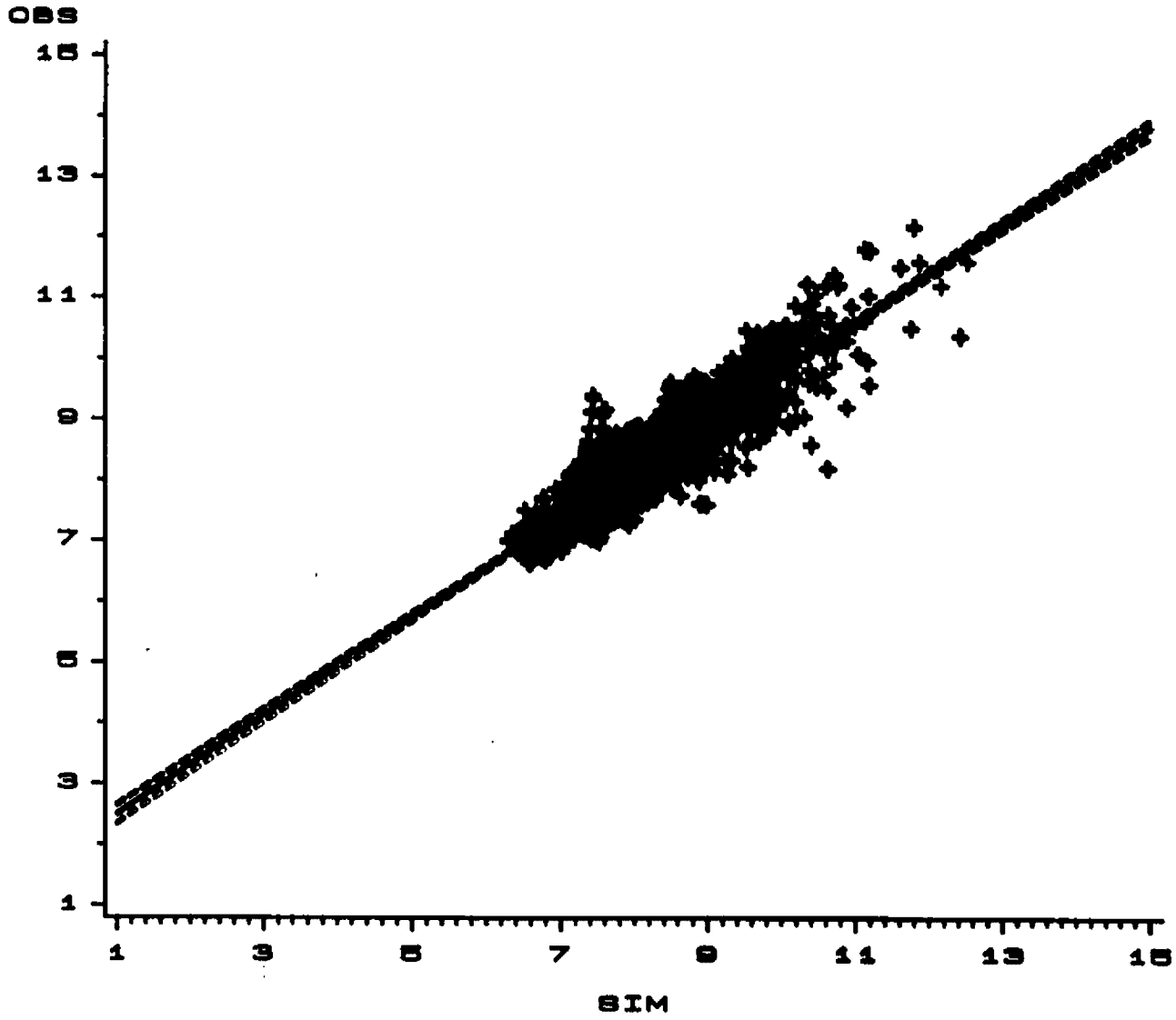
JAMES RIVER AT SEG. 280

FLOW ACTUAL ERRORS (CFS)



James River at Seg. 280

Regression of Log Simulated Flow versus Log Observed Flow



Note: Dashed lines represent the 95% confidence limits around the regression line.

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
JAMES RIVER, VA (Segments 265, 270, 280 and 290)

COMPARISON OF ANNUAL TOTAL OBSERVED AND SIMULATED FLOWS

Year	Observed* Flow (in)	Simulated+ Flow (in)
1984	20.52	20.34
1985	16.33	16.82
1986	9.10	7.84
1987	19.16	21.26
Mean	16.28	16.57

* Observed flow James River at Cartersville, VA
\+ Simulated outflow from RCH 280

REGRESSION OF LOG SIMULATED FLOW ON LOG OBSERVED FLOW
DAILY AND MONTHLY R-SQUARED

Year	Ave. Daily	Ave. Monthly
1984	0.7889	0.8575
1985	0.7723	0.8400
1986	0.7879	0.8334
1987	0.8344	0.8712
Mean	0.8023	0.8408

SEASONAL R-SQUARED

Year	Season 1	Season 2	Season 3	Season 4
1984	0.8385	0.8088	0.6564	0.7388
1985	0.7054	0.6925	0.8105	0.9513
1986	0.8705	0.6809	0.6089	0.9258
1987	0.3120	0.8392	0.8922	0.8326

Overall Seasonal R-squared 0.8032

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

CHESAPEAKE BAY WATERSHED HYDROLOGICAL SIMULATION
JAMES RIVER, VA (Segments 265, 270, 280 and 290)

REGRESSION OF LOG TRANSFORMED SIMULATED AND OBSERVED FLOWS

	Intercept	Probability Intercept=0*	Slope	Probability Slope=1*
DAILY FLOWS				
1984	0.7749	0.0004	0.9109	0.0004
1985	1.7957	0.0001	0.8003	0.0001
1986	2.0394	0.0001	0.7826	0.0001
1987	0.6966	0.0002	0.9152	0.0001
1984-87	1.6848	0.0001	0.8118	0.0001
MONTHLY FLOWS				
1984	-0.5275	0.6739	1.0524	0.7076
1985	2.0610	0.0473	0.7727	0.0589
1986	2.3106	0.0187	0.7525	0.0424
1987	0.4800	0.6435	0.9371	0.5929
1984-87	1.8429	0.0001	0.7946	0.0002
SEASONAL FLOWS				
1984 S1	1.1942	0.0709	0.8913	0.1257
S2	2.1270	0.0001	0.7984	0.0001
S3	3.3052	0.0001	0.5937	0.0001
S4	1.0623	0.0174	0.8607	0.0097
1985 S1	0.9185	0.1834	0.9015	0.2029
S2	3.5704	0.0001	0.6345	0.0001
S3	1.7116	0.0001	0.7858	0.0001
S4	0.1173	0.5613	0.9673	0.1534
1986 S1	1.1401	0.0038	0.8969	0.0269
S2	2.9523	0.0001	0.7101	0.0001
S3	1.3106	0.0045	0.8874	0.0880
S4	1.6326	0.0001	0.7897	0.0001
1987 S1	4.5913	0.0001	0.4803	0.0001
S2	1.3015	0.0010	0.8889	0.0088
S3	1.8128	0.0001	0.7560	0.0001
S4	0.0623	0.8694	0.9809	0.6769
1984-87	1.6707	0.0001	0.8140	0.0001

* If probability is less than .05 (95% confidence level) then intercept is significantly different from 0, or slope is significantly different from 1.

A.14 APPOMATTOX RIVER AT SEG. 310

Time Series Plot of Simulated and Observed Daily Flows for 1984-1987

Time Series Plot of Residual (Simulated Minus Observed) Daily Flows for 1984-1987

Time Series Plot of Cumulative Simulated and Observed Flows for 1984-1987

Plot of Percent Chance Flow Exceeded vs. Volume of Streamflow

Distribution of Percent Relative Errors Over Percentile Sample Population

Distribution of Percent Actual Errors Over Percentile Sample Population

Regression of Log Transformed Simulated Flow vs. Log Transformed Observed Flow Scatter Plot

Comparison of Annual Total Observed and Simulated Flow

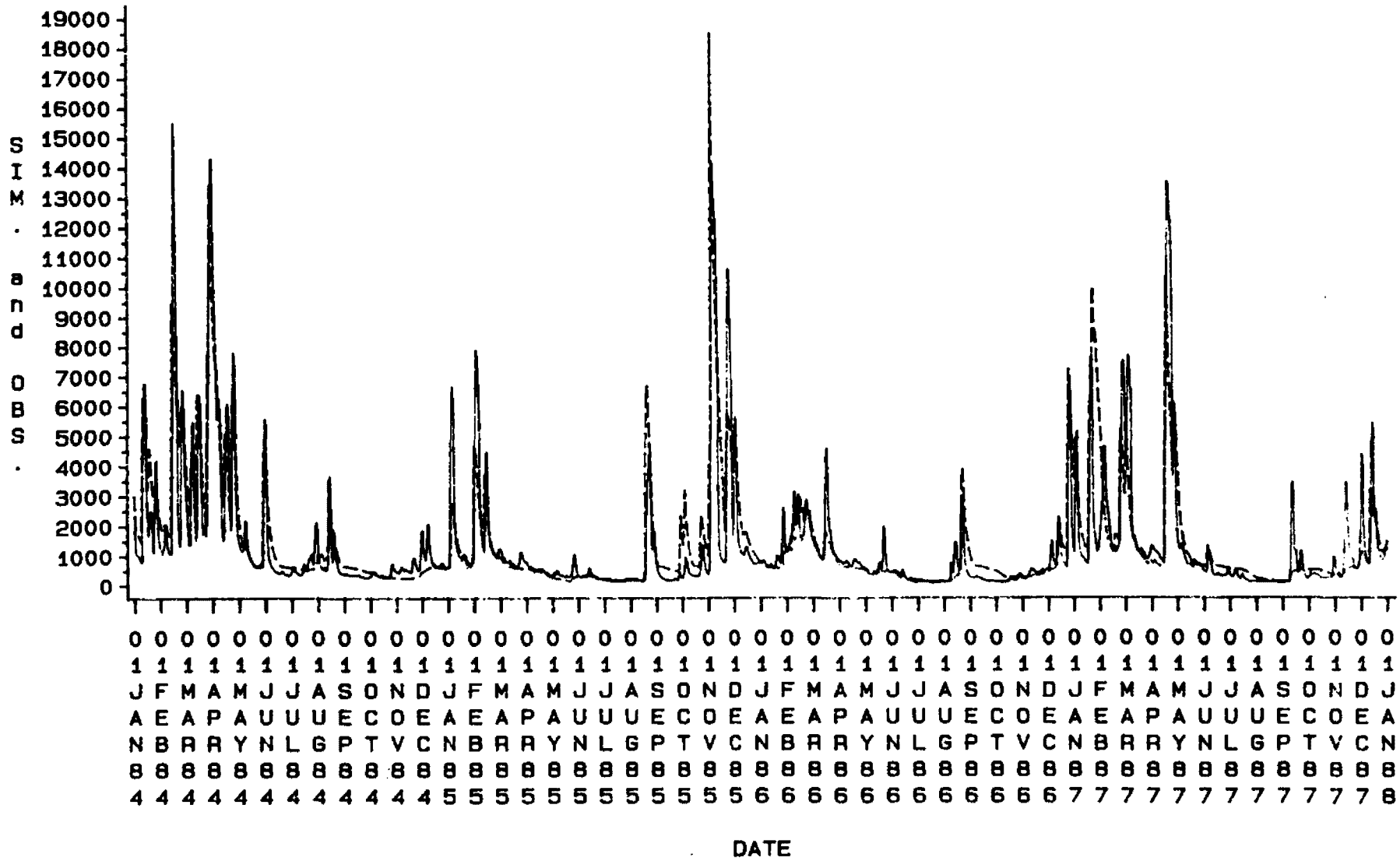
Average Daily and Monthly R-Squared for 1984-1987

Average Seasonal R-Squared for 1984-1987

Log Transformed Simulated and Observed Flow Regression Slope and Intercept Statistics

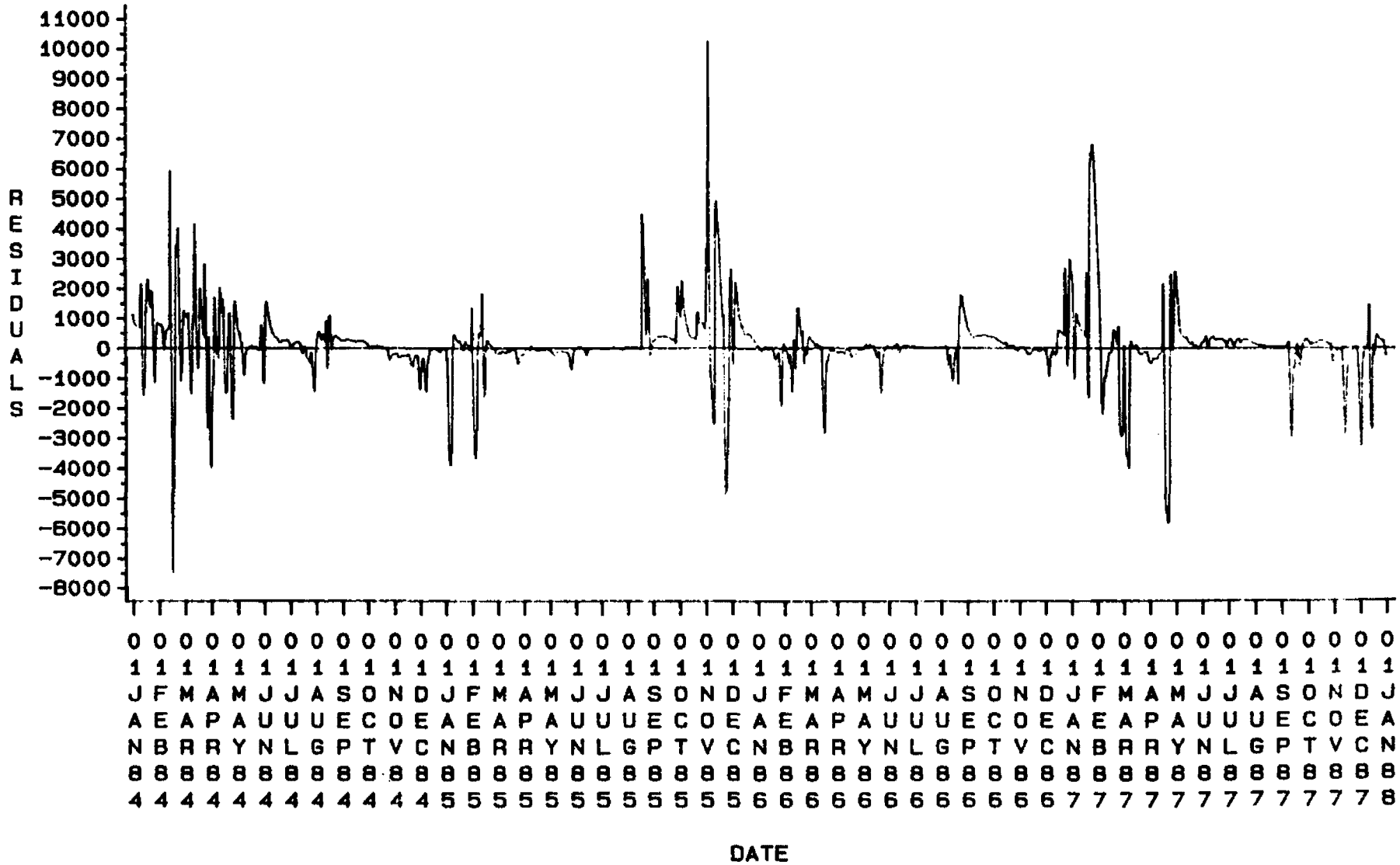
APPOMATTOX RIVER AT SEG. 310

FLOW (CFS)
RED DASHED: SIM., BLUE SOLID: OBS.



APPOMATTOX RIVER AT SEG. 310

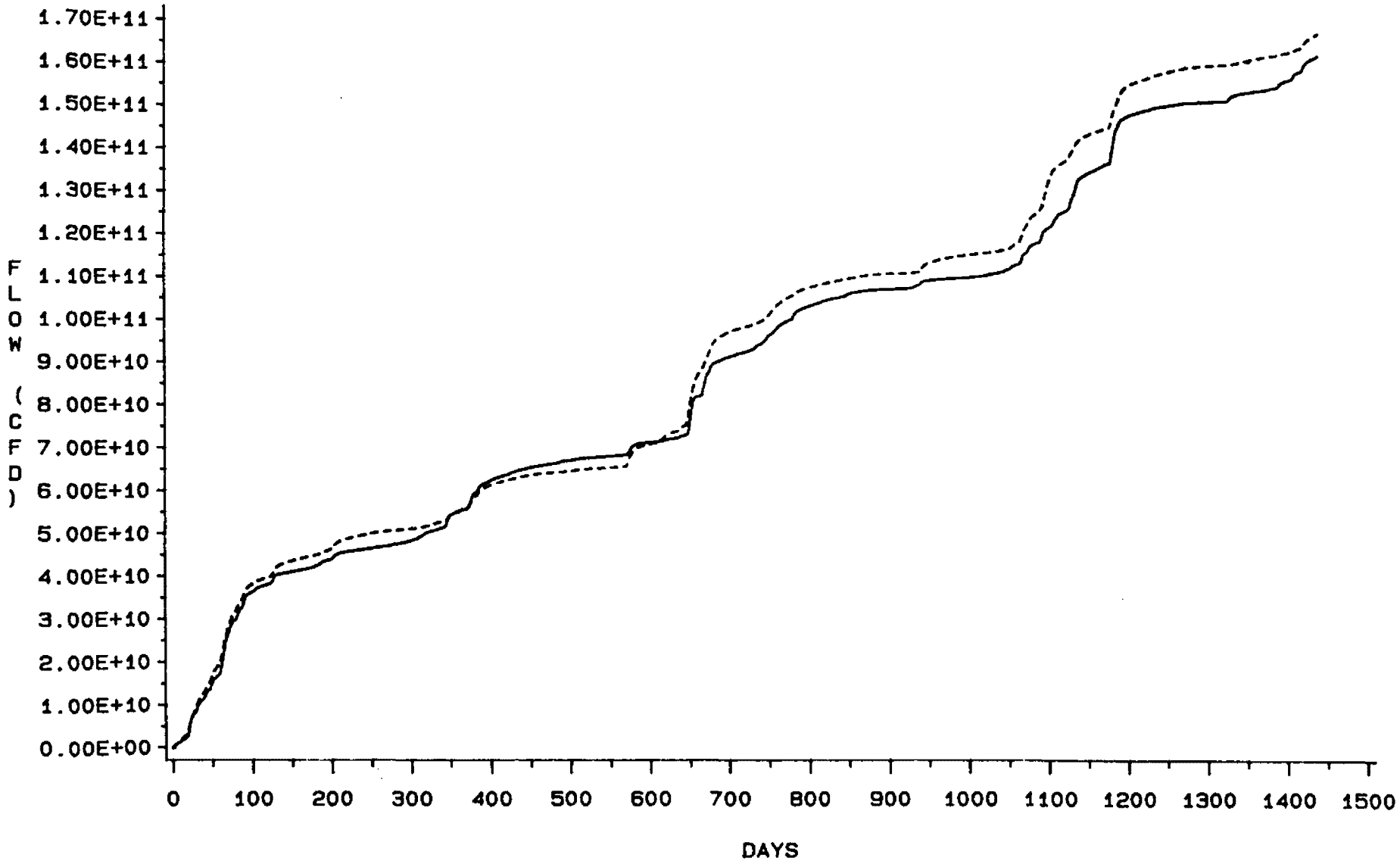
FLOW (CFS)
RESIDUALS (SIMULATED - OBSERVED)

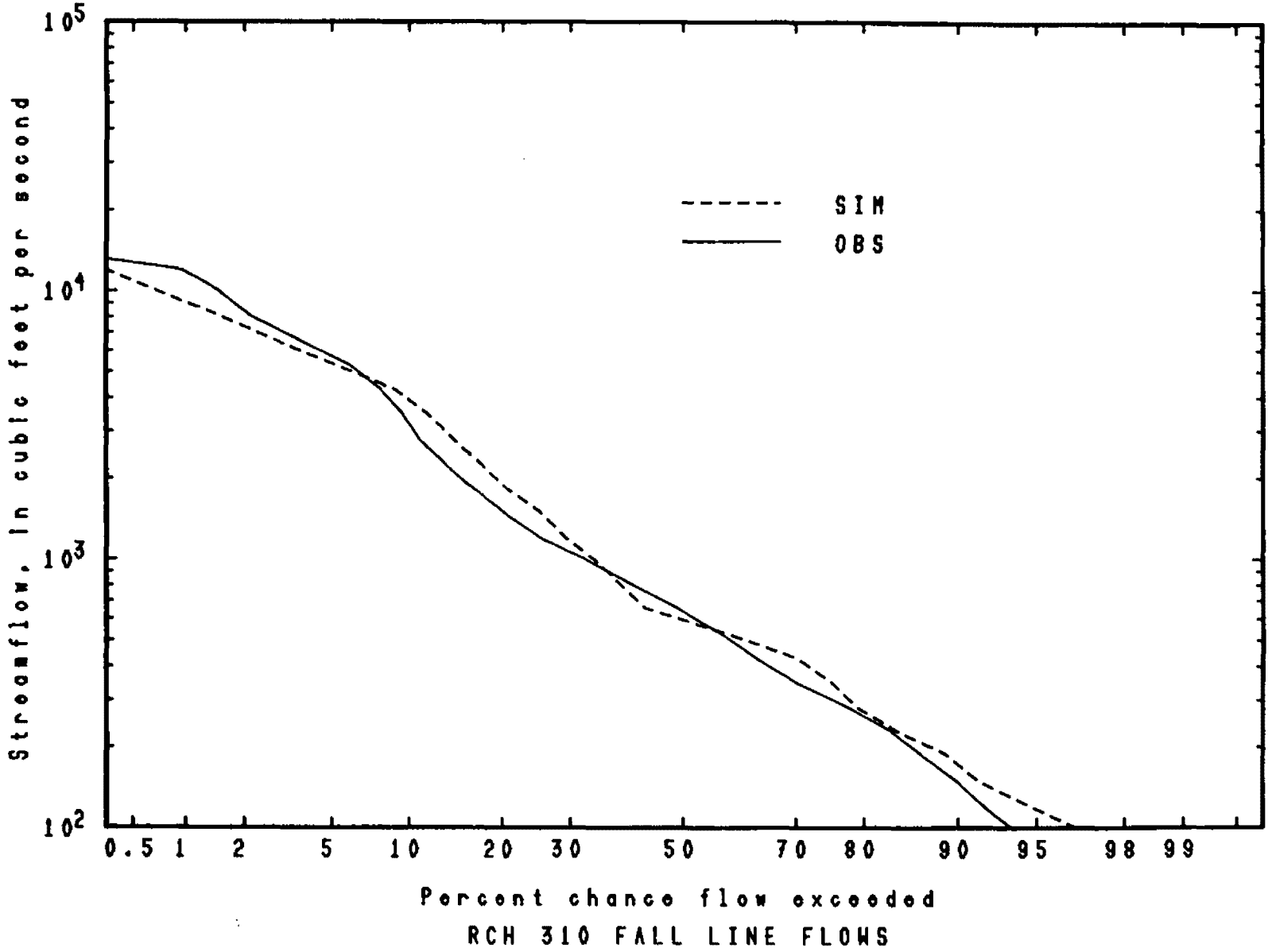


CUMULATIVE FLOWS (CFD) 1984 - 1987

APPOM

Simulated - - - - - Observed ---------

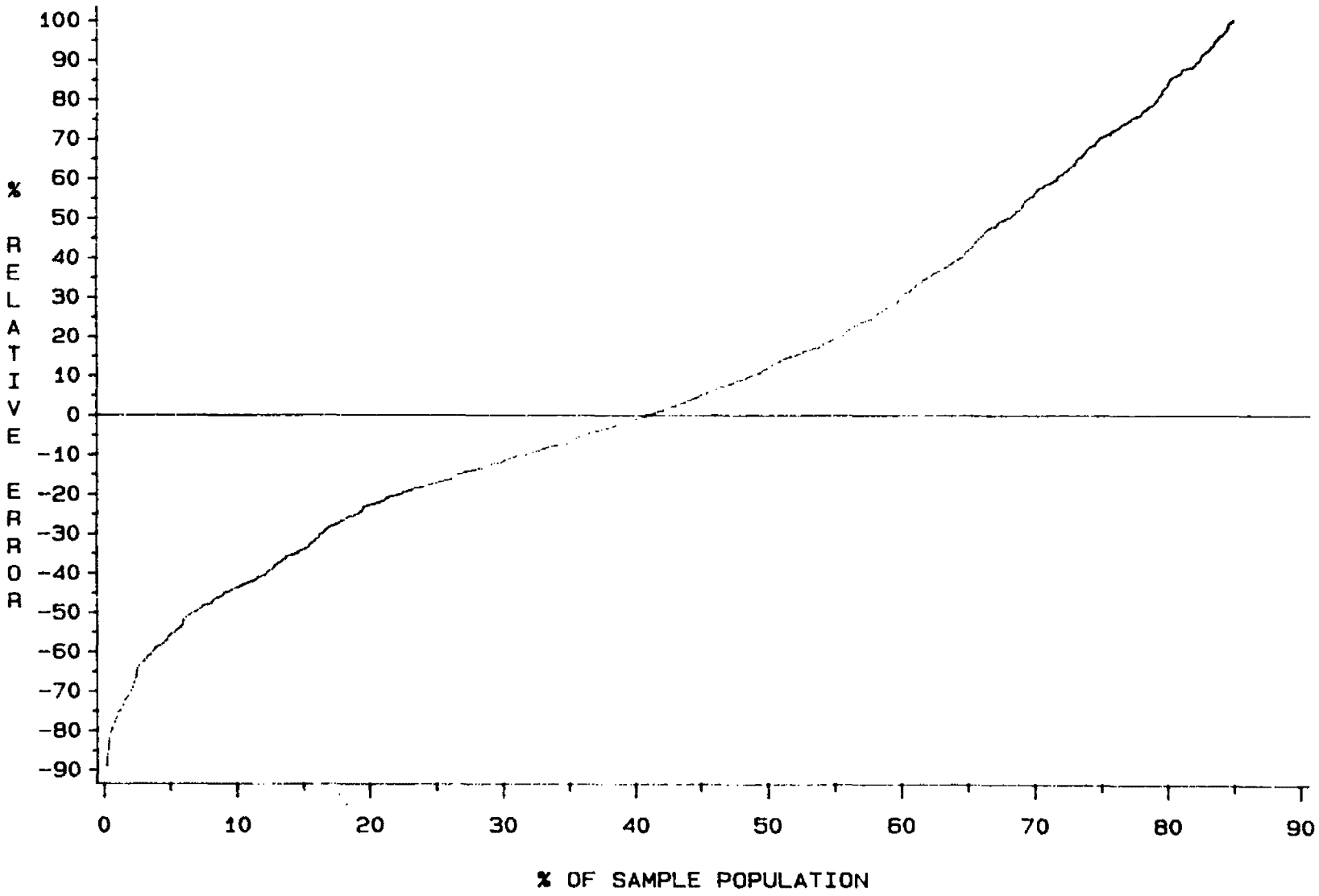



10^5
10^4
10^3
10^2
Streamflow, in cubic feet per second
SIM
OBS
0.5 1 2 5 10 20 30 50 70 80 90 95 98 99
Percent chance flow exceeded
RCH 310 FALL LINE FLOWS

APPOMATTOX RIVER AT SEG. 310

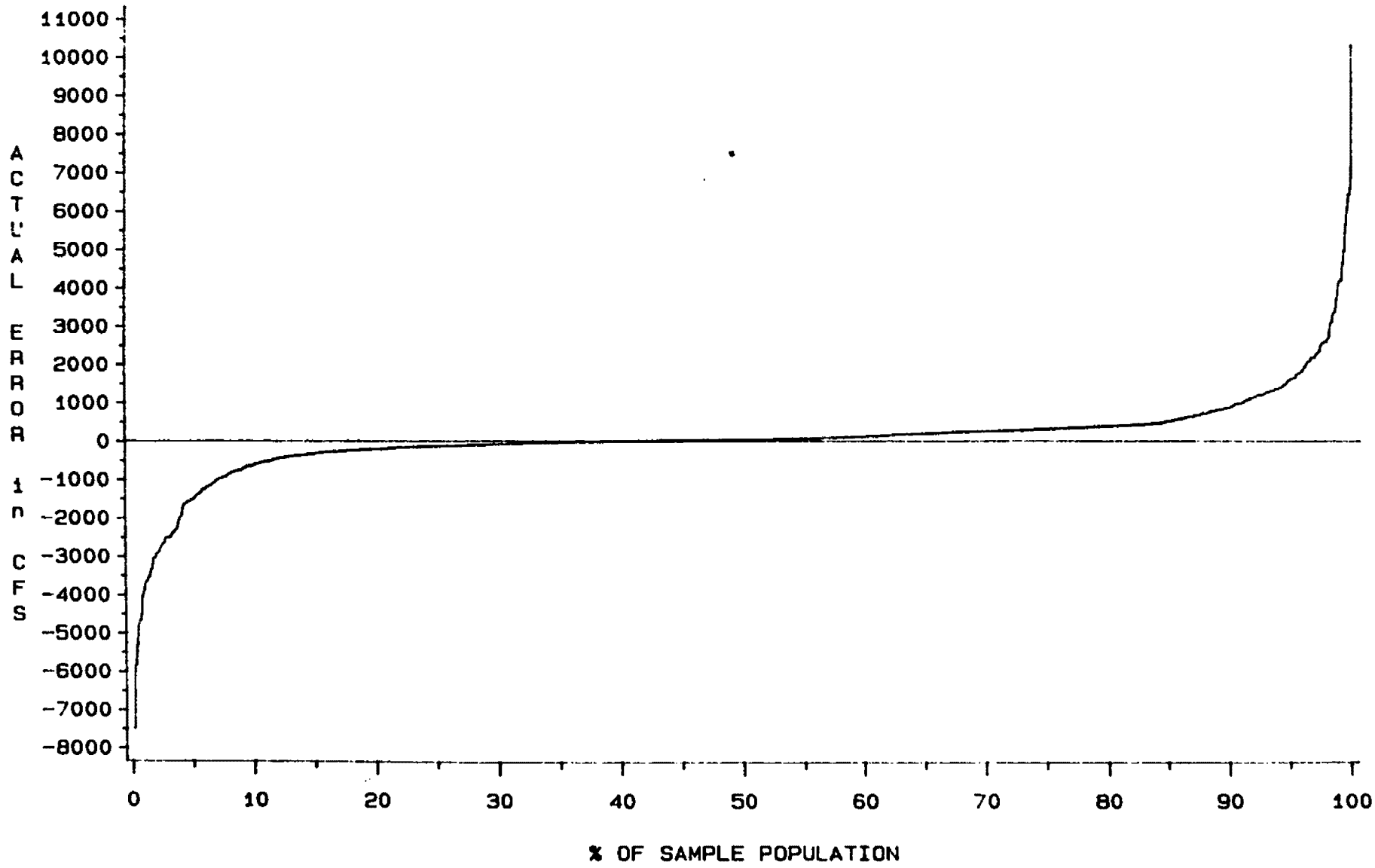
FLOW RELATIVE ERRORS

RELATIVE ERROR = (SIMULATED - OBSERVED)/OBSERVED



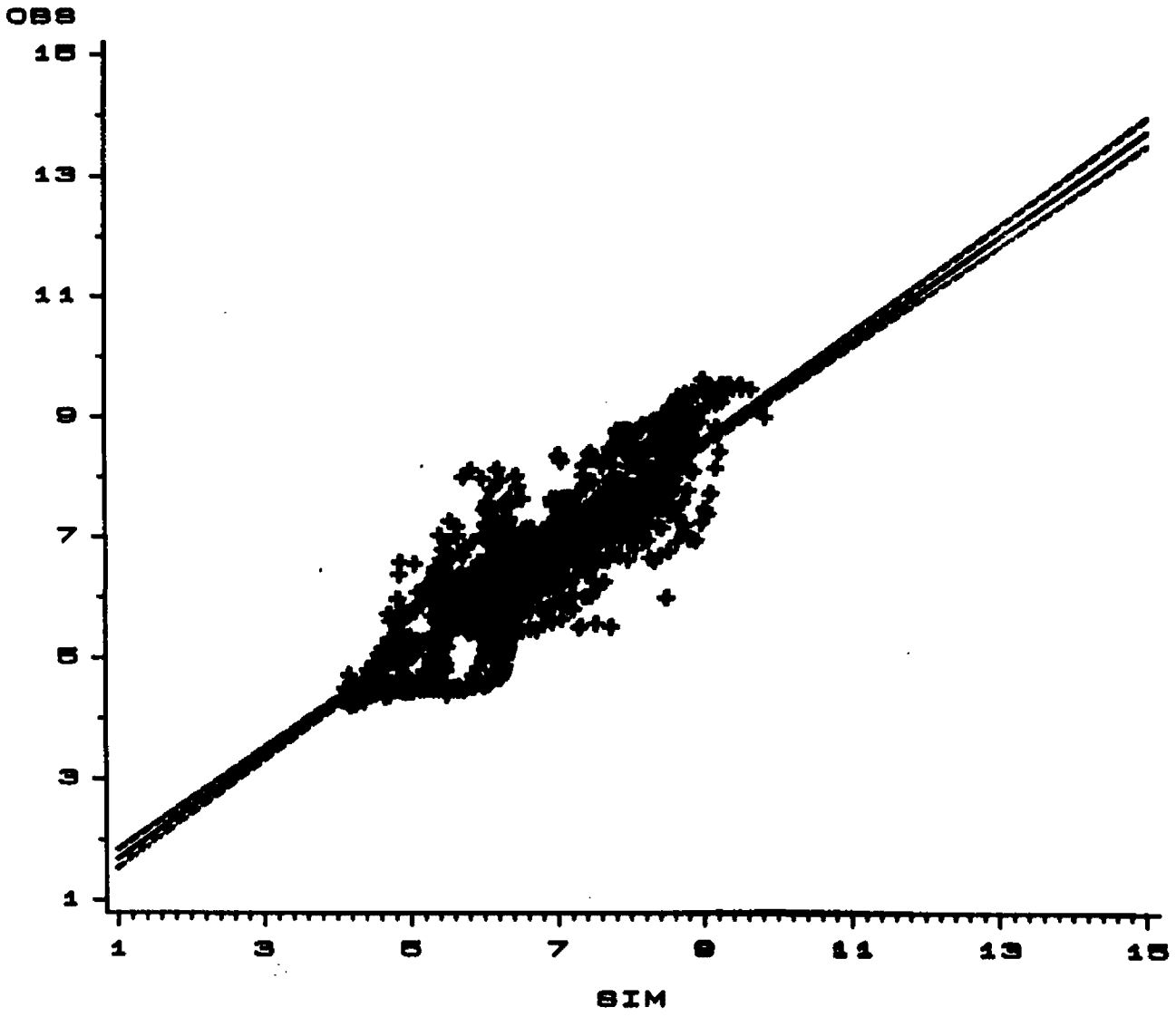
APPOMATTOX RIVER AT SEG. 310

FLOW ACTUAL ERRORS (CFS)



Appomattox River at Seg. 310

Regression of Log Simulated Flow versus Log Observed Flow



Note: Dashed lines represent the 95% confidence limits around the regression line.

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
APPOMATTOX RIVER, VA (Segments 300 and 310)

COMPARISON OF ANNUAL TOTAL OBSERVED AND SIMULATED FLOWS

Year	Observed* Flow (in)	Simulated+ Flow (in)
1984	18.16	19.16
1985	12.83	14.31
1986	7.68	7.72
1987	14.55	14.31
Mean	13.31	13.88

* Observed flow Appomattox River at Matoaca, VA
\+ Simulated outflow from RCH 310

REGRESSION OF LOG SIMULATED FLOW ON LOG OBSERVED FLOW
DAILY AND MONTHLY R-SQUARED

Year	Ave. Daily	Ave. Monthly
1984	0.7530	0.8556
1985	0.7194	0.7722
1986	0.6496	0.8015
1987	0.7581	0.8198
1984-87	0.7328	0.8153

SEASONAL R-SQUARED

Year	Season 1	Season 2	Season 3	Season 4
1984	0.6822	0.8600	0.5882	0.1578
1985	0.7353	0.6779	0.6962	0.7404
1986	0.6589	0.6221	0.4332	0.6132
1987	0.2975	0.8043	0.5781	0.5074

Overall Seasonal R-squared 0.7294

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

CHESAPEAKE BAY WATERSHED HYDROLOGICAL SIMULATION
APPOMATTOX RIVER, VA (Segments 300 and 310)

REGRESSION OF LOG TRANSFORMED SIMULATED AND OBSERVED FLOWS

	Intercept	Probability Intercept=0*	Slope	Probability Slope=1*
DAILY FLOWS				
1984	1.2532	0.0001	0.8107	0.0001
1985	1.4684	0.0001	0.7605	0.0001
1986	0.5620	0.0097	0.8985	0.0036
1987	0.1627	0.3953	0.9613	0.1757
1984-87	0.8305	0.0001	0.8616	0.0001
MONTHLY FLOWS				
1984	1.3858	0.0938	0.8077	0.0968
1985	1.3586	0.1701	0.7896	0.1519
1986	0.0315	0.9752	0.9867	0.9333
1987	0.2097	0.8357	0.9700	0.8391
1984-87	0.7049	0.1040	0.8925	0.0927
SEASONAL FLOWS				
1984 S1	-1.6555	0.1587	1.1683	0.2412
S2	0.0547	0.8703	0.9794	0.6267
S3	0.2774	0.5546	0.9128	0.2171
S4	3.5195	0.0001	0.4731	0.0001
1985 S1	-0.7842	0.2261	1.1224	0.1717
S2	2.9011	0.0001	0.5769	0.0001
S3	1.8850	0.0001	0.6467	0.0001
S4	-1.8084	0.0013	1.1509	0.0354
1986 S1	2.0742	0.0001	0.7235	0.0002
S2	0.4470	0.3908	0.9632	0.6463
S3	2.1253	0.0001	0.5683	0.0001
S4	0.5877	0.1918	0.8753	0.0869
1987 S1	3.0756	0.0014	0.5714	0.0005
S2	0.3632	0.3253	0.9609	0.4413
S3	0.3915	0.3265	0.8858	0.1039
S4	0.1379	0.8337	0.9929	0.9444
1984-87	0.8186	0.0001	0.8639	0.0001

* If probability is less than .05 (95% confidence level) then intercept is significantly different from 0, or slope is significantly different from 1.