Calibration of BATHTUB to Petenwell Reservoir, Wisconsin

Prepared for
University of Wisconsin, Stevens Point

By

William W. Walker, Jr., Ph.D., Environmental Engineer
1127 Lowell Road, Concord MA 01742
Tel. 978-369-8061, Fax. 978-369-4230
E-mail: wwwalker@shore.net

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A previous report (April 30, 1998) described preliminary calibration results and made specific recommendations for additional monitoring and revising model segmentation. This report describes calibration of the revised model to 1996 data, testing against 1997 data, and demonstrates model application to evaluate alternative loading scenarios.

Results are summarized in the following:

Table 1	Model Input File for 1996
Table 2	Model Output Files for 1996
Table 3	Model Input File for 1997
Table 4	Model Output File for 1997
Table 5	Predicted Responses to Hypothetical Reductions in Wisconsin River P Concentration & Internal P Load
Figure 1	Observed & Predicted Conditions, 1996
Figure 2	Observed & Predicted Conditions, 1997
Figure 3	Sampled Flows & Concentrations, Wisconsin River at Nekoosa

Two BATHTUB input files 'PET_96.BIN' and 'PET_97.BIN' are provided separately. Contents of these files are listed in Tables 1 and 3, respectively.

The revised model contains 6 segments sorted in downstream order. Reservoir morphometry has been re-computed by UW with segment boundaries specified by the author. Results are listed in the model input files (Tables 1 & 3).

Results of model calibration against 1996 data are given in Tables 1 & 2 and Figure 1. The 1996 phosphorus profile is fit by setting the decay rate calibration factor to 0.4 and specifying an internal loading rate of 20 mg/m^2-day in the second segment. With these coefficients, internal loading accounts for 17% of the total load. Calibration strategies for other parameters are described in my April 1998 report

Results of model testing against 1997 data (using the 1996 calibrated coefficients) are given in Tables 3 & 4 and Figure 2. Phosphorus concentrations are under-predicted by an average of 20%. The phosphorus profile suggests that the apparent internal loading in segment 2 was greater in 1997 than in 1996. Error analysis results indicate, however, that observed and predicted values are not significantly different, however, given the expected model error and uncertainty in the measurements.

Results suggest that the net sedimentation rate of phosphorus within the reservoir is considerably below typical values observed in the Corps of Engineer reservoirs used for model development. The low sedimentation rate in the reservoir as a whole and/or the apparent internal load in segment 2 could reflect under-estimation of one or more of the tributary phosphorus inputs, in particular the Wisconsin River. Figure 3 shows the daily hydrograph between May and October in 1994-1998 in relation to the dates of sample collection. It is apparent that high-flow regimes were infrequently sampled during these years. Only one major event was captured (June 1996). While the load computation procedure (FLUX program) attempts to account for correlations between flow and concentration, the accuracy and precision of the estimates is limited when high-flow concentration measurements are not available.

Table 5 shows predicted sensitivity to hypothetical reductions in external and internal P loads. The 1996 calibration has been re-run with 0%, 25%, 50%, and 75% reductions in Wisconsin River P concentration (starting with 128 ppb) and with 0% and 100% reductions in internal loading. Chlorophyll-a sensitivity to reductions in external load is limited by the internal load and high initial P concentration. Given the high calibration coefficient for chlorophyll-a (1.6), it is unlikely that nitrogen limitation is important. Despite the relatively low N/P ratio, potential effects of nitrogen limitation may be offset by algal fixation of atmospheric N.

Since the precise nature of the apparent internal load is unknown, there is considerable uncertainty in forecasting its response to reductions in external load. To the extent that it reflects recycling of recently deposited P or an artifact of sampling limitations, the internal load would be expected to decrease with reductions in external load, but over a longer time scale. Otherwise, an alum treatment or other sediment treatment would provide more immediate control. More detailed field studies would be needed to evaluate the nature and spatial extent of the internal load before proceeding with an alum treatment. Alternative load scenarios can be evaluated by UW using the calibrated input files provided.

Table 1 - Model Input File for 1996

Calibration to 1996 www 9/7/96

MODEL OPTIONS:

1	CONSERVATIVE SUBSTANCE	1 COMPUTED
2	PHOSPHORUS BALANCE	1 2ND ORDER, AVAIL P
3	NITROGEN BALANCE	0 NOT COMPUTED
4	CHLOROPHYLL-A	2 P, LIGHT, T
5	SECCHI DEPTH	1 VS. CHLA & TURBIDITY
6	DISPERSION	1 FISCHER-NUMERIC
7	PHOSPHORUS CALIBRATION	1 DECAY RATES
8	NITROGEN CALIBRATION	0 NONE
9	ERROR ANALYSIS	1 MODEL & DATA
10	AVAILABILITY FACTORS	1 USE FOR MODEL 1 ONLY
11	MASS-BALANCE TABLES	1 USE ESTIMATED CONCS

ATMOSPHERIC LOADS & AVAILABILITY FACTORS:

VARIABLE	ATMOSPHERIC-LOADS KG/KM2-YR	CV	AVAILABILITY FACTOR
1 CONSERV	.00	.00	.00
2 TOTAL P	30.00	.50	1.00
3 TOTAL N	1000.00	.50	.59
4 ORTHO P	15.00	.50	.00
5 INORG N	500.00	.50	.79

GLOBAL INPUT VALUES:

PARAMETER		MEAN	CV
PERIOD LENGTH	YRS	.500	.000
PRECIPITATION	M	.400	.200
EVAPORATION	M	.300	.300
INCREASE IN STORAGE	M	.000	.000

TRIBUTARY DRAINAGE AREAS AND FLOWS:

ID	TYPE	SEG	NAME	DRAINAGE AREA KM2	MEAN FLOW HM3/YR	CV OF MEAN FLOW
1	1	1	Wisconsin River	15462.000	4754.000	.030
2	1	1	10 Mile	190.000	62.000	.200
3	1	2	14 Mile	241.000	35.800	.200
4	5	2	Internal Load	.000	.000	.000

TRIBUTARY CONCENTRATIONS (PPB): MEAN/CV

ID	CONSERV	TOTAL P	TOTAL N	ORTHO P	INORG N
1	.0/ .00	128.0/ .08	.0/ .00	.0/ .00	.0/ .00
2	.0/ .00	74.0/ .77	.0/ .00	.0/ .00	.0/ .00
3	.0/ .00	26.0/ .20	.0/ .00	.0/ .00	.0/ .00
4	.0/ .00	20.0/ .20	.0/ .00	.0/ .00	.0/ .00

MODEL SEGMENTS & CALIBRATION FACTORS:

SEG	OUTFLOW	GROUP	SEGMENT NAME		CALIBRATION FACTORS: P SED	N SED	CHL-A	SECCHI	HOD	DISP
1	2	1	Inflow		1.00	1.00	1.00	1.00	1.00	1.000
				CV:	.000	.000	.000	.000	.000	.000
2	3	1	Upper		1.00	1.00	1.00	1.00	1.00	1.000
				CV:	.000	.000	.000	.000	.000	.000
3	4	1	Upper mid		1.00	1.00	1.00	1.00	1.00	1.000
				CV:	.000	.000	.000	.000	.000	.000
4	5	1	Middle		1.00	1.00	1.00	1.00	1.00	1.000
				CV:	.000	.000	.000	.000	.000	.000
5	6	1	Lower Middle		1.00	1.00	1.00	1.00	1.00	1.000
				CV:	.000	.000	.000	.000	.000	.000
6	0	1	Lower		1.00	1.00	1.00	1.00	1.00	1.000
				CV:	.000	.000	.000	.000	.000	.000

Table 1 (ct)

SEGMENT MORPHOMETRY: MEAN/CV

ID	LABEL	LENGTH KM	AREA KM2	ZMEAN M	ZMIX M	ZHYP M
1	Inflow	11.20	9.6000	2.20	2.20/ .00	.00/ .00
2	Upper	7.40	17.8000	3.20	3.20/ .00	.00/ .00
3	Upper mid	8.10	32.6000	4.50	4.50/ .00	.00/ .00
4	Middle	5.60	23.9000	6.90	6.90/ .00	.00/ .00
5	Lower Middle	5.50	23.0000	6.10	6.10/ .00	.00/ .00
6	Lower	4.20	19.0000	8.50	8.50/ .00	.00/ .00

SEGMENT OBSERVED WATER QUALITY:

SEG		TURBID 1/M	CONSER ---	TOTALP MG/M3	TOTALN MG/M3	CHL-A MG/M3	SECCHI M	ORG-N MG/M3	TP-OP MG/M3	HODV MG/M3-D	MODV MG/M3-D
1	MN:	.00	15.1	104.0	1210.0	56.9	.7	973.0	83.0	.0	.0
	CV:	.00	.07	.18	.18	.11	.09	.09	.19	.00	.00
2	MN:	.00	14.6	139.0	1408.0	70.0	.6	1215.0	113.0	.0	.0
	CV:	.00	.07	.18	.08	.11	.07	.09	.19	.00	.00
3	MN:	.50	.0	.0	.0	.0	.0	.0	.0	.0	.0
	CV:	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
4	MN:	.00	14.3	102.3	1360.0	34.0	.9	1096.0	71.0	.0	.0
	CV:	.00	.05	.06	.12	.21	.08	.09	.10	.00	.00
5	MN:	.50	.0	.0	.0	.0	.0	.0	.0	.0	.0
	CV:	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6	MN:	.00	13.3	82.0	1177.0	24.5	1.2	906.0	58.0	.0	.0
	CV:	.00	.06	.17	.11	.33	.13	.17	.25	.00	.00

MODEL COEFFICIENTS:

COEFFICIENT	MEAN	CV
DISPERSION FACTO	.000	.70
P DECAY RATE	.400	.45
N DECAY RATE	1.000	.55
CHL-A MODEL	1.700	.26
SECCHI MODEL	1.000	.10
ORGANIC N MODEL	1.000	.12
TP-OP MODEL	1.000	.15
HODV MODEL	1.000	.15
MODV MODEL	1.000	.22
BETA M2/MG	.015	.00
MINIMUM QS	4.000	.00
FLUSHING EFFECT	1.000	.00
CHLOROPHYLL-A CV	.620	.00

Table 2 - Model Output Files for 1996

CASE: Calibration to 1996

GROSS WATER BALANCE:

ID	T	LOCATION	DRAINAGE AREA KM2	---- FLOW (HM3/YR) ---- MEAN	VARIANCE	CV	RUNOFF M/YR
1	1	Wisconsin River	15462.000	4754.000	.565E+05	.050	.307
2	1	10 Mile	190.000	62.000	.154E+03	.200	.326
3	1	14 Mile	241.000	35.900	.513E+02	.200	.149
PRECIPITATION			124.900	99.920	.399E+03	.200	.800
TRIBUTARY INFLOW			15893.000	4851.800	.567E+05	.049	.305
***TOTAL INFLOW			16017.900	4951.720	.571E+05	.048	.309
ADVECTIVE OUTFLOW			16017.900	4876.780	.576E+05	.049	.304
***TOTAL OUTFLOW			16017.900	4876.780	.576E+05	.049	.304
***EVAPORATION			.000	74.940	.505E+03	.500	.000

GROSS MASS BALANCE BASED UPON ESTIMATED CONCENTRATIONS

COMPONENT: TOTAL P

ID	T	LOCATION	----- LOADING ---- KG/YR	%(I)	--- VARIANCE --- KG/YR**2	%(I)	CV	CONC MG/M3	EXPORT KG/KM2
1	1	Wisconsin River	608512.0	81.4	.336E+10	16.5	.095	128.0	39.4
2	1	10 Mile	4588.0	.6	.133E+08	.1	.796	74.0	24.1
3	1	14 Mile	930.8	.1	.693E+05	.0	.283	26.0	3.9
PRECIPITATION			3747.0	.5	.351E+07	.0	.500	37.5	30.0
INTERNAL LOAD			130029.0	17.4	.169E+11	83.4	1.000	.0	.0
TRIBUTARY INFLOW			614030.8	82.1	.337E+10	16.6	.095	126.6	38.6
***TOTAL INFLOW			747806.8	100.0	.203E+11	100.0	.190	151.0	46.7
ADVECTIVE OUTFLOW			384812.1	51.5	.796E+10	39.2	.232	78.9	24.0
***TOTAL OUTFLOW			384812.1	51.5	.796E+10	39.2	.232	78.9	24.0
***RETENTION			362994.7	48.5	.154E+11	75.9	.342	.0	.0

OVERFLOW RATE M/YR	HYDRAULIC RESIDENCE TIME YRS	TOTAL P: POOL CONC MG/M3	RESIDENCE TIME YRS	TURNOVER RATIO -	RETENTION COEF -
39.05	.1400	106.7	.0974	5.1313	.4854

CASE: Calibration to 1996

T STATISTICS COMPARE OBSERVED AND PREDICTED MEANS
USING THE FOLLOWING ERROR TERMS:
1 = OBSERVED WATER QUALITY ERROR ONLY
2 = ERROR TYPICAL OF MODEL DEVELOPMENT DATA SET
3 = OBSERVED AND PREDICTED ERROR

SEGMENT: 7 AREA-WTD MEAN

VARIABLE		OBSERVED MEAN	CV	ESTIMATED MEAN	CV	RATIO	T STATISTICS 1	2	3
CONSERVATIVE SUB		14.1	.06	.0	.00	.00	.00	.00	.00
TOTAL P	MG/M3	106.7	.14	106.8	.17	1.00	-.01	.00	-.01
TOTAL N	MG/M3	1304.0	.10	1304.0	.06	1.00	.00	.00	.00
C.NUTRIENT	MG/M3	71.0	.12	71.0	.08	1.00	-.01	.00	.00
CHL A	MG/M3	44.0	.17	44.1	.27	1.00	.01	.01	.01
SECCHI	M	.9	.09	.9	.17	.99	-.11	-.04	-.05
ORGANIC N	MG/M3	1060.2	.11	1199.8	.26	.88	1.15	.49	.44
TP-ORTHO-P	MG/M3	80.1	.17	86.4	.29	.93	-.45	-.21	-.23

CASE: Calibration to 1996

Table 2 (ct)

OBSERVED AND PREDICTED DIAGNOSTIC VARIABLES
RANKED AGAINST CE MODEL DEVELOPMENT DATA SET

SEGMENT: 7 AREA-WTD MEAN

VARIABLE	----- VALUES ----- OBSERVED	ESTIMATED	--- RANKS (%) ---- OBSERVED	ESTIMATED
CONSERVATIVE SUB	14.14	.00	.0	.0
TOTAL P MG/M3	106.69	106.82	81.3	81.4
TOTAL N MG/M3	1304.02	1304.02	66.0	66.0
C.NUTRIENT MG/M3	70.97	71.02	80.5	80.5
CHL A MG/M3	43.95	44.05	97.7	97.8
SECCHI M	.91	.92	40.9	41.5
ORGANIC N MG/M3	1060.18	1199.80	94.3	96.6
TP-ORTHO-P MG/M3	80.07	86.41	84.9	86.7
ANTILOG PC-1	1245.89	1298.16	89.3	89.8
ANTILOG PC-2	16.37	16.85	96.2	96.6
(N - 150) / P	10.82	10.80	25.3	25.3
INORGANIC N / P	9.16	5.11	11.9	3.9
TURBIDITY 1/M	.51	.51	42.1	42.1
ZMIX * TURBIDITY	2.79	2.79	43.8	43.8
ZMIX / SECCHI	6.03	5.96	65.6	64.9
CHL-A * SECCHI	39.89	40.40	97.3	97.4
CHL-A / TOTAL P	.41	.41	87.9	87.9
FREQ(CHL-a>10) %	98.11	98.13	.0	.0
FREQ(CHL-a>20) %	83.15	83.24	.0	.0
FREQ(CHL-a>30) %	62.02	62.16	.0	.0
FREQ(CHL-a>40) %	43.71	43.86	.0	.0
FREQ(CHL-a>50) %	30.22	30.35	.0	.0
FREQ(CHL-a>60) %	20.84	20.94	.0	.0
CARLSON TSI-P	71.49	71.51	.0	.0
CARLSON TSI-CHLA	67.71	67.73	.0	.0
CARLSON TSI-SEC	61.40	61.25	.0	.0

Table 3 - Model Input File for 1997

May Oct 1997

MODEL OPTIONS:

1	CONSERVATIVE SUBSTANCE	0 NOT COMPUTED
2	PHOSPHORUS BALANCE	1 2ND ORDER, AVAIL P
3	NITROGEN BALANCE	0 NOT COMPUTED
4	CHLOROPHYLL-A	2 P, LIGHT, T
5	SECCHI DEPTH	1 VS. CHLA & TURBIDITY
6	DISPERSION	1 FISCHER-NUMERIC
7	PHOSPHORUS CALIBRATION	1 DECAY RATES
8	NITROGEN CALIBRATION	0 NONE
9	ERROR ANALYSIS	1 MODEL & DATA
10	AVAILABILITY FACTORS	1 USE FOR MODEL 1 ONLY
11	MASS-BALANCE TABLES	1 USE ESTIMATED CONCS

ATMOSPHERIC LOADS & AVAILABILITY FACTORS:

VARIABLE	ATMOSPHERIC-LOADS KG/KM2-YR	CV	AVAILABILITY FACTOR
1 CONSERV	.00	.00	.00
2 TOTAL P	30.00	.50	1.00
3 TOTAL N	1000.00	.50	.59
4 ORTHO P	15.00	.50	.00
5 INORG N	500.00	.50	.79

GLOBAL INPUT VALUES:

PARAMETER	MEAN	CV
PERIOD LENGTH YRS	.500	.000
PRECIPITATION M	.400	.200
EVAPORATION M	.300	.300
INCREASE IN STORAGE M	.000	.000

TRIBUTARY DRAINAGE AREAS AND FLOWS:

ID	TYPE	SEG	NAME	DRAINAGE AREA KM2	MEAN FLOW HM3/YR	CV OF MEAN FLOW
1	1	1	Wisconsin River	15462.000	3769.000	.030
2	1	1	10 Mile	190.000	49.200	.200
3	1	2	14 Mile	241.000	27.700	.200
4	5	2	Internal Load	.000	.000	.000

TRIBUTARY CONCENTRATIONS (PPB): MEAN/CV

ID	CONSERV	TOTAL P	TOTAL N	ORTHO P	INORG N
1	.0/ .00	152.0/ .07	.0/ .00	.0/ .00	.0/ .00
2	.0/ .00	74.0/ .77	.0/ .00	.0/ .00	.0/ .00
3	.0/ .00	26.0/ .20	.0/ .00	.0/ .00	.0/ .00
4	.0/ .00	20.0/ .20	.0/ .00	.0/ .00	.0/ .00

MODEL SEGMENTS & CALIBRATION FACTORS:

SEG	OUTFLOW	GROUP	SEGMENT NAME		P SED	N SED	CHL-A	SECCHI	HOD	DISP
					----------- CALIBRATION FACTORS -----------					
1	2	1	Inflow		1.00	1.00	1.00	1.00	1.00	1.000
				CV:	.000	.000	.000	.000	.000	.000
2	3	1	Upper		1.00	1.00	1.00	1.00	1.00	1.000
				CV:	.000	.000	.000	.000	.000	.000
3	4	1	Upper mid		1.00	1.00	1.00	1.00	1.00	1.000
				CV:	.000	.000	.000	.000	.000	.000
4	5	1	Middle		1.00	1.00	1.00	1.00	1.00	1.000
				CV:	.000	.000	.000	.000	.000	.000
5	6	1	Lower Middle		1.00	1.00	1.00	1.00	1.00	1.000
				CV:	.000	.000	.000	.000	.000	.000
6	0	1	Lower		1.00	1.00	1.00	1.00	1.00	1.000
				CV:	.000	.000	.000	.000	.000	.000

Table 3 (ct)

SEGMENT MORPHOMETRY: MEAN/CV

ID	LABEL	LENGTH KM	AREA KM2	ZMEAN M	ZMIX M	ZHYP M
1	Inflow	11.80	9.6000	2.20	2.20/ .12	.00/ .00
2	Upper	4.30	17.8000	3.20	3.20/ .12	.00/ .00
3	Upper mid	5.30	32.6000	4.50	4.50/ .12	.00/ .00
4	Middle	4.70	23.9000	6.90	6.90/ .12	.00/ .00
5	Lower Middle	4.50	23.0000	6.10	6.10/ .12	.00/ .00
6	Lower	3.90	19.0000	8.50	8.50/ .12	.00/ .00

SEGMENT OBSERVED WATER QUALITY:

SEG		TURBID 1/M	CONSER ---	TOTALP MG/M3	TOTALN MG/M3	CHL-A MG/M3	SECCHI M	ORG-N MG/M3	TP-OP MG/M3	HODV MG/M3-D	MODV MG/M3-D
1	MN:	.00	14.6	141.0	1287.0	63.8	.7	1057.0	114.0	.0	.0
	CV:	.00	.05	.04	.10	.09	.06	.11	.06	.00	.00
2	MN:	.00	13.9	213.0	2002.0	92.1	.5	1699.0	180.0	.0	.0
	CV:	.00	.05	.20	.39	.31	.20	.39	.21	.00	.00
3	MN:	.50	.0	.0	.0	.0	.0	.0	.0	.0	.0
	CV:	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
4	MN:	.00	13.4	139.0	1577.0	54.8	.7	1288.0	100.0	.0	.0
	CV:	.00	.03	.08	.07	.21	.08	.09	.09	.00	.00
5	MN:	.50	.0	.0	.0	.0	.0	.0	.0	.0	.0
	CV:	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6	MN:	.00	12.4	89.0	1002.0	28.2	1.2	710.0	59.0	.0	.0
	CV:	.00	.05	.05	.16	.26	.17	.20	.15	.00	.00

MODEL COEFFICIENTS:

COEFFICIENT	MEAN	CV
DISPERSION FACTO	.000	.70
P DECAY RATE	.400	.45
N DECAY RATE	1.000	.55
CHL-A MODEL	1.600	.26
SECCHI MODEL	1.000	.10
ORGANIC N MODEL	1.000	.12
TP-OP MODEL	1.000	.15
HODV MODEL	1.000	.15
MODV MODEL	1.000	.22
BETA M2/MG	.015	.00
MINIMUM QS	4.000	.00
FLUSHING EFFECT	1.000	.00
CHLOROPHYLL-A CV	.620	.00

Table 4 - Model Output Files for 1997

CASE: May Oct 1997

GROSS WATER BALANCE:

ID	T	LOCATION	DRAINAGE AREA KM2	FLOW (HM3/YR) MEAN	VARIANCE	CV	RUNOFF M/YR
1	1	Wisconsin River	15462.000	3769.000	.355E+05	.050	.244
2	1	10 Mile	190.000	49.200	.968E+02	.200	.259
3	1	14 Mile	241.000	27.700	.307E+02	.200	.115
PRECIPITATION			124.900	99.920	.399E+03	.200	.800
TRIBUTARY INFLOW			15893.000	3845.900	.356E+05	.049	.242
***TOTAL INFLOW			16017.900	3945.820	.360E+05	.048	.246
ADVECTIVE OUTFLOW			16017.900	3870.880	.365E+05	.049	.242
***TOTAL OUTFLOW			16017.900	3870.880	.365E+05	.049	.242
***EVAPORATION			.000	74.940	.505E+03	.500	.000

GROSS MASS BALANCE BASED UPON ESTIMATED CONCENTRATIONS

COMPONENT: TOTAL P

ID	T	LOCATION	LOADING KG/YR	%(I)	VARIANCE KG/YR**2	%(I)	CV	CONC MG/M3	EXPORT KG/KM2
1	1	Wisconsin River	572868.0	80.6	.243E+10	77.9	.066	152.0	37.1
2	1	10 Mile	3640.8	.5	.839E+07	.3	.796	74.0	19.2
3	1	14 Mile	720.2	.1	.415E+05	.0	.283	26.0	3.0
PRECIPITATION			3747.0	.5	.351E+07	.1	.500	37.5	30.0
INTERNAL LOAD			130029.0	18.3	.676E+09	21.7	.200	.0	.0
TRIBUTARY INFLOW			577249.0	81.2	.244E+10	78.2	.086	150.1	36.3
***TOTAL INFLOW			711025.0	100.0	.312E+10	100.0	.079	180.2	44.4
ADVECTIVE OUTFLOW			309999.5	43.6	.536E+10	171.9	.236	80.1	19.4
***TOTAL OUTFLOW			309998.5	43.6	.536E+10	171.9	.236	80.1	19.4
***RETENTION			401026.5	56.4	.640E+10	205.2	.159	.0	.0

OVERFLOW RATE M/YR	HYDRAULIC RESIDENCE TIME YRS	TOTAL P POOL CONC MG/M3	RESIDENCE TIME YRS	TURNOVER RATIO -	RETENTION COEF -
30.99	.1764	145.3	.1396	3.5825	.5640

CASE: May-Oct 1997

T STATISTICS COMPARE OBSERVED AND PREDICTED MEANS
USING THE FOLLOWING ERROR TERMS:
1 = OBSERVED WATER QUALITY ERROR ONLY
2 = ERROR TYPICAL OF MODEL DEVELOPMENT DATA SET
3 = OBSERVED AND PREDICTED ERROR

SEGMENT: 7 AREA-WTD MEAN

VARIABLE		OBSERVED MEAN	CV	ESTIMATED MEAN	CV	RATIO	T STATISTICS 1	2	3
CONSERVATIVE SUB		13.4	.03	13.4	.02	1.00	.00	.00	.00
TOTAL P	MG/M3	145.3	.12	116.8	.13	1.24	1.86	.81	1.23
TOTAL N	MG/M3	1496.6	.20	1496.6	.14	1.00	.00	.00	.00
C.NUTRIENT	MG/M3	88.6	.17	80.7	.10	1.10	.55	.46	.47
CHL A	MG/M3	58.7	.24	48.0	.28	1.22	.85	.58	.55
SECCHI	M	.8	.13	.9	.18	.88	-.94	-.44	-.55
ORGANIC N	MG/M3	1211.4	.22	1289.3	.26	.94	.28	.25	.18
TP-ORTHO-P	MG/M3	111.8	.15	93.2	.29	1.20	1.23	.50	.56

Table 4 (ct)

OBSERVED AND PREDICTED DIAGNOSTIC VARIABLES
RANKED AGAINST CE MODEL DEVELOPMENT DATA SET

SEGMENT: 7 AREA-WTD MEAN

VARIABLE	VALUES OBSERVED	VALUES ESTIMATED	RANKS (%) OBSERVED	RANKS (%) ESTIMATED
CONSERVATIVE SUB	13.43	13.43	.0	.0
TOTAL P MG/M3	145.30	116.80	89.1	83.9
TOTAL N MG/M3	1496.64	1496.64	73.5	73.5
C.NUTRIENT MG/M3	88.57	80.74	87.2	84.6
CHL-A MG/M3	58.72	48.01	99.1	98.3
SECCHI M	.79	.89	33.8	40.0
ORGANIC N MG/M3	1211.44	1289.26	96.7	97.5
TP-ORTHO-P MG/M3	111.84	93.18	91.7	88.4
ANTILOG PC-1	1868.26	1526.51	94.0	91.9
ANTILOG PC-2	17.73	17.28	97.3	97.0
(N - 150) / P	9.27	11.53	18.6	28.4
INORGANIC N / P	8.52	8.78	10.5	11.0
TURBIDITY 1/M	.50	.50	41.0	41.0
ZMIX * TURBIDITY	2.73	2.73	42.6	42.6
ZMIX / SECCHI	6.95	6.14	74.1	66.8
CHL-A * SECCHI	46.20	42.77	98.4	97.9
CHL-A / TOTAL P	.40	.41	87.2	87.8
FREQ(CHL-a>10) %	99.45	98.68	.0	.0
FREQ(CHL-a>20) %	92.32	86.49	.0	.0
FREQ(CHL-a>30) %	78.03	67.32	.0	.0
FREQ(CHL-a>40) %	62.15	49.37	.0	.0
FREQ(CHL-a>50) %	47.97	35.36	.0	.0
FREQ(CHL-a>60) %	36.51	25.16	.0	.0
CARLSON TSI-P	75.94	72.80	.0	.0
CARLSON TSI-CHLA	70.55	68.58	.0	.0
CARLSON TSI-SEC	63.45	61.67	.0	.0

Table 5
Predicted Responses to Hypothetical Reductions in Wisconsin River P Concentration & Internal P Load

Internal Load Reduction = 0%

Wisc R. P Reduction	1	2	3	4	5	6	Weighted Mean
Total P (ppb)							
0%	123.9	136.6	117.5	100.2	88.8	78.9	106.6
25%	93.8	112.6	97.9	85.4	76.9	69.3	89.3
50%	63.3	85.5	76.6	68.6	62.9	57.7	70.1
75%	32.4	57.2	53.0	49.0	46.0	43.1	48.6
Chlorophyll-a (ppb)							
0%	92.2	70.6	48.7	27.8	31.3	21.6	44.1
25%	75.5	63.3	44.6	26.0	29.1	20.4	39.7
50%	53.6	53.1	38.7	23.3	26.0	18.6	33.7
75%	26.2	38.7	29.7	18.9	20.9	15.5	25.0
Secchi (meters)							
0%	0.53	0.62	0.81	1.04	1.03	1.30	0.92
25%	0.61	0.66	0.86	1.07	1.07	1.33	0.96
50%	0.76	0.74	0.93	1.12	1.12	1.38	1.03
75%	1.10	0.88	1.06	1.21	1.23	1.47	1.16

Internal Load Reduction = 100%

Wisc R. P Reduction	1	2	3	4	5	6	Weighted Mean
Total P (ppb)							
0%	123.9	115.3	100.0	87.1	78.2	70.4	93.3
25%	93.8	88.7	79.2	70.6	64.6	59.1	74.4
50%	63.3	60.9	56.2	51.7	48.3	45.2	53.5
75%	32.4	31.8	30.5	29.2	28.1	27.1	29.7
Chlorophyll-a (ppb)							
0%	92.2	64.1	45.1	26.2	29.4	20.6	41.4
25%	75.5	54.5	39.5	23.7	26.4	18.9	36.0
50%	53.6	40.8	31.1	19.6	21.7	16.0	28.1
75%	26.2	21.5	17.8	12.4	13.6	10.7	16.2
Secchi (meters)							
0%	0.53	0.66	0.85	1.07	1.06	1.33	0.95
25%	0.61	0.72	0.92	1.11	1.12	1.37	1.01
50%	0.76	0.85	1.03	1.19	1.21	1.46	1.11
75%	1.10	1.13	1.30	1.37	1.42	1.65	1.35

May-September 1996 Conditions
Wisconsin River Inflow Conc = 128 ppb for 0% Reduction

Figure 1
Observed & Predicted Conditions - 1996

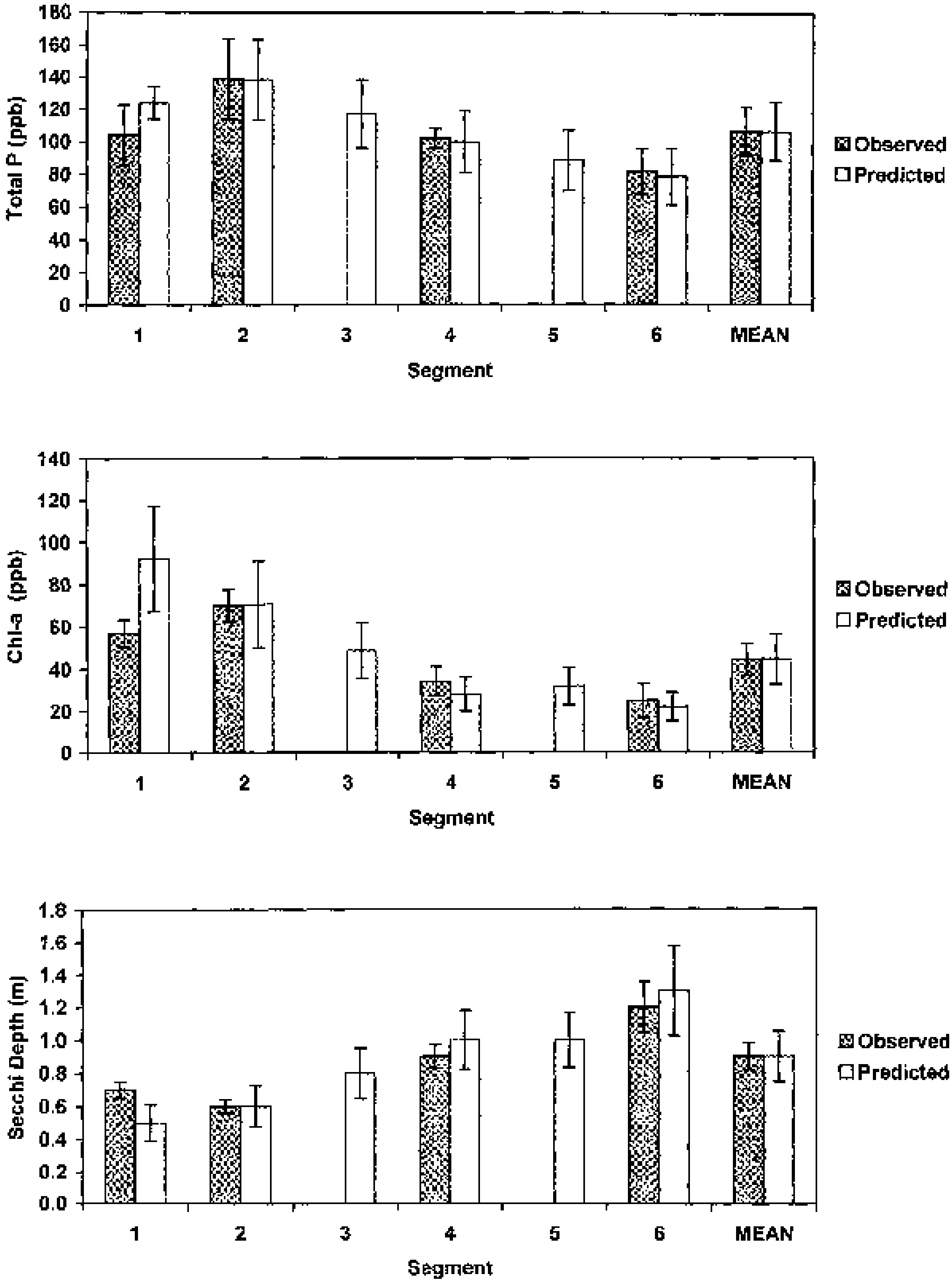

Figure 2
Observed & Predicted Conditions - 1997

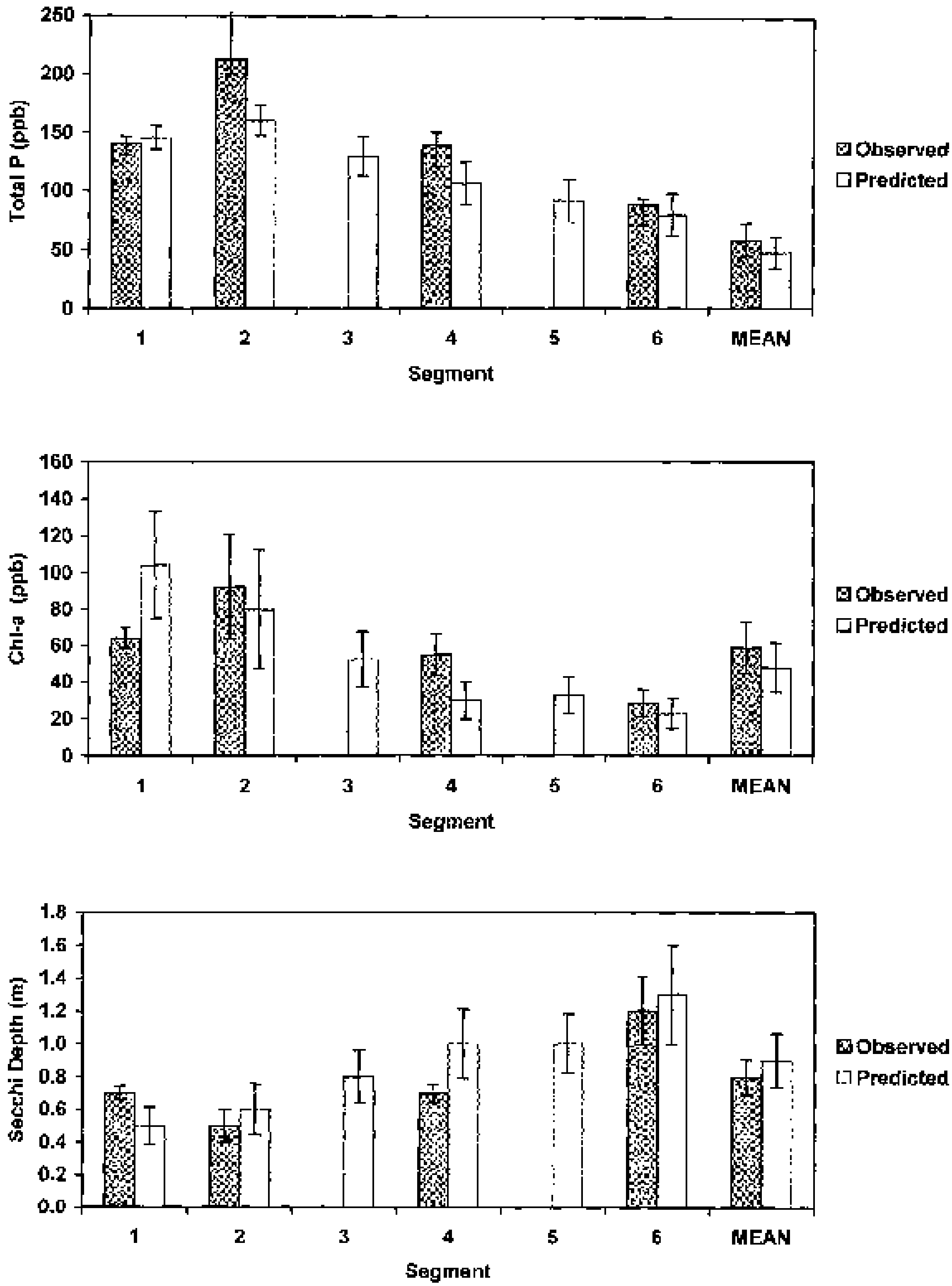

Figure 3
Sampled Flows & Concentrations, Wisconsin River at Nekoosa
May-October, 1994-1998