Overview for 2005

Annual Loading = 226.2 vs. 225 lbs limit

Maximum 3 Month Loading = 78.3 (Oct) and 77.4 (Nov) vs. 70 lbs limit

Hatchery Flow = 8.02 vs. 20 mgd limit

14,571 passed vs. 20,000 Adult Coho limit

571 passed vs. 1,000 Adult Chinook limit

Lake TP Concentration: 8.2 mg/m^3 volume - weighted

41% vs. 95% compliance with 8 mg/m^3 goal

Hatchery renovations have been completed.

Database capabilities have been expanded and historical and regional data added.

Storm event and tributary data have been collected. Correlations developed.

Hatchery P Mass Balance has been completed.

Preliminary Hatchery Process Model Developed

Special Studies: Sediment study completed. Bio-availability approved.

Watershed P and Flow Mass Balance have been completed.

Preliminary BASINS model completed – Funds approved to complete calibration

Preliminary Steady State and Seasonal water Quality Models Developed for Lake

Figure 1. Overview of 2005 Annual Report.

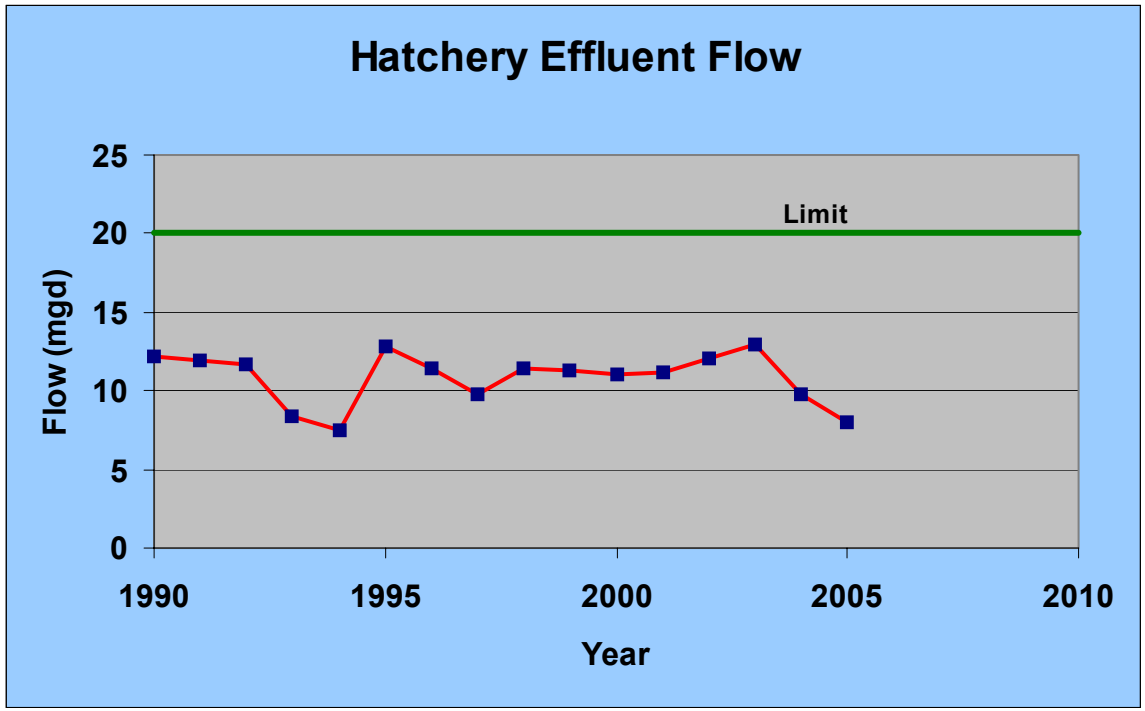


Figure 2. Annual Average Effluent Flow Rate.

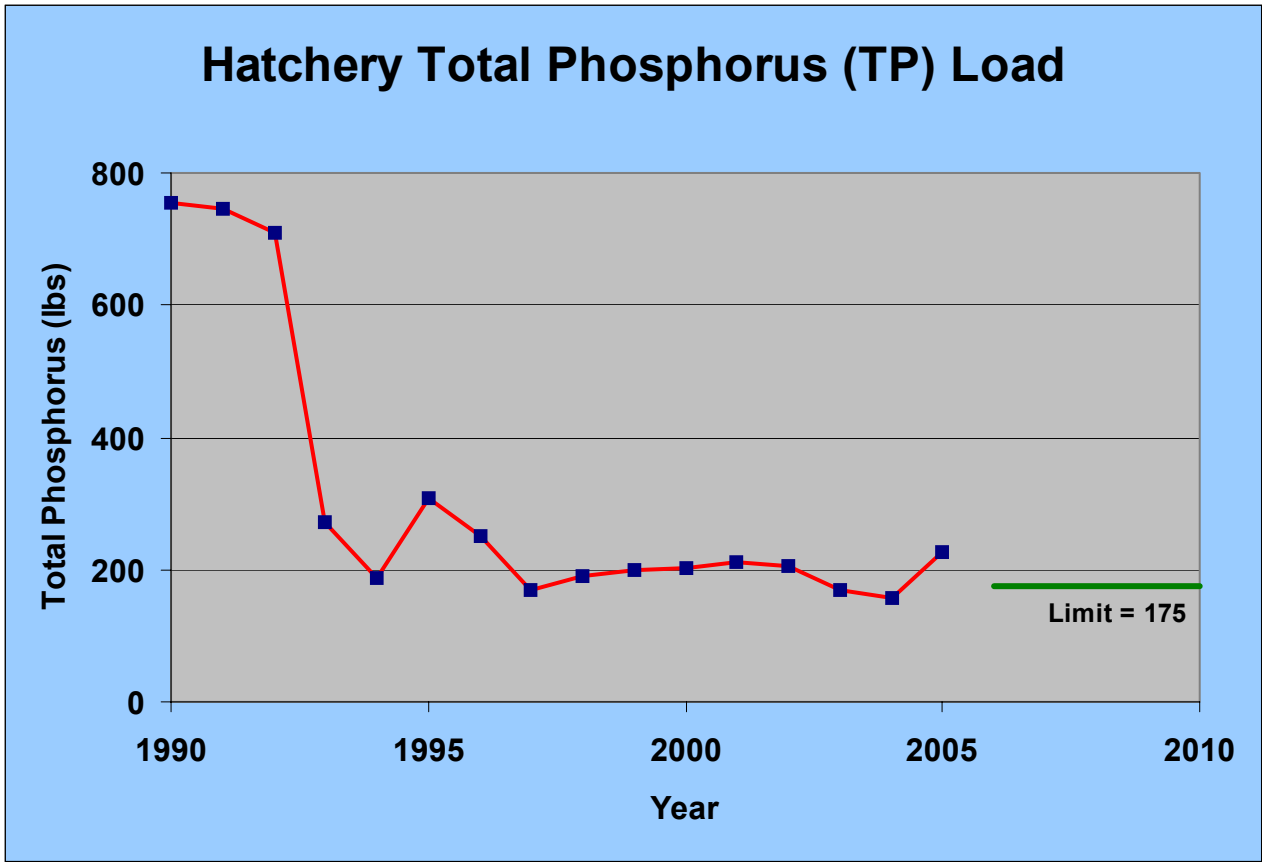


Figure 3. Hatchery Net Total Phosphorus Load (J/N).

Figure 4.

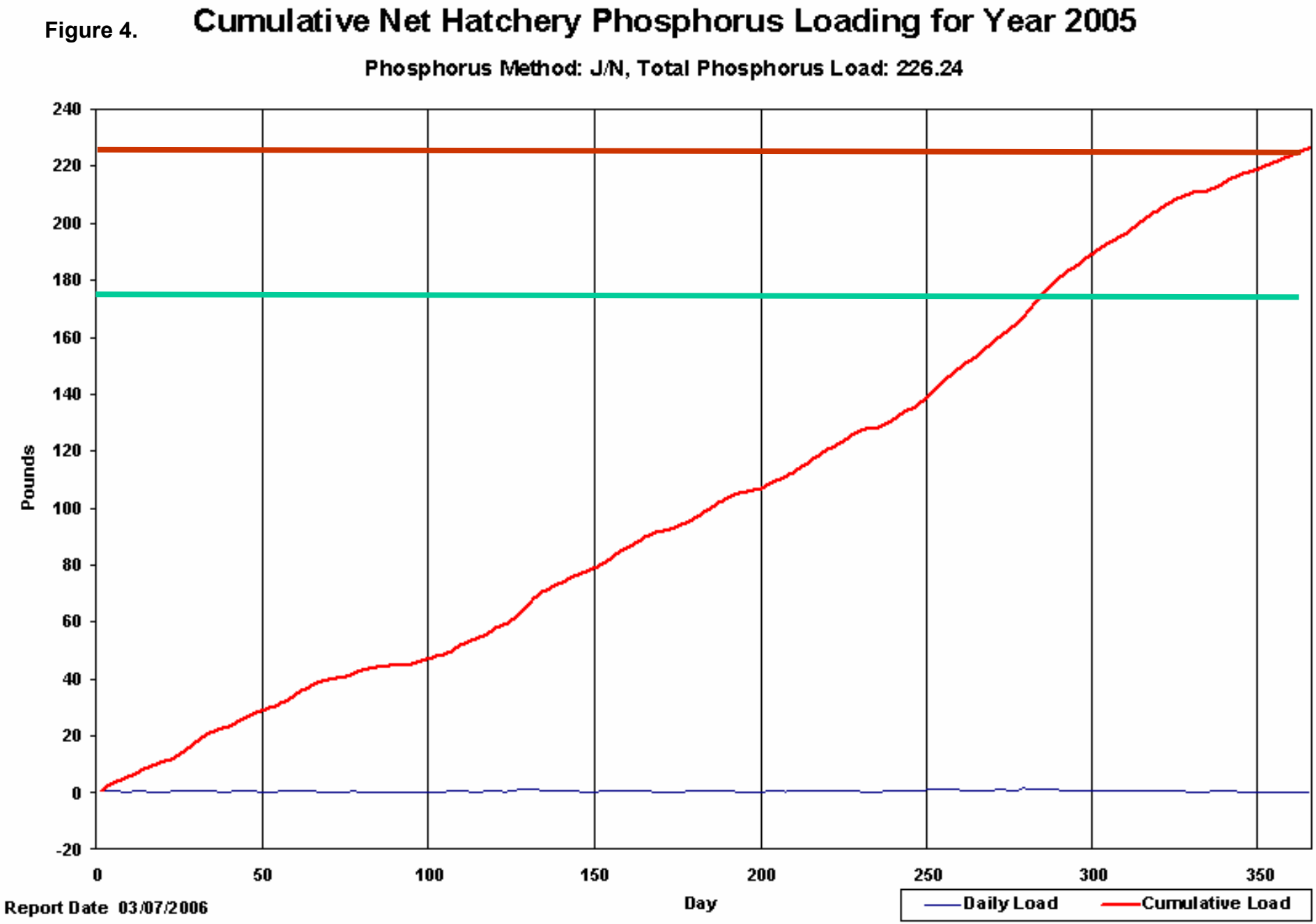

Cumulative Net Hatchery Phosphorus Loading for Year 2005
Phosphorus Method: J/N, Total Phosphorus Load: 226.24
Pounds
240
220
200
180
160
140
120
100
80
60
40
20
0
-20
0
50
100
150
200
250
300
350
Day
Report Date 03/07/2006
Daily Load
Cumulative Load

Figure 5.

Hatchery Average Monthly Net Load for 2005

Total Net Load is 226.24 Pounds for Method Jug & Needle (J/N)

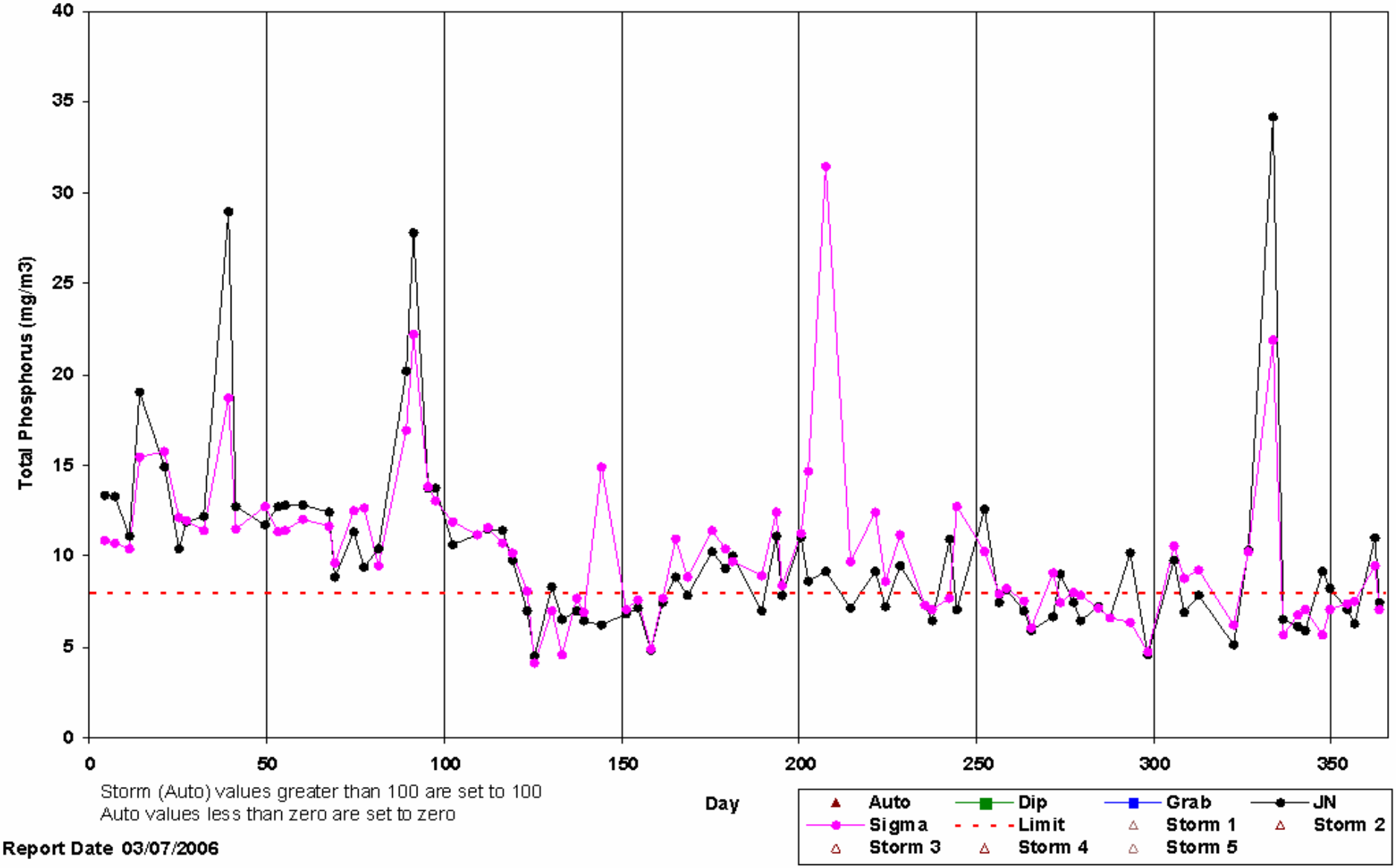
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bypass	0	0	0	0	0	0	0	0	0	0	0	0
Outfall	19.01	15.02	10.41	13.33	21.94	17.52	17.03	19.37	27.75	31.2	18.48	15.18
3 Mon	62.5	50.84	44.44	38.76	45.69	52.79	56.49	53.92	64.15	78.32	77.43	64.86
Limit	70	70	70	70	70	70	70	70	70	70	70	70

Report Date 03/07/2006

Figure 6.

Brundage Creek at Intake - Phosphorus for Year 2005

Average J/N: 10.00, Average Sigma: 10.20



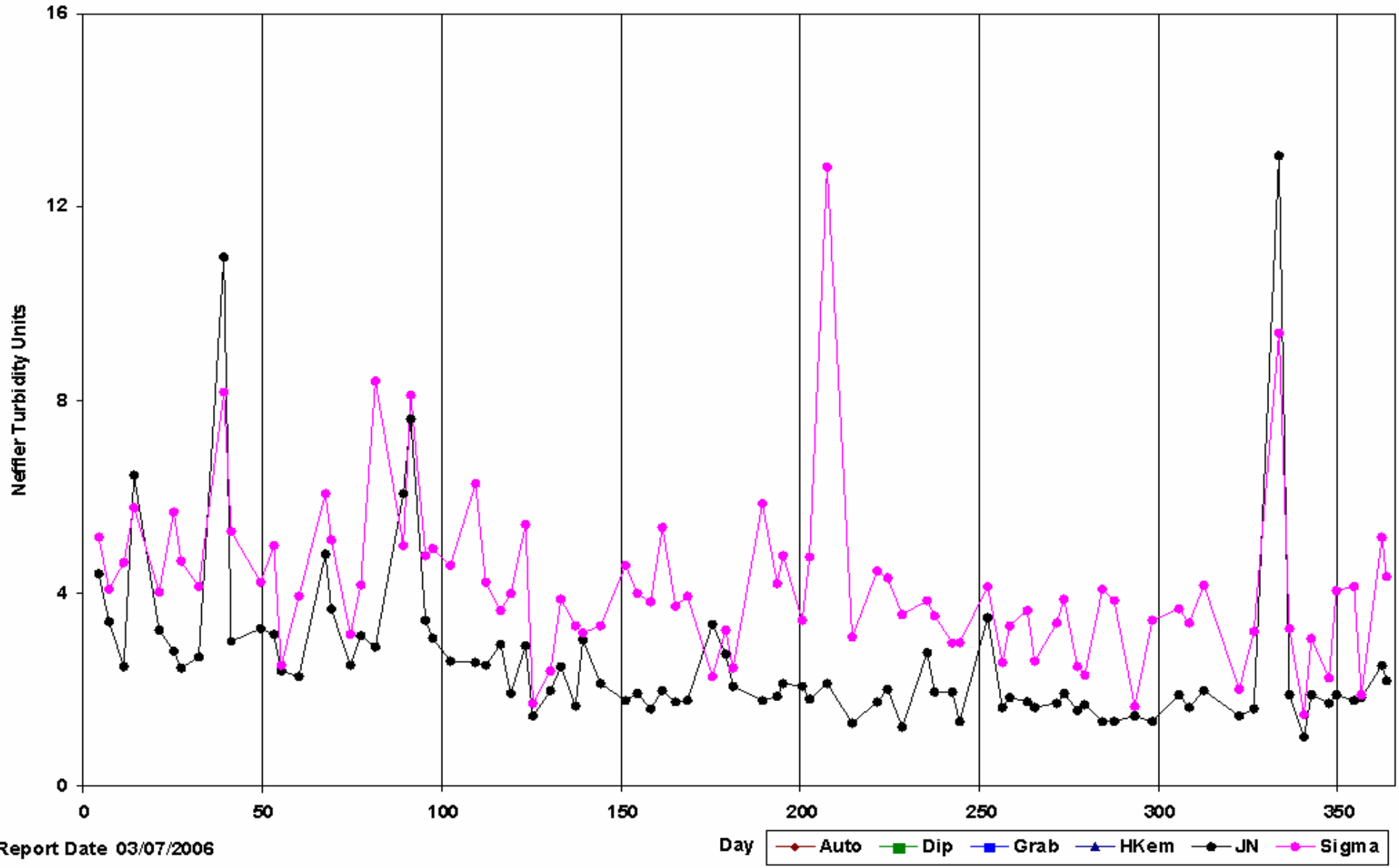
Storm (Auto) values greater than 100 are set to 100
Auto values less than zero are set to zero

Report Date 03/07/2006

Figure 7.

Brundage Creek at Intake Turbidity for Year 2005

Average J/N: 2.61, Average Sigma: 4.16

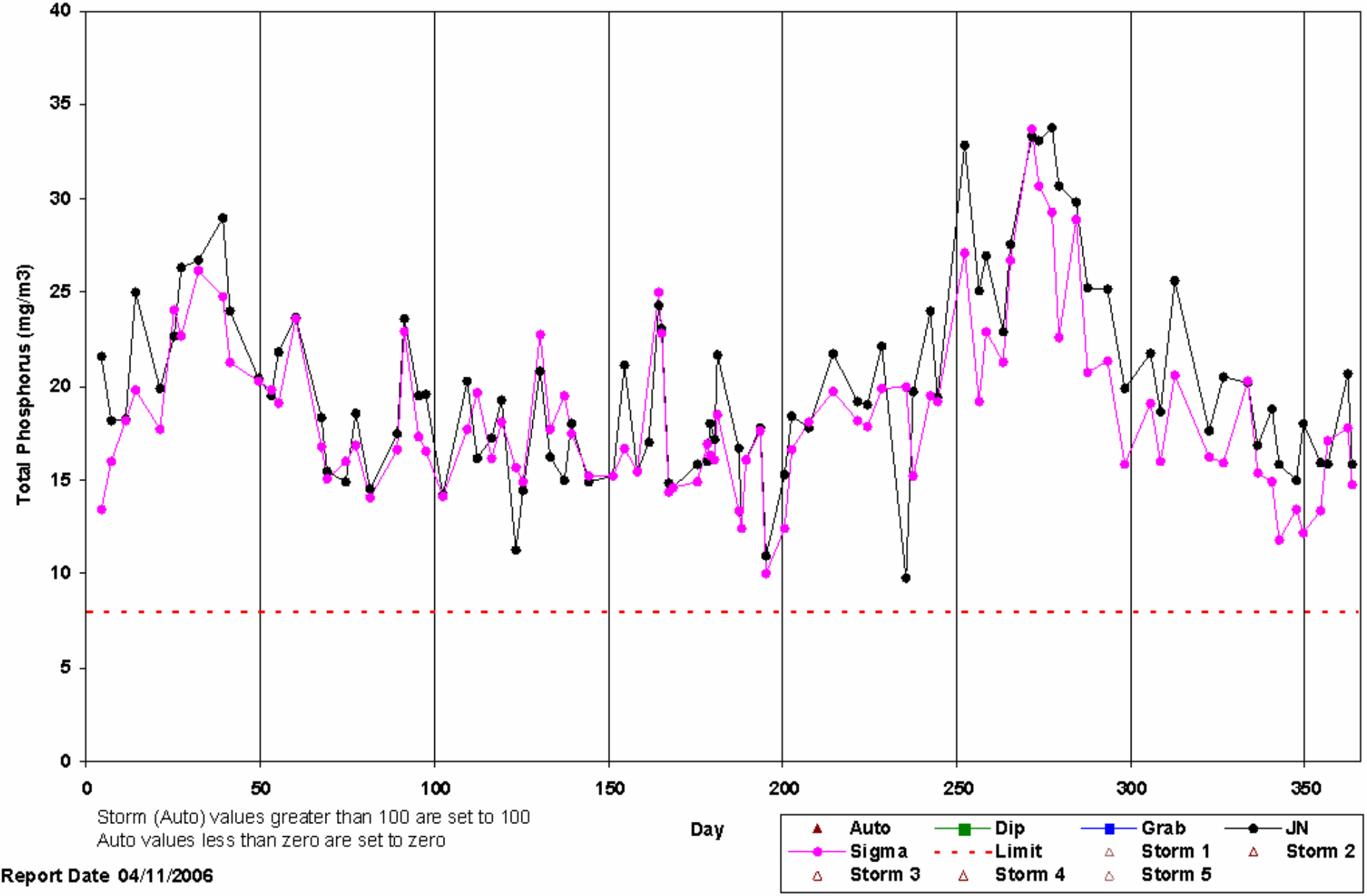


Report Date 03/07/2006

Figure 8.

Upper Discharge - Outfall 0002 - Phosphorus for Year 2005

Average J/N: 19.95, Average Sigma: 18.46



Storm (Auto) values greater than 100 are set to 100
Auto values less than zero are set to zero

Report Date 04/11/2006

	JN TP	JN Tur	Sigma TP	Sigma Tur
Spring	**12.2**	**2**	**10.2**	**2.1**
Creek	**10.0**	**2.6**	**10.2**	**4.2**
Pond In	**17.8**	**2.4**	**13.8**	**3.4**
Pond Out	**19.9**	**1.9**	**18.5**	**2.2**
Net Load	**226**		**197**	

Figure 9. Summary of Annual Average Jug & Needle and Sigma Hatchery Measurements for 2005.

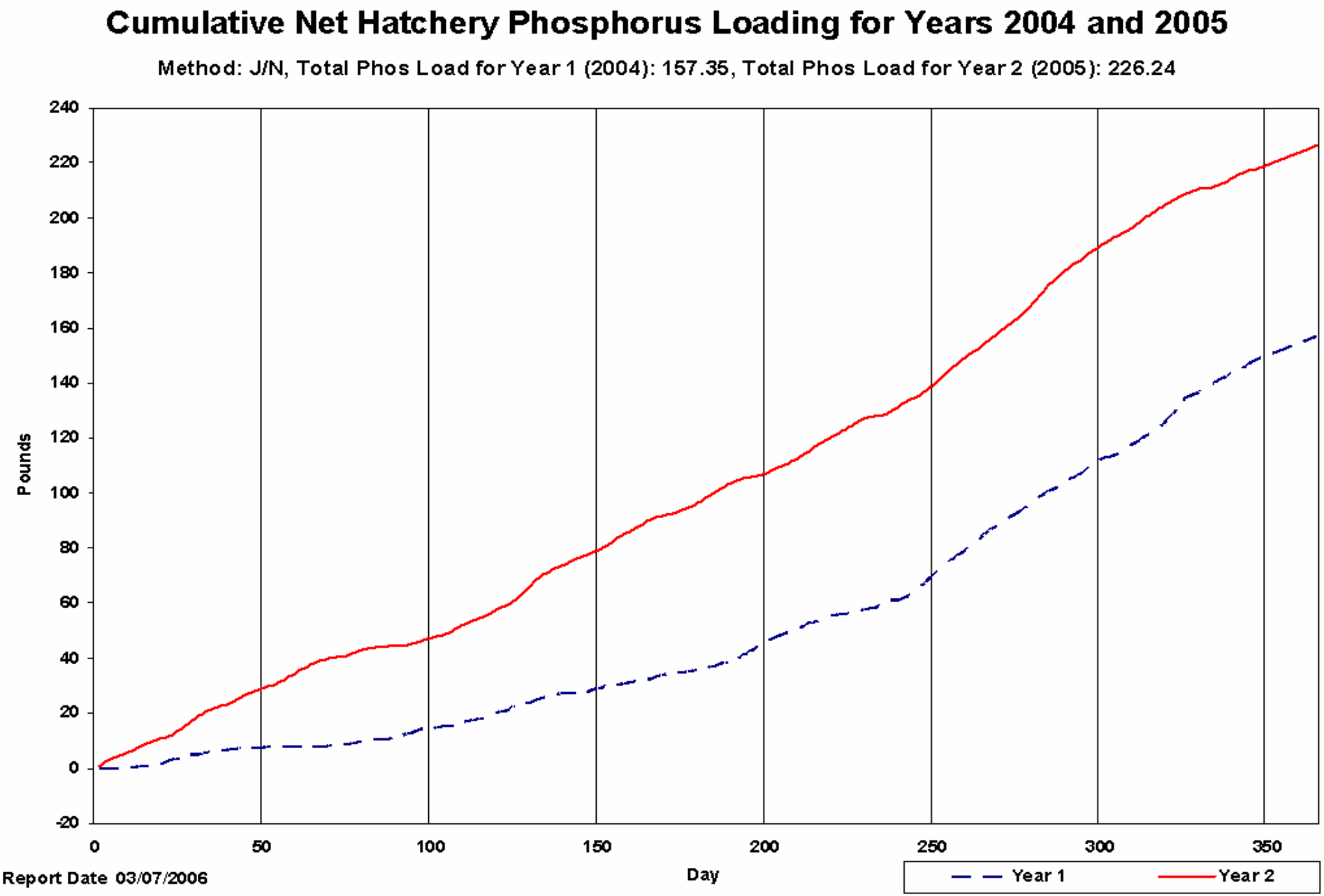

Cumulative Net Hatchery Phosphorus Loading for Years 2004 and 2005
Method: J/N, Total Phos Load for Year 1 (2004): 157.35, Total Phos Load for Year 2 (2005): 226.24
Pounds
240
220
200
180
160
140
120
100
80
60
40
20
0
-20
0
50
100
150
200
250
300
350
Day
Report Date 03/07/2006
Year 1
Year 2

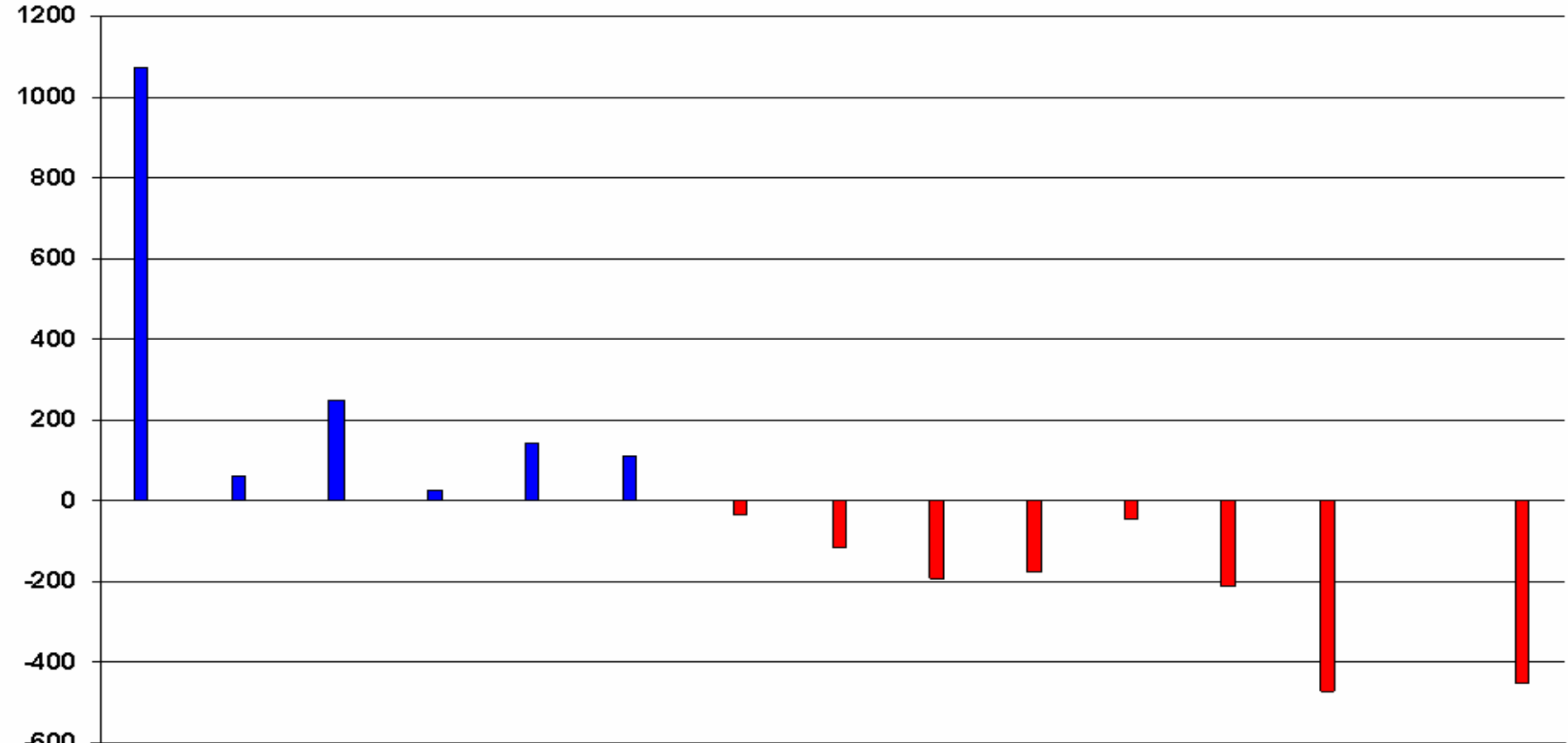
Figure 10.

Figure 11.

Hatchery Phosphorus Mass Balance for 2004

Total Sources: 1659.87 lbs, Total Losses: 1707.04 lbs

Method: Jug & Needle



	Feed	Spring	Creek	River	Fish Strt	Eggs In	Egg Morts	Fish Morts	Shipped	Planted	Pond	Waste Tank	Outlet	Bypass	Fish End
Sources	1070.98	62.09	249.32	25.32	142.63	109.52	0	0	0	0	0	0	0	0	0
Losses	0	0	0	0	0	0	-32.56	-118.82	-192.15	-179.13	-45.36	-213.2	-471.19	0	-454.65

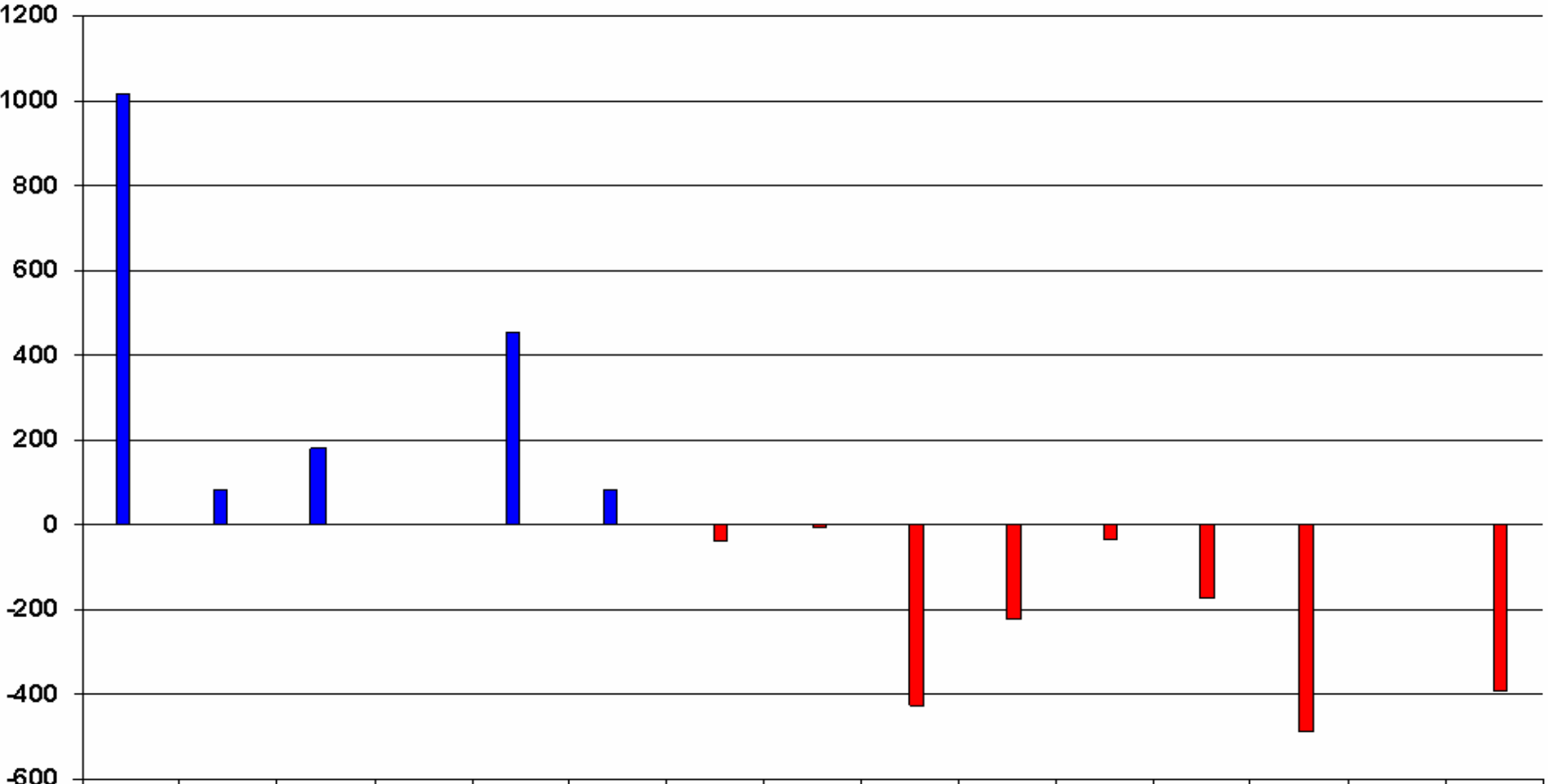
ort Date 03/07/2006

Figure 12.

Hatchery Phosphorus Mass Balance for 2005

Total Sources: 1818.28 lbs, Total Losses: 1779.81 lbs

Method: Jug & Needle



	Feed	Spring	Creek	River	Fish Strt	Eggs In	Egg Morts	Fish Morts	Shipped	Planted	Pond	Waste Tank	Outlet	Bypass	Fish End
ources	1016.54	81.4	182.92	0	454.64	82.79	0	0	0	0	0	0	0	0	0
osses	0	0	0	0	0	0	-36.67	-8.55	-427.57	-221.6	-33.58	-172.37	-486.75	0	-392.72

t Date 04/11/2006

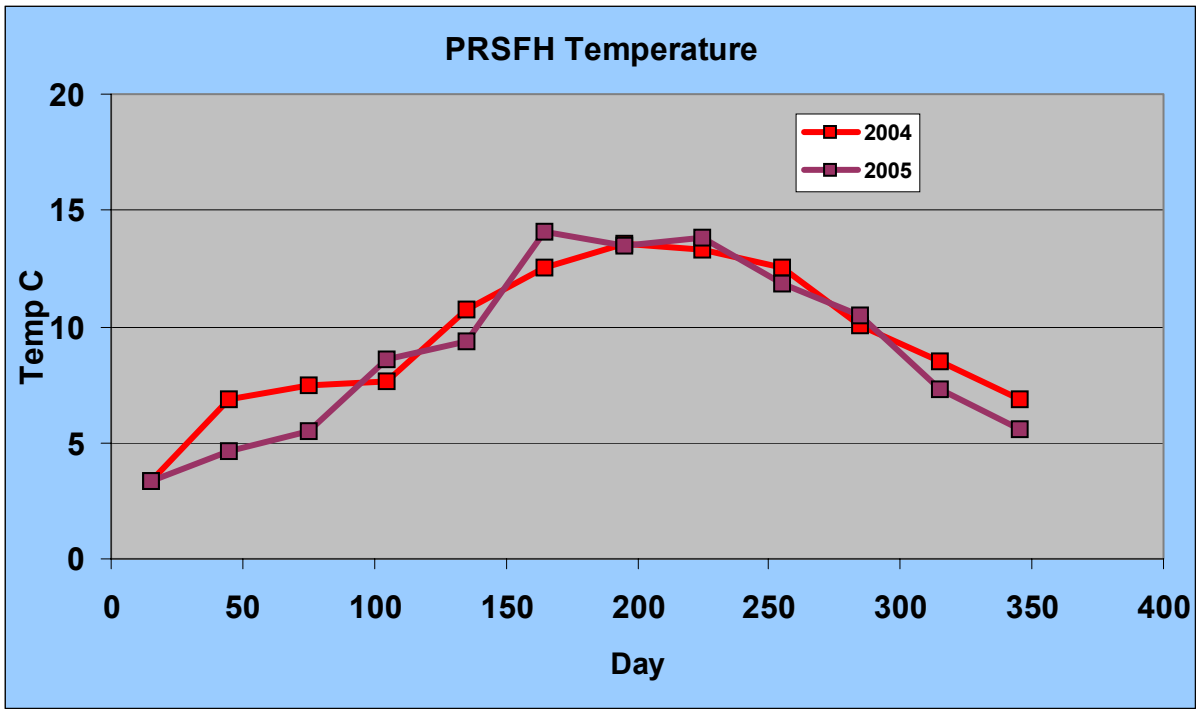


Figure 13. Monthly Average Raceway Temperatures for 2004 and 2005.

	2004	2005	
Food	1071	1017	
BS	62	81	
BC	249	183	
PR	25	0	
Total	336	264	Source Water Input
Eggs In	110	97	
Fish Start	143	455	
Total In	**1660**	**1833**	Lbs
Morts	119	9	
Planted	192	428	
Shipped	179	222	
Fish End	455	393	
Egg Morts	33	37	
Tank	213	172	
Pond	45	38	
Discharge	471	487	
Total Out	**1707**	**1786**	Lbs
Net Load	**135**	**223**	Lbs

Examine Hatchery Operations more carefully to better understand large differences in Net Loading

Figure 14. Comparison of Hatchery Operations for 2004 and 2005.

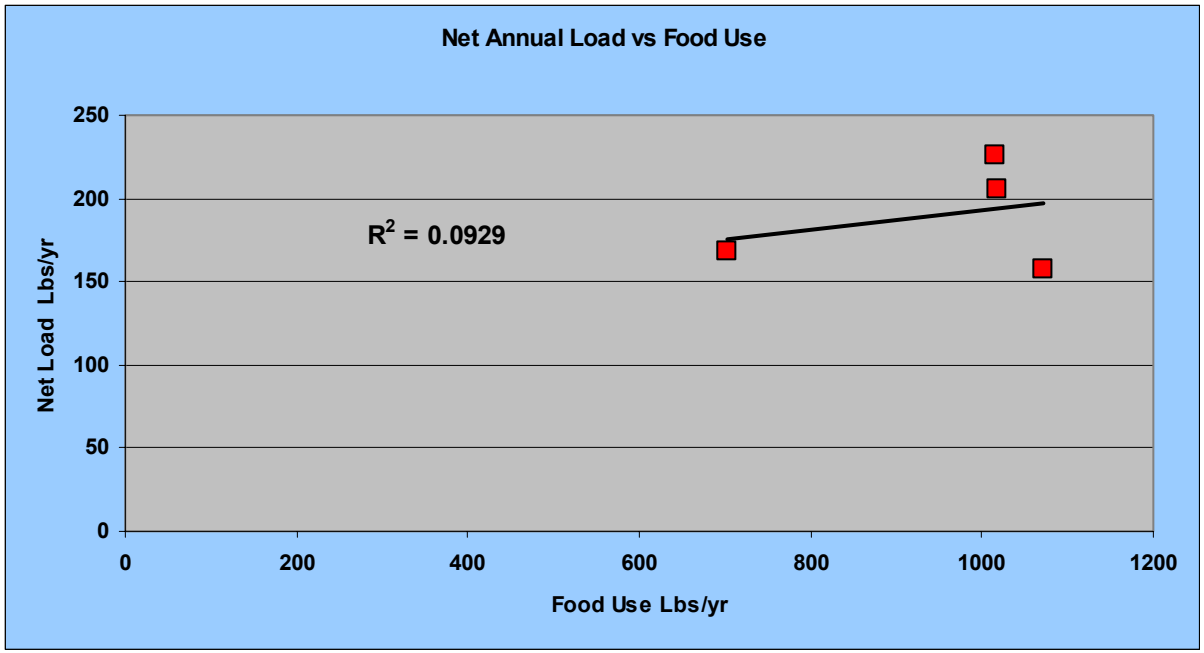


Figure 15. Net Load vs. Food Use for 2002 through 2005.

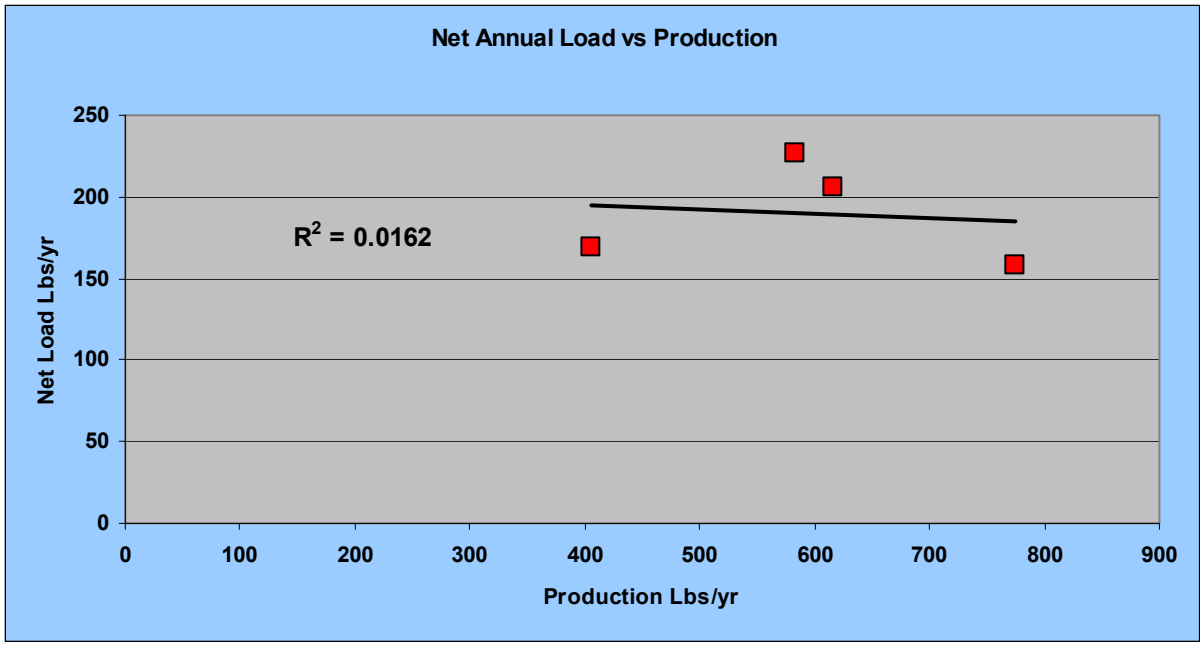


Figure 16. Net Load vs. Fish Production for 2002 through 2005.

2005 Annual Results

Weight Food (KG)	Food Phos %	P (KG)	
2257	0.81	18.4	
4659	0.81	37.7	
4457	0.79	35.4	
3959	0.83	32.7	
5561	0.86	48.0	
3580	0.89	32.0	
4165	0.88	36.7	
5811	0.74	42.9	
8785	0.73	64.2	
8365	0.77	64.3	
3223	0.82	26.4	
2596	0.86	22.2	
	Total	461.0	KG
		1017	Lb

	KG	%P	P (KG)	
Morts	868	0.4465	3.9	
Shipped	43468	0.4465	194.1	
Planted	22508	0.4465	100.5	
		Total	298.5	KG
	Gross Production		658.1	Lb

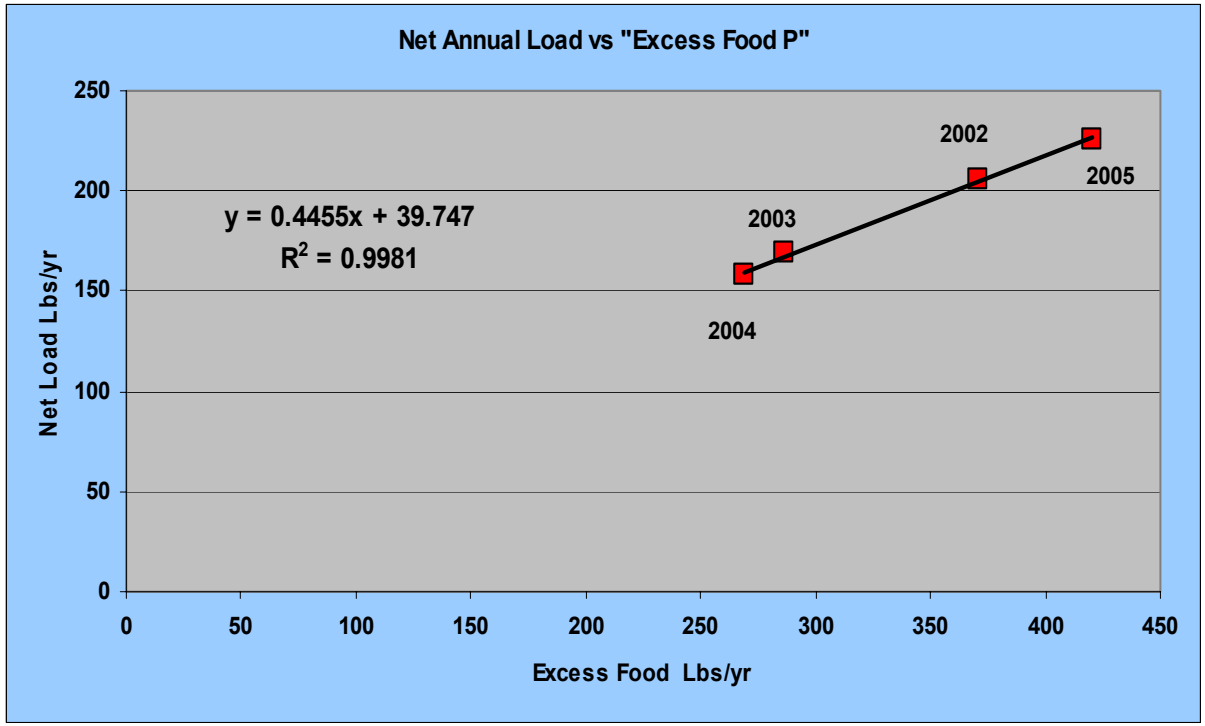
	KG	%P	P (KG)	
Start Fish	46178	0.4465	206.2	
End Fish	39889	0.4465	178.1	
		Loss	28.1	KG
			61.9	Lb

61.9 Lb of the Mort + Shipped + Planted was the result of stock depletion rather than new growth, therefore

Net Production = 658.1 - 61.9 = 596.2 Lbs

"Excess Food" = 1017 – 596 = 421 Lbs

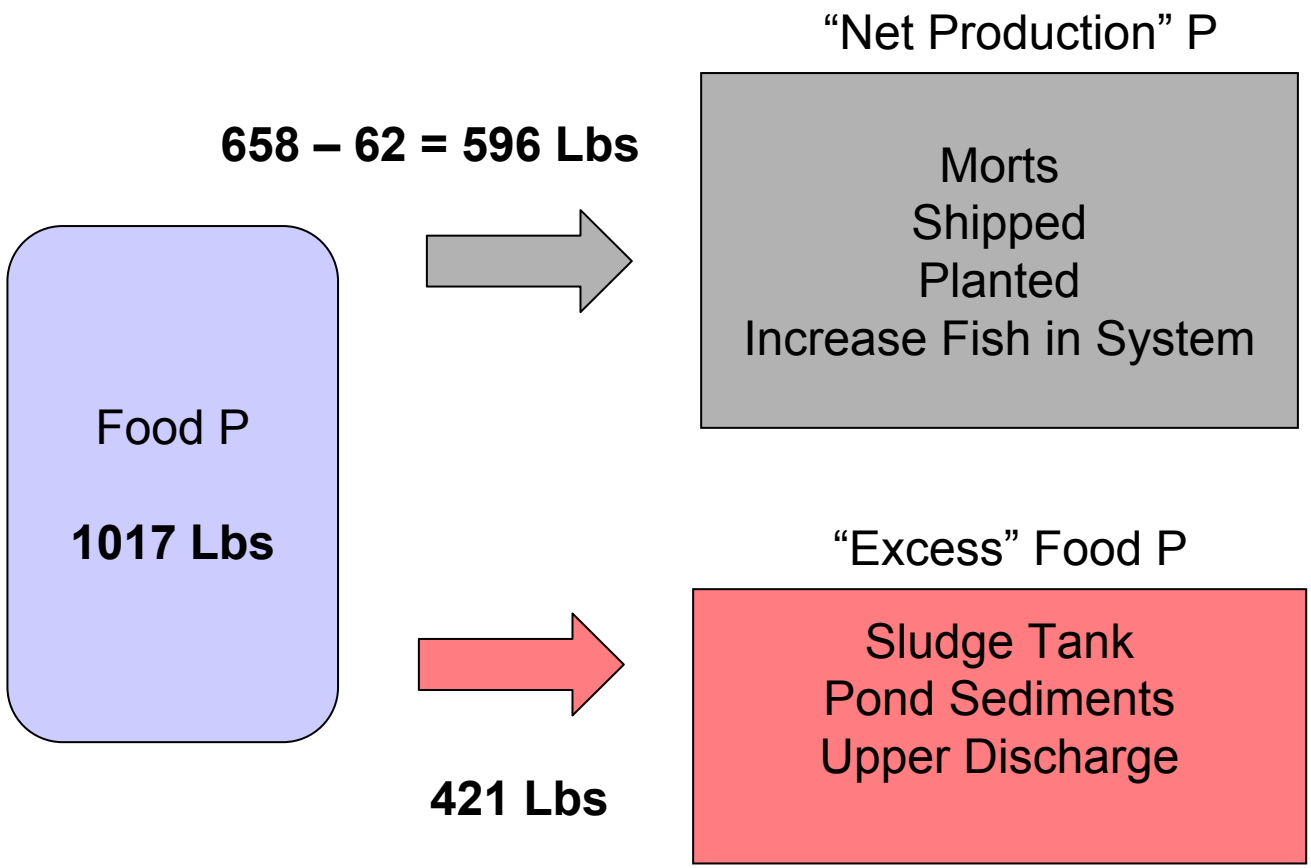
Figure 17. Production and Excess Food Calculation for 2005.



Model: Net Annual Load = Excess Food P x 0.4455 + 39.7

> 99% accurate !!

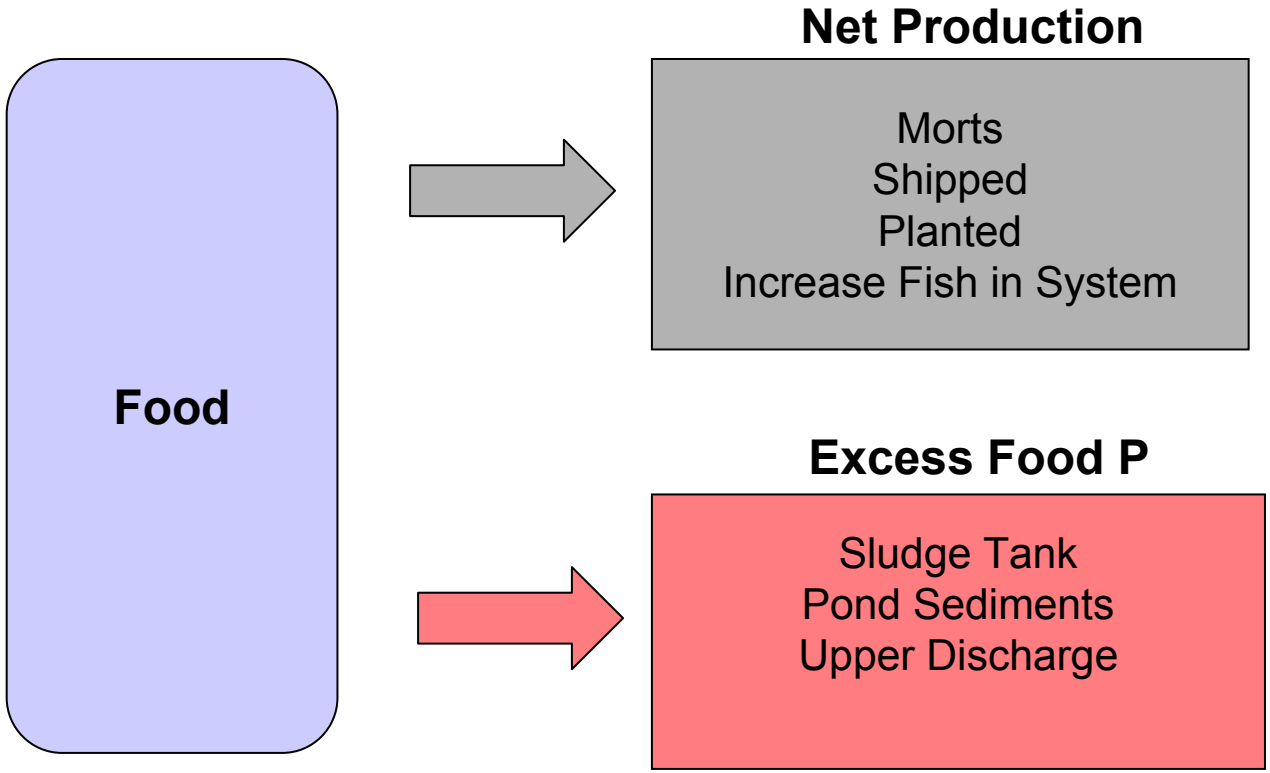
Figure 18. Net Load vs. Excess Food for 2002 through 2005.



Net Loading P = (Food P – Production P) x Reduction Factor

Excess P

Figure 19. Linear Model Components.



Net Loading = (Excess Food P) x Reduction Factor

Increase the efficiency of converting food to fish may create Less Excess Food while maintaining production. **Bio-Energetics**

Capture More P in Sludge Tank or Pond and remove from system. **Facility Operation**

A tool (model) for the system is needed that simulates both Bio-Energetics and facility operations. The model will help us to better understand why the load changes from year to year and to devise strategies to insure long-term compliance with the Consent Agreement.

Figure 20. Need for Hatchery Process Model.

Fish Production for year 2005

Month	Fish Weight (kg)			Food			Morts	Shipped	Planted	Harvested	Eggs Wt In (kg)		Egg Morts		Net Growth	
	Start	End	Avg	Wt (kg)	% Phos	kg Phos	Wt (kg)	Wt (kg)	Wt (kg)	Wt (kg)	Coho	Chinook	Coho	Chinook	(kg)	%
Jan	46,178	49,270	47,724	2,257	0.81	18.4	318.8	0.0	0.0	318.8	0.0	0.0	0.0	0.0	3410.8	7.15
Feb	49,298	54,728	52,013	4,659	0.81	37.7	157.5	0.0	0.0	157.5	0.0	0.0	0.0	0.0	5587.5	10.74
Mar	54,785	20,341	37,563	4,457	0.79	35.4	69.3	17196.1	17965.2	35230.6	0.0	0.0	0.0	0.0	786.6	2.09
Apr	20,489	13,354	16,922	3,959	0.83	32.7	72.2	8162.3	4543.3	12777.8	0.0	0.0	0.0	0.0	5642.8	33.35
May	13,512	5,856	9,684	5,561	0.86	48.0	74.3	16611.6	0.0	16685.9	0.0	0.0	0.0	0.0	9029.9	93.25
Jun	5,912	8,127	7,020	3,580	0.89	32.0	7.5	1240.2	0.0	1247.7	0.0	0.0	0.0	0.0	3462.7	49.33
Jul	8,328	13,351	10,840	4,165	0.88	36.7	9.6	0.0	0.0	9.6	0.0	0.0	0.0	0.0	5032.6	46.43
Aug	13,351	18,750	16,051	5,811	0.74	42.9	18.8	0.0	0.0	18.8	0.0	0.0	0.0	0.0	5417.8	33.75
Sep	18,899	26,763	22,831	8,785	0.73	64.2	75.8	0.0	0.0	75.8	0.0	0.0	0.0	0.0	7939.8	34.78
Oct	27,227	34,572	30,900	8,365	0.77	64.3	23.5	0.0	0.0	23.5	1307.0	2045.0	0.0	0.0	7368.5	23.85
Nov	34,571	37,590	36,081	3,223	0.82	26.4	19.3	0.0	0.0	19.3	39.2	0.0	52.5	65.8	3038.3	8.42
Dec	37,734	39,889	38,812	2,596	0.86	22.2	21.7	258.0	0.0	279.7	0.0	0.0	415.5	745.3	2434.7	6.27
Totals				**57,419**	**0.82**	**461.0**	**868.2**	**43468.2**	**22508.4**	**66844.8**	**1346.2**	**2045.0**	**468.0**	**811.1**	**59151.8**	**29.12**

Annual Check **60555.76**

Gross Production lb Phosphorus **658.1** (Mortalities + Shipped + Planted)

Total Food lb Phosphorus **1016.5** (Total Food Phosphorus)
Net Production lb Phosphorus **596.2** (Gross Production + (End - Start))
Excess Food lb Phosphorus **420.3** (Total Food - Net Production)

Morts + Shipped + Planted + (End – Start) = Net Growth

April 72 + 8162 + 4543 + (13354 - 20489) = 5643

July 10 + 0 + 0 + (13351 - 8328) = 5033

Figure 21. Net Growth Calculation.

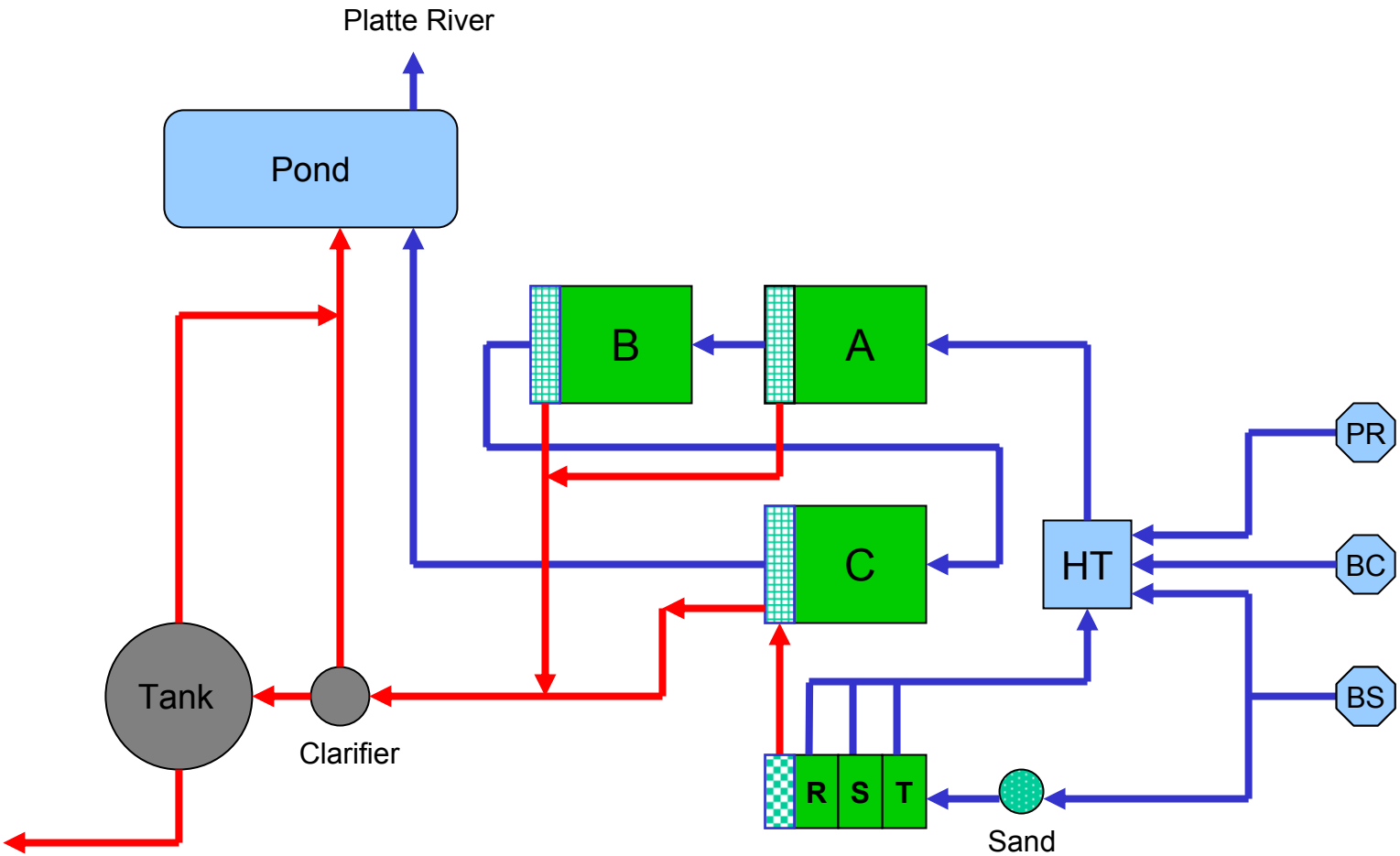


Figure 22. Major Hatchery Components and Flows.

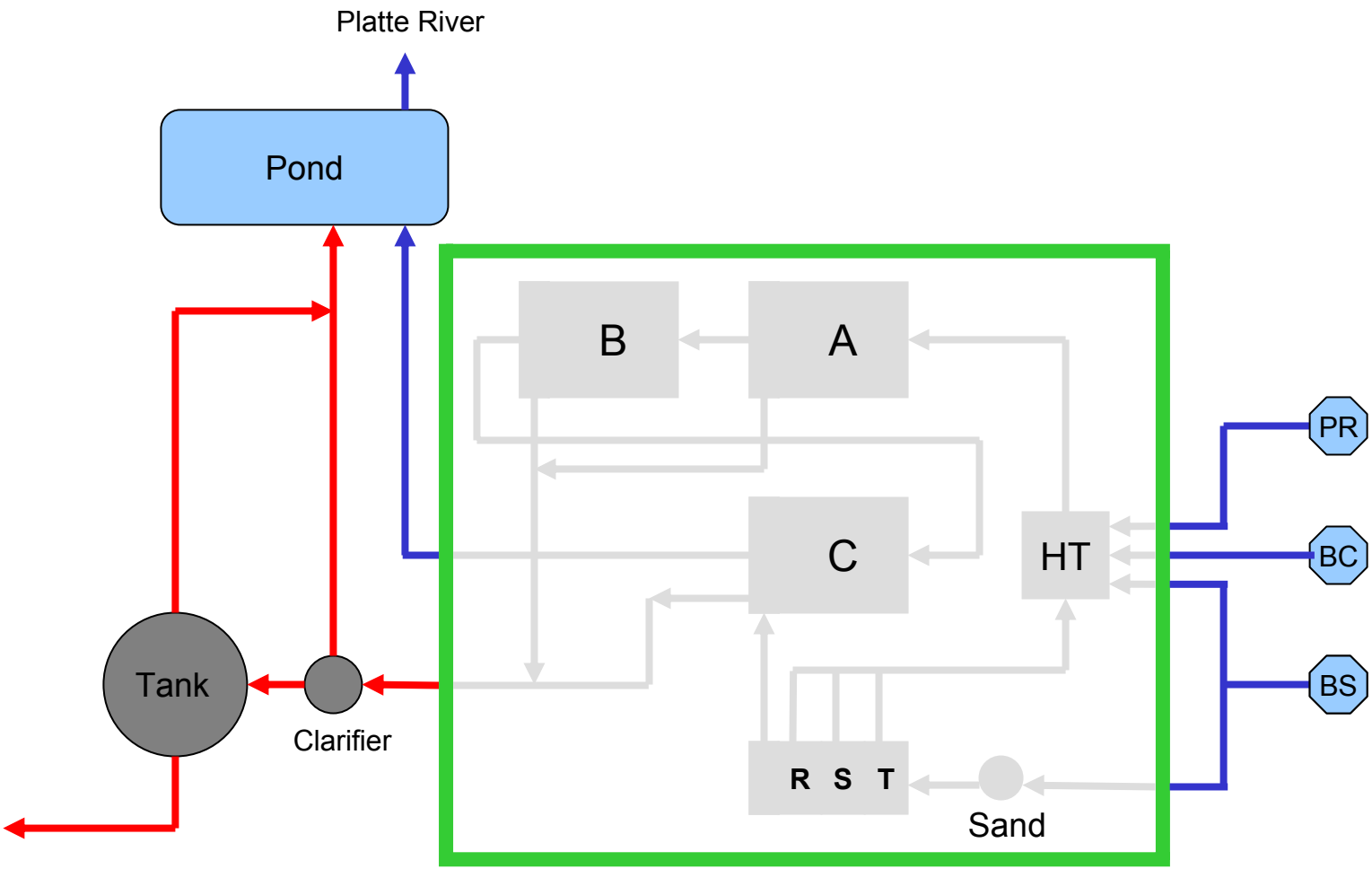


Figure 23. Major Hatchery Components and Flows.

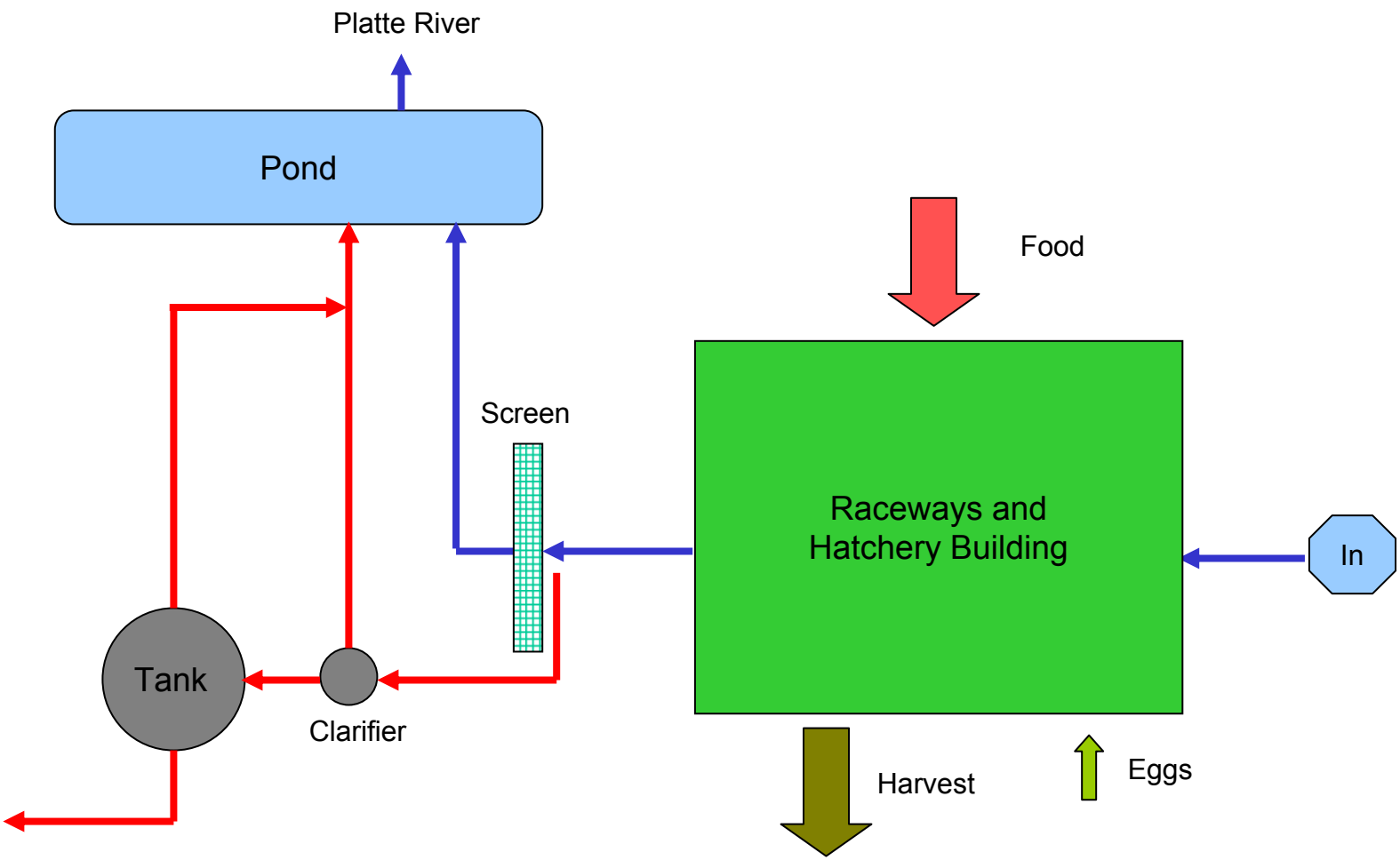


Figure 24. Major Hatchery Components and Flows.

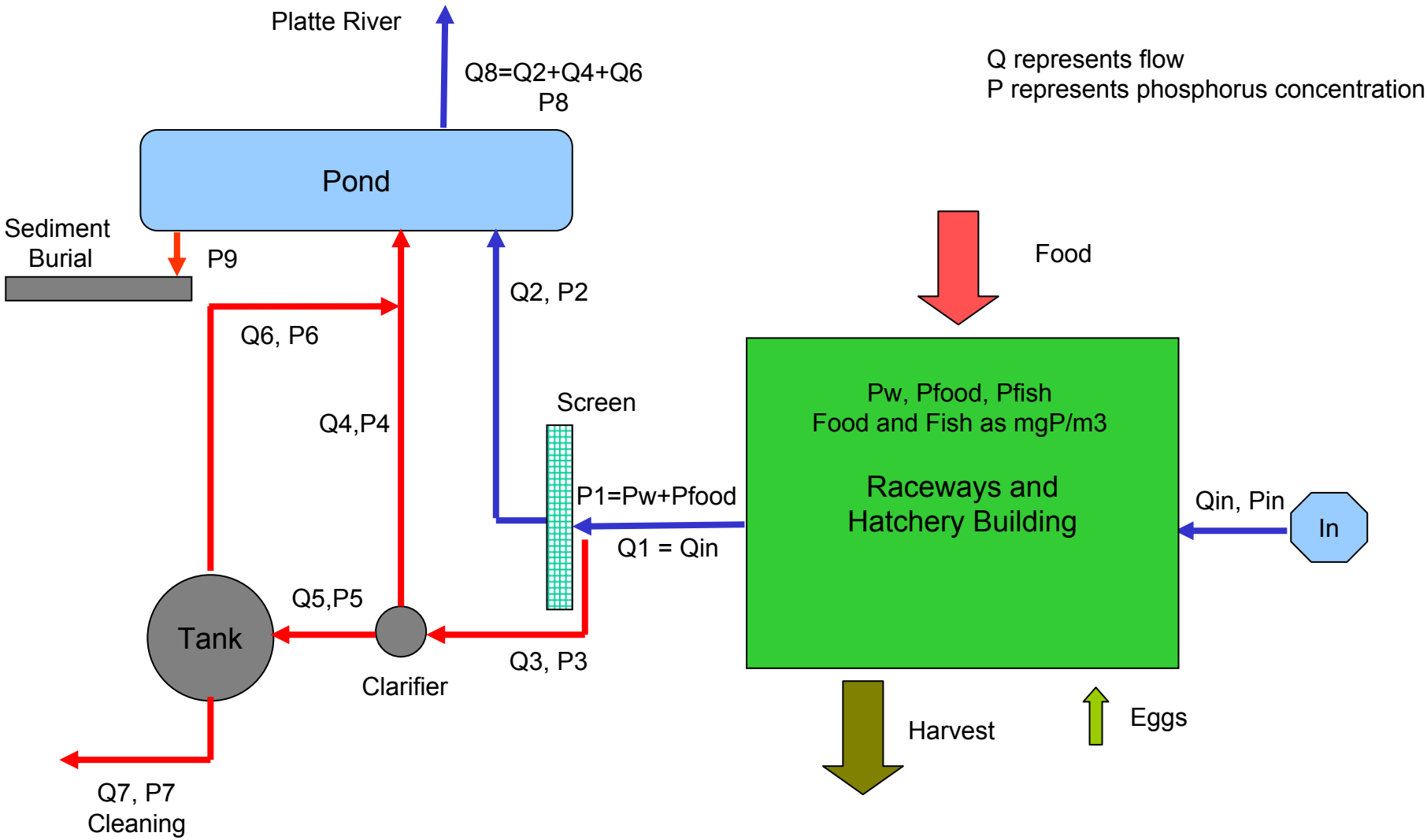


Figure 25. Major Hatchery Components and Flows.

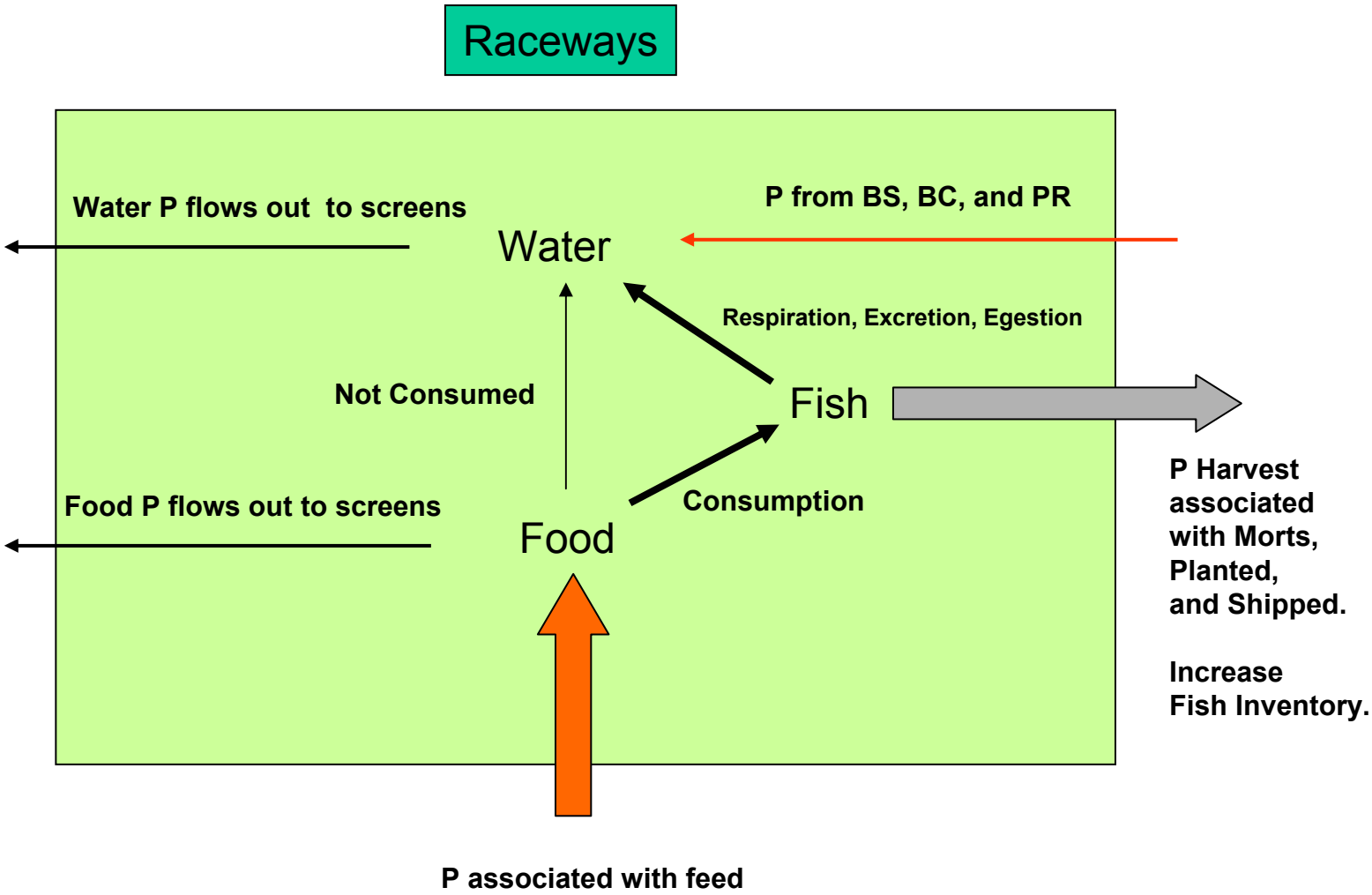


Figure 26. Raceway Model Mechanisms.

Raceway Mass Balance Equations

Accumulation of Water P in Raceways = Input P from Source water – overflow of P to Screens
+ Food P not consumed by fish
+ respired, egested, and excreted P from fish

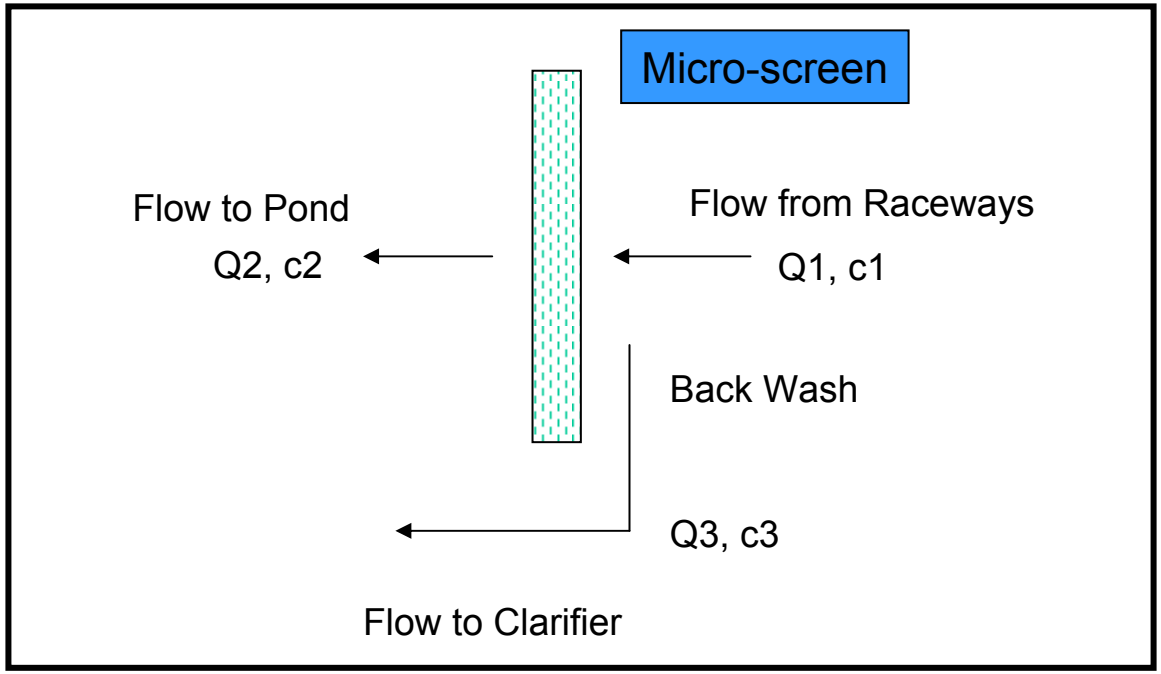
Accumulation of Food P in Raceways = Food application rate – consumption by fish
– food that escapes consumption
– overflow to screens

Net Growth

Accumulation of Fish Tissue P in Raceway = { Consumption – (respiration + egestion + excretion) }
– Harvest of P associated with fish tissue

Morts
Shipped
Planted

Figure 27. Raceway Model Equations.



Performance Criteria

% P Retained by Screen
% of Total Inflow used for Backwash

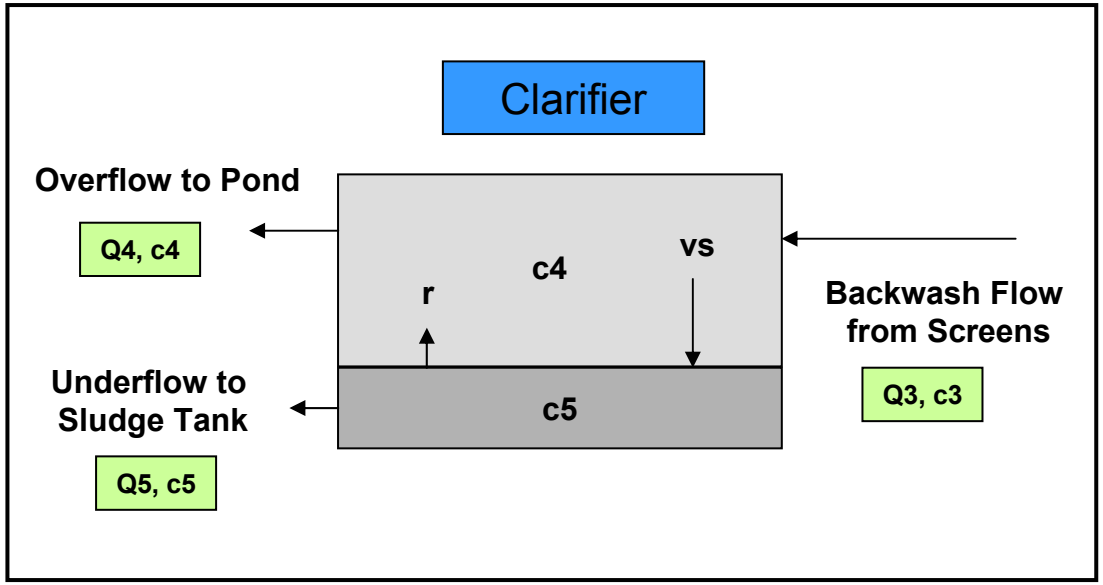
% P Retained by Screen = (1- c2/c1) x 100

% Flow used for Backwash = Q3/Q1 x 100

c2 = c1 (1 - % retained /100)

C3 = (Q1 x c1 – Q2 x c2) / Q3

Figure 28. Screen Model Mechanisms and Equations.



vs = settling velocity of particles in clarifier
r = release rate of dissolved P back into water from bottom solids

$$0 = Q3\ c3 - Q4\ c4 - Q5\ c4 - vs\ A\ c4 + r\ A\ c5$$

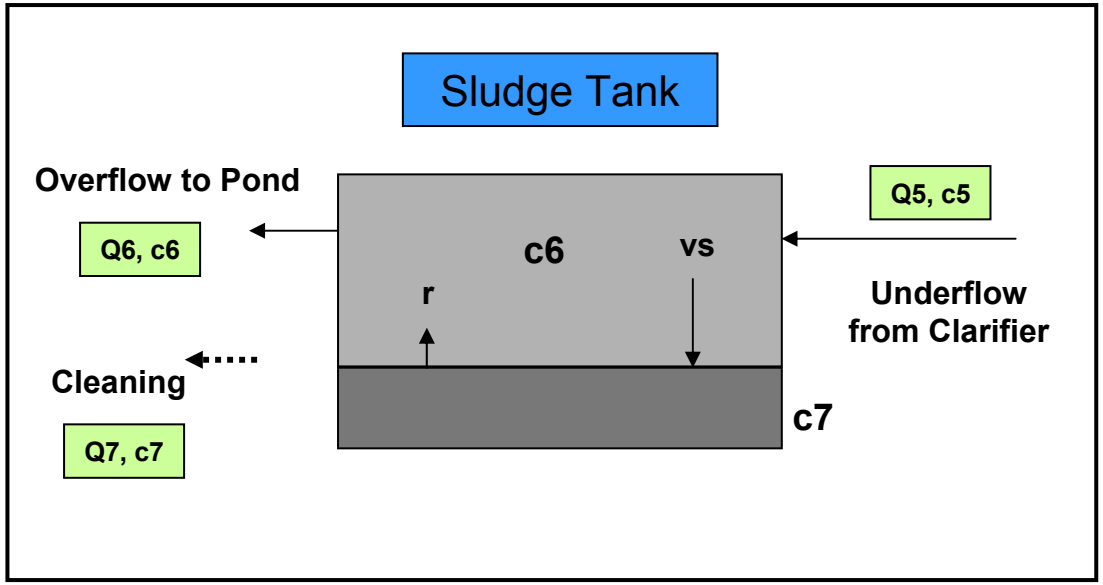
$$0 = Q5\ c4 - Q5\ c5 + vs\ A\ c4 - r\ A\ c5$$

SS Solution:

$$c5 = c4\ (Q5 + vs\ A)/(Q5 + r\ A)$$

$$c4 = Q3\ c3\ /(Q4 + Q5\ (Q5 + vs\ A)/(Q5 + r\ A))$$

Figure 29. Clarifier Model Mechanisms and Equations.



vs = settling velocity of particles in sludge tank
r = release rate of dissolved P back into water from bottom solids

Dynamics:

$$V6\ dc6/dt = Q5\ c5 - Q6\ c6 - Q7\ c6 - vs\ A\ c6 + r\ A\ c7$$

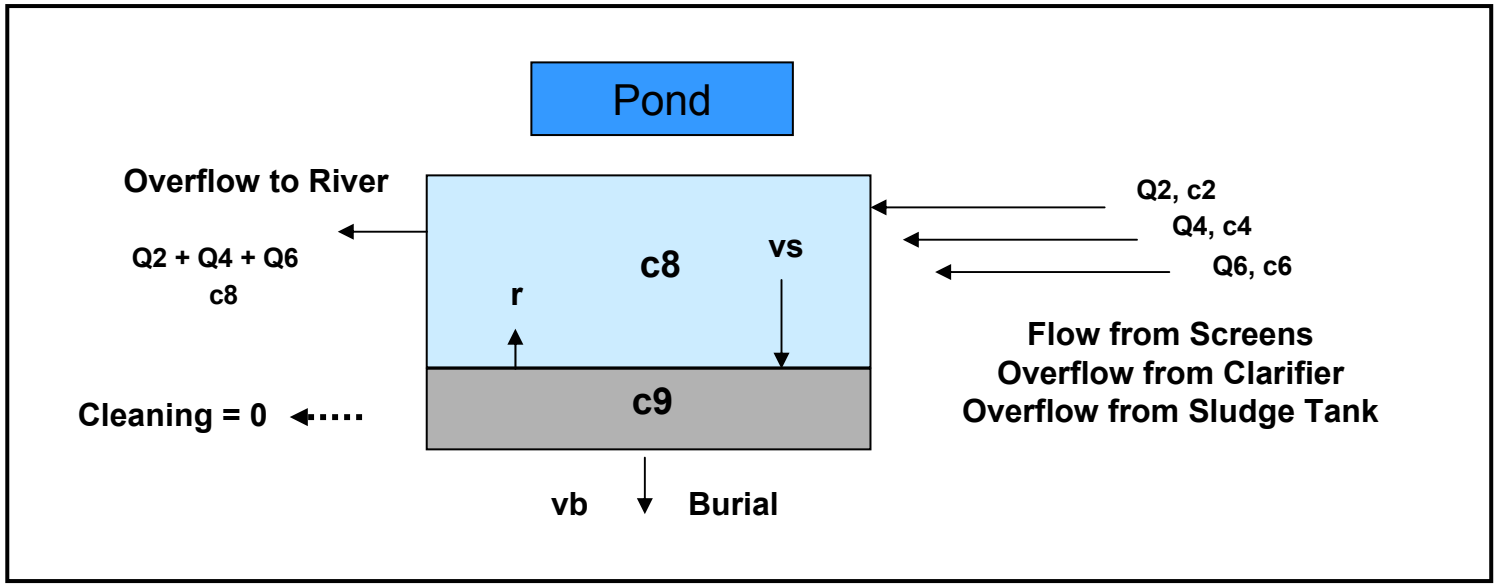
$$V7\ dc7/dt = Q7\ c6 - Q7\ c7 + vs\ A\ c6 - r\ A\ c7$$

SS Solution:

$$c7 = c6\ (Q7 + vs\ A)/(Q7 + r\ A)$$

$$c6 = Q5\ c5\ /(Q6 + Q7\ (Q7 + vs\ A)/(Q7 + r\ A))$$

Figure 30. Sludge Tank Model Mechanisms and Equations.



Dynamics:

$$V8\ dc8/dt = Q2\ c2 + Q4\ c4 + Q6\ c6 - (Q2 + Q4 + Q6)\ c8 - vs\ A\ c8 + r\ A\ c9$$

$$V9\ dc9/dt = vs\ A\ c8 - r\ A\ c9 - vb\ A\ c9$$

Steady State:

$$c9 = c8\ (vs / (r + vb))$$

$$C8 = (Q2\ c2 + Q4\ c4 + Q6\ c6) / (Q2 + Q4 + Q6 + vb\ A\ vs / (r + vb))$$

Figure 31. Pond Model Mechanisms and Equations.

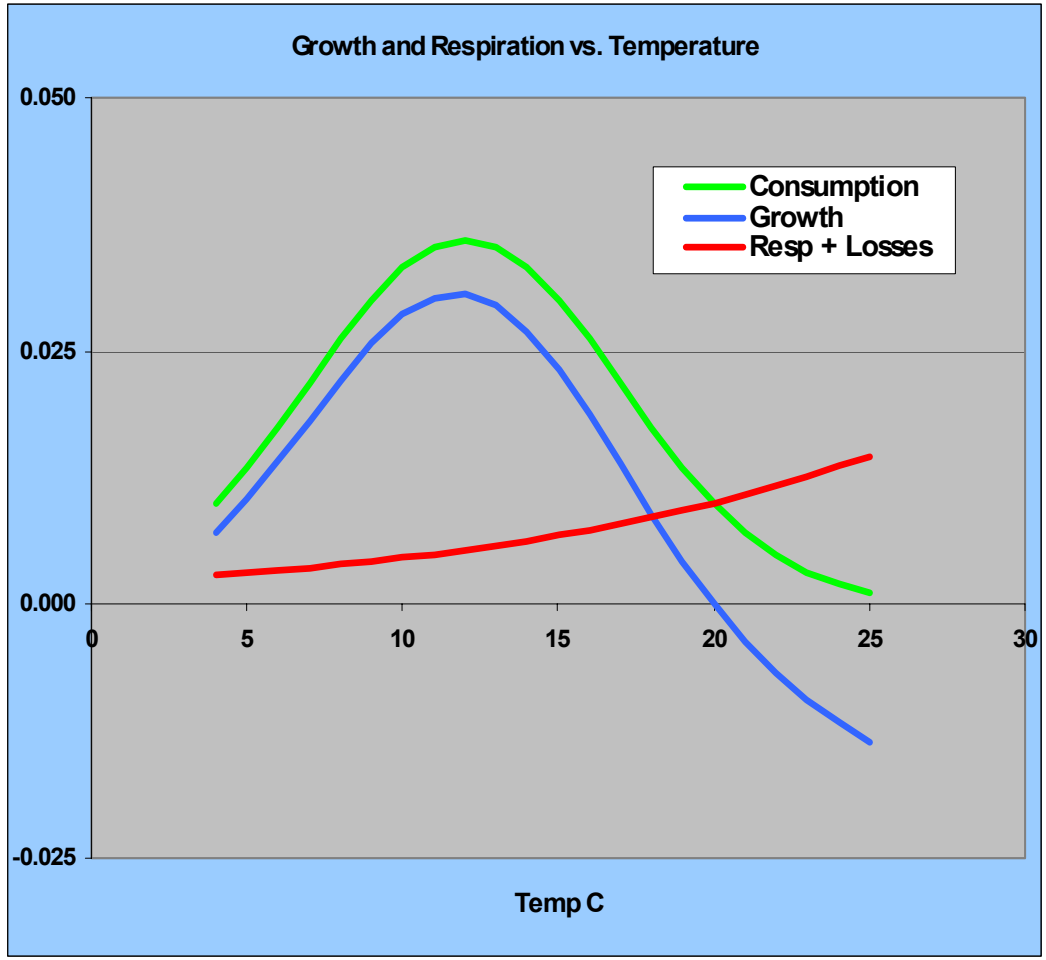
Hatchery Dynamics can be simulated using a System of 17 simultaneous equations

9 equations represent TP Concentrations
8 equations represent Flows
+
Bio-energetic Modeling
of fish consumption, growth, and losses

Figure 32. Summary of Hatchery Process Model.

C_{opt}	max consumption	1/day	0.09
β	temp coef	--	0.02
T_{opt}	opt temp	C	12
F	food limitation		0.4
R_{20}	resp & excretion	1/day	0.01
Θ_r	temp coef	--	1.08

Temp C	Model Consumption	Model Growth	Model Resp	% for Resp
4.0	0.0100	0.0071	0.0029	29.2
5.0	0.0135	0.0104	0.0032	23.3
6.0	0.0175	0.0141	0.0034	19.4
7.0	0.0218	0.0182	0.0037	16.8
8.0	0.0261	0.0222	0.0040	15.2
9.0	0.0301	0.0258	0.0043	14.3
10.0	0.0332	0.0286	0.0046	13.9
11.0	0.0353	0.0303	0.0050	14.2
12.0	0.0360	0.0306	0.0054	15.0
13.0	0.0353	0.0295	0.0058	16.5
14.0	0.0332	0.0269	0.0063	19.0
15.0	0.0301	0.0233	0.0068	22.6
16.0	0.0261	0.0188	0.0074	28.1
17.0	0.0218	0.0139	0.0079	36.4
18.0	0.0175	0.0089	0.0086	48.9
19.0	0.0135	0.0043	0.0093	68.5
20.0	0.0100	0.0000	0.0100	99.9
21.0	0.0071	-0.0037	0.0108	151.6
22.0	0.0049	-0.0068	0.0117	239.4
23.0	0.0032	-0.0094	0.0126	393.5
24.0	0.0020	-0.0116	0.0136	673.2
25.0	0.0012	-0.0135	0.0147	1198.8

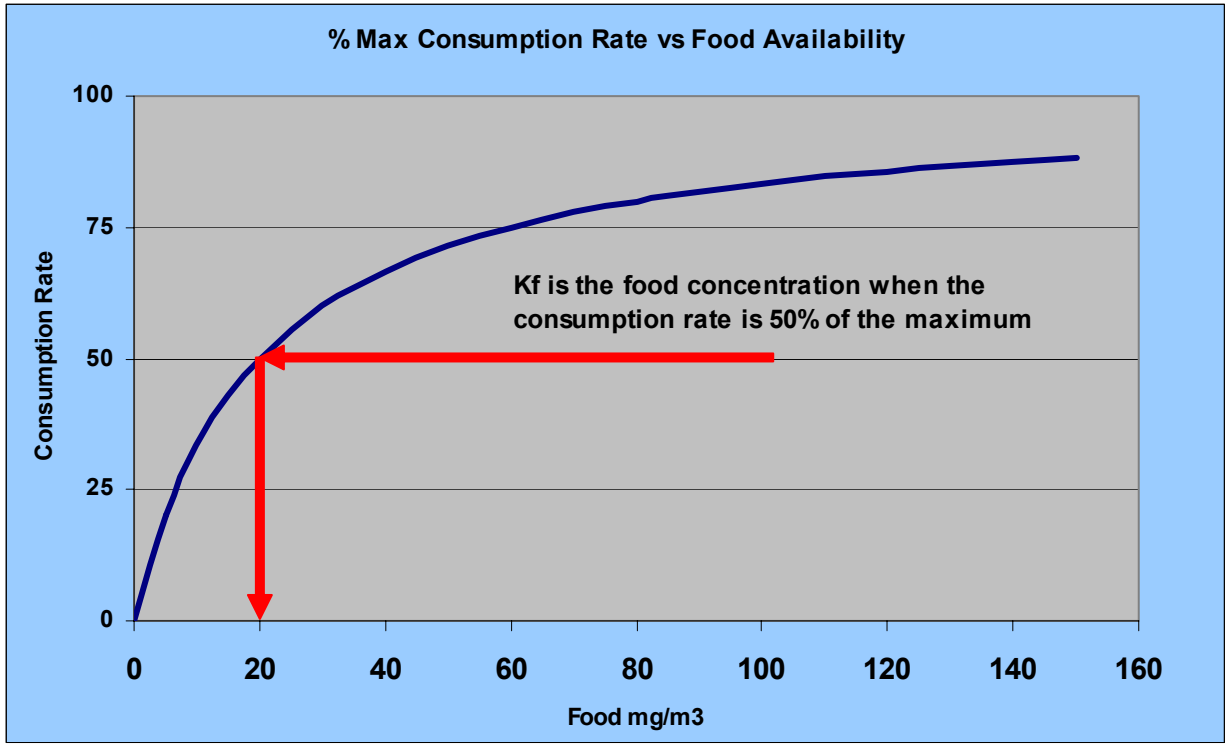


$$\text{Consumption Rate} = C_{max} \exp\{ -\beta*(T-T_{opt})^2 \}$$

$$\text{Respiration} = R_{20} * \theta^{(T-20)}$$

$$\text{Food Limitation} = \text{Consumption Rate} * \text{food} / (K_f + \text{food})$$

Figure 33. Consumption and Respiration Model Equations.



Food Limitation = Consumption * food / (K_f + food)

Figure 34. Model Equations for Food Uptake as a function of Food Availability.

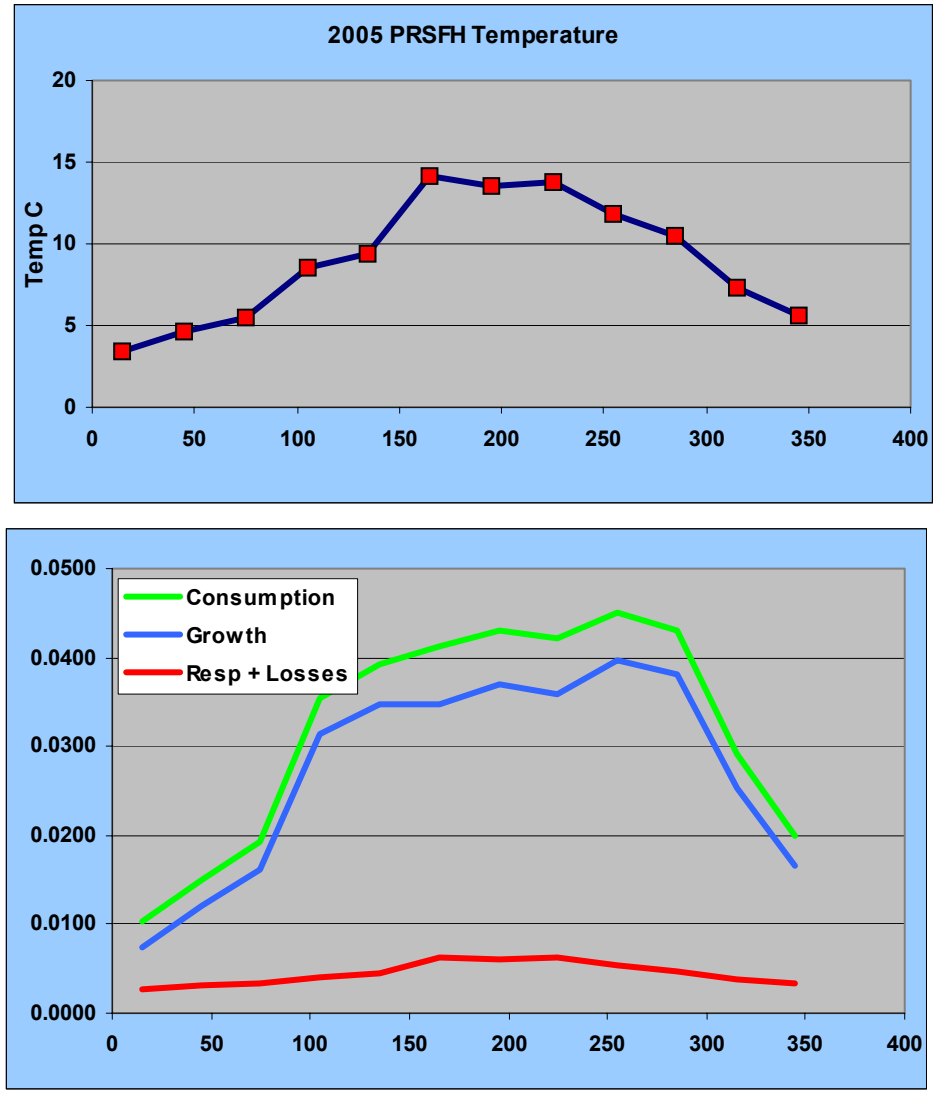


Figure 35. Model Simulation of Seasonal Variation of Consumption, Growth, and Losses.

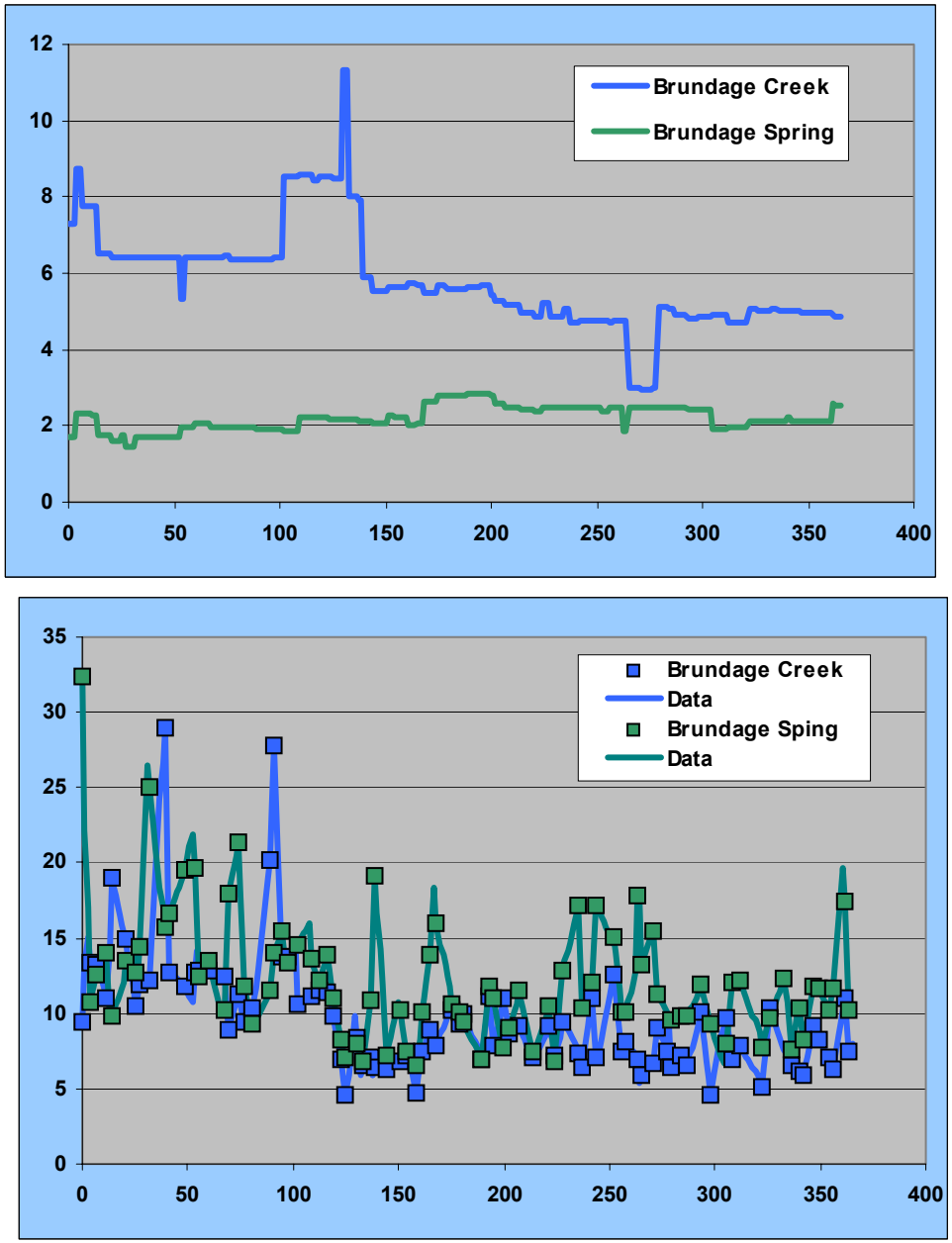


Figure 36. Hatchery Input Flows and Phosphorus Concentrations for 2005.

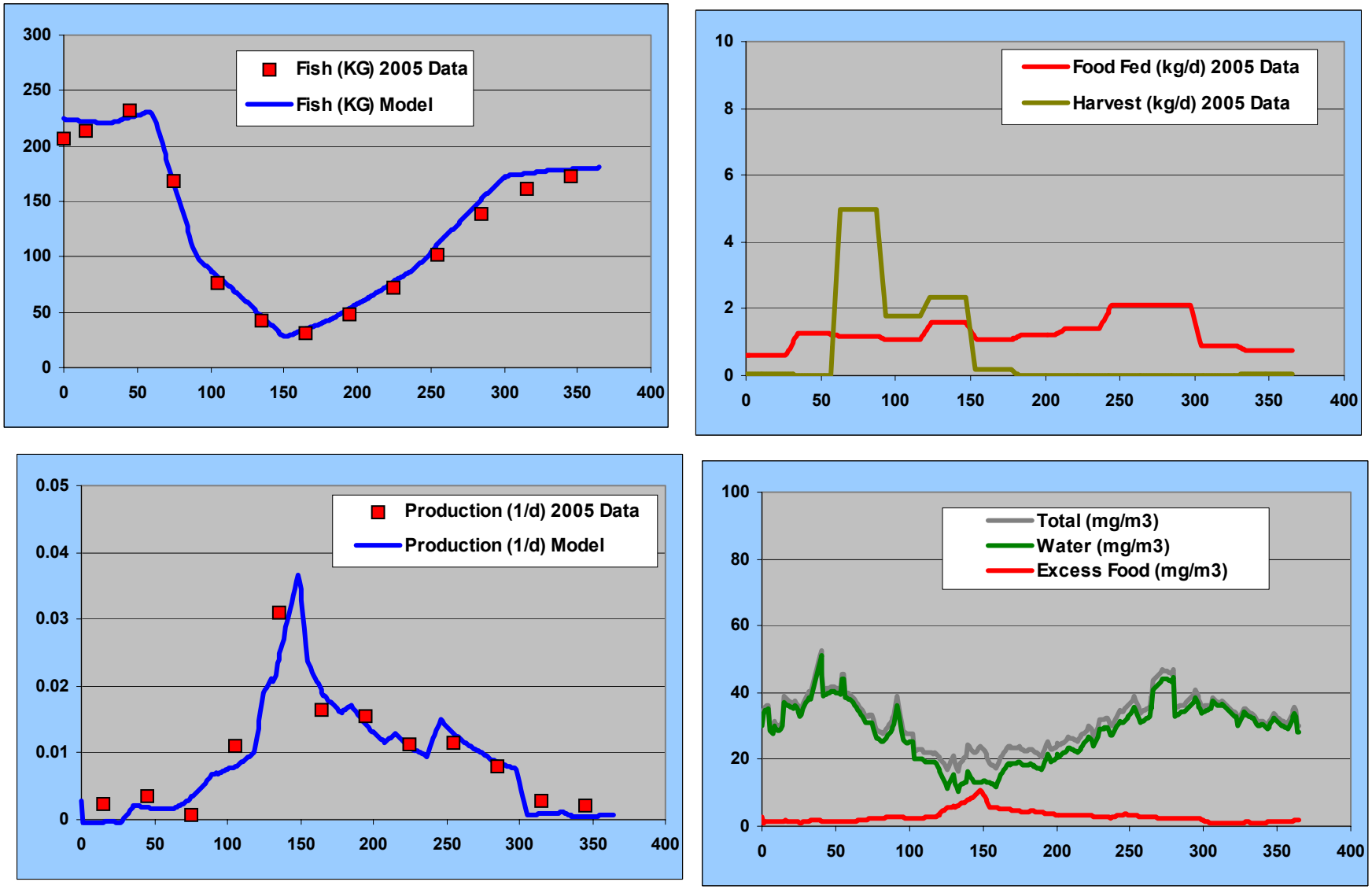


Figure 37. Model Simulation and Measurements for Fish Stock, Growth Rate, and Raceway Effluent Phosphorus Concentration for 2005.

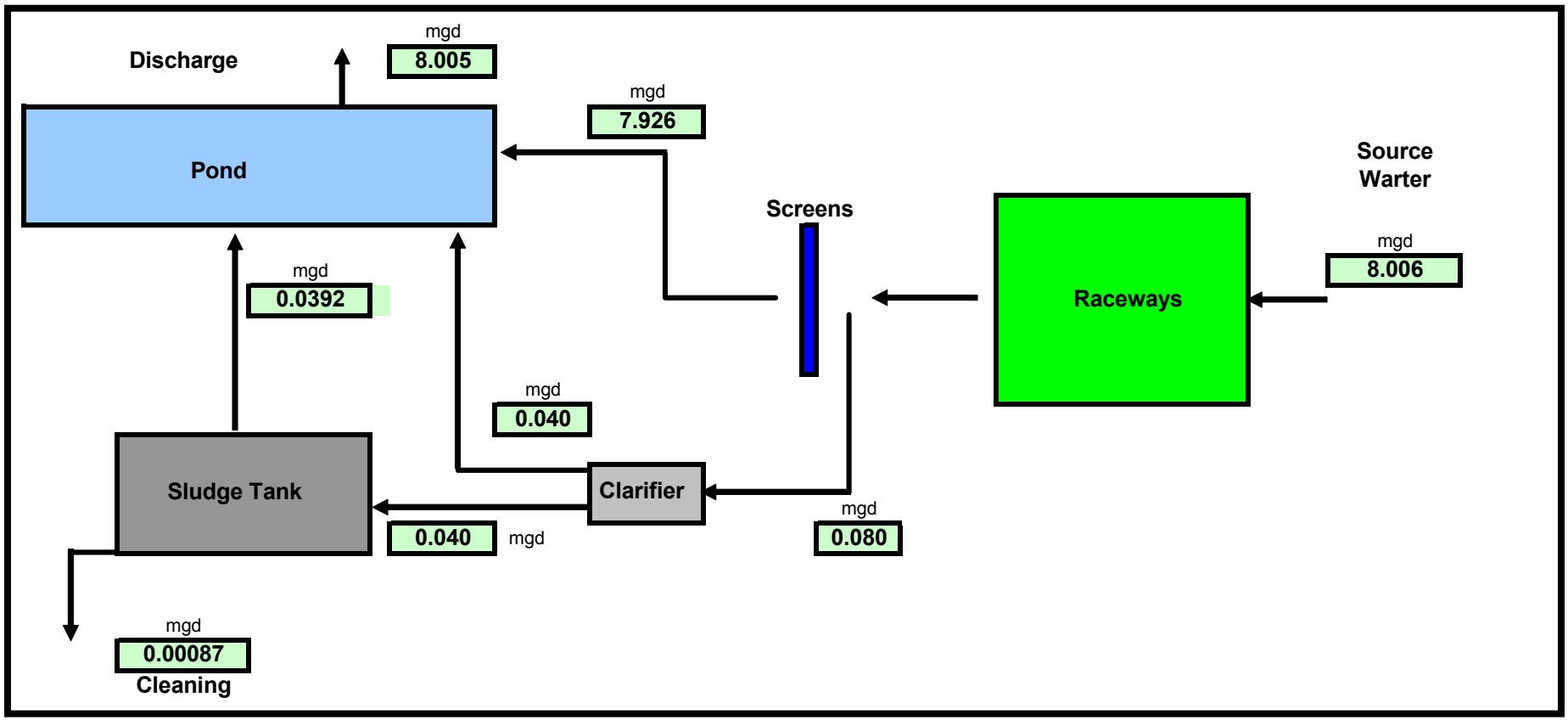


Figure 38. Model Simulation of Annual Average Hatchery Flows for 2005.

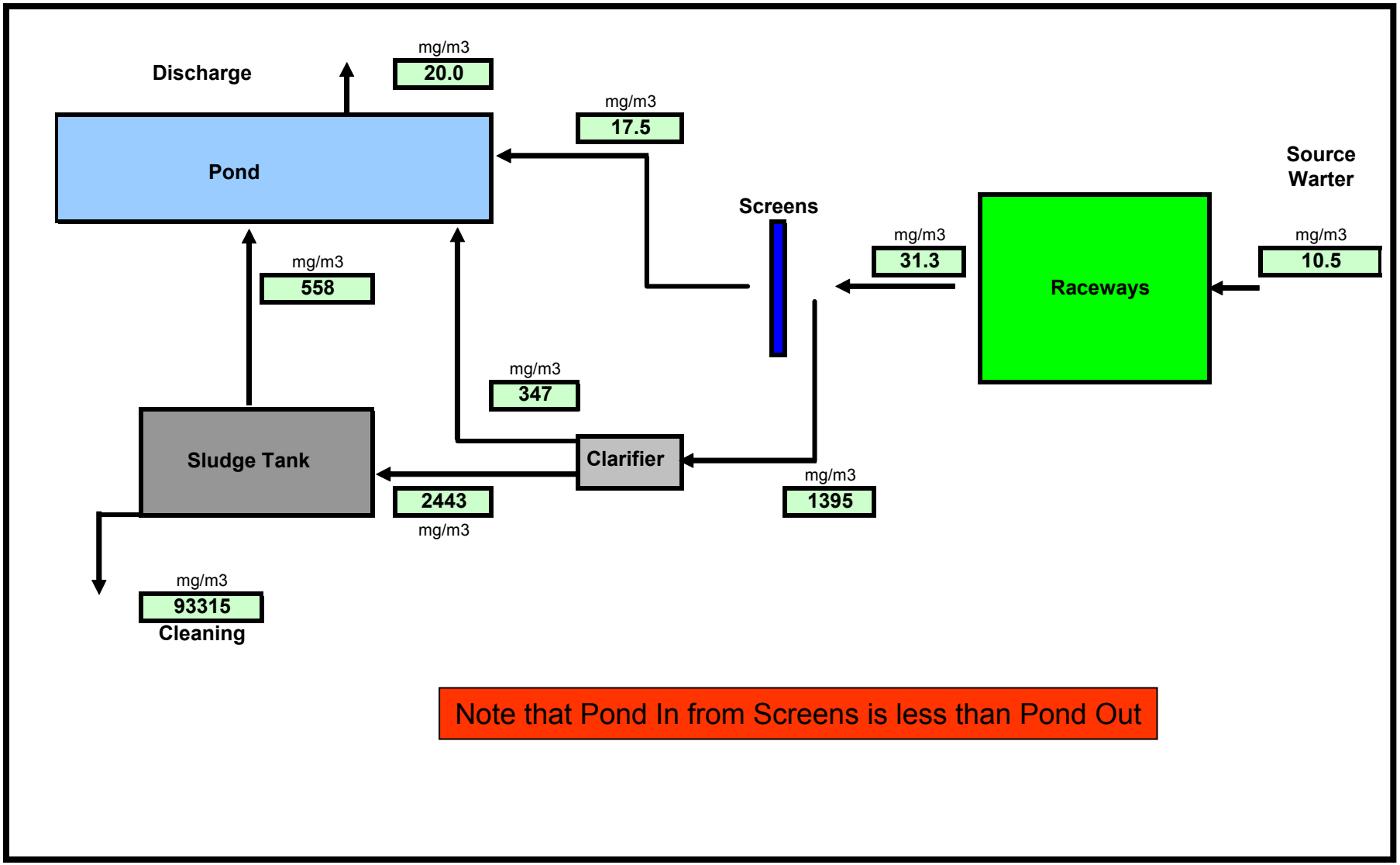


Figure 39. Model Simulation of Annual Average Phosphorus Concentrations for 2005.

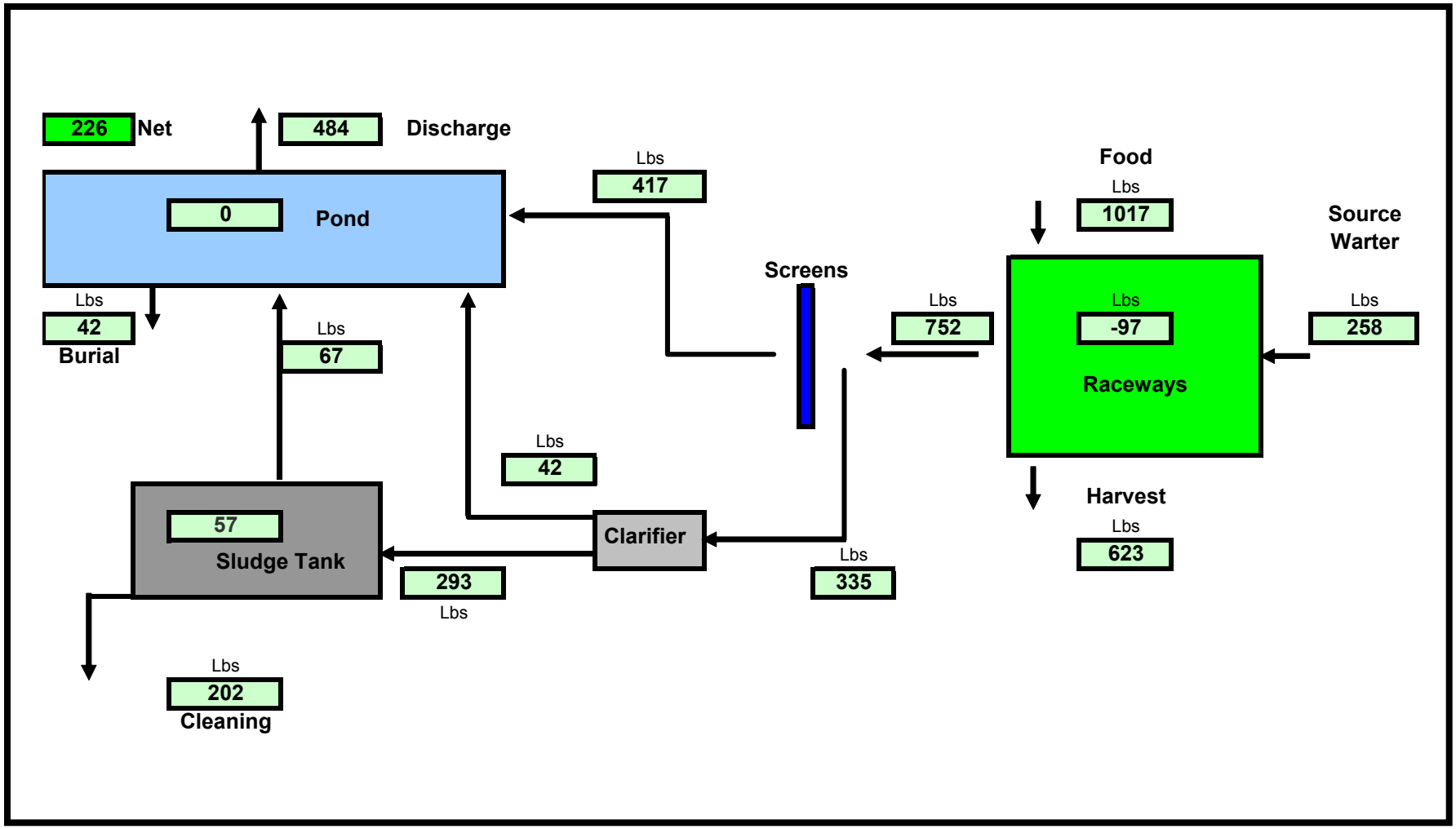


Figure 40. Model Simulation of Annual Average Phosphorus Loadings for 2005.

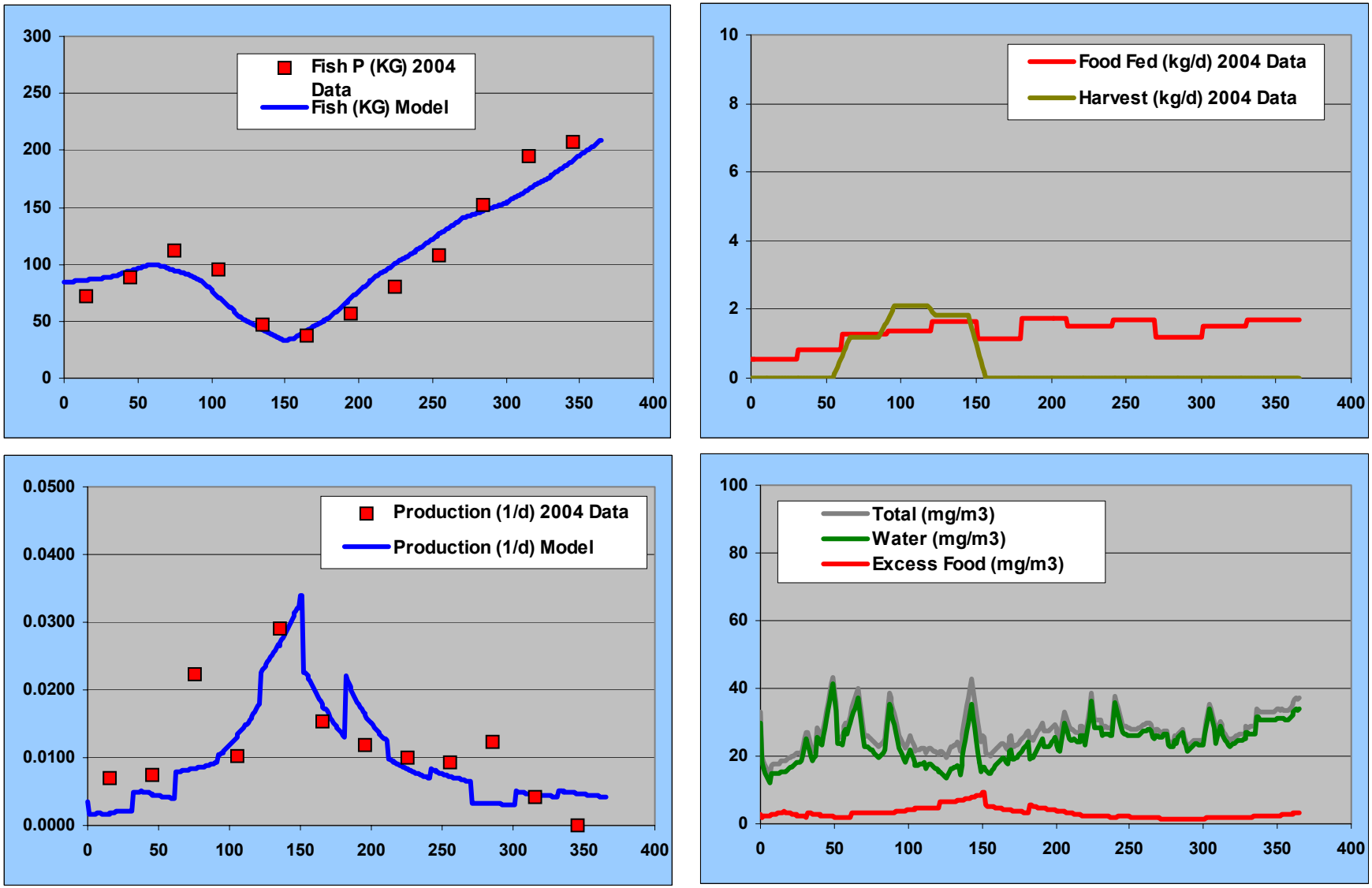


Figure 41. Model Simulation and Measurements for Fish Stock, Growth Rate, and Raceway Effluent Phosphorus Concentration for 2004.

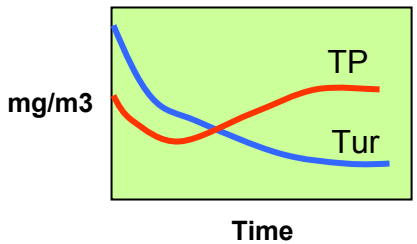
Recommendations

Monitoring

Report fish stock, food use, harvest, and production 2 times per month
Measure fish tissue P monthly
Measure flows and TP in and out of screens, clarifier, and sludge tank
Record daily raceway temperatures
Measure the amount of P in the sludge tank more accurately
Measure cleaning loss more accurately

Experiments

Bucket Experiment for inflow to clarifier and tank.
Use to estimate settling and release rates.



Model Refinements

Expand Model to include all raceways, screens, and recycle
Main Hatchery Building activities??
Separate Fish Age Classes ??
Include Food Composition Bio-Energetics ??
Egg activities??
Refine fish metabolism formulations ??

Figure 42. Recommendations to Improve Hatchery Process Model.

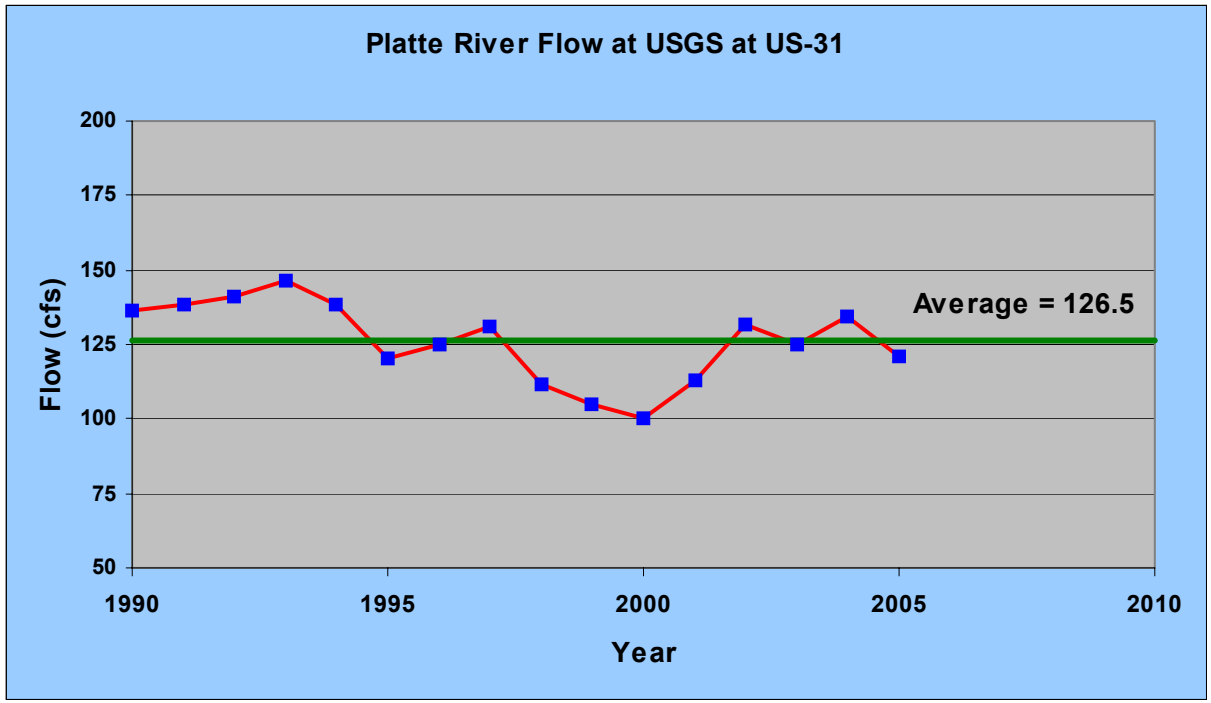


Figure 43. Annual Average USGS Flow of Platte River at US 31.

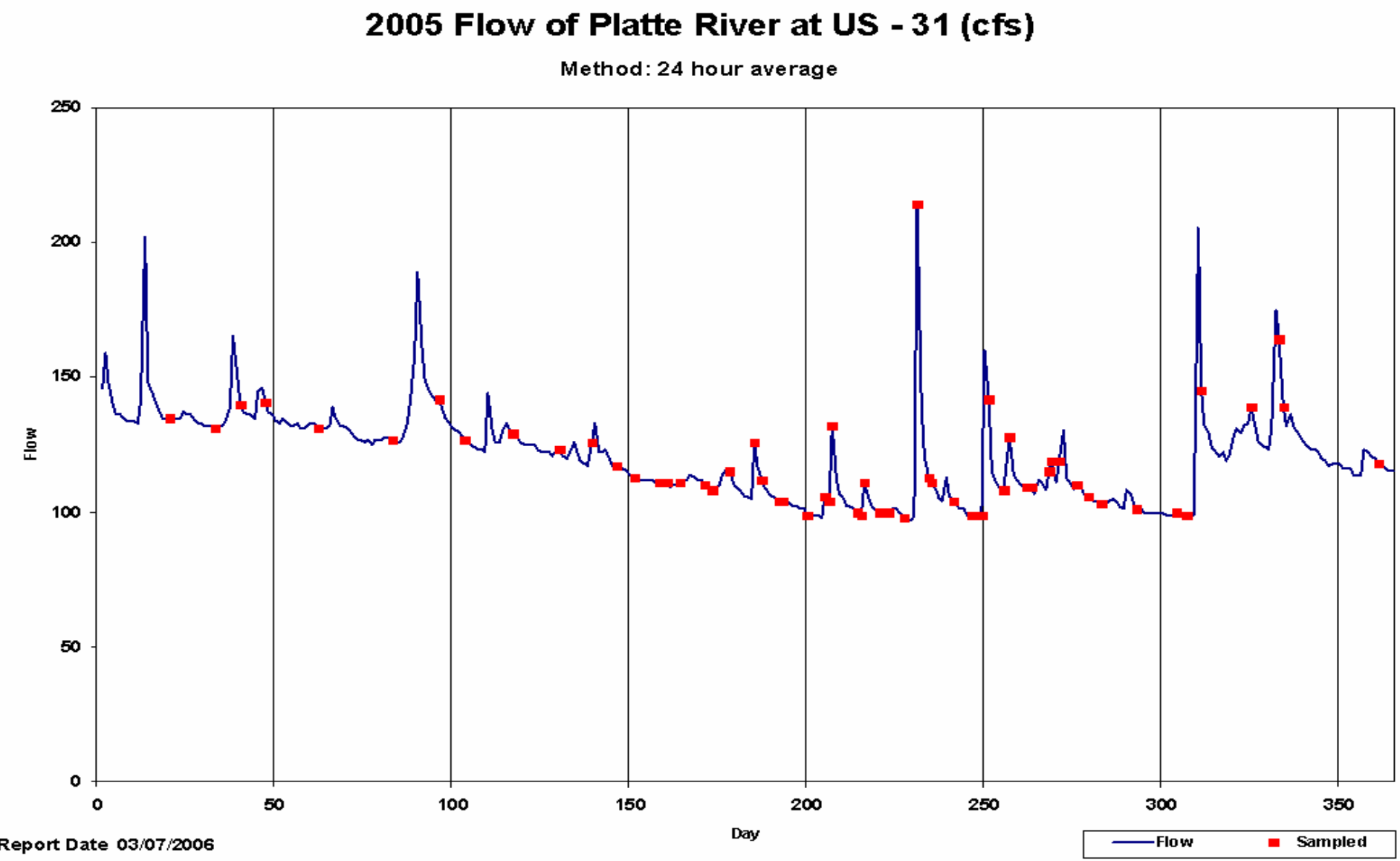


Figure 44. Daily Average Flow of Platte River and Sampling Dates.

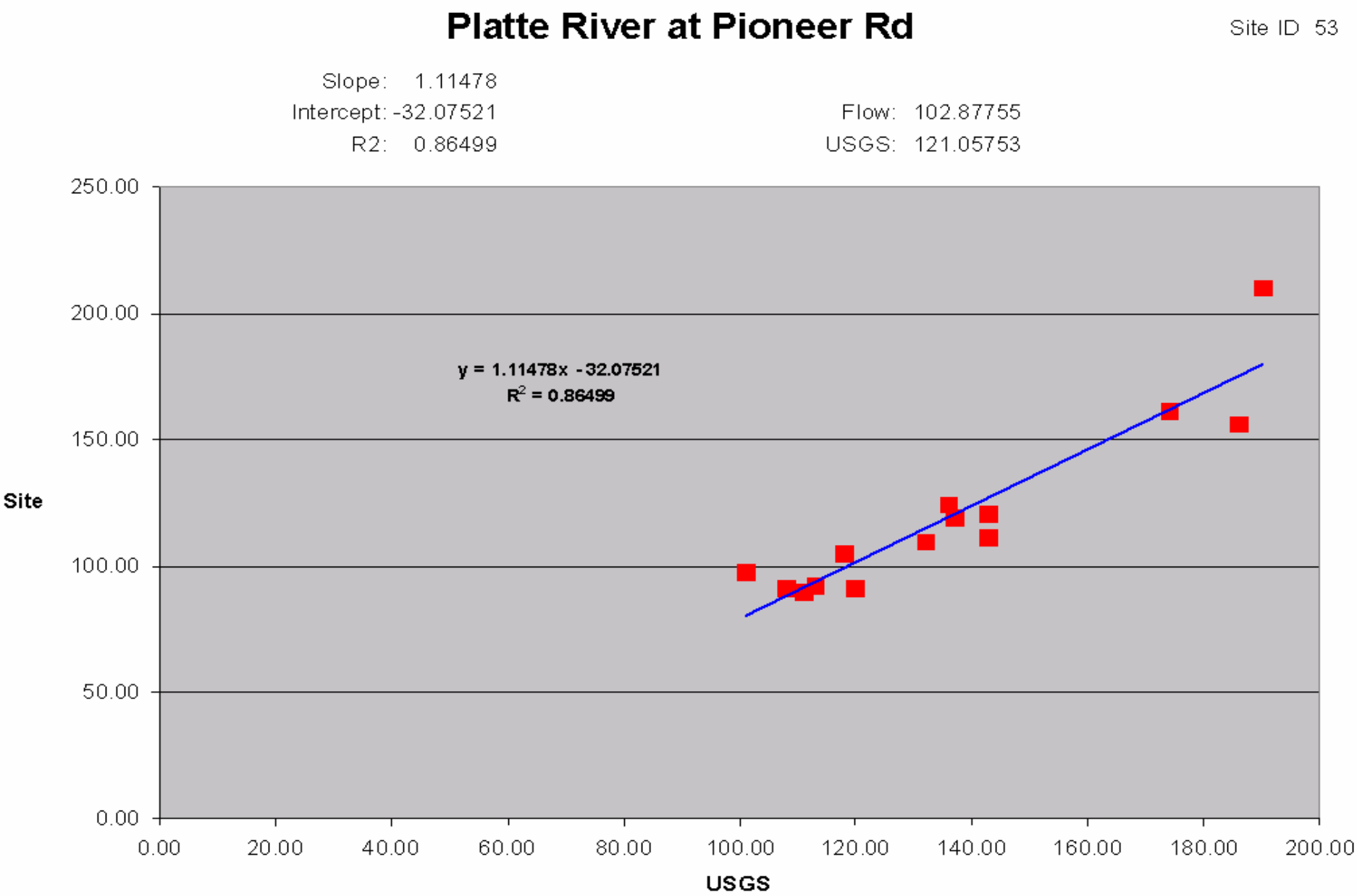


Figure 45. Correlation between USGS and Pioneer Roads Flows.

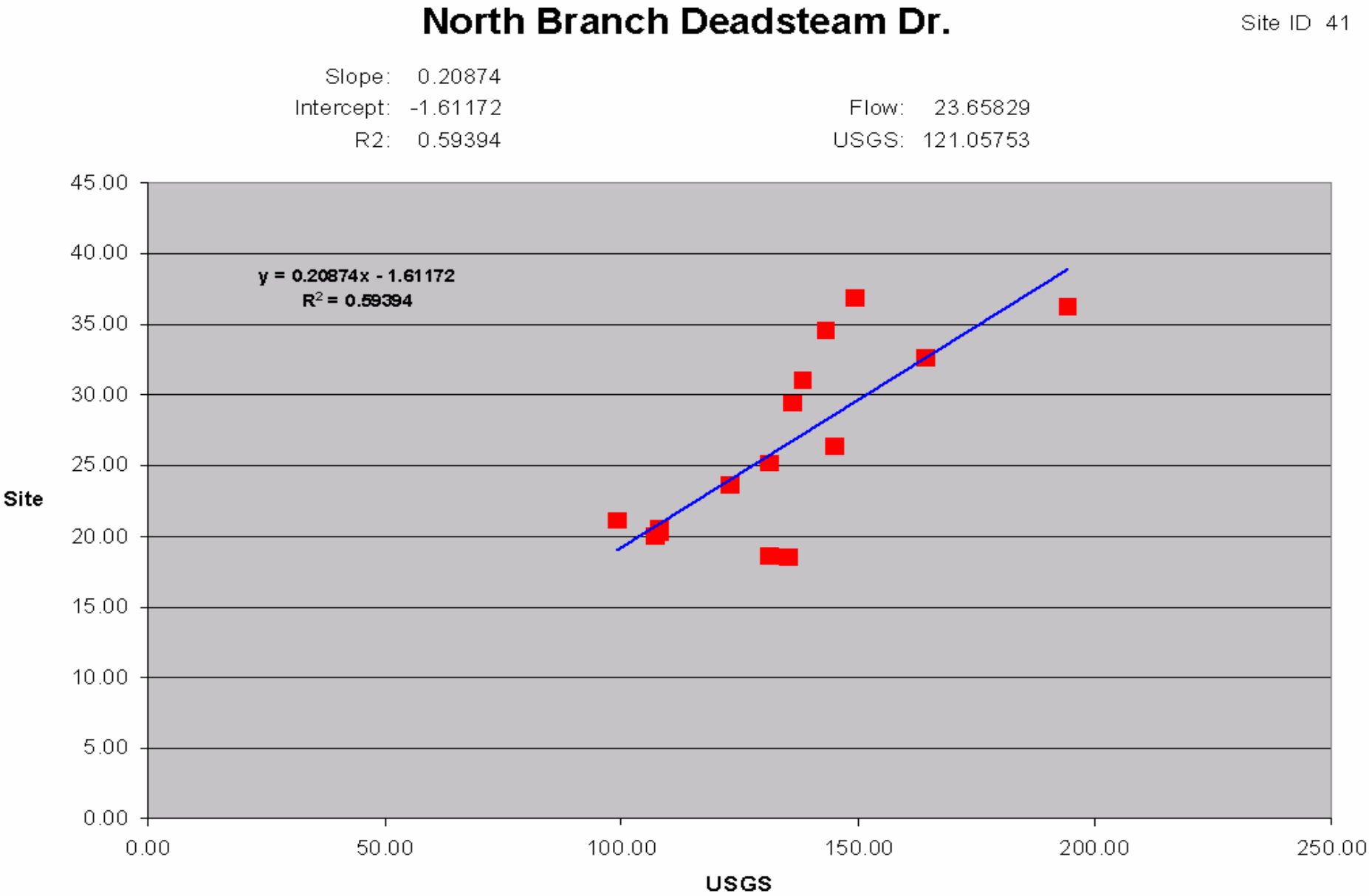
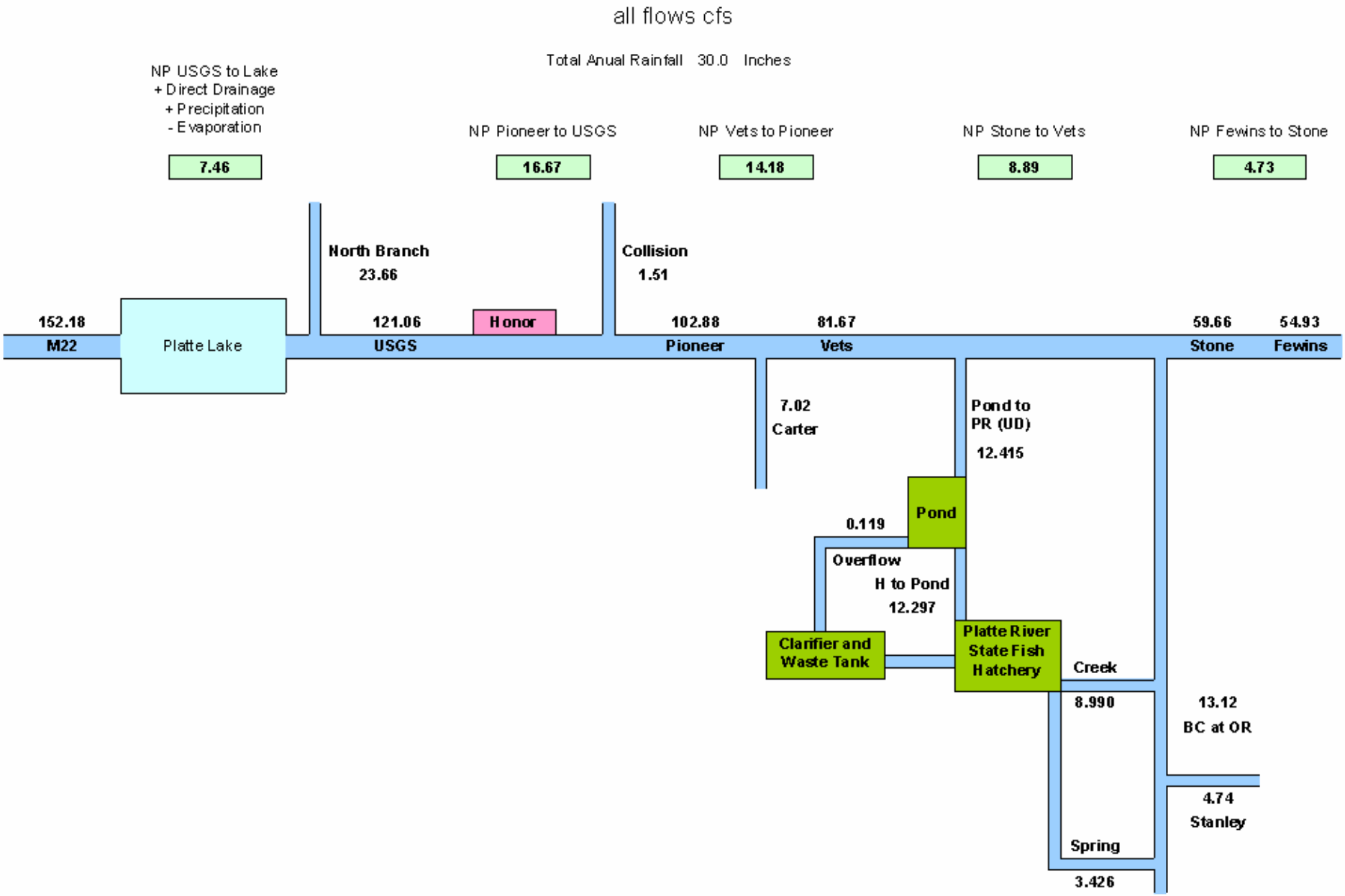


Figure 46. Correlation between USGS and North Branch Flows.

Figure 47. Annual Average Watershed Flow Balance for 2005



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Platte River Watershed

Figure 48.

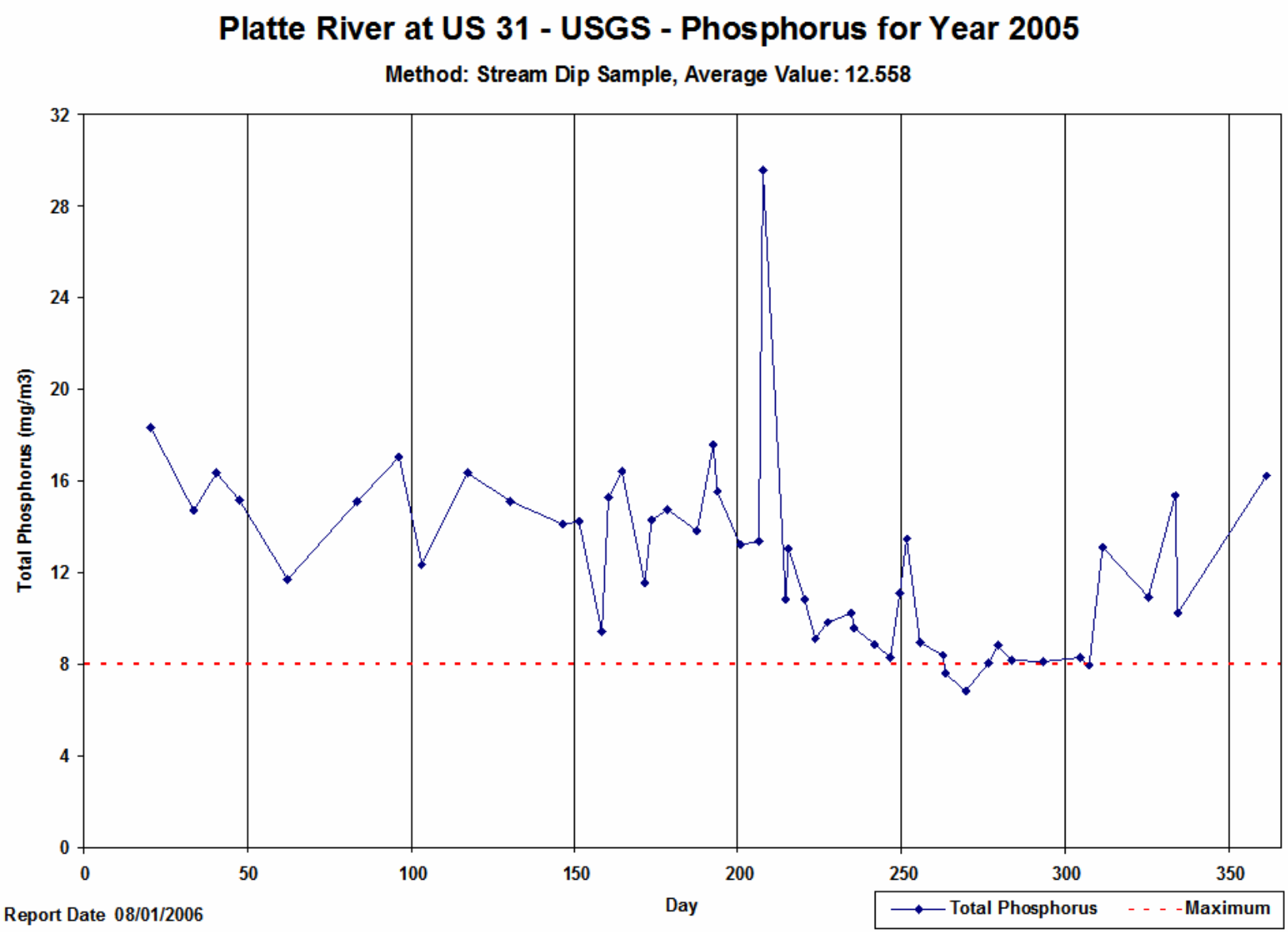
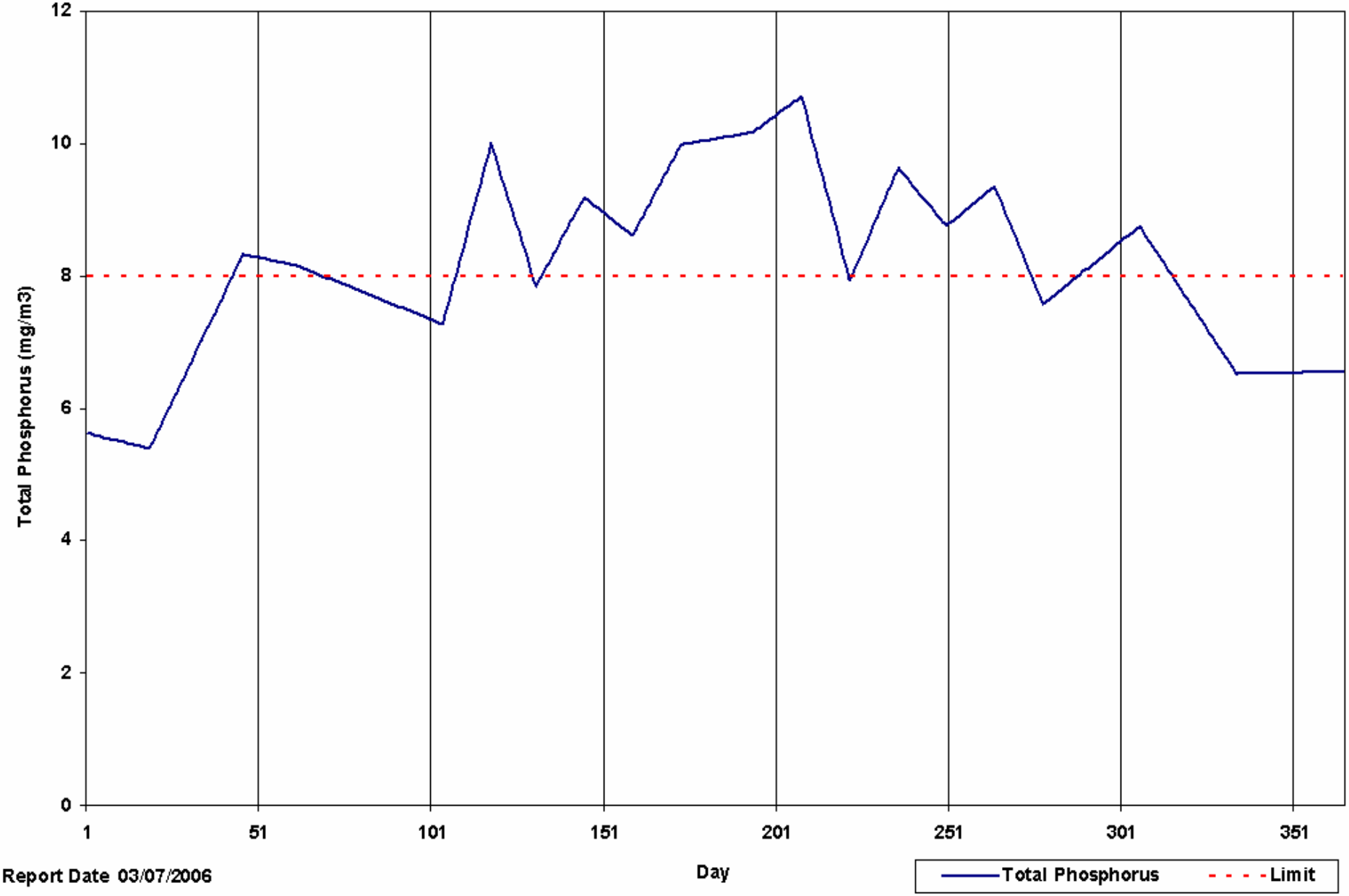

Platte River at US 31 - USGS - Phosphorus for Year 2005
Method: Stream Dip Sample, Average Value: 12.558
Total Phosphorus (mg/m3)
32
28
24
20
16
12
8
4
0
0
50
100
150
200
250
300
350
Day
Report Date 08/01/2006
Total Phosphorus
Maximum

Figure 49.

Big Platte Lake - Median Phosphorus for Year 2005

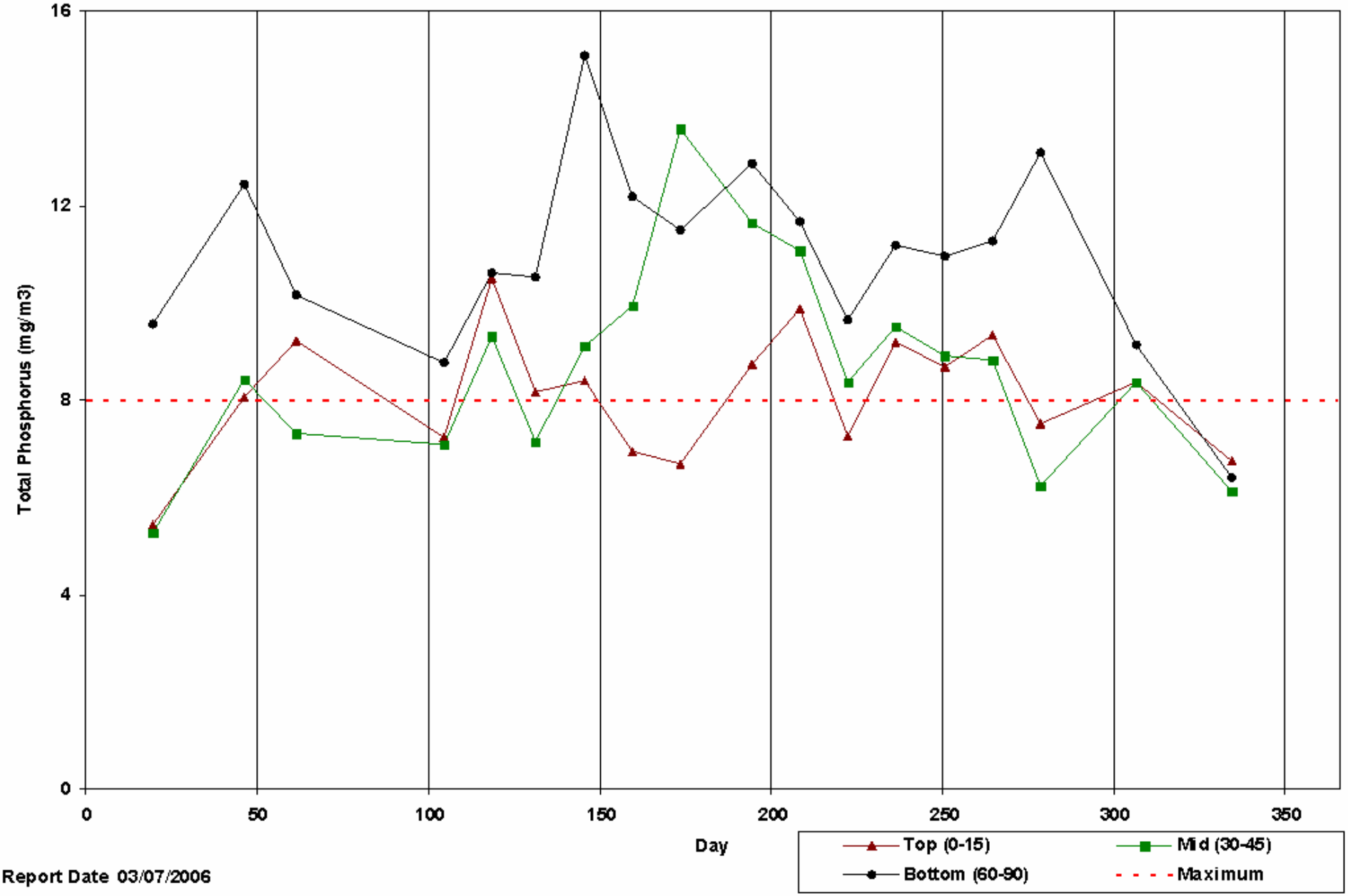
Average Median Phosphorus for Year is 8.18 (Above Limit 217 of 365 Days, 59%)



Report Date 03/07/2006

Figure 50.

Big Platte Lake - Phosphorus (Top-Mid-Bottom) for Year 2005

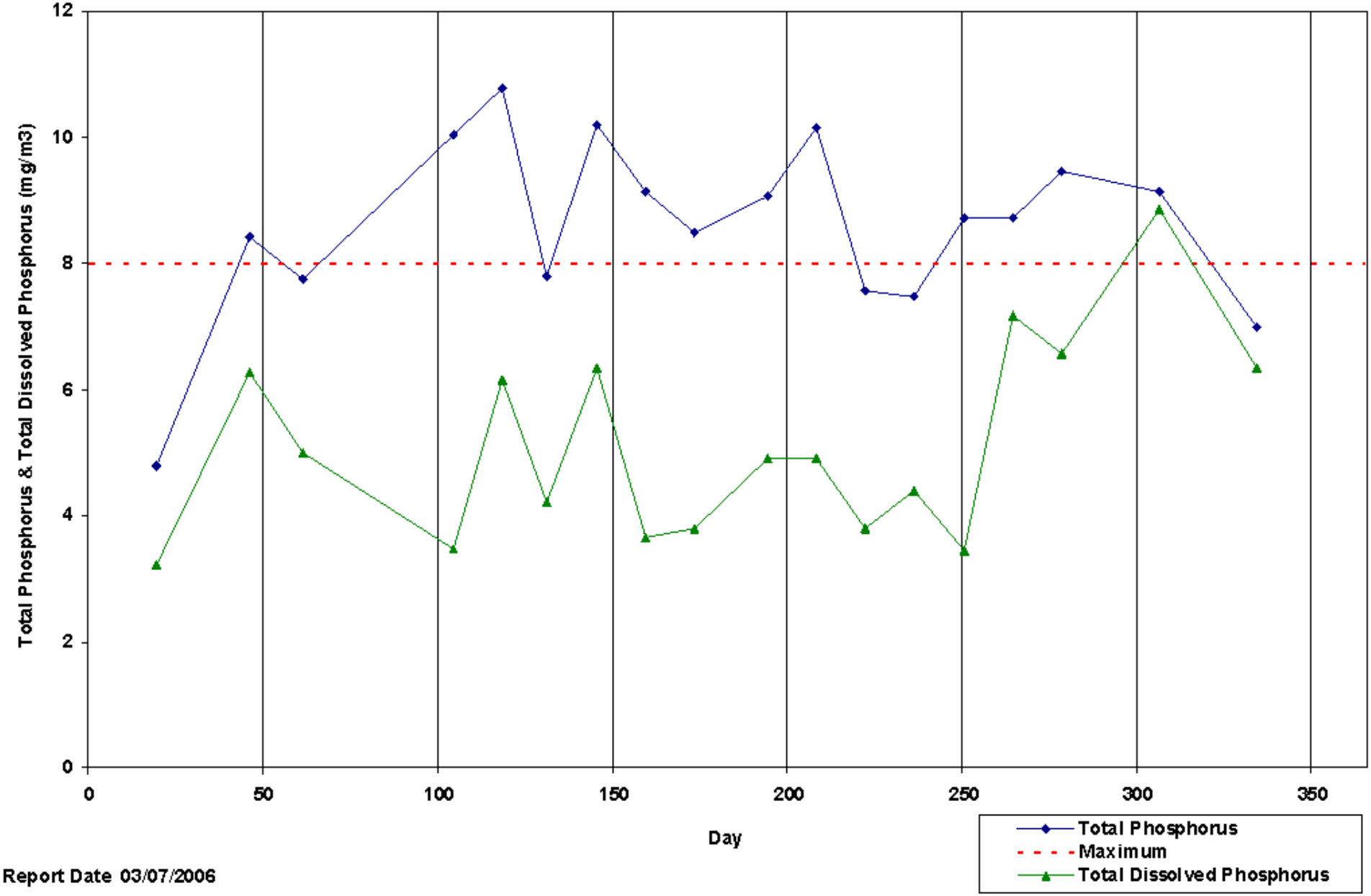


Report Date 03/07/2006

Figure 51.

Big Platte Lake - Phosphorus for Year 2005

Depth: 0-30 Feet, Average Value 8.589, TDP Avg Value 5.134

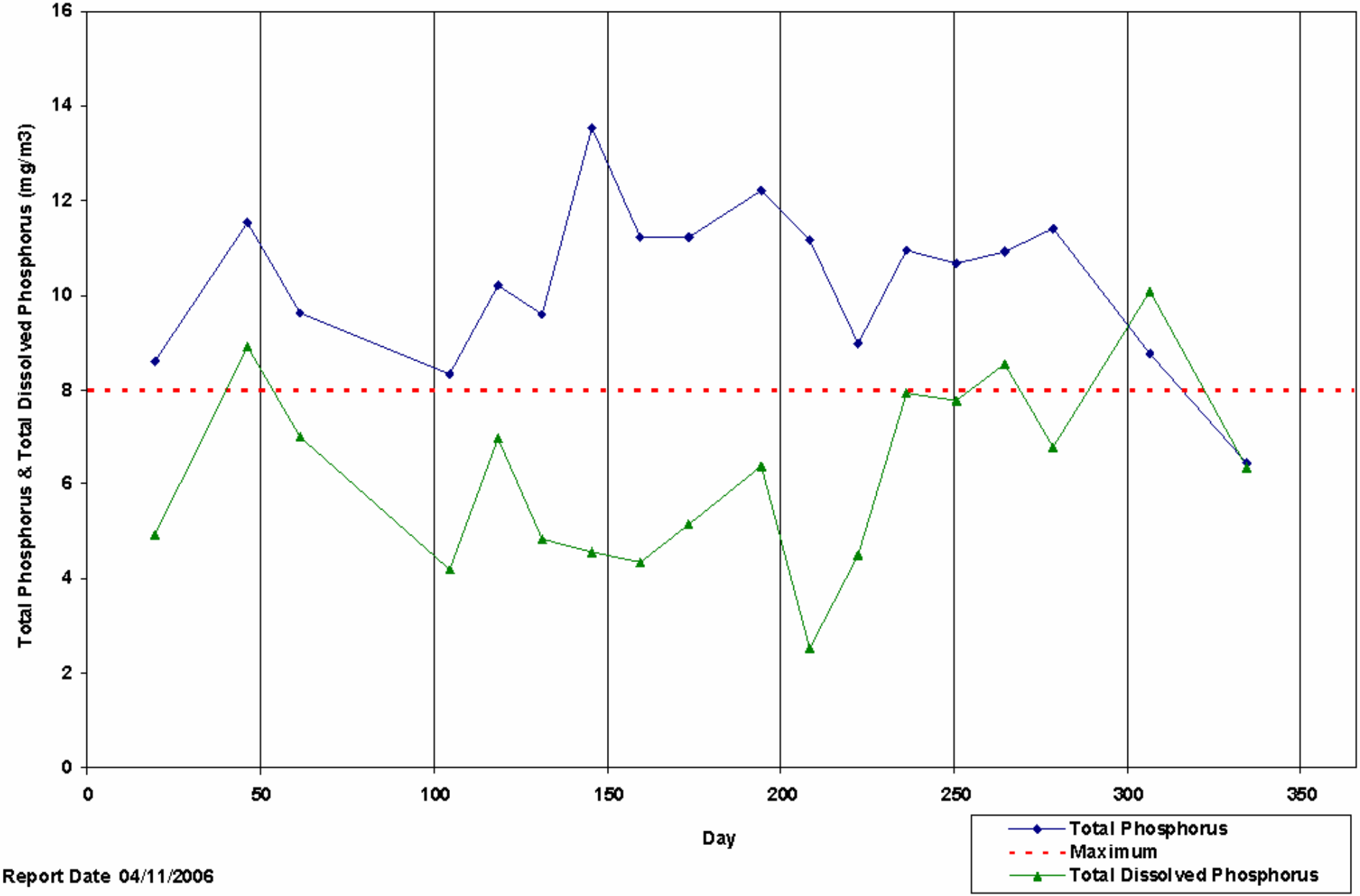


Report Date 03/07/2006

Figure 52.

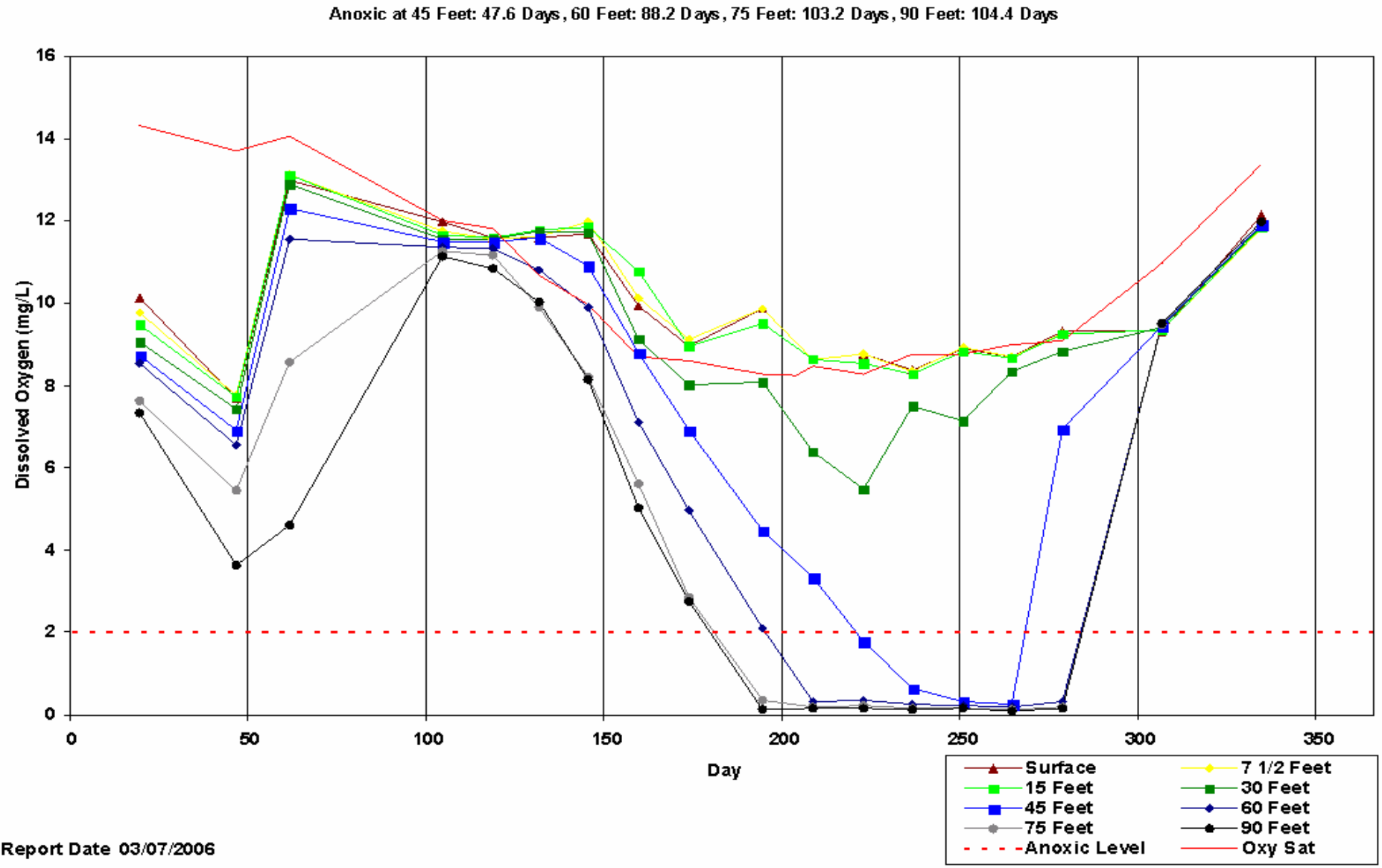
Big Platte Lake - Phosphorus for Year 2005

Depth: 45-90 Feet, Average Value 10.293, TDP Avg Value 6.208



Report Date 04/11/2006

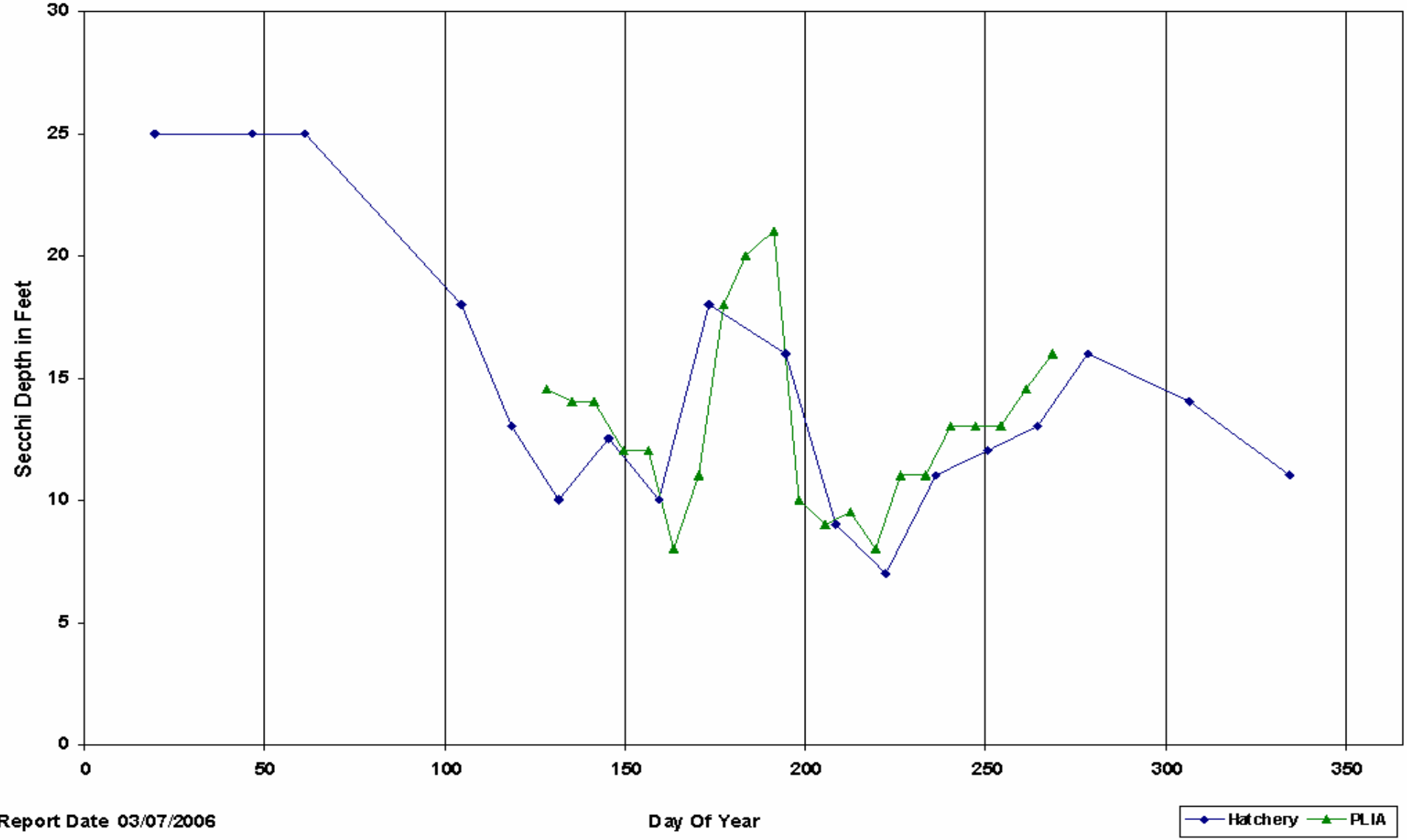
Figure 53. **Big Platte Lake Dissolved Oxygen (2005 at All Depths)**



Report Date 03/07/2006

Figure 54. **Big Platte Lake Secchi Depth for 2005**

Average Secchi Value: 13.795 (Minimum: 7, Maximum: 25, Hatchery Avg: 14.750, PLIA Avg: 12.976)

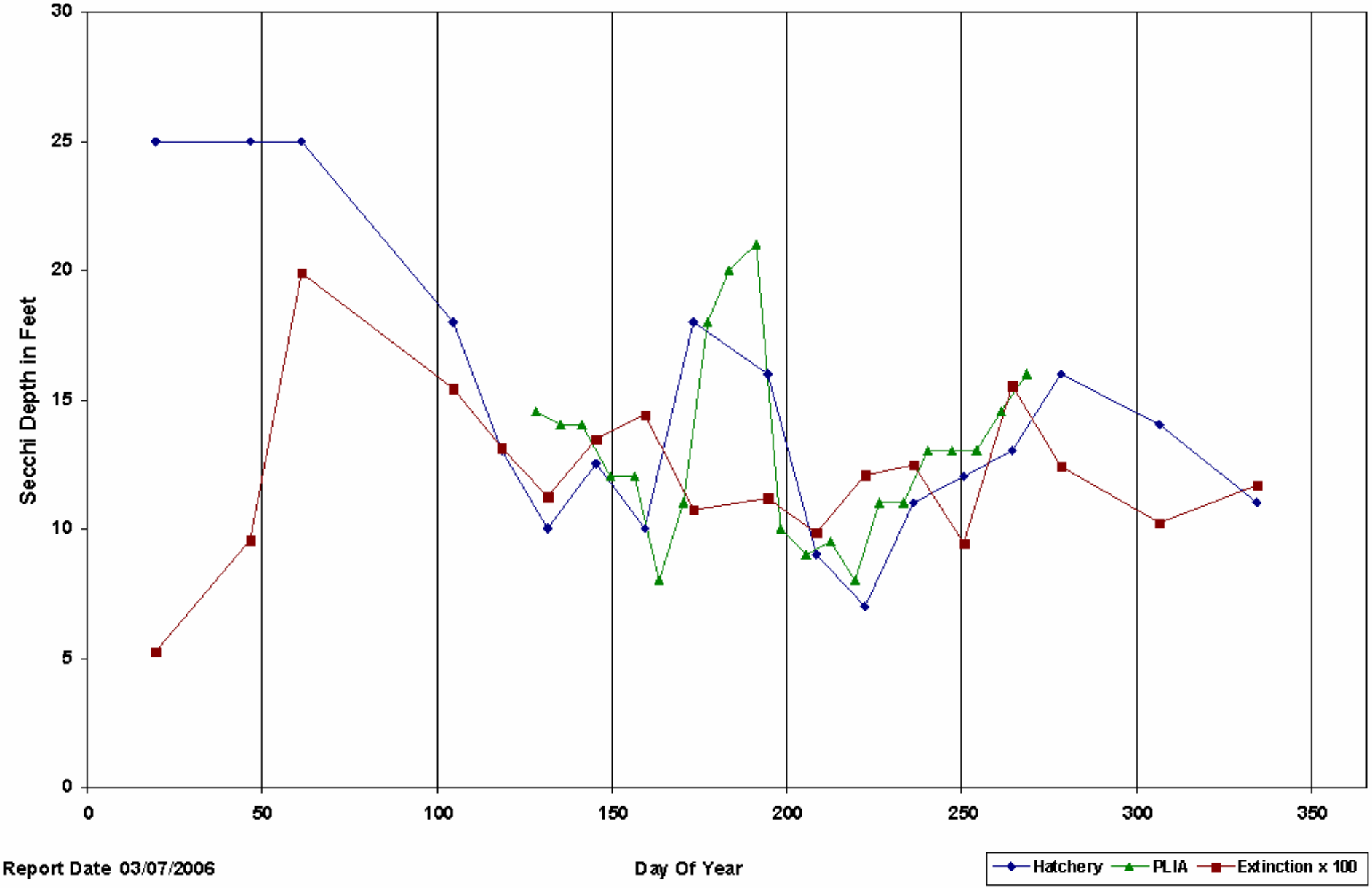


Report Date 03/07/2006

Figure 55.

Big Platte Lake Secchi vs Extinction (x100) for 2005

Average Secchi Value: 13.795 (Minimum: 7, Maximum: 25, Hatchery Avg: 14.750, PLIA Avg: 12.976)



Report Date 03/07/2006

Figure 56.

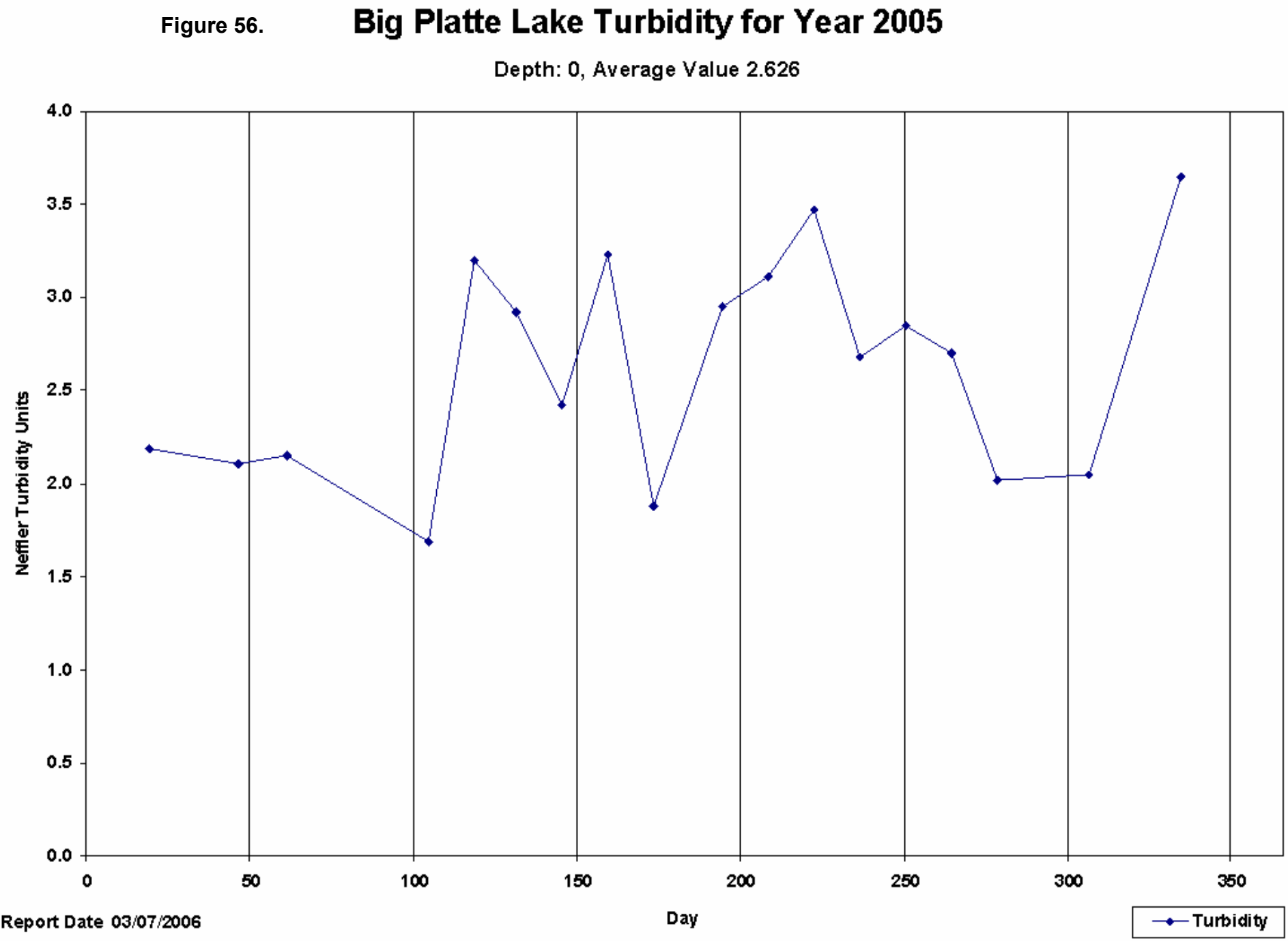
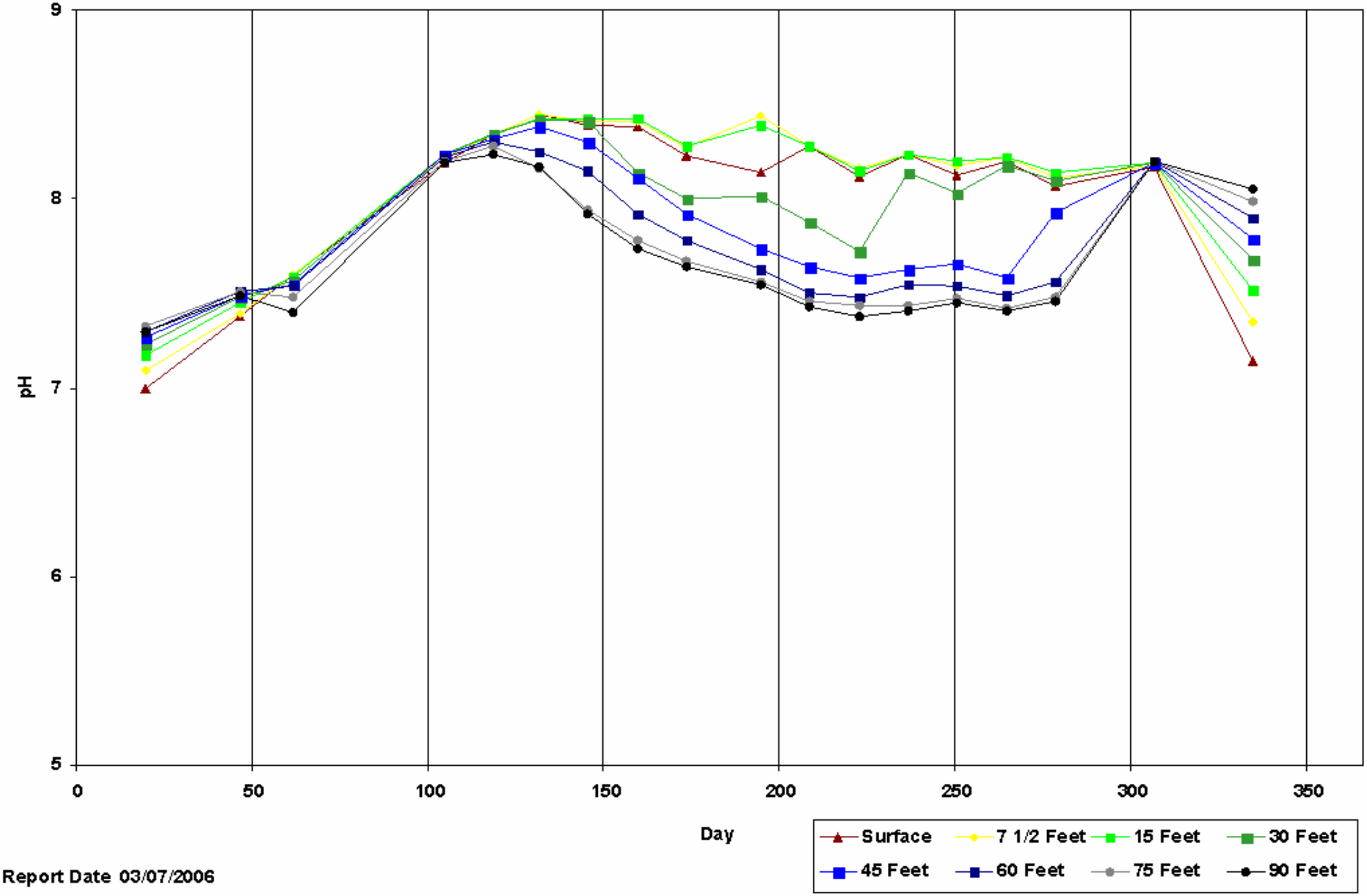

Big Platte Lake Turbidity for Year 2005
Depth: 0, Average Value 2.626
Neffler Turbidity Units
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
50
100
150
200
250
300
350
Day
Report Date 03/07/2006
Turbidity

Figure 57. **Big Platte Lake pH (2005 at All Depths)**



Report Date 03/07/2006

Figure 58.

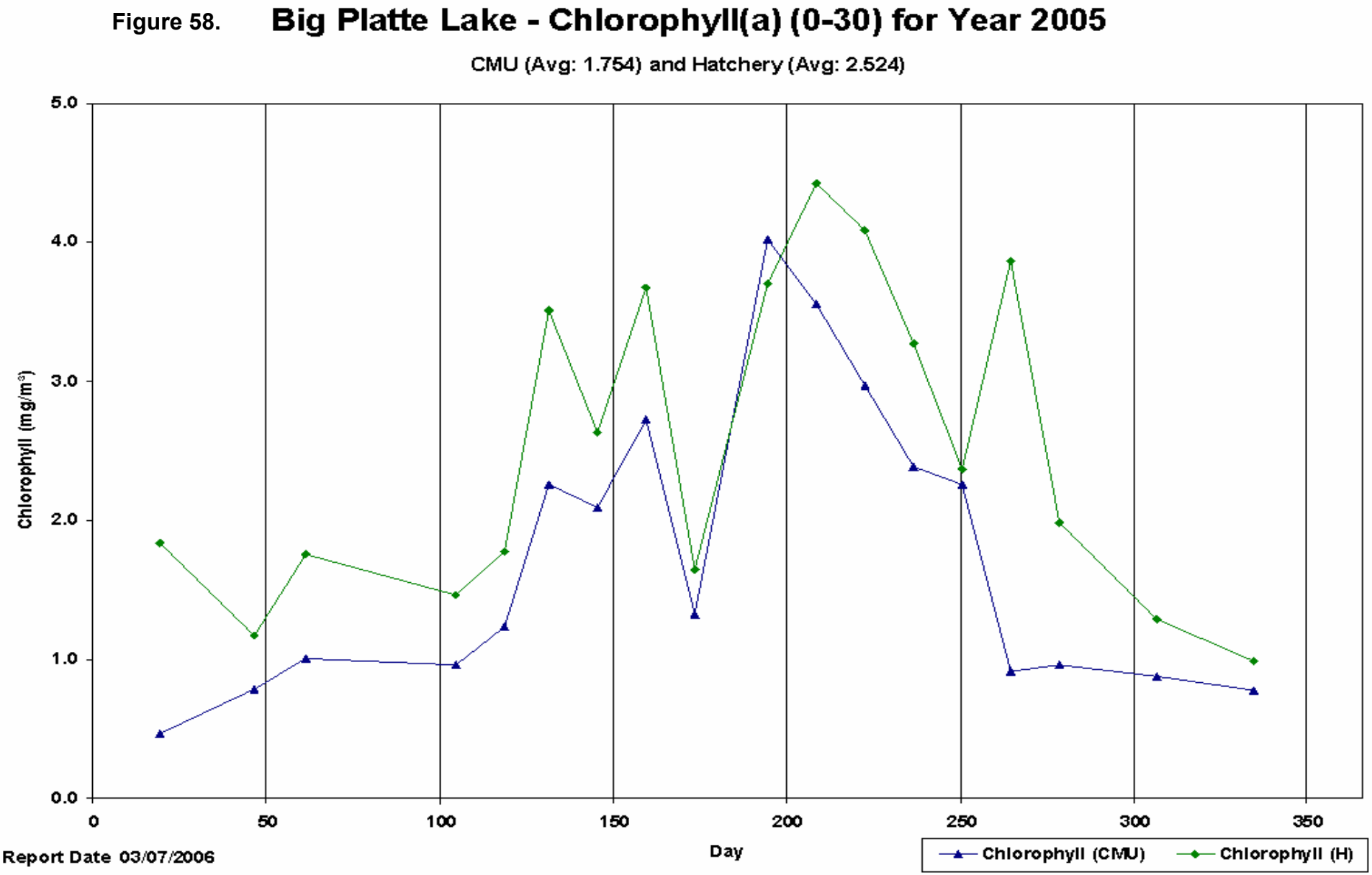

Big Platte Lake - Chlorophyll(a) (0-30) for Year 2005
CMU (Avg: 1.754) and Hatchery (Avg: 2.524)
Chlorophyll (mg/m³)
5.0
4.0
3.0
2.0
1.0
0.0
0
50
100
150
200
250
300
350
Day
Report Date 03/07/2006
Chlorophyll (CMU)
Chlorophyll (H)

Figure 59. **Big Platte Lake - Chlorophyll(a) (45-90) for Year 2005**

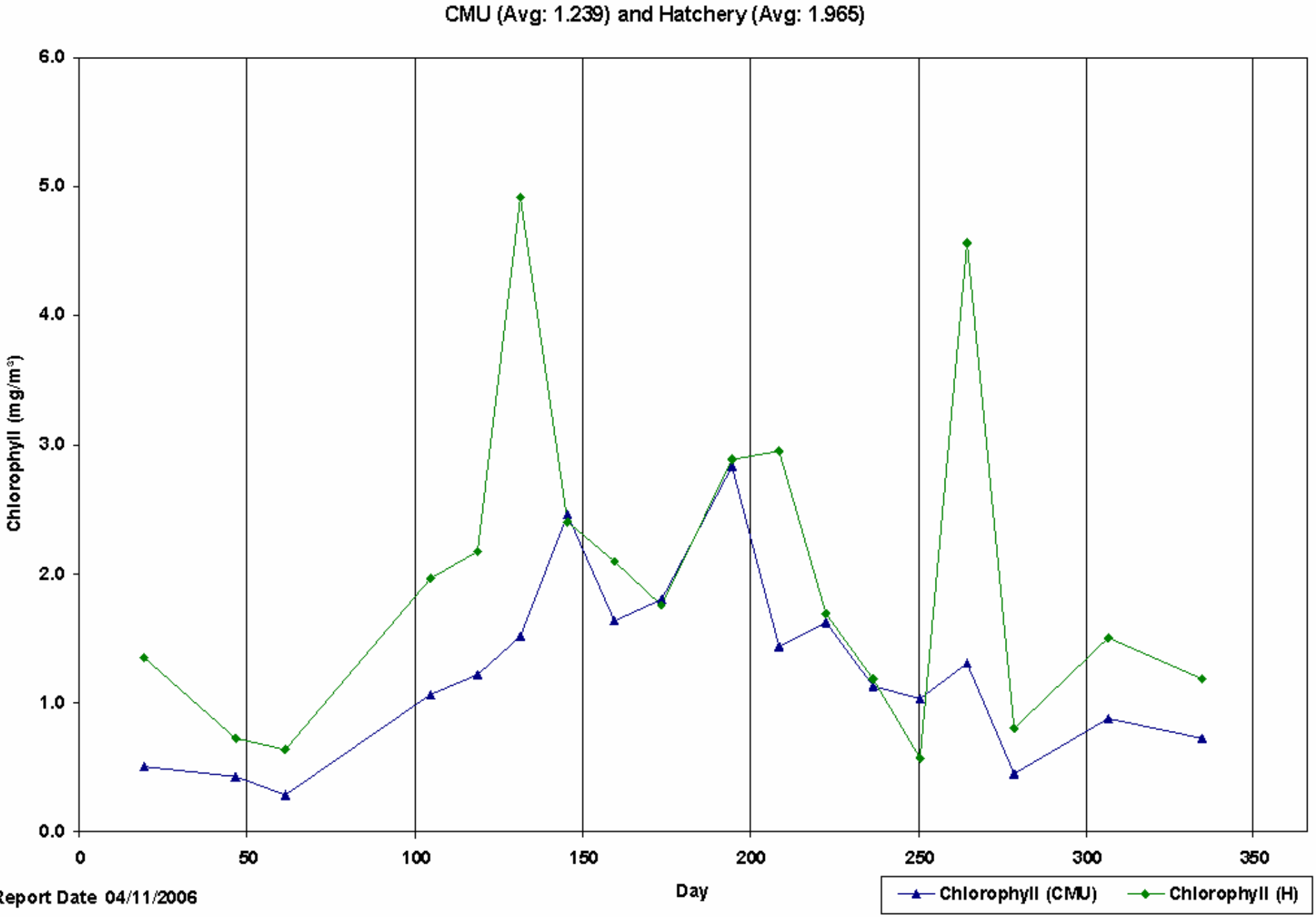
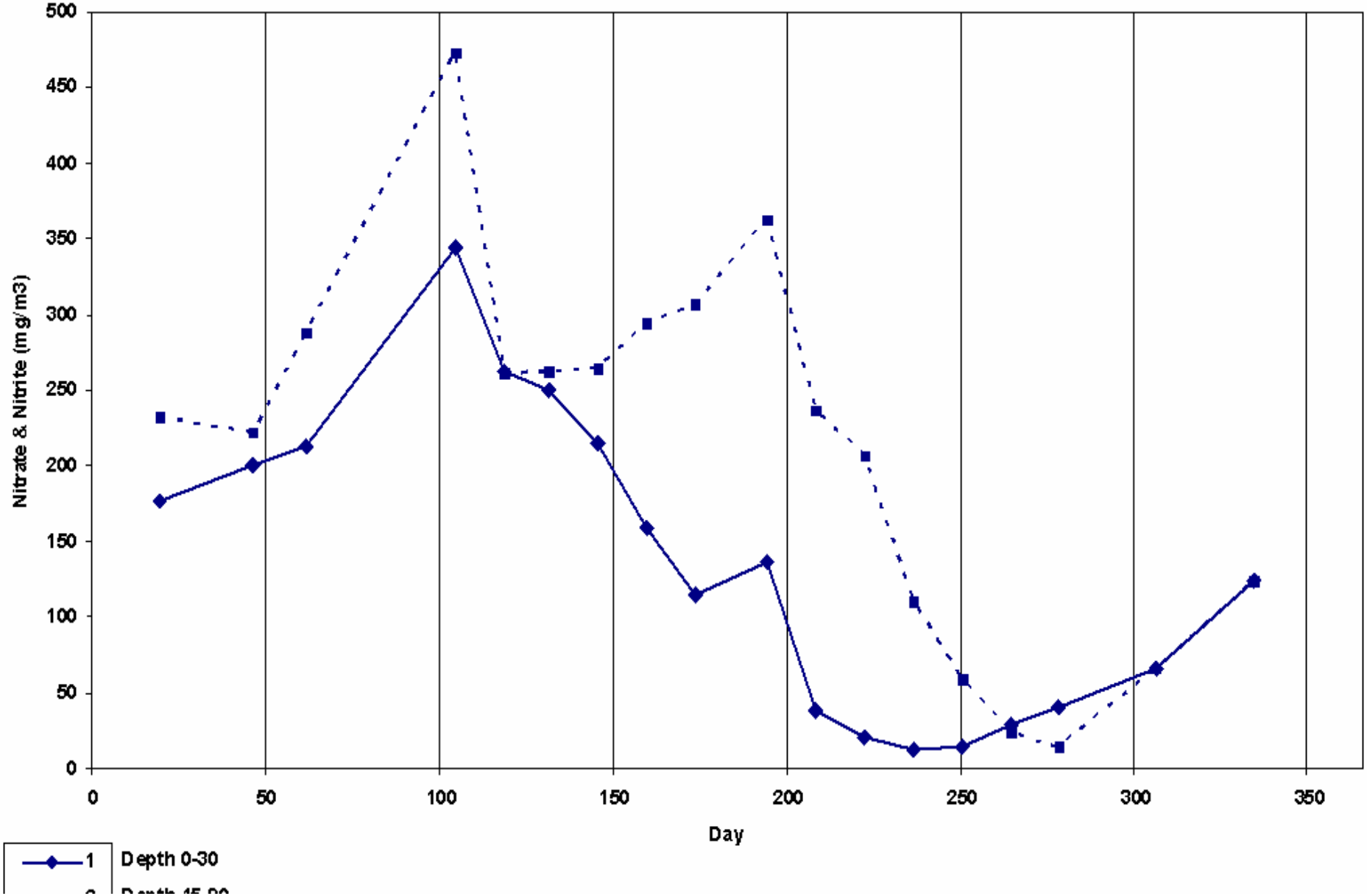


Figure 60.

Big Platte Lake - NOx for Year 2005

Average Value for Depth 0-30: 134.122, Average Value for Depth 45-90: 211.640



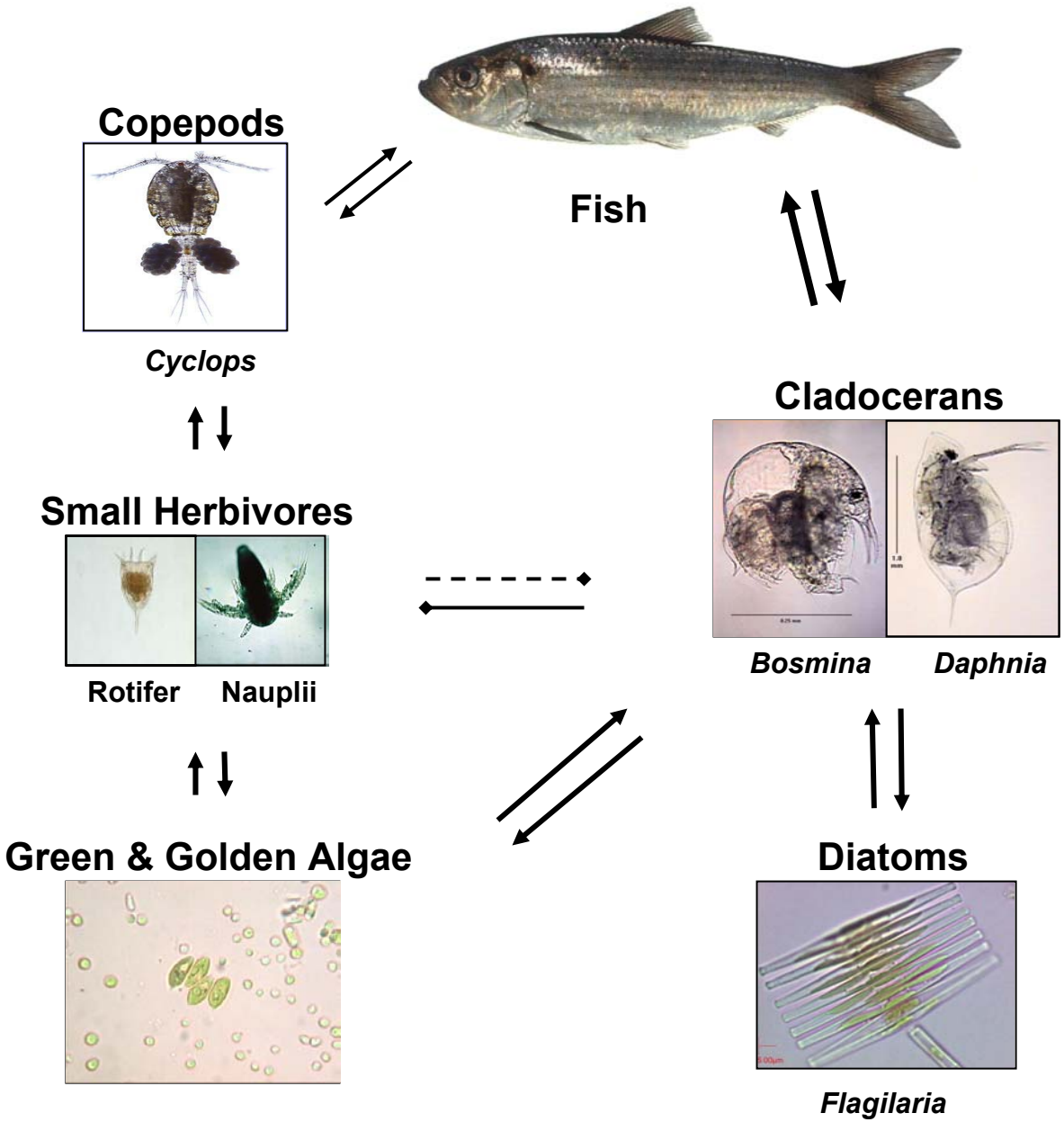


Figure 61. Food Web for Big Platte Lake.

Figure 62. **Big vs Little Platte Lake Temperature**

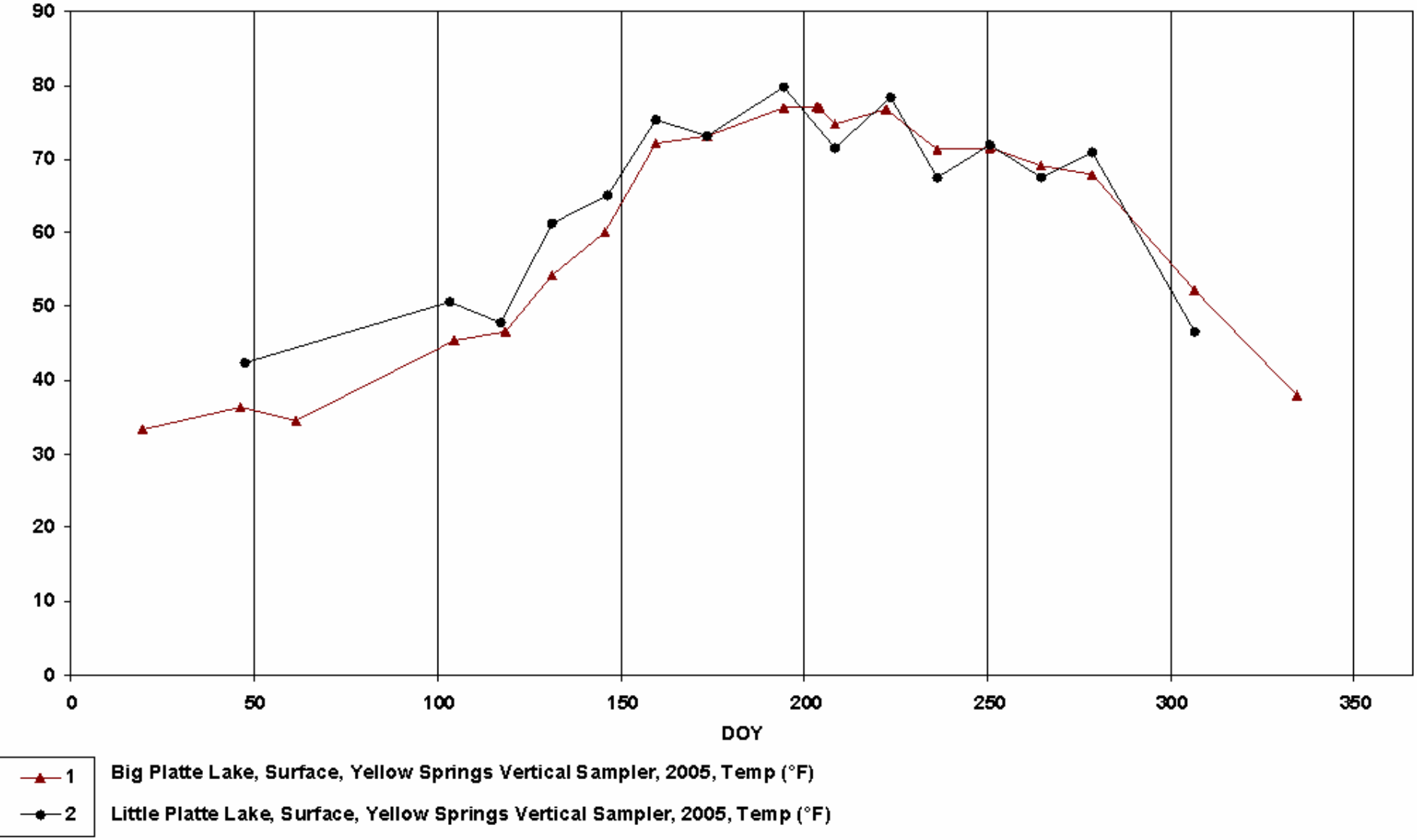


Figure 63. **Big vs Little Platte Lake Total Phosphorus**

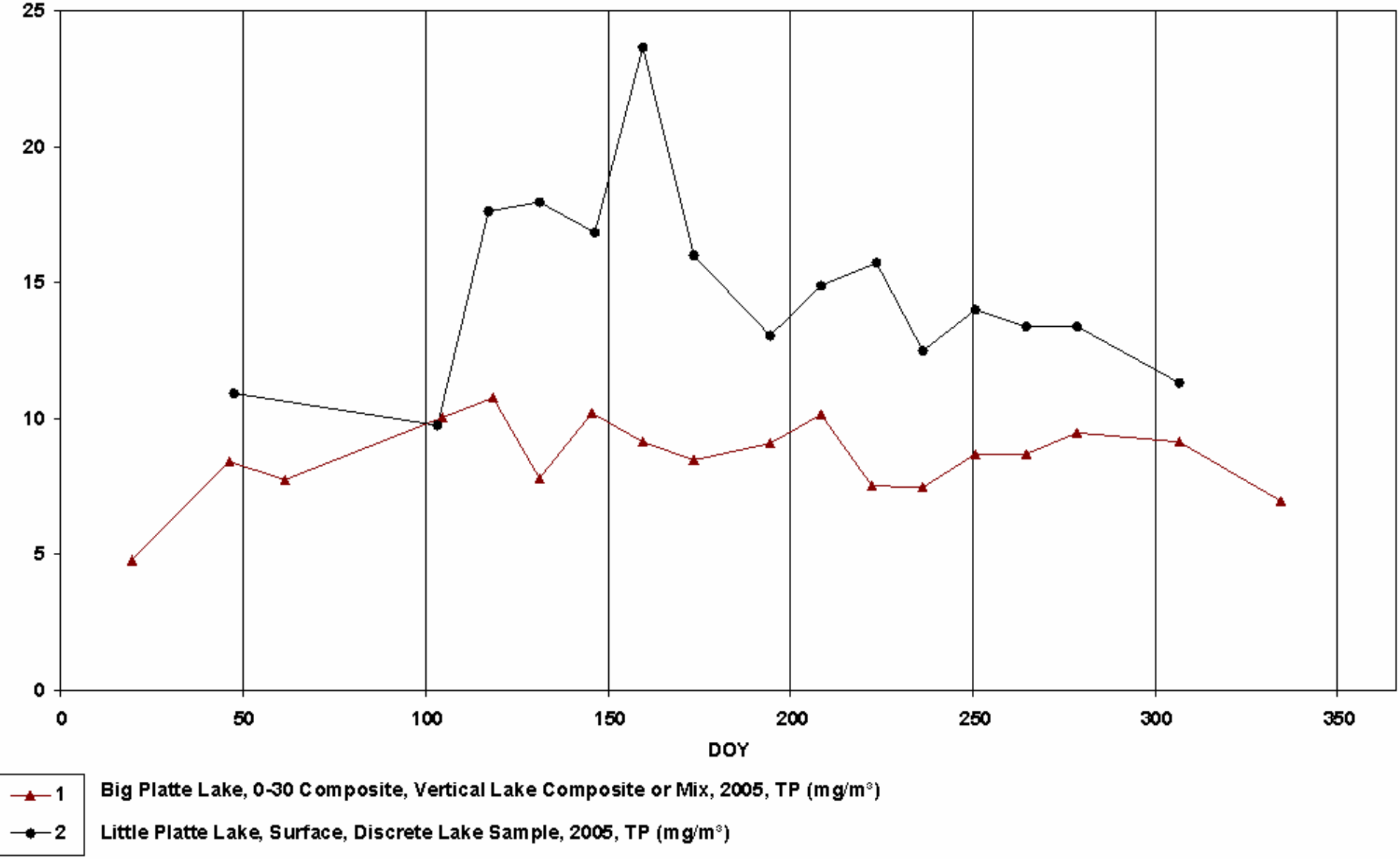


Figure 64. **Big vs Little Platte Lake Total Dissolved Phosphorus**

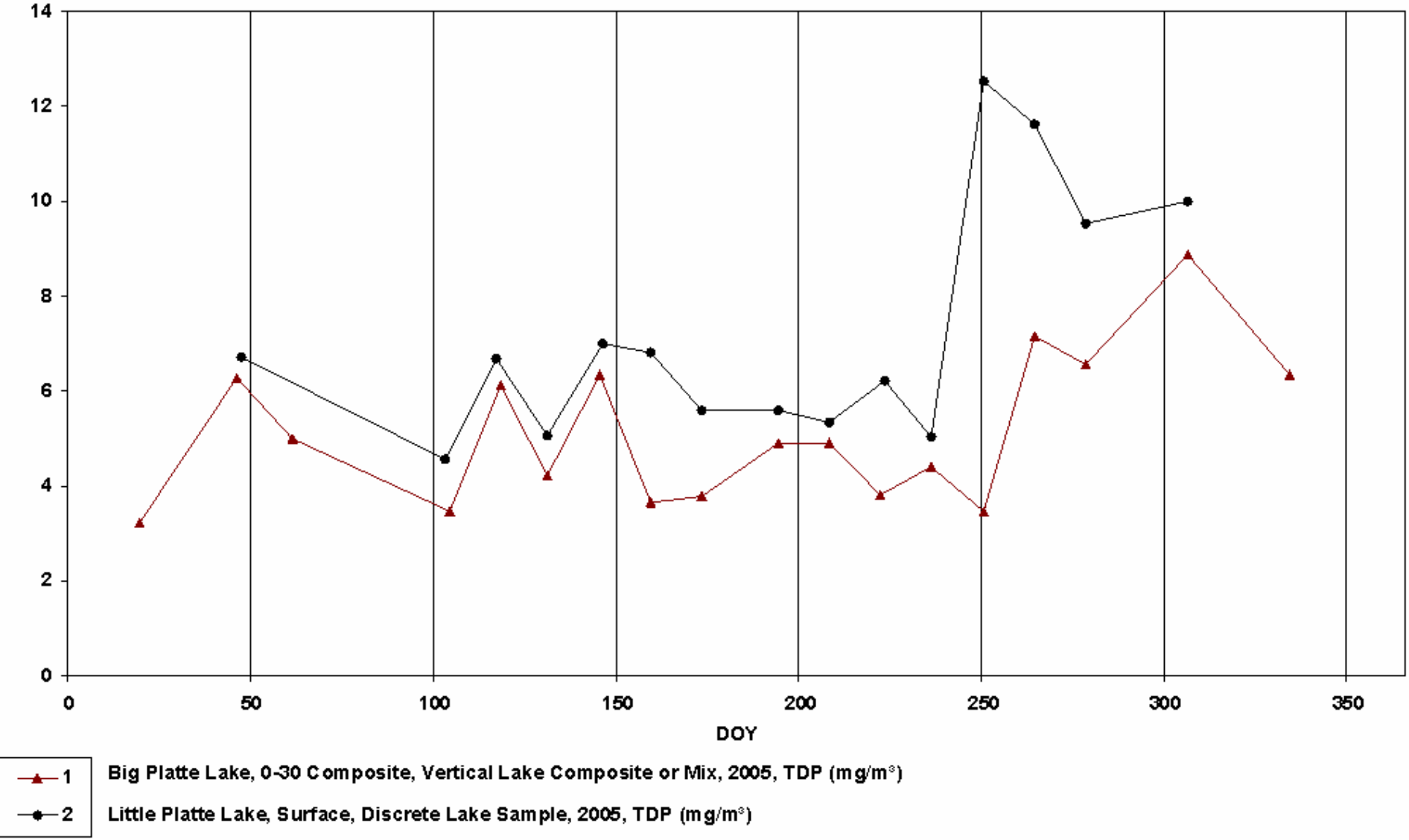


Figure 65. **Big vs Little Platte Lake Chlorophyll**

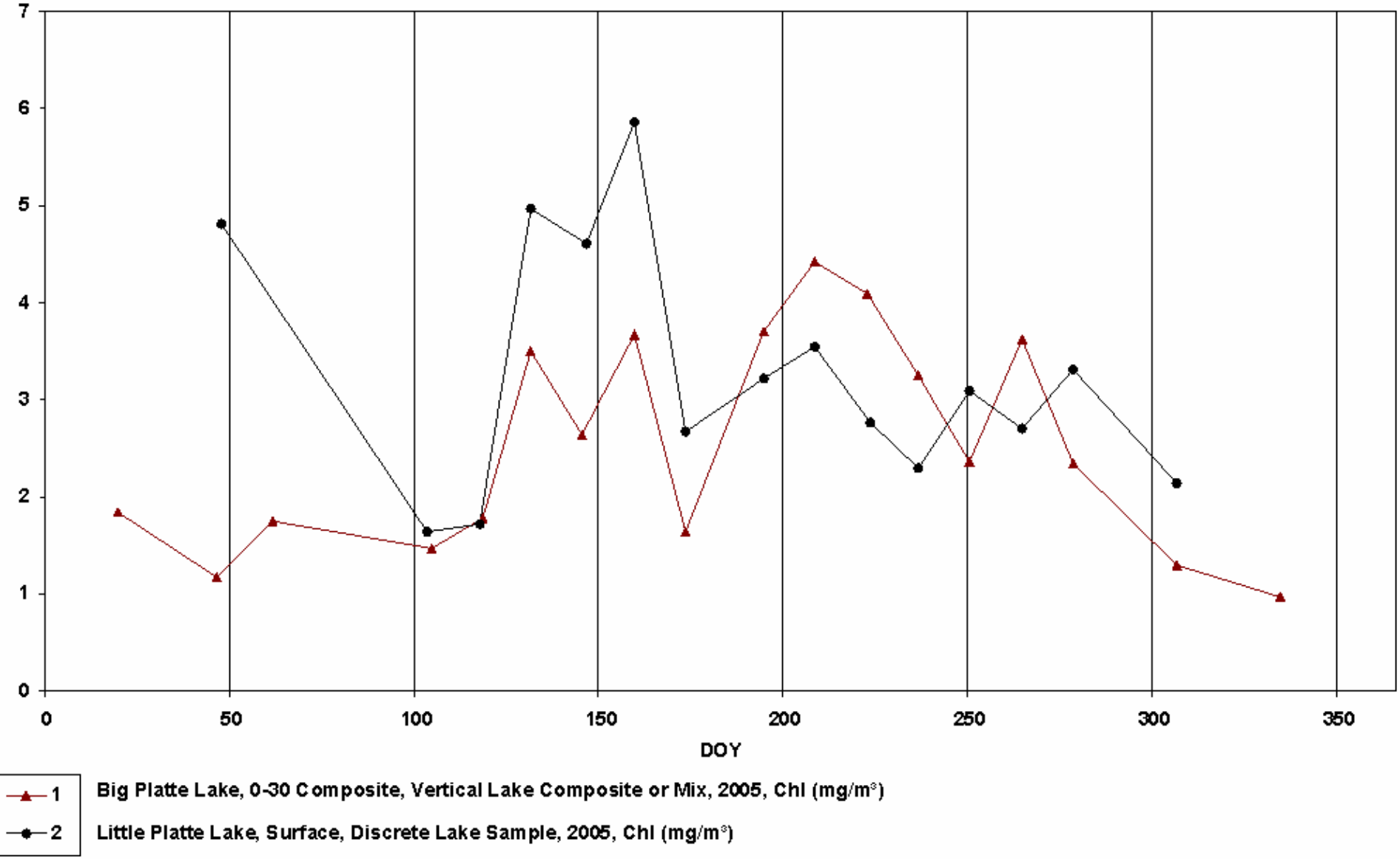


Figure 66.

Big vs Little Platte Turbidity

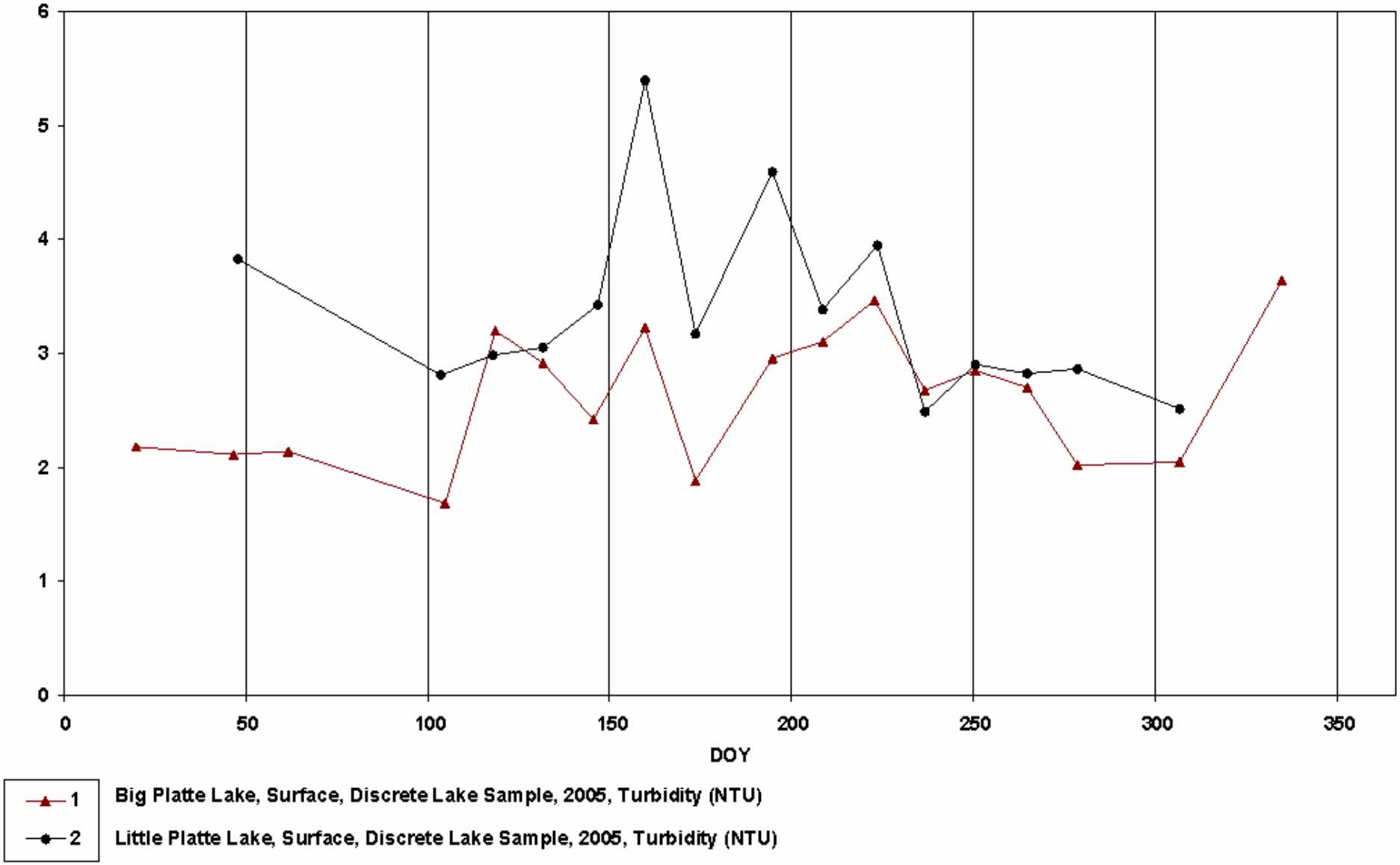
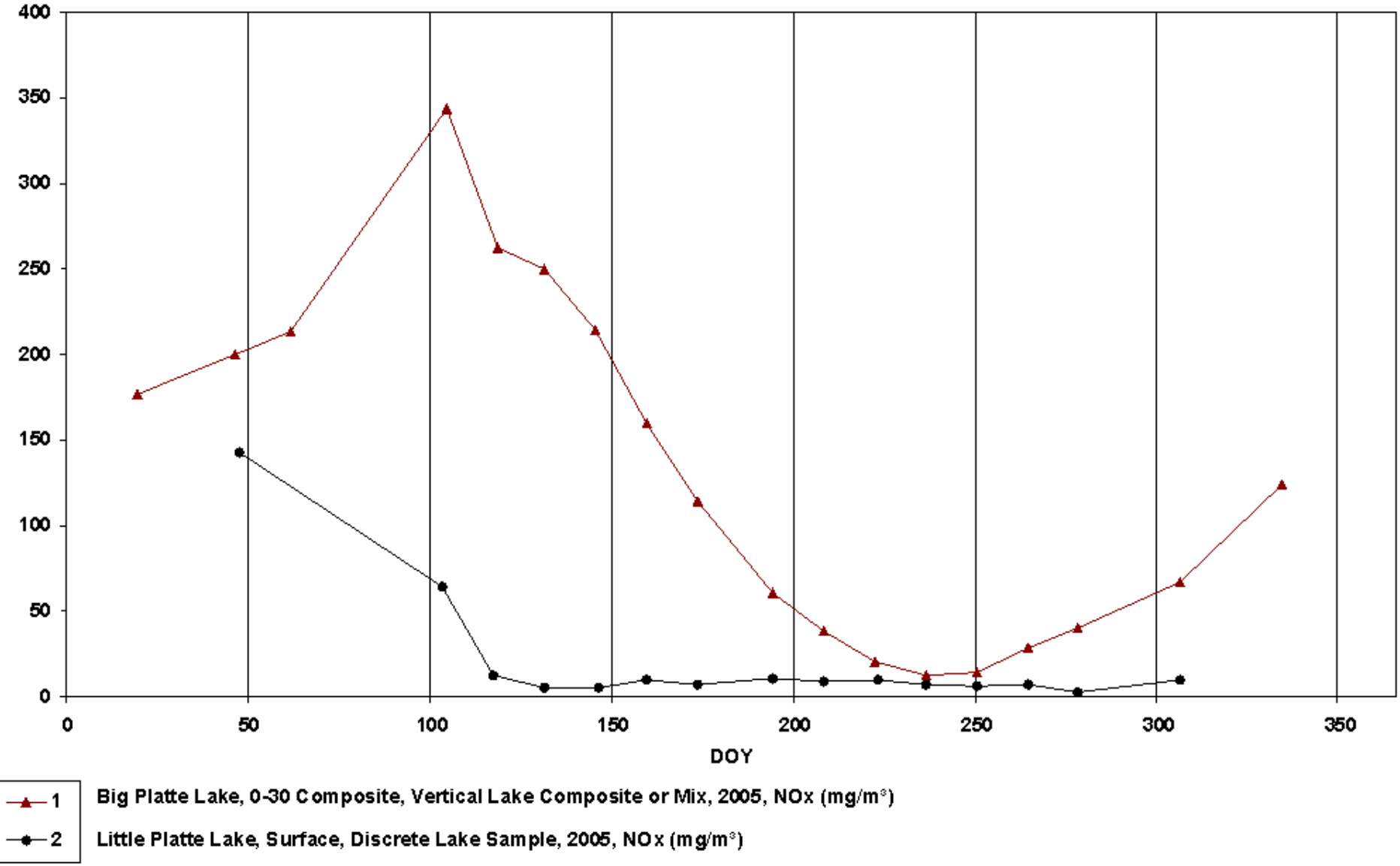


Figure 67.

Big vs Little Platte Lake Nox



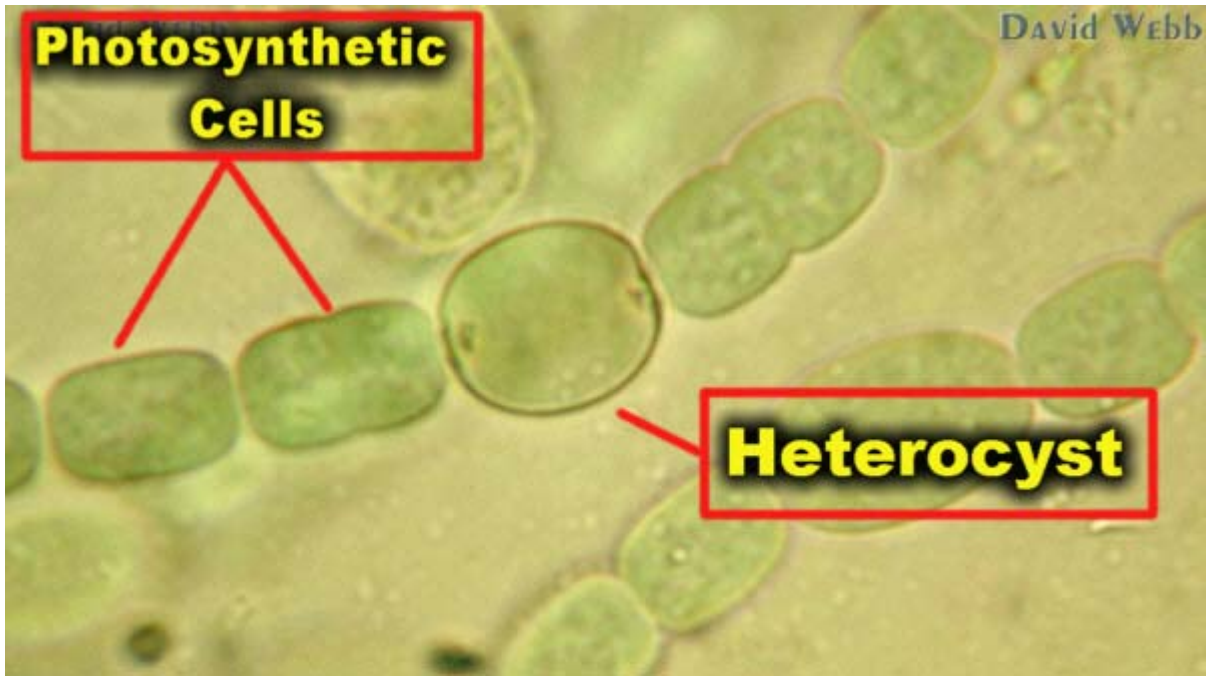


Figure 68. Photograph of Anabaena and Heterocyst Cells.

Figure 69. **Big vs Little Platte Lake Alkalinity**

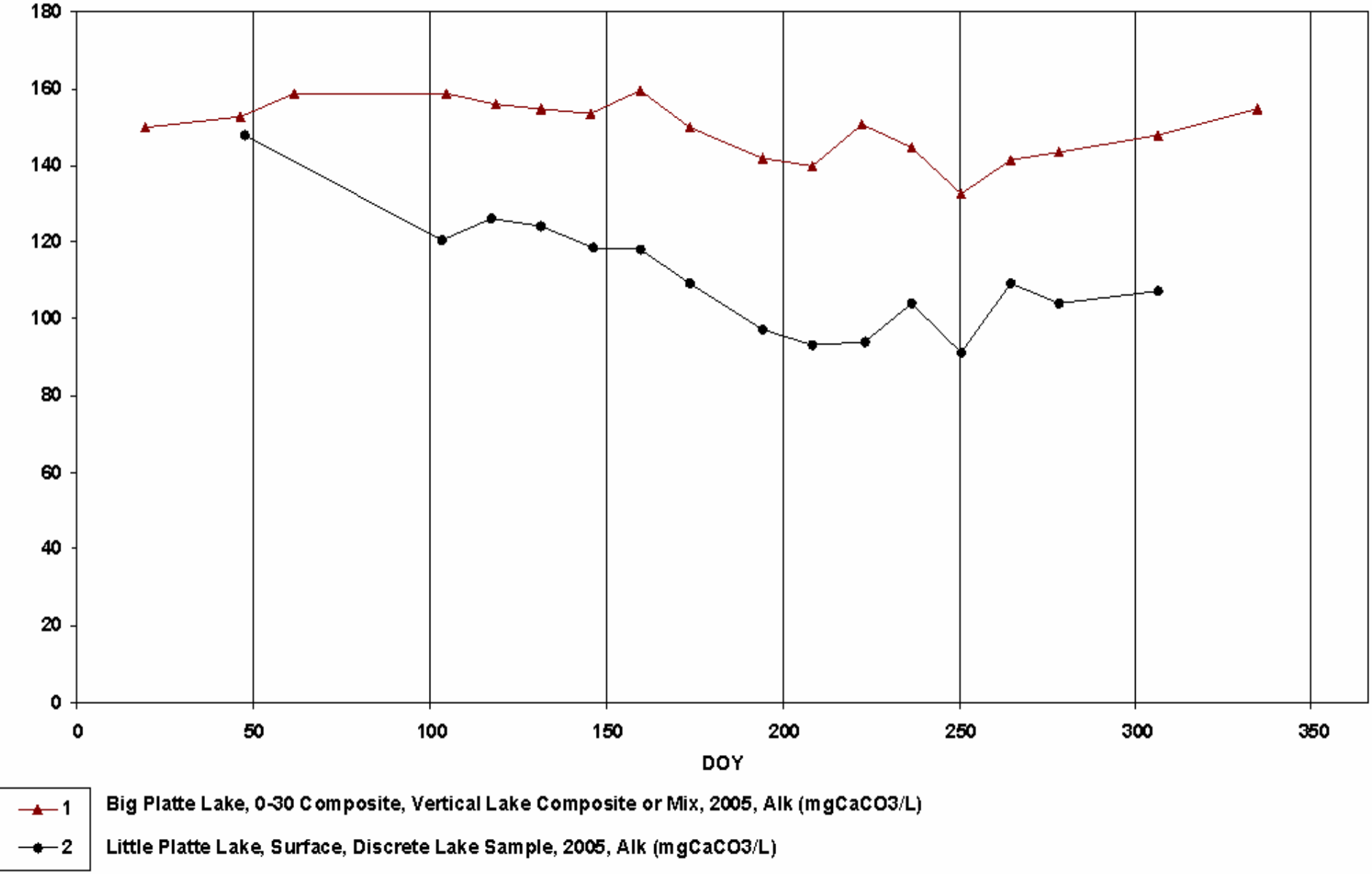


Figure 70. **Big vs Little Platte Lake pH**

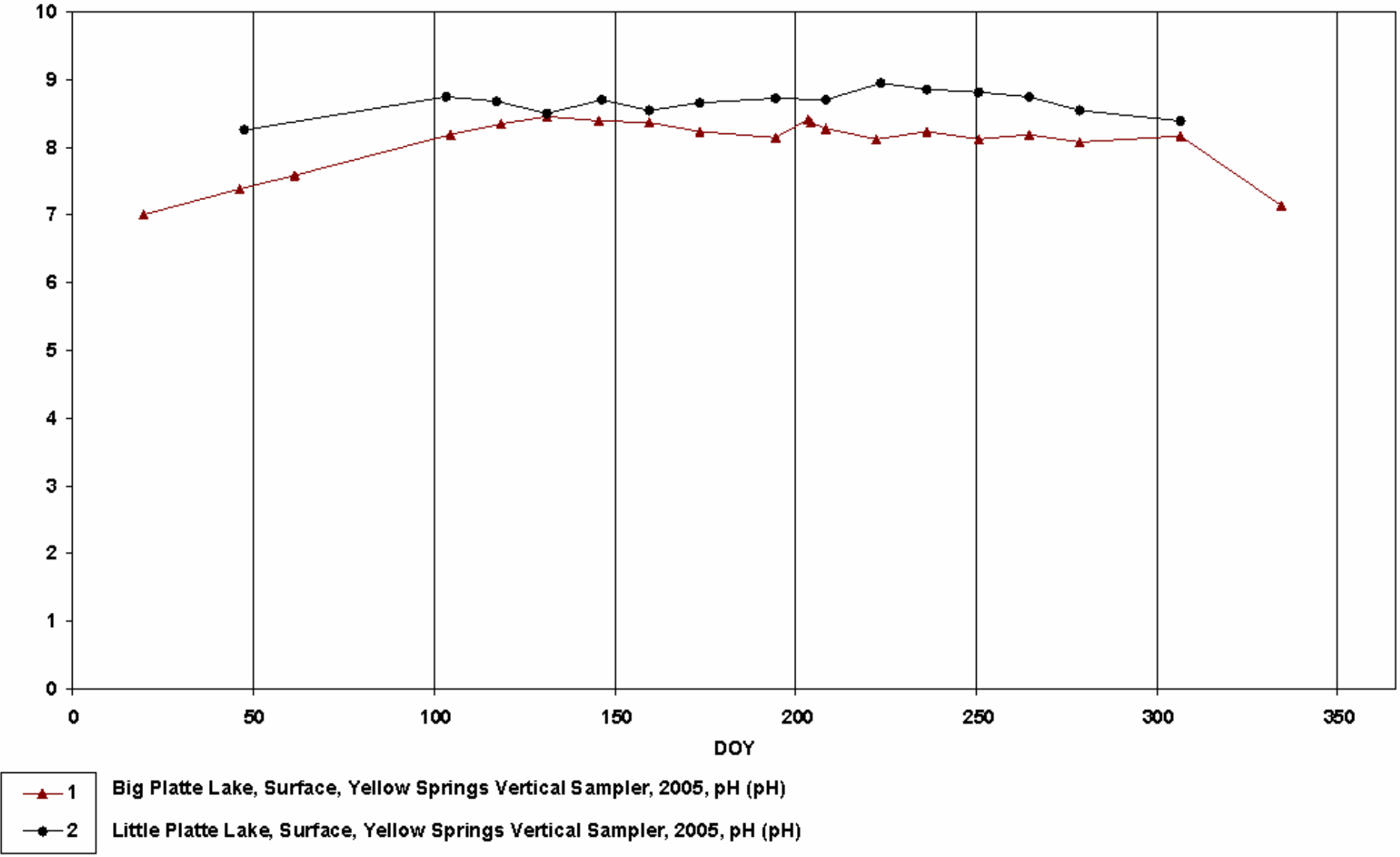
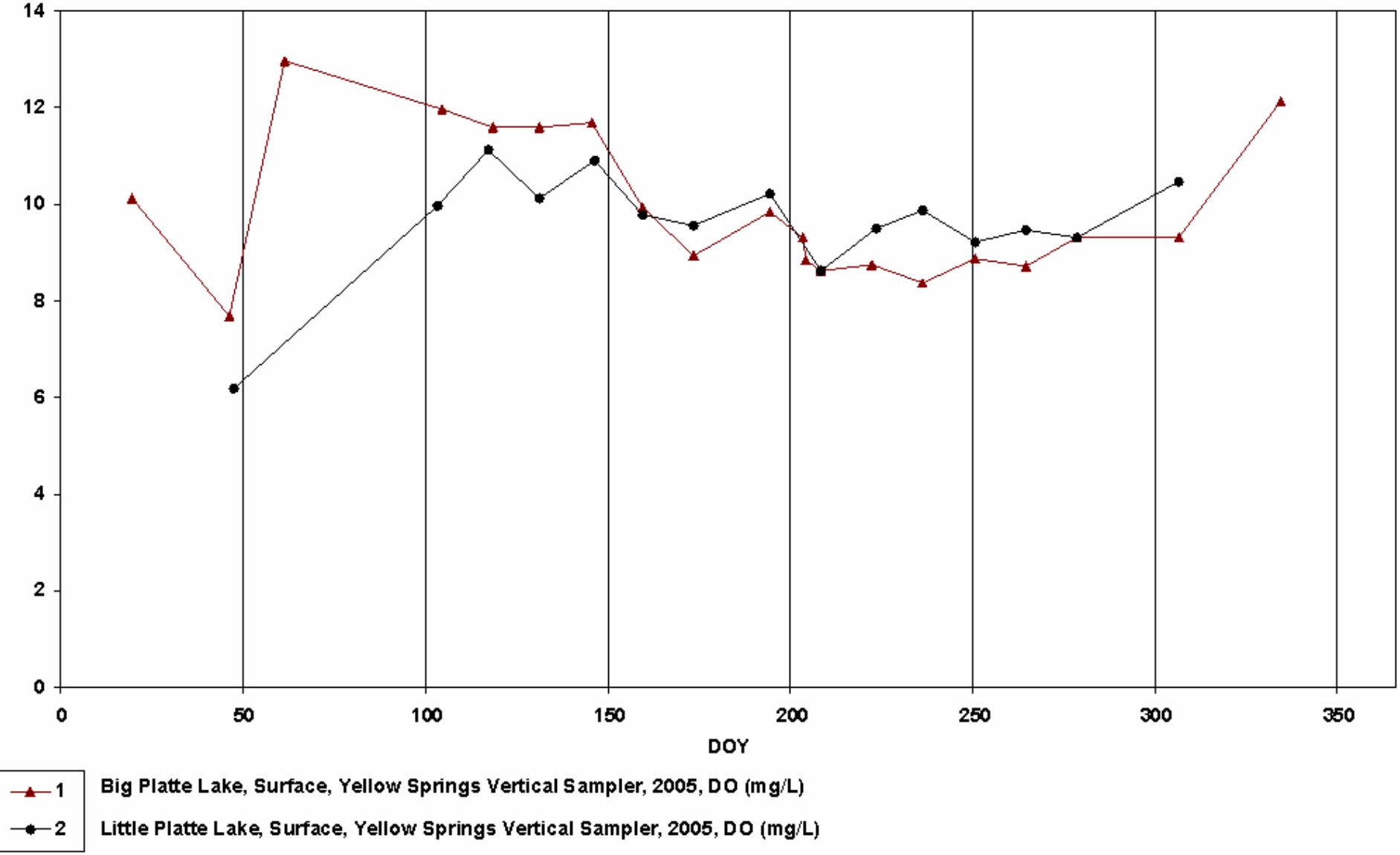


Figure 71. **Big vs Little Platte Lake Oxygen**



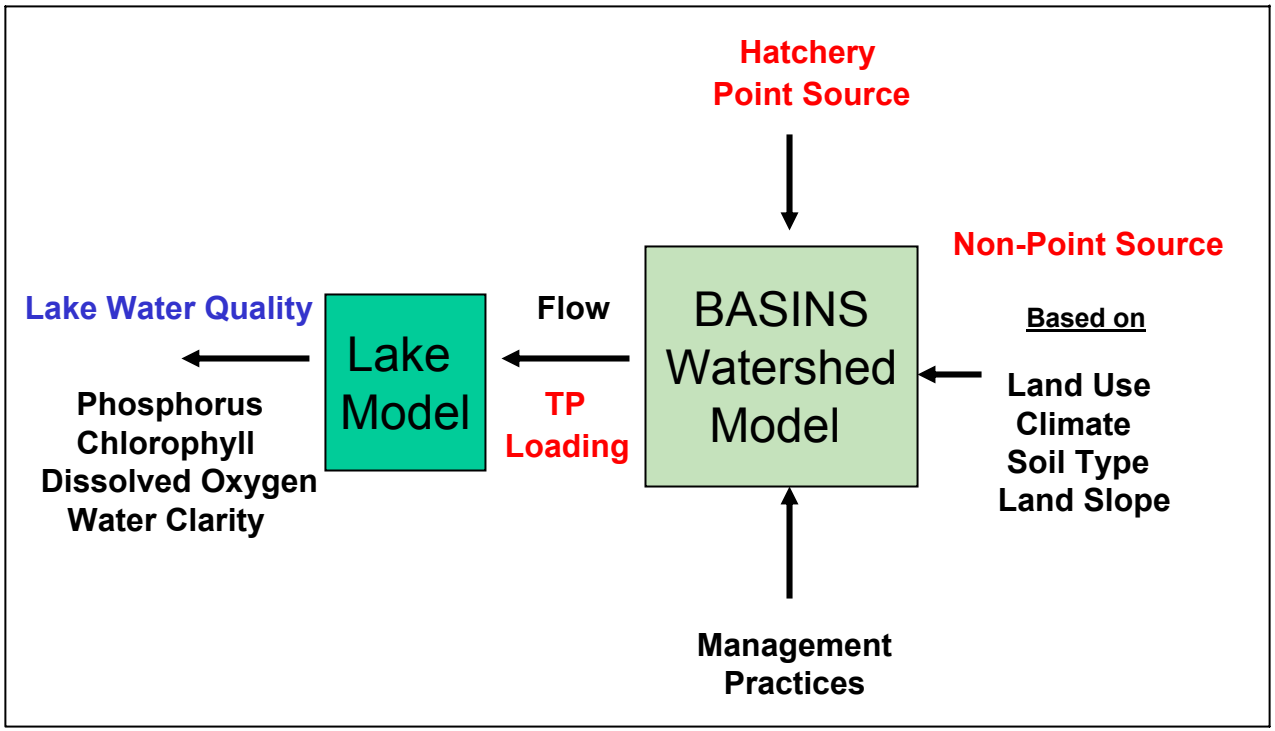


Figure 72. Components of BASINS and Lake Water Quality Model.

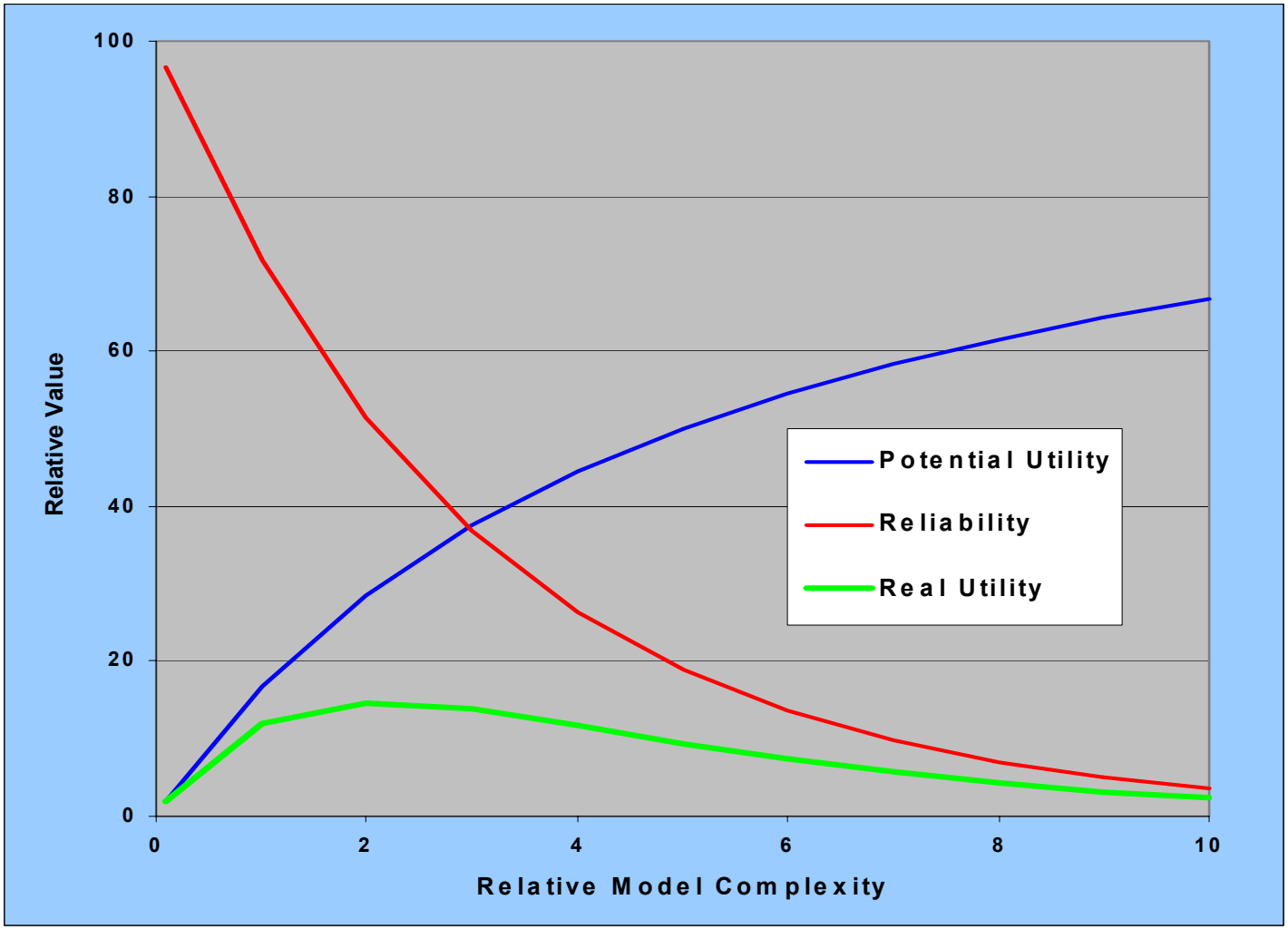
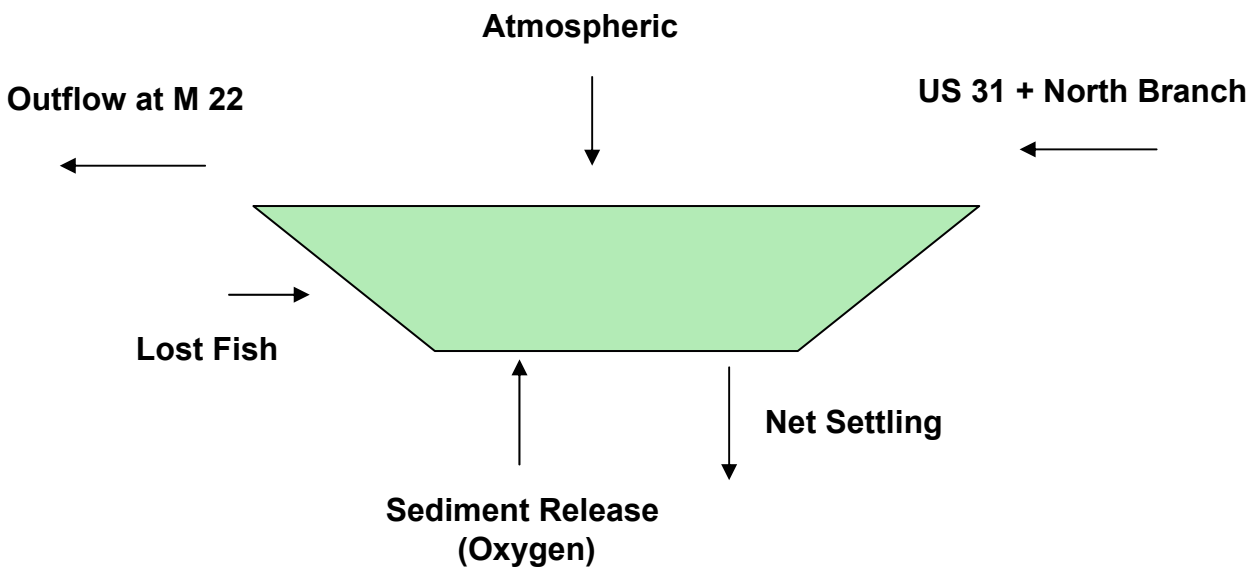


Figure 73. Relative Model Utility vs. Model Complexity.



W = Total Load = US31 + NB + Atmospheric + Sediment + Lost fish

p = volume weighted TP of lake

Q = average annual outflow at M22

A = bottom area of lake

v_s = apparent settling velocity (m/y)

At steady state IN = OUT or $W = Q\,p + v_s\,A\,p$

$$p = \frac{W}{(Q + v_s A)}$$

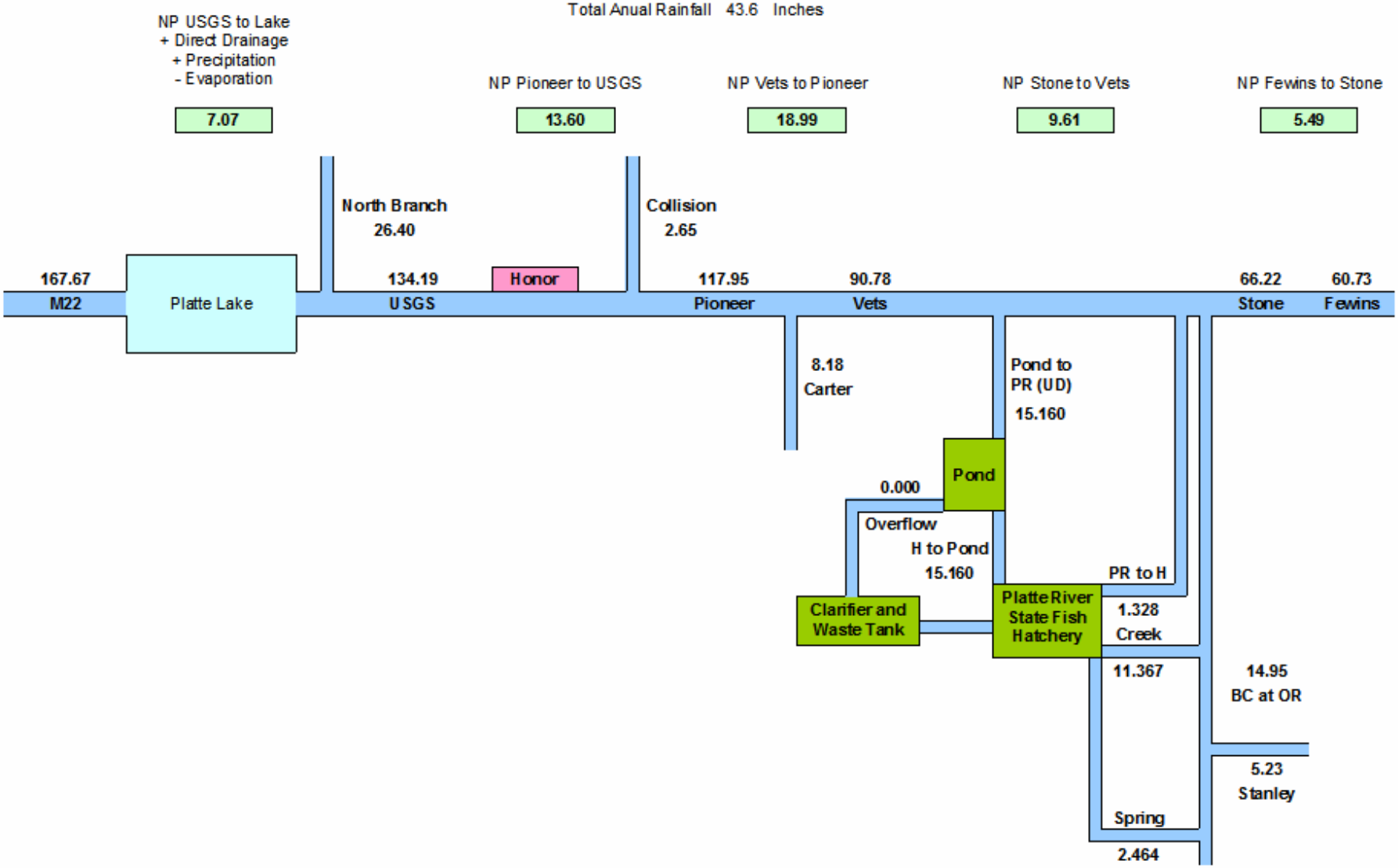
Figure 74. One – Parameter Model Mechanisms and Equations.

Figure 75.

Annual Average Watershed Flow Balance for 2004

all flows cfs

Total Anual Rainfall 43.6 Inches



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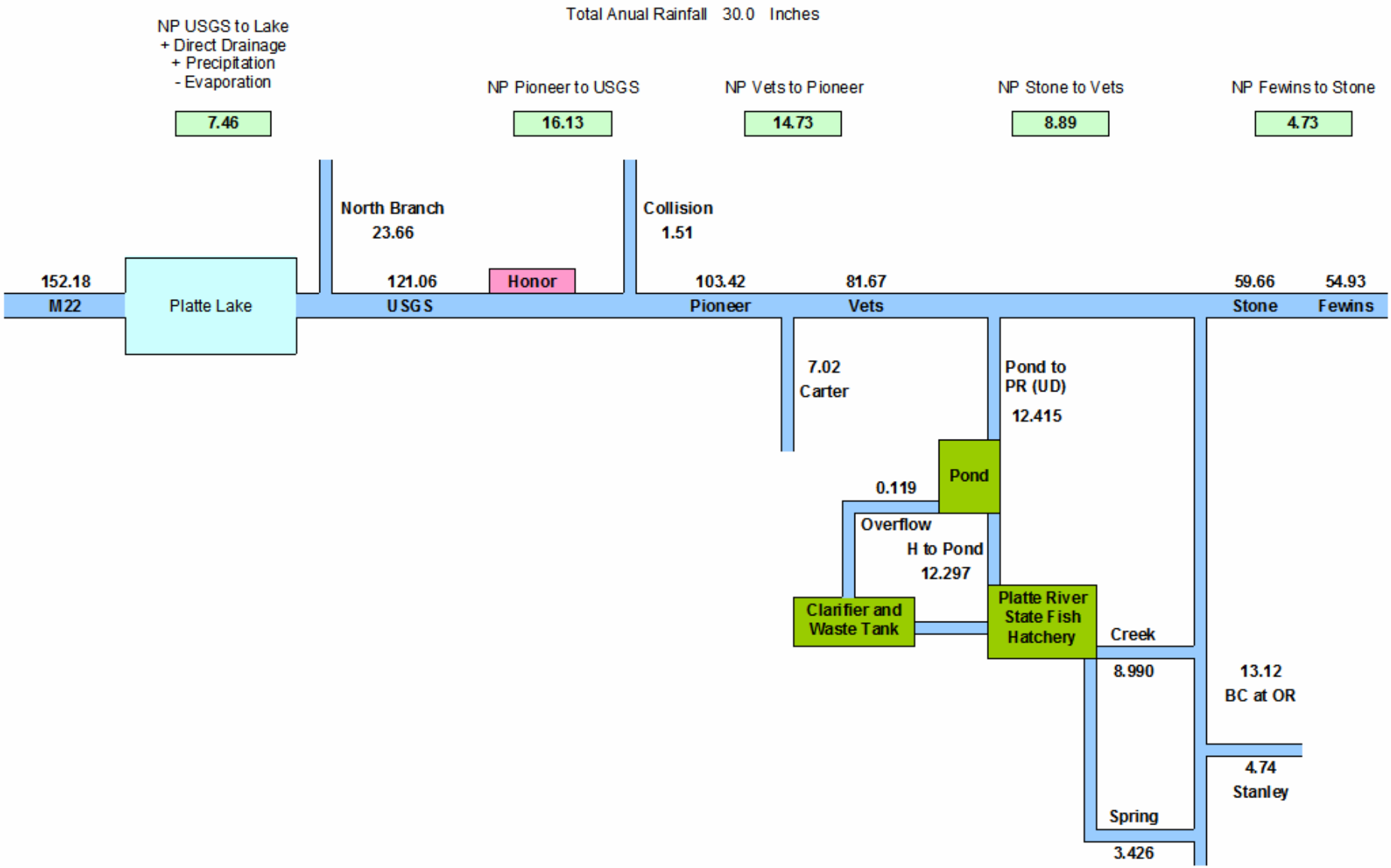
Platte River Watershed

Figure 76.

Annual Average Watershed Flow Balance for 2005

all flows cfs



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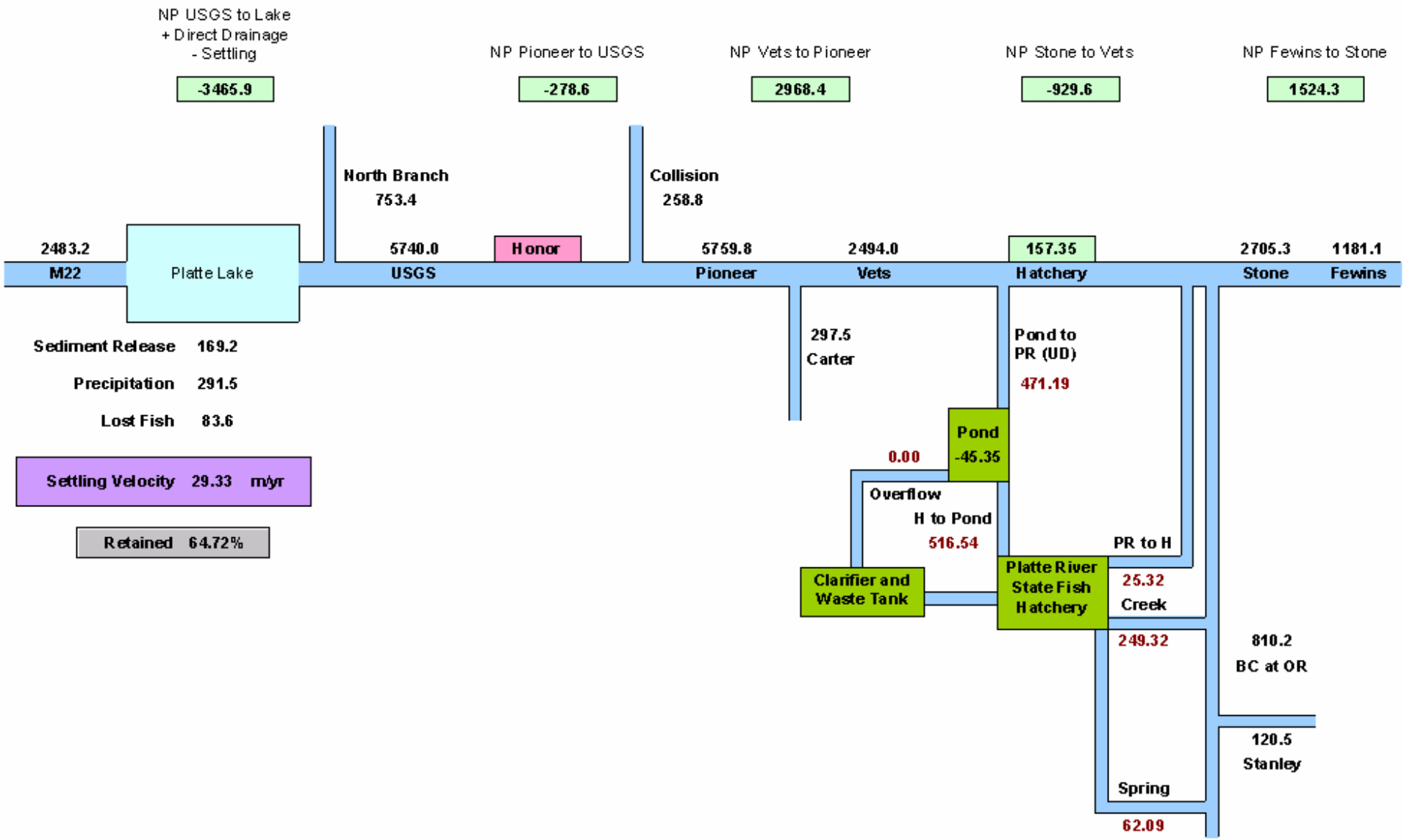
Platte River Watershed

Figure 77.

Annual Average Watershed Load Balance for 2004

all loads annual pounds



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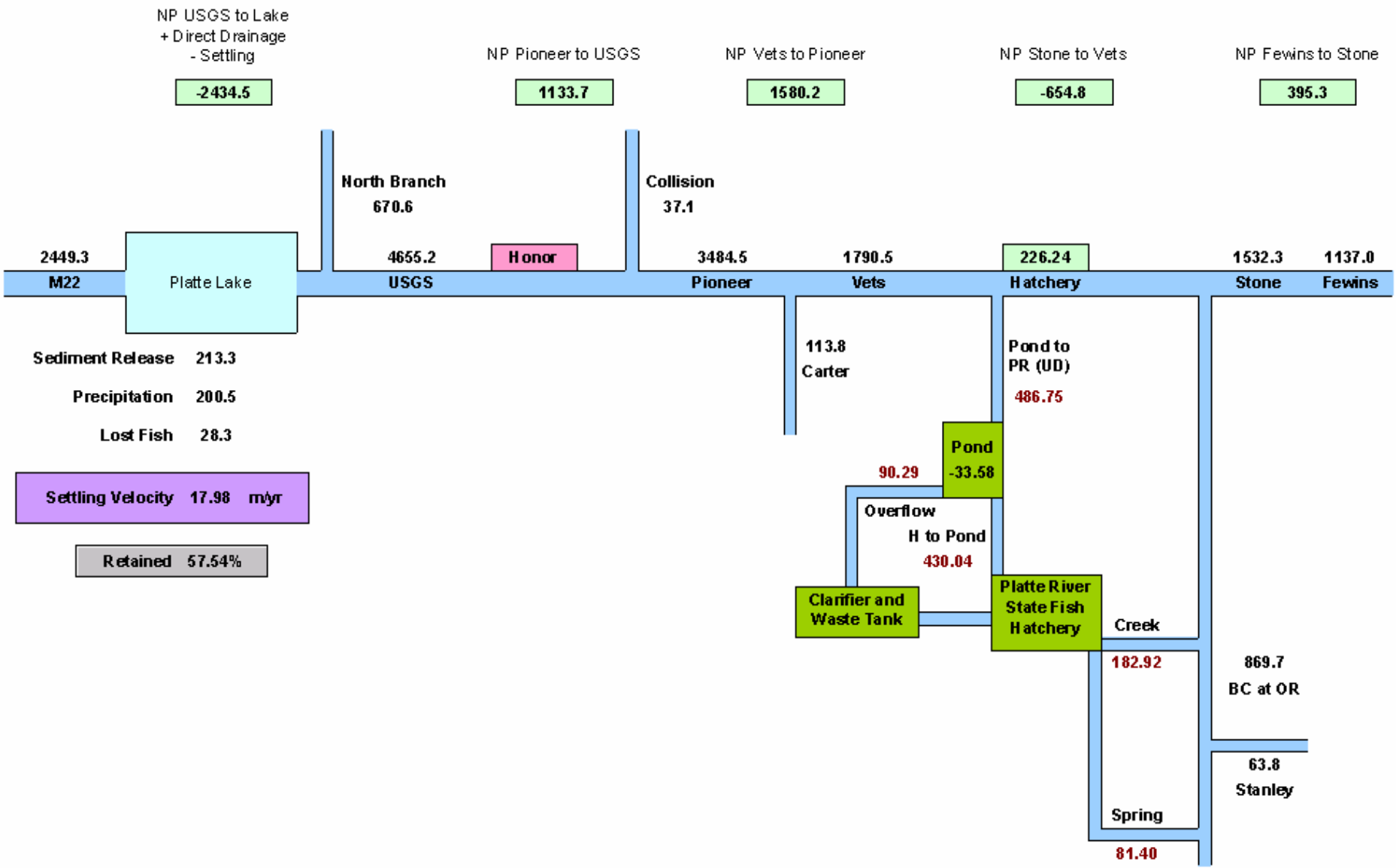
Platte River Watershed

Figure 78.

Annual Average Watershed Load Balance for 2005

all loads annual pounds



Lost fish - 2005

lbs	% P		
6,338	0.4465	28.3	lbs

Rainfall - 2005

annual inches	sur area m2	TP mg/m3		
30	10,222,058	11.7	200.5	lbs

Macrophytes - 2003

senesce		sloughing & excretion				
			period	rate		
lbs	%P	lbs	days	1/day		
2,014	1.3	1007	90	0.05	85	lbs

Sediment Release - 2005

depth feet	area m2	anoxic days	release rate mg/m2/day	lbs		
90	105215	104	1.55	37.3		
75	473468	103	0.41	44.2		
60	1023825	78	0.41	72.4		
45	1149273	48	0.41	50.0	total	
30	7470277	0	0.41	0.0	204	lbs

Pollen - 2005

gross flux mg/m2/yr	sur area m2		
26.3	10,222,058	392.3	lbs

Figure 79. Calculation of Phosphorus Mass Balance Terms for Big Platte Lake for 2005.

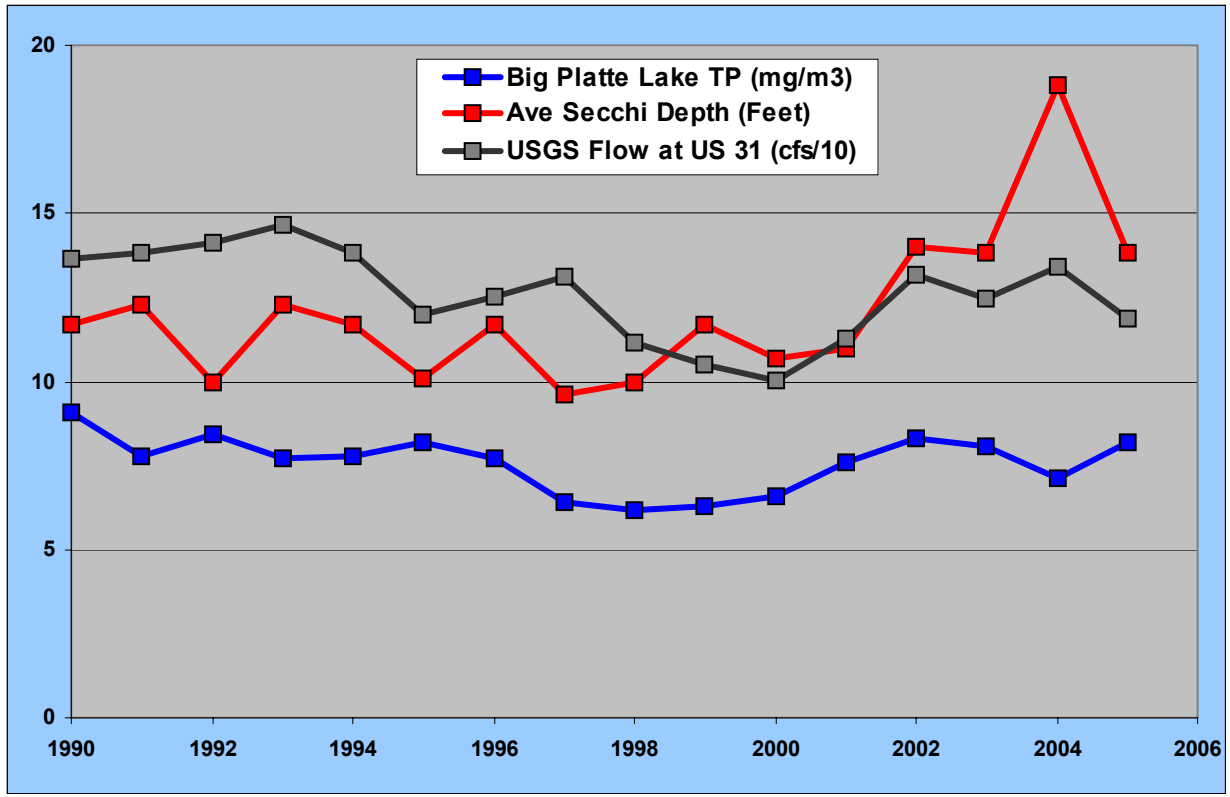
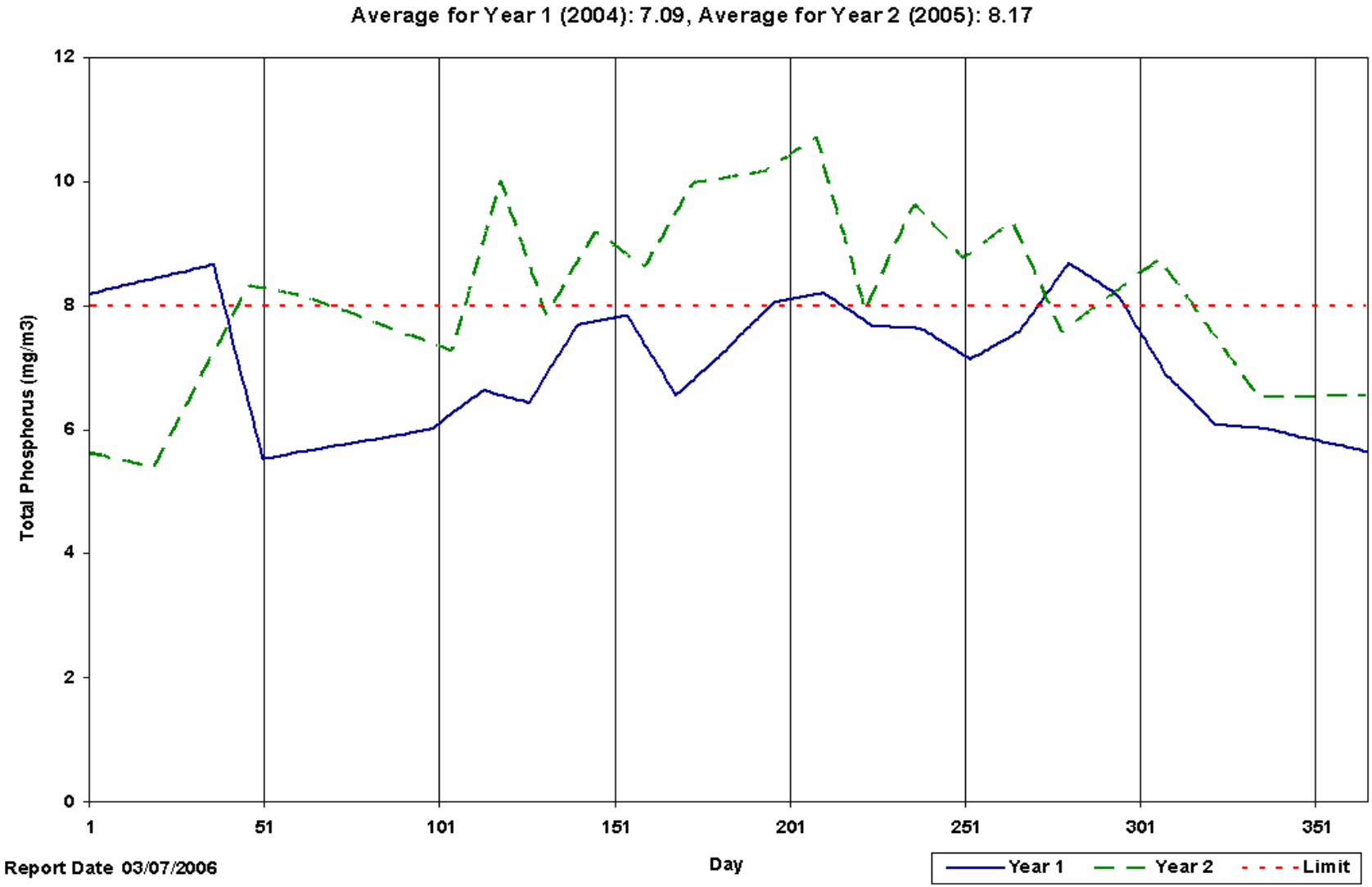


Figure 80. Long – Term Variation of Annual Average Total Phosphorus and Secchi Depth in Big Platte Lake and Flow at USGS.

Figure 81. **Big Platte Lake - Median Phosphorus for Years 2004 and 2005**



Report Date 03/07/2006

	2002	2004	corr 2004	dip only 2005	all 2005	pollen 2005	
Hatchery	205.1	157.4	157.4	226.2	226.2	226.2	Lbs
US-31	3202	5740	4701	3007	4655	4655	Lbs
NB	728	753	763	671	671	671	Lbs
Sed	170	169	169	213	213	213	Lbs
Rain	203	291	291	201	201	201	Lbs
Fish	55	84	84	28	28	28	Lbs
Pollen	0	0	0	0	0	392	Lbs
TP Lake	8.33	7.09	7.09	8.18	8.18	8.18	mg/m3
Flow Out	165.6	167.7	167.7	152.2	152.2	152.2	cfs
vs	8.7	29.4	22.9	9.0	18.0	20.1	m/yr
					Best	21.0	m/yr

Figure 82. Watershed Loads and Estimated Apparent Settling Velocity for Various Assumptions for 2002 through 2005.

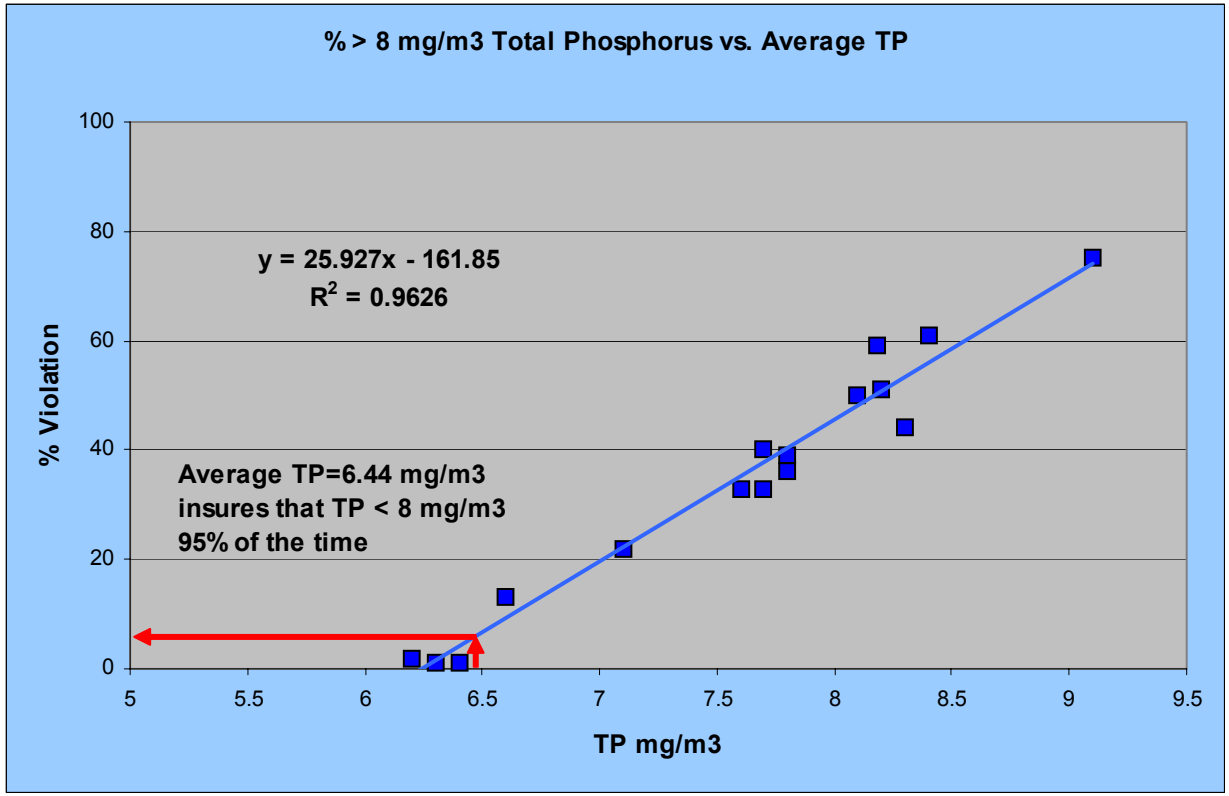


Figure 83. Percent of Time Total Phosphorus Concentrations Exceed 8 mg/m3 As Function of Annual Average Concentration.

Total Phosphorus Goal mg/m3	6.44	mg/m3
Avergage USGS Flow at US 31	126.5	cfs
Average Outlet Flow at M-22	157.1	cfs
Apparent Settling Velocity	21	m/yr
Bottom Area	10222058	m^2
Model Calculated Allowable Total Load	5043	lbs/yr
Hatchery Load	175	lbs/yr
Allowable Non-Point Load	4868	lbs/yr
Current Non-Point Load	5768	lbs/yr
Needed Reduction	900	lbs/yr
% Reduction of NP	15.6	

Figure 84. Calculated Percent Reduction of Non-Point Loading to Attain Water Quality Goal.

Lake 2K

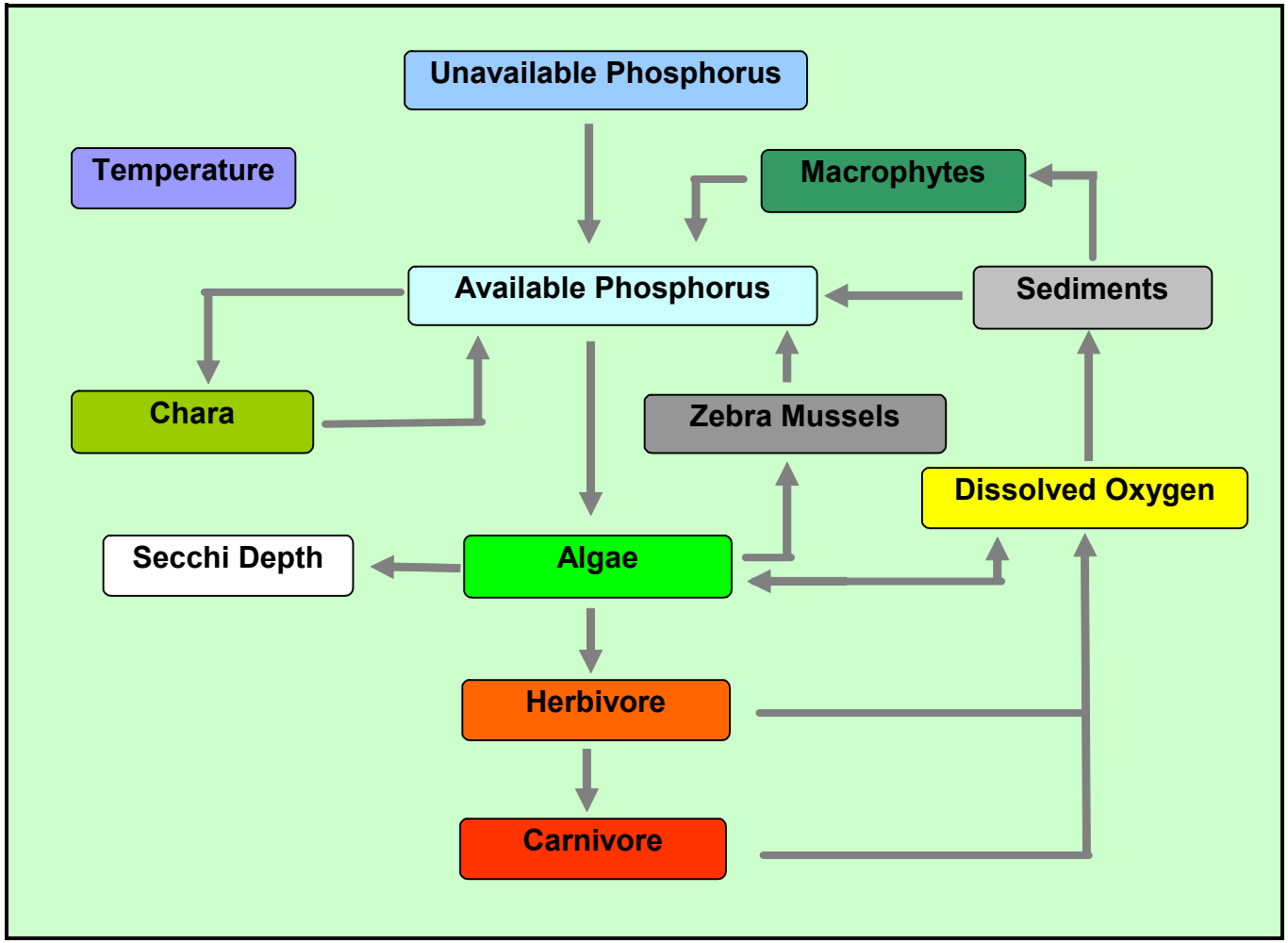


Figure 85. Kinetic Components of Lake Water Quality Model.

Advantages of One-Parameter Model:

One model coefficient (apparent settling velocity) estimated using extensive data
Simple to understand and apply. Easy to defend.

Limitations:

Cannot distinguish between wet and dry years BASINS

Cannot distinguish between warm and cold years Seasonal Ecosystem Model
Does not account for vertical gradients
Does not increase v_s when sediment release of TP decreases
Does not decrease Sediment Oxygen Demand when TP loads decrease
Does not predict changes dissolved oxygen
Does not predict changes in water clarity (the most difficult modeling task)
Does not provide insight into seasonal changes in water quality
Does not explicitly include the effects of macrophytes, Chara, zebra mussels, etc

Does not account for bio-availability of different phosphorus sources Special Study

Figure 86. Comparison of One – Parameter vs. Ecosystem Model.

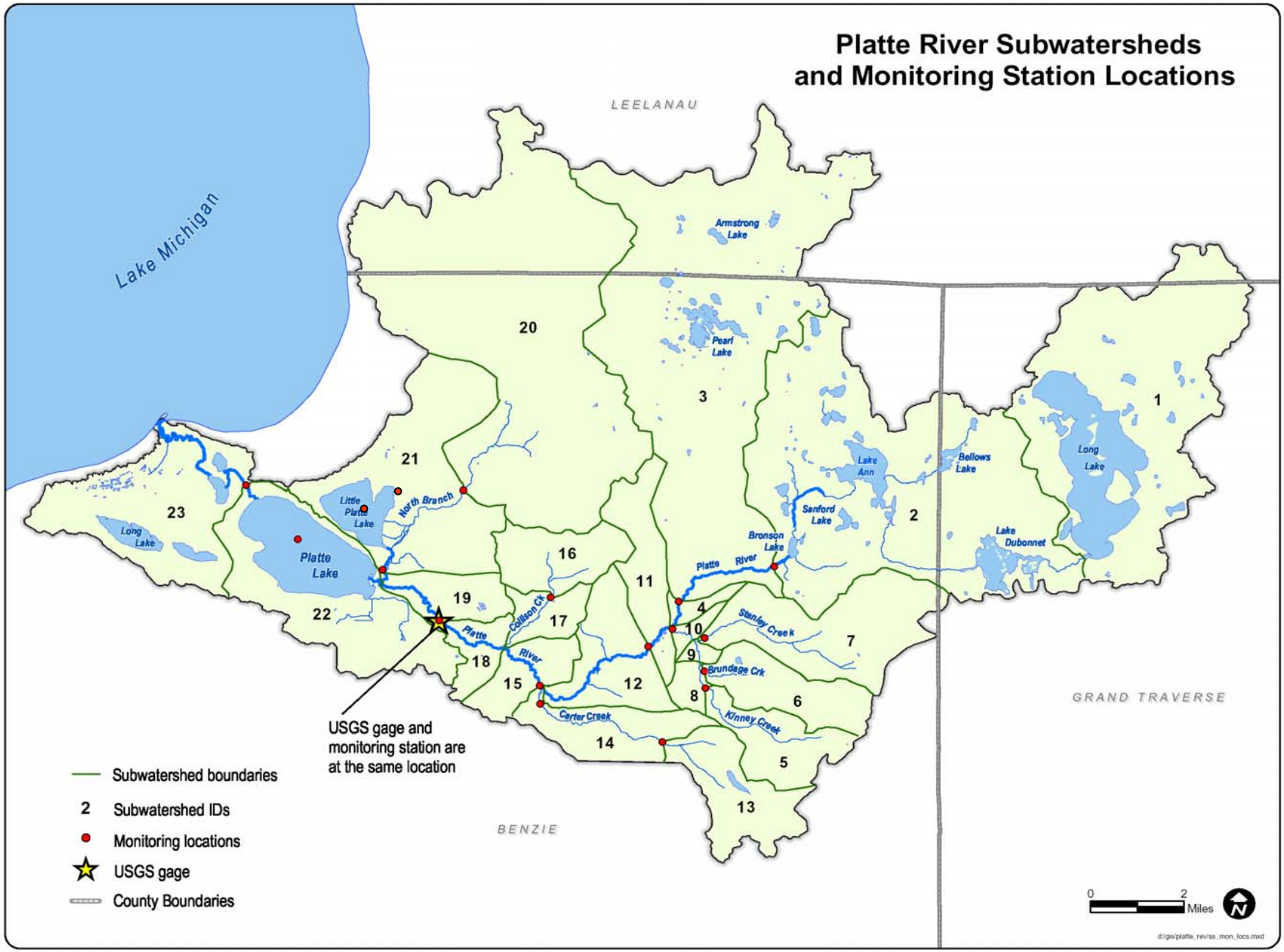
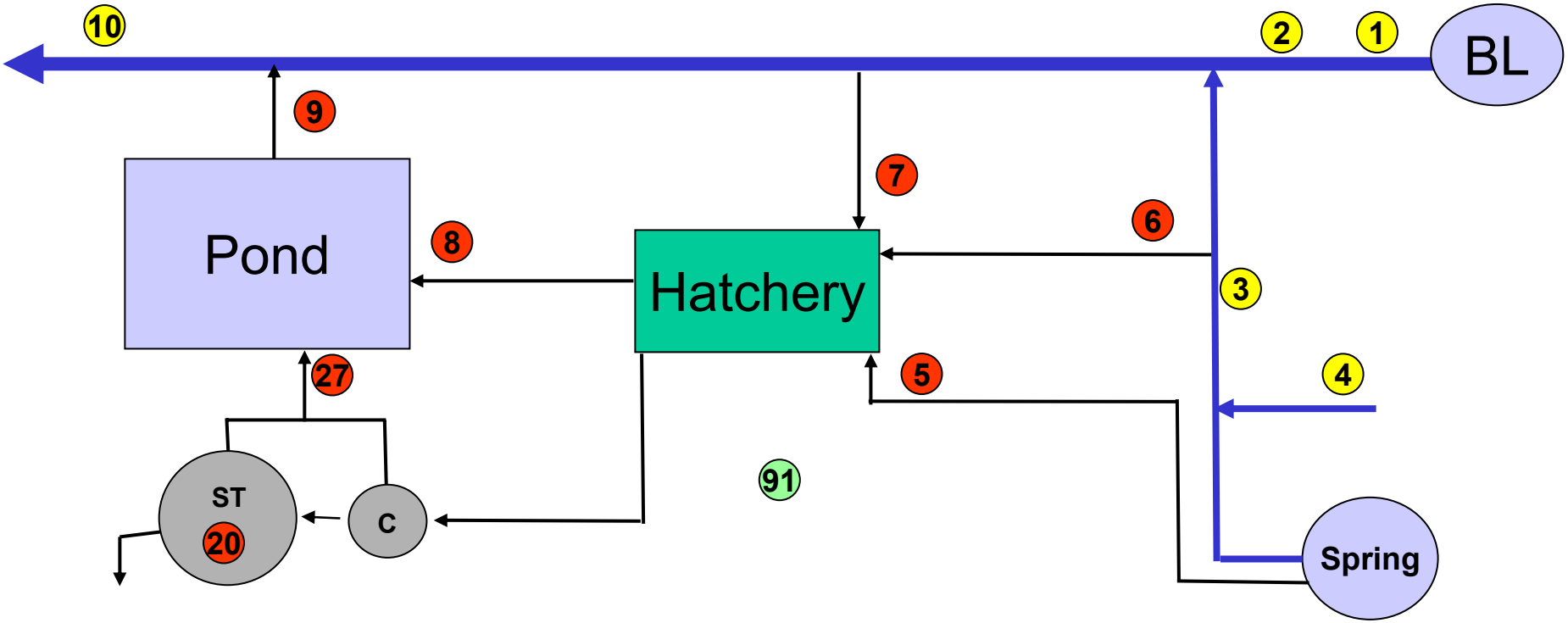


Figure 87. Platte River Sub-Watersheds and Monitoring Locations.



1 Platte River at Fewins Rd

2 Platte River at Stone Bridge

3 Brundage Cr at Old Residence

4 Stanley Creek

5 B. Spring to Hatchery

20 Solids Retention Tank

27 Input to pond

6 B. Creek to Hatchery

7 Platte River to Hatchery

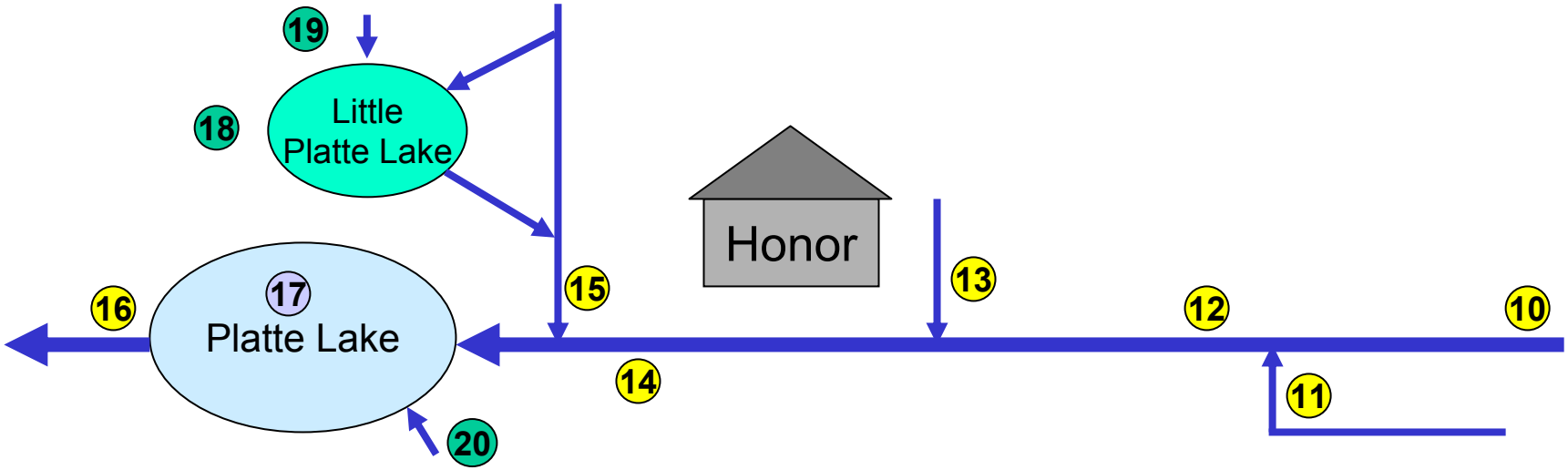
8 Inlet to Pond

9 Pond Outlet

10 Platte River at Vets Park

91 Weather Station

Figure 88. Hatchery and Upstream Sampling Stations



10 Platte River at Vets Park

11 Carter Creek at mouth

12 Platte River at Pioneer Rd

13 Collison Creek

18 Little Platte Lake

14 Platte River at USGS

15 North Branch at Deadstream

16 Lake Outlet at M - 22

17 Platte Lake at Center

19 Featherstone Creek

20 Tamarack Creek

Figure 89. Lake and Lower Tributary Sampling Stations for 2005.

	2006 Big Depths	2006 Big Dates	2006 Big Reps	2006 Big Total	2006 Little Depths	2006 Little Dates	2006 Little Reps	2006 Little Total	2006 Grand Total	2006 CMU Contract	Para
Alk	1	20	1	20	1	20	1	20	100	40	Alk
Ca	1	20	1	20	1	20	1	20	116	40	Ca
TDS	1	20	1	20	1	20	1	20	40	40	TDS
TP	9	20	3	540	1	20	3	60	2928	4400	TP
TDP	2	20	3	120	1	20	3	60	180	175	Phyto
Phyto	2	20	3	120	1	20	3	60	60	75	Zoop
Zoop	1	20	3	60	0	0	0	0	180	175	Chla
Chla	2	20	3	120	1	20	3	60	0	175	Chl-p
Chl-p	0	0	0	0	0	0	0	0	210	200	NOx
NOx	2	20	3	120	1	20	3	60	0	80	% water
% water				0				0	0	80	mgP/mgDW
mgP/mgDW				0				0			
TD Ca	1	20	1	20	1	20	1	20			

	H Sites	H Dates	H Reps	H Total	Tank Sites	Tank Dates	Tank Reps	Tank Total
TP	4	100	3	1200	1	30	3	90

	Trib JH sites	Trib JH Dates	Trib JH Reps		AS Trib Sites	AS trib Dates	AS trib Reps	AS trib Total
TP	12	12	3	432	5	20	3	300
Alk					3	20	1	60

	Storm Sites	Storm Dates	Storm Reps		Rain Sites	Rain Dates	Rain Reps	Rain Total
TP	2	8	6	96	1	10	3	30
NOx					1	10	3	30

TD Ca	Torch	6	6	36

Figure 90. Stations, Sampling Frequency, and Measured Parameters.

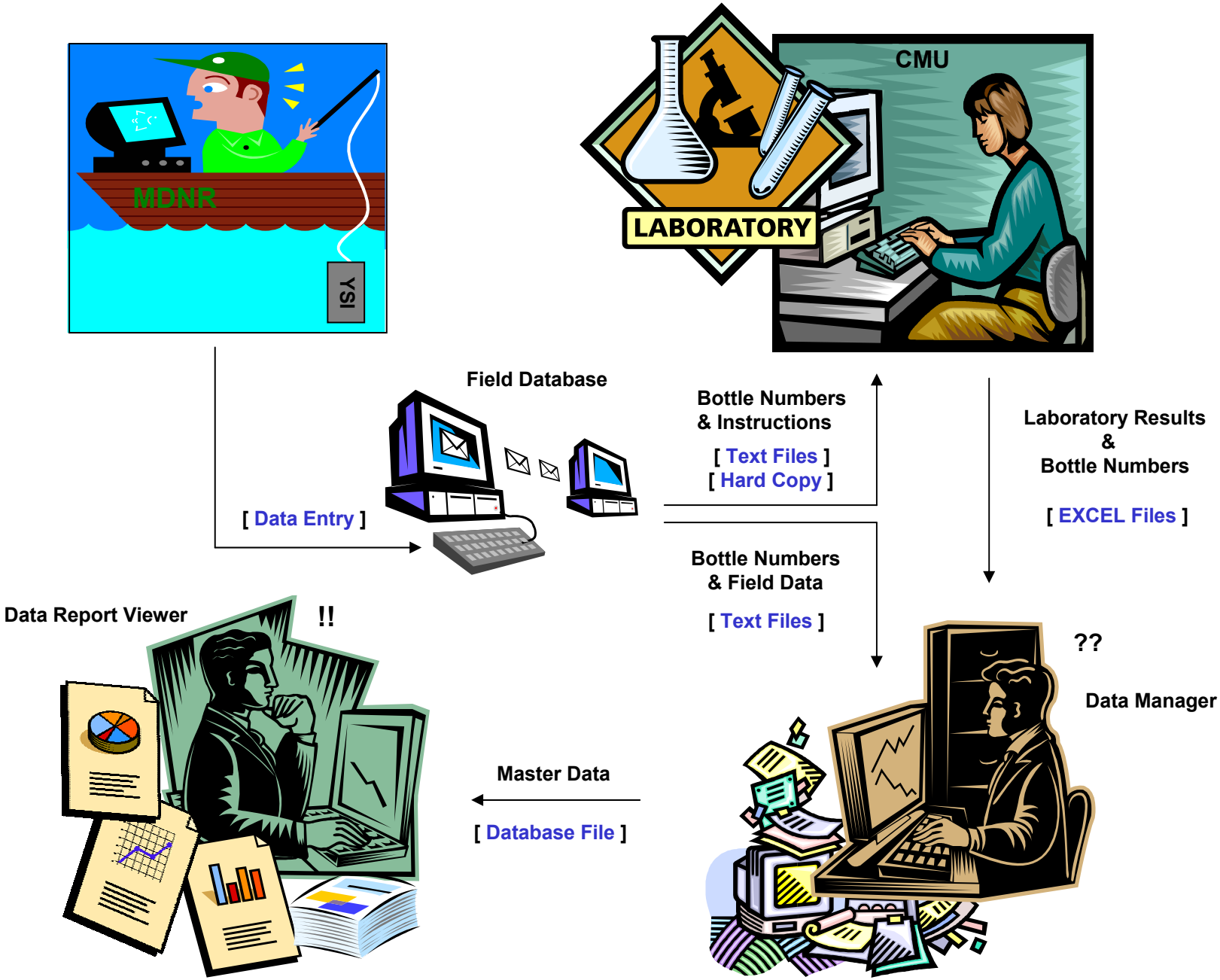


Figure 91. Database Components and Information Flow.

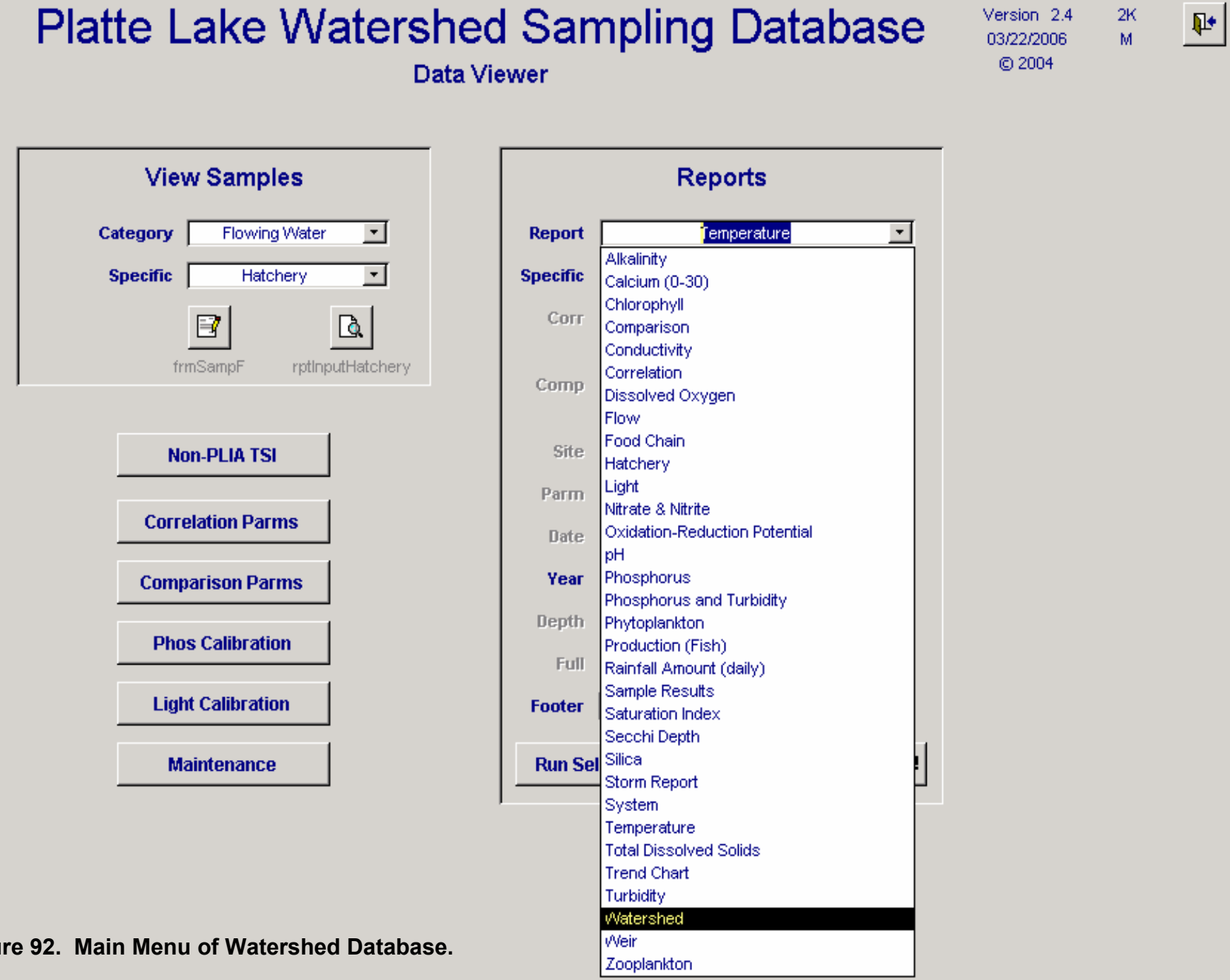
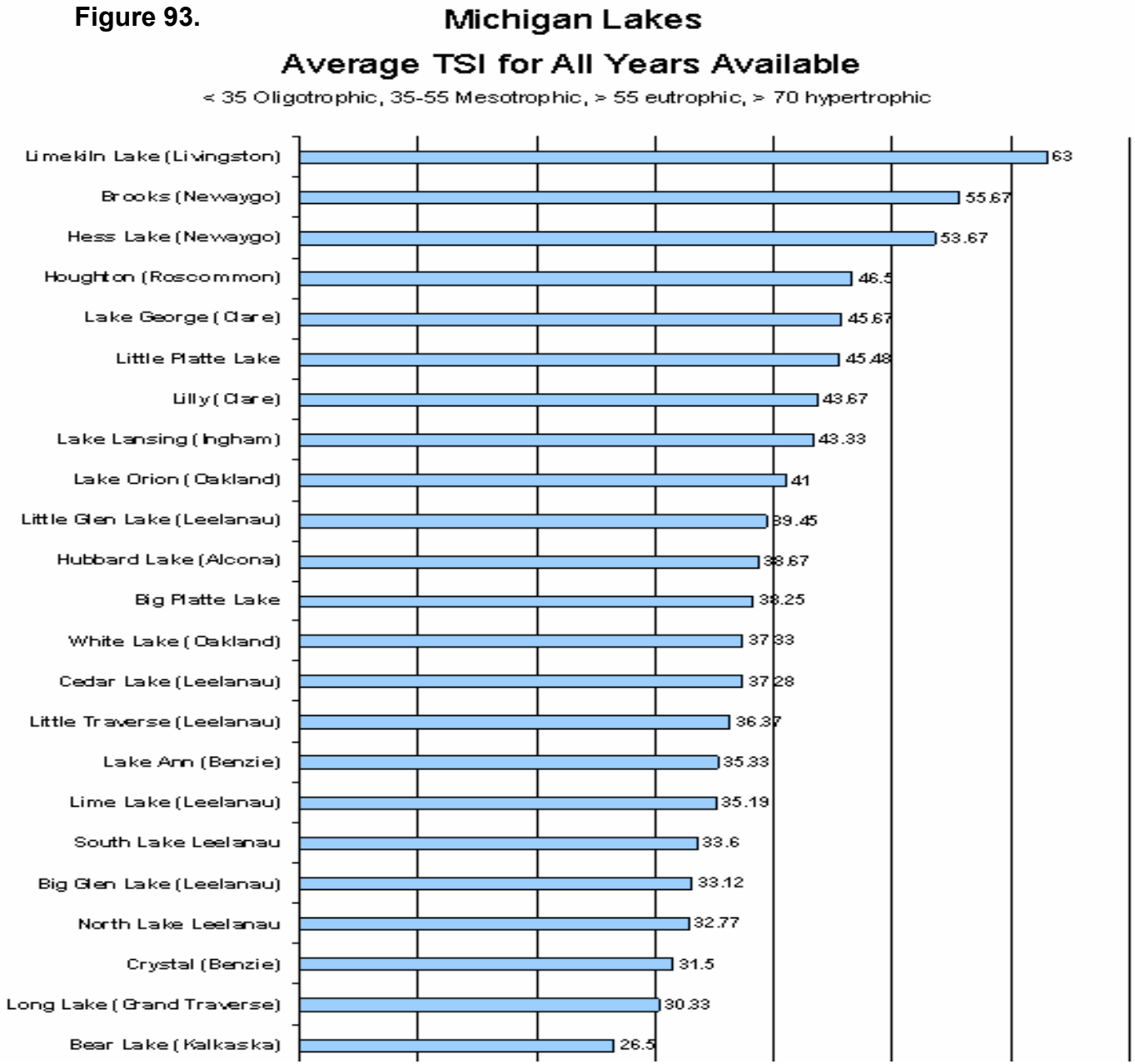


Figure 92. Main Menu of Watershed Database.

Figure 93.


Michigan Lakes
Average TSI for All Years Available
< 35 Oligotrophic, 35-55 Mesotrophic, > 55 eutrophic, > 70 hypertrophic
Limekiln Lake (Livingston) 63
Brooks (Newaygo) 55.67
Hess Lake (Newaygo) 53.67
Houghton (Roscommon) 46.5
Lake George (Clare) 45.67
Little Platte Lake 45.48
Lilly (Clare) 43.67
Lake Lansing (Ingham) 43.33
Lake Orion (Oakland) 41
Little Glen Lake (Leelanau) 39.45
Hubbard Lake (Alcona) 38.67
Big Platte Lake 38.25
White Lake (Oakland) 37.33
Cedar Lake (Leelanau) 37.28
Little Traverse (Leelanau) 36.37
Lake Ann (Benzie) 35.33
Lime Lake (Leelanau) 35.19
South Lake Leelanau 33.6
Big Glen Lake (Leelanau) 33.12
North Lake Leelanau 32.77
Crystal (Benzie) 31.5
Long Lake (Grand Traverse) 30.33
Bear Lake (Kalkaska) 26.5