

F

APPENDIX F

Watershed Analysis WiLMS Results

Date: 7/15/2016 Lake Puckaway

Lake Id: LakePuckaway
 Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 151935.0 acre
 Total Unit Runoff: 9.30 in.
 Annual Runoff Volume: 117749.6 acre-ft
 Lake Surface Area <As>: 5190.0 acre
 Lake Volume <V>: 22484.0 acre-ft
 Lake Mean Depth <z>: 4.3 ft
 Precipitation - Evaporation: 3.1 in.
 Hydraulic Loading: 395543.5 acre-ft/year
 Areal Water Load <qs>: 76.2 ft/year
 Lake Flushing Rate <p>: 17.59 1/year
 Water Residence Time: 0.06 year
 Observed spring overturn total phosphorus (SPO): 77.2 mg/m³
 Observed growing season mean phosphorus (GSM): 116.2 mg/m³
 % NPS Change: 0%
 % PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High	
		Loading (kg/ha-year)					Loading (kg/year)		
Row Crop AG	76994.0	0.50	1.00	3.00	46.9	15580	31159	93478	
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0	
Pasture/Grass	22243.0	0.10	0.30	0.50	4.1	900	2701	4501	
HD Urban (1/8 Ac)	89.0	1.00	1.50	2.00	0.1	36	54	72	
MD Urban (1/4 Ac)	1304.0	0.30	0.50	0.80	0.4	158	264	422	
Rural Res (>1 Ac)	2514.0	0.05	0.10	0.25	0.2	51	102	254	
Wetlands	30298.0	0.10	0.10	0.10	1.8	1226	1226	1226	
Forest	18493.0	0.05	0.09	0.18	1.0	374	674	1347	
Lake Surface	5190.0	0.10	0.30	1.00	0.9	210	630	2100	

POINT SOURCE DATA

Point Sources	Water Load (m ³ /year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %
Buffalo Lake	2.5E+008	0.0	23258.9	0.0	35.0
Lake Montello	9.1E+007	0.0	6338.5	0.0	9.5

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	
# capita-years	704.0			
% Phosphorus Retained by Soil	98.0	90.0	80.0	
Septic Tank Loading (kg/year)	4.22	35.20	112.64	0.1

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	40872.7	146478.2	228207.4	100.0
Total Loading (kg)	18539.7	66442.1	103514.2	100.0
Areal Loading (lb/ac-year)	7.88	28.22	43.97	
Areal Loading (mg/m ² -year)	882.71	3163.43	4928.50	
Total PS Loading (lb)	0.0	65250.4	0.0	44.5
Total PS Loading (kg)	0.0	29597.4	0.0	44.5
Total NPS Loading (lb)	40400.4	79761.0	223328.5	55.4
Total NPS Loading (kg)	18325.5	36179.4	101301.2	55.4

Water and Nutrient Outflow Module: Lake Puckaway

Date: 7/15/2016 Scenario: 6
Average Annual Surface Total Phosphorus: 113.24mg/m³
Annual Discharge: 3.96E+005 AF => 4.88E+008 m³
Annual Outflow Loading: 116468.1 LB => 52829.6 kg

Water and Nutrient Outflow Module: Lake Montello

Date: 5/31/2016 Scenario: 4
Average Annual Surface Total Phosphorus: 72.86mg/m³
Annual Discharge: 7.38E+004 AF => 9.10E+007 m³
Annual Outflow Loading: 13973.9 LB => 6338.5 kg

Water and Nutrient Outflow Module: Buffalo Lake

Date: 5/31/2016 Scenario: 5
Average Annual Surface Total Phosphorus: 98.9mg/m³
Annual Discharge: 2.00E+005 AF => 2.46E+008 m³
Annual Outflow Loading: 51276.6 LB => 23258.9 kg

Grand River Marsh Loading : 67129 LB => 30449 KG

Phosphorus Prediction and Uncertainty Analysis Module

Date: 7/15/2016 Scenario: 16

Observed spring overturn total phosphorus (SPO): 77.2 mg/m³

Observed growing season mean phosphorus (GSM): 116.2 mg/m³

Back calculation for SPO total phosphorus: 0.0 mg/m³

Back calculation GSM phosphorus: 0.0 mg/m³

% Confidence Range: 70%

Nurnberg Model Input - Est. Gross Int. Loading: 0 kg

Lake Phosphorus Model	Low Total P (mg/m ³)	Most Likely Total P (mg/m ³)	High Total P (mg/m ³)	Predicted -Observed (mg/m ³)	% Dif.
Walker, 1987 Reservoir	25	88	138	-28	-24
Canfield-Bachmann, 1981 Natural Lake	32	103	152	-13	-11
Canfield-Bachmann, 1981 Artificial Lake	29	83	116	-33	-28
Rechow, 1979 General	22	80	125	-36	-31
Rechow, 1977 Anoxic	33	119	186	3	3
Rechow, 1977 water load<50m/year	26	92	144	-24	-21
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	31	111	173	34	44
Vollenweider, 1982 Combined OECD	26	73	105	-24	-25
Dillon-Rigler-Kirchner	20	73	114	-4	-5
Vollenweider, 1982 Shallow Lake/Res.	21	64	94	-33	-34
Larsen-Mercier, 1976	31	110	171	33	43
Nurnberg, 1984 Oxidic	24	87	135	-29	-25

Lake Phosphorus Model	Confidence Lower Bound	Confidence Upper Bound	Parameter Fit?	Back Calculation (kg/year)	Model Type
Walker, 1987 Reservoir	42	132	z Tw	0	GSM
Canfield-Bachmann, 1981 Natural Lake	32	297	FIT	1	GSM
Canfield-Bachmann, 1981 Artificial Lake	26	239	FIT	1	GSM
Rechow, 1979 General	37	123	FIT	0	GSM
Rechow, 1977 Anoxic	58	176	FIT	0	GSM
Rechow, 1977 water load<50m/year	43	140	P	0	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	45	186	FIT	0	SPO
Vollenweider, 1982 Combined OECD	30	126	FIT	0	ANN
Dillon-Rigler-Kirchner	35	108	P L	0	SPO
Vollenweider, 1982 Shallow Lake/Res.	26	109	FIT	0	ANN
Larsen-Mercier, 1976	55	159	P Pin	0	SPO
Nurnberg, 1984 Oxidic	37	141	P	0	ANN

Date: 5/31/2016 Scenario: Lake Montello Current

Lake Id: LakeMontello

Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 91147.0 acre

Total Unit Runoff: 9.70 in.

Annual Runoff Volume: 73677.2 acre-ft

Lake Surface Area <As>: 341.0 acre

Lake Volume <V>: 1676 acre-ft

Lake Mean Depth <z>: 4.9 ft

Precipitation - Evaporation: 3.0 in.

Hydraulic Loading: 73762.4 acre-ft/year

Areal Water Load <qs>: 216.3 ft/year

Lake Flushing Rate <p>: 44.01 1/year

Water Residence Time: 0.02 year

Observed spring overturn total phosphorus (SPO): 65.5 mg/m³

Observed growing season mean phosphorus (GSM): 77.2 mg/m³

% NPS Change: 0%

% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High	
		Loading (kg/ha-year)				Loading (kg/year)			
Row Crop AG	33053.0	0.50	1.00	3.00	80.9	6688	13377	40130	
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0	
Pasture/Grass	10282.0	0.10	0.30	0.50	7.6	416	1248	2081	
HD Urban (1/8 Ac)	36.0	1.00	1.50	2.00	0.1	15	22	29	
MD Urban (1/4 Ac)	184.0	0.30	0.50	0.80	0.2	22	37	60	
Rural Res (>1 Ac)	1327.0	0.05	0.10	0.25	0.3	27	54	134	
Wetlands	15054.0	0.10	0.10	0.10	3.7	609	609	609	
Forest	31211.0	0.05	0.09	0.18	6.9	632	1137	2274	
Lake Surface	341.0	0.10	0.30	1.00	0.3	14	41	138	

POINT SOURCE DATA

Point Sources	Water Load (m ³ /year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %
---------------	--------------------------------------	------------------	--------------------------	-------------------	-----------

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	
# capita-years		0.0		
% Phosphorus Retained by Soil	98.0	90.0	80.0	
Septic Tank Loading (kg/year)	0.00	0.00	0.00	0.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	18568.8	36431.3	100207.9	100.0
Total Loading (kg)	8422.7	16525.1	45454.0	100.0
Areal Loading (lb/ac-year)	54.45	106.84	293.86	
Areal Loading (mg/m ² -year)	6103.53	11974.91	32938.22	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	18538.3	36340.0	99903.7	100.0
Total NPS Loading (kg)	8408.9	16483.7	45316.0	100.0

Water and Nutrient Outflow Module

Date: 5/31/2016 Scenario: 4

Average Annual Surface Total Phosphorus: 72.86mg/m³

Annual Discharge: 7.38E+004 AF => 9.10E+007 m³

Annual Outflow Loading: 13973.9 LB => 6338.5 kg

Phosphorus Prediction and Uncertainty Analysis Module

Date: 5/31/2016 Scenario: 12

Observed spring overturn total phosphorus (SPO): 65.5 mg/m³

Observed growing season mean phosphorus (GSM): 77.2 mg/m³

Back calculation for SPO total phosphorus: 0.0 mg/m³

Back calculation GSM phosphorus: 0.0 mg/m³

% Confidence Range: 70%

Nuremberg Model Input - Est. Gross Int. Loading: 0 kg

Lake Phosphorus Model	Low	Most Likely	High	Predicted	% Dif.
	Total P (mg/m ³)	Total P (mg/m ³)	Total P (mg/m ³)	-Observed (mg/m ³)	
Walker, 1987 Reservoir	66	129	354	52	67
Canfield-Bachmann, 1981 Natural Lake	79	148	368	71	92
Canfield-Bachmann, 1981 Artificial Lake	69	120	258	43	56
Rechow, 1979 General	67	132	363	55	71
Rechow, 1977 Anoxic	82	160	441	83	108
Rechow, 1977 water load<50m/year	N/A	N/A	N/A	N/A	N/A
Rechow, 1977 water load>50m/year	78	152	419	75	97
Walker, 1977 General	81	158	435	93	142
Vollenweider, 1982 Combined OECD	57	98	226	27	38
Dillon-Rigler-Kirchner	64	126	346	61	93
Vollenweider, 1982 Shallow Lake/Res.	48	88	214	17	24
Larsen-Mercier, 1976	80	158	434	93	142
Nurnberg, 1984 Oxidic	76	149	410	72	93

Lake Phosphorus Model	Confidence	Confidence	Parameter	Back	Model
	Lower Bound	Upper Bound	Fit?	Calculation (kg/year)	Type
Walker, 1987 Reservoir	76	274	z Tw	0	GSM
Canfield-Bachmann, 1981 Natural Lake	46	426	L	1	GSM
Canfield-Bachmann, 1981 Artificial Lake	37	346	FIT	1	GSM
Rechow, 1979 General	75	283	FIT	0	GSM
Rechow, 1977 Anoxic	97	339	FIT	0	GSM
Rechow, 1977 water load<50m/year	N/A	N/A	N/A	N/A	N/A
Rechow, 1977 water load>50m/year	107	315	P Pin	0	GSM
Walker, 1977 General	80	350	FIT	0	SPO
Vollenweider, 1982 Combined OECD	49	200	FIT	0	ANN
Dillon-Rigler-Kirchner	75	267	P L	0	SPO
Vollenweider, 1982 Shallow Lake/Res.	44	183	FIT	0	ANN
Larsen-Mercier, 1976	98	332	P Pin p	0	SPO
Nurnberg, 1984 Oxidic	79	326	P L	0	ANN

Date: 7/15/2016 Scenario: 24

Lake Id: Grand River Marsh

Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 121077.0 acre

Total Unit Runoff: 9.30 in.

Annual Runoff Volume: 93834.7 acre-ft

Lake Surface Area <As>: 0.0 acre

Lake Volume <V>: 0.0 acre-ft

Lake Mean Depth <z>: 0.00 ft

Precipitation - Evaporation: 3.1 in.

Hydraulic Loading: 93834.7 acre-ft/year

Areal Water Load <qs>: 0.00 ft/year

Lake Flushing Rate <p>: 0.00 1/year

Water Residence Time: 0.00 year

Observed spring overturn total phosphorus (SPO): 0.0 mg/m³

Observed growing season mean phosphorus (GSM): 0.0 mg/m³

% NPS Change: 0%

% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High	
		Loading (kg/ha-year)				Loading (kg/year)			
Row Crop AG	65879.0	0.50	1.00	3.00	87.6	13331	26661	79984	
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0	
Pasture/Grass	19024.0	0.10	0.30	0.50	7.6	770	2310	3850	
HD Urban (1/8 Ac)	65.0	1.00	1.50	2.00	0.1	26	39	53	
MD Urban (1/4 Ac)	209.0	0.30	0.50	0.80	0.1	25	42	68	
Rural Res (>1 Ac)	1947.0	0.05	0.10	0.25	0.3	39	79	197	
Wetlands	20029	0.10	0.10	0.10	2.7	811	811	811	
Forest	13924.0	0.05	0.09	0.18	1.7	282	507	1014	
Lake Surface	0.0	0.10	0.30	1.00	0.0	0	0	0	

POINT SOURCE DATA

Point Sources	Water Load (m ³ /year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %
---------------	--------------------------------------	------------------	--------------------------	-------------------	-----------

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	0.0				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		0.00	0.00	0.00	0.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	33694.9	67128.3	189541.2	100.0
Total Loading (kg)	15283.9	30449.2	85975.3	100.0
Areal Loading (lb/ac-year)	23.39	46.69	131.97	
Areal Loading (mg/m ² -year)	2621.85	5233.43	14792.24	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	33694.9	67128.3	189541.2	100.0
Total NPS Loading (kg)	15283.9	30449.2	85975.3	100.0

Phosphorus Prediction and Uncertainty Analysis Module

Date: 7/15/2016 Scenario: 15
 Observed spring overturn total phosphorus (SPO): 0.0 mg/m³
 Observed growing season mean phosphorus (GSM): 0.0 mg/m³
 Back calculation for SPO total phosphorus: 0.0 mg/m³
 Back calculation GSM phosphorus: 0.0 mg/m³
 % Confidence Range: 70%
 Nurenberg Model Input - Est. Gross Int. Loading: 0 kg

Lake Phosphorus Model	Low	Most Likely	High	Predicted	% Dif.
	Total P	Total P	Total P	-Observed	
	(mg/m ³)	(mg/m ³)	(mg/m ³)	(mg/m ³)	
Walker, 1987 Reservoir					
Canfield-Bachmann, 1981 Natural Lake					
Canfield-Bachmann, 1981 Artificial Lake					
Rechow, 1979 General					
Rechow, 1977 Anoxic					
Rechow, 1977 water load<50m/year					
Rechow, 1977 water load>50m/year					
Walker, 1977 General					
Vollenweider, 1982 Combined OECD					
Dillon-Rigler-Kirchner					
Vollenweider, 1982 Shallow Lake/Res.					
Larsen-Mercier, 1976					
Nurnberg, 1984 Oxidic					

Lake Phosphorus Model	Confidence	Confidence	Parameter	Back	Model
	Lower	Upper	Fit?	Calculation	Type
	Bound	Bound		(kg/year)	
Walker, 1987 Reservoir					GSM
Canfield-Bachmann, 1981 Natural Lake					GSM
Canfield-Bachmann, 1981 Artificial Lake					GSM
Rechow, 1979 General					GSM
Rechow, 1977 Anoxic					GSM
Rechow, 1977 water load<50m/year					GSM
Rechow, 1977 water load>50m/year					GSM
Walker, 1977 General					SPO
Vollenweider, 1982 Combined OECD					ANN
Dillon-Rigler-Kirchner					SPO
Vollenweider, 1982 Shallow Lake/Res.					ANN
Larsen-Mercier, 1976					SPO
Nurnberg, 1984 Oxidic					ANN

