

Pollutant Load Reductions from Wetland Restoration in Highly Critical Agricultural Subwatersheds
EPA STEPL Model

Subwatershed #3

446 acres

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
	lb/year	lb/year	lb/year	t/year
W1	1459.5	439.7	2975.7	287.9
W2	815.7	245.3	1663.2	160.4
W3	172.5	50.8	352.2	32.4
W4	1233.5	332.8	4001.1	229.0
Total	3681.2	1068.6	8992.3	709.6

	lbs/yr	lbs/yr	tons/yr
	N Load Reduction	P Load Reduction	Sediment Load Reduction
initial load	2447.7	735.8	480.7
new load	1233.5	332.8	229.0
load reduc	1214.2	403.0	251.7

Subwatershed #4

195 acres

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
	lb/year	lb/year	lb/year	t/year
W1	914.8	294.4	1856.4	206.4
W2	304.1	93.6	619.1	62.7
W3	69.3	20.9	141.2	13.6
W4	718.3	214.6	2105.7	156.2
Total	2006.5	623.4	4722.5	438.9

	N Load Reduction	P Load Reduction	Sediment Load Reduction
initial load	1288.2	408.9	282.7
new load	718.3	214.6	156.2
load reduc	569.9	194.3	126.5

Subwatershed #7

71 acres

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
	lb/year	lb/year	lb/year	t/year
W1	5.4	1.9	10.8	1.4
W2	117.0	36.8	237.9	25.2
W3	162.7	48.0	332.2	30.7
W4	401.7	110.8	823.7	65.1
W5	286.0	87.5	815.5	64.5
Total	972.8	284.9	2220.1	186.9

	N Load Reduction	P Load Reduction	Sediment Load Reduction
initial load	686.8	197.4	122.4
new load	286.0	87.5	64.5
load reduc	400.8	109.8	57.9

Subwatershed #10

204 acres

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
	lb/year	lb/year	lb/year	t/year
W1	179.6	57.5	364.6	40.1
W2	893.4	255.6	1827.7	157.6
W3	240.5	66.8	492.9	39.6
W4	645.9	183.7	1993.6	130.2
Total	1959.3	563.5	4678.8	367.5

	N Load Reduction	P Load Reduction	Sediment Load Reduction
initial load	1313.4	379.8	237.3
new load	645.9	183.7	130.2
load reduc	667.5	196.2	107.0

Subwatershed #12

80 acres

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
	lb/year	lb/year	lb/year	t/year
W1	90.7	29.4	183.9	20.8
W2	349.4	102.4	713.7	65.0
W3	96.1	27.3	196.6	16.7
W4	19.6	5.6	40.1	3.4
W5	334.6	103.5	942.2	76.7
Total	890.3	268.2	2076.6	182.6

	N Load Reduction	P Load Reduction	Sediment Load Reduction
initial load	555.8	164.7	105.9
new load	334.6	103.5	76.7
load reduc	221.2	61.2	29.2

Pollutant Load Reductions from Wetland Restoration in Highly Critical Agricultural Subwatersheds
EPA STEPL Model

Subwatershed #14

501 acres

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
	lb/year	lb/year	lb/year	t/year
W1	173.6	55.6	352.4	38.8
W2	853.5	244.5	1746.0	151.0
W3	2046.5	496.4	4228.1	238.4
W4	1430.1	390.7	4586.6	270.8
Total	4503.7	1187.2	10913.1	699.0

	N Load Reduction	P Load Reduction	Sediment Load Reduction
initial load	3073.6	796.5	428.2
new load	1430.1	390.7	270.8
load reduc	1643.5	405.8	157.4

Subwatershed #15

449 acres

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
	lb/year	lb/year	lb/year	t/year
W1	1013.2	312.7	2062.4	210.1
W2	1057.4	301.2	2163.8	184.7
W3	583.7	158.1	1198.2	90.8
W4	1.4	0.4	2.8	0.3
W5	1297.6	356.3	4141.9	247.7
Total	3953.3	1128.7	9569.1	733.5

	N Load Reduction	P Load Reduction	Sediment Load Reduction
initial load	2655.6	772.4	485.8
new load	1297.6	356.3	247.7
load reduc	1358.0	416.0	238.1

Subwatershed #16

337 acres

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
	lb/year	lb/year	lb/year	t/year
W1	50.8	16.7	103.0	11.9
W2	1565.9	410.9	3220.8	225.2
W3	79.9	22.8	163.4	14.1
W4	75.2	20.6	154.3	12.0
W5	1006.3	280.0	3172.5	196.1
Total	2778.1	751.0	6814.0	459.3

	N Load Reduction	P Load Reduction	Sediment Load Reduction
initial load	1771.8	471.0	263.2
new load	1006.3	280.0	196.1
load reduc	765.5	191.0	67.0

Subwatershed #18

374 acres

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
	lb/year	lb/year	lb/year	t/year
W1	804.9	249.6	1637.7	168.6
W2	199.3	59.2	406.8	38.2
W3	1365.7	361.2	2807.6	200.3
W4	10.3	3.0	21.1	1.9
W5	1104.7	305.9	3498.4	213.7
Total	3484.8	979.0	8371.5	622.7

	N Load Reduction	P Load Reduction	Sediment Load Reduction
initial load	2380.2	673.1	409.0
new load	1104.7	305.9	213.7
load reduc	1275.5	367.2	195.3

Subwatershed #20

449 acres

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
	lb/year	lb/year	lb/year	t/year
W1	420.1	132.1	853.9	90.6
W2	1744.5	455.6	3589.2	247.9
W3	56.8	16.4	116.1	10.2
W4	141.4	38.1	290.3	21.7
W5	1298.2	356.5	4143.6	247.8
Total	3660.9	998.7	8993.1	618.2

	N Load Reduction	P Load Reduction	Sediment Load Reduction
initial load	2362.7	642.2	370.3
new load	1298.2	356.5	247.8
load reduc	1064.6	285.7	122.5

Pollutant Load Reductions from Wetland Restoration in Highly Critical Agricultural Subwatersheds
EPA STEPL Model

Subwatershed #21

100 acres

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
	lb/year	lb/year	lb/year	t/year
W1	412.0	129.7	837.5	88.9
W2	104.9	31.7	213.8	20.8
W3	2.4	0.7	4.8	0.5
W4	100.0	27.2	205.2	15.7
W5	411.2	126.6	1165.0	93.5
Total	1030.4	315.8	2426.3	219.4

	N Load Reduction	P Load Reduction	Sediment Load Reduction
initial load	619.2	189.2	125.8
new load	411.2	126.6	93.5
load reduc	208.1	62.7	32.3

Subwatershed #27

482 acres

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
	lb/year	lb/year	lb/year	t/year
W1	52.8	17.9	106.8	13.1
W2	1215.3	340.5	2489.6	204.5
W3	8.7	2.8	17.7	1.9
W4	2095.8	513.5	4327.5	251.3
W5	1321.7	355.2	4302.1	243.8
Total	4694.3	1229.9	11243.7	714.6

	N Load Reduction	P Load Reduction	Sediment Load Reduction
initial load	3372.6	874.6	470.8
new load	1321.7	355.2	243.8
load reduc	2050.9	519.4	227.0

Subwatershed #28

363 acres

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
	lb/year	lb/year	lb/year	t/year
W1	314.5	103.2	637.2	73.7
W2	1202.8	358.4	2454.2	231.8
W3	5.7	1.8	11.6	1.3
W4	1349.5	359.8	2773.1	201.8
W5	1027.1	279.8	3302.4	193.6
Total	3899.6	1103.0	9178.5	702.3

	N Load Reduction	P Load Reduction	Sediment Load Reduction
initial load	2872.5	823.2	508.7
new load	1027.1	279.8	193.6
load reduc	1845.4	543.4	315.1

	N	P	Sediment
Totals	13285.0	3755.8	1927.0

Explanation of Methodology:

All pollutant load reduction calculations were developed utilizing EPA's Spreadsheet Tool for Estimating Pollutant Load (STEPL) with the help of MDEQ staff. Only subwatershed's characterized as "highly critical" were included in the analysis. A separate analysis was conducted for each subwatershed. The input date for each subwatershed was a summary of the hydrologic soil groups present by acreages. A step by step process follows:

1. Launch the STEPL model and select the number of subwatersheds equal to the number of hydrologic groups per subwatershed plus one (the additional subwatershed will be used to calculated loads associated with wetlands).
2. Click the yes button to show additional input tables.
3. Input the number of acres for each hydrologic group in box 1 under cropland, and then put total acres under "user defined".
4. Go to box 5 and select the hydrologic groups as appropriate for each subwatershed. Because the "user defined" class will represent wetland, select D hydrologic soil group.
5. In box 6 input 78 in the user defined under D soils
6. In box 7 under user defined input 0.79 for N, 0.08 for P and a 4 for BOD.

Here is some information for the methodology section for load reduction calculation for wetland restoration:

All presettlement wetlands within the thirteen critical subwatersheds that were identified in Landscape Level Functional Wetlands Assessment as performing "high" for sediment and other particles retention and nutrient transformation were selected for load reduction estimates. These high performing wetlands were then intersected in a GIS with agricultural lands and load reductions are estimated for these areas.

The Natural Resource Conservation Service's Soil Survey Geographic (SSURGO) Database and Soil Data Viewer were used to determine the current hydrologic groups of the potential wetland restoration areas and the acreage of each hydrologic group was summed by critical subwatersheds.


Wetlands event mean concentrations for nutrients were obtained from the Rouge Program Office Technical Memorandum RPO-MOD-TM34.00 and are as follows:

Total phosphorus concentration = 0.08 mg/L
Total Kjeldahl Nitrogen concentration = 0.79 mg/L

The NRCS's curve number of 78 was used for wetland. The Grand Rapids, Michigan WSFO weather station was used.

APPENDIX O: Summary of Estimated Pollutant Load Reductions for Traditional Agricultural BMPs

SUB	NAME	SEDIMENT REDUCTION (TONS/YR)	P REDUCTION (LBS/YR)	N REDUCTION (LBS/YR)
1	BEAVER DAM TO MR	1236	1809	4419
2	MR TO BEAVER DAM	70	170	346
3	MR@72ND	3533	4648	9083
4	MR@I-196			
5	MR TO HUNDEMAN	2015	2810	5631
6	BIG TO HUNDERMAN	1913	2669	5347
7	HUNDEMAN TO BIG	1786	2488	4985
10	UNNAMED TO PETERS 10	1617	2301	4621
11	PETERS	2668	3727	7468
12	UNNAMED TO PETERS 12	4871	5708	11424
14	KLEINHEKSEL	5048	5999	13002
15	JAARDA TO SB	1690	2393	4796
16	SBMR TO JAARDA	1113	1577	3159
18	EAST FILLMORE	3725	4567	10057
19	SBMR TO MR	2922	4081	8178
20	NBMR TO DEN BLEYKER 20	2242	3175	6362
21	VANDERBIE/ROTMAN	605	856	1716
22	NBMR TO DEN BLEYKER 22	333	465	932
23	DEN BLYKER	1003	1401	2808
24	NBMR @M-40	583	814	1632
26	BOSH&HULST @104TH	670	933	1866
27	BOSCH&HULST TO NOORD	1672	2437	4875
28	TRIB TO BOSCH&HULST	1079	1572	3144
29	HUNTERS TO BROWER	1415	2071	5059
30	BROWER TO HUNTERS	1272	1861	4546
31	NOORDELOOS TO #52	1173	1717	4195
37	NORTH HOLLAND TO #40	692	962	1925
38	#15&17 TO #40	1092	1598	3899
41	MAPLEWOOD TO MR	62	87	174
42	TROOST&BOVEN TO PINE	639	1051	1787
45	#37 TO PINE	169	236	471
	Totals	48909	66184	137909
	Totals (High Priority)	24111	32014	65802
	Totals (Mod Priority)	24798	34170	72107

 Moderately Critical Agricultural Areas
 Highly Critical Agricultural Areas

FOR COMPLETE DESCRIPTION OF METHODOLOGY SEE APPENDIX R

APPENDIX O: Estimated Pollutant Load Reductions for Traditional Agricultural BMPs
(Recommendations made by Allegan Conservation District)


SUB	NAME	FILTER STRIPS			NOTILL			OTHER PRACTICES			TOTALS		
		SEDIMENT REDUCTION (TONS/YR)	P REDUCTION (LBS/YR)	N REDUCTION (LBS/YR)	SEDIMENT REDUCTION (TONS/YR)	P REDUCTION (LBS/YR)	N REDUCTION (LBS/YR)	SEDIMENT REDUCTION (TONS/YR)	P REDUCTION (LBS/YR)	N REDUCTION (LBS/YR)	SEDIMENT REDUCTION (TONS/YR)	P REDUCTION (LBS/YR)	N REDUCTION (LBS/YR)
1	BEAVER DAM TO MR	5	7	15	1231	1802	4405				1236	1809	4419
2	MR TO BEAVER DAM	3	4	8	67	166	338				70	170	346
3	MR@72ND	30	46	93									
4	MR@I-196				2324	3468	6936	1180	1134	2055	3533	4648	9083
5	MR TO HUNDEMAN	1	2	4	2013	2808	5627				2015	2810	5631
6	BIG TO HUNDERMAN	4	6	12	1909	2663	5335				1913	2669	5347
7	HUNDEMAN TO BIG	8	11	23	1778	2477	4963				1786	2488	4985
10	UNNAMED TO PETERS 10	14	19	39	1603	2282	4582				1617	2301	4621
11	PETERS	9	13	26	2659	3714	7442				2668	3727	7468
12	UNNAMED TO PETERS 12	33	40	87	4212	5042	10082	626	626	1255	4871	5708	11424
14	KLEINHEKSEL	43	59	119	3581	4515	10034	1424	1424	2850	5048	5999	13002
15	JAARDA TO SB	3	5	9	1687	2389	4787				1690	2393	4796
16	SBMR TO JAARDA	4	5	11	1110	1571	3149				1113	1577	3159
18	EAST FILLMORE	15	21	41	3206	4042	9006	504	504	1010	3725	4567	10057
19	SBMR TO MR	4	6	13	2917	4075	8165				2922	4081	8178
20	NBMR TO DEN BLEYKER 20	18	26	53	2224	3149	6310				2242	3175	6362
21	VANDEBIE/ROTMAN	3	4	7	602	852	1708				605	856	1716
22	NBMR TO DEN BLEYKER 22	0	1	1	332	464	931				333	465	932
23	DEN BLYKER	3	5	10	1000	1397	2798				1003	1401	2808
24	NBMR @M-40	4	6	12	579	809	1620				583	814	1632
26	BOSH&HULST @104TH	1	2	3	669	932	1863				670	933	1866
27	BOSCH&HULST TO NOORD	3	4	9	1669	2433	4866				1672	2437	4875
28	TRIB TO BOSCH&HULST	5	8	16	1073	1564	3129				1079	1572	3144
29	HUNTERS TO BROWER	6	9	19	1409	2061	5040				1415	2071	5059
30	BROWER TO HUNTERS	5	8	15	1267	1853	4531				1272	1861	4546
31	NOORDELOOS TO #52	5	7	15	1168	1710	4180				1173	1717	4195
37	NORTH HOLLAND TO #40	1	1	2	691	961	1923				692	962	1925
38	#15&17 TO #40	12	18	36	1080	1580	3863				1092	1598	3899
41	MAPLEWOOD TO MR	4	6	13	58	80	161				62	87	174
42	TROOST&BOVEN TO PINE	1	3	5	638	1049	1782				639	1051	1787
45	#37 TO PINE	2	3	5	167	233	466				169	236	471
	Totals	249	356	719	44925	62140	130021	3735	3688	7169	48909	66184	137909
	Totals (High Priority)	177	249	505	25071	33784	69552	3735	3688	7169	28983	37721	77226
	Totals (Mod Priority)	71	107	214	19855	28356	60469	0	0	0	19926	28463	60683

Moderately Critical Agricultural Areas
Highly Critical Agricultural Areas

FOR COMPLETE DESCRIPTION OF METHODOLOGY SEE APPENDIX R

APPENDIX O: Details for Estimated Pollutant Load Reductions for Traditional Agricultural BMPs

SUB	NAME	POOR STREAM (FT)	BUFFER (AC)	RESIDUE MGT (AC)	COVER CROP (AC)	CRITICAL AREA PASTURE (AC)	GRASSED WATERWAY (AC)
1	BEAVER DAM TO MR	9155	4	1233			
2	MR TO BEAVER DAM	5586	3	1074			
3	MR@72ND	60045	28	2668	320	106	5
4	MR@I-196						
5	MR TO HUNDEMAN	2092	1	1564			
6	BIG TO HUNDEMAN	6024	3	1554			
7	HUNDEMAN TO BIG	11493	5	1455			
10	UNNAMED TO PETERS 10	17345	8	1451			
11	PETERS	14345	7	2109			
12	UNNAMED TO PETERS 12	30826	14	1601			7
14	KLEINHEKSEL	51684	24	1818			19
15	JAARDA TO SB	5028	2	1505			
16	SBMR TO JAARDA	5854	3	945			
18	EAST FILLMORE	18855	9	1673			6
19	SBMR TO MR	7158	3	2350			
20	NBMR TO DEN BLEYKER 20	29205	13	1922			
21	VANDEBIE/ROTMAN	4154	2	497			
22	NBMR TO DEN BLEYKER 22	781	0	264			
23	DEN BLYKER	5352	2	769			
24	NBMR @M-40	6442	3	452			
26	BOSH&HULST @104TH	3753	2	1156			
27	BOSCH&HULST TO NOORD	5442	2	1705			
28	TRIB TO BOSCH&HULST	9650	4	1114			
29	HUNTERS TO BROWER	11564	5	1433			
30	BROWER TO HUNTERS	9522	4	1269			
31	NOORDELOOS TO #52	9246	4	1188			
37	NORTH HOLLAND TO #40	2996	1	1193			
38	#15&17 TO #40	22632	10	1132			
41	MAPLEWOOD TO MR	14466	7	107			
42	TROOST&BOVEN TO PINE	3747	2	1111			
45	#37 TO PINE	6565	3	280			
	Totals	391006	180	38591	320	106	37
	Totals (High Priority)	218754	100	16752			
	Total (Mod Priority)	172251	79	21839			

 Moderately Critical Agricultural Areas
 Highly Critical Agricultural Areas

FOR COMPLETE DESCRIPTION OF METHODOLOGY SEE APPENDIX R

Management Measure: Drainage water management system applied to 50% of the drained land in highly critical agricultural subwatersheds

1. Total load by subwatershed(s)

Sub-watershed	Total Agricultural Acres	Estimated Acres of Drained Land	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
			lb/year	lb/year	lb/year	t/year
W3	1067.5	427	2562.9	615.5	5297.9	290.1
W4	1753.5	701.4	4071.1	957.6	8424.9	433.2
W7	1576.1	630.44	3685.4	870.8	7624.7	397.5
W10	2057.1	1028.55	5822.1	1347.3	12058.6	589.0
W14	2617.2	1701.18	9326.5	2111.8	19338.5	879.5
W15	2114	1374.1	7635.1	1744.9	15824.0	742.2
W16	1122.5	729.625	4223.9	991.9	8741.8	447.1
W18	2220.2	1443.13	7993.9	1823.0	16569.3	771.7
W20	2168.4	867.36	4964.4	1157.2	10278.3	513.8
W21	482.5	193	1390.8	367.7	2859.3	203.7
W27	2268.2	907.28	5177.6	1204.6	10720.9	532.7
W28	1482.7	593.08	3481.2	824.7	7201.4	378.4
Total	20929.9	10596.145	60334.8	14017.1	124939.3	6179.0

Drainage Water Management (30% reduction)
Applied to 50% of drained land (5298 acres)

Estimated Pollutant Reduction			
9050	2103	18741	Negligible
N	P	BOD	Sediment

Management Measure:Gypsum amendments applied to 50% of the agricultural land in highly critical agricultural subwatersheds

Total load by subwatershed(s) as calculated by EPA's STEPL Model

Sub-watershed	Agricultural Acres	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
		lb/year	lb/year	lb/year	t/year
W3	1067.5	6028.0	1392.8	12486.2	606.8
W4	1753.5	9595.2	2169.7	19897.0	900.9
W7	1576.1	6910.4	1692.7	14269.4	827.8
W10	2057.1	8833.4	2137.7	18252.3	1022.3
W14	2617.2	11031.8	2640.1	22808.5	1236.0
W15	2114	9058.5	2189.4	18718.8	1044.5
W16	1122.5	5056.3	1257.4	10432.1	631.6
W18	2220.2	9477.6	2285.5	19587.1	1085.8
W20	2168.4	9273.4	2238.7	19163.9	1065.7
W21	482.5	2329.5	600.6	4796.4	320.3
W27	2268.2	9666.5	2328.8	19978.6	1104.2
W28	1482.7	6532.3	1604.5	13486.7	788.5
Total	20929.9	93793.1	22537.8	193877.1	10634.4

Gypsum Amendments (30% reduction of phosphorus, sediment and runoff)
 No data was confirmed to estimate reduction of nitrogen
 Applied to 50% of agricultural land (10,465 acres)

Estimated Pollutant Reduction

Unknown	3381	29082	1595
N	P	BOD	Sediment

Management Measure: Two-stage ditch design applied in any subbasins with highly critical ag subwatersheds

Subbasins (with highly critical subwatersheds)	Streambank Erosion ¹			Surface Runoff Erosion ²		
	N	P	S	N	P	S
	lbs/yr	lbs/yr	tons/yr	lbs/yr	lbs/yr	tons/yr
Upper Macatawa	870	435	435	44885	8196	1343
Peters Creek	754	377	377	18359	3440	640
South Branch	2484	1242	1242	33271	6109	1092
North Branch	2470	1235	1235	35774	6533	1118
Noordeloos Creek	1902	951	951	48067	8245	1223
Totals	8480	4240	4240	180356	32523	5416

1: 2011 Geomorphology Report

2: 2009 MDEQ Pollutant Loading Report

Two-Stage Ditch (25% reduction of phosphorus, 23% reduction nitrogen and 15% reduction in sediment)

Estimated Pollutant Reduction		
43432	9191	1448
N	P	Sediment