

**Redwood-Cottonwood Rivers Control Area
Phosphorus Index Prototype Calculator
Sample Problems**

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Introduction/Background:

Redwood-Cottonwood Rivers Control Area (RCRCA) is a joint powers organization charged with improving the water quality of the Cottonwood River. The Cottonwood River originates near Balaton, MN in the Coteau des Prairie, a glacial formation, in southwestern Minnesota. The Minnesota River receives the water from the Cottonwood River at New Ulm, Minnesota. The Minnesota River is on the State of Minnesota's impaired waters Clean Water Act 303d list (Minnesota Pollution Control Agency, 2004). One of the pollutants degrading the water quality of the Cottonwood River and the Minnesota River is phosphorus. An excess amount of phosphorus encourages algae blooms, which consumes the dissolved oxygen and stresses aquatic life. This stress contributes to fish kills. Installation of various best management practices (BMPs) can reduce the amount of phosphorus entering the Cottonwood River. BMPs include, but are not limited to, vegetative filter and buffer strips, riparian corridor restoration, erosion control (by conserving the soil, the phosphorus attached to the soil particles remains on the land), and alternative tile intakes (ATIs) that replace traditional tile intakes.

ATIs have a variety of designs to choose from; the most common design involves placing perforated tile within a trench filled with pea-rock. The theory behind ATIs is that surface water percolates into the soil and pea rock, which filters out contaminants, including phosphorus; cleaner water enters the tile line, which carries excess water to nearby surface waters that drain into the Cottonwood River. Removal of excess water within agricultural crop land in less than 24 hours prevents drowning of cash crops, mainly corn and soybeans. ATIs benefit the farmer by preventing crop mortality by drowning; ATIs help improve water quality and meet the conservation goals of cleaner water.

The purpose of calculating and comparing various phosphorus indices is to determine how much phosphorus pollution is reduced through the implementation of BMPs, including ATIs. The extent of phosphorus reduction by ATIs isn't fully understood. Historical and current methods of assuming one pound of phosphorus reduction per intake per year may not be accurate. RCRCA's goal is to confirm or

improve this current reporting procedure. Soil samples were collected and tested; these test results were used in calculating the Iowa Phosphorus Index, the Wisconsin Phosphorus Index, the Minnesota Phosphorus Index, and the Barr Engineering Phosphorus Index. The indices were adjusted to meet the parameters of the Cottonwood River watershed. The indices' results were compared against one another to see how well the Cottonwood River watershed was represented. The RCRCRA Phosphorus Prototype Calculator software program was developed to make the various indices more user-friendly.

This paper is the part of a series of articles to calculate phosphorus reduction by various BMPs, including ATIs. This article includes sample problems and accompanies the software program used to calculate the Barr Engineering Index, Iowa Phosphorus Index, Wisconsin Phosphorus Index, and Minnesota Phosphorus Index.

Sample Problem #1:

Conservation professional Jack Smith is meeting with landowner John Doe to discuss phosphorus management issues with a new ATI being installed on John Doe's farm. John Doe has a 40-acre farm in Cottonwood County that is partially treated by an Alternative Tile Intake rock inlet. The farm is located in Rose Hill Township, Section 11, Northeast Quarter. The rock inlet receives drainage from 12.31 acres with a RUSLE value of 0.87 tons/ac/yr. There are no gullies or measurable sheet & rill erosion. The most recent soils test was taken two years ago and has a Bray test of 15 PPM and a Soil Organic Matter test of 3.8%. The soil survey for Cottonwood County has the ATI location listed as Webster Clay Loam Symbol # 113. He applies fertilizer at 50 lbs actual P and incorporates within 24 hours prior to planting in the spring. He has tile located in the field as part of the ATI BMP structure. There is no buffering vegetation around the ATI. John Doe's crop rotation is Corn-Soybeans with an average Corn yield about 150 bu/acre and Soybean Yield of 50 bu/acre. He chisel plows east-west (not on the contour) in the fall with up to 20% residue cover remaining after planting in the spring. The calculated watershed slope is 1.00%.

Answer Sample Problem #1:

The RCRC A Phosphorus Index Summary Sheet results are shown below. Conservation professional Jack Smith obtained cropping history, farm management history, soils test results from John Doe prior to his site visit. During the site visit, Jack Smith delineates the watershed for the proposed ATI on a soil survey map. After the visit, Jack Smith calculates RUSLE, the watershed slope, and the watershed area. For Residual Phosphorus input value, Jack Smith averages the residue values for corn and soybeans. After Jack Smith completes the RCRC A Phosphorus Index Summary Sheet, he calls John Doe. The Index indicates that John Doe's ATI poses very little risk for phosphorus loss at the current management techniques. Jack Smith gives John Doe the good news and congratulates him on the good job he's doing.



PHOSPHORUS INDEX SUMMARY SHEET

DATE 1/19/2005
 TECHNICIAN Jack Smith

PRINT PAGE

PRODUCER COUNTY FIELD LOCATION TRACT # FIELD # SOIL TEST #	RCRCA P Index Prototype Calculator Sample Problem #1 Cottonwood 11 NE/4 SECTION Rose Hill TOWNSHIP RANGE
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WATERSHED AREA RUSLE EPHEMERAL AREA EPHEMERAL MASS GULLY AREA GULLY MASS CONSERVATION PRACTICE ROCK TILE INLET FILTER BUFFER WIDTH FLOW DISTANCE to WATERCOURSE DOMINANT SLOPE of WATERCOURSE CROP TYPE/RESIDUE COVERAGE RESIDUE TILLAGE METHOD P-TEST TYPE PHOSPHORUS TEST RESULT ORGANIC MATTER % ACTUAL TOTAL "P" APPLIED (P205) PHOSPHORUS APPLICATION METHOD PHOSPHORUS INCORP. METHOD SOIL TYPE MAP SYMBOL/SOIL ID # HYDROLOGIC SOIL GROUP TILE PRESENCE PRECIPITATION RATE RUNOFF RATE EST. BASE RUNOFF SNOW PRECIPITATION EQUIVALENT POST TILLAGE "P" RESIDUE	12.31 ACRES 0.87 TONS/ACRE/YEAR ACRES TONS ACRES TONS Alternate Tile Intakes/Buffered Intake Yes (for tile inlets) 0-19 ft. 0 FEET 1 % Row crops -- SR + Crop residue good Chisel Plow; Straight Till Bray-1 P, Mehlich-3 15 PPM 3.8 % 50 LBS/ACRE Incorporate or Inject Within 24 Hours Chisel, Straight Webster clay loam 113 B/D Yes 26 INCHES/YR 3.5 INCHES/YR 1.5 INCHES/YR 0.5 2.4 LBS "P"/ACRE
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IOWA PHOSPHORUS INDEX (LBS./ACRE/YEAR)	V-Low 0.2280	0-1 -- V. Low 1-2 -- Low 2-5 -- Medium 5-15 -- High 15+ -- V. High
MINNESOTA PHOSPHORUS INDEX (UNITLESS)	V-Low 0.4128	0-1 -- V. Low 1-2 -- Low 2-4 -- Medium 4-6 -- High 6+ -- V. High
WISCONSIN PHOSPHORUS INDEX (LBS./ACRE/YEAR)	ACCEPTABLE 1.3994	<6 -- ACCEPTABLE >6 -- UNACCEPTABLE
BARR ENGINEERING REDUCTION FIG. (LBS "P" REDUCED/YEAR)	1.1842	BACK to MAIN

Sample Problem #2:

Conservation professional Jack Smith is meeting with landowner Bob Johnson to discuss phosphorus management issues with a new ATI being installed on Bob's farm. Bob has an 80-acre farm in Cottonwood County that is partially treated by an Alternative Tile Intake rock inlet. The farm is located in Rose Hill Township. The Rock Inlet receives drainage from 71.63 acres with a RUSLE value of 6.12 tons/ac/yr. There are no gullies or measurable sheet & rill erosion. The most recent soils test was taken two years ago and has a Bray test of 97 PPM and a Soil Organic Matter test of 2.8%. The soil survey for Cottonwood County has the ATI location listed as Letri Clay Loam Soil Symbol # 241. He applies fertilizer at 72 lbs actual P and incorporates within one week prior to planting in the spring. He has tile located in the field as part of the ATI BMP structure. There is no buffering vegetation around the ATI. Bob's crop rotation is Corn-Soybeans with an average Corn yield about 180 bu/acre and Soybean Yield of 50 bu/acre. He moldboard plows east-west (not on the contour) in the fall with up to 15% residue cover remaining. The calculated watershed slope is 2.52%.

Answer Sample Problem #2:

The RCRCA Phosphorus Index Summary Sheet results are shown below. Conservation professional Jack Smith obtained cropping history, farm management history, soils test results from Bob prior to his site visit. During the site visit, Jack Smith delineated the watershed for the proposed ATI on a soil survey map. After the visit, Jack Smith calculates RUSLE, the watershed slope, and watershed area. For Residual Phosphorus input value, Jack Smith averages the residue values for corn and soybeans. After Jack Smith uses the RCRCA Phosphorus Index Summary Sheet, he calls Bob. The Index indicates that Bob's ATI poses a low risk for phosphorus loss at the current management techniques, however, the management issues are pushing the upper limits for the low risk category. Jack Smith makes suggestions to Bob that by switching to chisel plow, reducing RUSLE to T value, incorporating fertilizer within 24 hours and reducing fertilizer rates to 50 lbs actual phosphorus, the phosphorus risk rating drops to the middle of Low and improves the soil health by having less erosion and more residue. However,

the phosphorus risk levels without making these changes was still acceptable by Iowa and Minnesota's Indices' standards.

Before:

RCRCA Redwood-Cottonwood Rivers Control Area		PHOSPHORUS INDEX SUMMARY SHEET			
		DATE	1/19/2005		PRINT PAGE
		TECHNICIAN	Jack Smith		
PRODUCER	RCRCA P Index Prototype Calculator Sample Problem #2				
COUNTY	Cottonwood				
FIELD LOCATION		SECTION			
	Rose Hill	TOWNSHIP			
		RANGE			
TRACT #					
FIELD #					
SOIL TEST #					
WATERSHED AREA	71.63	ACRES			
RUSLE	6.12	TONS/ACRE/YEAR			
EPHEMERAL AREA		ACRES			
EPHEMERAL MASS		TONS			
GULLY AREA		ACRES			
GULLY MASS		TONS			
CONSERVATION PRACTICE	Alternate Tile Intakes/Buffered Intake				
ROCK TILE INLET	Yes (for tile inlets)				
FILTER BUFFER WIDTH	0-19 ft.				
FLOW DISTANCE to WATERCOURSE	0	FEET			
DOMINANT SLOPE of WATERCOURSE	3	%			
CROP TYPE/RESIDUE COVERAGE	Row crops -- SR + Crop residue poor				
RESIDUE TILLAGE METHOD	Moldboard Plow; Straight Till				
P-TEST TYPE	Bray-1 P, Mehlich-3				
PHOSPHORUS TEST RESULT	97	PPM			
ORGANIC MATTER %	2.8	%			
ACTUAL TOTAL "P" APPLIED (P2O5)	72	LBS/ACRE			
PHOSPHORUS APPLICATION METHOD	Incorporate Within One Week				
PHOSPHORUS INCORP. METHOD	Moldboard				
SOIL TYPE	Letri clay loam				
MAP SYMBOL/SOIL ID #	241				
HYDROLOGIC SOIL GROUP	B/D				
TILE PRESENCE	Yes				
PRECIPITATION RATE	26	INCHES/YR			
RUNOFF RATE	3.5	INCHES/YR			
EST. BASE RUNOFF	1.5	INCHES/YR			
SNOW PRECIPITATION EQUIVALENT	0.5				
POST TILLAGE "P" RESIDUE	0.35	LBS "P"/ACRE			
IOWA PHOSPHORUS INDEX (LBS./ACRE/YEAR)	Low 1.0864		0-1 --	V. Low	
			1-2 --	Low	
			2-5 --	Medium	
			5-15 --	High	
			15+ --	V. High	
MINNESOTA PHOSPHORUS INDEX (UNITLESS)	V-Low 0.9367		0-1 --	V. Low	
			1-2 --	Low	
			2-4 --	Medium	
			4-6 --	High	
			6+ --	V. High	
WISCONSIN PHOSPHORUS INDEX (LBS./ACRE/YEAR)	UNACCEPTABLE 8.9303		<6 --	ACCEPTABLE	
			>6 --	UNACCEPTABLE	
BARR ENGINEERING REDUCTION FIG. (LBS "P" REDUCED/YEAR)	32.8142		BACK to MAIN		

After switching to chisel plow, reducing RUSLE to T value, incorporating fertilizer within 24 hours, and reducing fertilizer applications to 50 lbs actual phosphorus:

RCRCA Redwood-Cottonwood Rivers Control Area		PHOSPHORUS INDEX SUMMARY SHEET			
		DATE	1/19/2005		PRINT PAGE
		TECHNICIAN	Jack Smith		
PRODUCER	RCRCA P Index Prototype Calculator Sample Problem #2				
COUNTY	Cottonwood				
FIELD LOCATION		SECTION			
	Rose Hill	TOWNSHIP			
		RANGE			
TRACT #					
FIELD #					
SOIL TEST #					
WATERSHED AREA	71.63	ACRES			
RUSLE	5	TONS/ACRE/YEAR			
EPHEMERAL AREA		ACRES			
EPHEMERAL MASS		TONS			
GULLY AREA		ACRES			
GULLY MASS		TONS			
CONSERVATION PRACTICE	Alternate Tile Intakes/Buffered Intake				
ROCK TILE INLET	Yes (for tile inlets)				
FILTER BUFFER WIDTH	0-19 ft.				
FLOW DISTANCE to WATERCOURSE	0	FEET			
DOMINANT SLOPE of WATERCOURSE	3	%			
CROP TYPE/RESIDUE COVERAGE	Row crops -- SR + Crop residue good				
RESIDUE TILLAGE METHOD	Chisel Plow; Straight Till				
P-TEST TYPE	Bray-1 P, Mehlich-3				
PHOSPHORUS TEST RESULT	97	PPM			
ORGANIC MATTER %	2.8	%			
ACTUAL TOTAL "P" APPLIED (P2O5)	50	LBS/ACRE			
PHOSPHORUS APPLICATION METHOD	Incorporate or Inject Within 24 Hours				
PHOSPHORUS INCORP. METHOD	Chisel, Straight				
SOIL TYPE	Letri clay loam				
MAP SYMBOL/SOIL ID #	241				
HYDROLOGIC SOIL GROUP	B/D				
TILE PRESENCE	Yes				
PRECIPITATION RATE	26	INCHES/YR			
RUNOFF RATE	3.5	INCHES/YR			
EST. BASE RUNOFF	1.5	INCHES/YR			
SNOW PRECIPITATION EQUIVALENT	0.5				
POST TILLAGE "P" RESIDUE	3	LBS "P"/ACRE			
IOWA PHOSPHORUS INDEX (LBS./ACRE/YEAR)	V-Low 0.8644		0-1 --	V. Low	
			1-2 --	Low	
			2-5 --	Medium	
			5-15 --	High	
			15+ --	V. High	
MINNESOTA PHOSPHORUS INDEX (UNITLESS)	Low 1.0513		0-1 --	V. Low	
			1-2 --	Low	
			2-4 --	Medium	
			4-6 --	High	
			6+ --	V. High	
WISCONSIN PHOSPHORUS INDEX (LBS./ACRE/YEAR)	UNACCEPTABLE 7.4699		<6 --	ACCEPTABLE	
			>6 --	UNACCEPTABLE	
BARR ENGINEERING REDUCTION FIG. (LBS "P" REDUCED/YEAR)	27.9150		BACK to MAIN		