

**Redwood-Cottonwood Rivers Control Area
Phosphorus Index Prototype Calculator
User's Guide**

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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 RCRCA 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 accompanies the software program used to calculate the Barr Engineering Index, Iowa Phosphorus Index, Wisconsin Phosphorus Index, and Minnesota Phosphorus Index.

The RCRCA Phosphorus Prototype Calculator:

The user should note that this calculator is set up for use only within the Cottonwood River watershed. Other watershed data is not included in the calculator. The calculator takes a variety of inputs and returns the Indices ratings within a summary page. This calculator is only as accurate as the data used on the input page or tab, labeled "main". At first glance, some of the inputs appear repetitious. This is due to the nature of each individual index. For inputs specific to one index, it is noted next to the field which index utilizes that input. For some inputs, the units vary but the answers represent the same variable. This is noticeable with the rainfall, precipitation, and runoff look-ups. For most scenarios, this repetition only adds a few more minutes to the total time spent filling out the inputs page. Technicians may choose to calculate only one index by filling only those fields in.

Prior to sitting down at the computer, the conservation professional needs a variety of data prepared and calculated already. Much of this information is typically gathered during the site visit and landowner interview. More details of what's needed is discussed in greater detail below.

When opening the program, you may be prompted to enable the macros that allow the calculator to work. It may also ask for a password to unlock the software, just click on

“read only.” Users will not be able to save the program, only print out the summary page. At the bottom of the screen there are a number of tabs. The main tab (the first on the left) is the inputs page. After completing the inputs page, the user clicks on the “results” button which snaps the screen to the second tab, which is the summary page that is printed out and placed in the landowners file. The next seven tabs are “background” pages that allow the calculator to perform its equations and calculations. These background tabs include: indices, lookup, data, minn_sub, master_soil, soils_county, and landcover_lookup(RCN). The last five tabs are pages that the input page will prompt the user to use. These five tabs include the following labels: precip, runoff, base_runoff, snow, and residual_phos. These are items that the user must look at and either read a map or a table. The user needs to know where the property is located to read the maps. The user has the option of extrapolating between the data lines to obtain a more accurate value for that input. The table asks for cropping history and requires the user to read the desired value. All of these inputs are manually entered into the appropriate space on the main tab. After the user has completed reading each map or the table, the user can either click on the “return to main page” or manually click on the main tab at the bottom of the screen.

The following is a description of each input that is needed prior to sitting down at the computer. All of this data is obtained from landowner interviews, site visits, aerial photographs, soil surveys, and other conservation worksheets.

- Area of Watershed: calculated by user ahead of time using appropriate maps, in acres; used only for the Barr Index.
- RUSLE: Revised Universal Soil Loss Equation (RUSLE) calculated by user according to Natural Resources Conservation Service’s “Predicting Rainfall Erosion Losses, Revised Universal Soil Loss Equation (RUSLE)” found in the NRCS Technical Guide, Section 1-C, Part 1 dated September 1996. Units are Tons/acre/year. Required for all indices.
- Ephemeral Area or Mass: Calculated by user. User has a choice of entering this data. Not required for the indices but supplements RUSLE data. Enter one or the other, not both. Optional and only for the Iowa Index.

- Gully Area or Mass: Calculate by user. User has a choice of entering this data. Not required for the indices but supplements RUSLE data. Enter one or the other, not both. Optional and only for the Iowa Index.
- Conservation Practice: Obtained from aerial photos, site visits, and landowner interview. Refers to presence of BMPs, including rock inlet Alternative Tile Intakes. For now, only the Iowa Phosphorus Index computes index values for BMPs other than rock inlets. The rest of the calculator calculates only the ATI rock inlets. This will be updated as additional information becomes available. Use the drop down menu and click on appropriate BMP. Used in Iowa and Minnesota Indices.
- ATI Type: Obtained from aerial photos, site visits, and landowner interview. Use the drop down menu and select yes (if present), no, or Not Applicable. Used only for Barr Index.
- Filter Buffer Width: Obtained from aerial photos, site visits, and landowner interview. Select appropriate filter buffer width range, select 0-19 if rock inlet ATI since there is some minor filtering present. Used by Iowa Index only.
- Crop Residue: Obtained from aerial photos, site visits, and landowner interview. Select appropriate tillage management system, consider if the tillage occurs along the slope (or contour) or straight-row. Used in Iowa & Minnesota Indices.
- P-Test Factor: Obtained from soil test results less than four years old. Refer to lab sheet to determine if Bray, Mehlich, or Olsen testing procedures were used. Most landowners use local co-ops or elevators for soil testing. If landowner no longer has copies of the test results, check with their co-op agent to see if it is on file. Used in all but Barr Index.
- Phosphorus Test Result: Obtained from soil test results less than four years old. Refer to lab sheet for data for that specific project location. Units are in parts-per-million or PPM. Used in all but Barr Index.
- Organic Matter%: Also known as Soil Organic Matter (SOM) in percent. Obtained from soil test results less than four years old. Refer to lab sheet for data for that specific project location. Used in Wisconsin's Index.

- Flow Distance to watercourse from edge of watershed: Refers to travel distance or flowpath of surface runoff. Consider that ATI rock inlets have tile that does not allow filtering or treatment of tile water by the soil, so flow distance is zero once surface runoff reaches the ATI. Otherwise data obtained from landowner and maps. Used by Minnesota and Wisconsin.
- Dominant Slope: Refers to slope of watershed in percent (%). Calculate watershed slope using GIS or another accepted method. May also estimate watershed slope from dominant soils listed in county Soil Survey. Used by Wisconsin.
- County: Select from drop down menu. This prototype program is only valid for the Cottonwood River watershed and includes the counties of Brown, Cottonwood, Lyon, Murray, and Redwood. Used in all indices.
- Land Use/Residue: Select from drop down menu. Refers to vegetative cover such as crops, meadow, or woods. Used in all indices.
- Phosphorus Inc. Method: Refers to phosphorus incorporation method at time of application. Select appropriate tillage equipment. If no tillage, select “no incorporation.” Used by Minnesota Index.
- Phosphorus App. Method: Refers to phosphorus application method or how quickly and by what method phosphorus is “worked into” the soil. Used by all indices but Barr.
- Actual Total Phosphorus (P_2O_5): Refers to amount of Phosphorus in fertilizer. Compute in number of pounds per acre. Separate amount by season for Minnesota Index – April 1 to Nov 14 refers to growing season applications (that may either be absorbed by plants or run off during rain events) and Nov 15 to March 31 refers to off-season applications (that may run off during snow melt). For Iowa and Wisconsin Indices, enter annual “P” in either box listed.
- Soil Type, Soil ID #, and Soil Classification: These cells are in blue; select Soils Search button to select soils information. Select the appropriate county, then select dominant soil series from drop-down menu (look soils up in county soil survey). This drop-down menu is specific to each county. Then click “return to

main entry” button to return to inputs page. These blue cells will automatically fill in based on selections. Used in all indices.

- **Tile Presence:** Refers to tile presence in field. If tile presence is unknown, consider soil classification. If soil classification is B/D and crops grow every year without drowning out, select yes. If crops are unable to grow due to drowning, select no. Used in all indices.
- **Precipitation Rate:** Click on Precip Map to snap to lookup map. Find field location and extrapolate between the lines if needed. The Cottonwood River watershed values range from 25 to 29 inches/year. Click on Back to Main to return to inputs page. Type in appropriate value. Used in Iowa Index.
- **Runoff Rate:** Click on Runoff Map to snap to lookup map. Find field location and extrapolate between the lines if needed. The Cottonwood River watershed values range from 3 to 4 inches/year. Click on Back to Main to return to inputs page. Type in appropriate value. Used in Wisconsin Index only.
- **Est. Base Rainfall Runoff:** Refers to estimated base rainfall runoff. Click on Rain Runoff Map to snap to lookup map. Find field location and extrapolate between the lines if needed. The Cottonwood River watershed values range from 1.2 to 1.8 inches/year. Click on Back to Main to return to inputs page. Type in appropriate value. Used for Minnesota Index only.
- **Snow Precip. Equivalent:** Refers to snow precipitation equivalent. Click on Snow Equivalent to snap to lookup map. Find field location and extrapolate between the lines if needed. The Cottonwood River watershed values range from 0.5 to 1. Click on Back to Main to return to inputs page. Type in appropriate value. Note that this map was edited by the authors of the Minnesota Index and may be confusing – user can either use 0.5 or extrapolate between 0.5 and 1. This map does not provide units. Used for Minnesota Index only.
- **Crop Residual “P” Chart:** Refers to amount of phosphorus found in crop residue. Consider whether fall tillage or fall anhydrous application. The first row is abbreviations for various tillage operations: NT is no till, RT is ridge till, CP is chisel plow, MP is moldboard plow (“plow it black” tillage) and Disk refers to a disk. Next consider crop grown and amount yielded (bu/ac). If field in

permanent vegetation such as CRP, read the lower portion of the chart. Read chart for appropriate value. If more than one crop is used in the crop rotation, the values may be averaged or the Indices may be calculated for each crop year separately. Click on Back to Main to return to inputs page. Type in appropriate value. Used for Minnesota Index only.

Results:

When all of the yellow and blue cells have been filled in, click on results page. The screen will snap to RCRC A Phosphorus Index Summary Sheet, which summarizes the inputs from the inputs page and returns the final results for each index. Fill in appropriate fields in the upper portion of the table as needed for field and landowner information. The Indices results are listed at the bottom. The value given in middle column (to right of Index title) is the Index result. Check the units listed below the Index title. If needed, multiply the results by the number of acres to determine the amount of phosphorus in the watershed treated by the BMP. The right column lists the relative ranking scores to assist producers in determining if their score is “almost high” risk and needs to be lowered. Knowing this may help with future management decisions, such as changing tillage practices or reducing amount of fertilizer applied. Please note that the Barr Engineering Index calculates Phosphorus reduction by the ATI and not the general quantity of phosphorus present in the field. The user can click on Print Page button in the upper right corner of screen for a printout to place in landowner’s file. The user is unable to save since this will alter the original inputs page. An archive folder may be added in the future.

Appendix

Check-List for Redwood-Cottonwood Rivers Control Area
Phosphorus Index Prototype Calculator Inputs Page, All Indices

Office Information:

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|---|----------|
| Landowner/ Operator Name: | |
| Field Location (County, Township, Range, Section, ¼): | |
| Tract #: | Field #: |

Landowner Information:

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| Crop Rotation & Typical Yields: |
| Tillage Operations & Amount of Residue Remaining at Planting Time, including equipment used for each crop (ie Chisel, Straight or Chisel, Twisted): |
| Fertilizer Application for each crop(Type, Amount/Acre, Timing, Incorporation): |
| Manure Application (Type, Amount/Acre, Timing, Incorporation): |
| Most Recent Soils Test Data (Phosphorus Soil Test Type & Values, Soil Organic Matter, advise technician gets copy of soil test results) |
| Tile Presence, as part of BMP or other: |

Field Visit Information:

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| RUSLE Information: |
| RCN Information: |
| Residue Management Confirmation for each crop(does landowner have amount of residue they say they have?): |
| Watershed or Approximate Drainage Area (ADA) Information, including road culverts: |
| Ephemeral and Gully Information & Survey: |
| Presence of BMPs, including ATIs: |
| Presence of Tile: |

Calculated & Obtained After Field Visit:

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|------------------|---|
| RUSLE: | ADA or Watershed: |
| Watershed Slope: | Ephemeral or Gully Info: |
| RCN Value: | Flow Distance of Surface Runoff from Watershed Edge to ATI: |
| Soil Types: | |