

# TECHNICAL NOTES

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## California Phosphorus Index

The California Phosphorus Index is a tool designed to evaluate risk of P loss from individual agricultural fields to water bodies of concern for P pollution. The P Index is not designed to estimate the quantity of P lost from the field. The P Index can estimate risk of P loss under current management and management after a conservation plan is implemented. The Index can therefore provide guidance to the producer and planner in the preparation of a conservation plan to limit P loss.

P is not widely recognized as a pollutant in California, though new evidence is showing a broader problem than previously known. The California P Index is to be applied in watersheds known to have P impacts on water quality from agricultural activities. This policy will limit the required use of the tool to priority areas in the state. Voluntary use of the tool is encouraged where the producer and planner feel it would help to protect water not yet impacted by P.

The first step in using the Index is to apply a screening tool that will exclude fields with no risk to impact surface waters with P, or are in watersheds that have no P impacts on water quality. The screening tool is a flow chart found at the end of this Technical Note.

If a field must be further evaluated after applying the screening tool, then a risk assessment must be completed using the detailed P Index. Associated with this Technical Note is an Excel Spreadsheet that should be used to perform and illustrate the analysis required in the Phosphorus Index.

The result of using the P Index is to assign a field specific Risk Rating. The Risk Rating will determine the actions that must be taken on a given field to reduce risk of P loss to surface water. There are four Risk Ratings: Low, Medium, High, and Very High. Risk Ratings are assigned based on a score determined using the P Index.

The California P Index was developed considering the broad circumstances in California, and is not designed for any specific region of the state. Local experts may change scoring break points between Risk Ratings and remove or modify categories of risk assessment. Modification of the Index must be done through the Area and State Field Office Technical Guide committees, and must be approved by the State Conservationist.

The following actions are required for fields with the following Risk Ratings:

Fields rated **very high risk** for P loss must not receive manure or other organic forms of P fertilizer. Commercial P fertilizers may be applied according to University of California guidelines, or guidelines recognized by the University, utilizing soil or tissue sampling procedures and P response thresholds for the crop. Apply no P from any source if the Soil Test P exceeds 80 ppm (Olsen) or 120 PPM (Bray). When seeding winter vegetables into soils below 55 degrees Fahrenheit, 30 lbs./ac or less of P<sub>2</sub>O<sub>5</sub> may be injected as a starter fertilizer. A conservation plan must be in place and being applied to address the high risk of P loss. When the plan is implemented adequately to lower the risk rating then actions required for the lower risk level will apply.

Fields at **high risk** for P loss may receive manure at rates to meet crop P requirements based on the P content of the manure and anticipated crop yield. Commercial P fertilizers or high P content organic fertilizers may be applied according to University of California guidelines, or guidelines recognized by the University, utilizing soil or tissue sampling procedures and the P response threshold of the crop. All fields must have a conservation plan in place that will lower Risk Rating to medium or low.

Fields with **medium risk** for P loss may receive manure at rates based on the N content of the manure and calculated to meet crop nitrogen needs based on a nitrogen budget. Commercial P fertilizers may be applied according to University of California guidelines, or guidelines recognized by the University, utilizing soil or tissue sampling procedures and the P response threshold of the crop. Existing management on these fields will probably lead to higher risk over time. Risk should be monitored periodically using the P Index.

Fields with **low risk** for P loss may receive manure at rates based on the N content of the manure and calculated to meet crop nitrogen needs based on a nitrogen budget. Commercial P fertilizers may be applied according to University of California guidelines, or guidelines recognized by the University, utilizing soil or tissue sampling procedures and the P response threshold of the crop.

## **Interpretations of P Index Factors:**

There are two primary criteria that must be met before a field can be assigned risk for P loss:

- 1) There must be a means to transport available P offsite. These are collectively called "Transport Factors".
- 2) There must be P available for transport offsite in adequate quantities to create risk. These are collectively called "Source Factors".

## Transport Factors

**Soil Erosion – Sheet and Rill Erosion:** P loss from agricultural fields is strongly related to sediment loss. To assign points for this category calculate the sheet and rill erosion using RUSLE2 procedures and apply the criteria on the Index. Until further field testing is complete the RUSLE2 erosion estimates should not be used on fields that are ridged or furrowed during the winter rainy season. Record zero points in this category for those conditions. This category is needed in regions where erosion from rainfall is a consideration. Where erosion from rainfall is not a factor it may be removed from the Index.

**Ephemeral Gully Erosion:** Assign points based on the frequency of ephemeral gully erosion occurring in the field. Include erosion of this type occurring on fields that are ridged or furrowed during the rainy season. This category is needed in regions where erosion from rainfall is a consideration. Where erosion from rainfall is not a factor it may be removed from the Index.

**Irrigation Tailwater:** If irrigation tailwater from this field is allowed to leave the farm points will be assigned. This category considers the effect of runoff from irrigation tailwater that may carry suspended or dissolved P into water bodies. Suspended P is usually associated with organic material that floats, such as manure. If tailwater is lost offsite infrequently (once annually or less), assign four points. If the loss is more frequent assign eight points. If all tailwater from this field is captured and reused on the farm assign zero points. This category is needed in irrigated regions. Where irrigation is not used it may be removed.

**Hydrologic Soil Group:** This risk factor is based on the Hydrologic Soil Group assigned to the predominant soil in the field. Refer to the soil survey or Web Soil Survey Hydrologic Soil Group report. This category considers the effect of runoff from rainfall that may carry suspended or dissolved P into water bodies. Suspended P is usually associated with organic material that floats, such as manure. Soils with higher runoff will shed a higher portion of rainfall, and are more likely to shed P as well. If the runoff from rainfall is held on site, or is insignificant, assign zero points.

Below are instructions for obtaining the Hydrologic Soil group on Web Soil Survey:

- 1) Go to the Web Soil Survey Website at <http://websoilsurvey.nrcs.usda.gov/app/> and click on “Start WSS”
- 2) In the opening screen, select “Soil Survey Area” in the Quick Navigation menu. After selecting a survey, select “Set AOI”.
- 3) After the data loads select “Soil Data Explorer” at the top of the map area.
- 4) Select “Soil Properties and Qualities”
- 5) Select “Soil Qualities and Features”
- 6) Select “Hydrologic Soil Group”
- 7) At a minimum, select “Table”, then “View Rating”
- 8) At the top of the screen, select “Printable Version” to print a table of values for the soil survey area.

**Sediment from Irrigation Induced Erosion:** Risk in this category is based on the level of conservation being used to reduce irrigation induced erosion. Table 2 is provided to estimate the percent reduction of irrigation induced erosion from applying specific conservation practices. These reductions are based on conditions typical to west Stanislaus County. For areas in the state with similar furrow irrigation practices the relative reductions are probably similar. For significantly different circumstances reduction values can be estimated using the FUSED and FURROW4 irrigation induced erosion prediction models. If no sediment loss is observed during the first irrigation of the season, and no significant system or management changes are expected for future irrigations, then zero points can be assigned at the discretion of the planner.

Tailwater Tarps have the effect of grade stabilization in the tailwater ditch. They reduce the erosive force of the water by allowing it to lose elevation at controlled and protected points along the ditch. They are commonly constructed when 2" x 4" wood beams are placed in the ditch and a tarpaulin is placed over them to form a dam. Water is allowed to go over the structure at a certain elevation and through a notch in the dam wide enough to allow the desired flow, but narrow enough to protect the ditch banks from turbulence.

Table 2 assumes well managed and maintained practices. This category is needed in regions where erosion from irrigation is a consideration. In regions or watersheds with no irrigation it may be removed.

**Subsurface Drainage:** Current studies suggest that P dissolved in subsurface water is unlikely to move further than 500 feet from the source. For the purpose of the P Index, assume that in order for dissolved P from the subject field to be released to surface water there must be an outlet within 500 feet of the field being assessed. Outlets for dissolved P may be direct seepage into a drainage ditch; tile drains; or groundwater extraction from a depth of less than 50' that is discharged to surface waters. The well must have a perforated screen at a depth of 50' or less regardless of the depth of the well. The water drawn from the well must be discharged to a collection system and not used onsite for irrigation or domestic consumption. When considering tile drains, the drained field must be within 500 feet of the field being assessed. Seepage or groundwater extraction from < 50 feet deep must occur within 500 feet of the field being assessed. When such an outlet for groundwater transfer to surface water exists within 500 feet of the field assign eight points. If not, assign zero points.

**Discharge Rating:** This factor is used to identify highly efficient routes for the transport of P to impacted water bodies. If the field will outlet to a drainage system that provides little or no filtering, nor impediment, to flow to the impacted water body, assign a factor of 1.5. Examples of conduits with this property are a pipeline, free flowing ditch, or direct sheet or concentrated flow into the tributary from the field. These conduits might drain a tailwater ditch, tile drain, seepage site, shallow groundwater extraction well, field drain ditch, etc. If the outlet for the field has no access to an efficient drainage path then use a discharge rating of 1. This factor should be considered in all regions of California.

## Source Factors

**Soil Test P:** This factor is based on the concentration of available P in the top 12 inches of the soil profile. In most cases the Olsen test will be used in California. When soil pH is 6 or less the Bray method should be used. Points are assigned in proportion to the Soil Test P (STP). As STP goes higher than the threshold the points increase according to the formula shown on the P Index Worksheet. For the Olsen method a threshold of 20 ppm is used. One point is assigned for each 10 ppm the soil test P exceeds 20 ppm. For the Bray method the threshold is 40 ppm in 12 inches, so one point is assigned per 10 PPM above that level. This factor should be considered in all regions of California.

**Commercial P fertilizer application rate:** One point is assigned per 50 pounds/acre of  $P_2O_5$  applied. This factor should be included in the P Index for all regions.

**Commercial P fertilizer application method:** Risk is assigned in this category based on how P fertilizer is incorporated into the soil. If the fertilizer is banded, injected, applied as a liquid, or broadcast and then incorporated greater than 2" before irrigation or onset of the rainy season then assign zero points. If surface applied fertilizer is incorporated less than 2" prior to irrigation or onset of the rainy season assign two points. Broadcast fertilizer that is not incorporated prior to the rainy season or irrigation should be assigned 8 points. This factor should be included in the P Index for all regions.

**Organic P source application rate:** Risk is assigned in this category based on the level of management used while determining the amount of organic P fertilizer to be applied to the field. Producers using laboratory sampling, actual yield data, soil or tissue testing, recordkeeping, and consideration of all nutrient sources to determine the rate of manure application will be assigned Low Risk. As the management system drifts below this level higher risk categories will be assigned. *The producer must actively use these decision making tools when applying manure or other organic forms of fertilizer. Records need to be gathered and maintained for each field showing the data used, the recommended rate, and the amounts and dates of application.* Risk due to application of organic solids from storage ponds and solids from separators or settling basins should be evaluated using the same criteria as used for liquid manure or scraped solids.

**Organic P source application method for solids:** The method of solid manure application affects the risk of P loss during irrigation or rainfall runoff, and soil erosion. If solids are injected or incorporated to a depth of 3" or more before runoff from irrigation or rainfall is likely to occur then risk of loss is reduced. The producer, as a part of the routine management of the farm, must incorporate solids prior to the beginning of the rainy season or prior to irrigation to be low risk. Lowest risk occurs when solids are applied using a calibrated system as well. Solids refer to corral scrapings, material

removed from separators, organic solids from ponds, or fresh stacked manure from freestalls, lanes, etc.

**Organic P source application method for liquids:** Risk in this category is assigned based on the amount and frequency of organic solids applied with pond water. If organic solids are applied consistently and at low rates, then the risk is low. If organic solids are applied infrequently and at high rates, then the risk is high. A separation system effective enough that the pond does not require an agitator pump or other means to remove solids suggests low risk. Medium risk would be associated with a moderately effective separation system that requires use of an agitator pump and very infrequent use of other methods to remove solids from the pond. Organic solids applied consistently while using an agitator pump without a settling system is high risk. Very high risk occurs when organic solids are applied with irrigation water and an agitator pump while cleaning the pond at a yearly or less frequent interval, usually when none or a poor separation system is in place. Organic solids removed from the pond should be applied at agronomic rates.

## Categories of Risk from P Loss

There are three categories of risk from P loss. They are: P loss associated with soil erosion, P loss when dissolved or suspended in surface runoff, and P lost by leaching through the soil profile that ultimately enters surface water. Each of these categories is evaluated separately. Each category of loss is evaluated for risk. If a field is rated at a high risk for any of the three categories the actions to be taken should focus on the factors used to evaluate that risk category. The individual categories use the following risk factors to evaluate risk.

<b>Transport Factors:</b>	Erosion	Runoff	Leachable
Soil Erosion - RUSLE	X		
Irrigation induced erosion	X		
Ephemeral gully erosion	X		
Irrigation Tailwater		X	
Runoff Class		X	
Subsurface Drainage			X
Drainage system type	X	X	X

<b>Source Factors:</b>	Erosion	Runoff	Leachable
Soil Test P	X	X	X
Commercial P Rate	X	X	X
Commercial P Method	X	X	
Organic P Rate	X	X	X
Organic P Method - Solids	X	X	
Organic P Method - Liquids	X	X	

Table 2: Estimated reduction in irrigation induced erosion from selected conservation practices:

<b>Practices used with furrow irrigation on field crops or orchards</b>	Percent Reduction
Tailwater tarps	45
Cutback stream	60
Filter strips	45
Sediment basin	95
Conservation tillage w/ low residue crop	5
Conservation tillage w/ high residue crop	40
Surge Irrigation	80
Tailwater return system	95
Tailwater tarps and cutback stream	80
Tailwater tarps, cutback stream and sediment basin	95
Tailwater tarps and sediment basin	95
Surge Irrigation and sediment basin	95
Polyacrylamide addition to irrigation stream	95
<b>Other practices:</b>	
Permanent cover crop with surface irrigation in orchards	60
Temporary cover crop with furrow irrigation	20
Sprinkler irrigation w/ low runoff	60
Drip irrigation	90

# California P Index – Initial Risk Assessment

