Introduction

The Microsoft Excel® Spreadsheet Pollution Reduction Estimator - water erosion.xls is a version of the same pollution reduction estimator that was built-in to eLINK version 2. The inputs and results are the same. It requires Excel to Run.

There are 4 Water Erosion estimator types to choose from:

1. Sheet and rill erosion.
2. Gully stabilization.
4. Filter strip projects.

The spreadsheet “workbook” contains 4 worksheets, one for each of the 4 estimator types. These are accessed via the worksheet tabs at the bottom of the spreadsheets (circled in red above).

Each of the worksheets has cells that require user input (shaded yellow and outlined in blue), cells with intermediate calculated values (outlined in black), and final results (outlined in red). The results are Soil Loss Reduction (tons/year), Sediment Reduction (tons/year) and Phosphorus Reduction (lbs/year).
Estimators for **Sheet and rill erosion** and for **Filter strip projects** require input from the **Revised Universal Soil Loss Equation 2 (RUSLE2)**.

**RUSLE2** includes several components. One is the computer program that solves the many mathematical equations used by RUSLE2. A very important part of the RUSLE2 computer program is its interface that connects the user to RUSLE2. Another major component of RUSLE2 is its database, which is a large collection of input data values. The user selects entries from the database to describe site-specific field conditions. The other major component of RUSLE2 is the mathematical equations, scientific knowledge, and technical judgment on which RUSLE2 is scientifically based. RUSLE2 is very easy to use. With the exception of topography, the RUSLE2 user describes the site-specific field conditions by selecting database entries from menus. When a menu selection is made, RUSLE2 “pulls” values stored in the RUSLE2 database and uses them as input values to compute erosion. The user enters site-specific values for slope length and steepness to represent topography.

More information on RUSLE2: www.ars.usda.gov/Research/docs.htm?docid=6010

See Appendix A for more detailed explanation of the calculations behind the different estimates.

### 1. Water Erosion - Sheet & Rill Erosion

Required inputs for the sheet and rill erosion estimator are:

- Erosion before and after (tons/acre/year) estimated using the Revised Universal Soil Loss Equation 2 (RUSLE2).
- The distance from the edge of field to the receiving water resource. This determines the sediment delivery ratio (SDR).

#### Required inputs:

- Soil type (sand, silt, clay, peat).
- Units applied (acres).
- Area contributing to the hydrologic system (acres).
- Distance to surface water (feet).
- Presence of filter strip before project installation (yes or no).

#### Example of Excel sheet and filter strip boundary:

![Excel sheet and filter strip boundary diagram]

- **Distance to surface water (feet):**
- **Filter Strip present? (Yes or No):**

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2. Water Erosion - Gully Stabilization

The estimates for reductions in soil loss, sediment, and attached phosphorus delivery for gully stabilization are based on estimation of soil volume voided per year. The estimate assumes that once the practice is in place, the stabilized condition controls gully erosion. Soil loss reduction from the practice is equal to soil erosion before the project was put in place. A sediment delivery ratio (SDR) is assigned based on characteristics of flow from the gully and is applied to estimate sediment reduction. Sediment-attached phosphorus reduction is estimated from the sediment reduction, default phosphorus content of 1.0 lb of phosphorus per 1 ton of soil, and a correction for soil texture.

![Diagram of Gully Stabilization Estimator]

- **SOIL type**
- soil volume voided per year (ft³) \( \frac{1}{2} \) ((top width + bottom width) * depth * length)
- Number of years to form gully.
- Distance to receiving surface water (feet).
- Gully Conditions:
  - Is the flow from the gully channelized? (Does runoff from the gully travel in a channel to the receiving surface water?)
  - Does the gully outlet fan out? (Is flow not channelized?)
  - Is the gully site landlocked?
- Filter Strip present? (Yes or No)
- Filter Strip Factor (FS)
- Distance to surface water (feet)
- SEDR = SLB/SDR/FS
- Sed. Reduction (Tons/year)
- PR = SEDR * (1.0 lb/Ton) * CF
- P reduction (Lbs/yr)
3. Water Erosion - Stream and Ditch Bank Stabilization

The estimates for reductions in soil loss, sediment, and attached phosphorus delivery for bank stabilization are based on an estimate of volume voided per year. The estimate assumes that once the practice is in place, the stabilized condition controls bank erosion. Soil loss reduction from the practice is therefore equal to soil erosion before the project was put in place. The SDR = 1 since the practice is adjacent to the receiving surface water. Sediment-attached phosphorus reduction is estimated from the sediment reduction, a default phosphorus content of 1.0 lb of phosphorus per 1 ton of soil, and a correction for soil texture.

<table>
<thead>
<tr>
<th>SOIL type</th>
<th>Soil volume voided (ft^3).</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of years to erode bank to current position</td>
</tr>
</tbody>
</table>
4. Water Erosion - Filter Strip Projects

The pollution reduction estimates (soil loss reduction, sediment reduction, phosphorus reduction) from filter strip projects are made by:

1. Estimating pollutant reductions from the area of the filter strip itself resulting from conversion of the filter strip area to permanent vegetative cover;
2. Estimating pollutant reductions from the filter strip's treatment of runoff from the upland drainage area contributing to the filter strip; and
3. Summing the above to give the total pollution reduction estimate.

The worksheet for filter strip projects is divided into 3 areas – one for each of the steps.
4.1 Area of Filter Strip

Soil loss from filter strip area (Tons/acre/yr) before and after. From RUSLE2.

Soil Classification (sand, silt, or clay).

Area of Filter Strip (acres).

Width of Filter Strip (feet).
4.2 Filter Strip treatment of Upland Runoff

Area contributing to filter strip (area the filter strip is treating in acres).

Does the filter strip function as designed?

Examples of non-functioning filter strip:
- Contributing Area (CA) is too large
- Flow is channelized through filter strip

Soil loss from upland (Tons/ac/yr) before. From RUSLE 2.
### 4.3 Result

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<th>O</th>
<th>P</th>
<th>Q</th>
<th>R</th>
</tr>
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<td>Soil Loss Reduction</td>
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<td>From Filter Strip area (T/yr)</td>
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<tr>
<td>33</td>
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<td>39</td>
<td>PR&lt;sub&gt;TOT&lt;/sub&gt; =</td>
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</tr>
<tr>
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<td>41</td>
<td>28.77</td>
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</table>
Appendix A: Calculations Behind Pollution Reduction Estimates — Water Erosion

The Microsoft Excel Spreadsheet *Pollution Reduction Estimator - water erosion.xls* has the same water-erosion based pollution reduction estimators that were built-in to eLINK version 2. These include estimators for:

- Sheet and rill erosion
- Gully stabilization
- Stream bank/ditch stabilization
- Filter strip projects

The water erosion estimates are based on:

1. An estimate of soil erosion before and after installation of the practice;
2. An estimate of resulting reduction in sediment to the nearest surface water body; and
3. An estimate of resulting reduction in attached phosphorus

Soil erosion estimates use either: (1) the *Revised Universal Soil Loss Equation 2 (RUSLE2)* for sheet & rill erosion and filter strip projects, or (2) a volumetric calculation for gully/stream bank/ditch stabilization projects.

The estimates then calculate an estimated *Sediment Delivery Ratio (SDR)* based on the distance to the receiving water body, and is applies the SDR to the estimated soil loss reduction to produce an estimate of sediment reduction. Attached phosphorus reduction is derived from sediment delivery and a coefficient based on soil type.

Sheet & Rill Erosion Control

Erosion before and after, estimated using the Revised Universal Soil Loss Equation (RUSLE2) are required inputs. The distance from the edge of field to the receiving water resource determines the SDR. The SDR is applied to estimate sediment reduction. Sediment-attached phosphorus reduction is calculated using functions relating phosphorus content to sediment delivery.

Features:

- Use of an SDR estimator algorithm (Fig. 2) to estimate sediment delivery coefficient
- Sediment enrichment for sediment-borne phosphorus is factored in using functions estimating P content (pounds/acre/year) from sediment delivery (tons/acre/year) and soil type (Fig 3). The functions come from CREAMS (via AGNPS)\(^1\) tables with the default value set at 1.0 lb of phosphorus per 1 Ton of soil.

Inputs:

RUSLE2 Before \(\rightarrow\) SLB\(_{pa}\) soil loss before per acre (tons/acre/year)
RUSLE2 after \(\rightarrow\) SLA\(_{pa}\) soil loss after per acre (tons/acre/year)

SOIL type (sand, silt, clay, peat)
AC = units applied (acres)
CA = contributing acres (contributing watershed)
D = distance to surface water

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Soil Loss Reduction Estimate

\[ SLR_{pa} = SLB_{pa} - SLA_{pa} \]

Soil Loss Reduction per acre (tons/acre/year)

\[ SLR = SLR_{pa} \times AC \]

Soil Loss Reduction (tons/year)

Sediment Reduction Estimate

\[ SEDB_{pa} = SLB_{pa} \times SDR \]

Preliminary sediment before per acre (tons/acre/year)

\[ SEDA_{pa} = SLA_{pa} \times SDR \]

Preliminary sediment after per acre (tons/acre/year)

Where \( SDR \) = sediment delivery ratio, calculated from the algorithm (Fig. 2).

Preexisting filter/buffer strip

Was a filter strip present before the installation of the project?

YES: \( FS = 0.35 \)

NO: \( FS = 1 \)

The filter strip factor (\( FS \)) modifies the preliminary sediment estimates to account for removal of sediment by the filter strip. It represents the fraction of sediment passing through the filter strip. If no filter strip was previously installed, the initial sediment reduction estimate is not modified (\( FS = 1 \)). An estimate of the relative gross effectiveness of filter strips for sediment reduction is 65%. If the filter strip is judged to be functioning properly\(^2\) then we use the estimate of 65% sediment removal (\( FS = 0.35 \)).

\[ SEDB_{pa} = FS \times SEDB_{pa} \]

sediment before per acre (tons/acre/year)

\[ SEDA_{pa} = FS \times SEDA_{pa} \]

sediment after per acre (tons/acre/year)

\[ SEDR = (SEDB_{pa} - SEDA_{pa}) \times CA \]

Sediment Reduction (tons/year)

Phosphorus Reduction Estimate

\[ PB_{pa} = f(SEDB_{pa}, SOIL) \]

phosphorus before per acre (pounds/acre/year)

\[ PA_{pa} = f(SEDA_{pa}, SOIL) \]

phosphorus after per acre (pounds/acre/year)

Where \( f \) is the function estimating P content (pounds/acre/year) from sediment delivery (tons/acre/year) and soil type (Fig 3).

\[ PR = (PB_{pa} - PA_{pa}) \times CA \]

phosphorus reduction (pounds/year)

\(^2\) The filter strip credit should be given to a site that provides the following:

1) A healthy stand of grasses predominated by varieties of stem grasses versus blade grasses.
2) The stand of grass should be wide enough to impede the flow it receives (estimated ranges depend on the grass and the energy of the run-off. Widths can be as low as 10 feet for switch grass up to more common values of 66 feet).
3) Delivery of the run-off must remain in a thin overland flow pattern and not be channelized.
4) The delivery of the run-off from the credited area cannot be bypassed around or through the filter strip by a ditch, tile intake, side inlet or channel.
Fig. 1: Sheet & Rill Erosion Control

SLB_{pa}  
Soil Loss Before per acre (T/Ac/yr)  

SLA_{pa}  
Soil Loss After per acre (T/Ac/yr)  

SLR_{pa}  
Soil Loss Reduction per acre  
= SLB_{pa} - SLA_{pa}  
(T/yr)  

SLR = (SLR_{pa})(Ac)  
Soil Loss Reduction (T/yr)  

AC = units applied (acres)  
CA = contributing acres (acres)  
SOIL = sand, silt, clay, peat  

SDR  
sediment delivery ratio estimator  

f: function estimating P content (lbs/yr)  
from sediment delivery (T/yr) and soil type  
(see figure: phosphorus content of sediment  
delivered by sheet & rill erosion)  

SOIL:  
(clay, silt, sand, peat)  

D  
distance to surface water  
(ft or mi)  

SED = (SDR) \cdot (f(SDB_{pa}, SOIL))  
phosphorus before per acre  
(lbs/A/yr)  

P_{pa} = (f(SDA_{pa}, SOIL))  
phosphorus after per acre  
(lbs/A/yr)  

PR = (P_{pa} - P_{pa}) \cdot CA  
phosphorus reduction (lbs/yr)  

RUSLE 2 Before  

RUSLE 2 After  

Was a Filter Strip present before installation of project?  
(Y/N)  

Filter Strip Factor  
FS = 1  
FS = 0.35  

SED_{pa} = FS \cdot SDB_{pa} (T/yr)  
SED_{pa} = FS \cdot SDA_{pa} (T/yr)  

SED = \text{sediment reduction (T/yr)}
Fig. 2: Sediment Delivery Ratio Estimator for Sheet & Rill Erosion

The Sediment Delivery Ratio (SDR) estimator tool for sheet and rill erosion is based on an approximate relationship between SDR and distance from the edge-of-field to the receiving surface water. The relationship is defined by a power function passing through two points:

<table>
<thead>
<tr>
<th>Distance (ft)</th>
<th>SDR</th>
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<tbody>
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<td>200,000</td>
<td>0.08</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
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</table>

The same relationship has been proposed for use in the Phosphorus Index work currently underway. The graph shows the relationship in relation to the “step function” used in LARS.
Fig 3: Phosphorus Content of Sediment Delivered by Sheet and Rill Erosion

Functions estimate phosphorus content (pounds/acre/year) from sediment delivery (tons/acre/year) and soil type. Source: CREAMS (via AGNPS)\(^3\) tables with the default value set at 1.0 lb of phosphorus per 1 Ton of soil.


2. Gully Stabilization

The estimates for reductions in soil loss, sediment, and attached phosphorus delivery for gully stabilization are based on calculation of soil volume voided per year. The estimate assumes that once the practice is in place, the stabilized condition controls gully erosion. Soil loss reduction from the practice is equal to soil erosion before the project was put in place. A sediment delivery ratio (SDR) is assigned based on characteristics of flow from the gully. The SDR is applied to estimate sediment reduction. Sediment-attached phosphorus reduction is estimated from the sediment reduction, default phosphorus content of 1.0 lb of phosphorus per 1 ton of soil, and a correction for soil texture.

Inputs:

- **VOLV** volume voided ($\text{ft}^3$) 
  \[((\text{top width} + \text{bottom width})/2)\times \text{depth} \times \text{length}\]
- **SOIL** type (sand, silt, clay, peat)
- **YR** number of years to form gully

Characteristics of flow from Gully

- Is the flow from the gully channelized? (Does runoff from the gully travel in a channel to the receiving surface water?)
- Does the gully outlet fan out? (Is flow not channelized?)
- Is the gully site landlocked?

\(D\) distance to receiving surface water

**Soil Loss Reduction Estimate**

\[\text{SLB} = \frac{\text{SD} \times \text{VOLV}}{\text{YR}}\]

Soil Loss Before (tons/year)

Assumed equal to:

\[\text{SLR} \] Soil Loss Reduction (tons/year)

**Sediment Reduction Estimate**

Assign SDR based on the characteristics of flow from the gully.

Channelized

- \(D \leq 0.25\) mi: \(\text{SDR} = 1.00\)
- \(D > 0.25\) mi: \(\text{SDR} = 0.5\)

Not channelized - gully fans out

Use SDR estimator (Fig. 2)

Landlocked

\(\text{SDR} = 0\)

Preexisting filter/buffer strip

Was a filter strip present before the installation of the project?

- YES: \(\text{FS} = 0.35\)
- NO: \(\text{FS} = 1\)
The filter strip factor (FS) modifies the preliminary sediment estimates to account for removal of sediment by the filter strip. It represents the fraction of sediment passing through the filter strip. If no filter strip was previously installed, the initial sediment reduction estimate is not modified (FS = 1). An estimate of the relative gross effectiveness of filter strips for sediment reduction is 65%. If the filter strip is functioning properly then we use the estimate of 65% sediment removal (FS = 0.35).

\[ \text{SED}R = \text{SLB*SDR*FS} \]

Sediment Reduction (tons/year)

**Phosphorus Reduction Estimate**

\[ \text{CF} \]

Correlation factor for soil texture (Fig. 5)

Clay - 1.15  Silt - 1.00  Sand - 0.85  Peat - 1.50

\[ \text{PR} = \text{SED}R \times (1.0 \text{ pound/ton}) \times \text{CF} \]

Phosphorus reduction (pounds/year)

4 The filter strip credit should be given to a site that provides the following:

1) A healthy stand of grasses predominated by varieties of stem grasses versus blade grasses.
2) The stand of grass should be wide enough to impede the flow it receives (estimated ranges depend on the grass and the energy of the run-off. Widths can be as low as 10 feet for switch grass up to more common values of 66 feet).
3) Delivery of the run-off must remain in a thin overland flow pattern and not be channelized.
4) The delivery of the run-off from the credited area cannot be bypassed around or through the filter strip by a ditch, tile intake, side inlet or channel.
Fig 4: Gully Stabilization

Flow from Gully Characteristics:
1. Channelized (Runoff from the gully汇入 a channel to the receiving water)
2. Gully Fans Out (not channelized)
3. Gully land-locked

SD = SOIL density in Tons/ft³

SOIL classification (sand, silt, clay, peat)

SDR = Sediment Reduction (Tons/yr)

PR = P Reduction (Tons/yr)

CF = Correction Factor
day: clay 1.15, silt 1.00, sand 0.85, peat 1.50

SLB = Soil Loss Before (Tons/yr)

SLR = Soil Loss Reduction (Tons/yr)

VOLV = Volume voided (ft³)

(Top width + Bottom Width)/2 * depth * length

D = distance to surface water (m or ft)

FS = Filter Strip Factor

* See note on facing page
Fig 5 — Soil Properties

Soil Texture Triangle

<table>
<thead>
<tr>
<th>Soil Texture</th>
<th>Correction Factor</th>
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</thead>
<tbody>
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<td>Clay</td>
<td>1.15</td>
</tr>
<tr>
<td>Silt</td>
<td>1.00</td>
</tr>
<tr>
<td>Sand</td>
<td>0.85</td>
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<td>Peat</td>
<td>1.50</td>
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</table>

Phosphorus Correction Factors for Soil Texture

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<tr>
<th>Soil Texture</th>
<th>Dry Density Lbs/Ft³</th>
<th>Soil texture used for calculations</th>
<th>Dry Density used for calculations Lbs/Ft³</th>
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<td>Organic</td>
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3. Stream and Ditch Bank Stabilization

The estimates for reductions in soil loss, sediment, and attached phosphorus delivery for bank stabilization are based on an estimate of volume voided per year. The estimate assumes that once the practice is in place, the stabilized condition controls bank erosion. Soil loss reduction from the practice is therefore equal to soil erosion before the project was put in place. The SDR = 1 since the practice is adjacent to the receiving surface water. Sediment-attached phosphorus reduction is estimated from the sediment reduction, a default phosphorus content of 1.0 lb of phosphorus per 1 ton of soil, and a correction for soil texture.

Selection of the average lateral recession rate is critically important.

**Inputs:**

- **VOLV** volume voided (ft³)
- **SOIL** type (sand, silt, clay, peat)
- **YR** number of years to erode bank to current position

(D = 0 distance to receiving surface water)

(SDR = 1 all soil loss reduction is sediment reduction)

**Soil Loss Reduction Estimate**

\[
SLB = SD \times VOLV / YR
\]

Soil Loss Before (tons/year)

Assumed equal to:

**SLR** Soil Loss Reduction (tons/year)

**Sediment Reduction Estimate**

**SED** = **SLB** = **SLR** Sediment Reduction (tons/year)

**Phosphorus Reduction Estimate**

- **CF** correction factor for soil texture (Fig. 5)
  - Clay 1.15
  - Silt 1.00
  - Sand 0.85
  - Peat 1.50

\[
PR = SEDR \times (1.0 \text{ pound/ton}) \times CF
\]

phosphorus reduction (pounds/year)

Fig. 6 Stream & Ditch Bank Stabilization

- **SOIL classification** (sand, silt, clay, peat)
- **SD** SOIL density in Tons/ft³
- **VOLV** volume voided (ft³)
- **YR** number of years
- **D = 0** distance to surface water assumed to be 0

- **SLB = SD*VOLV/YR**
  - Soil Loss Before (Tons/yr)
  - **SLR** Soil Loss Reduction (Tons/yr)

- **SEDR = SLB*SDR**
  - Sediment Reduction (Tons/yr)

- **PR = SEDR *(1.0 Lb/Ton)*CF**
  - P reduction (Lbs/yr)

**CF**
- P Correction Factor
  - clay 1.15
  - silt 1.00
  - sand 0.85
  - peat 1.50
4. Filter Strip Projects

The pollution reduction benefits (soil loss reduction, sediment reduction, phosphorus reduction) from filter strip projects are estimated by summing the benefits from:

1. Reductions from just the area of the filter strip, through the conversion of the filter strip area to permanent vegetative cover.
2. Reductions from the filter strip’s treatment of runoff from the upland drainage area contributing to the filter strip.

Features:

1. Use the SDR estimator algorithm (Fig. 2) and the filter strip width; and
2. Correction of errors in the sediment and phosphorus reduction calculations for upland runoff.

4.1 Area of Filter Strip Itself

Inputs

\[
\text{RUSLE2 before} \rightarrow \text{SL}_{\text{FSpa}} \quad \text{soil loss before (from filter strip area)} \quad \text{per acre (tons/acre/year)}
\]

\[
\text{RUSLE2 after} \rightarrow \text{SL}_{\text{FSpa}} \quad \text{soil loss after (from filter strip area)} \quad \text{per acre (tons/acre/year)}
\]

(Revised Universal Soil Loss Equation analyses usually done locally)

\[
A_{FS} = \text{area of filter strip (acres)}
\]

\[
W_{FS} = \text{width of filter strip (ft.)}
\]

SOIL (sand, silt, clay, peat)

**Soil Loss Reduction Estimate**

\[
\text{SL}_{\text{FSpa}} = \text{SL}_{\text{FSpa}} - \text{SL}_{\text{FSpa}} \quad \text{Soil Loss Reduction (from filter strip area itself) per acre (tons/acre/year)}
\]

\[
\text{SLR}_{FS} = \text{SLR}_{FSpa} * A_{FS} \quad \text{Soil Loss Reduction (from filter strip area itself) (tons/year)}
\]

**Sediment Reduction Estimate**

\[
\text{SEDB}_{FSpa} = \text{SL}_{\text{FSpa}} * \text{SDR}_{FS} \quad \text{Sediment before (from filter strip area itself) per acre (tons/acre/year)}
\]

\[
\text{SEDA}_{FSpa} = \text{SL}_{\text{FSpa}} * \text{SDR}_{FS} \quad \text{Sediment after (from filter strip area itself) per acre (tons/acre/year)}
\]

Where \( \text{SDR}_{FS} = \text{sediment delivery ratio for filter strip area. Calculated using the SDR estimator algorithm (Fig. 2) with an input distance of} \quad \frac{1}{2} \text{width of filter strip. This is a change from LARS.} \)

\[
\text{SEDR}_{FS} = (\text{SEDB}_{FSpa} - \text{SEDA}_{FSpa}) * A_{FS} \quad \text{Sediment Reduction (tons/year)}
\]

**Phosphorus Reduction Estimate**

\[
\text{PB}_{FSpa} = f(\text{SEDB}_{FSpa}, \text{SOIL}) \quad \text{phosphorus before (from filter strip area itself) per acre (pounds/acre/year)}
\]

\[
\text{PA}_{FSpa} = f(\text{SEDA}_{FSpa}, \text{SOIL}) \quad \text{phosphorus after (from filter strip area itself) per acre (pounds/acre/year)}
\]

Where \( f \) is the function estimating P content (pounds/acre/year) from sediment delivery (tons/acre/year) and soil type (Fig. 3).

\[
\text{PR}_{FS} = (\text{PB}_{FSpa} - \text{PA}_{FSpa}) * A_{FS} \quad \text{phosphorus reduction from filter strip area (pounds/year)}
\]
4.2 Filter Strip treatment of upland area

**Inputs**

CA = acres contributing to filter strip

RUSLE2 before \( \rightarrow \) SLB\text{UPpa} \text{ upland soil loss before per acre (tons/acre/year)}

SOIL (sand, silt, clay, peat)

**Sediment Reduction Estimate**

\( SLT_{UP} = SLB_{UPpa} \times CA \) \text{ upland soil loss treated (tons/year)}

\( SEDB_{UPpa} = SLB_{UPpa} \times SDR_{UP} \) \text{ upland sediment before per acre (tons/acre/year)}

Where \( SDR_{UP} \) is the sediment delivery ratio for filter strip area treatment of upland runoff. Calculated using the SDR estimator algorithm (Fig. 2) with an input distance of 1 width of filter strip. This is a change from LARS).

Is the filter strip functioning as designed?

If YES: \( FS_c = 0.35 \)

If NO: \( FS_c = 1 \)

Examples of a non-functioning filter strip include:

- **channelized** flow through the filter strip
- the contributing area (CA) too large for adequate treatment by the filter strip?

This filter strip factor (\( FS_c \)) is used in the estimate the removal of sediment by the filter strip. It represents the fraction of sediment passing through the filter strip. If the flow is channelized through the filter strip, or if the contributing area to the filter strip is too large or would generate flows too large to be treated effectively by the filter strip, the sediment reduction is 0 (\( FS_c = 1 \)).

An estimate of the relative gross effectiveness of filter strips for sediment reduction is 65% (Penn. State, 1992) if the filter strip is judged to be functioning properly\(^5\) (if neither condition is met) then we use the estimate of 65% removal of sediment by the filter strip (\( FS_c = 0.35 \)).

\( SEDA_{UPpa} = SEDB_{UPpa} \times FS_c \) \text{ upland sediment after per acre (tons/acre/year)}

\( SEDR_{UP} = (SEDB_{UPpa} - SEDA_{UPpa}) \times CA \) \text{ Sediment reduction from filter strip treatment of upland runoff (tons/year)}

**Phosphorus Reduction Estimate**

\( PB_{UPpa} = f (SEDB_{UPpa}, SOIL) \) \text{ upland phosphorus before per acre (pounds/acre/year)}

\( PA_{UPpa} = f (SEDA_{UPpa}, SOIL) \) \text{ upland phosphorus after per acre (pounds/acre/year)}

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\(^5\) The filter strip credit should be given to a site that provides the following:

1) A healthy stand of grasses predominated by varieties of stem grasses versus blade grasses.
2) The stand of grass should be wide enough to impede the flow it receives (estimated ranges depend on the grass and the energy of the run-off. Widths can be as low as 10 feet for switch grass up to more common values of 66 feet).
3) Delivery of the run-off must remain in a thin overland flow pattern and not be channelized.
4) The delivery of the run-off from the credited area cannot be bypassed around or through the filter strip by a ditch, tile intake, side inlet or channel.
Where $f$ is the function estimating P content (pounds/acre/year) from sediment delivery (tons/acre/year) and soil type (Fig. 2).

$$PR_{UP} = (PB_{UPpa} - PA_{UPpa}) \times CA$$

Phosphorus reduction from upland runoff treatment (pounds/year)

### 4.3 TOTAL Filter Strip benefits

The total benefits are the sum of the benefits from the conversion of the filter strip area to permanent vegetative cover and from the filter strip’s treatment of upland runoff:

**Sediment Reduction Estimate**

$$SEDR_{TOT} = SEDR_{FS} + SEDR_{UP}$$

**Phosphorus Reduction Estimate**

$$PR_{TOT} = PR_{FS} + PR_{UP}$$