

FIELD RUNOFF: TILL LANDSCAPE

Root River Field to Stream Partnership



Karst

Glacial Till

Buffland

South Branch
Headwaters

Crystal Creek

Bridge Creek

PROJECT GOAL

Determine the range of sediment and nutrient losses associated with runoff from representative farming systems and small watersheds in southeastern Minnesota.

STATUS

Surface and subsurface runoff was measured during a six-year baseline period (2012-2017) on a tile drained field in Mower County. Additional best management practices (BMPs) have been implemented and will be evaluated during a post-BMP period.

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Sediment and nutrients from agricultural fields in the glacial till landscape are lost from **surface** runoff and **subsurface** (tile) drainage. Loss from both pathways were measured during a six-year baseline period on a tile drained field, Field 1, located in eastern Mower County (Table 1).



Field 1 Surface Runoff in April 2015

Subsurface Drain Tile Loss



Table 1. Average runoff, sediment and nutrient loss during a six-year baseline period on a corn-soybean field in the till landscape (2012-2017).

	Total Loss	% Surface	% Subsurface
Precipitation (in.)		-----34.0-----	
Runoff (in.)	15.6	23%*	77%
Sediment (lb/ac)	744	99%	1%
Total Phosphorus (lb/ac)	1.3	92%	8%
Total Nitrogen (lb/ac)	44	15%	85%

* Average 57% occurred during frozen soil conditions

- Field 1 is managed for a corn-soybean rotation. Urea fertilizer is broadcast-incorporated in the spring before planting. Typical nitrogen rates during the baseline period were 170 lb N/ac and included credits from the variable rate MAP applied in the fall and pre-plant starter. Phosphorus fertilizer rates (P₂O₅) for the corn-soybean rotation averaged 102 lb/ac and Bray P-1 concentrations were 30 ppm. There are no open tile intakes on this field.
- During the baseline period there was a mix of both dry, normal and wet conditions. Average rainfall was 34 inches with a range of 23 inches (2012) to 43 inches (2016).
- On average, 15.6 inches of water either drained off the surface or through the subsurface tile. This equates to 44% of the annual precipitation. Over 75% of the total water volume was from subsurface tile drainage.
- Over 90% of the annual sediment and phosphorus loss was contained in surface runoff while less than 10% was lost through subsurface tile drainage.
- On average, 44 lb/ac of total nitrogen (TN) was lost annually with 15% derived from surface runoff and 85% from subsurface tile drainage. 98% of the subsurface tile TN was in the nitrate-N form.
- About half of the annual subsurface drainage volume and nitrate-N loss occurred from April through June (Figure 1). This is the period when water and nitrogen demand by corn is low, but precipitation is high.

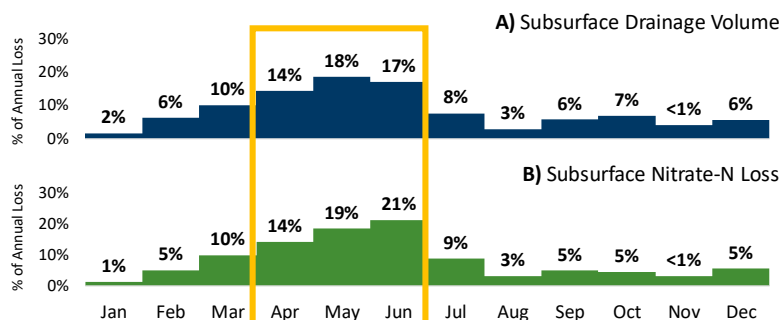


Figure 1. Timing of **A) subsurface drainage volume** and **B) nitrate-N loss** during the six-year baseline period (2012-2017).

Precipitation & Runoff

- **Precipitation** averaged 4% below normal with a mix of dry, near normal and wet conditions. The range was 34% below normal in 2012 to 22% above normal in 2016.
- **Runoff as a percent of annual precipitation** averaged 10% from surface (3.6 in.) runoff while 34% (12.1 in.) flowed through the subsurface tile drainage. *Range:* 6%-58%
- **Tile Flow** occurred an average of 222 days per year and has been trending upward since 2013. Remarkably, flow occurred all but one day in 2016. This was caused by above normal precipitation and a warm fall/winter. This water surplus carried over into 2017 resulting in elevated drainage even though precipitation was 13% below normal.

Sediment Loss

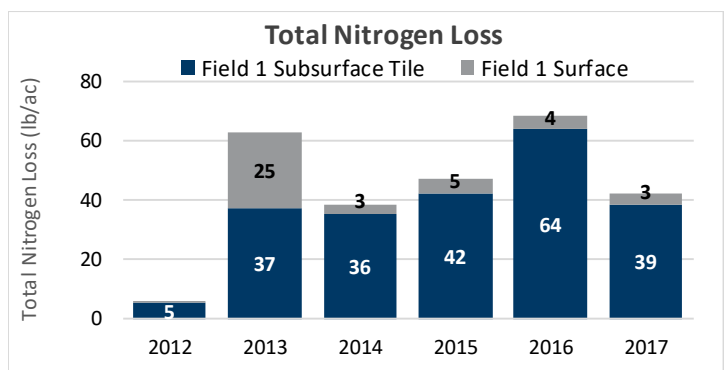
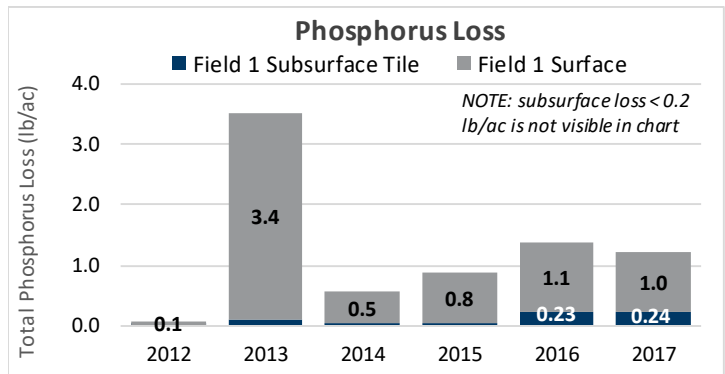
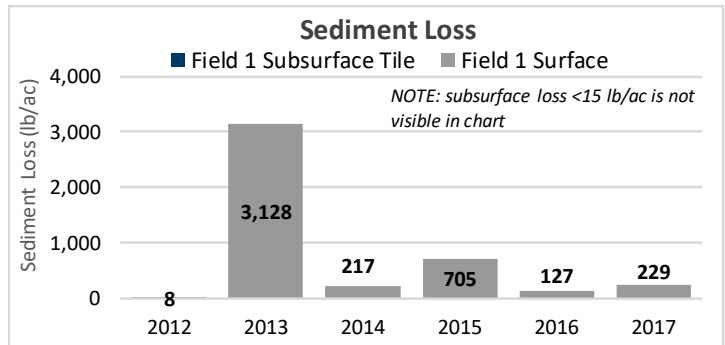
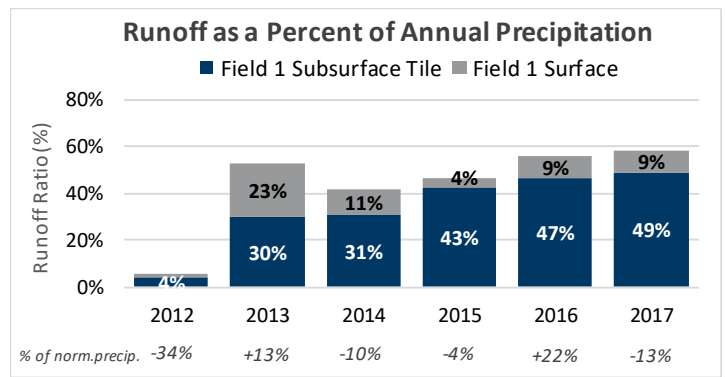
- **Average sediment loss** was 744 lb/ac. (0.37 tons/ac.) and ranged from 9 to 3,135 lb/ac. Surface runoff accounted for 99% of the total loss while subsurface was only 1%. The greatest surface loss occurred in 2013. In that year, 75% occurred during three very large runoff events in May.
- **Sustainable soil loss** is considered less than 1,000 lb/ac./year. If erosion is visible, losses likely exceed this.
- **May and June** accounted for 64% of the annual loss in surface runoff. During this critical time, fields were prepared for planting, but not at full canopy.

Phosphorus Loss

- **Average total phosphorus (TP)** loss averaged 1.3 lb/ac. and ranged from <0.1 to 3.5 lb/ac. Surface runoff accounted for 92% of the loss while subsurface was 8%. The highest TP loss occurred in 2013.
- **Dissolved P (DOP, not attached to sediment)** in surface runoff accounted for 95% of the loss while subsurface was only 5%. Most surface DOP, 64%, occurred during frozen soil runoff.
- **March through June** accounted for 73% of the TP loss in surface runoff. For every 1,000 lb/ac. of sediment loss, about 1.5 lb/ac. of TP was lost. A goal is to keep TP loss to less than 1.0 lb/ac/yr. Additional soil conservation can achieve this.

Nitrogen Loss

- **Average Total Nitrogen (TN)** loss was 44 lb/ac and ranged from 5 to 68 lb/ac. Surface runoff accounted for 15% of the annual TN loss while 85% was from subsurface tile drainage.
- **TN in surface runoff** averaged 7 lb/ac with 64% in the organic fraction. When substantial soil loss occurred, TN in surface runoff exceeded 25 lb/ac (year 2013). Like TP, most TN in surface runoff can be controlled through soil conservation.
- **Subsurface TN loss** averaged 37 lb/ac with a range of 5 to 64 lb/ac. Over 50% of the annual loss occurred from **April through June**. Almost all subsurface TN loss, 98%, was nitrate-N. The highest subsurface TN loss occurred in 2016 (64 lb/ac) due to the greatest number of days with tile flow.
- **30% Reduction?** Fine-tuning nitrogen rate and timing practices could potentially reduce subsurface TN loss by 20% and improve profitability an average of **\$17/ac***. With additional soil conservation practices, TN reductions from both surface and subsurface pathways could total 30%.



BMP Evaluations: To reduce surface runoff, an edge-of-field prairie strip was installed in 2018. To reduce subsurface nitrogen loss, nitrogen rates were reduced from 170 lb/ac to a more profitable* 130 lb/ac rate. The reduced nitrogen rate is split applied with 60% applied at pre-plant and 40% in early June. Monitoring for the next several years will evaluate economic and environmental performance of these practices.

*Based on actual economics, yield and nitrogen rate/timing research conducted on this farm from 2016-2019.

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