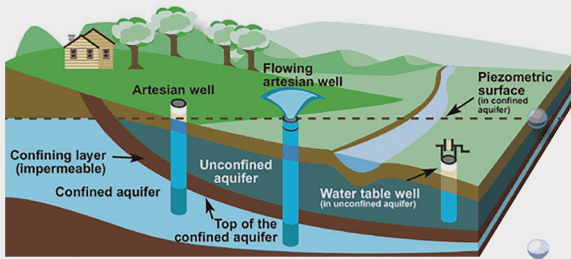


## What is a Seasonal High Water Table (SHWT)?

A SHWT is created when there is a fragipan or other aquitard in the soil preventing rainwater from further infiltrating through the soil profile. With continued precipitation a SHWT will rise closer to the surface. In Pennsylvania, SHWT's are most common from fall through spring. Unless there is a break in the fragipan, SHWTs drain downslope, and eventually outlet to a downslope stream. Bucks CCD evaluated if SHWTs serve as a transport channel for manure nutrients to surface waters.



Source: Environment Canada

## Manure Stacking & SHWTs

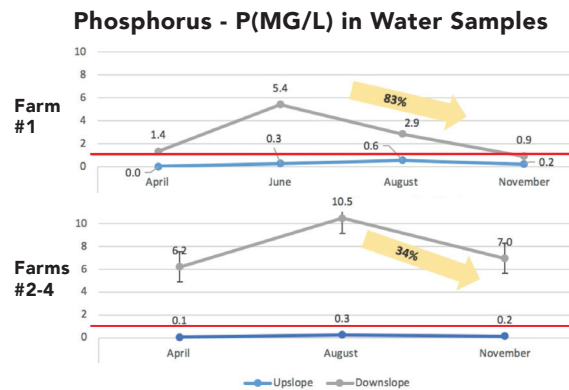
In 2018, Bucks CCD installed ground water monitoring wells on four equine farms. Each farm had three sample sites: Upslope of the manure pile, at the manure pile, and 50 FT downslope of the manure pile. Water samples were pulled from the ground water wells (see Experimental Layout). Soil samples were pulled by soil horizon. Water and soil sampling events were conducted in the spring, the summer and the fall.

## SHWT's Quick Response to Improved Manure Storage



**ABOVE:** April 2018 - Farm #1's manure stacking and water samples. August 2018 - Farm #1's water samples after manure storage installation.

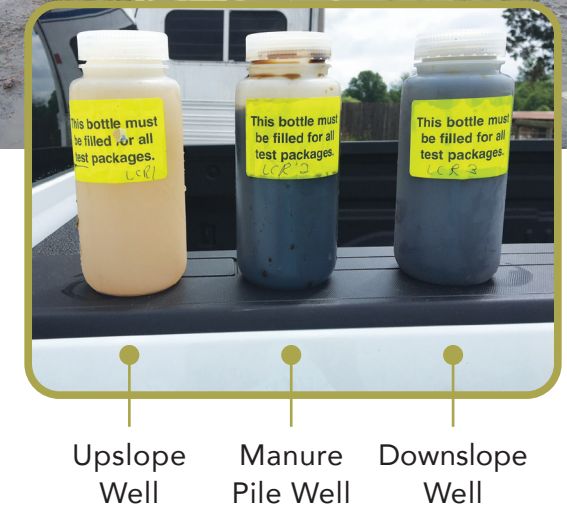
**BELOW:** Phosphorus (P) contents of the upslope and downslope wells by month. For Farm #1, P in the downslope well was below the manure contamination level by November 2018, five months after manure storage installation. Farms #2-4 did not make any changes to their manure stacking areas, and P levels remained well above the threshold.



The quick improvement in water quality post manure storage construction indicates how rapidly nutrients move downslope through the SHWT. This flushing effect is a positive for realizing swift responses to manure stacking improvements. However it also reflects a negative for manure piles on earthen surfaces in the presence of SHWTs, where additional manure nutrients move towards the downslope stream with every rain.



## Effects of Manure Stacking on Soils with a Seasonal High Water Table



# Experiment Layout

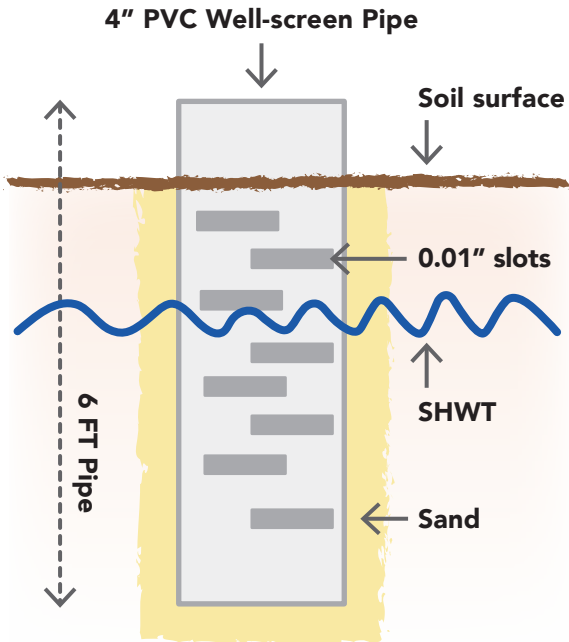
Monitoring wells installed at each farm:



**1**  
Upslope  
Min. 50 FT

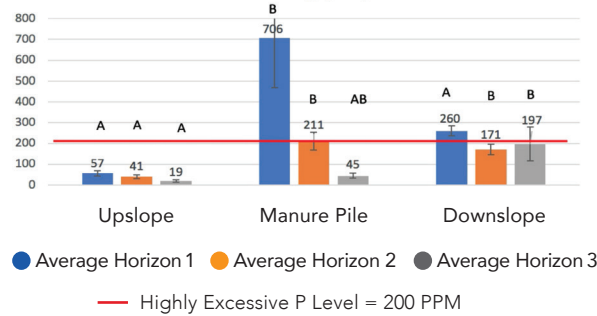
**2**  
At Manure  
Pile

**3**  
Downslope  
Min. 50 FT



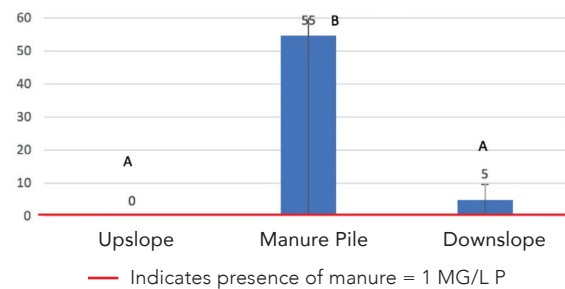
# Phosphorus

**Annual Average - All Farms**  
**SOIL P (PPM) by Horizon and Sample Location**



For each sample location, soil samples were taken by soil horizon. **HORIZON 1** is the surface horizon, **HORIZON 2** the middle horizon, and **HORIZON 3** is the lowest horizon, just above the fragipan. At the downslope location, phosphorus in the deeper soil horizons was significantly higher than the same soil horizons upslope of the manure pile.

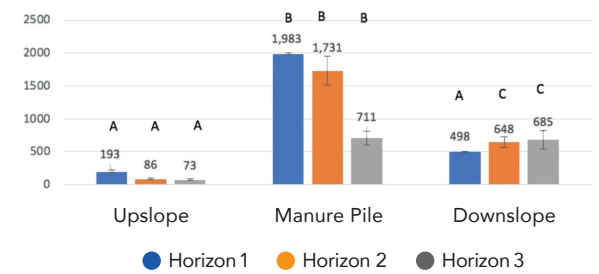
**Annual Average - All Farms**  
**WATER P (MG/L) by Pipe Location**



Total dissolved phosphorus (TDP) was, on average, five times higher in the downslope well compared to the upslope well. Due to data variability, only the TDP levels at the manure pile were determined to be significantly higher.

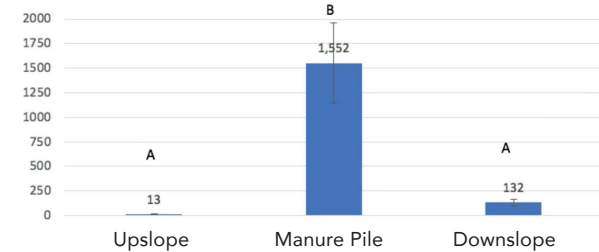
# Potassium

**Annual Average - All Farms**  
**SOIL K (PPM) by Horizon and Sample Location**



Potassium (K) is not a known water quality concern. However, manure is very high in K and K is very stable in the soil, making it a good marker for manure contamination. At the downslope location, potassium in the deeper soil horizons was significantly higher than the same soil horizons upslope of the manure pile.

**Annual Average - All Farms**  
**WATER K (PPM) by Pipe Location**



Potassium in the water samples was, on average, 10 times higher in the downslope well compared to the upslope well. Due to data variability, only potassium levels at the manure pile well were determined to be significantly higher.