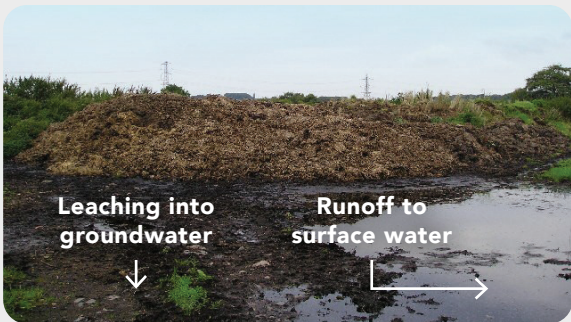


What is the concern with year round manure stacking on an unimproved surface?

Manure is high in nitrogen, phosphorus (P) and potassium. In regard to water quality, P is the primary nutrient of concern. P in streams and lakes leads to algal blooms, which can lower oxygen levels in the water and cause fish kills.



The photo below shows the two potential pathways for nutrient pollution from manure stacking. Rain hitting the manure pile causes both the leaching and the surface runoff.



The second pathway – leaching into groundwater – is a human health concern, especially if wells are within 100 FT. Nitrates in manure do not adsorb to the soil, easily moving down towards groundwater. High nitrate levels in drinking water are hazardous to vulnerable populations, particularly pregnant women and young children.

However, what happens if the soil has a seasonal high water table?

Manure Stacking: What are the regulations in Pennsylvania?

The regulations below are from PA's Chpt 91 Manure Management Manual. Manure stacking regulations differ depending on the type of manure stacking:

Farmstead manure stacking



Manure stacking in the farmstead area must use an improved stacking pad (see above photo) or covered area, such as a roof or tarp.

In-field manure stacking



Below are the regulations for temporary stacking of manure in a crop field. In-field stacking is not year round manure storage:

- Keep stacks 100 ft away from sensitive areas: streams, waterbodies, sinkholes and wells.
- No longer than 120 days, if longer - needs to be covered
- Field must have less than 8% slope
- Rotate location in the crop field year after year



Manure Stacking in the Farmstead: Protecting Groundwater & Surface Water



Upslope Well

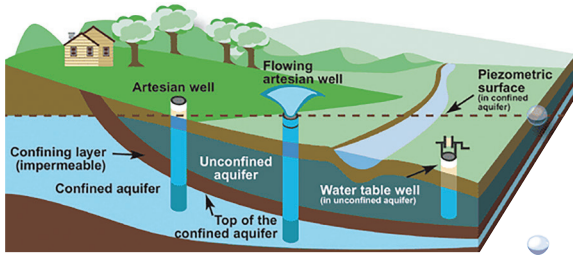
Manure Pile Well

Downslope Well



What is a Seasonal High Water Table (SHWT)?

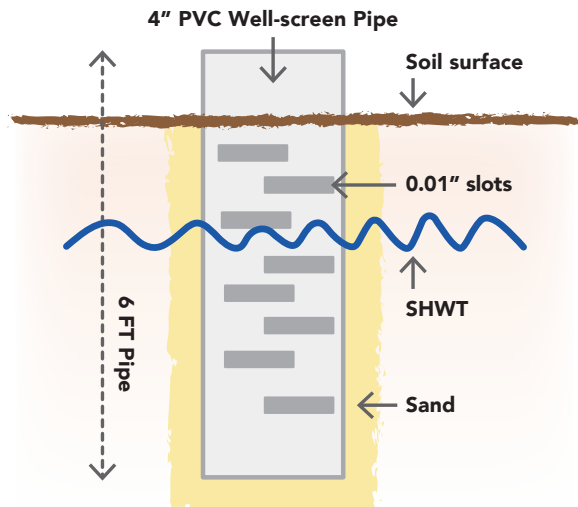
A SHWT is created when there is an impervious layer in the soil, preventing rainwater from infiltrating through the soil profile. With continued precipitation, a SHWT will rise closer to the surface. In Pennsylvania, SHWTs are present from the fall through the spring. Unless there is a break in the impervious layer, SHWTs drain downslope, and eventually outlet in a downslope stream.



Source: Environment Canada

The Bucks County Conservation District (BCCD) evaluated if SHWTs serve as a transport channel for manure nutrients to surface waters. Thanks to four participating equine farms in the county, water and soil samples were collected in the spring, summer, and fall over a 12-month period.

Groundwater monitoring well schematic:



Experiment Layout

Monitoring wells installed at each farm:



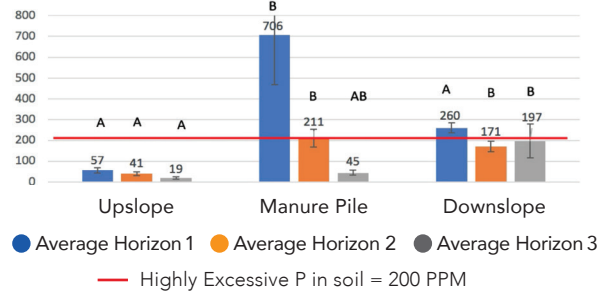
Upslope
Min. 50 FT

At Manure Pile

Downslope
Min. 50 FT

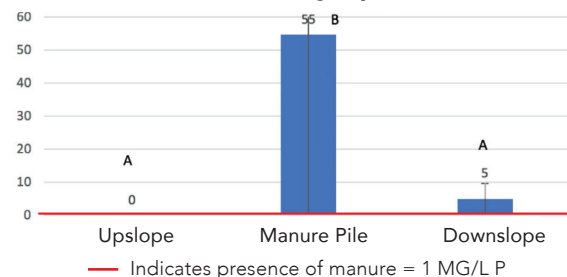
For each well location, soil samples were taken by horizon. **HORIZON 1** is the surface horizon, **HORIZON 2** the middle horizon, and **HORIZON 3** is the horizon just above the hardpan. Soil phosphorus in Horizon 3 of the downslope location was 10x higher than the same horizon at the upslope site.

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



Phosphorus in the water samples was five times higher in the downslope well compared to the upslope well.

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



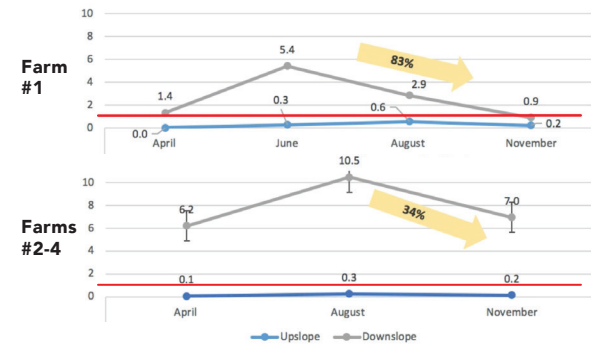
SHWT's Quick Response to Improved Manure Storage



↑ Upslope Well ↑ Manure Pile Well ↑ Downslope Well ↑ Upslope Well ↑ Downslope Well

Farm #1's manure pile and respective water samples from April 2018. A roofed manure storage was installed in June 2018; pictured water samples are from August 2018.

Phosphorus - P(MG/L) in Water Samples



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 1 mg/L 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 or waterbody with each rain event.