



# NUTRIENT MANAGER

Newsletter of the Maryland Cooperative Extension Agricultural Nutrient Management Program

## Focus On

## Nutrients and the Hydrologic Cycle

**W**ater, a substance essential to all living things, is also a transporter of nutrients. Water interacts with soil as it flows over and through it. If nutrients in soils are soluble or suspended in water, these nutrients can move with the water. Understanding how water behaves is helpful in devising ways to reduce the potential for nutrient loss from cropland and pastures to ground water and surface water.

### What is the hydrologic cycle?



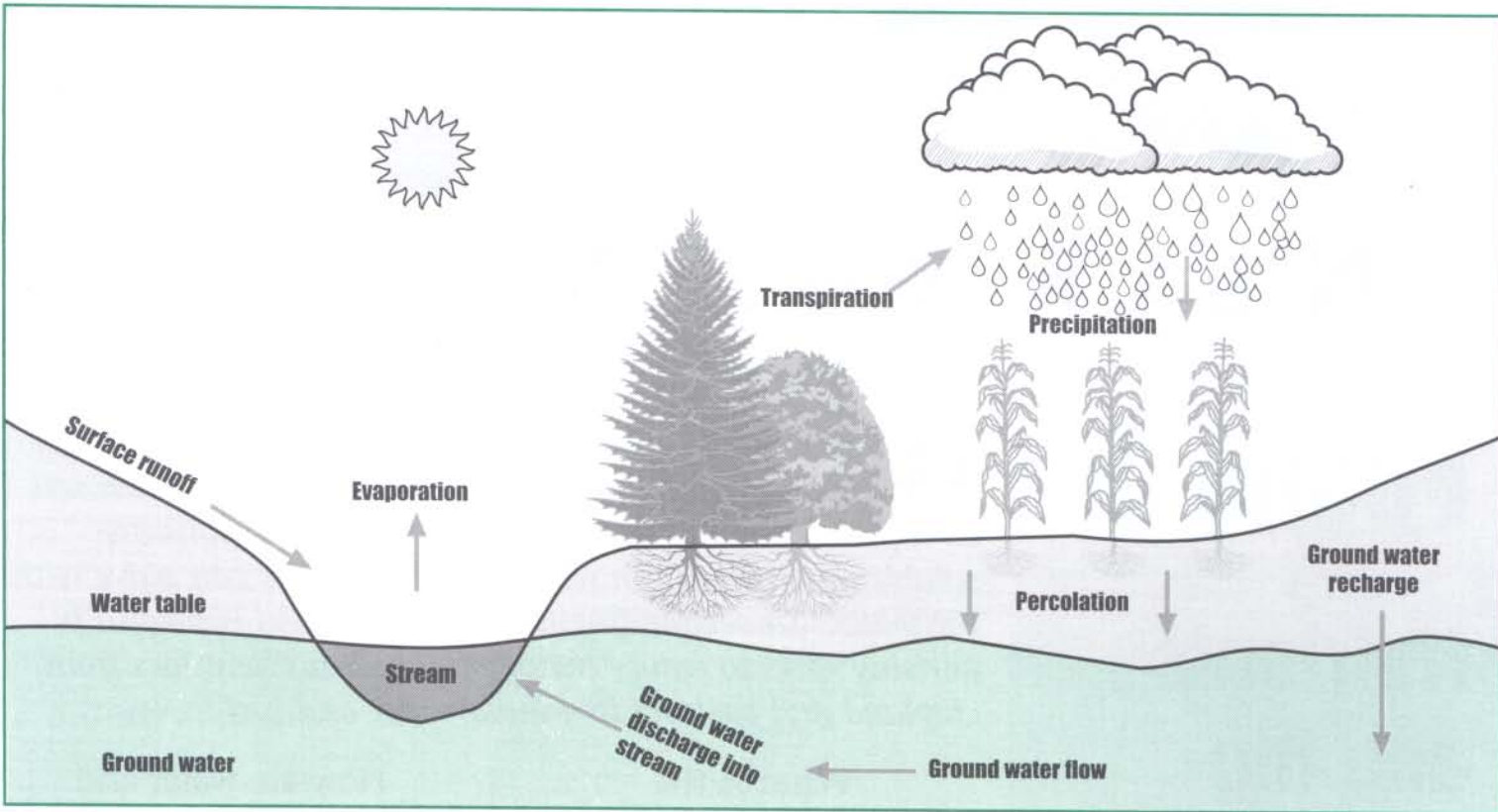
The hydrologic cycle describes a series of transformations of water as it circulates from the atmosphere to the earth and back again. Although some parts of the cycle, like precipitation and runoff, are very familiar to us because we observe them frequently, other parts of the cycle, like ground water recharge and evaporation, are not as obvious.

The hydrologic cycle can be represented graphically to show the many changes water goes through as it circulates. (See Figure 1.) When it rains, water can either enter the soil (infiltration) or flow over the soil surface (surface runoff). Water that enters the soil can be used by plants (transpiration), remain in the soil (storage), evaporate from the soil (evaporation), or flow through the soil (percolation) and replenish the ground water (ground water recharge). Ground water flows to a point of discharge, such as a stream, river, or lake (ground water discharge).

### How are water and nutrients lost from the soil?

Surface runoff, the water that flows over the soil surface if rainfall exceeds the soil's infiltration and surface storage capacity, can carry soil particles (minerals, organic matter, and attached nutrients), and dissolved nutrients with it. Fertile cropland contains enough phosphorus to sustain crop growth for many years. Some of that same phosphorus can be carried away during heavy rains, dissolved in surface runoff, or attached to soil particles. Surface runoff is the major pathway through which phosphorus is lost from the soil to surface water, such as streams and rivers. (See Figure 2.)

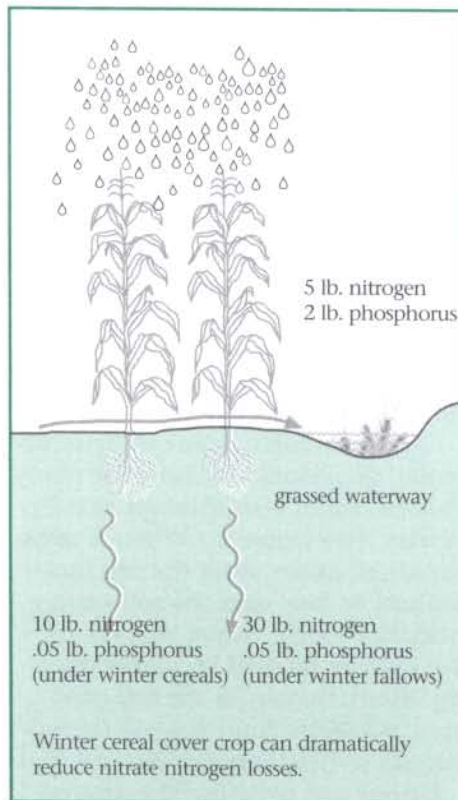
Percolation, the downward movement of water in soil, may lead to the loss of soluble nutrients from the soil to the ground water below. This process is also called "leaching." Percolation or leaching is the major pathway through which nitrate nitrogen is lost from the soil. Crops are not efficient at removing fertilizer and manure nitrogen from the soil during a growing season. Research done by agronomists from Pennsylvania State University found that under the best of circumstances—using commercial nitrogen sources at economically optimal rates—the aver-



**Figure 1.** The hydrologic cycle.

age recovery of nitrogen fertilizer by corn was only 35 percent. The unused or "residual" nitrogen is vulnerable to leaching before the next cropping year, particularly during fall and winter if precipitation occurs when no actively growing crop is on the field.

The presence of nutrients in surface water and ground water can limit the usefulness of these resources. Elevated nitrate nitrogen present in ground water used to supply drinking water to humans and animals can cause health problems. Nitrate can originate directly from fertilizers (like UAN) or from the nitrification of ammonium in fertilizers, manures, sewage sludge, or organic matter decomposition. Phosphate reaching streams, lakes and the Chesapeake Bay can lead to eutrophication, a process by which a nutrient-enriched body of water becomes oxygen deficient from excessive algal growth. Elevated levels of phosphorus in water can be due to the use of commercial fertilizers, manures and sewage sludge in crop production.



**Figure 2.** Typical nitrogen and phosphorus losses via surface runoff and leaching.

## What is ground water, where does it come from, and where does it go?

- **Ground water** is the water that fills the pores in sands or gravel or the cracks in fractured rocks.
- **Ground water** is recharged by water that percolates through the soil profile (deep percolation) and water that soaks in from streams whenever the level of water in streams is higher than the ground water. (See Figure 3.) Nutrients can reach ground water if they are leached out of the soil or if they are present in streams.
- **Ground water** can flow into streams when the water level is higher than the level of water in the stream, carrying any nutrients present along with it.
- **Ground water** is not stationary. It may move 1 foot a day in the fractured rock of the Piedmont region of Maryland, 1,000 feet a day in a karst (limestone) area in Frederick County or several feet a day on the Eastern Shore. It moves "downslope" until it is discharged into surface water, such as streams or rivers.

As ground water moves, dissolved pollutants will move with it, often great distances from where they were introduced. On the Eastern Shore, for example, ground water may travel for several miles before discharging. The presence of nutrients at a particular location in the ground water or in a stream or river does not necessarily indicate that the source of the nutrients is nearby.

The travel time (the time for ground water to move from beneath a field to the stream or river where it is discharged) varies tremendously from location to location, from as little as several weeks to many years. Regardless of where one lives in Maryland, ground water, and any nutrients that may be dissolved in it, will eventually enter a stream, a river, or the Chesapeake Bay.

## When are water and nutrients lost from the soil?

In Maryland, precipitation is evenly distributed throughout the year, with approximately 3 to 4 inches every month. The fate of that rainfall differs throughout the year. In the summer, much of the water is evaporated from the soil and transpired by plants, and the soil's storage of water is depleted. In the fall when both transpiration and evaporation decrease, the amount of water in the soil increases. In winter and early spring, the soil surface may be unprotected and the soil's water storage capacity is filled. Additional rainfall during these seasons can lead to surface runoff and leaching.

## BMPs to Reduce Nutrient Loss to Ground Water and Surface Water

Farmers cannot control many aspects of their production system—the soil properties, the geology of the earth below their fields, temperature, and rainfall. They do exercise control over their management practices. Implementation of best management practices (BMPs) can help to reduce potential nutrient pollution of both ground and surface water.

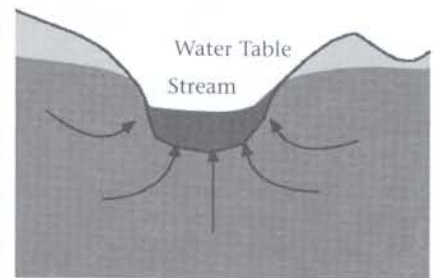
## BMPs to Reduce Nitrate Leaching

- Apply only the recommended rates of nitrogen fertilizer, manure, and sewage sludge.
- Take nitrogen credits for legumes in rotation and past applications of manure and sewage sludge.
- Time application of nitrogen fertilizer to coincide with crop use.
- Split-apply nitrogen fertilizer whenever possible.
- Set realistic yield goals.
- Calibrate nutrient application equipment.
- Plant a cover crop to utilize the residual nitrate left in the soil at the end of the growing season.

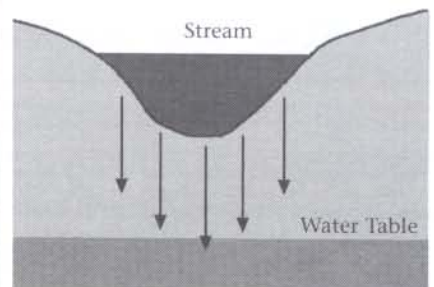
## BMPs to Reduce Phosphorus and Nitrogen in Surface Runoff

- Monitor soil phosphorus reserves with soil tests and avoid raising soil test levels above "high."
- Apply appropriate soil erosion control methods.
- Utilize phosphorus-rich organic nutrient sources, like animal manure and sewage sludge, on soils whose soil test levels for phosphorus are low or medium.

Much of the year, ground water contributes much of the surface water flow in streams.



Ground water becomes surface water



Surface water becomes ground water

When the water table is below a stream, however, surface water can flow into ground water.

**Figure 3.** The connection between surface water and ground water.

## Top 10 Facts to Remember About Nutrients and the Hydrologic Cycle

1. When water moves, it can take nutrients with it.
2. The two pathways through which water and nutrients are lost from the soil are percolation (leaching) and surface runoff.
3. Plant-available nutrients remain in the soil at the end of the growing season. Water percolating through the soil during the winter and early spring can carry soluble nutrients, such as nitrate nitrogen, out of the root zone and into the ground water.
4. Elevated levels of nitrate nitrogen in drinking water pose a health hazard to humans and domestic animals.
5. Phosphorus from fertile cultivated fields can be lost in runoff during heavy rains throughout the year.
6. Nitrogen and phosphorus in streams and rivers can cause eutrophication.
7. Ground water and surface water are interconnected. Soluble nutrients in one can be transported to the other.
8. Nutrients can be observed in ground water and surface water at considerable distances from where they entered the soil or water.
9. Changes in nutrient use practices may not be reflected in improved ground water and surface water quality for many years.
10. It is easier and less expensive to prevent pollution of ground water and surface water than to treat these waters to remove pollutants.

## The Following Fact Sheets are Available From Your County Extension Office:

- WR 9 Maryland's Ground Water Resource**
- WR 14 What You Should Know About Water Wells**
- WR 20 Protecting Your Water Supply**
- WR 22 Ground Water Protection: An Introduction**
- WR 23 Testing Drinking Water in Maryland**
- WQ 4 Home Water Testing**

For nutrient management planning services, call your Cooperative Extension educator at the county Extension office.

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, University of Maryland, College Park, and local governments. Thomas A. Fretz, Director of Maryland Cooperative Extension, University of Maryland.

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**ALLEGANY COUNTY**  
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**HOME AND GARDEN  
INFORMATION CENTER**  
12005 Homewood Road  
Ellicott City, MD 21042  
1-800-342-2507

*Nutrient Manager* is published by Maryland Cooperative Extension, University of Maryland, College Park and University of Maryland Eastern Shore. This issue was co-authored by former Communications Coordinator David Marsland and is in its second printing. The masthead sailing photo is courtesy of Skip Brown.

Patricia Steinhilber  
*Nutrient Management Program Coordinator*

Jennifer Salak  
*Communications Coordinator*

Address comments about this newsletter to  
Nutrient Manager, NRSL  
ANMP, Plant Sciences Building  
College Park, MD 20742-4452.

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September, 2002

