PennState Extension

Watershed-Friendly Lawn Fertilization and Care

A GUIDE FOR PENNSYLVANIA RESIDENTS

Introduction

Lawns are everywhere! Like patchwork quilts, they blanket the neighborhoods where we live, parks where we play, and the places where we work. According to the Penn State Center for Turfgrass Science, around 2 million acres in Pennsylvania are covered by turfgrass, of which 70% are residential lawns.[1] If home lawns were considered a crop, they would occupy more land than any other plant that is grown in Pennsylvania, including corn and soybeans (Figure 1).

Because lawns cover such a vast area, they have an enormous impact on the environment, including our surface and groundwater resources. While poorly managed lawns can degrade the environmental quality of local streams, rivers, and lakes, well-managed lawns can protect these same resources. If you care for a lawn, or hire someone to do it on your behalf, you may not realize it, but you are a water resource manager!

This guide was developed to help people manage lawns by using practices designed to protect Pennsylvania's water resources. We call this lawn management approach "watershed-friendly lawn care."

The guide divides watershed-friendly lawn care into five sections: connecting your lawn to the watershed, how lawn fertilizer affects water quality, watershed-friendly fertilization practices, sustainable turf care practices, and enhancing your landscape with additional best management practices. Adopting any of the tips and techniques presented in this guide can transform a landscape that is causing water quality concerns into one that provides water quality solutions.

You can access an online version of this book and links to more information about lawn and home practices that protect Pennsylvania's watersheds by visiting Penn State Extension's Watershed-Friendly Lawn Care website at *extension.psu.edu/campaigns/watershed-friendly-lawns*.

1 Source: Penn State College of Agriculture, Department of Plant Science, Home Lawns (plantscience.psu.edu/research/centers/turf/extension/home-lawns).

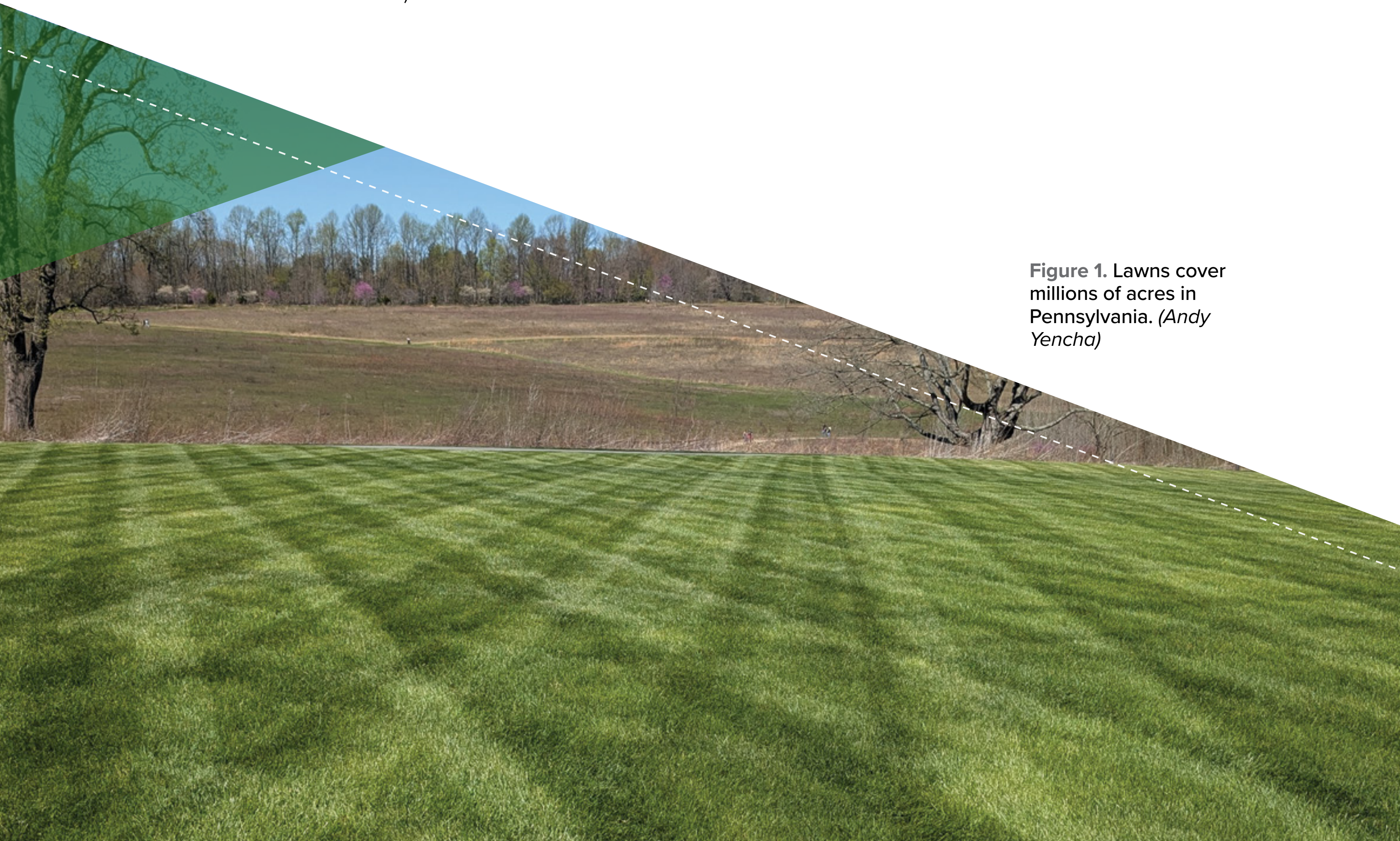
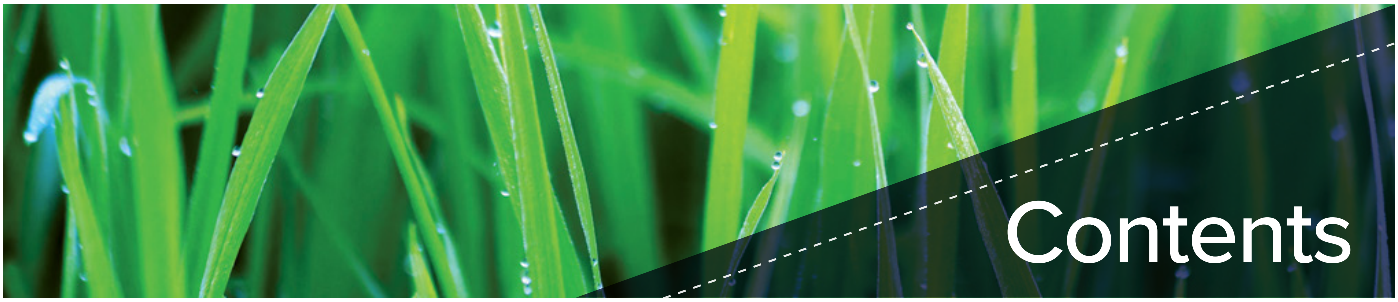


Figure 1. Lawns cover millions of acres in Pennsylvania. *(Andy Yencha)*



Contents

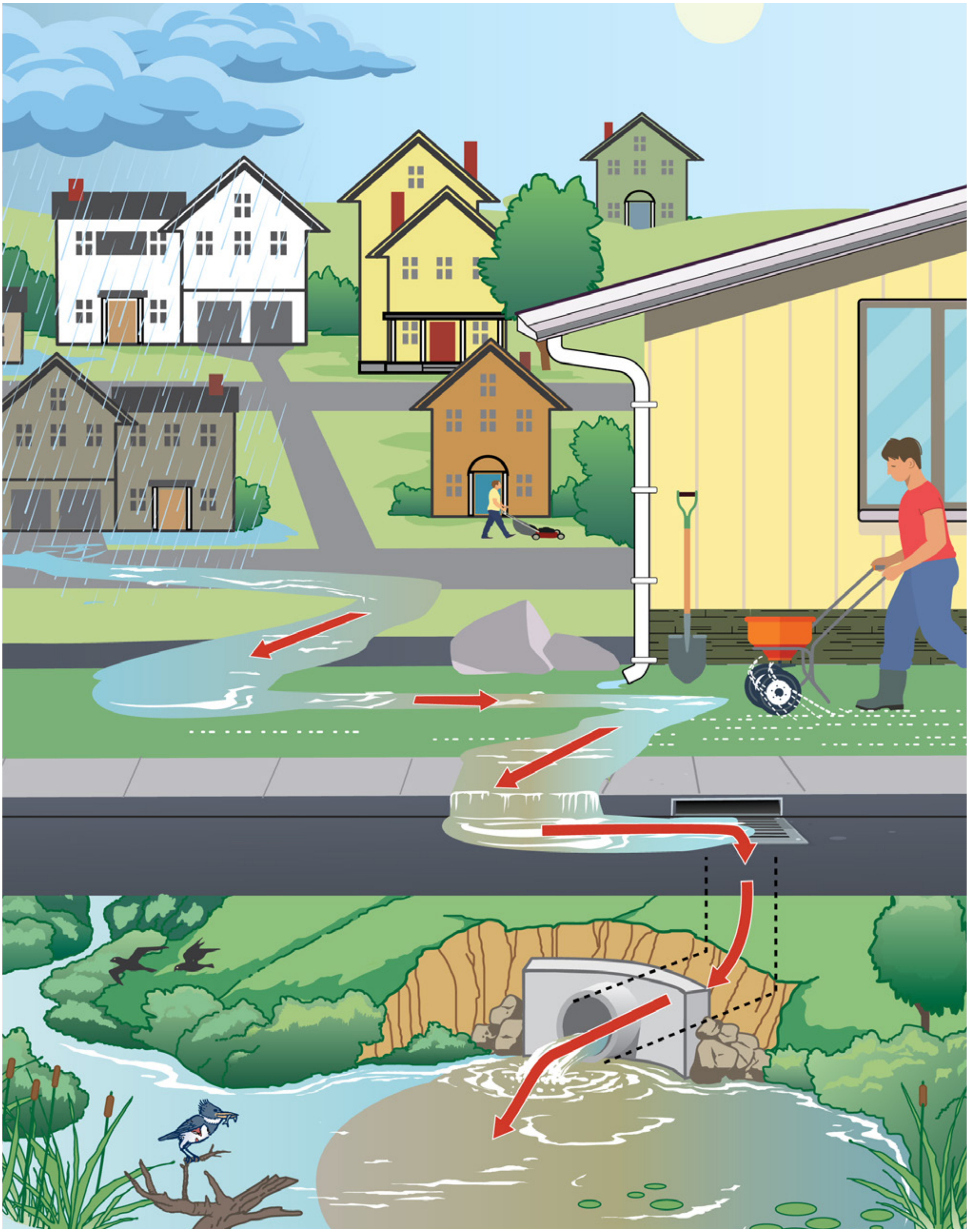


Figure 2. Rain falling on roofs, driveways, and other hard surfaces creates stormwater runoff that flows across lawns into storm sewers or roadside ditches that drain into local streams. *(Maxfield Design)*

Chapter 1:

Connecting Your Lawn to the Watershed

All lawns lie in watersheds

What Is a Watershed?

Every lawn lies in a land area that drains **stormwater**[2] into a stream, river, lake, or bay. This land area is called a **watershed**. When lawns develop bare spots, are overfertilized, suffer from soil compaction, or produce **runoff** after it rains, they are more likely to release **stormwater pollution** into local waterways (Figure 3a). On the other hand, when lawns are managed in ways that increase turf density, optimize **fertilizer** application, and limit runoff, they can reduce stormwater flows and improve water quality in nearby **waterbodies** and even **groundwater**. To understand the connection between lawns and water quality, it helps to know a little about stormwater.

How Stormwater Moves Through the Landscape

Stormwater starts as precipitation from either rain, melted snow, or ice. Stormwater that reaches the ground can either soak into the soil, called **infiltration**, or flow across the land, called stormwater **runoff**.

As Figure 2 shows, unchecked runoff from lawns and **impervious surfaces** that drain into waterways can cause **water pollution**, **stream bank erosion**, and flooding in communities across Pennsylvania. These problems can happen any place where lawns are located. But the potential is greatest in cities and suburbs where lawns and impervious surfaces are more common and **storm sewer systems** are nearby.

Storm sewer systems include grated inlets, underground pipes, ditches, and other structures (Figures 3b, 3c, and 3d). These systems are designed to prevent local flooding but do little to remove stormwater pollutants that wash off urban landscapes. These pollutants include **sediment**, and two major plant **nutrients**—**nitrogen and phosphorus**—found in fertilizer and **eroding** soil.

Figure 3a. Poor quality lawns produce runoff and stormwater pollution. *(Ruth Benner)*

Acre for acre, urbanized places can produce more stormwater than rural areas. This is because they have more impervious surfaces and drain into storm sewer systems that efficiently capture and transport runoff into nearby waterways.

Examples of impervious surfaces around our homes include roofs, sidewalks, driveways and, as we will explain in the section on turf care, lawns with **soil compaction**.

2 See Glossary for definitions of bolded terms.

Figure 3b. Runoff that flows into storm sewer inlets eventually drains into local waterways. *(Andy Yencha)*

Figure 3c. Not all lawns drain into storm sewer inlets. Many drain into grass swales or roadside ditches that also drain into local waterways. *(Andy Yencha)*

Figure 3d. Untreated stormwater flows into a local stream. *(Jenn Fetter)*

How Lawn Fertilizer Affects Runoff and Water Quality

The fertilizers that we add to our lawns and gardens to improve plant growth are made up of three **macronutrients**, nitrogen, phosphorus, and **potassium**, often written as **N-P-K**. These elements exist naturally in lawn soil and plants need them to grow. When soil nutrient levels are low, fertilizers may be beneficial. But if nitrogen and phosphorus levels are already sufficient, the additional nutrients in fertilizer may become water pollutants. Fertilizer should be thought of as a nutrient supplement that is only beneficial when existing nutrient levels are insufficient to meet plant needs. Proper fertilization starts by understanding how nutrients cycle in the environment.

THE NUTRIENT CYCLE

The macronutrients N-P-K constantly cycle through the air, water, soil, and living things on Earth, including our lawns. N-P-K are present in both organic and inorganic forms. Organic forms come from once-living things and contain carbon as part of their molecular structure. Inorganic forms come from non-living sources, such as rocks and minerals, and do not contain carbon. Inorganic nutrients in lawn soil can be taken up by plants for growth. Figure 4 shows how, as nutrients cycle, they change form and move. This means the N-P-K in the fertilizer we apply to our lawns and gardens will not always be quickly available for the plants to use. Next is a closer look at the nutrient cycle for nitrogen, phosphorus, and potassium, to better understand the science behind lawn and garden nutrient recommendations.[3]

NITROGEN (N)

Did you know that 78% of the air we breathe is made up of nitrogen gas and about 2,800 pounds (about 1,270 kg) is in each acre of soil?[4] Nitrogen is common in air and soil, but it is not always available in forms plants can use. Nitrogen gas in the air requires soil bacteria to convert it into a molecule that plants can use. Most nitrogen in the soil is in an organic form that cannot be used by plants until it is decomposed into ammonia and converted to ammonium or nitrate. Excess nitrate that is not used by plants may return to the atmosphere through a process called **denitrification** or become a water pollutant by washing away in runoff or **leaching** into groundwater. Since the nitrogen cycle is driven by bacteria, it is highly dependent on temperature and moisture conditions that favor their growth. Warm and wet conditions tend to speed up nitrogen transformations. This could mean that more nitrogen will be available to plants but also that

3 For more about nutrient cycles, see Managing Soil Health: Concepts and Practices (extension.psu.edu/managing-soil-health-concepts-and-practices).
4 Source: Penn State Extension, Nitrogen Fertilization of Corn (extension.psu.edu/nitrogen-fertilization-of-corn).

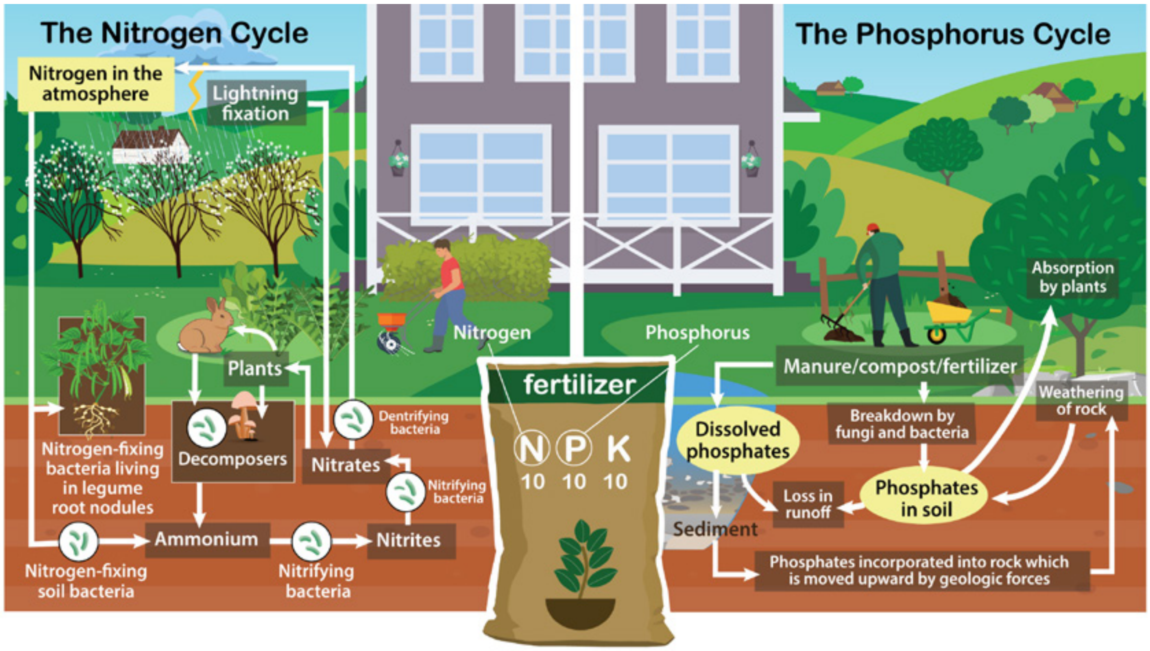


Figure 4. It helps to know how nitrogen and phosphorus nutrient cycles work to avoid overapplying fertilizer or applying it at the wrong time. *(Maxfield Design)*

nitrogen will become depleted more quickly, which may impact future plant growth. A watershed-friendly action to prevent nitrogen pollution is to time fertilizer applications as closely as possible to the time when plants will use the nutrient to grow instead of being lost through runoff or leaching.[5] See Figure 14 on page 12, as it highlights the recommended times to apply lawn fertilizer in Pennsylvania.

PHOSPHORUS (P)

Unlike nitrogen, phosphorus does not exist in the atmosphere, so the phosphorus cycle only involves the movement of phosphorus from the soil to living things like turfgrass and, potentially, into stormwater. Phosphorus in soil naturally comes from the weathering of rock and decomposition of organic materials. Most soil phosphorus is stable, meaning it is unavailable to plants. Only a small proportion is in a form plants can use, but—good news—it is usually enough to satisfy the needs of established turfgrass, so it is often not necessary to supplement phosphorus in residential lawns.

When phosphorus-containing fertilizer is applied, much of it quickly binds to soil particles, where soil microbes slowly release it in forms plants can use. This is a slow process, but it is adequate to sustain plant growth in many natural settings. Phosphorus does not easily leach into groundwater but can pollute surface waters when excess fertilizer is washed away by stormwater runoff or when soil that is rich with phosphorus erodes. The addition of phosphorus to lakes, streams, and rivers can cause aquatic plants and algae to grow dramatically, which leads to oxygen depletion, biodiversity loss,[6] and harm to fish and wildlife.

POTASSIUM (K)

Plants need potassium to regulate water internally and for gas exchange. It is released naturally from rocks and is usually present in large quantities in soil. Warm, wet conditions typically increase the plant availability of potassium.

Potassium dissolves in water, so leaching and runoff are pathways for it to reach waterways. But, since potassium is not a **limiting nutrient** in lakes and streams, it does not pose a water quality concern.

How Turfgrass and Other Landscape Plants Use Nitrogen and Phosphorus

Plants require nitrogen and phosphorus for different biological processes. Nitrogen is the growth nutrient. Once inside the plant, it is converted into amino acids, which are used to create proteins. Nitrogen is also part of chlorophyll molecules and helps plants create and use carbohydrates during photosynthesis. Consequently, nitrogen is the nutrient most responsible for green, leafy plant growth.

Phosphorus plays key roles in plant development. It supports energy transfer, such as moving carbohydrates to flowers or fruit and storing carbohydrates in roots or bulbs. Phosphorus is also essential for DNA replication and for root and seed production, thus an important part of plant establishment. For this reason, phosphorus is the primary component of **starter fertilizer,** which is designed for use when seeding a new lawn.

5 For more about the nitrogen cycle, see Nutrient Management to Improve Nitrogen Efficiency (extension.psu.edu/nutrient-management-to-improve-nitrogen-efficiency-and-reduce-environmental-loss).

6 Read more about phosphorus in the article Managing Phosphorus for Crop Production (extension.psu.edu/managing-phosphorus-for-crop-production).

Chapter 2:
Fertilizing for Clean Water

Fertilize properly following the 4R method

At its core, watershed-friendly fertilization is about providing plants with the nutrients they need, without applying too much. A common guide to nutrient stewardship is to follow the 4Rs—right source, right rate, right time, and right place. The 4R method provides your plants with the nutrients they need for proper growth while avoiding over application that may cause water pollution. We will look at each of the 4Rs closely next.

Choosing the Right Source

Many different fertilizer products are available to increase soil fertility. Each will contain a unique N-P-K ratio. Some fertilizers will only contain one or two of these macronutrients. A product that contains all three is considered a complete fertilizer. To avoid wasting fertilizer and polluting local waterways, you should first try to identify the turf species or other plants you are growing (page 16). Knowing your plants will help you with the next step, which is doing a soil test (page 8) to discover the phosphorus and potassium needs of your lawn or planting bed, and get a recommendation for nitrogen. The products you choose when fertilizer shopping may come from either an organic or inorganic source.

ORGANIC FERTILIZER

Organic fertilizers are derived directly from plant or animal sources, including compost, manure, and **biosolids**. Organic fertilizers contain a wide range of macro and **micronutrients** but in lower concentrations than inorganic fertilizers. Additionally, since the nutrients are bound in organic forms, they need to be broken down before plants can use them. This process takes time, which is why organic fertilizers are naturally **slow releasing**, especially during colder weather when soil microorganisms are less active. They also contain fewer salts than inorganic fertilizers and are less likely to "burn" plants by drawing away moisture. Another benefit of using organic fertilizers is that they contain organic matter, which can—over many years of regular use—improve soil structure and water-holding capacity. Organic fertilizers do have a few downsides. They are frequently more expensive, are harder to find than inorganic products, and do not usually provide the immediate greening response you might expect with commercially produced fertilizers.

Figure 5b. Manual compost spreader. *(Lloyd Jensen)*

Figure 5a. Top dressing compost using a tow-behind spreader. Most homeowners apply compost, an organic fertilizer, by hand or hire a professional; in either case, knowing the compost's nitrogen and phosphorus content is important. *(Peter Landschoot)*

How do you determine the nutrient value of organic fertilizers?

Sometimes organic soil amendments such as compost and manure are not labeled for use on turf as fertilizers. Because too much organic fertilizer can cause water pollution, just like too much inorganic fertilizer can, it is important to know the nutrient content of the organic product you want to use. When you source organic amendments from backyard compost piles, local farms, or other sources, you may need to test a sample to determine its fertilizer value. Penn State's Ag Analytical Services Lab offers both manure and compost testing to help you determine how much to apply to meet—but not exceed—plant needs.[7, 8]

Importantly, anyone who applies manure in Pennsylvania must have a Manure Management Plan that meets Department of Environmental Protection requirements to ensure that its application will not pollute local water resources. Those importing 3,000 pounds of manure or less (i.e., most people who care for a home lawn) can fulfill these requirements by completing the Manure Management Plan Short Form available from the DEP (see below).

Using Manure as Fertilizer?

Whether on a farm or in a residential setting, everyone who applies manure has a role in minimizing possible nutrient pollution. Manure management regulations outlined in 25PA Code §91.36(b) require anyone who produces or uses manure to develop and implement a Manure Management Plan to protect water resources by following best management practices, such as using the right application rate and observing **setbacks**. Guidance on fulfilling plan requirements and link to short form can be found at *www.pa.gov/*. Just search for manure management.

INORGANIC FERTILIZER

Inorganic fertilizers, commonly referred to as synthetic fertilizers, are manufactured from mineral deposits or atmospheric nitrogen. Since they are made in factories, they can be formulated to have specific nutrient concentrations and will often contain less nutrients than organic fertilizers, but in higher concentrations. Additionally, inorganic forms of nutrients are more easily used by plants. Thus, inorganic fertilizers are typically best used when you want nutrients to be available quickly. Note that nitrogen in some synthetic fertilizers can be lost more quickly if applied at rates exceeding plant needs, unless it is in a specially formulated slow-release fertilizer.

How to read a fertilizer product label

Synthetic fertilizers and commercially produced bagged organic fertilizers are legally required to have a label informing consumers of their nutrient content. The label may be on the front or back of the bag and contains important information. First, three numbers are listed, often near the top in larger print. These are the N-P-K numbers covered earlier. They indicate the percentages of nitrogen (N), **phosphate** (P), and **potash** (K). The fertilizer pictured below contains 30% nitrogen, 0% phosphate (phosphorus), and 4% potash (potassium) by weight. Fertilizer labels also list the types of nitrogen that are present[9] in the product, how much of that nitrogen is in quick-release or slow-release forms, and other micronutrients included. While all this information is useful, the N and P values are most important for determining how much fertilizer to apply without risking stormwater pollution.

Figure 6. Lawn fertilizers must prominently display their N-P-K ratio. This bag contains 30% nitrogen, 0% phosphorus, and 4% potassium. Since the bag weighs 42 lbs., it contains 12.6 lbs. of nitrogen, 0 lbs. of phosphorus, and 1.7 lbs. of potassium. *(Andy Yencha)*

7 A sample compost test report is available online at agsci.psu.edu/aasl/compost-testing/compost-sample-report.
8 A sample manure test report is available online at agsci.psu.edu/aasl/manure-testing/standard-manure-test/manure-sample-report.
9 Learn more about nitrogen types by visiting extension.psu.edu/turfgrass-fertilization-a-basic-guide-for-professional-turfgrass-managers.

Applying at the Right Rate

Lawn and garden fertilizer should not be applied according to a standardized schedule such as 1 pound of nitrogen per 1,000 square feet every year in May, for example. Instead, applications should always be based on plant need, soil test results, and weather conditions and ideally split into at least two applications across the growing season (Figure 14). With soil test recommendations, you can calculate the right rate of fertilizer to apply, based on the product you plan to use. Because different fertilizers will contain different N-P-K percentages, it can be challenging to find a product that will allow you to apply at a rate that will perfectly match what your plants need for each nutrient. In these cases, find a product with a rate that most closely meets plant needs without overapplying any nutrients or exceeding the limits established by the Pennsylvania Fertilizer Law (see page 13). Online fertilizer calculators, also called N-P-K fertilizer calculators, can be helpful in determining the right rate.

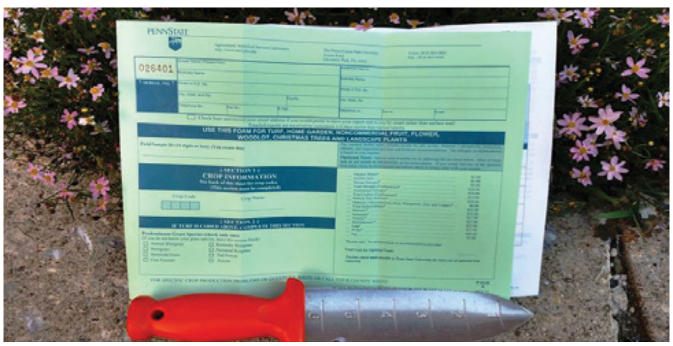


Figure 7a. Soil test submission form and digging tool for collecting a soil sample. *(Tim Abbey)*

Figure 7b. Digging down 4 inches to collect a soil sample from the lawn. *(Tim Abbey)*

TEST SOIL

Soil testing requires collecting a soil sample from your lawn or garden bed and sending it to a lab for nutrient analysis. Based on your sample's test results, the lab will provide recommendations for how much—if any—fertilizer and **limestone** (aka. lime) to apply. Applying fertilizer based on soil test results ensures plants get precisely the nutrients they need without any excess becoming a source of pollution or a waste of money and time. Because soils change over time, soil testing should be performed every 3 to 4 years.

How to collect a soil sample

Gather a clean bucket and digging tool (trowel, soil knife, or shovel). Collect 8–10 small scoops of soil in a regular pattern across the entire lawn or garden area you intend to fertilize (see Figure 8). Take samples from 3–4 inches deep for lawns with mostly bluegrass and ryegrass varieties, and 4–6 inches deep for lawns with deeper-rooted species such as tall fescue, as discussed in the grass identification section of this guide on page 16. Collect samples from 6–8 inches deep for vegetable gardens and ornamental planting beds. Remove thatch, sod, mulch, leaf, and stem materials from each sample. Add all the samples into the bucket and mix well. Remove about 1 cup of soil and allow it to dry on newspaper overnight. Place the dried soil in a zip-lock bag, label it, and mail or deliver it to the lab.

Separate soil samples should be collected from areas on your property that are managed differently or have different uses. For example, lawn soil should be sampled separately from garden soil. Similarly, if you have a large lawn, multiple samples may be needed if different areas have different soil types (clay vs sand, for example) or if you manage them differently (highly managed front yard vs minimally managed backyard).

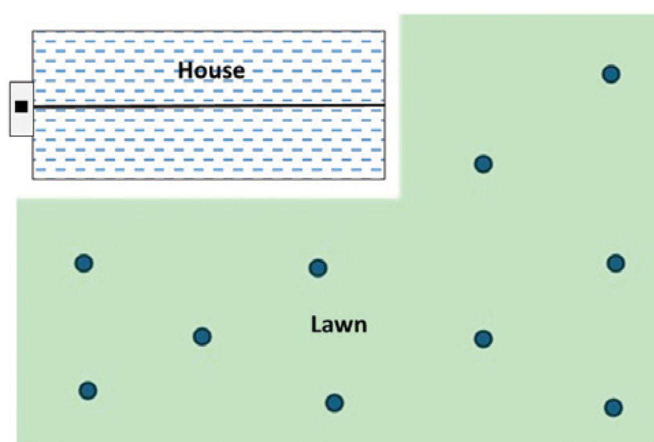


Figure 8. The green shape represents a lawn area. Each dot shows the location where the homeowner collected a small amount of soil. Note how collection spots are evenly spaced in a regular pattern, so the final soil sample is representative of the entire area. *(Andy Yencha)*

How to interpret a soil test report

The basic soil fertility test provided by Penn State's soil test laboratory measures pH, phosphorus, potassium, and magnesium. The lab report may also recommend applying limestone if the soil **pH** is too acidic.[10] Lime recommendations are important because most plants grow best at near-neutral pH values. A low or high soil pH can limit the availability of certain nutrients, meaning that even if you apply fertilizer at the proper rate, the plants may not be able to use all of it.

Lawn Liming

The ability of plants, such as lawn grass, to use fertilizer is partially determined by soil pH. If pH levels are outside a plant's preferred range, the plant may not grow well or look its best. In those cases, the soil pH will need to be adjusted; it can be lowered by applying sulfur or raised using a lime formulation.

Mineral lime, which is primarily calcium, is often recommended when the pH of lawn soil is below 6. Lime is best applied in late fall or early winter so it has time to work into the soil.

The results for soil pH, phosphorus, potassium, and magnesium will be reported as either below optimum, optimum, and above optimum. Plants growing in soils with below-optimum levels would respond well to fertilizer. Levels at optimum mean that sufficient nutrients are already in the soil, so additional nutrients will have a negligible effect on plant growth. When soil test results show above-optimum levels, nutrients are already higher than what plants can use. Thus, adding more fertilizer will not improve growth and is more likely to cause water pollution. Nutrient levels can remain above optimum for several years in lawns and gardens depending on management. Even after waiting a few years, it is best to retest optimum and above-optimum soils instead of assuming fertilizer is needed.

Fertilizer recommendations for soils below optimum are based on building nutrients to optimum levels. Fertilizer recommendations for soils already in the optimum range are based on maintaining optimum levels, or just enough to replace the nutrients used by turfgrass each year.[11] Fertilizer will not be recommended for soils that test above optimum.

Because soil nitrogen changes rapidly based on environmental conditions, most basic soil tests will not directly measure it; instead, they will provide nitrogen recommendations based on the nitrogen requirements of the predominant turfgrass species in the lawn (page 16). Soil test recommendations are provided to achieve soil nutrient levels within the optimum range over 3 years, after which another soil test is recommended.

MEASURE THE AREA TO FERTILIZE

In addition to recent soil test results, you will also need the fertilizer's nutrient content (i.e., the N-P-K ratio), the size of the area to be treated, and a properly calibrated fertilizer spreader.

To determine the size of the area that you plan to fertilize, divide it into several smaller square or rectangular sections. Then use a tape measure or measuring wheel to determine the length of two adjacent sides that, when multiplied by each other, will provide the area. Alternatively, you can use an online mapping tool, like Google Maps, to trace the perimeter of the area to be fertilized with a few clicks of a computer mouse (Figure 9). Online mapping tools are particularly useful for irregularly shaped yards.

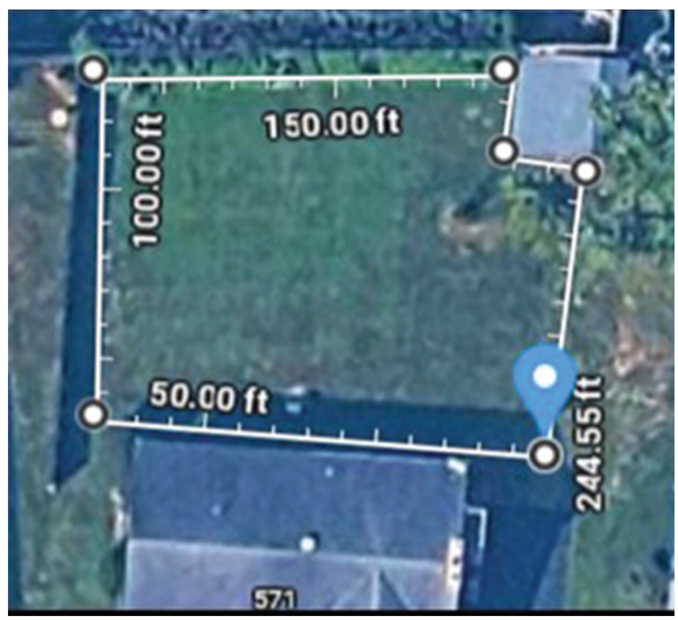


Figure 9. The area function in Google Maps can be used to determine the square footage of a lawn, even an irregularly shaped one. *(Google Screenshot)*

10 Read more about limestone and lawn liming at extension.psu.edu/liming-turfgrass-areas.
11 For more about interpreting soil test reports, visit extension.psu.edu/interpreting-your-soil-test-reports.

Figure 10. The fertilizer that plants do not use may wash away in stormwater runoff. *(Susan Boser)*

Law of Diminishing Fertilizer Returns

Overapplying fertilizer is unlikely to provide any additional plant benefit and may harm lawns with mostly fine fescue grass types. Generally, plants respond to fertilizer additions up to a certain point, after which they stop becoming greener, bigger, or more productive regardless of how much extra fertilizer you apply. This can be thought of as the law of diminishing returns for plant productivity.

Example

How to calculate the right fertilizer rate for a lawn

Background

In this example, the lawn is 40 ft. wide and 100 ft. long. So, the area to be fertilized is 4,000 sq. ft.
(Area = Length × Width, 100 ft. × 40 ft. = 4,000 sq. ft.)

Soil test report recommends 1 lb. of nitrogen, 3 lbs. of phosphate, *** and 2 lbs. of potash per 1,000 sq. ft.
The homeowner purchased a 50-lb. bag of 26-5-10 (N-P-K) and wants to apply enough fertilizer to meet the nitrogen (N) needs of their turfgrass (1 lbs. N/1,000 sq. ft.) over two applications, 0.5 lbs. N in spring and 0.5 lbs. N in early fall. How much fertilizer should they apply during each application?

Calculations

The best way to solve this problem is to first divide the amount of nitrogen desired (0.5 lb. nitrogen per 1,000 sq. ft.) by the percentage of nitrogen in the bag (26% or 0.26):

> 0.5 lb. nitrogen ÷ 0.26 = 1.9 lbs. of fertilizer needed to provide 0.5 lb. of nitrogen per 1,000 sq. ft.

Because this lawn is 4,000 sq. ft., divide this area by 1,000 sq. ft. and multiply the result by 1.9 lbs.:

> 4,000 sq. ft. / 1,000 sq. ft. = 4.
>
> 4 × 1.9 lbs. = 7.6 lbs. of fertilizer applied evenly across this 4,000-sq.-ft. lawn will achieve a nitrogen application rate of 0.5 lbs. of nitrogen per 1,000 sq. ft. Applying this rate in both spring and fall results in annual rate of 1 lb. N/1,000 sq. ft.

If 1.9 lbs. of fertilizer is applied to each 1,000 sq. ft. of lawn, how much phosphate and potash are you applying?

To solve this problem, multiply the amount of fertilizer you are applying (1.9 lbs. / 1,000 sq. ft.) by the percentage of phosphate in the bag (5%) and do the same for potash (10%).

> 1.9 lbs. of fertilizer / 1,000 sq. ft. X 0.05 phosphate = 0.1* lbs. phosphate / 1,000 sq. ft.
>
> 1.9 lbs. of fertilizer / 1,000 sq. ft. X 0.1 potash = 0.2** lbs. potash / 1,000 sq. ft.

Will applying 1.9 lbs. of fertilizer per 1,000 sq. ft. twice a year meet the plant's needs for phosphate and potash?

Remember the soil test report recommended 1 lb. of nitrogen, 3 lbs. of phosphate, and 2 lbs. of potash per 1,000 sq. ft., so applying at that rate will not meet the recommendations for phosphate and potash. However, applying more of the 26-5-10 fertilizer would not be recommended because it would mean that nitrogen is being overapplied and may be lost in runoff or leach into groundwater. To more closely meet the plant's needs, consider looking for a fertilizer that has a nutrient content more closely aligned to the soil test recommendation or a different fertilizer product that does not contain nitrogen.
extension.psu.edu/calculations-used-to-determine-the-amount-of-fertilizer-needed-to-treat-turf

* Rounded up from 0.09 lbs.
** Rounded up from 0.19 lbs.
***Pennsylvania's fertilizer law does not permit phosphorus additions to lawns unless – like in this example – they are proven to be needed based on recent soil test reports.

CALIBRATING A FERTILIZER SPREADER

Fertilizer spreaders are tools that apply fertilizer evenly over large areas (Figure 11), but all spreaders should be tested to precisely determine how much fertilizer they apply over a given area (usually 1,000 square feet), a process called **calibration**. Fertilizer labels often suggest application rates based on the flow settings for common fertilizer spreaders (Figure 12). The manufacturer's settings can serve as a starting point, but calibration is still recommended to determine your actual application rate. We describe a simple calibration method below and share a more accurate method in the footnote URL.[12]

Step 1: Set up the spreader

- Adjust the spreader opening to the setting recommended by either the fertilizer product or the spreader manufacturer.
- Fill the spreader with a known amount of fertilizer. Ten pounds is often recommended since it makes the math easier.

Step 2: Mark off a 1,000-square-foot test area

- Measure and mark off a 1,000-square-foot area in either your lawn or driveway.
- If using a driveway, completely sweep up the fertilizer afterward.

Step 3: Apply the fertilizer

- Ensure the hopper is closed and push the spreader to the test area. Open the hopper upon entering the test area.
- If using a rotary spreader, overlap passes to evenly cover the test area because rotary spreaders throw fertilizer in a fan-shaped pattern where less product is distributed on the sides of the arch (Figure 13a).
- Refer to the user manual for the spreader to learn the proper spacing between passes or, as general rule, set your spacing so the far edges of the spreader's throw pattern overlap ¼–⅓ of the area covered by the previous pass (Figure 13a).
- If using a drop spreader, walk at a normal pace until fertilizer is spread over the full test area. To reduce streaking (missing or overapplying to a narrow strip between passes), split the application rate in half and make two passes perpendicular to each other.

Step 4: Weigh the remaining fertilizer

- Weigh the amount of fertilizer remaining in the spreader and subtract from the starting amount. The result is the amount of fertilizer you applied to the test area.

Step 5: Adjust the spreader setting

- Now adjust the flow control level on the spreader until you find a setting that matches the target rate for your 1,000-square-foot test area. This may require repeating the above steps several times.

Figure 11. Using a fertilizer spreader properly requires calibration. *(Andy Yencha)*

Figure 12. A drop spreader precisely deposits fertilizer below the hopper and works well for smaller yards. *(AdobeStock)*

12 For more about calibrating a fertilizer spreader, visit extension.psu.edu/calibrating-your-fertilizer-spreader.

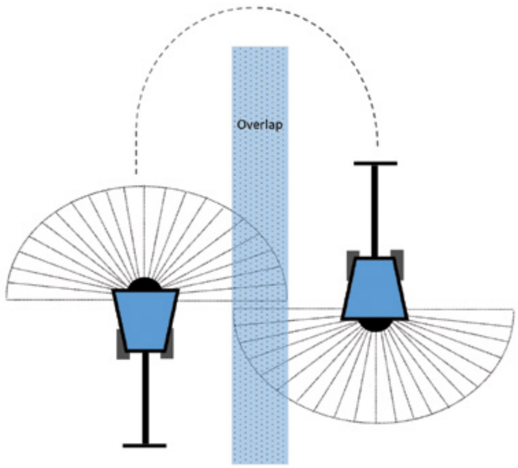


Figure 13a. Rotary spreaders dispense less fertilizer along the edges of their spray pattern. Overlap passes around 30% to achieve equal coverage. *(Andy Yencha)*

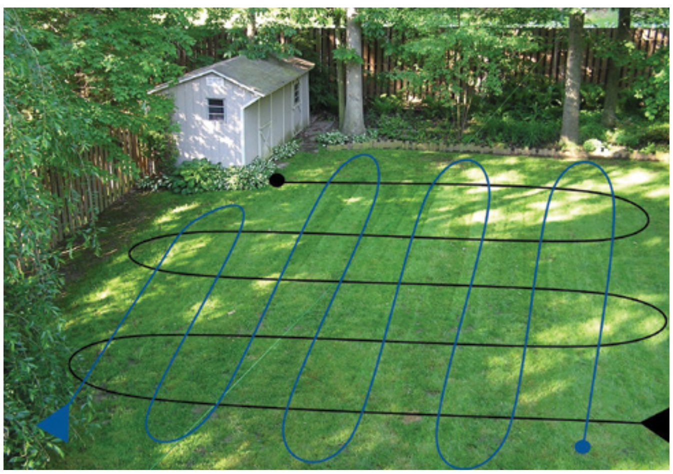


Figure 13b. It is easier to achieve even fertilizer coverage when you split your fertilizer application rate in half and make two coverage passes in opposite directions. *(Peter Landschoot)*

No Space to Calibrate?

If you lack the space to follow the calibration steps on page 11, try adjusting your spreader to its lowest setting to see how much lawn you cover for a given amount of fertilizer and then gradually adjust upward until you hit your target rate.

Fertilizing at the Right Time

Applying fertilizers at the right time is another key pillar of proper fertilization and a requirement of the Pennsylvania Fertilizer Law (Sidebar, page 13). Fertilizers should only be applied when plants are actively growing, as dormant plants are unable to take up nutrients. Turfgrass can go dormant in the winter and during dry weather in the summer. Importantly, if grass turns brown in the summer after a period without rain, it is likely not due to a lack of fertilizer, but a lack of water. Remember that as roots take up water, they also take up nutrients, so applying fertilizer to a dormant lawn will not improve your lawn's appearance and may harm grass by causing **fertilizer burn** or other stress. Alternately, heavy rain is more likely to become runoff when it falls on dry soil, so applying fertilizer just before a large rainstorm risks the nutrients being carried off-site in runoff, rather than being used by the grass. Consequently, the Pennsylvania Fertilizer Law includes the following important application restrictions:

- Do not apply if heavy rain is expected
- Do not apply if the ground is frozen or snow covered
- Do not use fertilizer to melt ice or snow

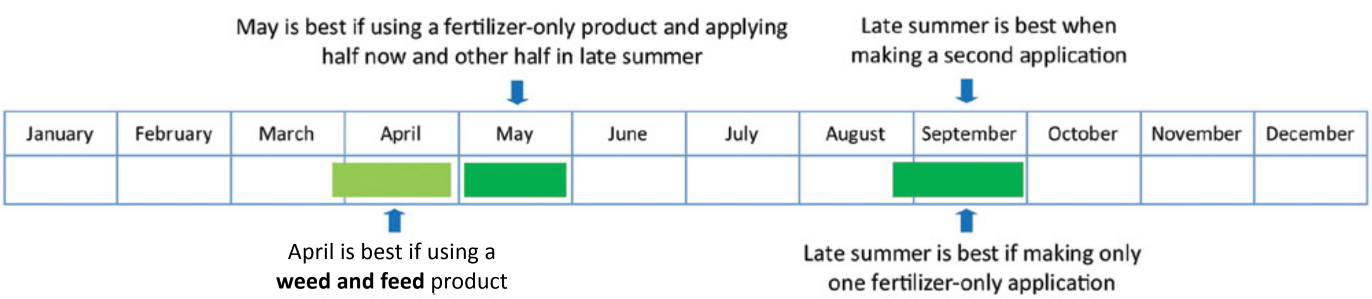


Figure 14. Recommended periods for applying fertilizer to lawns in central PA. Adapted from presentation by Peter Landschoot, Penn State Extension turfgrass specialist. *(Peter Landschoot)*

Keeping Nutrients in the Right Place

A basic goal of proper nutrient application is to apply fertilizer to the plants that need it, not to other plants or areas that do not. Taking care to ensure fertilizer stays off sidewalks, driveways, roads, streams, or other non-target areas helps nutrients reach plants rather than becoming pollution or a waste of money (Figure 15). To prevent off-target nutrient losses, the Pennsylvania Fertilizer Law established the following setbacks and restrictions:

- Maintain at least a 15-foot buffer from the top of stream banks or shorelines bordering lakes, ponds, wetlands, or flowing bodies of water.
- Do not apply near water, storm drains, or drainage ditches.
- Do not apply to impervious surfaces such as driveways, sidewalks, and roads, and promptly sweep or blow any material that lands on an impervious surface onto the turf (Figure 16).
- Do not store or dispose of fertilizer inconsistent with its label or in a manner that would result in a direct discharge to waterways.

Figure 15. Some rotary spreaders are equipped with edge guards that block one side of the spread pattern, which makes it easier to apply fertilizer along the edge of a non-target area. *(Peter Landschoot)*

Figure 16. Fertilizer that lands on hard-surfaced non-target areas like the sidewalk in this photo, should be swept or blown onto the lawn. *(AdobeStock)*

THE PENNSYLVANIA FERTILIZER LAW

Revisions to the Pennsylvania Fertilizer Law brought on new responsibilities to residents applying fertilizer to their lawns. Lawn care companies and DIY homeowners are now required to follow nutrient application rate limits, fertilizer application location restrictions, and best management practices specified on both the fertilizer label and in the law. The following limits have been set for fertilizer application on turfgrass (lawns):

- 0.7 lbs./1,000 ft.^{2} of **plant available nitrogen** per application
- 0.9 lbs./1,000 ft.^{2} of **total nitrogen** per application, unless it is an **enhanced-efficiency** nitrogen fertilizer
- NO phosphate may be applied unless:
  - A soil test indicates a phosphorus need
  - You are establishing, reestablishing, or repairing a turf area
  - You are using an organic or organic based fertilizer
  - Application of natural organic fertilizer, or organic-based fertilizers may not exceed 0.25 lbs./1,000 ft.^{2} (0.5 lbs./1,000 ft^2 per year maximum)

The fertilizer limits are set per application, so it is important to test your soil to determine the actual nutrient requirements of your lawn and to guide you in the number of applications that will be needed each year.

To further minimize pollution risk, applicators must follow site, rate, and timing restrictions:

Apply fertilizers to the right place:

- Do not apply near waters, storm drains, or drainage ditches
- Maintain a 15-ft. buffer from waterways
- Fertilizer that lands on an impervious surface (like roads, sidewalks, driveways) must be swept back onto turf
- Apply only to intended application site

Apply fertilizers at the right rate:

- Apply product using a properly calibrated fertilizer spreader

Apply fertilizers at the right time:

- Do not apply if ground is snow covered or frozen
- Do not apply if heavy rain is expected

pa.gov/agencies/pda/plants-land-water/fertilizer/homeowners-and-applicators

Figure 17. Shady lawn dominated by fine fescue grass species, which require less fertilizer, sunlight, and water than other cool-season grass types. *(Peter Landschoot)*

Chapter 3:

Sustainable Practices for a Healthy Lawn

Watershed-friendly actions that promote turf health and growth

Proper fertilization is only one part of a watershed-friendly lawn care program, and some homeowners choose not to fertilize. For any lawn—fertilized or unfertilized—other crucial steps are often needed to cultivate a robust, healthy lawn that minimizes runoff and water pollution. These include reseeding with more watershed-friendly turf species (Figure 17), proper mowing, water-wise irrigation, and core aeration to reduce soil compaction. All these **cultural practices** will promote a dense, attractive turfgrass stand that is resistant to weeds and other pests and better at absorbing stormwater.

Does every lawn need fertilization?

If your lawn is already thick and healthy without bare spots, you might want to go a year or more without fertilizing. But if your turf is already thin or gradually thinning, becoming increasingly weedy, or not bouncing back from the normal wear and tear after outside games or gatherings, the proper amount of fertilizer may help it grow thicker so it can hold onto more stormwater. Just remember to do a soil test first to discover if it needs something other than nitrogen fertilizer. **While non-fertilized lawns cannot lose fertilizer to runoff or leaching, thin turf and lawns with bare patches are more susceptible to runoff and soil erosion** (Figure 18).

Figure 18. Reseed bare spots to protect them from erosion. *(Tim Abbey)*

Choose Watershed-Friendly Grass Types

Lawns in Pennsylvania primarily consist of cool-season grass species (Figure 19). These include Kentucky bluegrass, rough stalk bluegrass, perennial ryegrass, fine fescues, and tall fescue. Rough stalk bluegrass is primarily considered a turfgrass weed, but it is an option for areas with heavy shade and ample soil moisture. A small percentage of lawns in southeastern Pennsylvania are zoysia grass, a warm-season grass. It is uncommon because it goes dormant and turns brown for months during chilly weather.

A watershed-friendly practice when starting a new lawn or reseeding bare spots is to use a blend of several cultivars of a single turfgrass species or a mixture of turfgrass species. This approach helps minimize damage from potential pests, including weeds, insects, and fungi.

Of the cool-season grasses, the fine fescues and tall fescue require less water, fertilizer, and mowing to look good. All the fine fescue species can tolerate partial shade too. These characteristics decrease lawn care costs while also conserving water and the chance of fertilizer runoff.

Figure 19. Nitrogen needs for common turfgrass types. *(Peter Landschoot)*

Turfgrass species	Amount of nitrogen per growing season for a medium- to high-quality lawn.* *Units: pounds per 1,000 sq. ft.*
Kentucky bluegrass	2–4
Rough bluegrass	2–3
Perennial ryegrass	2–4
Tall fescue	2–3
Fine fescue (creeping red, Chewings, hard, and sheep varieties)	1–2

The National Turfgrass Evaluation Program compiles the evaluation results of turfgrass testing sites in the United States. (ntep.org)

*Higher rates are for turf in new stands, infertile soils, areas where clipping are removed (a practice not recommended), and high traffic areas (frequently used for picnics, yard games, or driven on by vehicles). Lower rates are for established turf in fertile soils, areas where clippings are returned to the turf, and traffic is light.

Figure 20. Fine fescue grows well with less fertilizer than other common grass types. It is also drought and shade tolerant. *(Tanner Delvalle)*

Turfgrass Identification

As the prior section explained, a lawn with mostly fine fescues needs less nitrogen than lawns covered by any of the other four cool-season turfgrass species common in Pennsylvania (Figure 20). But how can you tell if your lawn is mostly fine fescue? Mature fine fescue grass blades are narrow, with widths 1.0 mm or less, compared to the wider leaf widths of the other four common grass species. Since most lawns contain a mix of turf species, it is important to study your whole lawn to determine if you have mostly fine fescue or if a different grass species is dominant. If you are not sure, you can either try using turf identification resources available online from both commercial businesses and academic institutions, including Penn State Extension.[13] Alternatively, you can contact your local extension office or a commercial turf management business for assistance.

Ask Tilva

extension.psu.edu/ask-tilva

Tilva gives you 24/7 access to the trusted knowledge of Penn State Extension researchers and educators. Find instant answers to your questions in English or Spanish, identify plants and pests from photos, gain insights based on real-time local weather and soil data, link to more learning, and get information from trusted ag organizations.

CONSIDER TURF ALTERNATIVES

One alternative to a lawn made up of only turfgrass is incorporating microclover varieties (*Trifolium repens var.*). It grows and performs best in lawns with mostly Kentucky bluegrass and tall fescue. Microclover varieties grow lower and have smaller leaves and flowers than the straight white clover species. These characteristics allow it to grow throughout a lawn instead of in patches (Figure 21). As it spreads through the lawn, it adds nitrogen to the soil, which can minimize the need for additional fertilizer. Microclover has two drawbacks: it is not drought tolerant, and broadleaf herbicides to control common weeds like dandelions, will kill it.

Figure 21. Unlike white clover, microclover varieties spread throughout a lawn. *(Sandra Feather)*

13 Identification resources can be found by visiting extension.psu.edu/turfgrass-species-for-pennsylvania and extension.psu.edu/the-cool-season-turfgrasses-identification.

Figure 22 Mowing properly promotes turf health. *(Tim Abbey)*

Mow Properly

Mowing practices are one of the most important factors contributing to the longevity and well-groomed appearance of turfgrass (Figure 22). Most turfgrass species should be maintained at 2 inches or above and mowed regularly when the grass is actively growing. During peak periods of growth in the spring, you may need to mow more than once per week. Try to avoid trimming more than 1/3 of the grass blade height when you mow to minimize plant stress.

Regular mowing allows for the clippings to be left on the lawn. Over a growing season, the clippings can provide approximately 1 pound of nitrogen per 1,000 square feet (one nitrogen fertilizer application!), and they do not add to the thatch layer because they break down quickly. Leaving clippings on the lawn is sometimes called **grasscycling**.

What about thatch?

Thatch develops at the top of the soil line in any turfgrass area. It is an intermingling of living and dead foliage, shoots, and roots. One-half to three-quarters of an inch is desirable. The thatch layer provides a cushion for any activities held on the lawn (Figure 23). If the thatch becomes thicker, the turf quality declines, and the cultural practices, fertilizing, irrigation, and mowing are negatively impacted. Excess thatch can be removed using a rake or dethatching machine to restore turfgrass vitality.

Figure 23. Cross-section of turf showing the thatch layer. *(Ruth Benner)*

Figure 24. Ragged looking turf was likely cut with a dull mower blade. *(Ruth Benner)*

Mowing at a height of 2.5–3 inches is less stressful for the cool-season grasses. It also allows the turfgrass to shade out weeds, which reduces weed competition and maintains the lawn's aesthetic appearance. Mowing equipment should be kept sharp and in good operating condition. Dull, improperly adjusted mower blades destroy the aesthetic value of the turf by shredding or bruising the leaf tips, which discolors the lawn and makes the plants more susceptible to pathogens (Figure 24).

Irrigate Properly

Most turfgrass in Pennsylvania can tolerate some dry conditions by entering semi-dormancy. When this happens, plant growth slows and grass blades start to turn brown. Grass can remain semi-dormant for some time before the plants begin to die, so it is usually not necessary to irrigate lawns in Pennsylvania except in rare periods of prolonged drought. If you do irrigate your lawn, you should follow watershed-friendly practices. No matter what equipment you use—hand-held hose, portable sprinkler, or in-ground irrigation system—watering your lawn should provide proper water distribution, permit good water infiltration, and ensure sufficient water retention to support plant growth without overwatering (Figure 25a). Excess irrigation wastes water, increases utility bills, and may create stormwater runoff.

Figure 25a. During extended dry weather, it may be necessary to irrigate a lawn. One inch of water once per week is a general recommendation. *(Andy Yencha)*

A practical irrigation program embodies three basic concepts:

- Rate: how quickly should water be applied?
- Quantity: how much water should be applied?
- Frequency: how often should water be applied?

Rate

Water should never be applied faster than the soil can absorb it. Thus, it is important to reduce your irrigation rate if you see runoff. The ability of soil to absorb moisture depends upon several factors, most of which are directly or indirectly associated with two soil characteristics:

- Texture: size of soil particles
- Structure: the arrangement of soil particles

Soils with good structure (a mix of different-sized soil particles that have a loose and crumbly structure) permit easy water infiltration; those without good structure (dense and compacted) may have less ability to absorb and retain water. These characteristics also influence a soil's water-holding capacity and ability to drain well, so plant roots are not always saturated. Letting your grass clippings decompose on the lawn, or grasscycling, helps improve soil structure by adding organic matter.

Quantity

The amount of water to apply at any one time will depend upon the soil's water-holding capacity, the amount of moisture present when irrigation is started, and how well the soil drains. Until you have a good feel for the water-holding capacity of your soil, it pays to dig a small hole, or purchase a soil moisture meter, to check moisture levels before watering. Soil may be dry on the surface but wet in the root zone, which indicates additional water may not be needed.

Frequency

Irrigation frequency depends on the type of grass, the soil's physical properties, and the climatic conditions—especially rainfall, humidity, temperature, and wind movement.

- Newly seeded areas must be kept moist when the seed is germinating and seedlings are becoming established. This will require frequent, shallow irrigation until the new lawn is established. Seedlings have minimal roots and will dry out quickly.
- Established lawns are best watered deeply and infrequently, with approximately 1 inch of water per week for most lawns. Watering established lawns frequently and shallowly encourages shallow rooting and makes them more susceptible to insects and disease. A rule of thumb during dry weather is to water just as the turf begins to wilt.

Perform Core Aeration to Avoid Soil Compaction

Soil compaction beneath lawns is natural and, unfortunately, hard to avoid. Locations that get frequent foot traffic or that are mowed by a ride-on mower are more prone to this problem. When soil is compacted, the tiny but beneficial pore spaces between soil particles get crushed. A smaller pore size slows the movement (infiltration) of water through the soil. It also makes it more challenging for turf roots to grow. Finally, with reduced pore space, less oxygen is available for turfgrass roots to capture.

Core aeration involves removing plugs of soil from the turf area using a machine called a **core aerator** (Figures 25b, 25c, and 25d). The process creates many small—but temporary—openings that allow additional oxygen, moisture, limestone (if applied as a **top dressing**), and plant nutrients into the soil. Aeration is used to alleviate soil compaction and can also significantly reduce thatch. Aeration should be performed during cool weather when turfgrass is usually growing vigorously (early to mid-spring or late summer to early fall) to facilitate rapid grass recovery. It should be done when soil moisture is adequate. After aeration, top dressing with ¼ to ½ inch of quality compost adds micronutrients and beneficial microorganisms to the soil profile.

Figure 25b. Core aeration machines remove narrow plugs of compacted soil. *(Adobe Stock)*

Figure 25c. Soil plugs may be left on the lawn to break down naturally. *(Adobe Stock)*

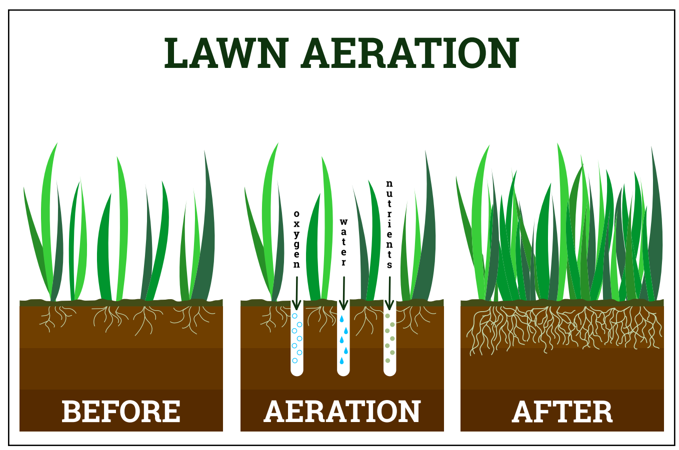


Figure 25d. Core aerations improves soil health which, in turn, improves turf health. *(Adobe Stock)*

Figure 26a. Part of this backyard was converted from turfgrass to a wildflower meadow. *(Jodi Sulpizio)*

Chapter 4:

Enhancing Your Landscape

More ways to make your property watershed friendly

To make their properties even more watershed friendly, some people downsize their lawns by converting turfgrass to meadows or trees or by installing **best management practices** (BMPs) such as rain gardens, rain barrels, or permeable surfaces to manage stormwater.

Options for Reducing Lawn Area

As mentioned in the Introduction, 7% of Pennsylvania is covered by turfgrass, or around 2 million acres (about the area of Connecticut!). Replacing turfgrass with other plants—especially **native species**—reduces lawn maintenance; creates habitat for wildlife, including birds, small mammals, and pollinating insects; and may increase stormwater infiltration (Figure 28a). A straightforward way to start reducing the size of your lawn is to extend planting beds or enlarge mulched tree rings (Figures 26b, 26c, and 26d). Lawn-to-meadow conversions build on this idea by replanting turf areas with perennial grass and flowers. Some people convert acres of turf using this practice, but others start with a small area and gradually expand to replace large areas of unused lawn with native plant cover. Downsizing lawn areas that are difficult to maintain or where turfgrass struggles to grow can be particularly beneficial for reducing lawn maintenance and fertilizer applications.

Figure 26b. Extended planting bed. *(Meagan Hopkins-Doerr)*

Figure 26c. Enlarged tree ring helps trees and shrinks lawn. *(Andy Yencha)*

Figure 26d. Trees can beautify a lawn, provide habitat diversity, and intercept rain so it never becomes runoff. *(Andy Yencha)*

Features That Capture and Infiltrate Stormwater

RAIN GARDENS

A rain garden is a shallow depression, often 4–8 inches deep, planted with a mix of native vegetation, including flowers, grasses, shrubs, and trees. Most residential rain gardens are small, covering less than 500 square feet. Their adaptability makes it possible to integrate them into existing residential yards. They can be shaped like rectangles, ovals, crescents, and more. Home rain gardens typically collect stormwater from downspouts, driveways, and patios (Figures 27a, 27b, 27c, and 27d).

Figure 27a. Runoff from the nearby home flows into the rain garden through the downspout. *(Andy Yencha)*

Figure 27b. Rain gardens can also reduce runoff from non-residential properties. *(Kristen Koch)*

Figure 27c. Rain garden on a small lot. *(Diane Oleson)*

Figure 27d. Backyard rain garden surrounded by fine fescue turf. *(Andy Yencha)*

RAIN BARRELS

Rain barrels are containers that collect rainwater from roofs for later use outdoors (Figures 28a and 28b). They help reduce the amount of stormwater runoff that reaches your lawn during a rainstorm, which can reduce flooding and water pollution. Rain barrels are also a way to conserve water and lower utility bills. Captured water can be used during dry periods instead of using water from your domestic supply.

Figure 28a. Rain barrel connected to downspout via sealed diverter. *(Jodi Sulpizio)*

Figure 28b. Large vessel used for lawn or garden irrigation. *(Andy Yencha)*

PERMEABLE SURFACES

Unlike impervious surfaces that block stormwater infiltration, **permeable pavement** allows water to soak into the ground, reducing runoff. Examples include permeable concrete and asphalt pavement or block pavers (Figures 29a, 29b, and 29c). In residential settings, most property owners use pavers. The block pavers themselves are not permeable; stormwater drains through the narrow joint spaces between each block.

For efficient drainage, install permeable material over a carefully prepared base—usually consisting of washed gravel and geotextile materials—engineered to support the maximum loads the pavement encounters and temporarily store stormwater until it soaks into the subsoil. Soil and organic material such as leaves or grass clippings can clog the joint spaces and hinder performance. Vacuuming the joint spaces is recommended to maintain drainage. Do-it-yourself permeable pavement installations most often involve sidewalks and patios where both the surface area and traffic loads are relatively small. Consult with a professional landscaper if you plan to use permeable pavement over places where cars, tractors, or other heavy equipment may pass.

Figure 29a. Permeable block pavers infiltrate runoff before it flows onto the lawn or street. *(Andy Yencha)*

Figure 29b. Permeable block pavers work for areas receiving light-duty parking, but professional design assistance is encouraged. *(AdobeStock)*

Figure 29c. Open space allows grass to grow and stormwater to infiltrate. *(Andy Yencha)*

Chapter 5:
Certify Your Watershed-Friendly Property

Inspire others to improve their landscapes

We hope this guide has helped you understand how lawn care is linked to water quality and will inspire you to adopt several watershed-friendly practices on your property. Doing so could help qualify your landscape for certification by Penn State Extension's Master Watershed Steward program and the Nurture Nature Center as a Watershed-Friendly Property (Figures 30 and 31). Certification has many benefits including:

- Rewarding your commitment to improve and maintain the water resources in your watershed.
- Showcasing your property as an example for friends, family, and neighbors to follow.
- Getting connected to a statewide network committed to helping you continue improving your watershed-friendly property.

To certify your property, complete the free online application (*nurturenaturecenter.org/programs/community/wfp-cert/*). Additional information and resources are provided throughout the process. If your property meets the requirements, you will receive an email with a certificate verifying that your landscape is watershed friendly and become eligible for a Watershed-Friendly Property sign to show everyone your commitment to improving Pennsylvania's water resources (*nurturenaturecenter.org/certify-your-property-sign/*).

Figure 30. Let people know your property is watershed friendly! *(Maxfield Designs)*

Figure 31. Watershed-Friendly Property Certification Program. *(Maxfield Designs)*

Glossary

Best management practices (BMPs) – structures or management techniques that reduce stormwater runoff and pollution.

Biosolids – municipal sewage sludge that has been treated and dried for safe use as a lawn and garden soil amendment.

Calibration – accurately determining, through testing, the amount of fertilizer your lawn spreader distributes over a known area, often 1,000 square feet.

Core aerator – a machine or tool designed to remove small plugs, or cores, of soil from a lawn to repair compacted soils, improve infiltration, and reduce runoff.

Cultural practices – lawn care practices such as reseeding, proper lawn mowing frequency, and core aeration, which promote a healthy lawn that is better able to minimize runoff.

Denitrification – a process where soil bacteria transform nitrate, a type of nitrogen plants can use for growth, into nitrogen gas, which most plants cannot use.

Enhanced-efficiency fertilizer – fertilizer products containing nitrogen formulations designed to slowly release small amounts of plant available nitrogen (weeks to months), which reduces nitrogen loss from leaching.

Erosion – Sediment loss caused by the movement of water. Examples may be obvious, like a new gully forming in a lawn, or subtle, like the appearance of muddy runoff following a rain storm.

Fertilizer – bagged or liquid products that contain the plant macronutrients nitrogen (N), phosphorus (P), and potassium (K).

Fertilizer burn – wilting, yellowing, or browning of turfgrass caused by overfertilization. Also called salt burn. Less likely when slow-release or enhanced-efficiency fertilizer products are used.

Grasscycling – letting grass clippings remain on the lawn as a source of nutrients.

Groundwater – water stored underground in bedrock fractures or small spaces between sand and gravel. Groundwater is replenished by infiltration.

Infiltration – the movement of water into soil. Increasing infiltration minimizes runoff.

Inorganic fertilizer – fertilizer products containing nutrients primarily derived from mined or manufactured nutrient sources such as atmospheric nitrogen. Also called synthetic or commercial fertilizer.

Impervious surfaces – any land covering, such as pavement, sidewalks, roofing materials, or even compacted soil, that hinders stormwater infiltration.

Leaching – the movement of nutrients, most often nitrogen, through soil into groundwater.

Limestone – a mineral that a soil test may recommend adding to lawn or garden soil. Limestone raises soil pH, which lowers soil acidity, making existing nutrients more available to plants and potentially reducing the need for fertilizer.

Limiting nutrient – the nutrient that, due to its low availability, prevents plant and algae growth. Nitrogen and phosphorus are commonly limiting nutrients in waterbodies.

Macronutrients – nutrients that plants need in large quantities to grow and reproduce. Watershed-friendly lawn care is focused on the wise application of the macronutrients nitrogen and phosphorus.

Micronutrients – nutrients that plants require in small quantities to grow and reproduce, such as iron and zinc. When plants are not growing well and soil tests confirm there are adequate macronutrients, testing for micronutrient deficiencies is often a wise next step.

N-P-K – the ratio of macronutrients nitrogen (N), phosphorus (P), and potassium (K) in a fertilizer product.

Native species – plant species that existed in Pennsylvania prior to European settlement and often recommended as an alternative to turfgrass since they are adapted to thrive in our local climate.

Nitrogen – macronutrient most responsible for green, leafy plant growth that can also pollute groundwater and surface water when overapplied. Excess nitrogen from stormwater runoff causes oxygen depletion in parts of the Chesapeake Bay, Gulf of Mexico, and the Great Lakes.

Nutrients – the essential compounds plants need to grow. Often used to refer to the two nutrients nitrogen and phosphorus that can cause water pollution when overapplied but also includes potassium and many micronutrients.

Organic fertilizer – fertilizer products derived from natural plant and animal sources, such as manure or compost. Even though they come from natural sources, overapplication may result in stormwater pollution.

Permeable pavement – paving materials that permit water infiltration.

pH – a scale between 0 and 14 that measure how acidic or alkaline (basic) a substance like soil is. A value between 0–6 is considered acidic, 7 is neutral, and above 7 is basic. Cool season turf species best utilize macronutrients when soil pH is between 6–7.

Phosphate – the compound in some fertilizers that supplies phosphorus.

Phosphorus – macronutrient needed by plants for reproduction, which is why it is the main nutrient in starter fertilizer. Phosphorus carried by runoff into waterbodies may cause aquatic weed and algae growth.

Plant available nitrogen – soil nitrogen that is present in forms that plants can use, mostly ammonium (NH_4^+) and nitrate (NO^{3-}).

Potash – the compound in some fertilizers that supplies potassium.

Potassium – macronutrient that is important for plant growth but not usually a cause of water pollution. It comes from potash minerals in fertilizer.

Runoff – water that flows across lawns and other landscapes due to the force of gravity. Frequently originates from stormwater, which is why the two words are paired: "stormwater runoff."

Runoff pollutants – any substance, material, or nutrient applied to the land that harms water quality if washed into a water body. Common runoff pollutants from lawns include nutrients and sediment.

Sediment – eroded soil particles and tiny bits of dead tissue from plants and animals that get picked up by runoff and often contain nutrients that cause water pollution.

Setbacks – a separation distance, usually measured in feet, designed to prevent a runoff pollutant from washing into a water body.

Slow-release fertilizer – a fertilizer product or material that releases nutrients (primarily nitrogen) over weeks or months rather than the few days typical for quick-release products.

Soil compaction – a process where microscopic air spaces between soil particles are crushed together. Compacted soils generate more runoff because they are resistant to infiltration.

Starter fertilizer – lawn fertilizer containing phosphorus designed to boost the growth of grass seedlings. Pennsylvania's fertilizer law allows the use of starter fertilizer when seeding a new lawn or overseeding bare areas in existing lawns.

Stormwater – water from rain, snow, or ice that either soaks into the ground (infiltration) or becomes runoff.

Stormwater pollution – when stormwater becomes contaminated with nutrients from fertilizer, manure, or other materials such as trash, sediment, toxic compounds, or pathogens.

Storm sewer systems – a network of stormwater management structures, including retention basins, ditches, roadside inlets, and underground pipes, designed to gather stormwater from developed places and transport it, without treatment, to local water bodies.

Stream bank erosion – loss of soil from the edge of a stream or river.

Top dressing – applying a thin layer of soil, compost, or other lawn amendment evenly over a lawn (usually with a mechanical spreader) without disturbing the soil.

Total nitrogen – the sum of all nitrogen in a soil sample, including forms that plants can and cannot use immediately for growth.

Waterbodies – a general term for any creek, river, pond, lake, or reservoir.

Water pollution – a condition where surface or groundwater is contaminated by nutrients, sediment, trash, or toxic materials.

Watershed – the land area that drains into a water body. Large watersheds may contain smaller watersheds, which is one reason the term can be confusing.

Weed and Feed – lawn care product containing both fertilizer and herbicides. May be a watershed-friendly choice if applied according to label directions, the N-P-K ratio is correct for the lawn's nutrient needs, and the herbicide is designed for controlling the weeds causing a problem on the lawn.

Prepared by Timothy Abbey, Ruth Benner, Genevieve Christ, Tanner DelValle, Meagan Hopkins-Doerr, Sandy Feather, Peter Landschoot, Danielle Rhea, Jodi Sulpizio, Denise Uzupis, Andy Yencha, and Beth Yount

Penn State College of Agricultural Sciences research and extension programs are funded in part by Pennsylvania counties, the Commonwealth of Pennsylvania, and the U.S. Department of Agriculture.

Code EE1184 UBR AGR 26-760 3.5M04/26MPC A11Y