# Best Management Practices for Landscape Fertilizer Use on Nantucket Island

**Prepared by the Article 68 Work Group**

**2010–2012**

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***Section 1***

## Introduction

THE PURPOSE OF *BEST MANAGEMENT PRACTICES FOR NANTUCKET* [*BMP*] is to provide science-based guidelines for fertilizer use and other landscape practices that, when followed, reduce the loss of soil nutrients from excessive, incorrectly timed, or inappropriate fertilizers. On Nantucket, lost nutrients find their way rapidly to the coastal waters, harbors, ponds, and streams where they may cause contamination that is harmful to aquatic organisms as well as to human health and welfare.

Objectives of the *BMP* are:

- To provide landscape professionals and homeowners with information for making environmentally sound landscaping decisions that take Nantucket's unique conditions and natural resources into consideration;
- To promote the protection of water resources while maintaining healthy and vibrant ornamental landscapes;
- To reduce the amount of fertilizer use by promoting cultural practices that help reduce nutrient inputs;
- To offer site-planning guidelines and suggestions for ecological restoration that help reduce island-wide fertilizer-dependent landscapes;
- To provide science-based guidance for nutrient management of lawns and gardens on Nantucket.

In 2010, Nantucket Annual Town Meeting authorized the Board of Selectmen [BOS] to introduce legislation to the Massachusetts State Legislature via the Home-Rule Petition (HRP) process to regulate the use of fertilizers in the Town and County of Nantucket. To assist in the process, the BOS appointed the Article 68 Work Group [WG] comprising representatives from interested groups in the community. The WG was charged to recommend constructive changes in perfecting the language of the proposed HRP legislation and to develop a comprehensive plan to reduce the amount of nitrogen and phosphorus contributed by landscape fertilizers in our waters. The WG concluded that, as the basis of its recommendations, it would create a *BMP* specific to Nantucket's climate and soil conditions as an educational document that incorporates the latest turf and soil science for safe and effective landscape-fertilizer management on Nantucket. The principles contained in the *BMP* would provide a foundation for the regulatory package developed for the HRP and for any subsequent use by Nantucket's Board of Health.

Nantucket's glacial soils are dominated by deep sands and gravels with low organic-matter [OM] content. These soils readily allow water to infiltrate and are particularly prone to leaching of fertilizer and other pollutants. Leaching is the loss of nutrient from the soil by water-based dissolution and transport. Nitrogen that reaches our waters comes from a variety of sources. Although the largest percentage comes from atmospheric deposition of combustion-caused nitrates (automobile and power-plant exhaust); other human-related land uses contribute a significant amount.

Exact percentages are nearly impossible to measure, but among the major N contributors from land-based uses are septic systems, road and roof runoff, and excessive or inappropriately applied fertilizers from both agricultural and landscape practices. Nutrient leaching from improper fertilizer use is one of the controllable contributing factors to the degradation of our groundwater and surface water bodies. It is estimated that approximately 10 to 19 percent of the nitrogen applied to turf on Cape Cod soils, which are similar to Nantucket's, eventually leaches into groundwater [Petrovic, 2008; Horsely Witten Group, 2009]. It is likely that N-loss rates may be higher for ornamental plantings than for turf [Cisar et al., 2003; Erickson et al., 2001]. The control of fertilizer application, along with controls on septic and sewer systems, will help reduce degradation of the critical resources of Nantucket's waters.

In recent decades, Nantucket has experienced significant land development resulting in increased N and phosphorus [P] inputs from land-based uses, including many high- maintenance lawns and gardens that are regularly fertilized. Continued development of the island and increases in atmospheric deposition further threaten our water resources and demonstrate the need for increased awareness of landscape choices and practices that reduce both N and P inputs without sacrificing the appeal of well-maintained landscapes or the health of our water resources.

Nantucket Island has abundant freshwater and saltwater resources. Nitrogen is the limiting nutrient for saltwater and some freshwater systems while phosphorus is most often the limiting nutrient for freshwater systems. Excessive concentrations of N in saltwater and P in freshwater will facilitate algae blooms and various levels of eutrophication. These algal blooms can be toxic to marine life and, in some cases, to humans, pets, and livestock.

The WG assigned a subgroup to review the 2003 *BMP for Turf, Tree, and Shrub Fertilization on Nantucket Island,* an earlier document produced by the Nantucket Landscape Association, and to make recommendations for updating and improving it. This resulting document incorporates and expands upon much of the previous Nantucket-based material with added guidelines from a number of other relevant sources. The recommendations and guidelines presented in this document reflect the experience and knowledge of Nantucket landscape professionals and have been peer reviewed by turf and soil scientists. Those reviewers are identified and thanked in the Acknowledgments. They voluntarily gave invaluable service to Nantucket, and we are in their debt.

This *BMP* is the educational document that will provide Nantucket landscape professionals and interested homeowners with information necessary for effective turf and garden fertilizer management with the larger aim of protecting our aquatic resources. It is derived from documents gathered by other entities interested in managing fertilizer applications, from newly written guidance documents for turfgrass management, from standard textbooks on soil and turf science, from the experience of the Article 68 Work Group members, and from members of the scientific and academic communities who gave freely of their knowledge when reviewing this work.

## *Section 2*

## Site Assessment and Planning

- **Site assessment is a stage in the construction-design process in which the pre-existing physical and biological conditions of a site are identified and used as the basis for developing a plan that takes best advantage of the existing conditions.**
- **Site assessment should include the following: determination of building and other construction envelopes; soil characteristics as determined by soil tests; land forms and contours; view-sheds; micro climate conditions including winds, temperatures, and sun exposure; a plant inventory; and identification of areas of critical environmental concern including wetlands and rare plant communities or animal populations.**
- **The site plan for new construction should take advantage of existing landforms, minimize disturbance to lands not slated for development, and conserve topsoil for post-construction landscaping.**
- **Landscape plans should aim to minimize areas requiring supplemental fertilization and include undisturbed natural areas where possible.**
- **Site planning for renovations to existing landscapes should include identification of all of the above conditions plus: an as-built plan delineating location and type of landscaped areas; irrigation system; other subsurface utilities; a fertilization history; a history of existing and potential problems; and any owner expectations for change and improvement.**
- **Site planning for the many areas of the island in proximity to wetland resource areas—including harbors, ponds, and marshes—must follow the guidelines and procedures of the Nantucket Conservation Commission.**

Site assessment is the identification and recording of site conditions, including areas of environmental sensitivity, that factor into how a site is developed. This fundamental information is used for site planning and determining how a particular property will be designed or renovated and managed.

In order to thrive and grow, most lawns, gardens, and man-made landscapes are dependent on varying degrees of alteration to natural ecosystems. Site planning determines how much of the area of a particular property will require fertilizers for proper management. Site planning that incorporates the preservation of naturally existing vegetation, on a site-by-site basis, plays an important role in reducing island-wide fertilizer use. Whenever self-sustaining natural plant communities can be preserved, either adjacent to or as components of manmade landscapes, fertilizer use island-wide is reduced.

### Identifying Site Conditions

The Town of Nantucket's Web GIS Map Page is a useful resource for identifying some basic Nantucket site conditions. [http://host.appgeo.com/nantucketma/]

The following site conditions form the basis for site planning:

- Soil characteristics obtained with a comprehensive soil test from a reputable laboratory to determine soil pH, texture, and nutrient analysis. [See Section 3: "Soil Nutrient Analysis: The Importance of the Soil Test" for detailed information on soil testing, interpretation, and application.]
- Prevailing and storm-related seasonal winds
- Seasonal patterns of sunlight exposure

- Land contours and elevations and how they influence drainage patterns and variations in microclimate
- Existing plant communities including trees, shrubs, grasslands, and invasive plants if present. Particular attention should be paid to rare plant and animal populations as determined by the Massachusetts Natural Heritage and Endangered Species Program.
- Environmentally sensitive areas such as wetland resource areas, as determined by the Nantucket Conservation Commission
- Desirable and undesirable views

**Site Planning for New Construction**

Careful site planning for construction on undisturbed lands is related to best management practices aimed at reducing landscape-related fertilizer use island-wide. On Nantucket, many new residences are built on, or adjacent to, relatively undisturbed natural areas. Naturalized plant communities consist primarily of plant species that have developed since grazing and farming practices were largely abandoned in the 1800s and are adapted to Nantucket's climate and soil conditions. Existing self-sustaining plant communities may be preserved for screening, as buffers to sensitive wetlands, or incorporated as integral aspects of the man-made landscape.

Planning for a site prior to construction starts by identifying the conditions listed above, then determining the maximum use area, or building envelope, needed both during and after construction. When preparing the landscape for new construction, it is recommended to identify the necessary building area including septic-system installation and other underground site work. Once the building envelope has been determined, existing topsoil should be carefully stripped and stockpiled within the work area. Desirable natural vegetation outside the building envelope should be fenced to avoid construction-related damage. During the construction process, areas down grade from stripped land should be protected from runoff with either siltation fencing or hay bales.

Oftentimes, more land needs to be disturbed for construction on a site than will be necessary for a well-designed man-made landscape. It is recommended that disturbed areas of a property unnecessary for the finished landscape plan be restored with low- maintenance plantings that do not require management with fertilizers or irrigation. [See Section 11: "Alternative Naturalistic Style Practices" for more on low-maintenance landscape alternatives.]

Soil is inevitably damaged during construction, but some practices help minimize the damage. When undisturbed land within the building envelope consists of brush or old field grasses, it should be brush cut, then rototilled before stripping and stockpiling. Where space allows, stockpiling of stripped topsoil in windrows instead of one large pile is less damaging to the microbiology of the soil. To determine nutrient or OM needs for turf or garden practices, any removed topsoil should be tested both while being stored and after being spread. A cover crop such as winter or annual rye applied to stockpiled topsoil may help minimize damage to stored soil and provide some OM content.

An important and often overlooked aspect of finish grading after construction is to improve subsoil that has been compacted by heavy machinery and vehicular traffic during construction. When possible, the transition from subsoil to amended topsoil should be gradual rather than abrupt by mixing some topsoil to the top layer of subsoil. When this practice is followed, air and water movement through the soil will benefit, contributing to plant health and vitality.

**Site Assessment for Existing Managed Landscapes**
Site assessment for managed landscapes starts by identifying the same conditions listed above with additional information as listed below. Assessment of an existing man-made landscape may be desirable to identify and correct problem areas, or when considering a renovation or change in management approach.

Some additional information to gather for assessing an existing manmade landscape:

- An as-built landscape plan, if available, showing major features and use areas
- Square footage of turf and garden areas being managed
- As-built drawings showing underground utilities
- An as-built irrigation plan or diagram
- The functional condition of existing irrigation system and drainage patterns
- A history or summary of recent fertility management
- A list of current or potential problem areas
- A list of client/owner requirements and expectations

**Choosing a Management Plan**
Developing a management plan for either a new or existing property depends on clear communication of options and choices between the property owner and the landscape professional or professionals involved in the design and maintenance of the property.

In choosing a management plan for lawn areas in particular, the higher the level of quality desired and the more intense the use, the higher the level of management necessary to maintain a quality surface. High-maintenance turf uses include playing fields, croquet surfaces, and suggest golf course quality turf. A lower-maintenance turf, with lower use levels, where “perfection” is not a priority and some weeds are tolerated, will require less intense management.

Once high-use areas such as lawns and gardens or other planting areas are determined, it is important to decide how to transition to undisturbed areas of a property whether they are environmentally sensitive or simply existing natural plant communities.
Recommended edge plantings, sometimes referred to as buffer plantings, consist of low-maintenance naturalistic style plantings. [See Section 11: “Alternative Naturalistic Style Practices.”]

## *Section 3*

## Soil Analysis: The Role of the Soil Test

- **Regular soil tests are necessary components of any turf or ornamental-planting management program that includes fertilization or the addition of soil amendments.**
- **A soil test provides the following information: soil pH; the amounts of plant nutrients present; soil texture and organic matter content: cation exchange capacity; and recommendations for fertilization, pH adjustment, and soil amendments.**
- **A soil test should be conducted as far in advance of new landscape plantings as possible.**
- **For established turf and plantings, a complete soil test should be conducted every three years and soil pH should be determined annually.**
- **Soil should be tested annually if phosphorous is added.**
- **Soil conditioners, top-dressing materials, composts, and other turf and garden amendments should be tested to ensure suitability for use.**
- **Applying soil-test recommendations, especially recommended nitrogen amounts, must take into consideration Nantucket's thin, sandy soils with the associated risks of nutrient leaching and runoff to vulnerable aquatic resources.**

### Soil

The uppermost layer of the earth's crust is referred to as soil. Soil is a mixture of mineral particles derived from underlying rock and organic matter derived from plant and animal residues and includes air and water in the pore spaces. Mineral particles in soil are classified as sand, silt, and clay in descending order of size. The particle size distribution determines soil texture. Soils consisting of approximately 40 % sand, 40 % silt, and 20 % clay are called loams and are generally considered the most appropriate soils for agricultural activities and turf. Soils with a high percentage of clay or sand are generally less suitable for agriculture or turf. Sandy soils, prevalent on Nantucket, are often low in nutrients and organic matter and do not retain water well and are, therefore, a poor base for turfgrasses and many ornamental plantings.

The organic matter [OM] in soil is derived from plants, microorganisms, and animal residues. OM in soil performs several important functions including providing food and habitat for organisms and increasing aeration and moisture-retention capacity. As soil OM decomposes, it releases nutrients that become available for plant uptake, and in that respect it is a form of fertilizer.

Soil structure refers to the aggregation of soil particles into larger sized units. Soil structure results from the physical and chemical activities of plant roots and soil organisms and the seasonal expansion and contraction due to freeze–thaw and wet–dry cycles. A well-structured soil permits air and water movement throughout the root zone, promoting soil health and plant growth. Loam soils tend to be well structured while sand and clay soils tend to be poorly structured. Soil structure is often destroyed by construction activities.

### Nantucket's Soil

A range of soil types is found on Nantucket. Although sandy soils are the most common on the island, clays, loams, and mucky organic soils are found in some areas. A typical Nantucket sandy soil is acidic, low in OM content, nutrient poor, and vulnerable to fertilizer leaching. Because of our poor soils, most lawns, gardens, and other man-made landscapes on Nantucket are dependent on varying degrees of augmentation with fertilizer and/or OM, depending on the type of plantings employed. A comprehensive soil test is recommended to ensure that science-based decisions for nutrient management are made for local soil conditions and the desired plantings.

**The Soil Test**

The soil test uses physical soil samples taken from a lawn, garden, or other area that are laboratory tested and provide information specific to the area where the samples were collected. A comprehensive soil test provides information on soil nutrients, heavy metals, salinity, pH, buffer pH, cation-exchange capacity (CEC), texture, and percentage of OM.

The soil test provides recommendations for corrective measures for the specified application such as turfgrass or a flower garden. Following the soil-test recommendations, as modified for Nantucket, is an important way to ensure that lawns and gardens are being fertilized correctly. Often, a soil-testing lab will recommend higher amounts of nutrients that are based on traditional crop demands, which can lead to over fertilization on Nantucket soils.

For healthy turf or gardens, a comprehensive soil test is recommended every three to four years. More frequent tests may be required for newly planted areas or in diseased or other problem areas. Soil should be tested annually in areas where compost or other fertilizers containing phosphorus are used to ensure that it is not being over applied. Turf pH should be measured annually, since turf performance and health can be affected by relatively small changes in pH. For new landscape plantings, the soil being used should be tested as far in advance of planting as possible to allow enough time for any recommended adjustments to the soil pH, texture, OM, or nutrient levels to become effective.

**Collecting a Proper Soil Sample**

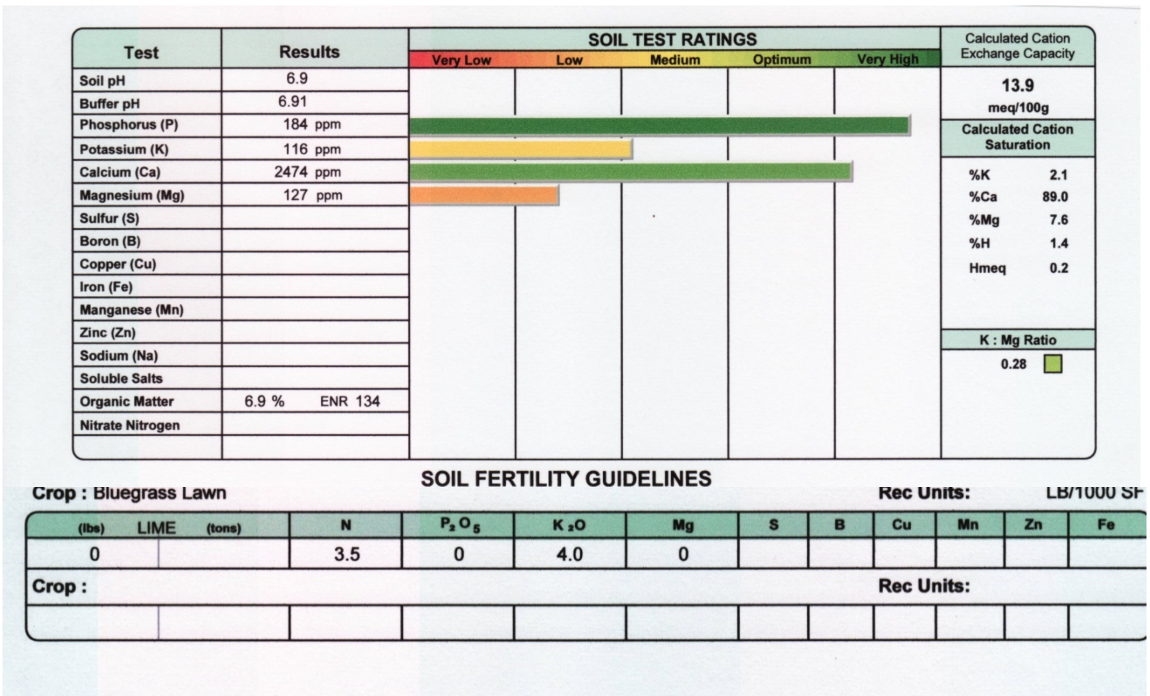
Accurate results and recommendations from a soil-test lab depend on obtaining a good sample. Individual labs provide detailed instructions on collecting, labeling, and submitting samples. [See Appendix 1 for links and mailing instructions for several recommended labs.]

Some tips for obtaining good soil samples follow:

- Use a stainless-steel or chrome-plated soil probe, auger, or trowel. Do not use brass, bronze, or galvanized tools because they may contaminate samples.
- Numerous samples of a representative area should be taken to a depth of 4″ and mixed together. Place one or two cups of the mixed sample into a quart-size sealable plastic bag and label it with property identification and type of use.
- Do not include thatch with soil sample.
- Each sample should represent one use area: e.g., a lawn, a vegetable garden, or a perennial garden.
- Samples may be taken at any time of year but should be at about the same time of the year in successive years. If done at the end of the calendar year, laboratory results will be returned in time for the next growing season.

- For recently limed or fertilized soil, testing should be delayed by eight weeks to allow time for the nutrients to become available.
- Take separate samples for areas showing abnormal plant growth, discoloration, or other cultural problem and for areas that have markedly different soil types.

**Figure 1. A Sample Soil-Test Analysis for a Nantucket Soil**. *This soil test came from an organically managed lawn where compost was both roto-tilled prior to establishment and subsequently added as top-dressing.*



| Test | Results |
|---|---|
| Soil pH | 6.9 |
| Buffer pH | 6.91 |
| Phosphorus (P) | 184 ppm |
| Potassium (K) | 116 ppm |
| Calcium (Ca) | 2474 ppm |
| Magnesium (Mg) | 127 ppm |
| Sulfur (S) | |
| Boron (B) | |
| Copper (Cu) | |
| Iron (Fe) | |
| Manganese (Mn) | |
| Zinc (Zn) | |
| Sodium (Na) | |
| Soluble Salts | |
| Organic Matter | 6.9 % ENR 134 |
| Nitrate Nitrogen | |



| Calculated Cation Exchange Capacity | |
|---|---|
| 13.9 meq/100g | |
| Calculated Cation Saturation | |
| %K | 2.1 |
| %Ca | 89.0 |
| %Mg | 7.6 |
| %H | 1.4 |
| Hmeq | 0.2 |
| K : Mg Ratio | 0.28 |

SOIL FERTILITY GUIDELINES

Crop : Bluegrass Lawn — Rec Units: LB/1000 SF

| (lbs) LIME (tons) | | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 3.5 | 0 | 4.0 | 0 | | | | | | |

Crop : — Rec Units:

**Explanation of the Sample Soil Test Analysis**

In this sub-section, the components of the soil test in Figure 1 are explained along with the acceptable range of values for each component. Further information on interpreting soil tests can be found in the reference works listed in the Bibliography.

**Soil Test Ratings:** Individual nutrient elements from this lab are rated with five levels ranging from “very low” to “very high.” “Very low,” “low,” and “medium” levels indicate various levels of deficiency, and specified amounts of the nutrient will be suggested to achieve the correct fertility. An “optimum” level indicates that the correct amount of nutrient is present in the soil. A “very high” level means the nutrient is present in excess of what the plant needs. Nutrients rated as “optimum” or “very high” should not be added to soils, as excess can lead to nutrient losses into ground and surface water.

**Soil pH:** pH is a measure of soil acidity or alkalinity. A pH of 7.0 is neutral while higher values are alkaline and lower values are acidic. Soil pH affects the plant’s ability to absorb nutrients. A pH of 6.0–7.0 is the desired range for most turf and garden plants. This soil test indicates that pH is in the optimum level for a bluegrass lawn.

**Phosphorus [P]:** Elevated levels of P are a major contributor to freshwater-pond contamination. This test measures P as phosphate [$P_2O_5^+$] that is readily available to plants. In this sample, P measured "very high," so none should be added. As explained in more detail in *Section 5,* two different tests are commonly used to measure P in Nantucket soils: the Mehlich III extraction method and the Modified-Morgan extraction method. These tests give somewhat different results, so the same test procedure should be used when comparing results among years or areas. In this example, the "very high" level of P in the soil may contribute to freshwater nutrient loading if in proximity to any of the island's many freshwater ponds.

**Potassium [K]:** This test measures available K in a soil. The optimum K level varies with plant, yield, and soil type. A K level of 120–200 PPM is adequate for most plants.

**Calcium and magnesium:** Calcium deficiencies are rare when the soil pH is adequate. Calcium will be in the optimum range once lime is applied to adjust to the pH-level appropriate for the chosen plants. Magnesium deficiencies are fairly common. Apply dolomitic lime if magnesium levels fall below 70 PPM.

**Sulfur:** This test shows no ratings for sulfate sulfur, the readily available form of sulfur for most plants. Optimum levels usually range from 20 to 30 PPM.

**Micronutrients (zinc, manganese, iron, copper, boron):** Turfgrasses need only small amounts of these micronutrients, and deficiencies are uncommon when the pH is below 7.0. For gardens and flowering plants, the optimum range for zinc is 6–10 PPM, manganese is 20–40 PPM, iron is 10–50 PPM, copper is 0.4–5.0 PPM, and boron is 0.8–2.0 PPM. These levels may be somewhat arbitrary as there are no scientific studies to confirm these levels for turfgrass.

**Calculated Cation Saturation:** Calculated Cation Saturation provides the relative abundances of the major cations in the soil. Until recently it was thought that there was an ideal balance of cations for maximizing soil fertility. More recent research suggests that the measured levels of the individual cations is more important than relative levels, so this section may provide little useful information.

**Sodium:** Sodium is a nonessential nutrient for most crops and high sodium levels may cause adverse physical and chemical conditions in soils. Excessive levels of sodium can be reduced by leaching and through the application of calcium sulfate (gypsum).

**Soluble Salts:** Excessive concentrations of various salts can develop in soils. This may be from natural causes, the result of irrigation with high-salt-content water, excessive fertilizer and compost application, or contamination from chemical or industrial waste. Amounts above 1,900 PPM are hazardous to plants and should be leached from the soil.

**Organic Matter [OM]:** Organic matter is expressed as a percentage of the total soil mass. It measures the amount of decomposed plant and animal residues in a soil. This soil tests 6.9% OM. Organic matter oxidizes rapidly in sandy soils, such as occur on Nantucket, resulting in native soils that are low in organic matter. OM at 6.9%, depending on its content, may leach both N and P during oxidation. On un-amended Nantucket soil, organic matter content can be gradually increased to a maximum of 4% OM for both Nantucket turf and gardens by adding leaf-based compost or other organic materials at rates recommended in Section 5: "The Role of Compost in Nantucket Soil"; Section 6: "Guidelines for Timing and Rate of Turfgrass Fertilizer Application"; and Section 9: "Guidelines for Nutrient Management of Gardens, Trees, Shrubs, and Hedges."

**Estimated Nitrogen Release [ENR]:** The ENR refers to the amount of N measured in pounds per acre that can potentially be released from soil OM during a growing season under ideal conditions. However, the actual rate at which OM will decompose and release N depends on many interrelated factors—soil type, moisture, and temperature having the greatest effects. Most of the soil scientists who were consulted during the preparation of this *BMP* believed that the ENR was not a reliable way to predict N-release rates and at best provides only a snapshot of the potentially available N in a soil.

**Calculated Cation Exchange Capacity [CEC]:** CEC measures the soil's ability to retain nutrients and other cations such as ammonium, calcium, magnesium, potassium, sodium, and hydrogen. The CEC of a soil increases with the percentage of clay and OM content. The normal CEC value for loamy soil is between 4 and 8. Recent studies indicate 6 as the critical CEC level for turf growth. This test shows excellent CEC capacity.

**Crop:** The crop is the vegetation or planting type from which the soil sample was collected. The type of crop will affect the amounts of nutrients recommended in the Soil Fertility Guidelines below.

**Soil Fertility Guidelines:** The soil fertility guidelines list the recommended rates of nutrient applications in pounds per 1000 square feet in order to correct nutrient deficiencies in the soil tested for the crop in question. The recommendation made by this lab for an annual 3.5 lbs. N /1000 sq. ft. exceeds the *BMP* guidelines for Nantucket soils.

**Applying the Soil Test Fertility Guidelines to Correct Deficiencies**

The example soil test in Figure 1 indicates that N and K are required for this soil and the bluegrass lawn that is present on the site. The recommendation of 3.5 lbs. N / 1000 sq. ft. is greater than allowed on Nantucket. This *BMP* recommends a conservative approach of adding small amounts of N, not to exceed 3 lbs. / 1000 sq. ft. per year, and monitoring plant response to determine overall N need rather that strictly following the soil test guidelines.

The soil test recommends adding 4.0 lbs. K (as $K_2O$)/1000 sq. ft.; an organic or synthetic source of K may be used. Care must be taken when using a combination product to not over-apply N or P to correct the K deficiency. Only one pound of K can be applied efficiently per application, so the K should be applied in successive applications over the season.

Once application rates for correcting deficiencies are determined, visual inspection of plants for color and vigor and cultural practices should factor into determining a seasonal fertility program for the turf.

## *Section 4*

## Fertilizer Types and Sources

- **Fertilizer is a generic term for a material that contains one or more plant mineral nutrients;**
- **Fertilizers may also contain microbial agents.**
- **Nitrogen [N], phosphorus [P], and potassium [K] are the primary nutrients found in fertilizers.**
- **This section discusses the similarities and differences between organic and synthetic fertilizers and between slow- or controlled-release (water insoluble, for the most part) and fast-release (water soluble) nitrogen fertilizers.**
- **Numerous, commonly used natural and synthetic sources and types of N, P and K fertilizers are discussed in an appendix, along with guidelines for their use on Nantucket.**
- **Instructions on how to read and interpret fertilizer labels are provided.**

The numerous types of fertilizers available include granular and liquid, slow- and fast- release, and organic and synthetic formulations. Many fertilizers are blended for specific applications such as turf, ornamentals, or gardens. This section provides information on reading and interpreting a fertilizer label, with particular attention to understanding the sources and types of nitrogen (N) and P present in the fertilizer. Sources and types of K are briefly discussed.

### *Sources and Types of Nitrogen Fertilizers*

**Nitrogen Uptake by Plants:** N is absorbed by plants in only two forms: nitrate [$NO_3^-$] and ammonium [$NH_4^+$]. Other forms of N must be converted to one of those forms to be utilized by plants. Both $NO_3^-$ and $NH_4^+$ are water soluble, which not only makes them readily available to plants but means they are easily leached from Nantucket's sandy soils.

Both organic and synthetic fertilizers are available with fast- and slow-release forms of N. The N in quick-release fertilizers is water soluble and is usually a salt of either $NO_3^-$ or $NH_4^+$ or in some form that is readily converted to one of them. Examples of quick-release synthetic fertilizers include ammonium nitrate, potassium nitrate, and urea. Compost tea is an example of an organic fast-release fertilizer.

The N in slow-release fertilizers is not in a readily soluble form. Slow-release synthetic fertilizers rely on a variety of mechanisms—such as coatings—to delay the release of N. Commonly used examples of synthetic slow-release fertilizers include Polyon and Nutralene. Most slow-release organic fertilizers contain N within complex organic molecules that are slowly broken down by soil organisms in a process called mineralization, which releases the N. Compost and Sustane are examples of slow-release organic fertilizers.

The following abbreviations are commonly used in describing the type of nitrogen contained in fertilizer.

**SRN** – Slow-release nitrogen or slowly available nitrogen. This encompasses many sources of N that are designed to release slowly over time. SRN can be organic, synthetic, or a combination of both. The time required for N release is dependent on the source or chemistry of the individual product (see WIN and CRN below).

**WIN** – Water-insoluble nitrogen. This is a type of SRN that does not break down by hydrolysis (water), but instead relies on microbial activity for release. It is important to note that microbial activity, and hence the release rate of WIN fertilizers, increases with soil moisture and temperature.

**CRN** – Coated slow-release nitrogen. CRN fertilizers are synthetic SRN products that employ coatings that dissolve slowly in water or rely on microbial activity to slowly remove the coating. The rate at which the coating is removed varies with the type of product. The N in many CRN products is often water soluble (see WSN below), and once the coating is removed the N is immediately available to plants.

**WSN** – Water-soluble nitrogen. WSN is quickly released by rain, irrigation, or water in the soil and is immediately available to plants. Large rain events or excessive irrigation just after the application of WSN can result in excessive N leaching or runoff.

Most fertilizers contain a blend of WIN, WSN, and SRN, and the percentage of each is usually indicated on the fertilizer label. Fertilizers used on Nantucket must not contain more than 0.25 lb./1000 sq. ft. of fast-release N, with at least two weeks between applications (see Section 6: "Guidelines for Timing and Rate for Application of Turfgrass Fertilizer"). Total applications can be higher, up to 1.0 lb./1000 sq. ft., but the balance of the N must be in slow-release form.

Recent studies suggest that slow-release fertilizers aren't always effective in reducing N leaching. Nitrogen release from slow-release fertilizers, whether organic or synthetic, does not occur at a steady or predictable rate but varies with some combination of temperature, soil moisture, and microbial activity. The rate of N release also varies among products depending on the form of N and the mechanism employed to control N release. Problems can arise if slow-release fertilizers are applied during a period when environmental conditions do not favor release. The applicator, seeing no response in the turf, may apply additional fertilizer, effectively overloading the soil with N. Large amounts of N can then be released when appropriate conditions return that overwhelm the turf's ability to capture it. In wet years, compared to fast-release fertilizers, slow-release fertilizers are most effective at reducing N leaching, but they may only delay leaching in years of average precipitation.

Whether synthetic or organic, slow or fast release, most of the N applied is eventually released into the soil, and over-application can result in increased fertilizer leaching and runoff. This *BMP* recommends applying both slow- and fast-release fertilizers in several small applications spaced throughout the growing season and monitoring plant performance before applying additional fertilizers. This will help prevent N buildup in the soil and reduce leaching rates (see Section 8: "Guideline for Timing and Rate of Fertilizer Applications").

**Phosphorus Uptake by Plants**

Phosphorus [P] fertilizers are available in both synthetic- and organic- and fast- and slow- release forms. Although many forms of P exist in soil, it is best absorbed by plant roots as the $H_2PO_4^-$ form of phosphate. P is mined in phosphate-bearing minerals and also occurs as part of many organic molecules. Commonly used fast-release P fertilizers include super triple phosphate, ammonium phosphate, and potassium phosphate. Commonly used organic P fertilizers include compost, manures (typically as compost), and worm castings. Though composts and manures contain organic forms of P, most of the P found in those sources is inorganic in form. Studies show that up to 85% of P in composted manures can be inorganic. It is important to note that most synthetic and virtually all organic sources of P also contain N; any N additions resulting in addition of P fertilizer must be included in annual N totals.

Phosphorus is relatively immobile in soil and is generally considered not to be prone to leaching in most soil types. However, sandy soils, such as those occurring on Nantucket, are susceptible to P leaching and care must be taken to not over-apply P. It is essential that a soil test be conducted to determine the need for P prior to application (see Section 3: "Soil Nutrient Analysis"). Two phosphorus-extraction methods, the Morgan and the Mehlich III, are commonly used in soil tests. However, these methods provide different P amounts from the same soil sample. Therefore, the same method and testing laboratory should be used for all soil tests on a given property.

Newly established lawns may require readily available P to promote root growth and seedling development (see Section 7: "Turf Establishment Guidelines"). A soil test should be conducted prior to seeding to determine if additional P is required. Research has shown that the inoculation of soil with mycorrhizal fungi at the time of seeding can increase grass-seed germination, seedling establishment, and root growth Mycorrhizal fungi also increase the efficiency of nutrient uptake, including P, and may reduce the need for P during turf establishment.

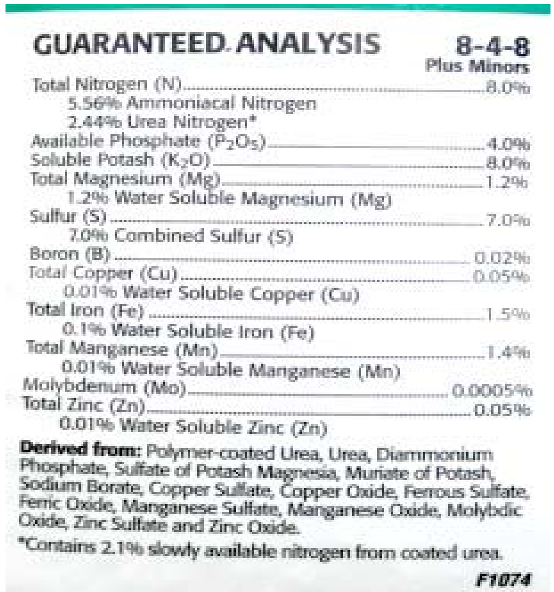
**Sources and Types of Potassium**

Though potassium [K] is not a major focus of this *BMP*, its use and application still needs to be made responsibly and in accordance with soil-test results. Sources and types of K fertilizers are included in Appendix 3.

**Interpreting the Fertilizer Label**

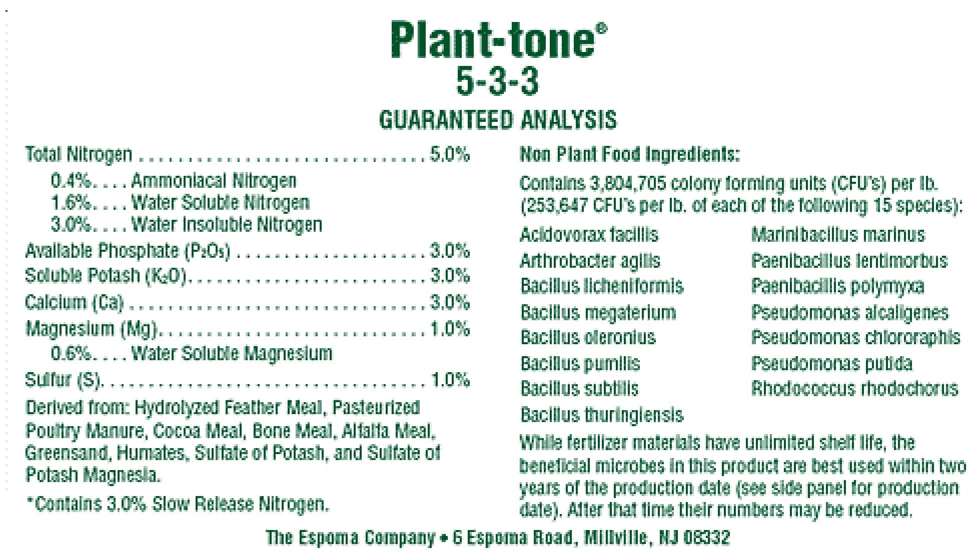
The fertilizer label provides the legal guarantee of the percentage of nutrients contained in the fertilizer. The label contains information on the source and amount of the nutrients and other materials found in the fertilizer, including elemental N, P as phosphate [$P_2O_5$], and K as potash [$K_2O$], as well as other nutrients (Figures 3 and 4). The fertilizer ratio compares the percentages by weight of the three major nutrients (N, P, K) contained in the fertilizer. In the sample label in Figure 3, the fertilizer ratio is 8-4-8 or 8% elemental N, 4% phosphate, and 8% potash by weight. The label also describes the chemical sources of the nutrients and the proportion of N as $NO_3$- and $NH_4$+, as well as the percentage of slow-release N in the fertilizer.

**Figure 3.** *A sample fertilizer label*




Some fertilizers also provide information on micronutrients and non-plant food ingredient content and the amounts and types of beneficial microbes in the product, as indicated in the label in Figure 4.

**Figure 4.** *A fertilizer label including information on non-nutritive ingredients.*




Always consult a soil test when determining the proper fertilizer for the soil in question. Soil tests are discussed in detail in Section 3: "Soil Nutrient Analysis: The Importance of the Soil Test." [See Section 6: "Guidelines for Timing and Rates of Turfgrass Fertilizer Application" for detailed information concerning fertilizer application rates.] See Appendix 3 for a detailed description of nitrogen fertilizers.

## *Section 5*

## The Role of Compost

- **Composts and compost teas are considered fertilizers for the purposes of the Nantucket *BMP***
- **Composts are derived from a wide range of sources and must be tested for nitrogen [N] and phosphorus [P] content, soluble salts, and pH before being applied for landscape purposes. Testing for heavy metals is also recommended if the source of the compost is unknown.**
- **Composts are sources of nutrients, increase soil organic matter[OM] and aeration, provide food for beneficial bacteria and fungi, and improve soil-water and nutrient-holding capacity.**
- **Due to its low N and P content, compost derived from leaf litter is preferred for Nantucket soils.**
- **Compost should be applied only between April 15 and October 15 and when soil temperatures are above 55°F.**
- **For soils testing at optimum P levels, a maximum annual rate of ½ inch of leaf-based compost is allowed applied in two ¼ inch applications with a minimum of three months between applications.**
- **Composts made from feedlot and dairy manure contain relatively high levels of both N and P and should be applied only if a soil test indicates severe P deficiencies and at rates recommended for Nantucket's soils.**
- **Composts made from poultry manure are not recommended because they contain high levels of N and P and can contain elevated levels of soluble salts.**
- **Compost tea is an aqueous extract of compost that is used as a foliar fertilizer and as a means of inoculating soil with beneficial microorganisms. The latter claim has not been scientifically verified.**
- **The maximum organic matter [OM] percentage recommended for sandy Nantucket lawns and gardens soils is 4%. It is difficult to increase the OM content of soils more than 1% above the native OM content without increasing soil test P values above the Environmental Critical Level [ECL].**

### Compost
Compost is partially decomposed organic matter that can be produced from plant material, animal waste, or both. Compost is commercially available in bulk or bags for the landscape trade and can also be produced at home. Compost performs several important functions for lawns, gardens, and ornamental plantings. This section will discuss compost as a means of increasing soil OM content, increasing the number and diversity of soil organisms, and as a fertilizer. All composts used as soil amendments on Nantucket must have a known nutrient content or be tested for nutrient content before use.

### Compost and Soil Organic Matter Content
Compost is often added to soil to increase OM content. Soil OM improves soil structure, aeration, water- and nutrient-holding capacity, biological activity, and fertility. As soil OM decomposes, nutrients are released and made available to plants. The decomposition rate depends on a variety of factors including soil moisture, aeration, temperature, biological activity, and the type of compost used. Although the precise decomposition rate is difficult to predict accurately, it tends to be high in sandy soils.

The generally prescribed range of OM for turf, gardens, and crop soil is between 5 and 8%. Nantucket's native sandy soils tend to have much lower OM content, ranging from 0.8 to 3.5 %. It is difficult to increase soil OM content more that 1% above the native OM content without increasing the likelihood of nutrient leaching. Therefore, a maximum soil OM level of 4% is recommended for Nantucket soils used for turf, gardens, or ornamental plantings. Increases in soil OM should occur slowly over several years and include monitoring of soil test P levels to ensure the Environmental Critical Level [ECL] for P is not exceeded. Adding additional amounts of OM increases the risk of excessive nutrient application and nutrient loss to leaching or runoff. The process of using soil test P values to limit additions of compost to soils, and hence the soil OM content, is discussed in more detail in "Compost Phosphorus Content," below, and was arrived at after consultation with several of the turf- and soil-science professionals who reviewed the *BMP* (see Bibliography).

**Compost and Soil Organisms**

Soil OM, whether from compost or other sources, provides food and habitat for a complex array of soil organisms including bacteria, fungi, microorganisms, worms and insects. Soil organisms increase soil aeration and water infiltration and, in some cases, help prevent or reduce the severity of plant diseases. Soils with a diverse array of native organisms are often referred to as "healthy soils." Soil organisms are largely responsible for the decomposition of soil OM, which releases nutrients and makes them available to plants.

**Compost as a Fertilizer**

The *BMP* considers compost to be a fertilizer because it contains varying amounts of N, P, K, and other nutrients, depending on its source (Table 1). While the nutrient concentration of most composts is lower than that found in most granular fertilizers, much larger amounts of compost are often added to soils compared to fertilizers, so care must be taken to avoid over-applying compost. Leaf-litter compost tends to be the lowest in P and N and is the preferred compost for use on Nantucket. Manure, lawn, garden, and food-waste composts contain much higher levels of N and P. Some manure-based composts, especially poultry-manure compost, contain excessive amounts of soluble salt. Manure-based composts should not be used on Nantucket unless a soil test indicates otherwise.

**Table 1.** *Typical percentages of N and P in compost from various sources*

| Compost Type | %N | %P |
|---|---|---|
| **Leaf litter** | 0.1 | 0.05–0.2 |
| **Horse manure** | 0.5–1.5 | 0.5–1.5 |
| **Lawn, garden, and food waste** | 1.0–1.5 | 1.0–1.5 |
| **Dairy manure** | 1.0–1.5 | 1.0–1.5 |
| **Feedlot manure** | 1.0–1.5 | 1.0–1.5 |
| **Poultry manure** | 1.5–2.0 | 1.5–2.5 |

**Compost Phosphorus Content**

All currently available composts contain P in amounts that may result in over-application of P if applied at commonly recommended rates. This *BMP* recommends compost application rates based on soil and compost P content and on the Agronomic Critical Level [ACL] and Environmental Critical Level [ECL] of P in an effort to ensure that soil P levels do not exceed recommended amounts. The ACL is the soil P level at which an adequate amount of P is present for crop or turf production. The recommended P application rate in the soil-test report is designed to bring the soil P concentration above the ACL. The ECL is the soil P level at which P will run off or leach from the soil in amounts that can cause environmental damage. In general, the ECL is higher than the ACL, but the difference may be small, especially in sandy soils (Table 2). This results in a small margin of error when applying P in sandy soils.

Soil-testing laboratories in the Northeast typically use either a Modified-Morgan or the Mehlich III extraction method to determine soil P levels. These tests use different extraction solutions and produce very different results, so it is critical that applicators know which extraction solution was used. This information is provided in the soil-test report. It is important for applicators to use the same soil-testing laboratory and extraction method for repeated soil testing on a given property so that values can be compared. The ACL and ECL for a typical sandy soil such as those that commonly occur on Nantucket are presented in Table 2. The ECL for Nantucket's soils was arrived at from recent research on sand soils and after consultation with several of the turf-science professionals who reviewed the *BMP* (see bibliography).

**Table 2.** *The Agronomic and Environmental Critical Concentrations for Sandy Soils for the Modified Morgan and Mehlich III extraction methods.*

| Extraction Method | Agronomic Critical Level | Environmental Critical Level |
|---|---|---|
| **Modified Morgan** | 6 PPM or 12 lbs./acre | 14 PPM or 28 lbs./acre |
| **Mehlich III** | 50 PPM or 100 lbs./acre | 150 PPM or 300 lbs./acre |

PPM = parts per million.

**Guidelines for Compost Application Based on Compost P Content**

The average P concentrations of various types of compost are shown in Table 3. Most manure-based composts contain high concentrations of P. Up to 85% of the P in manure composts may be in fast-release inorganic form. Manure-based composts should be applied only if a soil test indicates a P deficiency. Even small applications of manure-based composts—for example, application of 1 inch of a 1% $P_2O_5$ concentration compost—may cause soils to exceed the ECL. In general, only leaf-based composts contain P in sufficiently low concentrations to prevent over-application of P. *Only leaf-based composts should be used on Nantucket.*

A routine soil test should be conducted before applying compost or any fertilizer. No P should be added to soils that are at or above the ACL. For soils that test below the ACL, apply the amount of $P_2O_5$ recommended in the soil-test report. It may be difficult to apply the amount of $P_2O_5$ recommended in a soil test report when using compost to maintain fertility. For example, recommended application rates for soils that test low for P often are in the range of 1 to 2 lbs./1000 sq. ft. Only ⅛ inch of a compost with a $P_2O_5$ concentration of 0.5% (e.g. leaf-based compost) will be needed because it supplies about 1.6 lbs. $P_2O_5$/1000 sq. ft. However, a ⅛ inch of compost with a $P_2O_5$ concentration of 1.0% (e.g. manure-based compost) would apply 3.1 lbs. of $P_2O_5$/1000 sq. ft., which is greater than the recommended amount. An additional soil test should be conducted before another application of P is made.

Soils that test between the ACL and the ECL for P can receive applications of compost if needed for improving soil quality and/or OM content, but such applications are discouraged. Application of a maximum of a quarter-inch of leaf-based compost is recommended for these soils. Applicators should wait at least three months and conduct a soil test before applying additional compost to these soils to ensure that the soil-test level does not exceed the ECL. Additional applications should not exceed one-quarter inch. No more than one-half inch of compost should be applied annually when a soil test shows P is at or above the ALC, and no compost should be added when the soil test P level is at or above the ECL.

The above guidelines apply to turf, trees, shrubs, and gardens and to both new plantings and established landscapes. [See Section 7: “Guidelines for Establishment and Renovation of Turfgrass”; Section 8: “Cultural Practices for Turf Care”; and Section 9: “Guidelines for Establishment and Fertility of Ornamental Gardens, Trees, Shrubs, and Hedges” for detailed establishment, maintenance, and renovation practices.]

**Table 3.** *Total pounds of phosphate [$P_2O_5$] applied /1000 sq. ft. in composts with various percentages of P concentration and at various application rates. See Table 1 for the percentage of P in various types of compost.*

| **Application rate** | | | **Percent $P_2O_5$ in Compost** | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Depth Inches** | **Yd/ Acre*** | **Tons/ Acre** | **.05%** | **0.5%** | **1%** | **1.5** | **2%** | **2.5%** |
| | | | **Pounds phosphate [$P_2O_5$] applied per 1000 sq. ft.** | | | | | |
| **1/8** | **16.9** | **6.8** | 0.16 | 1.6 | 3.1 | 4.7 | 6.2 | 7.8 |
| **¼** | **33.8** | **13.5** | 0.3 | 3.1 | 6.2 | 9.3 | 12.4 | 15.5 |
| **½** | **67.5** | **27.0** | 0.6 | 6.2 | 12.4 | 18.6 | 24.8 | 31.0 |
| **1** | **135.0** | **54.0** | 1.2 | 12.4 | 24.8 | 37.2 | 49.6 | 62.0 |
| **2** | **270.0** | **108.0** | 2.5 | 24.8 | 49.6 | 74.4 | 99.2 | 124.0 |

***Based on an average compost weight of 800 lb./cubic yard (wet weight)**

### Compost Nitrogen Content

Although these *BMP* guidelines for compost application are based on P content, attention must also be paid to the amount of N applied in compost. Table 4 provides estimates of total lbs. of N per 1000 sq. ft. contained in various types of compost. Nitrogen in compost is slowly released as the compost decomposes. Approximately 10 to 25% of the N is mineralized and released during a one-year period, although the release rate is likely near the 25% rate on sandy soils. Therefore, a compost application containing 12 lbs. N/1000 sq. ft. would be expected to release about 3 lbs.

N/1000 sq. ft. during the first year, which is the maximum allowed by the *BMP*. However, adding this much of any compost would supply about 12 lbs $P_2O_5$/1000 sq. ft. and would overload the soil with P. Therefore, it may not always be possible to achieve the desired annual N release rate using only compost, and organic landscape practitioners may need to supplement compost with organic fertilizers that contain no P.

Since only a portion of the compost decomposes each year, much of it remains in the soil for several years. Repeated compost applications may overload the soil with N and increase the possibility of nitrate loss to leaching or runoff.

**Table 4.** *Total pounds of N applied per 1000 sq. ft. in composts with various percentages of N composition and at various application rates. See Table 1 for the percentage of N in various types of compost. The application rate is presented with three different measurements, but the actual application amount in a row is the same for each measurement.*

| Application Rates | | | Percent Nitrogen in Compost | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Depth Inches** | **Yd/ Acre*** | **Tons/ Acre** | **0.1%** | **0.5%** | **1%** | **1.5** | **2%** | **2.5%** |
| **1/8** | **16.9** | **6.8** | 0.3 | 1.6 | 3.1 | 4.7 | 6.2 | 7.8 |
| **¼** | **33.8** | **13.5** | 0.6 | 3.1 | 6.2 | 9.3 | 12.4 | 15.5 |
| **½** | **67.5** | **27** | 1.2 | 6.2 | 12.4 | 18.6 | 24.8 | 31.0 |
| **1** | **135** | **54** | 2.5 | 12.4 | 24.8 | 37.2 | 49.6 | 62.0 |
| **2** | **270** | **108** | 5.0 | 24.8 | 49.6 | 74.4 | 99.2 | 124.0 |

**Adapted from the Composting Council, University of Missouri Extension**
***Based on an average compost weight of 800 lb./cubic yard (wet weight)**

**Compost Tea**
Compost tea is a fertilizer and soil amendment made by steeping well-aged compost plus a variety of nutrients and supplements in oxygenated water. The microorganisms and nutrient content of compost tea can vary widely, depending on brewing methods. Compost tea contains fast release N, P, and other nutrients, and it should be tested for nutrient content before application. Compost tea also contains a variety of microorganisms that are believed to be beneficial to soil health, though this assertion has not been scientifically established. It is also important to test compost tea for human pathogenic bacteria that may develop during the brewing process. Additional information on compost tea can be found in Section 6: "Guidelines for Timing and Rate for Application of Turfgrass Fertilizer.

## *Section 6*

## Guidelines for Timing and Rates for Application of Turfgrass Fertilizer

- **Effective and safe turf fertilizer use depends on correct application rates and timing.**
- **A soil test analysis should be consulted for making informed fertilizer application decisions.**
- **Fertilizer, both synthetic and organic, including composts, should only be applied on Nantucket after April 15 and before October 15 and when soil temperatures are above 55° F.**
- **Fertilizers should not be applied before a heavy rain and irrigation after application is limited to moistening the root zone.**
- **The maximum nitrogen [N] application rate for lawns on Nantucket is 3 lbs. N/1000 /sq. ft. /year.**
- **No individual N application shall exceed 1 lb. N/1000 sq. ft.**
- **No individual N application shall contain more than .25 lbs fast-release N/1000 sq. ft.**
- **Timing for N applications intervals depends on the amount of N per application and should never be less than two weeks apart.**
- **Observation of turf color and vigor should help guide application intervals over the course of the growing season.**
- **Phosphorus [P] should not be applied unless a soil test indicates a deficiency. Detailed exceptions are made for compost.**
- **Spoon-feeding of smaller amounts of fertilizer at more frequent intervals is often the most efficient and safe way to fertilize, but may not be realistic for most applicators or homeowners.**
- **Three sample fertility programs are detailed for an organic approach, a synthetic approach, and a hybrid (combined organic and synthetic) approach for annual turf fertilization.**

### Timing
The proper timing and rate of fertilizer application are important for both meeting plant requirements and avoiding nutrient contamination of aquatic resources. Turfgrass does not efficiently utilize nitrogen [N] or [P] when the ground temperature is below 55$^{o}$ F or during very hot or dry conditions. Applying fertilizer at times when it is not available to plants can lead to surface runoff into wetlands or leaching into groundwater. Fertilizers should be applied only between April 15 and October 15 and when soil temperatures are above 55° F. Soil temperatures can be measured at a four-inch depth with a simple, inexpensive soil thermometer. Special precaution should be taken for fertilizer applications at either end of the growing season when plant uptake rates may be slow. Visual examination of turf health and vigor is an important component for the assessment of fertilizer needs.

### Application Rates
The total amount of N applied to turf should not exceed 3 lbs.N/1000 sq. ft. per year. P should be applied to turf only if a soil test indicates a P deficiency. Detailed exceptions are made for compost, as described in Section 5: “The Role of Compost.”

Applying fertilizer in smaller amounts, spaced over the growing season, is the safest way to reduce the likelihood of fertilizer runoff or leaching. This *BMP* recommends application rates of 0.5 lb N/1000 sq. ft. per application and no more than 1 lb. N/1000 sq. ft. per application. At least a two-week interval between applications should be maintained if applying at a rate of 0.5 lb N/1000 sq ft. At the rate of 0.75 lb N/1000 sq ft, the interval between applications should be a minimum of three weeks. And any applications of 1 lb N/1000 sq. ft. should not be repeated for at least four weeks. Always observe and assess plant vigor to determine the need for fertilizer prior to applications.

Fertilizer applications may continue throughout the summer as long as sufficient soil moisture is available. Application intervals should be extended or applications terminated during periods of drought unless supplemental water is provided. Most of the N applied in early fall will be utilized for root growth instead of shoot growth and helps prepare the turf for surviving winter conditions.

Care must be taken when applying slow-release N fertilizers to avoid N build up in the soil. When applying slow release N, particularly in the spring when soil temperatures are low, a product that releases a portion of its N quickly is recommended. Slow-release forms of N, which are dependent on microbial activity for availability, may require higher soil temperatures than are typical for Nantucket's spring.

Soil OM and the amount of stored N in the soil increases as lawns mature and can reach a maximum between 10 and 25 years of age. A sufficient amount of soil N for plant growth may be present in soil OM in mature lawns so that they require little to no application of N. Application of even small amounts of fertilizer to mature lawns can increase the risk of N leaching. Careful visual inspection of plant performance can help reduce fertilizer rates on mature lawns.

Leaving clippings while mowing can provide up to 33 % of the N required for turf fertility. Leaving clippings is encouraged, and the amount of N in the clippings must be factored into calculating annual N inputs. For example, if a lawn requires 3 lbs. N/1000 sq. ft. and clippings are recycled, the annual amount of N fertilizer applied should decrease to 2 lbs.N/1000 sq. ft.

**Table 5** *Fertilizer Application Guidance for Turfgrass*

| | |
|---|---|
| **Timing** | Apply only between April 15 and October 15 |
| **Interval** | Maintain intervals of two weeks or more between applications. Lengthen intervals if applying more than 0.5 lb. N/1000 sq. ft. at any one time. |
| **Total annual application** | No more than 3.0 lb N/1000 sq ft. No P unless a P deficiency is identified by a soil test (certain exemptions for compost). |
| **Individual application amount** | Less than 0.5 lb. N/1000 sq. ft. per application is preferred. No more than 1.0 lb. N/1000 sq. ft. is allowed per application. If a total 3.0 lbs. N is applied at rates of 0.5 lb. N/1000 sq. ft., this implies six applications over no less than twelve weeks. If all 3.0 lbs. are applied at 1.0 lb. N/1000 sq. ft., this implies three applications over no less than twelve weeks. |
| **Fertilizer release type** | During times of rapid growth and fertilizer uptake, up to 0.25 lb. N/1000 sq. ft. of fast-release fertilizer may be used in an application. The balance must be slow-release fertilizer. |
| **Fertilizer source** | This guidance is based on the turf's need for N. Either organic or synthetic fertilizers may be used. |

**Applying Compost as a Fertilizer**
Compost types, sources, and guidelines for application are described in Section 5. Compost is generally applied to increase the amount of organic matter [OM] found in Nantucket's native sandy soils, which average between 0.8 and 3.5 %, and rarely exceed 3.5 % OM. Compost is also a source of nutrients and is considered a fertilizer on Nantucket. The nutrient content of composts varies widely depending on its source material (see Section 5). Leaf-based composts are relatively low in both N and P and are the best sources for increasing soil organic matter while minimizing N and P inputs. Composts derived from animal manures are relatively high in both N and P and some are not suitable for use on Nantucket. Poultry manure can be very high in N, P, and sodium and is not recommended unless diluted with a low N and P compost.

The nutrient content of compost must be determined prior to application in order to avoid applying excess N or P. Most forms of P in compost are in readily available forms and the application of even modest amounts of high-P composts, such as animal-manure composts, can result in excessive amounts of P being added to the soil. Leaf-based composts, are low in P and are the recommended composts for use on Nantucket. Compost containing P should only be applied when a soil test identifies a P deficiency. Detailed exceptions to this rule are explained in Section 5.

Nitrogen is slowly released as compost decomposes, and is made available for plant growth. The N release rate varies with soil temperatures, precipitation, and bacterial activity. As a general rule for compost, between 10 and 25 % of the total N applied is released on an annual basis. The remaining N is released in subsequent years as the compost continues to break down. As new applications are made in later years, it is necessary to estimate the amount of nitrogen that may become available from previous applications. This will help to avoid N building up to levels that may result in leaching or runoff.

For detailed information related to compost sources, nutrient content, and appropriate application rates, see section 5.

**Spoon-Feeding**
Spoon-feeding is the practice of applying small amounts of water-soluble fertilizer as often as every two weeks during the growing season. The small amounts of fertilizer applied are designed to meet the plants immediate needs so little is lost to leaching or runoff. Although many applications are made, the individual amounts applied are so small that the annual total applied is often considerably less than achieved with other application methods. Disadvantages to spoon-feeding include the need to closely monitor the plants in the application area and the time required for multiple applications. Granular fertilizers with sufficiently low nutrient concentrations for spoon-feeding may not be readily available so liquid fertilizers are generally used.

Biweekly application rates when spoon-feeding turf with N can be as low as 0.10–0.25 lbs.N/1000 sq. ft. Do not exceed 0.25 lbs. of N per 1,000 sq ft for any one application.

**Foliar-Feeding**
Foliar fertilizing is one type of spoon-feeding. For the Nantucket *BMP,* foliar fertilizers are

defined as any fertilizer designed for uptake into a plant through its leaves rather than through its roots. Foliar fertilizers are typically liquids containing low concentrations of nutrients that are sprayed directly on the foliage of the plant. As with other products designed for spoon-feeding, the nutrients in foliar fertilizers must be fast release to ensure rapid uptake by the plants.

**Spreader Calibration**
Correct application rates for turf fertilizers are dependent on correctly calibrated spreaders. Fertilizer spreaders should be calibrated annually and should be recalibrated when using different products. Detailed step-by-step instructions for spreader calibration are included in Appendix 4.

**The Weather Factor**
Large rainfall events or excessive irrigation coupled with improper fertilizer applications are major contributors to surface runoff and leaching of fertilizers. A weather forecast should be consulted prior to any fertilizer application. Fertilizer applications that contain N or P should not be made if a weather forecast predicts more than ½″of rain, or intense rain of any amount, such as during a thunderstorm is predicted within 7 days following application.

**Watering and Irrigation**
The amount of water applied with irrigation systems or sprinklers following fertilizer applications should be limited to less than ½″ per application for seven days following fertilizer application to avoid fertilizer loss via runoff or leaching. This is an average value that will vary with soil type, weather, and other site conditions. In general, only the amount of water required to moisten soil to the bottom of the root zone should be applied. A soil-moisture probe can be used to determine the depth of soil moisture for adjusting irrigation. "Watering-in" is a technique used to begin the breakdown of water-soluble N or for any slow-release N that depends on hydrolysis for release. Watering-in can also reduce N loss from volatilization and can decrease the risk of runoff. Between 1/10″ and 1⁄4″ of rain or irrigation is sufficient for the watering-in of fertilizer.

**Special Care and Clean-Up**
Care should be taken when applying fertilizers to make sure that wetlands and other water resources are not at risk from improper applications. Any fertilizer that spills or is spread on a sidewalk, driveway, or other impervious surface should be swept up and added back to the bag or the spreader. Exposed storm-water drains should be covered with a small tarp or plywood to prevent fertilizer from falling into the drains. Any fertilizer remaining on the plywood or tarp should be added back to the bag or spreader.

**Record Keeping**
Keeping proper records of fertilizer applications is necessary to track the amount of nutrients applied over a season. Record keeping also allows applicators to compare actual amounts with predicted results and helps to refine future fertilizer programs. A sample sheet for record keeping is included in Appendix 3.

**Three Sample Turf Fertilizer Management Programs**
Three sample annual turf fertilizer programs, one using only organic fertilizers, one using primarily synthetic fertilizers, and one designed for spoon feeding are provided as guidelines for

turf fertilizer application rates and timing. As always, a soil test analysis forms the basis for nutrient management.

**An Organic Fertility Program**

This program is designed for renovation of a homeowner-maintained lawn that is underperforming. The soil-analysis identified pH at 5.3, "optimum" P content, "very low" K content, "low" magnesium [Mg] and OM at 3.4 %.

*First application:* Apply dolomitic limestone as indicated by the soil test at rates up to 50 lbs./1000 sq. ft. to raise pH and improve Mg levels in late fall of the previous season, when possible, as lime takes up to six months to alter pH.

*Second application:* As soil temperatures reach 55° F in spring (late April to mid-May), apply natural sulfate of potash (0-0-50) at 1 lb./1000 sq. ft. of $K_2O$ to improve K levels. Apply sulfate of potash, magnesia at 0.5 lb./1000 sq. ft. of $K_2O$ to improve K, Mg, and sulfur. Alternatively, use dolomitic limestone in the step above to alter Mg content if needed. Top-dress with leaf-litter compost at a ⅛″depth to increase the soil's OM level, supply a small amount of N (0.3 lbs N/1000 sq. ft.) and increase soil microbiology.

*Third application, June 15.* Apply an organic fertilizer blend of 6-0-6, at the rate of 1 lb. N/1000 sq. ft. A typical organic blend of 6-0-6 is made from sulfate of potash, natural nitrate of soda, peanut meal, feather meal, and pasteurized poultry litter. 75% of the N is water insoluble, or slow release.

*Fourth application, July 15.* Apply compost tea to supply beneficial microorganisms, micro elements, and less than 0.1 lb. N/1000 sq. ft.

*Fifth application, Aug 15.* Apply compost tea to supply beneficial microorganisms, micro elements, and less than 0.1 lb. N/1000 sq. ft.

*Sixth application, Sept 1.* Top-dress with leaf-litter compost at a 1⁄8″ depth to increase soil OM, N (est. 0.3 lb. N/1000 sq. ft.) and microbiology. Combine this application with aeration and over seeding to increase turf density.

*Seventh application, Sept 15.* Apply the 6-0-6 organic blend as described in the Third Appliction, at a rate of 1 lb. N/1000 sq. ft.
*Eighth application, Oct 1.* If the need is indicated by a subsequent soil test, apply natural sulfate of potash (0-0-50) at a rate of 1 lb. K/1000 sq. ft. $K_2O$ to improve K levels.

*Totals for the season:*
N – 2.8 lb./1000 sq. ft.
P (from leaf-based compost) – 0.45 lbs $P_2O_5$/1000 sq. ft.
K – 4.5 lbs. $K_2O$/1000 sq. ft.
Sulfur – 0.5 lb./1000 sq. ft.
Mg – 0.5 lb per 1000 sq ft.

**A Program for (Primarily) Synthetic Turf Fertilizer**
The following program consists of products that contain primarily synthetic sources of N. It presumes a relatively healthy irrigated turf with sufficient phosphorus available in the soil.

*First application, late fall of previous season.* Application of dolomitic limestone at 50 lbs./1000 sq. ft. to raise pH and improve Mg levels in late fall of the previous season, if possible, as lime takes up to six months to alter pH

*Second application, May 15.* Apply 30-0-7 with 75% slow-release N, at a rate of 1 lb. actual N/1000 sq. ft.

*Third application, July 1.* Apply (15-0-8) an organic/synthetic bridge product with 92% slow-release N, at a rate of 1 lb. actual N/1000 sq. ft.

*Fourth application, Aug 15.* Apply a synthetic fertilizer (29-0-10) with 70 % slow-release N at the rate of 0.5 lb. actual N/1000 sq. ft.

*Fifth application*, *Oct 1.* Apply (15-0-8) an organic/synthetic bridge product at the rate of 0.5 lb. actual N/1000 sq. ft.

*Totals for the season:*
N – 3.00 lbs./1000 sq. ft., 83% of which is slow release and 40% organic
P – 0.0 lbs.$P_2O_5$ /1000 sq. ft.
K– 1.2 lbs. $K_2O$/1000 sq. ft.

**Hybrid Fertilizer Program – Spoon-Feeding**
The following turf-fertility program consists of products that contain both organic and synthetic sources of N. The assumption is that P levels are optimum, as indicated by a soil test, and that K is deficient. Some of these products below are "bridge products" that contain both organic and synthetic materials. This program emphasizes the spoon-feeding of N.

*First application, May 14.* Apply 6-0-12, at a rate of 0.24 lb. N/1000 sq. ft., 100% fast release. Also contains manganese sulfate (which will provide enhanced green color similar to iron sulfate) and magnesium sulfate to increase Mg levels.

*Second application, June 4.* Apply 12-0-12, 0.48 lb.N/1000 sq. ft., 50% slow release. This fertilizer is a bridge product that is 50% organic and 50% synthetic. Urea and methylene urea (slow release) make up the synthetic portion of this product. Organic sources of N include kelp meal, fish meal, crab meal, alfalfa meal, poultry meal, and blood meal. These sources include fast- and slow-release sources of N. A small amount of P is included in this product. It also contains ferrous sulfate for color and magnesium sulfate to increase Mg levels.

*Third application, July 2.* Apply 12-0-12, 0.48 lb.N/1000 sq. ft., 50% slow release.

*Fourth application, Aug 6.* Apply12-0-12, 0.48 lb.N/1000 sq. ft., 50% slow release.

*Fifth application, Sept 3*. Apply 6-0-12, 0.24 lb N/1000 sq. ft., 100% quick release.

*Sixth application, Sept 24*. Apply 6-0-12, 0.24 lb.N/1000 sq. ft., 100% quick release.

*Totals for season:*
N – 2.16 lbs. /1000 sq. ft., 33% of which is slow release, 33% organic
P – 0.0 lbs. $P_2O_5$ /1000 sq. ft.
K – 2.88 lbs. $K_2O$/1000 sq. ft.

## *Section 7*

## Guidelines for Establishment and Renovation of Turfgrass

- **Detailed steps are provided for establishing a lawn from seed or sod and for renovating a damaged or underperforming lawn.**
- **A soil test should be conducted to provide the basis for determining and correcting nutrient and other soil deficiencies during establishment or renovation.**
- **Phosphorus should only be applied if a soil test indicates a deficiency.**
- **Use of certified seed and pre-germination of seed are recommended.**
- **Careful monitoring of soil moisture and appropriate watering practices will improve seed germination and establishment.**
- **Recommendations for follow-up fertilization and mowing timing and height are provided.**
- **Numerous species, cultivars, blends, and mixes of grasses appropriate for use on Nantucket are provided.**
- **Species and cultivar selection is discussed based on intended use, soil, and other environmental conditions and degree of intended maintenance. A mix of species or a blend of cultivars is preferable for most uses.**
- **A mix of fine fescue species is recommended for low-maintenance lawns requiring reduced water and fertilizer inputs.**

Many of the principles for establishing and renovating lawns are the same as for maintaining them. Special care needs to be taken when establishing a lawn to avoid the runoff or leaching of fertilizers applied to bare or sparsely vegetated soil. The following guidelines will help ensure both successful turf establishment and protection of our water resources from nutrient contamination.

Late summer or early fall is the preferred time to establish or renovate a lawn on Nantucket. During these times, soil temperatures are still warm, there is plenty of sun, and moisture is available for maximum seed germination. This starting time allows for sufficient root and shoot development for plants to survive the winter. Establishing a lawn in the spring or summer almost always requires more water and fertilizer and may require herbicides to control competition from spring germinating weeds. Sod should be considered as an alterative to seed when establishing a lawn in spring or summer.

### Establishing a Lawn from Seed: A Step-by-Step Guide

1. *Obtain a soil test.* A comprehensive soil test is recommended that includes, at minimum, the following: phosphorus [P], potassium [K], pH, and percent organic matter [OM]. Nutrients should only be added if the soil test indicates a deficiency. See Section 3: “Soil Nutrient Analysis: The Role of the Soil Test” for more information on obtaining and applying a soil test.

2. *Rough grade the site.* Remove stumps, large rocks, and debris. Smooth the surface and finish grade to achieve a desired surface drainage pattern. Grade so that water drains away from structures and does not pool.

3. *Amend the soil based on the soil-test analysis to achieve a maximum 4" – 6" of topsoil.* Compost is recommended for increasing soil OM to a maximum of 4% OM. The nutrient and salt content of compost can vary greatly. Only leaf-based composts with low P content should be used on Nantucket. Composts should be tested if the nutrient and salt contents are unknown.

Compost applications should follow the guidelines found in Section 5, "The Role of Compost"; Section 6, "Guidelines for Timing and Rate for Application of Turfgrass Fertilizer"; and Section 9 "Guidelines for Nutrient Management of Gardens, Trees, Shrubs, and Hedges."

4. *Adjust pH* – Adjust the pH of the top 4″ – 6″ of soil to between 6.0 and 7.0 if necessary. Use dolomitic lime to raise the pH if both calcium and magnesium are deficient. Use a calcitic limestone if only calcium is deficient.

5. *Fine grade the site.* This creates the final surface for seeding. Install irrigation systems and make any final pH or OM adjustments prior to final grading if necessary.

6. *Seed.* Certified seed is strongly recommended to guarantee cultivar authenticity. More on selecting turfgrass blends appropriate for use on Nantucket is found later in this section. Apply seed at the rate recommended on the bag. Dry soil should be lightly watered before applying seed. To pregerminate seed for quicker establishment, place it in a cloth bag and soak it in water for at least 12 hours. Lift the bag in and out of the water several times every few hours to aerate the seeds. Remove the seed from the bag and spread it out to dry sufficiently enough to pass through the spreader. If hydro- seeding, be sure to specify the seed mix, seeding rate, and fertilizer content, if included, of the hydro-seed solution. Use a hydroseed mix without added fertilizer if possible.

7. *Apply a starter fertilizer following seed germination*. It is preferable to fertilize after seeds germinate and are capable of using the nutrients. Applying fertilizer prior to germination increases the risk of nutrient runoff and leaching. Fertilizer should be added only if a soil test reveals a deficiency. Any fertilizer application must conform to the guidelines in Section 6: "Guidelines for Timing and Rate for Application of Turfgrass Fertilizer."

8. *Protect the seed*. Lightly rake or roll the area following seeding to maximize seed-to- soil contact and to minimize seed loss to wind or water erosion. Cover the seed with a thin layer of straw or mulch to help protect the seed from temperature extremes and desiccation. Mulching is unnecessary when hydroseeding as most hydroseed mixes include a mulch-like material.

9. *Water.* Keep seeds moist by lightly watering 2–3 times a day, or as necessary, until seedlings are about an inch high. As seedlings grow, reduce watering frequency and increase the amount of water applied to recharge the entire root zone. Allow the surface to dry between waterings. Adjust watering as necessary to account for precipitation, drying winds, and variation in temperatures.

10. *Mow*. A lawn should be mown for the first time when the grass is a third higher than the desired mowing height. For example, if the desired height is 2 inches, mow for the first time when it reaches between 2.5 and 3 inches.

11. *Fertilize.* A follow-up fertilizer application is recommended after the first or second mowing. Apply fertilizer with an application rate of 0.5 lb. N/1000 sq. ft. Apply no more than 3.0 lbs. N/1000 sq. ft. during the year of establishment, Apply P only if a soil test indicates a deficiency. Apply fertilizer in accordance with the guidelines in Section 6.

**Establishing a Lawn with Sod: A Step-by-Step Guide**
Sod may be the preferred choice to establish a lawn in some circumstances. Examples include establishing a lawn in late fall or when a lawn must be established quickly. Follow these steps when establishing a lawn with sod.

*Repeat steps 1 – 5 from above.*

6. *Install the sod*. Use quality sod from a reliable source with experience in transporting sod to Nantucket. Lay sod as soon as possible following cutting. Prevent sod from drying out or overheating prior to installation. Select sod grown in soil that is as similar as possible to the soil in which it will be laid. For Nantucket, this usually means selecting sod grown in soils with a low clay content. Sods grown in heavy-clay soils may impede air and water movement into the soil and reduce nutrient uptake. The sod bed should be watered to a depth of 3–4 inches prior to laying the sod to promote rapid establishment. Stagger seams and avoid creating gaps where weeds can become established.

7. *Roll and hand-water*. The sod should be lightly rolled prior to watering to smooth out any surface irregularities. Hand-water sod immediately after rolling.

8. *Water*. Water sod sufficiently to keep the soil moist and promote root establishment. Begin with frequent light watering. As sod matures, reduce watering frequency and increase the amount of water applied to recharge the entire root zone. Adjust watering as necessary to account for precipitation, drying winds, and variation in temperatures.

9. *Fill gaps*. Top-dress any gaps that develop with a mix of topsoil and grass seed that is compatible with the newly installed sod.

10. *Fertilize*. Apply fertilizer with an application rate of 0.5 lb. N/1000 sq. ft. approximately 3–4 weeks after installation. Apply no more than 3.0 lbs. N/1000 sq. ft. during the year of establishment. Apply P only if a soil test indicates a deficiency. Apply fertilizer in accordance with the guidelines in Section 6.

**Renovating an Existing Lawn: A Step-by-Step Guide**
Renovation is the process of making improvements to, or correcting problems in, an existing lawn. Follow these steps to renovate an existing lawn.

1. *Diagnose and correct underlying problems*. Common problems include poor soil, poor drainage, soil layering, excessive weed content, or inappropriate grasses for Nantucket. Consult an experienced lawncare specialist to help ensure an appropriate diagnosis.

2. *Obtain a soil test*. Obtain a soil test 3–4 weeks before beginning work to allow time to correct any deficiencies in the existing soil. Refer to Section 3: "Soil Nutrient Analysis: The Importance of the Soil Test" for obtaining and applying the soil test analysis.

3. *Prepare restoration area for amendments and seeding*. Mow the restoration area to one inch or lower to allow the new seed to better compete for sunlight and water. Aerate and dethatch as necessary to prepare a good seed bed.

4. *Add soil amendments*. Top-dress and incorporate compost into the soil to a maximum of 4% OM. The nutrient and salt contents of compost can vary greatly. Only leaf-based composts with a low P content should be used on Nantucket. Composts should be tested if the nutrient and salt contents are unknown. See Section 5 for compost application rates. Core-aerate prior to top-dressing with compost to allow it to penetrate below the existing grass layer. Apply N fertilizer in accordance with the guidelines in Section 6. P should be applied only if the soil test indicates a deficiency.

5. *Seed*. Spread the seed at the rate recommended on the bag. Lightly rake and roll the area to ensure good soil-to-seed contact. To pre-germinate seed for quicker establishment, place it in a cloth bag and soak it in water for at least 12 hours. Lift the bag in and out of the water several times every few hours to aerate the seeds. Remove the seed from the bag and spread it out to dry sufficiently enough to pass through the spreader.

6. *Irrigate*. Irrigate in the same manner as for new seedlings to ensure that the seed remains moist at all times while germinating.

7. *Mow*. The lawn should be mown for the first time when the new grass is a third to one-half higher than the desired mowing height.

8. *Fertilize*. Fertilize the restoration area approximately 1–3 weeks after seed germination in accordance with the guidelines in Section 6. The application rate should be no more than 0.5 lb.N/1000 sq. ft. and no more than 3 lbs. N/1000 sq. ft. should be applied during the year of establishment. Apply P only if a soil test indicates a deficiency.

**Selection of Turfgrass Species**

Turfgrass seed should be selected based on fertilizer needs, local soil and other environmental conditions, the type of use proposed, and the degree of maintenance desired for the turf in question. High-maintenance turf generally requires irrigation, relatively large fertilizer inputs, and increased management time. High-maintenance areas include golf courses, parks, athletic fields, and high-quality or heavily used residential lawns. Low-maintenance areas require little or no fertilization or irrigation and minimal management. They include roadsides, sensitive areas adjacent to wetlands, and lower quality or less frequently used residential lawns.

Turf performance can be improved by combining several species or varieties rather than using a single species or variety. Grass mixes are a combination of two or more different species while a grass blend consists of two or more cultivars of the same species. Blends are often used in highly maintained areas where uniform appearance and performance are required or for over-seeding established lawns. Mixes are often used for lower maintenance lawns. At least three species or three varieties should be included in mixes and blends, respectively, to minimize losses to disease or weather stress. Species mixes and blends for different types of lawns on Nantucket are recommended at the end of this section.

Cultivars of perennial ryegrass, tall fescue, and fine fescues have been developed that contain fungal endophytes. Endophytic fungi live within grasses and do not alter grass appearance. Endophytic grasses have a high tolerance of environmental stress and increased resistance to leaf-feeding insects such as billbugs, sod webworm, and chinch bugs. Some endophytic cultivars of fine fescues also resist dollar spot, a disease associated with low fertility. Fungal endophytes may be toxic to grazing animals, so endophytic grasses should never be planted where animals might graze.

The principal turf grasses used on Nantucket include Kentucky bluegrass, perennial ryegrass, and several species of tall and fine fescues in varying percentages. Characteristics, advantages, and disadvantages of these grass species are summarized as follows:

***Kentucky Bluegrass***

Kentucky bluegrass has a fine-to-medium leaf texture and is dark green in color. Its growth habit is to spread via rhizomes, making it a popular choice for sod farming. It has the ability to recover fairly easily from damage. Tolerance is high for wear and cold temperature, but moderate for heat and drought. This grass becomes semi-dormant very quickly under hot and dry conditions. It recovers quickly once cooler temperatures with adequate moisture return. Kentucky bluegrass is best grown in well-drained, sunny areas, although a few cultivars will tolerate some shade. It requires higher amounts of nitrogen (2–3 lbs. N/1000 sq. ft. annually) than some other cool-season grasses and may produce a significant amount of thatch if over-fertilized or over-watered. Kentucky bluegrass can be susceptible to diseases such as leaf spot, dollar spot, ring spot, and summer patch. Some newer cultivars show some disease resistance.

*Advantages*

Fast recovery from wear or abuse
Dense turf
Excellent cold tolerance
Dark green color

*Disadvantages*

Poor shade tolerance,
Requires regular watering to maintain quality.

***Perennial Ryegrass:***

Perennial ryegrass has a fine-to-medium leaf texture and tends to be dark green in color. It germinates rapidly and is quick to establish, making it suitable for over-seeding. It is competitive with other grasses and is used either alone or in combinations with Kentucky bluegrass or fine fescues. Use no more than 20% perennial ryegrass when mixing with other grass species. It is wear- and heat-tolerant, but will not tolerate shade well. Perennial ryegrass does best on well-drained soils with moderate fertility. The N requirement for perennial ryegrass is approximately 2–3lb.N/1000 sq.ft. annually. Perennial ryegrass has little thatch accumulation. Perennial ryegrass is susceptible to diseases such as brown patch, Pythium blight, dollar spot, red thread, and rust. Several cultivars contain beneficial fungal endophytes, which provide some disease and insect resistance.

*Advantages*
Fast establishment
Good wear tolerance

*Disadvantages*
Does not tolerate poorly drained soils
Requires full sun.

***Fine Fescues.***
Fine fescues (creeping red, chewing, and hard fescues) are narrow-leaved, medium-green to dark-green grasses that can be used alone or in combination with other grasses. Each species varies somewhat in terms of growth characteristics, but all are appropriate for low-maintenance situations. They are very tolerant of low pH, low fertility, drought, and shade. Fine fescues become semi-dormant in heat and drought but recover quickly. These grasses require 1–2lbs. N/1000 sq.ft.per year with minimal production of thatch. Fine fescues are susceptible to leaf spot, red thread, and dollar spot. Endophytically enhanced cultivars have some resistance to dollar spot and insects. Cultivars without endophytes are highly susceptible to damage from chinch bugs.

*Advantages*
Tolerates shade
Requires minimal fertility
Has low water requirements
*Disadvantages*
Susceptible to heat and drought
Poor wear tolerance and poor recovery rates

***Tall Fescues***
Many new “turf-type” tall-fescue varieties that are fine textured and dark green are a viable option for lawns. Tall fescue is slow to establish, preferring temperatures above 70° F for optimal germination. It has only a fair recovery potential, but it is both drought and heat tolerant. Tall fescues perform best in well-drained soils in open sunny locations but can withstand moderate shade. Overall, tall fescues are more shade tolerant than Kentucky bluegrass and perennial ryegrass, but less so than fine fescues. Tall fescue requires 2.5–3lbs.N/1000sq.ft.with minimal accumulation of thatch. Most cultivars should not be mown at less than 2″. Tall fescue is susceptible to brown patch, red thread, and pythium blight.

*Advantages*
Some shade tolerance
Has low water requirements
Good wear tolerance

*Disadvantages*
Not very cold tolerant.

**Recommended Seed Mix for Lower-Maintenance Lawns Requiring Reduced Inputs.**
An endophytically enhanced mix of fine fescues is recommended for low-maintenance, non-irrigated lawns on Nantucket. This mix requires little to no nutrient inputs and performs well with minimal care. Fine fescues are deep rooted, use water efficiently, and go dormant only in the driest parts of the season. Fine fescues should be watered only during hot, droughty periods and not more than twice a week; actual timing of watering depends upon turf density, soil type, and temperature. Excessive watering of fine fescues can stress the plant and lead to disease and thin turf. Minimum mowing height for fine fescues is 2.5 inches. Fine fescues may be mixed with a small percentage of perennial rye grass during initial establishment to provide quick cover and erosion control. The fine fescues will replace the ryegrass over time if irrigation is kept to a minimum.

**Recommended Seed Blend for a Medium- to High-Maintenance Irrigated Lawn.**
A blend of relatively new varieties of turf-type tall fescues is recommended for a dense, dark green, high-quality lawn. Turf-type tall fescues are very similar in color to Kentucky bluegrass, although the leaf is slightly coarser in texture. Turf-type tall fescues develop deep root systems, allowing more efficient use of both water and nutrients. They require only 2–3 lbs. N/1000 sq.ft. per year and should be irrigated only when it becomes visually apparent that it is necessary. Irrigation water should be applied at the rate of one-half inch per application with a maximum of two applications per week. Watering should be monitored to assure recharge into the entire root zone and to avoid over-watering. Good cultural practices are important to maintain tall fescue performance (see Section 10: "Turf Care Cultural Practices"). Annual over-seeding in late summer is recommended to maintain turf density. Turf-type tall fescues look best when they are used alone rather than mixed with Kentucky bluegrass or perennial ryegrass.

**Native and Warm-Season Grasses**.
Most Nantucket native grasses are varieties of warm-season grasses. While somewhat difficult to establish, once mature, warm-season grasses require little maintenance and no fertilization or irrigation. These species are good choices for open land and property-boundary breaks. More information about the use of native warm season grasses can be found in Section 11: "Alternative Naturalistic Style Practices."

## *Section 8*

# Turf Care Cultural Practices

- **Cultural practices for turf maintenance— including mowing, aeration, dethatching, top-dressing, and spiking—all contribute to healthy lawns and in some cases contribute directly to lowering fertilizer requirements.**
- **Mowing height should follow the one-third rule, specifically never mowing off more than 1/3 of the total height of the turf at a time. •**
- **Maintaining sharp mower blades is critical to maintaining healthy, attractive turf.**
- **Recycling grass clippings may contribute up to 33% of nitrogen [N] needs per season, allowing N fertilizer application to be reduced accordingly.**
- **Core aeration, top-dressing, mechanical dethatching, and spiking are turf care cultural practices that contribute to optimum turf health and vitality of more intensively managed lawns, including playing fields and golf courses.**

### Mowing
Mowing is the most fundamental cultural practice used to manage turf and plays a large role in its health. Improper mowing can stress and damage turf. The following mowing practices directly influence the vigor and health of turf and in some cases, can reduce fertilizer requirements.

### Mowing Height
Mowing height is of primary importance to the health of turf. For aesthetic reasons, some Nantucket lawns are mown at lower than optimum heights. Mowing at a low height can damage turf, particularly for certain grass species, by limiting root growth and production, carbohydrate uptake, and stress tolerance. Mowing higher, particularly during times of extreme heat or drought, is especially important to turf vigor. For example, if mowing is done at a height of two inches instead of three inches in July, water-use efficiency may decrease, fungal pressures may increase, fertilizer requirements may increase, and tolerance to heat and drought may be reduced. Fertility requirements increase with certain species when they are mown too short, due to most of the nutrients being utilized for shoot development instead of other parts of the plant, such as roots. Simply raising the height to three inches may decrease, or eliminate, these stresses.

### Sharp Blades/Clean Cuts
Proper blade, reel, or bed-knife sharpening is important for healthy turf. The importance of sharp mowing blades cannot be over emphasized. The tearing or ripping of grass blades, instead of leaving clean, sharp cuts, creates unintended wound surfaces where pathogens can more easily enter and spread disease. The jagged ends also increase water loss. These wounds also give a "brownish" look to the lawn. To maintain clean cuts, mower blades should be sharpened after every eight hours of use.

### Mowing Frequency
Removal of more than one third of top growth at any given time can directly slow or stop root growth. Because the degree of root growth is crucial to the success of a healthy turf, whenever possible mowing frequency should be based on how fast or slowly the grass is growing, adhering to the "one-third rule" – remove a maximum of one-third of the grass height while mowing.

**Recycling Clippings**
Recycling clippings over the course of the growing season can add up to 33 % (1.0 lb. N/1000 sq. ft.) of the annual nitrogen [N] requirement. Mulching mowers, designed to chop mown grass into fine pieces, not only recycle N but also increase mowing efficiency as bags don't need to be emptied or clippings hauled away. Because lawn clippings from either a mulching mower or a reel mower are composed of easily degradable compounds, they break down rapidly and do not contribute to thatch buildup.

**Core Aeration**
Core aerating the soil is especially beneficial for compacted turf surfaces such as heavy-use lawns and playing fields and irrigated lawns. It not only alleviates surface compaction but increases microbial activity, water infiltration and gas exchange. Aeration also helps reduce excess thatch. Thatch is necessary in small amounts to cushion the crown of the plant and provide some water- and nutrient-holding capacity. However, excess thatch leads to increased water requirements, decreased fertilizer efficiency, decreased root vigor, increased insect pressure, and greater disease susceptibility. It is recommended that high-use lawns or playing fields be aerated a minimum of once a season. Fall is the preferred time for aeration as lower temperatures aid in recovery.

**Dethatching**
Dethatching is a practice that uses vertical blades to slice through the turf canopy and, depending on the depth setting, into the thatch. It also helps to clean the surface and mat area (zone between crown and thatch) of any accumulated debris. Dethatching contributes to reduced water use, increases the efficiency of fertilizer uptake, and decreases the incidences and severity of turf diseases.

**Top-dressing**
Top-dressing is the application of a layer of material, such as sand or compost, across the turf surface or into the root zone after core aeration. The sand or compost is then brushed into the turf canopy and eventually finds its way into the thatch layer. Top-dressing can help dilute thatch, provide protection for the crown of the plant, and smooth out low areas. Top-dressing can increase N utilization and water infiltration while decreasing water use. Top-dressing with compost also adds beneficial microbes and bacteria to increase microbial activity while building the soil. Compost contains N and P, so it is important to know the compost nutrient content before making applications. Top-dressing associated with and immediately after core aeration is recommended as there is less chance that compost will form "bands" of P or N.

**Spiking**
Spiking is the cutting of spikes 1–3 inches deep into the subsurface. It is a cultural practice commonly used on high-use and high-maintenance turfs such as playing fields and golf courses. Although these practices do not relieve compaction or control thatch, they do allow oxygen to enter the root zone, improve water infiltration, and provide a good environment for over-seeding and repairs.

## *Section 9*

## Nutrient Management of Gardens, Trees, Shrubs, and Hedges

- **Fertility guidelines for ornamental plantings are aimed at maintaining acceptable soil fertility while reducing the risk of nutrient contamination of Nantucket's aquatic resources.**
- **Due to its nutrient content, compost is considered a fertilizer for the purposes of the *BMP*.**
- **No phosphorus [P] should be added to soil unless a soil test identifies a deficiency. Certain exceptions are made for compost.**
- **Animal manure composts contain high amounts of P and should not be used unless a soil test indicates a significant P deficiency.**
- **Leaf-based composts are low in P and are recommended for use on Nantucket.**
- **The maximum recommended soil organic matter [OM] content for Nantucket's sandy soils is 4%.**
- **When using compost to increase soil OM, multiple small applications should be applied at 8–12 week intervals rather than one large application.**
- **No more than 2 lbs. nitrogen [N] per 1000 sq. ft. should be applied annually to ornamental plantings; individual applications should not exceed 0.5 lb. N/1000 sq ft.**
- **Fertilizers, including compost, should only be applied on Nantucket after April 15 and before October 15 and when soil temperatures are above 55$^{o}$F.**
- **Any granular fertilizers applied to ornamental plantings should be mixed into the top one or two inches of soil to minimize the potential for loss from surface runoff.**
- **Most trees, shrubs, and hedges adjacent to lawns will not require supplemental fertilizers once established unless a lack of vitality is observed and a deficiency is identified by a soil test.**
- **Native plants are well adapted to local conditions and do not require fertilization.**

Herbaceous perennial gardens, mixed borders, vegetable gardens, and ornamental trees and shrubs (henceforth referred to as "ornamental plantings") are common components of Nantucket's residential landscapes. There is substantial variation in the nutrient requirements and appropriate cultural practices among the many species and varieties of ornamental plants found on Nantucket. A detailed description of the best management practices for each species is beyond the scope of this *BMP*. Instead, this section will present guidelines for fertilizing and building the soil with compost for ornamental plantings.

Important basic information that applies to ornamental plantings is provided in Section 3: "Soil Nutrient Analysis: The Role of the Soil Test"; Section 4: "Fertilizer Types and Sources"; and Section 6: "Guidelines for Timing and Rate for Application of Turfgrass Fertilizer." Since many, if not most, of the ornamental planting beds on Nantucket are amended with compost, landscape practitioners should pay particular attention to Section 5: "The Role of Compost" for recommendations and limitations on compost application for ornamental plantings.

### Nutrient Application to Ornamental Plantings

Most of the material relating to turf soil fertility discussed in other section of the *BM*P also applies to ornamental plantings, though there are differences. Perhaps most important, the diffuse root structure of most ornamental plants is not as efficient in nutrient uptake as the dense rooting system of turf, which causes ornamental beds to be much more prone to nutrient leaching than turf. Although ornamental plantings may make up a relatively small portion of a residential landscape, their nutrient "leakiness" can make them relatively large contributors to nutrient contamination of groundwater and wetlands. The recommendations for nutrient application provided in this section are aimed at achieving healthy ornamental plantings while reducing negative impacts to water resources.

The nutrient content of commercially available fertilizers is discussed in detail in Section 4. The nitrogen [N] and phosphorus [P] content of various types of compost are presented in Tables 3 and 4 in Section 5. The *BMP* allows a maximum of 2 lbs. N/1000 sq. ft. per year to be applied to ornamental plantings, and P may be applied only if recommended by a soil test. A comprehensive soil test, as outlined in Section 3, should be conducted prior to establishing ornamental plantings and at least every three years thereafter. Soil should be tested annually in areas being amended with compost or if fertilized with P. Only those nutrients recommended by the soil test should be applied. In some cases, fertilizer blends that are specifically formulated for ornamental plantings or specific ornamental species may not be appropriate for use on Nantucket as they may contain nutrients not recommended by a soil test.

Climate plays an important role in the timing of fertilizer applications for ornamental plantings. Fertilizers, whether in composts or in granular or liquid form, should be applied only between April 15 and October 15 and when soil temperatures are above 55$^{o}$F (see Section 6). Granular fertilizers applied to ornamental plantings should be mixed into the top one or two inches of soil to reduce the likelihood of fertilizer runoff from bare soil. Fertility requirements for hedges, trees, and shrubs planted within or adjacent to lawn areas will most likely be met by fertilizers applied to turf. No additional fertilization is recommended unless visual observation or a soil test identifies a deficiency. Native plants incorporated into ornamental landscapes are well adapted to local conditions and should not be fertilized (see Section 11: "Alternative Naturalistic Style Practices").

**Compost as Soil Conditioner and for Soil Fertility**

Compost is often applied to ornamental beds in order to increase soil OM and nutrient content. Compost is commercially available in bags or bulk for the landscape trade. Soil OM improves soil structure, aeration, water- and nutrient-holding capacity, biological activity, and fertility. Most of the nutrients in soil OM are slowly released as the OM decomposes. Phosphorus is an exception, and up to 85% of the P in manure-based compost can be in fast-release form. The OM decomposition rate depends on a variety of factors including soil moisture, aeration, temperature, and biological activity and the type of compost used. The OM decomposition rate tends to be high in sandy soils, so care must be taken to avoid over-application on Nantucket's sandy soils. All composts used as soil amendments on Nantucket must have a known nutrient content or be tested for nutrient content before use.

Although a soil OM content of between 5% and 8 % with soils amended to a depth of 8–12 inches is often recommended for ornamental plantings, these values are not appropriate for Nantucket. Nantucket's native sandy soils tend to have much lower OM content, ranging from 0.8 to 3.5 %, with a topsoil depth of only a few inches. It is difficult to increase soil OM content more than about 1% above the native OM content without increasing the likelihood of nutrient leaching. Therefore, the BMP recommends a maximum soil OM level of 4% for Nantucket soils used for ornamental plantings. Both the percent OM and depth of OM amendment should be increased slowly over several years, and such efforts should include monitoring of soil test P levels to ensure the Environmental Critical Level [ECL] for P is not exceeded. Adding additional

OM increases the risk of excessive nutrient application and nutrient loss to leaching or runoff. This process of using soil-test P values to limit additions of compost to soils and hence the soil OM content is discussed in more detail in Section 5. Care must be taken when amending native soils with commercially available "topsoil" or "organic topsoil." These products often contain a high percentage of organic matter and can easily overload the soil with nutrients and result in nutrient leaching.

**Compost Application Based on Phosphorus Content**

Compost contains varying amounts of N, P, and other nutrients, depending on its source (see Table 1 in Section 5). Although the nutrient concentration of most composts is lower than that found in most granular fertilizers, compared to granular fertilizers, much larger amounts of compost are often applied to soils, so care must be taken to avoid over- applying compost. Leaf-litter compost tends to be the lowest in N and P and is the preferred compost for use on Nantucket. Manure- and lawn-, garden- and food-waste composts contain much higher levels of N and P, and some manure-based compost, especially poultry-manure compost, contain excessive amounts of soluble salt. Manure- based composts should not be used on Nantucket unless a soil test indicates a severe nutrient deficiency.

All currently available composts contain P in amounts that may result in over-application if applied at commonly recommended rates (see Table 3 in Section 5). Soil-testing laboratories typically use either the Modified-Morgan or the Mehlich III extraction method to determine soil P levels. These tests use different extraction solutions and produce very different results. The soil-test report will indicate which extraction method was used. It is important for applicators to use the same soil-testing laboratory and extraction method for repeated soil testing on a given property so that values can be compared.

This *BMP* recommends compost application rates based on soil and compost P content and on the Agronomic Critical Level [ACL] and Environmental Critical Level [ECL] of P in an effort to ensure that soil P levels do not exceed recommended amounts. The ACL is the soil P level at which an adequate amount of P is present for crop or turf production. The recommended P application rate in the soil-test report is designed to bring the soil P concentration to, or slightly above, the ACL. The ECL is the soil P level at which P will run off or leach from the soil in amounts that can cause environmental damage. In general, the ECL is higher than the ACL, but the difference may be small, especially in sandy soils (Table 6). For example, there is only a small difference between the ACL and the ECL for the Modified Morgan extraction for ornamentals (Table 6). This results in a very small margin of error when applying P in sandy soils especially for soil tests conducted with the Modified Morgan extraction method.

**Table 6.** *The Agronomic and Environmental Critical Levels for many ornamental plants for the Modified Morgan and Mehlich III extraction methods.*

| **Extraction Method** | **Agronomic Critical Level** | **Environmental Critical Level** |
|---|---|---|
| **Modified Morgan** | 10 PPM or 20 lbs./acre | 14 PPM or 28 lbs./acre |
| **Mehlich III** | 50 PPM or 100 lbs./acre | 150 PPM or 300 lbs./acre |

PPM = parts per million.

Compost application procedures for ornamental plantings should follow the detailed guidelines presented in Section 5.

**Compost Nitrogen Content**

Although the BMP guidelines for compost application are based on soil and compost P content, attention must also be paid to the amount of N applied in compost. Table 4 in Section 5 provides estimates of total lbs. of N per 1000 sq. ft. contained in various types of compost. Nitrogen in compost is slowly released as the compost decomposes. Approximately 10-to-25% of the N is mineralized and released during a one-year period, although the release rate is more likely near the 25% rate on sandy soils. Therefore, a compost application containing 8 lbs. N/1000 sq. ft. would be expected to release about 2 lbs. N/1000 sq. ft. during the first year, which is the maximum allowed by the *BMP.* However, adding that much of any compost would supply about 8 lbs $P_2O_5$/1000 sq. ft. and would most likely overload the soil with P. Therefore, it may not always be possible to achieve the desired annual N release rate using only compost, and organic landscape practitioners may need to supplement compost with organic fertilizers that contain no P.

Since only a portion of the compost decomposes each year, much of it remains in the soil and is released over several years. Repeated compost applications may overload the soil with N and increase the possibility of nitrate loss to leaching or runoff. If compost application rates are based on N availability, then only the amount of compost required to replace the amount that has decomposed should be added. Soil OM content can be determined by conducting a soil test.

The Nantucket *BMP* recommended application rates for compost, together with estimates of P and N content and availability, were determined after extensive discussion and communication with science reviewers listed in the Acknowledgments. The ECL for Nantucket's soils was arrived at from recent research on sand soils and after consultation with several of the turf science professionals who reviewed the *BMP* (see Bibliography).

## *Section 10*

## The Role of Irrigation

- **Placement of the irrigation system should be included in the initial site-planning process and included in the final as-built plan.**
- **Irrigation zones should be tailored to the requirements of specific plantings including turf, gardens, or mixed borders.**
- **Irrigation water should not penetrate below the root zone. A simple soil probe or spade can be used to determine depth of moisture from irrigation.**
- **Regular monitoring and adjustment of irrigation-control clocks over the course of the growing season are important to provide adequate moisture for plants without overwatering.**
- **Excess irrigation may contribute to runoff or leaching of fertilizers.**
- **Special monitoring of irrigation at times of planting, fertilization, and renovation is essential for promoting healthy plant growth and avoiding runoff or leaching.**
- **Turn irrigation systems off during periods of adequate rainfall.**
- **Avoid watering impervious surfaces such as sidewalks, driveways, and roads.**
- **Seasonal record-keeping of natural precipitation and clock adjustments is recommended.**

Properly designed, monitored, and maintained irrigation systems play an important role in managed landscapes and gardens on Nantucket. Proper water management promotes healthy landscapes while reducing the leaching of fertilizers into our groundwater, ponds, and harbors.

### System Design

The design of an irrigation system for a new landscape should be based on careful site planning as outlined in Section 2: "Site Assessment and Planning." Permission from the Nantucket Conservation Commission must be obtained before installing irrigation systems within 100 feet of wetland resource areas. The location and separation of the system into different zones should be tailored to specific site conditions as well as the water requirements of the different aspects of a proposed landscape. For example, a lawn, or the part of it on a windy exposed site, will require more water than a lawn in an area more protected area. Turf has different water requirements than a shrub border, or a perennial garden. Some shrubs popularly used in Nantucket gardens, hydrangeas for example, need more water than others that are more adapted to Nantucket's conditions. After becoming established, a border of native plants may need no irrigation at all.

Both the professional landscaper and the homeowner will find an as-built map or diagram showing labeled irrigation zones of a particular landscape and garden a useful tool for effectively understanding and monitoring the system. Keeping irrigation-clock labels properly updated over time and as changes are made to systems is also important.

### System Monitoring

Regular monitoring of the irrigation system over the growing season is fundamental to using water efficiently and avoiding over-watering, which may increase the possibility of fertilizer leaching or surface runoff. Coordination of watering with fertilizer applications is especially important. When turf fertilizer has just been applied, providing the correct amount of water to replenish just the root zone is crucial in avoiding leaching to ground- water. Depth of root zone and water from irrigation or rainfall can be easily determined with a simple soil probe or shovel.

New landscapes initially require more water as turf and plants are becoming established. Close observation of watering needs over time will usually lead to less water being used as plants and turf mature, except during times of extreme heat and drought.

A recommended component of monitoring irrigation is to keep a written journal of clock adjustments and weather conditions over the growing season. Adjusting the irrigation system during the growing season so that irrigation supplements natural rainfall patterns is recommended practice.

The simplest way to avoid excess watering, which may contribute to fertilizer runoff or leaching, is to turn irrigation clocks off when it is raining. Wait to turn clocks back on until conditions warrant.

**System Maintenance**

Over time, as plantings grow and mature, water coverage throughout an irrigated landscape should be inspected and reviewed. Sprinkler-head locations may periodically need to be adjusted to ensure adequate moisture is reaching the plants they were intended for. Careful annual inspection of water coverage when systems are reactivated in the spring should include any necessary revisions to ensure efficient watering.

In summary, irrigation systems are useful components of successfully managed landscapes and gardens. Seasonal and long-term monitoring and clock adjustment in conjunction with plant growth needs and weather conditions are important aspects of a successful irrigation system.

Irrigation-system design based on specific site conditions, regular maintenance, and adjustment over time—especially close monitoring and record keeping during the growing season—will help direct fertilizers to the plants they are intended for while promoting healthy landscapes with minimal risk to nutrient runoff or leaching to our ponds, harbors, and groundwater.

## *Section 11*

## Alternative Naturalistic-Style Practices

- **Native plants occur naturally in an area and were not introduced by people.**
- **Naturalized plants were introduced by people and have adapted to natural conditions.**
- **Native and naturalized plants are: well adapted to local conditions; do not require fertilizer; are often resistant to diseases and pests; and support local biodiversity.**
- **Preserving existing areas of native plant communities is encouraged in the site-planning process.**
- **Native plants are recommended for use in managed landscapes as ornamental plants, borders, or buffers.**
- **Restoration of disturbed lands with native grasses is recommended.**
- **Invasive exotic plants are introduced species that aggressively displace native species. Removal of invasive exotic species is recommended where possible.**

The naturalistic style of landscape design and management is based on knowledge of existing plant communities, the conditions in which they grow, and an understanding of how plant communities develop and change over time. It is an approach based on knowledge of, and adaptation to, self-sustaining landscapes that exist on Nantucket.

Naturalistic-style landscapes require little or no alteration of existing conditions, no irrigation, and no fertilizer inputs. Entire individual properties can be designed and managed in a naturalistic style, or, some naturalistic-style practices can be incorporated as components of higher-maintenance landscapes. Thorough site assessment and planning determines how much of a particular property is desired or needed for fertilizer-dependent turf or plantings and how much can be managed naturalistically, whether restored or left undisturbed.

The principles and practices of naturalistic landscaping are closely related to the science of ecological restoration but on a smaller scale. For further information on ecological restoration and alternatives to lawns, refer to the Bibliography for a list of recommended reading.

**Native Plants**
There are many benefits to using native plants in man-made landscapes. Native plants are those that have evolved naturally in an area, in our case Nantucket with its unique setting, history, and conditions. Specifically, native plants refer to plants that were growing here before humans introduced plants from distant places. Native plants consist of plant species and communities adapted to similar soil, moisture, and climate conditions. The native plants we have on Nantucket today are also influenced by the impact of historical land uses including grazing and farming practices, as well as the relatively recent introduction and spread of invasive plant species.

One of the primary benefits of using native plants is that, once established, they require no fertilization or irrigation. Other benefits are winter hardiness, drought tolerance, and for most species, increased pest and disease resistance.

**Naturalized Plant Communities**
Over time, plants introduced from around the world have adapted to Nantucket’s conditions, and

become naturalized. Some of them are common in natural areas and many would mistake them as natives. Examples of naturalized plants are Rosa rugosa, found in stands on sand dunes; almost all of the pines growing on the island; and common roadside weeds or wildflowers, such as Queen Anne's lace and common daisies.

Some introduced plants have great competitive advantage over native plants and are considered exotic invasives. A few examples of exotic invasives on Nantucket are Japanese knotweed [*Polyganum cuspidatum*], which has a bamboo-like appearance and spreads rapidly forming dense monocultures; Japanese honeysuckle [*Lonicera japonica*], one of the first shrubs to leaf out in the spring and gaining a dominant foothold in more and more areas of the island; and oriental bitter sweet [*Celastrus orientalis*], a very aggressive vine with orange and yellow berries that is unfortunately used for decorating, inadvertently promoting its spread. Exotic invasives tend to be found predominantly on disturbed lands and old dumping grounds. They are continuing to spread and are altering native plant communities. When preserving naturalized plant communities as part of the landscape, one should remove exotic invasives, where possible, and encourage native plant communities.

As with all plant communities, naturally occurring vegetation continues to change over time. An understanding of what factors influence past, present, and future changes is fundamental to implementing management decisions for natural areas if incorporated as part of the man-made landscape. Preserving an area of undisturbed plant communities or planting with native plant species are two distinct naturalistic style practices.

When a nursery-grown native plant is planted in an amended garden soil, it will perform differently from the same native species existing in Nantucket's natural soil conditions. One of the keys to successful use of native plants is to replicate the natural conditions the native plant grows in. The second is to carefully monitor the transition from nursery-grown plant to established landscape plant. The seasonal timing of planting and the size of the plant are contributing factors to the successful use of native plants. The ease or difficulty of establishment varies species to species. The third factor in the successful use of native plants, once established or preserved, is to manage them appropriately, which means hardly at all.

As mentioned in Section 2. "Site Assessment and Planning," it is common for new construction practices in rural parts of the island to disturb more area than will be necessary for a well-planned man-made landscape. Those extra areas, between the designed functional landscape and undisturbed land beyond, are opportunities to
incorporate alternative naturalistic landscape practices. The primary benefit, as it relates to the *BMP*, is the overall reduction of fertilizer use by incorporating alternative plantings that require no fertilizers. A corollary benefit is the aesthetic softening of edges between the closer, "tamed" landscape, and the surrounding "wild" natural areas beyond.

**Tall Grass Meadows**
One recommended practice for restoring disturbed land is to plant areas with native grass species. Sand-plain grasslands, one of Nantucket's special native plant communities, is an excellent model for a grassland. Little bluestem [Schizachyrium scoparius], switchgrass [Panicum virgatum], and Pennsylvania sedge [Carex pennsylvanica] are three native-grass

species that work well for meadow planting. When a grassland is being established, it is important to use existing Nantucket soil, not to fertilize, and to water only during extreme drought periods. Amended soil, fertilizer, or added irrigation will increase the competitive advantage of weeds compared to native species. In time, with selective hand-removal of unwanted species and mowing once or twice a year (at a recommended height of 3–4 inches), a grassland will mature and even incorporate other native species that grow from seed found in native soil and surrounding vegetation. The land above and around a newly installed or repaired septic system leach area is a recommended location for establishing a grassland.

**Using Native Trees and Shrubs**

The inclusion of native plant shrub buffers, whether of newly planted or of preserved existing vegetation, is another example of naturalistic style practice, that when used reduces fertilizer inputs. If a preserved shrub thicket is included as an edge planting or integrated part of a man-made landscape, it requires no fertilizer or water. Below are some native shrubs and trees recommended for buffer plantings, available in local nurseries. Cultivars and varieties of many native species have been selected or developed for landscape use.

***Shrubs***

Bayberry – *Myrica pennsylvanica*
Viburnum – *Viburnum dentatum*
Beach plum – *Prunus maritima*
Inkberry – *Ilex glabra*
Winterberry – *Ilex verticillata*
Sweet pepperbush – *Clethra alnifolia*
Highbush blueberry – *Vaccinium corymbosum*

***Trees***

American holly – *Ilex opaca*
Red maple – *Acer rubrum*
Sassafras – *Sassafras albidum*
Tupelo – *Nyssa sylvatica*
American beech – *Fagus grandifolia*
White oak – *Quercus alba*
Black oak – *Quercus velutina*

Native plants and plant communities, when planted and established correctly, do not require fertilizers or irrigation, and thus contribute to reducing potential nutrient leaching into our aquatic resources.

## Appendix 1. Recommended Soil and Compost Testing Laboratories

- A & L Analytical Laboratories, Inc., 2790 Whitten Road, Memphis, TN 38133 Phone 800 -264-4522; 901-213-2400 Fax 901-213-2440 http://www.al-labs.com/

- UMass Soil Testing Soil and Plant Tissue Testing Laboratory, West Experiment Station 682 North Pleasant St., University of Massachusetts Amherst, MA 01003 http://www.umass.edu/soiltest

- The University of Maine: Analytical Laboratory and Maine Soil Testing Service, 5722 Deering Hall, Orono, ME 04469-5722 http://anlab.umesci.maine.edu/

# Appendix 2. Sources and Types of Nitrogen, Phosphorus, and Potassium

## 2.A. Sources and Types of Nitrogen Fertilizer

### 2.A.1 Sources and Types of Fast-Release Nitrogen Fertilizer

**2.A.1.a Synthetic Fast Release Nitrogen Fertilizers.** Fast release synthetic nitrogen (N) fertilizers are generally applied in products that contain a variety of other nutrients.

Urea. Urea is the most widely used of all N fertilizers. Urea is a simple organic molecule that occurs naturally in animal urine though most urea used in fertilizers is manufactured. Urea is soluble in water and is rapidly broken down in the soil to release ammonia making if a fast release N source. Urea can be coated or chemically altered to make it slow release (SRN) and it is the main constituent of synthetic SRN products.

Ammonium sulfate. Ammonium sulfate is a fast release fertilizer with $NH_4^+$ as the N source. Ammonium sulfate releases N at cooler soil temperatures than urea and most other N sources.

Potassium nitrate – Potassium nitrate is a fast-release fertilizer with $NO_3^-$ as the N source and is also a source of potassium (K).

Ammonium nitrate. Ammonium nitrate is a fertilizer with both $NH_4^+$ and $NO_3^-$ as N sources. Ammonium nitrate is typically found as a constituent of blended fertilizers or synthetic slow-release nitrogen fertilizers (SRN). Straight ammonium nitrate is very difficult to purchase and used mainly in agricultural applications.

**2.A.1.b Organic Fast Release Nitrogen Fertilizers.** Most fast release organic fertilizers contain a variety of other plant nutrients. Though these sources are listed as fast release nitrogen, some of their total N content may be in slow release form.

Compost tea – Compost tea is a water extraction of compost that contains fast release N and is generally applied in small amounts as foliar fertilizer.

Blood meal – Blood meal is derived from animal blood that is heated, dried, and ground. Blood meal contains a high percentage of N and has the potential to burn plants if over applied. Blood meal also contains phosphorus (P), K and iron (Fe).

Meat meal – Meat meal is derived animal tissue and also contains P and Fe.

Fish meal – Fish meal is derived from fish tissue and also contains P and K.

Seaweed (Kelp Powder and Liquid Kelp) – Kelp powder and liquid kelp contain small amounts of N, P, and K and high amounts of micronutrients. Liquid kelp is typically used as a foliar fertilizer.

All fast release fertilizers, whether synthetic or organic, are susceptible to leaching if improperly used or used in excess of the rate guidelines in Section 6.

**2.A.2 Sources and Types of Moderate to Slow-Release Nitrogen Fertilizers**

Group I. Carbon-containing compounds are dependent on microbial decomposition for nitrogen release. Maximum nutrient release occurs when soil temperatures are above 55°F, pH is 6.5, and there is adequate moisture present. This group includes natural organics and ureaformaldehydes (UF). UFs are synthetically produced organic compounds that function in a similar manner to naturally occurring organic fertilizers.

Natural Organics – The nitrogen in natural organic fertilizers is derived from animal and plant materials. Sewage based products are also considered to be natural organic fertilizers though their use on Nantucket is discouraged because of heavy metal content.

- Moderate to slow release organic N sources
    - Fish emulsion – Fish emulsions are soluble, liquid N fertilizers derived from fish waste processed by heat and acid. They also contain micronutrients.
    - Fish hydrolyzate – Fish hydrolyzate is derived from fish waste that is partially digested by enzymes. Fish hydrolyzed also contains P, K, micronutrients, vitamins, and proteins.
    - Alfalfa meal – Alfalfa meal is also contains P, K, and bio-stimulants. Alfalfa meal is also used to increase soil organic matter content.
    - Crab meal – Crab meal also contains P, K, and calcium.
- Slow to very-slow release organic N sources
    - Feather meal – Feather meal is derived from poultry waste and has a higher N content than most organic fertilizers.
    - Seaweed (Kelp Meal) – Kelp meal is derived from seaweed and is low in N, P, and K but high in micronutrients.
    - Cottonseed meal – Cottonseed meal also contains P and K, with a typical analysis of 6-2-2.

Ureaformaldehyde (UF) fertilizers – UF fertilizers are synthetically produced fertilizers that may contain "fractions" that vary in N release rate from several weeks to several years.

Below are two examples of UF fertilizers containing different 'fractions'. Please note that they are referenced by their brand name because that is how they are often identified by practitioners. This use of names is not an endorsement of any particular product.

- Nutralene – Nutralene is a mix of water soluble fast release nitrogen (WSN), slow release nitrogen (SRN), and methylene urea. Nutralene depends on temperature, microbial activity, and soil moisture to release the SRN over a 16-week period.

- Nitroform – Nitroform is similar to Nutralene and contains WSN, SRN, and WIN, but with a greater percentage of WIN than Nutralene. Nitroform releases N over a 22-week period.

Group II. These products contain carbon compounds that have a low solubility in water. Nitrogen is released as the fertilizer particles are slowly dissolved by water. Group II fertilizers can release N at cooler soil temperatures than Group I fertilizers.

Below is one example of a Group II fertilizer.

IBDU – Isobutylidene diurea – IBDU releases N through a process called slow hydrolysis. IBDU is the slow-release component in many combination products and the percentages of slow release can vary from 25% to 90% of total N.

Group III – These products consist of water soluble N compounds that are coated with a physical barrier such as polymers, plastic, and sulfur that delay N release.

An example of each is presented below:

Polymer Coated Urea – Polyon is an example of Polymer Coated Urea. Nitrogen slowly diffuses through Polyon's membrane coating at a rate that varies with soil temperature. Release is not dependent on moisture or microbial activity. Polyon is available in a number of formulations that contain different amounts of fast release N along with the SRN.

Plastic Coated Urea - Osmocote is sealed with a plastic/polymer coating. The release of nitrogen is largely dependent on temperature and to a lesser degree on water. The release rate of nitrogen is mainly determined by the thickness of the plastic - the thicker the coating, the longer the release time.

Sulfur Coated Ureas (SCU) – SCUs have coatings that are slowly dissolved by water. The best SCUs have thick, consistent coatings that accurately control the rate of N release. Some inexpensive SCU have weak coatings that are easily broken by handling or by mower traffic. Broken coatings allow for a more rapid release of N. Some SCUs seal and protect the coating with wax which helps slow the release of N. The wax sealant is slowly removed by microbial activity. Only high quality SCU products with thick consistent coatings should be used.

**2.B. Sources and Types of Phosphorus Fertilizer**

Since most organic fertilizers contain P in addition to N, many sources of P are detailed in the prior category with N. Additional sources of organic and synthetic P are detailed below:

- Additional organic sources of phosphorus
  - Bone meal – Bone meal is derived from the bones of poultry, cows, or pigs that have been sterilized with intense heat. The amount of N in bone meal is low and it is used more often as a source of P. If used as a N source, it is imperative to take into account the amount of phosphorus in bone meal. When using bone meal, the amount of P should be applied based on a soil test identified deficiency and recommendation.
  - Mushroom compost – Mushroom compost is the composted waste from commercial mushroom growing facilities and is typically derived from horse manure. Mushroom compost has a very high P content and a small amount of slowly released N.
  - Bat guano – Bat guano is a good source of P and also contains N and K. Its N release rate is fast to medium so consideration of N rates and timing must be accounted for. Bat guano is preferably included as part of a slower release blend.
  - Worm castings – Worm castings also contain small amounts of N and K and are a good source of organic matter.
  - Soft rock phosphates – Though not truly organic, soft rock phosphates are derived from naturally occurring clay deposits that include phosphate and calcium. Soft rock phosphates can require 3-12 years to completely breakdown.
- Synthetic sources of phosphorus
  - Monoammonium phosphate (MAP) – MAP is a fast release source of P that also contains fast release N. MAP's typical analysis is 11-52-0.
  - Diammonium phosphate (DAP) – DAP is a fast release source of P which also contains fast release N. DAP's typical analysis is 18-56-0.
  - Monopotassium phosphate (MKP) – MKP is a fast release source of P and K but contains no N. It is often used for foliar applications. MKP's typical analysis is 0-52-34.
  - Triple super phosphate – Triple super phosphate is a fast release synthetic source of P that is popular in greenhouse and garden uses.

**2. C. Sources and Types of Potassium Fertilizer**

- Greensand. Greensand is a naturally derived source of K extracted from mineral deposits that were once part of the **o**cean floor. Greensand may contain small amounts of P.

- Sulfate of potash. Sulfate of potash is a naturally occurring mineral. It also contains sulfur and has a low burn potential.

- Langbeinite. Langbeinite is a naturally occurring mineral extracted from evaporated seawater. It also contains sulfur and magnesium. Langbeinite is often referred to as Sul-Po-Mag.

- Muriate of potash. Muriate of potash is a synthetic source of K that is popular in fertilizer blends due to its low cost of manufacturing. However, muriate of potash contains chlorine, which may negatively impact soil microbial populations. It also has a high burn potential on turfgrass. The use of muriate of potash is not recommended on Nantucket.

## Appendix 3. Sample Record Keeping Sheet for Fertilizer Applications

NAME OF APPLICATOR:______________________________
LICENSE #__________________________
CUSTOMER:______________________________
LOCATION:_______________________________
APPLICATION DATE:_______________________
PRODUCT:___________________________________________
PRODUCT:___________________________________________
PRODUCT:___________________________________________
ADDITIONAL INGREDIENTS:___________________________________________________
WEATHER CONDITIONS:_______________________________________________________
AREA OF APPLICATION IN SQUARE FEET:________________________
APPLICATION RATE IN #s/1000 SQ. FT.:_____________________________
SPREADER SETTING:____________________________________
AMOUNT OF PRODUCT USED:_____________________________
TYPE OF PLANTING:__________________________________________
SITE OBSERVATIONS:________________________________________________________
TOTAL N, P, AND K APPLIED DURING SEASON:________________________________

## Appendix 4. Instructions for Spreader Calibration: A Step by Step Guide:

**Step 1. Calculate the pounds of product to be spread.** Pounds of a given nutrient per 1000 sq. ft. is the most common way to describe the application rate of fertilizer products for turfgrass. Pounds per acre (lbs/A) is sometimes used, especially for large applications of lime and compost.

In this example we will apply a fertilizer with a 10-0-8 analysis (10% nitrogen) and with an application rate of 0.5 lb nitrogen (N) per 1000 sq ft. The required amount of product to apply per 1000 sq ft must first be calculated. We calculate the pounds of product per 1000 sq ft as follows:

Convert the percent of N in the product to a decimal portion by dividing by 100%.

In this example: 10% / 100% = 0.1

Product application rate = N application rate divided by the decimal portion of N in product

In this example: 5# product/1000 ft sq = 0.5# N/1000 ft sq / by 0.1 N in product.

**Step 2. Weighing the required material for calibration.** We next calibrate the spreader to apply 5# product /1000 sq. ft. First, weigh and load a known amount of fertilizer into the spreader. A basic rule is to load twice the amount of the desired rate of product; in this case that would be 10 pounds of fertilizer.

**Step 3. Determining spreader swath width of fertilizer for calibration.** The swath width is determined by walking at normal speed, engaging the spreader, and measuring the width of the fertilizer thrown from left to right. Because the amount of fertilizer decreases at the edges of the swath, it is a good practice to overlap swaths slightly (6-12 inches). Let's assume that our swath width was 10 feet.

**Step 4. Setting up calibration course.** We now know our swath width (10 feet) and pounds of product needed per 1000 sq. ft. (5) necessary to achieve our desired rate of 0.5 lb of N per 1000 sq. ft. We now set up a 1000 sq ft area for calibration. Dividing 1,000 by the 10-foot swath width, we get 100 feet; this is our "run." Measure out 100 feet being sure to mark the starting and ending points. Set the spreader using the setting on the bag as a starting point only. A fertilizer label might have a 'recommended' setting for your desired rate and type of spreader. This setting can be a starting point for calibration.

**Step 5. Walking the calibration course and completion.** Begin fertilizing while walking at a normal pace until reaching the end point. After finishing this calibration course, empty the remaining fertilizer into the bucket and weigh the material using a scale. If you still have 5 pounds remaining, your calibration is correct. If you have too much or not enough left, adjust the spreader setting, and repeat the calibration using a different calibration course. This is a very important point – using the same course can effectively double the amount of fertilizer applied in that area. This is not only harmful to the turfgrass, but allows for the possibility of leaching and/or runoff. Once proper calibration has been achieved, do not fertilize the calibration course or courses for the same reason as above. Of course, you can calibrate on a hard surface that allows for recovery and proper clean up of the fertilizer.

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