Soil Management

Description

Soil management is managing soil to provide the best growing conditions for turf and other vegetation. It may include adding lime, fertilizer, topsoil or other constituents to the existing soil to address low fertility, abnormal moisture content or inappropriate pH. It also includes cultivation and drainage techniques.

All soil additions (amendments) should be based on the results of **soil tests**. Soil samples should be taken following procedures in the attached Exhibit.

Other Terms Used to Describe

Liming
Soil conditioning
Soil preparation

Pollutants Controlled and Impacts

Proper soil treatment applied in conjunction with proper vegetative establishment will help prevent erosion and promote the filtering of runoff water. Soil treatment will also reduce the potential of groundwater contamination by providing a better environment for vegetative growth.

Application

Land Use
The BMP is applicable to all land uses where soils will be used for vegetative establishment.

Soil/Topography/Climate
Soil management varies based on soil classification and the use of that soil.

When to Apply
Certain aspects of this BMP will need to be applied at various times throughout the year. For example, when establishing new turf areas, liming materials should be incorporated into the soil before or during final seedbed or sodbed preparation.

Where to Apply
Apply to all soils.

Relationship With Other BMPs

This BMP is used in conjunction with all vegetative BMPs, as well as the Pesticide Management and Fertilizer Management BMPs.

Specifications

General Considerations:

Naturally existing soils are divided into layers called horizons (see Exhibit 1). These horizons may differ by pH, organic content, moisture, texture, etc. For the purposes of providing good soils for vegetation, only the top two soil layers are of concern. Exhibit 2 shows typical plants which can survive at various pHs.

Changes to the characteristics of the soil may be needed if the soil is not suitable for its intended use (e.g. if the soil is to support a building, its composition will be completely different than if its purpose is to grow grass). Therefore, first determine what the intended use of that soil is.

Since many land uses involve the establishment of grasses and other vegetation, the remaining text of this BMP is devoted to soil amendments for improving vegetative growing conditions. Refer to Exhibit 3, the USDA Soil Texture Classification, to determine soil texture based on the percentage of clay, silt or sand. This chart helps clarify what soils like "loam" and "clay loam" are comprised of.

All soil additions should be done based on the results of soil tests. Exhibit 4 is a step-by-step procedure for collecting soil samples. The Michigan State University, Cooperative Extension Service (MSU, CES) lab can analyze the samples, and staff can offer suggestions on the appropriate amount of fertilizer and other additives that are needed. Exhibit 5 lists the MSU CES laboratory fees.

The discussion below includes possible treatments which will be needed based on the results of the soil test. Much of the information was derived from "Turfgrass Pest Management," Michigan State University, Cooperative Extension Service, Bulletin E-2327.

pH:

pH is a measure of acidity. Soils with a pH less than 7 are considered acid, while soils with pH greater than 7 are considered alkaline. A pH of 7.0 is considered to be neutral.

Although most turf grasses grown in Michigan will grow well under a wide range of soil pH conditions, the optimum pH range for turf grasses is 5.0 to 7.5, depending on the turf species selected. Some acid-loving plants such as blueberries and rhododendrons prefer pHs between 4.0 and 7.0. Again, the type of plant to be grown in the soil will determine the pH requirements. Determine pH by soil test.

If the pH is too low:

Soils that are too acidic for the plant type should be treated with **lime** to raise the pH. This is particularly important because as the soil becomes more acidic, metals become more soluble. As metals become soluble they can be more easily transported to surface and ground waters. Lime should be mixed into the soil to a depth of at least 3 inches before seeding or sodding.

If the pH is too high:

pH levels higher than the optimum range (to 7.5) are generally not encountered in Michigan. Where necessary, sulfur or sulfur compounds may be added to lower the pH to the optimum range.

In droughty soils:
Droughty soils may be caused by a lack of irrigation, or because of a lack of organic material. Determine the cause of the droughty condition, then adjust the irrigation schedule, or add organic matter, loamy material, or preferably, topsoil to increase the moisture holding capacity of the soil.

Nutrients (Phosphorus and Nitrogen):
Nutrients in a soil are in constant flux, becoming more or less available as soil conditions change. Fertilizers sold commercially contain varying amount of the 16 mineral elements essential for turf growth and development, nitrogen, phosphorus and potassium being the three most common elements. Remember that only a soil sample will tell you how much of each nutrient is available in your soil.

Nitrogen:
Nitrogen is an essential element for plant growth. Because nitrogen makes grass "green," it is often used in excess of what the plant needs. Nitrogen which is not absorbed by vegetation can leach through the soil and into the groundwater. During this leaching process, nitrogen is converted into nitrate, which can contaminate drinking water supplies and cause health problems. The Environmental Protection Agency limits the acceptable level of nitrate in drinking water to 10 ppm (parts per million).

Nitrogen is often unavailable to turf roots because it leaches through the soil rapidly. Turf deficient in nitrogen may have poor color, decreased elasticity, and is less able to compete with weeds. Apply nitrogen based on soil tests. Do not apply any more than one pound of actual nitrogen per 1,000 square feet during a single application.

Phosphorus:
Phosphorus is important for root development, maturation, and seed production. This element is found chemically bound to oxygen; two particles of phosphorus are bonded to five oxygen particles (P_2O_5). Since this molecule is practically immobile in soil, few soils are deficient in phosphorus. Soils that are deficient show purpling of grass blades. Note that this symptom can be confused with the color change induced by cold weather.

Many Michigan soils have been historically over-applied with phosphorus. Since phosphorus binds readily with soil, excessive applications of phosphorus which are carried off in eroded soil can result in algae blooms and nuisance aquatic plant growth. This, in turn, results in eutrophication.

Phosphorus fertilizer must be delivered directly to turf roots. This can be done by fertilizing after aeration or by liquid fertilizer injection. Apply all phosphorus amendments based on the results of soil tests.

Potassium:
Turf uses potassium in quantities second only to nitrogen. This element is important for rooting, and wear and climatic stress tolerance. While rarely visually evident, turf deficient in potassium has yellowing and dead blade tips.

Potassium generally does not cause water quality problems, nor is it over-applied in the same manner as phosphorus and nitrogen. Apply potassium amendments on the basis of soil test results.

For all Nutrient-Deficiencies:
If soils are nutrient-deficient, follow specifications in the Fertilizer Management BMP.

Micro-Nutrients:
Micronutrients are elements used by plants in relatively small amounts. They include manganese, boron, copper, and zinc. Typically, micronutrients required by turf are naturally present in Michigan soils in adequate amounts. High soil pH, however, can render these elements insoluble, making them unavailable to turf roots. Iron is an example of a micronutrient that is commonly deficient in alkaline soils (i.e. those soils with a pH greater than 7). Iron is required for chlorophyll production, and therefore the green coloring of plants. It is also important for root and shoot development and drought resistance. Iron-deficient turf usually has blotchy yellow patches. Severe iron deficiencies may result in white grass blades or the death of plants. Application of iron fertilizer will provide temporary green-up of turf. Since the deficiency is due to soil alkalinity, long-term treatment requires modifying the soil pH.

Soil Organisms:
Living and decaying soil organisms contribute greatly to a soil's organic matter and fertility. As they burrow, organisms break down organic matter, making nutrients available for absorption by turf roots.

Earthworms are the best known of soil organisms, but a great number of microorganisms also occupy the soil. One teaspoon of soil can contain a billion bacteria, a million fungi, and several thousand algae. Most of these organisms improve soil conditions for plants.

Turf managers who appreciate the benefits of soil life are careful not to destroy it with unnecessary soil amendments. Again, make amendments to the soil based on the result of soil tests.

Managing for Compacted Soils:
Compacted and heavy clay soils contain less air and have a hard surface that drains poorly. Turf growing in such soils lack air and beneficial micro-organisms, and suffer from poor drainage. Root development and turf quality declines.

Mechanical aerators create holes in compacted and heavy soils. This practice increases the movement of air in the soil and improves drainage. Machines that remove cores from the soil are generally more efficient aerators than those that spike or slit the soil. Coring machines remove a quarter to one-inch diameter cores and deposit them on the surface of the turf. Fall is the best time to aerate turf, when weed seed germination is at a minimum.

When practical, break up deposited cores by dragging chain-linked fence or similar material over them. Cores of poor quality soil should be discarded. Holes will more rapidly be covered by turf if the area is top dressed, seeded and fertilizer is applied directly after aeration. Follow this with a light watering. Fall is the best time to aerate turf, when weed seed germination is at a minimum.

Site Preparation:
For established areas:
1. Collect soil samples following the procedures in the attached Exhibit.

2. Discuss the soil test results with the local Soil Conservation District or Cooperative

Extension Service staff, and buy the recommended amount of fertilizers, lime, or other needed amendments. Apply fertilizers following specifications in the Fertilizer Management BMP. Lime should not be spread using a hydroseeder. It can be blown onto steep slopes in dry form. For the application of compost, see the Organic Debris Disposal BMP.

For a typical seeding or sodding operation as part of a construction project:

1. Collect soil samples following the procedures in the attached Exhibit.

2. Discuss the soil test results with the local Soil Conservation District or Cooperative Extension Service staff and buy the recommended amount of fertilizers, lime, or other needed amendments.

3. In large areas, topsoil should be removed and stored in storage piles according to specifications in the Spoil Piles BMP.

4. Where appropriate, grade following specifications in the Grading Practices BMP. Complete all cut and fill activities. Use Diversions and other BMPs to prevent soil erosion and sedimentation. Follow the site plan.

5. The earth bed upon which the topsoil is placed for seedbed and sodbed preparation should be at the required grade.

6. Work lime, fertilizer and other additives into the topsoil, either before or during final seedbed preparation, or before sod is laid. Lime should be mixed into the soil to a depth of at least 3 inches before seeding or sodding. Lime should not be spread using a hydroseeder. It can be blown onto steep slopes in dry form. For all seeding applications, follow specifications in the Seeding BMP.

   For all sodding applications, follow specifications in the Sodding BMP. For the application of compost, see the Organic Debris Disposal BMP.

7. Inoculate all legume seed in accordance with the manufacturer's recommendations.

Maintenance

If the vegetation doesn't grow according to its intended use, additional soil tests may need to be taken and analyzed for other parameters. Additional soil samples should also be taken as new areas are developed.

Once vegetation is established, additional soil amendments, including fertilizers, should only be made based on the results of soil tests.

Additional Considerations

Treating soils on-site is less expensive than importing soils from off-site. Existing soils are also usually compatible with the lower horizons.

Exhibits

Exhibit 1: Soil Horizons. Michigan Department of Natural Resources, Soil Erosion Control Unit.

Exhibit 2: pH Toxicity Chart. Michigan Department of Natural Resources, Soil Erosion Control Unit.

Exhibit 3: USDA Soil Texture Classification.

Exhibit 4: How to Collect a Soil Sample. Compiled from several sources.

Exhibit 5: Michigan State University Testing Laboratory Fee Schedule. Lists prices effective July 1, 1990.

Exhibit 1:

Soil Horizons

Horizon O - This uppermost horizon consists of detritus, leaf litter, and other organic material lying on the surface of the soil. This layer is dark because of the decomposition that is occurring, and is usually 0" to 2" deep, or it may be as deep as 16" for poorly drained, unclassified soil.

Horizon A - The second layer of soil, called topsoil, is darker than the lower layers. It is loose and crumbly with varying amounts of organic matter. In cultivated fields, the plowed layer is topsoil. As water moves down through the topsoil, many soluble minerals and nutrients dissolve. The dissolved materials leach from the topsoil. This is generally the most productive layer of soil, and ranges from 2" to 10" in depth.

Horizon B - The third layer is commonly called subsoil. This layer is usually light colored, dense, and low in organic matter. The subsoil is a zone of accumulation since most of the materials leached from the topsoil accumulate here. This zone ranges from 10" to 30" in depth.

Horizon C - This layer is beneath the subsoil. It is lighter in color than the subsoil. It is typically described to a depth of 60" in soil survey reports, but may be many feet thick. It may or may not be like the material from which the A and B horizons have formed. If it is dissimilar, it is designated as 2C or IIC.

Horizon R - This layer represents bedrock.

Source: Michigan Department of Natural Resources, Soil Erosion Control Unit.

Exhibit 2

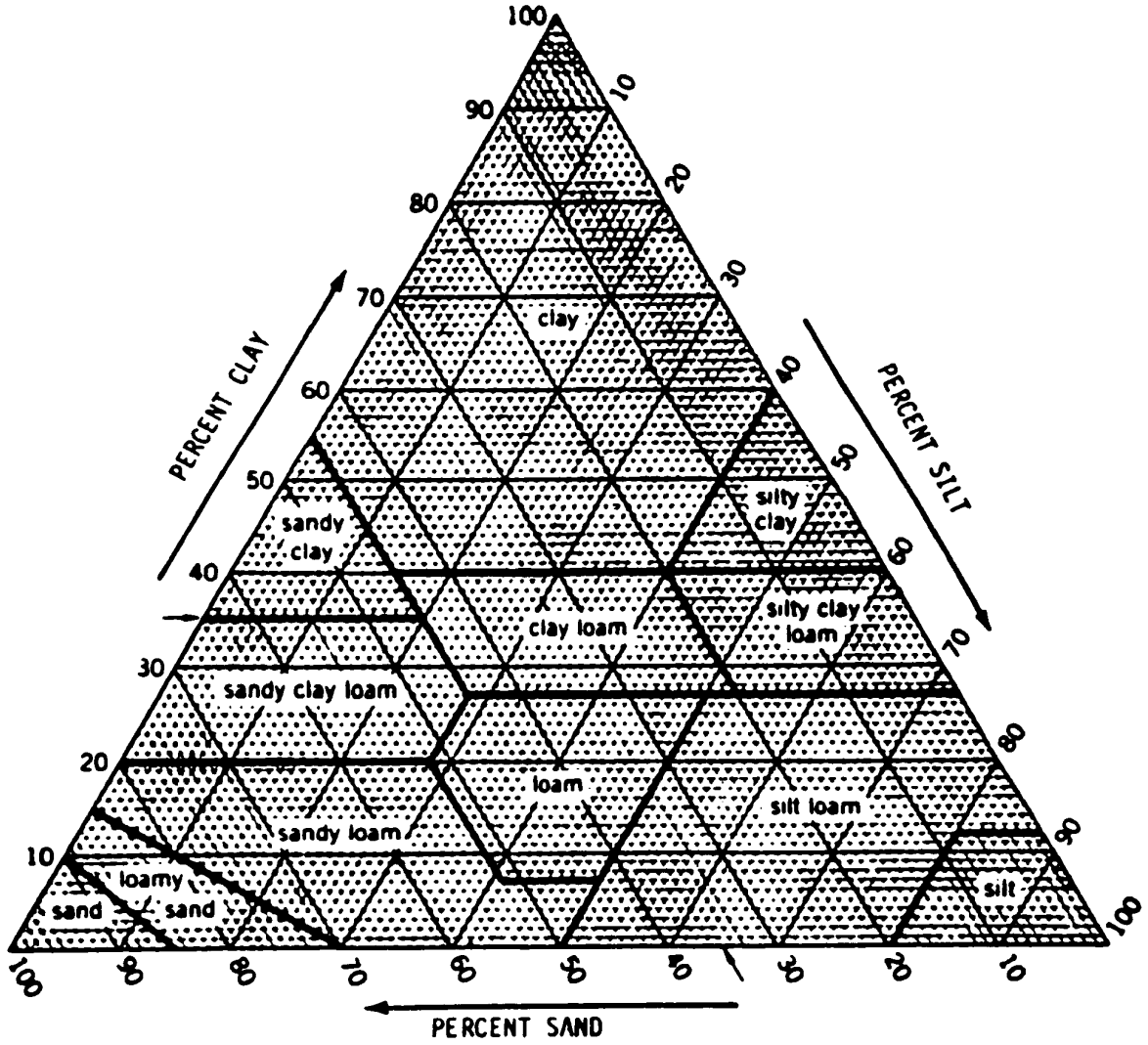
pH Toxicity Chart

	pH		
	14		
B	13		
A	12	Typical Basic Soils	Typical Plants Tolerant of Basic Soils
S	11	Alpena, Aurelius, Barry, Belleville	Willow, American Elm, Poison Sumac, Poison Ivy
I	10		
C	9		
	8		
	7	Neutral	Vegetation grows best when it is within the range of 5.5 and 8.0
	6		
	5		
A	4		
C	3	Typical Acid Soils	Typical Plants Tolerant of Acid Soils
I	2	Burt, Champion, Gogebic, Isabella	Red Maple, Balsam Fir, Bunchberry
D	1		
	0		

Source: Michigan Department of Natural Resources, Soil Erosion Control Unit.

Exhibit 3

USDA Soil Texture Classification



Source: USDA, Soil Conservation Service

Exhibit 4:

How To Collect a Soil Sample

Soil tests are generally collected and analyzed for nitrate-nitrogen, phosphorus, and pH. As discussed in the Lawn Maintenance BMP and above, BMP, nitrogen and phosphorus are two of the three primary nutrients which make up commercial fertilizers. Fertilizers put on the soil in excess of that which is needed by the plant may 1) run off the soil into lake, rivers and streams, causing algae blooms; or 2) leach through the soil and impair groundwater supplies.

Generally, a representative sample should be taken. This may mean only a few samples, as in the case of an average one-acre yard, or a dozen or more, as in the case of a large field. The more variety of soil textures in the area to be vegetated, the more samples that should be taken. Turf areas that differ significantly in grass type, use, or growing conditions should be analyzed separately.

Remember that there are three primary types of soil textures are sands, silts and clays. Soil which is comprised of a mixture of sand, silt and clay is called loam. Use Exhibit 3, the USDA Soil Texture Classifications, to determine the soil textures of your soils.

Step by step process:

For Yards/Lawns Less than 1 Acre:

1. Take a spade or trowel and stick it in the soil to a depth of 4-5 inches at a 45-degree angle (to make a V-shaped cut). Take the spade out and move it 1/2-inches away from the first cut and dig out a 1/2-inch chunk of soil. Then, trim off from each side of the spade all but a thin ribbon of soil down the center of the spade face. Place this in a clean bucket, plastic container or paper bag. Do not contaminate samples by mixing them in a metal container.

2. Take additional samples, as needed for different textures of soils, and for the different ways turf can differ--by grass type, use, or growing conditions. Add the soil to the bucket/container and mix thoroughly.

3. Air dry the sample by spreading the soil out in the bottom of the bucket/container, or, if a lot of soil is collected, in the bottom of a flat pan.

4. When the soil is dry, mix it thoroughly. Then take out about a half-pint, and put it in a jar for testing.

5. Take the soil test to the county Cooperative Extension Service (CES) office or a private lab experienced in the analysis of soils. Be prepared to answer questions about the amount of fertilizer you've used in the past, the spreading/spraying technique used, and the type of grass or sod the fertilizer will be applied to. Also indicate to the CES staff any problems which have been encountered on the lawn: look for thin spots, brown spots, etc.

Exhibit 4 (Con't)

6. The CES staff will have the soil test analyzed and present you with the results, along with a recommendation for the amount of fertilizer needed, the application rate, the best time to apply the fertilizer, and frequency of applications. By tailoring fertilizer applications to your lawn, you will put on only what is needed, thus saving money and protecting surface and ground waters, and will likely save money.

7. Homeowners should have their soil tested once every three or four years, unless additional problems arise.

<u>For Yards Larger than 1 Acre, Including Parks, Cemeteries, etc.</u>

1. Get a copy of a soils map from the Soil Conservation District or the Cooperative Extension Service to identify the number and types of soils on your property.

2. Collect soil tests to a depth of 4-5 inches and 1/2-inch thick using a spade, soil auger or soil sampling tube.

3. Trim off from each side of the spade all but a thin ribbon of soil down the center of the spade face. Place this in a clean bucket.

4. Take additional samples, as needed for each different type of soil identified on the soil map. If you were unable to access the soil map, at least take additional samples for each soil texture (sand, silt, or clay). Add the additional soil samples to the bucket.

5. Follow steps 3 - 6 in the above section.

6. People with large acres to manage should collect soil samples annually.

Compiled from several sources.

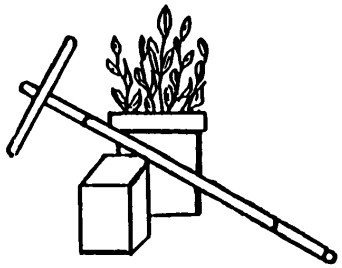
Exhibit 5

MICHIGAN STATE UNIVERSITY
SOIL TESTING LABORATORY

FEE SCHEDULE

For
SOIL ANALYSIS
And OTHER MATERIALS

(EFFECTIVE JULY 1, 1990)



Cooperative Extension Service
Crop and Soil Sciences Department
A81 Plant and Soil Sciences Building
East Lansing MI 48824-1325

Telephone (517) 355-0?18
FAX (517) 355-1732

PRICES EFFECTIVE July 1, 1990

1a. REGULAR FIELD SOIL TEST. . . . . $ 6.00*
pH, lime requirement, P, K, Ca, Mg & recommendations

1b. REGULAR FIELD TEST PLUS ZN & MN $10.00*

*Samples coming into the lab not in pre-paid boxes add $.50 per sample for boxing

2. MICRONUTRIENT TESTS (Zn, Mn, Cu, & Fe) .$ 3.00/EA
(price is per micronutrient per sample)

3. GREENHOUSE TEST $14.00
(For artificial growth media) pH, Nitrate-N, P, K, Ca, Mg, soluble salts, Na, Cl and nutrient balance

4. SUPPLEMENTAL SOIL TESTS

a. Nitrate - Nitrogen . . . . . $ 3.00
b. Nitrate - N + Ammonium - N . . . . . $ 4.00
c. Sodium . . . . . $ 3.00
d. Chloride . . . . . $ 3.00
e. Soluble Salts . . . . . .$ 3.00
f. Organic Matter . . . . . $ 3.00
g. pH . . . . . $ 2.00
h. Total Nitrogen $12.00
i. C.E.C. by ammonium saturation . . . $15.00
j. Boron (analysis by U. Of Wisconsin). $ 5.50
Sulfur . . . . . $ 5.50

5. PARTICLE SIZE ANALYSIS $10.00
(percent sand, silt and clay)

6. GOLF COURSE ANALYSIS Sand Classification $15.00
(USGA size limits by wet sieving)

7. PEAT FOR SALE . . . . . .$ 7.00
(pH, organic matter, moisture content, peat type)

PRE-PAYMENT IS ENCOURAGED - OTHERWISE A SERVICE FEE OF $6.00 WILL BE ADDED

Exhibit 5 (con't.)

8. LIMESTONE ANALYSIS

a. Neutralizing Value, Sieve Analysis…….$18.00
% $MgCO_3$ and Moisture

b. Neutralizing Value only……...$ 6.00

c. Sieve Analysis only……..$ 6.00

d. Percent $MgCO_3$ only……$ 6.00

9. MARL ANALYSIS

a. Neutralizing Value, $CaCO_3$ equivalent per cubic yard, % $MgCO_3$, % moisture……...$18.00

b. Neutralizing Value, $CaCO_3$ equivalent per cubic yard and % moisture……...$12.00

c. Percent $MgCO_3$ only……$ 6.00

10. WATER TESTS

a. **COMPLETE…**…….$12.00
(soluble salts, alkalinity, pH, Nitrate-N, P, K, Ca, Mg, Na and chloride)
b. Total Soluble Salts…..…….$ 2.00
c. Alkalinity……..$ 2.00
d. Nitrate-N…..……$ 2.00
e. Nitrate-N + Ammonium-N……..……$ 3.00
f. Any single soluble element……...$ 2.00

11. PLANT TISSUE ANALYSIS

COMPLETE tissue analysis includes N, P, K, Ca, Mg, Zn, Mn, Cu, Fe, B, Al and Mo.
a. Field Crop & Vegetable tissue……$16.00
(includes interpretation of results)
b. Fruit trees, grapes, strawberries,…….$18.00
blueberries & raspberries (includes interpretation of results & computerized fertilizer recommendations)
c. Complete analysis <u>without N</u>……..….$12.00
d. N alone..……...$ 8.00

12. SUPPLIES

a. Soiltex pH kits……..$ 3.00

b. Hoffer Soil Sampling Probes……...$20.00

13. DISCOUNT INFORMATION
(on purchases of soil sample boxes only)

a. 0-99……..……..No discount
100-199…….4%
200-399…….8%
400 +……...10%

TURNAROUND TIME for Regular Soil Tests is one week, turnaround time for Greenhouse tests is two (2) days from receipt. A 20% surcharge will be added for Rush samples.

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