# Maryland Nutrient Management

# Consultant's Resource Notebook

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EPA REGION III
JUN 23 2011
NPDES ENFORCEMENT BRANCH
(3WP42)

**Maryland Department of Agriculture**
Nutrient Management Program
50 Harry S. Truman Parkway
Annapolis, Maryland 21401
410-841-5959

# Introduction

**This notebook contains a variety of resources that you will turn to over and over as you work with agricultural operators.**

The design follows the outline of the "Fundamentals" course, allowing you to add notes and handouts. Space has been left intentionally for you to add materials in the future. The MDA Nutrient Management Program will help you keep your "Law, Regulations and Reference Manual" up to date. This notebook however, is yours. Use the internet references and continuing education courses to keep your notes up to date. Add materials that relate to the type of operations you work with.

**Materials for "Fundamentals of Nutrient Management Course"**

1) Textbook: "Chesapeake Bay Region Nutrient Management Training Manual"

   *New* version just released digitally:
   http://www.agnr.umd.edu/users/waterqual/themes/nutrient_management/manmh2006.htm

2) Notebook: "Maryland Nutrient Management: Law, Regulations and Manual"

3) Consultant's Resource Notebook

**Course Description for "Fundamentals of Nutrient Management"**

This two-day course provides instruction in the basic concepts of nutrient management required to pass the Nutrient Management Certification Exam. The exam consists of 100 multiple choice questions from nine knowledge areas. Eight of these knowledge areas are covered by the "Chesapeake Bay Region Nutrient Management Training Manual." Each of the Bay states uses this core question pool for its certification exam. The ninth knowledge area is specific to Maryland.

| Knowledge Area | Percentage |
|---|---|
| 1. General Nutrient Management | 10 |
| 2. Basic Soil Science | 12 |
| 3. Agricultural & Environmental Management | 15 |
| 4. Sampling, Testing and Analysis | 10 |
| 5. Basic Soil Fertility | 15 |
| 6. Fertilizer Management | 10 |
| 7. Manure Management | 12 |
| 8. Biosolids (Sludge) Management | 6 |
| 9. Technical Recommendations, Regulations & Incentives | 10 |
| **Total** | **100** |

**Reciprocity Agreements**

Maryland, Pennsylvania, Virginia and Delaware have reciprocity agreements on training, exam standards, certification and continuing education credits. Persons seeking certification in Maryland who plan to work in PA, VA or DE need to consult their state nutrient management program for state-specific regulations and requirements.

**Questions or comments should be directed to:**

Maryland Nutrient Management Program
Maryland Department of Agriculture
50 Harry S. Truman Parkway
Annapolis, MD 21401
Phone: 410-841-5959 Fax: 410-841-5950

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Section I

- **Maryland Leaching Indices for Nitrates and Soluble Nutrients**

# MARYLAND LEACHING INDICES FOR NITRATES AND SOLUBLE NUTRIENTS

## 1. GENERAL

This section describes a way to determine the degree to which water percolates below the crop root zone (1 meter) in Maryland soils. Percolating water containing soluble nitrate-nitrogen ($NO_3$ - $^-$N) or other soluble nutrients could be a hazard to ground water quality, especially shallow groundwater sources used for drinking water supply.

The method is based on the Soil Nitrogen Leaching Index (L.I.) developed by the USDA-ARS. The L.I. is an estimate of the average annual percolation below the one meter crop root zone, based on the hydrologic soil group (HSG), the amount of average annual precipitation, and the average amount of seasonal precipitation (October through March). The unit of measure for the Leaching Index (L.I.) Is:

**L.I = inches of water infiltrating below the 1 meter root zone**

The resulting L.I. vulnerability ratings are to be used as guidance or planning tools when developing resource management systems, and for nutrient management planning purposes. Keep in mind, that the L.I. rankings only address the soluble nutrients (including $NO_3$ - $^-$N) moving below the crop root zone into groundwater, and that the surface runoff loss component is not addressed here. Both the surface and ground water concerns need to be considered in order to completely address potential nutrient losses.

## 2. LEACHING INDEX

Figure 1 identifies the state climatic divisions for Maryland. Table 1[1] lists the soil names for Maryland and the associated HSG. The HSG classification (A through D) is a description of soils by their reference to intake rate of infiltration of water, which is influenced by texture, organic matter content, stability of soil aggregates, and soil horizon development. The HSG describes soils that do <u>not</u> have dual hydrologic ratings because of difference in artificial drainage. The L.I. does not account for water supplied through irrigation. If irrigation is applied only to meet crop needs during the growing season, there will be little additional loss below the root zone. Table 2 provides the L.I. values for each state climatic division (1 through 8) by HSG.

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[1] A complete information on Maryland NPURG Soils Data is available at USDA-NRCS Maryland State Office. You may call 410-757-0861 for a copy.

Table 1

# MARYLAND NPURG SOILS DATA

## Soil Leaching Potential (SLP) and Soil Surface Loss Potential (SSLP)

Tagged Soil Series Data

| Soil Series & Texture Class | K_Fact | % Organic Matter | Layer Depth | Hydro Group | Depth to GW | SLP | SSLP |
|---|---|---|---|---|---|---|---|
| ABBOTTSTOWN L, SIL | 0.43 | 2.0- 3.0 | 10 | C | 0.5 | NOM | INT |
| ABBOTTSTOWN STV-L, STV-SIL | 0.32 | 2.0- 3.0 | 10 | C | 0.5 | NOM | INT |
| ABBOTTSTOWN STX-L, STX-SIL | 0.32 | 2.0- 3.0 | 10 | C | 0.5 | NOM | INT |
| ADELPHIA SL, FSL, SIL | 0.32 | 0.5- 3.0 | 14 | B | 1.5 | INT | INT |
| ADELPHIA SL, FSL, SIL | 0.32 | 0.5- 3.0 | 14 | C | 1.5 | NOM | INT |
| ADEN SIL | 0.43 | 0.5- 2.0 | 8 | C | 0.0 | NOM | INT |
| ALBRIGHTS SIL, L | 0.32 | 1.0- 4.0 | 8 | C | 1.0 | NOM | INT |
| ALBRIGHTS GR-SIL, GR-L, CN-SIL | 0.28 | 1.0- 4.0 | 8 | C | 1.0 | NOM | INT |
| ALBRIGHTS STV-SIL, STV-L | 0.24 | 0.0- 0.0 | 8 | C | 0.5 | NOM | INT |
| ALDINO SI, SIL | 0.43 | 1.0- 3.0 | 10 | C | 1.5 | NOM | INT |
| ALDINO STV-SIL | 0.37 | 1.0- 3.0 | 10 | C | 1.5 | NOM | INT |
| ALLEGHENY L, SIL | 0.32 | 1.0- 4.0 | 8 | B> 6 | | INT | INT |
| ALLEGHENY FSL | 0.28 | 1.0- 4.0 | 8 | B> 6 | | INT | INT |
| ALLEGHENY CB-FSL, CB-L, CB-SIL | 0.20 | 1.0- 4.0 | 10 | B> 6 | | INT | INT |
| ALLEGHENY L, SIL | 0.32 | 1.0- 4.0 | 9 | B> 6 | | INT | INT |
| ALLEGHENY FSL | 0.28 | 1.0- 4.0 | 9 | B> 6 | | INT | INT |
| ALLEGHENY L | 0.32 | 1.0- 4.0 | 9 | B> 6 | | INT | INT |
| ANDOVER SIL, L, SL | 0.28 | 1.0- 4.0 | 7 | D | 0.0 | NOM | HIG |
| ANDOVER GR-SIL, GR-L, GR-SL | 0.24 | 1.0- 4.0 | 7 | D | 0.0 | NOM | HIG |
| ANDOVER CB-SIL, CB-L, CB-SL | 0.24 | 1.0- 4.0 | 7 | D | 0.0 | NOM | HIG |
| ANDOVER STV-SIL, STV-L, STV-SL | 0.17 | 1.0- 4.0 | 7 | D | 0.0 | NOM | HIG |
| ANDOVER STX-SIL, STX-L, STX-SL | 0.17 | 1.0- 4.0 | 7 | D | 0.0 | NOM | HIG |
| ARMAGH SIL, SICL | 0.24 | 1.0- 4.0 | 10 | D | 0.0 | NOM | HIG |
| ARMAGH STV-SIL, STV-SICL | 0.17 | 0.0- 0.0 | 10 | D | 0.0 | NOM | HIG |
| ARMAGH STX-SIL, STX-SICL | 0.17 | 0.0- 0.0 | 10 | D | 0.0 | NOM | HIG |
| ASHE L, SL, FSL | 0.24 | 1.0- 5.0 | 7 | B> 6 | | INT | INT |
| ASHE GR-L, GR-SL, GR-FSL | 0.17 | 1.0- 5.0 | 7 | B> 6 | | INT | NOM |
| ASHE GRV-L, GRV-SL, GRV-FSL | 0.15 | 1.0- 5.0 | 7 | B> 6 | | INT | NOM |
| ASHE STV-L, STV-SL, STV-FSL | 0.15 | 1.0- 5.0 | 7 | B> 6 | | INT | NOM |
| ASHE ST-L, ST-SL, ST-FSL | 0.17 | 1.0- 5.0 | 7 | B> 6 | | INT | NOM |
| ASHTON SIL, L | 0.32 | 2.0- 4.0 | 9 | B> 6 | | INT | INT |
| ASHTON FSL | 0.28 | 2.0- 4.0 | 9 | B> 6 | | INT | INT |
| ATHOL SIL, L | 0.32 | 2.0- 4.0 | 8 | B> 6 | | INT | INT |
| ATHOL GR-SIL, GR-L | 0.28 | 2.0- 4.0 | 8 | B> 6 | | INT | INT |
| ATHOL STV-SIL, STV-L | 0.24 | 0.0- 0.0 | 8 | B | | HIG | INT |
| ATKINS SIL, SICL | 0.32 | 2.0- 4.0 | 10 | D | 0.0 | NOM | HIG |
| ATKINS L, FSL | 0.28 | 2.0- 4.0 | 10 | D | 0.0 | NOM | HIG |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| WEIKERT CN-L, CN-SIL, CNV-SIL | 0.28 | 1.0- 4.0 | 7 | D> 6 | | NOM | HIG |
| WEIKERT SIL | 0.37 | 1.0- 4.0 | 7 | D> 6 | | NOM | HIG |
| WEIKERT STV-L, STV-SIL | 0.20 | 1.0- 3.0 | 7 | B> 6 | | INT | INT |
| WEIKERT STV-L, STV-SIL | 0.20 | 1.0- 3.0 | 7 | C> 6 | | NOM | INT |
| WESTBROOK HM, FB, MPT | 0.00 | 20.0-90.0 | 10 | D | +1.0 | HIG | INT |
| WESTMORELAND L, SIL, SICL | 0.37 | 1.0- 4.0 | 7 | B> 6 | | INT | INT |
| WESTMORELAND CN-L, CN-SIL, SH-SICL | 0.32 | 1.0- 4.0 | 7 | B> 6 | | INT | INT |
| WESTMORELAND BTV-L | 0.28 | 1.0- 4.0 | 3 | B> 6 | | INT | INT |
| WESTMORELAND STV-L, STV-SICL, STV-SI | 0.28 | 0.0- 0.0 | 7 | B> 6 | | HIG | INT |
| WESTPHALIA FSL, VFSL | 0.49 | 0.5- 3.0 | 10 | B> 6 | | INT | INT |
| WEVERTON FLV-L, FLV-SL | 0.15 | 0.5- 2.0 | 7 | B> 6 | | INT | NOM |
| WEVERTON FLX-L, FLX-SL | 0.10 | 0.5- 2.0 | 7 | B> 6 | | INT | NOM |
| WHARTON SIL, SICL | 0.37 | 1.0- 4.0 | 9 | C | 1.5 | NOM | INT |
| WHARTON CN-SIL, CN-SICL | 0.32 | 1.0- 4.0 | 9 | C | 1.5 | NOM | INT |
| WHARTON RUB-SIL | 0.17 | 0.0- 0.0 | 9 | C | 1.5 | NOM | INT |
| WHARTON STV-SIL, STV-SICL | 0.28 | 0.0- 0.0 | 9 | C | 1.5 | NOM | INT |
| WHEATON SIL, L | 0.49 | 0.0- 0.5 | 6 | B> 6 | | HIG | INT |
| WHEATON CN-SIL, CN-L | 0.28 | 0.0- 0.5 | 6 | B> 6 | | HIG | INT |
| WHITEFORD SIL | 0.32 | 0.0- 0.0 | 10 | B> 6 | | HIG | INT |
| WICKHAM SL, FSL, L | 0.24 | 0.5- 2.0 | 6 | B> 6 | | INT | INT |
| WICKHAM LS, LFS | 0.15 | 0.5- 1.0 | 6 | B> 6 | | HIG | NOM |
| WICKHAM SCL, CL | 0.24 | 0.5- 1.0 | 6 | B> 6 | | HIG | INT |
| WICKHAM SL, FSL, L | 0.24 | 0.5- 2.0 | 9 | B> 6 | | INT | INT |
| WICKHAM LS, LFS | 0.15 | 0.5-10.0 | 9 | B> 6 | | NOM | NOM |
| WOODSTOWN SL, FSL | 0.24 | 1.0- 2.0 | 11 | C | 1.5 | NOM | INT |
| WOODSTOWN L | 0.32 | 1.0- 2.0 | 11 | C | 1.5 | NOM | INT |
| WOODSTOWN SL | 0.28 | 0.5- 2.0 | 12 | C | 1.5 | NOM | INT |
| WORSHAM FSL, SL | 0.28 | 1.0- 2.0 | 8 | D | 0.0 | NOM | HIG |
| WORSHAM L, SIL | 0.37 | 1.0- 3.0 | 8 | D | 0.0 | NOM | HIG |

HIGH / INTERMEDIATE / NOMINAL ratings.

G (guessed) / E (estimated) database values.

Table 2

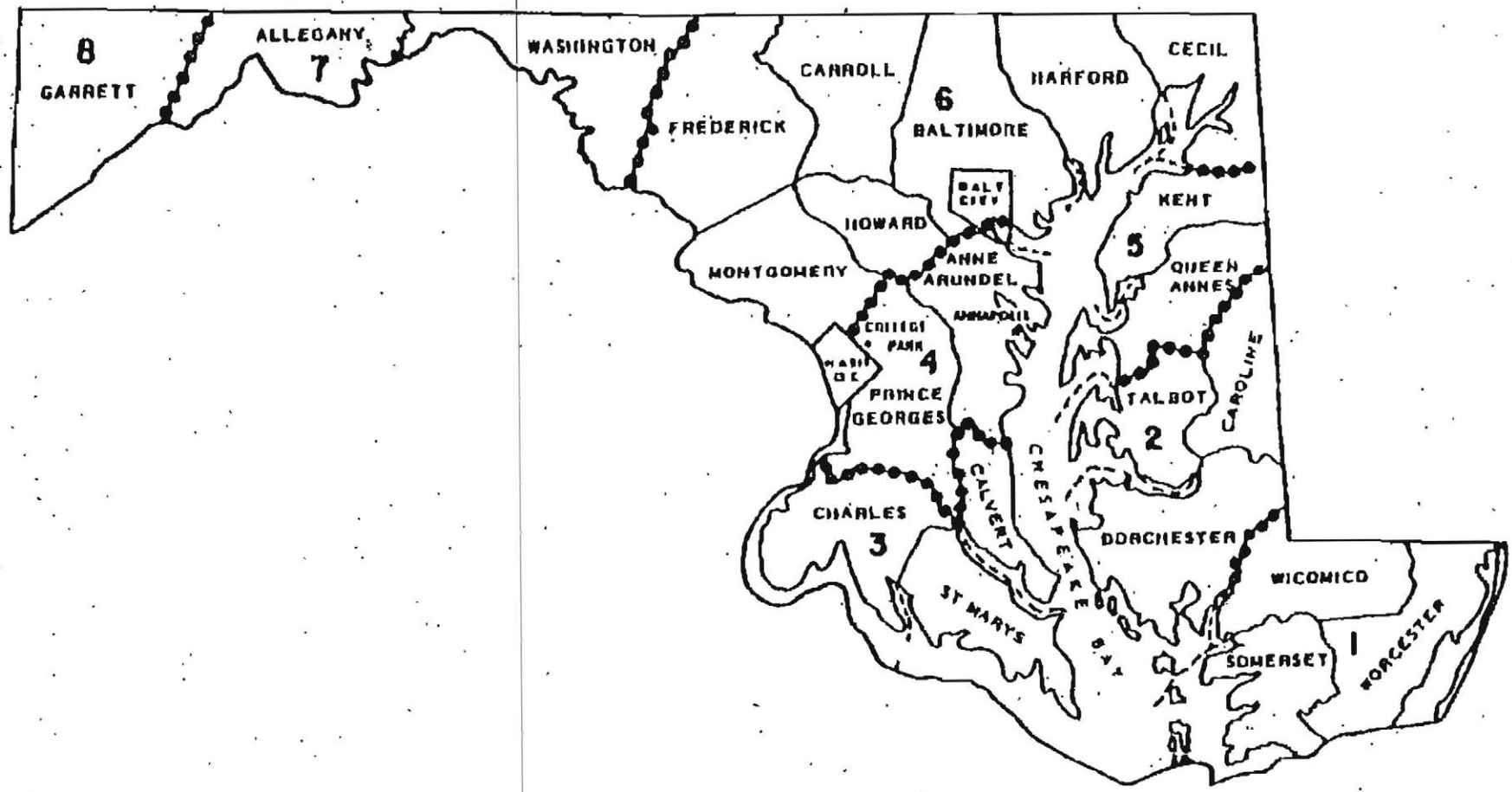
## SOIL NITROGEN LEACHING INDECES BY MARYLAND CLIMATIC REGIONS

| CLIMATIC REGION | HYDROLOGIC SOIL GROUP | ANNUAL PRECIP. (IN) | PRECIP. WINTER (IN) | N LEACHING INDEX (IN) |
|---|---|---|---|---|
| 1 | A | 43 | 20 | 18 |
| | B | 43 | 20 | 12 |
| | C | 43 | 20 | 7 |
| | D | 43 | 20 | 5 |
| 2 | A | 43 | 20 | 18 |
| | B | 43 | 20 | 11 |
| | C | 43 | 20 | 7 |
| | D | 43 | 20 | 5 |
| 3 | A | 42 | 19 | 17 |
| | B | 42 | 19 | 11 |
| | C | 42 | 19 | 7 |
| | D | 42 | 19 | 5 |
| 4 | A | 41 | 18 | 16 |
| | B | 41 | 18 | 10 |
| | C | 41 | 18 | 6 |
| | D | 41 | 18 | 4 |
| 5 | A | 41 | 19 | 16 |
| | B | 41 | 19 | 10 |
| | C | 41 | 19 | 6 |
| | D | 41 | 19 | 4 |
| 6 | A | 41 | 19 | 16 |
| | B | 41 | 19 | 10 |
| | C | 41 | 19 | 7 |
| | D | 41 | 19 | 4 |
| 7 | A | 37 | 17 | 13 |
| | B | 37 | 17 | 8 |
| | C | 37 | 17 | 5 |
| | D | 37 | 17 | 3 |
| 8 | A | 45 | 21 | 19 |
| | B | 45 | 21 | 13 |
| | C | 45 | 21 | 8 |
| | D | 45 | 21 | 6 |

Figure 1

# MARYLAND

## STATE CLIMATIC DIVISIONS



- **Rainfall Data for Maryland Counties**

# Rainfall Data for Maryland Counties (average in inches)

**Source: USDA/NRCS AWM SOFTWARE**

| County | Station | 25yr-24 hr storm | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Yearly Total | Apr-Sep Total | Oct-Mar Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Allegany | Cumberland | 4.9 | 2.43 | 2.36 | 3.24 | 3.31 | 3.64 | 3.51 | 3.61 | 3.42 | 3.06 | 2.78 | 2.78 | 2.66 | 36.80 | 20.55 | 16.25 |
| Anne Arundel | Annapolis | 5.9 | 3.14 | 3 | 3.47 | 3.31 | 4.11 | 3.63 | 3.81 | 3.98 | 3.47 | 3.26 | 3.43 | 3.39 | 42.00 | 22.31 | 19.69 |
| Baltimore | Cockeysville | 5.5 | 3.22 | 3.06 | 3.66 | 3.61 | 4.48 | 3.97 | 3.97 | 4 | 3.75 | 3.29 | 3.77 | 3.64 | 44.42 | 23.78 | 20.64 |
| Calvert | Prince Frederick | 6.1 | 3.3 | 3.06 | 3.62 | 3.3 | 4.16 | 3.85 | 3.99 | 3.93 | 3.58 | 3.28 | 3.42 | 3.32 | 42.81 | 22.81 | 20.00 |
| Caroline | Denton | 6 | 3.44 | 3.06 | 3.67 | 3.36 | 4 | 3.72 | 3.89 | 4.3 | 3.6 | 3.16 | 3.31 | 3.51 | 43.02 | 22.87 | 20.15 |
| Carroll | Westminster | 5.4 | 2.97 | 2.77 | 3.42 | 3.48 | 4.23 | 3.93 | 3.59 | 3.46 | 3.62 | 3.27 | 3.47 | 3.31 | 41.52 | 22.31 | 19.21 |
| Cecil | Elkton | 5.6 | 3.16 | 2.84 | 3.43 | 3.59 | 4.1 | 4.03 | 4.18 | 4.02 | 3.75 | 3.17 | 3.47 | 3.61 | 43.34 | 23.67 | 19.67 |
| Charles | La Plata | 6 | 3.12 | 2.95 | 3.52 | 3.17 | 4 | 3.76 | 3.96 | 4.12 | 3.65 | 3.28 | 3.39 | 3.27 | 42.19 | 22.66 | 19.53 |
| Dorchester | Cambridge | 6.2 | 3.59 | 3.3 | 3.84 | 3.33 | 3.79 | 3.62 | 4.11 | 4.63 | 3.55 | 3.07 | 3.28 | 3.51 | 43.62 | 23.03 | 20.59 |
| Frederick | Frederick | 5.4 | 2.84 | 2.75 | 3.34 | 3.47 | 4.21 | 3.97 | 3.54 | 3.43 | 3.6 | 3.37 | 3.46 | 3.13 | 41.11 | 22.22 | 18.89 |
| Garrett | Mt. Lake Park | 4.8 | 3.11 | 2.92 | 3.97 | 4.08 | 4.42 | 4.13 | 4.74 | 3.97 | 3.39 | 3.19 | 3.42 | 3.54 | 44.82 | 24.73 | 20.09 |
| Harford | Forest Hill | 5.5 | 3.2 | 2.89 | 3.5 | 3.7 | 4.32 | 4.19 | 4.18 | 4.27 | 3.83 | 3.2 | 3.68 | 3.64 | 44.60 | 24.49 | 20.11 |
| Howard | Woodbine | 5.6 | 3.01 | 2.95 | 3.55 | 3.39 | 4.35 | 3.83 | 3.73 | 3.81 | 3.61 | 3.32 | 3.57 | 3.41 | 42.53 | 22.72 | 19.81 |
| Kent | Chestertown | 5.8 | 3.2 | 2.98 | 3.57 | 3.32 | 4.02 | 4.11 | 3.79 | 3.99 | 3.66 | 3.16 | 3.36 | 3.67 | 42.83 | 22.89 | 19.94 |
| Montgomery | Derwood | 5.6 | 2.81 | 2.79 | 3.34 | 3.24 | 4.21 | 3.81 | 3.72 | 3.81 | 3.58 | 3.27 | 3.39 | 3.15 | 41.12 | 22.37 | 18.75 |
| Prince George's | Upper Marlboro | 5.9 | 3.04 | 2.84 | 3.37 | 3.27 | 4.18 | 3.75 | 3.99 | 4.08 | 3.57 | 3.32 | 3.39 | 3.28 | 42.08 | 22.84 | 19.24 |
| Queen Anne's | Centreville | 5.9 | 3.32 | 2.99 | 3.56 | 3.31 | 4.01 | 3.92 | 3.79 | 3.97 | 3.6 | 3.17 | 3.36 | 3.62 | 42.62 | 22.60 | 20.02 |
| Somerset | Prince Anne | 6.4 | 3.42 | 3.26 | 3.94 | 3.12 | 3.36 | 3.27 | 3.94 | 4.76 | 3.47 | 3.13 | 3.08 | 3.24 | 41.99 | 21.92 | 20.07 |
| St Mary's | Leonardtown | 6.2 | 3.33 | 3.14 | 3.74 | 3.22 | 4.11 | 3.81 | 4.12 | 4.04 | 3.68 | 3.28 | 3.37 | 3.3 | 43.14 | 22.98 | 20.16 |
| Talbot | Easton | 6 | 3.51 | 3.17 | 3.72 | 3.36 | 4.07 | 3.68 | 3.97 | 4.25 | 3.55 | 3.14 | 3.38 | 3.6 | 43.40 | 22.88 | 20.52 |
| Washington | Hagerstown | 5.1 | 2.55 | 2.5 | 3.2 | 3.32 | 3.84 | 3.71 | 3.51 | 3.38 | 3.17 | 3.19 | 3.19 | 2.82 | 38.38 | 20.93 | 17.45 |
| Wicomico | Salisbury | 6.3 | 3.65 | 3.41 | 4.05 | 3.28 | 3.53 | 3.56 | 4.06 | 5.06 | 3.58 | 3.22 | 3.15 | 3.48 | 44.03 | 23.07 | 20.96 |
| Worcester | Snow Hill | 6.4 | 3.7 | 3.47 | 4.16 | 3.23 | 3.51 | 3.41 | 4.04 | 5.15 | 3.38 | 3.22 | 3.18 | 3.43 | 43.88 | 22.72 | 21.16 |

8/06

AGRICULTURAL NUTRIENT MANAGEMENT PROGRAM
(301) 405-1319 ▪ FAX (301) 314-7375
1145 COLE STUDENT ACTIVITIES BUILDING ▪ ENVIRONMENTAL SCIENCE AND TECHNOLOGY ▪ COLLEGE PARK, MARYLAND 20742-1038
LOCAL GOVERNMENTS ▪ U.S. DEPARTMENT OF AGRICULTURE COOPERATING EQUAL OPPORTUNITY PROGRAMS

- **Sources for Soil Maps**

United States Department of Agriculture
NRCS Natural Resources Conservation Service

Maryland

**Field Office Technical Guide**
**Soil-Part of Section II**

**Containing the Official Copy**
**Of Soil Maps**

District of Columbia

Delaware — Delaware NRCS

Maryland — Maryland NRCS

NRCS Soil Survey Staff Directory

**Other Soils Links:**

Ag Nutrient Mangement - Maryland Cooperative Extension's Agricultural Nutrient Management Program
Delaware DataMill - source for Delaware geographic data
Geospatial Data Gateway - Website for state and county-level digital products such as hydrography, topography images, ortho-imagery, soils and climate data.
GIS Coverages - NRCS GIS coverages; includes county, state, MLRA and HUA coverages
Keys to Soil Taxonomy - Taxonomic keys for field classification
MAPSS - Mid-Atlantic Association of Professional Soil Scienctists
MLRA Office #13 - The Major Land Resource Area office servicing Maryland, Delaware and the District of Columbia, located in Morgantown, West Virginia.
Merlin - Geospatial Data - Maryland DNR site for GIS coverages
NASIS - National Soil Information System Homepage
NCGC Intranet - NRCS data from the National Cartography and Geospatial Center in Ft. Worth
National Soil Survey Center - Provides technical leadership and coordination for the national soil survey program and state-of-the-art soil survey data.
NRCS Technical References - Link to the National Soil Survey Handbook, Soil Survey Manual, Lab Methods Manual, Soil Classification and more.
Official Series Descriptions (OSDs) - Standard descriptions and characteristeristics of soil series
SAWGAL - Soil and Water Geospatial Analysis Lab at the University of Maryland
Soil Data Mart - Future warehouse for all official NRCS soils products
SSURGO - Digital data for complete and updated soils surveys that meet national standards
Soil Data Viewer - NRCS custom interactive soils software.
TerraServerUSA - Terra Server Address Search
Toolkit - Customer Service Toolkit Homepage

This web site is hosted by the Soil and Water Geospatial Analysis Laboratory (SAWGAL) at the University of Maryland, College Park. Refer web related questions to Dr. Brian Needelman at the University of Maryland or Rebecca Hickman at NRCS Maryland.

- **Soil pH Management and Determining Liming Rates**

MARYLAND COOPERATIVE EXTENSION
UNIVERSITY OF MARYLAND
COLLEGE PARK-EASTERN SHORE

Information

NATURAL RESOURCE SCIENCES AND LANDSCAPE ARCHITECTURE • H.J. PATTERSON HALL • COLLEGE PARK, MD 20742
PHONE (301) 405-1351 • FAX (301) 314-9049 • fc26@umail.umd.edu

# Soil Fertility Management

SFM-5
May 1997

## SOIL pH MANAGEMENT AND DETERMINING LIMING RATES

### What is soil pH?

Determination of soil pH is a measurement of the acidity or alkalinity of a soil. The pH scale ranges from 0 (very acidic) to 14 (very alkaline). At pH 7, the soil is neutral, neither acidic nor alkaline. To help put the pH scale into perspective: lemon juice is very acidic (pH 2), vinegar is also acidic (pH 3), rainfall is slightly acidic (pH 5 to 6), pure water is neutral (pH 7), bicarbonate of soda is slightly alkaline (pH 8), milk of magnesia is quite alkaline (pH 10), and bleach is very alkaline (pH 13). Plant growth and plant nutrient availability from a soil are strongly influenced by soil pH.

### What is the optimum soil pH?

The optimum soil pH varies for different crops. Most agronomic crops grow best in slightly acidic soil with pH between 6.0 and 6.5. Some crops, like alfalfa, perform best at a slightly higher soil pH, between 6.6 and 7.0. On the other hand, potato and sweet potato yields are optimized at a soil pH of approximately 5.2, and tobacco production is best at pH 5.6. Several horticultural species (azalea, rhododendron, blueberry) perform best under even more acidic soil conditions.

### How do I adjust soil pH?

Most of our farmland soils are acid generating soils and soil pH tends to decline over time. Therefore, in an effort to maintain an optimum soil pH for crop production, we amend our soils with liming materials that neutralize soil acidity. A liming material may be any substance that reduces the acidity of a soil. Typically, liming materials are oxide, hydroxide, or carbonate forms of calcium and/or magnesium. It is the oxide, hydroxide, or carbonate contained in the liming material, and *not* the calcium or magnesium, that acts to neutralize soil acidity. Different liming materials have different acid neutralizing capabilities.

Liming materials are most effective at neutralizing soil acidity when they are thoroughly incorporated and mixed with the soil of the plow layer (8 inches deep). For continuous no-tillage row crop production or for topdressing hay or pasture land, liming is still effective, but annual lime application rates should not exceed 1,500 pounds oxides per acre. (see discussion of total oxide content, below, and Tables 2 and 3).

Lime effectiveness and the quantity of a liming material necessary to achieve a



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desired adjustment in soil pH will vary by soil type, soil texture, and soil organic matter content. The impact of different soil types on liming recommendations are evident in Tables 2 through 5.

**How is the acid neutralizing capability of different liming materials expressed?**

The acid neutralizing capability of liming materials may be expressed in several ways. The most useful determination of neutralizing capability is the determination that permits the most simple and direct application of the recommendations provided by your soil testing laboratory.

The *calcium carbonate equivalent* (CCE) expresses the relative ability of a liming material to neutralize acid as compared to pure calcium carbonate (pure pulverized limestone). The CCE is determined by the chemical composition of the liming material. Table 1 presents average acid neutralizing values, expressed as CCE, for some common liming materials. The physical particle size of the liming material is sometimes used together with the CCE to determine the *effective neutralizing value* (ENV) of the liming material.

Often, the acid neutralizing potential of a liming material is determined from the *total oxide content* (calcium oxide plus magnesium oxide) of the liming material. The physical particle size of a liming material also may be used in conjunction with the liming material's oxide content to determine a lime application rate adjusted for lime fineness.

Any one of the above methods of expressing the relative acid neutralizing capacity of liming materials may be the most useful and convenient as you attempt to follow the liming recommendations of your soil testing laboratory. Purchased liming materials must be accompanied by a product description label that describes the acid neutralizing value of the material. Always refer to the labeled acid neutralizing information provided with the purchased liming material when making lime application rate decisions.

**Table 1.** Typical acid neutralizing value, expressed as calcium carbonate equivalent (CCE), of common liming materials and the quantity of each liming material necessary to achieve acid neutralization equivalent to one ton (2,000 pounds) of pure pulverized limestone.

| Liming material | Calcium carbonate equivalent (CCE) | Equivalent to one ton pure limestone |
|---|---|---|
| | % | *pounds* |
| Ground limestone, calcitic limestone, calcitic lime, calcite, hi-cal limestone, calcium carbonate | 100 | 2,000 |
| Burned lime, quick lime, unslaked lime, calcium oxide | 178 | 1,120 |
| Hydrated lime, builders' lime, slaked lime, calcium hydroxide | 134 | 1,490 |
| Dolomitic limestone, hi-mag limestone, calcium magnesium carbonate | 95 - 109 | 1,830 - 2,100 |
| Ground shells | 80 - 90 | 2,200 - 2,500 |
| Calcium silicate slag | 70 - 80 | 2,500 - 2,860 |
| Blast furnace slag, basic slag | 67 - 75 | 2,670 - 2,990 |
| Flue dust | 96 | 2,080 |
| Marl | 40 - 90 | 2,220 - 5,000 |
| Wood ashes | 40 | 5,000 |

## How do I use the total oxide analysis of a liming material to determine liming rate?

Total oxide content of a liming material is typically the sum of the percent calcium oxide (CaO) plus the percent magnesium oxide (MgO) contents. This information is usually stated on the label of purchased liming materials. Frequently, recommended liming rates are expressed in pounds per acre of oxides. Thus, if a soil test recommends lime application in pounds oxides per acre, then the corresponding application rate of a given liming material would be:

$$\frac{\text{pounds oxides/acre}}{\text{\% total oxides}} \times 100 = \text{pounds lime / acre.}$$

Example 1, below, demonstrates the use of total oxide content to determine lime application rate. Calculated lime application rates should be rounded off to the nearest quantity practical for the spreading equipment to apply. Typically, agricultural lime application rates are approximated no closer than to the nearest 500 pounds / acre application rate.

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Example 1: A soil test analysis recommends the application of 2,000 pounds oxides / acre. Liming material #1 contains 29% CaO and 37% MgO. Liming material #2 contains 33% CaO and 8% MgO. What are the corresponding lime application rates for the two liming materials?

*Material #1*
Total oxides = 29% CaO + 37% MgO
Total oxides = 66%

$$\frac{\text{2,000 lbs oxides/acre}}{\text{66\% oxides}} \times 100 = \text{3,030 lbs lime / acre}$$

**Apply 3,000 pounds lime / acre**

*Material #2*
Total oxides = 33% CaO + 8% MgO
Total oxides = 41%

$$\frac{\text{2,000 lbs oxides/acre}}{\text{41\% oxides}} \times 100 = \text{4,878 lbs lime / acre}$$

**Apply 5,000 pounds lime / acre**

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## How do I determine effective neutralizing capacity of a liming material?

The effective neutralizing capacity of a liming material is determined by the chemical composition of the liming material and the physical particle size, or fineness, of the material. The chemical characteristics are typically expressed as either the calcium carbonate equivalent (CCE) or total oxide content of the liming material. The finer the particle size, the more reactive the material. Coarse materials with large particles are much less reactive and much less effective at neutralizing soil acids.

Liming materials are graded for particle size, or fineness, by determining the percentage of the material that passes through each of a series of sieves with increasing mesh size (smaller openings). The calculated *fineness factor* uses the percent (by weight) of the material retained by an 8-mesh sieve, the percent retained by a 60-mesh sieve, and the percent that passes through a 60-mesh sieve. The material retained by the 8-mesh sieve is assumed to be not effective in neutralizing soil acidity for the following crop season. The material that passes through the 8-mesh sieve but is retained by the 60-mesh sieve is assumed to have 50% neutralizing effectiveness and that which passes through the 60-mesh sieve is assumed to be 100% effective at neutralizing soil acidity for the following crop season.

Particle size information should be used to adjust lime application rates. The fineness factor may be used to adjust the lime application based on total oxide content by correcting for the particle size of the liming material (*Example 2*).

Frequently, lime application rate recommendations are based on the assumption that pure calcium carbonate, CCE=100%, will be used. Actual application rates should be

corrected for the true CCE and particle size of the liming material. The fineness factor may be used to modify the CCE of a liming material by calculating the *effective neutralizing value (ENV)* of the material (*Example 3*).

**Liming recommendations.**

Recommended lime application rates based on the total oxide content of the liming material and initial soil pH, are presented in Tables 2 through 5, for agronomic crops having a target pH=6.5, alfalfa with target pH=7.0, tobacco with target pH=5.6, and potato with target pH=5.2, respectively. These recommendations assume a fineness factor of 100%. Application rates of liming materials with fineness factors less than 100% should be adjusted as outlined in *Example 2*.

Remember, even the most precisely calculated lime application rate is only as accurate as the spreader used to apply the lime. Check the calibration of spreader equipment regularly. Take time to verify the application rate of custom-applied lime.

Soils can be over-limed as easily as they can be under-limed. Both over-liming and under-liming can reduce yields. A program of routine soil testing can help manage soil pH, maximize crop yields, and minimize input costs.

*Prepared by:*
Frank J. Coale
Soil Fertility/Nutrient Management Specialist
Department of Natural Resources &
Landscape Architecture

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*Example 2: Liming material #1 from Example 1 has the following sieve analysis: 95% passes through 8-mesh sieve and 81% passes through 60-mesh sieve. What is the adjusted application rate of liming material #1 after correction for particle size?*

Percent retained by 8-mesh sieve: 100% - 95% = 5%
Percent retained by 60-mesh sieve: 95% - 81% = 14%
Percent passing through 60-mesh sieve: = 81%

*Calculated fineness factor:*
5% retained by 8-mesh x 0% effectiveness = 0%
14% retained by 60-mesh x 50% effectiveness = 7%
81% passing 60-mesh x 100% effectiveness = 81%
Fineness factor = 0% + 7% + 81% = 88%

*Application rate of liming material #1 corrected for particle size:*
3,000 pounds lime/acre x 100 = 3,409 lbs lime/acre
88% fineness factor
**Apply 3,500 pounds lime / acre**

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*Example 3: Calculate the effective neutralizing value (ENV) of an agricultural limestone that has a CCE = 90% and a sieve analysis of: 98% passes through 8-mesh sieve and 76% passes through 60-mesh sieve. What is the correct lime application rate if a soil test recommends applying 3,000 lbs lime/acre, assuming a liming material with CCE=100% and ENV=100%?*

Percent retained by 8-mesh sieve: 100% - 98% = 2%
Percent retained by 60-mesh sieve: 98% - 76% = 22%
Percent passing through 60-mesh sieve: = 76%

*Calculated fineness factor:*
2% retained by 8-mesh x 0% effectiveness = 0%
22% retained by 60-mesh x 50% effectiveness = 11%
76% passing 60-mesh x 100% effectiveness = 76%
Fineness factor = 0% + 11% + 76% = 87%

ENV = CCE x Fineness factor = 90% x 87% = 78.3%

*Application rate corrected for ENV:*
3,000 lbs/acre recommended rate x 100 = 3,831 lbs/acre
78.3% ENV
**Apply 4,000 pounds lime/acre**

**Table 2.** Recommended application rates for liming materials based on total oxide content for most agronomic crops. Target soil pH = 6.5. Recommendations presented by soil texture and region within Maryland.*

| Initial soil pH | Loamy Sand | Sandy Loam | Loam | | Silt Loam & Clay Loam | |
|---|---|---|---|---|---|---|
| | All Regions | All Regions | Coastal Plain | Piedmont & Mountain | Coastal Plain | Piedmont & Mountain |
| | Pounds per Acre of Total Oxides | | | | | |
| 6.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.3 | 0 | 0 | 0 | 0 | 0 | 1000 |
| 6.2 | 0 | 0 | 1000 | 1000 | 1000 | 1000 |
| 6.1 | 0 | 1000 | 1000 | 1000 | 1000 | 1500 |
| 6.0 | 500 | 1000 | 1000 | 1000 | 1000 | 2000 |
| 5.9 | 500 | 1000 | 1000 | 1500 | 1000 | 2000 |
| 5.8 | 500 | 1000 | 1500 | 1500 | 1500 | 2500 |
| 5.7 | 500 | 1000 | 1500 | 2000 | 1500 | 3000 |
| 5.6 | 1000 | 1500 | 1500 | 2000 | 2000 | 3500 |
| 5.5 | 1000 | 1500 | 2000 | 2500 | 2000 | 3500 |
| 5.4 | 1000 | 1500 | 2000 | 2500 | 2000 | 4000 |
| 5.3 | 1000 | 2000 | 2000 | 3000 | 2500 | 4500 |
| 5.2 | 1500 | 2000 | 2500 | 3000 | 2500 | 4500 |
| 5.1 | 1500 | 2000 | 2500 | 3500 | 3000 | 4500** |
| 5.0 | 1500 | 2500 | 2500 | 3500 | 3000 | 4500** |
| 4.9 | 1500 | 2500 | 3000 | 4000 | 3000 | 4500** |
| 4.8 | 2000 | 2500 | 3000 | 4000 | 3500 | 4500** |
| 4.7 | 2000 | 3000 | 3500 | 4000** | 3500 | 4500** |
| 4.6 | 2000 | 3000 | 3500 | 4000** | 3500** | 4500** |
| 4.5 | 2000 | 3000 | 3500 | 4000** | 3500** | 4500** |

* For continuous no-tillage or for topdressing hay or pasture land, lime application rates should not exceed 1500 pounds total oxides / acre / year. Soil pH should be measured within one year of lime application to determine the quantity of additional lime needed.

** The amount of oxide recommended probably will not be enough to raise soil pH to 6.5, but is the maximum amount that should be applied in one application. Soil pH should be measured within one year of lime application to determine the quantity of additional lime needed.

**Table 3.** Recommended application rates for liming materials based on total oxide content for alfalfa seedbed preparation. Target soil pH = 7.0. Recommendations presented by soil texture and region within Maryland.*

| Initial soil pH | Loamy Sand All Regions | Sandy Loam All Regions | Loam Coastal Plain | Loam Piedmont & Mountain | Silt Loam & Clay Loam Coastal Plain | Silt Loam & Clay Loam Piedmont & Mountain |
|---|---|---|---|---|---|---|
| | Pounds per Acre of Total Oxides | | | | | |
| 7.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.9 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.8 | 0 | 0 | 0 | 0 | 0 | 1000 |
| 6.7 | 0 | 0 | 1000 | 1000 | 1000 | 1000 |
| 6.6 | 0 | 1000 | 1000 | 1000 | 1000 | 1500 |
| 6.5 | 500 | 1000 | 1000 | 1000 | 1000 | 2000 |
| 6.4 | 500 | 1000 | 1000 | 1500 | 1000 | 2000 |
| 6.3 | 500 | 1000 | 1500 | 1500 | 1500 | 2500 |
| 6.2 | 500 | 1000 | 1500 | 2000 | 1500 | 3000 |
| 6.1 | 1000 | 1500 | 1500 | 2000 | 2000 | 3500 |
| 6.0 | 1000 | 1500 | 2000 | 2500 | 2000 | 3500 |
| 5.9 | 1000 | 1500 | 2000 | 2500 | 2000 | 4000 |
| 5.8 | 1000 | 2000 | 2000 | 3000 | 2500 | 4500 |
| 5.7 | 1500 | 2000 | 2500 | 3000 | 2500 | 4500 |
| 5.6 | 1500 | 2000 | 2500 | 3500 | 3000 | 5000 |
| 5.5 | 1500 | 2500 | 2500 | 3500 | 3000 | 5000** |
| 5.4 | 1500 | 2500 | 3000 | 4000 | 3000 | 5000** |
| 5.3 | 2000 | 2500 | 3000 | 4000 | 3500 | 5000** |
| 5.2 | 2000 | 2500 | 3500 | 4500 | 3500 | 5000** |
| 5.1 | 2000 | 3000 | 3500 | 4500 | 4000 | 5000** |
| 5.0 | 2000 | 3000 | 3500 | 4500** | 4000 | 5000** |
| 4.9 | 2500 | 3000 | 4000 | 4500** | 4000 | 5000** |
| 4.8 | 2500 | 3500 | 4000 | 4500** | 4500 | 5000** |
| 4.7 | 2500 | 3500 | 4000** | 4500** | 4500 | 5000** |
| 4.6 | 2500 | 3500 | 4000** | 4500** | 4500** | 5000** |
| 4.5 | 2500 | 3500 | 4000** | 4500** | 4500** | 5000** |

* For topdressing established alfalfa, lime application rates should not exceed 1500 pounds total oxides / acre / year. Soil pH should be measured within one year of lime application to determine the quantity of additional lime needed.

** The amount of oxide recommended probably will not be enough to raise soil pH to 7.0, but is the maximum amount that should be applied in one application. Soil pH should be measured within one year of lime application to determine the quantity of additional lime needed.

**Table 4.** Recommended application rates for liming materials based on total oxide content for tobacco. Target soil pH = 5.6. Recommendations presented by soil texture and region within Maryland.

| Initial Soil pH | Loamy Sand All Regions | Sandy Loam All Regions | Loam All Regions | Silt Loam & Clay Loam All Regions |
|---|---|---|---|---|
| | Pounds per Acre of Total Oxides | | | |
| 5.6 | 0 | 0 | 0 | 0 |
| 5.5 | 0 | 0 | 0 | 0 |
| 5.4 | 0 | 150 | 200 | 200 |
| 5.3 | 150 | 250 | 250 | 300 |
| 5.2 | 200 | 300 | 350 | 400 |
| 5.1 | 250 | 400 | 450 | 500 |
| 5.0 | 300 | 450 | 550 | 600 |
| 4.9 | 350 | 550 | 650 | 700 |
| 4.8 | 400 | 600 | 700 | 750** |
| 4.7 | 450 | 700 | 750** | 750** |
| 4.6 | 500 | 750 | 750** | 750** |
| 4.5 | 550 | 750** | 750** | 750** |

** The amount of oxide recommended probably will not be enough to raise soil pH to 5.6, but is the maximum amount that should be applied in one application. Soil pH should be measured within one year of lime application to determine the quantity of additional lime needed.

**Table 5.** Recommended application rates for liming materials based on total oxide content for potato and sweet potato. Target soil pH = 5.2. Recommendations presented by soil texture and region within Maryland.

| Initial soil pH | Loamy Sand All Regions | Sandy Loam All Regions | Loam Coastal Plain | Loam Piedmont & Mountain | Silt Loam & Clay Loam Coastal Plain | Silt Loam & Clay Loam Piedmont & Mountain |
|---|---|---|---|---|---|---|
| | Pounds per Acre of Total Oxides | | | | | |
| 5.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5.1 | 0 | 50 | 100 | 100 | 100 | 200 |
| 5.0 | 100 | 150 | 200 | 250 | 200 | 350 |
| 4.9 | 150 | 250 | 250 | 350 | 300 | 550 |
| 4.8 | 200 | 300 | 350 | 500 | 400 | 700 |
| 4.7 | 250 | 350 | 450 | 600 | 500 | 900 |
| 4.6 | 300 | 450 | 550 | 750 | 600 | 1100 |
| 4.5 | 350 | 550 | 650 | 850 | 700 | 1300 |

Section II

- **Soil Sampling Procedures for Nutrient Management**

MARYLAND COOPERATIVE EXTENSION
UNIVERSITY OF MARYLAND

**For the Nutrient Management Advisor**

# Soil Sampling Procedures for Nutrient Management

1. **Define the management units.** A management area is an area that can and will be managed separately from any other. If different field areas have different soil types, past cropping histories, or different production potentials, these areas should be sampled separately and managed separately (See *Figure 1*). If it is impossible for a farmer to manage different areas separately, they should be treated as one management unit.

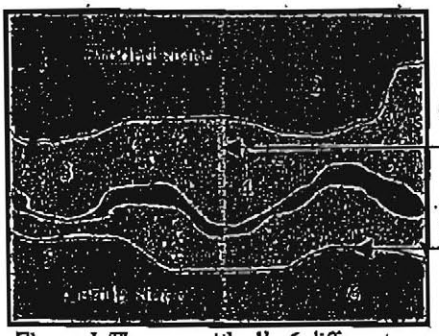


*Figure 1: There are ideally 6 different management units in this field because of differences in landscape position and past management.*

2. **Sample the management units.** Each unit should be sampled separately. Follow these steps for each management unit.
- Collect 15 to 20 samples in a clean plastic bucket.
- Take samples from throughout the entire area of the unit.
- Follow a sampling pattern similar to that in *Figure 2*.
- Avoid sampling unusual areas such as windbreaks, old fence lines, wet areas or areas near lime rock roads.
- Scrape away any surface residues.
- Sample to the correct depth (See *Figure 3*).
  - 2 inches for monitoring pH on no till cropland and pasture
  - 8 inches for fertility samples on cropland and pasture
  - 12 inches for PSNT

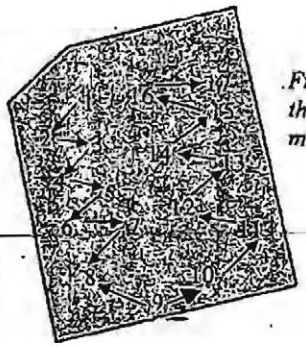

*Figure 2: Sample from the entire area of the management unit.*

3. **Mix the sample.** Thorough mixing is essential.
- Sieve the samples through the sieve into a receiving box. If the sample is hard or strongly aggregated, use a mallet to help break up soil aggregates.
- Transfer the soil to the ODJOB mixer. Roll the mixer at least 50 revolutions. Spread the sample out.
- Return the soil to the receiving box. Spread the sample out.

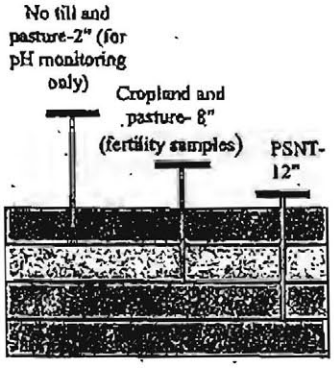


*Figure 3: Sample to the correct depth.*

**Soil Sampling Procedures for Nutrient Management (continued)**

- Take 5 scoops of soil from different parts of the sample to provide a total soil volume of approximately 1 pint.
- Place the soil into the sample bag.
- Take the soil back to the office.

4. **Drying the sample.**

- Spread the sample out in a warm place overnight to air dry it.
- DO NOT HEAT the soil.

5. **Label and place the soil into a soil bag.**

6. **Fill out the information sheet** as completely and accurately as possible.

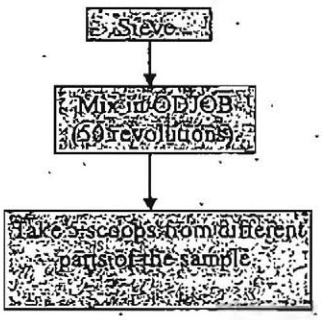


*Figure 4: Thorough mixing is essential.*

February 2006, Agricultural Nutrient Management Program

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- **Comparison of Soil Test Labs**

# Comparison of Soil Test Labs
## (Labs Participating in the 2000 Sample Exchange)
## (2/28/08 update)

| Lab | Cost | Analyses | Comments | Soil Submission Form on Website? | Ordering Supplies |
|---|---|---|---|---|---|
| A & L Eastern Agricultural Lab<br>7621 Whitepine Road<br>Richmond, VA 23237<br>Ph: 804-743-9401<br>www.al-labs-eastern.com | **$7.60 (Mehlich-3)** without recs<br><br>**$8.40 (Bray-Ammonium Acetate)** without recs | **Basic Mehlich Package (S1)** OM, P, K, Ca, Mg, Ca, pH, buffer pH, CEC, percent base saturation of cations<br><br>**Basic (Bray-Ammonium Acetate) Package (SA1)** OM, P, K, Ca, Mg, Ca, pH, buffer pH, CEC, percent base saturation of cations | Several micronutrient combinations are also available. See Schedule of Fees. | Yes. Go to<br><br>www.al-labs-eastern.com/agri<br><br>Choose "Submittal Form" next to Soil Analysis. | Order form is on the website.<br><br>www.al-labs-eastern.com/agri<br><br>Choose "Download the Supply Order form." |
| Agri Analysis, Inc.<br>280 Newport Road<br>PO Box 483<br>Leola, PA 17540<br>Ph: 717-656-9326<br>www.agrianalysis.com | **$6.50 commercial**<br>**$8.25 private**<br><br>**$8.75 commercial**<br>**$10.00 private** | **SBA**<br>pH, buffer pH, lime requirement, $P_2O_5$, $K_2O$, Ca, Mg, CEC<br><br>**SBOM**<br>SBA+OM<br><br>Also have several analyte lists with trace elements (see website). | Lab has pick-up locations in Cecil County, Walkersville, and Keymar.<br><10 samples - $5.00;<br>10-20 samples - $0.50 each;<br>>20 samples - $10.00<br><br>See website for routes.<br><br>Reduced shipping rates are also available through DHL. | Yes. Go to<br>www.agrianalysis.com<br><br>Click on "Resources."<br><br>Scroll down to the Soil Information heading and click on "Soil Request Form Page 1." | Call 717-656-9326 or send e-mail to info@agrianalysis.com for bags and info sheets. |
| Brookside Laboratories, Inc.<br>308 South Main Street<br>New Knoxville, OH 45871<br>Ph: 419-753-2448<br>www.blinc.com | **Will be determined by a consultant** | **SOO1**<br>pH, OM, Mehlich-3 P, Mn, Zn, B, Cu, Fe, Al, CEC, percent base saturation of cations, S, Bray II P | Brookside does not provide recs. Consultants develop the recs. Brookside prefers to receive samples from their consultants only. | Yes.<br><br>www.blinc.com/worksheet_pdf/SoilWorksheet.pdf | Call 419-753-2448 to order soil bags. |

**NOTES:**

- **ASSUME PAYMENT MUST BE INCLUDED WITH SAMPLES.**
- Organic matter (OM) is an important soil property to track but is not offered in some basic packages. Producers are advised to request OM even if they choose a lab that charges an additional fee for the information.
- Soil texture is not offered by most labs and is very expensive by those who do offer it. Obtain information from soil survey after determining the dominant mapping unit of a field.
- Sample depths should be 8 inches.
- There is no need to request recommendations from the soil test labs.
- Web pages are updated frequently and addresses for the soil information sheets may change. If this occurs, go to the lab's home page and follow the links to the soil information sheet.

AGRICULTURAL NUTRIENT MANAGEMENT PROGRAM

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MARYLAND COOPERATIVE EXTENSION

# Comparison of Soil Test Labs
## (Labs Participating in the 2000 Sample Exchange)
## (2/28/08 update)

| Lab | Cost | Analyses | Comments | Soil Submission Form on Website? | Ordering Supplies |
|---|---|---|---|---|---|
| Pennsylvania Agricultural Analytical Services<br>Penn State University<br>University Park, PA 16802<br>Ph: 814-863-0841<br>www.aasl.psu.edu | $9.00<br><br>$5.00 | Standard Soil Test<br>pH, Mehlich lime requirement, P, K, Ca, Mg, Zn, Cu, S<br><br>OM | See website for more analyses. | Yes. Go to<br><br>www.aasl.psu.edu/Submissionforms_all.html<br><br>Click on the desired form. | Call 814-863-0841 to purchase kits. |
| Spectrum Analytic, Inc.<br>PO Box 639<br>1087 Jamison Road NW<br>Washington Court House, OH 43160<br>Ph: 800-321-1562<br>www.spectrumanalytic.com | $7.00 (dealer) $10.00 (grower)<br><br>$10.00 (dealer) $13.00 (grower) | S1<br>pH, buffer pH, OM, P, K, Ca, Mg, CEC, percent base saturation of cations<br><br>S2<br>Basic package plus any 3 of the following - B, Cu, Fe, Mn, S, Zn | Dealer price is available to MCE or other consultants. Soil info form would have to indicate "MCE" under "company," and the sample must be sent by the MCE office. Report comes back to MCE, not the grower. Checks from individual growers are OK. | Yes. Go to<br><br>www.spectrumanalytic.com/services/forms/agsoil.pdf | Order form is on the website.<br><br>www.spectrumanalytic.com/services/supplies |
| University of Delaware<br>Soil Testing Program<br>152 Townsend Hall<br>531 S. College Avenue<br>Newark, DE 19717-1303<br>Ph: 302-831-1392<br>http://ag.udel.edu/other_websites/DSTP/ | $7.50 | M3 Routine Analysis<br>pH, buffer pH, OM, P, K, Ca, Mg, Mn, Zn, Cu, Fe, S, B, Al | | Yes. Go to<br><br>http://ag.udel.edu/other_websites/DSTP/forms/cominfo.pdf | Call 302-831-1392 or e-mail kgartley@Udel.edu<br><br>Soil bags are purchased for $7.50, which includes the price of analysis. |

**NOTES:**

- **ASSUME PAYMENT MUST BE INCLUDED WITH SAMPLES.**
- Organic matter (OM) is an important soil property to track but is not offered in some basic packages. Producers are advised to request OM even if they choose a lab that charges an additional fee for the information.
- Soil texture is not offered by most labs and is very expensive by those who do offer it. Obtain information from soil survey after determining the dominant mapping unit of a field.
- Sample depths should be 8 inches.
- There is no need to request recommendations from the soil test labs.
- Web pages are updated frequently and addresses for the soil information sheets may change. If this occurs, go to the lab's home page and follow the links to the soil information sheet.

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# Comparison of Soil Test Labs
## (Labs Participating in the 2000 Sample Exchange)
## (2/28/08 update)

| Lab | Cost | Analyses | Comments | Soil Submission Form on Website? | Ordering Supplies |
|---|---|---|---|---|---|
| Waters Agricultural Laboratories, Inc.<br>PO Box 382<br>257 Newton Highway<br>Camilla, GA 31730-0382<br>Ph: 229-336-7216<br>www.watersag.com | $6.50<br><br>$5.50<br><br>$10.00<br><br>$0.75<br>(If requested along with other soil tests.) | **Routine Test 1**<br>pH, buffer pH, P, K, Ca, Mg, CEC, percent base saturation of cations plus any 2 of the following – Zn, Mn, Fe, Cu, B<br><br>**Basic Test 2**<br>pH, buffer pH, P, K, Ca, Mg, CEC, percent base saturation of cations<br><br>**Basic Test 3**<br>pH, buffer pH, P, K, Ca, Mg, CEC, percent base saturation of cations, Zn, Mn, Fe, Cu, B<br><br>Other packages are available. Check web site.<br><br>**OM** | Waters has UPS ARS labels available and will pay for shipping of cartons, which contain 25 or more samples of any kind – soil, manure, or plant tissue.<br><br>Waters offers both Melich-1 and Melich-3 extraction methods. All Maryland samples should be analyzed using Melich-1. Confirm the extraction method in the upper left corner of the report. If Melich-3 was used, contact a regional specialist for the appropriate conversion. | Yes. Go to<br><br>www.watersag.com<br><br>Click on the "Soil Analysis" link (#1).<br><br>Scroll down to the SUPPLIES section and click on the "Sample Submission Sheet." | Order form is on the web site.<br><br>www.watersag.com<br><br>Click on the "Sampling Supplies" link (#17). (UPS ARS labels can be ordered here.) |

NOTES:

- **ASSUME PAYMENT MUST BE INCLUDED WITH SAMPLES.**
- Organic matter (OM) is an important soil property to track but is not offered in some basic packages. Producers are advised to request OM even if they choose a lab that charges an additional fee for the information.
- Soil texture is not offered by most labs and is very expensive by those who do offer it. Obtain information from soil survey after determining the dominant mapping unit of a field.
- Sample depths should be 8 inches.
- There is no need to request recommendations from the soil test labs.
- Web pages are updated frequently and addresses for the soil information sheets may change. If this occurs, go to the lab's home page and follow the links to the soil information sheet.

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Department of Natural Resource Sciences
and Landscape Architecture

Agricultural Nutrient Management Program

# MANAGING OUTPUT FROM VARIOUS SOIL TEST LABORATORIES NOT INCLUDED IN 2000 SAMPLE EXCHANGE (12-05)

**A & L (Memphis, Tennessee)**

| NUTRIENT | EXTRACT USED | EXTRACT UPON WHICH NUTRIENT LEVELS ARE BASED | UNITS | ACTION |
|---|---|---|---|---|
| | Mehlich-3 | Mehlich-3 | ppm P (default)<br>lbs P/A (if requested) | **If results are expressed in ppm**, choose "Penn State, ppm" in *NuMan Pro* and enter the A&L (Tennessee) soil test values.<br><br>**If results are expressed in lb/A** elemental P, K, Ca, and Mg, you must first pre-convert to oxide basis. Multiply –<br>P by 2.3<br>K by 1.2<br>Ca by 1.4<br>Mg by 1.7<br>Choose "Penn State, lb/A" in *NuMan Pro* and enter the converted soil test values.<br><br>**You must also enter soil texture for fields to generate recommendations.** |
| K, Ca, Mg | Mehlich-3 | Mehlich-3 | ppm K, Ca, Mg (default)<br>lbs K, Ca, Mg/A (if requested) | |

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AgriEnergy Resources

| NUTRIENT | EXTRACT USED | EXTRACT UPON WHICH NUTRIENT LEVELS ARE BASED | UNITS | ACTION |
|---|---|---|---|---|
| P | Bray P1, Bray P2 | Bray P1, Bray P2 | lbs P/A | For P, use Soluble Tests (Bray 1, P-1) to convert to "A&L, VA, Bray" ppm.<br>(Do **NOT** use Bray 2, P-2, reported as Exchangeable Extracts.)<br>For K, Mg, and Ca, use Exchangeable Extracts (Ca-2, Mg-2, K-2) to convert to "A&L VA, Bray" ppm.<br>(Do **NOT** use Soluble Tests for K, Ca and Mg.)<br>Multiply the AgriEnergy Resources soil test results by 0.5 to convert them to ppm, and then choose "A&L, VA, Bray" in *NuMan Pro*, and enter the converted values.<br>**You must also enter soil texture for fields to generate recommendations.** |
| K, Ca, Mg | 1N $NH_4OAC$ | 1N $NH_4OAC$ | lbs K, Ca, Mg/A | |

CLC

| NUTRIENT | EXTRACT USED | EXTRACT UPON WHICH NUTRIENT LEVELS ARE BASED | UNITS | ACTION |
|---|---|---|---|---|
| P | Bray P1 | Bray P1 | lbs P/A | Multiply the CLC soil test results by 0.5 to convert them to ppm, and then choose "A&L, VA, Bray" in *NuMan Pro*, and enter the converted values.<br>**You must also enter soil texture for the fields to generate recommendations.** |
| K, Ca, Mg | 1N $NH_4OAC$ | 1N $NH_4OAC$ | lbs K, Ca, Mg/A | |

Kinsey Ag Services (using Parry Agricultural Laboratory)

| NUTRIENT | EXTRACT USED | EXTRACT UPON WHICH NUTRIENT LEVELS ARE BASED | UNITS | ACTION |
|---|---|---|---|---|
| P | Bray P2; Olsen (routine); Bray P1 by request only | Bray P1, Bray P2 or Olsen | lbs $P_2O_5$/A | **ONLY Bray P1 P results can be used!**<br>Multiply the Kinsey soil test results for P by 0.22 and K, Ca, and Mg by 0.5 to convert them to ppm, and then choose "A&L, VA, Bray" in *NuMan Pro*, and enter the converted values.<br>**You must also enter soil texture for the fields to generate recommendations.** |
| K, Ca, Mg | 1N $NH_4OAC$ | 1N $NH_4OAC$ | lbs K, Ca, Mg/A | |

**Agron Labs, LLC**

| NUTRIENT | EXTRACT USED | EXTRACT UPON WHICH NUTRIENT LEVELS ARE BASED | UNITS | ACTION |
|---|---|---|---|---|
| P | Mehlich-3 | Mehlich-3 | lbs $P_2O_5$/A | Choose "Brookside, lb/A" in *NuMan Pro*.<br>Note: Use easily extractable P values.<br>**You must also enter soil texture for fields to generate recommendations.** |
| K, Ca, Mg | Mehlich-3 | Mehlich-3 | lbs K, Ca, Mg/A | |

**Midwest Laboratories Inc.**

| NUTRIENT | EXTRACT USED | EXTRACT UPON WHICH NUTRIENT LEVELS ARE BASED | UNITS | ACTION |
|---|---|---|---|---|
| P | Bray P1 | Bray P1 | ppm P | Choose "A&L, VA, Bray" in *NuMan Pro* and enter the Midwest soil test values.<br>**You must also enter soil texture for fields to generate recommendations.**<br>Note: For P, enter P1 (weak Bray or available P) values into *NuMan Pro*, **NOT** P2 (strong Bray) or Bicarbonate P. |
| K, Ca, Mg | 1N $NH_4OAC$ | 1N $NH_4OAC$ | ppm K, Ca, Mg | |

**Skyview Laboratory Inc. (Samples analyzed after 1/1/03).**[3]

| NUTRIENT | EXTRACT USED | EXTRACT UPON WHICH NUTRIENT LEVELS ARE BASED | UNITS | ACTION |
|---|---|---|---|---|
| P | Mehlich-3 | Mehlich-3 | ppm P | Choose "Penn State, ppm" *in NuMan Pro* and enter the Skyview Lab soil test values.<br>**You must also enter soil texture for fields to generate recommendations.** |
| K, Ca, Mg | Mehlich-3 | Mehlich-3 | ppm K, Ca, Mg | |

[3] Soil test values from all samples received from a Maryland address will be reported in ppm. If you receive a soil test report with other units, contact your regional specialist for information on appropriate conversions.

**Virginia Tech**

| NUTRIENT | EXTRACT USED | EXTRACT UPON WHICH NUTRIENT LEVELS ARE BASED | UNITS | ACTION |
|---|---|---|---|---|
| P | Mehlich-1 | Mehlich-1 | lbs P/A | Choose "Waters" in *NuMan Pro* and enter the Virginia Tech soil test values.<br>**You must also enter soil texture for fields to generate recommendations.** |
| K, Ca, Mg | Mehlich-1 | Mehlich-1 | lbs K, Ca, Mg/A | |

| NUTRIENT | EXTRACT USED | EXTRACT UPON WHICH NUTRIENT LEVELS ARE BASED | UNITS | ACTION |
|---|---|---|---|---|
| P | Mehlich-1 | Mehlich-1 | lbs P/A | Convert from lbs/A of the elemental form to lbs/A of the oxide form as follows:<br>Multiply lbs P/A x 2.3<br>Multiply lbs K/A x 1.2<br>Then consult Table 2 in SFM-3 to convert to index. |
| K, Ca, Mg | Mehlich-1 | Mehlich-1 | lbs K, Ca, Mg/A | Consult Table 2 in SFM-3 to convert Ca and Mg to index.<br>Choose "U. of Maryland" in *NuMan Pro* and enter these converted values.<br>**You must also enter soil texture for fields to generate recommendations.** |

- **Equivalent Phosphorus Index Threshold Levels**

# Equivalent Phosphorus Index Threshold Levels

| | |
|---|---|
| University of Maryland, Mehlich 1, FIV | 150 |
| A & L Labs (Richmond) | |
| Bray P1 (weak Bray), P1 (ppm) | 86 |
| Mehlich 3 (ppm) | 136 |
| Agri Analysis, Mehlich 3, $P_2O_5$ (lb/A) | 640 |
| Brookside | |
| Mehlich 3 (easily extractable), P (ppm) | 123 |
| Mehlich 3 (easily extractable), $P_2O_5$ (lb/A) | 565 |
| Penn State | |
| Mehlich 3, P (ppm) | 129 |
| Mehlich 3, $P_2O_5$ (lb/A) | 591 |
| Spectrum Analytic | |
| Mehlich 3 expressed as Bray, P (lb/A)* | 187 |
| Mehlich 3, P (ppm)** | 134 |
| ~~University of Delaware, Mehlich 3, P (index)~~ | ~~142~~ |
| Waters, Mehlich 1, P (lb/A) | 124 |

* mode of reporting until 7/1/05
** default mode of reporting effective July 1, 2005

(Printed by the Agricultural Nutrient Management Program. Updated 2/27/06; replaces previous versions; consistent with SFM-4 "Converting Among Soil Test Analyses Frequently Used in Maryland", revised May 2001)

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# • Making Decisions for Nitrogen Fertilization of Corn Using the Pre-sidedress Soil Nitrate Test (PSNT)

MARYLAND COOPERATIVE EXTENSION
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Information

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# Soil Fertility Management

SFM-2
April 1996

## MAKING DECISIONS FOR NITROGEN FERTILIZATION OF CORN USING THE PRE-SIDEDRESS SOIL NITRATE TEST (PSNT)

The pre-sidedress soil nitrate test (PSNT) has become a valuable and widely-used tool for optimizing the N fertilizer use efficiency for corn production in Maryland. The rationale for use of the PSNT has been presented in Maryland Cooperative Extension Service Fact Sheet 559, "Nitrogen Recommendations for Corn Using the Pre-sidedress Nitrate-Nitrogen Soil Test." The PSNT is based on a timely measurement of the recently mineralized soil nitrate in the top foot of soil just prior to the corn crop's period of rapid N uptake. The PSNT is most useful for soils with high N mineralization capacities.

As our understanding of soil nitrogen dynamics has advanced, and as we use the PSNT under many different field conditions, we are able to refine and update the use of this nutrient management tool. The data set used to develop these PSNT recommendations was derived from 58 site-years of field research conducted in 15 Maryland counties (7 Eastern Shore, 5, Central & Western Maryland, 3 Southern Maryland). The purpose of this publication is to revise the existing decision-making process when using the PSNT to determine optimum sidedress N application rate for corn.

### What is the PSNT and when should I use it?

The PSNT should be used as a tool that is both complementary to and an integral part of a comprehensive nutrient management plan for N fertilization of corn. The flowchart on the following page outlines the logical decision making process for appropriate use of both the PSNT and the information generated from using this tool.

The PSNT is highly recommended on fields that have received manure, sewage sludge, or other organic residual products or have grown a forage legume (alfalfa or clover) or a legume cover crop. Use of the PSNT is appropriate if the manure or sludge was applied recently (this year) or if it has been several years since application. The PSNT is not recommended on fields where commercial fertilizer N is, and historically has been, the only source of N for corn production.

In order for the PSNT to be a reliable tool for determining corn sidedress N rate, the total fertilizer N application prior to sidedress must not be greater than 50 lb N/acre. This total maximum of 50 lb N/acre includes preplant broadcast and starter band applied N.

### How do I take a PSNT sample?

The PSNT should be conducted when the corn measures 6 - 12 inches tall from the soil surface to the top of the leaf canopy. The PSNT soil sample should be collected from 0 - 12 inches and represent areas of the field that have similar soil properties and past managment histories. One composite PSNT sample should contain 30 to 40 soil cores. Soil nitrate nitrogen ($NO_3$-N) should be determined in strict accordance with the instructions provided with the particular test kit being used.



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## How do I interpret the PSNT?

A critical level of soil $NO_3$-N measured by the PSNT has been established above which corn yield response to sidedress fertilizer N is not expected. If PSNT $NO_3$-N concentrations are greater than or equal to 21 parts per million (ppm or mg N/kg soil) do not apply sidedress N fertilizer. The PSNT critical level of 21 ppm $NO_3$-N is a revised value that is lower than the critical level previously used for the PSNT (which was 25 ppm). This revision is the result of continuing research and PSNT calibration in commercial corn fields. Future revisions will be made as dictated by new research results.

## What if the PSNT is below 21 ppm?

If the PSNT $NO_3$-N concentrations are less than 21 ppm, refer to the existing nutrient management plan. If the measured PSNT $NO_3$-N concentrations are less than 21 ppm and the nutrient management plan recommends sidedress N fertilization, then apply the sidedress N rate recommended in the nutrient management plan.

## What if the PSNT is below 21 ppm and the nutrient management plan does not recommend any sidedress N application?

First, review the nutrient management plan and determine if the data used, field history, available N supply and crop N requirement calculations are accurate and reliable. If the site specific data and field history information used for the original calculation of the nutrient management plan N recommendations are inaccurate, questionable, rough approximations, or guesses, recalculate the N fertilization recommendation using the most accurate available data, including conservative estimates for crop available N from organic sources. If the new, recalculated nutrient management plan recommends sidedress N application, apply the sidedress N rate recommended by the revised nutrient management plan.

## What if the PSNT is below 21 ppm and I am confident that the nutrient management plan is reliable, but the plan still does not recommend any sidedress N application?

If PSNT $NO_3$-N concentrations are less than 21 ppm and, after critical review, the nutrient management plan is deemed accurate and reliable, and the nutrient management plan still does not recommend any sidedress N application, then the sidedress N fertilizer rate should be determined as follows:

1) If the nutrient management plan does not forecast a need for sidedress N fertilization, and PSNT $NO_3$-N concentrations are 15 - 21 ppm, apply 0 - 40 lb N/acre sidedress (Fig. 1).

2) If the nutrient management plan does not forecast a need for sidedress N fertilizer and PSNT $NO_3$-N concentrations are less than 15 ppm, there are two different sidedress N recommendations depending on whether or not an alfalfa crop preceeded the corn:

a) If the nutrient management plan does not predict a need for sidedress N fertilization, and PSNT $NO_3$-N concentrations are less than 15 ppm and alfalfa was growing on this soil within 6 months of the PSNT sample collection, then apply 0 - 40 lb N/acre sidedress (Fig. 1).

b) If the nutrient management plan does not predict a need for sidedress N fertilization, and PSNT $NO_3$-N concentrations are less than 15 ppm and alfalfa was not growing on this soil within 6 months of the PSNT sample collection, then apply 40 - 80 lb N/acre sidedress (Fig. 1).

## How should I interpret the ranges in N recommendations given in Figure 1?

All sidedress N recommendations are given as ranges of application rates (e.g. 40 - 80 lb N/acre). Selection of a sidedress N rate in the lower or higher portion of the recommended range should be based on specific site characteristics. Site specific factors that would favor choosing a lower or higher sidedress N rate within a recommended range appear in Table 1, on the following page. These factors include soil physical characteristics, recent weather conditions, manure analysis and application practices, and farm management practices.

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Maryland Nutrient Management Program

Figure 1. Nitrogen fertilization of corn using the pre-sidedress soil nitrate test (PSNT).

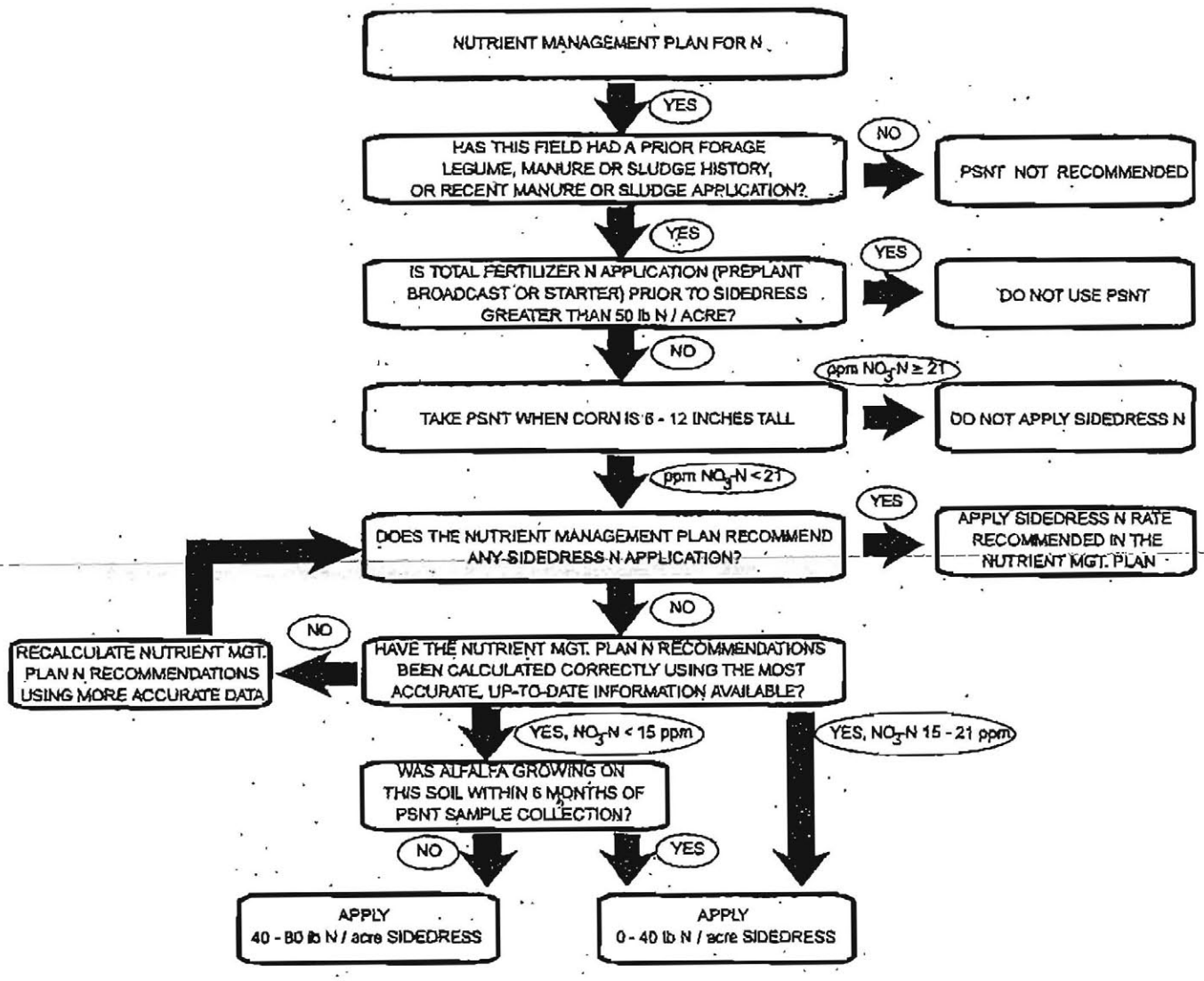
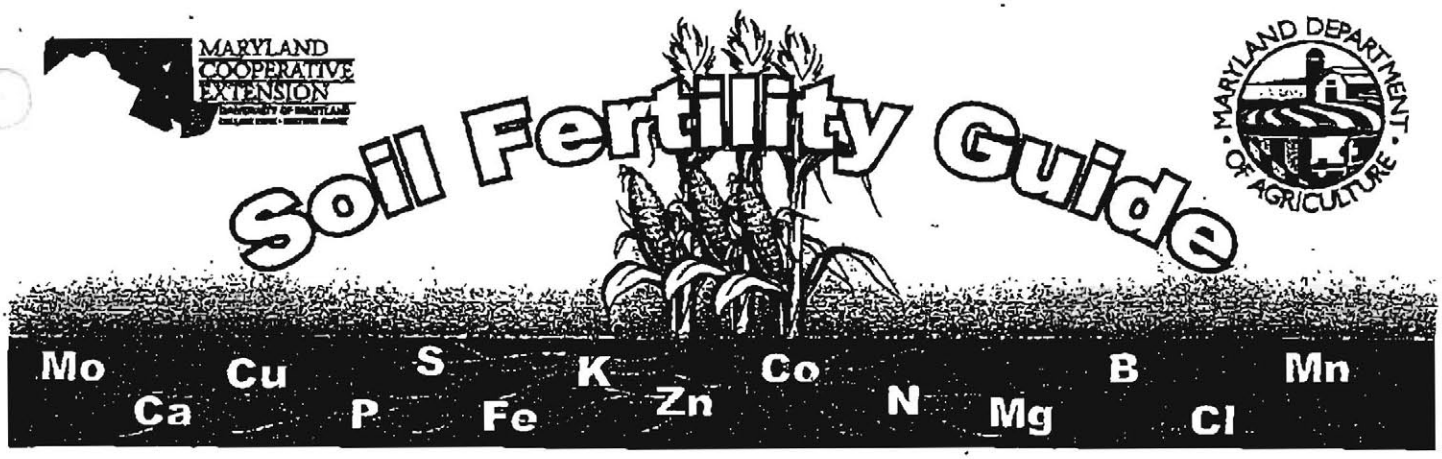


Table 1. Site specific factors that would favor choosing a higher or lower sidedress N rate within the recommended ranges based on the pre-sidedress soil nitrate test (PSNT).

| Factors that would favor choosing a lower sidedress N rate within the recommended range | Factors that would favor choosing a higher sidedress N rate within the recommended range |
|---|---|
| Well drained soils | Poorly drained & excessively well drained soils |
| Silt loam & loam soils | Loamy sands, sands, & sandy loam soils |
| Manure applied 0 - 3 months before PSNT | Most recent manure application was more than 3 months before PSNT |
| Reliable, recent manure sampling & analysis | Uncertain, old (several years), questionable manure sampling & analysis |
| Manure spreader calibrated, uniform application | Manure spreader not calibrated, uneven application |
| Less than 4" of rain within the last 30 days | More than 4" of rain within the last 30 days |
| Alfalfa was the prior crop | The prior crop was not alfalfa |
| Legume winter cover crop was grown | Rye, small grain winter cover crop |
| Ammonium was not credited when calculating the manure application rate | Ammonium was credited when calculating manure application rate, but may have volatilized |
| The measured ppm $NO_3$-N was near the high cutoff value in one of the above ranges (i.e almost 15 ppm or almost 21 ppm) | The measured ppm $NO_3$-N was greater than, but near the lower cutoff value of 15 ppm |
| Soils with relatively low yield potentials | Soils with a relatively high yield potential |

# Plant Tissue Analysis




# PLANT TISSUE ANALYSIS

**Introduction**

Plant tissue analysis is a laboratory determination of the total elemental content of plants or of certain plant parts. It is used for a variety of purposes including monitoring the nutrient status of crops and troubleshooting problem areas. It also serves as the basis for nutrient recommendations for perennial fruit crops.

Plant tissue analysis should not be confused with tissue testing. Tissue testing typically refers to a field test that involves taking sap samples from fresh plant tissue and analyzing the samples on site. Plant tissue analysis is performed on dried plant tissue that has been processed in a laboratory.

**Interpreting Plant Tissue Analysis Information**

When using plant tissue analysis information from a laboratory, you need to use interpretive guidance in order to determine the nutrient status categories. Plant and soil scientists have spent years performing experiments in order to develop this interpretive guidance for plant tissue analysis.

Figure 1 on page 2 is a graphical depiction of interpretive guidance for a generic crop. The nutrient concentration ranges (% or ppm) for each nutrient status category and the shape of the growth curve will change for each crop.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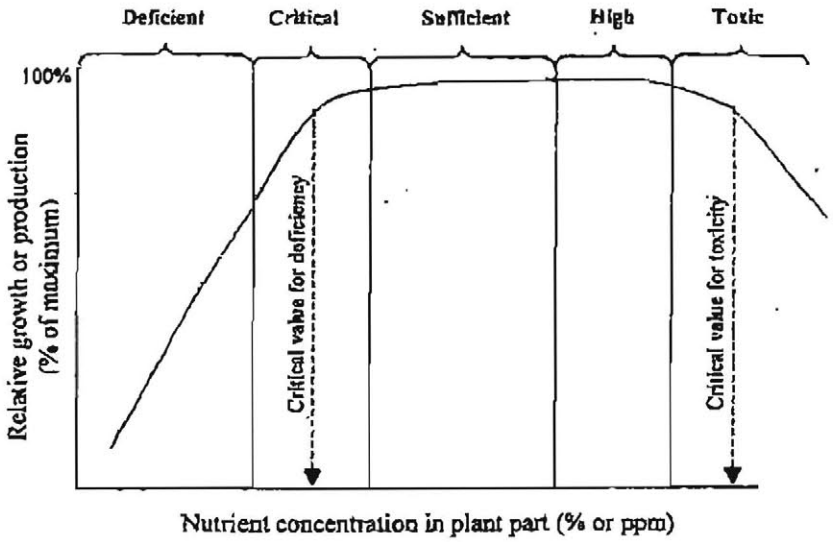


**Figure 1.** An illustration of the meaning of plant tissue analysis interpretive terminology (© Australasian Soil and Plant Analysis Council Inc. 1997; Modified from p. 78 in *Plant Analysis: An Interpretation Manual* (DJ Reuter et al.), with permission from CSIRO PUBLISHING, Melbourne Australia – http://www.publish.csiro.au/pid/437.htm)

Table 1 on page 3 gives a more detailed explanation of the nutrient status categories encountered when interpreting plant tissue nutrient concentration data for manganese (Mn) in corn. For corn, a plant tissue analysis showing a value of 16 for Mn would indicate that the nutrient status category is the critical range. Nutrients may need to be added to bring plant tissue levels into the sufficient range and improve crop yield. If nutrient applications to the current crop are not feasible they can be made before planting future crops.

**Table 1.** Nutrient status category terminology using corn as an example

| Nutrient Status Category | Definition | Manganese (Mn) in corn# (ppm*) |
|---|---|---|
| deficient | • concentration of a nutrient associated with visible deficiency symptoms<br>• deficiencies severely reduce growth and production | less than 15 |
| critical value or range (marginal) | • concentration of a nutrient below which production is adversely affected<br>• producers should strive to keep all nutrient levels above their critical value or critical range | 16 – 19 |
| sufficient range (adequate/normal/ optimal) | • concentration of a nutrient that is optimal for plant growth and production<br>• if all nutrient concentrations for a crop are within each nutrient's sufficiency range, nutrient status should not be considered a limiting factor for crop production | 20 – 150 |
| high | • concentration of a nutrient that is greater than needed for optimal growth<br>• in some crops, this level of nutrients may be associated with undesirable quality or vigor | 151 – 200 |
| toxic (excessive) | • concentration of a nutrient, greater than optimal, that is associated with reduced growth and production<br>• this is usually observed only for minor nutrients | greater than 200 |

# An example taken from *Plant Analysis: An Interpretation Manual*
* ppm = parts per million

**Important Basics of Plant Tissue Analysis**

**RULE 1: The amount of a specific nutrient that is sufficient or adequate for plant growth varies from crop to crop.**

Table 2 shows the sufficiency ranges in percentages (%) of dry weight for N, P, and K for five different crops.

**Table 2.** Sufficiency ranges of N, P, and K for five selected crops

| Crop | N (%)* | P (%)* | K (%)* |
|---|---|---|---|
| corn | 2.70 – 4.00 | 0.25 – 0.50 | 1.70 – 3.00 |
| wheat | 1.75 – 3.00 | 0.21 – 0.50 | 1.50 – 3.00 |
| soybeans | 4.00 – 5.50 | 0.26 – 0.50 | 1.70 – 2.50 |
| cucumbers | 4.50 – 6.00 | 0.34 – 0.75 | 3.90 – 5.00 |
| tomatoes | 4.50 – 6.00 | 0.25 – 0.75 | 2.90 – 5.00 |

* Information obtained from *Plant Nutrition Manual*

**Caveat** – If a producer is using plant tissue analysis as a monitoring tool, access to interpretive information for the specific crops being monitored (like those shown in Table 2) is essential.

**RULE 2: The amount of a specific nutrient for a particular crop that is adequate for growth varies across the season. The concentration of many nutrients decreases as the crop matures.**

As shown in Figure 2, the optimal concentration of nitrate in potato petioles decreases as the season progresses.

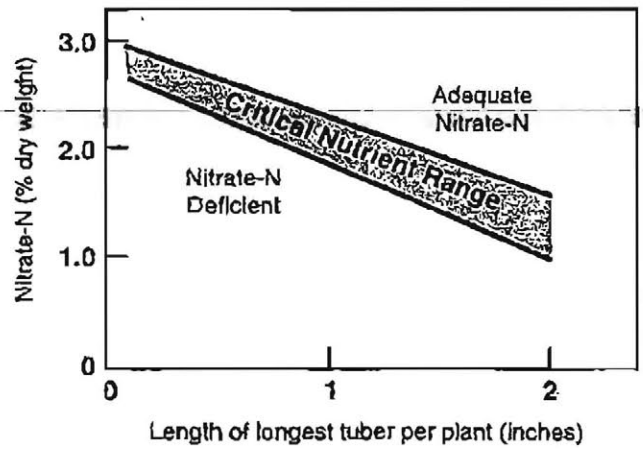


**Figure 2.** Nutrient status categories for nitrate-N in potato petioles over time (© 1990 From Journal of Plant Nutrition by Williams & Maier. Modified and used with permission by Taylor & Francis Group, LLC, http://www.taylorandfrancis.com)

**Caveat** – Collect plant tissue samples at the same growth stage that was used in the development of the interpretive guidance.

**RULE 3: The amount of a specific nutrient that is adequate for plant growth may vary from one plant part to another plant part.**

Table 3 shows five crops and the appropriate sampling time as well as the appropriate plant part to sample.

**Table 3.** Sampling time and plant part for five crops

| Crop | Sampling Time | Plant Part |
|---|---|---|
| corn | initial silk | ear leaf |
| wheat | just prior to heading | top two leaves |
| soybeans | prior to pod set | most recent leaf |
| cucumbers | flower to small fruit set | fifth leaf from growing tip |
| tomatoes | mid-bloom | leaf adjacent to top flower cluster |

**Caveat** – Collect plant tissue samples from the same plant part used in the development of the interpretive guidance.

---

**Collecting Plant Tissue Samples**

Just like in soil sampling, it is important to collect a representative plant tissue sample. This involves taking samples from many plants (25 – 50, depending upon size of plant part) throughout the entire area of interest. Two sampling patterns are shown in Figure 3.

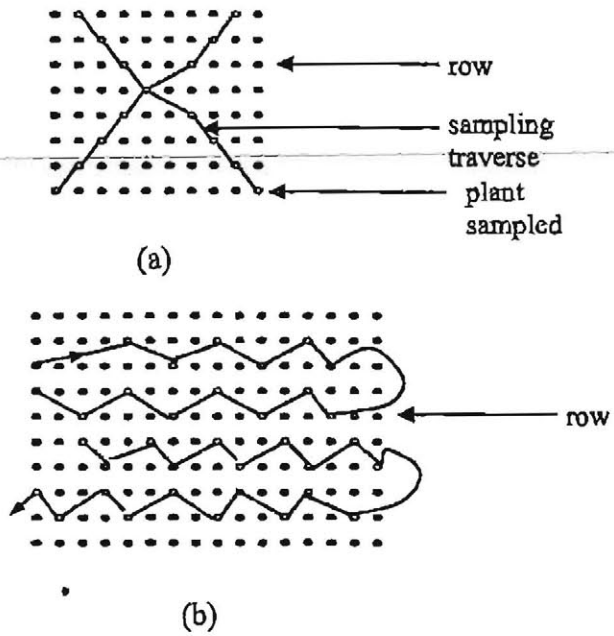


**Figure 3.** Sampling patterns for collecting representative samples
(© Australasian Soil and Plant Analysis Council Inc. 1997; Modified from p. 78 in *Plant Analysis: An Interpretation Manual* (DJ Reuter et al.), with permission from CSIRO PUBLISHING, Melbourne Australia – http://www.publish.csiro.au/pid/437.htm)

Do not include diseased leaves in the sample unless your intent is to determine the nutrient status of the diseased tissue.

Many agricultural testing laboratories provide nutrient status information along with plant tissue nutrient analysis. If that is the case, contact your laboratory for any guidance they can provide on sampling time, plant part, and number of plants to sample.

---

**Analyzing Plant Tissue for Nutrient Content**

Plant tissue analysis is a laboratory procedure that involves certain steps (see Table 4).

**Table 4.** Laboratory procedures for analyzing plant tissue samples

| Step | Action |
|---|---|
| 1 | Preliminary preparation<br>• drying, grinding, and mixing plant tissue |
| 2 | Destruction of organic matrix<br>• strong acids or very high temperatures are used during this step |
| 3 | Analysis of mineral residue for nutrient content<br>• many different techniques can be used for this step |

Plant tissue analysis is a more time-consuming process than soil testing, therefore leading to longer turn-around times for agricultural analytical laboratories. Plant tissue analysis is also more expensive than soil testing.

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**Using Plant Tissue Analysis in a Monitoring Program**

For some producers, especially producers of high-value vegetable crops, plant tissue analysis is used as part of a monitoring program that also includes soil testing.

Plant tissue analysis can confirm the adequacy of all nutrients or identify an inadequacy of one or more nutrients.

Plant tissue samples should be collected from the correct plant part at the appropriate stage of development.

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**Using Plant Tissue Analysis as a Trouble-shooting Tool**

Producers often face situations where the crop in one part of a field is doing poorly even though it has been managed the same way as the part of the field where the crop is growing well.

The first step in information gathering should be to collect soil samples from both areas (the healthy area and the problem area).

If the soil tests reveal a difference, address the fertility issues. If soil tests indicate similar results, analysis of plant tissue samples from both the healthy area and the problem area should be taken. They may indicate the nature of the problem, assuming the problem is nutritional.

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**Plant Tissue Analysis as a Basis of Nutrient Recommendations**

Although soil tests are most commonly used as a basis of generating nutrient recommendations for row crops and hay and pasture, soil testing alone has not proven useful for perennial crops like tree fruits and small fruits. Perennial fruit crops have deep root systems, take up nutrients for a larger portion of the growing season, and have efficient mechanisms for recycling nutrients from season to season.

Fruit scientists have found that nutrient concentrations in plant tissue do a better job of indicating the nutrient status than soil tests alone. For these reasons, nutrient recommendations for mature (bearing) perennial fruit crops are based primarily on plant tissue nutrient concentrations and only secondarily rely on soil tests.

As with any crop, sampling the appropriate plant part at the appropriate time is critical for reliable, valid plant tissue analyses of perennial fruit tissue. Consult Table 5 on page 8 to determine the appropriate time to sample, number of samples, plant part to sample, and the sampling location on the plant for each fruit crop. Figure 4, also on page 8, has additional information on the proper sampling location for fruit trees. On fruit trees, the current year's growth extends from the last set of bud scale scars to the bud.

**Table 5.** Plant tissue sampling information for perennial fruit crops

| Crop | Time to Sample | Number of Samples/Plant Part to Sample | Sampling Location on Plant |
|---|---|---|---|
| blueberries | 1st week of harvest | 40 leaves (detach petioles) | Current year's growth. |
| brambles | Aug 1st – Aug 20th | 60 leaves (detach petioles) | Select the most recent fully expanded leaf blade of each primocane. |
| fruit trees | Jul 15th – Sept 1st | 50 leaves and petioles | Select shoots at eye level from around the outside of the tree that make a vertical angle of 45-60 degrees to the ground. Remove 1 or 2 leaves from the mid-portion of the current year's growth. (See Figure 4.) |
| grapes | at full bloom | 75 petioles | Remove the petiole across from the first blossom cluster, closest to the cordon or permanent cane. |

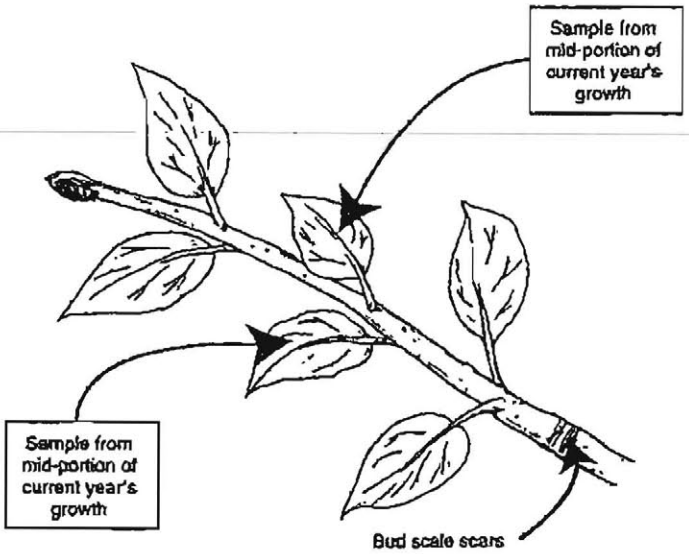


**Figure 4.** Proper sampling locations for fruit trees (Drawn by Pete Mazzocchi, Senior Graphic Designer, UMCP, College of AGNR)

In Maryland, there are four nutrient status categories for tree fruits and small fruits: deficient, low, normal, and high. Nutrient concentrations associated with each category vary from species to species. Furthermore, nutrient concentrations for nitrogen in apples actually vary among cultivars. (Apples are the only tree fruit crop in Maryland where nitrogen recommendations vary across cultivars.) Table 6 shows the variation for two groups of apples and three other fruit crops.

**Table 6.** Normal or adequate N, P, and K concentrations in plant tissue of four perennial fruit crops

| Fruit Crop | N (%)* | P (%)* | K (%)* |
|---|---|---|---|
| apples | | | |
| soft | 1.80 – 2.10 | 0.15 – 0.31 | 1.20 – 2.01 |
| fresh market | 2.20 – 2.25 | 0.15 – 0.31 | 1.20 – 2.01 |
| peaches | 2.50 – 3.41 | 0.15 – 0.31 | 2.10 – 3.01 |
| brambles | 2.00 – 3.00 | 0.25 – 0.40 | 1.50 – 2.50 |
| blueberries | 1.70 – 2.10 | 0.07 – 0.18 | 0.40 – 0.65 |

* Information obtained from *NM-5, Nutrient Management for Tree Fruits and Small Fruits*

**References**


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Walsh, C. and P. Steinhilber. 2005. *Nutrient Management for Tree Fruits and Small Fruits*. NM-5. University of Maryland Department of Natural Resource Sciences and Landscape Architecture, College Park, MD, 20742.

Williams, C. M. J. and N. A. Maier. 1990. Determination of the nitrogen status of irrigated potatoes. I. Critical nutrient ranges for nitrate-nitrogen in petioles. *Journal of Plant Nutrition*. 13 (8): 971-984.


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June 2007
PL-1 in the *Soil Fertility Guide* series.
The *Soil Fertility Guide* was written and produced by the University of Maryland College of Agriculture and Natural Resources and funded by the Maryland Department of Agriculture.

- **Comparison of Some Labs Testing Plant Tissue**

# Comparison of Some Labs Testing Plant Tissue
## (8-15-06 update)

| Lab | Cost | Analyses | Comments | Sample Preparation | Tissue Submission Form on Website? |
|---|---|---|---|---|---|
| A & L Eastern Agricultural Lab<br>7621 Whitepine Road<br>Richmond, VA 23237<br>Ph: 804-743-9401<br>www.al-labs-eastern.com | $22.20 w/o recommendations | PT2<br>N, P, K, Mg, Ca, Na, Fe, Al, Mg, B, Cu, Zn | | Air dry if very wet and place in paper bag – no plastic. | Yes. Go to<br><br>www.al-labs-eastern.com/agri<br><br>Choose "Submittal Form" next to Plant Analysis. |
| Agri Analysis, Inc.<br>280 Newport Road<br>PO Box 483<br>Leola, PA 17540<br>Ph: 717-656-9326<br>www.agrianalysis.com | $24.00<br><br>$28.00 | PLT<br>N, P, K, Ca, Mg, Cu, Fe, Mn, Zn, B, Al, Na, S<br><br>PMO<br>PLT plus Molybdenum | | Do not dry samples. Place in paper bag. | Yes. Go to<br><br>www.agrianalysis.com<br><br>Click on "Resources."<br><br>Scroll down to the Plant Tissue heading and click on "Plant Tissue Request Form 1." |
| Brookside Laboratories, Inc.<br>308 South Main Street<br>New Knoxville, OH 45871<br>Ph: 419-753-2448<br>www.blinc.com | N/A | N/A | Brookside prefers to receive samples from their consultants only. | Samples should be taken by a Brookside consultant. | N/A |
| Pennsylvania Agricultural Analytical Services<br>Penn State University<br>University Park, PA 16802<br>Ph: 814-863-0841<br>www.aasl.psu.edu | $24.00 | Standard<br>N, P, K, Ca, Mg, Mn, Fe, Cu, B, Zn | Sulfur is not included as part of the standard analysis.<br><br>$15.00 – sulfur testing | Air dry samples and place in paper bag – no plastic. | Yes. Go to<br><br>www.aasl.psu.edu/Submissionforms_all.html<br><br>Click on the desired form. |

NOTES:

- ASSUME PAYMENT MUST BE INCLUDED WITH SAMPLES.
- Follow University of Maryland recommendations for sampling protocol. See NM-5 "Nutrient Management for Tree Fruits and Small Fruits" at www.agnr.umd.edu/users/agron/nutrient.
- Web pages are updated frequently and addresses for the plant tissue information sheets may change. If this occurs, go to the lab's home page and follow the links to the plant tissue information sheet.

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# Comparison of Some Labs Testing Plant Tissue
## (8-15-06 update)

| Lab | Cost | Analyses | Comments | Sample Preparation | Tissue Submission Form on Website? |
|---|---|---|---|---|---|
| Spectrum Analytic, Inc.<br>PO Box 639<br>1087 Jamison Road NW<br>Washington Court House, OH 43160<br>Ph: 800-321-1562<br>www.spectrumanalytic.com | $20.00 w/o recommendations | P2<br>N, P, K, Ca, Mg, S, B, Cu, Fe, Mn, Na, Zn | | Air dry samples and place in a paper bag – no plastic. | Yes. Go to<br>www.spectrumanalytic.com/services/forms/plant.pdf |
| University of Delaware Soil Testing Program<br>152 Townsend Hall<br>531 S. College Avenue<br>Newark, DE 19717-1303<br>Ph: 302-831-1392<br>http://ag.udel.edu/other_websites/DSTP/ | N/A | N/A | | N/A | N/A |
| Waters Agricultural Laboratories, Inc.<br>PO Box 382<br>257 Newton Highway<br>Camilla, GA 31730-0382<br>Ph: 229-336-7216<br>www.watersag.com | $14.00 | Basic Test<br>N, P, K, Mg, Ca, S, B, Zn, Mn, Fe, Cu<br><br>Individual analysis available. See price list. | | Air dry and place in a paper bag. | Yes. Go to<br>www.watersag.com<br><br>Click on the "Plant Analysis" link (#2).<br><br>Scroll down to "How to Take a Plant Sample" and choose the "Information Sheet" link. |

NOTES:

- ASSUME PAYMENT MUST BE INCLUDED WITH SAMPLES.
- Follow University of Maryland recommendations for sampling protocol. See NM-5 "Nutrient Management for Tree Fruits and Small Fruits" at www.agnr.umd.edu/users/agron/nutrient.
- Web pages are updated frequently and addresses for the plant tissue information sheets may change. If this occurs, go to the lab's home page and follow the links to the plant tissue information sheet.

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- **Sampling Manure for Nutrient Content**

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# Nutrient Management

NM-6
Revised February 2006

## SAMPLING MANURE FOR NUTRIENT CONTENT

**Introduction**

For manure to be utilized in an economically and environmentally sound manner in crop production, its nutrient content must be known. Collecting a valid, representative sample of the manure is the key to having a meaningful nutrient analysis.

Information on the average nutrient content of manures is available from many sources. However, manures vary in nutrient content from farm to farm depending upon time of year, storage, type and age of livestock, feed management, amount and type of bedding, and manure management practices. Considerable variability can be encountered within a manure pile or liquid storage system. Some liquid storage systems have agitation capability and can be mixed before sampling thus aiding in the collection of a representative sample. Others have no agitation capability. Liquid manure in a non-agitated liquid storage system will be stratified with a watery, low-nutrient material on top, a material of intermediate solids and nutrient content in the middle, and a nutrient-rich sludge material on the bottom.

The current policy of the Maryland Department of Agriculture's Nutrient Management Program allows the use of a published "typical" manure analysis ("book value") for the development of a producer's first nutrient management plan and requires actual manure analysis for updated plans.

Because the nutrient composition of manure varies from operation to operation, the use of book values is not a recommended practice.



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**General Principles of Sampling**

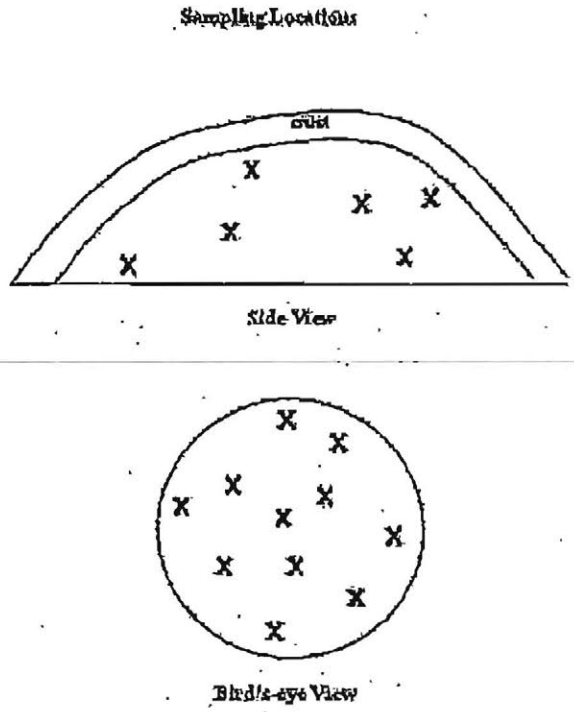
## Goal

- COLLECT A REPRESENTATIVE SAMPLE, i.e., a sample whose nutrient analysis represents the nutrient content of the manure being utilized.

## Accomplishing the Goal

1. Many individual samples (10 – 15) must be collected to form a composite sample. See Figure 1.
2. Be sure to include any bedding in the sample to the same extent that it exists in the animal waste material being characterized.
3. Mix the composite sample thoroughly in a plastic container. **The composite sample must be mixed well.**
4. Take a small sample (laboratory sample) from the well-mixed composite sample and prepare the laboratory sample for shipment to the lab.

**Figure 1.** How to collect a sample of solid manure




Avoid the outer crust. Using a long, narrow shovel, collect 10 – 15 samples from various locations and depths around the pile and place the composite sample in a clean, plastic container.

**Sampling Options**

## SAMPLING BEFORE APPLICATION

- For those situations where a representative sample of manure can be collected, sampling before application allows the manure analysis to be used for the calculation of the appropriate rate of manure application.
- Sampling before application is practical for many solid manures.
- The nutrient content of manure can change during storage. Sample as close to application time as is practical, allowing time for both analysis and plan development. Four (4) to 6 weeks is advisable.

## SAMPLING DURING LOADING

Sampling during loading is a quick and easy way to collect a representative sample.

**Solid or Semi-solid**

- Sampling solid and semi-solid manure during loading of the manure spreader is advantageous because the manure has already undergone some mixing.
- It is the most practical time to collect a representative sample in a daily haul operation.
- Collect one or more grab samples from 10 – 15 loads to make the composite sample.
- For daily haul operations, collect a total of 10 – 15 samples, collecting some samples from each load if more than one load is being applied.

**Liquid**

A good time to collect a liquid sample from an agitated pit is immediately after filling the spreader tank. One or more samples can be collected from each load (tank) at the unloading or outlet port.

## SAMPLING DURING SPREADING

Sampling during spreading is a good option for many situations.

**Solid or Semi-solid**

- For solid manures with lots of bedding, sampling during spreading may be the best method of collecting a representative sample.
- Spread a total of 10 – 15 plastic sheets (3' x 3', for example) in the path of the manure spreader, collecting some samples from each load.
- Combine all samples to make a composite sample.

**Liquid**

- For non-agitated pits, sample collection during spreading is the only practical time to collect samples that represent the different layers of the pit. Separate samples should be collected from the upper, middle, and lower layers of the pit.
- Place collection containers (for example, aluminum baking pans) near the path of the manure spreader. Collect separate samples at the beginning, middle, and end of the pit emptying process so that samples represent the top, middle, and lower layers of the pit. Make a separate composite sample for each layer in the pit.

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**Mixing Composite Samples**

The composite manure sample must be very well mixed before shipment to the laboratory for analysis.

- For easily mixed materials like poultry litter, mix well using a baffled tumbler or the sheet method (see page 5).
- Moist manures can be mixed using the sheet method (see page 5).
- Liquid samples should be swirled or mixed thoroughly.

## How to Mix a Sample of Manure Using the Sheet Method

1. Pour composite sample onto a plastic sheet (6' x 6').
2. Break up any clumps of manure with a shovel or fork.
3. To obtain a good mix, gradually lift one corner of the plastic sheet, rolling the litter over itself towards the middle of the sheet. Do the same from the diagonally opposite corner. See Figure 2.
4. Roll the manure into a pile using the other two corners. See Figure 3.
5. Once the manure is piled in the center of the sheet, spread it out again and repeat steps 3 and 4 at least 10 more times.

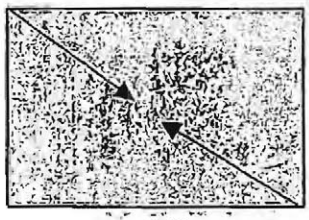

Figure 2

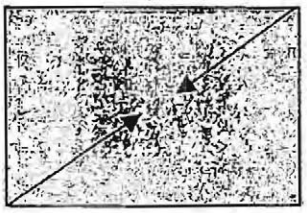

Figure 3

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**Selecting a Laboratory Sample for Shipment**

The composite sample is too large to send to the laboratory for analysis. Consult Table 1 on page 6 to determine the sample size required by the analytical lab you choose. Additional information is available at the University of Maryland Agricultural Nutrient Management Program's website (www.agnr.umd.edu/users/agron/nutrient).

### Solid and Semi-solid Manures

1. Take several grab samples from the well-mixed composite manure sample and place in a resealable plastic bag, filling the bag about half full.
2. Squeeze out excess air before sealing.
3. Double bagging is preferable both for containing the sample and for odor control during shipment.

### Liquid Manures

1. While swirling the composite sample, pour the laboratory sample into a clean, plastic bottle. **Never use a glass jar!**
2. Rinse outside of the bottle with clean water before packing.

Table 1. Comparison of some labs testing manure

| Lab Information | Minimum Package to Request | Sample Size Solid/Liquid |
|---|---|---|
| A & L Eastern Agricultural Laboratories, Inc.<br>7621 Whitepine Road<br>Richmond, VA 23237<br>Ph: 804-743-9401<br><br>www.al-labs-eastern.com | M1 package<br>N (total), $NH_4$-N, $P_2O_5$, $K_2O$, % moisture, and density (lbs/100 gallons) | 2 cups/2 cups |
| Agri Analysis, Inc.<br>280 Newport Road<br>P.O. Box 483<br>Leola, PA 17540<br>Ph: 717-656-9326<br><br>www.agrianalysis.com | MDMP4 package<br>N (total), $NH_4$-N, $P_2O_5$, $K_2O$, % moisture, density (lbs/100 gallons), and % dry matter | 4 cups/2 cups |
| Agricultural Analytical Services Laboratory<br>Penn State University<br>University Park, PA 16802<br>Ph: 814-863-0841<br><br>www.aasl.psu.edu | Standard Manure Test 1<br>N (total), $NH_4$-N, $P_2O_5$, $K_2O$, and % solids | 2 cups/2 cups |
| Spectrum Analytic, Inc.<br>P.O. Box 639<br>1087 Jamison Road NW<br>Washington Court House, OH 43160<br>Ph: 800-321-1562<br><br>www.spectrumanalytic.com | M3 package<br>N (total), $NH_4$-N, $P_2O_5$, $K_2O$, % moisture, and % solids | 1 cup/2 cups |
| Waters Agricultural Laboratories, Inc.<br>P.O. Box 382<br>257 Newton Highway<br>Camilla, GA 31730-0382<br>Ph: 229-336-7216<br><br>www.watersag.com | #1 Maryland package<br>N (total), $NH_4$-N, $P_2O_5$, $K_2O$, and % moisture | 4 cups/2 cups |

**General Principles of Packaging and Shipping**

- Label bag or bottle with your name, address, and a manure identification.
- Keep sample cool (preferably refrigerated) until shipment.
- Ship early in the week so the sample does not sit in a mail handling facility over the weekend.
- Ship as soon as possible to minimize sample degradation.

**Nutrient Analysis**

**Minimum analyses required**

Be sure the laboratory you choose tests for the following:

- total nitrogen
- ammonium nitrogen
- total phosphorus
- total potassium
- moisture (or dry matter)

**Optional analyses**

Most laboratories offer a selection of secondary and micronutrient analyses for an additional charge.

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1st printing: March 2005

- **Comparison of Some Labs Testing Manure**

# Comparison of S[illegible] Labs Testing Manure
## (2/28/08 update)

| Lab | Cost[1] | Analyses | C Reporting Available? | Comments | Manure Submission Form on Website?[2] | Ordering Supplies |
|---|---|---|---|---|---|---|
| Pennsylvania Agricultural Analytical Services<br>Penn State University<br>University Park, PA 16802<br>Ph: 814-863-0841<br>www.aasl.psu.edu | $32.00 | **Standard Manure Test 1**<br>N (total), ammonium N, $P_2O_5$, $K_2O$, % solids<br><br>A more extensive analyte list is available for an additional charge. | Order C:N ratio - $15.00 | % moisture = 100 - % solids<br><br>If using manure information form from the website, Maryland clients fill out Page 1 only. | Yes. Go to<br><br>www.aasl.psu.edu/Submissionforms_all.html<br><br>Click on the desired form. | |
| Spectrum Analytic Inc.<br>PO Box 639<br>1087 Jamison Road NW<br>Washington Court House, OH 43160<br>Ph: 800-321-1562<br>www.spectrumanalytic.com | $37.00 | **M3 Package**<br>N (total), ammonium N, $P_2O_5$, $K_2O$, % moisture, % solids<br><br>A more extensive analyte list is also available for an additional charge. | C:N ratio - $8.00 when ordered with the basic test. | Does not provide density (lbs/100 gallons); planner must use average value for liquids. | Yes. Go to<br><br>www.spectrumanalytic.com/services/forms/manure.pdf | Order form is on the web site.<br><br>www.spectrumanalytic.com/services/supplies |
| University of Delaware<br>Soil Testing Program<br>152 Townsend Hall<br>531 S. College Avenue<br>Newark, DE 19717-1303<br>Ph: 302-831-1392<br>http://ag.udel.edu/other_websites/DSTP/ | N/A | University of Delaware Soils Lab does not do manure analyses. Delaware Department of Agriculture has a manure test lab, but they will only accept Delaware samples. | N/A | | N/A | N/A |
| Waters Agricultural Laboratories, Inc.<br>PO Box 382<br>257 Newton Highway<br>Camilla, GA 31730-0382<br>Ph: 229-336-7216<br>www.watersag.com | $25.00 | **#1 Maryland package**<br>N (total), ammonium N, $P_2O_5$, $K_2O$, % moisture<br><br>A more extensive analyte list is also available for an additional charge. | No | Does not provide density (lbs/100 gallons); planner must use average value for liquids.<br><br>Manure is reported as ppm.<br>ppm x .0001 = % | Yes. Go to<br>www.watersag.com<br><br>Click on the "Manure/Sludge Analysis" link (#10).<br><br>Download "Sample Information Sheet." | Order form is on the web site.<br><br>www.watersag.com<br><br>Click on the "Sampling Supplies" link (#17). (UPS ARS labels can be ordered here.) |

**ASSUME PAYMENT MUST BE INCLUDED WITH SAMPLES. Prices may change without notice. Check with lab for current price.**
Web pages are updated frequently and addresses for the manure information sheets may change. If this occurs, go to the lab's home page and follow the links to the manure information sheet.

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# Comparison of Some Labs Testing Manure
## (2/28/08 update)

| Lab | Cost[1] | Analyses | C Reporting Available? | Comments | Manure Submission Form on Website?[2] | Ordering Supplies |
|---|---|---|---|---|---|---|
| A & L Eastern Agricultural Lab<br>7621 Whitepine Road<br>Richmond, VA 23237<br>Ph: 804-743-9401<br>www.al-labs-eastern.com | $40.00 | **M1 package**<br>N (total), ammonium N, $P_2O_5$, $K_2O$, % moisture, density (lbs/100 gallons)<br><br>A more extensive analyte list is also available for an additional charge. | No | | Yes. Go to www.al-labs-eastern.com/agri<br><br>Choose "Submittal Form" next to Manure Analysis. | Order form is on the web site.<br><br>www.al-labs-eastern.com/agri<br><br>Choose "Download the Supply Order form." |
| Agri Analysis, Inc.<br>280 Newport Road<br>PO Box 483<br>Leola, PA 17540<br>Ph: 717-656-9326<br>www.agrianalysis.com | $47.00 | **MDMP4 package**<br>N (total), ammonium N, $P_2O_5$, $K_2O$, % moisture, density (lbs/100 gallons), % dry matter<br><br>A more extensive analyte list is also available for an additional charge. | Order the Ash test and write on the request form "Include C:N ratio."<br><br>Ash test - $10.00 | | Yes. Go to www.agrianalysis.com<br><br>Click on "Resources."<br><br>Scroll down to the Manure & Compost Information heading and click on "Manure Request Form." | Call 717-656-9326 or send an e-mail to info@agrianalysis.com for bags and info sheets. |
| Brookside Laboratories, Inc.<br>308 South Main Street<br>New Knoxville, OH 45871<br>Ph: 419-753-2448<br>www.blinc.com | Will be determined by a consultant | **Standard Manure Analysis**<br>N (total), ammonium N, nitrate N, $P_2O_5$, $K_2O$, % moisture, organic matter<br><br>A more extensive analyte list is also available for an additional charge. | $6.90 | Expresses results for P and K on both oxide and elemental basis. Be sure to use oxide data in *NuMan Pro*. | No. Brookside prefers to receive samples from their consultants only. | |

ASSUME PAYMENT MUST BE INCLUDED WITH SAMPLES. Prices may change without notice. Check with lab for current price.
Web pages are updated frequently and addresses for the manure information sheets may change. If this occurs, go to the lab's home page and follow the links to the manure information sheet.

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- **Sampling Litter for Nutrient Content in Poultry Houses**

# SAMPLING LITTER FOR NUTRIENT CONTENT IN POULTRY HOUSES

## 1. MATERIALS

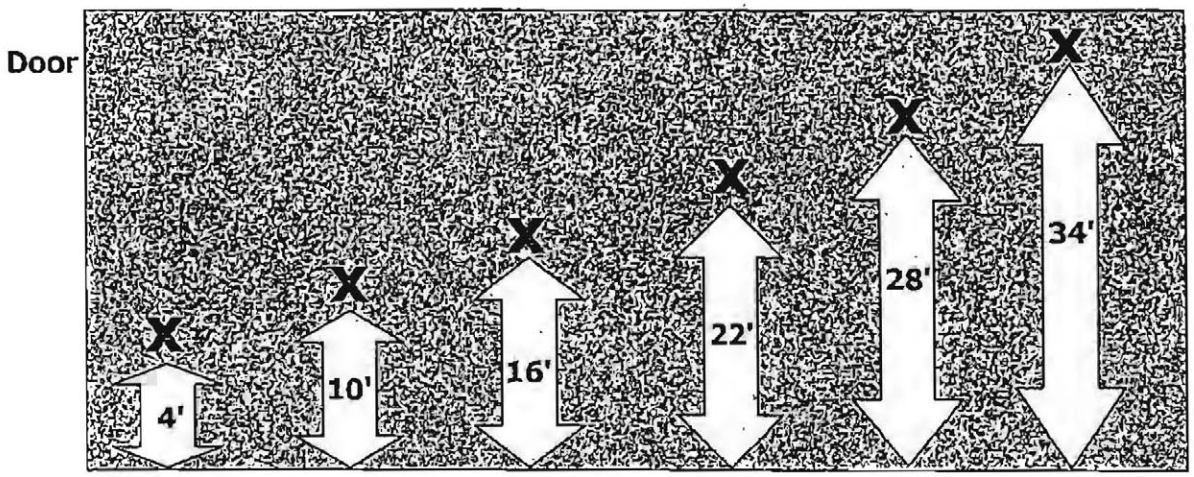
- A trowel or narrow-bladed tool such as a tiling spade or small post hole digger for sampling
- One or two clean plastic buckets for collecting samples
- A plastic sheet about 6′ X 6′ for mixing
- A plastic zip-lock bag about 8″ X 10″ for shipping the litter sample to the lab (bags of 4 mi thickness are preferred)

## 2. SAMPLING

### SAMPLING PATTERN

1. Mentally divide the poultry house into 3 chambers of equal size. Within *each chamber* take 6 cores (see Figure 1). Take one core from within 1 foot of the feed line and one core from within 1 foot of the water line.
2. Repeat the sampling procedure in the remaining 2 chambers. Take a total of 18 cores for all 3 chambers.

**Figure 1.** An example of a poultry house. Each **X** represents the area to be sampled,

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## SAMPLING PROCEDURE

1. Using the sampling tool, take a representative cross section of litter from the litter surface down to where it contacts the soil.
2. Empty the sample into the bucket. If the bucket(s) becomes full before all 18 samples are taken, pour the contents onto the plastic sheet and continue sampling.

## MIXING THE SAMPLE

1. After you take 18 samples, 6 from each chamber, pour the litter from all 3 chambers onto the plastic sheet.
2. Thorough mixing is critical to ensure that the sample you send for analysis is representative of the entire house. Break up any clumps of litter. If clumps are sticky, you may need to break them up by grating them against a coarse screen.
3. To obtain a good mix, gradually lift one corner of the plastic sheet, rolling the litter over itself toward the middle of the sheet. Do the same from the diagonally opposite corner. See Figure 2.
4. Once the litter is piled in the center of the sheet, spread it out again and roll it into a pile using the other 2 corners. See Figure 3.
5. Repeat steps 3 and 4 at least 5 more times.
6. After the litter is well mixed, spread the litter over the entire sheet again and take at least 9 small sub-samples (about 1 quart total for all 9 sub-samples in a grid pattern). Sample all the way to the plastic in case finer material has settled out during mixing. See Figure 4.

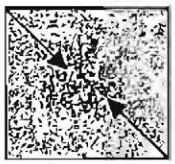

**Figure 2**

**Figure 3**

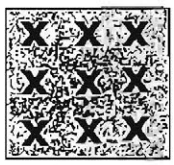

**Figure 4**

# 3. PACKAGING THE SAMPLE FOR SHIPMENT

1. Fill the plastic bag about 2/3 full with the sample and squeeze the air out before sealing.
2. Keep the sample cool until it is shipped to an analytical laboratory for analysis.

February 2006, Agricultural Nutrient Management Program
University of Maryland Cooperative Extension would like to acknowledge Bud Malone, Extension Poultry Specialist, University of Delaware, Georgetown, DE, for his assistance in developing this procedure.

Section III

- **Maryland's Agronomic Soil Capability Assessment Program (MASCAP)**

# Maryland's Agronomic Soil Capability Assessment Program (MASCAP)

## CROP YIELD ESTIMATES / YIELD GOALS

The ability to estimate crop yield goals that reflect yield increases due to improvements in varieties and production practices under Maryland's diverse growing conditions is an important component of Maryland's Nutrient Management Program. The goal of nutrient management is to reduce nutrient losses into the region's surface and groundwater, increasing efficiencies and maintaining agricultural productivity and profitability. Therefore, a major effort is underway to more closely match recommended nutrient applications on agricultural land with actual crop nutrient requirements.

This task is complicated by the fact that soils differ remarkably in their yield capabilities. According Maryland's Nutrient Management regulations, nutrient rate recommendations shall be based on "Expected Crop Yield" and other criteria as explained under section (10). Expected crop yield is determined from crop yield records and the soil productivity on the given farm.

### Crop Yield Records

The calculation of expected crop yield is based on an average of 3 highest yielding years out of the latest consecutive 5-year cropping sequence for a given field. Since field specific crop yield records are recognized as the best information available to determine the expected crop yield for nutrient management planning, certified consultants should encourage farmers and help them develop a record-keeping system.

### Estimating Crop Yields from Soil Characteristics

In the absence of long-term, site specific yield records, soil productivity information is used to estimate the expected crop yield goals.

The land capability classification and crop yield estimates usually appear in soil survey reports developed by the USDA Natural Resources Conservation Service (NRCS). Since soil survey information and the relevant crop yield estimates have not been updated in all counties of Maryland, the University of Maryland Cooperative Extension Service developed a new database relating the best available crop yield information to specific soil characteristics. This document, *Maryland's Agronomic Soil Capability Assessment Program (MASCAP)*, was published in September 1994.

MASCAP yield predictions are to serve only as a guideline in the absence of site-specific yield data. If a grower can provide recent yield records for three to five years or more, these values should take precedence over MASCAP yield predictions.

The MASCAP model assumes that all of the information stored in the master database is accurate. It also assumes that even though the magnitude of many of the yield values may no longer be accurate, there continues to be a high degree of correlation between yield estimate and soil property values, i.e., the higher yields are most frequently associated with soils having property values favoring a higher yield capability, and the lower yields are typically associated with soils

possessing characteristics that normally limit crop yields. By basing the multiple linear regression calculations on NRCS/CES yield estimates and soil property values, yield predictions should be directly related to soil capability used as a broad definitive.

Obviously, the finest estimates that MASCAP is capable of generating are limited by the accuracy of the database. Some allowance should be made for natural spatial or other variations that may influence final yield predictions. For instance, variability in yield predictions of approximately ±5 Bu/Ac for grain or ±0.5 Tons/Ac for hay for the same soil mapping unit, compared across county lines, should not be considered unusual.

It is further recognized that there are many site-specific factors affecting yield which cannot be predicted. Weather variations significantly influence yields on a seasonal basis, as well as management by the producer. Since such factors vary with site and time, and since they ultimately represent an infinite number of combinations that would be impossible or impractical to tabulate, it is assumed that the MASCAP yield predications are representative of what might be expected to occur under average climatic and management conditions. Many regional differences due to climate, length of growing season, cultivars, etc., are automatically accounted for in the model.

Presently, this document (MASCAP) is the best available tool for nutrient management consultants to estimate crop yields based on soil information in the absence of reliable field records.

### Updating Soil Information and Yield Predictions

The USDA Natural Resources Conservation Service (NRCS) is in process of updating and digitizing soil survey information as part of their national long-term program based on availability of resources. In the meantime, the University of Maryland's Agronomy Department has initiated a project to develop a new updated system for crop yield estimates. The project includes development of the soil yield potential digital data for the counties where soil survey information has been updated and digitized. Crop yield information obtained from yield monitoring sources will be used in correlation with soil data for specific soil types, and will be grouped into soil yield potential classes.

The Geographic Information System (GIS) technology will be used to develop a new soil capability yield prediction system.

Until a new system becomes available, the current MASCAP tables will be used for crop yield estimates in the absence of reliable field records. Copies may be obtained by contacting the:

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1103 H J Patterson Hall
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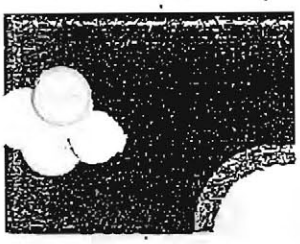
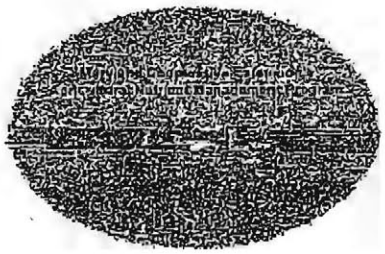
301-405-1319







# Maryland's Agronomic Soil Capability Assessment Program (MASCAP)

**Introduction to Mascap**

**Crop Yield Predictions According to County**

Click on a county below to view the corresponding crop yield predictions:

| | |
|---|---|
| Allegany County | Howard County |
| Anne Arundel County | Kent County |
| Baltimore County | Montgomery County |
| Calvert County | Prince George's County |
| Caroline County | Queen Anne's County |
| Carroll County | Somerset County |
| Cecil County | St. Mary's County |
| Charles County | Talbot County |
| Dorchester County | Washington County |
| Frederick County | Wicomico County |
| Garrett County | Worcester County |
| Harford County | |

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# • Phosphorus Removal by Crops in the Mid-Atlantic

MARYLAND COOPERATIVE EXTENSION
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Information

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# Nutrient Management

NM-3
Revised August 2004

## PHOSPHORUS REMOVAL BY CROPS IN THE MID-ATLANTIC STATES

Reliable data about phosphorus (P) removal rates of crops are essential for nutrient management planners developing P-removal based recommendations. P-removal is available from many sources, although no source is comprehensive.

P-removal data from 7 regional or national published sources were used to compile the P-removal tables in this information sheet:

[1] *Chesapeake Bay Region Nutrient Management Manual*
[2] *Plant Food Uptake* booklet
[3] *Knott's Handbook for Vegetable Growers*
[4] *Nutrients Available from Livestock Manure Relative to Crop Growth Requirements*
[5] *The PLANTS Database*
[6] *The Fertilizer Handbook*
[7] *National Nutrient Database for Standard Reference*

P-removal was expressed as phosphate ($P_2O_5$) per unit yield.

- When P-removal information was available from more than one source, the source with the highest reported P-removal rate was used.
- When no data were available from regional or national published sources, data were obtained from an Extension Specialist with expertise on that particular crop. Typically, in these instances P-removal data were estimated from closely-related species with similar removal potential.
- Superscripts after each crop indicate the source of information.



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| CROP | YIELD UNIT | LB $P_2O_5$ PER YIELD UNIT |
|---|---|---|
| GRAINS | | |
| barley [4] | bushels | 0.41 |
| barley straw (per bushel grain) [5] | bushels | 0.11 |
| buckwheat [4] | bushels | 0.37 |
| corn [1] | bushels | 0.40 |
| corn stover (per bushel grain) [5] | bushels | 0.14 |
| oat [1] | bushels | 0.30 |
| oat straw (per bushel grain) [5] | bushels | 0.09 |
| proso millet [5] | bushels | 0.39 |
| rye [1] | bushels | 0.50 |
| rye straw (per bushel grain) [5] | bushels | 0.17 |
| sorghum [1] | bushels | 0.42 |
| triticale [4] | bushels | 0.39 |
| wheat [1] | bushels | 0.56 |
| wheat straw (per bushel grain) [5] | bushels | 0.11 |

| CROP | YIELD UNIT | LB $P_2O_5$ PER YIELD UNIT |
|---|---|---|
| OILSEEDS | | |
| canola [5] | cwt | 1.3 |
| soybean [1] | bushels | 1.0 |
| sunflower [5] | tons | 27 |

| CROP | YIELD UNIT | LB $P_2O_5$ PER YIELD UNIT |
|---|---|---|
| SILAGE | | |
| corn silage [2] | tons | 3.6 |
| grass silage [4] | tons | 3.7 |
| sorghum silage [4] | tons | 5.6 |

| CROP | YIELD UNIT | LB $P_2O_5$ PER YIELD UNIT |
|---|---|---|
| FORAGES | | |
| alfalfa hay [2] | tons | 15 |
| bermudagrass [2] | tons | 12 |
| birdsfoot trefoil [2] | tons | 21 |
| bluegrass [1] | tons | 18 |
| bluegrass/white clover [#] | tons | 13 |
| bluestem species [#] | tons | 10 |
| bromegrass [1] | tons | 13 |
| buffalograss [#] | tons | 10 |

| CROP | YIELD UNIT | LB $P_2O_5$ PER YIELD UNIT |
|---|---|---|
| FORAGES (Continued) | | |
| clover and grass [2] | tons | 15 |
| crown vetch [#] | tons | 13 |
| gamagrass [5] | tons | 11 |
| hairy vetch [5] | tons | 14 |
| indiangrass [#] | tons | 10 |
| lespedeza [5] | tons | 10 |
| millet [#] | tons | 8.4 |
| orchardgrass [1] | tons | 17 |
| red clover [1] | tons | 10 |
| reed canarygrass [5] | tons | 12 |
| ryegrass (annual [#] & perennial [2]) | tons | 17 |
| small grain, hay or pasture [5] | tons | 10 |
| sorghum [2] | tons | 8.4 |
| sorghum x sudangrass [1] | tons | 15 |
| soybean and sorghum [1,2] | tons | 9.2 |
| soybean hay [1] | tons | 10 |
| soybean and millet [1,#] | tons | 9.2 |
| soybean and sudangrass [1,5] | tons | 11 |
| switchgrass [#] | tons | 10 |
| sudangrass [5] | tons | 12 |
| tall fescue [1] | tons | 19 |
| timothy [1] | tons | 14 |
| weeping lovegrass [#] | tons | 10 |

# No P-removal information was available in published sources for these forages. P-removal was estimated by Dr. Lester Vough, Extension Specialist, Forage Systems Management, from closely-related crops with similar uptake potential.

| CROP | YIELD UNIT | LB $P_2O_5$ PER YIELD UNIT |
|---|---|---|
| SEED CROPS | | |
| crimson clover seed [4] | pounds | 0.018 |
| lespedeza seed [4] | pounds | 0.016 |
| red clover seed [4] | pounds | 0.016 |
| white clover [4] | pounds | 0.030 |

| CROP | YIELD UNIT | LB $P_2O_5$ PER YIELD UNIT |
|---|---|---|
| VEGETABLES & HERBS | | |
| artichoke (globe) [5] | cwt | 0.20 |
| artichoke (Jerusalem) [5] | cwt | 0.14 |

| CROP | YIELD UNIT | LB $P_2O_5$ PER YIELD UNIT |
|---|---|---|
| **VEGETABLES & HERBS (Continued)** | | |
| asparagus [5] | cwt | 0.13 |
| basil [7] | cwt | 0.16 |
| beans (dried, all types) [4] | cwt | 1.1 |
| beet (root) [5] | cwt | 0.092 |
| beet (top) [5] | cwt | 0.12 |
| broccoli [5] | cwt | 0.18 |
| brussels sprout [3] | cwt | 0.29 |
| cabbage [1] | tons | 1.8 |
| carrot [3] | cwt | 0.092 |
| cauliflower [5] | cwt | 0.14 |
| celery [5] | cwt | 0.083 |
| chervil ^ | cwt | 0.092 |
| chickpeas ^ | cwt | 1.1 |
| chive [5] | cwt | 0.12 |
| cilantro ^ | cwt | 0.092 |
| collard ^ | cwt | 0.13 |
| cucumber [5] | tons | 1.1 |
| dill ^ | cwt | 0.092 |
| eggplant [5] | cwt | 0.050 |
| endive [5] | cwt | 0.051 |
| escarole [5] | cwt | 0.032 |
| fennel ^ | cwt | 0.092 |
| garlic [5] | cwt | 0.39 |
| horseradish [7] | cwt | 0.071 |
| kale [5] | cwt | 0.13 |
| leafy greens (various) [5] | cwt | 0.10 |
| leek [5] | cwt | 0.080 |
| lettuce (head) [3] | cwt | 0.079 |
| lettuce (leaf) [5] | cwt | 0.10 |
| lima bean [5] | cwt | 0.34 |
| mint [7] | cwt | 0.17 |
| mustard green [5] | cwt | 0.10 |
| okra [5] | cwt | 0.15 |
| onion (dry) [5] | cwt | 0.60 |
| onion (green) [5] | cwt | 0.084 |
| oregano ^ | cwt | 0.17 |
| parsley [5] | cwt | 0.092 |
| parsnip [5] | cwt | 0.16 |

^ No P-removal data were available in published sources. P-removal was estimated by Extension Vegetable Specialists from closely-related crops with similar removal potential.

| CROP | YIELD UNIT | LB $P_2O_5$ PER YIELD UNIT |
|---|---|---|
| VEGETABLES & HERBS (Continued) | | |
| pea [3] | cwt | 0.57 |
| pepper [5] | cwt | 0.066 |
| potato [4] | cwt | 0.14 |
| pumpkin [5] | tons | 1.7 |
| radish [5] | cwt | 0.064 |
| rutabaga [5] | cwt | 0.092 |
| snap bean [3] | cwt | 0.23 |
| soybeans (green, Edamame) [7] | cwt | 0.44 |
| spinach [6] | cwt | 0.15 |
| squash (summer) [5] | cwt | 0.064 |
| squash (winter) [5] | cwt | 0.079 |
| sweet corn [3] | cwt | 0.14 |
| sweet potato [3] | cwt | 0.12 |
| Swiss chard [5] | cwt | 0.11 |
| tomatillos ^ | cwt | 0.10 |
| tomato [1] | tons | 2.0 |
| turnip (green) [5] | cwt | 0.14 |
| turnip (root) [5] | cwt | 0.065 |

| CROP | YIELD UNIT | LB $P_2O_5$ PER YIELD UNIT |
|---|---|---|
| FRUITS | | |
| apple [1] | bushels | 0.020 |
| grape [1] | tons | 2.0 |
| honeydew melon [3] | tons | 1.3 |
| muskmelon (cantaloupe) [3] | tons | 3.5 |
| peach [1] | bushels | 0.033 |
| Persian melon ^ | tons | 3.5 |
| rhubarb (stalk) ^ | cwt | 0.046 |
| watermelon [5] | tons | 0.47 |
| strawberry [5] | cwt | 0.043 |

| CROP | YIELD UNIT | LB $P_2O_5$ PER YIELD UNIT |
|---|---|---|
| MISCELLANEOUS | | |
| cotton (seed & lint) [1] | tons | 27 |
| cotton (stalk, leaf & bur) [1] | tons | 10 |
| tobacco (leaf & stalk - based on harvest leaf weight) [1] | tons | 30 |

**Sources:**

[1] Nagle, S., G. Evanylo, W.L. Daniels, D. Beegle, V. Groover, and F. Coale. 1997. Chesapeake Bay region nutrient management training manual. Misc. Publ.
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[7] USDA, ARS. Nutrient Data Laboratory. (http://www.nal.usda.gov/fnic/foodcomp/). National Nutrient Database for Standard Reference, Release 16-1.

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1st printing: January 2002

# • The Maryland Phosphorus Site Index: An Overview

MARYLAND COOPERATIVE EXTENSION
UNIVERSITY OF MARYLAND
COLLEGE PARK-EASTERN SHORE

Fact Sheet

SFM-6
Revised April 2005

# THE MARYLAND PHOSPHORUS SITE INDEX: AN OVERVIEW

## The Phosphorus Index Concept

In 1990, a national cooperative workgroup of scientists from numerous Universities and the USDA was organized to develop a procedure that could identify soils, farm management practices, and specific locations within a farm where phosphorus (P) losses in field drainage water may pose the potential for negative environmental impacts on nearby surface waters. The goals of this national workgroup were:

- To develop an easily used field rating system that rates farm fields according to the potential for P loss to surface water (the Phosphorus Index).
- To relate the P Index to the sensitivity of receiving surface waters to eutrophication and degradation resulting from nonpoint source P enrichment.
- To facilitate adaptation and modification of the P Index to regional and site-specific conditions.
- To develop agricultural management practices that will minimize the buildup of soil P to excessive levels and the transport of P from soils to sensitive water bodies.

## The Objective of the Phosphorus Index

The P Index uses readily available information to evaluate two broad categories of factors that contribute to the potential for P loss from agricultural land: 1) P loss potential due to site and transport characteristics; 2) P loss potential due to management and source characteristics. The first group of factors assesses the potential for P to be transported off of the field with runoff, leaching, and drainage water. The second group of factors assesses the quantity, availability, and forms of P present at the site and the likelihood that the P present in the soil is a source of potential environmental concern. The aim of the P Index is to identify critical areas where there is a high P loss potential from the site because there is both a large potential for transport of P off of the field and a large source of P present in the soil that may potentially pose a significant environmental impact if it reaches nearby surface waters.

## Development of a Modified Phosphorus Index Specifically For Maryland Conditions

In 1994, we began the development of a P Index specifically tailored to Maryland's soils, agricultural management practices, climate, topography, hydrology and surface water characteristics. The Maryland Phosphorus Site Index (PSI) was originally based on the generic national model published in 1993 by the USDA's Natural Resources Conservation Service, but has undergone many substantive changes and modifications during its development so that it more accurately reflects Maryland conditions.

The Maryland PSI has been evaluated on nearly eight hundred farm fields across the state.

The information generated from those on-farm evaluations has been used to develop this initial version of the PSI. As more farm fields are evaluated and we gain more information on the strengths and weaknesses of this nutrient management planning tool, revised and improved versions of the PSI will likely be developed.

## How the Maryland Phosphorus Site Index Works

The Maryland PSI is structured into two distinct portions: Part A and Part B (Table 1). Part A evaluates the P loss potential due to physical site characteristics and P transport potential. This assessment is made by evaluation of six site-specific characteristics: soil erosion, surface runoff, subsurface drainage, leaching potential, distance to surface water, and watershed priority ranking. Part B evaluates the P loss potential due to farm management practices and P source characteristics by assessing six additional factors: conventional soil-test P level, P fertilizer application rate, P fertilizer application method, organic-source P (manures, biosolids, composts, etc.) application rate, organic-source P availability or solubility, and organic-source P application method.

Each of the twelve site characteristics or management factors is evaluated for a specific location and assigned a numeric value. The sum of the site characteristics determined for Part A is multiplied by a scaling factor (0.02) so that P transport potential is expressed on a relative scale with a range of 0 to 1, for most situations. Thus, the total site and transport value determined for Part A can be interpreted as the proportion of the P source present at the site that is susceptible to being transported off of the field by drainage water and impacting adjacent surface waters.

The sum of the management practice and source characteristic values determined for Part B is multiplied by the total site and transport value determined for Part A and the product is the final "P Loss Rating" for the site. This multiplicative operation assures that the fields that have the highest P Loss Rating have both a high P transport potential (large Part A value) and large source of potentially damaging P (large Part B value). If either the P transport potential (Part A) or the P source characteristics (Part B) are low, then the final P Loss Rating will be relatively low.

## Interpreting the P Loss Rating

The final P Loss Rating is subdivided into four interpretive categories: Low, Medium, High, and Very High. Table 2 can be used to interpret the management implications of the P Loss Rating determined for a specific site. It is important to understand that the P Loss Rating is only a relative value and is not a numeric or quantitative prediction of P loss from the field. Sites with a P Loss Rating in the "Low" category are predicted to have a relatively lower potential for P losses than sites in the "Medium" category. Sites with a P Loss Rating in the "Medium" category are predicted to have a relatively lower potential for P losses then those locations with a "High" P Loss Rating, and so on.

## Using the Maryland Phosphorus Site Index

The purpose of this publication was to present a brief overview of the Maryland Phosphorus Site Index. For specific detailed information on how use the Maryland PSI in developing an agricultural nutrient management plan, please see *The Maryland Phosphorus Site Index Technical Users Guide*, Soil Fertility Management Information Series, SFM-7, which is available from Maryland Cooperative Extension.

Prepared by:

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*Table 1. The Maryland Phosphorus Site Index, April 2005.*

Part A: Phosphorus loss potential due to site and transport characteristics

| Characteristics | Phosphorus Loss Rating | | | | | Value |
|---|---|---|---|---|---|---|
| Soil Erosion (tons/acre) | 2 X tons soil loss/acre/year | | | | | |
| Soil Runoff Class | Negligible or Very Low 0 | Low 2 | Medium 4 | High 6 | Very High 8 | |
| Subsurface Drainage | Very Low 0 | Low 2 | Medium 4 | High 6 | Very High 8 | |
| Leaching Potential | Low 0 | | Medium 2 | High 4 | | |
| Distance From Edge of Field to Surface Water (feet) | > 100 feet 0 | < 100 feet AND >50 feet vegetated buffer OR <100 feet AND > 25 feet vegetated buffer AND > 25 feet additional no P application zone 2 | < 100 feet AND > 25 feet vegetated buffer AND < 25 ft additional no P application zone 4 | < 100 feet AND < 25 feet vegetative buffer AND > 25 feet additional no P application zone 6 | < 100 feet AND < 25 feet vegetative buffer AND < 25 ft additional no P application zone 8 | |
| Priority of Receiving Water | Category 2 0 | Category 3 1 | Category 3, Selected 2 | Category 1 3 | Category 1, Priority 4 | |

**Sum of Site and Transport Characteristics:**_____

**Scaling Factor:** *x* **0.02**

**Total Site and Transport Value:** _____

Part B: Phosphorus loss potential due to management practice and source characteristics

| Characteristics | Phosphorus Loss Rating | | | | | Value |
|---|---|---|---|---|---|---|
| Soil Test P Fertility Index Value | 0.2 X FIV | | | | | |
| P Fertilizer Application Rate (lbs $P_2O_5$) | 0.6 X (lbs $P_2O_5$ / acre) | | | | | |
| P Fertilizer Application Method | None applied 0 | Injected/ Banded below surface at least 2" 15 | Incorporated within 5 days of application 30 | Surface applied March through November OR Incorporated more than 5 days after application 45 | Surface applied December through February 60 | |
| Organic P Application Rate (lbs $P_2O_5$) | PSC X (lbs $P_2O_5$ / acre) | | | | | |
| Organic P Application Method | None applied 0 | Injected/banded below surface at least 2" 15 | Incorporated within 5 days of application 30 | Surface applied March through November OR Incorporated more than 5 days after application 45 | Surface applied December through February 60 | |

**Total Management and Source Value:**_____

*Table 2. Interpretation of the Maryland Phosphorus Site Index P Loss Ratings.*

| P Loss Rating | Interpretation of P Loss Rating |
|---|---|
| 0-50 | ·**LOW** potential for P movement from this site given current management practices and site characteristics. There is a low probability of an adverse impact to surface waters from P losses from this site.<br>·Nitrogen-based nutrient management planning is satisfactory for this site.<br>·Soil P levels and P loss potential may increase in the future due to continued nitrogen-based nutrient management. |
| 51-75 | ·**MEDIUM** potential for P movement from this site given current management practices and site characteristics. Practices should be implemented to reduce P losses by surface runoff, subsurface flow, and erosion.<br>·Nitrogen-based nutrient management should be implemented no more than one year out of three.<br>·Phosphorus-based nutrient management planning should be implemented two years out of three during which time P applications should be limited to the amount expected to be removed from the field by crop harvest or soil-test based P application recommendations, whichever is greater. |
| 76-100 | ·**HIGH** potential for P movement from this site given current management practices and site characteristics.<br>·Phosphorus-based nutrient management planning should be used for this site. Phosphorus applications should be limited to the amount expected to be removed from the field by crop harvest or soil-test based P application recommendations.<br>·All practical management practices for reducing P losses by surface runoff, subsurface flow, or erosion should be implemented. |
| >100 | ·**VERY HIGH** potential for P movement from this site given current management practices and site characteristics.<br>·No phosphorus should be applied to this site.<br>·Active remediation techniques should be implemented in an effort to reduce the P loss potential from this site. |

Section IV

# Manure Management

# Manure Production Rate
# and
# Quantity Estimation

MARYLAND COOPERATIVE EXTENSION

# Manure Production Rate

| Manure Type | Description | lbs. manure/ AU/day | Cu. ft. manure/ AU/day |
|---|---|---|---|
| Dairy | Lactating cow [6] | | |
| | 12,500 lbs milk/yr | 81 | 1.3 |
| | 15,000 lbs milk/yr | 88 | 1.4 |
| | 17,500 lbs milk/yr | 94 | 1.5 |
| | 20,000 lbs milk/yr | 100 | 1.6 |
| | 22,500 lbs milk/yr | 106 | 1.7 |
| | 25,000 lbs milk/yr | 113 | 1.8 |
| | 27,500 lbs milk/yr | 119 | 1.9 |
| | Dry cow | 82 | 1.3 |
| | Heifer | 85 | 1.3 |
| | Bull [3] | 70 | 1.1 |
| | Veal | 60 | 0.96 |
| Beef | Feeder yearling (750 - 1100 lbs.) - high forage diet | 59 | 0.95 |
| | Feeder yearling (750 - 1100 lbs.) - high energy diet | 51 | 0.82 |
| | Calf (450 - 750 lbs.) | 58 | 0.93 |
| | Cow | 63 | 1.00 |
| | Bull [3] | 63 | 1.00 |
| Swine | Grower (up to 250 lbs.) | 63 | 1.00 |
| | Replacement gilt | 33 | 0.53 |
| | Sow - gestation | 27 | 0.44 |
| | Sow - lactation | 60 | 0.96 |
| | Boar | 21 | 0.33 |
| | Nursing / nursery pig (0 - 65 lbs.) [1] | 65 | 1.03 |
| Poultry (Free Range)* | Broiler | 80 | |
| | Layers | 61 | |
| | Turkeys | 44 | |
| Sheep | Feeder Lamb | 40 | 0.63 |
| Goat | | 40 | |
| Horse | | 50 | 0.80 |
| Exotic Mammal | Llama [3] | 40 | |
| | Alpaca [3] | 40 | |
| | Buffalo [3] | 60 | |
| | Rabbit [5] | 150 | |
| Exotic Bird | Peacock [2] | 44 | |
| | Duck [4] | 55 | |
| | Emu (breeding stock) [2] | 50 | |
| | Emu (young, growing birds) [2] | 40 | |
| | Ostrich [2] | 26 | |
| | Quail [2] | 80 | |
| | Guinea Fowl [2] | 44 | |
| | Pheasant [2] | 44 | |

Updated 11-6-06

Estimates are from the USDA/NRCS, *Agricultural Waste Management* Field Handbook unless otherwise indicated.

[1] Dr. Thomas Hardsock, UMCP, Department of Animal and Avian Sciences
[2] Dr. Rosalina Angel, UMCP, Department of Animal and Avian Sciences
[3] Dr. Richard Kohn, UMCP, Department of Animal and Avian Sciences
[4] *Manure Characteristics*, MWPS-18, Manure Management Systems Series, 2000
[5] Willie Lantz, Garrett College
[6] *USDA, NRCS AWM Software Program*
* Not appropriate for integrated poultry production

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# MANURE QUANTITY ESTIMATION

(Use when both solid and liquid manure are generated by a single livestock group)

Farm name: _____

**Manure Production period:**

Starting date: _____ Ending date: _____

A. Total days in manure production period: 0

## Livestock Information

| | | 1 | 2 | 3 |
|---|---|---|---|---|
| B. | Livestock group | | | |
| C. | Average weight (lbs.) | | | |
| D. | # of animals | | | |
| E. | Animal units (AU) [(C x D)/1000] | 0 | 0 | 0 |
| F. | Full days confined during manure production period | | | |
| G. | Days partially confined during manure production period | | | |
| H. | Hours per day confined | | | |
| I. | Day equivalents partially confined (G * H)/24 | 0 | 0 | 0 |
| J. | Total day equivalents confined (F + I) | 0 | 0 | 0 |
| K. | Fraction of manure collected as liquid waste (expressed as a decimal) | | | |
| L. | Total day equivalents unconfined on pasture (A - J) | 0 | 0 | 0 |
| M. | Weight of manure/AU/day (lbs.) (see Table 1.) | | | |

## Bedding Estimation

| | | 1 | 2 | 3 |
|---|---|---|---|---|
| N. | Bedding type (straw, sawdust, etc.) | | | |
| O. | Volume of bedding this production period (cu.ft.). (If weight of bedding is known, proceed to Q and enter it directly.) | | | |
| P. | Density of bedding (lbs. per cu.ft.) (see Table 2.) | | | |
| Q. | Weight of bedding (tons) [(O x P)/2000] | 0.0 | 0.0 | 0.0 |
| R. | Fraction of bedding collected with liquid waste (expressed as a decimal) | | | |

## Uncollected Manure (Deposited on Pasture)

| | | 1 | 2 | 3 |
|---|---|---|---|---|
| S. | Weight of manure on pasture (tons) [(E x L x M)/2000] | 0 | 0 | 0 |

## Collected Solid Waste (Manure And Bedding)

| | | 1 | 2 | 3 |
|---|---|---|---|---|
| T. | Weight of collected manure (tons) [E x (J - (J x K)) x M]/2000] | 0 | 0 | 0 |
| U. | Weight of collected manure & bedding (tons) [Q - (Q x R) + T] | 0 | 0 | 0 |

## Collected Liquid Manure and Bedding

| | | 1 | 2 | 3 |
|---|---|---|---|---|
| V. | Volume of liquid manure/AU/day (cubic feet) (See Table 1) | | | |
| W. | Volume of liquid manure collected (cubic feet) [E x (J x K) x V] | 0 | 0 | 0 |
| X. | Volume of collected liquid manure & bedding collected with liquid (cubic feet) [0.5 x (O x R) + W] | 0 | 0 | 0 |
| Y. | Total volume of collected liquid manure & bedding (cubic feet) [X1 +X2 + X3]* | 0 | | |

* Adding these liquid manure sources is legitimate if they all feed into the same liquid manure storage system

| | | |
|---|---|---|
| Z. | Volume of waste collected (gallons) (Y x 7.481) | 0 |
| AA. | Volume of washwater per day (gallons) | |
| BB. | Volume of washwater collected during manure production period (gallons) (AA x A) | 0 |
| CC. | Drainage area (square feet) | |
| DD. | Inches of rain during manure production period (see Table 3.) | |
| EE. | Inches of rain during a 25yr - 24 hr storm (see Table 3.)** | |
| FF. | Storage structure area (square feet) | |
| GG. | Volume of rainfall collected (gallons) [(0.6 x CC x DD) + (FF x DD) + (0.75 x CC x EE**) + (FF x EE**)] x 7.481 / 12 | 0 |
| HH. | Total volume of liquid waste collected (gallons) (Z + BB + GG) | 0 |

** Required for CAFOs/CNMPs

Updated: 1-10-05

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# POULTRY LITTER QUANTITY ESTIMATE

Name:
Address:
City, State, Zip:

County:
Watershed:
Phone:

Date:
Tract / Farm:
Houses included:

## Bird type: Broiler

| | | |
|---|---|---|
| A. | Years between total cleanouts: Yr. next total cleanout: | |
| | - Yr. last total cleanout: | |
| | = Years in cleanout cycle: | |
| B. | Total # of birds per flock (for all houses on this cleanout cycle): | |
| C. | Flocks per year | |
| D. | Number of flocks per cleanout cycle (A x C): | |
| E. | Estimated tons of cake per 1000 birds per flock: * | 0.2 |
| F. | Estimated tons of litter + cake per 1000 birds per flock: * | 1.1 |
| G. | Tons cake produced per flock (B x E/1000): | |
| H. | Tons cake removed per cycle (G x [D-1]) | |
| I. | Tons litter + cake produced per cycle (B x D x F/1000): | |
| J. | Tons of litter produced per cycle (I - H): | |
| K. | Tons of litter produced per year (J/A): | |

## Quantity of Poultry Litter Available - Broiler

| | Tons Available Litter | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | L | M | N | O | P | Q | R | S | T |
| Year | % of partial or total litter to be removed this year (enter % of N removed) | Tons of litter remaining in the house from last year (N-O), prev. year | Total tons of litter that is present in the house this year (K) + (M, this year) | Tons of litter removed this year (L x N)/100 | Cakeouts this Year | Tons Cake Removed (G x P) | Tons litter + Cake removed this year (O + Q) | Tons used in NMP | Tons Surplus (R - S) |
| | | | | | | | | | |
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| | | | | | | | | | |
| | | | | | | | | | |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 |

* 2000 Delmarva Poultry Litter Production Estimates, George W. Malone, University of Delaware, Georgetown Delaware.

# POULTRY LITTER QUANTITY ESTIMATE

Name:
Address:
City, State, Zip:

County:
Watershed:
Phone:

Date:
Tract / Farm:
Houses included:

## Bird type: Roaster

| | | |
|---|---|---|
| A. | Years between total cleanouts: Yr. next total cleanout: | |
| | - Yr. last total cleanout: | |
| | = Years in cleanout cycle: | |
| B. | Total # of birds per flock (for all houses on this cleanout cycle): | |
| C. | Flocks per year | |
| D. | Number of flocks per cleanout cycle (A x C): | |
| E. | Estimated tons of cake per 1000 birds per flock: * | 0.2 |
| F. | Estimated tons of litter + cake per 1000 birds per flock: * | 1.55 |
| G. | Tons cake produced per flock (B x E/1000): | |
| H. | Tons cake removed per cycle (G x [D-1]) | |
| I. | Tons litter + cake produced per cycle (B x D x F/1000): | |
| J. | Tons of litter produced per cycle (I - H): | |
| K. | Tons of litter produced per year (J/A): | |

## Quantity of Poultry Litter Available - Roaster

| | Tons Available Litter | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | L | M | N | O | P | Q | R | S | T |
| Year | % of partial or total litter to be removed this year (enter % of N removed) | Tons of litter remaining in the house from last year (N-O), prev. year | Total tons of litter that is present in the house this year (K) + (M, this year) | Tons of litter removed this year (L x N)/100 | Cakeouts this Year | Tons Cake Removed (G x P) | Tons litter + Cake removed this year (O + Q) | Tons used in NMP | Tons Surplus (R - S) |
| | | | | | | | | | |
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| | | | | | | | | | |
| | | | | | | | | | |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 |

* 2000 Delmarva Poultry Litter Production Estimates, George W. Malone, University of Delaware, Georgetown Delaware.

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# POULT TER QUANTITY ESTIMATE

Name:
Address:
City, State, Zip:

County
Watershed:
Phone:

Date:
Tract / Farm:
Houses included:

## Bird type: Cornish

| | | |
|---|---|---|
| A. | Years between total cleanouts: Yr. next total cleanout: | |
| | - Yr. last total cleanout: | |
| | = Years in cleanout cycle: | |
| B. | Total # of birds per flock (for all houses on this cleanout cycle): | |
| C. | Flocks per year | |
| D. | Number of flocks per cleanout cycle (A x C): | |
| E. | Estimated tons of cake per 1000 birds per flock: * | 0.04 |
| F. | Estimated tons of litter + cake per 1000 birds per flock: * | 0.5 |
| G. | Tons cake produced per flock (B x E/1000): | |
| H. | Tons cake removed per cycle (G x [D-1]) | |
| I. | Tons litter + cake produced per cycle (B x D x F/1000): | |
| J. | Tons of litter produced per cycle (I - H): | |
| K. | Tons of litter produced per year (J/A): | |

## Quantity of Poultry Litter Available - Cornish

| | Tons Available Litter | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | L | M | N | O | P | Q | R | S | T |
| Year | % of partial or total litter to be removed this year (enter % of N removed) | Tons of litter remaining in the house from last year (N-O), prev. year | Total tons of litter that is present in the house this year (K) + (M, this year) | Tons of litter removed this year (L x N)/100 | Cakeouts this Year | Tons Cake Removed (G x P) | Tons litter + Cake removed this year (O + Q) | Tons used in NMP | Tons Surplus (R - S) |
| | | | | | | | | | |
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| | | | | | | | | | |
| | | | | | | | | | |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 |

* 2000 Delmarva Poultry Litter Production Estimates, George W. Malone, University of Delaware, Georgetown Delaware.

# POULTRY LITTER QUANTITY ESTIMATE

Name:
Address:
City, State, Zip:

County
Watershed:
Phone:

Date:
Tract / Farm:
Houses included:

## Bird type: Broiler Breeder

**Tons Litter produced per Year = (Total # of birds per flock) x (1 Flock per year) x (24 tons litter/1000 birds/flock)**

## Estimated Quantity of Poultry Litter - Broiler Breeder

| Tons Available Litter | | | | |
|---|---|---|---|---|
| Year | Total # of Birds per flock | Tons Litter Produced per year | Tons used in NMP | Tons Surplus |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| Totals: | | 0 | 0 | 0 |

* 2000 Delmarva Poultry Litter Production Estimates, George W. Malone, University of Delaware, Georgetown Delaware.

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# POUL LITTER QUANTITY ESTIMATE

Name:
Address:
City, State, Zip:

County
Watershed:
Phone:

Date:
Tract / Farm:
Houses included:

## Bird type: Broiler Breeder Pullet

**Tons Litter produced per Year = (Total # of birds per flock) x (2 Flocks per year) x (6.7 tons litter/1000 birds/flock)**

### Estimated Quantity of Poultry Litter - Broiler Breeder Pullet

| Tons Available Litter | | | | |
|---|---|---|---|---|
| Year | Total # of Birds per flock | Tons Litter Produced per year | Tons used in NMP | Tons Surplus |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| Totals: | | 0 | 0 | 0 |

* 2000 Delmarva Poultry Litter Production Estimates, George W. Malone, University of Delaware, Georgetown Delaware.

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# POULTRY LITTER QUANTITY ESTIMATE

Name:
Address:
City, State, Zip:

County
Watershed:
Phone:

Date:
Tract / Farm:
Houses Included:

## Bird type: Table-Egg Layer

**Tons Litter produced per Year = (Total # of birds per flock) x (1 Flock per year) x (19.7 tons litter/1000 birds/flock)**

### Estimated Quantity of Poultry Litter - Table-Egg Layer

| Tons Available Litter | | | | |
|---|---|---|---|---|
| Year | Total # of Birds per flock | Tons Litter Produced per year | Tons used in NMP | Tons Surplus |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| Totals: | | 0 | 0 | 0 |

* 2000 Delmarva Poultry Litter Production Estimates, George W. Malone, University of Delaware, Georgetown Delaware.

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# POULT ITTER QUANTITY ESTIMATE

Name:
Address:
City, State, Zip:

County
Watershed:
Phone:

Date:
Tract / Farm:
Houses included:

## Bird type: Turkey

**Tons Litter produced per Year = (Total # of birds per flock) x (1 Flock per year) x (10 tons litter/1000 birds/flock)**

### Estimated Quantity of Poultry Litter - Turkey

| Tons Available Litter | | | | |
|---|---|---|---|---|
| Year | Total # of Birds per flock | Tons Litter Produced per year | Tons used in NMP | Tons Surplus |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| Totals: | | 0 | 0 | 0 |

* 2000 Delmarva Poultry Litter Production Estimates, George W. Malone, University of Delaware, Georgetown Delaware.

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# POULTRY LITTER REMOVAL RECORDS

Owner(s) Name:
Farm Name:

Year:

Bird Type:

Year of Last Total Cleanout:

| Date (mm/dd/yr) | Cleanout Type: (Partial = P; Total = T; Cakeout = C) | Load Identification* | Capacity of Load** (Tons) | Number Of Loads | Total Removal (3) x (4) = (Tons) | Receiving Party (Name) | Quantity Received (Tons) | Final Destination of Waste (Location) |
|---|---|---|---|---|---|---|---|---|
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* Identify each piece of equipment used to remove waste from the farm (i.e. truck, spreader, etc.)

** If capacity in tons is unknown, calculate using the following estimates: 1 cu.ft. capacity = 28 lbs; 1 bushel capacity = 35 lbs.

# POULTRY LITTER QUANTITY ESTIMATION

(Annual Format)

Farm Name: _____

**Manure Production Period**

Starting Date: _____ Ending Date: _____

## A. Total Litter Produced per Year

| Bird Type | 1 | 2 | 3 |
|---|---|---|---|
| 1. # of birds per flock for all houses | | | |
| 2. # of flocks per year | | | |
| 3. Estimated tons of litter and cake (crust) per 1000 birds per flock* | | | |
| 4. Total tons of litter and cake produced per year **(A1 x A2 x A3 / 1000)** | 0 | 0 | 0 |

## B. Litter Removed by Cakeouts (Crustouts) per Year

| | | | |
|---|---|---|---|
| 1. # of birds per flock for all houses | | | |
| 2. # of flocks per year | | | |
| 3. Estimated tons of cake (crust) per 1000 birds per flock* | | | |
| 4. Total tons of cakeout (crustout) removed per year **(B1 x B2 x B3 / 1000)** | 0 | 0 | 0 |

## C. Litter Removed at Total Cleanout

(Complete only if doing a total cleanout during the next planning period.)

| | | | | |
|---|---|---|---|---|
| 1. | Years between last cleanout and next scheduled cleanout | | | |
| 2. | Total tons of litter and cake produced per year **(A4)** | 0 | 0 | 0 |
| 3. | Tons of cakeout removed since last total cleanout **(B4 x C1)** | 0 | 0 | 0 |
| 4. | Tons of litter removed in total cleanout **(C1 x A4) - C3** | 0 | 0 | 0 |
| 5. | Total tons of litter and cakeout removed this year **(B4 + C4)** | 0 | 0 | 0 |

*See Table 1 for estimated tons of cake and litter for various birds.

Updated: 11-15-04

Table 1. Estimated tons of cake (crust) and litter for various birds*

| | Bird Type | | | | | | |
|---|---|---|---|---|---|---|---|
| | Broiler | Roaster | Cornish | Breeder | Pullet | Layer | Turkey |
| Estimated tons of cake (crust) per 1000 birds per flock | 0.2 | 0.2 | 0.04 | - | - | - | - |
| Estimated tons of litter and cake (crust) per 1000 birds per flock | 1.1 | 1.55 | 0.5 | 24 | 6.7 | 19.7 | 10 |

* 2000 Delmarva Poultry Litter Production Estimates, George W. Malone, University of Delaware, Georgetown Delaware.

- **Density of Bedding Materials**

# Density of Bedding Materials

| Loose Bedding Material | Density (lbs./ft$^3$) |
|---|---|
| Straw | 2.5 *,# |
| Wood shavings | 9 *,# |
| Sawdust | 12 *,# |
| Ground limestone | 95 # |
| Soil | 75 # |
| Sand | 105 *,# |
| Non-legume hay | 4 *,# |
| Alfalfa | 4 * |
| Other legume hay | 4.25 # |
| **Baled Bedding Material** | **Density (lbs./ft$^3$)** |
| Straw | 5 * |
| Wood shavings | 20 * |
| Non-legume hay | 7 * |
| Alfalfa | 8 * |
| **Chopped Bedding Material** | **Density (lbs./ft$^3$)** |
| Straw | 7 *,# |
| Newspapers | 14 * |
| Non-legume hay | 6 *,# |
| Alfalfa | 6 * |
| Other legume hay | 6.5 # |

Updated 8-3-06

Values are approximate.

# USDA/NRCS *Agricultural Waste Management Field Handbook*

* *Manure Characteristics*, MWPS-18, Manure Management Systems Series

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- **Determining the Amount of Manure in a Pile or a Pool**

MARYLAND COOPERATIVE EXTENSION
UNIVERSITY OF MARYLAND
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Information

DEPARTMENT OF BIOLOGICAL RESOURCES ENGINEERING • COLLEGE PARK, MD 20742-2315 • (301) 405-1198 • FAX (301) 314-9023

Biological Resources Engineering **FACTS**

Facts 176
March 1990

# DETERMINING THE AMOUNT OF MANURE IN A PILE OR A POOL

Herbert L. Brodie
Extension Agricultural Engineer

Planning for the most effective use of manure on your farm requires a combination of information that defines the quality and quantity of manure available. The manure analysis tells you the nutrient content of the manure in pounds per ton or pounds per gallon. A manure spreader calibration allows you to develop a manure application rate that matches the crop nutrient need with the manure nutrient content in terms of tons or gallons of manure per acre. An estimate of the total amount of manure in storage allows you to determine the total number of acres that can be fertilized at the calibration rate.

The determination of the amount of manure available for spreading requires estimation of the volume in a pile or container. This fact sheet describes methods of measurement and calculation of volume and the conversion of volume to weight.

## What is volume?

Volume is the amount of space contained within or occupied by an object. Volume is measured in cubic units such as cubic feet, cubic inches, cubic meters or cubic yards. With simple straight sided right angled boxes (Figure 1), the calculation of volume (V) is simply the width (W) multiplied by the height (H) multiplied by the length (L) of the space (V = H x W x L).

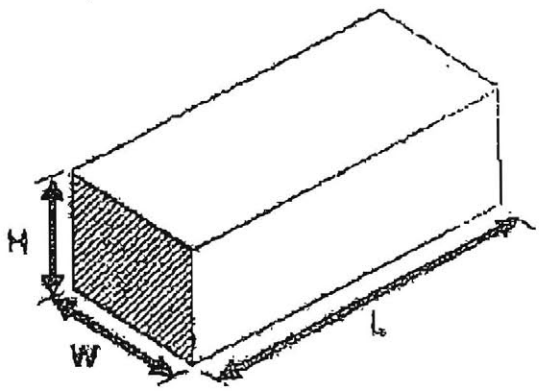


**Figure 1.** Volume of a simple box.

Volume can also be considered as the area (width multiplied by height) of the end of a uniform object multiplied by its length. In Figure 1, the end area (A) can be W x H and the volume (V) is then A x L. With the end area we can develop the volume of objects more complex than a simple box. Formulas for computing the volume of uniform shapes are shown in Appendix A.



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Use consistent measurement units

Measured dimensions for computing volume must all be in the same units. For example, a length measured as 5 feet - 6 inches must be written as 5 1/2 feet or 5.5 feet or 66 inches but not as a combination of feet and inches. All measurements must have the same units. If you measure height in inches then you must measure both length and width in inches and the volume will be calculated as cubic inches. Unit conversions are shown in Table 1.

| Unit 1 | Factor | Unit 2 |
|---|---|---|
| LENGTH | | |
| foot | 12 | inches |
| | 0.3048 | meters |
| | 0.333 | yards |
| | 30.48 | centimeters |
| inch | 2.54 | centimeters |
| mile | 5,280 | feet |
| | 1,760 | yards |
| | 1,609 | meters |
| AREA | | |
| acre | 43,560 | square feet |
| | 4,860 | square yards |
| | 4,047 | square meters |
| | 0.4047 | hectare |
| square foot | 144 | square inches |
| | 0.0929 | square meters |
| square inch | 6.45 | square centimeters |
| | 645 | square millimeters |
| square mile | 2.59 | square kilometers |
| square yards | 9 | square feet |
| | 1,296 | square inches |
| | 0.8361 | square meters |
| VOLUME | | |
| acre-foot | 12 | acre-inches |
| | 43,560 | cubic feet |
| | 325,848 | gallons |
| acre-inch | 102.8 | cubic meters |
| | 3,621 | cubic feet |
| | 27,154 | gallons |
| bushel | 1.25 | cubic feet |
| | 0.035 | cubic meters |
| cubic feet | 7.5 | gallons |
| | 0.028 | cubic meters |
| | 1,728 | cubic inches |
| cubic inch | 0.016 | liters |
| | 16.39 | cubic centimeters |
| cubic yard | 0.7646 | cubic meters |
| | 27 | cubic feet |
| gallon | 3.79 | liters |
| WEIGHT | | |
| pounds | 0.454 | kilograms |

Unit 1 multiplied by factor equals Unit 2.
5 gallons times 3.79 equals 18.95 liters

---

Unit 2 divided by factor equals Unit 1.
50 cubic feet divided by 27 equals 1.85 cubic yards.

Table 1. Unit conversions

Computing volume of piles

Volumes of complex shapes must be computed by breaking the complex shape into an imaginary group of simple shapes. The volume of each simple shape is computed and when all the simple volumes are added together the result is a good estimate of the complex shape. Several examples are shown in Figure 2. For example, a manure tank with an annex becomes two rectangular prisms; a heaped load on a wagon becomes a rectangular prism and a rectangular pyramid.

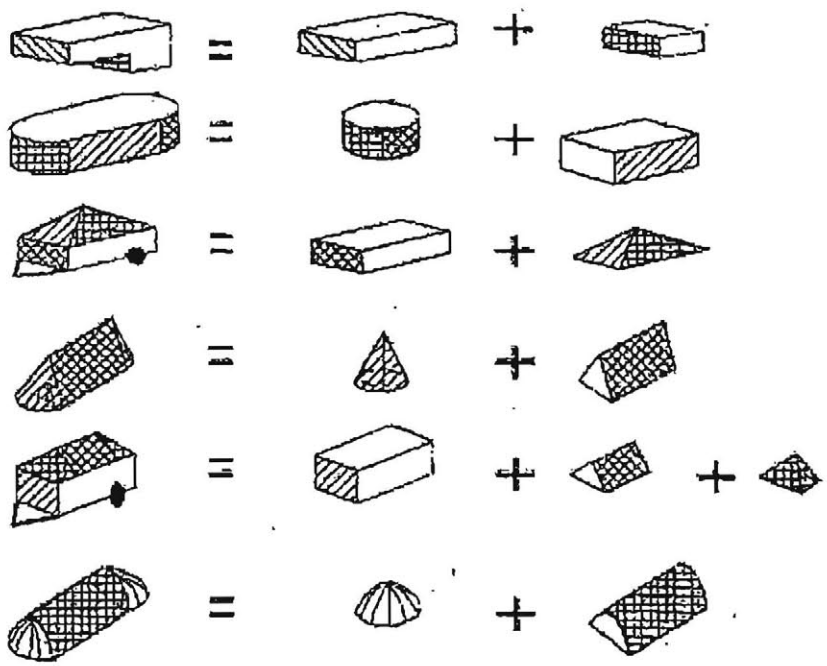


Figure 2. Breaking complex shapes.

Where prism ends are not parallel or where a dimension is not uniform along a shape estimate an average for the dimension and use the average in the calculations. In Figure 3 the height of the left shape is the average of the four corner heights. The top length of the right shape is the average of the two edge lengths.

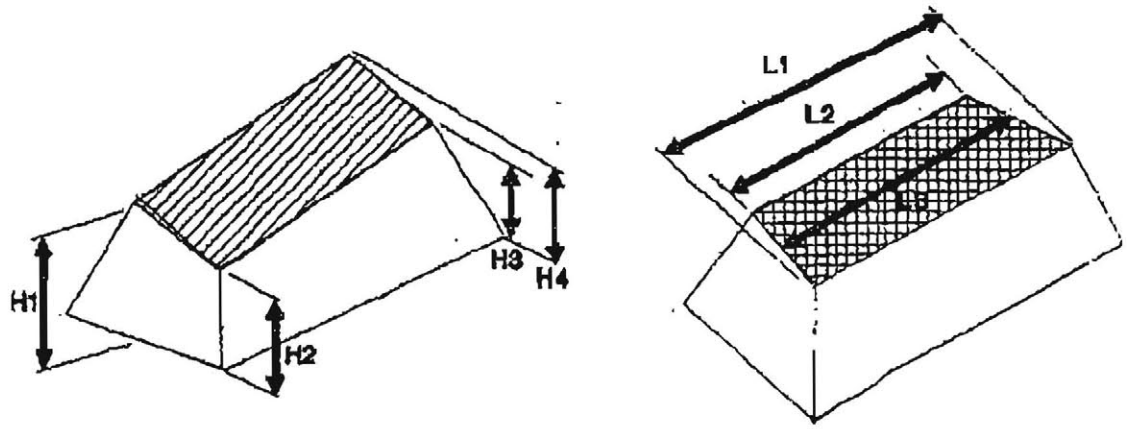



Figure 3. Averaging unequal sides.

Manure piles usually do not have straight geometric sides. Although imaginary uniform shapes can be broken out of the total shape there is always some odd shape left over. In these cases it becomes necessary to imagine moving manure around to form a measurable shape. Then estimate the dimensions of the imaginary shape for use in the calculations. Of course, the estimate of volume becomes less accurate as more imagination is required.

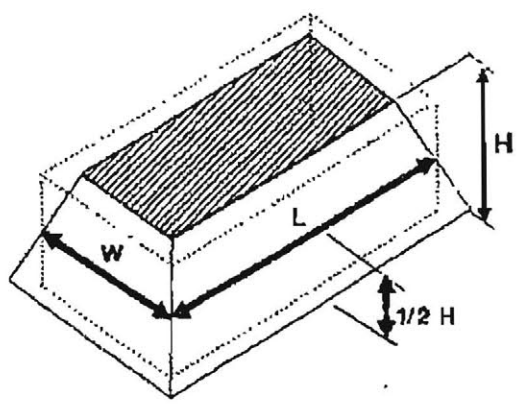



Figure 4. Making a pile into a box.

A pile can be turned into a box by imagining the sides vertical. Do this by placing a flag at a point one half the height of the pile at each corner. The distance measured between the flags represents the length and width of the box. Develop an average width or length if the opposite sides are not of similar dimension. Measure an average height using the actual height of the pile. The imaginary box is now the average of the width by the average of the length by the average of the height as shown in Figure 4. A similar approach can be used with nearly circular piles to form a cylinder. This method provides a good estimation that is usually slightly less than the amount actually in the pile.

## Ponds and basins

Ponds and in-ground manure basins can be considered as inverted piles (Figure 5) and volume can be computed using the same estimating procedures as used for piles. Some in-ground manure storage basins are too complex to be readily broken into simple shapes and alternative methods for estimating volume may be necessary.

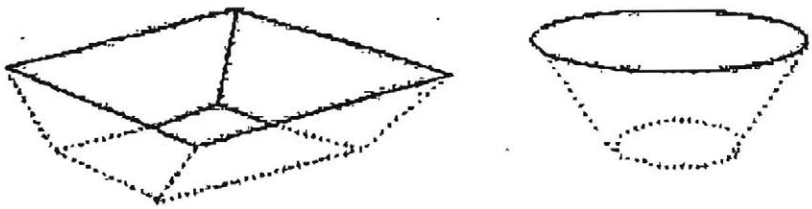


Figure 5. Basins are inverted piles.

Volumes may have been computed during the design of the basin and, assuming construction closely followed the design, reviewing the design data may provide a good estimate of volume.

Volume can also be estimated by measuring the amount of manure removed from the basin. Simply count the number of loads removed and measure the amount in an average load. With highly liquid waste the storage basin can be calibrated by measuring the number of loads removed between different depths. A pole marked as a depth gauge can then be erected within the basin and used to indicate the volume of storage or number of spreader loads available at any level.

## Converting volume to field application units

Manure application to cropland is usually specified as so many gallons or tons per acre. Yet, the volume computed for the basin, pile or spreader is usually in units of cubic feet and sometimes as gallons. This situation requires further computation to convert the units of estimated volume into units of application.

Converting volume to gallons can be accomplished using the relations given in Table 1. For example, if we estimated the volume of a manure basin at 5,000 cubic feet then the conversion to gallons would be: 5,000 x 7.5 = 37,500 gallons (cubic feet multiplied by 7.5 equals gallons from Table 1).

Converting manure volume to weight requires additional measurement and computation to determine the weight of manure in a unit of volume (bulk density). The conversion of total volume to total weight is then computed by multiplying the volume by the bulk density. For example, if the average bulk density of the manure was 50 pounds per cubic foot of volume then the total weight of 5,000 cubic feet of manure volume would be: 5,000 x 50 = 250,000 pounds or 125 tons.

## Determining bulk density

Bulk density is determined simply by multiplying a unit volume of the manure and dividing the weight by the volume. Although any volume can be used, a 5-gallon plastic bucket is very convenient. From Table 1, a 5-gallon bucket contains 0.667 cubic feet (5 gallons/7.5 = 0.667).

As an example, if a 5-gallon bucket weighed 1 pound when empty and 30 pounds when filled with manure then the weight of the manure would be 30 - 1 = 29 pounds. The bulk density would be the manure weight divided by the bucket volume or 29 pounds/0.667 cubic feet = 43.5 pounds/cubic foot.

The bulk density of manure depends on how much water, solids and air it contains. A volume of wet manure pack weighs considerably more than an equal volume of dry manure. In preparing a volume of manure for weighing to determining bulk density it is important to fill all the space in the bucket and to pack the manure to the same degree as exists in the pile, basin or spreader that is being measured.

The density of manure stored in a pile or basin may not be uniform throughout. Some areas may contain more bedding or more water than others. Bulk density should be determined from areas that best represent the majority of the manure. The average of several bulk density measurements from different areas is recommended.

## Summary

Determining the amount of manure available for land application is an important part of manure nutrient management. Estimating the volume of a pile or basin of manure requires imaginative manipulation of lines and complex shapes to develop shapes adaptable to simplified equations. Manure applications specified by weight require a further estimation of manure bulk density. Bulk density is the weight per unit volume of the manure as it exists in the storage pile or basin. Bulk density can be estimated by weighing a know volume of the manure.

## Appendix A. Formulas for Volume Computation

A = area  V = volume

$A = W \times H \div 2$
$V = A \times L$

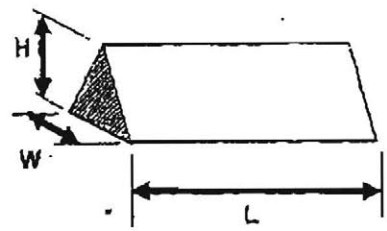



Figure a. Triangular prism.

$A = H \times (Wt + Wb) \div 2$
$V = A \times L$

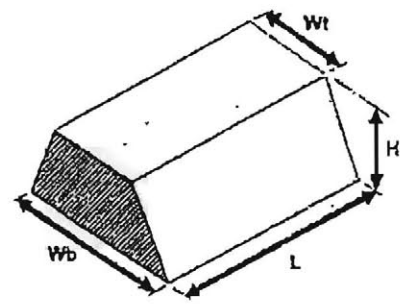



Figure b. Trapezoid prism.

$A = 0.785 \times D \times D$
$V = A \times L$

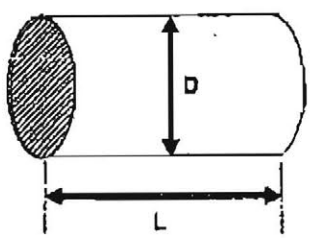



Figure c. Circular prism.

$A = 0.7 \times H \times W$ (approximate)
$V = A \times L$

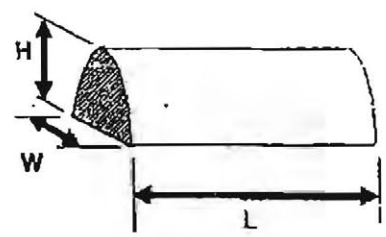



Figure d. Circular segment prism.

$A = W \times L$
$V = A \times H \div 3$

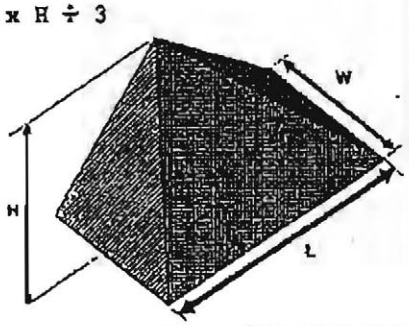
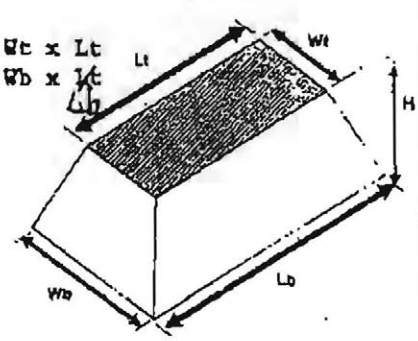



Figure e. Pyramid.

$At = Wt \times Lt$
$Ab = Wb \times Lb$




$V = H \times (Ab + At + \sqrt{Ab \times At}) \div 3$

Figure f. Frustum of pyramid.

## Appendix A (cont.). Formulas for Volume Computation

A = area  V = volume

$A = B \times W \div 2$
$V = A \times H \div 3$

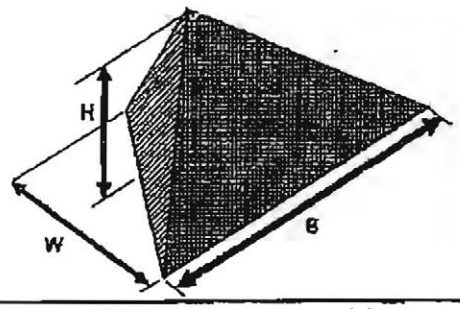
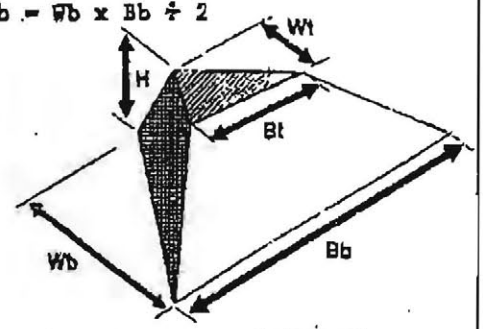



Figure g. Triangular pyramid

$At = Wt \times Bt \div 2$
$Ab = Wb \times Bb \div 2$




$V = H \times (Ab + At + \sqrt{Ab \times At}) \div 3$

Figure h. Frustum triangle pyramid

$A = 0.785 \times D \times D$
$V = A \times H \div 3$

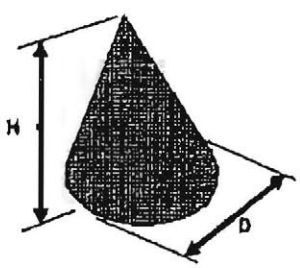
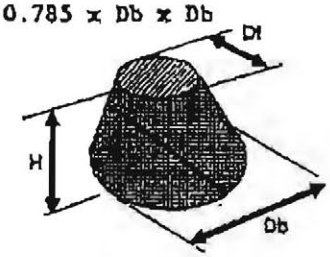



Figure i. Cone.

$At = 0.785 \times Dt \times Dt$
$Ab = 0.785 \times Db \times Db$




$V = H \times (Ab + At + \sqrt{At \times Ab}) \div 3$

Figure j. Frustum of a cone.

$V = 0.524 \times D \times D \times D$

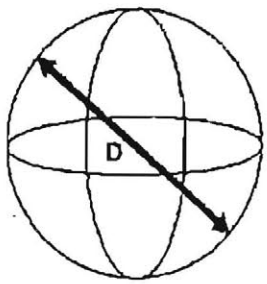
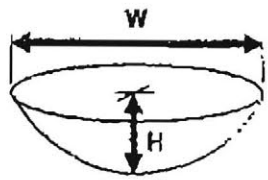



Figure k. Sphere.

$P = 3 \times W \times W$  $Q = 4 \times H \times H$




$V = 0.131 \times H \times (P + Q)$

Figure l. Spherical segment.

- **Poultry Waste Production and Storage Calculation Worksheet**

# POULTRY WASTE PRODUCTION AND STORAGE CALCULATION WORKSHEET

## INSTRUCTIONS HOW TO USE THE WORKSHEET

This worksheet will provide quantities for total litter production, litter and cake removed per year, total cleanout, storage size, and total annual manure generated. Use the nutrient and waste management plans to determine storage needs based on frequency of field application. Auxiliary storage beyond the roofed structure may be necessary for the portion of the total cleanout in excess of roofed storage capacity.

These calculations are based on Bud Malone's January 1994 recommendations. All storage facilities should be designed for broilers even if the grower is presently raising roasters or cornish hens.

The minimum length calculated is based upon NRCS standard drawing MD-84-02, "Roofed Animal Structure", revised 6/87.

The number of cakeouts to be used shall be obtained from the following table:

**Number of Cakeouts**

| Days of Storage | Cakeouts |
|---|---|
| Up to 90 | 2 |
| Up to 120 | 3 |
| Up to 150 | 3 |
| Up to 180 | 4 |
| Up to 210 | 4 |
| Up to 240 | 5 |
| Up to 270 | 5 |
| Up to 300 | 6 |
| Up to 330 | 6 |
| Up to 360 | 7 |

Source: U.S.D.A. Natural Resources Conservation Service
Maryland State Office

## INPUT DATA

1. Number of birds, N = _____
2. Number of days per flock, DA = _____
3. Number of flocks per year, FL = _____
4. Brood chamber size as percent of house, PC = _____
5. Years between total cleanouts, YR = _____
6. Required days storage period, ST = _____
7. Number of brood chamber cleanouts, BR = _____
8. Number of cakeouts, NC = _____

## TOTAL LITTER PRODUCTION

TP = 0.00002 N [ {FL x DA x YR} + { (YR - 1) x PC} + 100 ]
TP = 0.00002 _____ [ {____ x ____ x ____} + { (____ - 1) x ____} + 100 ]
TP = _____ tons/cycle

## LITTER AND CAKE REMOVED PER YEAR

Brood, B = TP x 0.29 / YR
B = _____ x 0.29 / _____
B = _____ tons / yr

Cake, C = N x FL x 0.0004
C = _____ x _____ x 0.0004
C = _____ tons / yr

## TOTAL CLEANOUT

TC = [TP - {B (YR - 1) } - {C x YR} ] / 0.018
TC = [_____ - {_____ (_____ - 1) } - {_____ x _____} ] / 0.018
TC = _____ $ft^3$

## STORAGE SIZE

Storage = ( [ NC x C / FL ] / 0.0165 ) + ( B x BR / 0.015 )
Storage = ( [ _____ x _____ / _____ ] / 0.0165 ) + ( _____ x _____ / 0.015 )
Storage = _____ $ft^3$
Min. Length of Std. Roofed Structure = _____ / 200 ft3 / ft = _____ ft
Storage

## AUXILIARY STORAGE VOLUME

Auxiliary = Total Cleanout - storage
Auxiliary = _____ - _____ = _____ $ft^3$

## TOTAL ANNUAL MANURE GENERATED

Total Amount = ( C / 0.0165 ) + ( B / 0.015 ) + TC / YR
Total Amount = ( _____ / 0.0165 ) + ( _____ / 0.015 ) + ( _____ / _____ )
Total Amount = _____ $ft^3$

# Converting Nutrient Content of Wastes from Dry-weight Basis to Wet Basis

Department of Environmental Science
and Technology .

Agricultural Nutrient Management Program

**Converting Nutrient Content of Wastes From a Dry-weight Basis to an As-received (or Wet) Basis**

Type of Material _____

Record from lab report:

1) solids (%) _____

2) nitrogen (total, % N) _____

3) ammonium nitrogen (% $NH_4$-N) _____

4) phosphorus (% P) _____

5) potassium (% K) _____

Calculate nutrients as percent N, $P_2O_5$ and $K_2O$ to an as-received basis:

6) Convert % nitrogen (% N) from a dry-weight basis to an as-received basis.
   a. multiply #2 by #1 and divide by 100 _____

7) Convert % ammonium nitrogen (% $NH_4$-N) from a dry-weight basis to an as-received basis.
   a. multiply #3 by #1 and divide by 100 _____

8) Convert % phosphorus (% P) from a dry-weight basis to an as-received basis.
   a. multiply #4 by #1 and divide by 100 _____

9) Convert % phosphorus (% P) as-received basis to % phosphate (% $P_2O_5$) as-received basis.
   a. multiply #8 by 2.29 _____

10) Convert potassium (% K) from a dry-weight basis to an as-received basis.
   a. multiply #5 by #1 and divide by 100 _____

11) Convert potassium (% K) as-received basis to potash (% $K_2O$) as-received basis.
   a. multiply #10 by 1.2 _____

Include this worksheet in nutrient management plan.

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# Biosolids/Sludge Management

- **Sewage Sludge Utilization in Maryland**

# Facts About ...
# Solid Waste Management

MDE

Maryland Department of the Environment

## Sewage Sludge Utilization in Maryland

Utilization of sewage sludge in agriculture is beneficial to all Marylanders. Sewage sludge customers get an economical disposal plan. Farmers get a free source of nutrients that increase soil fertility. Maryland gets a cleaner environment by constructively reusing something that is traditionally thought of as waste.

**WHAT IS SEWAGE SLUDGE?**
Sewage sludge (also known as biosolids) is not sewage. It is one of the final products of the treatment of sewage at a sewage (wastewater) treatment plant. After treatment breaks down the organic matter and kills disease-causing organisms, the remaining fine particles ultimately become sludge. Although much of the water has been removed, sewage sludge for farmland application is still mostly water and resembles mud.

**HOW MUCH SEWAGE SLUDGE IS PRODUCED IN MARYLAND?**
Each year more than 700,000 wet tons of sewage sludge is generated in Maryland. As restoration of the Chesapeake Bay continues, fewer nutrients are being released to surface waters from sewage treatment plants, and the amount of sewage sludge generated continues to increase.

**HOW IS SEWAGE SLUDGE USED?**
There are five major ways that sewage sludge is used in Maryland. An estimated 50 percent of the sewage sludge produced in the State is applied to agricultural land, 18 percent is composted or pelletized and made into a commercial soil supplement, and 21 percent is used for land reclamation such as restoring surface mines. The remaining 11 percent is disposed in landfills or incinerated.

**WHY APPLY SEWAGE SLUDGE ON FARMLAND?**
By applying sewage sludge on farmland we are recycling nutrients, saving landfill space and money, and helping to reduce nutrient pollution to the Chesapeake Bay. Sewage sludge, freely available to farmers, is an excellent fertilizer because it contains nutrients such as magnesium, zinc, copper, iron, calcium, and sulfur that are beneficial to crops.

**WHAT IS THE ROLE OF STATE GOVERNMENT?**
The Maryland Department of the Environment (MDE) is the primary agency regulating the utilization of sewage sludge. A sewage sludge contractor files an application with MDE for a Sewage Sludge Utilization Permit that contains the results of soil and sewage sludge tests and other information used to ensure that all regulatory requirements are met. The site is also inspected to be sure that the application is correct. If everything is satisfactory, the contractor is permitted to apply the sewage sludge. MDE inspects the farm during and after sewage sludge application. To support the administration of the sewage sludge program, sewage treatment plants are charged fees based on the amount of sewage sludge they produce and how it is used.

**WHAT IS THE ROLE OF LOCAL GOVERNMENTS?**
County governments, who receive copies of every permit application, can review and comment on each application, request a public meeting, participate in site assessment visits, inspect and monitor each site in their county, and have the right to enforce the permit requirements.

## WHAT IS THE ROLE OF THE PUBLIC?

Residents near proposed sewage sludge application sites or facilities can attend public informational meetings or hearings that are scheduled upon request from the local county government after a permit application is received. This is an opportunity to learn about the proposed projects and address any issues that residents may have about these projects. Should any problems develop during a permitted operation, the county or State should be notified to investigate.

## SEWAGE SLUDGE STATISTICS

Although MDE has issued more than 4900 sewage sludge permits since 1974, there have been no documented cases of ill health effects or water pollution from sewage sludge use on farms in Maryland. About 60,000 acres on more than 500 farms throughout Maryland are currently permitted to receive sewage sludge. In Maryland, sewage sludge is recycled more than any other material, both in terms of quantity (over 440,000 tons per year) and rate (about 88%).

## HOW CAN YOU BE SURE SEWAGE SLUDGE APPLICATION IS SAFE?

MDE has set up the following requirements to ensure that use of sewage sludge on land is safe for both humans and the environment:

- **Pathogen Control** - Regulations require that sewage sludge be treated to reduce disease-causing organisms to safe levels.
- **Heavy Metals** - Regulations set maximum allowable concentrations in sewage sludge and maximum amount that can be applied to land.
- **Pretreatment** - Industrial waste is treated to remove contaminants before being released to the sewer system.
- **Buffer Zones** - setbacks from 10 to 400 feet from various site features may be required.
- **Slope Requirements** - Sewage sludge may not be applied on slopes greater than 15% unless otherwise approved by MDE.
- **Application Rates** - Application rates are calculated to ensure that crops use all sewage sludge nitrogen without excess runoff or leaching to the groundwater.
- **Frozen Ground Restrictions** - Slopes must be less than 6%, buffers are increased, soils must have good drainage, and vegetative cover must be present.
- **Nutrient Management Plans** - These required plans show the amount and kind of nutrients needed on each field of a farm and set a nutrient budget to ensure no excess nutrients are applied. This protects water quality by minimizing runoff.
- **Time Restrictions** - No grazing by animals for 30 days, controlled public access for 12 months, no crops to be eaten raw by people for 3 years.
- **Monitoring Records** - Sewage sludge analyses are submitted to MDE from treatment plants, a recent sewage sludge analysis is required for each permit application, and records from applicators, site inspections, and treatment plants are reviewed.
- **Site Inspection** - Site inspections are held during permit review by MDE and County Health staff, during sewage sludge operation, and after completion the application of sewage sludge.

## NEED MORE INFORMATION?

Please contact the Maryland Department of the Environment's Sewage Sludge Utilization Section at (410) 537-3375 with questions regarding sewage sludge utilization in Maryland.

MARYLAND DEPARTMENT OF THE ENVIRONMENT χ WASTE MANAGEMENT ADMINISTRATION
Sewage Sludge Utilization Section
1800 Washington Boulevard • Suite 605 • Baltimore, Maryland 21230-1719
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*Together We Can Cleanup*

www.mde.state.md.us

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01/15/03

# What You Should Know About Sewage Sludge

This pamphlet is designed to give essential information about sewage sludge to farmers and landowners who intend to have sludge applied to their land, or are considering the use of sludge on their land. It also gives basic information for members of the public who are concerned about the use of sludge on agricultural land. It includes answers to frequently asked questions about sludge, explains how it is applied and regulated, gives practical advice on its use, and lays out the rights and responsibilities of farmers and landowners in regard to sludge use on their land.

## WHAT IS SEWAGE SLUDGE?

Sewage sludge is not sewage. It is one of the final products of the treatment of sewage at a sewage treatment plant. More than 99% of sewage consists of water. The basic function of a treatment plant is to separate suspended or dissolved solids from the water and to treat both the water and the removed solids. The treated water, called *effluent*, is usually discharged to an adjacent body of water such as a river or the Chesapeake Bay. The removed solids fall into two categories. Relatively large or heavy objects, such as sand, gravel, or sticks are removed during some of the earliest treatment processes, and are called *grit and screenings*. Grit and screenings are disposed of at a landfill, usually without further treatment. The other removed solids consist of fine particles. These particles ultimately become *sewage sludge*.

Sewage sludge undergoes biological treatment which breaks down biodegradable substances such as food particles or paper into more basic compounds consisting of even smaller, soil-sized particles. Before sludge may be applied to land, it must be treated to kill disease-causing organisms (pathogens). Usually it is further treated to remove more water (dewatering). Sludges which have not been dewatered usually have a solids content of 1% to 5%. They resemble gray water. After dewatering, most sludges have a solids content of 15% to 35%. Sludges in this moisture range closely resemble mud. Most of the solids consist of decomposed organic matter.

## WHY USE SLUDGE ON LAND?

Applying sludge on land returns essential nutrients to the soil, adds organic matter, and can improve the tilth and moisture retention capability of the soil. Sludge provides most of the nutrients needed for healthy plant growth. Most sludges are deficient in only one macronutrient—potassium—and one micronutrient—manganese. The nitrogen content of sludges ranges from about 2% to 7% as measured on a dry weight basis. Phosphorus is present in similar concentrations. Trace metal micronutrients such as copper, zinc, molybdenum, boron, and iron are present in concentrations sufficient to support plant growth. Use of sludge on farmland can drastically reduce fertilizer costs. In many cases, no additional fertilizer is required. Many sludges also contain a significant percentage of lime which has been added at the treatment plant to help kill pathogens and control odors. The lime in such sludges can serve as a useful soil conditioner.

From a larger perspective, properly managed application of sludge on land is an ecologically sound recycling program which returns nutrients and organic matter to the soil in much the same way as nature accomplishes this. In regard to costs to taxpayers, it is much cheaper to apply sludge on land than to incinerate it or bury it in a landfill. Recycling the nutrients in sludge by applying it to land is as safe as incinerating or landfilling it. Furthermore, recycling sludge saves scarce landfill space.

## WHY IS IT REGULATED?

Sewage sludge is a regulated material because of public concern about its use. These concerns have focused on the following issues:

### Metal content

Sludge contains a wide variety of metals in various concentrations. Some of these (known as micronutrients) are essential for plant growth. Other metals, such as lead and cadmium, may be harmful to crops or to humans if they are present in water-soluble form at high enough concentrations. Even some micronutrients may harm crop growth if they are present in excessive concentrations, and if soil conditions promote their uptake by plants.

Twenty years ago, metal concentrations in sludges were much higher than now. Since then, a nationwide program to pre-treat industrial wastes prior to discharge into sewer lines has greatly reduced the metal content of sludges. Most of the metals in sludges today are probably coming from leaching of metals contained in plumbing into slightly acidic tap water.

Much research has been devoted to the effects of metals in sludge. Recent findings by the U.S. Department of Agriculture indicate that if the metal concentrations in a sludge are low enough to meet regulatory standards, such as Maryland's Class I standards for use on agricultural land, sludge may be applied for an unlimited number of years on the same parcel of land with no adverse effects to crops, soil, water, animals, or humans.

It should be noted that metals are natural elements found everywhere in living organisms and the environment, including soil. The presence of metals in the environment is not necessarily the result of pollution. The proper issue for consideration is therefore not whether sludge contains metals, but whether their concentrations are high enough to cause adverse effects.

### Pathogens

Pathogens are disease-causing organisms. They include bacteria, viruses, parasites, and fungi. Since sewage sludge is derived from sewage, the public is understandably concerned about the potential for disease transmission from sewage sludge to humans. Maryland regulations require that all sludges applied to land must first be treated by a Process to Significantly Reduce Pathogens (PSRP).

The PSRP treatment occurs at the sewage treatment plant, and is usually accomplished by digestion (sludge is held in a digester for a specified number of days under controlled conditions) or lime stabilization (sufficient lime is added to the sludge to raise the pH to a minimum of 12.0 for two hours). PSRP treatment kills 90% to 99% of all pathogens in the sludge. Maryland regulations impose additional controls on the use of sludge to reduce the risk of pathogen transmission to near zero.

The risk of becoming ill from using sludge on land is very low. A study conducted in the state of Ohio showed no difference in illness rates when comparing families and livestock living on sludge-applied farms with farm families and livestock having no contact with sludge. Many diseases, such as AIDS, cannot be transmitted through sewage sludge. There have been no confirmed cases of disease transmission of any kind to humans through land application of properly treated sewage sludge. After treatment, sludges are actually at least as safe to handle as animal manures.

### Toxic organic compounds

These are carbon-based chemical compounds which could harm humans, animals, or crops if exposed to them at sufficient concentrations over a given period of time. They include industrial chemicals such as PCB's, agricultural chemicals such as pesticides, and naturally formed chemicals such as alcohols. Concerns have been raised by some about the possible presence of these compounds in sludge.

Maryland regulations limit the concentration of PCB's in sludge which may be applied to agricultural land. PCB's are persistent compounds which are widespread in the environment at trace concentrations. Similar concentrations (less than 1 part per million) are found in sludge. To our knowledge, no adverse effects to crops, animals, or humans have been linked to these compounds through the use of sewage sludge.

The industrial pre-treatment program mentioned earlier limits the discharge of these compounds into sewer lines. Many of them are further reduced by evaporation and biological degradation during sewage treatment. The U.S. Environmental Protection Agency issued new regulations on sewage sludge in 1993. These regulations are based on extensive nationwide sampling of sewage sludges and comprehensive risk analyses. Several toxic organic compounds were evaluated by EPA during this process, and were found not to be present in sludge in concentrations which could cause harm, even over protracted periods of time.

### Odors

All sludge has an odor, which many people find objectionable. Sludge odors are similar to odors from manure. The strength of the odor varies with the kind of treatment used, the length of time the sludge may be held in storage before transportation to the farm, and other factors. Sludge odors may be controlled, but not entirely eliminated, on farms by injecting the sludge beneath the soil surface, by rapidly incorporating it into the soil if it is surface spread, or by application of lime.

Odors may "rebound" for a time following subsequent rainfall, but at diminishing intensity. Odors may persist for two days to a week following application. This is normal. However, the strongest odor is experienced during application. Odor is very subjective, but most sludge odors do not seem as intense as many commonly used manures.

### Water pollution

If sludge is overapplied, it could cause water pollution. The same is true of manure and commercial fertilizer. The only constituents of sludge which are readily soluble in water are nitrogenous compounds such as nitrate and ammonia. Therefore,

these are the substances most likely to cause water pollution if sludge is overapplied.

MDE sets application rates for sludge based on the nitrogen content of the sludge to be used, the nitrogen uptake of the crop to be planted, and the expected crop yield. This is designed to ensure that excessive nitrogen compounds are not available to leach into groundwater, provided that other nitrogen sources are not applied in addition to the sludge. The use of nutrient management plans further refines these calculations by taking into account residual nitrogen in the soil prior to sludge application. A nutrient management plan is required for any agricultural site utilizing sewage sludge in Maryland, and the plan must be prepared by a nutrient management consultant certified by the Maryland Department of Agriculture.

## HOW IS SLUDGE USE REGULATED?

In Maryland, sludge use is regulated through permits issued by MDE. These permits are usually issued to contractors or municipalities who apply the sludge, rather than to individual landowners. The permit designates specific areas where sludge may be applied, sets application rates for different crops and sources of sludge, and establishes restrictions on how the sludge may be applied and on how the land may be used for a period of time following sludge application. Application rates are calculated in a nutrient management plan based on the nitrogen content of the sludge to be used, the nitrogen uptake of the crop to be grown, the expected crop yield, and residual nitrogen in the soil prior to sludge application. A new nutrient management plan is required if sewage sludge or manure has been applied to the site, or one year has passed since the previous plan was prepared.

Maryland law provides that these permits may be issued for a term of up to five years. A new permit may be issued at any time, provided that all legal and regulatory requirements have been satisfied.

Permits are not issued for use on agricultural land if the sludge does not meet Maryland's Class I standards. These standards are:

| Constituent | Concentration (parts per million) |
|---|---|
| Cadmium | 25 or less |
| Copper | 1,000 |
| Mercury | 10 |
| Nickel | 200 |
| Lead | 1,000 |
| Zinc | 2,500 |
| PCB's | 10 |

The only exceptions to the above are for copper and zinc. Sludges with copper concentrations up to 2,000 ppm or zinc concentrations up to 4,000 ppm may be permitted for use on agricultural land provided that certain additional safeguards have been satisfied. The Class I standards may be changed in the near future to match the 1993 EPA standards for sludge.

The sludge must be sampled by the applicant for the permit to verify that it meets Class I standards and to document its nutrient content. In addition, treatment plants which generate sludge are required to sample it on a regular basis. The samples are analyzed by state labs or by certified independent labs, and the results are sent to MDE.

The permit establishes buffer zones, or setbacks, to the following features:

| Buffer Zones | Surface Application (feet) | Subsurface Injection (feet) |
|---|---|---|
| Occupied off-site dwellings | 200 | 100 |
| Occupied on-site dwellings | 100 | 50 |
| Potable wells | 100 | 100 |
| Non-potable wells | 25 | 25 |
| Public roads | 25 | 15 |

| Buffer Zones *(continued)* | Surface Application (feet) | Subsurface Injection (feet) |
|---|---|---|
| Property lines (unless waived by adjacent landowner) | 50 | 25 |
| Bedrock outcrops | 50 | 25 |
| Streams or other water bodies | 50 | 25 |
| Drainage ditches | 15 | 10 |
| Tidal water or tidal marshes | 100 | 100 |
| Groundwater (vertical from surface) | 2 | 2 |
| Bedrock | 2 | 2 |

The permit also limits the steepness of slopes to which sludge may be applied, and restricts application on certain designated poorly drained soil types from November 1 to March 15.

MDE keeps records on the amount of sludge applied to each parcel of permitted land. Based on these records, the cumulative amounts of the metals shown in the Class I standards can be calculated for each parcel of land. Maryland regulations establish maximum cumulative metal loading rates for each of the Class I metals. MDE will not issue a permit to apply additional sludge to a parcel of land if the additional application would cause one of the cumulative metal loading rates to exceed the regulatory standard. Most Maryland sludges could be applied at agricultural rates to the same land parcel for 20 to 40 years before the cumulative metal loading limits would be met.

The permits also impose certain temporary land use restrictions after sludge has been applied. These include a one month restriction on grazing livestock on sludged land, a requirement to control public access to sludged land for one year, and a three year restriction on growing crops to be eaten raw by humans. These are pathogen control measures. Tobacco may not be grown on sludged land during the life of the permit.

Before a permit holder (permittee) may apply the sludge, he must first mark off the required buffer zones, restricted slopes, restricted soil types, areas of high groundwater or shallow bedrock, etc. in the field where sludge is to be applied. This is done with stakes or small wire-mounted flags, such as surveyors use.

An MDE inspector may visit the site unannounced at any time during the life of the permit to verify that sludge is applied in accordance with the permit conditions, that permitted application rates are not exceeded, that the intended crop is grown, and that prohibited crops are not grown. MDE performs over 500 sludge site inspections to verify compliance each year.

The permits also require that initial soil pH be raised to 6.0 at the time of sludge application and be maintained at a minimum of 6.0 during the life of the permit. This is a good agronomic practice. Another intent of this requirement was to provide an added safety margin against the possibility of metals leaching into groundwater or being taken up by crops. More recent research indicates that the organic matter in sludge acts to bind the metals in insoluble form. The metals in sludge will not pose a problem to groundwater or crops at any soil pH which may reasonably be found on agricultural land, provided that the sludge meets quality standards such as Maryland's Class I standards.

## HOW IS SLUDGE APPLIED?

Liquid sludge is hauled to farms in fully enclosed tank trucks. Sludges with a solids content of 15% to 35% (this is the majority) are usually hauled in dump trailer trucks with partially enclosed tops. Liquid sludge (0-15% solids content) may be sprayed on top of an existing small grain crop, hay crop, or pasture; it may be sprayed on top of bare soil followed by same-day incorporation into the soil by disc or plow; it may be sprayed on top of soil without incorporation followed by planting, provided a no-till plan is in place and MDE determines that site features are sufficient to prevent runoff; or it may be subsurface injected beneath the soil. Spraying is usually accomplished by applicator vehicles equipped with splash plates or nozzles. Subsurface injection is accomplished with specialized vehicles designed for this purpose. These vehicles have a tank which holds the sludge, and hoses which connect the tank to hollow shanks equipped with nozzles. The shanks are lowered into the soil and the sludge is injected into the soil through the nozzles as the vehicle moves through the field. With this method, sludge may be placed at depths ranging from about 6 inches to 12 inches beneath the soil surface. Subsurface injection vehicles are equipped with large, high flotation tires to lessen soil compaction.

Sludges in the 15-35% solids content range are usually applied with manure spreaders. The sludge is most often dumped in an unloading zone on one of the fields, where it is transferred to the manure spreader by means of a front-end loader. After spreading, the sludge is usually plowed or disced into the soil by the end of the work day. In some cases, no incorporation is required. No matter what the application method, the permit requires that the sludge be evenly distributed over the field.

## FREQUENTLY ASKED QUESTIONS ABOUT SLUDGE

***Couldn't some unknown constituent or property of sewage sludge cause harmful health or environmental effects at some time in the distant future?***

This is theoretically true of any substance in common use on the farm or in households, such as commercial fertilizer, aspirin, or coffee. It is impossible to prove that everything is known about any substance. However, the longer a product has been in use, the less likely that "surprise" effects will be seen in the future. In this regard, it is important to understand that the agricultural use of sewage sludge is not experimental or new. Sludge has been applied to farmland as long as treatment plants have existed, and long before this practice was regulated. Extensive research has been conducted on the agricultural use of sludge over many years. It is therefore extremely unlikely that any "surprise" effects will be seen in the future.

***Who hauls sludge, and who applies it?***

Hauling and land application of sludge are usually done by the municipality or sanitary district that generates the sludge, or by a contractor hired by the generator. Sludge contractors are usually professional companies specializing in the land application of sludge. Often a contractor will pay an independent trucking company to haul the sludge as a subcontractor. In such cases, the hauler does not do the spreading; it is done by the contractor. Sometimes a contractor will employ a local farmer to do the sludge spreading.

***What is the relationship between the sludge generator and the contractor?***

The sludge generator (usually a municipality or sanitary district, but sometimes a private company or individual) is the owner of the treatment plant that produces the sludge. The generator may sign a contract with a company (the contractor) to remove sludge from the treatment plant. The contractor is paid on the basis of the number of tons removed. In return, the contractor pays the costs of transportation, locates landowners who agree to have sludge applied to their property, obtains permits from MDE to use sludge on the property, performs the sludge spreading, submits reports to MDE, and monitors the soil pH of spread fields during the life of the permit.

***Who is liable if something goes wrong?***

If environmental damage occurs as a result of a violation of the permit or regulations, MDE will hold the permittee responsible. In almost every case, the permittee is the generator or contractor. In the event of a private lawsuit seeking compensation for alleged damages, the courts would have to decide based on the merits of the case. MDE may issue a penalty to the permittee for a violation, or may issue an order requiring corrective action.

***What kind of restrictions will be placed on my land if sludge is applied to it?***

The restrictions and the reasons for them are:

**Crops to be eaten raw** by humans must not be grown for three years following sludge application. This is a measure to prevent the possibility of pathogen transmission to humans. Crops that may come into direct contact with the sludge, such as carrots, radishes, and tomatoes, should not be eaten raw during this time. MDE may waive this requirement if the edible portion of the crop (such as sweet corn) does not come into direct contact with sludge. The great majority of pathogens in sludge are killed during treatment at the treatment plant. Most of the remaining pathogens quickly die when exposed to sunlight, air, and the soil environment. However, a few pathogens may survive for longer periods of time.

**Tobacco** must not be grown on sludged land during the life of the permit. This was intended to prevent excessive cadmium uptake by the tobacco plant. More recent research indicates that the other regulatory controls in place are probably sufficient to accomplish this.

**Public access** to sludged land must be controlled for one year following sludge application. This is a pathogen control measure. To control access is not the same as prohibiting it. Most activities, such as walking across the land, riding horseback over it, or hunting on it are completely safe. This restriction is intended to prevent unsupervised children from eating soil mixed with sludge, or walking across recently sludged land with bare feet which may have open cuts. In such cases, there is a very slight chance of pathogen transmission. Controlling public access may be achieved in most cases by

the customary practices farmers use to prevent trespassing. If your land is next to a public gathering place, such as a school or park, MDE may require that signs be posted around the perimeter of the sludged fields for one year.

Semiannual soil samples for pH must be taken from the sludged fields by the permittee during the life of the permit. The reason for this is pH control. (See Section IV, last paragraph.)

Major excavations, such as for building foundations or roads, should not be initiated on sludged land for one year following application. This is a pathogen control measure.

Livestock must not be grazed on sludged land for one month following application. This is a pathogen control measure.

***Can AIDS be transmitted through sludge?***

No.

***Can humans or animals become infected by eating crops grown on sludged land?***

No, not unless they eat sludge attached to the edible portion of the crop. Even then, infection is unlikely. Plants cannot become infected with human diseases, and animals cannot become infected with plant diseases. In experiments, cattle fed on freshly sludge-coated pasture land showed no increase in infectious diseases.

***Can humans become infected by smelling odors from sludge?***

No. Diseases are not transmittable through odors.

***Will canners buy vegetables grown on sludged land?***

Some will not, and some will provided that 18 months have elapsed since sludge application. These are business decisions on the part of canners, and do not necessarily reflect health policy. If you plan to grow vegetables to be sold to canners, check with the canners to find out what their policy is.

***Won't sludge run off land where it has been spread and pollute nearby bodies of water?***

Sludge will not easily run off land. Most land-applied sludges are in a solid or semi-solid form which resists runoff. Researchers have found that liquid sludge sprayed on top of pasture grasses or small grain crops will dry very quickly and cling to the vegetation and soil surface. Once dried, it cannot be washed off by frequent heavy rainfall, or even by washing the pasture grasses with detergent. A study comparing runoff rates of water-soluble nutrients in sludge, poultry manure, dairy manure, and commercial fertilizer found that the nutrients in sludge were the least likely to run off. Chances of runoff are further reduced by MDE's regulatory controls on how close sludge may be applied to bodies of water, wells, and other features. Further regulatory controls to prevent runoff include slope limitations, a daily limit on application of liquid sludges, prohibition of application in drainage swales, water channels, and gullies, and prohibition of application on saturated soils.

***Will land application of sludge pollute my well?***

No, not if the permit conditions are followed. There have been no known cases of polluted drinking water in Maryland from land application of sludge.

## ADVICE FOR FARMERS AND LANDOWNERS

Satisfy yourself that the permittee has the expertise needed to do a good job before you sign a contract with him.

Read the permit and NMP and become familiar with their conditions.

Establish a working relationship with the permittee. Take an active part in the application process.

Tell the permittee about problem areas on your land, such as soft spots where heavy equipment may become bogged down or cause rutting or excessive soil compaction. Tell the permittee to avoid these areas.

Don't be afraid to complain to the permittee if part of the work doesn't satisfy you. Remember that the contractor's livelihood depends on landowners and farmers like you.

Do not allow application during wet soil conditions. Wet conditions promote soil compaction even with flotation type tires. MDE inspectors will not allow application on saturated soils, but they cannot be present at all times.

Do not allow loaded vehicles where they can become stuck.

Reach an agreement with the permittee on where sludge trucks will be unloaded. These areas will be subject to greater compaction than others.

Observe what is going on and make your presence and interests known to the permittee.

Keep track of how much sludge and what kind of sludge is applied to each field, along with the dates of application. You can obtain records of wet tonnages applied from the permittee. Wet tonnage is the amount delivered "as is". You can convert this to dry tons by multiplying the wet tons figure by the percentage of solids (shown on the lab analysis) expressed as a decimal. For example, 1,000 wet tons times .20 (if the sludge is 20% solids) equals 200 dry tons. If this amount is spread over 20 acres, the application rate is 10 dry tons per acre. To calculate the pounds of nitrogen per acre, multiply the pounds of plant available nitrogen (PAN) per dry ton of sludge by the application rate expressed in terms of dry tons per acre.

Do not sign any blank forms to be filled in later by the permittee. Read everything before you sign it.

It may be a good idea to talk with your neighbors before sludge is applied to let them know what is going to happen. There may be many sludge trucks arriving within the space of a few days, and temporary odors are to be expected. However, the material is not dangerous, will not cause illness, and will not cause pollution if the permit conditions are followed. There is no greater risk of pollution from the use of sludge than there is from the use of manure or commercial fertilizer.

## RESPONSIBILITIES OF LANDOWNERS AND FARMERS

You must tell the permit holder (permittee) what crop you intend to grow following sludge application, in order that the proper application rate may be selected from the options listed in the permit.

You must plant the intended crop during the subsequent planting season.

You may have to plant a winter cover crop, particularly if the sludge application is included in a nutrient management plan.

You must comply with the land use restrictions shown in Section VI, Question 5.

You must allow the permittee to take semiannual soil pH samples following sludge application during the life of the permit. You must allow the permittee to adjust the soil pH if needed.

You must allow inspections of your fields by MDE or the county health department during the life of the permit. This includes the right to take samples and photographs.

You should notify prospective buyers of your land about the above restrictions and responsibilities so long as they are in effect.

You should not apply additional nitrogen or phosphorus sources to sludge-applied land during the same growing season, unless the permitted application rate has not been met. Sludge releases plant-available nitrogen slowly over the course of 3 to 4 years, so you should reduce nitrogen inputs accordingly during that time. Consult with your nutrient management consultant about this.

## RIGHTS OF LANDOWNERS AND FARMERS

You may withdraw your consent to apply sludge at any time. To do this, contact the permittee and call MDE at (410) 537-3375. If you follow up with a written notice to MDE, the permit will be canceled.

You may sign a contract with the permittee which gives you some control over the application. For instance, you may require that sludge not be applied without your consent each day, or that you be given frequent summaries of the amount of sludge applied, the kind applied, and the areas applied in each field. The contract may include a provision stating that the permittee takes full responsibility for physical damage to any land, roadways, equipment, animals, humans, or structures during application of sludge to your farm. The contract may outline a procedure for damage assessment and compensation.

You may demand a copy of the laboratory analysis of the sludge or sludges to be applied to your land. You may obtain this from the permittee, MDE, or your county health department.

If you believe that the permittee is not complying with the conditions of the permit, you may call MDE at (410) 537-3424 or (410) 537-3375. An inspector will visit.

**For more information:**

**Design and Certification Division**
**Maryland Department of the Environment**
**1800 Washington Boulevard, Suite 605**
**Baltimore, Maryland 21230-1719**
**(410) 537-3375**

# • Guidelines for Application of Digested Sewage Sludge and Composted Sewage Sludge to Agricultural Land

MARYLAND COOPERATIVE EXTENSION
UNIVERSITY OF MARYLAND
COLLEGE OF AGRICULTURE

Fact Sheet

Fact Sheet 336

# Guidelines for Application of Digested Sewage Sludge and Composted Sewage Sludge to Agricultural Land

## Introduction

In states such as Maryland that have a rapidly increasing population and a relatively small land area, the effects of a growing population are threatening water and air quality. This is especially true when rapidly urbanizing areas concentrate near streams and rivers, lakes, or coastlines of the Chesapeake Bay and the Atlantic Ocean. One effect of a growing population is the need to safely treat increasing volumes of wastewater and dispose of the semisolid sewage sludge the treatment produces.

The application of the best available technology to protect Maryland's environmental resources is a major commitment of the "Agreement for the Continued Restoration of the Chesapeake Bay," signed by the Governors of Maryland, Pennsylvania and Virginia and the Mayor of the District of Columbia. However, as more effective wastewater treatment processes are used, greater quantities of sludge will be generated and require disposal. Safe disposal of the massive amounts of sewage sludge produced in today's society presents a major problem in environmental management.

This fact sheet presents guidelines for the optimum agronomic utilization of wastewater sludge on agricultural lands. Guidelines for the use of sludge in the production of ornamental and floricultural crops, orchards, nurseries, and home gardens are available in a companion Fact Sheet.

## What Is Sludge?

Sludge is an inevitable byproduct of wastewater treatment that is produced in sewage treatment plants as organic material and nutrients (nitrogen and phosphorus) are removed from the wastewater before releasing the treated water back into the environment (streams or rivers). Sludge is a thick mixture of bacteria and other microorganisms, organic and inorganic material, nutrients and heavy solids that settles from wastewater during treatment.

Sludge has a physical and chemical composition that varies greatly depending on the industries and communities served by the sewage treatment system and by the type of treatment system. Sludge from systems that receive wastewater primarily from residential areas usually contains much lower levels of heavy metals than does sludge from areas where there are industrial users. However, sludge also contains several components potentially useful as soil additives. Maryland sewage sludge typically contains from less than 1 percent to more than 10 percent nitrogen (N) on a dry weight basis; 2 to 7 percent is common. Phosphate ($P_2O_5$) contents range from less than 1 percent to more than 14 percent; 3 to 8 percent is

common. Nitrogen and phosphorus are valuable as plant nutrients. The organic matter in sludge also is particularly useful as a soil additive.

## Sludge Types

Primary sludge is composed of the solids (mostly remains of food and fecal matter) and microorganisms that settle from wastewater during the initial stages of treatment. In some treatment facilities, lime may be added at this stage of treatment.

Activated sludge accumulates during more advanced stages of sewage treatment. This sludge consists mainly of the bodies of bacteria that have been feeding on the soluble and suspended organic material in the sewage.

Digested sludge is formed when mixtures of primary and activated sludge are combined and further processed in tanks with or without oxygen to kill disease-producing organisms. Digested sludge is a stabilized material that can be applied to agricultural land and is the most common type produced in the United States. It still contains a relatively high percentage of water.

Composted sludge is made by combining either digested or undigested dewatered sludge with wood chips or other bulking agents under carefully controlled conditions. With the proper amount of air and moisture, microorganisms convert the sludge into a composted product that has little odor and is relatively free of pathogenic microorganisms. Composted sludge makes a good soil conditioner.

## What Options Exist for Sludge Disposal?

In the past, sludge was disposed of in a number of ways that are no longer acceptable. The two most common techniques of sludge disposal in the United States have been land application and incineration. Both methods have potential drawbacks. Landfills can no longer be used. Land and management costs of landfills are very high, and there often is a risk of materials in landfills contaminating both surface and ground water. Suitable disposal areas near cities have become more and more difficult to locate. Many citizens strongly object to disposal sites close to residential areas and to transporting sludge through or past their communities. Ocean dumping has been a solution for some coastal communities, but no longer can be used because of negative environmental impacts. Incineration requires a large capital investment and requires expensive safeguards against atmospheric pollution. Incineration uses large amounts of fuel and produces a concentrated and sometimes toxic end product (residual ash) that has no nutrient or organic value as a soil additive and often is more difficult to dispose of than the original sludge.

The application of sludge to agricultural land presents a partial solution to the problem. It offers farmers some economic advantages by providing organic matter and nutrients that can partially replace fertilizer for some crops. The limits on the amounts of sludge that should be applied are controlled by two factors: 1) the nutrient requirements of the crop being grown, which should not be exceeded to avoid polluting surface and ground waters, and 2) the need to keep the accumulated amounts of heavy metals below the total that is safe for a particular soil. The last restriction is particularly important. If the amounts accumulated become too high, the soil may be permanently and irreversibly damaged for growing crops to be eaten by humans or animals. Regulations and application guidelines have been developed to make sludge disposal as environmentally acceptable as possible, while at the same time protective of human health.

### Regulations

Legal regulations governing land application of sewage sludge in Maryland were established in 1986 by the Department of Health and Mental Hygiene under the authority of the Health-Environmental Articles 9-230 through 9-249 and 9-269 through 9-270 of the Annotated Code of Maryland. The regulations are administered by the Maryland Department of the Environment.

The regulations require the issuance of permits for land application of sludge within the state and also define the maximum permissible application rates and amounts of heavy metals that may be allowed to accumulate in various types of soil. The regulations also include detailed specifications on the timing and distribution of sludge applications. Since July 1, 1989, a permanent record of sludge applications to agricultural land must be maintained at each local county soil conservation district office. Further details about these regulations may be found in the Maryland Cooperative Extension Fact Sheet 439, "Using Sewage Sludge on Farmland."

**The University of Maryland endorses the state regulations as statements of the maximum amounts of sludge that may be safely used while protecting the quality of the environment and the health of the people in the state.** Any differences between statements and guidelines contained in this fact sheet and the state regulations reflect the advisory nature of this document. The recommendations presented here take into account several factors that are not emphasized in the regulations, which principally are concerned with setting the limits for protecting the environment.

The guidelines presented in this fact sheet represent the considered judgment of the technical and scientific faculty of the University of Maryland on the way that digested or composted sewage sludge should be used on agricultural soils in the state. These guidelines are based on our present knowledge of the agronomic and environmental effects of sludge used for this purpose. However, it must be recognized that increased loadings of heavy metals and long-lasting organic chemicals may have long-term effects on soils that we do not yet understand.

**In the light of these limitations to our knowledge, the University of Maryland recognizes that it is not possible to predict with complete certainty the possible long-term environmental and health effects of applications of sewage sludge, and the University does not, therefore, accept responsibility for future effects that are due to causes that are unknown at this time.**

## Recommendations

1. The annual rate of sludge application to farmland should be determined according to the nitrogen requirement of the crop. For digested sludge, this rate is based on the content of inorganic nitrogen plus 20 percent of the organic nitrogen for anaerobically or chemically stabilized sludge, and 40 percent of the organic nitrogen for aerobically digested sludge. In the case of sewage sludge

**Table 1. Maximum cumulative sludge metal applications for farmland.**

| Metal | Textural classes | | |
|---|---|---|---|
| | Loamy sand, sandy loam | Fine sandy loam, very fine sandy loam, loam, silt loam | Silt, clay loam, sandy clay loam, silty clay loam, sandy clay, silty clay, clay |
| | Pounds per acre | | |
| Cd | 2.0 | 3.0 | 4.5 |
| Zn | 50.0 | 150.0 | 300.0 |
| Cu | 25.0 | 75.0 | 150.0 |
| Ni | 10.0 | 30.0 | 60.0 |
| Pb | 100.0 | 300.0 | 600.0 |
| Cr | 100.0 | 300.0 | 600.0 |

If the percentage of coarse fragments is greater than 15 percent by volume, the recommended loading rate should be lowered by an appropriate amount. As a first approximation, the loading rate could be reduced by the estimated percentage of coarse fragments.

compost, it is estimated that 10 percent of the organic nitrogen is available to the crop.

2. The maximum amounts of sludge-borne metals that may be applied to farmland are given in Table 1.

3. The annual cadmium loading rate should not exceed 0.4 pounds per acre.

4. Sludge that contains more than the amounts of the following materials on a dry weight basis should not be applied to farmland.

| | |
|---|---|
| Zinc (Zn | 2,500 ppm |
| Copper (Cu) | 1,000 ppm |
| Nickel (Ni) | 200 ppm |
| Cadmium (Cd) | 25 ppm |
| Lead (Pb) | 1,000 ppm |
| Mercury (Hg) | 10 ppm |
| Chromium (Cr) | 1,000 ppm |
| PCB's | 10 ppm |

5. Soil pH should be adjusted to between 6.5 and 7.0 when sludge is applied and should be maintained at 6.0 or above as long as the land is used for production of crops for human or animal consumption.

6. On pastures or hay crops, sludge should be applied immediately after hay harvest or close grazing. The fields should not be harvested or grazed for at least 30 days after application. Application is also recommended in the spring after soils have thawed but before significant growth has occurred.

7. Sludge must not be used on land where tobacco is to be grown.

8. Do not apply sludge on soils where the bedrock is less than 24 inches deep. Applications should be confined to well-drained and moderately well-drained soils with at least 24 inches depth to the seasonal high water table, and where surface slopes do not exceed 15 percent unless surface structures are used to control runoff and erosion.

9. Sludge should not be applied to soils that test "very high" in available soil phosphate. Continued applications of sludge over several years may result in the accumulation of very high levels of total phosphate in topsoil. Under some circumstances, this may induce imbalances of some minor elements. Surface runoff or sediment from such soils also may deliver unacceptably high concentrations of phosphates to surface waters.

10. Do not apply sewage sludge in any form to commercial vegetable crops. Unless the levels of heavy metals in both the sludge and in the soil are known and unless the soil pH is controlled carefully, there are possible risks to human health from the ingestion of vegetables containing excessive cadmium. Some leafy vegetables tend to accumulate large amounts of this metal.

### Application of Sludge to Legume Crops

Legumes fix their own nitrogen; thus, application of sewage sludge to land used for growing legumes is a poor use of a valuable resource. Preliminary evidence indicates that sewage sludge may initially depress legume yields for a period of 1 year following the application of sludge to land. The high soluble salt content of the sludge is believed to be responsible for this observation. Once the salts are leached from the soil, the remaining micronutrients and improved soil physical properties enhance legume growth. Further data, however, is required to confirm initial observations. Applications of sludge to perennial legumes, such as alfalfa, may also make it more difficult to control weeds, especially if excess nitrogen is added to the soil. The excess sludge-nitrogen, if added at the wrong time of the year, may increase weed germination and the subsequent growth of annual weed grasses.

## Determining Application Rates of Sewage Sludge

Maryland Cooperative Extension will provide, on request, specific recommendations for the use of sewage sludge based on crop nutrient requirements, projected yields, soil conditions, and cumulative heavy metal loadings for the particular soil. These recommendations require the results of a soil test (see Soil Analysis below) and the results of an analysis of the particular sludge to be used from the Maryland Department of Agriculture State Chemist. In the absence of an analysis

of the particular sludge, which should be available from the application contractor, recommendations can be made using data on the average composition of other sludge samples recently available from the same source.

## Available Nitrogen in Sludge

Nitrogen loading is one of the principal criteria for establishing an annual application rate for a particular sludge on a specific soil. The nitrogen requirement of the crop and the available nitrogen are used to determine this application rate where it is not controlled by the limitations of the heavy metal application (see Recommendation 1.) The amount of nitrogen that is available to the crop during the first growing year from various types of sludge is estimated as follows:

| Sludge type | Plant available nitrogen |
|---|---|
| Aerobically digested<br>Lime stabilized<br>Unstabilized primary<br>Waste activated | Inorganic N + 40% of the organic N |
| Anaerobically digested<br>Chemically stabilized | Inorganic N + 20% of the organic N |
| Sewage sludge compost | Inorganic N + 10% of the organic N |

To estimate the available residual nitrogen in the soil from sludge applied in previous years, it is assumed that the decay rate of the organic nitrogen in all types of sludge decreases by 50 percent each year during the first 3 years following the year of application. For instance, for aerobically digested sludge, the amount of plant available nitrogen during the first cropping season after application would be estimated as above. For the second, third and fourth seasons after application, the plant available nitrogen released would be estimated by determining 20 percent, 10 percent and 5 percent, respectively, of the remaining organic nitrogen.

## Soil Analysis

Instructions and containers for submitting samples for analysis can be obtained from a regional soil testing lab. See http://www.agnr.umd.edu/SoilTesting/ for a list of regional soil testing labs.

## Sewage Sludge Analysis

The analysis of the sewage sludge must include total nitrogen, ammonium nitrogen, phosphate, potash, calcium, magnesium, manganese, iron, chromium, zinc, copper, nickel, cadmium, lead, and mercury with the percentage of total solids and pH. The State Chemist may be reached through the Maryland State Department of Agriculture, 50 Harry S. Truman Parkway, Annapolis, Maryland 21401.

## Sludge Application Methods

Sludge must be stabilized before land application to reduce public health hazards and to prevent objectionable odors and nuisance conditions. Liquid digested sludge may be applied to the land by using a spreading method such as a tank truck, liquid manure spreader, or subsurface injection in the plow layer. Dried or dewatered stabilized sludge or composted material from digested sludge can be spread with a manure spreader.

It is very important that sludge be applied uniformly over the field so that recommended application rates are not exceeded. Dumping sludge in piles in the field and then spreading it is not an acceptable practice.

## Economics of Land Application of Sewage Sludge

The principal economic benefit from the use of sewage sludge application lies in the reduction of fertilizer needs because of the nutrients added in the sludge. The immediate benefits most often result from savings in the cost of nitrogen. In particular cases, the savings depend on the projected yield goal, the sludge application rate, and the reduction in fertilizer costs (including the time and cost of application). An estimate of the value of a sludge application can be obtained using a computerized examination of the

range of options available from your county Extension office.

Long-term benefits may accrue from the accumulation of increased levels of soil phosphate. This may happen because the amount of phosphorus in most sludge is high in proportion to the nitrogen, so if sludge applications that completely replace fertilizer nitrogen are continued over a long period, soil phosphate will steadily increase. In contrast, the low potassium content of most sludge may lead to the depletion of this nutrient, particularly in sandy soils. Therefore, the short-term economic advantages sometimes may be offset by costs that may be needed to adjust the nutrient balances at a later time. The possible costs of future lime applications that may be needed to maintain pH levels above 6.0 required for the issuance of a permit to apply sludge on agricultural land should be evaluated also.

Potential economic disadvantages may arise from the permanent increase in heavy metal content of the soil associated with repeated sludge use. Such increases may limit the market value of future forages and vegetables produced on sludge-treated land. The possibility of this occurrence should be taken into account in making any decisions concerning sewage sludge applications to land.

Projections of the effects that repeated land applications of sludge and animal waste in various cropping sequences have on the reserves of soil nutrients are available through county Cooperative Extension agents. These estimates are based on computerized calculations of the long-term balances between the amounts of nutrients removed by the crops and those added in the sludge or fertilizer.

## Guidelines for Application of Digested Sewage Sludge and Composted Sewage Sludge to Agricultural Land

by
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Ken Aycock
Allan Bandel
Herbert Brodie
Morris Decker
Frank Gouin
Bruce James
Alan Taylor
Richard Weismiller

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914. In cooperation with the U.S. Department of Agriculture, University of Maryland, College Park, and local governments. Bruce L. Gardner, Interim Director of Maryland Cooperative Extension, University of Maryland.

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Published 1982–83
Revised 1987–88
Revised 1988–89
Revised 1989–90

Section V

- **Application for Consultant Certification & Application for License**

MARYLAND NUTRIENT MANAGEMENT PROGRAM
50 HARRY S. TRUMAN PARKWAY
ANNAPOLIS, MARYLAND 21401
TEL. NO. 410-841-5959, FAX NO. 410-841-5950

## INFORMATION FOR CERTIFICATION APPLICANTS

Revised: May 2005

The Nutrient Management Certification is available to individuals with the expertise to provide nutrient management services to the agricultural community.

1) The requirements for certification and program criteria are explained in detail in the "Maryland Nutrient Management Regulations" COMAR 15.20.04 & .08

2) Certification Exam Application Requirements:
To apply for the certification exam, an applicant shall file the following with the Department of Agriculture at least 15 days before any announced examination:
   a) An application on a form provided by the Department.
   b) Except for government employees, the certification fee of $50 by check or money order, payable to the Maryland Department of Agriculture.
   c) Proof of meeting one of the following:
      1. A school authenticated college degree in an agriculturally related area, and one year of practical experience acceptable to the Department in nutrient management planning; or
      2. A combination of education and practical experience related to nutrient management planning and acceptable to the Department.
   d) Verification of nutrient management experience must be included. A minimum of twelve months experience must be verified by current or former employers who supervised the applicant's nutrient management activities. Transcripts indicating college work may be requested when education is used to meet eligibility requirements.

3) The completed application shall be mailed to:
**Maryland Department of Agriculture**
Nutrient Management Program
50 Harry S. Truman Parkway
Annapolis, Maryland, 21401

4) Certification application must be completely filled out and accompanied by a $50 application fee. Incomplete application will be returned.

5) A copy of training manuals will be provided to the applicant which is included in the $50 application fee.

6) Information submitted on the application is used to evaluate eligibility for certification examination. You have a right to inspect, amend or correct this information. State Government Article 10-616(h), Annotated Code of Maryland, with certain exceptions, prohibits the Department from disclosing this information. This information is not routinely shared with state, federal or local government agencies.

6) Once an application is approved, the applicant will receive an exam registration confirmation. The information will include the date and location of the certification examination.

If you have any questions, please call the Maryland Nutrient Management Program at 410-841-5959.

# APPLICATION FOR NUTRIENT MANAGEMENT CERTIFICATION

| For Department Use Only | |
|---|---|
| Date Appl. Rec'd: | |
| Check Number: | |
| Date Appl. Approved: | |
| Cert. Number: | |
| Exam Date: | |

Mail To:

MARYLAND DEPARTMENT OF AGRICULTURE
NUTRIENT MANAGEMENT PROGRAM
50 HARRY S. TRUMAN PARKWAY
ANNAPOLIS, MARYLAND 21401
TEL. (410) 841-5959, FAX (410) 841-5950

## 1 – APPLICANT'S NAME AND HOME ADDRESS

Name: _____ SSN: _____
Last First MI

Street: _____ Home Phone: _____

_____
City State Zip

## 2 – EMPLOYMENT / BUSINESS INFORMATION

### A – Present Employment

Agency Firm Name: _____ Self Employed: ☐

Federal ID No: _____

Street: _____ Starting Date: _____

_____ Phone Number: _____
City State Zip

Nutrient Management License Number (if applicable): _____ County: _____

Position Held: _____ Immediate Supervisor: _____

Duties: _____

_____

Nature of Work (Check as many as apply): ☐ Farming ☐ Crop Advisory Services
☐ Sales or Distributions of Nutrients ☐ Commercial Fertilizer, ☐ Sewage Sludge
☐ Government Agency: (Specify) _____

### B – Former Employment

Name: _____ Phone Number: _____

Address: _____
City State Zip Code

Employment From: _____ To: _____ Position Held: _____
Month /Year Month /Year

Duties: _____

## 3 – EDUCATION

a. High School/Name/City: _____ Years Completed: _____
Year Graduated: _____

b. College/Name/City: _____ Years Completed: _____
Year Graduated: _____

Major Field of Study and Degree: _____

*(copy of transcript may be requested to verify areas pertinent to nutrient management)*

## 4 – ADDITIONAL EXPERIENCE/TRAINING

a. Any related training or short courses?

Title: _____ Sponsor: _____

Location: _____ Duration: _____ Date: _____

b. Other professional certification, registration, or credentials

Title: _____ Date: _____

c. Additional reference (pertinent to your knowledge/experience)

Name: _____

Address: _____

Phone No.: _____

5. Have you applied for certification in Maryland before? Yes ☐, No ☐

6. Application fee/money order number and date: _____

7. I hereby apply for nutrient management certification in accordance with the provisions of Agricultural Article 15.20.04 and certify that the above information is true and accurate to the best of my knowledge.

_____
Signature Date

**FOR OFFICIAL USE ONLY**

**Qualification Reviewed By:** _____ **Date:** _____

**Comments:** _____

_____

# VERIFICATION OF NUTRIENT MANAGEMENT EXPERIENCE

**The work experience of an applicant for nutrient management certification must be verified by employer(s) as part of the application form.**

## PRESENT EMPLOYMENT VERIFICATION

I certify that _____ is employed by
Applicant's Name

_____ and duties are related to providing nutrient management technical services.
Name of Business/Agency

Position Held: _____ from _____ to _____
Month / Year Month / Year

_____
Name Signature Title

_____
Nutrient Management License # (if applicable) Telephone Date

## FORMER EMPLOYMENT VERIFICATION
## (If additional years of experience are required)

I certify that _____ is employed by
Applicant's Name

_____ and duties are related to providing nutrient management technical services.
Name of Business/Agency

Position Held: _____ from _____ to _____
Month / Year Month / Year

_____
Name Signature Title

_____
Nutrient Management License # (if applicable) Telephone Date

AUTHORIZATION FOR

# VERIFICATION OF CERTIFICATE TO

| | | |
|---|---|---|
| ☐ Nutrient Management Commission<br>Department of Agriculture<br>2320 South Dupont Hwy.<br>Dover, DE 19901<br>Tel. #: 302-698-4500<br>Fax #: 302-697-6287 | ☐ Pennsylvania Department of Agriculture<br>Nutrient Management Program<br>2301 N. Cameron Street<br>Harrisburg, Pennsylvania 17105-8555<br>Tel. #: 717-787-4843<br>Fax #: 717-783-3275 | ☐ Virginia Dept. of Soil & Water Conservation<br>Nutrient Management Program<br>203 Governor Street, Suite 206<br>Richmond, Virginia 23219-2094<br>Tel #: 804-371-0061<br>Fax #: 804-786-1798 |

_____
(NAME OF APPLICANT)

_____
Address

_____
City State Zip Code

This is to authorize **Maryland Department of Agriculture** to verify that the applicant is currently a Certified Nutrient Management Consultant and in good standing by the state of :

☐ Delaware ☐ Pennsylvania ☐ Virginia

Signature of Applicant _____ DATE_____

---

**TO: Maryland Department of Agriculture**
**Nutrient Management Program**
**50 Harry S. Truman Parkway**
**Annapolis, Maryland 21401**
**Tel. #: 410-841-5959**
**Fax #: 410-841-5950**

1. THE ABOVE NAMED PERSON WAS CERTIFIED AS:

| | CERT NUMBER | CERT TYPE | DATE ISSUED | EXP. DATE |
|---|---|---|---|---|
| Certified Nutrient Management Consultant | _____ | _____ | _____ | _____ |

Agency Name:_____
Address:_____
City, State, Zip Code:_____
Tel. No:_____

Authorized Name & Signature:_____ Date:_____

MARYLAND NUTRIENT MANAGEMENT PROGRAM

# APPLICATION FOR NUTRIENT MANAGEMENT CERTIFIED CONSULTANT BY RECIPROCITY

Mail To:

MARYLAND DEPARTMENT OF AGRICULTURE
NUTRIENT MANAGEMENT PROGRAM
50 Harry S. Truman Parkway
Annapolis, MD 21401
(410) 841-5959

**For Department Use Only**
Date Appl. Rec'd: _____
Date Appl. Approved: _____
Cert. Number: _____
Exp. Date: _____

## 1. APPLICANT'S NAME AND ADDRESS

NAME: _____ SSN: _____

Last Name First Name MI

Street: _____ Day Phone : _____

City: _____ State: _____ Zip Code : _____

## 2. CERTIFICATION AND LICENSING INFORMATION

Certificate No: _____ Exp. Date: _____

Certification Type: _____ Date Issued: _____

Issued By (Name of State): _____

## 3. BUSINESS INFORMATION

Agency/Firm Name: _____ Fed. ID No.: _____

Address: _____ Phone No.: _____

City: _____ State: _____ Zip Code: _____ Fax No: _____

Maryland Nutrient Management Licence No. : ☐ Yes Lic. No. _____ Exp.Date: _____
☐ No *(If No, please complete application for license)*

4. I hereby apply for nutrient management certification in Maryland in accordance with the Reciprocal Agreement on Certification of Persons preparing Nutrient Management Plans between states of Delaware, Pennsylvania, and Virginia. I certify that the above information is true and accurate to the best of my knowledge. Authorization form for verification of my certification is attached.

Signature of Applicant _____ Date: _____

MARYLAND NUTRIENT MANAGEMENT PROGRAM
50 HARRY S. TRUMAN PARKWAY
ANNAPOLIS, MARYLAND 21401
TEL. NO. 410-841-5959, FAX NO. 410-841-5950

# INFORMATION ON NUTRIENT MANAGEMENT LICENSING

Revised: December 2004

1. Any person or company who wants to provide state certified nutrient management plans must be licensed by the Maryland Department of Agriculture and be state certified to provide nutrient management services or employ one or more people who are certified.

2. CERTIFIED NUTRIENT MANAGEMENT CONSULTANTS CANNOT PROVIDE STATE CERTIFIED NUTRIENT MANAGEMENT PLANS UNLESS OPERATING UNDER A STATE LICENSE, EXCEPT FOR A CERTIFIED FARMER WHO WRITES PLAN EXCLUSIVELY FOR HIS/HER FARM OPERATION.

3. Persons or companies wishing to obtain a nutrient management license must submit an application with the following fee:

| | |
|---|---|
| Individual or sole proprietorship | - $ 50 |
| Corporation or partnership | - $100 |
| Government agencies | - $ 0 |

4. Licenses are valid for one year and expire unless the applicant renews the license for a 3-year term and paying an applicable fee of $150.00. (except for government agency).

5. Licensed persons or companies agree to comply with regulations set forth in COMAR 15.20.04.

6. The following regulatory requirements apply:

a. Nutrient management planning services will be provided only by state certified nutrient management persons.

b. Nutrient management plans will be developed in accordance with regulatory criteria and content requirements. (COMAR 15.20.08.04-.07.)

c. License holders shall keep records for a minimum of five years and make them available to the Department upon request. Record keeping requirements are identified in COMAR 15.20.04.11.

d. License holders must file with the Department by September 30 of each year an annual activity report covering the previous year (July 1 through June 30) that contains all the following information: (COMAR 15.20.04.11A)

1. Name and number of license holder
2. Name of certified nutrient management consultant (s) employed between the previous July 1 and June 30
3. Number of nutrient management plans completed
4. Acreage covered by these plans broken down according to county and State watershed codes[1]

[1] *Watershed coding and maps used by the state is available upon request.*

# APPLICATION FOR NUTRIENT MANAGEMENT LICENSE

| For Department Use Only | |
|---|---|
| Date Appl. Rec'd: | |
| Check Number: | |
| Date Appl. Approved: | |
| License Number: | |
| Expiration Date: | |

Mail To:

MARYLAND DEPARTMENT OF AGRICULTURE
NUTRIENT MANAGEMENT PROGRAM
50 HARRY S. TRUMAN PARKWAY
ANNAPOLIS, MARYLAND 21401
TEL. (410) 841-5959, FAX (410) 841-5950

## I – LICENSE HOLDER INFORMATION

Name: _____ Position Held: _____

## II – FIRM / AGENCY NAME AND ADDRESS

Firm /Agency Name: _____ Fed. ID No. _____

Street: _____ Phone Number: _____

_____ Fax Number: _____
City State Zip

County: _____

County(ies) of Activity: _____

## III – BUSINESS INFORMATION

Business Status:

- Corporation/Partnership ☐
- Individual/Sole Proprietorship ☐
- Government Agency ☐

A. Nature of Business: (Check as many as apply)

- Crop Advisory Services ☐
- Sale or Distribution of Nutrients ☐
- Nutrient Sources: Commercial Fertilizer ☐ Biosolids ☐ Manure ☐
- Government Agency: (Specify) ☐ _____
- Others: (Specify) ☐ _____

B. Certified Consultants Information:

Total number of certified consultants: _____

Total number of certified consultants writing plans: _____

## IV. CERTIFIED NUTRIENT MANAGEMENT CONSULTANTS LIST

| Name: (Last, First, MI) | Certificate Number | Expiration Date | Writing Plans, Yes/No |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |

*(List any other names on the back of this page)*

V. I understand that nutrient management services provided under this license must be conducted in accordance with COMAR 15.20.04. These requirements include, but are not limited to, the following:

(1) Accurate records pertaining to site analysis and development of nutrient management plans content and following criteria set by regulations must be kept a minimum of 5 years and made available to Maryland Department of Agriculture upon request.

(2) An annual activity report must be filed by September 30 using a departmental form to document planning activity for the previous year (July 1 - June 30).

(3) Failure to comply with these regulations may result in a loss of license.

I hereby apply for a nutrient management license in accordance with the provisions of Agricultural Articles 8-801-8-806, and certify that the above information is true and accurate to the best of my knowledge.

_____

Signature Date

- **Guidelines and Procedures for Inspection of Certified Nutrient Management Plans**

# GUIDELINES AND PROCEDURES FOR INSPECTION OF CERTIFIED NUTRIENT MANAGEMENT PLANS

December 2006

According to the Nutrient Management Certification and Licensing Regulations, license holders are required to keep records for at least 5 years and make them available to the Department upon request. The Department may deny, suspend or revoke the certificate or license of any person who violates any of the regulatory requirements including failure to promptly provide any report or allow the Department access to inspect any record required by the regulations.

## PURPOSE

The purpose of inspections and review of plans developed by certified consultants is to ensure compliance will all regulatory requirements including the preparation of nutrient management plans, record keeping and reporting. It also provides an opportunity to identify and review any problem areas, provide technical assistance on a one to one basis and organize workshops and group training programs as needed.

## PROCEDURES

1. The inspection form is the basis for the inspector's report and evaluation.

2. In so far as possible, a license holder will be informed in advance in order to appropriately schedule inspections. However, an inspection may be conducted without prior notification.

3. The MDA inspector may require a consultant to provide explanations about any element of a nutrient management plan if needed to adequately evaluate regulatory compliance.

4. Records will be reviewed for inspection is a percentage of the nutrient management plans completed under a license. Review will include at least one plan by each certified consultant under a license. Information reviewed will include the following:

- Firm / Agency and Consultant Information
- Farm ID and location
- Field specific information on nutrient sources, recommendations and basis for recommended rates.
- General comments and evaluations of inspected plans ad signed by both inspector and consultant/licensee.

5. The original inspection report and evaluation form will be kept in the Department's records. Inspection reports shall be maintained in the files for further reference and evaluation purposes.

6. Copies will be given to the license holder and any certified consultants operating under a license.

7. Follow up actions will depend on the inspector's findings and comments on the inspection and evaluation form. The inspector will identify any problem areas, a timetable for improvement and any required steps for compliance with regulatory requirements.

8. The license holder and the pertinent certified consultants will be kept abreast of their inspection result and status. Any details or specific questions about an inspection may be discussed with the inspector or by calling the Nutrient Management program at (410) 841-5959.

9. Recommendations for denial, suspension, or revocation of certificate or license will be reviewed by the Nutrient Management Program Director. Appropriate actions will be taken by the Department in accordance with Nutrient Management Certification and Licensing regulations. These regulations also allow for appeal of such Departmental actions.

## utrient Management Certified Plans, Progress Reporting the Period ( / / - / / ) Dec. 199

Firm Name: Lic. #: Cert. Consultant (Name & #):

| County - State | Watershed or Location code[1] | New Plans[2] | | Breakdown of New Planned Acreage by Major Crops[3] | | | Updated Plans[4] | |
|---|---|---|---|---|---|---|---|---|
| | | No. | Acres | Corn and Soybean[5] | Small Grains[6] | Other[7] | No. | Acres |
| | | | | | | | | |
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1 Location Code is a 4 digit number shown on the County Watershed Map.
2 New nutrient management plans developed for the first time during this reporting period and not included in previous reports.
3 Crop acreage breakdown is only for new plans. It describes approximate distribution of the new plans by major crops. The total may not be equal to the plan acres.
4 Updated plans are revised nutrient management plans that have been reported as new plans in activity reports of a previous year.
5 Includes corn for grain or silage and soybeans both full season and double crop.
6 Includes wheat, barley, oat, rye and all other small grains.
7 Any other crop or pasture not included in other columns.

MARYLAND DEPARTMENT OF AGRICULTURE
NUTRIENT MANAGEMENT PROGRAM
50 Harry S. Truman Parkway
Annapolis, Maryland 21401
Tel. No. 410-841-5959, Fax No. 410-841-5950
www.mda.state.md.us

| For Office Use |
|---|
| NMPR#: |
| Date: |

# Certified Consultants Nutrient Management Plan Review, Evaluation and Compliance Form

Operator's Name: _____

Consultant's Name _____ No. of Fields Inspected: _____

REMARKS AND COMMENTS

1. Farm Operation and Animal Information
   - A. Animal Type: ☐ Dairy ☐ Beef ☐ Swine ☐ Poultry ☐ Turkey ☐ Horse ☐ Others ☐ N/A
   - B. No. Of Animals _____ _____ _____ _____ _____ _____ _____
   - C. Average Weight _____ _____ _____ _____ _____ _____ _____
   - D. Total Annual Manure Generated: _____ Tons and/or _____ Gal.
   - E. Total Manure Used in Operation: _____ Tons and/or _____ Gal.
   - F. Total Acres Under Plan: _____
   - G. Acres of Manure Application: _____
   - H. Imported Manure Source : ☐ Yes ☐ No
   - I. Excess Manure ☐ Yes ☐ No
   - J. Exported Manure ☐ Yes ☐ No
   - K. Receiver's Name & Address: _____

2. Required Plan Recommendations
   - A. Basis of Crop Yield Goals: ☐ Farmer's Records ☐ Soil Productivity ☐ Consultant's Knowledge ☐ Neighbor's Farms ☐ Others
   - B. Split Application Recommended: ☐ N/A ☐ Yes ☐ No
   - C. Soil Tests or Diagnostics used for crop nutrient requirements ☐ N/A ☐ Yes ☐ No
   - D. Equipment Calibration Recommended ☐ N/A ☐ Yes ☐ No
   - E. Nutrient Application Timing ☐ Timely ☐ Untimely
     Explain if Untimely: _____

3. Required Plan Content

| | N/A | COMPLETE | INCOMPLETE |
|---|---|---|---|
| A. Plan Identification | ☐ | ☐ | ☐ |
| B. Farm Map / Sketch | ☐ | ☐ | ☐ |
| C. Animal Information | ☐ | ☐ | ☐ |
| D. Field or Management Unit Specific Information | ☐ | ☐ | ☐ |
| E. Summary of Nutrient Recommendations | ☐ | ☐ | ☐ |
| F. Plan Maintenance Information | ☐ | ☐ | ☐ |
| G. Biosolids Analysis Information | ☐ | ☐ | ☐ |
| H. Management Recommendations for Out-of-Ground Production | ☐ | ☐ | ☐ |
| I. Summary of Plant Production | ☐ | ☐ | ☐ |

   - J. Required Best Management Practices: _____

4. General Evaluation and Comments

| PLAN AREAS OR ACTIVITIES | COMPLETE | INCOMPLETE |
|---|---|---|
| Farm Operation and Animal Information | | |
| Required Plan Recommendations | | |
| Required Plan Content | | |
| Record Keeping | | |
| Overall Plan Rating | | |

I acknowledge that an inspection was made and that any deficiency notes were discussed with me.

_____ License /Consultant or Designee _____ Date

Reviewed By: _____ Nutrient Management Specialist _____ Date

MDA-N-112 B (9-06)

MARYLAND DEPARTMENT OF AGRICULTURE
NUTRIENT MANAGEMENT PROGRAM
50 Harry S. Truman Parkway
Annapolis, Maryland 21401
Tel. No. 410-841-5959, Fax No. 410-841-5950
www.mda.state.md.us

| For Office Use |
|---|
| NMPR#: |
| Date: |

# Certified Consultants Nutrient Management Plan Review, Evaluation and Compliance Form

Firm Agency Name: _____ Lic. No.: _____ Exp. Date: _____

Consultant's Name: _____ Cert. No.: _____ Exp. Date: _____

Operator's Name: _____ Address: _____

Date Written: _____ Implementation Date: _____ Plan Duration, yrs. _____ Plan Type: ☐ New ☐ Updated ☐ Cost Share

Operation Type: ☐ Poultry/Livestock ☐ Grain/Soybeans ☐ Nursery/Greenhouse ☐ Vegetable ☐ Organic
☐ Horses ☐ Pasture/Alfalfa Mix ☐ Trees/Orchards ☐ Others:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Account ID # | | | | | | | | |
| County - W-shed. Loc. Code | | | | | | | | |
| Field No. - Field Acres or Area | | | | | | | | |
| Crop(s) to be Grown | | | | | | | | |
| Expected Yield Goal | | Bu/A | | Tons/A | | Bu/A | | Tons/A |
| Previous Crops - Yield | | Bu/A | | Tons/A | | Bu/A | | Tons/A |
| Previous Manure / Biosolids T/A or Gal./A | Last Yr. | 2 Yrs. Ago | 3 Yrs. ago | | Last Yr. | 2 Yrs. ago | 3 Yrs. ago | |
| | | | | | | | | |
| Tillage Method | ☐ No Till | ☐ Minimum Till | ☐ Conventional Till | | ☐ No Till | ☐ Minimum Till | ☐ Conventional Till | |
| Soil Information | Soil Name | Texture: | | | Soil Name | Texture: | | |
| Soil Lab Name: | P-FIV Level: | pH level: | | | P-FIV Level: | pH level: | | |
| Date Analyzed: | K-FIV Level: | P-Site Index | | | K-FIV Level: | P-Site Index | | |
| Nutrient Source Type (Check) | ☐ Cattle ☐ Swine ☐ Poultry ☐ Chem. Fert. ☐ Biosolids ☐ Others | | | | ☐ Cattle ☐ Swine ☐ Poultry ☐ Chem. Fert. ☐ Biosolids ☐ Others | | | |
| Irrigation Type (Check) | ☐ Overhead ☐ Trickle ☐ Others ☐ Drip ☐ Sub-Irrig. ☐ N/A | | | | ☐ Overhead ☐ Trickle ☐ Others ☐ Drip ☐ Sub-Irrig. ☐ N/A | | | |
| Nutrient Base Recommendation | ☐ N – Based ☐ P – Based Remarks: | | | | ☐ N – Based ☐ P – Based Remarks | | | |
| Total Recommended Nutrient Rates, lbs/A | Plan Rates N - $P_2O_5$ - $K_2O$ | Optimum Rates N - $P_2O_5$ - $K_2O$ | +/(-) Difference N - $P_2O_5$ - $K_2O$ | | Plan Rates N - $P_2O_5$ - $K_2O$ | Optimum Rates N - $P_2O_5$ - $K_2O$ | +/(-) Difference N - $P_2O_5$ - $K_2O$ | |
| | | | | | | | | |
| N-Credit, Previous Crop, #/A | | | | | | | | |
| N-Credit, Manure/Biosolids, #/A | | | | | | | | |
| Chemical Fertilizer Rate, lbs/A | | | | | | | | |
| Manure / Biosolids Plant Available Rate, lbs/A | | | | | | | | |
| Application Rate per Acre | Tons or Gals. | Recommended Appl. Time, season/Yr | | | Tons or Gals. | Recommended Appl. Time, season/Yr | | |
| Manure / Biosolids Application Method & Incorporation | ☐ Surface ☐ Subsurface | Nutrient Recommendations Within Range | | | ☐ Surface ☐ Subsurface | Nutrient Recommendations Within Range | | |
| | Incorp. days | N | YES ☐ | NO ☐ | Incorp. days | N | YES ☐ | NO ☐ |
| Use of PSNT | Yes No N/A | $P_2O_5$ | ☐ | ☐ | Yes No N/A | $P_2O_5$ | ☐ | ☐ |
| | | $K_2O$ | ☐ | ☐ | | $K_2O$ | ☐ | ☐ |
| Lime Rate, Tons/Acre | | Note: | | | | Note: | | |

MDA-N-112 A (9-06)

# Nutrient Management Plan Quality Rating Form

Consultant Name: _____
Certificate #: _____
License #: _____

Operators Name: _____
Review Date: _____
Reviewer: _____
County: _____

| Plan Category: | | | Commercial Fertilizer | | Manure Prod. & Use | | Organics Use | | Nursery/ Greenhouse | | No-Land | | Pasture Only | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PLAN ELEMENTS | TOTAL POINTS | Max Pts. | CF | | MCF | | O | | NG | | NL | | P | |
| 1. Animal Production Information | 15 | | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 |
| A. Animal Information | | 5 | | | 0 | | | | | | 0 | | 0 | |
| B. Manure Generation/Mgt. | | 10 | | | 0 | | | | | | 0 | | 0 | |
| 2. Required Plan Recommendations | 45 | | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 |
| A. Basis of Crop Yield | | 5 | 0 | | 0 | | 0 | | 0 | | | | 0 | |
| B. Soil Tests | | 5 | 0 | | 0 | | 0 | | | | | | 0 | |
| C. Summary of Nutrient Rates | | 25 | 0 | | 0 | | 0 | | 0 | | | | 0 | |
| D. P-Site Index/Env. Risk | | 10 | 0 | | 0 | | 0 | | 0 | | | | | |
| 3. Required Plan Content | 30 | | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 |
| A. Plan Identification | | 2 | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | |
| B. Farm Map(s) | | 5 | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | |
| C. Field Specific Information | | 12 | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | |
| D. Plan Maintenance | | 2 | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | |
| E. BMP(s) - Required | | 2 | 0 | | 0 | | 0 | | 0 | | | | 0 | |
| F. Crop/Plant Listing | | 2 | 0 | | 0 | | 0 | | 0 | | | | 0 | |
| G. Manure/BiosolidsTests | | 5 | | | 0 | | 0 | | | | 0 | | | |
| 4. Record Keeping | 10 | | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 |
| A. Record Keeping | | 10 | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | |
| Total # of Elements used | | 100 | 11 | | 14 | | 12 | | 10 | | 8 | | 12 | |
| QUALITY RATING | 100 | | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 |

**see next tab for Scoring Criteria for Ratings:**

*Revised: Sept. 11, 2006*

MARYLAND DEPARTMENT OF AGRICULTURE
NUTRIENT MANAGEMENT PROGRAM
50 Harry S. Truman Parkway
Annpolis, Maryland 21401
Tel. No. 10-841-5959, Fax No. 410-841-5950
www.mda.state.md.us

MACS # _____
Date: _____

# NUTRIENT MANAGEMENT PLAN EVALUATION FORM FOR MARYLAND AGRICULTURAL COST SHARE PROGRAM

Operator's Name: _____
Street Address: _____ City: _____ State: _____ Zip Code: _____
Consultants Name: _____ Cert. No.: _____ Lic. No.: _____
Date Plan Written/Updated: _____ Plan Duration, yrs. _____ County: _____

MACS Practice: ☐ Litter Transport (101) ☐ Manure Transport (103) ☐ Waste Storage (313) ☐ Dead Bird Composting Facility (318) ☐ Waste Treatment Lagoon (359) ☐ Heavy Use Protection Area (561) ☐ Nutrient Management (590)

1. Plan Content Requirements:

| | | | |
|---|---|---|---|
| A. Operator Information w/ Account ID's | ☐ Yes | ☐ No | |
| B. Farm Map / Sketch | ☐ Yes | ☐ No | |
| C. Soil Test Analysis Information | ☐ Yes | ☐ No | ☐ N/A |
| D. Manure Analysis Information | ☐ Yes | ☐ No | ☐ N/A |
| E. Summary of Nutrient Recommendations | ☐ Yes | ☐ No | ☐ N/A |
| F. Plan Maintenance Information | ☐ Yes | ☐ No | |

2. Farm & Livestock Manure Information:
   A. Plan: _____
   B. Animal Type: ☐ Dairy ☐ Beef ☐ Swine ☐ Poultry ☐ Turkey ☐ Horses ☐ Others: _____
   C. No. of Animals: _____ _____ _____ _____ _____ _____ _____

| | Collected | | | Uncollected |
|---|---|---|---|---|
| D. Total Manure Generated Per Year | _____ Tons | and or | _____ Gal. | _____ Tons |
| E. Total Manure Used in the Farm | _____ Tons | and or | _____ Gal. | |
| F. Excess Manure Quantity (D-E) | 0 Tons | and or | 0 Gal. | |

   G. Receiver's Name & Address _____

3 Plan Evaluation:

| | | | |
|---|---|---|---|
| A. Plan Content MACS Requirements | ☐ Adequate | ☐ Inadequate | ☐ N/A |
| B. Nutrient Recommendations Adequacy | ☐ Adequate | ☐ Inadequate | ☐ N/A |
| C. Land Acreage Receiving Nutrients | ☐ Adequate | ☐ Inadequate | ☐ N/A |
| D. Manure Generation Information | ☐ Adequate | ☐ Inadequate | ☐ N/A |
| E. Overall Evaluation | ☐ Adequate | ☐ Inadequate | |

4 Plan Compliance Recommendations:

_____

Plan Reviewed By: _____ _____
Nutrient Management Specialist — Date

Approved By: _____ _____
Supervising Specialist — Date

- **Guidelines for Continuing Education Requirements**

MARYLAND NUTRIENT MANAGEMENT PROGRAM

# GUIDELINES FOR CONTINUING EDUCATION REQUIREMENTS

The requirements for certification, licensing, plan content and criteria, and certification renewal are explained in detail in the "Nutrient Management Certification and Licensing Regulations" COMAR 15.20.04

1. A nutrient management certificate (operators and consultants) is initially issued for one year. Thereafter it may be renewed for a 3-year term.

2. Renewal requires continuing education and compliance with all requirements for the preparation of a nutrient management plan.

   - **Certified Consultants** must complete 6 hours of training within the first year, and 12 hours every three years thereafter.
   - **Certified Operators** must complete 2 hours of training within the first year, and 6 hours every three years thereafter.

> The purpose of continuing education is to review and provide greater detail about nutrient management concepts and their practical application; to update certificate holders on the latest research finding and new technologies related to management of nutrients; and to keep certificate holders abreast of program policies and strategies.

3. Maryland Department of Agriculture (MDA) in cooperation with the University of Maryland Cooperative Extension Service and other agencies offer continuing education courses or workshops throughout the year.

4. The private sector, agencies and institutions may organize nutrient management related training programs and announce that MDA continuing education credits will be granted after submitting the following materials for review and receiving notification of approval from MDA
   - Course, workshop or seminary title.
   - Program content, agenda, and instructor's names
   - Date(s) and number of classroom hours (50 minutes) for nutrient management related topics.
   - Organizer and location.

   After the event, proof of attendance (MDA sign-in sheet) must be provided by the organizer of the training program.

5. It is recommended that certificate holders keep a record of continuing education events attended with date, subject, and instructor. Applications for certificate renewal will request a list of continuing education events attended.

6. Individuals who attend continuing education events where MDA continuing education units have not been sought, may submit on their own the agenda, date and proof of their attendance for processing.

**Maryland Department of Agriculture – Nutrient Management Program**
**50 Harry S. Truman Pkwy, Annapolis, MD 21401**
**Phone: 410-841-5959 Fax: 410-841-5950**

MARYLAND NUTRIENT MANAGEMENT PROGRAM

# Nutrient Management Continuing Education Approval Form

*Please apply for only one activity per form and carefully fill out all requested information. Thank you.*

1. Applicant's Name:_____ Cert #:_____

   Address:_____

   _____

2. Affiliation:_____ License #:_____

3. Training Course, Workshop or Seminar Title:

   _____

4. Organized by (Name and Address):_____

   _____

   Name of Contact Person:_____Phone #:_____

5. Dates/Duration:_____

6. Location:_____

7. Attach program content, agenda and instructors names.

8. Mark specific topic(s) from the program agenda related to Nutrient Management to be considered as required continuing education.

9. Attach proof of attendance and completion of the course to the certificate renewal application form.

FOR DEPARTMENT USE ONLY

Reviewed by:_____ Date:_____

Approved Credit Hrs.:_____

Comments:

Section VI

- **Finding Watershed Codes with Help from the Internet**

## FINDING WATERSHED CODES
## WITH HELP FROM THE INTERNET

At the current time, Maryland 4-digit watershed codes are not available on the internet, however you can find the 8 digit watershed code easily and then use the tables that follow to determine the Maryland 4-digit code.

On the internet:

Go to the "Maryland Surf Your Watershed" site
http://www.dnr.state.md.us/watersheds/surf/index.html

Select "Watershed Profile" and you will see a Maryland map

Click the area of the state where the property you are working with is located

That takes you to a map of the watershed "basins" in that area. Click on the one where the property you are searching for is located.

There you will find additional information and the 8 digit "Watershed Code"

Using the pages that follow in this notebook you can find the 4 digit location code that you need for a Nutrient Management Plan

- County Watershed Codes & Maps
- Order Form

# LIST OF WATERSHEDS IN MARYLAND



COUNTY : **Allegany**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| Upper Potomac | Evitt's Creek | 0067 | 02-14-10-02 | |
| Upper Potomac | Fifteen Mile Creek | 0068 | 02-14-05-11 | |
| Upper Potomac | George's Creek | 0065 | 02-14-10-04 | |
| Upper Potomac | Potomac N. Branch | 0063 | 02-14-10-01 | |
| Upper Potomac | Sideling Hill Creek | 0069 | 02-14-05-10 | |
| Upper Potomac | Town Creek/Upper Potomac | 0062 | 02-14-05-12 | |
| Upper Potomac | Upper Potomac | 0061 | 02-14-05-08 | |
| Upper Potomac | Will's Creek | 0066 | 02-14-10-03 | |

COUNTY : **Anne Arundel**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| Patapsco/Back | Bodkin Creek | 0018 | 02-13-09-02 | |
| Patapsco/Back | Harbor | 0019 | 02-13-09-03 | |
| Patapsco/Back | Lower North Branch | 0015 | 02-13-09-06 | |
| Patapsco/Back | Magothy River | 1010 | 02-13-10-01 | |
| Patapsco/Back | Severn River | 1011 | 02-13-10-02 | |
| Patapsco/Back | South River | 1012 | 02-13-10-03 | |
| Patapsco/Back | West Chesapeake Shore | 0014 | 02-13-10-05 | |
| Patapsco/Back | West River | 1013 | 02-13-10-04 | |
| Patuxent | Little Patuxent | 0017 | 02-13-11-05 | |
| Patuxent | Lower Patuxent | 0012 | 02-13-11-02 | |
| Patuxent | Patuxent East / Patuxent | 0016 | 02-13-11-04 | |
| Patuxent | Patuxent Estuary | 0013 | 02-13-11-01 | |

COUNTY : **Baltimore**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| Patapsco/Back | Back River | 1211 | 02-13-09-01 | |
| Patapsco/Back | Baltimore Harbor | 1210 | 02-13-09-03 | |
| Patapsco/Back | Gwynns Falls | 1213 | 02-13-09-05 | |
| Patapsco/Back | Jones Falls | 1212 | 02-13-09-04 | |
| Patapsco/Back | Liberty Reservoir | 0219 | 02-13-09-07 | |
| Patapsco/Back | Lower North Branch Patapsco | 0215 | 02-13-09-06 | |
| Upper Western Shore | Bird River | 1216 | 02-13-08-03 | |
| Upper Western Shore | Deer Creek | 0213 | 02-12-02-02 | |
| Upper Western Shore | Gunpowder Falls | 1215 | 02-13-08-02 | |
| Upper Western Shore | Little Gunpowder Falls | 0214 | 02-13-08-04 | |
| Upper Western Shore | Loch Raven/Gunpowder Falls | 0217 | 02-13-08-05 | |
| Upper Western Shore | Middle River/Gunpowder Falls | 0216 | 02-13-08-07 | |
| Upper Western Shore | Prettyboy /Gunpowder Falls | 0218 | 02-13-08-06 | |
| Upper Western Shore | Seneca Creek-Gunpowder | 1214 | 02-13-08-01 | |

COUNTY : **Calvert**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| Patapsco/Back | West Chesapeake | 0163 | 02-13-10-05 | |
| Patuxent | Lower Patuxent | 0161 | 02-13-11-02 | |
| Patuxent | Patuxent Estuary | 0162 | 02-13-11-01 | |

COUNTY : **Caroline**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| Choptank | Lower Choptank | 0072 | 02-13-04-03 | |
| Choptank | Tuckahoe | 0073 | 02-13-04-05 | |
| Choptank | Upper Choptank | 0079 | 02-13-04-04 | |
| Lower Eastern Shore | Marshyhope | 0076 | 02-13-03-06 | |

COUNTY : **Carroll**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| PA | Hanover | 4161 | 12-12-02 | |
| Patapsco/Back | Liberty | 0238 | 02-13-09-07 | |
| Patapsco/Back | South Branch-Patapsco | 0235 | 02-13-09-08 | |
| Upper Potomac | Double Pipe Creek | 0239 | 02-14-03-04 | |
| Upper Potomac | Lower Monocacy | 0234 | 02-14-03-02 | |
| Upper Potomac | Upper Monocacy | 0233 | 02-14-03-03 | |
| Upper Western Shore | Loch Raven | 0236 | 02-13-08-05 | |
| Upper Western Shore | Prettyboy | 0237 | 02-13-08-06 | |

COUNTY : **Cecil**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| Upper Eastern Shore | Back Creek | 1096 | 02-13-06-04 | |
| Upper Eastern Shore | Big Elk Creek | 1095 | 02-13-06-06 | |
| Upper Eastern Shore | Bohemia | 0097 | 02-13-06-02 | |
| Upper Eastern Shore | Christiana River | 1094 | 02-13-06-07 | |
| Upper Eastern Shore | Little Elk Creek | 0098 | 02-13-06-05 | |
| Upper Eastern Shore | Lower Elk | 1098 | 02-13-06-01 | |
| Upper Eastern Shore | Middle Elk | 1097 | 02-13-06-03 | |
| Upper Eastern Shore | Northeast River | 1093 | 02-13-06-08 | |
| Upper Eastern Shore | Principio | 0099 | 02-13-06-09 | |
| Upper Eastern Shore | Sassafrass | 0096 | 02-13-06-10 | |
| Upper Western Shore | Conowingo | 1090 | 02-12-02-04 | |
| Upper Western Shore | Lower Susquehanna | 1092 | 02-12-02-01 | |
| Upper Western Shore | Octoraro Creek | 1091 | 02-12-02-03 | |

COUNTY : **Charles**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| Lower Potomac | Gilbert Run | 1130 | 02-14-01-07 | |
| Lower Potomac | Lower Potomac-Main | 0137 | 02-14-01-02 | |
| Lower Potomac | Mattawoman | 0135 | 02-14-01-11 | |
| Lower Potomac | Nanjemoy Creek | 0138 | 02-14-01-10 | |
| Lower Potomac | Port Tobacco River | 1131 | 02-14-01-09 | |
| Lower Potomac | Potomac-Lower Main | 0134 | 02-14-01-01 | |
| Lower Potomac | Wicomico River | 0136 | 02-14-01-06 | |
| Lower Potomac | Zekiah | 0132 | 02-14-01-08 | |
| Patuxent | Patuxent Estuary | 0133 | 02-13-11-01 | |

COUNTY : **Dorchester**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| | Honga | 0039 | 02-13-04-01 | |
| Choptank | Little Choptank | 0038 | 02-13-04-02 | |
| Choptank | Lower Choptank | 0035 | 02-13-04-03 | |
| Lower Eastern Shore | Bay Islands | 0030 | 02-13-99-98 | |
| Lower Eastern Shore | Blackwater | 0037 | 02-13-03-07 | |
| Lower Eastern Shore | Marshyhope | 0033 | 02-13-03-06 | |
| Lower Eastern Shore | Nanticoke | 0034 | 02-13-03-05 | |
| Lower Eastern Shore | Transquaking River/Nantic | 0036 | 02-13-03-08 | |

COUNTY : **Frederick/Catoc**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| Upper Potomac | Catoctin | 0113 | 02-14-03-05 | |
| Upper Potomac | Double Pipe Creek | 0114 | 02-14-03-04 | |
| Upper Potomac | Little Catoctin Creek | 0118 | 02-14-03-01 | |
| Upper Potomac | Lower Monocacy | 0116 | 02-14-03-02 | |
| Upper Potomac | Mid. Potomac-Main | 0117 | 02-14-03-01 | |
| Upper Potomac | Upper Monocacy | 0115 | 02-14-03-03 | |

COUNTY : **Garrett**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| | Casselman River | 0151 | 05-02-02-04 | Outside C.B., H.U. |
| | Deep Creek Lake | 0154 | 05-02-02-03 | Outside C.B., H.U. |
| | Little Youghiogheny | 0152 | 05-02-02-02 | Outside C.B., H.U. |
| | Youghiogheny | 0153 | 05-02-02-01 | Outside C.B., H.U. |
| Upper Potomac | George's Creek | 0157 | 02-14-10-04 | |
| Upper Potomac | Potomac-Upper North Branch | 0156 | 02-14-10-05 | |
| Upper Potomac | Savage River | 0155 | 02-14-10-06 | |

COUNTY : **Harford**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| Upper Western Shore | Aberdeen | 1020 | 02-13-07-05 | |
| Upper Western Shore | Broad Creek | 1022 | 02-12-02-05 | |
| Upper Western Shore | Bush River | 0026 | 02-13-07-01 | |
| Upper Western Shore | Bynum Run | 0029 | 02-13-07-04 | |
| Upper Western Shore | Deer Creek | 0022 | 02-12-02-02 | |
| Upper Western Shore | Gunpowder-Seneca | 0025 | 02-13-08-01 | |
| Upper Western Shore | Little Gunpowder Falls | 0023 | 02-13-08-04 | |
| Upper Western Shore | Loch Raven/Gunpowder | 0024 | 02-13-08-05 | |
| Upper Western Shore | Lower Susquehanna | 1024 | 02-12-02-01 | |
| Upper Western Shore | Lower Winters Run | 0027 | 02-13-07-02 | |
| Upper Western Shore | Susquehanna Above Conoweng | 1023 | 02-12-02-04 | |
| Upper Western Shore | Swann Creek | 1021 | 02-13-07-06 | |
| Upper Western Shore | Upper Winters Run | 0028 | 02-13-07-03 | |

COUNTY : **Howard**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| Patapsco/Back | Lower North Branch | 0104 | 02-13-09-06 | |
| Patapsco/Back | South Branch-Patapsco | 0103 | 02-13-09-08 | |
| Patuxent | Little Patuxent | 0108 | 02-13-11-05 | |
| Patuxent | Middle Patuxent | 0102 | 02-13-11-06 | |
| Patuxent | Patuxent | 0105 | 02-13-11-07 | |
| Patuxent | Patuxent East | 0106 | 02-13-11-08 | |
| Patuxent | Patuxent East | 0107 | 02-13-11-04 | |

COUNTY : **Kent**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| Upper Eastern Shore | Chester Estuary/Lower Chester | 1053 | 02-13-05-05 | |
| Upper Eastern Shore | Langford Creek | 1052 | 02-13-05-06 | |
| Upper Eastern Shore | Middle Chester-Chester | 1051 | 02-13-05-09 | |
| Upper Eastern Shore | Sassafrass | 0059 | 02-13-06-10 | |
| Upper Eastern Shore | Still Pond - Fairlee | 0050 | 02-13-06-11 | |
| Upper Eastern Shore | Upper Chester-Chester | 0058 | 02-13-05-10 | |

COUNTY : **Montgomery**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| Middle Potomac | Anacostia River | 1181 | 02-14-02-05 | |
| Middle Potomac | Cabin John Creek | 0189 | 02-14-02-07 | |
| Middle Potomac | Potomac River | 0185 | 02-14-02-02 | |
| Middle Potomac | Rock Creek | 1180 | 02-14-02-06 | |
| Middle Potomac | Seneca Creek | 0188 | 02-14-02-08 | |
| Patuxent | Patuxent | 0186 | 02-13-11-07 | |
| Patuxent | Patuxent | 0187 | 02-13-11-08 | |

COUNTY : **Montgomery**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| Upper Potomac | Lower Monocacy | 0184 | 02-14-03-02 | |

COUNTY : **Prince George's**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| Lower Potomac | Mattawoman | 0227 | 02-14-01-11 | |
| Lower Potomac | Zekiah Swamp | 0228 | 02-14-01-08 | |
| Middle Potomac | Anacostia River | 1222 | 02-14-02-05 | |
| Middle Potomac | Main Potomac | 1225 | 02-14-02-01 | |
| Middle Potomac | Oxon Run | 1223 | 02-14-02-04 | |
| Middle Potomac | Piscataway | 1224 | 02-14-02-03 | |
| Patuxent | Lower Patuxent | 0225 | 02-13-11-02 | |
| Patuxent | Patuxent East | 1221 | 02-13-11-04 | |
| Patuxent | Patuxent Estuary | 0226 | 02-13-11-01 | |
| Patuxent | Patuxent West | 0224 | 02-13-11-03 | |

COUNTY : **Queen Anne's**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| Choptank | Tuckahoe Creek | 0047 | 02-13-04-05 | |
| Choptank | Upper Choptank | 0043 | 02-13-04-04 | |
| Upper Eastern Shore | Chester Estuary/Lower Chester | 1140 | 02-13-05-05 | |
| Upper Eastern Shore | Corsica | 0046 | 02-13-05-07 | |
| Upper Eastern Shore | Eastern Bay | 1144 | 02-13-05-01 | |
| Upper Eastern Shore | Kent Island | 1143 | 02-13-05-11 | |
| Upper Eastern Shore | Kent Narrows | 1141 | 02-13-05-04 | |
| Upper Eastern Shore | Middle Chester/Chester | 0049 | 02-13-05-09 | |
| Upper Eastern Shore | Southeast Creek | 0048 | 02-13-05-08 | |
| Upper Eastern Shore | Upper Chester/Chester | 0045 | 02-13-05-10 | |
| Upper Eastern Shore | Wye River | 1142 | 02-13-05-03 | |

COUNTY : **Somerset**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| Lower Eastern Shore | Annemessex | 0171 | 02-13-02-07 | |
| Lower Eastern Shore | Bay Islands | 0246 | 02-13-99-98 | |
| Lower Eastern Shore | Dividing Creek | 0240 | 02-13-02-04 | |
| Lower Eastern Shore | Lower Pocomoke | 0176 | 02-13-02-02 | |
| Lower Eastern Shore | Manokin River | 0243 | 02-13-02-08 | |
| Lower Eastern Shore | Monie Bay | 0245 | 02-13-03-02 | |
| Lower Eastern Shore | Pocomoke Sound/Pocomoke | 0175 | 02-13-02-01 | |
| Lower Eastern Shore | Tangier Sound | 0179 | 02-13-02-06 | |
| Lower Eastern Shore | Wicomico Creek | 0242 | 02-13-03-03 | |

COUNTY : **St. Mary's**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| Lower Potomac | Breton Bay | 0145 | 02-14-01-04 | |
| Lower Potomac | Gilbert Run | 0147 | 02-14-01-07 | |
| Lower Potomac | Potomac-Lower Main | 0143 | 02-14-01-01 | |
| Lower Potomac | St. Clement Bay | 0144 | 02-14-01-05 | |
| Lower Potomac | St. Mary's River | 0141 | 02-14-01-03 | |
| Lower Potomac | Wicomico/Lower Potomac | 0146 | 02-14-01-06 | |
| Patuxent | Patuxent Estuary | 0142 | 02-13-11-01 | |

COUNTY : **Talbot**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| Choptank | Lower Choptank | 0083 | 02-13-04-03 | |
| Choptank | Tuckahoe Creek | 0084 | 02-13-04-05 | |
| Choptank | Upper Choptank | 0082 | 02-13-04-04 | |
| Upper Eastern Shore | Eastern Bay | 0087 | 02-13-05-01 | |
| Upper Eastern Shore | Miles River | 0085 | 02-13-05-02 | |
| Upper Eastern Shore | Wye River | 0086 | 02-13-05-03 | |

COUNTY : **Washington**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| Upper Potomac | Antietam Creek | 0124 | 02-14-05-02 | |
| Upper Potomac | Conococheague | 0125 | 02-14-05-04 | |
| Upper Potomac | Licking Creek | 1121 | 02-14-05-06 | |
| Upper Potomac | Little Conococheague | 1122 | 02-14-05-05 | |
| Upper Potomac | Little Tonoloway Creek | 0129 | 02-14-05-09 | |
| Upper Potomac | Marsh Run / U- Potomac | 0127 | 02-14-05-03 | |
| Upper Potomac | Mid. Potomac-Main | 0122 | 02-14-03-01 | |
| Upper Potomac | Sideling Hill Creek | 0128 | 02-14-05-10 | |
| Upper Potomac | Tonoloway Creek | 1120 | 02-14-05-07 | |
| Upper Potomac | Upper Potomac | 0126 | 02-14-05-08 | |
| Upper Potomac | Upper Potomac - Main | 0123 | 02-14-05-01 | |

COUNTY : **Wicomico**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| Lower Eastern Shore | Dividing Creek | 0195 | 02-13-02-04 | |
| Lower Eastern Shore | Lower Wicomico | 0196 | 02-13-03-01 | |
| Lower Eastern Shore | Nanticoke | 0198 | 02-13-03-05 | |
| Lower Eastern Shore | Nassawango | 0191 | 02-13-02-05 | |
| Lower Eastern Shore | Upper Pocomoke | 0194 | 02-13-02-03 | |
| Lower Eastern Shore | Upper Wicomico | 0197 | 02-13-03-04 | |
| Lower Eastern Shore | Wicomico Creek | 0199 | 02-13-03-03 | |

COUNTY : **Worcester**

| TRIB. NAME | WATERSHED NAME | LOC. CODE | WATERSHED CODE | REMARKS |
|---|---|---|---|---|
| | Assawoman Bay | 0206 | 02-13-01-02 | Outside C.B., H.U. |
| | Chincoteague Bay | 0209 | 02-13-01-06 | Outside C.B., H.U. |
| | Isle of Wight Bay | 0204 | 02-13-01-03 | Outside C.B., H.U. |
| | Newport Bay | 0208 | 02-13-01-05 | Outside C.B., H.U. |
| | Sinnpuxent Bay | 0207 | 02-13-01-04 | Outside C.B., H.U. |
| Lower Eastern Shore | Dividing Creek | 0205 | 02-13-02-04 | |
| Lower Eastern Shore | Lower Pocomoke | 0202 | 02-13-02-02 | |
| Lower Eastern Shore | Nassawango | 0201 | 02-13-02-05 | |
| Lower Eastern Shore | Upper Pocomoke | 0203 | 02-13-02-03 | |

# APPENDIX

## County Watershed Codes and Maps

A licensed nutrient management consultant is required to identify the location of nutrient management plans developed. The county and watershed where land under a plan is located are required as elements of the plan contents. Watershed codes can be used to identify a hydrologic unit area. Depending on the end use of the information, different scales of hydrologic units or watersheds can be used to identify the watershed area. The U.S. Geological Survey (USGS) has developed a hydrologic unit coding system to identify the scale and location of each watershed for the entire United States. The scale of watershed is determined by its respective digital code number. The common hydrological unit codes vary from 6 to 14 digits. Every two digits identify specific locational information about the watershed. For example, the first two digits from the left of the code sequence identify the national region and the second two digits represent the subregion. The coding becomes more specific down to the stream catchment or sub-catchment area.

The County Watershed Maps developed for the Nutrient Management Program are based on Maryland's eight-digit Hydrologic Units. In Maryland, there are about 140 eight-digit watershed boundaries corresponding with the name of a specific part of the river, stream or creek. In order to simplify the use of watershed maps, MDA has developed a set of four-digit watershed location codes corresponding to the eight-digit Hydrologic Units. The watershed boundaries may fall in more than one county. In such cases, different location codes have been used for the same watershed to identify the respective county of the watershed.

The map scale is about 1:62,000 (1 inch = 1 mile). The map size varies from county to county. The average size is about 3' X 4'. Maps are printed in two colors. Features of the base, county road map are black. Watershed boundaries and numerical location codes are in brown. This section includes a statewide list of the four-digit watershed location codes, corresponding eight-digit watershed codes, river or creek names, and location in a Tributary Basin[1]. A set of small scale county maps illustrates this information.

Four-digit county watershed location codes are required for the development of nutrient management plans and annual progress reporting. The County Watershed Maps are available at the Maryland Department of Agriculture. The first copy is provided free of charge to certified consultants working under a license. Additional copies will be sold for $3.50 per copy to cover postage and handling. To obtain County Watershed Maps, complete and mail the attached order form to:

**Maryland Department of Agriculture**
Nutrient Management Program
50 Harry S. Truman Parkway
Annapolis, Maryland 21401

[1] A larger group of watersheds for water quality management. Maryland has divided its Chesapeake Bay watershed into ten tributary basins.

## MARYLAND NUTRIENT MANAGEMENT PROGRAM

### Map Order and Activity Areas of the Nutrient Management Consultants

Firm Name: License #:

| Consultant Names | Certificate # | County(s) of Activity |
|---|---|---|
| | | |
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| County Name | Free Copy* | Additional | $3.50 | Total $ |
|---|---|---|---|---|
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| | | | Total | |

Please complete and mail to: **MDA, Nutrient Management Program**
**50 Harry S. Truman Parkway**
**Annapolis, Maryland 21401**

** First copy to be provided to each consultant under license free of charge*
*(Please use the reverse side if additional space is needed)*

- **Plan Reporting Form (New Plans)**

# Ma[illegible]d Department of Agriculture, Nutrient Managem[illegible]ogram

## NUTRIENT MANAGEMENT PLAN REPORTING FORM (NEW PLANS)

(Use this form when filing your Nutrient Management Plan. Use only Blue or Black Ink. Instructions on reverse.)

For MDA Use
Date Received ___ / ___ / ___ Record # _____

## Part A: Farmer/Operator Information

Last Name | First Name | Social Security #

Business/Operation Name (if applicable) | Federal ID # | Telephone #

Address | County

City | State | Zip | Name above is: ☐ Operator ☐ Owner and Operator

## Part B: Farm Information

| Account ID(s) | Number of Acres | Watershed/Loc. Code |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

Nutrient Source(s): ☐ Chemical Fertilizers ☐ Animal Manure ☐ Other (Indicate Below) ☐ Biosolids

Manure Storage ☐ Yes ☐ No

Excess Manure ☐ Yes ☐ No

Number of Animals: Dairy, Beef, Horse, Poultry (in 1,000 / yr), Other Livestock Type, Number

Total Account ID Acres | Total Farmed Acres | Quantity Excess/Yr | Quantity Unit ☐ Ton ☐ Gal.

Operation Type: ☐ Crop Production ☐ Nursery/ Greenhouse ☐ Organic ☐ Animal ☐ No-land ☐ Other

## Part C: Plan Information

Date Written (Mo/Yr) /

Plan Period Ending Date (Mo/Yr) /

Parts of Plan Submitted: Map ☐ Yes ☐ No; Soil Test(s) ☐ Yes ☐ No ☐ N/A; Summary Recommendations ☐ Yes ☐ No ☐ N/A

Total Acres Managed Under Plan: Cost-Share Plan ☐ Yes ☐ No

Operation Acres Breakdown: Crops, Hay, Pasture, Other

## Part D: Consultant Information

Consultant's Last Name | License #

Consultant's First Name | Certificate #

☐ Operator Certified

## Part E: Farmer/Operator Signature

The above information is true and accurate to the best of my knowledge. A valid nutrient management plan will be followed during the current cropping season and upcoming cropping year.

Signature: _____ Date: _____

# MARYLAND NUTRIENT MANAGEMENT PROGRAM

## Instructions for Completing Nutrient Management Plan Reporting Form

**Certified Consultants may help operator with completion of the form, but it must be signed by the operator**

### Part A: Farmer/Operator Information

Information applies only to the person, and/or business who operates or makes primary decisions in the use and application of nutrients for the agricultural operation.

### Part B: Farm Information

Information on all land /properties operated by the above person/firm.

***Account ID(s)***: A unique 10 to 16 digit number used by the Maryland Department of Assessments and Taxation (MDAT) to identify a unit of land. To obtain the property account IDs visit MDAT's website at www.dat.state.md.us/sdat/CICS/. This information is also included on your tax bill. Include all Account IDs within the operations. Use additional page(s) of Reporting Form if needed.
***Acres***: List the total acreage corresponding to each Account ID number.
***Watershed Code***: Use the four digit location code shown on the county watershed maps to identify a hydrologic unit area. If a land unit is located in more than one watershed, use the watershed where a majority of the land resides. List applicable watershed code(s) that corresponds with each parcel in the farm operation and the plan.
***Total Account ID Acres***: Add acreage of land within the Account IDs including agricultural, woodland, homestead and other land uses for each Account ID.
***Total Farmed Acres***: Total acreage of land intended for agriculture use including crops, pasture, hay, green houses, etc.
***Operation Type:*** Identify all types of operations under the plan. (Check all that apply)
***Nutrient Source:*** Identify the applicable nutrient source(s) used on the operation. (Check all that apply)
***Manure Storage***: Check 'Yes' if there is manure storage for the operation. 'No' if you have no storage.
***Excess Manure:*** Indicates the amount of manure generated on the farm in excess of what you use according to the nutrient management plan for crops. If 'yes' is checked, list the approximate ***Quantity*** and the ***Unit*** of surplus manure per year .
***Number of Animals***: Identify the applicable type and number of animals on the operation. For poultry, indicate the number in thousands of birds per year. Example: 30,000 birds/flock x 5 flocks per year = 150,000 birds per year. Write 150. Under other livestock, include swine or any other animal type.

### Part C: Plan Information

***Date Written:*** Date the plan was completed by the consultant and explained to and accepted by operator.
***Plan period:*** Indicate the ending date of the plan (the approximate harvest time of the last crop within the plan period.
***Parts of Plan Submitted***: Check all listed items you have submitted. With some exception for certain types of operations, these are required to be attached to the completed Reporting Form and submitted to MDA.
***Total Acreage Managed Under Plan***: Indicate the total acreage included in the submitted plan, and a breakdown of crops, pasture, hay, and other.
***Cost-Share Plan***: Indicate if cost share funding was used to develop the plan. Plans developed by the Cooperative Extension are not considered cost-shared.

### Part D: Consultant Information

Indicate the *Name*, *Certificate #*, and *License #* issued by the Maryland Department of Agriculture for the consultant who developed the plan. Check the Operator Certified box if you are certified to do your own plan.

### Part E: Farmer/Operator Signature

Signature of the same person printed in Part A as farmer/operator and the date the form is signed.

### SEND YOUR PLAN TO MDA REGIONAL OFFICES

*Send your nutrient management plan information to the MDA Regional office serving your county. If the operation straddles regions, submit to the office where majority of operation resides.*

**Region 1: Allegany, Garrett, and Washington counties**
**Maryland Department of Agriculture**
**Nutrient Management Program**
3 Pershing Street, Room 100
Cumberland, MD 21502
301-722-9193

**Region 2: Carroll, Frederick, Howard, and Montgomery counties**
**Maryland Department of Agriculture**
**Nutrient Management Program**
604 Solarex Court, Suite 105
Frederick, MD 21703
301-694-9290

**Region 3: Anne Arundel, Calvert, Charles, Prince George's, and St. Mary's counties**
**Maryland Department of Agriculture**
**Nutrient Management Program**
50 Harry S. Truman Parkway
Annapolis, MD 21401
410-841-5959

**Region 4: Baltimore, Harford, Cecil, and Kent counties**
**Maryland Department of Agriculture**
**Nutrient Management Program**
19 Newport Drive, Suite 106
Forest Hill, MD 21050
410-838-6181

**Region 5: Caroline, Dorchester, Queen Anne's, and Talbot counties**
**Maryland Department of Agriculture**
**Nutrient Management Program**
411 Franklin Street
Denton, MD 21629
410-479-4929

**Region 6: Somerset, Wicomico, and Worcester counties**
**Maryland Department of Agriculture**
**Nutrient Management Program**
27722 Nanticoke Road, Unit # 2
Salisbury, MD 21801
410-677-0802

- **Annual Implementation Report & Instructions**

# Maryland Department of Agriculture
# NUTRIENT MANAGEMENT
# ANNUAL IMPLEMENTATION REPORT
## for Calendar Year 2007

*The Nutrient Management Annual Implementation Report is due by March 1st and represents nutrient application and farm operation information from the previous calendar year (i.e. 2007 crop year is due March 1, 2008).*

For MDA Use:
Record #: _____
Date Received: _____

## Part A: Farmer/Operator Information

Name (First) _____ (Last) _____ FID # or S.S. # _____

Business Name _____

Mailing Address _____

City _____ State _____ Zip _____ Telephone _____

County _____ *(where the majority of the farm operation is located)* ❑ Operator ❑ Owner/Operator

## Part B: Farm/Operation Information

**Operation Type** ❑ Crop Production ❑ Nursery/Greenhouse ❑ Organic ❑ Animal ❑ No-Land ❑ Other_____

**Nutrient Sources** *(Check all that apply)* ❑ Commercial Fertilizers ❑ Biosolids ❑ Animal Manure ❑ Other _____

**Animal Type & Number** Dairy_____ Beef_____ Horse_____ Poultry *(in 1,000 per year)* _____

Other: Type_____ Number_____

**Manure Information** Manure Quantity Generated/Year_____ Unit: ❑ Ton ❑ Gallon

Manure Storage? ❑ Yes ❑ No Excess Manure? ❑ Yes ❑ No Quantity/Year _____ Unit: ❑ Ton ❑ Gallon

Manure Imported? Type_____ Quantity/Year_____ Unit: ❑ Ton ❑ Gallon

**Total Acres Farmed** _____

**Account ID Information Updates** *(List all acres & associated Account ID's added or deleted from operation in previous calendar year report. If you need assistance, please contact your MDA Regional Nutrient Management Office.)*

| Account ID(s) | Added | Deleted *(Check one box only)* |
|---|---|---|
| _____ | ❑ | ❑ |
| _____ | ❑ | ❑ |
| _____ | ❑ | ❑ |
| _____ | ❑ | ❑ |

## Part C: Plan and Consultant Information

Consultant's Name (First) _____ (Last) _____

Certificate # _____ License # _____ ❑ Operator Certified

Nutrient Management Plan Cost-Share: ❑ Yes ❑ No

Plan Period: Starting Date (m/y): _____ Ending Date (m/y): _____

## Part D: Summary of Nutrient Use

1. This annual nutrient application report covers all crops or agricultural products grown and associated nutrients applied during the previous calendar year (January 1 - December 31). The report is due to MDA by March 1.

2. Information on actual nutrient application should include crop acreage and all nutrient types used for each crop. If you did not apply nutrients, please list the crop and place zero (0) in the nutrient columns.

3. You may combine fields and fertilizer use by crop type. *(For example, all nutrient inputs for all your corn acres could be lumped together. If you have several plantings of vegetable crops during a year, you may add together the total acres planted and total nutrients applied.)*

4. Include any topdress in the calendar year report when it was applied. If your rotation includes winter wheat, please differentiate spring and fall nutrient applications. *(Spring topdress and fall starter applied to different wheat crops in same calendar year.)*

5. If nutrient application, sources, or crops are different than originally indicated on your nutrient management plan, keep information noting or explaining changes with your farm records.

**Farm/Operation Name** _____

**Operator Name** (First) _____ (Last) _____

**Calendar Year:** **2007**

| CROP | ACRES | TOTAL COMMERCIAL FERTILIZER $N$-$P_2O_5$-$K_2O$ (lbs.) | TOTAL MANURE Amount (ton or gallon) | TOTAL BIOSOLIDS Amount (ton or gallon) |
|---|---|---|---|---|
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## Part E: Farmer/Operator Signature

Information provided on the Nutrient Management Annual Implementation Report is true and accurate to the best of my knowledge. A **valid nutrient management plan** will be followed during the current cropping season and upcoming cropping year.

_____ _____

Signature Date

# Maryland Department of Agriculture
## Nutrient Management Annual Implementation Report
# GENERAL INSTRUCTIONS

*Certified consultants may help operators complete the form, however, the form must be signed by the operator.*

***Contact your MDA Regional Nutrient Management Office if you need assistance with any part of the form.***

### Part A: Farmer/Operator Information

Information applies only to the person, and/or business who operates or makes primary decisions in the use and application of nutrients for the agricultural operation. This year we have provided the information we currently have in our database. If any of this information is incorrect please note and include the corrections for our records.

### Part B: Farm/Operation Information

Information on all land /properties operated by the above person/firm.

***Operation Type:*** Identify the type of operation under the plan (Check all that apply.)
***Nutrient Source:*** Identify the applicable nutrient source(s) used on the operation. (Check all that apply.)
***Animal Type and Number:*** Identify the applicable type and number of animals on the operation. For poultry, indicate the number in thousands of birds per year. *Example*: 30,000 birds/flock x 5 flocks per year=150,000 birds per year. Under other livestock, include swine or other animal types not listed.
***Manure Information:*** Indicate the total amount of manure generated by the operation. Indicate whether the amount given is in tons per year, or gallons per year.
***Manure Storage:*** Check "Yes" if there is manure storage for the operation. Check "No" if you do not have any storage.
***Excess Manure:*** Indicate if the amount of manure generated on the farm is in excess of what you use for crops according to the nutrient management plan. If you checked "Yes" list the approximate Quantity and the Unit of surplus manure last year.
***Manure Imported:*** Indicate the amount of manure imported on to your operation in the last year. If manure was imported, list the approximate quantity and the unit of measure.
***Total Acres Farmed:*** Total acreage farmed. (Do not include woodland or land in set aside programs such as CREP.)
***Account ID(s):*** A unique 10 to 16 digit number used by the Maryland Department of Assessments and Taxation (MDAT) to identify a unit of land. Include only account ID's for property that is new to your operation or is no longer part of your operation. Use additional page(s) if needed. *If you have not added or deleted any account ID's to your operation, you may leave this section blank.* To obtain the property account IDs visit MDAT's website at www.dat.state.md.us/sdat/CICS/. Contact your MDA Regional Nutrient Management Office for assistance. This information is also included on your tax bill.
***Added/Deleted:*** Check the appropriate box for land that has been added or deleted from the nutrient management plan beside its corresponding account ID.

### Part C: Plan Implementation and Consultant Information

Write the name, certificate #, and license # issued by the Maryland Department of Agriculture for the consultant who developed the plan.
***Operator Certified:*** Check box if the nutrient management plan was developed by the person identified in Part A, or a person with financial interest in the farm.
***Cost-Share Plan:*** Indicate whether state or federal cost-share funding was used to develop the plan. (Plans developed by Maryland Cooperative Extension are not cost-shared.)
***Plan Period:*** Indicate the starting and ending date of your current nutrient management plan.

### Part D: Nutrients Used

Include all acres where crops, hay, pasture, agricultural products, or horticultural products are grown and what, if any nutrient application they received during the previous calendar year. *Example*: A 100 acres of corn with an application of 150-30-30 per acre would be entered as 15,000-3,000-3,000. Since the report covers the entire year, more than one crop may be grown on the same acreage and, therefore, the acreage reported here may be greater than that reported on the line indicating total acres farmed under Part B. Additional instructions are on the form.

### Part E: Farmer/Operator Signature

Signature of the same person whose name appears in **Part A** as farmer/operator and the date the form is signed.

### SEND YOUR PLAN TO MDA REGIONAL OFFICES

*Send the Nutrient Management Annual Implementation Report to the MDA Regional Nutrient Management Office serving your county. If the operation straddles regions, submit to the office where the majority of the operation is located.*

**Region 1: Allegany, Garrett, and Washington counties**
**Maryland Department of Agriculture**
**Nutrient Management Program**
3 Pershing Street, Room 100
Cumberland, MD 21502 301-722-9193

**Region 2: Carroll, Frederick, Howard, and Montgomery counties**
**Maryland Department of Agriculture**
**Nutrient Management Program**
92 Thomas Johnson Drive, Suite 110
Frederick, MD 21702 301-694-9290 x137

**Region 3: Anne Arundel, Calvert, Charles, Prince George's, and St. Mary's counties**
**Maryland Department of Agriculture**
**Nutrient Management Program**
50 Harry S. Truman Parkway
Annapolis, MD 21401 410-841-5959

**Region 4: Baltimore, Harford, Cecil, and Kent counties**
**Maryland Department of Agriculture**
**Nutrient Management Program**
19 Newport Drive, Suite 106
Forest Hill, MD 21050 410-838-6181 x118

**Region 5: Caroline, Dorchester, Queen Anne's, and Talbot counties**
**Maryland Department of Agriculture**
**Nutrient Management Program**
317 Carter Ave, Suite 100
Denton, MD 21629 410-479-4929

**Region 6: Somerset, Wicomico, and Worcester counties**
**Maryland Department of Agriculture**
**Nutrient Management Program**
27722 Nanticoke Road, Unit # 2
Salisbury, MD 21801 410-677-0802

**Section VII**

- **Incentives:**

**Technical Assistance & Cost-Share**

# Incentives

## Technical Assistance

### Soil Conservation Districts

Maryland's 24 soil conservation districts were created by state law during the Dust Bowl Years of the 1930s to involve local citizens in conservation planning and erosion and sediment control programs. They are part of a nationwide network of more than 3,000 soil conservation districts working to conserve and protect our land, water, forest, wildlife and related natural resources.

Soil conservation districts function independently under a five-member Board of Supervisors. As an independent political subdivision of state government, they exercise public powers and receive guidance from the State Soil Conservation Committee. Although districts occupy the same boundaries as counties, they are not part of county government. Their staff and operating budgets are funded through a combination of federal, state, and local assistance. Additional funding may be obtained by charging fees for sediment and erosion control plan reviews and administering projects for cooperating agencies.

In Maryland, each of the 23 counties is incorporated into a conservation district bearing its name, with one exception: Frederick County is divided into two geographically distinct districts—the Frederick and Catoctin soil Conservation Districts.

A typical soil conservation district staff may include a district manager and district conservationist, engineers, agricultural planners, technicians, soil scientist, urban reviewers, and administrative staff. These professionals oversee a range of soil conservation and water quality protection efforts to enhance farming operations, improve or protect water quality, prevent flooding, safeguard streams and reservoirs, foster wildlife habitat and address natural resource impacts from urban growth. Detailed advice on planning and establishing agricultural best management practices (BMPs) such as terraces and grassed waterways to help control erosion and protect water quality is at the core of their mission. To that end, SCD staff also help farmers determine costs to install individual BMPs and eligibility for both state and federal cost share assistance. Assistance with applications, project design and layout, both state and federal cost share assistance. Assistance with applications, project design and layout, construction inspections and payment claims is provided, as well. Additional responsibilities and services include providing landowners and developers with information on soils and other natural resources, and approving storm water management plans for local governments and sediment and erosion control plans as required by Maryland Law.

Many federal and state mandates are carried out by soil conservation districts. The 1985 and 1990 Federal Food Security Acts mandated conservation plans—developed by the local SCD— on all highly erodible lands, as a provision for certain federal benefits. On the state level, soil conservation and water quality plans are required for all farms in the Chesapeake Day Critical Area—the 1,000 foot strip of land along the Bay's shorelines. These plans are also required for easement purchases under the Ag Land Preservation Program and are a key feature in Maryland's Tributary Strategies—watershed based action plans aimed at reducing nutrient pollution in ten major Bay tributaries.

To carry out their mission, soil conservation districts work with a number of local, state and federal agencies including the Maryland Department of Agriculture, Environment and Natural Resources, the USDA Natural Resources Conservation Service and Farm Service Agency, Cooperative Extension Service, US Fish and Wildlife Service and US Army Corps of Engineers.

**Maryland Cooperative Extension Service**

In 1914, Congress created the Cooperative Extension Service network so that research conducted at land-grant universities could be extended to and applied by the public. Nationwide, there are nearly 3,000 Extension offices based in counties throughout the 50 states. State programs are supported and coordinated by a Federal Extension staff at the U.S. Department of Agriculture.

Here in Maryland, the Cooperative Extension Service serves as a statewide, informal education system within the University of Maryland at College Park and the University of Maryland Eastern Shore. County Extension offices are located in each of Maryland's 23 counties and Baltimore City. These offices are staffed by Extension faculty and supported by subject-matter specialists based at the University of Maryland's College Park and Eastern Shore campuses and the Center for Environmental and Estuarine Studies. Regional specialists are housed at four area research and education centers and the Home and Garden Information Center.

Area research and education centers include the Central Maryland Research and Education Center in Ellicott City, the Lower Eastern Shore Research and education Center in Salisbury, the Western Maryland Research and Education Center at Keedysville, and the Wye Research and Education Center in Queenstown. These centers facilitate research and Extension cooperation in rapid delivery of new technology to all Maryland geographic regions.

The mission of the Cooperative Extension Service is to provide a variety of services to individuals, families and young people, including nutrition counseling, 4-H youth programs, and a Master Gardeners program. Included among its farmer education services are pest management, crops and livestock management, financial management, commodity marketing, aquaculture, natural resources and nutrient management programs.

With funding from the Maryland Department of Agriculture, the Cooperative Extension Service employs nutrient management consultants throughout the State. Consultants work under the direction of agricultural science Extension agents and provide planning services to farmers. Each consultant is assigned to one or two counties. Extension consultants give priority to working with farmers who: *1) require nutrient management plans for cost-share agreements or discharge permits, 2) utilize manure as nutrient source, or, 3) use multiple nutrient sources.* Extension agents and consultants conduct education programs on the economic and environmental benefits of nutrient management planning and establish demonstration plots to illustrate nutrient management practices.

# Incentives

## Maryland Agricultural Water Quality Cost-Share Program (MACS)

### Background

The Maryland Agriculture Water Quality Cost-Share Program (MACS) provides farmers with up to 87.5 percent of the cost to install eligible best management practices (BMPs) to reduce water pollution caused by nutrients, sediment or animal wastes. Under the program, grants are made to farmers to conserve soil and water resources and protect or restore the environment for public benefit.

Approximately 25 best management practices are eligible for MACS grants. These practices must address and treat non-point sources of pollution related to agricultural sources. Costs for installing BMPs vary depending on the area being protected, the scope of the problem, and local construction costs. Specific BMP cost-share percentages vary from 65 percent to a maximum of 87.5 percent of eligible project costs. The amount of grant support provided also depends on the cost–effectiveness of the proposed BMP when compared with other alternatives for that site.

The MACS program is funded by both state and federal monies. Projects receiving cost-share assistance from state funds are authorized by the State Water Quality Loan Act and must be approved by the State Board of Public Works. Projects receiving cost-share assistance from federal funds are supported by an EPA grant and are approved by the Secretary of the Maryland Department of Agriculture.

Soil conservation districts (SCDs) promote and administer the program locally. They assist participants in applying for cost-share and act as liaisons to assure that all information needed by MDA to process an application is provided. SCDs evaluate alternative non-point source treatment options, recommend appropriate BMPs to solve water quality problems, design and supervise construction of the practices, and develop maintenance plans. Through this process, they help assure the technical integrity and eligibility of the BMP proposed for cost-share. The role of the soil conservation district is ongoing, since it also conducts periodic inspections during the maintenance life of a MACS project.

## Cost-Share Funding Limits

Costs for installing BMPs vary depending on the site being protected, the scope of the problem, and local construction costs. Following are the maximum levels of assistance available:

### Animal Waste Treatment and Containment Projects

- Up to $100,000 per project, with a maximum of $150,000 per farm, when combined with other BMPs

### All Other BMPs

- Up to $35,000 per project, with a maximum of $75,000 per farm.

A flat rate ceiling applies to all BMP components. Under the ceiling, average allowable rates for materials and services required to install a BMP are established annually for each

county. Actual MACS grant amounts are based on applying these standard flat rates to the eligible components approved for each project.

## MACS Practices Requiring a Nutrient Management Plan

Waste storage structures, waste treatment lagoons, heavy use area protection and dead bird composting facilities require a nutrient management plan prepared by an MDA certified and licensed nutrient management consultant as part of the eligibility requirements under the MACS program. *Following is a brief summary of eligible practices.*

### Waste Storage Structure

*Description:* A fabricated structure for temporary storage of animal waste.
*Purpose:* This practice is intended to prevent or abate pollution of the waters of the State by construction of a storage facility for animal waste as a component of a waste management system.
*Condition:* This practice applies where there is need for fabricated structures to temporarily store liquid, slurry or solid livestock manure or other agricultural wastes until they can be treated, utilized, recycled, or otherwise disposed of in a safe manner.

### Dead Bird Composting Facility

*Description:* A roofed structure designed for the composting of the normal daily accumulation of dead birds from a poultry growing or breeding operation.
*Purpose:* This practice is intended to eliminate the on-site burial of large numbers of carcasses as the principal disposal method of a poultry operation, thus reducing the potential for groundwater contamination. When properly managed, composting greatly reduces the volume of carcasses, kills most pathogens, prevents odors, and produces a stable, odorless, humus-like material which is useful as fertilizer substitute and a soil amendment.
*Condition:* This practice applies where:

1. Composting is needed to treat and manage organic waste material;
2. Adequate area is available for installation;
3. Foundation materials are sufficiently stable;
4. Sufficient cropland is available for proper compost utilization; and,
5. State and local laws allow composting of animal carcasses.

### Waste Treatment Lagoon

*Description:* An impoundment made by excavation, earthen fill, or a combination of both for the biological treatment of animal or other agriculture waste.
*Purpose:* The purpose of this practice is to develop a waste management system that will provide biological treatment and storage of animal waste until it can be safely utilized on cropland. This practice should be implemented where it is necessary to prevent pollutants from animal wastes or wastewater from reaching the waters of the State.
*Condition:* Apply this practice to areas on farmland where animal wastes or wastewater from dairy operations constitute a significant pollution hazard or to livestock operations where wastewater or rainwater runoff is contributing to a water quality issue.

### Heavy Use Area Protection

*Description:* Stabilization to protect an area on a farm which is being utilized frequently and intensively by livestock or farm equipment.
*Purpose:* The purpose of this practice is to stabilize facility areas on the farm which are disturbed due to frequent and intense livestock or equipment use in order to prevent or abate pollution of the waters of the State.
*Condition:* This practice may be applied only to farms which have been determined to have severe erosion and water quality problems along areas of frequent and intense livestock use, and where there is a need for properly designed and artificial or vegetative cover crop in order to prevent the delivery of animal waste, sediment and nutrients to the waters of the State.

**MACS Guidelines and Procedures**

Since nutrient management plans and animal waste management system plans are required under the eligibility guidelines of the MACS program, it is important that the applicant, local soil conservation district and nutrient management consultant coordinate their efforts to assure consistence in information. The desired storage period, the amount of waste generated, anticipated crop rotations, field acreage, and recommended timing of nutrient applications are essential components of both plans and cannot be developed independently. The following procedures should be followed to assure coordination of nutrient management to address MACS program requirement:

1. A joint meeting should be held between the applicant, the district staff person and the nutrient management consultant. Such a meeting will facilitate exploration of various alternatives which could meet the farmer's needs and make the most efficient use of cost-share funds.

2. A current nutrient management plan or a MACS nutrient management certification form acknowledging commitment to obtain a nutrient management plan must accompany the MACS application.

3. Only plans prepared by a certified operator or a nutrient management consultant certified and licensed by the Maryland Department of Agriculture may be submitted in conjunction with a MACS project. The plan should be signed by the certified operator or consultant including certification (and license) number.

4. Updating and modifying the nutrient management plan is an ongoing process, and should be specified as such in the plan.

5. If an applicant does not have adequate acreage to apply the stored waste, the name and address of the recipient of the waste is required to be identified in the nutrient management plan along with information about the amount and approximate timing of waste being transported to the recipient. The farmer receiving the waste is also required to have a nutrient management plan. The nutrient management consultant should follow up with landowners identified as receiving waste from a cost-shared waste storage system.

6. Cost-share applicants must examine and agree to their waste management plan and nutrient management plan before signing the MACS Agreement. A copy of the required pages of the nutrient management plan must accompany the MACS agreement when it is signed and returned to MDA. Pages of the nutrient management plan that are required to be on file in the MACS office are:

A. The cover letter including comments and notes;
B. The farm map; and,
C. The crop fertility recommendations summary signed by the farmer. Recommendations for individual fields do not need to be sent to the MACS office.

7. Nutrient management plans required for all MACS-funded animal waste management facilities and dead poultry composting facilities should be reviewed and updated as necessary, at least once every three years by an MDA-certified and licensed nutrient management consultant (or certified operator).

*For more information of nutrient management plans required under the MACS program, contact the local soil conservation district office or the MACS Program at 410-841-5864

**MACS Cost-Share Assistance for Nutrient Management Plan Preparation**

In fiscal year 1999, nutrient management services became eligible for cost-share funding through MACS. Farmers who hire a private certified consultant to develop or update their nutrient management plan can now apply to MACS for cost-share assistance.

# Incentives:
# Tax Subtractions

# Incentives

## Tax Subtractions for Conservation Equipment

The Maryland Income Tax Subtraction Modification for Conservation Equipment is available to help farmers offset costs associated with buying certain types of conservation equipment to control soil erosion, manage nutrients and protect water quality in streams, rivers and the Chesapeake Bay. A taxpayer is allowed a subtraction on his/her individual or corporate Maryland Tax Return equal to 100 percent of the cost of buying and installing conservation tillage equipment, drills, rippers, liquid manure injection equipment, poultry or livestock manure spreading equipment provided they meet the following criteria:

**Conservation Tillage Equipment designed to minimize soil movement during agricultural production**

- May be attached to other equipment
- Must have been purchased after December 31, 1985
- Must have a minimum useful life of four years following the purchase date and be owned for at least three years after the tax subtraction is taken

**Deep No-Till Rippers used to address soil compaction in high residue cropping systems**

- Equipment must not invert the soil profile
- Must have been purchased after December 31, 2001
- Must have a minimum useful life of four years following the purchase date, and be owned for at least three years after the tax subtraction is taken.

**Liquid Manure Injection Equipment designed to reduce nutrient runoff**

- May be attached to other equipment but may not be used to inject sludge
- Equipment must have been purchased after December 31, 1989
- Must have a minimum useful life of four years following the purchase date, and be owned for at least three years after the tax subtraction is taken.

**Poultry of Livestock Manure Spreading Equipment**

- Must be used to apply solid or liquid livestock waste according to a current nutrient management plan
- Must be capable of being calibrated to 1.0 ton/per acre to spread poultry manure and bedding from normal poultry production
- Must have been purchased after December 31, 1997 and be owned for at least three years after the tax subtraction is taken.

## How to Certify the Equipment Expense

Contact your local soil conservation district to obtain the certification form and information about eligibility requirements for the subtraction modification.

- Provide the soil conservation district with a dated receipt for the equipment purchase
- The soil conservation district will forward the complete certification form to the Maryland Department of Agriculture for final approval
- Operators receive two copies of the form — the original which accompanies their Maryland Tax Return, and a copy for their records

# Appendix 1

- **Nutrient Management Resources on the Internet**

# Nutrient Management Resources on the Internet

## Chesapeake Bay States

### Maryland

| | |
|---|---|
| Maryland Department of Agriculture | http://www.mda.state.md.us |
| University of Maryland | |
| Agricultural Nutrient Management Program | http://anmp.umd.edu |
| Nursery/Greenhouse Water & Nutrient Management | http://www.nursery.umd.edu/nutrient.html |

### Delaware

| | |
|---|---|
| Delaware Dept. of Agriculture – Nutrient Management | http://dda.delaware.gov |
| University of Delaware | http://ag.udel.edu/extension/NutriManage/ |

### Pennsylvania

Pennsylvania Dept. of Agriculture
http://www.agriculture.state.pa.us/agriculture/cwp/view.asp?=129636

| | |
|---|---|
| Pennsylvania State University | http://panutrientmgmt.cas.psu.edu/ |

# Nutrient Management Resources on the Internet

## Federal Government

United States Department of Agriculture
National Resources and Environment
http://www.usda.gov/wps/portal/!ut/p/_s.7_0_A/7_0_1OB?navtype=SU&navid=NATURAL_RESOURCES

USDA, National Agricultural Library,
Water Quality Information Center http://www.nal.usda.gov/wqic/

USDA, Agricultural Resource Service
Pasture Systems and Watershed Management Research Unit
http://ars.usda.gov/Main/site_main.htm?modecode=19-02-00-00

USDA, Natural Resources Conservation Service http://www.nrcs.usda.gov/

USDA, NRCS, Technical Resources http://www.nrcs.usda.gov/technical

USDA, NRCS, Technical Service Providers http://techreg.usda.gov

## Virginia

Virginia Dept. of Conservation & Recreation http://www.dcr.virginia.gov/soil_&_water/nutmgt.shtml

Virginia Tech Cooperative Extension
http://www.ext.vt.edu/cgi-bin/WebObjects/Docs.woa/wa/getcat?cat=ir-nrem

## West Virginia

West Virginia Dept of Agriculture-Nutrient Management
http://www.wvagriculture.org/programs/Nutrient_Management/Introduction.htm

West Virginia University Cooperative Extension http://www.wvu.edu/~agexten/wastmang/index.html

## New York

New York Dept. of Agriculture http://www.agmkt.state.ny.us/SoilWater/index.html

Cornell Cooperative Extension – Environment http://nmsp.css.cornell.edu/

Cornell Manure Management Program http://www.manuremanagement.cornell.edu/

- **Nutrient Management Planning Software**

# MARYLAND NUTRIENT MANAGEMENT PROGRAM

February 2005

Announcing the Availability of the

## Nutrient Management Planning Software for Professionals "NuMan Pro"

We are pleased to announce the availability of the Nutrient Management planning software program for Professionals "NuMan Pro" developed by the University of Maryland College of Agriculture and Natural Resources. The program will work on computers supporting Windows 95 (OSR2 or better), Windows 98, Windows NT4, Windows ME, Windows 2000, and Windows XP operating systems.

NuMan Pro represents the most advanced software available to complete Maryland nutrient management plans presented in a user-friendly Windows environment. A partial list of the nutrient management software program features includes: fertilizer recommendations for over 220 cropping management scenarios for forage, vegetable, and row crops; mineralization coefficients for 28 types of organic materials; multiple measurement units for fertilizers and organic materials; ability to handle split applications of the same or different organic materials; electronic uploading and conversion of soil analyses files; calculation of crop P removal; support for P removal and manure transport plans; calculation of manure and sewage sludge N credits; extensive user help files; and over 300 cropping notes.

NuMan Pro contains the Maryland Phosphorus Site Index (PSI) software and a simplified version of the Revised Universal Soil Loss Equation (RUSLE) model to estimate soil erosion losses in support of the Maryland PSI. A new waste balance component has been added that will allow users to determine if waste utilization for a particular waste material within the nutrient management plan is properly balanced with waste production and waste storage capacity. A waste generation component has been developed that estimates manure production for almost any animal operation. These new components provide the user with the capabilities to meet the nutrient management requirements for confined animal feeding operations (CAFO). All components of the program are integrated and work together in nutrient management planning.

To order a copy of the Nutrient Management for Professionals (NuMan Pro) software program, please complete the form below and send it with a check for **$75 per copy, payable to the University of Maryland**, to the following address:

Agricultural Nutrient Management Program
Office of Technology Commercialization
University of Maryland
6200 Baltimore Avenue, Suite 300
Riverdale, MD 20737

Telephone orders may be placed via credit card by calling 301-403-2711. Please provide all information requested on order form including an email address for notification of software upgrades. The NuMan Pro software is copyrighted and a separate copy should be purchased for each computer on which the program will be used.

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## Order Form

Please send ____ copy/copies of the Nutrient Management for Professionals (NuMan Pro) software to:

Name: _____ MDA Certification #: _____

Affiliation: _____

Address: _____

City: _____ State: _____ Zip Code: _____

Telephone: _____ Fax: _____ E-mail: _____

Enclosed is a check for $ _____, payable to the University of Maryland.

**Appendix 2**

MARYLAND COOPERATIVE EXTENSION
UNIVERSITY OF MARYLAND
COLLEGE PARK•EASTERN SHORE

Fact Sheet

Fact Sheet 789

# Fertilizer Recommendations

## for Landscape Trees and Shrubs

### (For Professional Grounds Managers and Landscape Contractors)

## Background Information

Grounds managers play an important role in creating and maintaining a healthy environment in Maryland. Studies reported by the Chesapeake Bay Program indicate that nutrients, sediments, and toxic substances are polluting Maryland's ground and surface water. Grounds managers can help reduce their contribution of nutrients, sediments, and toxins by using environmentally sound practices while still making a profit.

Events in the late 1990s led Maryland officials to take an even closer look at our state's water quality. As a result, the Maryland General Assembly passed the Water Quality Improvement Act (WQIA) of 1998. The WQIA specifies that all agricultural operations with annual incomes above $2,500, that apply nutrients, whether in the form of commercial or organic fertilizers and/or manure, must comply with this legislation. Farmers must now have a nitrogen- and phosphorus-based plan, which must be implemented by December 31, 2002, or July 15, 2005, depending on the type of nutrients applied. In addition, grounds managers and persons hired to apply nutrients (fertilizer) to land not used for agricultural purposes that is cumulatively 10 or more acres, or land that is state-owned and of any size, are also included in the WQIA. The 10 acres "cumulative" should be interpreted as including several small lots (each lot under 10 acres) that together add up to 10 acres or more. Although grounds managers are not required to have nutrient management plans, they are required to apply fertilizer according to University of Maryland Cooperative Extension recommendations, take soil tests, and keep records of those applications for 3 years.

Records must include

- soil test results,
- management objectives,
- total nutrients applied to the whole landscape,
- date applied and rate of each application(s),
- location of application(s), and
- the nutrient content of any fertilizer applied.

Record keeping requirements and the regulations regarding them became effective May 30, 2000. See the Maryland Department of Agriculture COMAR (Code of Maryland) recommendations for a summary of penalties.

## University of Maryland Fertilizer Recommendations

Following the practices suggested in this publication should assure compliance with the nutrient management law and prevention of nutrient runoff.

The University of Maryland Cooperative Extension (MCE) recommends analyzing the soil prior to any fertilizer application. Analysis reveals any nutrient deficiencies. Once nutrient deficiencies are determined, apply a fertilizer high in water insoluble nitrogen (WIN).

### Test Soil

The goals of tree and shrub fertilization include overcoming obvious visual deficiencies that are confirmed by soil tests, increasing resistance to specific diseases and maintaining tree health. Before fertilizing, conduct a soil test to determine if any nutrients are deficient. With many horticultural plants MCE suggests that a foliar analysis be run in combination with a soil test to help determine which nutrients are deficient and the degree of deficiency. Currently, there is little published data on the ideal foliar nutrient levels for all of the species of shade trees and landscape plants. Soil test results should be used to determine the fertilizer needs of landscape woody plants until further data is available on foliar analysis. Soil tests should be run a minimum of every 3 years to determine the nutrient needs of the landscape plants.

Secondary and micronutrient deficiencies are closely related to soil pH. The pH should be corrected, if necessary, before the deficient nutrient is applied to the soil. Correcting the pH will make nutrient availability optimal. Recent findings suggest that the optimum pH for turf in Maryland is between 5.8 and 6.2. Most trees will perform well in this pH range.

In general, young trees in good condition produce approximately 8 to 12 inches of growth on the main branches yearly. A soil test will indicate whether elements are in short supply. Fertilizer applications should be based on the results of this test. If the soil test shows optimum or excessive levels of phosphorus or potassium, no additional phosphorus or potassium needs to be applied. Keep in mind that the yearly rate of new twig growth for a tree varies depending on the species, soil conditions, rainfall, and general environment. However, as trees mature, the growth may be only half as much and yet they are still healthy.

### Select the Proper Fertilizer

There are many types of fertilizers available for use. Each one has specific properties that make it different from another. A complete fertilizer contains nitrogen, phosphorus and potassium, major nutrients required for plant growth. A commonly used complete fertilizer for trees and shrubs has a ratio of 3:1:1, 3:1:2, or 3:1:3. An incomplete fertilizer lacks at least one of the three elements, N, P or K. These incomplete fertilizers are sometimes used to supply exact amounts of a specific element when necessary. Secondary and microelements may also be included in some fertilizers. These elements will be listed under "guaranteed analysis."

Slow-release fertilizers are preferred over quick-release or water-soluble types for nutrient management purposes. Another term for 'slow release' is water-insoluble nitrogen (WIN). Slow-release fertilizers provide nitrogen more slowly than water-soluble sources. The result is more uniform growth. Slow-release fertilizers are longer lasting and have a lower impact on the environment. Quick-release fertilizers, or water-soluble nitrogen, are good for restoring leaf nitrogen content with resulting green-up and should be used in moderation. The technical data sheet or label on the fertilizer bag should show that a minimum of 50 percent of the nitrogen source is water insoluble (WIN) and the salt index is less than 50. (Note: Salt index is relative to sodium nitrate, $NaNO_3$, which has a salt index of 100.)

Slow-release fertilizers should be applied at a rate of between 1 to 4 pounds of actual

nitrogen per 1,000 square feet per application. Apply no more than a total of 4 pounds of actual nitrogen per 1,000 square feet annually. Quick release fertilizers should only be used when the objectives of fertilization cannot be met with a slow-release fertilizer. When using quick-release fertilizers, rates should be between 1 to 3 pounds of actual nitrogen per 1,000 square feet per application and shall not exceed 3 pounds of actual nitrogen per 1,000 square feet annually. The combination of slow and quick release fertilizers should not exceed the maximum recommendation of 4 pounds of actual nitrogen per year. All of the fertilizer does not need to be applied at one time. Split applications of two more applications, at lower rates, may be more beneficial and reduce the chance of runoff. Terms such as IBDU, sulfur-coated urea, resin-coated urea, and nitroform indicate slow-release fertilizers.

In order to avoid movement into streams or groundwater, it is usually best to choose a slow-release form of nitrogen. Fertilizers, with at least 50 percent of their N as WIN are considered slow-release.

## Calculate Fertilization Area and Application Rate

Fertilizer should be applied where shrub and tree roots are present. The root spread varies with plant species and with several species the roots extend beyond the dripline of the plant. Knowledge of the plant species and its root growth habits will help in directing the fertilizer application. In the absence of information on the root habits, direct fertilizer applications within the dripline area of the plant. The dripline is defined as the area directly below the canopy of the tree.

Define the area to be fertilized prior to application. Consider root accessibility and location, fertilization objectives (rate of growth desired), and plant species (e.g., ericaceous, broadleaf, or deciduous) when determining the target area to be fertilized.

The target fertilization area for trees and shrubs is generally the area within the dripline of the plant. For some aggressively rooting plants such as Norway maple and pin oak, an area 1.5 times the dripline area can be considered the target area to be fertilized. Inaccessible and paved surfaces should not be included in the target area. If one target area overlaps a second target area, use the shared area only once when calculating the total area to be fertilized.

The area, or square footage, of some common shapes is listed in the chart below. The area is always written as square feet ($ft^2$).

| Shape | Area | Formula |
|---|---|---|
| Square or Rectangle | Length X Width | A = L x W |
| Triangle | ½ Base X Height | A = ½ B x H |
| Circle | 3.14 X Radius Squared | $A = \pi r^2$ ($\pi$=3.14) |

### Fertilizer Application Rates

| Status | Rate/Year |
|---|---|
| Newly planted (1-2 years) | 0-1 lb. N/1,000 $ft^2$/year |
| *(New transplants in poor soil, as is common at construction sites, may respond to slightly higher rates of N.)* | |
| Established plants | 2-4 lb. N/1,000 $ft^2$/year |
| (Trees that have not yet reached full potential size) | |
| Maturing trees | 1-3 lb. N/1,000 $ft^2$/year |
| (Trees that have generally reached full size for the species) | |

## Calculation of area for fertilizer application

### Example:

How much 36-12-12 fertilizer is needed to fertilize a 20-foot diameter spread, established red maple? See Figure 1.

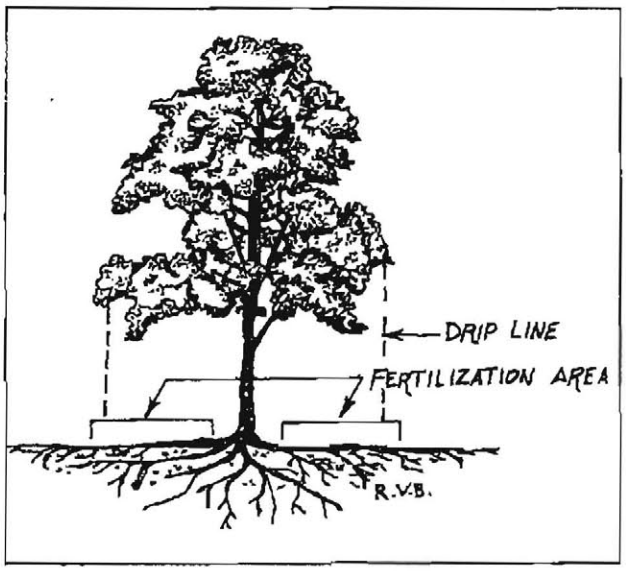


Figure 1. Example of dripline and fertilization area.

### Solution:

This is a three-step problem. The first step is to determine the area to be fertilized. The second step is to calculate the amount of actual nitrogen needed. The third step is to convert the amount of actual nitrogen needed into the amount of fertilizer needed.

**Step 1.**

Since the diameter of the tree is 20 feet wide, the radius is one half the diameter ($r = \frac{1}{2} D$)

$$r = \frac{1}{2} \times 20 \text{ feet} = 10 \text{ feet}$$

Now that the radius is known, it is possible to calculate the area.

$$A = \pi r^2 \quad (\pi = 3.14)$$

$$A = \pi r^2$$

$$A = 3.14 \times 10 \text{ ft}^2 = 3.14 \times 10 \text{ feet} \times 10 \text{ feet} = 314 \text{ sq. ft.}$$

**Step 2.**

Since this tree is established, we are using the lower fertilization rate of 2 pounds of nitrogen per 1,000 sq. ft. per year.

$$\frac{X \text{ lbs. of actual N}}{314 \text{ ft}^2} = \frac{2 \text{ lbs. of actual N}}{1{,}000 \text{ ft}^2}$$

$$X = \frac{314 \text{ ft}^2 \times 2 \text{ lbs. of N}}{1{,}000 \text{ ft}^2}$$

$$X = \frac{628 \text{ lbs. of N}}{1{,}000}$$

$$X = 0.628 \text{ lbs. of actual N}$$

Therefore, .628 lbs. of actual nitrogen is needed to fertilize a 20-foot diameter established tree.

**Step 3.**

To determine how much *fertilizer* is needed to deliver the 0.628 lbs. of actual nitrogen per sq. ft., use the following formula.

$$\text{Total Product Needed} = \frac{\text{Application Rate (lbs. of N)}}{\text{\% N in Product (expressed as a decimal)}}$$

$$\text{Total Amount of 36-12-12 Needed} = \frac{0.628 \text{ lbs. of N}}{.36}$$

Total Amount of 36-12-12 Needed = 1.74 lbs.

Therefore, it takes 1.74 pounds of a 36-12-12 fertilizer to fertilize a 20-foot-wide established red maple.

## How often to fertilize

How much and how often to fertilize shade trees depends on your landscape goals and the current nutrient status of the soil. Small trees, where rapid growth is desired, should be fertilized annually. Split applications (spring, early summer) may have less chance of causing runoff.

Established trees typically are fertilized once every 3 to 4 years, although most arborists prefer an annual application of a low level (1-2 lbs N/1,000 sq. ft./year) of nutrients because infrequent, high rates (3-4 lbs N/1,000 sq. ft./year) tend to contribute more to environmental contamination.

Technically, fertilizer can be applied and is absorbed by plants any time during the year as long as the soil is not frozen or too dry. The best time of the year to fertilize shade trees with slow-release fertilizer runs from the fall through the late winter, before growth appears in the spring. If you are using quick-release nitrogen sources, then spring to early summer is the best time for applications of fertilizer. Avoid applications during the period between late summer and when deciduous trees drop their leaves. Roots absorb fertilizer during the winter months as long as soil temperatures are above 40°F. Most N uptake is driven by leaf growth active flushes. The nitrogen that is fall applied in slow-release form will be available for root uptake with the spring flush of growth. If turfgrass growing in the root zone of the tree is receiving regular fertilization, then in many cases no additional nutrients may be required.

## Fertilizer application methods

For surface application all fertilizer should be uniformly distributed within the defined area of fertilization. Broadcast the fertilizer in the area under the tree, beginning near the trunk to the dripline. Broadcasting on slopes greater than 5-8 percent should be avoided. **Surface application should not be made where surface runoff is likely to occur.** Where runoff is likely or turf or ground cover exists, subsurface fertilization should be the preferred method of fertilization.

For subsurface liquid fertilizer injection, the injection sites should be evenly distributed within the fertilization area. For liquid injection systems, the pressure should not exceed 200 pounds per square inch. Fertilizer should be evenly distributed between holes. See Figure 2.

For subsurface dry fertilization, holes should be evenly spaced within the defined fertilization area. Holes should be 2 to 4 inches in diameter, spaced 12 to 36 inches apart, and 4 to 10 inches deep. See Figure 3. The fertilizer should be evenly distributed among the holes. The fertilizer should not be closer than 2 inches to the soil surface.

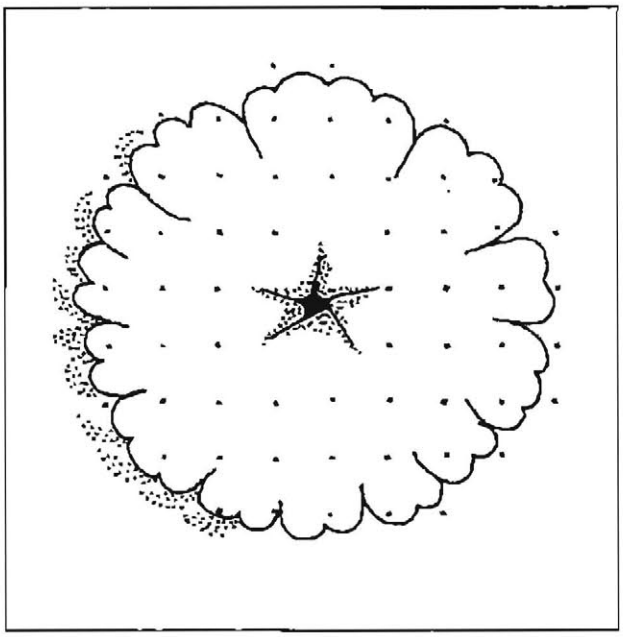

**Figure 2.** Example of guide to positioning fertilizer application holes beneath the tree canopy.

Foliar applications, injections, or fertilizer implants should only be used when soil application of fertilizer is impractical or ineffective in achieving fertilization objectives.

An excessive concentration of fertilizer can burn the foliage. This damage is usually caused by ammoniacal N or urea N. Foliar fertilization is a common way to apply

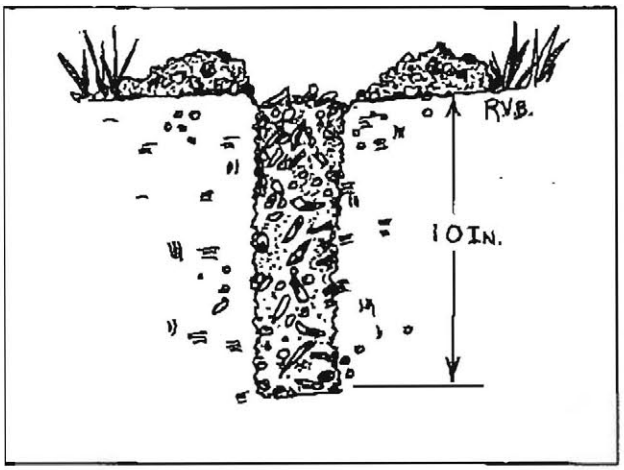


**Figure 3.** Example of subsurface fertilization holes.

chelated iron to plants suffering from iron chlorosis. The benefits of foliar application of nutrients are often only seen for one season for many of the micronutrients.

## Fertilizing Evergreen and Deciduous Shrubs

Broadcast a granular fertilizer (slow-release is preferable) uniformly on the soil under the shrub and a little beyond its dripline. Use an application rate of 2 to 3 pounds of actual nitrogen per 1,000 square feet. A lower rate of nitrogen fertilizer is used around foundation plantings to reduce excessive growth and the resultant need for pruning and trimming.

Ericaceous evergreens such as rhododendrons, azaleas, camellias, mountain laurel, pieris, and leucothoes perform best in an acidic soil. They require a soil pH range of 4.5 to 6.0. Fortunately, many undisturbed Maryland soils are already acidic enough to grow these plants well. Soils in regions of the state with a limestone base are not suitable for these plants unless special procedures are used to lower the soil pH.

### Two Prevalent Nutrient Problems in Landscape Plantings

#### Iron chlorosis:

A symptom of a soil with a high pH problem is iron chlorosis. Chlorosis is an interveinal yellowing of new leaves. This deficiency can be temporarily corrected by applications of chelated iron to the foliage or the soil. The soil pH should be corrected or the symptoms will gradually recur. If the pH is too high (alkaline), sulfur and/or iron sulfate are applied to the soil to lower the pH. Follow the directions based on the results of a soil pH analysis. If chlorosis persists, have the soil tested for manganese (Mn). Always test first to avoid misapplications. Keep in mind, chlorosis is also a secondary symptom of root rot or death of roots. Some conditions that can cause root death and chlorosis include poor soil drainage, over-watering, over-mulching, planting too deeply, magnesium deficiency, root nematodes, or a root injury.

#### Magnesium deficiency:

In very sandy soils, magnesium deficiency can also be a serious problem with acid-loving plants. These symptoms generally appear as chlorosis of older leaves and short, unhealthy new growth. Soil, or foliar, testing is the only accurate method to determine this deficiency. The deficiency can easily be corrected by applying 4 to 16 ounces of magnesium sulfate (Epsom salts) per 100 square feet and irrigating thoroughly.

## Problems Caused by Excessive Fertilizer

Fertilization can be beneficial to plants with a deficiency. However, very high fertilizer concentrations can cause root damage to the plant.

"Burn" is a term describing visual symptoms of salinity due to over-application of fertilizer. Symptoms resemble those of drought damage because plants are injured by lack of water, even though sufficient water may be present in the soil. Fertilization in droughty times of the season is more likely to burn roots.

Excessive use of fertilizer in the landscape can contribute to the nitrogen and phosphorus contamination of groundwater, streams, and ultimately the Chesapeake Bay. Most runoff problems are due to surface applications on slopes and paved surfaces. Groundwater problems may result from fast-release fertilizers on sandy soils. It is very important to select the correct analysis fertilizer, use slow-release whenever possible, and always read the label instructions.

## Summary

### University of Maryland Cooperative Extension Recommendations

1. Test soil to determine nutrient deficiencies, then fertilize accordingly.
2. Use a fertilizer containing at least 50 percent WIN.
3. Apply no more than 4 pounds of nitrogen per 1,000 square feet per year to trees and shrubs.
4. Remove granular fertilizer from paved surfaces.

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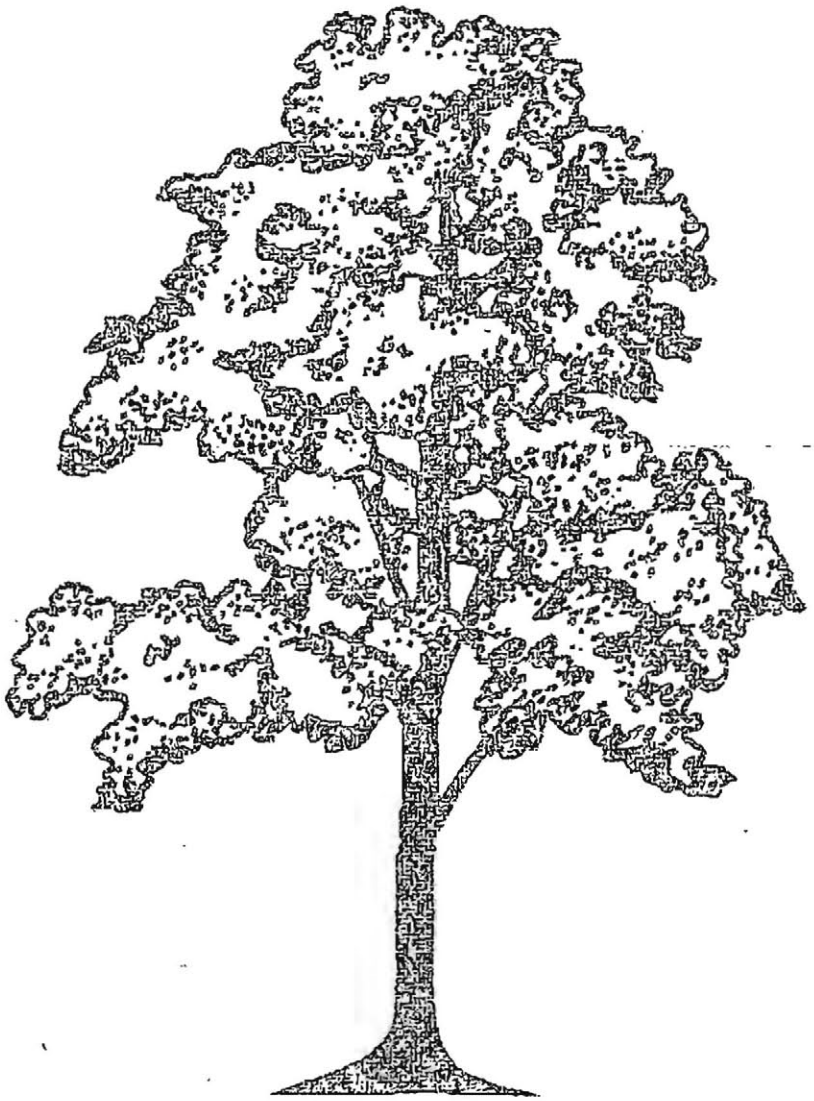

# Fertilizer Recommendations for Landscape Trees and Shrubs

## (For Professional Grounds Managers and Landscape Contractors)

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

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Department of Environmental Science and Technology

Agricultural Nutrient Management Program

# MINERALIZATION RATES FOR ORGANIC NUTRIENT SOURCES

(4/07 update)

| Manure Sources and Types | % of Organic Nitrogen Mineralized Each Year | | |
|---|---|---|---|
| | Year of Application | 1st Year After Application | 2nd Year After Application |
| cattle (dairy & beef) (*buffalo) | 35 | 18 | 9 |
| poultry | | | |
| a. caged layers | 60 | 10 | 5 |
| b. all other (*emus) | 50 | 15 | 8 |
| swine (all types) | 50 | 15 | 8 |
| horse (*ostriches) | 20 | 10 | 5 |
| sheep (*goats, alpacas, camels, llamas) | 30 | 15 | 5 |
| chinchilla * | 15 | 7 | 3 |
| rabbit[1] | 5 | 2 | 1 |
| vegetable processing effluent [1] | 40 | 15 | 8 |
| meat processing residuals [1] | 50 | 10 | 5 |
| aquaculture waste (semi-solid)[1] | 50 | 15 | 8 |
| aquaculture effluent[1] | 80 | 5 | 0 |
| fish emulsion[1] | 80 | 5 | 0 |
| corn gluten, alfalfa meal, peanut meal [1] | 85 | 10 | 5 |
| compost (if C/N<25) [1] | 5 | 0 | 0 |
| feather meal and crab meal [1] | 60 | 10 | 5 |
| fish powder, hydrolyzed[1] | 60 | 10 | 5 |
| seabird guano[1] | 60 | 10 | 5 |
| blood meal[1] | 65 | 10 | 5 |

* Based on consultation with animal nutritionists, species in parenthesis are similar in diet and digestive system to the animal about which mineralization data are available.

[1] Data based on values from the literature or values considered best estimates by specialists with expertise in the area.

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# Appendix 3

# Government Agency Contacts

**Maryland Department of Agriculture**
Nutrient Management 410-841-5959
Agricultural Cost-Share 410-841-5864

Region 1:
Allegany, Garrett, Washington Counties
301-722-9193
Region 2:
Frederick, Carroll, Howard, Montgomery
301-694-9290
Region 3:
Anne Arundel, Calvert, Charles, Prince George's, St. Mary's 410-841-5959

Region 4:
Harford, Baltimore, Cecil, Kent Counties
410-838-6181
Region 5:
Caroline, Dorchester, Talbot, Queen Anne's
410-479-4929
Region 6:
Wicomico, Somerset, Worcester Counties
410-677-0802

**Soil Conservation Districts**

| | |
|---|---|
| Allegany | 301-777-1747 |
| Anne Arundel | 410-571-6757 |
| Baltimore County | 410-666-1188 |
| Calvert | 410-535-1521 |
| Caroline | 410-479-1202 |
| Carroll | 410-848-8200 |
| Catoctin | 301-695-2803 |
| Cecil | 410-398-4411 |
| Charles | 301-934-9588 |
| Dorchester | 410-228-5640 |
| Frederick | 301-695-2803 |
| Garrett | 301-334-6950 |
| Harford | 410-838-6181 |
| Howard | 410-489-7987 |
| Kent | 410-778-5150 |
| Montgomery | 301-590-2855 |
| Prince George's | 301-574-5162 |
| Queen Anne's | 410-758-3138 |
| St. Mary's | 301-475-8402 |
| Somerset | 410-651-1575 |
| Talbot | 410-822-1577 |
| Washington | 301-797-6821 |
| Wicomico | 410-546-4777 |
| Worcester | 410-632-5439 |

**Maryland Department of the Environment**
410-537-3000 800-633-6101

**USDA-NRCS** 410-757-0861

**DNR, Tributary Team Coordinator**
410-260-8988

**Maryland Cooperative Extension Service**
Nutrient Management Coordinator
301-405-1319

| | |
|---|---|
| Allegany | 301-724-3320 |
| Anne Arundel | 410-222-6759 |
| Baltimore City | 410-856-1850 |
| Baltimore County | 410-666-1024 |
| Calvert | 410-535-3662 |
| Caroline | 410-479-4030 |
| Carroll | 410-386-2760 |
| Cecil | 410-996-5280 |
| Charles | 301-934-5403 |
| Dorchester | 410-228-8800 |
| Frederick | 301-694-1594 |
| Garrett | 301-334-6960 |
| Harford | 410-638-3255 |
| Howard | 410-313-2707 |
| Kent | 410-778-1661 |
| Montgomery | 301-590-9638 |
| Prince George's | 301-868-9366 |
| Queen Anne's | 410-758-0166 |
| St. Mary's | 301-475-4482 |
| Somerset | 410-651-1350 |
| Talbot | 410-822-1244 |
| Washington | 301-791-1304 |
| Wicomico | 410-729-6141 |
| Worcester | 410-632-1972 |

**Home & Garden Information Center**
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