Drainage and Wet Soil Management

AY-300
June 2001

Drainage Recommendations for Indiana Soils

D. P. Franzmeier, Department of Agronomy, Purdue University

W. D. Hosteter, Soil Scientist, Natural Resources Conservation Service, Indianapolis

R. E. Roeske, Agricultural Engineer, Natural Resources Conservation Service, Rochester

Knowledge to Go
Purdue Extension

Cover photo by:

David Drew
Wetland Conservationist
Natural Resources Conservation Service
Rockport, IN

Drainage and Wet Soil Management

Drainage Recommendations for Indiana Soils

D. P. Franzmeier, Department of Agronomy, Purdue University
W. D. Hosteter, Soil Scientist, Natural Resources Conservation Service, Indianapolis
R. E. Roeske, Agricultural Engineer, Natural Resources Conservation Service, Rochester

This bulletin gives drainage recommendations for specific soils in Indiana. It is divided into three parts. Part I explains the nature of soil drainage associations and the variables of drainage systems. Part II describes 21 soil drainage associations, illustrates each association with a soil map and a diagram, and gives drainage recommendations for each one. Part III lists 597 soil series mapped in Indiana and lists the natural drainage class and soil drainage association for each.

People who are considering installing subsurface drainage systems should determine the kinds of soils in the field using a soil survey, find the number of the soil drainage association for those soils in Part III, and then read the information about that association in Part II. Soil Surveys are available from the local Extension or Soil and Water Conservation District office. To understand more about the nature of wet soils, see the publication, *Wet Soils of Indiana*, in this series. For technical guidance on system design and maintenance, use this guide in conjunction with the publication, *Design of Agricultural Drainage Systems*.

PART I
SOIL DRAINAGE ASSOCIATIONS

A field in which a drainage system is to be installed rarely contains only one kind of soil. Usually two or more soils occur together in a landscape, and these soils comprise a soil association. Soil associations that have similar drainage characteristics are grouped together to form a soil drainage association. Indiana fields that will benefit from tile drainage usually contain an association of somewhat poorly and poorly drained soils. In gently undulating landscapes, somewhat poorly drained soils are on swells (the high parts of the landscape) and poorly drained soils are in depressions (the low parts). In flat landscapes, poorly drained soils generally occupy the centers of the large flats and are surrounded by somewhat poorly drained soils. Often these soils have a limiting layer—one with very slow permeability—within a few feet of the soil surface. This layer holds up water to make the soils wet. Several of the figures that appear later in this bulletin show soil drainage associations on swell-and-depression landscapes and the underlying limiting layer.

In Part II, 21 Soil Drainage Associations (SDA) are described. The first 18 usually benefit from drainage. Some soils in SDA 19 may benefit from drainage, while those in SDA 20 rarely or never benefit from drainage. Those in SDA 21 are special cases, usually because they have been drastically disturbed by human activity, and require on-site examination to determine if they might benefit from drainage. Soils that comprise SDA 21 are of small extent. Each Indiana soil series was placed in one SDA by soil scientists familiar with soil properties, especially permeability of the various soil layers, and by engineers familiar with how soils have responded to drainage. Each soil drainage association description contains these sections:

Soils and landscapes – This section describes the landforms, parent materials, and permeability of the soils included in the Soil Drainage Association.

Representative soil series – This section lists the soil series included in the Soil Drainage Association. If many series are included, it lists only the more extensive ones.

Representative soil map – This section includes 1) a representative soil map of a quarter-section of land (160 acres or 1/2 mile by 1/2 mile, enlarged from the published soil survey) that shows how the soils are related to each other spatially; 2) a cross section diagram, not to scale, that illustrates soils, landforms, and parent materials; and 3) a discussion of the specific soils, landforms, and parent materials illustrated in the map and cross section.

Drainage recommendations – Included are recommendations for the pattern of drains, their lateral spacing, and their depth. Also included are suggestions about special problems or installations that might be relevant, such as the need for surface inlets, the benefits of "socks," problems with iron ochre, and other special concerns. This section also explains **why** various recommendations were made.

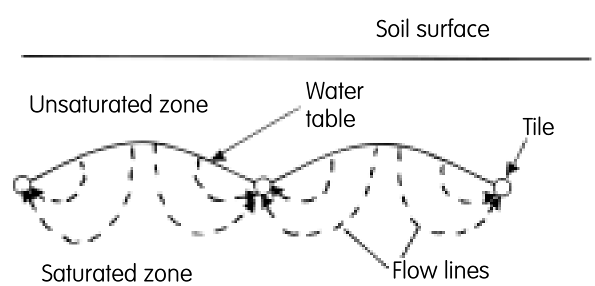
SURFACE AND SUBSURFACE DRAINAGE SYSTEMS

Water can be removed from both the surface and subsurface of soils. If water is held in closed depressions (bowls) on the soil surface, the soil will remain wet for a long time. Therefore, farmers first improve surface drainage by grading or planing the soil to open up depressions or partially fill them to promote surface runoff and faster drying of the soil. This runoff, however, may enhance erosion, even in slightly sloping soils, so erosion control practices might also be necessary.

Subsurface water is removed through tile drains and open ditches. Ditches are used mainly in sandy soils and organic soils. These soils have rapid permeability so the ditches can be widely spaced. More slowly permeable soils require more closely spaced drains, and

FIGURE 1.

Cross section at right angles to tile lines showing flow lines, paths along which water flows to enter a tile line, and how a tile line lowers the water table. Note that water actually may flow up to enter the line. The water table separates the unsaturated zone from the saturated zone.



closely spaced ditches would greatly hinder field operations. In these soils, underground drainage lines are installed. Originally, the drainage lines were made from ceramic, "clay," tiles about one foot long and three or four inches in diameter. They were placed end-to-end in a trench, and water entered the tile through the space between adjoining tiles. Concrete tiles replaced some of the clay tiles, and then slotted plastic tubes replaced the tiles. A plastic tube in the soil is still called a "tile line," however. Usually the tile line is installed at least 30 to 36 inches deep and lies at a uniform gradient of about 0.1% to 0.5%, so in undulating topography it is much deeper than 36 inches in some places. Subsurface water follows certain flow lines to enter the tile line, illustrated for a soil with uniform permeability in Fig. 1. Tile lines usually empty into open ditches.

Many closed depressions pond water, are difficult to drain, and often remain wet for a long time after a rain. They can be drained through a surface inlet, which is a vertical pipe from the surface to the tile line. Because they open to the surface, sediment and surface-applied chemicals can easily enter the drainage system through surface inlets. A buffer strip should be established around a surface inlet to filter out the potential pollutants.

Variables of Subsurface Drainage Systems

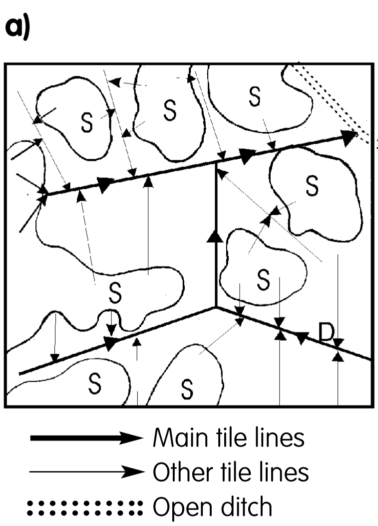
In the drainage recommendations for the various soil associations (Part II) the main design variables are the pattern, depth, and spacing of tile lines. Details of drainage system design are in the publication, *Design of Agricultural Drainage Systems*.

Pattern

The kind of pattern recommended depends mainly on the relief of the field or the difference in elevation between the highs and the lows. Figure 2 represents a view from above of an undulating field comprised of swells (S) and depressions (D), and Fig. 3 represents a cross section of the same field showing much relief (Fig. 3a) and little relief (Fig. 3b). The soils have moderately permeable material over a slowly permeable limiting layer. Moderately permeable material is deeper in the depressions than on the swells. The pattern of tile lines may be either random (Fig. 2a) or parallel (Fig. 2b). Whether a parallel or random system is installed depends greatly on the relief of the field. Remember that tile lines are installed at a uniform grade; they do not follow the elevation of the surface. If parallel lines

Figure 2.

Aerial view of a field with landscape swells (S) and depressions (D) showing random or dendritic (a) and parallel (b) designs for tile drainage systems. The highest elevations in the field are within S units. Parallel systems are better suited to fields with low relief (see Figure 3). In the random design, main tile lines follow the lower parts of depressions (D) and finger lines reach up into the somewhat poorly drained soils on the swells.



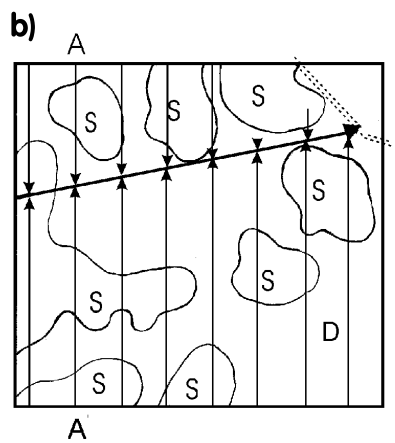
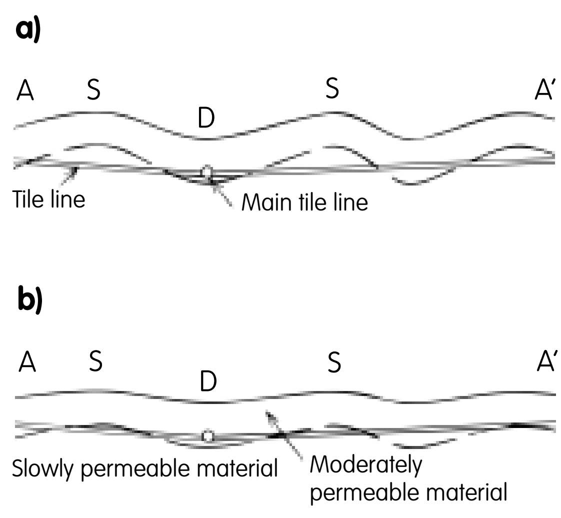


Figure 3.

Cross sections parallel to tile lines through soils with moderately permeable material over slowly permeable material (limiting layer) in a landscape with high relief (a) and with low relief (b). S = swell, D = depression. The section represents the drainage line A-A' in Fig. 2b. The tile line passes through more slowly permeable soil material where the relief is high, which results in slower water flow to the tile. The vertical scale is exaggerated relative to the horizontal scale to show the relationships.



were installed in a field with high relief (Fig. 3a), the tiles lines would be very deep under the swells, they would go through much more slowly permeable material, and the soil would drain very slowly. If, however, the field had little relief (Fig. 3b), the tile lines would not be so deep under the swells; they would pass through more permeable material; and the soil would drain more rapidly. Thus, a parallel system (Fig. 2b) is well suited to fields with little relief. In a field with much relief, the main tile lines should be installed in the deepest parts of the depressions with branches reaching into the upper depression and lower parts of swells (Fig. 2a).

Depth

The deeper the tile line, the larger area it will drain. A very deep line will drain a wide area, but it will drain it so slowly that it would be ineffective for farming. For practical purposes, tile lines are installed at least 30 to 36 inches deep, and much deeper in some parts of the field.

Spacing

Tile lines must be spaced more closely in slowly permeable material if the water table is to be lowered in a reasonable time. In Fig. 4, the closer spacing on the right lowers the water table more than the larger spacing on the left, and lowers it faster as illustrated by the shorter flow lines where the spacing is closer. In the recommendations for soil drainage associations, the suggested maximum spacing is twice the minimum (e. g., 40 to 80 feet). A farmer can install a system first at the wider spacing, and if this spacing is less effective than he had hoped, he can install new drain lines down the center line of the original ones.

Figure 4.

Cross sections at right angles to tile lines comparing two tile spacings. The water table (solid line) separates the unsaturated zone from the saturated zone. The limiting layer has very slow permeability and holds up the water table. Flow lines (dashed lines) are much longer in the larger spacing, and they flatten out in the top of the limiting layer.

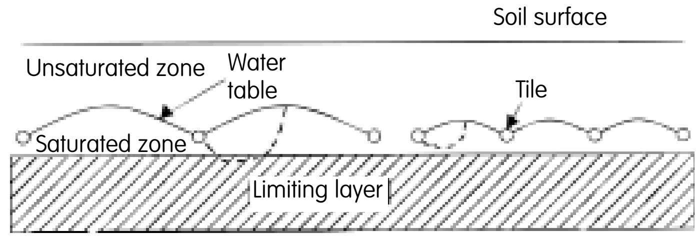


TABLE 1. Definitions of Parent Materials, Landforms, and Landform Components Used in the Descriptions of Soil Drainage Associations.

DEFINITIONS OF PARENT MATERIALS

Alluvium - Material deposited by a stream in relatively recent time.

Bedrock - Rock that underlies soil. In Indiana, bedrock includes sedimentary rocks, such as sandstone, siltstone, shale, and limestone.

Eolian sand - Sand transported and deposited by the wind, mainly medium and fine sand.

Lacustrine deposit - Relatively fine-textured inorganic material deposited in a lake or other body of still water by non-biological processes. Particle size is mainly finer than sand.

Loess - Mainly silt-size material transported and deposited by the wind.

Organic deposit - An accumulation of plant material. Usually it occurs as thick deposits in former lakes or as thin surface layers, overlying mineral soil material, under forest.

Outwash - Stratified coarse-textured material washed out from a glacier by meltwater streams and deposited in front of the margin of an active glacier Particle size is mainly sand and gravel.

Till - Unsorted and unstratified material deposited by glacier ice, and consisting of a heterogeneous mixture of clay, silt, sand, gravel, stones, and boulders; **dense till** has a bulk density of ≥ 1.75 g/cm^3, and **friable till** has a bulk density of < 1.75 g/cm^3.

DEFINITIONS OF LANDFORMS

Bog - A lake or depression filled with organic soil. The term is used in a general sense; more specific definitions may differentiate among bog, marsh, swamp, fen, or other names.

Dune - A low mound, ridge, bank, or hill of loose, wind-blown sand; collectively, *dunes*.

Flood plain - The surface or strip of relatively smooth land adjacent to a river channel, constructed by the present river in its existing regimen and covered when the river overflowed its banks.

Kame - A low mound, knob, hummock, or short irregular ridge composed of stratified sand and gravel deposited by a subglacial stream as a fan or delta at the margin of a melting glacier.

Lake plain - The nearly level surface marking the floor of an extinct lake, filled in by well-sorted deposits, mostly silt and clay size, from inflowing streams.

Loess plain - A nearly level surface underlain by deep loess (>6 feet); usually another landform controls the topography, but the nature of this plain may not be known because of the thick loess cover.

Moraine - A mound, ridge, or other distinct accumulation (depositional surface) of glacial drift, predominantly till.

Outwash plain - A broad, gently sloping sheet of outwash, not contained in a valley, deposited by meltwater streams flowing in front or beyond a glacier.

Sand plain - A sand-covered plain consisting of sandy outwash.

Terrace - A long, narrow, relatively level or gently inclined surface, bounded on one edge by a steeper descending slope (terrace bevel) and along the other edge by a steeper ascending slope, contained in a valley and composed of unconsolidated material such as outwash.

Terrace bevel - A sloping surface that descends from a terrace.

Till plain - An extensive area, with a flat to undulating surface, underlain mainly by till.

Till plain bevel - A sloping surface that descends from a till plain.

DEFINITIONS OF LANDFORM COMPONENTS

Drainageway - A course along which water moves in draining an area; narrow area of joined footslopes if cross section is U-shaped, or of joined backslopes if it is V-shaped.

Hillslope - A part of a hill between its crest (or summit) and the drainage line at the toe of the slope.

Natural levee - A long, broad, low ridge or embankment of sediment, built by a stream on its flood plain along its channel, especially in time of flood when water overflowing the normal banks is forced to deposit the coarsest part of its load.

Plain components:

Swell - A well-rounded hill with gentle slopes.

Flat - A general term for a level or nearly level surface marked by little or no relief; a surface with no apparent convexity or concavity. The term may be modified or replaced by words that describe more specifically a location within the flat, such as **interior** or **rim**.

Depression - A slightly concave area in the midst of generally level land; an **open depression** has a natural outlet for surface drainage, and a **closed depression** has no natural outlet.

Pothole - A pot-shaped pit or hole, not over limestone, with no outlet; deeper than a depression with steeper sidewalls.

Drainage Recommendations for Indiana Soils

Part II.

Descriptions of Soil Drainage Associations

Soil Drainage Association 1

Soils and landscapes

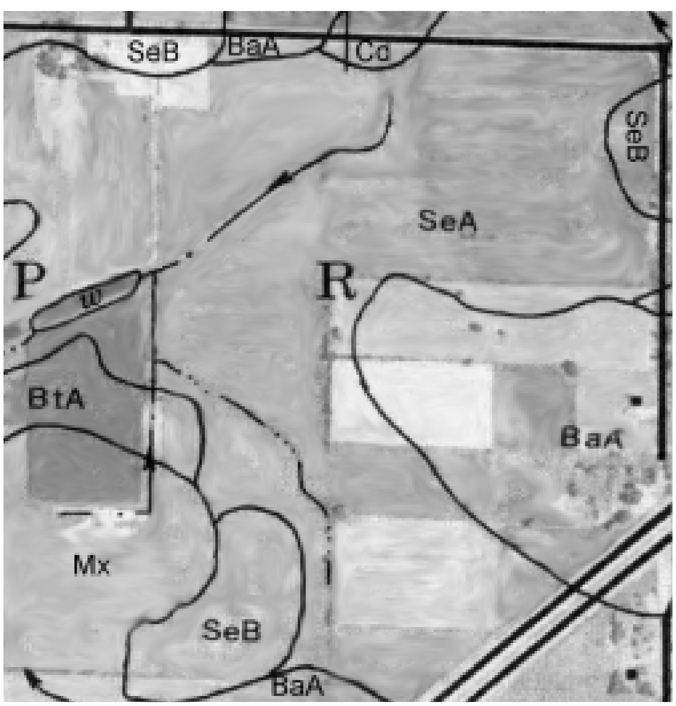
Coarse or medium textured outwash over dense till or lacustrine deposits on till plains and lake plains. Soils on swells have 20 to 40 in. of soil material with moderately rapid permeability over slowly permeable soil material. Soils in depressions have >48 in. of soil material with moderately rapid permeability over dense till or lacustrine material.

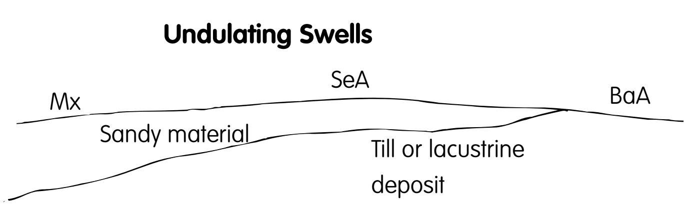
Representative soil series

Somewhat poorly drained soils: Aubbeeenaubbee, Markton, Selfridge
Poorly or very poorly drained soils: Belleville, Iroquois, Mermill, Wauseon

Representative soil map

(LaPorte Co., sheet 2):





These soils formed in sandy material and the underlying till. In this area, the sandy layer is thickest in the southwest corner and thins eastward. Most of it is gently undulating, somewhat poorly drained Selfridge (SeA, 0-2%). Adjoining somewhat poorly drained soils, in different drainage associations, are Morocco (Mx, 0-2%) in deep sands and Blount (BaA, 0-3%) with little or no sand cap. The drainageways shown in the map are good outlets for tile drains. The area shown is 160 acres, 1/2 mile by 1/2mile.

Drainage recommendations

If relief between the surface of the swells and depressions in the field to be drained is less than two ft., one of the parallel systems is often most effective, at a spacing of 60 to 120 ft. If relief is more than two ft., a parallel system is less effective because many of the tile lines would be in slowly permeable dense material, and therefore, a random system is recommended. The main lines are installed below surface drainageways that follow the depressions. Surface inlets may be needed in some deep depressions, especially in closed depressions or potholes. Finger lines reach from the mains into the wettest areas of soils on the swells. Minimum tile depth is 36 in. In a few fields, the soils may be deeper than 36 in. to till or lacustrine material, and the tile can be deeper. If possible, the tile should be installed at the contact between the coarser-textured material and the finer-textured material. Cut-banks created during excavation in these soils are prone to caving in.

Soil Drainage Association 2

Soils and landscapes

Till plains and terraces on which bedrock is within 40 in. of the surface. Soils above the bedrock are moderately coarse to fine textured and have moderate or moderately slow permeability.

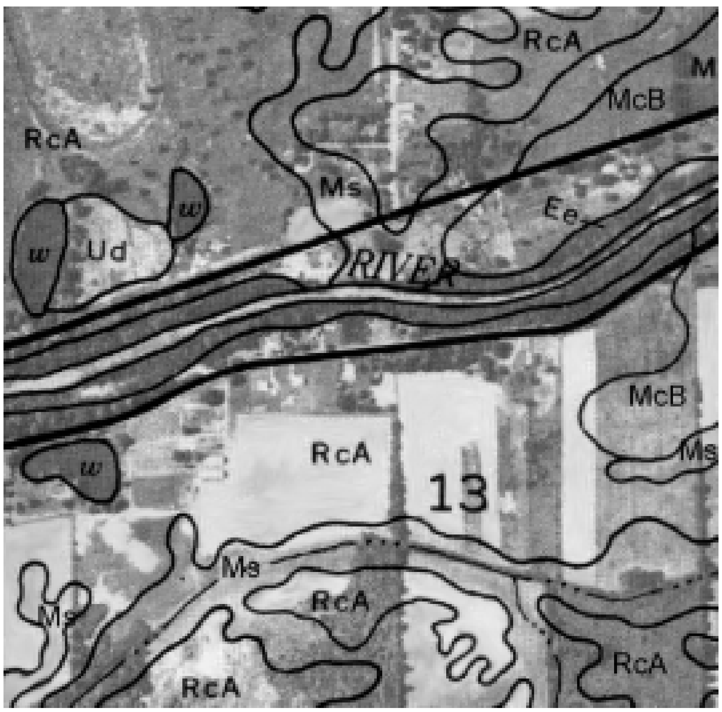
Representative soil series

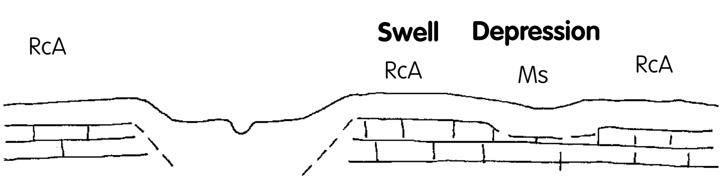
Somewhat poorly drained soils: Adeland, Francesville, Randolph, Shadeland

Poorly or very poorly drained soils: Faxon, Millsdale

Representative soil map

(Huntington Co., sheet 19):





This area is a terrace cut into limestone bedrock along the Wabash River near Huntington. It has mainly somewhat poorly drained Randolph soils (RcA, 0-2%) with natural drainageways and depressions occupied by poorly drained Millsdale (Ms). Well drained Martinsville soils (McB, 2-8%) are on higher areas. The area shown is 160 acres, 1/2 mile by 1/2 mile.

Drainage recommendations

Tile drainage is generally not feasible because of the shallow bedrock, but detailed on-site investigation could reveal a route that is deep enough for tile, or the rock may be soft enough to be ripped by trenching machines.

Soil Drainage Association 3

Soils and landscapes

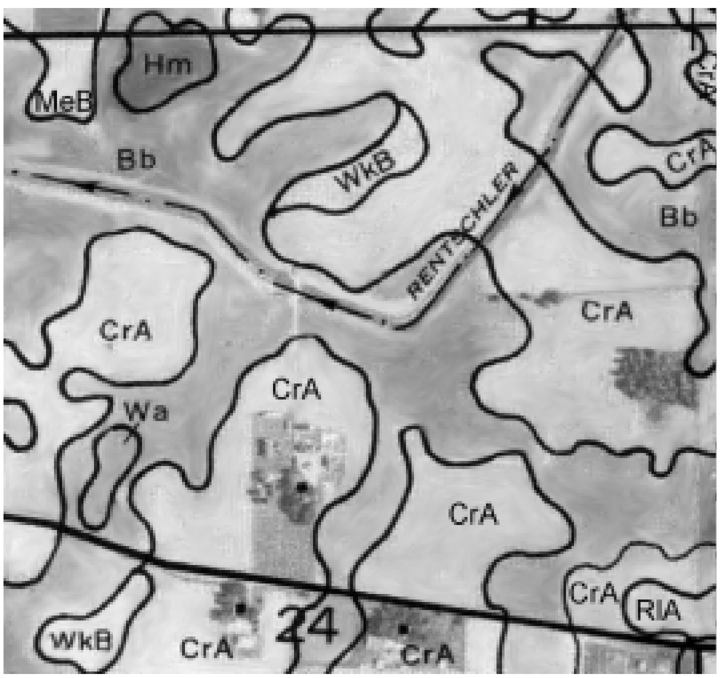
Swells and depressions are randomly arranged on the till plain. On the swells, somewhat poorly drained soils have 20 to 40 in. of moderately coarse to moderately fine material with moderate permeability over slowly permeable dense till. In depressions, poorly drained soils have more than 48 in. of material with moderate permeability over slowly permeable dense till.

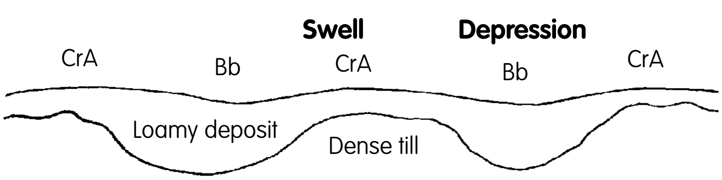
Representative soil series

Somewhat poorly drained soils: Crosier, Conover, Metamora, Gilboa
Poorly drained soils: Barry

Representative soil map

(Fulton Co., sheet 50):





Somewhat poorly drained Crosier soils (CrA, 0-2%) with light-colored, loam-textured surface horizons are on nearly level swells, and dark-colored, poorly drained Barry soils (Bb) are in low-lying flats and depressions. In this map, CrA is more extensive than Bb, but the relation may be reversed in other places in the association. A major drainage ditch (Rentschler Ditch), fed by tile lines, passes through this field. The area shown is 160 acres, 1/2 mile by 1/2 mile.

Drainage recommendations

If relief between the surface of the swells and depressions in the field to be drained is less than two ft., one of the parallel systems is often most effective, at a spacing of 60 to 120 ft. Usually, the poorly drained soils are more permeable than the somewhat poorly drained soils, so the larger spacing is used where poorly drained soils predominate in the field, and the smaller spacing is used where somewhat poorly drained soils predominate. If relief is more than two ft., a parallel system is less effective because many of the tile lines would be in slowly permeable dense till, so a random system is recommended. The main lines follow the surface drainageways in the depressions. Surface inlets may be used in the deeper depressions. Finger lines reach from the mains into the wettest soils on the swells. Minimum tile depth is 36 in. If the field is dominated by soils that are deeper than 36 in. to dense till, the tile can be deeper.

Soil Drainage Association 4

Soils and landscapes

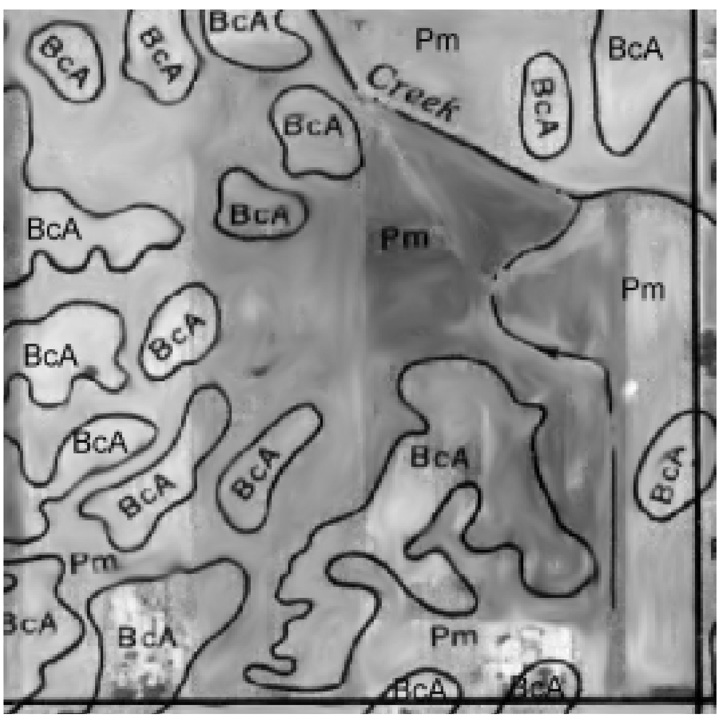
Swells and depressions are randomly arranged on the till plain. On the swells, somewhat poorly drained soils have 20 to 40 in. of moderately fine or fine material with moderately slow permeability over slowly permeable dense till. In depressions, poorly drained soils have more than 48 in. of material with moderately slow permeability over slowly permeable dense till.

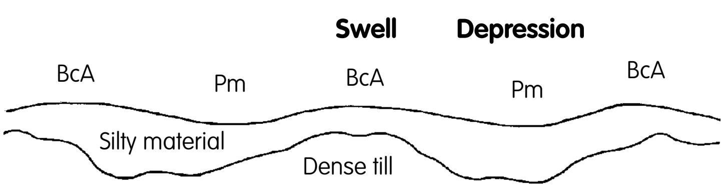
Representative soil series

Somewhat poorly drained soils: Beecher, Blount, DelRey, Kimmel, Elliot, Haskins
Poorly or very poorly drained soils: Pewamo, Milford, Reddick, Lenawee, Ashkum

Representative soil map

(Adams Co., sheet 25):





Somewhat poorly drained Blount soils (BcA, 0-1% slope) with light-colored surface horizons are on nearly level swells, and dark-colored, poorly drained Pewamo soils (Pm) are in low-lying flats and depressions. In this example Blount occurs as islands in Pewamo, but in other areas the relationship is reversed. The relief within the field for this association varies. In Adams County the slope range for BcA is 0 to 1%. Slopes with these low gradients indicate that the relief within a field is small. The area shown is 160 acres, 1/2 mile by 1/2 mile.

Drainage recommendations

If relief between the surface of the swells and depressions in the field to be drained is less than two ft., one of the parallel systems is often most effective, at a spacing of 40 to 80 ft. If relief is more than two ft., a parallel system is less effective because many of the tile lines would be in slowly permeable dense till, and, therefore, a random system is recommended. The main lines are installed below surface drainageways that follow the depressions. Surface inlets should be installed in the deepest part of the depressions, especially in closed depressions or potholes. Finger lines reach from the mains into the wettest areas of soils on the swells. Minimum tile depth is 36 in. In a few fields, the soils may be deeper than 36 in. to dense till, and the tile can be deeper.

Soil Drainage Association 5

Soils and landscapes

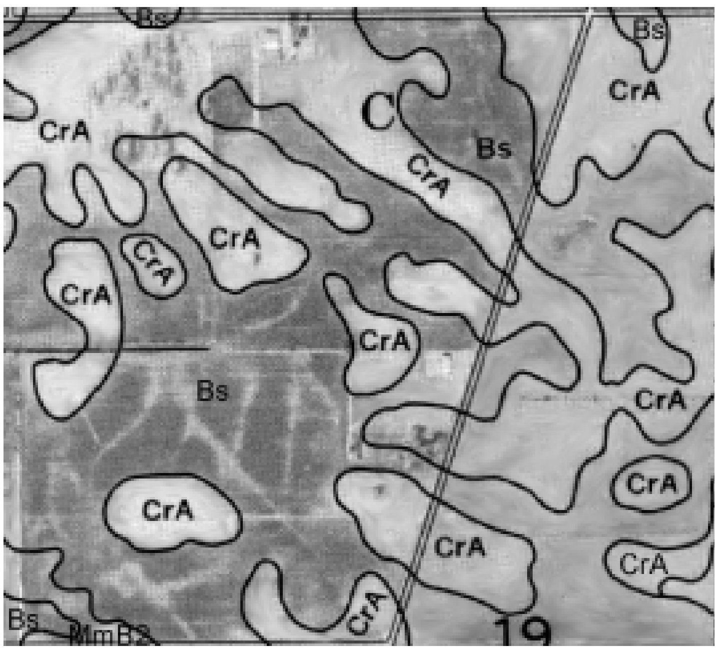
Swells and depressions are randomly arranged on the till plain. On the swells, somewhat poorly drained soils have 20 to 40 in. of medium or moderately fine material with moderate permeability over slowly permeable dense till. In depressions, poorly drained soils have more than 48 in. of material with moderate permeability over slowly permeable dense till.

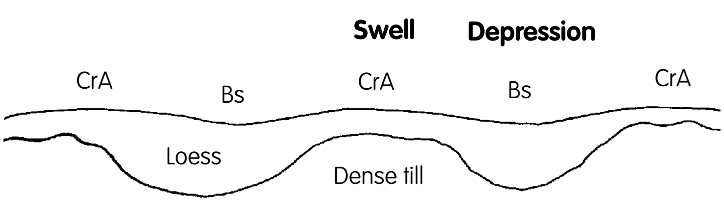
Representative soil series

Somewhat poorly drained soils: Crosby, Lisbon
Poorly drained soils: Brookston, Wolcott

Representative soil map

(Boone Co., sheet 24):





Somewhat poorly drained Crosby soils (CrA, 0-3%) with light-colored surface horizons are on nearly level swells, and dark-colored, poorly drained Brookston soils (Bs) are in low-lying flats and depressions. The slope range up to 3% in the Crosby map unit indicates that the relief is larger in this area than in areas where the slope ranges up to 1 or 2%. The straight line in the west-central part of the map is a drainage ditch. The light streaks in the Bs unit show tile lines that lead to the ditch in a random pattern. The area shown is 160 acres, 1/2 mile by 1/2 mile.

Drainage recommendations

If relief between the surface of the swells and depressions in the field to be drained is less than two ft., one of the parallel systems is often most effective, at a spacing of 50 to 100 ft. Usually, the poorly drained soils are more permeable than the somewhat poorly drained soils, so the larger spacing is used where poorly drained soils predominate in the field, and the smaller spacing is used where somewhat poorly drained soils predominate. If relief is more than two ft., a parallel system is less effective because many of the tile lines would be in slowly permeable dense till, so a random system is recommended. The main lines follow the surface drainageways in the depressions. Surface inlets may be used in the deeper depressions. Finger lines reach from the mains into the wettest soils on the swells. Minimum tile depth is 36 in. If the field is dominated by soils that are deeper than 36 in. to dense till, the tile can be deeper.

SOIL DRAINAGE ASSOCIATION 6

SOILS AND LANDSCAPES

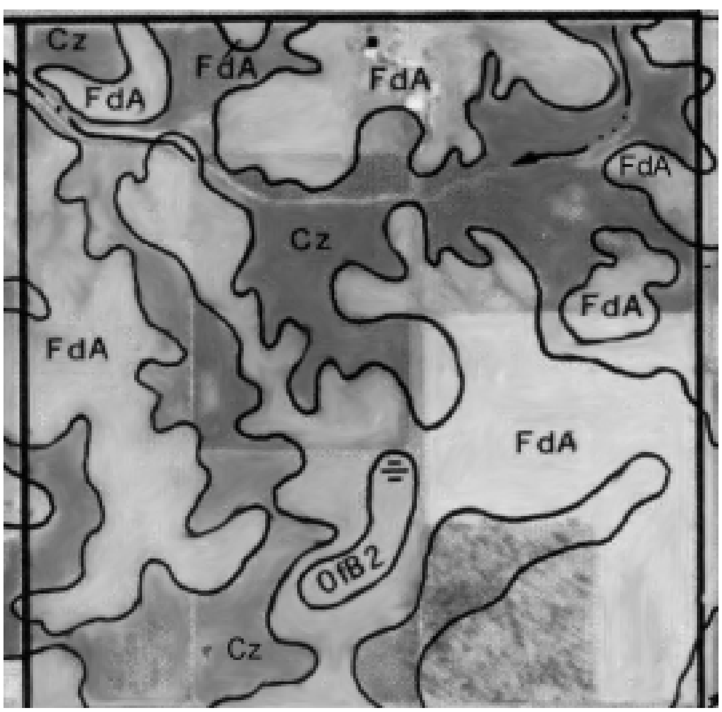
Swells and depressions are randomly arranged on the till plain. On the swells, somewhat poorly drained soils have 20 to 60 in. of medium or moderately fine textured material with moderate permeability over slowly permeable dense till. In depressions, poorly drained soils have more than 60 in. of material with moderate permeability over slowly permeable dense till.

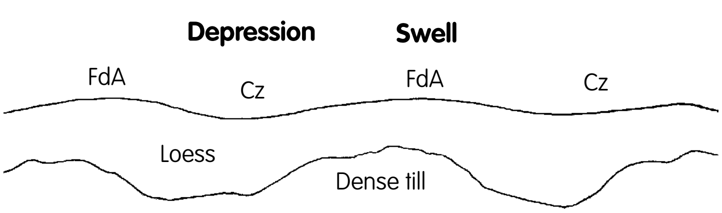
REPRESENTATIVE SOIL SERIES

Somewhat poorly drained soils: Fincastle, Toronto, Raub, Flanagan, Williamsport
Poorly or very poorly drained soils: Treaty, Cyclone, Chalmers, Kokomo, Washtenaw*, Harpster*
(* usually in deep, closed depressions)

REPRESENTATIVE SOIL MAP

(Montgomery Co., sheet 12):





Somewhat poorly drained Fincastle soils (FdA, 0-2% slope) with light-colored surface horizons are on nearly level swells, and dark-colored, poorly drained Cyclone soils (Cz) are in low-lying flats and depressions. The main natural drainageway passes through Cz in the north part of the area. A tile main would probably follow this drainageway. The area shown is 160 acres, 1/2 mile by 1/2 mile.

DRAINAGE RECOMMENDATIONS

If relief between the surface of the swells and depressions in the field to be drained is less than three to four ft., one of the parallel systems is often most effective, at a spacing of 60 to 120 ft. If relief is more than three to four ft., a parallel system is less effective because many of the tile lines would be in slowly permeable dense till, and a random system is recommended. The main lines are installed below surface drainageways that follow the depressions. Finger lines reach from the mains into the wettest soils on the swells. Minimum tile depth is 36 in., but in many fields they can be deeper because the dense till is deeper than 36 in.

Surface inlets may be needed to drain soils in deeper parts of the depression and in potholes. The soils above marked with an asterisk often occupy those landscape positions.

In some fields the somewhat poorly drained soils occur in association with moderately well drained soils instead of poorly drained soils. If the relief within such a field is less than three ft., a parallel system with a spacing of about 60 ft. may be used. If the relief is greater, a random system is recommended, with tile lines following the surface drainageways.

SOIL DRAINAGE ASSOCIATION 7

SOILS AND LANDSCAPES

Soils formed in deep loess on till plains and lake plains. Soils on swells have >48 in. of medium or moderately fine material, often loess, and are somewhat poorly drained. Soils in depressions have >60 in. of loess and are poorly drained.

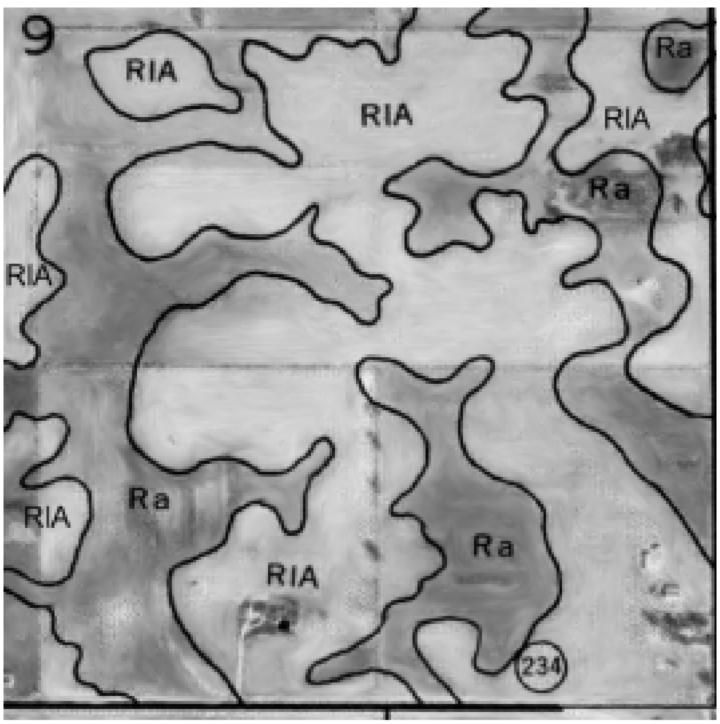
REPRESENTATIVE SOIL SERIES

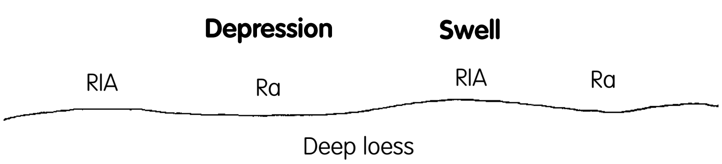
Somewhat poorly drained soils: Reesville, Henshaw, Iva, Ipava

Poorly drained soils: Patton, Ragsdale, Evansville, Whitson, Sable, Hoosierville

REPRESENTATIVE SOIL MAP

(Montgomery Co., sheet 58):





Relatively large areas of somewhat poorly drained Reesville soils with light-colored surface horizons (RIA, 0-2%) are cut by dark-colored, poorly drained Ragsdale (Ra) in the open depressions. These soils formed in loess or similar permeable material that is deeper than the usual depth of tile lines. Below these permeable materials are materials with slower permeability that hold up the water table, generally dense till, paleosols, or slowly permeable lacustrine material. The area shown is 160 acres, 1/2 mile by 1/2 mile.

DRAINAGE RECOMMENDATIONS

If relief between the surface of the swells and depressions in the field to be drained is less than three to four ft., one of the parallel systems is often most effective, at a spacing of 60 to 120 ft. If relief is more than three to four ft., a parallel system is less effective because many of the tile lines would be in slowly permeable material, and a random system is recommended. The main lines are installed below surface drainageways that follow the depressions. Finger lines reach from the mains into the wettest soils on the swells. Minimum tile depth is 36 in., but in many fields they can be deeper because more permeable materials are deeper than 36 in. Surface inlets may be needed to drain soils in deeper parts of the depression and in potholes.

Soil Drainage Association 8

Soils and landscapes

Loess-covered plains in southern Indiana comprise large, flat, poorly drained interiors surrounded by a rim of very gently sloping, somewhat poorly drained soils, and then steeper slopes on the bevel. Poorly drained soils in the interiors have 36 to 48 in. of moderately permeable loess over slowly permeable fragipans or other horizons. Somewhat poorly drained soils on the rims have 30 to 42 in. of moderately permeable loess over slowly permeable fragipans or other horizons.

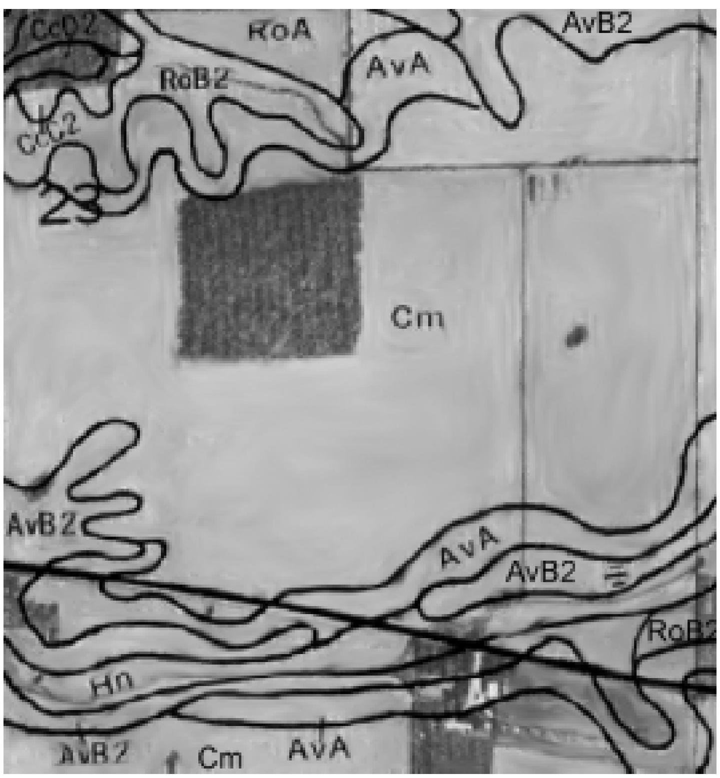
Representative soil series

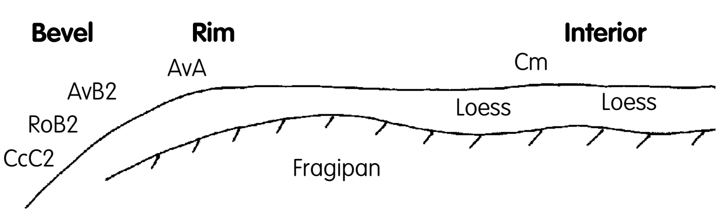
Somewhat poorly drained soils: Avonburg, Bartle, Dubois, Johnsburg, Patricksburg, Stoy, Vigo, Weinbach, Whitcomb

Poorly drained soils: Clermont, Cobbsfork, Ginat, Peoga

Representative soil map

(Ripley Co., sheet 14):





Poorly drained Cobbsfork soils (Cm, 0-1% slope) are on the interiors of large upland flats surrounded by a rim of nearly level, somewhat poorly drained Avonburg (AvA, 0-2%) and modratelу well drained Rossmoyne soils (RoA, 0-2%). On the bevel are sloping Avonburg (AvB2, 2-6%), Rossmoyne (RoB2, 2-6%), and Cincinnati soils (CcC2, 6-12%). Mainly the poorly and somewhat poorly drained soils are drained, but some RoA and seepy areas in RoB2 may also benefit from drainage. All these soils have light-colored surface horizons. The area shown is 160 acres, 1/2 mile by 1/2 mile.

Drainage recommendations

Mainly, the soils on the interiors and rims respond to drainage. Over the years, farmers have learned that, first, surface drainage should be improved by land planing (leveling) the field, with small ditches to collect water at the edges of the field. This practice can be very effective, but it requires maintenance every year or two. Erosion control practices are also needed because the long but gradual slopes on silty soils are very erodible.

Subsurface drainage is also effective. In most fields, a parallel system with a spacing of 30 to 60 ft., and a depth >30 in., but above the fragipan, is recommended. Drains in these silty soils with poor structure are subject to accumulating silt. To minimize this problem, the drain tubes can be covered with filter fabric (sock), and they should be installed at a grade steep enough to flush out any silt that enters the tile line, always more than 0.3%, and usually 0.4 to 0.5% for slotted plastic tubing. The grade is more critical than the sock. Some of these soils are on large flat areas. If the tile line is 30 in. deep in the center of the divide and a 0.4% grade is maintained, the main tile lines or ditches to which they empty must be very deep toward the edge of the divide. Because of the closer spacing of tile lines in these soils, 3-inch tile may be used instead of 4-inch tile. In some cases, laterals begin with a French drain in a roadside ditch. Water entering the tile from the ditch helps flush silt out of the tile line. Drainage systems have been installed and tested on the Southeastern Indiana Purdue Agricultural Center near North Vernon. Consult your local NRCS office for more information.

Soil Drainage Association 9

Soils and landscapes

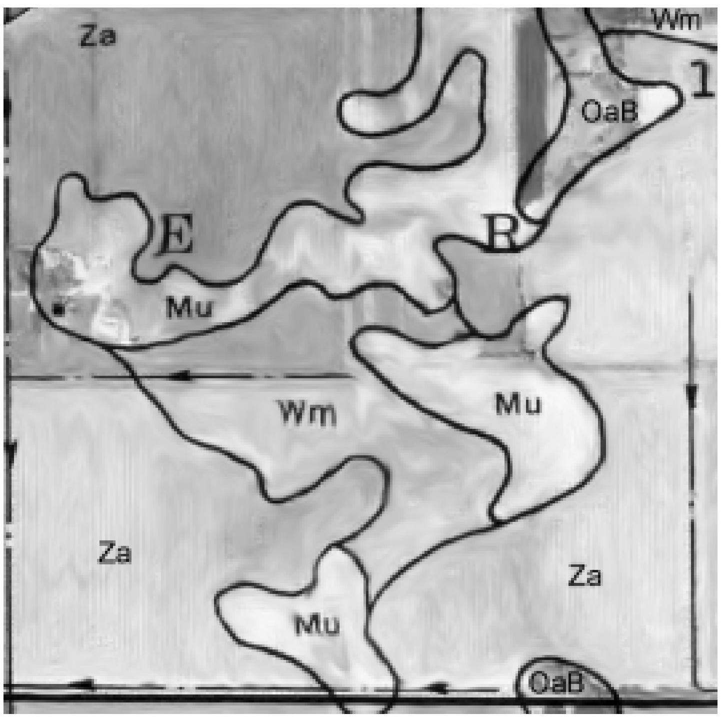
Coarse textured soils on sand plains and outwash plains. The wetter soils that may require drainage often are associated with soils on sand dunes that do not need drainage.

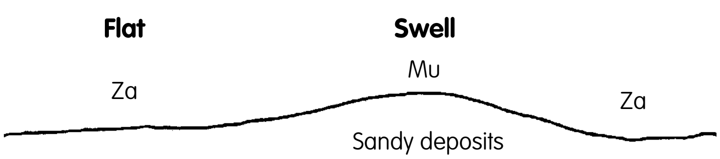
Representative soil series

Somewhat poorly drained soils: Morocco, Pipestone, Tedrow, Watseka, Zabrosky
Poorly or very poorly drained soils: Granby, Kentland, Maumee, Newton, Zadog

Representative soil map

(Jasper Co., sheet 23):





This area consists mainly of dark-colored, poorly drained Zadog (Za) and similar Watseka-Maumee soils (Wm) on large sandy flats. On the swells are somewhat poorly drained Morocco (Mu) soils with light-colored surface horizons. The southern half of the area is almost completely surrounded by drainage ditches (lines with arrows). A small dune with well drained Oakville soils (OaB) formed in eolian sand rises above the Morocco soils in the northeast part of the map. The area shown is 160 acres, 1/2 mile by 1/2 mile.

Drainage recommendations

Open ditches, 2 1/2 to 4 ft. deep spaced 660 ft. (1/8 mile) to 1,320 ft. (1/4 mile) apart, are recommended. In some cases, the ditches are supplemented with tile lines to drain problem areas. Filter fabric “socks” may be used around the tubes to keep sediment out. Also, cut-banks created during excavation in these soils are prone to caving in.

In the spring, after initial water removal, some of the drains can be blocked to maintain a high water table for sub-irrigation of crops. During dry periods some farmers pump water from streams into ditches to provide sub-irrigation.

Soil Drainage Association 10

Soils and landscapes

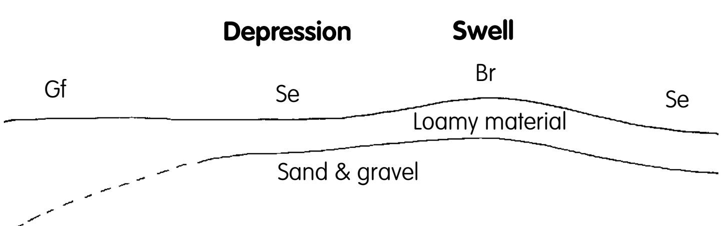
Soils are on outwash plains or terraces. They formed in moderately coarse, medium, or moderately fine material over coarse-textured material with rapid permeability. Soils on swells are somewhat poorly drained, and those in depressions are poorly drained. The relative area of swells and depressions may vary considerably.

Representative soil series

Somewhat poorly drained soils: Ayrshire, Brady, Roby, Riverdale, Ridgeville, Seafield
Poorly drained soils: Gilford, Lyles, Quinn, Pinhook

Representative soil map

(Fulton Co., sheet 36):



The area consists mainly of Brady soils (Br, 0-2%) on the swells and Sebewa (Se) and Gilford soils (Gf) in the depressions and flats. Organic soils (Hm and Ad) are in the lowest parts of the landscape. The area shown is 160 acres, 1/2 mile by 1/2 mile.

Drainage recommendations

A parallel system with some tile lines and some open ditches is recommended. Tile lines are installed at a spacing of 75 to 150 ft., with a minimum depth of 36 in. Filter fabric "socks" may be used around the tubes to keep sediment out. Open ditches 2 1/2 to 4 ft. deep may replace some tile lines of the parallel system. Cutbanks created during excavation in these soils are prone to caving in. The mixture of tile lines and open ditches may be determined largely according to farming systems and field equipment.

In the spring, after initial water removal, some of the drains can be blocked to maintain a high water table for sub-irrigation of crops. In some fields, iron-ochre (a reddish-brown deposit) builds up mainly on the outside of drain lines, but some is deposited inside the tile, near the slots. It plugs the slots or the gaps between tiles and decreases their effectiveness and also the life span of the drain. Iron ochre is a problem in parts of fields, but usually not in the whole field. It tends to be associated with the deeper depressions in a field. Some farmers flush iron ochre out of the tile lines every three to five years.

Soil Drainage Association 11

Soils and landscapes

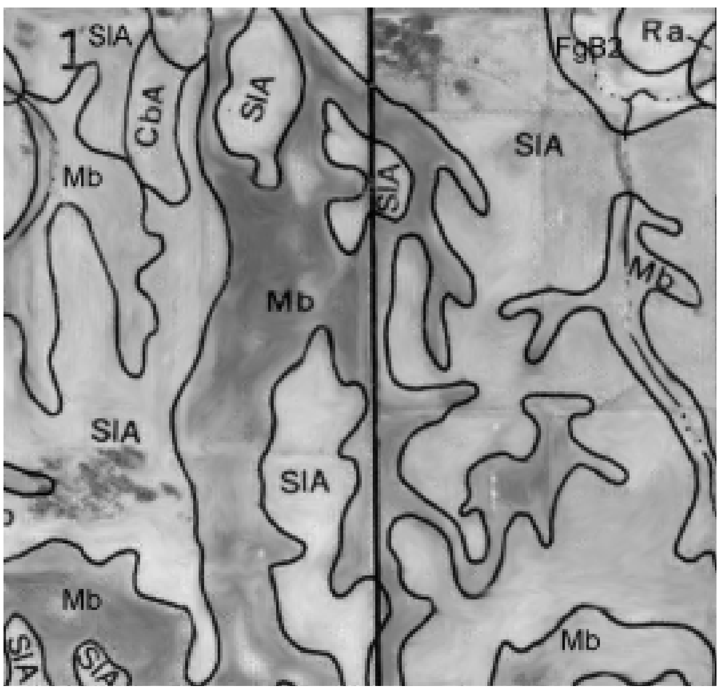
The soils are on low-relief outwash plains and lake plains and outwash-covered till plains. They formed in medium or moderately fine material over coarse or moderately coarse material. Swells and depressions are randomly arranged in the landscape. Soils on swells are somewhat poorly drained and those on flats and depressions are poorly drained.

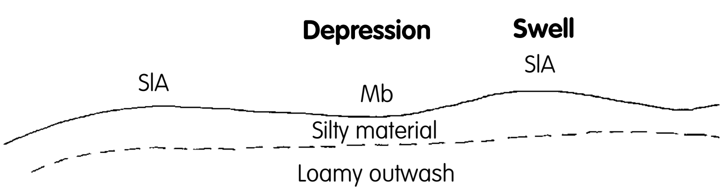
Representative soil series

Somewhat poorly drained soils: Brenton, Darroch, Millbrook, Whitaker, Sleeth, Starks
Poorly drained soils: Drummer, Mahalasville, Rensselaer, Selma, Westland, Millgrove

Representative soil map

(Montgomery Co., sheet 42):





Starks soils with light-colored surface horizons (SlA, 0-2%) are on the swells and dark-colored Mahalasville soils (Mb) are in the depressions. The area shown is 160 acres, 1/2 mile by 1/2 mile.

Drainage recommendations

Random systems are usually adequate in gently undulating landscapes with a relatively even mix of somewhat poorly and poorly drained soils. These soils have permeable strata in the subsoil that conduct water to tile lines. Main lines are installed in the lowest depressions of the field with branches into high parts of depressions and swells. Usually, the total length of tile lines in these soils is less than in the same size field with soils underlain by dense till, such as Soil Drainage Association 6. Supplemental surface inlets may be used to drain shallow closed depressions, and these depressions can be connected to nearby ones with surface drains. Minimum tile depth is 36 in.. Parallel systems may be effective in fields that are dominated by either somewhat poorly drained soils or by poorly drained soils because these fields usually have less relief than those with a more even mix. The recommended spacing is 60 to 120 ft., with a minimum depth of 36 in. Cut-banks created during excavation in these soils are prone to caving in.

Soil Drainage Association 12

Soils and landscapes

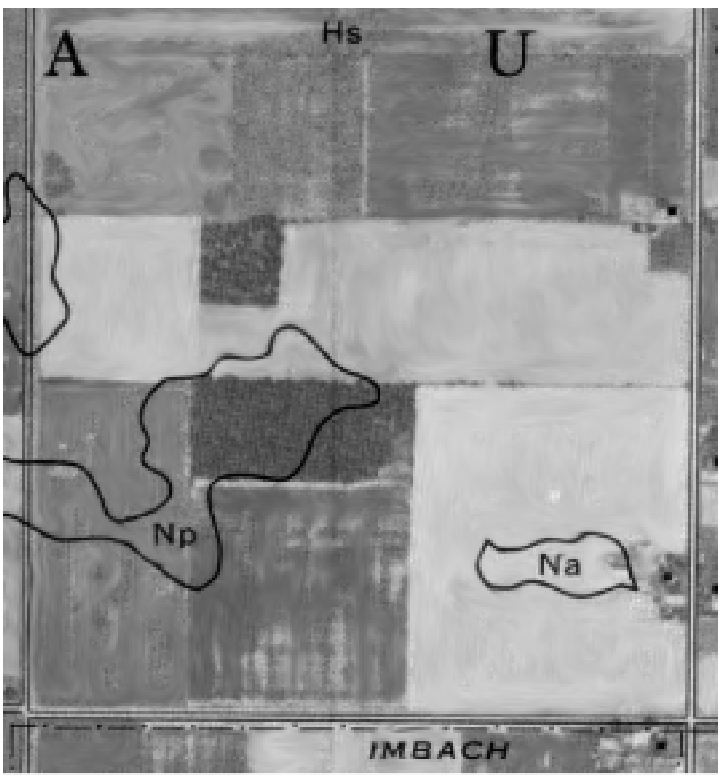
Fine-textured soils on low-relief lake plains. Soils on swells are somewhat poorly drained and those on flats and depressions are poorly drained. Often the flats are very extensive.

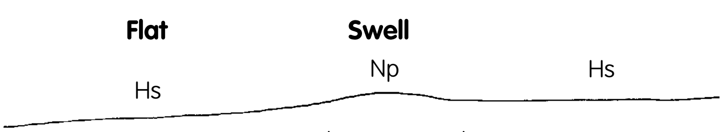
Representative soil series

Somewhat poorly drained soils: Nappanee, McGary, Fulton, Strole, Swygert
Poorly or very poorly drained soils: Hoytville, Zipp, Montgomery, Toledo, Booker

Representative soil map

(Allen Co., sheet 55):





The area illustrated is a lake plain. The topography is very flat with a few swells. The flat area has Hoytville soils (Hs), and Nappanee soils (Np) are on the swells. The area shown is 160 acres, 1/2 mile by 1/2 mile.

Drainage recommendations

Parallel systems are recommended, with spacing of 25 to 50 ft., and minimum depth of 30 in. Supplemental surface inlets can be installed in shallow closed depressions, and these depressions can be connected to nearby closed depressions with surface drains. Because of the closer spacing of tile lines, 3-inch tile can be used instead of 4-inch tile.

SOIL DRAINAGE ASSOCIATION 13

SOILS AND LANDSCAPES

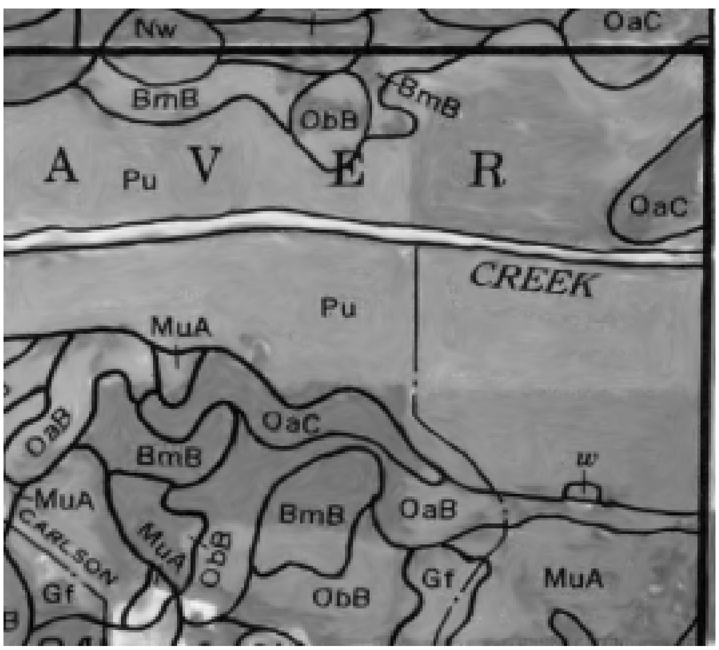
Poorly and somewhat poorly drained, coarse-textured soils on flood plains, largely in northwestern Indiana. In most places they are adjacent to streams or chanellized streams, as shown in the representative soil map, but in other places better drained soils are on the higher natural levees near the streams and the wetter soils are in the lower-lying backswamps and old meander channels beyond the natural levees.

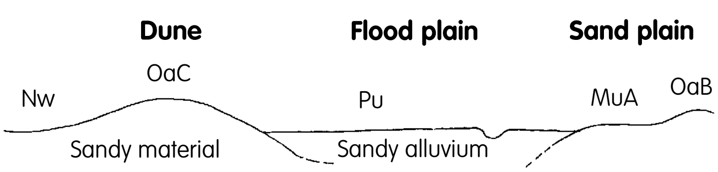
REPRESENTATIVE SOIL SERIES

Somewhat poorly drained soils: Algansee
Poorly drained soils: Prochaska

REPRESENTATIVE SOIL MAP

(Newton Co, sheet 34):





Beaver Creek flows through poorly drained Prochaska (Pu) soils. They are surrounded by well drained soils including Oakville soils on sand dunes (OaB, OaC) and somewhat poorly drained Morocco soils (MuA) and poorly drained Newton soils (Nw) on sand plains. Organic soils (Ad) are in the lowest parts of the landscape. The area shown is 160 acres, 1/2 mile by 1/2 mile.

DRAINAGE RECOMMENDATIONS

There are many problems in draining somewhat poorly and poorly drained soils on flood plains. They may flood frequently, many occur in small units, or they may not be accessible for farming. Outlets for this association are often difficult to locate. In some areas, however, drainage is practical. First, use open ditches 2.5 to 4 ft. deep with 660 ft. spacing. Since over-draining may make these soils droughty, consider controlling the water table. Ditches may be supplemented with tile drainage. Parallel systems can be used in large poorly drained flats at a spacing of 75 to 150 ft. and a depth of at least 36 in. Random systems may be more appropriate in fields with many former oxbow lakes and meander channels. Cut-banks created during excavation in these soils are prone to caving in. Wet soils in narrow backswamps and old meander channels may be drained by running a tile line lengthways through the wet area. A filter fabric “sock” to keep sediment out of the line is recommended.

Soil Drainage Association 14

Soils and landscapes

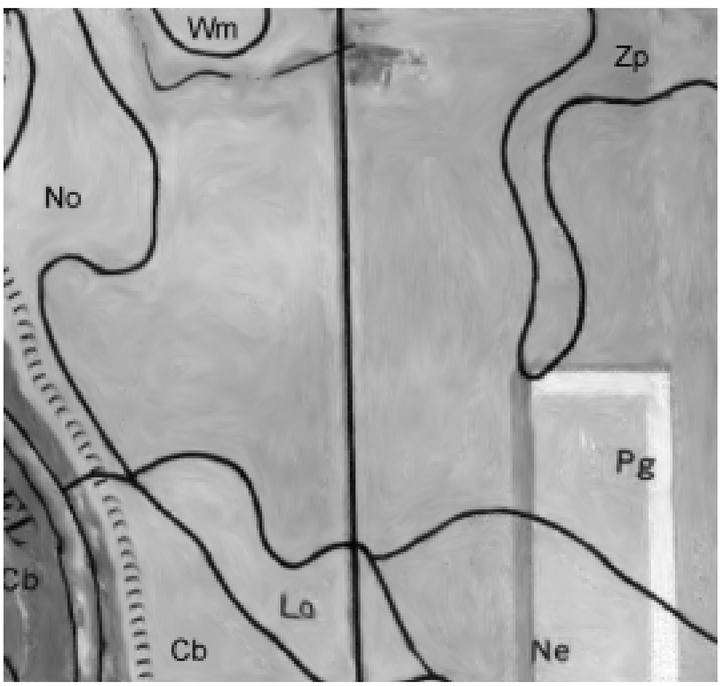
Somewhat poorly and poorly drained, medium-textured soils on flood plains. On larger streams, better drained soils are on the natural levees near the channel, and the wetter soils that may benefit from tile drainage are on the backlands or backswamps. This is the pattern in the representative soils map.

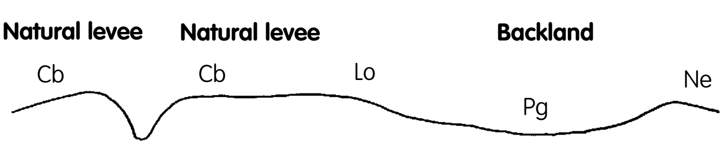
Representative soil series

Somewhat poorly drained soils: Wakeland, Newark, Stendal, Shoals, Holton, Ceresco
Poorly or very poorly drained soils: Birds, Bonnie, Sloan, Craigmile, Cohoctah, Ambraw

Representative soil map

(Clay Co., sheet 45):





This is a flood plain along the Eel River. Well and moderately well drained soils (No, Lo, and Cb) are on the natural levee near the river. A man-made levee, shown by a row of hatch lines, was constructed on the natural levee to protect soils beyond it from floods. Somewhat poorly drained Newark (Ne) and poorly drained Petrolia soils (Pg) are on the lower-lying backlands. The area shown is about 160 acres, 1/2 mile by 1/2 mile.

Drainage recommendations

There are many problems in draining somewhat poorly and poorly drained soils on flood plains. They may flood frequently, occur in small units, or are not accessible for farming. Parallel tile systems can be used in large areas of at a spacing of 60 to 120 ft. and a depth of at least 36 in. Drains in these silty soils with poor structure are subject to accumulating silt. To minimize this problem, the drain tubes can be covered with a filter fabric "sock," and they should be installed at a grade steep enough to flush out any silt that enters the tile line, always more than 0.3%, and usually 0.4 to 0.5% for slotted plastic tubing. Cut-banks created during excavation in these soils are prone to caving in. If the field contains mainly poorly drained soils, the spacing may be around 60 ft., and if it contains mainly somewhat poorly drained soils, around 120 ft. Random systems may be more appropriate in fields with many former oxbow lakes and meander channels. Soils in narrow backswamps and old meander channels may be drained by running a tile line lengthways through the wet area. Shallow surface drains might be used to supplement subsurface drains in fields that do not flood frequently. Also, it might be necessary to install diversions to cut off runoff from upland soils and interceptor drains to intercept seepage water.

Soil Drainage Association 15

Soils and landscapes

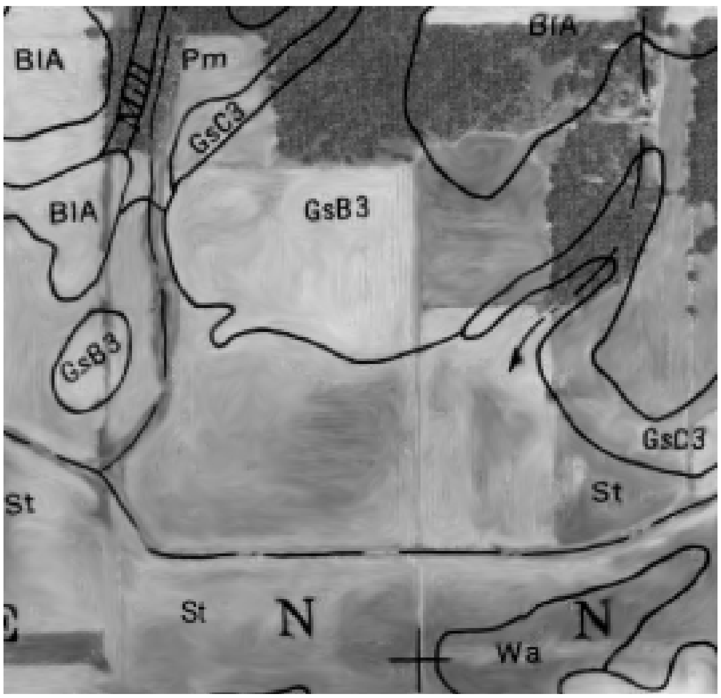
Poorly and very poorly drained, fine-textured soils on flood plains.

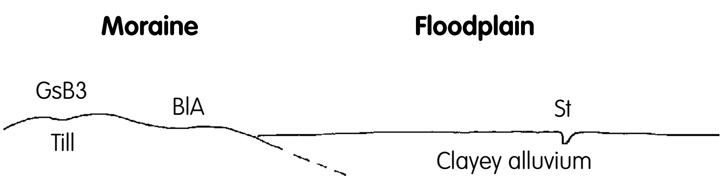
Representative soil series

Poorly drained soils: Driftwood, Wilhite
Very poorly drained soils: Bellcreek, Saranac

Representative soil map

(Blackford/Jay Cos., sheet 15):





Poorly drained Saranac soils (St) are on the flood plain along Beaver Creek, which has been channelized. About 1.5 miles downstream from this site, Beaver Creek flows into the Salamonie River. When it floods, flood water probably backs up onto these Saranac soils, which finger into an area of fine-textured upland soils. Glynwood (GsB3) and Blount (BlA) soils are on the moraine. The area shown is 160 acres, 1/2 mile by 1/2 mile.

Drainage recommendations

There are many problems in draining somewhat poorly and poorly drained soils on flood plains. They may flood frequently, occur in small units, or are not accessible for farming. Parallel systems can be used in large flat areas at a spacing of 40 to 80 ft. and a depth of at least 36 in. Random systems may be more appropriate in fields with many former oxbow lakes and meander channels. Poorly and somewhat poorly drained soils in narrow backswamps and old meander channels may be drained by running a tile line lengthways through the wet area.

Shallow surface drains are recommended to supplement subsurface drains. Also, it might be necessary to install diversions to cut off runoff from upland soils and interceptor drains to intercept seepage water. If the field contains mainly poorly drained soils, the spacing may be around 40 ft., and if it contains mainly somewhat poorly drained soils, around 80 ft. Surface inlets may be used in the deeper depressions.

Soil Drainage Association 16

Soils and landscapes

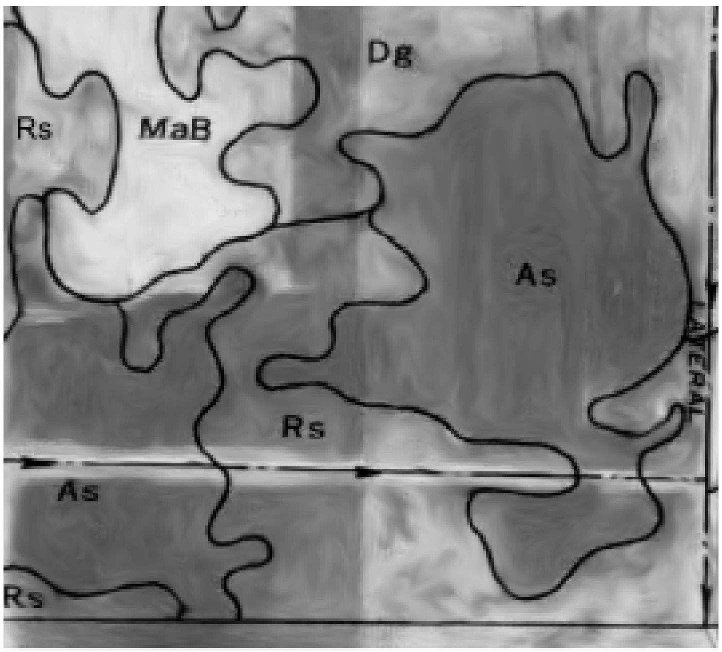
Shallow muck, 16 to 51 in. deep, over loamy or sandy material in bogs that formed in relatively large lakes, smaller oxbow lakes, and other depressions.

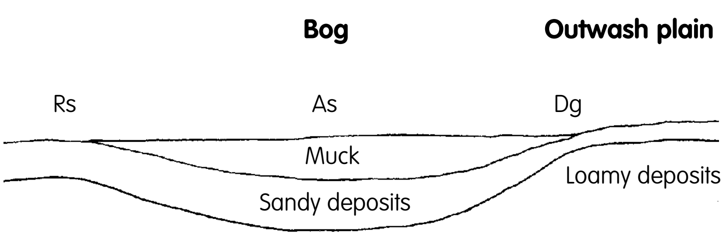
Representative soil series

Very poorly drained soils: Palms, Linwood, Adrian

Representative soil map

(Jasper Co., sheet 37):





Relatively large areas of Adrian muck (As) are surrounded by somewhat poorly and poorly drained loamy soils. A drainage ditch goes through the As unit and poorly drained Rensselaer soils (Rs). The area shown is 160 acres, 1/2 mile by 1/2 mile.

Drainage recommendations

Primary drainage is by open ditches at a spacing of 200 ft. Pumping may be required if a gravity outlet is not available. Use diversions to cut off upland water. Ditches may be supplemented with tile lines. Parallel systems with a spacing of 80 to 160 ft. and a depth of 48 to 60 in. can be installed in large areas of these soils. A random pattern works best in small areas. Plastic lines are recommended because subsidence may cause concrete or clay tile to shift and become mis-aligned. Some of the lines probably will pass through mineral soil materials below the muck. To prevent siltation from these materials, the lines should be covered with filter material, or a “sock.” In some places iron ochre, a reddish-brown precipitate, builds up on the outside and within drain tubes. It is most likely to be a problem where sandy soils are near organic soils. (See the discussion about iron ochre in Association 10).

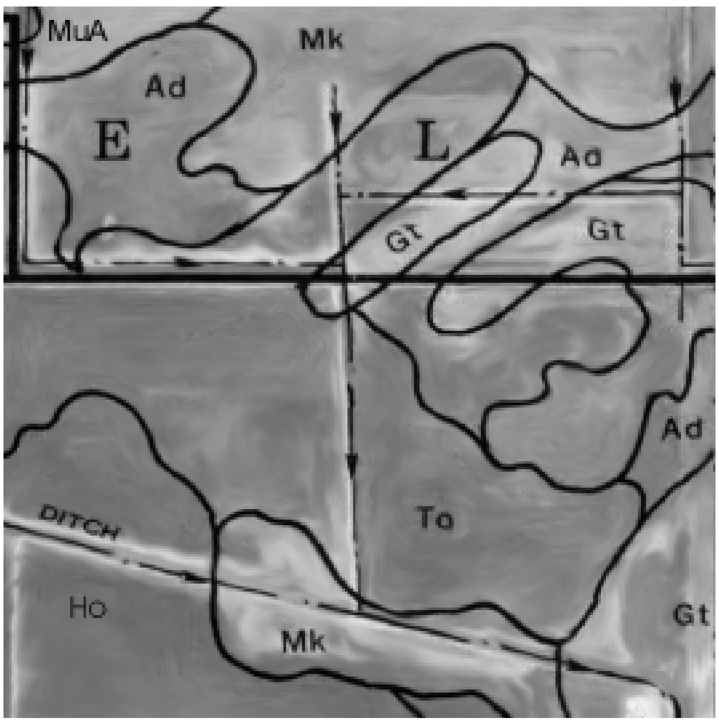
Organic soils formed in shallow lakes where oxygen was scarce. When they are drained, oxygen becomes plentiful in the soil, organic matter is consumed by oxidation (analogous to burning), and the surface subsides. To minimize oxidation, the water table should be kept as high as possible by installing gates in ditches. Water may need to be pumped into the drain lines to maintain the high water table, and supply water for crop growth.

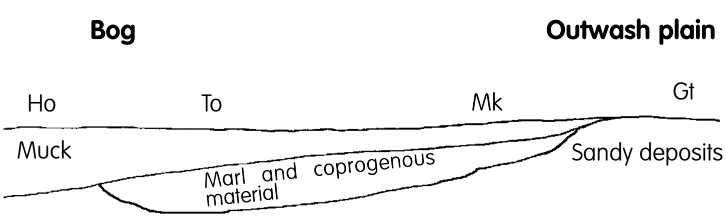
Soil Drainage Association 17

Soils and landscapes
Shallow organic soils in bogs formed in relatively large lakes, smaller oxbow lakes, or depressions. These soils have 16 to 51 in. of muck over slowly permeable material such as marl, coprogenous material (sedimentary muck), or fine-textured mineral soil material. Also included are soils that have mineral outwash over organic soils.

Representative soil series
Very poorly drained soils: Edwards, Willette, Martisco, Muskego, Toto, Warners

Representative soil map
(Newton Co., sheet 24):





Toto soils (To), shallow muck over marl and coprogenous material, are bordered by deep Houghton muck (Ho) in the southwest part of the map and by shallow muck over sand Adrian (Ad) to the north, and by poorly drained mineral soils with a mucky surface Maumee (Mk) and poorly drained soils with a dark-colored mineral surface Granby (Gt). The area shown is 160 acres, 1/2 mile by 1/2 mile.

Drainage recommendations
Soil properties in this unit vary considerably. Often draining these soils is too expensive to be practical. If drainage is to be installed, use open ditches at a spacing of around 200 ft. Pumping may be required if a gravity outlet is not available. Use diversions to cut off upland water. In larger areas of these soils, ditches may be supplemented with tile lines. Parallel systems with a spacing of 80 to 160 ft. and a depth of 48 to 60 in. can be installed.

Organic soils formed in shallow lakes where oxygen was scarce. When they are drained, oxygen becomes plentiful in the soil, organic matter is consumed by oxidation (analogous to burning), and the surface subsides. To minimize oxidation, the water table should be kept as high as possible by installing gates in ditches. It may be necessary to pump water into the drain lines to maintain the high water table, and supply water for crop growth. Coprogenous material is especially difficult to manage. When moist, it is gelatin-like. As it dries, it shrinks to a fraction of its moist volume. If it becomes thoroughly dry, it will not wet up again.

Soil Drainage Association 18

Soils and Landscapes

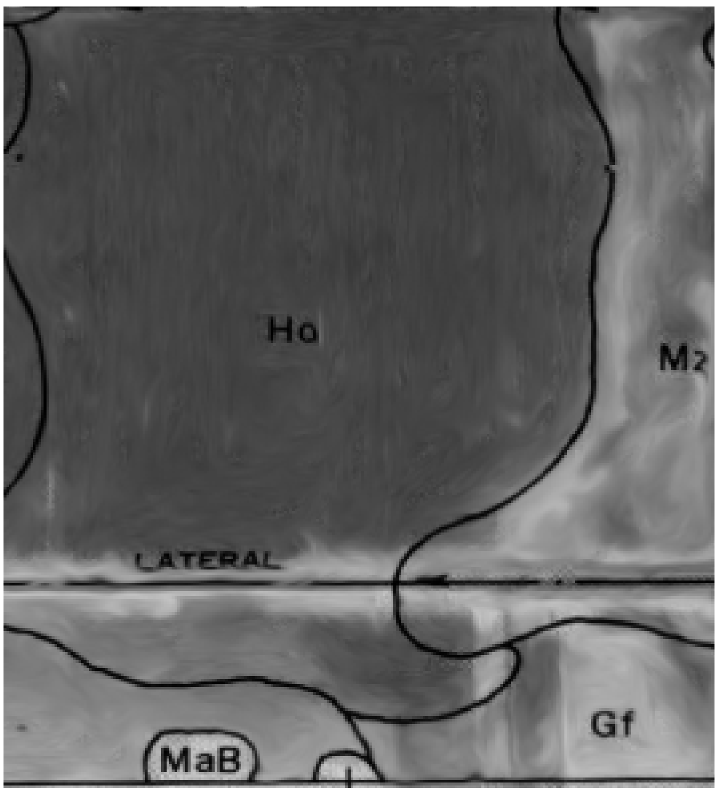
Deep peat and muck deposits (>51 in.) in bogs.

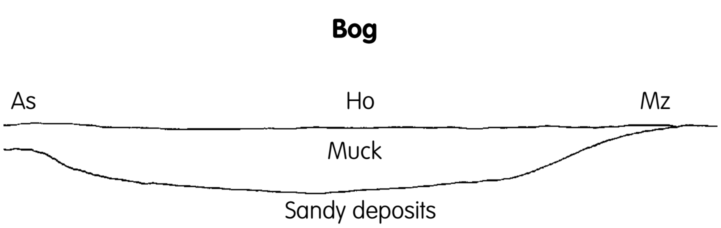
Representative soil series

Very poorly drained soils: Houghton, Napoleon, Boots, Carlisle, Wallkill

Representative soil map

(Jasper Co., sheet 36):





A large area of deep muck (Houghton, Ho) is bordered on the west by shallow muck (Adrian, As) and on the east by a poorly drained mineral soil with a mucky surface (Mussey, Mz). A major drainage ditch (lateral) is shown on the southern part of the map. The area shown is 160 acres, 1/2 mile by 1/2 mile.

Drainage recommendations

Primary drainage is by open ditches about 2 1/2 to 4 ft. deep at a spacing of around 200 ft. Pumping may be required if a gravity outlet is not available. Use diversions to cut off upland water. Ditches may be supplemented with tile lines. Parallel systems with a spacing of 80 to 160 ft. and a depth of 48 to 60 in. can be installed in large areas of these soils. A random pattern works best in small areas. Plastic lines are recommended because subsidence may cause concrete or clay tile to shift and become mis-aligned. A reddish-brown deposit of iron ochre may accumulate around and in the drain tubes (See the discussion about iron ochre in Association 10). This is a problem mainly where sandy soils are nearby.

Organic soils formed in shallow lakes where oxygen was scarce. When they are drained, oxygen becomes plentiful in the soil, organic matter is consumed by oxidation (analogous to burning), and the surface subsides. To minimize oxidation, the water table should be kept as high as possible by installing gates in ditches. Water may need to pumped into the drain lines to maintain the high water table, and supply water for crop growth.

Soil Drainage Association 19

Soils and landscapes

These moderately well and well drained soils either lack morphological indicators of wetness or the indicators are deeper than 30 in., but they occasionally have a seasonally high water table. Many of the soils are on slopes and lack reduction features in the upper 30 in. because water moves in the soil and picks up oxygen instead of being more stagnant as it is in somewhat poorly and poorly drained soils. Many soils in this association have a layer that restricts water movement in the substratum, such as dense till, fragipan, or bedrock. These soils often have seepy areas on lower hillslopes. Some soils of this association are on floodplains. They do not have limiting layers, but water tables are close enough to the surface to cause problems for crop production in some areas.

Representative soil series

Moderately well and well drained soils: Bedford, Brems, Celina, Glynwood, Miami

Drainage recommendations

These soils usually do not require drainage, but in some places it might be beneficial. The areas that will benefit from drainage must be identified from experience. They do not show on a soil map. Often they are near more poorly drained soils that are drained by tile, and tile lines can be run from these soils into the better drained ones. Generally the tile lines will be placed beneath natural drainageways. Tile lines may also be installed into seepy hillsides.

Soil Drainage Association 20

Soils and landscapes

These soils are very well drained naturally. They are highly permeable or on steep slopes.

Representative soil series

Well and excessively drained soils: Oakville, Plainfield, Berks, Fox, Weikert, Gilpin

Drainage recommendations

They do not require additional drainage.

Soil Drainage Association 21

Soils and landscapes

This association includes "odds and ends" of soils, many of which have been highly disturbed by man's activities. It includes reclaimed surface-mined land, former gravel pits, and graded areas. It also includes some natural wetlands such as marshes.

Representative soil series

Fairpoint, Hollybrook, Made land, Marsh, Marl beds

Drainage recommendations

Generally these areas are not farmed intensively and drainage would not be feasible. If drainage is to be considered, an on-site investigation is required.

PART III

Drainage Recommendations for Indiana Soils

Soil Series and Their Natural Drainage Class and Soil Drainage Association Number

List of soil series names (or other map unit identifiers), natural drainage class, and Soil Drainage Association number. The Associations are discussed in Part II.

Natural drainage class abbreviations:		
	VP - very poor	P - poor
	SP - somewhat poor	MW - moderately well
	W - well	SE - somewhat excessive
	E - excessive	VR - variable

Soil	Class	Assoc.
Abscota	MW	19
Ackerman	VP	16
Adeland	SP	2
Adrian	VP	16
Adrian Variant	VP	16
Adrian, undrained	VP	16
Adyeville	W	20
Alford	W	20
Algansee	SP	13
Algansee Variant	SP	13
Algiers	SP	14
Alida	SP	10
Allison	W	20
Allison Variant	W	20
Alluvial land	W	20
Alvin	W	20
Ambraw	P	14
Andres	SP	6
Angatoka	W	20
Antung	P	16
Aptakisic	SP	11
Aquents	P	21
Aquolls	VP	21
Armiesburg	W	20
Armiesburg Var.	W	20
Arney	MW	19
Ashkum	P	4
Atkins	P	14
Aubbeenaubbee	SP	1
Ava	MW	19
Avonburg	SP	8
Ayr	W	19
Ayr Variant	MW	19
Ayrmount	MW	19
Ayrshire	SP	10
Ayrshire Variant	SP	10
Bainter	W	20
Banlic	SP	14
Barce	MW	19
Barry	P	3
Bartle	SP	8
Battleground	W	20
Baugo	SP	11
Beaches	SE	20
Beanblossom	MW	19
Beasley	W	19
Beaucoup	VP	14
Beckville	MW	19
Bedford	MW	19
Beecher	SP	4
Belknap	SP	14
Bellcreek	VP	15
Belleville	VP	1
Belmore	W	20
Belmore Variant	W	20
Benadum	VP	17
Berks	W	20
Berrien	MW	19
Bethesda	W	14
Billett	MW	19
Birds	P	14
Birkbeck	MW	19
Blocher	MW	19
Blocher, hard bedrock	MW	19
Blocher, soft bedrock	MW	19
Bloomfield	SE	20
Blount	SP	4
Bobtown	MW	19
Bonnel	W	20
Bonnie	P	14
Bono	VP	4
Bono Variant	VP	4
Bonpas	VP	12
Booker	VP	12
Boots	VP	18
Bourbon	SP	10
Bowes	W	20
Bowes Variant	MW	19
Boyer	W	20
Brady	SP	10
Brems	MW	19
Brenton	SP	11
Brenton Variant	SP	11
Bristol	E	20
Bronson	MW	19
Brookston	P	5
Brouillett	SP	14
Brownstown	W	20
Bryce	P	12
Budd	SP	10
Burnside	MW	19
Cadiz	MW	19
Camden	W1	9
Camden Variant	W	19
Caneyville	W	20
Carlisle	VP	18
Carmel	W	19
Carmi	W	20
Casco	W	20
Celina	MW	19
Ceresco	SP	14
Ceresco Variant	SP	14
Chagrin	W	20
Chagrin Variant	W	20
Chalmers	P	6
Chatterton	W	20
Cheektowaga	P	1
Chelsea	E	20
Chetwynd	W	20
Cincinnati	MW	19
Cincinnati Variant	MW	19
Clay pits	W	21
Clermont	P	8
Cobbsfork	P	8
Coesse	VP	4
Cohoctah	VP	14
Cohoctah Variant	VP	14
Coloma	SE	20
Colyer	W	20
Comfrey	VP	14
Conotton	W	14
Conover	SP	3
Conrad	P	9
Coolville	MW	19
Cope	P	6
Corwin	MW	19
Cory	P	7
Corydon	W	20
Cosperville	W	20
Coupee	W	20
Craigmile	VP	14
Craigmile Variant	SP	14
Crane	SP	11
Crawleyville	SP	11
Crider	W	20
Crider Variant	W	20
Crosby	SP	5
Crosier	SP	3
Cuba	W	20
Cyclone	P	6
Dana	MW	19
Darroch	SP	11
Deam	W	20
Dearborn	W	20
Del Rey	SP	4
Del Rey Variant	SP	4
Delmar	P	6
Denham	MW	19
Deputy	MW	19
Desker	W	20
Digby	SP	11
Door	W	20
Driftwood	P	15
Drummer	P	11
Dubois	SP	8
Dune land	W	20
Dupage	W	20
Ebal	MW	19
Eden	W	19
Edenton	W	19
Edsel	VP	17
Edwards	VP	17
Edwards Variant	VP	17
Eel	MW	19

Soil	Class	Assoc.
Eldean	W	20
Eldean Variant	W	20
Elkinsville	W	20
Elliott	SP	4
Elston	W	20
Elston Variant	MW	19
Evansville	P	7
Fairmount	W	20
Fairpoint	W	21
Faxon	VP	2
Fincastle	SP	6
Flanagan	SP	6
Fluvaquents	SP	21
Foresman	MW	19
Foresman Variant	W	20
Fox	W	20
Fox Variant	W	20
Francesville	SP	2
Frederick	W	20
Free	P	11
Fulton	SP	12
Gallimore	W	20
Genesee	W	20
Genesee Variant	W	20
Gessie	W	20
Gessie Variant	W	20
Gilboa	SP	3
Gilford	P	10
Gilford Variant	P	10
Gilpin	W	20
Gilpin Variant	W	20
Gilwood	W	20
Ginat	P	8
Glenhall	MW	19
Glynwood	MW	19
Glynwood Variant	MW	19
Gnawbone	W	20
Goodell	P	10
GoSPort	M	19
Granby	P	9
Granby Variant	VP	9
Gravelton	VP	14
Grayford	W	20
Greybrook	W	20
Griswold	W	19
Grovecity	SP	3
Gudgel	W	19
Gumz	P	9
Hagerstown	W	20
Haney	MW	19
Hangingrove	SP	10
Hanna	MW	19
Haplaquepts	P	21
Harpster	P	6
Haskins	SP	4
Haskins Variant	SP	4
Haymond	W	19
Haymond Variant	W	20
Headlee	SP	4
Hennepin	W	20
Henshaw	SP	7
Henshaw Variant	SP	7
Hickory	W	19
High Gap	W	19
High Gap Variant	MW	19
Hillsdale	W	19
Histosols	VP	18
Hollybrook	SP	21
Holton	SP	14
Homer	SP	11
Hononegah	E	20
Hoopeston	SP	10
Hoosierville	P	7
Hosmer	MW	19
Houghton	VP	18
Hoytville	VP	12
Huntington	W	20
Huntington Var.	W	20
Huntsville	W	20
Iona	MW	19
Ipava	SP	7
Iroquois	VP	1
Iva	SP	7
Jamestown	SP	14
Jasper	W	19
Jennings	MW	19
Jennings Variant	MW	19
Jessietown	W	19
Johnsburg	SP	8
Judyville	W	20
Jules	W	20
Junius	P	9
Junius Variant	P	9
Kalamazoo	W	20
Kendall	SP	11
Kendallville	W	19
Kentland	VP	9
Kimmell	SP	4
Kings	VP	12
Kokomo	VP	6
Kosciusko	W	20
Kurtz	W	20
La Hogue	SP	11
Lafayette	SP	11
Landes	W	20
Landes Variant	W	20
Lash	W	20
Lauramie	W	19
Lenawee	VP	4
Lickcreek	W	20
Lieber	SP	8
Lindside	MW	19
Linkville	W	20
Linwood	VP	16
Lisbon	SP	5
Lobdell	MW	19
Lomax	W	20
Longlois	W	20
Losantville	MW	19
Loudonville	MW	19
Lucas	MW	19
Lybrand	W	19
Lydick	W	20
Lyles	P	10
Madaus	VP	17
Made land	W	21
Made land and pits	W	21
Mahalasville	P	11
Mahalasville Var.	VP	11
Manlove	MW	19
Maplehill	SP	14
Marker	MW	19
Markham	MW	19
Markland	W	19
Markton	SP	1
Marl beds	VP	21
Marsh	VP	21
Martinsville	W	20
Martisco	VP	17
Martisco Variant	VP	17
Matherton	SP	11
Maumee	P	9
Maumee Variant	P	9
McAdoo	W	20
McGary	SP	12
Medora	MW	19
Medway	MW	19
Mellott	W	19
Mermill	P	1
Metamora	SP	3
Metea	MW	19
Miami	MW	19
Miamian	MW	19
Milford	VP	4
Milford Variant	VP	4
Millbrook	SP	11
Millbrook Variant	SP	11
Millgrove	P	11
Millsdale	P	2
Milton	W	19
Milton Variant	W	20
Mine dumps	VR	21
Mine pits and dumps	VR	21
Minnehaha	SE	19
Mishawaka	E	20
Mississinewa	MW	19
Mitiwanga	SP	2
Monon	P	10
Montgomery	P	12
Montgomery Var.	P	12
Montmorenci	MW	19
Moon	MW	19
Morley	MW	19
Morocco	SP	9
Mosley	VP	17
Mountpleasant	W	19
Mudlavia	W	20
Mudlavia Variant	W	19
Mulvey	SP	11
Muncie	W	19
Mundelein	SP	11
Muren	MW	19
Muskego	VP	17
Muskingum	W	20
Mussey	P	11
Nabb	MW	19
Napoleon	VP	18
Nappanee	SP	12
Nawakwa	W	21
Negley	W	20
Nesius	MW	19
Newark	SP	14
Newglarus	W	19
Newton	P	9
Nicholson	MW	19
Nineveh	W	20
Nineveh Variant	W	20
Nolin	W	20
Oakville	W	20
Ockley	W	20
Octagon	MW	19
Odell	SP	3
Oldenburg	MW	19
Olephant	W	20
Onarga	W	20
Ormas	W	20
Ormas Variant	SP	10
Orrville	SP	14
Orthents	W	21
Oshtemo	W	20
Osolo	W	20
Otwell	MW	19
Ouiatenon	SE	20
Owosso	W	19
Palms	VP	16
Palms Variant	VP	16
Papineau	SP	1
Parke	W	20
Parr	MW	19
Pate	W	19
Patricksburg	SP	8
Patton	P	7
Pekin	MW	19
Pella	P	7
Peoga	P	8
Peoga Variant	P	8
Peotone	VP	4
Petrolia	P	14
Pewamo	P	4
Pewamo Variant	P	4
Philo	MW	19
Piankeshaw	W	20
Piankeshaw Var.	W	20
Pike	W	20
Pinevillage	W	20
Pinhook	P	10

Soil	Class	Assoc.
Piopolis	P	14
Pipestone	SP	9
Plainfield	E	20
Plainfield Variant	E	20
Plano	W	20
Poorly drained Aquent	P	21
Pope	W	20
Potawatomi	MW	19
Pottersville	W	19
Princeton	W	20
Prochaska	P	13
Proctor	W	19
Psamments	SE	19
Quinn	P	10
Radioville	P	11
Ragsdale	P	7
Rahm	SP	14
Rainsville	MW	19
Randolph	SP	2
Randolph Variant	SP	2
Rarden	MW	19
Raub	SP	6
Rawson	MW	19
Rawson Variant	MW	19
Reddick	P	4
Reesville	SP	7
Rensselaer	P	11
Rensselaer Variant	P	11
Richardville	W	19
Riddles	W	19
Ridgeville	SP	10
Riverdale	SP	10
Riverwash	W	21
Roby	SP	10
Roby Variant	MW	19
Rockcastle	SE	20
Rockfield	MW	19
Rockmill	P	16
Rockton	W	19
Rodman	E	20
Rohan	W	20
Romona	W	19
Ross	W	20
Ross Variant	W	20
Rossburg	W	20
Rossmoyne	MW	19
Royerton	MW	19
Ruark Variant	P	11
Rush	W	20
Rush Variant	MW	19
Russell	W	19
Ryker	W	20
Sable	P	7
Saranac	VP	15
Saugatuck	P	9
Sawabash	VP	14
Sciotoville	MW	19
Scottsburg	MW	19
Seafield	SP	10
Seafield Variant	SP	2
Sebewa	VP	11
Selfridge	SP	1
Selma	P	11
Seward	MW	19
Shadeland	SP	2
Shadeland Variant	SP	2
Shakamak	MW	19
Shipshe	W	20
Shircliff	MW	19
Shoals	SP	14
Shoals Variant	SP	14
Sidell	W	19
Silverwood	W	20
Simonin	MW	19
Sisson	W	19
Skelton	W	20
Sleeth	SP	11
Sloan	VP	14
Sloan Variant	VP	2
Solsberry	MW	19
Southwest	P	14
Sparta	E	20
Spickert	MW	19
Spinks	W	20
St. Charles	W	19
St. Clair	MW	19
Starks	SP	11
Steff	MW	19
Stendal	SP	14
Stinesville	W	19
Stockland	W	20
Stonehead	MW	19
Stonelick	W	20
Stonelick Variant	W	20
Stoy	SP	8
Strawn	W	19
Strole	SP	12
Stubenville	W	19
Suman	VP	14
Sumava	SP	3
Swanwick Variant	W	21
Switzerland	W	19
Swygert	SP	12
Swygert Variant	MW	19
Sylvan	W	19
Symerton	MW	19
Taftown	W	19
Taggart	SP	11
Tama	W	19
Tapawingo	W	19
Tawas	VP	16
Tecumseh	W	20
Tedrow	SP	9
Thackery	MW	19
Throckmorton	MW	19
Tice	SP	14
Tilsit	MW	19
Tippecanoe	MW	19
Tipsaw	W	20
Toledo	VP	12
Toronto	SP	6
Totanang	MW	19
Toto	VP	17
Tracy	W	20
Trappist	W	19
Treaty	P	6
Troxel	W	20
Tulip	W	19
Tyner	SE	20
Udorthents	W	21
Uniontown	MW	19
Varna	MW	19
Vigo	SP	8
Vincennes	P	11
Vincennes Variant	P	11
Vistula	E	20
Volinia	W	20
Wakeland	SP	14
Wakeland Variant	SP	14
Wallkill	VP	18
Wallkill Variant	VP	18
Wallkill, upland	VP	18
Wapahani	MW	19
Warners	VP	17
Warners Variant	VP	17
Warners, upland	VP	17
Warsaw	W	20
Washtenaw	P	6
Washtenaw Var.	P	6
Waterford	SP	14
Watseka	SP	9
Watseka Variant	SP	9
Waupecan	W	20
Wauseon	P	1
Wawaka	W	20
Wawasee	W	19
Waynetown	SP	11
Wea	W	20
Weddel	MW	19
Weikert	W	20
Weikert Variant	W	19
Weinbach	SP	8
Weisburg	MW	19
Wellston	W	19
Wesley	SP	1
Westland	P	11
Westland Variant	P	11
Wheeling	W	20
Wheeling Variant	MW	19
Whiskerville	MW	19
Whitaker	SP	11
Whitaker Variant	MW	19
Whitcomb	SP	8
Whitepost	P	10
Whitson	P	7
Wilbur	MW	19
Wilhite	P	15
Willette	VP	17
Williamsport	SP	6
Williamstown	MW	19
Winamac	MW	19
Wingate Variant	MW	19
Wirt	W	20
Wolcott	P	5
Woodmere	MW	19
Woolper	W	19
Wrays	W	20
Wrock	W	20
Wunabuna	VP	17
Wynn	W	19
Xenia	MW	19
Yeddo	SP	7
Zaborosky	SP	9
Zadog	P	9
Zanesville	MW	19
Zipp	P	12
Zipp Variant	P	12

1-**888**-EXT-INFO

http://www.agcom.purdue.edu/AgCom/Pubs/