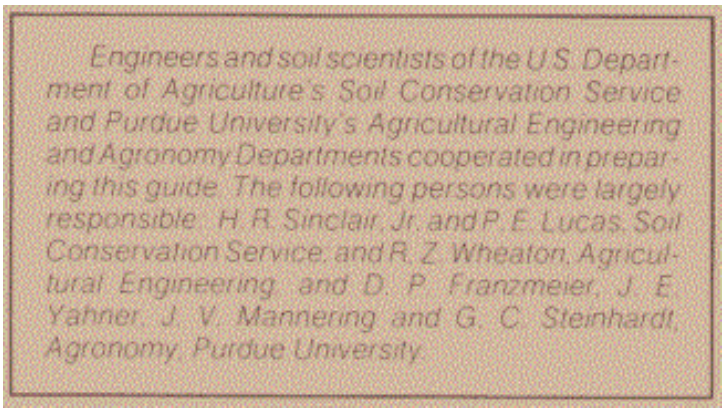
agronomy guide

COOPERATIVE EXTENSION SERVICE, PURDUE UNIVERSITY, WEST LAFAYETTE, INDIANA
(DRAINAGE) ID-160

Indiana Drainage Guide: Part I. Soils Drainage Recommendations



The drainage recommendations presented here were prepared for two purposes-(1) to help Indiana landowners, and operators identify the drain- age needs on their farms, and (2)10 help engineers, contractors, and other professionals make the proper recommendations to landowners in planning, designing and constructing drainage systems. "Indiana Drainage Guide: Part II. Planning, Design and Construction Information for Various Drainage Methods," *when completed,* will provide the more detailed specifications.

The organization of Indiana soils into drainage groups, the number designations of those groups, and the specific drainage recommendations for each have been modified somewhat from the previous edition of this publication-"Indiana Farm Drainage Guide" (ID-55, dated 1966). If you note any errors In this revised material or have suggestions for improvement, contact J. V. Mannering, Department of Agronomy, Purdue University, West Lafayette, IN 47907.

For other design and construction information, use ID-55 until Part II is published. DO not use the title size charts inID-55; revised ones are included here.

Caution. The drainage recommendations in Table 2 should be viewed as a guide only. Although based on the best information available, there are undoubtedly situations where local experience and successful practice indicate that they need to be modified. Also, these recommendations are subject to change as a result of additional research or field experience.

HOW TO USE THIS DRAINAGE GUIDE

Type and amount of drainage needed depend, to a great extent, on the soil type. Table 1 lists alphabetica1ly the soil series that have been mapped in Indiana and places each soil1nto one of 29

drainage groups. Table 2 then presents the principle drainage problem of each group and the sub- sequent drainage recommendations.

To use this guide, simply ascertain the soil series name, look it up in Table 1 to determine its drainage group number, then refer to Table 2 for the drainage recommendations.

On some soils there are alternative drainage methods, most of which are listed in the table. As a rule, on nearly all soils needing drainage, a combination of surface and subsurface drainage gives best results.

The recommendations in Table 2 are for field crops. Truck crops usually require a more intensive drainage system.

Accompanying the installation of a drainage system should bean adequate soil conservation program on the drained land. Sound management and good agronomic practices will maximize the efficiency and life of the system. Tillage, fertility, liming, crop rotations, and crop residue management all need to be considered. Special care must be exercised to avoid soil compaction, which seals off upper soil horizons and prevents water from moving down through the soil into tile lines. Compaction is minimized by reducing the number of tillage operations and keeping out of the fields when they are wet.

DETERMINING TILE/TUBING SIZE

Sizing Main Lines

Subsurface main drains are designed to flow full but without pressure. It is the slope, size and roughness (Mannings "n") of the line that deter- mines its capacity. The roughness varies with the material; and in the case of flexible plastic tubing, it also varies with the size.

Required diameter of a drainage system's main line can be determined from tile sizing charts (Figures 1 and 2). To "read" the charts, the material, slope, acres to be drained, and drainage coefficient must be known. Figure 1 is for sizing clay or concrete tile, Figure 2 for sizing plastic tubing.

EXAMPLE. Let’s assume that a 50-acre field is to be drained using plastic tubing, that the field’s drainage coefficient (DC) is 3/8 inch (i.e., 3/8 of water removed from each acre in 24 hours), and that the main line slope is to be 0.15 foot per 100 feet (0.15%).

In Figure 2 for plastic tubing, find 50 acres in the column for 3/8” DC, then draw a line horizontally to the left until it intersects with the vertical line representing a 15’/100’ grade. This falls into area served by a 12-inch plastic main line

Sizing Lateral Line

Laterals are normally selected on the basis of minimum size, not on capacity. Four-inch diameter laterals are the most common, although 3- to 6- inch diameter may be used.

*Drainage coefficient is the amount of water to be removed from the area in ~4 hours and is usually expressed as inches of depth per unit area. For example, Mineral soils with complete surface drainage have a coefficient of 3/8 to ½ inch for field crops, and ½ to ¾ inch for truck crops On the other hand. Organic soils have a coefficient of ½ to ¾ inch for field crops, and 3/4 to 1½ inches for truck crops

Table 1. Indiana Soil Series and Drainage Group Numbers [.pdf file]

Table 2. Drainage Groups and Agricultural Drainage Recommendations.

Drainage Group Number and Description	Representative Soil Types	Principal Drainage Problems	Drainage Recommendations[1]
VERY POORLY DRAINED, DARK COLORED ORGANIC SOILS IN DEPRESSIONS			
1. Deep, very poorly drained, moderately slow to moderately rapidly permeable organic soils more than 50" thick in depressions. Slopes are less than 1%.	Carlisle Houghton	Poor outlets, high water table.	Use open drains spaced 200' apart and 3' deep--side slopes 1:1 first 3-5 years until initial subsidence has occurred. Use diversion to cut off upland runoff. Controlled drainage is usually profitable and practical by holding the water table 30"-36" below surface for field crops. Subsurface drainage is recommended, although pumping may be required where gravity outlet is not available. Plastic tubing or 24" length of tile should be used. See recommendations for subsurface drainage in muck soils under drain size. Depth of tile 48"-60", spacing 80'-200'.
2. Moderately deep, organic material over mineral material, very poorly drained, slowly to moderately rapidly permeable organic soils in depressions and along streams. Kerston has interbedded organic and sand layers. Slopes are less than 1%.	Adrian Kerston Palms Tawas Willette	Same as Group 1.	Same as Group 1. However, length of tile would depend on whether placed in the muck soil or an underlying mineral soil. Adrian and Tawas require encasement of the subsurface drains with filter materials. Depth 36"-48", spacing 50'-150'.
3. Moderately deep organic material over very poorly drained organic soils that are slowly permeable to moderately rapidly permeable in the organic material and very slow to very rapid in the underlying material. Wallkill has mineral material over organic material: others have marlas underlying materials.	Edwards Martisco Toto Wallkill Warners	Same as Group1.	Use diversions to cut off upland runoff. Use open drains spaced 200' apart and 3' deep--side slopes 1:1. Pumping may be required if a gravity outlet is not available. Control water table with control structures. High cost investment in draining these soils is usually not warranted. Soils are widely variable. Detailed onsite borings recommended.
SOILS ON FLOODPLAINS REQUIRING DRAINAGE			
4. Poorly drained and somewhat poorly drained, and very poorly drained moderately slowly or slowly permeable silty clay loam and silt loam soils on overflow bottom lands. Birds and Petrolia are neutral. Bonnie is strongly acid in the sub- soil. Slopes are less than 1%.	Birds Bonnie Petrolia	Impounded upland runoff and/or flood water. Outlets may back up during flood periods.	Random or parallel shallow surface drains are recommended to supplement subsurface drains. Use diversions to cut off upland runoff. Use interceptor drains at base of slopes to intercept seepage water. These soils are low in productivity unless drained. Depth 30"-36", spacing 45'-60' .Siltation of drains is aggravated by frequent flooding of the outlets. Grades that provide velocity of 1.4' per sec. when the drain is flowing full are recommended. This requires grades of 0.4-0.6 percent depending on

			drain material. See drain design nomographs in subsurface drainage section. Consider use of filters. Inlets at the ends of laterals may be used to flush drains.

1 The wider spacings permitted as depths are increased. Maximum feasible depth based upon underlying material should be used.

Table 2. Continued.

Drainage Group Number and Description	Representative Soil Types	Principal Drainage Problems	Drainage Recommendations[1]
5. Somewhat poorly and moderately well drained, moderately permeable silt loam soils on overflow bottom lands. These soils have strongly acid subsoils and are on 0-2% slopes	Steff Stendal	Same as Group 4.	Use random or parallel shallow surface drainage, supplemented with subsurface drainage, to remove impounded water. Use interceptor drains at base of slopes to intercept seepage water. Depth 36"-42", spacing 50'-120'. Frequent flooding of outlets may cause siltation of lines. See velocity suggestions in Group 4. Also consider filters and inlets at upper ends of laterals.
6. Moderately well and somewhat poorly drained, moderately and moderately rapidly permeable loamy soils on overflow bottom lands. Medium acid to neutral. Slopes are less than 1%.	Eel Shoals Wakeland Wilbur	Same as Group 4.	Same as Group 5. Depth 36"-42", spacing 50'-120' Sands may be encountered in the area requiring use of filters.
VERY POORLY DRAINED SOILS IN DEPRESSIONS AND FLATS			
7. Very poorly drained, slowly and very slowly permeable clayey soils in depressions. Clay content ranges from 40-55% in the subsoil. Slopes are less than 1%.	Hoytville Kings Montgomery	High water table. Very slow drainage in subsoil surface water occasionally impounded.	A well designed, complete surface drainage system, including land smoothing, is highly recommended. Use diversions to cut off upland runoff. Use subsurface drainage to supplement the surface drainage systems. Tile or tubing may be needed as random lines along grassed waterways or surface drains. In some cases, a complete system may be justified. Blind and/or surface inlets to the subsurface drainage. Depth 36"-42", spacing 40' -80' .
8. Very poorly drained, slowly or moderately slowly permeable clayey soils in depressions. Clay content ranges from 35-45% in the subsoil. Slopes are less than 1%	Kokomo Milford Pewamo	High water table and surface ponding.	Provide random shallow surface drainage supplemented by subsurface drainage. Use diversions to cut off upland runoff. Blind and/or surface inlets to subsurface drainage. Depth 36"-42", spacing 50"-30".
9. Very poorly drained, moderately to slowly perme- able loamy soils in depressions and broad flats. Clay content of the subsoil ranges from 25-35%. No major stratification of materials.	Brookston Chalmers Evansville Patton Ragsdale Treaty	Same as Group 8.	Same as Group 8. Depth 36"-42", spacing 70'-120'.

10. Very poorly drained, moderately to slowly perme- able loamy soils in depressions and broad flats. Materials below about 40" depth are stratified and contain some coarse layers, such as sand or gravelly sand.	Lyles Mahalasville Rensselaer Westland	Same as Group 8.	Same as Group 8. In addition, sands and gravel may be a hazard to installing drains deeper than 40” due to unstable trench walls. Depth 36 120'. Spacing 70’-120’. Filters may be needed if sands are encountered.
11. Very poorly drained soils in depressions and on broad flats, moderate to rapidly permeable in the subsurface layers and rapidly to very rapidly permeable below depths ranging from 20"-40". Sandy or loamy above 40" and sand or gravelly sand below 40". Saugatuck and Zadog have slow permeability in the iron pan horizons. Slopes are less than 1%.	Gilford Maumee Saugatuck Sebewa Cohoctah* Craigmile*	High water table. Siltation of drains.	For water table control, use field laterals (open ditches) spaced 660' and 2.5-4' deep bottom width 4', side slopes 2:1 or flatter. Since over-drainage may make these soils droughty, consider controlling water table depth at 24"-36" for crop production. Encase subsurface drains with filter materials. Depth 36"-48", spacing 100'-150'.

[1] The wider spacings permitted as depths are increased. Maximum feasible depth based upon underlying material should be used.

*Subject to flooding.

Table 2. Continued.

Drainage Group Number and Description	Representative Soil Types	Principal Drainage Problems	Drainage Recommendations[1]
SOMEWHAT POORLY AND POORLY DRAINED, MODERATELY DARK OR LIGHT COLORED SOILS ON FLATS OR LANDSCAPE SWALES			
12. Somewhat poorly and poorly drained soils on level slopes with moderate to rapidly permeable subsurface layers and rapidly to very rapidly permeable layers below depths of 20"-40". Loamy or sandy soils underlain with sand or gravelly sand at depths of 20"-40" or more. Slopes are less than 1%.	Brady Homer Morocco Pinhook Quinn	Same as Group 11.	Same as Group 11. Depth 36"-48", spacing 100’-150’.
13. Poorly and somewhat poorly drained soils on nearly level slopes with slowly or very slowly permeable subsoils. These strongly acid loamy soils have dense, compact silt loam or silty clay loam subsoils and are on uplands and terraces. Locally often called “gray flats". Slopes are less than 1%. These soils are often on broad, flat landscapes.	Clermont Cory Hoosierville Peoga	Very slow subsoil drainage. Siltation of drains. Limited grade for laterals. Drainage outlets may not be readily available.	A well designed system of surface drainage is highly recommended. On the sloping areas, dross-slope drains should be used. Land smoothing is recommended with these systems. Use grassed waterways on erosive slopes. Use subsurface drainage to supplement the surface drainage systems. Depth 36"-42", spacing 401-60'. See velocity recommendations of Group 4. Also consider filters and inlets at upper ends of laterals.

14. Somewhat poorly and poorly drained, slowly or very slowly permeable soils with compact silt loam or silty clay subsoils. Many of these soils have fragipans. These soils have strongly acid subsoils and are on nearly level and gently sloping uplands and terraces. Slopes range from 0-4%.	Avonburg Bartle Dubois Jonnsburg Vigo	Slow subsoil drain- age. Siltation of drains.	Use surface drainage systems supplemented with subsurface drains. Cross-slope drains and terracing may be adapted on the steeper slopes. Depth 36"-42", spacing 50'-80' .See suggestions on siltation, velocity grades, etc., in Group 4.
15. Moderately deep, somewhat poorly and very poorly drained, moderately slowly and moderately permeable soils. These loamy soils have silty clay loam or clay loam subsoils, and bedrock is within a depth of 20"-40". Millsdale is a dark-colored soil in depressions. Randolph and Shadeland are on convex, nearly level to gentle slopes.	Millsdale Randolph Shadeland	Slow subsoil drainage and impounded water.	Provide shallow surface drainage where necessary. Sub-surface drainage is generally not recommended because of shallow depth to rock. Tile mains may cross these soils to get to an outlet. Thorough investigation along the route of the tile is required for bedrock depth.
16. Somewhat poorly drained, slowly and very slowly permeable, clayey, nearly level and gently sloping soils on uplands and terraces. Clay content is 40-60% in the subsoil. Slopes are convex and 0-4%.	Fulton McGary Nappanee	Very slow subsoil drainage. Surface water occasionally impounded on the	Same as Group 7. Terracing may be used for water disposal and erosion control. Depth 40'-80'.
17. Somewhat poorly drained, slowly or moderately slowly permeable, clayey, nearly level and gently sloping soils on uplands and terraces. Clay content is 35-45% in the subsoil. Slopes are convex and 0-4%.	Blount Crosby Del Rey Elliott	Same as Group 14.	Provide grassed waterways, terraces and diversion where needed. Subsurface drainage recommended. Only random lines may be needed on the upper slope limits Depth 36"-42", spacing 40'-80'.
[1] The wider spacings permitted as depths are increased. Maximum feasible depth based upon underlying material should be used.			

Table 2. Continued.

Drainage Group Number and Description	Representative Soil Types	Principal Drainage Problems	Drainage Recommendations[1]
18. Somewhat poorly drained, moderately slowly and moderately permeable, loamy, nearly level and gently sloping soils on uplands and terraces. Clay content is 25-35% in the subsoil. Slopes are convex and 0-4%.	Crosier Fincastle Flanagan Iva Markton	Same as Group 17, but subsoil drainage easier to achieve.	Same as Group 17. Depth 36"-42", spacing 70’-120’.

19. Somewhat poorly drained, moderately and moderately slowly permeable, loamy, nearly level and gently sloping soils on uplands and terraces. These soils have stratified silt and sand, sand or sand and gravel below a depth of about 40"-50". Slopes are convex and 0-4%.	Ayrshire Darroch Sleeth Whitaker	Same as Group 17, but subsoil drainage easier to achieve.	Same as Group 17. Depth 36"-42", spacing 50’-120’.
MOOERATELY WELL AND WELL DRAINED SOILS THAT MIGHT HAVE SEEPS			
20. Moderately well and well drained, slowly and very slowly permeable soils with fragipans. These are nearly level to strongly sloping soils on uplands and terraces. Very strongly acid subsoils. Slopes are commonly 1-18%.	Ava Bedford Cincinnati Hosmer Jennings Rossmoyne Zanesville	None for agricultural uses. Some lateral seeps on lower slopes.	Provide grassed waterways and terraces on land slopes up to 8-10% for water disposal and erosion control. Subsurface drainage is usually not needed. Drainage mains may cross these soils to get to an outlet. Interceptor drains may be needed to intercept seepage water.
21. Deep, well drained and moderately well drained, moderately to moderately slowly permeable loamy soils. Nearly level to moderately steep soils except for the Hennepin and Hickory, which are steep to very steep. All are on uplands. Underlying materials are moderately alkaline (calcareous) loamy till. Slopes commonly range from 1-18%. Hennepin and Hickory are on slopes usually greater than 18%.	Hennepin Hickory Miami Parr	Some lateral seeps on lower slopes of the more clayey soils.	Subsurface drainage is usually not needed. Use grassed waterways and terraces on slopes up to 8-10% for water disposal and erosion control. Interceptor drains may be needed to intercept seepage water.
22. Deep, well and moderately well drained, moderately slow to slowly permeable clayey soils. These are commonly gent1y sloping to moderately steep soils. They are on uplands, terraces, lacustrine plaints and on colluvium from shale and uplands. Underlying materials are slowly or very slowly permeable, are clayey and moderately alkaline. Slopes commonly range from 6-18%.	Markham Markland Morley St. Clair	Same as Group 21.	Use grassed waterways and low intensity crop rotations for water disposal and erosion control. Interceptor drains may be needed to intercept seepage water.
WELL DRAINED SOIL ON FLOODPLAINS, NO DRAINAGE REQUIRED			
23. Bottom lands well drained, moderately to rapidly permeable loamy soils on overflow bottom lands. Strongly acid to neutral. Slopes are less than 1%.	Cuba Genesee Raymond Huntington Ross	None for agricultural uses. Subject to flooding.	Surface and subsurface drainage are usually not needed. Drainage mains may cross these soils outlet.
1 The wider spacings permitted as depths are increased. Maximum feasible depth based upon underlying material should be used.			

Table 2. Continued.

Drainage Group Number and Description	Representative Soil Types	Principal Drainage Problems	Drainage Recommendations[1]
WELL DRAINED AND MODERATELY WELL DRAINED SOILS IN WHICH BEDROCK MIGHT BE ENCOUNTERED			
24. Shallow to bedrock, well and somewhat excessively drained, slowly to moderately rapidly permeable clayey and loamy soils with bedrock within a depth of 20". Slopes are dominantly more than 25%, but a few areas are less.	Colyer Corydon Fairmount Weikert	None for agricultural uses.	Seldom used as cropland.
25. Moderately deep to bedrock, moderately to very slowly permeable loamy and clayey soils on uplands and bottom lands. Bedrock at a depth ranging from 2011-40". These nearly level to very steep stoils are on slopes dominantly of more than 25%, but a few areas are less.	Berks Gilpin Muskingum	None for agricultural uses.	Same as Group 20. Thorough investigation is required along the route of a tile main for bedrock depth.
26. Deep over bedrock, well drained, moderately to very slowly permeable clayey and loamy soils. Depth to bedrock is dominantly 48"-96", but in some places it might be shallower. These gently sloping to steep soils are on uplands.	Baxter Hagerstown Wellston	None for agricultural uses.	Same as Group 20. Terraces may also be used for water disposal and erosion control. Cleanup of small rock fragments on the soil surface is required after terrace cut and fill operations.
OTHER WELL DRAINED AND MODERATELY WELL DRAINED SOILS			
27. Silty and loamy terraces, deep, well drained, moderately and moderately slowly permeable silty and loamy soils. These are nearly level to sloping soils except for Negley, which is steep to very steep. Underlying materials stratified and range from sand to loam and sandy loam. They are strongly acid in the subsoil and under- lying materials. Slopes commonly range from 1- 6%. Negley has slopes usually over 25%.	Negley Parke Wheeeling	None for agricultural uses.	Same as Group 20. Terraces may also be used for water disposal.
28. Deep, well and moderately well drained, moderately and moderately slowly permeable silty and loamy soils. These are commonly nearly level to moderately steep soils. Underlying materials moderately to very rapidly permeable silts, silts and sands, sands or gravel, and are neutral to moderately alkaline. Slopes commonly range from 1-18%, but a few are steeper.	Alford Martinsville Ockley	Same as Group 21.	Same as Group 21.

29. Eolian sands and sand-gravel terraces. Deep and moderately deep to sand and gravel, moderately well to excessively drained, moderately slowly to very rapidly permeable sandy and loamy soils. Materials below 40" are rapidly to very rapidly permeable sand and gravelly sand. These are nearly level to sloping soils, but a few areas are steeper. Slopes commonly range from 1-12%.	Bloomfield Chelsea Fox Oshtemo Plainfield Warsaw	None for agricultural uses.	Droughty soils. Drainage mains may cross these soils to get to an outlet.
[1] The wider spacings permitted as depths are increased. Maximum feasible depth based upon underlying material should be used.			

Figure 1. Chart for determining required size of clay or concrete tile.

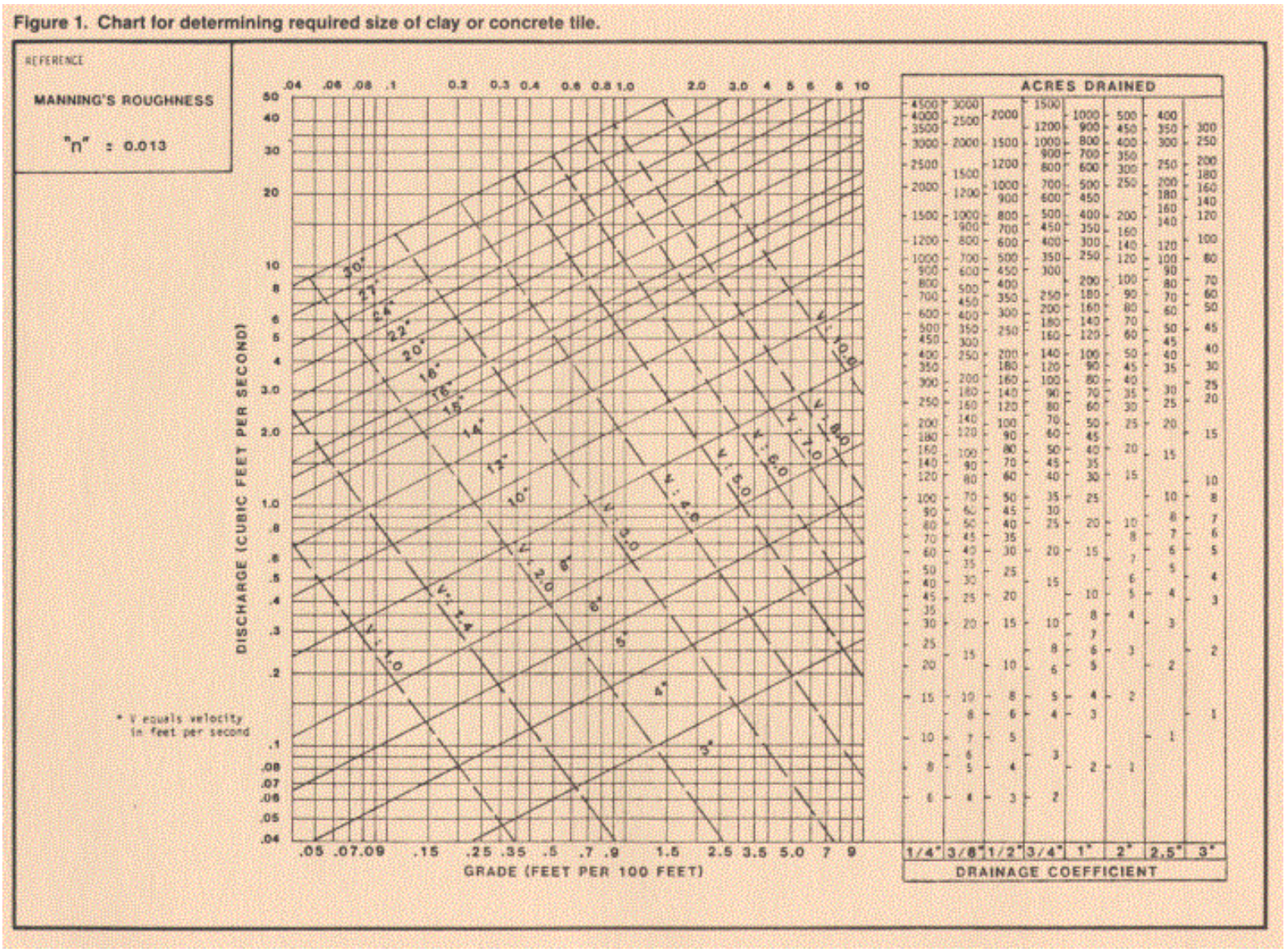


Figure 2. Chart for determining required size of corrugated plastic drainage tubing.

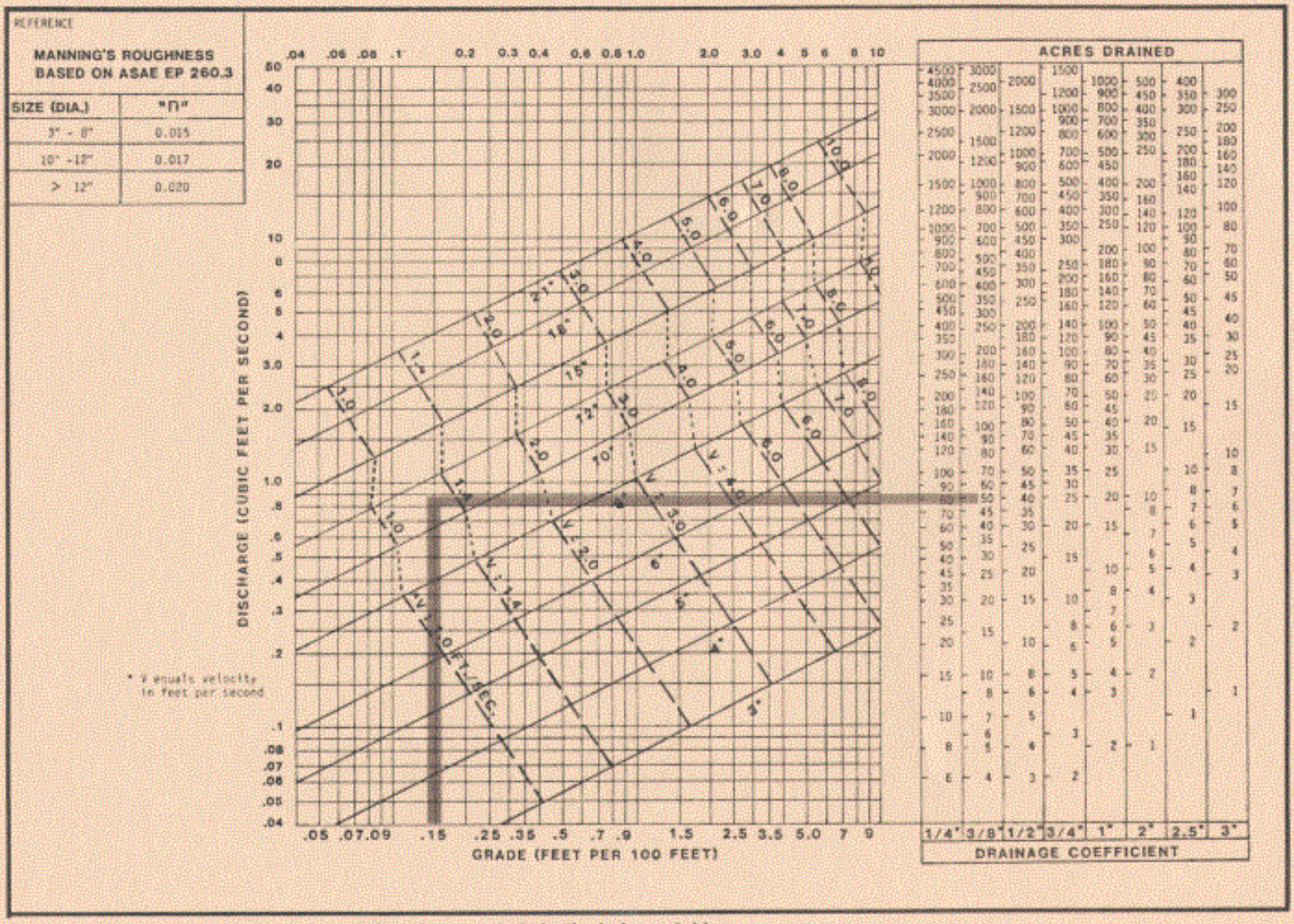


Figure 2. Chart for determining required size of corrugated plastic drainage tubing.

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