DESCRIPTION OF THE NORTH DAKOTA (NASIS) DRAIN PROGRAM

This program is the result of the combined efforts of South Dakota, North Dakota, Minnesota, and Iowa to achieve consistency between the states in the evaluation of scope and effect on wetland hydrology due to lateral effects of subsurface drainage features. The program allows the user to select between four methods to determine lateral effects to wetland hydrology due to subsurface drainage features. The user of this program is cautioned that these equations apply to saturated soil conditions only and are not intended for use in the evaluation of duration of ponding, removal of ponding by subsurface movement of water, or surface hydrology. Refer to the Engineering Field Handbook (EFH), Chapter 19, for methods to evaluate subsurface drainage features effects on ponding.

The program has four methods to calculate the lateral effect of subsurface drainage on saturated soil conditions. These methods are the Ellipse Equation, Hooghoudt Equation, van Schilfgaarde Equation, and Skagg's Semi-Infinite Medium. All four methods assume surface water has been removed and does not have to go through the subsurface drainage system.

The Ellipse Equation, as detailed in the National Engineering Handbook (NEH) 16, Drainage of Agricultural Land, and EFH 19, Hydrology Tools for Wetland Determination, is a steady state equation and was developed for determining spacing of parallel drains. The Ellipse Equation makes several assumptions: the soil is homogeneous and has a uniform hydraulic conductivity; rain is falling or irrigation water is applied and removed at a constant rate; an impermeable layer underlies the drain at some depth; and the drains are evenly spaced. The Ellipse Equation has several limitations. These include:

(1) When the depth to the impermeable layer is large the equation is not valid.

(2) The equation should not be used when vertical hydraulic conductivity exceeds horizontal hydraulic conductivity, or when the soils are not homogeneous.

(3) The equation itself does not have a factor for time (assumed time used in the equation is 24 to 48 hours, but parameters used in the equation can be adjusted to account for other durations). This program adjusts time.

The Hooghoudt Equation is quite similar to the Ellipse except that the hydraulic conductivity is calculated separately for the layers above and below the drainage feature. The depth from the drain to the impermeable barrier is modified to an effective depth with the use of the effective radius of the drainage feature. The same assumptions and limitations of the Ellipse Equation apply to the Hooghoudt Equation.

The van Schilfgaarde Equation is preferred for determining lateral effects of subsurface drainage features. It is a non-steady state equation. Limitations of van Schilfgaarde's equation are that it does not give reasonable solutions when the drain rests on the impermeable barrier and the equation uses equivalent depth instead of actual depth.

Skagg's Semi-Infinite Medium method is a nonsteady state equation and uses the same assumptions and limitations as van Schilfgaarde's Equation. The main limitation is it is only applicable for single drains.

GENERAL OPERATING INSTRUCTIONS

Select the soil to be evaluated by clicking *Soil Data, then Get Soil (if soils information is known it can be directly entered into the appropriate cells). Select a county name. The MapUnits, Soil Component Name, and Percent of that soil in the MapUnit will be displayed. Select desired soil.*

The order of data entry is not important; the entry order described below assumes you use the 'Tab' key between entries. Click *Help for input descriptions (see Input Descriptions section).*

Notice that Hydraulic Conductivity Above Drain, (Ka) and Hydraulic Conductivity Below Drain, (Kb) will not be available for entry if *Soil Data and Get Soil were clicked (soil properties will be used). If Soil Data and User Soil were clicked initially, Ka and Kb - as well as Drainable Porosity, (f) - would be required entries.*

Enter the Initial Water Level Height Over Barrier, (h1) and the Final Water Level Height Over the Barrier, (h2). Water levels are in feet, and refer to the saturated level at the wetland boundary. The final water level height over the barrier is typically 12 inches less than the initial water level height over barrier. Note that the 12-inch difference is the height agreed to during the multi-state meeting and is a reflection of the change to the driving head.

Enter the Drain Height Above Barrier, (h3) in feet. This is the height from the barrier to the drain invert. Next, enter the Drain Depth Below Ground line, (h4) in feet. This is the depth from the ground surface to the drain invert. Note: h3 + h4 should equal the total depth from the ground line to the barrier. Also, it is recommended that this overall depth not exceed 10 feet.

The Effective Radius of Drain, (Re) is needed for the van Schilfgaarde or Hooghoudt Equations. Click *Help for assistance on the appropriate Re value (see Input Descriptions section) . Select Re from the table for the corresponding size of the drain.*

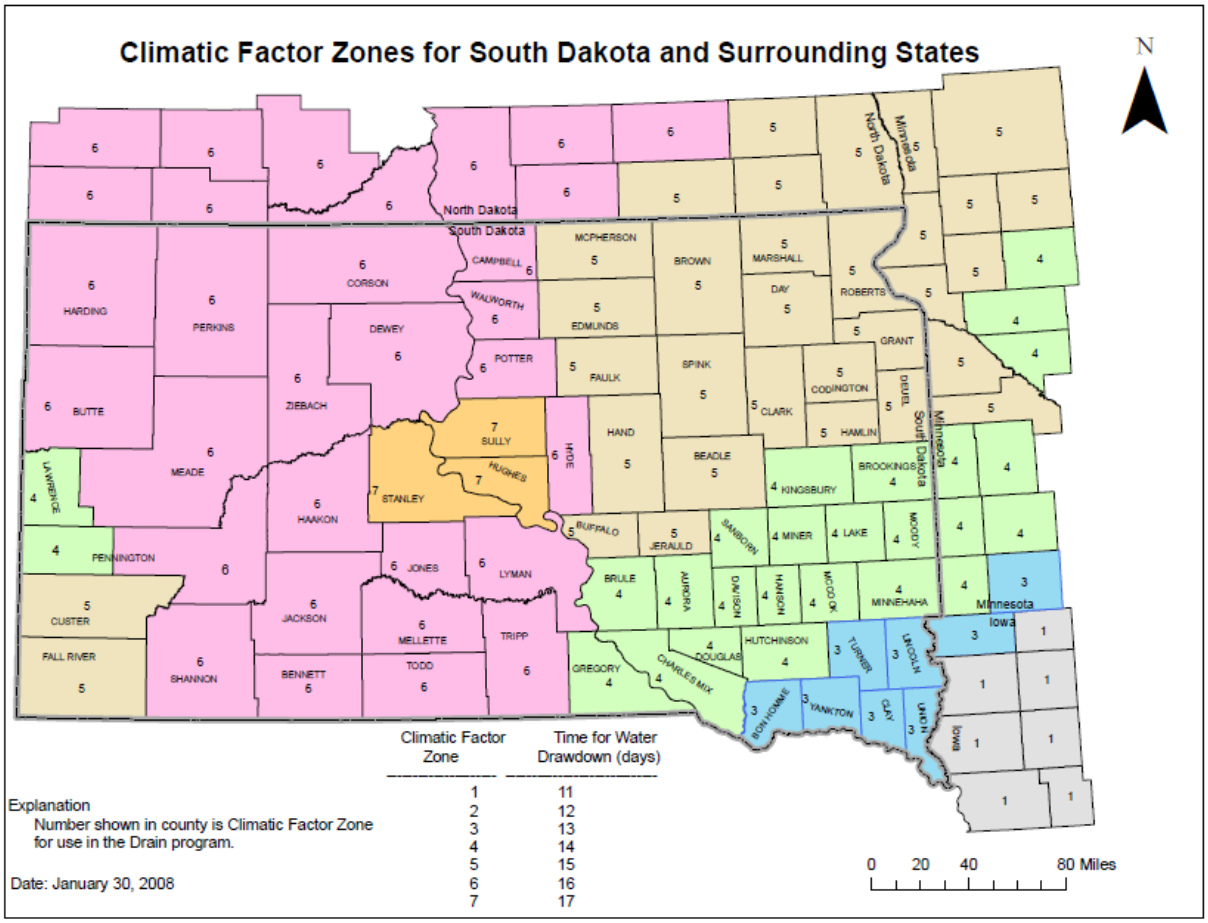
From the state Climatic Factor Zones map (see Figure 1), select the number of days it takes to accumulate 1" of rain in May. Enter the days for Time For Water Drawdown, T. Throughout the four- state region, this value varies from about 10 to 20 days. The climatic data map is to be used only for drainage systems located outside of the wetland. To use these equations for evaluation of scope and effect for systems within a wetland, 14 days will be the only time factor used. If unsure of the value, contact your state hydrologist, climate data liaison, or wetland specialist.

Click *Compute and the desired equation name to perform the calculations. Note the van Schilfgaarde Equation is preferred (agreed by the four states). Skagg's Semi-Infinite Medium uses the same assumptions and limitations as van Schilfgaarde's Equation, and is also supported for use. The main limitation is it is only applicable for single drains.*

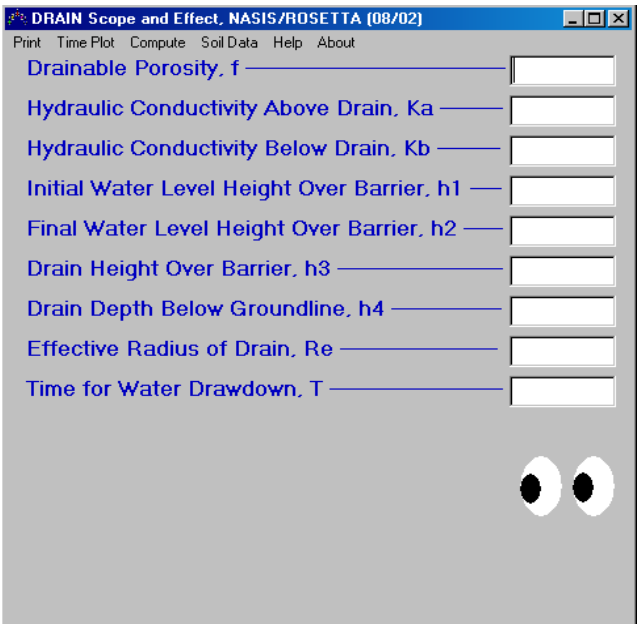
You should not experience a great difference between any of the four methods. The most important thing to remember is that the program uses soil properties from only one (1) soil at a time. If a MapUnit has more than 1 soil associated with it, you should check the lateral effect of each component. For instance a component that includes 65 percent of the MapUnit may not be the controlling soil, if the remaining 35 percent components have more restrictive properties (higher permeability). In lieu of site-specific investigations, the most restrictive soils in the MapUnit should be considered.

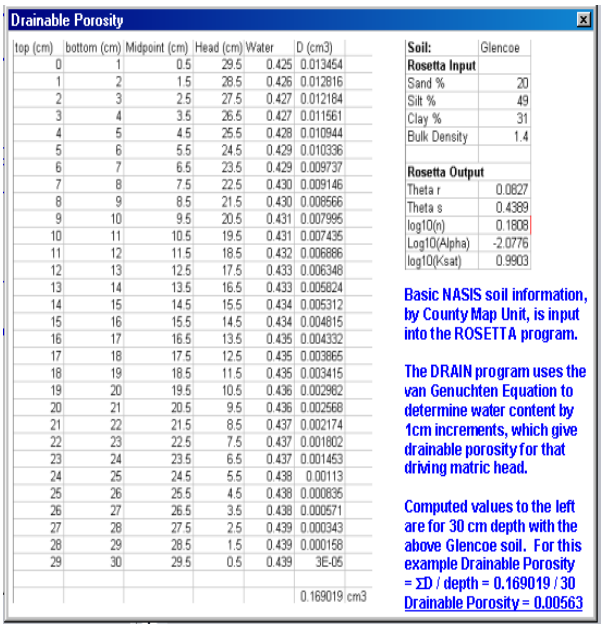
Disclaimer: This program is a rewrite of the previous versions, using NASIS database and soil drainage characteristics calculated by centimeter. It is assumed more accurate as it uses measured hydraulic conductivity instead of averaging the "drainage class" permeability (e.g. 0.6 - 2.0 inch/hour = 1.3 average). Instead of dropping 1 drainage class to account for compaction below 60 inches, the program reduces the permeability by one half (½ Ksat). No guarantees. Check output. Potential errors may occur as a result of inaccurate soils information within the database or changes in soil map units. Enter specific soils information directly entered into the program if known.

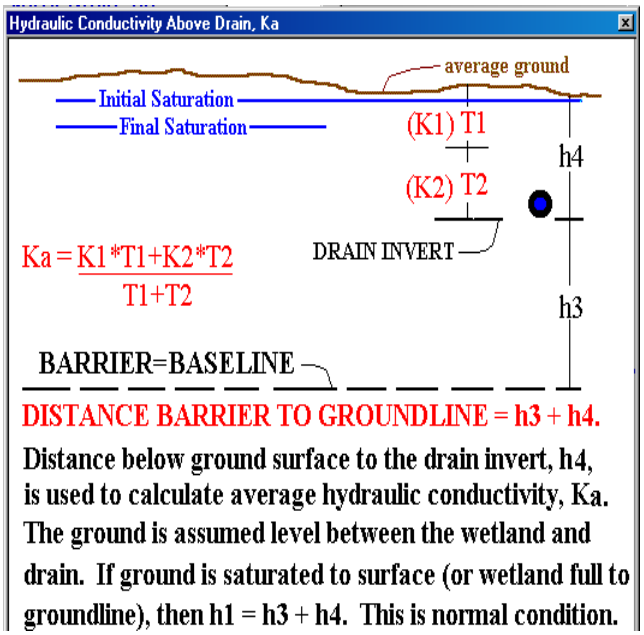
Figure 1. Climatic factor zones for South Dakota and surrounding states.

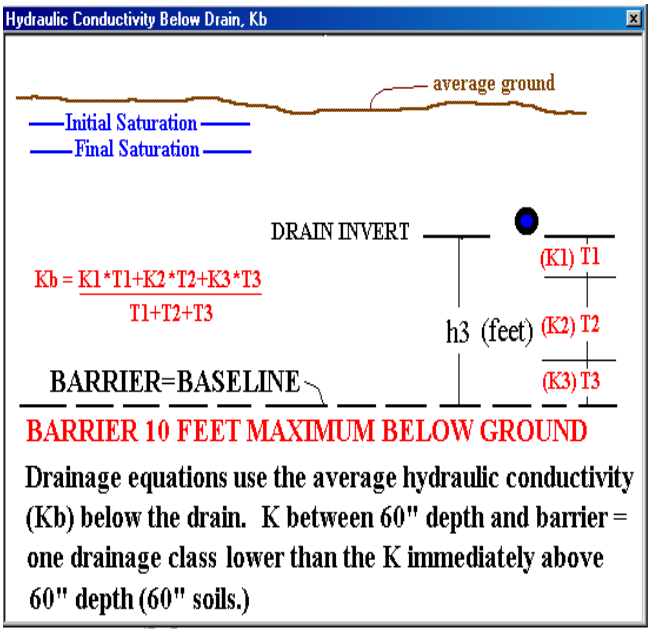


INPUT DESCRIPTIONS FOR THE ND (NASIS) DRAIN PROGRAM

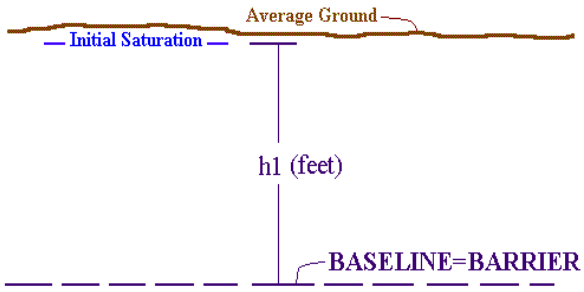








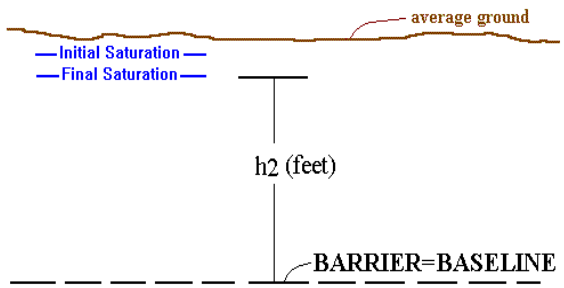
Initial Water Height Above Barrier, h1



NOTE: BARRIER DEPTH SHOULD NOT EXCEED 10 FEET

This input is a requirement for all drainage equations. Use only with relatively flat (non-sloping) conditions.

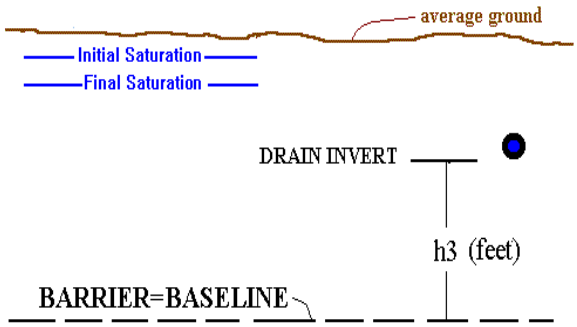
Final Water Height Over Barrier, h2



NOTE: USE SAME BARRIER/BASELINE (h1, h2, h3).

The distance (feet) between h1 and h2 is the water table drawdown caused by the drain, over the time period T. h2 is required for all drainage equations. h1 > h2 > h3.

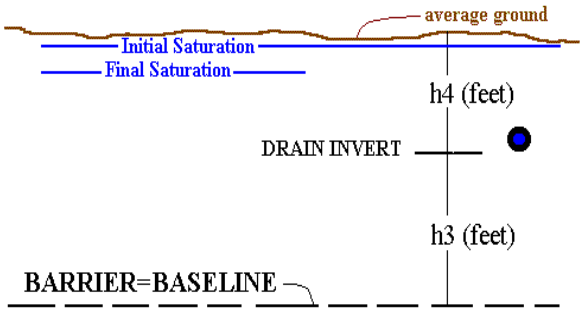
Drain Height Over Barrier, h3



BARRIER 10 FEET MAXIMUM (RECOMMENDED)

Distance from drain to barrier/baseline, h3 (feet), is used by all drainage equations. Barrier depths are the same, all entries must be measured off the same baseline (h1,h2,h3).

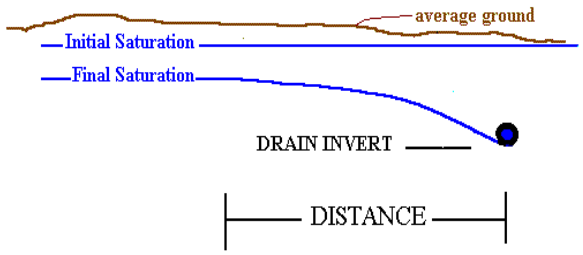
Drain Depth Under Groundline, h4



DISTANCE BARRIER TO GROUNDLINE = h3 + h4.

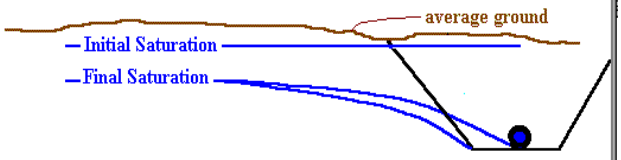
Distance below ground surface to the drain invert, h4, is used to calculate average hydraulic conductivity, Ka. The ground is assumed level between the wetland and drain. If ground is saturated to surface (or wetland full to groundline), then h1 = h3 + h4. This is normal condition.

Time for Water Drawdown, T



T = the TIME, in days, to be used in calculations. The draining profile after that time will approximate the above. DISTANCE is the horizontal dimension, in feet, that a drain would be to cause the drawdown to occur over the period of time T.

Effective Radius of Drain, Re



The drawing illustrates the difference between a drain tile and drain ditch. The term "effective radius" or "Re" is used to describe the relative number of openings for tile or tube and comparative soil contact area for a ditch. Values to use with the Hooghoudt equation are (Re = feet):

TILE DIAMETER:	4"	5"	6"	8"	10"	12"
Re =	0.0167	0.034	0.048	0.080	0.111	0.142

DITCH (any size): Re = 1.0

Drain tube (std.): Re = 1.177n (gravel envelope 2n/side)