# Appendix 5: Van Schilfgaarde Equation and Parameters

The predicted impact of surface drainage systems on wetlands can be evaluated through the use of the van Schilfgaarde equation. This equation may be used to estimate lateral drainage effects at a single location or programmed into a spreadsheet or GIS tool to estimate lateral drainage effects along multiple segments of an entire drainage system. The Van Schilfgaarde equation was developed for non-steady state conditions and is a natural fit for the unsteady (i.e., continuous simulation) modeling found within the EPA-SWMM modeling engine.

The following is a description of the input parameters for the van Schilfgaarde equation and a description of parameter derivation, based on Part 650, Engineering Field Handbook, Chapter 19, Hydrology Tools for Wetland Determination.



* **S =** drain spacing (ft); as calculated with the equation. The drain spacing is equivalent to two times the lateral effect distance perpendicular to the drainage feature centerline. Effectively, this becomes the computed distance of altered wetland hydrology.
* **S' =** estimated drain spacing (ft).
* **K =** hydraulic conductivity (ft/day); Based upon values for soil types. A weighted average value may be obtained from SSURGO databases.
* **a =** depth from the free water surface to the impermeable layer (ft); The value for this parameter is based upon the total depth to the impermeable layer from the ground surface (D) and the depth to the free water surface from the ground surface (d) (a = D – d).
* **D =** total depth to the impermeable layer from the ground surface (ft); The Chapter 19 guidance states that when an impermeable barrier is not encountered, a depth of 10 feet should be used for this parameter. It is assumed the soil at this depth will have a reduced permeability, due to the weight of the soil above.
* **d =** depth to free water surface from the ground surface (ft); The van Schilfgaarde equation greatly simplifies the drawdown inputs by defining a static starting water level and determining the drawdown to be the bottom of the drainage feature. This works well for tile systems. However, since open channels public drainage systems typically have relatively flat grades and rarely drain completely dry (especially during the wetland defining period for seasonal wetlands), a more accurate and conservative methodology may be required.

To estimate the depth to the free water surface, an average daily water level within the open channel during a typical growing season may be determined utilizing a continuous hydrology/hydraulics simulation (e.g. EPA-SWMM or proprietary programs that utilize that modeling engine). Natural ground elevations adjacent to the open channel may then be used to compute parameter d, which is the difference between the ground surface elevation and free water surface elevation. This approach conforms generally with US Army Corps of Engineers (USACE) 1987 Wetland Delineation Manual guidance for the determination of wetland hydrology.

* **de =** equivalent depth from the drainage feature to the impermeable barrier (ft); This is the equivalent depth from the tile or ditch bottom to the impermeable barrier, given S’, a, and the effective radius of drainage tile (re). This is the second step in the iterative process, where the estimated drain spacing is used to calculate the equivalent depth.
* **t =** time for water table to drop from m0 to m (days); When utilizing the van Schilfgaarde equation for analyzing lateral drainage effects, this parameter is set with the intent to see where the wetland hydrology indicator is met or not met after the defined continuous period in the growing season. According to the USACE 1987 Wetland Delineation Manual, the wetland hydrology criterion is met if the water table is normally within 12 inches of the soil surface for a continuous period of 5% to 12.5% of the growing season. “t” may thus be set as a value of approximately 10% of the growing season days within the area of study.
* **m0 =** initial height of water table above the center of the drainage feature (i.e., the open channel) at time t=0 (ft); It is assumed that the starting water levels within the wetlands are at the surface of the soil column and the value is set equal to d.
* **m =** height of water table above the center of the drainage feature at mid-plane after time t (ft); This parameter can be set to be 1 foot less than m0, in accordance with the wetland hydrology determination status from the USACE. For segments where the average daily water level over the growing season was within 1 foot of the ground surface, this term can be set equal to zero because, given the assumptions used for meeting wetland hydrology criterion, wetland status will be maintained in these areas.
* **ƒ =** drainable porosity of the water-conducting soil (ft/ft); This is described as the amount of water that could be removed via subsurface drainage, also called gravitational water, or the amount of water between soil saturation and field capacity. Values for different soil types can be obtained from county soil surveys.
* **ƒ1 =**drainable porosity adjusted for surface roughness (ft/ft); The adjusted drainable porosity is equal to ƒ+(s/(m0-m)).
* **s =** water trapped on the surface by soil roughness (ft); This is the small amount of moisture that may be held on the surface of the soil by the particles. This is also equivalent to the initial abstraction or depressional storage. The Chapter 19 guidance states that a value of 0.1 inches (0.0083 feet) should be used for Minnesota.
* **re =**effective radius of the drainage feature (ft); For tiles, this is simply the radius of the pipe. Chapter 19 guidance states that 1 foot should be used to estimate the effective radius of an open channel.
* **π =**3.1416