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Part 630 Hydrology

National Engineering Handbook

Chapter 8: Land Use and Land Treatment Classes

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Natural Resources Conservation Service - Donald E. Woodward, Robert D. Nielsen, Robert Kluth, Arlis Plummer, Joe Van Mullem, and Gary Conaway;

Agricultural Research Service - William J. Gburek, Keith Cooley, Allen T. Hjelmfelt, Jr., and Virginia A. Ferriera; and

University of Arizona - Richard H. Hawkins.

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Authors and Contributors: This September 2017 revision was prepared by the Curve Number Task Group of the Watershed Management Technical Committee, Environmental Water Resources Institute (EWRI) of the American Society of Civil Engineers. The major authors and contributors

have been, in alphabetical order: Hunter Birckhead, P.E., M.ASCE; James V. Bonta, Ph.D., P.E., F.ASCE; Donald Frevert, Ph.D., P.E., D.WRE(Ret), F.ASCE; Claudia Hoeft, P.E., F.ASCE (USDA NRCS liaison); Richard H. Hawkins, Ph.D., P.E., F.EWRI, F.ASCE (Task Group chair); Rosanna La Plante, P.E., M.ASCE; Michael E. Meadows, Ph.D., P.E., F.ASCE; Julianne Miller, A.M.ASCE; Steven C. McCutcheon, Ph.D., P.E., D.WRE(Ret), F.EWRI, F.ASCE; Glenn Moglen, Ph.D., P.E., F.EWRI, F.ASCE; David Powers, P.E., D.WRE, F.ASCE; John Ramirez-Avila, Ph.D., ING., M.ASCE; E. William Tollner, Ph.D., P.E., M.ASCE, F.ASABE (American Society of Agricultural and Biological Engineers [ASABE] representative), Joseph A. Van Mullem, P.E., M.ASCE; Tim J. Ward, Ph.D., P.E., F.EWRI, F.ASCE (Task Group co-chair),; and Donald E. Woodward, P.E., F.ASCE (Task Group co-chair).

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630.0800 General

The land use and treatment classes ordinarily evaluated in watershed studies are briefly described. These classes define hydrologic soil-cover complexes which are used in a method for estimating runoff from rainfall, [See National Engineering Handbook, section 630, (NEH 630), Chapter 9 for more information on hydrologic soil-cover complexes and Chapter 10 for methods for estimating runoff from rainfall (NRCS, 1999a).]

630.0801 Classification of land use and land treatment

In the Natural Resources Conservation Service (NRCS) method of runoff estimation, the effects of the surface conditions of a watershed are evaluated by means of land use and treatment classes. *Land use* is watershed cover and includes all vegetation, litter and mulch, fallow, and bare soil as well as nonagricultural uses, such as water surface (lakes and swamps) and impervious surfaces (e.g., roads and impermeable roofs). *Land treatment* primarily applies to agricultural land uses. Land treatments include mechanical practices, grazing control, and rotation of crops. Low impact developments (LIDs) are also considered as land treatments. The combinations of land use and of land treatment *classifications* that occur on watersheds are used to determine the potential for runoff from rainfall

Land use and land treatment classifications can be obtained by casual observation or by detailed measurement of plant and litter density and coverage on representative sample areas with the later approach having the higher potential for accuracy.

630.0802 Classes

The different land uses and land treatments are described in this chapter and their use in estimating runoff Curve Numbers (CNs) for hydrologic soil-cover complexes and the hydrologic conditions is described in Chapter 9. Chapter 9 contains tables listing CNs for different land use and land treatment combinations.

(a) Cultivated land

Fallow is the agricultural land use and treatment with the highest potential for runoff because the land is kept as bare as possible to conserve moisture (reduce evapotranspiration) for use by a succeeding crop. However, bare soils can become very dry though evaporation only. Other types of fallow, such as stubble mulch, are not listed, but they can be evaluated by comparing their field condition with those for classes that are listed and should be defined as experience-based CNs.

Row crop is any field crop (e.g., maize, sorghum, soybeans, tomatoes, tulips, or grapes) planted in rows far enough apart that most of the soil surface is exposed to rainfall impact throughout the growing season. At planting time, the crop is equivalent to fallow and may again be in fallow after harvest. Row crops are planted either in straight rows or along contours. They are in either a poor or a good rotation as described under the following section on rotations.

Small grain (e.g., wheat, oats, barley, or flax) is planted in rows close enough together that the soil surface is not exposed except during planting and shortly thereafter. Land treatments are those used with row crops.

Close-seeded or broadcast legumes or rotation meadows (alfalfa, sweet clover, timothy, and combinations of these) are either planted in close rows or broadcast. This cover may be allowed to remain for more than a year so that year-round protection is given to the soil.

Straight-row fields are those farmed in straight rows either up and down the hill or across the hillslope. Where land slopes are less than about 2 percent, farming across the slope in straight rows is equivalent to contouring and should be considered when estimating the CN.

Rotations are planned sequences of crops. Their purpose is to maintain soil fertility, reduce erosion or provide an annual supply of a particular crop. Hydrologically, rotations range from poor to good in proportion to the amount of dense vegetation in the rotation, and are evaluated in terms of hydrologic effects. *Poor rotations or no rotations* are generally one-crop land uses, such as continuous corn (maize) or continuous wheat or combinations of row cops, small grains, and fallow.

Good rotations generally include alfalfa or another close-seeded legume or grass to improve tilth and increase infiltration. These hydrologic effects may carry over into succeeding years after the crop is removed, although normally the effects are minor after the second year. The carryover effect is not considered when estimating the CN.

Contoured fields are those farmed as nearly as possible on the contour. The hydrologic effect of contouring results from the surface storage provided by the furrows because the storage prolongs the time during which infiltration can take place. The magnitude of storage depends not only on the dimensions of the furrows but also on the land slope, crop, and manner of planting and cultivation. Planting small grains or legumes on the contour creates small furrows that disappear because of climatic action during the growing season. The contour furrows used with row crops are either large when the crop is planted and made smaller by cultivation or small after planting and made larger by cultivation, depending on the type of farming. Average conditions for the growing season are listed in Chapter 9. The relative effects of contouring for all croplands are based on data from experimental watersheds with slopes ranging from 3 to 8 percent. *Strip cropping* is a land use and treatment not specifically used in estimating CN because it is a composite of uses and treatments. It is evaluated by the method of example 10-4 in Chapter 10. Terraced entries refer to systems that have open-end level or graded terraces, grassed waterway outlets, and contour furrows between the terraces. The hydrologic effects due to the replacement of a low-infiltration land use by grassed waterways and to the increased opportunity for infiltration are evaluated by the methods in NEH 630, Chapter 12.

Conservation tillage is a broad term representing specific residue management practices, such as no-till/strip-till, mulch-till, or ridge-till. These practices leave all or a portion of the previous crop's residue on the soil surface to: reduce soil erosion caused by the forces of wind and water,

- reduce surface runoff,
- increase infiltration, and
- reduce soil evaporation.

No-till is defined as managing the amount, orientation, and distribution of crop and other plant residue on the soil surface year-round. This is accomplished by growing crops in narrow slots or

tilled or residue-free strips in soil previously untilled by full-width inversion implements (NRCS, 1999b).

Mulch-till is defined as managing the amount, orientation, and distribution of crop and other plant residue on the soil surface year-round. This is accomplished by growing crops where the entire field surface is tilled prior to planting (NRCS, 1999b).

Ridge-till is defined as managing the amount, orientation, and distribution of crop and other plant residue on the soil surface year-round. This is accomplished by growing crops on preformed ridges alternated with furrows protected by crop residue (NRCS, 1999b).

(b) Grassland

Grassland in watersheds can be classified by means of the three hydrologic conditions for native pasture or range shown in Table 8-1, which are based on cover condition, not forage production. The percent of area covered (or density) and the intensity of grazing are visually estimated. In making the estimates, one should consider that grazing on anything other than dry soils results in lowering of infiltration rates because of compaction of the soil by hooves, an effect that may carry over for a year or more even without further grazing.

Table 1. Classification of native pasture or range

Vegetative condition	Hydrologic condition
Heavily grazed – No mulch or has plant cover on < 50% of area	Poor
Not heavily grazed – Plant cover on 50% to 75% of the area	Fair
Lightly grazed – Plant cover on > 75% of the area	Good

An alternative system of evaluation is shown in Table 8-2. In this system, density and air-dry weights of grasses and litter are used. The air-dry weights are determined from filed samples. The field work can be kept to a minimum by sampling a small number of representative sites rather than a large number of random sites. In Table 8-2, the classes with plus signs are midway between adjacent classes so that the CNs for these classes should be estimated by interpolation in Chapter 9.

Contour furrows on native pasture or range are longer lasting than those on cultivated land, with the length of life being dependent on the soil, intensity of grazing, and cover density. The dimensions and spacing of furrows vary with the climate and topography. The CNs in Chapter 9 are based on data from contoured grassland watersheds in the central and southern Great Plains. Terraces are

Table 2. Air-dry weight classification of native pasture or range

Cover density (%)	**Plant and litter air-dry weight (tons/ac)***		
	< 0.5	**0.5 to 1.5**	**> 1.5**
< 50	Poor	Poor +	Fair
50 to 75	Poor +	Fair	Fair +
> 75	Fair	Fair +	Good

*Classes with plus signs are midway between adjacent classes so CN should be estimated by interpolation in Chapter 9 tables.

seldom used on grassland; however, when used, the construction methods expose bare soils. Thus, the terraced grassland is more like terraced cropland in its effect on surface runoff for 2 or 3 years.

Meadow is a field on which grass is continuously grown, protected from grazing, and generally mowed for hay. Drained meadows (those having a low water table) have little or no surface runoff except during storms that have a high rainfall intensity. Undrained meadows (those having a high water table) may be so wet that the fields are the equivalent of water surfaces in the runoff computations of Chapter 10. If a wet meadow is drained, the soil-group classification as well as the land use and treatment class may change (see Chapter 7 regarding the change in soil group classification and/or dual hydrologic soil groups.)

(c) Woods and forests

Woods are usually small isolated groves of trees being raised for farm or ranch use. Woods can be evaluated as shown in Table 8-3, which is based on cover effectiveness, not on timber production. The hydrologic condition is visually estimated.

Forests: As contrasted to woods, forests are characterized by extensive or continuous vegetative cover, abundant organic material, and extensive ground cover. Forests may have several layers of over-story and under-story canopy cover, are often found on steep slopes, are often located in inaccessible locations, and infrequently disturbed. A humid climate, which is needed to generate the vegetation, is also a characteristic of forests. Grazing is usually minimal and timber production may be a management goal. While forest soils may be classified as HSG A or HSG B, forested watersheds are not always compatible with the CN method, as described in Chapter 9.

Common hydrologic processes include: canopy and litter interception and stem-flow, an impeding soil layer causing delayed drainage, secondary (subsurface) flow contributions, non-Darcy soil-water flow processes, base-flow from local upland groundwater sources, and direct channel interception. There is, however, very little overland flow and no direct or unimpeded rain contact with the soil surface. Infiltration capacities far exceed the expected effective rainfall intensities; Hortonian overland flow is non-existent or very rare.

Where areas of national or commercial **forests** covered a large part of a watershed, the NRCS hydrologist was guided by the letter between the USDA Forest Service and the Soil Conservation Service dated November 8, 1954 (USDA, 1954), when determining CNs for National Forest lands. The USDA Forest Service will make the determination of CNs for National Forests in consultations with the NRCS**.**

Table 3. Classification of woods

Vegetative condition	Hydrologic condition
Heavily grazed or regularly burned. Litter, small trees, and brush are destroyed.	Poor
Grazed, but not burned. Some litter, but woods are not protected.	Fair
Protected from grazing. Litter and shrubs cover the soil.	Good

630.0803 Determination of classes

The land use and treatment classes on a watershed can be determined at the same time the soils are classified (NEH 630, Ch. 7). As with soils, the classes are determined for a hydrologic unit (NEH 630, Ch. 6). Distributions of the classes within the units is not required, just the percentage of each. A worksheet with classes shown in the order given in Chapter 9 can be convenient for tabulating percentages or acreages and is useful later in computing composite runoff volume (depth) or Q and then determining the total Q for the subwatershed. By using Geographic Information Systems (GIS) remote sensing procedures in conjunction with the National Land Cover Database (NLCD) database, classifying the cover on a 400 square mile watershed may take less than a day.

630.0804 References

United States Department of Agriculture. (1954). A letter between U.S. Forest Service and the Soil Conservation Service, November 8, 1954, on classifying hydrologic conditions of woods and forests.

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