

Annex 2. Taules de n composta per lleres.

Extretes de “Guide for Selecting Manning’s Roughness Coefficients for Natural Channels and Flood Plains” del Servei Geològic dels Estats Units (USGS).

- Valors del coeficient de manning de base (n_b) per una llera recte, uniforme i materials naturals:

Bed Material	Median Size of bed material (in millimeters)	Base n Value	
		Straight Uniform Channel ¹	Smooth Channel ²
Sand Channels			
Sand ³	0.2	0.012	--
	.3	.017	--
	.4	.020	--
	.5	.022	--
	.6	.023	--
	.8	.025	--
	1.0	.026	--
Stable Channels and Flood Plains			
Concrete	--	0.012-0.018	0.011
Rock Cut	--	--	.025
Firm Soil	--	0.025-0.032	.020
Coarse Sand	1-2	0.026-0.035	--
Fine Gravel	--	--	.024
Gravel	2-64	0.028-0.035	--
Coarse Gravel	--	--	.026
Cobble	64-256	0.030-0.050	--
Boulder	>256	0.040-0.070	--

[Modified from Aldridge & Garret, 1973, [Table 1](#) --No data
¹Benson & Dalrymple --No data
² For indicated material; Chow(1959)
³ Only For Upper regime flow where grain roughness is predominant

The flow regime is governed by the size of the bed materials and the stream power, which is a measure of energy transfer. Stream power (SP) is computed by the formula

$$SP = \gamma R S_w V \quad (4)$$

where:

- SP = Stream Power, in newton-meters per second per square meter.
- γ = specific weight of water, in Newtons per cubic meter
- R = hydraulic radius, in meters
- S_w = water surface slope, in meter per meter
- V = mean velocity, in meters per second

The values in for sand channels are for upper regime flows and are based on extensive laboratory and field data obtained by the U.S. Geological Survey. When using these values, a check must be made to ensure that the stream power is large enough to produce upper regime flow ([Fig. 2](#)). Although the base n values given in for stable channels are from verification studies, the values have a wide range because the effects of bed roughness are extremely difficult to separate from the effects of other roughness factors. The choice of n values selected

- Valors del coeficient manning per factors que afecten la rugositat de les lleres (n_1, n_2, n_3, n_4):

Table 2 . Adjustment Values for Factors that Affect the Roughness of a Channel
[modified from Aldridge and Garrett, 1973, Table 2]

Channel Conditions	n Value Adjustment ¹	Example
Degree of Irregularity (n_1)		
Smooth	0.000	Compares to the smoothest channel attainable in a given bed material.
Minor	0.001-0.005	Compares to carefully degraded channels in good condition but having slightly eroded or scoured side slopes.
Moderate	0.006-0.010	Compares to dredged channels having moderate to considerable bed roughness and moderately sloughed or eroded side slopes.
Severe	0.011-0.020	Badly sloughed or scalloped banks of natural streams; badly eroded or sloughed sides of canals or drainage channels; unshaped, jagged, and irregular surfaces of channel
Variation in channel cross section (n_2)		
Channel Conditions	n Value Adjustment ¹	Example
Gradual	0.000	Size and shape of channel cross sections change gradually.
Alternating occasionally	0.001-0.005	Large and small cross sections alternate occasionally, or the main flow occasionally shifts from side to side owing to changes in cross-sectional shape.
Alternating frequently	0.010-0.015	Large and small cross sections alternate frequently, or the main flow frequently shifts from side to side owing to changes in cross-sectional shape.
Effect of obstruction (n_3)		
Channel Conditions	n Value Adjustment ¹	Example
Negligible	0.000-0.004	A few scattered obstructions, which include debris deposits, stumps, exposed roots, logs, piers, or isolated boulders, that occupy less than 5 percent of the cross-sectional area.
Minor	0.005-0.015	Obstructions occupy less than 15 percent of the cross-sectional area, and the spacing between obstructions is such that the sphere of influence around one obstruction does not extend to the sphere of influence around another obstruction. Smaller adjustments are used for curved smooth-surfaced objects than are used for sharp-edged angular objects.
Appreciable	0.020-0.030	Obstructions occupy from 15 percent to 50 percent of the cross-sectional area, or the space between obstructions is small enough to cause the effects of several obstructions to be additive, thereby blocking an equivalent part of a cross section.
Severe	0.040-0.050	Obstructions occupy more than 50 percent of the cross-sectional area, or the space between obstructions is small enough to cause turbulence across most of the cross section.
Amount of vegetation (n_4)		
Channel Conditions	n Value Adjustment ¹	Example

Small	0.002-0.010	Dense growths of flexible turf grass, such as Bermuda, or weeds growing where the average depth of flow is at least two times the height of the vegetation; supple tree seedlings such as willow, cottonwood, arrowhead, or saltcedar growing where the average depth of flow is at least three times the height of the vegetation.
Medium	0.010-0.025	Turf grass growing where the average depth of flow is from one to two times the height of the vegetation; moderately dense stemy grass, weeds, or tree seedlings growing where the average depth of flow is from two to three times the height of the vegetation; brushy, moderately dense vegetation, similar to 1-to-2-year-old willow trees in the dormant season, growing along the banks, and no significant vegetation is evident along the channel bottoms where the hydraulic radius exceeds 0.61 meters.
Large	0.025-0.050	Turf grass growing where the average depth of flow is about equal to the height of the vegetation; 8-to-10-years-old willow or cottonwood trees intergrown with some weeds and brush (none of the vegetation in foliage) where the hydraulic radius exceeds 0.60 m; bushy willows about 1 year old intergrown with some weeds along side slopes (all vegetation in full foliage), and no significant vegetation exists along channel bottoms where the hydraulic radius is greater than 0.61 meters.
Very Large	0.050-0.100	Turf grass growing where the average depth of flow is less than half the height of the vegetation; bushy willow trees about 1 year old intergrown with weeds along side slopes (all vegetation in full foliage), or dense cattails growing along channel bottom; trees intergrow with weeds and brush (all vegetation in full foliage).

(Degree of Meandering m)^{1 2} m

Channel Conditions	n Value Adjustment ¹	Example
Minor	1.00	Ratio of the channel length to valley length is 1.0 to 1.2.
Appreciable	1.15	Ratio of the channel length to valley length is 1.2 to 1.5.
Severe	1.30	Ratio of the channel length to valley length is greater than 1.5.

¹ Adjustments for degree of irregularity, variation in cross section, effect of obstructions, and vegetation are added to the base n value (Table 1) before multiplying by the adjustment for meander.

² Adjustment values apply to flow confined in channel and do not apply where downvalley flow crosses meanders.