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GUIDE FOR EVALUATION OF SOIL PROPERTIES RELEVANT TO IRRIGATION

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GUIDE FOR EVALUATION OF SOIL PROPERTIES RELEVANT TO IRRIGATION

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(*Continued on page* 2)

(*Continued from page* 1)

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GUIDE FOR EVALUATION OF SOIL PROPERTIES RELEVANT TO IRRIGATION

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 25 October 1982, after the draft finalized by the Water Requirements for Crops Sectional Committee had been approved by the Agricultural and Food Products Division Council.

0.2 Irrigation water plays a vital role in many soil process. The manner in which water is distributed within the soil mass depends to a consider able extent on the individual soil properties.

0.3 In rating land for irrigation (agriculture), first attention should be given to physical condition which make the land adoptable to careful control of moisture. Freedom from undesirable chemical characteristics receives second consideration and third, the soil properties which effect the inherent productivity are to be considered.

0.4 It is hoped that this guide would help in deciding the method of irrigation, suitable crops for the area in relation to efficient utilization of water. This would also be useful to planners in selecting site for irrigation projects.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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1. SCOPE

1.1 This standard gives guidelines for evaluation of soil properties in relation to irrigation.

*Rules for rounding off numerical values (*revised*).

2. PHYSICAL PROPERTIES

2.1 Texture

2.1.1 Texture is an expression to indicate the coarseness or fineness of the soil as determined by the relative proportion of the various sized primary particles in the soil mass. It is one of the fundamental and permanent characteristics that has direct bearing on structure, porosity adhesion and consistency. Sandy soils of open characters possess good drainage and aeration and are usually loose and friable and easy to handle in tillage operation. Clayey and silty soils owing to have large surface area possess high absorbtive and retention capacity for moisture. They usually have fine pores, are moderate to poor in drainage and aeration and are relatively difficult to handle for cultivation purpose. Proforma for land irrigability classes has also been mentioned in Appendix A.

2.1.2 The standards followed for soil irrigability classes are mentioned below:

Soil Irrigability Class	*Texture*
A	Sandy loam to clay loam
B	Loamy sand and clay
C	Sand and clay
D	Sand and clay
Non-irrigable class	Any texture

2.1.3 Basis for above classification of soil texture are given in Table 1.

2.2 Effective Soil Depth

2.2.1 Soil depth modifies to a great extent the rooting system of plants which is ultimately reflected in irrigation, crop growth and yield.

2.2.2 The standards followed for effective soil depth in soil irrigability classification are as under:

Soil Irrigability Class	*Effective Depth in mm*
A	More than 900
B	450 to 900
C	225 to 450
D	75 to 225
Non-irrigable soil class	Less than 75

TABLE 1 BASIS FOR CLASSIFICATION FOR TEXTURE
(Clause 2.1.3)

Sl No.	Type of Soil	Classification of Soil	Texture	Symbol	Range in Percent		
					Sand	Silt	Clay
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Sandy soils	Coarse	Sands	*s*	93-100	0-4	0-18
			Loamy sands	*ls*	63-92	5-25	0-12
ii)	Loamy soils	Moderately course	Sandy loam	*sl*	70-92	0-13	9-20
			Fine sandy loam	*fsl*	—	—	—
		Medium	Very fine sandy loam	*vfsl*	—	—	—
			— Loam	*l*	50-70	10-25	10-26
			— Silt loam	*sil*	25-75	25-50	0-26
			— Silt	*si*	0-50	50-100	0-26
		Moderately fine	Sandy clay loam	*scl*	65-85	0-13	17-30
			Clay loam	*cl*	35-70	0-25	21-40
			Silty clay loam	*sicl*	0-48	28-74	25-40
iii)	Clayey soils	Fine	— Sandy clay	*sc*	50-75	0-8	26-50
			— Silty clay	*sic*	0-35	25-60	40-75
			— Clay	*c*	0-62	0-25	32-100

2.3 Infiltration

2.3.1 Infiltration is the downward entry of water into the soil. It is the maximum rate at which a soil in a given condition at given time can absorb rain or irrigation water. It is classified as below:

Class	*Basic Infilteration Rate mm/Hour*
1. Very slow	Less than 0·25 cm/hour to 2·5
2. Slow	2·5 to 12·5
3. Moderate	12·5 to 25
4. Rapid	More than 25

2.3.2 Infiltration is a dynamic and quite variable character of soil and can be fairly well controlled by management practices.

2.4 Permeability

2.4.1 Permeability are of two types (i) Qualitative (ii) Quantitative.

2.4.1.1 *Qualitative* — The quality or state of porous medium relative to the readyness with which such a medium conducts or transmit fluids.

2.4.1.2 *Quantitative* — The specific properties governing the rate or readyness with which a porous medium transmits fluid under standard position.

2.4.2 The permeability depends upon pore size distribution of the soil. Texture and structure of a soil often studied in field for qualitative assessment of permeability. Concentration and composition of salts dissolved in irrigation water also effect the permeability of soils.

2.4.3 The degree of permeability may be distinguished as follows:

Permeability Class	*mm/hour*
1. Very slow	Less than 1·2
2. Slow	1·3 to 5
3. Moderately slow	5 to 20
4. Moderate	20 to 50
5. Moderately rapid	50 to 130
6. Rapid	130 to 250
7. Very rapid	Above 250

2.4.4 The standards followed for permeability for soil irrigability class are as under:

Soil Irrigability Class	*Permeability mm/hour*
A	5 to 50
B	1·3 to 5
	50 to 130
C	0·3 to 1·3
	130 to 250
D	Less than 0·3 and greater than 250

Soil permeability as a criteria is not applicable to deep black soil because of their unique properties. Deep black soils (vertisols) which are inherently slowly permeable due to expanding 2:1 lattic type minerals do not qualify for irrigability class-A, they would qualify for B, C & D Class.

2.5 Drainage

2.5.1 The processes of discharge of water from an area of soil by sheet or streams flow (surface drainage) and removal of excess water from within soil by downward flow through the soil (internal drainage). Generally speaking coarse texture soil drain better than fine texture soil. Drainage depends directly on permeability of soil.

2.5.2 Standards followed for drainage for irrigability class are as below:

A and B Class	:	Lower subsoil is at least moderately permeable or permeable layer of at least 6 inch thickness occurs immediately below soil but within 10 feet (sand and gravels).
C and D Class	:	Moderately permeable subsoil or other permeable layer of at least 6 inch thickness occurs with depth of 10 metres.

2.6 Soil Temperature

2.6.1 Soil temperature has extensive effect on soil properties and behaviour. The water holding capacity of soil decreases slightly with rise in temperature. Soil moisture is the most vital controlling factor in soil temperature.

3. CRITERIA FOR CLASSIFICATION

3.1 Criteria for classification of soil on the basis of properties (*see* **2**) are given in Table 2.

TABLE 2 CRITERIA FOR CLASSIFYING SOILS INTO IRRIGABILITY CLASSES

(*Clause* 3.1)

Sl No.	Soil Properties	Irrigable Soil Classes				Non-irrigable Soil Class
		A	*B*	*C*	*D*	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Effective soil depth (useful to crops)	More than 900 mm	450 to 900 mm	225-450 mm	75-225 mm	Less than 75 mm
ii)	Texture of surface 30 cm	Sandy loam to clay loam inclusive	Loamy sand; clay	Sand; clay	Sand clay	Any texture
iii)	Soil permeability (*see* Note 1) (of least permeable layer)	5·0-50 mm/hr	1·3-5 mm/hr 50-130 mm/hr	0·3-1·3 mm/hr 130-250 mm/hr	Less than 0·3 mm, Greater than 250 mm/hr	Not applicable
iv)	Available water holding capacity to depth of 90 cm	120 mm or more	90-120 mm	60-90 mm	20-60 mm	Less than 20 mm
v)	Coarse fragments cobbles and stones (more than 75 mm)	Less than 5 percent	5-15 percent	15-35 percent	35-65 percent	More than 65 percent
vi)	Gravel and *Kankar* (more than 25 up to 75 mm)	Less than 15 percent	15-35 percent	35-55 percent	55-70 percent	More than 70 percent
vii)	Rockout crops (distance apart in metres)	40 metres	20 metres	15 metres	5 metres	Less than 5 metres

viii)	Salinity (E.C × 10^3) (in saturation extract) (*see* Note 2)	Less than 4 mmhos	4-8 mmhos	8-12 mmhos	12-16 mmhos	More than 16 mmhos
ix)	Salt affected (visual) (percent of area affected)	Less than 20 percent	—	20-50 percent	—	More than 50 percent
x)	Severity of alkali problem	ESP (*see* Note 3) less than 15 percent	—	ESP (*see* Note 3) more than 15 percent	ESP (*see* Note 3) more than 15 percent	—
xi)	Sub-soil or substrata drainage characteristics	Lower subsoil is at least moderately permeable or a permeable layer of at least 18 cm thickness occurs immediately below the soil but within 9 metres (sand, gravel)			No moderately permeable subsoil or other permeable layer of at least 18 cm thickness occurs within depth of 9 metres	
xii)	Soil erosion status	Effects of sheets and rill erosion are reflected in effective soil depth, available moisture holding capacity and in some other factors shown above. Moderately or severely gullied soils may be classified based on local experience.				

NOTE 1 — Soil permeability as a criteria is not applicable to deep black soils because of their unique properties. Deep black soil (vertisols) which are inherently slowly permeable due to expanding 2 : 1 lattice type minerals do not qualify for irrigation soil class A. They would qualify for being placed in B, C & D Class.

NOTE 2 — The method recommended by soil testing laboratories in India prescribed 1 : 2 soil to water ratio for soil salinity determinations and hence corresponding conductivity figures are given here:

Salinity in	Less than	1-1·5	1·5-2·5	2·5-3	More than
1 : 2 dilution	1 mmhos	mmhos	mmhos	mmhos	3 mmhos

NOTE 3 — Exchangeable sodium percent.

APPENDIX A

(*Clause* 2.1.1)

PROFORMA FOR LAND IRRIGABILITY CLASSES

Land Characteristics	Irrigable Land Class				Class 5 Temporarily Non-irrigable (Unclassified)	Class 6 not Suitable for Irrigation
	Class 1	Class 2	Class 3	Class 4		
Soil Irrigability Class	A	A to B	A to C	A to D	Further Investigations needed	Includes lands which do not meet the minimum requirements for the other land classes and are not suitable for irrigation or small isolated tracts (specifying size or distance from canal) not susceptible to delivery or irrigation water
TOPOGRAPHY						
1. Slope	Less than 1 percent	1-3 percent	3-5 percent	5-10 percent		
2. Surface grading	No restriction or less than____ metres excavation per ha., less than____ metres average cut and fill	Moderate restrictions (specifications to be developed locally)	Moderately severe restrictions (develop specifications locally)	Severe restrictions (develop specifications locally)		
DRAINAGE						
1. Outlets	Suitable outlets available	Suitable outlets available	Suitable outlets available	No drainage outlets available	Further investigations needed	
2. Surface	Less than____ metres of shallow surface drains required per acre	Less than____ metres of shallow surface drains required per acre	Develop specifications			

3.	Subsurface	No subsurface drainage needed; or land is within ____ metres of adequate drainage way (*nulla* or rivers)	No subsurface drainage needed; or land is within ____ metres of adequate drainage way (*nulla* or river)	Subsurface drainage needed. Specifications to be developed	No natural drainage outlets available; cost of pump off drainage exceed ____ Rs/ha
4.	Depth of water table	More than 5 metres	3·0-5 metres	1·5-3 metres	1·5 metres and below

With regard to items under Topography (2) and Drainage (2) and (3) the criteria will have to be worked out for each project on the basis of local conditions.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	Unit	Symbol
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	Unit	Symbol	Definition
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

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Corrigendum

(*Page 6, clause 2.4.3, against Sl No. 1*) - Substitute 'Less than 1.3' *for* 'Less than 1.2'.

(AFDC 58)

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