TECHNICAL NOTES

USDA-Natural Resources Conservation Service
Boise, Idaho

ENGINEERING TECHNICAL NOTE NO. 02 December 16, 1981

ESTIMATING SEDIMENT CONCENTRATIONS BY IMHOFF CONE IN RUNOFF WATER FROM SILT LOAM SOILS

General

Imhoff cones were designed for measuring settleable material in sewage at various stages of treatment. Using the standard Imhoff cone methods for measuring sediment concentrations does not give satisfactory results, primarily because soil has a greater density than settleable solids in sewage.

A method for determining sediment concentrations has been developed by Agricultural Research Service personnel at Kimberly, Idaho based upon field studies conducted by them and the personnel of Washington State University and the University of Idaho.

Sampling Procedure

The recommended sampling procedure is as follows:

1. Collect a 1 liter sample of water. To assure that the sample represents the actual condition of the water being evaluated, obtain the sample at a point where the sediment load is thoroughly mixed. The sample may be taken with the Imhoff cone directly or with any container that holds at least 1 liter. If the sample is collected with another container, make sure the sample is thoroughly mixed before pouring it into the Imhoff cone.

2. To measure the sediment once the water sample is in the Imhoff cone, set the cone upright and allow the contents to settle for 30 minutes.

3. At the end of 30 minutes, record the volume of sediment that has settled into the bottom section of the cone.

4. Using the appropriate column in Table A, the sediment concentration (weight per unit runoff) in milligrams/liter, tons/acre foot, or pounds/gallon can be determined for the given Imhoff cone reading.

5. The quantity of sediment being carried off in the runoff water can be determined by multiplying the sediment concentration (Step 4) by the water flow. The water flow rate and duration should be measured at the time the 1 liter sample is taken. Example 1 shows a method for determining the erosion rate for a single irrigation. Example 2 shows a method for estimating a seasonal erosion rate.

Limitations

The relationships in Table A are for silt loam soils. Relationships for sandy, clay or clay loam soils have not been determined. Also the Imhoff cone is not intended to substitute for filter testing where a high degree of accuracy is needed.

Example 1

Imhoff cone 30 minute reading = 11.0 ml/l
Length of run = 800 feet
Row Width = 30 inches
Outflow = 5.5 gpm average
Outflow time = 500 minutes

Find the sediment rate per acre from the field for this irrigation.

Step 1. Conversion factor for 11.0 ml/l

Reading from Table A = 0.0675 lbs/gal.

Step 2. Amount of sediment per furrow

Sediment = (Outflow 5.5 gpm) (Outflow time 500 minutes)

x (Conversion factor 0.0675 lbs/gal. ÷ 2000 lbs/ton)

= 0.0928 tons

Step 3. Area

$$A = \frac{\text{(Furrow width 2.5 feet) (Furrow length 800 feet)}}{43{,}560\ ft^2/ac.}$$

Step 4. Sediment Rate

$$\text{Rate} = \frac{0.0928\ \text{tons}}{0.0459\ \text{acres}} = 2.02\ \text{tons/acre}$$

The seasonal sediment rate can be estimated by multiplying this value times the number of irrigations. This assumes the value for this irrigation is an average value for all irrigations.

Example 2

Imhoff cone 30 minute reading = 11.0 ml/l

The estimated irrigation water deliver to the field is 4 ac. ft/ ac./yr.

The percent runoff is estimated at 40 percent of inflow. (This rate is from knowledge of the soil, typical soil intake, inflow and outflow measurements).

Estimate the sediment rate per acre from the field for a season.

Step 1. Conversion factor for 11.0 ml/l reading.

From Table A = 10.99 tons/acre foot.

Step 2. Runoff per acre

R_o = (Seasonal irrigation 4 ac.ft./ac.) (Runoff 40%) = 1.6 ac.ft./ac.

Step 3. Sediment rate

Sediment rate = (Conversion factor 10.99 tons/ac.ft.)

x (Runoff per acre 1.6 ac.ft./ac.)

= 17.58 tons/acre

This method assumes that the Imhoff cone reading used is an average value for all irrigations.

/s/ H. LeRoy Zollinger
H. LeRoy Zollinger
State Conservation Engineer

Attachments: Table A

TABLE A

Imhoff Cone Reading Versus Sediment Concentration for Various Units of Runoff

SILT LOAM SOILS

Imhoff Cone Reading	Sediment Concentration Conversion Factors for Various Units Of Weight per Unit of Runoff			Imhoff Cone Reading	Sediment Concentration Conversion Factors for Various Units of Weight per Unit of Runoff		
ml/l	mg/l	tons/ac ft	lbs/gallon	ml/l	mg/l	tons/ac ft	lbs/gallon
0.10	756	1.03	0.0063	18.00	12796	17.39	0.1070
0.25	857	1.16	0.0071	19.00	13468	18.30	0.1120
0.50	1025	1.39	0.0086	20.00	14141	19.22	0.1180
0.75	1193	1.62	0.0100	21.00	14814	20.13	0.1240
1.00	1362	1.85	0.0114	22.00	15486	21.05	0.1290
1.25	1530	2.08	0.0128	23.00	16159	21.96	0.1350
1.50	1698	2.31	0.0142	24.00	16831	22.87	0.1400
1.75	1866	2.54	0.0156	25.00	17504	23.79	0.1460
2.00	2034	2.76	0.0170	26.00	18177	24.70	0.1520
2.25	2202	2.99	0.0184	27.00	18849	25.60	0.1570
2.50	2371	3.22	0.0198	28.00	19522	26.50	0.1630
2.75	2539	3.45	0.0212	29.00	20194	27.40	0.1690
3.00	2707	3.68	0.0226	30.00	20867	28.40	0.1740
3.25	2875	3.91	0.0240	32.00	22212	30.20	0.1850
3.50	3043	4.14	0.0254	34.00	23557	32.00	0.1970
3.75	3211	4.36	0.0268	36.00	24903	33.80	0.2080
4.00	3379	4.59	0.0282	38.00	26248	35.70	0.2190
4.25	3547	4.82	0.0300	40.00	27593	37.50	0.2300
4.50	3716	5.05	0.0310	42.00	28938	39.30	0.2410
4.75	3884	5.28	0.0324	44.00	30283	41.10	0.2530
5.00	4052	5.51	0.0338	46.00	31629	43.00	0.2640
5.50	4388	5.96	0.0366	48.00	32974	44.80	0.2750
6.00	4725	6.42	0.0394	50.00	34319	46.60	0.2860
6.50	5061	6.88	0.0422	52.50	36000	48.90	0.3000
7.00	5397	7.33	0.0450	55.00	37682	51.20	0.3140
7.50	5734	7.79	0.0479	57.50	39364	53.50	0.3290
8.00	6070	8.24	0.0507	60.00	41045	55.80	0.3430
9.00	6742	9.16	0.0563	62.50	42727	58.10	0.3570
10.00	7415	10.08	0.0619	65.00	44408	60.40	0.3710
11.00	8088	10.99	0.0675	67.50	46090	62.60	0.3850
12.00	8760	11.90	0.0731	70.00	47771	64.90	0.3990
13.00	9433	12.82	0.0787				
14.00	10105	13.73	0.0843				
15.00	10778	14.65	0.0900				
16.00	11451	15.56	0.0956				
17.00	12123	16.48	0.1010				

FURROW SEDIMENT YIELD
BY IMHOFF CONE METHOD

Date_____

Cooperator_____ County_____ District_____

Furrow No._____ Length_____ Irrigation Width_____ By_____

Station_____ Page__of__

1	2	3	4	5*	6**	7	8	9
24-HOUR CLOCK	ELAPSED TIME (Minutes)	OUTFLOW (GPM)	IMHOFF (Ml/l)	CONVERSION FACTOR (lbs/gal)	SEDIMENT (Tons)	AREA (Acres)	YIELD (Tons/Ac)	SUM YIELD (Tons/Ac)
		( )		( )				
		( )		( )				
		( )		( )				
		( )		( )				
		( )		( )				
		( )		( )				

* Conversion Factor from TN-2(Eng), Table A.
** Use average values in Cols. 3 and 5 to compute Col. 6.

1. From outflow data
2. Incremental clock time
3. From outflow data
4. Imhoff cone measurement
5. TN-2(Eng.), Table A
6. Col. 2 x Col. 3 x Col. 5 ÷ 2,000
7. Furrow length x irrigation width ÷ 43,560
8. Col. 6 ÷ Col. 7
9. Summation of Col. 8