CHAPTER 10. GULLY TREATMENT

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DESIGN PROCEDURE FOR WATER AND SEDIMENT CONTROL BASINS (WASCOB)

DETERMINATION THAT TERRACES WILL NOT FIT

Steps

1. Determine that there is no reasonable farmable set of terracss that can be installed. Determine that field slopes will be controlled by cultural and management practices, but there will still be a need for erosion control in the watercourses or to protect lower lying land. WASCOB's predominately control gully erosion and terraces control sheet and rill erosion.

WASCOB LOCATION

2. Check that the first WASCOB is as far up the drainageway as possible taking into account property lines, storage characteristics, etc.

NOTE: Steps 3 thru 5 can be deleted for a single WASCOB

3. Determine maximum spacing from table in Tech. Guide Spec. 600 using slope of the watercourse.

4. Determine the maximum spacing using the USLE.

   a. Determine land slope of the watercourse from field surveys.

   b. Determine soil type and erosion from soil surveys

   c. Determine T/K value from Technical Guide Section I-C Erosion Prediction.

   d. Determine rainfall factor (R) for location from Technical Guide Section I-C Erosion Prediction.

   e. Determine erosion index (EI) for location from Technical Guide Section I-C Erosion Prediction.

   f. Determine cropping and management from planning with landowner. Planning must consider slopes parallel with the fill centerline which are not broken by the WASCOB.

   g. Determine design "C" value from Technical Guide Section I-C Erosion Prediction. This will be used for sediment analyses.

   h. Determine slope length using the soil loss calculator or equation.

   i. Determine the maximum spacing by adding the front slope to the slope length.

(EFM Notice IN38, August 1981)

5. Determine the actual WASCOB spacing. Do not exceed the maximums established in Steps 3 or 4. Actual locations are to be determined from field observation of watercourse erosion, the "lay" of the land influencing storage characteristics, and the need to limit fill heights. (Where WASCOB's will be cropped the required flat slopes will result in tremendous amounts of earth fill required for fills in excess of 5 or 6 feet).

REQUIRED STORAGE

Runoff Storage

6. Determine drainage areas to WASCOB's. The level fill may not extend to the drainage area break. Sufficient field surveys should be taken to accurately determine the drainage areas.

7. Determine 10 yr. 24 hr. rainfall in inches from EFM Chapter 2, Ex. IN-2-4.

8. Determine CN from EFM Chapter 2 based on the soils and the cropping and management proposed. Use IN-ENG-10 as needed.

9. Determine runoff in inches from EFM Chapter 2, Ex. 2-7A

10. Determine acceptable drawdown time in hours for WASCOB's based on crops and landowners desires. Normally 12 to 24 hours is acceptable. The smaller the drawdown time in hours the larger the underground outlet.

11. Determine runoff in cu. ft. by multiplying the drainage area in acres by the runoff in inches by 3,630.

Sediment Storage

Note: (1) Provide 10 yr. sediment storage unless provisions are made for periodically cleaning it. Because of the shape of most WASCOB's, plowing is not a practical method of cleaning. (2) Steps 12 & 13 may be omitted by applying the allowable soil loss to the entire drainage area. If some areas may lose more than the allowable amount or if a more accurate answer is desired, use steps 12 and 13.

12. As needed, divide drainage areas into sub-areas according to the expected soil loss from each sub-area.

13. Using the USLE determine soil loss in tons/ac. for each sub-area.

14. Multiply tons/ac. by acres for each area.

15. Total tons. Use IN-ENG-38 for large drainage areas (25 + acres) See EFM Ch 11 p 11-70 and Ex 11-10.

16. Convert tons to cu. ft. for a 10 year design life. Multiply tons by 22 cu. ft. per ton (equivalent to soil to 90 lbs. per cu. ft).

Total Storage Required

17. Add the sediment storage to the runoff storage.

AVAILABLE STORAGE

18. Determine which method to use. Check shape of storage area. Terrace charts, EFM Ch 8, Ex 8-2, 8-3, IN-8-3 or IN-8-12, are to be used for uniform slopes. A contour map should be used for irregular basins.

NOTE: If terrace charts are to be used, go to Step 20. If contour map is used go to step 19a.

19. Select a fill height.

    a. Planimeter contours above toe of fill.

    b. Compute available storage at each elevation.

    c. Interpolate to find fill height where available storage equals required storage

20. Using EFM Ch 8 Ex 8-2, 8-3, IN-8-3 or IN-8-12 determine available storage at the selected fill height.

21. Compare total storage required. If insufficient try a new fill height.

ORIFICE DESIGN

NOTE: WASCOB's in series require an orifice if underground outlet is not designed for pressure flow or other controls are not in the system. Single WASCOB's may require an orifice to protect the underground outlet from pressure flow.

22. Determine required cfs. Required cfs - runoff in cu. ft. divided by the number of seconds in drawdown period (86,400 for 24 hr.)

23. From profile determine elevation of ridge and channel.

24. Determine d_1 & $0.7d_1$ (d_1 is elevation ridge - elevation channel)

25. Determine minimum value of H = $0.7d_1 + 1.0$ (1.0 is the minimum value of d_2)

26. Determine orifice size. Using required cfs & H(min) enter EFM p 8-102.

NOTE: If d_2 is to be held at 1.0', select an orifice size that yields an actual discharge in excess of the required discharge at the H(min). Proceed to Step 29. If you wish to make the actual discharge equal the required discharge proceed to Step 27.

27. Interpolate values of H to get actual orifice discharge = required cfs.

28. Using new value of H, adjust d_2.

29. Using d_2 find orifice elevation. Channel elev - d_2 (d_2 = 1.0 for minimum) Check underground outlet profile to be sure that orifice elevation will not conflict with drain elevation.

UNDERGROUND OUTLET DESIGN

30. Determine required cfs. Required cfs is the sum of the orifice discharges to the section in question.

31. Using drain grade on the profile and the required cfs., enter EFM, Ch 8 Ex IN-8-6, after p 8-102 to determine drain size and capacity for plastic tubing or Ch 14 Ex IN-14-11 p 14-109 for clay or concrete tile.

32. Fill out the sheets in your plan.

33. Check all your work for omissions and errors.

Given : Eroding watercourse in Crawford County
Landowner is using no till with 5,000# residue. Soil type is Tilsit 2 erosion.

Example : Water and Sediment Control Basins

DETERMINATION THAT TERRACES WILL NOT FIT

1. A reasonable set of terraces cannot be installed due to steepness into the watercourse. Soil is shallow and deep channel cuts are not feasible. Field slopes will be controlled by no till but water concentration in watercourse will need control.

WASCOB LOCATION

2. Locate first WASCOB about 200' to 250' from the drainage break.

3. Maximum spacing from Tech. Guide Spec. 600 from land slope 2% or less = 450' (slope of watercourse - 1.3%)

4. a. Land slope of watercourse - 1.3%
   b. Soil type - Tilsit 2 erosion
   c. T/k = 7, T = 3 Tons/Ac.
   d. Rainfall factor - 200
   e. EI - 19
   f&g. No till with 5,000# residue C = 0.070 (Determined from planning considering most critical slopes.)
   h. Slope length exceeds slide rule value of 2,000 feet.

5. With the first WASCOB placed at 250' from the drainage break, another one will fit in at 50' from the property line fence with an interval of about 300' and should control the watercourse erosion.

REQUIRED STORAGE

Runoff storage

6. Drainage Areas
   W-1 - 2.7 Ac.
   W-2 - 3.1 Ac.

7. 10 yr. 24 hr. rainfall = 4.5"

8. CN = 78

9. Runoff = 2.30"

10. Drawdown time desired is 24 hours

11. Runoff in Cu. Ft.
    W-1 (2.7 Ac.) (2.3") (3630) = 22,542 Cu. Ft.
    W-1 (3.1) (2.3") (3630) = 25,882 Cu. Ft.

(EFM Notice IN38, August 1981)

Sediment Storage

12. W-1 0.7 Ac. - 2% - 100' slopes up and down
2.0 Ac. - 1% - contour 250' slopes

W-2 1.6 Ac. - 4% - 180' slopes up and down
1.5 Ac. - 2% - 250' slopes up and down

13., 14. & 15. Use slide rule to determine tons/Ac. (For sediment yields less than 1 Ton/Ac. use 1 Ton/Ac.)

W-1 0.7 Ac. @ 1.2 Tons/Ac. = .8 Tons/Yr.
2.0 Ac. @ 1 Ton/Ac. = 2.0 Tons/Yr.
2.8 Tons/Yr.

W-2 1.6 Ac. @ 3 Tons/Ac. = 4.8 Tons/Yr.
1.5 Ac. @ 1.6 Tons/Ac. = 2.4 Tons/Yr.
7.2 Tons/Yr.

16. W-1 (2.8 Tons/Yr.) (10Yr.) (22 Cu. Ft./Ton) = 616 Cu. Ft.
W-2 (7.2 Tons/Yr.) (10Yr.) (22 Cu. Ft./Ton) = 1,584 Cu. Ft.

Total Storage

17. W-1 22,542 + 616 = 23,158 Cu. Ft.
W-2 25,882 + 1584 = 27,466 Cu. Ft.

AVAILABLE STORAGE

18. Use contour map due to long narrow storage area (Contours are planimetered starting 20' upstream fill centerline to allow for ½ half the fill).

19a & 20a

	Elev.	Plan rd.	Area Sq.Ft.	Ave. Area	Elev. Difference	Internal Storage (Ac.Ft.)	Cumulative Storage (Ac.Ft.)
W-1	97.5		0				0
				1,800	0.5	900	
	98		3,600				900
				8,200	1	8,200	
	99		12,800				9,100
				24,275	1	24,275	
	100		35,750				33,375
W-2	93.5		0				0
				200	0.5	100	
	94		400				100
				5,225	2	10,450	
	96		10,050				10,550
				20,550	2	41,100	
	98		31,050				51,650

20a W-1 Elev. = $98 + \left[\frac{23,662-9,100}{33,375-9,100}\right] 1 = 99.6$

W-2 Elev. = $96 + \left[\frac{28,762-10,550}{51,650-10,550}\right] 2 = 96.9$

ORIFICE DESIGN

22. Required cfs for 24 hour drawdown period.

W-1 $\frac{22,542 \text{ Cu.Ft.}}{86,400 \text{ sec./24 hr.}} = 0.261$ cfs.

W-2 $\frac{25,882}{86,400} = 0.300$ cfs.

23.

	Elev. Ridge	Elev. Channel
W-1	99.6	97.5
W-2	96.9	93.5

24. W-1 $d_1 = 99.6 - 97.5 = 2.1$ $0.7d_1 = 1.5$

W-2 $d_1 = 96.9 - 93.5 = 3.4$ $0.7d_1 = 2.4$

25. W-1 H(min.) = 1.5 + 1.0 = 2.5
W-2 H(min.) = 2.4 + 1.0 = 3.4

26. W-1 2.50" orifice at 2.5' of head carries 0.259 cfs.
at 3.0 of head carries 0.284 cfs.

W-2 2.50" orifice at 3.0' of head carries 0.284 cfs.
at 3.5 of head carries 0.307 cfs.

27. Interpolation - 2.50" orifice

Head	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5
Dis-charge	0.259	0.264	0.269	0.274	0.279	0.284	0.289	0.293	0.298	0.302	0.3

W-1 Use 2.6 & 0.264 cfs.
W-2 Use 3.4 & 0.302 cfs.

28. W-1 H = 2.6 $d_2 = 2.6 - 1.5 = 1.1'$

W-2 H = 3.4 $d_2 = 3.4 - 2.4 = 1.0'$

29. W-1 Orifice elev. = 97.5 - 1.1 = 96.4
W-2 Orifice elev. = 93.5 - 1.0 = 92.5

UNDERGROUND OUTLET DESIGN

30. Outlet required cfs.
Below W-1 = 0.264 cfs
Below W-2 = 0.264 + 0.302 = 0.566 cfs.

31. Outlet grade is 1.3%
    Capacity of 5" plastic tubing is 0.33 cfs. (Use below W-1)
    Capacity of 8" plastic tubing is 1.1 cfs. (Use below W-2)

32. Fill out the sheet of the plan.

33. Check all work for omissions and errors.

DESIGN DATA

Land slope 2-4 % Soil type and erosion Tilsit - 2 erosion

T/K value 7 Rainfall factor 200 Erosion index 19

Most intensive land use expected and type of management: No till - Continuous corn - 5,000# residue

Design "C" value 0.070 Design slope length (L) = _____ feet L_1 = _____ feet

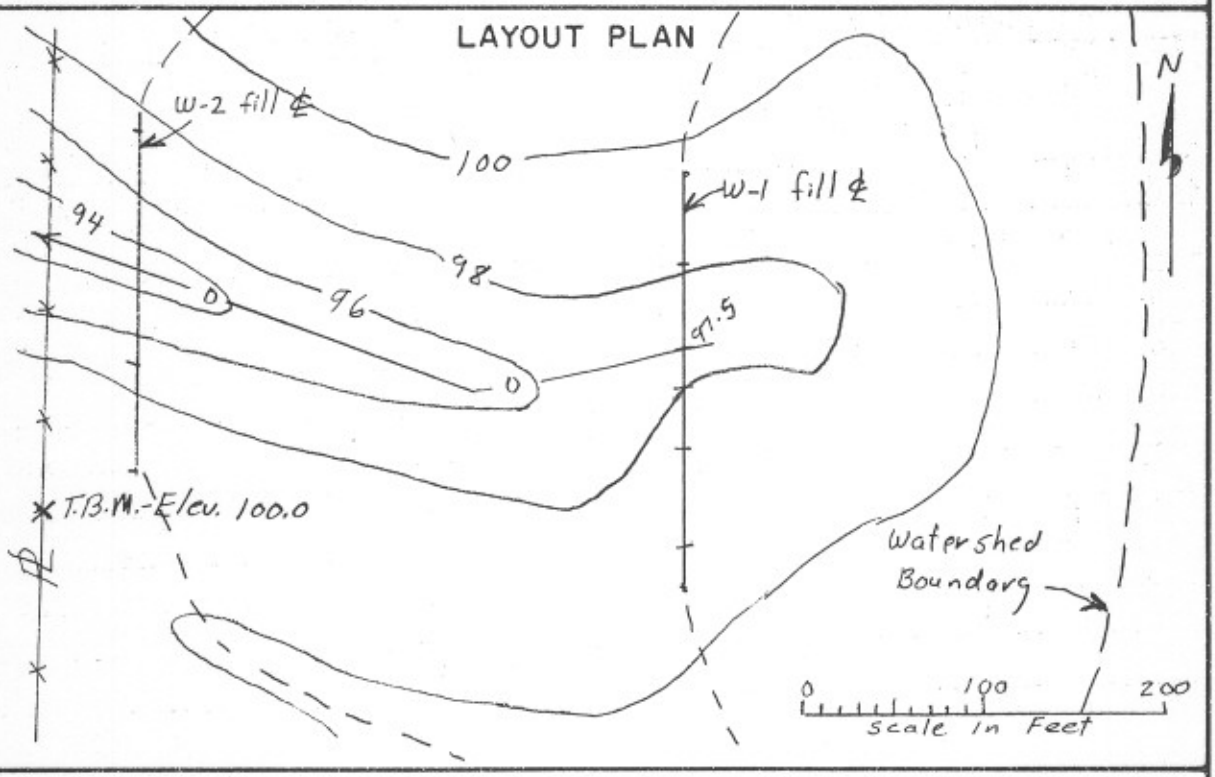
Ridge spacing ($L + L_1$) = _____ feet Ridge spacing used 1/ = 300 feet

10-Year Rainfall 4.5 inches Curve Number 78 Runoff 2.3 inches

Planned Draw-down Time 24 hours

1/ Horizontal spacing may be increased as much as 10 percent to provide better alignment and location to miss obstacles in the field, to adjust for farm machinery, or to reach a satisfactory outlet. An additional 10 percent may be added where underground outlets are used.

LAYOUT PLAN



Benchmark Description and Elevation: 60 d nail in 10" wild cherry 160' south of underground outlet.

ESTIMATED QUANTITIES

Item	Unit	Quantities
Earth Fill	Cu.Yd.	200
5" Plastic Tube.	Lin.Ft.	300
8" Plastic Tube.	Lin.Ft.	60
10" HCMP	Lin.Ft.	10
Risers	Each	2

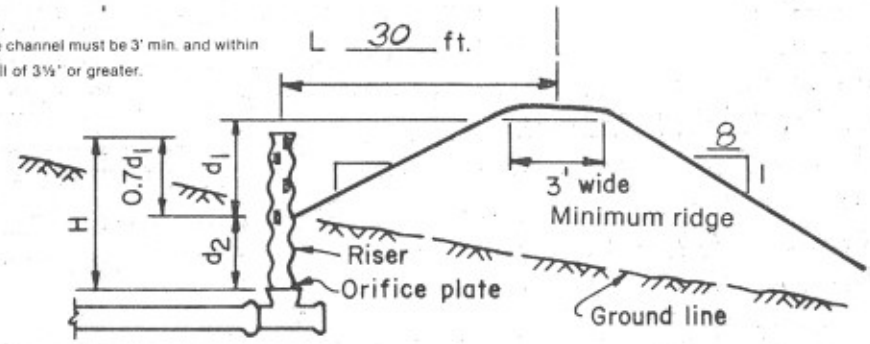
TERRACES OR WATER AND SEDIMENT CONTROL BASINES WITH UNDERGROUND OUTLETS

NAME Sam Hill - Crawford Co.

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date		
Designed	T.S. Alec	1-81	Approved by	/s/U.B. Had
Drawn			Title	DC
Checked	P.A. Jones	2-81	Title	
Reviewed	P.A. Jones	2-81	Sheet No. 1 Of. 3	Drawing No.

Note: Riser hieght above channel must be 3' min. and within 6" of top of any fill of 3½' or greater.



DESIGN HEAD FOR ORIFICE PLATE

REQUIRED STORAGE

Ridge No.	D.A. Acres	Accum. D.A. Acres	Required d Storage		
			Runoff Cu.Ft.	Sed. Cu.Ft.	Total Cu.Ft.
W-1	2.7	2.7	22,542	616	23,158
W-2	3.1	5.8	25,882	1584	27,466

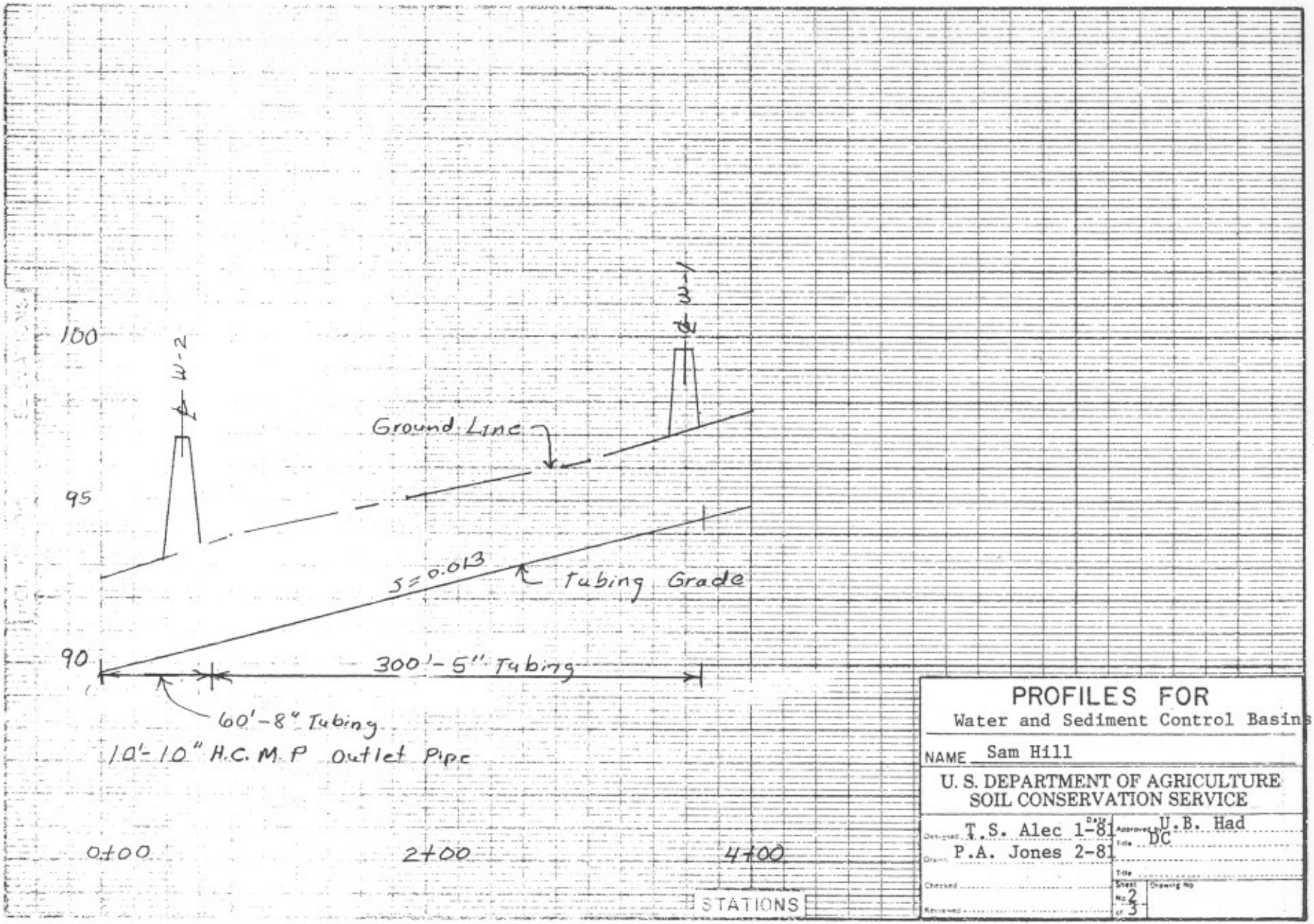
ORFICE DESIGN

Ridge Length	Ridge Elev.	Channel Elev.	d_1 Ft.	$0.7d_1$ Ft.	Orifice Elev.	d_2 Ft.	H Ft.
230	99.6	97.5	2.1	1.5	96.4	1.0	2.5
130	96.9	93.5	3.4	2.4	92.5	1.0	3.4

ORIFICE DESIGN AND SUBSURFACE DRAIN

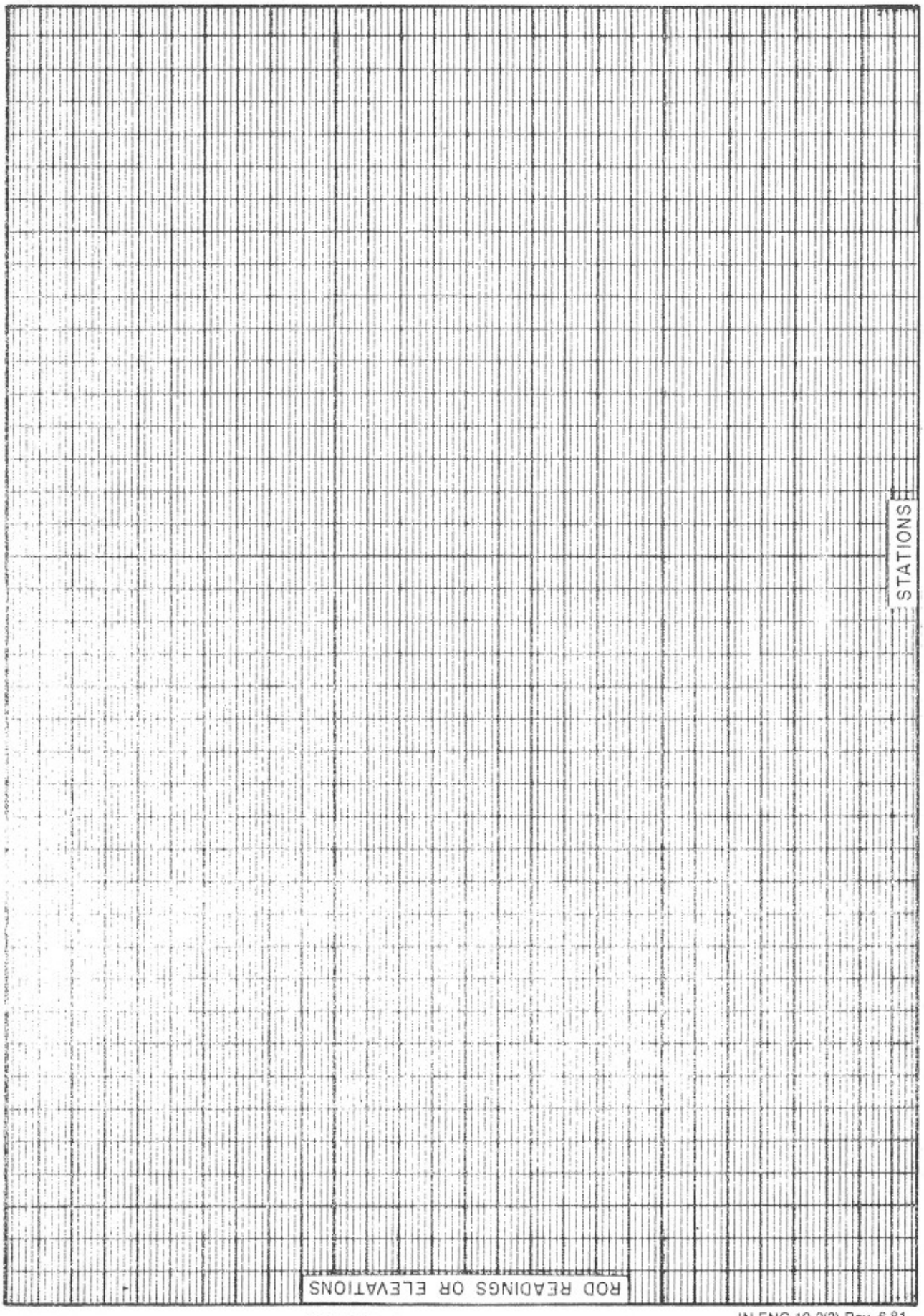
Ridge No.	Required Capacity CFS	Orifice Size Inches	Discharge Provided CFS	Accum. Discharge CFS	Drain Grade %	Drain Size Inches	Max. Drain Cap. CFS	Draw-down Hours	Channel Above Level Ridge		
									Depth Ft.	Channel Grade %	Vel.1 FPS
W-1	0.261	2.6	0.264	0.264	1.3	5	0.33	24	N/A	N/A	N/A
W-2	0.300	3.4	0.302	0.566	1.3	8	1.1	24	N/A	N/A	N/A

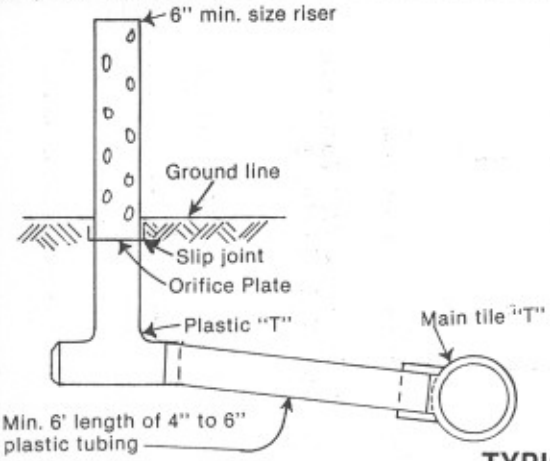
1/ SHOW VELOCITY ONLY IF GRADE EXCEEDS 0.6%

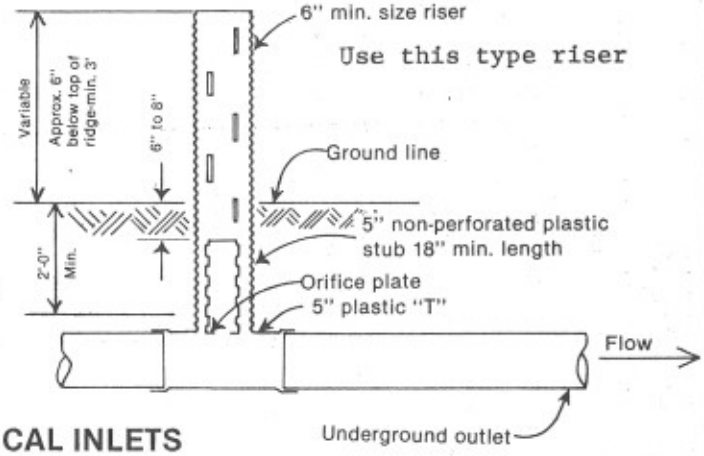


(EFM Notice IN38, August 1981)

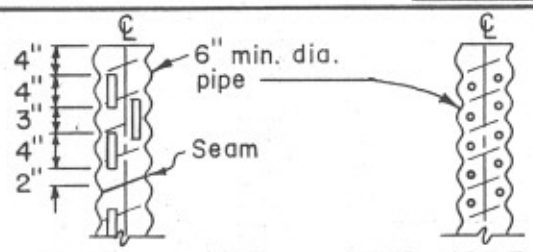
10-27


STATIONS
ROD READINGS OR ELEVATIONS





TYPICAL INLETS



SLOTTED INTAKE

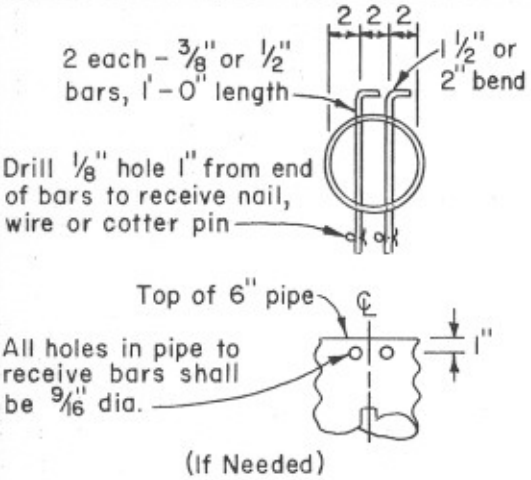
1. CUT 3/4" X 4" SLOTS IN 4 ROWS AROUND THE PIPE (90° SPACING). DO NOT SPACE CLOSER THAN 2" TO THE SEAMS OR END OF PIPE.
2. CAPACITY – 20 ACRE INCHES PER DAY.

ROUND HOLE INTAKE

1. FABRICATE 24 HOLES PER LIN.FT., 3/4" DIAMETER.
2. ALTERNATE FABRICATION APPROXIMATELY 12 HOLES PER FOOT OF 1" DIAMETER.
3. CAPACITY – 8 ACRE INCHES PER DAY.

DETAILS OF RISER

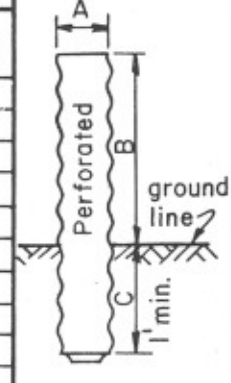
ACTUAL INLET



DETAILS OF TRASH GUARD

RISER DIMENSIONS

TERR. NO.	INLET NO.	RISER DIMENS. A	B	C	DIA. ORIF.
W-1	W-1	6"	3'	1'-0	2.6"
W-2	W-2	6"	3'	1'-0	3.4"



Notes:

1. Aluminum, iron, P.V.C., Smooth P.E. or steel pipe must be used for the riser. A standard trash guard will be installed in the top of the riser unless otherwise specified.

2. The conduit trench from the toe of the backslope to the riser, must be excavated with I:I s.s. and backfilled with compacted fill. The backfill around the riser shall be hand tamped.

INLETS FOR PRACTICE WITH UNDERGROUND OUTLETS AND CONSTRUCTION CHECK DATA

NAME Sam Hill

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed T.S. Alec Date 1-81 Approved by
Drawn Title
Checked P.A. Jones 2-81 Sheet No. 3 of 3 Drawing No.
Reviewed

CONSTRUCTION CHECK OF PRACTICE LEAST LIKELY TO MEET SPECIFICATIONS

PRACTICE NUMBER W-1 LAND SLOPE 2 % PRACTICE SPACING 300 FEET

STATION	CHANNEL ELEVATION OR ROD READING	RIDGE ELEVATION OR ROD READING	CONSTRUCTED DEPTH FT.	CUT DEPTH FT.	STORAGE CU.FT./FT.	AVERAGE STORAGE CU.FT./FT.	DISTANCE FT.	CONSTRUCTION STORAGE CU.FT.	DESIGNED STORAGE CU.FT.
1+20	97.7	99.7	2.0	0	---				
						---	---	24,200	23,158

PRACTICE NUMBER	CONSTRUCTED LENGTH FT.
W-1	200'
W-2	110'
TOTAL	

I CERTIFY THAT THIS JOB MEETS ALL THE REQUIREMENTS OF INDIANA STANDARDS AND SPECIFICATIONS FOR TERRACES (CODE 600) OR WATER AND SEDIMENT CONTROL BASIN (CODE 638) AND THE PLAN AS DESIGNED.

CHECKED BY: Tom S. alec, SCT DATE: 5-12-81

REMARKS

(EFM Notice IN38, August 1981)

IN-ENG-20 2(2) REV. 6-81