§KS591.00 General

Design using the guidelines in Chapter 8 of the Engineering Field Manual and the criteria listed in the Kansas Standard and Specifications for Terrace - 600.

§KS591.01 Layout

Use Form KS-ENG-1 for terraces and record the following items. Each letter represents the corresponding circled designation on the sample KS-ENG-1 forms on pages KS591-7 and KS591-13.

(A) Owner/Operator

(B) Legal description

(C) County

(D) Farm number (optional)

(E) Tract number

(F) Applicable identification number - GPCP, ACP, etc.

(G) Check the appropriate line as to the known existence of any buried utilities. If buried utilities are known to exist, safety procedures listed in National Engineering Manual, Part 503, should be strictly followed.

Show the following on the location map:

(H) Terrace locations

(I) Location of any known buried utilities

(J) Map scale

Under the upper block on the right-hand side of the form, determine and list the following data:

(K) Terrace number

(L) Average field slope for the numbered terrace

(M) Vertical interval or vertical spacing in feet - Circle VI or VS on the field sheet.

(N) Horizontal interval or horizontal spacing in feet - Circle HI or HS on the field sheet. It is recommended that HS be used for underground outlet terraces as this data is generally used to calculate drainage area during the design process.

(O) Record appropriate value of y according to purpose of terrace and site conditions.

(P) Record the storage depth for level terraces.

(Q) Record block height for level terraces.

(R) Above the upper block, check the block for the appropriate type of terrace being designed and record the x value being used in design.

Under the main block, record the following survey information:

(S) Stations

(T) Rod readings for each terrace line

(U) For underground outlet terraces, it is recommended that a stake be set to locate the riser. A rod reading for both the terrace line and the riser should be recorded at this station.

(V) Record total layout length in feet.

Under "Design Cross Section" list the following:

(W) Terrace numbers

(X) Terrace cross section dimensions and side slopes, if applicable.

Record the following in the appropriate locations:

(Y) Signature of person doing the layout and date.

(Z) Signature of person doing the design and date.

(AA) Signature of person checking the design and date.

(BB) Signature of person approving the design and date.

§KS591.02 Design

(a) For a gradient terrace design, refer to the Engineering Field Manual, Pages KS-8-5 through KS-8-12c.

(b) For a level terrace design (erosion control and water conservation), design terrace height and cross section to contain the design runoff plus anticipated sediment accumulation. Refer to the Kansas Handheld Calculator Handbook of Programs and other aids approved for area use in design procedures.

(c) For an underground outlet terrace design, refer to EFM, Pages KS-8-1 and KS-8-2.

(d) The design of storage terraces may be accomplished by using LOTUS template STOR2.WK1, the TI-59 program in the Kansas Handheld Calculator Handbook of Programs, approved storage charts, or Pages KS-8-13 through KS-8-30 of the EFM. The design should be documented on LOTUS template STOR2.WK1 printed output, Form KS-ENG-17a, Underground Outlet Terrace Design, or Form KS-ENG-17.

(e) Complete Form KS-ENG-17 according to the following instructions. Each number represents the corresponding circled designation on the sample Form KS-ENG-17 on page KS591-10.

(1) Record basic information on first two lines of sheet (self-explanatory).

(2) Calculate drainage area as shown, or planimeter if the area is of an odd shape.

(3) Determine soil loss for the terrace interval and convert to inches of sediment per ten years.

(4) Determine design runoff using the 10-year, 24-hour rainfall and the runoff curve number. The runoff curve number (CN) is based upon the hydrologic soils group and the land use and condition of the terrace interval. Do not use a CN for storage or gradient terraces to design an individual terrace.

(5) Select a time of duration of flooding and determine the appropriate storage factor. Using this factor, the drainage area, and the inches of runoff and sediment storage, calculate the required depth and volume of storage.

(6) Select a design cross section (channel width, top width, and side slopes). The average land slope may be the same as recorded during layout. Calculate actual design storage. This volume should be greater than, or equal to, the storage volume calculated in Item 5.

(7) Repeat calculation of storage in Item 6 as necessary. Record the final design storage in the space at the bottom of Form KS-ENG-17.

(8) It is recommended that terraces have balanced earth volumes. A cut-to-fill ratio of 1.2 to 1.4 is usually considered acceptable. Cut-to-fill ratios of less than 1.2 may be used if sources of fill other than the terrace channel are used in construction of the terrace ridge.

(9) The rest of Form KS-ENG-17 is devoted to the design of the underground outlet. Refer to Part 594 of this manual for further information.

(f) For cut-fill terraces, refer to Form KS-ENG-1A or Form KS-ENG-1B.

(g) When using Form KS-ENG-1A, complete all necessary data concerning stations, grades, cuts, fills, heights, and cross sections. For underground outlet terraces, much of this information can be taken from Form KS-ENG-17 or KS-ENG-17a.

(h) Form KS-ENG-1B will be printed automatically when using LOTUS template STOR2.WK1.

§KS591.03 Checkout

(a) Terraces constructed with laser-equipped machinery will require the same checkout documentation as terraces constructed with other types of construction equipment.

(b) Use the back side of Form KS-ENG-1 to record the profile and cross section surveys for terraces of uniform height. Each letter represents the corresponding circled designation on the backside of sample KS-ENG-1 forms on pages KS591-8 and KS591-14.

(a) Under "Ridge and Channel Profile" section, profile at least one terrace of each type designed (i.e., level, gradient, or grassed-back) on the field sheet. Record the rod readings of the terrace channel and ridge at 100-foot intervals - more frequently for apparent lows, etc. Take at least one channel rod reading on the centerline of channels 15 feet wide or less. Take at least two rod readings in the channel (near the outer edges of the bottom) for widths from 15 to 30 feet. Take at least a centerline rod reading and a rod reading near each of the outer edges of channels over 30 feet wide. Record the difference of the average

channel rod reading from the ridge rod reading in the height ("Ht.") column. For level terraces, the average channel rod reading is determined after taking all of the channel rod readings.

Under "Cross-Section":

(b) Cross section at least one terrace representative of each design shown on the "Design Cross Section" portion of Form KS-ENG-1. Show terrace number for each cross-section. If the terrace was profiled, show both terrace number and station where the cross-section was taken.

(c) List dimensions on the lines and rod readings in the circles provided.

(d) Record the type of measuring device and calibration factor.

Record the following in the table provided:

(e) Terrace number

(f) Counter reading and constructed length in feet

(g) Total constructed length in feet

Record the following items in the appropriate locations:

(h) Signature of person doing checkout and date.

(i) Signature of person auditing the field sheet and date.

For level terraces, record the following additional information on the back of Form KS-ENG-1 in the appropriate locations:

(j) Average channel rod

(k) Minimum allowable ridge rod, which is the average channel rod minus the design terrace height.

(l) Block grade rod, which is the average channel rod minus the design storage depth.

(c) Use Form KS-ENG-1A or Form KS-ENG-1B for underground outlet terraces and other terraces of variable heights and/or cross sections, and record the following. Each letter represents the corresponding circled designation on sample Forms KS-ENG-1A and KS-ENG-1B on pages KS591-9 and KS591-12.

(m) Profile - channel and ridge rod readings and constructed height

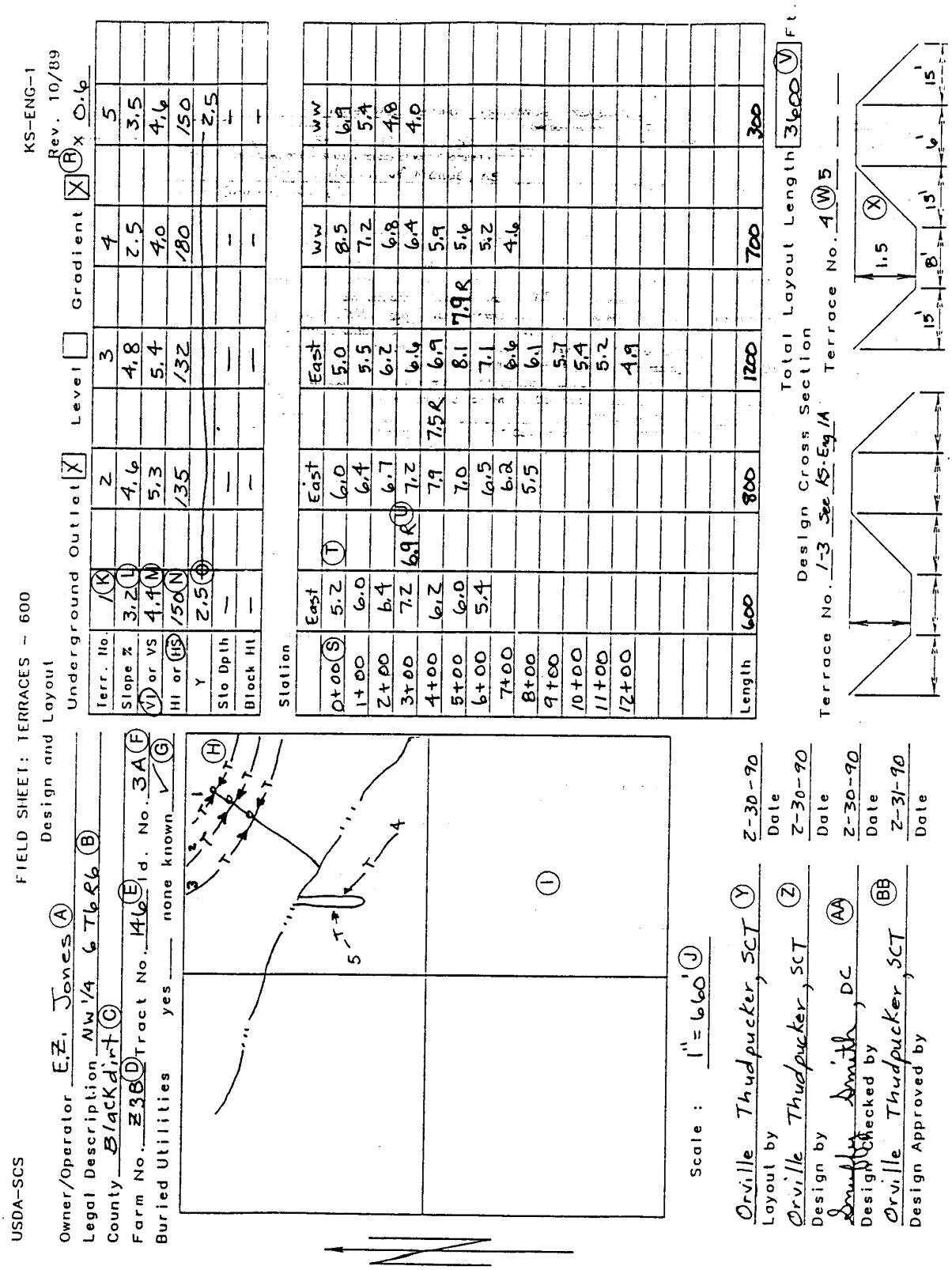
(n) Grade or drop between stations

(o) Effective height to document capacity for storage terraces. Effective height is determined after shots have been taken on the entire terrace. The effective height for each station is the difference between the lowest ridge shot and the channel shot at that station.

(p) Cross section

(q) Signature of person doing checkout and date.

§KS591.04 Sample of Form KS-ENG-1 for gradient terraces.



CHECKOUT

Channel and Ridge Profiles (a)

Sta.	Terrace No. Channel Rod.			Ridge Rod	Ht.* (Ft)

Sta.	Terrace No. 4 Channel Rod			Ridge Rod	Ht.* (Ft)
West				WW	
0+00	7.8			5.8	2.0
1+00	7.2			5.5	1.7
2+00	6.9			5.2	1.7
3+00	6.5			4.9	1.6
4+00	6.1			4.5	1.6
5+00	5.8			4.1	1.7
6+00	5.5			3.8	1.7
7+00	4.9			3.4	1.5

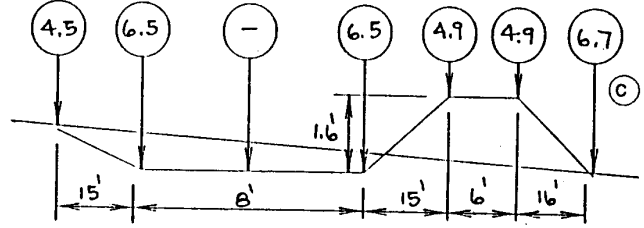
Level Terraces Only { Avg. Channel Rod (j) / Min. All. Ridge Rod (k) / Block Grade Rod** (l) } Level Terraces Only

*Ht. (level terraces)= Avg. Channel Rod – Ridge Rod

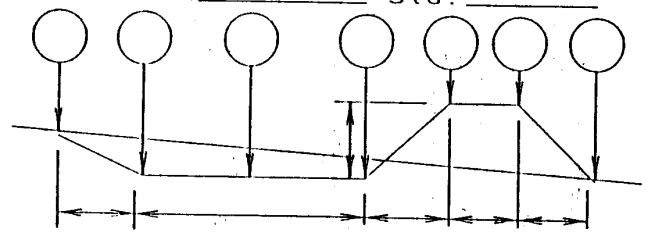
**Block Grade Rod = Avg. Chan. Rod – Sta. Dpth.

Cross Section

Terr. No. 4 (b) Sta. 3+00



Terr. No. _____ Sta. _____



Type of Meas. Device wheel (d)

Calibration Factor 2.04

Checkout Terrace Lengths

Terr. No.	Counter Reading	Length (Ft.)	Terr. No.	Counter Reading	Length (Ft.)
1 (e)	305	622 (f)			
2	395	806			
3	586	1195			
4	348	710			
5	145	296			

Total Const. Length 3629 (g) Ft.

Joe Contractor (h) — Checkout by — 3-4-90 Date

Smuffy Smith, DC (i) — Audited by — 3-12-90 Date

USDA-SCS

SUPPLEMENTAL FIELD SHEET: TERRACE CUT AND FILL

(Use with Form KS-ENG-1)

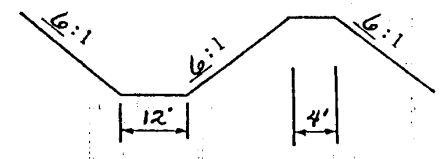
KS-ENG-1A
Rev. 8/84

Terrace No. 2 DESIGN						CHECKOUT				
Station	Grade or Drop	Channe Width	Cut	Fill	Ht.	Grade or Drop	Channe Rod	Ridge Rod	Const. Height	Effect. Height*
East								(m)		
0+00		12'	0.7	0.6	1.3		5.9	4.4	1.5	0.8 (o)
1+00	0.4		0.7	0.6	1.3	0.4 (n)	6.3	4.5	1.8	1.2
2+00	0.4		0.8	0.8	1.6	0.5	6.8	5.1	1.7	1.7
3+00	0.5		0.8	1.3	2.1	0.4	7.2	5.1	2.1	2.1
4+00	0.7		0.8	2.5	3.3	0.8	8.0	4.7	3.3	2.9
5+00	0.7		1.0	1.1	2.1	0.8	7.2	5.1	2.1	2.1
6+00	0.5		1.0	0.6	1.6	0.5	6.7	4.9	1.8	1.6
7+00	0.5		0.8	0.5	1.3	0.4	6.3	4.9	1.4	1.2
8+00	0.5	12'	1.0	0.3	1.3	0.5	5.8	4.3	1.5	0.7
							Storage O.K.			

*Measured from the channel bottom to the lowest point in the terrace ridge. Ample storage is provided when the effect. height is equal to or greater than the design height over that length where the design terrace ridge is level.

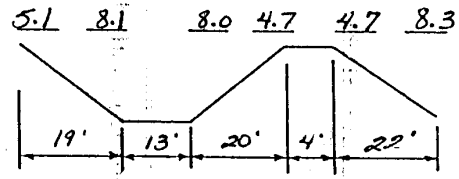
OWNER E. Z. Jones

DESIGN CROSS SECTION



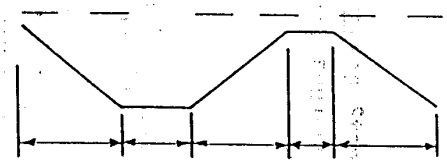
CHECKOUT CROSS SECTION

Station 4+00-Riser (p)



CHECKOUT CROSS SECTION

Station _____



Orville Thudpucker — Checkout by

4-31-85 — Date (q)

J. Hawk — Contractor

KS591.06 Sample of Form KS-ENG-17

USDA
SCS

UNDERGROUND OUTLET TERRACE DESIGN

KS-ENG-17
Rev. 6/87

(1) Owner E. Z. Jones; Legal Description NW 1/4 6 T6 R6

Design for Terrace No. T2

Designed by Orville Thudpucker Date 6-1-87 Design Checked by Sauffy Smith Date 6-2-87

Drainage Area = Terr. Lgth. 800 ft. x Terr. Spacing 135 ft. ÷ 43560 = 2.48 acres (2)

Soil Loss = 5 tons/acre/year; Sediment Storage = 0.34 inches/10 yr. (3)

Soil Cover Complex No., AMC II = 84; 10 yr. 24 hr. rainfall = 5.1 in.; Runoff = 3.36 in. (4)

Duration of flooding = 24 hrs.; Storage Factor = 0.63

Design Storage = Sed. Stor. 0.34 + (Runoff 3.36" x Storage Factor 0.63) = 2.45 in.

Storage Volume = Design Storage 2.45 " x Dr. Area 2.48 ac. x 3630 = 22,056 cu. ft. (5)

Min. Release Rate = .042 x Dr. Area 2.48 ac. x Runoff 3.36" x Release Factor 1.00 = 0.35 cfs

Water depth at riser, d, = 2.5 ft.; Riser Dia. = 6 in.; holes/ft. = 30; Disch. = 1.25 cfs (9)

Orifice Head, h = 0 '+ .7d = 0 + .7 x 2.5 = 1.7'; 3.25" Diameter Orifice, Q = 0.36 cfs

Accumulated Flow, $Q_{acc.} = Q_{above} + Q_{terrace}$ = 0.31 + 0.36 = 0.67 cfs

n = 0.015 for CCP Pipe; 6 " Diameter on 0.045 Grade (Feet/Foot); Q = 1.03 cfs

n = ____ for ____ Pipe; ____ " Diameter on ____ Grade (Feet/Foot); Q = ____ cfs

Top Width 4; Back Slope Z_2 6 : 1; Front Slope Z_3 6 : 1; Channel Slope Z_4 6 : 1 (6)

STO 4 Chan. Width	Slope %	100 Slope STO 01	Sta.	Stake Rod	Ridge Rod	Ridge Fill F_1	Channel Rod	Channel Cut C_1	Depth D_1	Ridge Rod	Ridge Fill F_1	Channel Rod	Channel Cut C_1	Depth D_1	End Area	Volume Stored
12	5		0	6.0	5.4	0.6	6.7	0.7	0.5							
12	5		100	6.4	5.8	0.6	7.1	0.7	0.9							1158
12	5		200	6.7	5.9	0.8	7.5	0.8	1.3							2070
12	5		300	7.2	5.9	1.3	8.0	0.8	1.8							3339
12	5		400	7.9	5.4	2.5	8.7	0.8	2.5							5436
12	5		500	7.0	5.9	1.1	8.0	1.0	1.8							5436
12	5		600	6.5	5.9	0.6	7.5	1.0	1.3							3339
12	5		700	6.2	5.7	0.5	7.0	0.8	0.8							1959
12	5		800	5.5	5.2	0.3	6.5	1.0	0.3							879

From TI-59 Program

Cut 25,614 cu. ft. = 949 cu. yd.

Fill 18,529 cu. ft. = 686 cu. yd. = 1.38 (8) Balance; Storage = 23616 (7) cu. ft.

(KS210-KNKDM, August 1991)

§KS591.07 Sample of Form KS-ENG-17a

USDA-SCS UNDERGROUND OUTLET TERRACE DESIGN STOR2.WK1 JUNE 12, 1990 KS-ENG-17a

NAME	E.Z. Jones	DRAINAGE AREA	2.48 ACRES	RISER DIAMETER	6 INCHES
LEGAL	SE4-25-14-3	SOIL LOSS	5 T/AC/YR	NO. OF HOLES/FT	30 NUMBER
COUNTY	Blackdirt	CURVE NUMBER	84	SIZE OF HOLES	1 INCHES
TERRACE	T-2	10-YR RAINFALL	5.1 INCHES	ORIFICE BELOW GROU	0 FEET
BURIED		FLOOD DURATION	24 HOURS		
UTILITIES	No			RISER DISCHARGE	1.25 CFS
DESIGNER	OT			MIN ORIFICE DIA	3.18 INCHES
DATE	01-Nov-90	SOIL LOSS	0.34 INCHES	DESIGN ORIFICE DIA	3.25 INCHES
		RUNOFF	3.36 INCHES	PIPE FLOW ABOVE	0.31 CFS
		REQUIRED STORAGE	2.45 INCHES	PIPE DIAMETER	6 INCHES
		STORAGE VOLUME	22087 CU.FT.	PIPE SLOPE	4.5 PER CENT
		RELEASE RATE	0.35 CFS	PIPE MATERIAL	cpp CPP,SM,N12
				PIPE DISCHARGE	1.03 CFS
				ACTUAL DISCHARGE	0.68 CFS

TERRACE CROSS SECTION

TOP WIDTH	4	MINIMUM HEIGHT	1.3	CUT VOL	25614	949	CU.YD.
RATIO/LENGTH Ratio		FREEBOARD	0.3	FILL VOL	18529	686	CU.YD.
CUT SLOPE	6 :1	RISER STATION	400	C/F RATIO	1.38		
FRONT SLOPE	6 :1	OVERFILL AT RISER	0.5	STORAGE VOL	23615		
BACK SLOPE	6 :1	H2O DEPTH @ RISER	2.5	STORAGE RATIO	1.07		
STAKE METHOD	2						

STATION	LANDSLOPE (%)	BOTTOM WIDTH	STAKE ROD	CHANNEL ROD	RIDGE ROD	CUT (FT)	FILL (FT)	WATER DEPTH	HEIGHT (FT)	CUT/FILL RATIO	CUT LENGTH	FRONT LENGTH	BACK LENGTH
0	5	12	6.0	6.7	5.4	0.7	0.6	0.5	1.3	2.9	13	8	8
100	5	12	6.4	7.1	5.8	0.7	0.6	0.9	1.3	2.9	13	8	8
200	5	12	6.7	7.5	5.9	0.8	0.8	1.3	1.6	2.2	14	10	11
300	5	12	7.2	8.0	5.9	0.8	1.3	1.8	2.1	1.0	14	13	16
400	5	12	7.9	8.7	5.4	0.8	2.5	2.5	3.3	0.3	14	20	30
500	5	12	7.0	8.0	5.9	1.0	1.1	1.8	2.1	1.7	16	13	14
600	5	12	6.5	7.5	5.9	1.0	0.6	1.3	1.6	4.3	16	10	8
700	5	12	6.2	7.0	5.7	0.8	0.5	0.8	1.3	4.3	14	8	7
800	5	12	5.5	6.5	5.2	1.0	0.3	0.3	1.3	10.1	16	8	5

DESIGNED BY Orville Thudy 01-Nov-90 CHECKED BY Snuffy Smitty DATE 11-1-90

KS591.08 Sample of Form KS-ENG-1B

USDA-SCS SUPPLEMENTAL FIELD SHEET: TERRACE CUT & FILL STOR2.WK1 JUNE 12, 1990 KS-ENG-1b

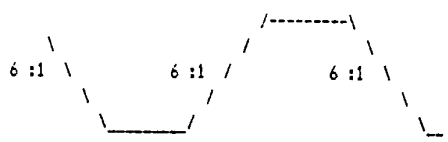
(Use with Form KS-ENG-1)

RISER STA 400
Terrace T-2

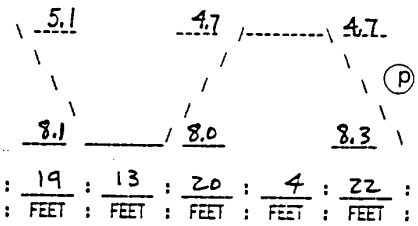
OWNER: E.Z. Jones LEGAL: SE4-25-14-3
DESIGNER OT BURIED UTILITIES: No

STATION	DROP	CHANNEL WIDTH	DESIGN CUT	DESIGN FILL	DESIGN HEIGHT	DESIGN EFFECT. HEIGHT	(n) DROP	CHECKOUT CHANNEL ROD	CHECKOUT CHANNEL ROD	CHECKOUT RIDGE ROD (m)	CHECKOUT CONST HEIGHT	CHECKOUT EFFECT HEIGHT	EFFECT HEIGHT DIFF * (o)
0		12	0.7	0.6	1.3	0.8		5.9	5.9	4.4	1.5	0.8	0
100	0.4	12	0.7	0.6	1.3	1.2	0.4	6.3	6.3	4.5	1.8	1.2	0
200	0.4	12	0.8	0.8	1.6	1.6	0.5	6.8	6.8	5.1	1.7	1.7	+.1
300	0.5	12	0.8	1.3	2.1	2.1	0.4	7.2	7.1	5.1	2.1	2.1	0
400	0.7	12	0.8	2.5	3.3	2.8	0.8	8.0	8.0	4.7	3.3	2.9	+.1
500	0.7	12	1.0	1.1	2.1	2.1	0.8	7.2	7.3	5.1	2.1	2.1	0
600	0.5	12	1.0	0.6	1.6	1.6	0.5	6.7	6.7	4.9	1.8	1.6	0
700	0.5	12	0.8	0.5	1.3	1.1	0.4	6.3	6.3	4.9	1.4	1.2	+.1
800	0.5	12	1.0	0.3	1.3	0.6	0.5	5.8	5.9	4.3	1.5	0.7	+.1
												TOTAL =	+.4

DESIGN CROSS SECTION



CHECKOUT CROSS SECTION



* Checkout effective height minus design effective height in storage section. When total is zero or positive, adequate storage is present.

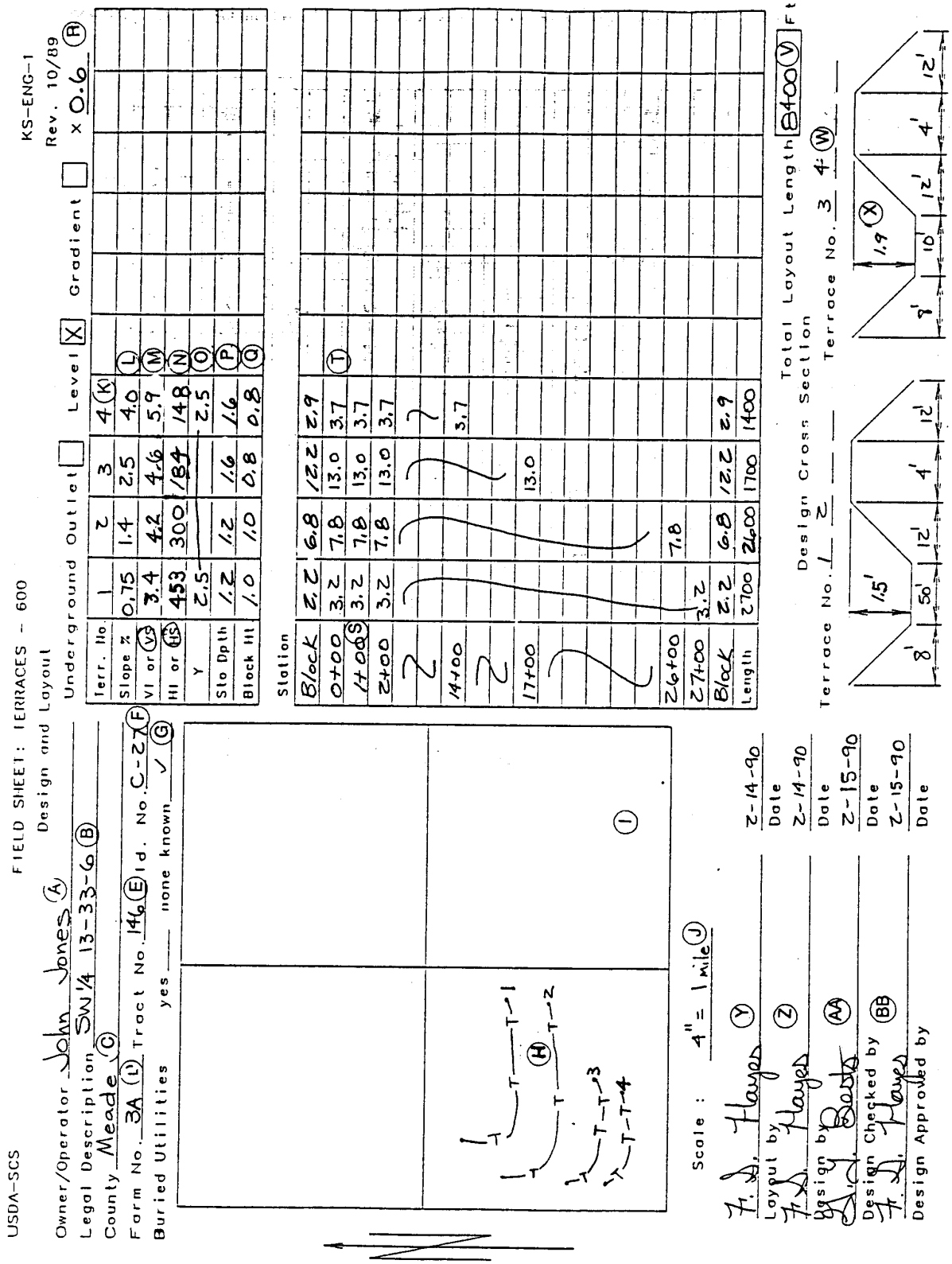
STATION 4+00 TERRACE LENGTH 806

DATE 11-15-90 (q) CHECKOUT BY J. Hawkeye

CONTRACTOR J. Hawkeye

CHECKED BY Snuffy Smitty DATE 11-16-90

§KS591.09 Sample of Form KS-ENG-1



CHECKOUT

Channel and Ridge Profiles (a)

Sta.	Terrace No. 2 Channel Rod			Ridge Rod	Ht.* (Ft)	Sta.	Terrace No. 2 Channel Rod			Ridge Rod	Ht.* (Ft)
Block				3.3		Block				3.2	
0+00	4.6	4.5	4.5	2.8	1.7						
1	4.6	4.7	4.6	2.9	1.6						
2	4.6	4.6	4.6	2.9	1.6	See separate sheet					
3	4.6	4.5	4.5	2.9	1.6	for profile of T-4.					
4	4.6	4.5	4.6	2.8	1.7						
5	4.5	4.4	4.5	2.8	1.7						
6	4.5	4.5	4.4	2.9	1.6						
7	4.4	4.5	4.4	2.9	1.6						
8	4.4	4.4	4.5	2.8	1.7						
9	4.5	4.5	4.4	2.7	1.8						
10	4.4	4.5	4.6	2.7	1.8						
11	4.4	4.4	4.4	2.7	1.8						
12	4.5	4.4	4.5	2.8	1.7						
13	4.4	4.5	4.6	2.8	1.7						
14	4.5	4.6	4.6	2.9	1.6						
15	4.6	4.6	4.6	2.9	1.6						
16	4.5	4.5	4.4	2.8	1.7						
17	4.4	4.5	4.5	2.9	1.6						
18	4.4	4.4	4.5	2.9	1.6						
19	4.5	4.4	4.4	2.8	1.7						
20	4.5	4.5	4.5	2.9	1.6						
21	4.6	4.6	4.5	2.9	1.6						
22	4.7	4.6	4.5	2.8	1.7						
23	4.5	4.5	4.4	2.8	1.7						
24	4.4	4.4	4.4	2.9	1.6						
25	4.5	4.6	4.4	2.8	1.7						
26	4.4	4.4	4.4	2.9	1.6						
26+20	4.3	4.3	4.2	2.7	1.8						

Level Terraces Only:
- 4.5 (j) Avg. Channel Rod
- 3.0 (k) Min. All. Ridge Rod
- 3.3 (l) Block Grade Rod**

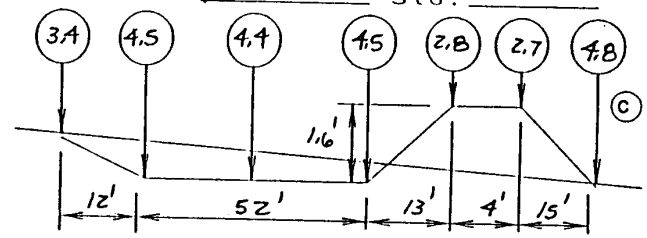
Level Terraces Only

*Ht. (level terraces) = Avg. Channel Rod − Ridge Rod

**Block Grade Rod = Avg. Chan. Rod − Sta. Dpth.

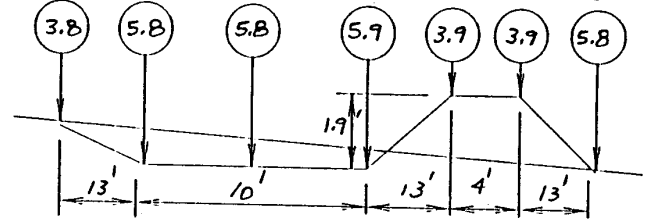
Cross Section (b)

Terr. No. 2 Sta. 12+00



(c)

Terr. No. 4 Sta. 7+00



Type of Meas. Device wheel (d)

Calibration Factor 9.82

Checkout Terrace Lengths

Terr. No.	Counter Reading	Length (Ft.)	Terr. No.	Counter Reading	Length (Ft.)
1 (e)	277.5	2725	(f)		
2	266.8	2620			
3	172.0	1689			
4	143.1	1405			

Total Const. Length 8439 (g) Ft.

Joe R. Contractor (h) — Checkout by — 3-14-90 Date

H. J. Best (i) — Audited by — 3-15-90 Date