U. S. Department of Agriculture
Soil Conservation Service
National Engineering Staff

Design Unit
April 1980

Design Note No. 19 *

Subject: Input Data for Design Unit Programs

Input requirements are summarized for the following structures or structural components:

- Single cell conduits
- Twin cell conduits
- Rectangular structural channels
- SAF stilling basins
- Monolithic straight drop spillways
- Wingwalls (SAF or drop spillway)
- Riprap gradient control structures
- WSP for riprap gradient control structures

Relevant technical releases should be consulted for complete presentation of required input data.

Suggested forms for easy tabulation of required input are given for each program. The forms may be reproduced as needed. Each computer job requires two lines of alphameric information. Each line may contain up to 80 (72 for single and twin cell conduits) alphameric characters. These two alphameric lines must precede all other input data in the job. The format for each line of numeric data is eight ten-column fields. Each value tabulated requires a decimal point. Fields to be left blank are indicated.

The structural channel, stilling basin, and drop spillway programs use the concept of design parameters consisting of primary and secondary parameters. Values of primary parameters must be supplied by the user. Secondary parameters will be assigned default values if values are not supplied by the user. It is strongly suggested that the values of secondary parameters be specified by the user. Use of default values may result in an overly conservative (or unconservative) design. Although various lines of input data may be omitted, depending on use of default values, those supplied must be complete and in the order indicated.

The riprap gradient control structure program treats the provision of default values somewhat differently. The program provides default values for certain parameters, called default parameters, if their values are not specified by the user. A zero or blank in a default parameter location means use the default value. The WSP program requires that all parameter values be supplied except that Manning's n may be omitted, in which case its indicated default value is used.

*Prepared by Joan Robison and Edwin S. Alling, Design Unit, National Engineering Staff, Lanham, Maryland

RECTANGULAR CONDUITS -- SINGLE AND TWIN CELL

Reference sources: TR-42, TR-43, TR-45, and DN-10

Each design run requires only one line of numeric data. A computer job may include many design runs. The following information is required for each design requested:

(1) the design mode, given in the first two fields
(2) the clear height and width of one cell of the conduit, in ft
(3) the vertical and horizontal unit loads for load combination #1; i.e., PV1 and PH1, in psf
(4) the vertical and horizontal unit loads for load combination #2; i.e., PV2 and PH2, in psf

Design Modes

The program designs conduit sections in accordance with the design mode. A design mode characterizes the conditions for which the conduit is designed. Four modes are established:

earth foundation, no internal water load ≡ 00
earth foundation, with internal water load ≡ 01
rock foundation, no internal water load ≡ 10
rock foundation, with internal water load ≡ 11

Loads Specified by User

The design of rectangular conduit sections by the program is independent of the methods by which the user determines his external loads. The user specifies, or selects, unit pressures in two load combinations. These load combinations are defined as:

LC#1 is the load combination having the maximum possible vertical unit load combined with the minimum horizontal unit load consistent with that vertical unit load.

LC#2 is the load combination having the maximum possible horizontal unit load combined with the minimum vertical unit load consistent with that horizontal unit load.

The computer design is adequate for these two load combinations as well as a number of others constructed from them. If PV1, PH1, PV2, and PH2 are the unit loads, then by these definitions

$$PV1 \geq PV2 \qquad \text{and} \qquad PH2 \geq PH1$$

Note that these unit pressures should not include dead weight. Dead weight effects are automatically considered in the programs.

SINGLE	TWIN

ALPHAMERIC INFORMATION

CONDUITS (TR-42, TR-43, TR-45, and DN-10)

FOUNDATION TYPE 0. ≡ EARTH 1. ≡ ROCK	INT. WATER 0. ≡ NO INT. WATER 1. ≡ WITH INT. WATER	CLEAR HEIGHT	CLEAR WIDTH	LC#1 (LARGE VERT.)		LC#2 (LARGE HORIZ.)	
				PV1	PH1	PV2	PH2

RECTANGULAR STRUCTURAL CHANNELS

Reference source: TR-50 (Note: See TR-50, pages 57-58, for discussion of input requirements.)

PRIMARY PARAMETERS

B	≡ clear width of channel, in ft
HT	≡ height of wall above top of floor slab, in ft
HB	≡ height of backfill above top of floor slab, in ft

SECONDARY PARAMETERS

		DEFAULT VALUES
HW1	≡ submergence height above top of floor slab, load condition No. 1, in ft	0.8 HB
HW2	≡ submergence height above top of floor slab, load condition No. 2, in ft	0.1 HB
HWP	≡ uplift head on pavement slab, load condition No. 1, in ft	HW1
KO1	≡ lateral earth pressure ratio, load condition No. 1	0.8
KO2	≡ lateral earth pressure ratio, load condition No. 2	0.2
KPASS	≡ passive earth pressure ratio	1/KO1
GMOIST	≡ moist unit weight of backfill, in pcf	120.0
GSAT	≡ saturated unit weight of backfill, in pcf	140.0
FLOATR	≡ safety factor against flotation	1.5
MAXFTG	≡ maximum acceptable footing projection, in ft	0.5 B
JOINTS	≡ longitudinal span between transverse joints, in ft	*
CFSC	≡ coefficient of friction, soil to concrete	0.35
CFSS	≡ coefficient of frcition, soil to soil	0.55
MFOUND	≡ modulus of the foundation, in pcf	100000.**

*when $B \leq 10.$: JOINTS = 20.

$10. < B < 20.$: JOINTS = 2B

$B \geq 20.$: JOINTS = 40.

**Note that MFOUND = 1. produces a design corresponding to "Rigid Body Mechanics."

ALPHAMERIC INFORMATION CHANNELS (TR-50)

B	HT	HB	DESIGN	DEFAULT1	DEFAULT2	DEFAULT3	____
HW1	HW2	HWP	GMOIST	GSAT	KO1	KO2	FLOATR
MAXFTG	JOINTS	MFOUND	____	____	____	____	____
CFSC	CFSS	KPASS	____	____	____	____	____

B	HT	HB	DESIGN	DEFAULT1	DEFAULT2	DEFAULT3	____
HW1	HW2	HWP	GMOIST	GSAT	KO1	KO2	FLOATR
MAXFTG	JOINTS	MFOUND	____	____	____	____	____
CFSC	CFSS	KPASS	____	____	____	____	____

SAF STILLING BASINS

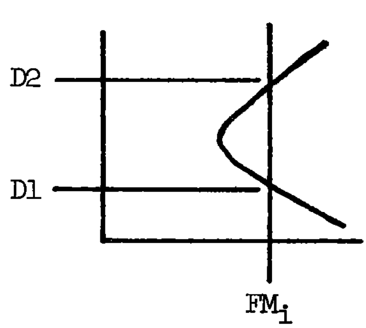
Reference source: TR-54 (Note: See TR-54, pages 68-70, for discussion of input requirements.)

PRIMARY PARAMETERS

W ≡ width of SAF stilling basin, in ft
J ≡ height of basin sidewall, in ft
LB ≡ length of SAF stilling basin, in ft
N ≡ height of sidewalls at upstream end section, in ft
D1 ≡ entrance depth of water to SAF stilling basin, in ft
V1 ≡ entrance velocity of water to SAF stilling basin, in fps

SECONDARY PARAMETERS

		DEFAULT VALUES
HTW2	≡ tailwater depth above top of floor of basin for load condition No. 2, in ft	D2
HUP2	≡ uplift head above top of floor of basin for load condition No. 2, in ft	HTW2
HTW1	≡ tailwater depth above top of floor of basin for load condition No. 1, in ft	0.0
HUP1	≡ uplift head above top of floor of basin for load condition No. 1, in ft	0.5 HUP2
HB	≡ earthfill height above top of floor of basin at downstream end of basin, in ft	0.5 J
ZS	≡ slope parameter of inclined portion of stilling basin	3.0
HTW	≡ depth of toewall below top of floor of basin, in ft	4.0
TTW	≡ thickness of toewall, in inches	10.0
GM	≡ moist unit weight of earthfill, in pcf	120.0
GS	≡ saturated unit weight of earthfill, in pcf	140.0
KO	≡ lateral earth pressure ratio	0.8
BAT	≡ inside sidewall batter, in inches per ft of height	0.375
MAXFTG	≡ maximum acceptable footing projection, in ft	0.5 W
FLOATR	≡ safety factor against flotation	1.5
SLIDER	≡ safety factor against sliding	1.0
CFSC	≡ coefficient of friction, soil to concrete	0.35



D2 is sequent depth:

$$D2 = \frac{D1}{2}\left(\sqrt{1 + 8F} - 1\right)$$

where

$$F = \frac{V1^2}{gD1}$$

ALPHAMERIC INFORMATION SAF (TR-54)

W	J	LB	N	D1	V1	DESIGN	DFALTS
DFALT1	DFALT2	DFALT3	____	____	____	____	____
HB	HTW2	HUP2	HTW1	HUP1	____	____	____
MAXFTG	FLOATR	SLIDER	ZS	BAT	____	____	____
GM	GS	KO	CFSC	HTW	TTW	____	____

W	J	LB	N	D1	V1	DESIGN	DFALTS
DFALT1	DFALT2	DFALT3	____	____	____	____	____
HB	HTW2	HUP2	HTW1	HUP1	____	____	____
MAXFTG	FLOATR	SLIDER	ZS	BAT	____	____	____
GM	GS	KO	CFSC	HTW	TTW	____	____

STRAIGHT DROP SPILLWAYS

Reference source: TR-63

(Note: See TR-63, pages 87-91, for discussion of input requirements.)

PRIMARY PARAMETERS

H	≡ depth of weir, in ft
F	≡ drop from crest of weir to top of transverse sill, in ft
S	≡ height of transverse sill above top of apron, in ft
J	≡ height of sidewall and wingwall at their junction, in ft
L	≡ crest length = stilling basin width, in ft
LB	≡ length of basin, in ft

SECONDARY PARAMETERS

		DEFAULT VALUES
CREEPR	≡ weighted creep ratio	5.0
FLOATR	≡ safety factor against flotation	1.5
SLIDER	≡ safety factor against sliding	1.0
BAT	≡ inside sidewall batter, in inches per ft of height	0.0
SWLDRN	≡ sidewall design switch indicates no/yes presence of sidewall drains	0.0
HB	≡ earthfill height above top of apron at downstream end of basin, in ft	*
ZPS	≡ slope parameter for earthfill adjacent to the sidewall in the direction parallel to the sidewall	2.0
HTOE	≡ depth of toewall below top of apron, in ft	4.0
TTOE	≡ thickness of toewall, in inches	10.0
CFSS	≡ coefficient of friction, soil to soil	0.55
CFSC	≡ coefficient of friction, soil to concrete	0.35
KOH	≡ lateral earth pressure ratio, soil against headwall	0.80
GMH	≡ moist unit weight of earthfill, soil against headwall, in pcf	120.0
GSH	≡ saturated unit weight of earthfill, soil against headwall, in pcf	140.0
KOF	≡ lateral earth pressure ratio, foundation soil	KOH
GMF	≡ moist unit weight of foundation soil, in pcf	GMH
GSF	≡ saturated unit weight of foundation soil, in pcf	GSH
KPF	≡ passive earth pressure ratio, foundation soil	2.0
KOW	≡ lateral earth pressure ratio, soil against sidewall and wingwall	KOH
GMW	≡ moist unit weight of earthfill, soil against sidewall and wingwall, in pcf	GMH
GSW	≡ saturated unit weight of earthfill, soil against sidewall and wingwall, in pcf	GSH
KPW	≡ passive earth pressure ratio, soil against sidewall and wingwall	KPF

*HB = 0.707(J − 1.0)/ZPS + 1.0

Water parameters, options, and default values

M	DW	HEAD	TAIL	ASSUMED QM/QLC2
		OPTION 1 – COMPLETE DEFAULT		
1	DW2 = H	HEAD2 = HEAD1 + TAIL2	TAIL2 = 1.17H	1.0
2	0.86 DW2	HEAD1 + 0.86 TAIL2	0.86 TAIL2	0.8
3	0.71 DW2	HEAD1 + 0.71 TAIL2	0.71 TAIL2	0.6
4	0.54 DW2	HEAD1 + 0.54 TAIL2	0.54 TAIL2	0.4
5	0.34 DW2	HEAD1 + 0.34 TAIL2	0.34 TAIL2	0.2
6	0.0	HEAD1 = (S + .25F)	− (S + 1.0)	0.0
		OPTION 2 – PARTIAL DEFAULT		
1	[DW2]	[HEAD2]	[TAIL2]	1.0
2	0.86 DW2	HEAD1 + .86(HEAD2 − HEAD1)	0.86 TAIL2	0.8
3	0.71 DW2	HEAD1 + .71(HEAD2 − HEAD1)	0.71 TAIL2	0.6
4	0.54 DW2	HEAD1 + .54(HEAD2 − HEAD1)	0.54 TAIL2	0.4
5	0.34 DW2	HEAD1 + .34(HEAD2 − HEAD1)	0.34 TAIL2	0.2
6	0.0	[HEAD1]	− (S + 1.0)	0.0
		OPTION 3 – NO DEFAULT		
1	[DW2]	[HEAD2]	[TAIL2]	–
2	[DWM2]	[HEADM2]	[TAILM2]	–
3	[DWM3]	[HEADM3]	[TAILM3]	–
4	[DWM4]	[HEADM4]	[TAILM4]	–
5	[DWM5]	[HEADM5]	[TAILM5]	–
6	0.0	[HEAD1]	− (S + 1.0)	–

[ ] ≡ user supplied values

ALPHAMERIC INFORMATION — STRAIGHT DROP SPILLWAYS (TR-63)

H	F	S	J	L	LB	DESIGN	DFALTS
DFALT1	DFALT2	DFALT3	DFALT4	DFALT5	DFALT6	DFALT7	—
CREEPR	FLOATR	SLIDER	BAT	SWLDRN	—	—	—
HB	ZPS	HTOE	TTOE	CFSS	CFSC	—	—
KOH	GMH	GSH	—	—	—	—	—
KOF	GMF	GSF	KPF	—	—	—	—
KOW	GMW	GSW	KPW	—	—	—	—
DW2	HEAD2	TAIL2	HEAD1	—	—	—	—
DWM2	HEADM2	TAILM2	—	—	—	—	—
DWM3	HEADM3	TAILM3	—	—	—	—	—
DWM4	HEADM4	TAILM4	—	—	—	—	—
DWM5	HEADM5	TAILM5	—	—	—	—	—

RIPRAP GRADIENT CONTROL STRUCTURES

Reference source: TR-59 (Note: See TR-59, pages 23-25, for discussion of input requirements.)

Required data common to all modes

1. Mode number (1.0, 2.0, 3.0, or 4.0)
2. Q, design discharge to be conveyed within the prismatic channel of the riprap structure
3. ZU, side slopes of the prismatic channel of the riprap structure.

Other required data

1. Mode 1 requires the specific energy head, H, corresponding to the design discharge.
2. Modes 2 and 3
   a. Two, and only two, of the parameters H, BS, DS, and VS are required. The other two parameters are ascertained by the computer.
   b. ZS, the side slope at the ends of riprap structure is required.
3. Mode 4 requires ZL, ZR, BS, and DS. The specific energy head, H, and the velocity, VS, are defined by the specified BS and DS.

Default Parameters

All other parameter values required for the design are obtained by default unless they are specified. The specified value of each parameter must be greater than zero. Default parameters D50, CONV, and DIV may be specified in modes 2, 3, and 4. The remaining default parameters may be specified only in modes 3 and 4. A value of 0.0 or a blank for a default parameter is interpreted to mean the default value is to be used.

The default parameters D50 and CS have default values equal to their recommended maximum allowable values. These are:

D50 = 1.0 ft CS = 0.7	Default values and recommended maximum allowable values.

The default parameters CONV and DIV have default values equal to their recommended minimum allowable values. These are:

CONV = 2.0 DIV = 4.0	Default values and recommended minimum allowable values.

The values of any of the following default parameters may be specified. The default values of these default parameters are:

C50 = 4.0	FS = 1.25	THETA = 35^{o}
CN = 0.0395	EXPN = 0.1667	

ALPHAMERIC INFORMATION　　　　　　　　　　RGC STRUCTURE (TR-59)

—	MODE 1.	Q	ZU	D50	H	—	—

—	MODE 2.	Q	ZU	D50	H	—	—
—	ZS	—	BS	DS	VS	CONV	DIV

—	MODE 3.	Q	ZU	D50	H	—	—
—	ZS	—	BS	DS	VS	CONV	DIV
—	CS	C50	FS	THETA	CN	—	EXPN

—	MODE 4.	Q	ZU	D50	—	—	—
—	ZL	ZR	BS	DS	—	CONV	DIV
—	CS	C50	FS	THETA	CN	—	EXPN

RIPRAP GRADIENT CONTROL STRUCTURES – WSP

Reference source: TR-59 Supplement 2

(Note: See TR-59, Supplement 2, pages 9 and 10 for discussion of input requirements.)

Values of all parameters listed below must be given except that the value of n is optional.

Line 0

Q ≡ Discharge for which WSP is desired, cfs

n ≡ Manning's coefficient of roughness. $n = 0.0395\ D_{50}^{1/6}$ unless user specified

D50 ≡ Size of rock in riprap of which 50 percent by weight is finer, ft

DIV ≡ Rate of divergence of the bottom width of the downstream transition, ft/ft

CONV ≡ Rate of convergence of the bottom width of the upstream transition, ft/ft

ZL ≡ Side slope of the left bank at the ends of riprap structure (looking downstream), ft/ft

ZR ≡ Side slope of the right bank of the ends of riprap structure, ft/ft

Lines 1 and 2

DS ≡ Starting depth at the most downstream end of the riprap structure, ft

BSD ≡ Bottom width at the most downstream end of the riprap structure, ft

$R_j = [RISE]_j$ ≡ The vertical distance from the bottom of the channel at the downstream end of the transition, to the bottom of the channel at any section j in the transition, ft. The subscript, j, is numbered from 1 to 10 inclusive; 1 being the first preselected section upstream from the most downstream end section of the transition and 10 being the 10th or the last section (most upstream end section) of the transition. The values of $(RISE)_j$ are obtained from the computer output design of TR-59.

Line 3

ZU ≡ Side slope of the prismatic channel, ft/ft

BU ≡ Bottom width of the prismatic channel, ft

LPC ≡ Length of the prismatic channel, ft

SN ≡ Slope of the prismatic channel, ft/ft

THETA ≡ Angle of repose of the riprap, degrees

FSU ≡ Factor of safety used in the design of riprap structure

Lines 4 and 5

BSU ≡ Bottom width of the most upstream end of the riprap structure, ft

$R_j = [RISE]_j$ ≡ See definition above; except that j is numbered from 11 to 20 for the upstream transition, ft

ALPHAMERIC INFORMATION RGC STRUCTURE WSP (TR-59, Sup. 2)

LINE NO. 0.	Q	n	D50	DIV	CONV	ZL	ZR
1.	DS	BSD	R_1	R_2	R_3	R_4	R_5
2.	R_6	R_7	R_8	R_9	R_{10}	———	———
3.	ZU	BU	LPC	SN	THETA	FSU	———
4.	BSU	R_{11}	R_{12}	R_{13}	R_{14}	R_{15}	R_{16}
5.	R_{17}	R_{18}	R_{19}	R_{20}	———	———	———

LINE NO. 0.	Q	n	D50	DIV	CONV	ZL	ZR
1.	DS	BSD	R_1	R_2	R_3	R_4	R_5
2.	R_6	R_7	R_8	R_9	R_{10}	———	———
3.	ZU	BU	LPC	SN	THETA	FSU	———
4.	BSU	R_{11}	R_{12}	R_{13}	R_{14}	R_{15}	R_{16}
5.	R_{17}	R_{18}	R_{19}	R_{20}	———	———	———

$n = 0.0395\ D_{50}{}^{1/6}$ unless user specified

WINGWALL DESIGN

Reference source: TR-54 and TR-63

This program uses the TR-54 wingwall routine to obtain independent wingwall designs. The program permits the use of different allowable bearing pressures. PALLOW = 0. means use the default value per TR-54, page 49.

The separate wingwall design program does not compute wingwall volumes since the wingwall design applies to both SAF basin and straight drop spillway designs.

The first set of input shown is for SAF basins. The second set of input is for straight drop spillways. The output nomenclature is that of TR-54.

ALPHAMERIC INFORMATION SAF and SDS (TR-54 and TR-63)

Nomenclature for TR-54

J	HB	HTW2	HUP1	HTW1	ZPS	——
KO	GM	GS	GB	CFSC	SLIDER	PALLOW

Nomenclature for TR-63

J	HB	TAIL2+S	HWING1	TAIL1+S	ZPSE	——
KOW	GMW	GSW	GBW	CFSC	SLIDER	PALLOW

HWING – see computation page 22 (HCUT may be obtained from computer design or manual computation.)

ZPSE – see computation page 59

OBTAINING DESIGNS

Currently, computer designs may be obtained by two different approaches. Requests for special designs may be sent or, in rush instances, phoned to the Design Unit. The address is:

Head, Design Unit
National Engineering Staff
Soil Conservation Service
10000 Aerospace Road
Lanham, Maryland 20801
Phone: 436-7377

Users with sufficient ADP capability may access the program load modules and independently execute any of the designs. Load module names are listed below with the corresponding reference technical documents.

DESIGN UNIT LOAD MODULES	REFERENCE
SCS05.SINGCELL.LOAD	TR-42, TR-43, DN-10
SCS05.TWINCELL.LOAD	TR-45
SCS05.STRUCHAN.LOAD	TR-50
SCS05.SAFBASIN.LOAD	TR-54
SCS05.DROPSPIL.LOAD	TR-63
SCS05.NEWWING.LOAD	TR-54 (Wingwalls)
SCS05.RIPRAPST.LOAD	TR-59
SCS05.WSPRRGCS.LOAD	TR-59, Supplement 2

These load modules may be accessed at the Washington Computer Center (WCC). Users require a WCC account number. The Design Unit uses the following command procedure to execute the programs on its Time Sharing Option (TSO) terminal.

DESIGN UNIT COMMAND PROCEDURE

```
SCS05.DESIGN.CLIST
PROC 1 NAME
SEND 'NOTE - MUST CREATE DESIGN.DATA BEFORE GIVING EXEC COMMAND' USER(*)
SEND 'EXECUTION COMMENCING                                     ' USER(*)
ALLOC FI(FT06F001) DA(*)
ALLOC FI(FT08F001) DA(*)
ALLOC FI(FT05F001) DA(DESIGN.DATA) SHR
CALL &NAME.
FREE FI(FT05F001,FT06F001,FT08F001)
DELETE DESIGN.DATA
SEND 'EXECUTION TERMINATED, DESIGN.DATA DELETED                ' USER(*)
END
```

Appropriate changes can be made in writing similar procedures for particular installations. Note that output is written on devices 6 and 8 and input is read on device 5. DESIGN.DATA is used in the procedure as the input data set. It is deleted at the end of the run.

The programs may be run on other remote terminals in addition to TSO, for example, Remote Job Entry (RJE) or Remote Batch Terminals (RBT). Suitable job control language is required. Questions pertaining to specific terminal requirements and capabilities should be referred to the appropriate computer specialist.