DESIGN OF BOX INLET TOEWALL DROP SPILLWAYS

General

Box inlet toewall drop spillways are economical structures for low overfall grade stabilization when design discharges are too great to be handled economically by pipe conduits.

Several materials and configurations may be used for these structures. Concrete block, reinforced concrete, and corrugated aluminum have been used and accepted as approved materials. Structure configuration and dimensions vary with the material used; however, certain flow characteristics and velocity relationships must be met for any structure configuration used. These are discussed in the design portion of this section.

Concrete block structures have greater acceptability where farm labor is available for installation. Where work is contracted, the demand for prefabricated structures has increased. Any approved structure type may be used, provided the design requirements for that structure type are met.

Structures with an overfall greater than four feet or those that are above the employee's approval level must be referred to an employee with the proper approval level for design.

"Cast-in-place concrete may be used in lieu of concrete blocks if the same configuration and dimensions of the concrete block box inlet toewall are used, and #4 (½ inch) reinforcing bars are used in each direction on 12" centers on the centerline of an 8" wall."

Design

The following design procedures and criteria apply to all types of box inlet toewall drop structures:

1. From field design and analysis, determine:

    a. Overfall Height (F) -- The channel must be stable upstream and downstream from the structure. The applicable technical guide standards must be followed. Flow depth in the downstream channel, based on the design capacity of the structure, should be not less than three-fourths (3/4) of the overfall height, to provide backwater conditions at the structure outlet. Bank protection must be provided unless the backwater condition is present. The structure apron should be set at approximately the same elevation as the channel 100 feet downstream.

    b. Notch Depth (H) -- The notch depth includes an allowance of 0.25 to 0.50 foot for freeboard. Therefore, the design depth of the waterway above the structure should not be deeper than the notch depth of the structure less 0.25 to 0.50 foot.

    c. Notch Width (W) -- The notch width selected should be approximately equal to the bottom width of the downstream channel.

d. Emergency Spillway -- All structures must have an adequate emergency spillway, with the crest elevation 0.25 to 0.50 foot below the top of the structure headwall.

e. Structure Levee -- The levee over the headwall must be a minumum of one foot above the top of the headwall and have a minumum top width of four feet.

f. Structure Capacity (Q) -- The minimum structure capacity shall be as shown in Standard and Specification 410, Grade Stabilization Structure, in Section IV of the Technical Guide. Peak flow shall be determined by the procedures in Chapter 2 of the Engineering Field Manual. Design data will be recorded on Form IN-ENG-10 or in other approved manner.

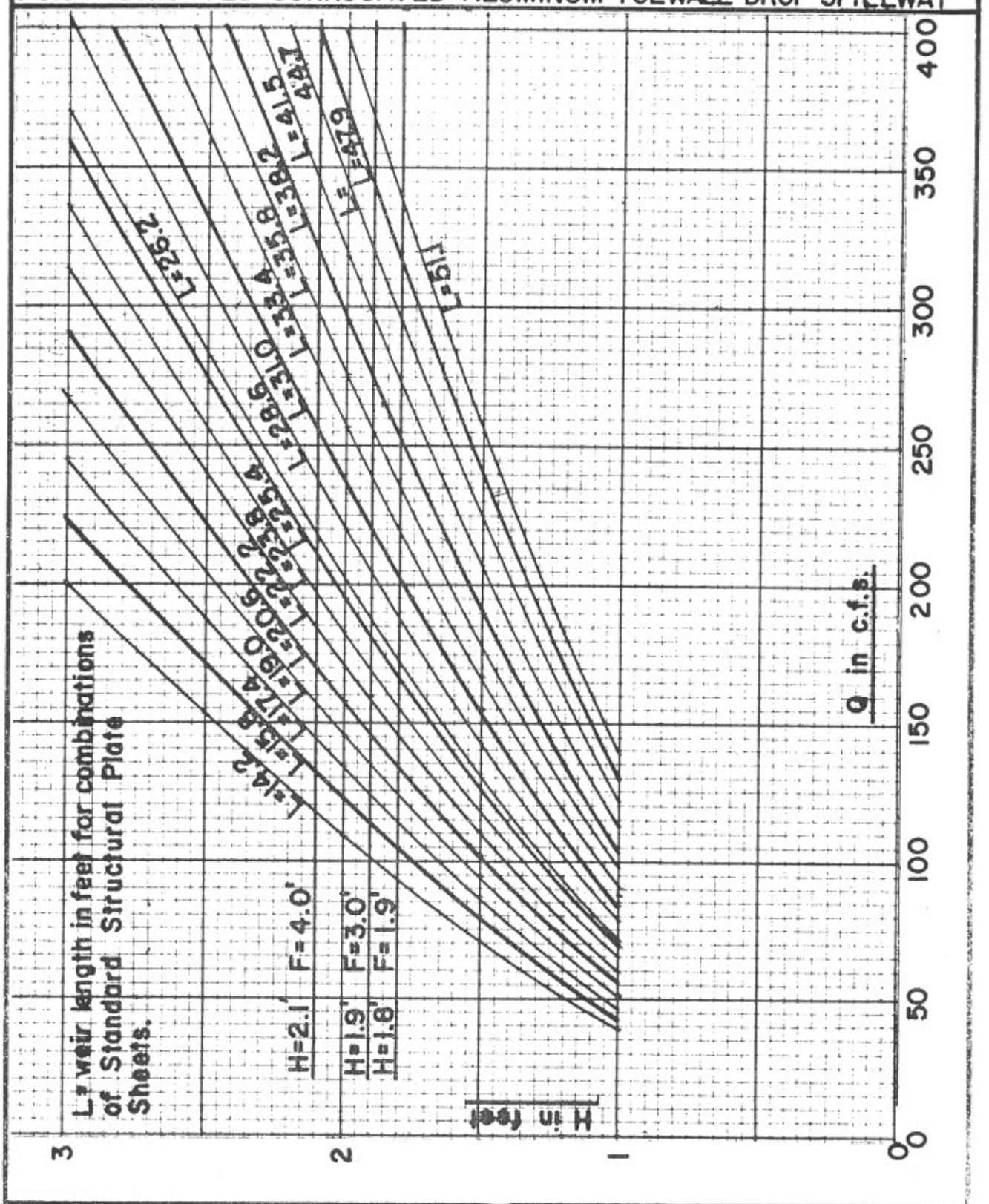
2. Design the type of structure and complete the design using the appropriate data sheets, forms, etc. Examples of some data sheets and forms are used with the examples in this section.

a. From the structure capacity table for the overfall (F) required, select a structure with a capacity equal to or exceeding the Q required which most nearly fits the site conditions.

b. Complete the data sheets by recording the structure dimensions, elevations, quantities, tile outlets, etc. The data sheets are supplied in pad form to make it easy to provide the necessary number of copies by inserting carbons. Plans should be provided as necessary to the owner, contractor, etc.

3. When construction has been completed, record as-built information and certify completion on the appropriate data sheet. One set of plans with all as-built modificaitons shown in red shall be filed with other supporting data.

CAPACITY IN C.F.S.
FOR FABRICATED CORRUGATED ALUMINUM TOEWALL DROP SPILLWAY



REFERENCE

Based on $Q=\left(\frac{3.1L}{1.14}\right)H^{3/2}$

US DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
INDIANA

Figure IN-6-1

Feb. 1973

(EFM Notice IN38, August 1981)

TABLE OF "B" DIMENSIONS IN FEET FOR FABRICATED CORRUGATED ALUMINUM TOEWALL DROP SPILLWAY

L \ W	7	8	10	12	14	16	18	20	Str. Plate Panels
									2 Each[2]
14.2	1.6 [4]	0.8 [4]							9 N
15.8	2.4 [4]	1.6 [4]	0.0 [4]						10 N
17.4	3.2	2.4	0.8 [4]						11 N
19.0		3.2	1.6	0.1					12 N
20.6			2.4	0.9					13 N
22.2			3.2	1.7	0.1				14 N
23.8			4.0	2.5	0.9				15 N
25.4			4.8	3.3	1.7	0.1			16 N
									3 Each[2]
21.4			2.8	1.3					9 N
23.8			4.0	2.5	0.9				10 N
26.2				3.7	2.1	0.5			11 N
28.6				4.9	3.3	1.7	0.2		12 N
31.0					4.5	2.9	1.4		13 N
33.4					5.7	4.1	2.6	1.0	14 N
35.8					6.9	5.3	3.8	2.2	15 N
38.2						6.5	5.0	3.4	16 N
									4 Each[2]
28.6				4.9	3.3	1.7	0.2		9 N
31.8					4.9	3.3	1.8	0.2	10 N
35.0					6.5	4.9	3.4	1.8	11 N
38.2						6.5	5.0	3.4	12 N
41.5							6.6	5.0	13 N
44.7							8.2	6.6	14 N
47.9								8.2	15 N
51.1								9.8	16 N

Insufficient length of weir — $(\frac{W}{2} + B) > W$

May not be most economical

2. When F=1.9' the number of standard sheets used is 1/2 the no. of panels shown.

Note: Design Q MUST NOT EXCEED 5 x F x W. (Outlet V ≤ 5.0 fps)

4. Shall not be used for F= 4.0 feet [1.5 F > (W/2 + B)]

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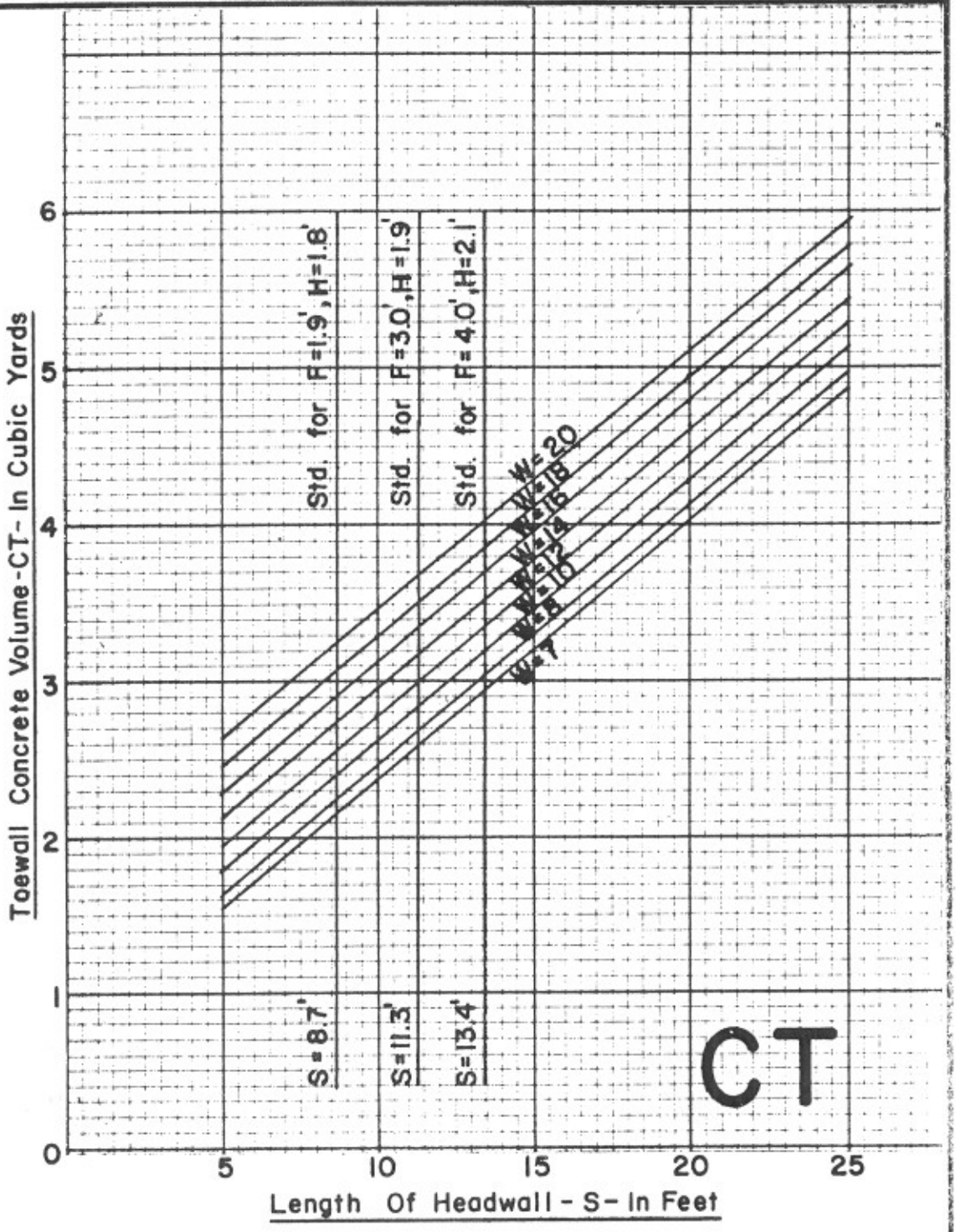
Configuration of the weir section limited to $1.5\,F \leq (W/2 + B) \leq W$

US DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
INDIANA

Figure IN-6-2

Feb. 1973

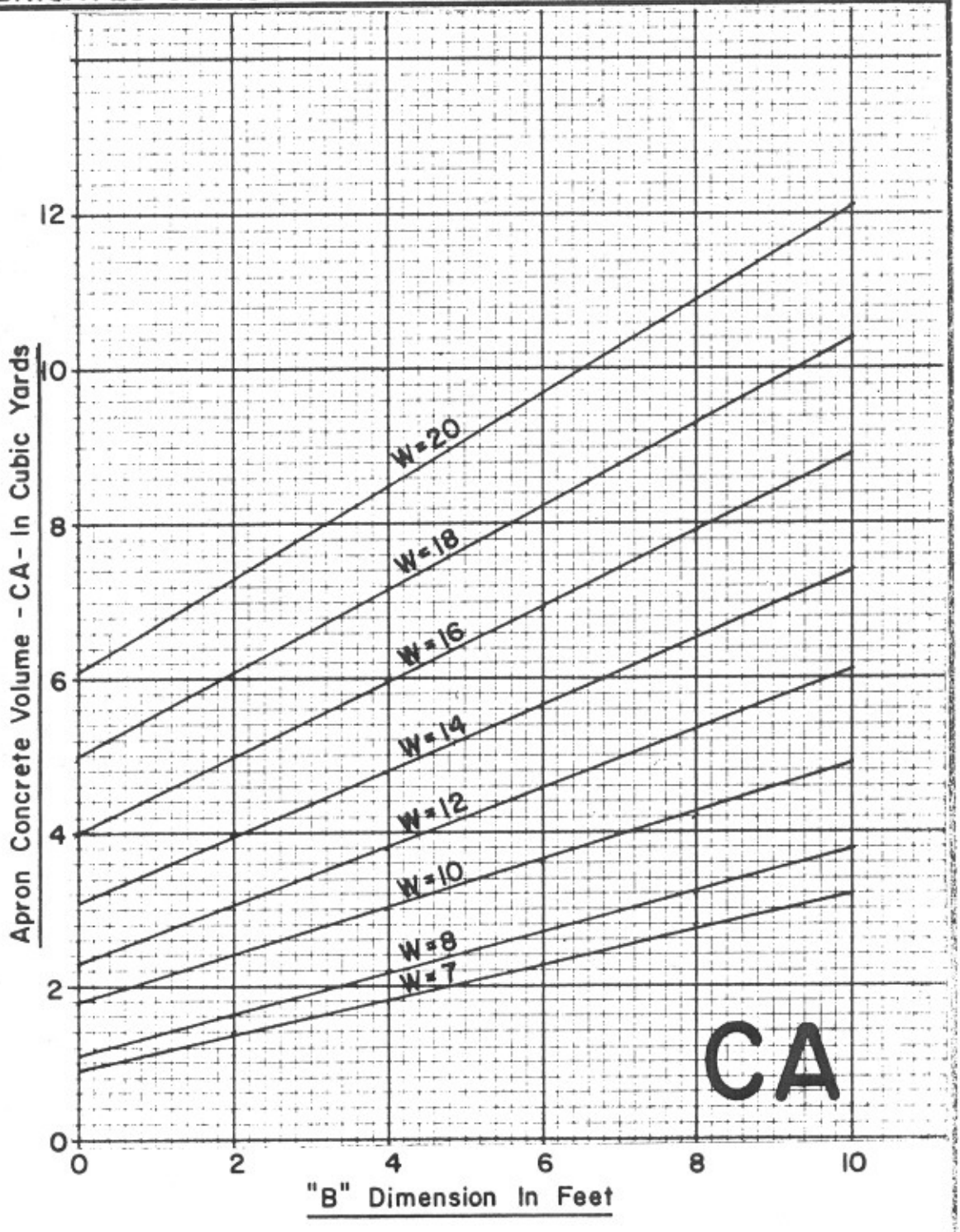
TOEWALL CONCRETE VOLUME - CT
FOR FABRICATED CORRUGATED ALUMINUM TOEWALL DROP SPILLWAY



Note: Total volume of concrete = CT + CA

REFERENCE		
Based on $(2S+W+1.5)\frac{2.25}{27}$	US DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE INDIANA	Figure IN-6-3.1 Feb. 1973

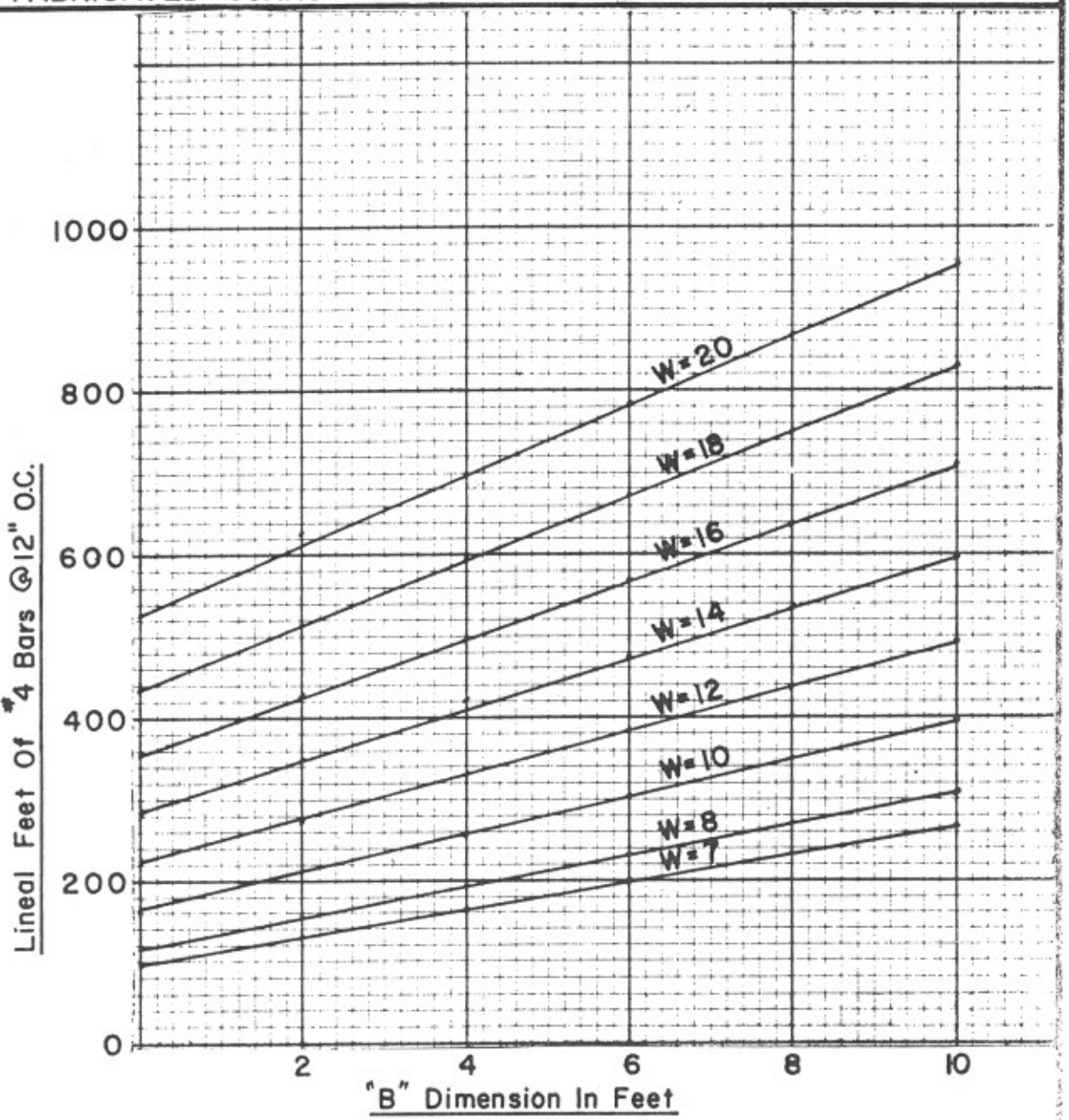
APRON CONCRETE VOLUME - CA
FOR FABRICATED CORRUGATED ALUMINUM TOEWALL DROP SPILLWAY



Note: Total volume of concrete = CT + CA

REFERENCE		
Based on $(W+1.5)(\frac{W}{2}+B+0.25)\frac{.75}{27}$	US DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE INDIANA	Figure IN-6-3.2 Feb. 1973

REINFORCEING STEEL QUANTITY FOR FABRICATED CORRUGATED ALUMINUM TOEWALL DROP SPILLWAY



Note: #5 bars @ 15" O.C. may be substituted for #4 bars @ 12" O.C.

Quantity of #5 bars = 0.8 x lineal feet of #4 bars.

REFERENCE		
Based on $2(W+1.5)(\frac{W}{2}+B+2.25)$	US DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE INDIANA	Figure IN-6-4 Feb. 1973

(EFM Notice IN38, August 1981)

FABRICATED CORRUGATED ALUMINUM TOEWALL DROP SPILLWAY

Overfall Height (F) = 1.9 Feet
Notch Depth (H) = 1.8 Feet
Headwall Height (A) = 4.2 Feet
Headwall Length (S) = 8.7 Feet

CAPACITY	NOTCH WIDTH	LEG LENGTH	WEIR LENGTH	CONCRETE IN APRON AND TOEWALL	STEEL IN APRON AND TOEWALL #4 (½") Bars*	
Q	W	B	L	Vol.	Length	Wt.
cfs	ft	ft	ft	cu.yd.	ft.	lbs
65	7	1.6	14.2	3.5	125	84
75	8	0.8	14.2	3.7	135	90
95	10	0.0	15.8	4.3	170	114
115	12	0.1	19.0	5.0	230	154
135	14	0.1	22.2	6.0	290	194
150	16	0.1	25.4	7.1	360	241
170	18	0.2	28.6	8.3	450	301
190	20	1.0	33.4	10.1	575	384

Overfall Height (F) = 3.0 Feet
Notch Depth (H) = 1.9 Feet
Headwall Height (A) = 5.4 Feet
Headwall Length (S) = 11.3 Feet

CAPACITY	NOTCH WIDTH	LEG LENGTH	WEIR LENGTH	CONCRETE IN APRON AND TOEWALL	STEEL IN APRON AND TOEWALL #4 (½") Bars*	
Q	W	B	L	Vol.	Length	Wt.
cfs	ft	ft	ft	cu.yd.	ft	lbs
100	7	1.6	14.2	3.9	125	84
100	8	0.8	14.2	4.1	135	90
105	7	2.4	15.8	4.1	140	94
115	8	1.6	15.8	4.3	150	100
115	10	0.0	15.8	4.7	170	114
120	8	2.4	17.4	4.5	165	110
125	10	0.8	17.4	5.0	190	127

Overfall Height (F) = 3.0 Feet
Notch Depth (H) = 1.9 Feet
Headwall Height (A) = 5.4 Feet
Headwall Length (S) = 11.3 Feet

CAPACITY	NOTCH WIDTH	LEG LENGTH	WEIR LENGTH	CONCRETE IN APRON AND TOEWALL	STEEL IN APRON AND TOEWALL #4 (½") Bars*	
Q	W	B	L	Vol	Length	Wt.
cfs	ft	ft	ft	cu.yd.	ft.	lbs
135	10	1.6	19.0	5.3	210	140
135	12	0.1	19.0	5.4	230	154
145	10	2.4	20.6	5.5	225	150
145	12	0.9	20.6	5.7	255	170
150	10	3.2	22.5	5.7	245	164
160	12	1.7	22.5	6.0	275	184
160	14	0.1	22.5	6.4	290	194
170	12	2.5	23.8	6.3	290	194
170	14	0.9	23.8	6.7	315	210
180	12	3.3	25.4	6.6	315	210
180	14	1.7	25.4	7.1	340	227
180	16	0.1	25.4	7.5	360	241
190	14	2.1	26.2	7.3	355	237
190	16	0.5	26.2	7.7	375	251
205	14	3.3	28.6	7.8	390	261
205	16	1.7	28.6	8.3	420	281
205	18	0.2	28.6	8.7	450	301
210	14	4.5	31.0	8.3	430	287
220	16	2.9	31.0	8.9	460	307
220	18	1.4	31.0	9.4	495	331
240	16	4.1	33.4	9.5	505	337
240	18	2.6	33.4	10.1	540	361
240	20	1.0	33.4	10.5	575	384
255	18	3.8	35.8	10.7	590	394
255	20	2.2	35.8	11.1	625	418
270	18	5.0	38.2	11.4	640	428
275	20	3.4	38.2	11.9	675	451
300	20	5.0	41.5	12.9	745	498

REFERENCE

US DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
INDIANA
(EFM Notice IN38 August 1981)

Figure IN-6-5.1

Feb. 1973

FABRICATED CORRUGATED ALUMINUM TOEWALL DROP SPILLWAY

Overfall height (F) = 4.0 feet
Notch depth (H) = 2.1 feet
Headwall height (A) = 6.6 feet
Headwall length (S) = 13.4 feet

CAPACITY	NOTCH WIDTH	LEG LENGTH	WEIR LENGTH	CONCRETE IN APRON AND TOEWALL	STEEL IN APRON AND TOEWALL #4(½") Bars*	
Q	W	B	L	Vol.	Length	Wt.
cfs	ft.	ft.	ft.	cu.yd.	ft.	lb.
100	7	1.6	14.2	4.3	125	84
120	7	2.4	15.8	4.5	140	94
140	7	3.2	17.4	4.7	155	104
145	8	2.4	17.4	4.9	165	110
160	8	3.2	19.0	5.1	180	120
160	10	1.6	19.0	5.5	210	140
160	12	0.1	19.0	5.8	230	154
170	10	2.4	20.6	5.8	225	150
170	12	0.9	20.6	6.1	255	170
185	10	3.2	22.2	6.0	245	164
185	12	1.7	22.2	6.4	275	184
185	14	0.1	22.2	6.8	290	194
195	10	4.0	23.8	6.3	260	174
195	12	2.5	23.8	6.7	290	194
195	14	0.9	23.8	7.1	315	210
200	10	4.8	25.4	6.8	280	187
210	12	3.3	25.4	7.0	315	210
210	14	1.7	25.4	7.5	340	227
210	16	0.1	25.4	7.8	360	241
220	12	3.7	26.2	7.2	330	220
220	14	2.1	26.2	7.6	355	237
220	16	0.5	26.2	8.0	375	251
235	12	4.9	28.6	7.6	360	241
235	14	3.3	28.6	8.2	390	261
235	16	1.7	28.6	8.6	420	281
235	18	0.2	28.6	9.1	450	301

Overfall height (F) = 4.0 feet
Notch depth (H) = 2.1 feet
Headwall height (A) = 6.6 feet
Headwall length (S) = 13.4 feet

CAPACITY	NOTCH WIDTH	LEG LENGTH	WEIR LENGTH	CONCRETE IN APRON AND TOEWALL	STEEL IN APRON AND TOEWALL #4(½") Bars*	
Q	W	B	L	Vol.	Length	Wt.
cfs	ft.	ft.	ft.	cu.yd.	ft.	lb.
255	14	4.5	31.0	8.7	430	287
255	16	2.9	31.0	9.2	460	307
255	18	1.4	31.0	9.7	495	331
275	14	5.7	33.4	9.2	500	334
275	16	4.1	33.4	9.8	505	337
275	18	2.6	33.4	10.4	540	361
275	20	1.0	33.4	10.9	575	384
280	14	6.9	35.8	9.7	505	337
300	16	5.3	35.8	10.4	545	364
300	18	3.8	35.8	11.0	590	394
300	20	2.2	35.8	11.5	625	418
320	16	6.5	38.2	11.0	590	394
320	18	5.0	38.2	11.7	640	428
320	20	3.4	38.2	12.3	675	451
345	18	6.6	41.5	12.5	700	468
345	20	5.0	41.5	13.3	745	498
360	18	8.2	44.7	13.5	765	511
370	20	6.6	44.7	14.2	810	541
400	20	8.2	47.9	15.2	885	591

*NOTE: #5(5/8") bars @ 15" o.c. may be substituted for #4(½") bars @ 12" o.c.
Quantity of #5 bars = 0.8 x feet of #4 bars.
Weight of #5 bars = 1.043 x feet of #5 bars.

FERENCE

US DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
INDIANA
(EFM Notice IN38, August 1981)

Figure IN-6-5.2

July 1973

CONCRETE BLOCK TOEWALL DROP SPILLWAY

OVERFALL HEIGHT	NOTCH DEPTH	HEADWALL LENGTH
F = 2'- 0"	H = 1'- 4"	S = 8'- 0"

Sheet 1 of 2

CAPACITY	NOTCH WIDTH	BOX LENGTH	MATERIALS REQUIRED																	
						#3 (3/8" diam.) Reinforcing Steel														
						(1)		(2)		(3)		(4)		(5)		(6)		TOTAL	
Q	W	B	CONCRETE BLOCKS	CONCRETE IN APRON AND TOEWALL	MASONRY WALL REINFORCING	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	LENGTH	WEIGHT
cfs	ft-in	ft-in	ea	cu yd	ft	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ft	lbs
40	4-0	4-0	90	2.8	90	4	6-11	4	4-8	24	3-8	20	2-2	NONE REQUIRED		24	3-2	254	96
55	5-4	4-0	93	3.1	93	6	6-11	4	6-0	24	3-8	22	2-2			24	3-2	277	104
60	6-8	4-0	96	3.4	96	7	6-11	4	7-4	24	3-8	24	2-2			24	3-2	294	111
65	6-8	5-4	102	3.7	101	7	8-3	6	7-4	24	3-8	28	2-2			24	3-2	327	123
65	8-0	4-0	99	3.7	98	8	6-11	4	8-8	24	3-8	26	2-2			24	3-2	311	117
75	9-4	4-0	102	4.0	101	10	6-11	4	10-0	24	3-8	28	2-2			24	3-2	334	126
80	8-0	5-4	105	4.0	104	8	8-3	6	8-8	24	3-8	30	2-2			24	3-2	347	130
80	10-8	4-0	105	4.2	104	11	6-11	4	11-4	24	3-8	30	2-2			24	3-2	350	132
85	9-4	5-4	108	4.4	106	10	8-3	6	10-0	24	3-8	32	2-2			24	3-2	376	141
85	12-0	4-0	110	4.5	107	12	6-11	4	12-8	24	3-8	32	2-2			24	3-2	367	138
90	10-8	5-4	111	4.7	109	11	8-3	6	11-4	24	3-8	34	2-2			24	3-2	397	149
90	13-4	4-0	113	4.8	110	14	6-11	4	14-0	24	3-8	34	2-2			24	3-2	391	147
95	9-4	6-8	114	4.8	112	10	9-7	7	10-0	24	3-8	36	2-2			24	3-2	408	[illegible]
95	12-0	5-4	116	5.1	112	12	8-3	6	12-8	24	3-8	36	2-2			24	3-2	417	[illegible]
95	14-8	4-0	116	5.1	112	15	6-11	4	15-4	24	3-8	36	2-2			24	3-2	407	[illegible]
100	10-8	6-8	117	5.2	114	11	9-7	7	11-4	24	3-8	38	2-2			24	3-2	431	162
100	13-4	5-4	119	5.4	115	14	8-3	6	14-0	24	3-8	38	2-2			24	3-2	446	168
100	16-0	4-0	119	5.4	115	16	6-11	4	16-8	24	3-8	38	2-2			24	3-2	424	159
105	10-8	8-0	123	5.6	120	11	10-11	8	11-4	24	3-8	42	2-2			24	3-2	466	[illegible]
105	12-0	6-8	122	5.6	118	12	9-7	7	12-8	24	3-8	40	2-2			24	3-2	455	[illegible]
105	14-8	5-4	122	5.7	118	15	8-3	6	15-4	24	3-8	40	2-2			24	3-2	467	176
105	17-4	4-0	122	5.6	118	18	6-11	4	18-0	24	3-8	40	2-2			24	3-2	448	168
110	13-4	6-8	125	5.9	120	14	9-7	7	14-0	24	3-8	42	2-2			24	3-2	487	183
110	16-0	5-4	125	6.0	120	16	8-3	6	16-8	24	3-8	42	2-2			24	3-2	487	[illegible]
110	18-8	4-0	125	5.9	120	19	6-11	4	19-4	24	3-8	42	2-2			24	3-2	464	[illegible]
120	12-0	8-0	128	6.1	123	12	10-11	8	12-8	24	3-8	44	2-2			24	3-2	492	18[illegible]
120	14-8	6-8	128	6.3	123	15	9-7	7	15-4	24	3-8	44	2-2			24	3-2	511	[illegible]

REFERENCE

US DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
INDIANA
(EFM Notice IN38, August 1981)

Figure IN-6-6.1

January 1974

CONCRETE BLOCK TOEWALL DROP SPILLWAY

OVERFALL HEIGHT **F= 2′- 0″**

NOTCH DEPTH **H= 1′- 4″**

HEADWALL LENGTH **S= 8′- 0″**

Sheet 2 of 2

CAPACITY	NOTCH WIDTH	BOX LENGTH	MATERIALS REQUIRED																	
						#3 (3/8" diam.) Reinforcing Steel														
						(1)		(2)		(3)		(4)		(5)		(6)		TOTAL	
Q	W	B	CONCRETE BLOCKS	CONCRETE IN APRON AND TOEWALL	MASONRY WALL REINFORCING	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	LENGTH	WEIGHT
cfs	ft-in	ft-in	ea	cu yd	ft	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ft	lbs
120	17-4	5-4	128	6.3	123	18	8-3	6	18-0	24	3-8	44	2-2	NONE REQUIRED		24	3-2	516	194
120	20-0	4-0	128	6.2	123	20	6-11	4	20-8	24	3-8	44	2-2			24	3-2	481	181
125	13-4	8-0	131	6.5	126	14	10-11	8	14-0	24	3-8	46	2-2			24	3-2	529	199
125	16-0	6-8	131	6.7	126	16	9-7	7	16-8	24	3-8	46	2-2			24	3-2	534	201
125	18-8	5-4	131	6.7	126	19	8-3	6	19-4	24	3-8	46	2-2			24	3-2	537	202
130	14-8	8-0	134	6.9	128	15	10-11	8	15-4	24	3-8	48	2-2			24	3-2	555	209
130	17-4	6-8	134	7.1	128	18	9-7	7	18-0	24	3-8	48	2-2			24	3-2	567	213
130	20-0	5-4	134	7.0	128	20	8-3	6	20-8	24	3-8	48	2-2			24	3-2	557	210
135	13-4	9-4	137	7.0	131	14	12-3	10	14-0	24	3-8	50	2-2			24	3-2	584	220
135	16-0	8-0	137	7.3	131	16	10-11	8	16-8	24	3-8	50	2-2			24	3-2	581	218
135	18-8	6-8	137	7.5	131	19	9-7	7	19-4	24	3-8	50	2-2			24	3-2	590	222
140	14-8	9-4	140	7.5	134	15	12-3	10	15-4	24	3-8	52	2-2			24	3-2	614	231
140	17-4	8-0	140	7.8	134	18	10-11	8	18-0	24	3-8	52	2-2			24	3-2	618	232
140	20-0	6-8	140	7.8	134	20	9-7	7	20-8	24	3-8	52	2-2			24	3-2	613	231
145	14-8	10-8	146	8.1	139	15	13-7	11	15-4	24	3-8	56	2-2			24	3-2	658	247
145	16-0	9-4	143	8.0	136	16	12-3	10	16-8	24	3-8	54	2-2			24	3-2	644	242
145	18-8	8-0	143	8.2	136	19	10-11	8	19-4	24	3-8	54	2-2			24	3-2	643	241
150	17-4	9-4	146	8.5	139	18	12-3	10	18-0	24	3-8	56	2-2			24	3-2	686	[illegible]
150	20-0	8-0	146	8.6	139	20	10-11	8	20-8	24	3-8	56	2-2			24	3-2	669	[illegible]
155	16-0	10-8	149	8.7	142	16	13-7	11	16-8	24	3-8	58	2-2			24	3-2	691	[illegible]
155	18-8	9-4	149	9.0	142	19	12-3	10	19-4	24	3-8	58	2-2			24	3-2	716	[illegible]
160	17-4	10-8	152	9.2	144	18	13-7	11	18-0	24	3-8	60	2-2			24	3-2	737	[illegible]
160	20-0	9-4	152	9.4	144	20	12-3	10	20-8	24	3-8	60	2-2			24	3-2	746	[illegible]
170	18-8	10-8	155	9.7	147	19	13-7	11	19-4	24	3-8	62	2-2			24	3-2	769	[illegible]
175	20-0	10-8	158	10.3	150	20	13-7	11	20-8	24	3-8	64	2-2			24	3-2	802	[illegible]

REFERENCE

US DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
INDIANA
(EFM Notice IN38, August 1981)

Figure IN-6-6.2

January 1974

CONCRETE BLOCK TOEWALL DROP SPILLWAY

OVERFALL HEIGHT **F= 2′- 8″**

NOTCH DEPTH **H= 1′- 4″**

HEADWALL LENGTH **S= 9′- 4″**

Sheet 1 of 3

CAPACITY	NOTCH WIDTH	BOX LENGTH	MATERIALS REQUIRED			#3 (3/8" diam.) Reinforcing Steel													
						(1)		(2)		(3)		(4)		(5)		(6)		TOTAL	
Q	W	B	CONCRETE BLOCKS	CONCRETE IN APRON AND TOEWALL	MASONRY WALL REINFORCING	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	LENGTH	WEIGHT
cfs	ft-in	ft-in	ea	cu yd	ft	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ft	lbs
50	4-0	4-0	124	3.1	133	4	6-11	4	4-8	28	3-8	20	2-10	NONE REQUIRED		28	3-10	313	118
55	5-4	4-0	128	3.4	137	6	6-11	4	6-0	28	3-8	22	2-10			28	3-10	338	127
60	6-8	4-0	132	3.7	141	7	6-11	4	7-4	28	3-8	24	2-10			28	3-10	356	134
65	5-4	5-4	136	3.7	145	6	8-3	6	6-0	28	3-8	26	2-10			28	3-10	369	139
65	8-0	4-0	136	4.0	145	8	6-11	4	8-8	28	3-8	26	2-10			28	3-10	374	140
75	6-8	5-4	140	4.0	149	7	8-3	6	7-4	28	3-8	28	2-10			28	3-10	391	147
75	9-4	4-0	140	4.3	149	10	6-11	4	10-0	28	3-8	28	2-10			28	3-10	398	150
80	8-0	5-4	144	4.3	153	8	8-3	6	8-8	28	3-8	30	2-10			28	3-10	413	155
80	10-8	4-0	144	4.5	153	11	6-11	4	11-4	28	3-8	30	2-10			28	3-10	416	157
85	6-8	6-8	148	4.3	157	7	9-7	7	7-4	28	3-8	32	2-10			28	3-10	419	156
85	9-4	5-4	148	4.7	157	10	8-3	6	10-0	28	3-8	32	2-10			28	3-10	446	167
85	12-0	4-0	151	4.8	159	12	6-11	4	12-8	28	3-8	32	2-10			28	3-10	434	163
90	8-0	6-8	152	4.6	161	8	9-7	7	8-8	28	3-8	34	2-10			28	3-10	444	167
90	10-8	5-4	152	5.0	161	11	8-3	6	11-4	28	3-8	34	2-10			28	3-10	465	173
90	13-4	4-0	155	5.1	163	14	6-11	4	14-0	28	3-8	34	2-10			28	3-10	459	173
95	9-4	6-8	156	5.1	165	10	9-7	7	10-0	28	3-8	36	2-10			28	3-10	478	180
95	12-0	5-4	159	5.4	167	12	8-3	6	12-8	28	3-8	36	2-10			28	3-10	487	183
95	14-8	4-0	159	5.4	167	15	6-11	4	15-4	28	3-8	36	2-10			28	3-10	477	179
100	8-0	8-0	160	5.1	169	8	10-11	8	8-8	28	3-8	38	2-10			28	3-10	474	178
100	10-8	6-8	160	5.5	169	11	9-7	7	11-4	28	3-8	38	2-10			28	3-10	502	189
100	13-4	5-4	163	5.7	171	14	8-3	6	14-0	28	3-8	38	2-10			28	3-10	517	194
100	16-0	4-0	163	5.7	171	16	6-11	4	16-8	28	3-8	38	2-10			28	3-10	495	186
105	9-4	8-0	164	5.5	173	10	10-11	8	10-0	28	3-8	40	2-10			28	3-10	512	193
105	12-0	6-8	167	5.9	175	12	9-7	7	12-8	28	3-8	40	2-10			28	3-10	527	198
105	14-8	5-4	167	6.0	175	15	8-3	6	15-4	28	3-8	40	2-10			28	3-10	539	203
105	17-4	4-0	167	5.9	175	18	6-11	4	18-0	28	3-8	40	2-10			28	3-10	520	195
110	10-8	8-0	168	5.9	177	11	10-11	8	11-4	28	3-8	42	2-10			28	3-10	540	20[illegible]

REFERENCE

US DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
INDIANA
(EFM Notice IN38, August 1981)

Figure IN6-6.3

January 1974

CONCRETE BLOCK TOEWALL DROP SPILLWAY

OVERFALL HEIGHT F= 2'- 8"

NOTCH DEPTH H= 1'- 4"

HEADWALL LENGTH S= 9'- 4"

Sheet 2 of 3

CAPACITY	NOTCH WIDTH	BOX LENGTH	MATERIALS REQUIRED																	
						#3(3/8" diam.) Reinforcing Steel														
						(1)		(2)		(3)		(4)		(5)		(6)		TOTAL	
Q	W	B	CONCRETE BLOCKS	CONCRETE IN APRON AND TOEWALL	MASONRY WALL REINFORCING	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	LENGTH	WEIGHT
cfs	ft-in	ft-in	ea	cu yd	ft	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ft	lbs
110	13-4	6-8	171	6.2	179	14	9-7	7	14-0	28	3-8	42	2-10	NONE REQUIRED		28	3-10	561	211
110	16-0	5-4	171	6.3	179	16	8-3	6	16-8	28	3-8	42	2-10			28	3-10	561	211
110	18-8	4-0	171	6.2	179	19	6-11	4	19-4	28	3-8	42	2-10			28	3-10	538	202
120	9-4	9-4	172	5.9	181	10	12-3	10	10-0	28	3-8	44	2-10			28	3-10	557	209
120	12-0	8-0	175	6.4	183	12	10-11	8	12-8	28	3-8	44	2-10			28	3-10	567	213
120	14-8	6-8	175	6.6	183	15	9-7	7	15-4	28	3-8	44	2-10			28	3-10	586	220
120	17-4	5-4	175	6.6	183	18	8-3	6	18-0	28	3-8	44	2-10			28	3-10	591	222
120	20-0	4-0	175	6.5	183	20	6-11	4	20-8	28	3-8	44	2-10			28	3-10	556	209
125	10-8	9-4	176	6.4	185	11	12-3	10	11-4	28	3-8	46	2-10			28	3-10	588	221
125	13-4	8-0	179	6.8	187	14	10-11	8	14-0	28	3-8	46	2-10			28	3-10	605	228
125	16-0	6-8	179	7.0	187	16	9-7	7	16-8	28	3-8	46	2-10			28	3-10	610	229
125	18-8	5-4	179	7.0	187	19	8-3	6	19-4	28	3-8	46	2-10			28	3-10	613	231
130	12-0	9-4	183	6.9	191	12	12-3	10	12-8	28	3-8	48	2-10			28	3-10	620	233
130	14-8	8-0	183	7.2	191	15	10-11	8	15-4	28	3-8	48	2-10			28	3-10	632	238
130	17-4	6-8	183	7.4	191	18	9-7	7	18-0	28	3-8	48	2-10			28	3-10	644	242
130	20-0	5-4	183	7.3	191	20	8-3	6	20-8	28	3-8	48	2-10			28	3-10	635	239
135	10-8	10-8	184	6.8	193	11	13-7	11	11-4	28	3-8	50	2-10			28	3-10	626	235
135	13-4	9-4	187	7.3	195	14	12-3	10	14-0	28	3-8	50	2-10			28	3-10	663	249
135	16-0	8-0	187	7.6	195	16	10-11	8	16-8	28	3-8	50	2-10			28	3-10	660	248
135	18-8	6-8	187	7.8	195	19	9-7	7	19-4	28	3-8	50	2-10			28	3-10	669	251
140	12-0	10-8	191	7.4	199	12	13-7	11	12-8	28	3-8	52	2-10			28	3-10	659	248
140	14-8	9-4	191	7.8	199	15	12-3	10	15-4	28	3-8	52	2-10			28	3-10	694	261
140	17-4	8-0	191	8.1	199	18	10-11	8	18-0	28	3-8	52	2-10			28	3-10	698	262
140	20-0	6-8	191	8.1	199	20	9-7	7	20-8	28	3-8	52	2-10			28	3-10	693	261

REFERENCE

US DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
INDIANA
(EFM Notice IN38, August 1981)

Figure IN-6-6.4

January 1974

CONCRETE BLOCK TOEWALL DROP SPILLWAY

OVERFALL HEIGHT F = 2′- 8″

NOTCH DEPTH H = 1′ - 4″

HEADWALL LENGTH S = 9′ - 4″

Sheet 3 of 3

CAPACITY	NOTCH WIDTH	BOX LENGTH	MATERIALS REQUIRED																	
						#3 (3/8" diam.) Reinforcing Steel														
						(1)		(2)		(3)		(4)		(5)		(6)		TOTAL	
Q	W	B	CONCRETE BLOCKS	CONCRETE IN APRON AND TOEWALL	MASONRY WALL REINFORCING	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	LENGTH	WEIGHT
cfs	ft-in	ft-in	ea	cu yd	ft	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ft	lbs
145	13-4	10-8	195	7.9	203	14	13-7	11	14-0	28	3-8	54	2-10	- NONE REQUIRED -		28	3-10	709	266
145	16-0	9-4	195	8.3	203	16	12-3	10	16-8	28	3-8	54	2-10			28	3-10	726	273
145	18-8	8-0	195	8.5	203	19	10-11	8	19-4	28	3-8	54	2-10			28	3-10	725	273
150	14-8	10-8	199	8.4	207	15	13-7	11	15-4	28	3-8	56	2-10			28	3-10	741	279
150	17-4	9-4	199	8.8	207	18	12-3	10	18-0	28	3-8	56	2-10			28	3-10	767	289
150	20-0	8-0	199	8.9	207	20	10-11	8	20-8	28	3-8	56	2-10			28	3-10	752	283
155	16-0	10-8	203	9.0	211	16	13-7	11	16-8	28	3-8	58	2-10			28	3-10	775	291
155	18-8	9-4	203	9.3	211	19	12-3	10	19-4	28	3-8	58	2-10			28	3-10	800	301
165	17-4	10-8	207	9.5	215	18	13-7	11	18-0	28	3-8	60	2-10			28	3-10	822	309
165	20-0	9-4	207	9.7	215	20	12-3	10	20-8	28	3-8	60	2-10			28	3-10	832	313
170	18-8	10-8	211	10.0	219	19	13-7	11	19-4	28	3-8	62	2-10			28	3-10	856	322
175	20-0	10-8	215	10.6	223	20	13-7	11	20-8	28	3-8	64	2-10			28	3-10	890	335

REFERENCE

US DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
INDIANA
(EFM Notice IN38, August 1981)

Figure IN-6-6.5

January 1974

CONCRETE BLOCK TOEWALL DROP SPILLWAY

OVERFALL HEIGHT F= 2′- 8″

NOTCH DEPTH H= 2′- 0″

HEADWALL LENGTH S= 10′- 8″

Sheet 1 of 1

CAPACITY	NOTCH WIDTH	BOX LENGTH	MATERIALS REQUIRED																	
						#3 (3/8" diam.) Reinforcing Steel														
						(1)		(2)		(3)		(4)		(5)		(6)		TOTAL	
Q	W	B	CONCRETE BLOCKS	CONCRETE IN APRON AND TOEWALL	MASONRY WALL REINFORCING	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	LENGTH	WEIGHT
cfs	ft-in	ft-in	ea	cu yd	ft	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ft	lbs
70	5-4	4-0	156	3.6	172	6	6-11	4	6-0	32	3-8	22	2-10	NONE REQUIRED		32	4-6	389	146
90	6-8	4-0	160	3.9	176	7	6-11	4	7-4	32	3-8	24	2-10			32	4-6	407	153
105	8-0	4-0	164	4.2	180	8	6-11	4	8-8	32	3-8	26	2-10			32	4-6	425	160
125	9-4	4-0	168	4.5	184	10	6-11	4	10-0	32	3-8	28	2-10			32	4-6	450	169
140	10-8	4-0	172	4.7	188	11	6-11	4	11-4	32	3-8	30	2-10			32	4-6	468	176
155	12-0	4-0	179	5.0	194	12	6-11	4	12-8	32	3-8	32	2-10			32	4-6	486	183
160	12-0	5-4	187	5.6	202	12	8-3	6	12-8	32	3-8	36	2-10			32	4-6	538	202
165	13-4	4-0	183	5.3	198	14	6-11	4	14-0	32	3-8	34	2-10			32	4-6	511	192
175	14-8	4-0	187	5.6	202	15	6-11	4	15-4	32	3-8	36	2-10			32	4-6	528	199
180	13-4	5-4	191	5.9	206	14	8-3	6	14-0	32	3-8	38	2-10			32	4-6	568	214
185	16-0	4-0	191	5.9	206	16	6-11	4	16-8	32	3-8	38	2-10			32	4-6	546	205
195	14-8	5-4	195	6.2	210	15	8-3	6	15-4	32	3-8	40	2-10			32	4-6	590	222
195	17-4	4-0	195	6.1	210	18	6-11	4	18-0	32	3-8	40	2-10			32	4-6	571	215
205	16-0	5-4	199	6.5	214	16	8-3	6	16-8	32	3-8	42	2-10			32	4-6	612	230
205	18-8	4-0	199	6.4	214	19	6-11	4	19-4	32	3-8	42	2-10			32	4-6	589	222
215	16-0	6-8	207	7.2	222	16	9-7	7	16-8	32	3-8	46	2-10			32	4-6	662	249
215	17-4	5-4	203	6.8	218	18	8-3	6	18-0	32	3-8	44	2-10			32	4-6	642	242
215	20-0	4-0	203	6.7	218	20	6-11	4	20-8	32	3-8	44	2-10			32	4-6	607	228
225	18-8	5-4	207	7.2	222	19	8-3	6	19-4	32	3-8	46	2-10			32	4-6	664	[illegible]
230	17-4	6-8	211	7.6	226	18	9-7	7	18-0	32	3-8	48	2-10			32	4-6	696	[illegible]
235	20-0	5-4	211	7.5	226	20	8-3	6	20-8	32	3-8	48	2-10			32	4-6	686	[illegible]
245	18-8	6-8	215	8.0	230	19	9-7	7	19-4	32	3-8	50	2-10			32	4-6	720	[illegible]
250	18-8	8-0	223	8.7	238	19	10-11	8	19-4	32	3-8	54	2-10			32	4-6	804	[illegible]
255	20-0	6-8	219	8.3	234	20	9-7	7	20-8	32	3-8	52	2-10			32	4-6	745	280
265	20-0	8-0	227	9.1	242	20	10-11	8	20-8	32	3-8	56	2-10			32	4-6	804	[illegible]

REFERENCE

US DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
INDIANA
(EFM Notice IN38, August 1981)

Figure IN-6-6.6

January 1974

CONCRETE BLOCK TOEWALL DROP SPILLWAY

OVERFALL HEIGHT F = 3′ - 4″

NOTCH DEPTH H = 1′ - 4″

HEADWALL LENGTH S = 10′ - 8″

Sheet 1 of 2

CAPACITY	NOTCH WIDTH	BOX LENGTH	MATERIALS REQUIRED																	
						#3 (3/8" diam.) Reinforcing Steel														
						(1)		(2)		(3)		(4)		(5)		(6)		TOTAL	
Q	W	B	CONCRETE BLOCKS	CONCRETE IN APRON AND TOEWALL	MASONRY WALL REINFORCING	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	LENGTH	WEIGHT
cfs	ft-in	ft-in	ea	cu yd	ft	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ft	lbs
65	5-4	5-4	177	3.9	197	6	8-3	6	6-0	32	3-8	26	1-8	26	3-2	32	4-6	473	178
70	6-8	5-4	182	4.2	202	7	8-3	6	7-4	32	3-8	28	1-8	28	3-2	32	4-6	499	188
75	8-0	5-4	187	4.5	208	8	8-3	6	8-8	32	3-8	30	1-8	30	3-2	32	4-6	525	197
80	6-8	6-8	192	4.5	213	7	9-7	7	7-4	32	3-8	32	1-8	32	3-2	32	4-6	535	201
80	9-4	5-4	192	4.9	213	10	8-3	6	10-0	32	3-8	32	1-8	32	3-2	32	4-6	559	210
85	8-0	6-8	197	4.8	218	8	9-7	7	8-8	32	3-8	34	1-8	34	3-2	32	4-6	563	212
85	10-8	5-4	197	5.2	218	11	8-3	6	11-4	32	3-8	34	1-8	34	3-2	32	4-6	585	220
90	9-4	6-8	202	5.3	224	10	9-7	7	10-0	32	3-8	36	1-8	36	3-2	32	4-6	601	226
90	12-0	5-4	207	5.6	228	12	8-3	6	12-8	32	3-8	39	1-8	36	3-2	32	4-6	616	232
95	8-0	8-0	207	5.3	229	8	10-11	8	8-8	32	3-8	38	1-8	38	3-2	32	4-6	602	226
95	10-8	6-8	207	5.7	229	11	9-7	7	11-4	32	3-8	38	1-8	38	3-2	32	4-6	638	237
95	13-4	5-4	212	5.9	233	14	8-3	6	14-0	32	3-8	41	1-8	38	3-2	32	4-6	650	244
100	9-4	8-0	212	5.7	234	10	10-11	8	10-0	32	3-8	40	1-8	40	3-2	32	4-6	644	242
100	12-0	6-8	217	6.1	238	12	9-7	7	12-8	32	3-8	43	1-8	40	3-2	32	4-6	664	250
100	14-8	5-4	217	6.2	238	15	8-3	6	15-4	32	3-8	43	1-8	40	3-2	32	4-6	676	254
105	10-8	8-0	217	6.1	240	11	10-11	8	11-4	32	3-8	42	1-8	42	3-2	32	4-6	675	254
105	13-4	6-8	222	6.4	244	14	9-7	7	14-0	32	3-8	45	1-8	42	3-2	32	4-6	702	264
105	16-0	5-4	222	6.5	244	16	8-3	6	16-8	32	3-8	45	1-8	42	3-2	32	4-6	702	264
110	9-4	9-4	222	6.1	245	10	12-3	10	10-0	32	3-8	44	1-8	44	3-2	32	4-6	697	262
110	12-0	8-0	227	6.6	249	12	10-11	8	12-8	32	3-8	47	1-8	44	3-2	32	4-6	712	268
110	14-8	6-8	227	6.8	249	15	9-7	7	15-4	32	3-8	47	1-8	44	3-2	32	4-6	730	275
110	17-4	5-4	227	6.8	249	18	8-3	6	18-0	32	3-8	47	1-8	44	3-2	32	4-6	736	277
115	10-8	9-4	227	6.6	250	11	12-3	10	11-4	32	3-8	46	1-8	46	3-2	32	4-6	732	275
115	13-4	8-0	232	7.0	254	14	10-11	8	14-0	32	3-8	49	1-8	46	3-2	32	4-6	754	283
115	16-0	6-8	232	7.2	254	16	9-7	7	16-8	32	3-8	49	1-8	46	3-2	32	4-6	759	285
115	18-8	5-4	232	7.2	254	19	8-3	6	19-4	32	3-8	49	1-8	46	3-2	32	4-6	762	286
120	12-0	9-4	237	7.1	260	12	12-3	10	12-8	32	3-8	51	1-8	48	3-2	32	4-6	772	290

REFERENCE

US DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
INDIANA
(EFM Notice IN38, August 1981)

Figure IN-6-6.7

January 1974

CONCRETE BLOCK TOEWALL DROP SPILLWAY

OVERFALL HEIGHT F= 3′- 4″

NOTCH DEPTH H= 1′- 4″

HEADWALL LENGTH S = 10′- 8″

Sheet 2 of 2

CAPACITY	NOTCH WIDTH	BOX LENGTH	MATERIALS REQUIRED																	
						#3 (3/8" diam.) Reinforcing Steel														
						(1)		(2)		(3)		(4)		(5)		(6)		TOTAL	
Q	W	B	CONCRETE BLOCKS	CONCRETE IN APRON AND TOEWALL	MASONRY WALL REINFORCING	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	LENGTH	WEIGHT
cfs	ft-in	ft-in	ea	cu yd	ft	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ft	lbs
120	14-8	8-0	237	7.4	260	15	10-11	8	15-4	32	3-8	51	1-8	48	3-2	32	4-6	785	295
120	17-4	6-8	237	7.6	260	18	9-7	7	18-0	32	3-8	51	1-8	48	3-2	32	4-6	797	300
120	20-0	5-4	237	7.5	260	20	8-3	6	20-8	32	3-8	51	1-8	48	3-2	32	4-6	788	296
125	10-8	10-8	237	7.0	261	11	13-7	11	11-4	32	3-8	50	1-8	50	3-2	32	4-6	777	292
125	13-4	9-4	242	7.5	265	14	12-3	10	14-0	32	3-8	53	1-8	50	3-2	32	4-6	820	308
125	16-0	8-0	242	7.8	265	16	10-11	8	16-8	32	3-8	53	1-8	50	3-2	32	4-6	817	307
125	18-8	6-8	242	8.0	265	19	9-7	7	19-4	32	3-8	53	1-8	50	3-2	32	4-6	826	310
130	12-0	10-8	247	7.6	270	12	13-7	11	12-8	32	3-8	55	1-8	52	3-2	32	4-6	820	308
130	14-8	9-4	247	8.0	270	15	12-3	10	15-4	32	3-8	55	1-8	52	3-2	32	4-6	855	322
130	17-4	8-0	247	8.3	270	18	10-11	8	18-0	32	3-8	55	1-8	52	3-2	32	4-6	859	323
130	20-0	6-8	247	8.3	270	20	9-7	7	20-8	32	3-8	55	1-8	52	3-2	32	4-6	854	321
135	13-4	10-8	252	8.1	276	14	13-7	11	14-0	32	3-8	57	1-8	54	3-2	32	4-6	872	328
135	16-0	9-4	252	8.5	276	16	12-3	10	16-8	32	3-8	57	1-8	54	3-2	32	4-6	891	335
135	18-8	8-0	252	8.7	276	19	10-11	8	19-4	32	3-8	57	1-8	54	3-2	32	4-6	890	335
140	14-8	10-8	257	8.6	281	15	13-7	11	15-4	32	3-8	59	1-8	56	3-2	32	4-6	910	342
140	17-4	9-4	257	9.0	281	18	12-3	10	18-0	32	3-8	59	1-8	56	3-2	32	4-6	938	353
140	20-0	8-0	257	9.1	281	20	10-11	8	20-8	32	3-8	59	1-8	56	3-2	32	4-6	921	346
145	16-0	10-8	262	9.2	286	16	13-7	11	16-8	32	3-8	61	1-8	58	3-2	32	4-6	948	356
145	18-8	9-4	262	9.5	286	19	12-3	10	19-4	32	3-8	61	1-8	58	3-2	32	4-6	973	366
150	17-4	10-8	267	9.7	292	18	13-7	11	18-0	32	3-8	63	1-8	60	3-2	32	4-6	999	376
150	20-0	9-4	267	9.9	292	20	12-3	10	20-8	32	3-8	63	1-8	60	3-2	32	4-6	1009	379
155	18-8	10-8	272	10.2	297	19	13-7	11	19-4	32	3-8	65	1-8	62	3-2	32	4-6	1037	390
160	20-0	10-8	277	10.8	302	20	13-7	11	20-8	32	3-8	67	1-8	64	3-2	32	4-6	1075	404

REFERENCE

US DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
INDIANA
(EFM Notice IN38, August 1981)

Figure IN-6-6.8

January 1974

CONCRETE BLOCK TOEWALL DROP SPILLWAY

OVERFALL HEIGHT
F = 3′ - 4″

NOTCH DEPTH
H = 2′ - 0″

HEADWALL LENGTH
S = 12′ - 0″

Sheet 1 of 2

CAPACITY	NOTCH WIDTH	BOX LENGTH	MATERIALS REQUIRED																	
						Ø3 (3/8" diam.) Reinforcing Steel														
						(1)		(2)		(3)		(4)		(5)		(6)		TOTAL	
Q	W	B	CONCRETE BLOCKS	CONCRETE IN APRON AND TOEWALL	MASONRY WALL REINFORCING	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	LENGTH	WEIGHT
cfs	ft-in	ft-in	ea	cu yd	ft	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ft	lbs
90	5-4	5-4	209	4.2	237	6	8-3	6	6-0	36	3-8	26	1-8	26	3-2	36	5-2	530	199
110	6-8	5-4	214	4.5	242	7	8-3	6	7-4	36	3-8	28	1-8	28	3-2	36	5-2	556	209
135	8-0	5-4	219	4.8	248	8	8-3	6	8-8	36	3-8	30	1-8	30	3-2	36	5-2	582	219
155	9-4	5-4	224	5.2	253	10	8-3	6	10-0	36	3-8	32	1-8	32	3-2	36	5-2	616	232
165	10-8	5-4	229	5.5	258	11	8-3	6	11-4	36	3-8	34	1-8	34	3-2	36	5-2	642	241
175	10-8	6-8	239	6.0	269	11	9-7	7	11-4	36	3-8	38	1-8	38	3-2	36	5-2	687	258
175	12-0	5-4	239	5.9	268	12	8-3	6	12-8	36	3-8	39	1-8	36	3-2	36	5-2	673	253
185	13-4	5-4	244	6.2	273	14	8-3	6	14-0	36	3-8	41	1-8	38	3-2	36	5-2	706	266
195	12-0	6-8	249	6.4	278	12	9-7	7	12-8	36	3-8	43	1-8	40	3-2	36	5-2	721	271
195	14-8	5-4	249	6.5	278	15	8-3	6	15-4	36	3-8	43	1-8	40	3-2	36	5-2	733	275
200	12-0	8-0	259	6.9	289	12	10-11	8	12-8	36	3-8	47	1-8	44	3-2	36	5-2	769	289
205	13-4	6-8	254	6.7	284	14	9-7	7	14-0	36	3-8	45	1-8	42	3-2	36	5-2	759	285
205	16-0	5-4	254	6.8	284	16	8-3	6	16-8	36	3-8	45	1-8	42	3-2	36	5-2	759	285
215	14-8	6-8	259	7.1	289	15	9-7	7	15-4	36	3-8	47	1-8	44	3-2	36	5-2	787	296
215	17-4	5-4	259	7.1	289	18	8-3	6	18-0	36	3-8	47	1-8	44	3-2	36	5-2	793	298
220	13-4	8-0	264	7.3	294	14	10-11	8	14-0	36	3-8	49	1-8	46	3-2	36	5-2	812	305
225	16-0	6-8	264	7.5	294	16	9-7	7	16-8	36	3-8	49	1-8	46	3-2	36	5-2	816	307
225	18-8	5-4	264	7.5	294	19	8-3	6	19-4	36	3-8	49	1-8	46	3-2	36	5-2	819	308
235	14-8	8-0	269	7.7	300	15	10-11	8	15-4	36	3-8	51	1-8	48	3-2	36	5-2	842	317
235	17-4	6-8	269	7.9	300	18	9-7	7	18-0	36	3-8	51	1-8	48	3-2	36	5-2	854	321
235	20-0	5-4	269	7.8	300	20	8-3	6	20-8	36	3-8	51	1-8	48	3-2	36	5-2	845	318
245	14-8	9-4	279	8.3	310	15	12-3	10	15-4	36	3-8	55	1-8	52	3-2	36	5-2	912	343
245	16-0	8-0	274	8.1	305	16	10-11	8	16-8	36	3-8	53	1-8	50	3-2	36	5-2	873	328
245	18-8	6-8	274	8.3	305	19	9-7	7	19-4	36	3-8	53	1-8	50	3-2	36	5-2	883	332
255	17-4	8-0	279	8.6	310	18	10-11	8	18-0	36	3-8	55	1-8	52	3-2	36	5-2	915	344
255	20-0	6-8	279	8.6	310	20	9-7	7	20-8	36	3-8	55	1-8	52	3-2	36	5-2	911	343
265	16-0	9-4	284	8.8	316	16	12-3	10	16-8	36	3-8	57	1-8	54	3-2	36	5-2	947	356

REFERENCE

US DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
INDIANA
(EFM Notice IN38, August 1981)

Figure IN-6-6.9

January 1974

CONCRETE BLOCK TOEWALL DROP SPILLWAY

OVERFALL HEIGHT F= 3′-4″

NOTCH DEPTH H= 2′- 0″

HEADWALL LENGTH S= 12′-0″

Sheet 2 of 2

CAPACITY	NOTCH WIDTH	BOX LENGTH	MATERIALS REQUIRED																	
						#3 (3/8" diam.) Reinforcing Steel														
						(1)		(2)		(3)		(4)		(5)		(6)		TOTAL	
Q	W	B	CONCRETE BLOCKS	CONCRETE IN APRON AND TOEWALL	MASONRY WALL REINFORCING	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	LENGTH	WEIGHT
cfs	ft-in	ft-in	ea	cu yd	ft	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ft	lbs
265	18-8	8-0	284	9.0	316	19	10-11	8	19-4	36	3-8	57	1-8	54	3-2	36	5-2	947	356
275	17-4	9-4	289	9.3	321	18	12-3	10	18-0	36	3-8	59	1-8	56	3-2	36	5-2	995	374
275	20-0	8-0	289	9.4	321	20	10-11	8	20-8	36	3-8	59	1-8	56	3-2	36	5-2	978	368
285	18-8	9-4	294	9.8	326	19	12-3	10	19-4	36	3-8	61	1-8	58	3-2	36	5-2	1030	387
290	17-4	10-8	299	10.0	332	18	13-7	11	18-0	36	3-8	63	1-8	60	3-2	36	5-2	1056	397
295	20-0	9-4	299	10.2	332	20	12-3	10	20-8	36	3-8	63	1-8	60	3-2	36	5-2	1065	401
305	18-8	10-8	304	10.5	336	19	13-7	11	19-4	36	3-8	65	1-8	62	3-2	36	5-2	1094	411
315	20-0	10-8	309	11.1	342	20	13-7	11	20-8	36	3-8	67	1-8	64	3-2	36	5-2	1132	426

REFERENCE

US DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
INDIANA
(EFM Notice IN38, August 1981)

Figure IN-6-6.10
January 1974

CONCRETE BLOCK TOEWALL DROP SPILLWAY

OVERFALL HEIGHT
F = 4′ - 0″

NOTCH DEPTH
H = 1′ - 4″

HEADWALL LENGTH
S = 12′ - 0″

Sheet 1 of 2

CAPACITY	NOTCH WIDTH	BOX LENGTH	MATERIALS REQUIRED																	
						#4 (½" diam.) Reinforcing Steel														
						(1)		(2)		(3)		(4)		(5)		(6)		TOTAL	
Q	W	B	CONCRETE BLOCKS	CONCRETE IN APRON AND TOEWALL	MASONRY WALL REINFORCING	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	LENGTH	WEIGHT
cfs	ft-in	ft-in	ea	cu yd	ft	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ft	lbs
85	6-8	6-8	240	4.8	274	7	9-7	7	7-4	36	4-0	32	2-0	32	3-10	36	5-2	635	424
90	8-0	6-8	246	5.1	281	8	9-7	7	8-8	36	4-0	34	2-0	34	3-10	36	5-2	666	445
95	9-4	6-8	252	5.6	288	10	9-7	7	10-0	36	4-0	36	2-0	36	3-10	36	5-2	706	471
100	8-0	8-0	258	5.6	294	8	10-11	8	8-8	36	4-0	38	2-0	38	3-10	36	5-2	708	473
100	10-8	6-8	258	6.0	294	11	9-7	7	11-4	36	4-0	38	2-0	38	3-10	36	5-2	736	492
105	9-4	8-0	264	6.0	301	10	10-11	8	10-0	36	4-0	40	2-0	40	3-10	36	5-2	753	503
105	12-0	6-8	272	6.4	308	12	9-7	7	12-8	36	4-0	44	2-0	40	3-10	36	5-2	775	518
110	10-8	8-0	270	6.4	308	11	10-11	8	11-4	36	4-0	42	2-0	42	3-10	36	5-2	786	525
110	13-4	6-8	278	6.7	314	14	9-7	7	14-0	36	4-0	46	2-0	42	3-10	36	5-2	815	544
115	9-4	9-4	276	6.4	314	10	12-3	10	10-0	36	4-0	44	2-0	44	3-10	36	5-2	809	541
115	12-0	8-0	284	6.9	321	12	10-11	8	12-8	36	4-0	48	2-0	44	3-10	36	5-2	827	552
115	14-8	6-8	284	7.1	321	15	9-7	7	15-4	36	4-0	48	2-0	44	3-10	36	5-2	846	565
125	10-8	9-4	282	6.9	321	11	12-3	10	11-4	36	4-0	46	2-0	46	3-10	36	5-2	846	565
125	13-4	8-0	290	7.3	328	14	10-11	8	14-0	36	4-0	50	2-0	46	3-10	36	5-2	871	582
125	16-0	6-8	290	7.5	328	16	9-7	7	16-8	36	4-0	50	2-0	46	3-10	36	5-2	876	585
130	12-0	9-4	296	7.4	334	12	12-3	10	12-8	36	4-0	52	2-0	48	3-10	36	5-2	892	596
130	14-8	8-0	296	7.7	334	15	10-11	8	15-4	36	4-0	52	2-0	48	3-10	36	5-2	904	604
130	17-4	6-8	296	7.9	334	18	9-7	7	18-0	36	4-0	52	2-0	48	3-10	36	5-2	916	612
135	10-8	10-8	294	7.3	334	11	13-7	11	11-4	36	4-0	50	2-0	50	3-10	36	5-2	896	598
135	13-4	9-4	302	7.8	341	14	12-3	10	14-0	36	4-0	54	2-0	50	3-10	36	5-2	941	629
135	16-0	8-0	302	8.1	341	16	10-11	8	16-8	36	4-0	54	2-0	50	3-10	36	5-2	938	626

REFERENCE

US DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
INDIANA
(EFM Notice IN38, August 1981)

Figure IN-6-6.11

January 1974

CONCRETE BLOCK TOEWALL DROP SPILLWAY

OVERFALL HEIGHT
F = 4′ - 0″

NOTCH DEPTH
H = 1′ - 4″

HEADWALL LENGTH
S = 12′ - 0″

Sheet 2 of 2

CAPACITY	NOTCH WIDTH	BOX LENGTH	MATERIALS REQUIRED																	
						#4 (½" diam.) Reinforcing Steel														
						(1)		(2)		(3)		(4)		(5)		(6)		TOTAL	
Q	W	B	CONCRETE BLOCKS	CONCRETE IN APRON AND TOEWALL	MASONRY WALL REINFORCING	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	LENGTH	WEIGHT
cfs	ft-in	ft-in	ea	cu yd	ft	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ft	lbs
135	18-8	6-8	302	8.3	341	19	9-7	7	19-4	36	4-0	54	2-0	50	3-10	36	5-2	947	633
140	12-0	10-8	308	7.9	348	12	13-7	11	12-8	36	4-0	56	2-0	52	3-10	36	5-2	953	636
140	14-8	9-4	308	8.3	348	15	12-3	10	15-4	36	4-0	56	2-0	52	3-10	36	5-2	978	654
140	17-4	8-0	308	8.6	348	18	10-11	8	18-0	36	4-0	56	2-0	52	3-10	36	5-2	982	656
140	20-0	6-8	308	8.6	348	20	9-7	7	20-8	36	4-0	56	2-0	52	3-10	36	5-2	976	653
145	13-4	10-8	314	8.4	354	14	13-7	11	14-0	36	4-0	58	2-0	54	3-10	36	5-2	997	666
145	16-0	9-4	314	8.8	354	16	12-3	10	16-8	36	4-0	58	2-0	54	3-10	36	5-2	1016	678
145	18-8	8-0	314	9.0	354	19	10-11	8	19-4	36	4-0	58	2-0	54	3-10	36	5-2	1015	678
150	14-8	10-8	320	8.9	361	15	13-7	11	15-4	36	4-0	60	2-0	56	3-10	36	5-2	1037	693
150	17-4	9-4	320	9.3	361	18	12-3	10	18-0	36	4-0	60	2-0	56	3-10	36	5-2	1065	711
150	20-0	8-0	320	9.4	361	20	10-11	8	20-8	36	4-0	60	2-0	56	3-10	36	5-2	1048	700
155	16-0	10-8	326	9.5	368	16	13-7	11	16-8	36	4-0	62	2-0	58	3-10	36	5-2	1077	719
155	18-8	9-4	326	9.8	368	19	12-3	10	19-4	36	4-0	62	2-0	58	3-10	36	5-2	1102	736
160	17-4	10-8	332	10.0	374	18	13-7	11	18-0	36	4-0	64	2-0	60	3-10	36	5-2	1130	755
160	20-0	9-4	332	10.2	374	20	12-3	10	20-8	36	4-0	64	2-0	60	3-10	36	5-2	1140	761
170	18-8	10-8	338	10.5	381	19	13-7	11	19-4	36	4-0	66	2-0	62	3-10	36	5-2	1170	782
175	20-0	10-8	344	11.1	388	20	13-7	11	20-8	36	4-0	68	2-0	64	3-10	36	5-2	1210	808

REFERENCE

US DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
INDIANA
(EFM Notice IN38, August 1981

Figure IN6-6.12

January 1974

CONCRETE BLOCK TOEWALL DROP SPILLWAY

OVERFALL HEIGHT **F= 4′ - 0″**

NOTCH DEPTH **H= 2′ - 0″**

HEADWALL LENGTH **S= 13′ - 4″**

Sheet 1 of 2

CAPACITY	NOTCH WIDTH	BOX LENGTH	MATERIALS REQUIRED																	
						#4 (½" diam.) Reinforcing Steel														
						(1)		(2)		(3)		(4)		(5)		(6)		TOTAL	
Q	W	B	CONCRETE BLOCKS	CONCRETE IN APRON AND TOEWALL	MASONRY WALL REINFORCING	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	LENGTH	WEIGHT
cfs	ft-in	ft-in	ea	cu yd	ft	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ft	lbs
135	6-8	6-8	276	5.1	320	7	9-7	7	7-4	40	4-0	32	2-0	32	3-10	40	5-10	698	466
160	8-0	6-8	282	5.4	326	8	9-7	7	8-8	40	4-0	34	2-0	34	3-10	40	5-10	729	487
175	9-4	6-8	288	5.9	333	10	9-7	7	10-0	40	4-0	36	2-0	36	3-10	40	5-10	769	514
185	9-4	8-0	300	6.3	346	10	10-11	8	10-0	40	4-0	40	2-0	40	3-10	40	5-10	816	545
185	10-8	6-8	294	6.3	340	11	9-7	7	11-4	40	4-0	38	2-0	38	3-10	40	5-10	799	534
195	12-0	6-8	308	6.7	353	12	9-7	7	12-8	40	4-0	44	2-0	40	3-10	40	5-10	838	560
205	10-8	8-0	306	6.7	353	11	10-11	8	11-4	40	4-0	42	2-0	42	3-10	40	5-10	849	567
205	13-4	6-8	314	7.0	360	14	9-7	7	14-0	40	4-0	46	2-0	42	3-10	40	5-10	878	587
215	10-8	9-4	318	7.2	366	11	12-3	10	11-4	40	4-0	46	2-0	46	3-10	40	5-10	909	608
215	12-0	8-0	320	7.2	366	12	10-11	8	12-8	40	4-0	48	2-0	44	3-10	40	5-10	890	595
215	14-8	6-8	320	7.4	366	15	9-7	7	15-4	40	4-0	48	2-0	44	3-10	40	5-10	909	607
225	13-4	8-0	326	7.6	373	14	10-11	8	14-0	40	4-0	50	2-0	46	3-10	40	5-10	934	624
225	16-0	6-8	326	7.8	373	16	9-7	7	16-8	40	4-0	50	2-0	46	3-10	40	5-10	939	627
235	12-0	9-4	332	7.7	379	12	12-3	10	12-8	40	4-0	52	2-0	48	3-10	40	5-10	955	638
235	14-8	8-0	332	8.0	380	15	10-11	8	15-4	40	4-0	52	2-0	48	3-10	40	5-10	967	646
235	17-4	6-8	332	8.2	380	18	9-7	7	18-0	40	4-0	52	2-0	48	3-10	40	5-10	979	654
240	12-0	10-8	344	8.2	393	12	13-7	11	12-8	40	4-0	56	2-0	52	3-10	40	5-10	1007	673
245	13-4	9-4	338	8.1	386	14	12-3	10	14-0	40	4-0	54	2-0	50	3-10	40	5-10	1004	671
245	16-0	8-0	338	8.4	386	16	10-11	8	16-8	40	4-0	54	2-0	50	3-10	40	5-10	1001	669
245	18-8	6-8	338	8.6	386	19	9-7	7	19-4	40	4-0	54	2-0	50	3-10	40	5-10	1010	675
245	14-8	9-4	344	8.6	393	15	12-3	10	15-4	40	4-0	56	2-0	52	3-10	40	5-10	1041	695
255	17-4	8-0	344	8.9	393	18	10-11	8	18-0	40	4-0	56	2-0	52	3-10	40	5-10	1045	698
255	20-0	6-8	344	8.9	393	20	9-7	7	20-8	40	4-0	56	2-0	52	3-10	40	5-10	1041	695
263	13-4	10-8	350	8.7	400	14	13-7	11	14-0	40	4-0	58	2-0	54	3-10	40	5-10	1060	708

REFERENCE

US DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
INDIANA
(EFM Notice IN38, August 1981)

Figure IN-6-6.13

January 1974

CONCRETE BLOCK TOEWALL DROP SPILLWAY

OVERFALL HEIGHT
F = 4′-0″

NOTCH DEPTH
H = 2′-0″

HEADWALL LENGTH
S = 13′-4″

Sheet 2 of 2

CAPACITY	NOTCH WIDTH	BOX LENGTH	MATERIALS REQUIRED																	
						#4(½" diam.) Reinforcing Steel														
						(1)		(2)		(3)		(4)		(5)		(6)		TOTAL	
Q	W	B	CONCRETE BLOCKS	CONCRETE IN APRON AND TOEWALL	MASONRY WALL REINFORCING	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	LENGTH	WEIGHT
cfs	ft-in	ft-in	ea	cu yd	ft	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ft	lbs
265	16-0	9-4	350	9.1	399	16	12-3	10	16-8	40	4-0	58	2-0	54	3-10	40	5-10	1079	721
265	18-8	8-0	350	9.3	400	19	10-11	8	19-4	40	4-0	58	2-0	54	3-10	40	5-10	1078	720
275	14-8	10-8	356	9.2	406	15	13-7	11	15-4	40	4-0	60	2-0	56	3-10	40	5-10	1100	735
275	17-4	9-4	356	9.6	406	18	12-3	10	18-0	40	4-0	60	2-0	56	3-10	40	5-10	1128	754
275	20-0	8-0	356	9.7	406	20	10-11	8	20-8	40	4-0	60	2-0	56	3-10	40	5-10	1111	742
285	16-0	10-8	362	9.8	413	16	13-7	11	16-8	40	4-0	62	2-0	58	3-10	40	5-10	1140	762
285	18-8	9-4	362	10.1	413	19	12-3	10	19-4	40	4-0	62	2-0	58	3-10	40	5-10	1165	778
295	17-4	10-8	368	10.3	420	18	13-7	11	18-0	40	4-0	64	2-0	60	3-10	40	5-10	1193	797
295	20-0	9-4	368	10.5	419	20	12-3	10	20-8	40	4-0	64	2-0	60	3-10	40	5-10	1203	803
305	18-8	10-8	374	10.8	426	19	13-7	11	19-4	40	4-0	66	2-0	62	3-10	40	5-10	1233	824
315	20-0	10-8	380	11.4	433	20	13-7	11	20-8	40	4-0	68	2-0	64	3-10	40	5-10	1273	851

REFERENCE

US DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
INDIANA
(EFM Notice IN38, August 1981)

Figure IN-6-6.14

January 1974

CONCRETE BLOCK TOEWALL DROP SPILLWAY

OVERFALL HEIGHT
F = 4′ - 0″

NOTCH DEPTH
H = 2′ - 8″

HEADWALL LENGTH
S = 14′ - 8″

Sheet 1 of 1

CAPACITY	NOTCH WIDTH	BOX LENGTH	MATERIALS REQUIRED																	
						#4 (½" diam.) Reinforcing Steel														
						(1)		(2)		(3)		(4)		(5)		(6)		TOTAL	
Q	W	B	CONCRETE BLOCKS	CONCRETE IN APRON AND TOEWALL	MASONRY WALL REINFORCING	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	Quantity	Length	LENGTH	WEIGHT
cfs	ft-in	ft-in	ea	cu yd	ft	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ea	ft-in	ft	lbs
185	9-4	6-8	328	6.1	384	10	9-7	7	10-0	44	4-0	36	2-0	36	3-10	44	6-6	838	560
215	10-8	6-8	334	6.5	390	11	9-7	7	11-4	44	4-0	38	2-0	38	3-10	44	6-6	868	580
240	12-0	6-8	348	6.9	404	12	9-7	7	12-8	44	4-0	44	2-0	40	3-10	44	6-6	907	606
265	13-4	6-8	354	7.2	410	14	9-7	7	14-0	44	4-0	46	2-0	42	3-10	44	6-6	947	633
295	14-8	6-8	360	7.6	417	15	9-7	7	15-4	44	4-0	48	2-0	44	3-10	44	6-6	978	653
320	16-0	6-8	366	8.0	424	16	9-7	7	16-8	44	4-0	50	2-0	46	3-10	44	6-6	1008	673
345	17-4	6-8	372	8.4	430	18	9-7	7	18-0	44	4-0	52	2-0	48	3-10	44	6-6	1048	700
375	18-8	6-8	378	8.8	437	19	9-7	7	19-4	44	4-0	54	2-0	50	3-10	44	6-6	1079	721
400	20-0	6-8	384	9.1	444	20	9-7	7	20-8	44	4-0	56	2-0	52	3-10	44	6-6	1109	741

REFERENCE

US DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
INDIANA
(EFM Notice IN38, August 1981)

Figure IN6-6.15

January 1974

Nominal Block Width, in.	Core Volume, cu.yd./blk.	Mortar Vol., cu.yd./blk.
8	0.012	0.0010
10	0.015	0.0011
12	0.019	0.0012

Note: These volumes are approximate and a contingency of 10% should be allowed when computing quantities for estimating purposes.

Assumptions made are that the block are 16 inch nominal length and are the two hole type.

Computations are based on shell and web thicknesses as specified in ASTM C-90.

Figure IN-6-6.16 Volume of Mortar to Use for Concrete Block Structures per Block

DESIGN PROCEDURE FOR PEAK FLOW BOX INLET TOEWALL DROP STRUCTURE

STEPS

1. Determine drainage area from USGS maps, field observations, and/or aerial photos.

2. Determine average watershed slope from survey data, soil survey, field observations, and/or USGS maps. For definition of average watershed slope, see EFM, Chapter 2, pages 2-7.

3. Determine CN from EFM, Chapter 2, based on soils, cover, etc., as determined by field observation and soil survey. Use Form IN-ENG-10

4. From survey data, determine controlled drop; and based on drainage area, determine minimum design frequency from Standard and Specification 410, Grade Stabilization Structure, in Section IV of the Technical Guide.

5. Determine rainfall from EFM, Chapter 2, Indiana Supplement (yellow sheets).

6. Determine peak discharge in cfs from EFM, Chap. 2, Ex. 2-10, Drawing ES-1027. Correction can be made for exact slope by using EFM, Figure 2.1B, "Interpolationg Factors for Various Slopes and Drainage Areas." Correction can be made for ponding and swampy areas using EFM pages 2-10.1 thru 2-10.4.

7. Select structure type and size from examples contained in this section.

8. Fill out the sheets for the plan. Use Standard Drawings IN-ENG-4, IN-ENG-5, or IN-ENG-6.

9. Check all your work for ommissions and errors.

The design computations and uses of each type of standard structure and applicable engineering drawings are shown in the following examples.

EXAMPLE No. 1 - Concrete Block Structure

Given: Watershed Area = 68 acres, Putnam County

Soils - Iva; 10 acres cultivated without conservation treatment, 40 acres cultivated with conservation treatment.

Cincinnati; 8 acres poor woods.

Vigo; 10 acres without conservation treatment.

Average watershed slope = 2%
Overfall to be controlled (F) = 4.0 feet
Waterway grade above structure = 1.5%
Waterway depth of flow = 1.0 foot
Outlet channel - stable

I. Determine design peak runoff (Q) using Form IN-ENG-10. (An experienced technician should be able to estimate the curve number (CN), in which case Form IN-ENG-13 could be used instead of Form IN-ENG-10.) See Exhibit IN-6-1.1.

A. From the Engineering Field Manual (EFM), Exhibit 2-1, the hydrologic soil group for Cincinnati and Iva soils is group "C" and for Vigo soil is group "D."

B. List the acres of each combination of soil and use.

C. Determine the weighted CN (81) and round to nearest five (80).

D. Record the watershed slope as flat.

E. The design storm frequency, from Table 2 of Standard and Specification 410, Section IV of the Technical Guide, using watershed = 68 acres and overfall = 4 feet, is 5 years. The 24-hour rainfall for a 5-year, 24-hour storm for this location is 3.9 inches.

F. The peak runoff from EFM, Exhibit 2-10, is 60 cfs.

II. Select the structure assuming, in this case, the owner wants to do as much of the work personally as possible. Therefore, a concrete block structure will be used. From the Figure IN-6-6.11 the smallest four-foot

III. Complete the data sheets for the concrete block toewall drop spillway. See Exhibits IN-6-1.2, 1.3, and 1.4.

A. On sheet one, record the structure dimensions from the Figure IN-6-6.11 and other information necessary for identification and layout.

B. Complete sheet two. This structure will also serve as an outlet for a tile; therefore, show the tile's approximate location on the plan view. Delete the buttress, because the structure width (W) is less than 12 feet.

C. On sheet three, record the quantities and other materials information from the Figure IN-6-6.11 and compute and record the other quantities as required.

D. After construction has been completed, complete the construction check-out certification on sheet one.

EXAMPLE No. 2 - Aluminum Structure

Given: Watershed Area = 85 acres, Putnam County

Soils - Cincinnati; pasture and woods, fair to good cover.

Average watershed slope = 7%
Overfall to be controlled (F) = 4 feet
Waterway grade above structure = 2%
Waterway depth of flow = 1.0 foot
Outlet channel - stable

IN-ENG-10 & 10A or computer program

I. Determine design peak runoff (Q) using Form ~~IN-ENG-13.~~ See Exhibit IN-6-2.1.

EFH Table IN 2-2

A. From the Engineering Field Manual (EFM), ~~Exhibit 2-1,~~ the hydrologic soil group for Cincinnnati soil is group "C."

B. The curve number (CN) for this watershed is estimated to CN 75. (Form IN-ENG-10 may be used to determine the CN.)

C. Complete the information called for on the top of the form. The peak runoff from EFM, Exhibit ~~2-10~~ 2-11, is 85 cfs.

II. Select the structure assuming, in this case, the owner wants to contract the job and get it done as soon as possible. Therefore, an aluminum structure will be used. From Figure IN-6-5.2, the 4-foot overfall structure with the closest capacity is the 100 cfs structure. The notch depth (H) of 2.1 feet and the notch width (W) of 7 feet are compatible with the site. Therefore, the structure will be satisfactory.

III. Complete the data sheets for the fabricated corrugated aluminum toewall drop spillway. See Exhibits IN-6-2.1, 2.2, 2.3 and 2.4.

A. On sheet one, record the structure dimensions from Figure IN-6-5.2 and the other information necessary for identification and layout.

B. On sheet two, record the quantities from Figure IN-6-5.2 and complete the other information indicated.

C. Complete sheet three. Show the size and location of the tile outlet stub for the tile drain that will outlet at this structure.

D. After construction has been completed, complete the construction check-out certification on sheet one.

EXAMPLE No. 3 - Aluminum Structure Attached to Existing Culvert

Given: Road culvert with eroding waterway above
Watershed Area =290 acres, Elkhart County
Soils - Hoytville and Nappanee, row crops
Average watershed slope ~~=<~~ 1%
Overfall to be controlled (F) = 2 feet

IN ENG 10 & 10A OR COMPUTER PROGRAM

I. Determine design peak runoff (Q), using Form ~~IN-ENG-13.~~ See Exhibit IN-6-3.1.

A. Check culvert capacity against a Q_{50} peak in accordance with Table 4 of Standard and Specification 410, Section IV of the Technical Guide.

B. From the Engineering Field ~~Manual~~ Handbook (EFM) EFH, ~~Exhibit 2-1~~ Table IN 2-2, the hydrologic soil group for Hoytville and Nappanee soils is group "D."

C. From the EFM, ~~Exhibit 2-2~~ Table 2-3, the curve number (CN) for this watershed is estimated to be CN 85.

D. Complete the additional information for a structure attached to a culvert.

1. The culvert has a free outlet and a check of the EFM Section on hydraulics of Culverts, pages 3-30 and Exhibits 3-9 and 3-11 for concrete culverts, indicates that the flow will be controlled by inlet conditions. The culvert is concrete with square-edged entrance conditions. The low spot in the road is 2 feet above the top of the 4-foot culvert; therefore, the headwater (HW) depth is 6 feet. From EFM Exhibit 3-9, using 48-inch diameter culvert and HW/D = 6/4 = 1.5, read Q_c = 110 cfs.

2. The capacity of the existing road culvert is less than the normal design peak flow. Therefore, the structure will be designed for 1.25 times the existing structure capacity, or 138 cfs.

II. Select the structure, assuming an aluminum structure is desired. From Figure IN-6-1, using 138 cfs and H limited to 2.5 feet, find that the weir length (L) = 14.2 feet is the smallest standard structure and that it has a capacity of 158 cfs. Record this information on Form IN-ENG-13. From Figure IN-6-2, using L = 14.2, select the structure that best fits the site. For this example, select the structure dimensions, W = 7 feet and B = 1.6 feet.

III. Complete the data sheets for an aluminum toewall drop spillway attached to existing culvert. See Exhibits IN-6-3.1, 3.2, and 3.3.

A. On sheet one, record the structure dimensions from II above and the other information necessary for identification and layout. This structure will be attached to a county road culvert; therefore, the approval of the County Commissioners was obtained and documented by the landowner's signature on the plans.

B. Complete sheet two.

1. Delete the toewall requirement, because this structure is attached to a headwall with existing toewall, and complete the title block.

2. Determine the volume of concrete and steel in the apron. From Figure IN-6-3.2, the concrete volume is 1.3 cubic yards. From Figure IN-6-4, the reinforcing steel amount is 120 lineal feet of #4 bars. This includes the steel for a toewall and should be reduced. The amount of steel in a toewall is approximately 4W lineal feet; therefore, the amount of steel in the apron is 92 lineal feet (120 - 4W = 120 - (4 x 7) = 92). Record this under quantities and complete the other amounts.

3. After construction has been completed, complete the construction check-out certification on sheet one.

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

EXHIBIT IN-6-1.1

IN-ENG-10
Rev. 3/81
File Code 210-11

PEAK RUNOFF COMPUTATION SHEET

Cooperator I.A. Farmer Project Erosion Control Structure

By D. Designer Date 6-29-81 Checked by A. Checker Date 6-30-81

HYDROLOGIC CURVE NUMBER (CN)

WATERSHED DESCRIPTION	MAJOR SOIL TYPES				ACRES	PRODUCT
			Cinn. Irva	Vigo		
	Hydrologic Soil Group (Exhibit 2-1 EFM)					
	A	B	C	D		
Cultivated - without conservation treatment	72	81	88	91	10	880
					10	910
- with conservation treatment	62	71	78	81	40	3120
Pasture or range - poor condition	68	79	86	89		
- good condition	39	61	74	80		
Meadow	30	58	71	78		
Woods or Forest - thin stand, poor cover, no mulch	45	66	77	83	8	616
- good cover	25	55	70	77		
Farmsteads	59	74	82	86		
Roads	74	84	90	92		
Other (Specify)						
			TOTALS		68	5526

Weighted CN = $\frac{\text{Product Total}}{\text{Total Acres}} = \frac{5526}{68} = 81$

CN Rounded to nearest Exhibit 2-10 Value (65, 70, 75, etc.) = 80
(Do not use less than CN 60 without approval of area engineer)

Average Watershed Slope: Flat (Flat = 0-3%; Moderate = 3-8%; Steep = >8%)

Adjustment Factors: Slope --- Ponding ---

	Storm 1	Storm 2
From Technical Guide Section IV and EFM (Ex. IN 2-4)		
Design Frequency - Years	5	
Rainfall - inches	3.9	
Storm Duration - hours	24	
From EFM, Exhibit 2-10, sheet 5 of 21		
Peak Discharge - cfs	60 cfs	

Sheet 1 of 1

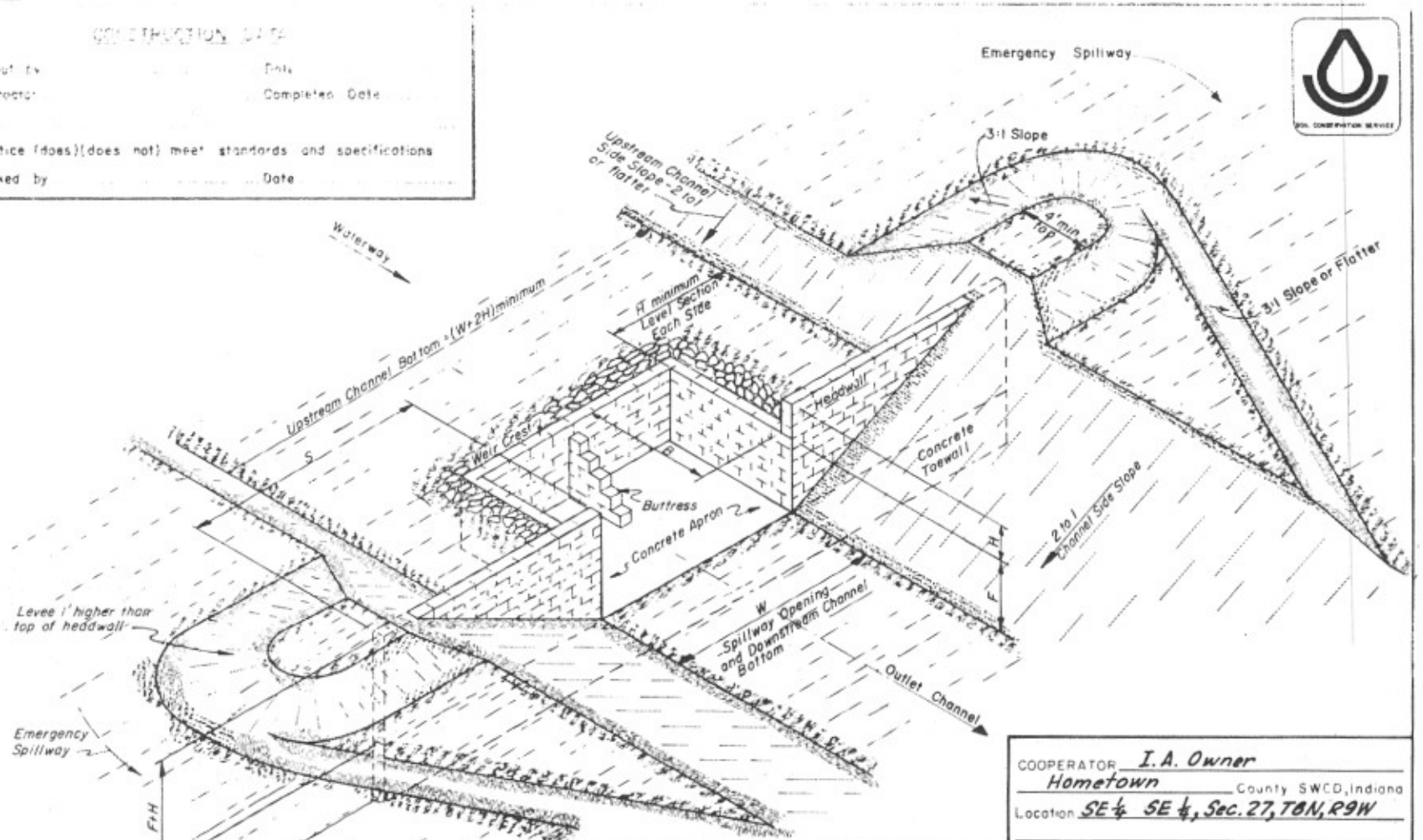
CONSTRUCTION DATA

Layout by ..... Date .....

Contractor ..... Completion Date .....

Practice (does)(does not) meet standards and specifications

Checked by ..... Date .....



COOPERATOR I.A. Owner

Hometown County SWCD, Indiana

Location SE ¼ SE ¼, Sec. 27, T8N, R9W

ELEVATIONS	
Top of Levee	100.1
Top of Headwall	99.1
Emergency Spillway	98.8
Weir Crest	97.8
Concrete Apron	93.8

BENCH MARK	
Elevation	100
Description:	40d spike in W. root of 18" maple, 70' E. of structure ℄

STRUCTURE DIMENSIONS	
F	4'-0"
H	1'-4"
W	6'-8"
B	6'-8"
S	12'-0"

CONCRETE BLOCK TOEWALL DROP SPILLWAY GENERAL LAYOUT

EXAMPLE

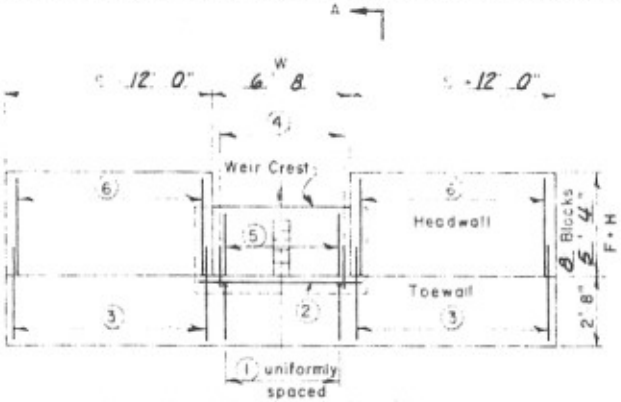
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	Approved by D. Designer
Designed	IN-EDU	9-73	Title Conservation Technician
Drawn	J. Keller	9-73	L. M. Boss
Accepted	D. Designer	10-73	Title District Conservationist
Checked	A. Checker	10-73	Sheet No. 1 of 3 — Drawing No.

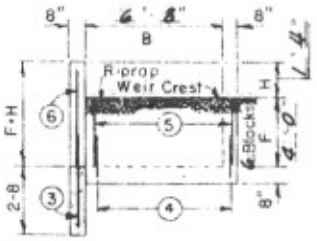
Based on original design by C. C. Belcher 9-61

Reference ENG. FIELD MANUAL Chap. 6

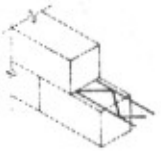
Not to Scale



DOWNSTREAM ELEVATION



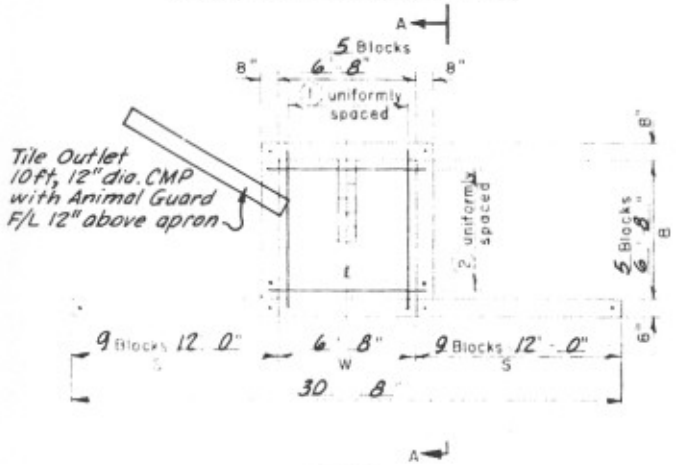
SECTION A-A



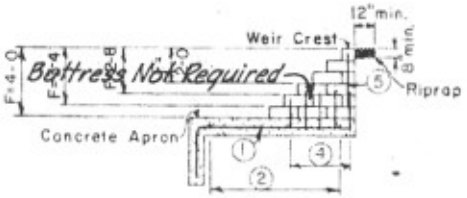
MASONRY WALL REINFORCING

9 gage galvanized wire, 6" width

Place between each course of blocks



PLAN



SECTION ON CENTERLINE

NOTES:

1. BUTTRESS IS NOT REQUIRED WHEN W IS LESS THAN 12'-0".
2. FIELD REINFORCING STEEL LAYOUT 1 AND 2, SHALL BE PLACED 8" O.C. SPACING.
3. CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH AT 28 DAYS EQUAL TO 3000 P.S.I. (5-BAG MIX).
4. RIPRAP MAY CONSIST OF WELL-GRADED ROCK, MAXIMUM SIZE 12" OR 6" CONCRETE BLOCK SET WITH LONG DIMENSIONS UP AND FILLED WITH SOIL.

COOPERATOR *I. A. Owner*
Hometown County SWCD, Indiana

CONCRETE BLOCK TOEWALL
DROP SPILLWAY
STRUCTURE DETAILS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

EXAMPLE

Drawn	IN-ENG	9-73
Traced	J. Seller	9-73
Adapted	*D. Designer*	*10-73*
Checked	*A. Checker*	*10-73*

IN-ENG-4 REV. 8/81

QUANTITIES

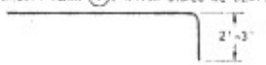
[illegible]	240	
[illegible]	0.3	
[illegible]	3.4	
[illegible]	4.9	
[illegible]	275	
4 1/2 [illegible]	627	
[illegible]	0.7	
[illegible]	SUM	JOB
EXCAVATION AND BACKFILL	SUM JOB	
DRAINTILE OUTLET 12 DIAMETER		

REINFORCING STEEL SCHEDULE

MARK	QUANTITY	LENGTH	TOTAL
1	7	9-7	67-1
2	7	7-4	51-4
3	36	4-0	144-0
4	32	2-0	64-0
5	32	3-9	120-0
6	36	5-0	180-0
	Total Lin. Ft		626-5

NOTES

1. ALL REINFORCING STEEL SHALL BE 4 (1/2" DIA.).
2. ALL REINFORCING STEEL SHALL BE STRAIGHT BARS EXCEPT MARK (1), WHICH SHALL BE BENT:

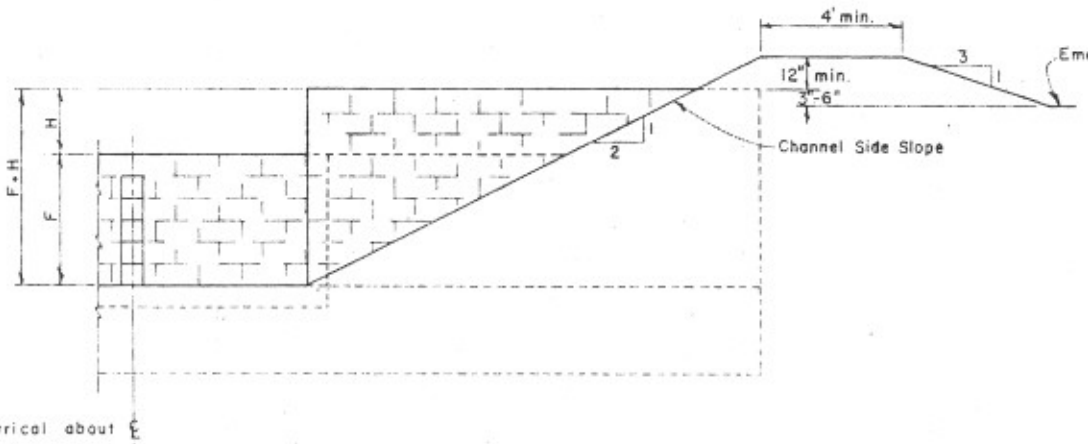


CONSTRUCTION NOTES

1. EXCAVATE FOR APRON AND TOEWALL IN UNDISTURBED SOIL. IF ALLOWED, EXCAVATE FOR TOEWALL AND APRON AND TOEWALL SHALL BE CAST IN PLACE.
2. PLACE REINFORCING BARS (MARK 1) BEFORE POURING CONCRETE IN APRON AND TOEWALL.
3. LAY FIRST COURSE OF CONCRETE BLOCKS IN FRESHLY POURED CONCRETE IN APRON AND TOEWALL.
4. PLACE VERTICAL STEEL BARS 3 AND 4 INTO WET CONCRETE THRU HOLES IN CONCRETE BLOCKS SO THAT THEY PROJECT ABOVE THE FIRST COURSE OF CONCRETE BLOCKS AS FOLLOWS:

1-	3"	3"
2-6	7"	13"
2-8	7"	21"
3-4	7"	7"
3-6	11"	11"

5. AFTER CONCRETE HAS SET, PLACE DRAIN TILE OUTLET PIPE, IF REQUIRED.
6. LAY BALANCE OF CONCRETE BLOCKS. USE ONE PART CONCRETE AND THREE (3) PARTS SAND FOR MORTAR. PLACE MASONRY WALL REINFORCING BETWEEN EACH COURSE OF BLOCKS.
7. AFTER BLOCKS ARE LAID, WET DOWN HOLES. PLACE STEEL BARS 5 AND 6 IN WALLS THRU HOLES IN BLOCKS AND FILL HOLES WITH CONCRETE. TAMP CONCRETE WELL INTO HOLES THRU MASONRY REINFORCING SO THAT ALL HOLES ARE FILLED.
8. AFTER MORTAR AND CONCRETE HAVE SET, LAY DRAIN TILE TO TILE OUTLET PIPE, IF REQUIRED, AND BACKFILL AROUND STRUCTURE WITH MOIST SOIL. PLACE BACKFILL IN SHALLOW LAYERS AND TAMP WELL. REMOVE DRY SOIL FROM SIDES OF EXCAVATION AS BACKFILL IS PLACED SO THAT MOIST SOIL IS TAMPED AGAINST MOIST SOIL. KEEP BACKFILL APPROXIMATELY LEVEL AROUND ALL PARTS OF THE STRUCTURE.
9. PLACE RIPRAP AND COMPLETE SHAPING AND GRADING.
10. SEED ALL DISTURBED AREAS.



HALF DOWNSTREAM VIEW

Not to Scale

COOPERATOR I. A. Owner
Hometown County SWCD, Indiana

CONCRETE BLOCK TOEWALL
DROP SPILLWAY
DETAIL

EXAMPLE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date
Designed	IN-EDU	10-73
Drawn	J. Keller	9-73
Adapted	D. Designer	10-73
Checked	A. Checker	10-73

(EFM Notice IN38, August 1981)

EXHIBIT IN-6-1.4

EXHIBIT IN-6-2.1

EROSION CONTROL STRUCTURE DESIGN DATA

Cooperator I. A. Owner County Hometown

Address R.R. 1, Howntown Indiana, Zip Code 44444

Struc. Location: SE ¼ SE ¼ Sec 27 T 8N R 9W Designed By D. Designer Date 8/30/81

Watershed: 85 Ac., Slope 7 %, Hydrologic Soil Group C (Ex.2-1), CN 75 (Ex.2-2)

Design Freq. 5 Yrs. (Tech Guide Spec. 410), 24 Hr. Rainfall (P) 3.9 In. (EFM Ex. IN 2-

Q_p = 85 CFS (Table 2-1 & Ex. 2-10 or Form IN-ENG-10), Controlled Drop (F) 4 Ft.

Select structure from EFM, Ch. 6., Q provided 100 CFS.

Additional Information for Structures Attached to Bridges or Culverts

Type: Concrete _____, CMP _____ Other _____ Length _____ Ft.

Width _____ Ft. or Diameter (D) ____ In., Height _____ Ft., Area Opening (A) _____ SF.

Culvert-Inlet Control

Entrance Type _____ (Ex. 3-9 & 10)

Headwater (HW) _____ Ft. (Fig. 3-7)

HW/D = _____, Q_c _____ CFS (Ex. 3-9 & 10)

Culvert-Outlet Control

Head (H) _____ Ft. (Fig. 3-8)

Q_c _____ CFS (EX. 3-11 & 12)

Bridge

$r = \frac{A}{P}$ = _____ = _____ (Ex. 3-13), Ditch Slope(s) _____ Ft./Ft., n _____

$Q_c = A \frac{1.486}{n} r^{2/3} s^{1/2}$ = _____ $\frac{(1.486)}{(____)}$ (_____)$^{2/3}$ (_____)$^{1/2}$ = _____ CFS

If $Q_c < Q_p$ then $Q = 1.25\ Q$

If $Q_c \geq Q_p$ then $Q = 1.0\ Q_c$ except

If $Q_c > 1.5\ Q_p$ then $Q = 1.5\ Q_p$ Max.

$Q = Q_c$ (_____) = (_____) (_____) = _____ CFS for Bridge Culvert

Head (H) _____ Ft. (H limited to 2.5 feet maximum is the difference between the weir crest and the low spot in the road.

Select structure from EFM Ch. 6.

Weir Length (L) _____ Ft. (Fig. IN 6-1, EFM), Q provided _____ CFS.

Note: All Exhibits (Ex.) and Tables are from SCS Engineering Field Manual For Conservation Practices

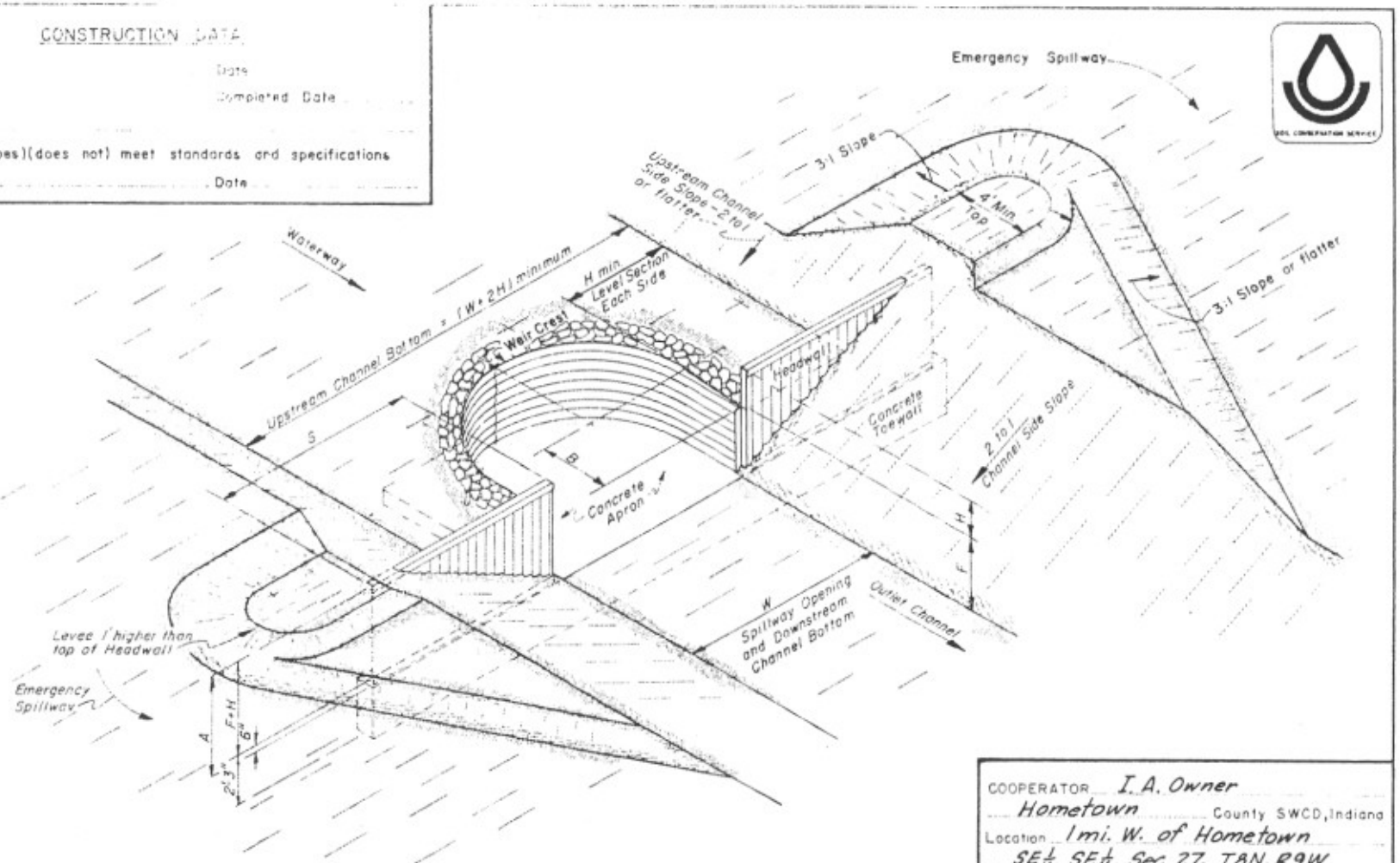
CONSTRUCTION DATA

Layout by ..... Date .....

Contractor ..... Completed Date .....

Practice (does)(does not) meet standards and specifications

Checked by ..... Date .....



COOPERATOR I. A. Owner

Hometown County SWCD, Indiana

Location 1 mi. W. of Hometown

SE¼ SE¼, Sec. 27, T8N, R9W

ELEVATIONS	
Top of Levee	100.9
Top of Headwall	99.9
Emergency Spillway	99.5
Weir Crest	97.8
Concrete Apron	93.8

BENCH MARK	
Elevation	100.0
Description	40d spike in W. root of 18" maple, 70' E. of st. ℄.

STRUCTURE DIMENSIONS	
F	4.0'
H	2.1'
W	7.0'
B	1.6'
L	14.2'
A	6.6'
S	13.4'

FABRICATED CORRUGATED ALUMINUM TOEWALL DROP SPILLWAY GENERAL LAYOUT

EXAMPLE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	IN-ES	3-73	Approved by D. Designer
Drawn	M.N. Seikel	3-73	Title Conservation Technician
Adapted	D. Designer	10-73	L. M. Boss, District Conservationist
Checked	A. Checker	10-73	Sheet 3

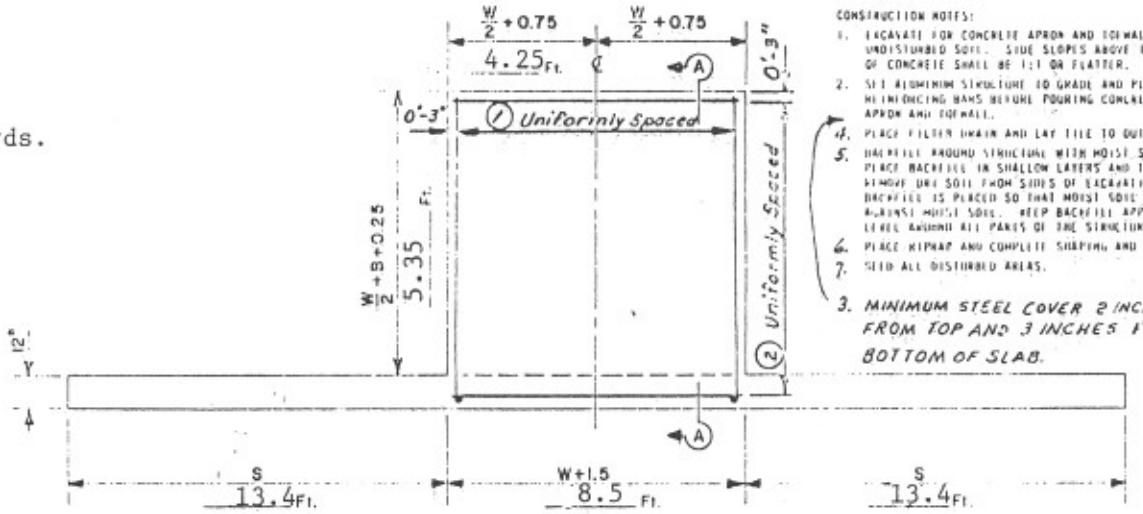
STANDARD STRUCTURE SIZES			
F	1.9'	3.0'	4.0'
H	1.8'	1.9'	2.1'
A	4.2'	5.4	6.6'
S	8.7'	11.3	13.4'

Reference
ENG FIELD MANUAL
Chap. 6

EXHIBIT IN-6-2.3

QUANTITIES

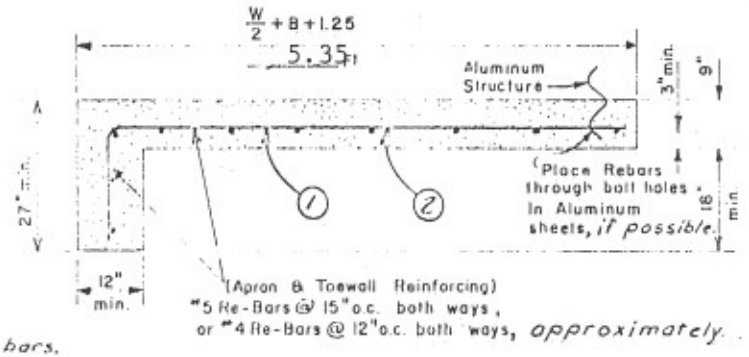
Structure	1 each
Concrete (CT + CA)	4.3 cu yds
Reinforcing Bars #5's (5/8" ø)	186.8 in ft
or #4's (1/2" ø)	233.5 in ft
Filter Drain (0.04 x L)	0.6 cu yds.
Riprap (0.03 x L cu yds.)	0.3 cu. yds.
Site Preparation	1 Job
Excavation and Backfill	1 Job
Drain Tile Outlet	1 each



TOP VIEW – CONCRETE SLAB ONLY

CONSTRUCTION NOTES:

1. EXCAVATE FOR CONCRETE APRON AND TOEWALL IN UNDISTURBED SOIL. SIDE SLOPES ABOVE THE TOP OF CONCRETE SHALL BE 1:1 OR FLATTER.
2. SET ALUMINUM STRUCTURE TO GRADE AND PLACE REINFORCING BARS BEFORE POURING CONCRETE FOR APRON AND TOEWALL.
4. PLACE FILTER DRAIN AND LAY TILE TO OUTLET SLOB.
5. BACKFILL AROUND STRUCTURE WITH MOIST SOIL. PLACE BACKFILL IN SHALLOW LAYERS AND TAMP WELL. REMOVE DRY SOIL FROM SIDES OF EXCAVATIONS AS BACKFILL IS PLACED SO THAT MOIST SOIL IS TAMPED AGAINST MOIST SOIL. KEEP BACKFILL APPROXIMATELY LEVEL AROUND ALL PARTS OF THE STRUCTURE.
6. PLACE RIPRAP AND COMPLETE SHAPING AND GRADING.
7. SEED ALL DISTURBED AREAS.
3. MINIMUM STEEL COVER 2 INCHES FROM TOP AND 3 INCHES FROM BOTTOM OF SLAB.



SECTION A-A

Note Concrete shall have a minimum compressive strength at 28 days equal to 3000 psi. (6 bag mix)

1) If #5 bars are used, use 80% of number required of #4 bars.

2) Round number of bar to nearest whole number.

REINFORCING STEEL SCHEDULE

Mark	Size	Type	Quantity 1)	Length	Total
①		1'-6"	w+2 = 9	W/2 + B + (2-0) = 7'-2"	13'-6"
②			W/2 + B + 1.5 = 20 2)	w + 1'-0" = 8'-0"	160'-0"
			Total 1 in. Ft		233'-6"

Not to Scale

COOPERATOR I. A. Owner
Hometown County SWCD, Indiana

FABRICATED CORRUGATED ALUMINUM TOEWALL DROP SPILLWAY CONCRETE APRON DETAIL

EXAMPLE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	IN-EDU	3-73	Approved by
Drawn	M.N. Seikel	3-73	Title
Adapted	D. Designer	10-73	Scale
Checked	A. Checker	10-73	Drawing No. 2/3

5.0

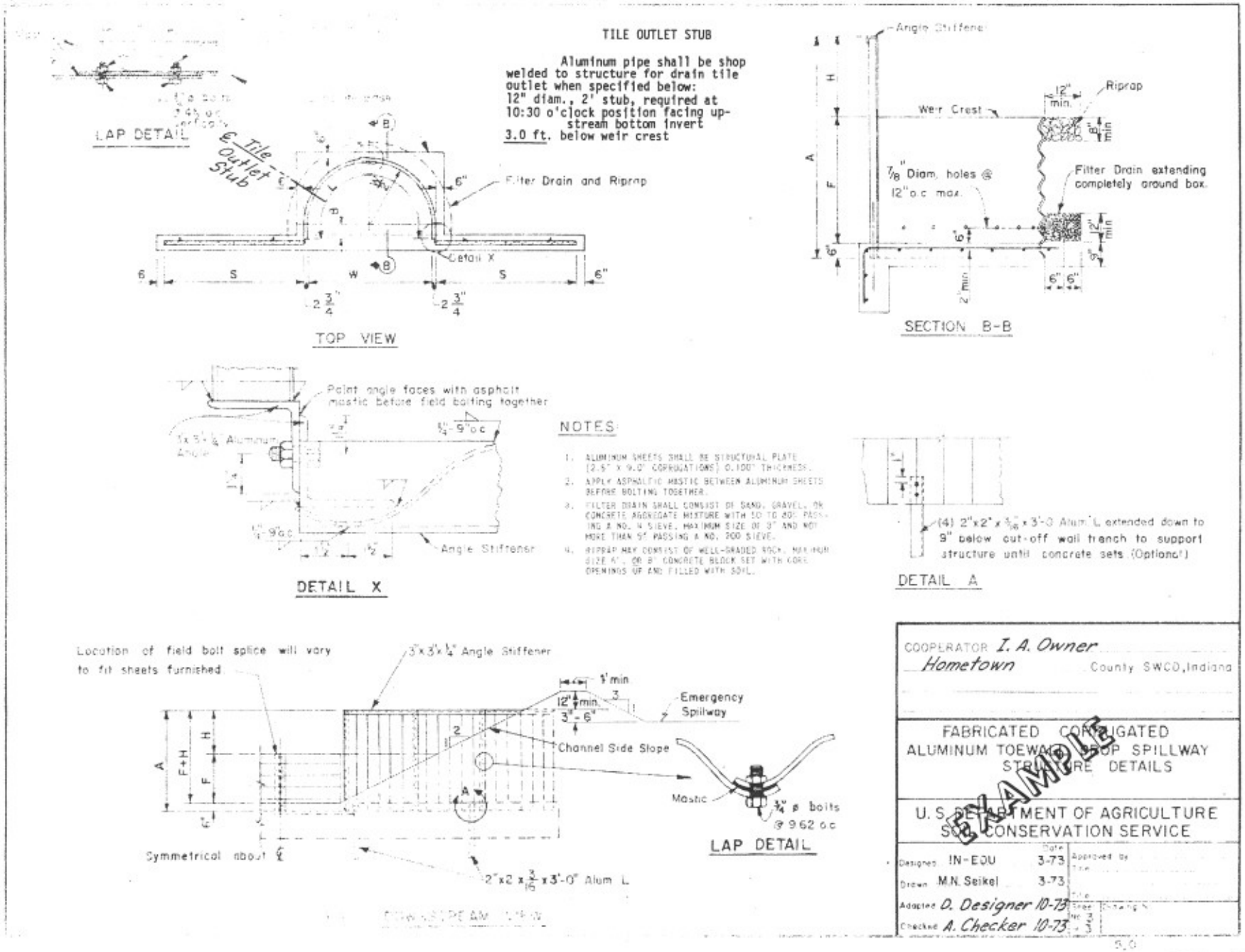

TILE OUTLET STUB
Aluminum pipe shall be shop welded to structure for drain tile outlet when specified below: 12" diam., 2' stub, required at 10:30 o'clock position facing upstream bottom invert 3.0 ft. below weir crest
LAP DETAIL
℄ Tile Outlet Stub
Filter Drain and Riprap
Detail X
TOP VIEW
Angle Stiffener
Weir Crest
Riprap
7/8" Diam. holes @ 12" o.c. max.
Filter Drain extending completely around box.
SECTION B-B
Paint angle faces with asphalt mastic before field bolting together
Angle Stiffener
DETAIL X
NOTES:
1. ALUMINUM SHEETS SHALL BE STRUCTURAL PLATE (2.5" X 9.0" CORRUGATIONS) 0.100" THICKNESS.
2. APPLY ASPHALTIC MASTIC BETWEEN ALUMINUM SHEETS BEFORE BOLTING TOGETHER.
3. FILTER DRAIN SHALL CONSIST OF SAND, GRAVEL, OR CONCRETE AGGREGATE MIXTURE WITH 50 TO 80% PASSING A NO. 4 SIEVE. MAXIMUM SIZE OF 3" AND NOT MORE THAN 5% PASSING A NO. 200 SIEVE.
4. RIPRAP MAY CONSIST OF WELL-GRADED ROCK, MAXIMUM SIZE 4", OR 8" CONCRETE BLOCK SET WITH CORE OPENINGS UP AND FILLED WITH SOIL.
(4) 2"x2"x 3/16 x 3'-0 Alum. L extended down to 9" below cut-off wall trench to support structure until concrete sets. (Optional)
DETAIL A
Location of field bolt splice will vary to fit sheets furnished.
3"x3"x1/4" Angle Stiffener
Emergency Spillway
Channel Side Slope
Mastic
3/4" ø bolts @ 9.62 o.c.
LAP DETAIL
Symmetrical about ℄
2"x2"x 3/16 x 3'-0" Alum. L
COOPERATOR I. A. Owner
Hometown
County SWCD, Indiana
FABRICATED CORRUGATED ALUMINUM TOEWALL DROP SPILLWAY STRUCTURE DETAILS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SAMPLE
Designed IN-EDU 3-73
Drawn M.N. Seikel 3-73
Adapted D. Designer 10-73
Checked A. Checker 10-73

EXHIBIT IN-6-3.1

Sheet 1 of 1

EROSION CONTROL STRUCTURE DESIGN DATA

Cooperator I.A. Owner County Hometown

Address R.R. 1, Hometown Indiana, Zip Code 44444
1 mile west of Hometown on County Road 200 E.

Struc. Location: ¼ ¼ Sec T R Designed By D.D. Date 7-1-81

Watershed: 290 Ac., Slope <1 %, Hydrologic Soil Group D (Ex.2-1), CN 85 (Ex.2-2)

Design Freq. 50 Yrs. (Tech Guide Spec. 410), 24 Hr. Rainfall (P) 5.0 In. (EFM Ex. IN 2-

Q_p = 300 CFS (Table 2-1 & Ex. 2-10 or Form IN-ENG-10), Controlled Drop (F) 2 Ft.

Select structure from EFM, Ch. 6., Q provided ------ CFS.

Additional Information for Structures Attached to Bridges or Culverts

Type: Concrete X, CMP ____ Other ____ Length 30 Ft.

Width ____ Ft. or Diameter (D) 48 In., Height ____ Ft., Area Opening (A) ----- SF.

Culvert-Inlet Control	Culvert-Outlet Control
Entrance Type 1 (Ex. 3-9 & 10)	Head (H) ____ Ft. (Fig. 3-8)
Headwater (HW) 6 Ft. (Fig. 3-7)	Q_c ____ CFS (EX. 3-11 & 12)
HW/D = 1.5, Q_c 110 CFS (Ex. 3-9 & 10)	

Bridge

$r = \frac{A}{P}$ = ____ = ____ (Ex. 3-13), Ditch Slope(s) ____ Ft./Ft., n ____

$Q_c = A \frac{1.486}{n} r^{2/3} s^{1/2}$ = ____ $\frac{(1.486)}{(___)}$ (____)$^{2/3}$ (____)$^{1/2}$ = ____ CFS

If $Q_c < Q_p$ then $Q = 1.25\ Q$

If $Q_c \geq Q_p$ then $Q = 1.0\ Q_c$ except

If $Q_c > 1.5\ Q_p$ then $Q = 1.5\ Q_p$ Max.

$Q = Q_c$ (1.25) = (110) (1.25) = 138 CFS for Bridge Culvert

Head (H) 2.5 Ft. (H limited to 2.5 feet maximum is the difference between the weir crest and the low spot in the road.

Select structure from EFM Ch. 6.

Weir Length (L) 14.2 Ft. (Fig. IN 6-1, EFM), Q provided 158 CFS.

Note: All Exhibits (Ex.) and Tables are from SCS Engineering Field Manual For Conservation Practices.
(EFM Notice IN38, August 1981)

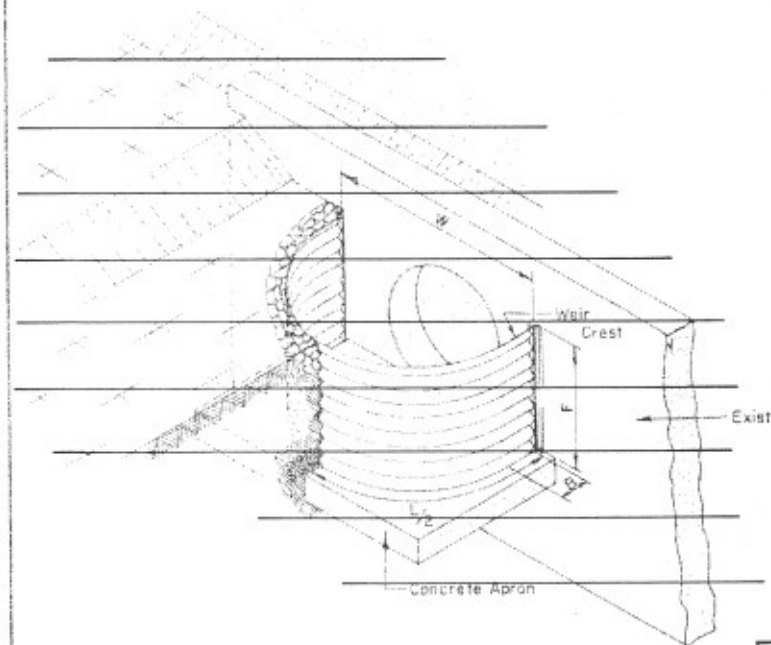
CONSTRUCTION DATA

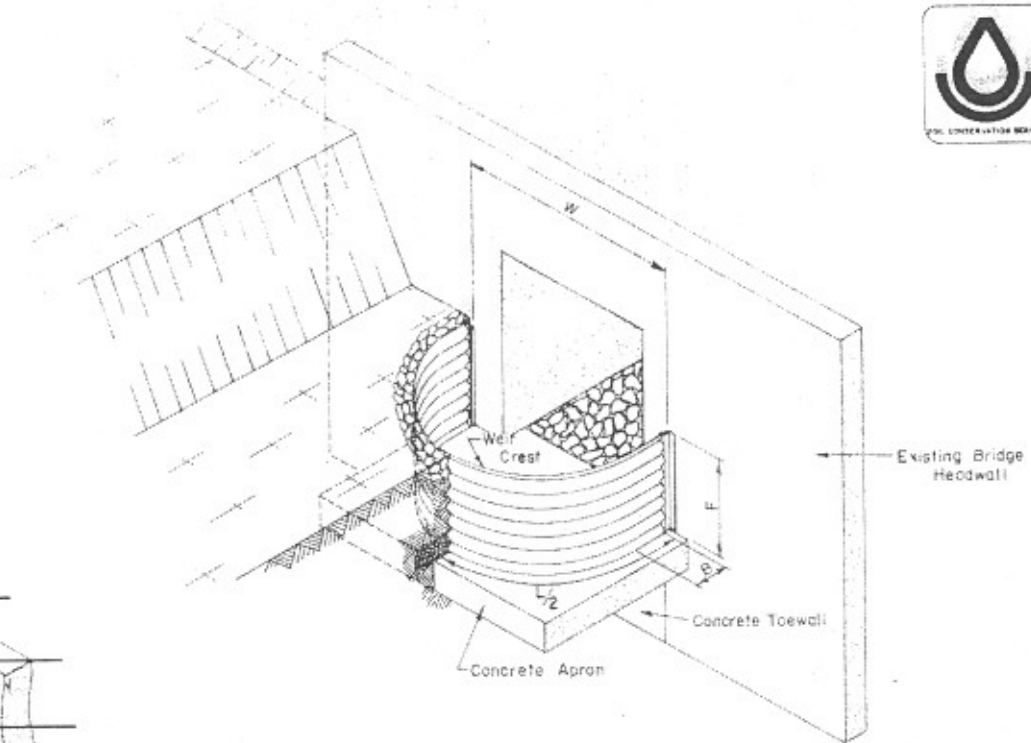
Layout by ..... Date .....

Contractor ..... Completed Date .....

Practice (does/does not) meet standards and specifications

Checked by ..... Date .....





Not to Scale

COOPERATOR I. A. Owner

Hometown County SWCD, Indiana

Location 1 mi. W. of Hometown on county road 200 E.

ELEVATIONS	
Road at Structure ℄	98.6
Low Point in Road	97.4
Weir Crest	93.3
Apron	91.4

STRUCTURE DIMENSIONS	
F	1.9'
W	7.0'
L	14.2'
B	1.6'

FABRICATED CORRUGATED ALUMINUM TOEWALL DROP SPILLWAY ATTACHED TO EXISTING CULVERT GENERAL LAYOUT

EXAMPLE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STANDARD STRUCTURE SIZES			
F	1.9	3.0	4.9

Public Road Official's Approval

Approved by

Signature P.R. Official

Title Pres., County Commissioners

BENCH MARK

Elevation 100.0

Description: 40d spike in W. root of 18" maple 70' N. of culvert ℄, E. road fence.

Designed IN-ENG-U Date 3-73

Drawn R. A. Bishop 4-73

Adapted D. Designer 10-73

Checked A. Checker 10-73

Approved by D. Designer, Title Conservation Technician

I. M. Boss, Title District Conservationist

Sheet No. 1 2

Drawing No.

Reference ENG. FIELD MANUAL Chap. 6

QUANTITIES

Structure ..... 1 each

Concrete ..... 1.3 cu. yds.

Reinforcing Bars #5's (5/8"ø) 74 lin. ft.

or #4's (1/2"ø) 92 lin. ft.

Filter Drain (0.04 x L) ..... 1 cu. yds.

Riprap (0.03 x L cu. yds.) ..... 1 cu. Yds.

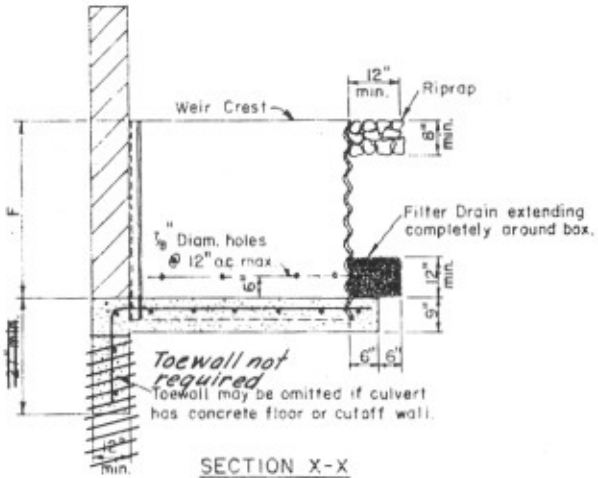
Site Preparation ..... Sum Job

Excavation and Backfill ..... Sum Job

Drain Tile Outlet ..... None each

CONSTRUCTION NOTES

1. EXCAVATE FOR CONCRETE APRON AND TOEWALL IN UNDISTURBED SOIL. ON SLOPE, APPLY THE TOP OF CONCRETE SHALL BE FLUSH OR FLATTER.
2. SET ALUMINUM STRUCTURE IN PLACE, ANCHOR TO EXISTING HEADWALL AND PLACE REINFORCING BARS THROUGH ROTHOLES IN ALUMINUM SHEET BEFORE POURING CONCRETE FOR APRON AND TOEWALL.
3. PLACE FILTER DRAIN AND LAY TILE TO OUTLET STUB.
4. BACKFILL AROUND STRUCTURE WITH MOIST SOIL. PLACE BACKFILL IN SHALLOW LAYERS AND TAMP WELL. REMOVE DRY SOIL FROM SIDES OF EXCAVATIONS AS BACKFILL IS PLACED SO THAT MOIST SOIL IS TAMPED AGAINST MOIST SOIL. KEEP BACKFILL APPROXIMATELY LEVEL AROUND ALL PARTS OF THE STRUCTURE.
5. PLACE RIPRAP AND COMPLETE SHAPING AND GRADING.
6. SEED ALL DISTURBED AREAS.



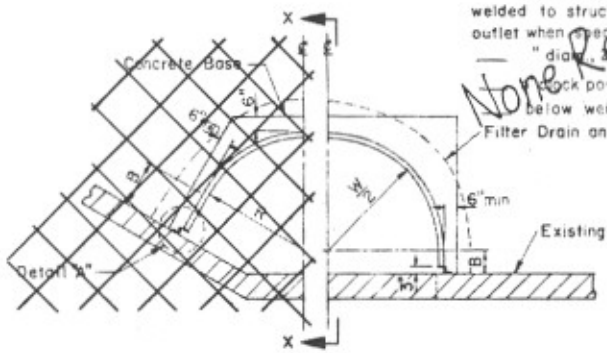
SECTION X-X

TILE OUTLET STUB

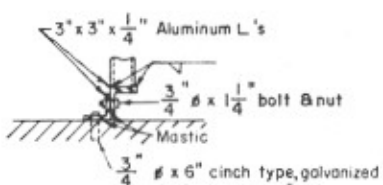
Aluminum pipe shall be shop welded to structure for drain tile outlet when specified below:

— " diam. stub required at clock position. Bottom invert below weir crest.

None Required



TOP VIEW - ALUMINUM STRUCTURE ONLY



DETAIL "A"

Not to Scale

MATERIAL NOTES:

1. ALUMINUM SHEETS SHALL BE STRUCTURAL PLATE (2.5" x 9.0" CORRUGATIONS) 0.100" THICKNESS.
2. APPLY ASPHALTIC MASTIC BETWEEN ALUMINUM SHEETS BEFORE BOLTING TOGETHER.
3. APRON AND TOEWALL REINFORCING SHALL BE #5 RE-BARS @ 15" O.C. BOTH WAYS, OR #4 RE-BARS @ 12" O.C. BOTH WAYS.
4. CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH AT 28 DAYS EQUAL TO 3000 P.S.I. (6-BAG MIX).
5. FILTER DRAIN SHALL CONSIST OF SAND, GRAVEL, OR CONCRETE AGGREGATE MIXTURE WITH 50 TO 80% PASSING A NO. 4 SIEVE, MAXIMUM SIZE OF 3" AND NOT MORE THAN 5% PASSING A NO. 200 SIEVE.
6. RIPRAP MAY CONSIST OF WELL-GRADED ROCK, MAXIMUM SIZE 6", OR 8" CONCRETE BLOCK SET WITH CORE OPENINGS UP AND FILLED WITH SOIL.

COOPERATOR I. A. Owner

Hometown County SWCD, Indiana

FABRICATED CORRUGATED ALUMINUM TOEWALL DROP SPILLWAY ATTACHED TO EXISTING CULVERT STRUCTURE DETAILS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

EXAMPLE

Designed IN-ENG	Date 3-73	Approved by	
Drawn R. A. Bishop	5-73	Title	
Adapted D. Designer	10-73	Time	
Checked A. Checker	10-73	Sheet No. 2 of 2	Drawing No.

(EFM Notice IN38, August 1981)

EXHIBIT IN-6-3.3

DESIGN PROCEDURE FOR PEAK FLOW PIPE

STRUCTURE WITH HOOD, DROP OR FLARED INLET

Steps

1. Determine drainage area from USGS maps, field observations, and/or aerial photos.

2. Determine average watershed slope from soil survey, field observations, and/or USGS maps. For definition of average watershed slope, see EFM, Ch 2, p 2-7.

3. Determine CN from EFM, Ch 2, based on soils, cover etc. as determined by field observations and soil survey. Use Form IN-ENG-10.

4. From survey data, assume tentative elevations of outlet invert, inlet invert and auxiliary spillway and determine controlled drop. With drainage area determine minimum design frequencies from Tech. Guide Spec. 410.

5. Determine rainfalls from EFM, Chapter 2, Exh. IN-2-4, for design frequency.

6. Determine peak discharges in cfs from EFM, Ch 2, Ex 2-10, Drawing Number E.S.-1027. Correction can be made for exact slope by using EFM, Fig. 2.1B "Interpolatiog Factors for Various Slopes and Drainage Areas." Correction can be made for ponding and swampy areas using EFM pages 2-10.1 thru 2-10.4.

7. Assume a pipe size, type of inlet and length of conduit.

8. Determine head on pipe: Difference between auxiliary spillway elevation and the elevation at 0.5D above the outlet invert or the tailwater elevation of the outlet of the pipe, which ever is smaller. (D is diameter of pipe conduit). (Tailwater elevation is the expected elevation of the water in the outlet ditch at the time of peak flow of the pipe.)

9. Determine if the assumed pipe in Step 7 above will carry the required cfs from Step 6 above, from EFM, Ch 3, p 3-94.2,3-94.4, 3-94.6, Ch 6, p 6-41, 6-42, 6-42.1, 6-42.2, 6-50 or 6-51.

10. Determine if a larger pipe is needed or if a smaller pipe can be used. If any changes are made in pipe size, repeat Steps 8 and 9.

11. Determine riser diameter, if a drop inlet is used, from EFM, Ch 6, p 6-43 or Form IN-ENG-27.

12. Determine if stage is sufficient at inlet.
    (a) Drop inlet - EFM, p 6-43
    (b) Hooded inlet - 1.8D minimum
    (c) Flared inlet - 2.0D minimum

    Note: There is no advantage of using a hooded inlet for pipe conduits on slopes less than critical slope or with the outlet submerged.

(EFM Notice IN38, August 1981)

eck for full pipe flow if a drop inlet
ne of the following conditions must be met:

a) Outlet of pipe completely submerged.
b) Riser depth five times the diameter of the barrel.
c) Pipe barrel slope is flatter than critical slope. Exhibit 3-5 EFM can be used to determine friction slope which is same as critical slope. Use correct "n" value.

Determine required capacity of auxiliary spillway. Subtract pipe discharge from the peak discharge for the total capacity frequency.

Determine spillway dimensions. Use EFM Exhibit 11-2. Check layout to be sure spillway water can safely re-enter the channel.

Fill out the sheets for the plan.
(a) Baffle dimension from IN-ENG-27.
(b) Pipe angle and degrees - angle is obtained by computing the slop of barrel in ft./ft. Use this answer in mathematical tables, p. 11, Tab. 2 to find the angle for this slope and add 90 degree

Check all your work for omissions and errors.

(EFM Notice IN38, August 1981)

Example Design

Peak Flow Pipe w/Drop Inlet

Steps

1. Drainage area: 10 - Putnam County

2. Average Watershed slope: 2%; Slope Factor: Flat

3. CN - From page 2-30.1 EFM or See IN-ENG-10 on page 6.138.
   Soils of Watershed: Chalmers - 10 ac with conservation treatment
   CN = 80

4. Survey data plotted and the following elevations determined:

   Outlet Channel elevation - 92.0
   Pipe outlet invert elevation - 93.0
   Pipe inlet invert elevation - 94.0
   Crest of drop inlet - 98.0
   Crest of auxiliary - 99.0

   (a) Controlled drop = 98.0 - 92.0 = 6.0 ft.
   (b) Minimum design frequencies:
   Structural Spillway 10 Yr. - 24 Hr. storm
   Total Capacity 25 Yr. - 24 Hr. storm

5. Rainfall: 4.3 in. 10 Yr. storm
   5.0 in. 25 Yr. storm

6. Peak discharge: 20 cfs. 10 Yr.
   25 cfs. 25 Yr.

7. Assume an 18 in. corrugated metal pipe - 30 ft. long with a pipe drop inlet and tile outlet stub.

8. Head on pipe with free outlet:
   99.0-[93.0 + (1.5 ft. diameter of C.M.P.) x 0.5] =
   99.0 -93.8 = 5.2 feet

9. 18 in. cmp with drop inlet with 5.0 ft. of head 70 ft. long will carry 14.1 cfs from EFM p. 6-42.1. Corrected for a 30 foot length 12.2 x 1.24 17.5 cfs.

10. Pipe is not adequate to provide peak flow of 20 cfs. Try next larger pipe of 21" cmp and go back to step 8.
    8. Head on pipe: 99.0-(93.0 + (1.75)0.5)
    99.0-93.9 = 5.1 ft.
    9. 21 in. with drop inlet with 5.0 ft. of head 70 ft. long will carry 20.4 cfs from EFM p. 6-42.1. Corrected for 30 ft. length and 5.1 ft. of head = 20.4 x 1.21 = 24.7 cfs.
    10. Pipe is adequate.

Steps

11. Riser diameter: 30 in.

12. Stage required at crest of 30 in riser to provide peak discharge of 20 cfs; 0.85 feet - Available 99.0 - 98.0 = 1.0 feet

13. Check for full pipe flow

    (a) Outlet of pipe not submerged - No
    (b) Riser depth is not five times the diameter of barrel - No, but is greater than 2D
    (c) Pipe barrel slope is 94.0 - 93.0 = 1.0 ft.

    From EFM Exhibit 3-5 for "n" = 0.020
    friction slope = 0.06 ft/ft. for 24.7 cfs.
    or 0.06 ft./ft. x 30 ft. = 1.8 ft.
    Pipe will flow full because slope less than critical.

14. Capacity of Auxiliary Spillway:
    25 cfs - 24.7 cfs = 0.3 cfs

15. Dimensions of Auxiliary Spillway:
    Note that required capacity of auxiliary spillway is very minor. Exhibit 11-2 in the EFM can be consulted. However, equipment limitations preclude building a spillway less than six feet which will easily carry the required flow at elevation 99.0.

16. Fill out the Sheets for the plan
    (a) Baffle dimensions 2' - 0' X 4' - 6"
    (b) Slope in pipe $= \frac{1.0 \text{ ft.}}{30 \text{ ft.}} = 0.033$

    Angle with sine value of 0.033 = $1^\circ - 54'$
    $\theta^\circ = (1^\circ - 54') + (90^\circ) = 91^\circ - 54'$

17. Check all your work for omissions and errors

(EFM Notice IN38, August 1981)

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Exhibit IN-6-4.1

IN-ENG-10
Rev. 3/81
File Code 210-11

PEAK RUNOFF COMPUTATION SHEET

Cooperator E.Z. Day - Putnam Co. Project Peak Flow Pipe Structure

By D. Designer Date 1/26/81 Checked by A. Checker Date 1/27/81

HYDROLOGIC CURVE NUMBER (CN)

WATERSHED DESCRIPTION	MAJOR SOIL TYPES (Hydrologic Soil Group (Exhibit 2-1 EFM)) A	B	C (Chal.)	D	ACRES	PRODUCT
Cultivated - without conservation treatment	72	81	88	91		
- with conservation treatment	62	71	(78)	81	10	780
Pasture or range - poor condition	68	79	86	89		
- good condition	39	61	74	80		
Meadow	30	58	71	78		
Woods or Forest - thin stand, poor cover, no mulch	45	66	77	83		
- good cover	25	55	70	77		
Farmsteads	59	74	82	86		
Roads	74	84	90	92		
Other (Specify)						
			TOTALS		10	780

Weighted CN = $\frac{\text{Product Total}}{\text{Total Acres}} = \frac{780}{10} = 78$

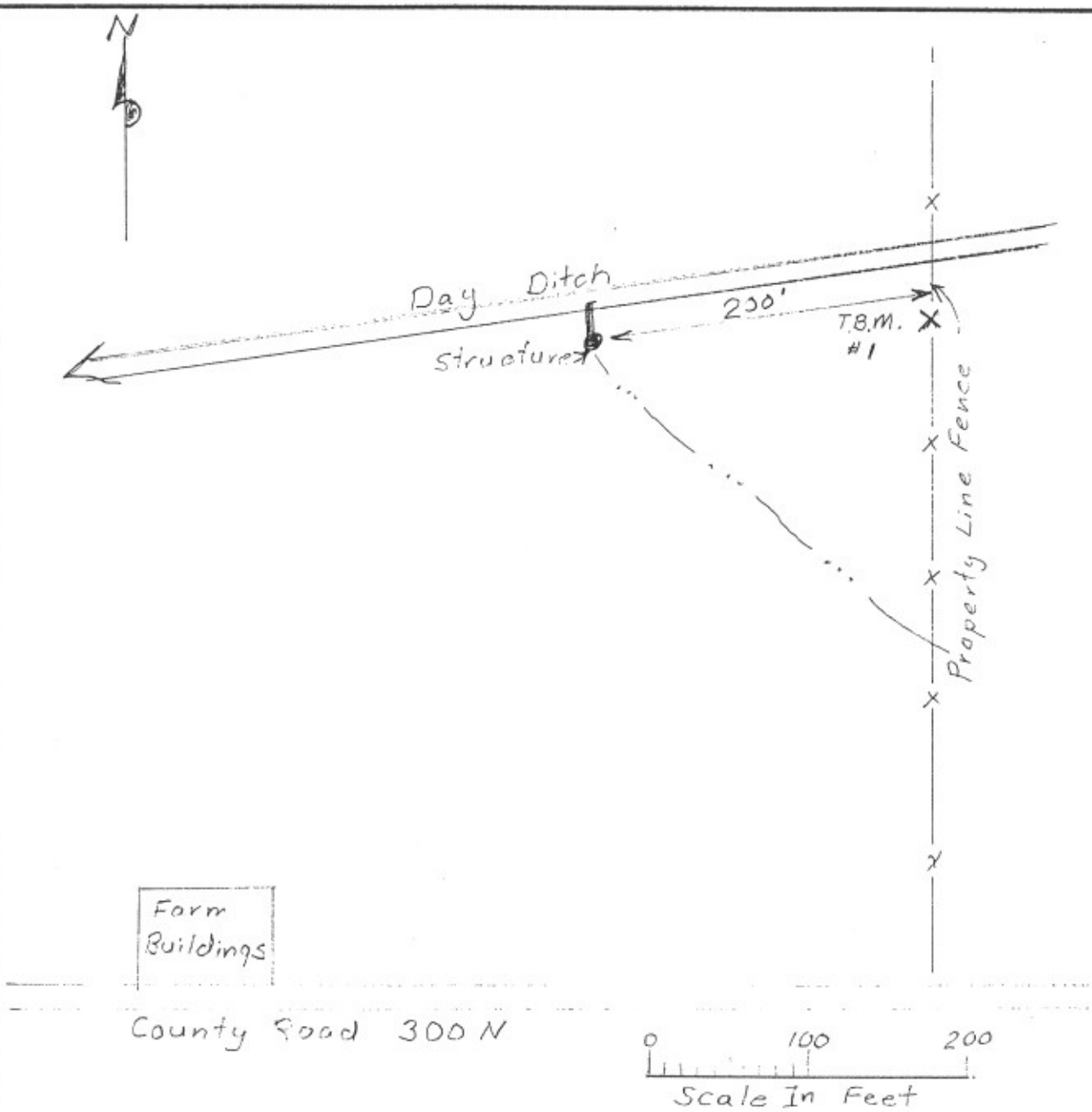
CN Rounded to nearest Exhibit 2-10 Value (65, 70, 75, etc.) = 80
(Do not use less than CN 60 without approval of area engineer)

Average Watershed Slope: 2% (Flat = 0-3%; Moderate = 3-8%; Steep = >8%)

Adjustment Factors: Slope ---- Ponding ----

	Storm 1	Storm 2
From Technical Guide Section IV and EFM (Ex. IN 2-4)		
Design Frequency - Years	10	25
Rainfall - inches	4.3"	5.0"
Storm Duration - hours	24 Hr.	24 Hr.
From EFM, Exhibit 2-10, sheet 5 of 21		
Peak Discharge - cfs	20	25

Sheet 1 of 1

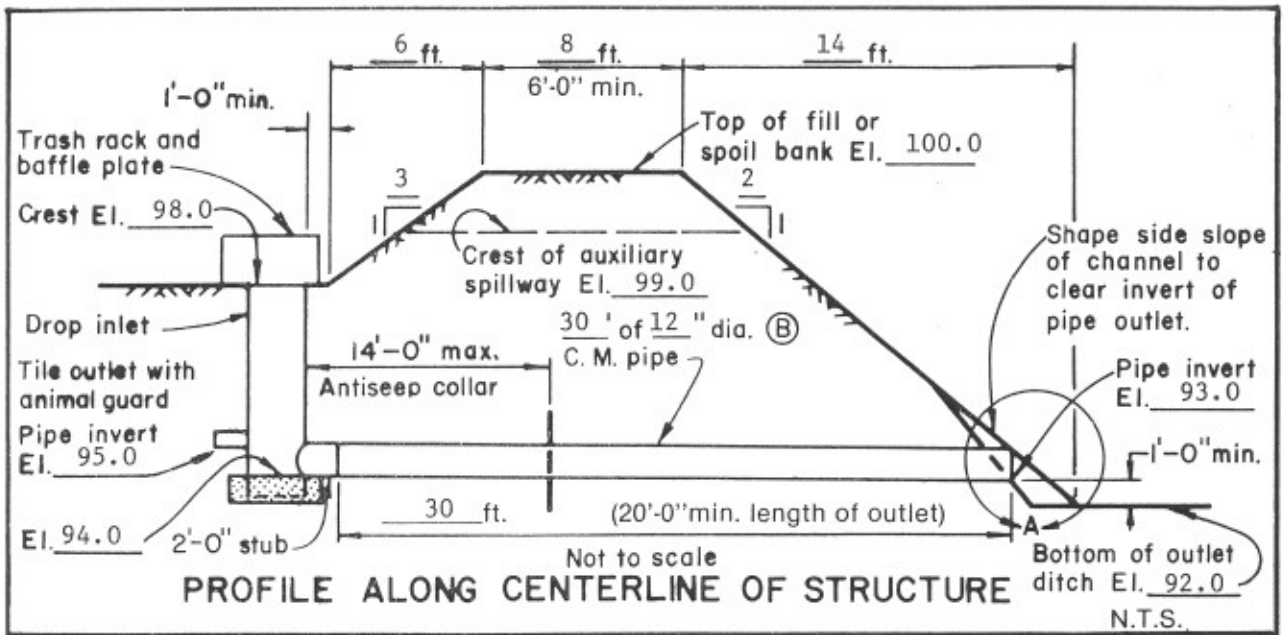


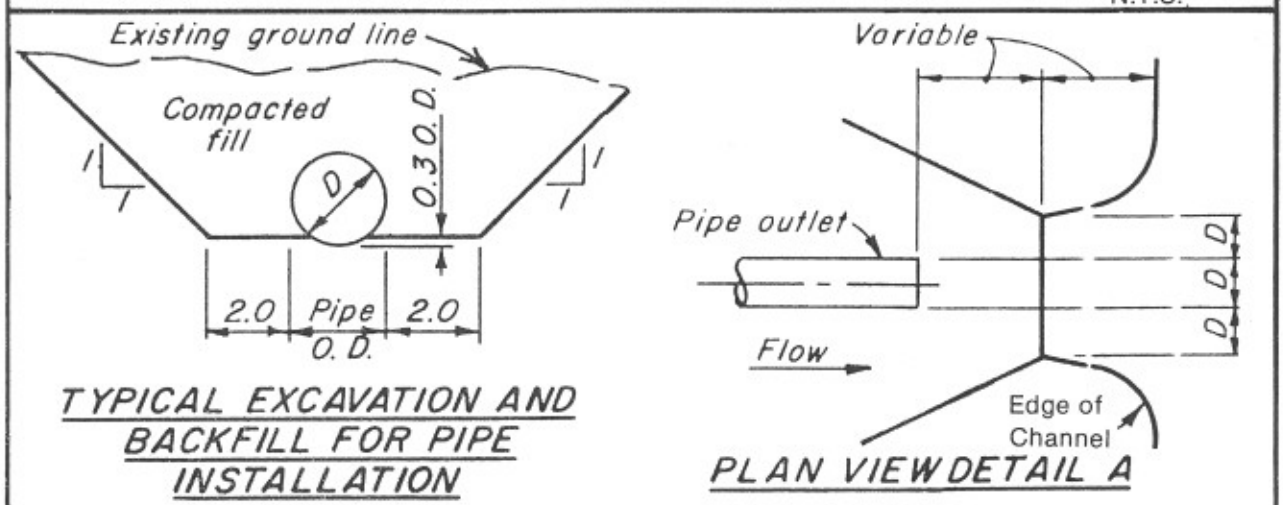
LOCATION MAP

T.B.M. #1 - 16d nail in west side of fence post in property line fence 200' east of structure site Elev. 100.00

PLAN FOR Pipe Drop Structure	
COOPERATOR E. Z. Day SEC. 24 T. 15N R. 3W	
COOPERATING WITH Putnam Co. SWCD	
COUNTY Putnam STATE Indiana	
SURVEYED A. Checker DATE 12/80	
U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE	
Designed D. Designer Date 1/81	Approved by Dan Designer
Drawn D. Designer	Title S.C.T. 1/81
Traced A. Checker 1/81	Title
Checked	Sheet No. 1 of 3 Drawing No.

IN-ENG-42 1 (1) Rev. 6-81





ESTIMATE OF MATERIALS

ITEM	QUANTITY	
Clearing		Acres
Excavation		Cu.yd.
Earth fill	341	Cu.yd.
Pipe 21 inch diameter Ⓑ, C.M. metal thickness 0.06" (~~16 ga.~~)	30	Lin.ft.
Riser 30 inch diameter Ⓐ, C.M. metal thickness 0.06" (16 ga.) Ⓑ	5	Lin.ft.
Tile stub 8 inch diameter	2-0	Lin.ft.
Animal guard	1	Each
Baffle plate	1	Each
Trash rack	--	Each
Antiseep collar	1	Each
Concrete	1.1	Cu.yd.
Seeding and mulching	0.2	Acres
Fencing	--	Lin.ft.

SOIL INVESTIGATION REPORT

LOCATION OF BORINGS	DEPTH FEET	UNIFIED SOIL CLASSIFICATION
0+20 ℄ Fill	0-1	ML
	1-5	CL

CORRUGATED METAL PIPE CONDUIT WITH DROP INLET

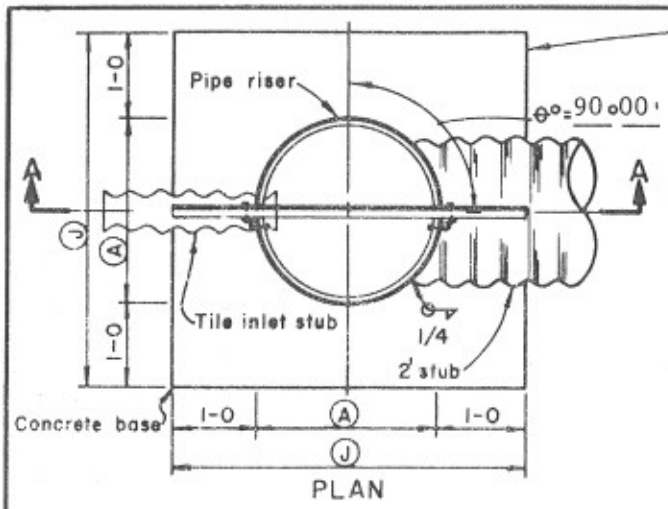
NAME E. Z. Day

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Date
Designed
Drawn
Checked
Reviewed

Approved by
Title
Title
Sheet No. 2 of 3

IN-ENG-27 1(2) Rev. 6-81

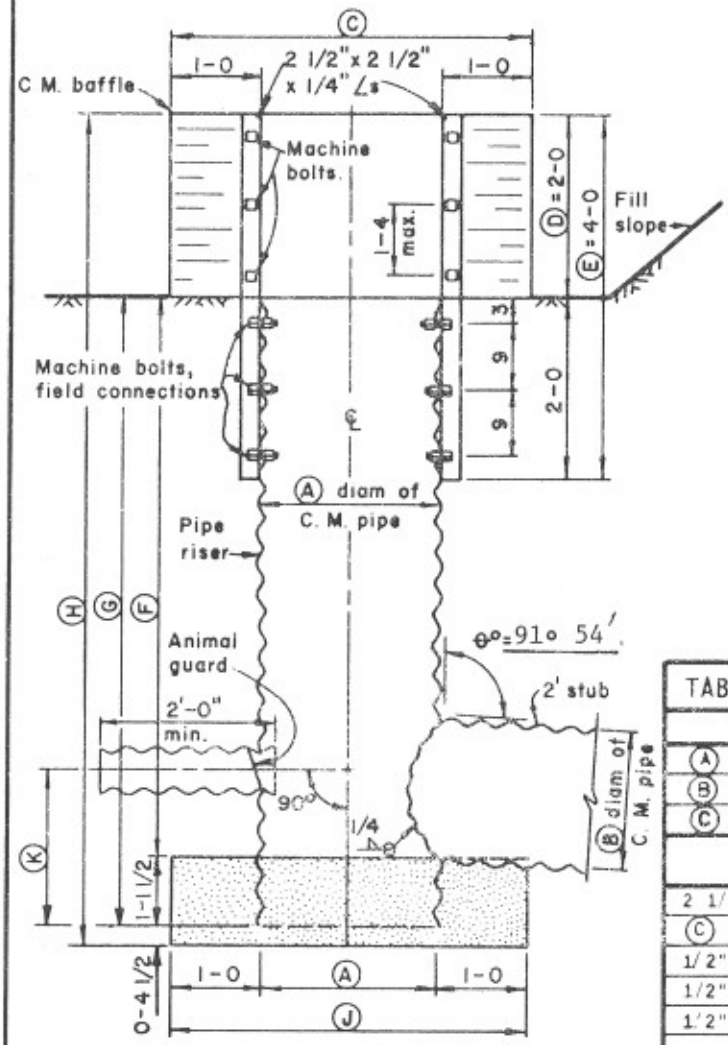


Concrete shall have a minimum compressive strength at 28 days equal to a minimum of 2500 lb./sq. in. (5 bag mix).

TABLE OF QUANTITIES FOR CONCRETE RISER BASE

DIA. OF RISER IN INCHES	18"	21"	24"	30"
CONCRETE, CU.YD.	0.68	0.78	0.89	1.12

INLET PROPORTIONS (MIN.)		ANTIVORTEX BAFFLE
PIPE DIA. CONDUIT (B)	RISER DIA. (A)	LENGTH FEET (C)
8 TO 12	18	3-6
15	21	3-9
18	24	4-0
21 AND 24	30	4-6



SECTION ON CENTERLINE
SECTION A-A

DETAILS OF INLET

NOTES:

1. CORRUGATED METAL PIPE MAY BE MADE OF ALUMINUM OR ZINC-COATED IRON OR STEEL AND MEET FEDERAL SPECIFICATIONS, WW-P-402C OR WW-P-405A AND SHALL BE CLASS I OR II, SHAPE 1. USE 16 GAGE (THICKNESS = 0.06")
2. ALL ACCESSORIES AND FASTENERS SHALL BE OF COMPATIBLE METALS THROUGHOUT STRUCTURE. GALVANIZED OR CADMIUM PLATED BOLTS, NUTS, AND WASHERS MAY BE USED.
3. ALL HOLES FOR BOLTS SHALL BE 1/16" LARGER THAN DIAMETER OF BOLTS.
4. DROP INLET SHALL BE SHOP FABRICATED.
5. ZINC-COATED METALS, AFTER WELDING OR CUTTING, SHALL BE REPAIRED AS FOLLOWS:
   (A) THOROUGHLY CLEAN THE DAMAGED AREAS ON BOTH SIDES OF THE PIPE WITH WIRE BRUSH.
   (B) PAINT THE CLEANED AREAS WITH TWO COATS OF ZINC OXIDE - ZINC DUST PAINT.
   (C) APPLY A HEAVY COAT OF ASPHALT OVER THE PAINTED AREAS.

TABLE SHOWING DIMENSIONS AND MATERIALS

DIMENSIONS			
(A) 21"	(D) 2-0	(G) 5-0	(K) 2-0
(B) 30"	(E) 4-0	(H) 7-0	
(C) 4'-6"	(F) 4-0	(J) 4-6	

MATERIAL ITEMS	QUANTITY REQUIRED
2 1/2" X 2 1/2" X 1/4" ANGLES X (E) 4-0	2
(C) X (D) C.M. SHEET	1
1/2" X 1 1/4" MACHINE BOLTS	12
1/2" STEEL SPLIT LOCKWASHERS	12
1/2" NUTS	12

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GENERAL DATA

Drainage Acres 10 Acres; Runoff Curve No. 80

Ave. W.S. Slope = $\frac{\text{Vertical Drop}}{\text{Length}}$ = 2 % (Flat) Moderate, Steep (Circle One)

PRINCIPAL SPILLWAY

Elevations: Outlet Channel Bottom 92.0; Invert Inlet 94.0; Invert Outlet 93.0
Top Fill 100.0; Emerg. Spillway 99.0; Tailwater None;
Weir (Pipe Drop) 98.0

Controlled Drop 6.0 feet; Design Frequency 10 years(24 hr.); Rainfall 4.3 inches;
Runoff -- inches; Q from ES-1027 20 cfs; Slope correction factor --;
Ponding or Swampy Area adjusting factor --; Design Q 20 cfs;
Pipe Diam. 21 inches; Pipe Length 30 Feet; Riser Diam. 30 inches; n = 0.020

Outlet Control:
Hydraulic head 5.1 ft; Assumed Capacity 24.7 cfs.
One of the following criteria must apply (check one)

Drop Inlet:
- ☐ outlet slope is completely submersed and Z = 2D
- ☒ pipe slope is less than critical slope and Z = 2D
- ☐ Z = 5D

Hooded Inlet:
- ☐ outlet is pipe completely submerged
- ☐ stage at inlet is 1.8D
- ☐ pipe slope is less than critical slope

Flared Inlet:
- ☐ outlet of pipe completely submerged
- ☐ stage at inlet is 2.0D
- ☐ pipe slope is less than critical slope

Inlet Control: Hydraulic head 1.0 ft.; Assumed Capacity 25 cfs.
Prinicipal Spillway Capacity 24.7 cfs (smaller of inlet or outlet control)

DETENTION STORAGE

Volume of Runoff (Vr) 0 Ac.Ft.; Required Volume of Storage (Vs) 0 Ac. Ft.
Available Volume of Storage (Vsa) 0 Ac.Ft.

24 Hr. REMOVAL VOLUME

Principal Capacity ____ x 1.983 x outflow factor ____ = ____ Ac.Ft.
(outflow factor = 0.4 for pipe drop inlets; 0.3 for flared and hooded inlets)

ENERGENCY SPILLWAY

Design frequency 25 yrs(24hr.); Rainfall 5.0 inches; Q from ES-1027 25 cfs;
Slope correction factor --; Ponding or Swampy Area adjusting factor --;
Corrected Total Q = 25 cfs;

Design Q = Total Q 25 — Principal Spillway Q 24.7 = 0.3 cfs;
Max. Velocity = ____ ft/s.; Retardance ____;
Discharge q ____ cfs/ft.; L ____ ft;

Use minimum width of 6-foot bottom width at elevation 99.0.

Bottom Width (b) (Stability) = $\frac{\text{Design Q}}{\text{Discharge q}}$ = ____ ft.

Hp ____ ft; Bottom Width b (used) ____ ft;

Discharge q (used) = $\frac{\text{Design Q}}{\text{B}}$ = 6 cfs/ft;

Hp (used) ____ ft; Min. Slope ____ %
Max. Slope ____ %;
Exit Slope (Actual) ____ %
Freeboard ____ ft.

PIPE STRUCTURE DATA

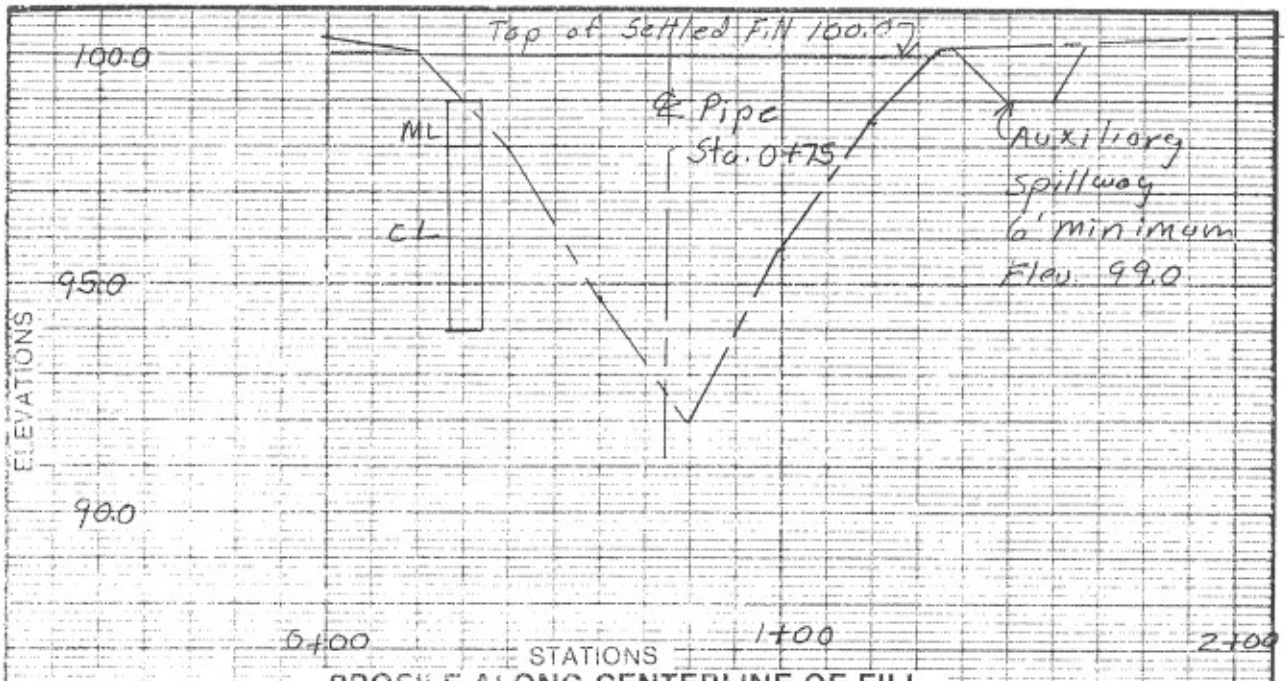
NAME E. Z. Day

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date		
Designed		Approved by	
Drawn		Title	
Checked		Title	
Reviewed		Sheet No. 3 Of. 3	Drawing No.

(EFM Notice IN38, August 1981)

IN-ENG-28 1(2) Rev. 6-81



PROFILE ALONG CENTERLINE OF FILL
(Show soil borings)

EARTHWORK COMPUTATIONS

Station	Elevation	Fill height ft.	Cu.yd. per ft.	Average fill cu.yd.	Distance ft.	Fill cu.yd.
0+20	100.0	0	0			
				0.5	20	10
0+40	98.0	2.0	1.0			
				2.6	20	52
0+60	94.7	5.3	4.2			
				6.3	20	126
0+80	92.0	8.0	8.3			
				5.6	20	112
1+00	95.7	4.3	3.0			
				1.8	20	36
1+20	98.5	1.5	0.7			
				0.4	12	5
1+32	100.0	0	0			
Total Cubic Yards						341

Total cubic yards

CONSTRUCTION CHECK

Top of fill el. 101.0
Auxiliary spillway el. 99.2
Crest of drop inlet el. 98.1
Invert inlet el. 94.2
Invert outlet el. 93.2

I certify that this job meets all the requirements of Indiana Standards and Specifications for Structures (Code 410 or 587) and the plans as designed.

Checked by Dan Designer
Date 2-20-80

IN-ENG-28 2(2) Rev. 6-81

DESIGN PROCEDURE FOR DRAINAGE APPURTENANCES WITH HOODED, DROP OR FLARED INLET WITH OR WITHOUT STORAGE

1. Determine drainage area from USGS maps, field observations and/or aerial photos.
2. Determine average watershed slope from field survey or USGS maps (Total vertical fall ÷ by total length of Watershed). For definition of average watershed slope, see EFM, Chapter 2, p. 2-7
3. Assume structure type and elevations using plotted survey data.
4. Determine Controlled drop
5. Determine design requirements from Technical Guide Section IV, Standard and Specification 410, Grade Stabilization Structure.
6. Determine runoff in inches and cfs using Chapter 2 of the EFM or Chapter 14 of the EFM if "B" curve runoff is used for design. IN-ENG-10 may be used to record this information.
7. Determine available hydraulic head for outlet control using assumed elevations in step 3.
8. Assume a pipe size, type of inlet, and determine pipe length required.
9. Determine pipe capacity using charts on pages 3-94.2, 3-94.4, 3-94.6, 6-41, 6-42,6-42.1, 6-42.2, 6-50 or 6-51 of EFM.
10. Check to determine that pipe is in full flow condition by meeting one of the following criteria:

    Drop Inlet

    a. outlet of pipe is completely submerged and Z = 2D as shown on page 6-43 of EFM.

    b. pipe slope is less than critical slope (see exhibit 3-5 on page 3-81 of EFM) and Z = 2D as shown on page 6-43 of EFM

    c. Z = 5D as shown on page 6-43 of EFM.

Hooded Inlet

a. outlet of pipe completely submerged

b. stage at inlet is 1.8D

c. pipe slope is less than critical slope (see exhibit 3-5 on page 3-81 of EFM)

Flared Inlet

a. outlet of pipe completely submerged

b. stage at inlet is 2.0D

c. pipe slope less than critical slope (see exhibit 3-5 on page 3-81 of EFM)

If above criteria is not met, then inlet conditions will determine pipe capacity and step 9 is invalid. Step 12 will determine structure capacity.

11. Determine hydraulic head for inlet control conditions (see pages 3-94.1 and 6-43 of EFM for details).

12. Determine capacity of assumed pipe size in step 8 using inlet control condition from step 11. Use charts on pages 6-43, 3-94.1, 3-94.3 and 3-94.5 of EFM.

13. Determine capacity of assumed structure in step 8 by comparing capacities from step 9 (if valid) and step 12. The smaller capacity will be the capacity of the structure unless step is invalid and then step 12 capacity is capacity of pipe.

14. If storage is available, proceed to step 15. If storage is not available then determine if capacity found in step 13 is too small or too and adjust pipe size accordingly, repeat steps 8 thru 14 and then proceed to step 17.

15. Determine required volume of storage using exhibit 11-4, table A or B on pages 11-55b and 11-55c respectively, by using pipe release rate per acre (divide step 13 by step 1 = cfs/ac), and runoff in

watershed inches, step 6.

16. Determine available volume of storage from field surveys if (1) available and (2) "B" curve is not used for design. If available storage is less than that determined in step 15, assume a larger pipe and repeat steps 9 thru 16. If available storage is much more than that determined in step 15, assume a smaller pipe and repeat steps 9 thru 16.

17. If a larger amount of storage is used, check to determine if structure will remove in 24 hours the Ac. Ft. stored in step 14. Multiply the structure Q from step 13 x 1.983 x average outflow factor to obtain Ac. Ft. removed. If crop can tolerate 48 hours of standing water, then use a value of 3.966 instead of 1.983. The average outflow factor for a pipe drop structure is 0.4 and for a flared inlet or hooded inlet is 0.3. If structure will not remove storage from step 15 in 24 to 48 hours, then return to step 8 and assume a larger size pipe and repeat steps 9 thru 17.

18. If an emergency spillway is required as per step 5, and the existing ditch bank is not used on an emergency then design emergency spillway according to Chapter 11 of EFM. If ditch bank is used an emergency spillway, place 1.0' of additional fill on ditch bank for 25' either side of structure centerline. To <u>determine auxiliary spillway capacity</u> proceed as follows:

    a. repeat step 6 for required capacity as determined in step 5

    b. subtract pipe discharge from the peak discharge step 6 from the total capacity step 18a.

    c. Design emergency spillway using Chapter 11 of EFM for the amount determined in step 18b.

19. Fill out standard data sheets to complete construction plan.

20. Check all your work and have someone else check your work if possible.

(EFM Notice IN38, August 1981)

EXAMPLE DESIGN - DRAINAGE APPURTENANCE WITH DROP INLET

1. Drainage area: 42 acres, Jasper County

2. Average watershed slope $= \frac{22'}{1850'} = 1.2\%$

3. Assumed elevations from plotted survey data:

   Outlet channel bottom = 91.8

   Structure inlet = 96.0

   Auxiliary Spillway = 98.0 (low spoil bank)

   Invert Inlet to barrel = 93.0

   Invert outlet of barrel = 92.8

4. Controlled drop = 96.0 - 91.8 = 4.2'

5. Required principal spillway design frequency = 5 yr. (24 hr.)

   Required emergency spillway design frequency = 10 yr. (24 hr.)

6. CN = 80 (page 2-30.1 EFM)

   5 year (24 hr.) rainfall = 3.6" (page 2-95 EFM)

   Runoff = 1.72" (page 2-50.8 EFM)

   Q_5 = 38 cfs (page 2-59 EFM)

   Ponding correction factor = 0.94 (page 2-10.3 EFM)

   Watershed slope correction factor = 1.03 (figure 2.1B EFM)

   Q_5 design = 38 x 1.03 x 0.94 = 36.8 cfs

7. Available head $= \frac{98.0 - 91.8}{2} =$ 3.1 ft. outlet control

8. Assume 21" CMP x 40 feet long with 30" riser

9. CFS provided: outlet control = 15.8 x 1.21 = 19.1 cfs (page 6-42.1 EFM)

10. Outlet of structure is submerged but Z does not = 2D; therefore, use riser size needed for next size pipe = 30" (riser for 24" pipe).

    Critical slope = 0.035 ft/ft (page 3-81 EFM) and actual pipe slope $= \frac{0.2'}{40'}$ 0.005 ft/ft. Pipe will flow full because actual pipe slope less than critical or friction slope.

(EFM Notice IN38, August 1981)

11. Hydraulic head at inlet on:

weir = 98.0 - 96.0 = 2.0' (weir flow)

barrel = (98.0 - 93.0) - 1.75 = 3.25' over top of pipe.

12. Capacity of weir = 56 cfs plus (page 6-43 of EFM) O.K.

Capacity of barrel = 21.5 cfs (page 3-94.1 of EFM) O.K.

13. Outlet control Q = 19.1 cfs, from step 9, inlet control Q = 21.5 cfs from step 12. Structure capacity = 19.1 cfs.

14. Storage is available.

15. Pipe release rate per acre $= \frac{19.1 \text{ (from step 13)}}{42 \text{ Ac}} = 0.45$ cfs/acre

use Exhibit 11-4 Table B page 11-55c EFM, using Vr = 1.72 inches (step 6)

Required storage (Vs) = 0.50 inches/Ac

$$= \frac{0.50 \times 42 \text{ Ac}}{12''/\text{ft}} = 1.75 \text{ Ac. Ft.}$$

16. Available storage = 2.1 Ac. Ft. from field surveys. Storage is adequate.

17. 19.1 cfs (peak flow) x 0.4 (average flow factor) x 1.983 = 15.1 Ac. Ft. > 1.75 Ac. Ft. from step 15.

18. Ditch Banks will be used as emergency spillway (steps 18a through 18c are completed here for example procedural purposes only).

a. CN = 80

10 yr (24 hr.) rainfall = 4.1"

Runoff = 2.12"

Q_{10} = 48 cfs x 0.94 x 1.03 = 46.4 cfs

b. Design Q of auxiliary spillway = 46.4 cfs - 36.8 cfs = 9.6 cfs

c. Channel bank is fairly level and will be used as emergency spillway. Add 1.0 foot of fill over structure to elevation 99.0 for 25' either side of C_L of structure.

19. Angle ° between riser and barrel = arc sine of the pipe slope in ft/ft + 90° .

Pipe slope $= \frac{92.9 - 92.7}{40' \text{ length}} =$ 0.005 ft/ft

sine 0.005 = 0° - 17' (from math tables)

0° = 0° - 17' + 90° = 90°-17'