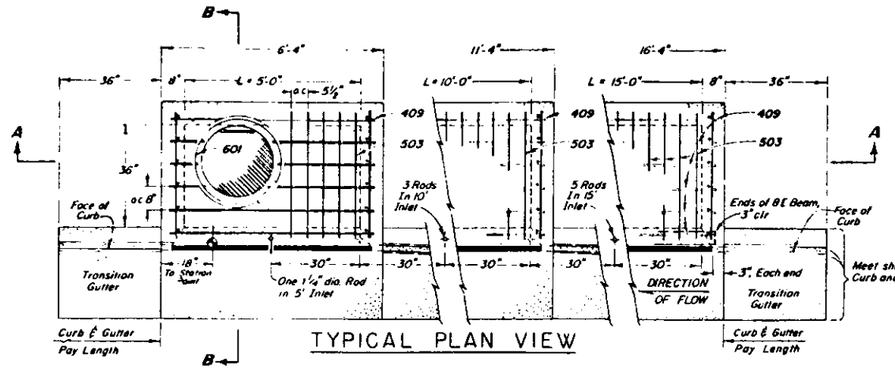
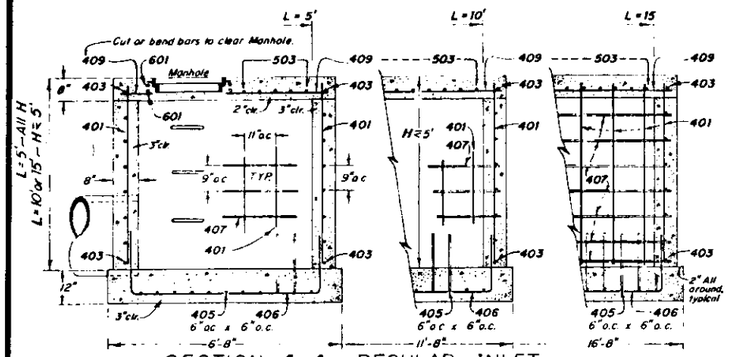
LIST OF STANDARD DETAILS

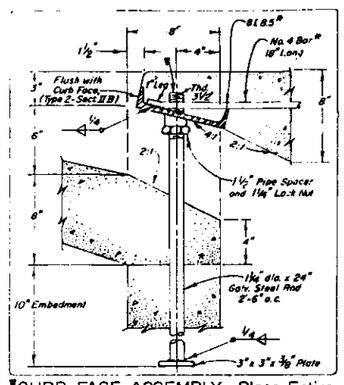
SD-1	CURB INLET TYPE R
SD-2	GRATED INLET TYPE C
SD-3	GRATED INLET TYPE 13
SD-4	COMBINATION INLET TYPE 13
SD-5	PIPE INSTALLATION IN TRENCH
SD-6	STORM SEWER MANHOLE
SD-7	HAEDWALLS FOR PIPE CULVERTS
SD-8	WINGWALLS
SD-9	CONCRETE OR METAL END SECTIONS
SD-10	LOW WATER CROSSING



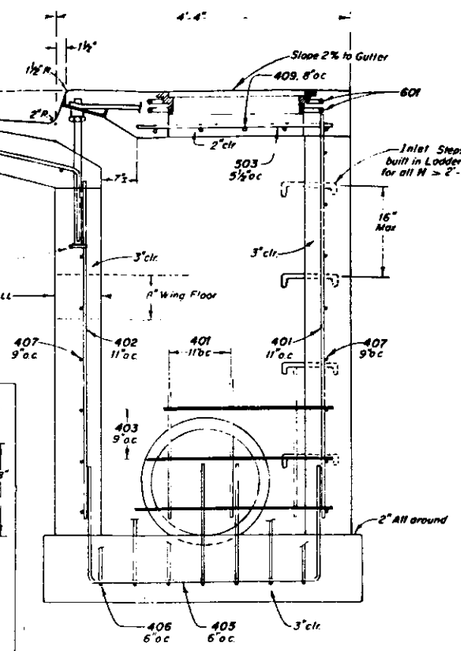
TYPICAL PLAN VIEW



SECTION A-A REGULAR INLET



▼CURB FACE ASSEMBLY, Place Entire Assembly Before Pouring Concrete.



SECTION B-B
TYPICAL END VIEW

GENERAL NOTES

All work shall be done in accordance with the Standard Specifications applicable to the project.

All concrete shall be Class A.

Concrete walls shall be formed on both sides and shall be 8" thick.

Inlet Steps shall be as shall be as shown on the applicable Division "M" Standard.

Curb Face Assembly shall be galvanized after welding.

Exposed concrete corners shall be beveled to a 1½" face. Curb and Gutter corners shall be finished to match the existing curb and gutter beyond the Transition Gutter.

All reinforcing bars shall be tagged with bar designation and station number.

Reinforcing bars shall be deformed and shall be of intermediate grade steel.

Dimensions and weights of Typical Manhole Ring and Cover are nominal.

All bars shall be a minimum 2" clear.

Since pipe entries into the inlet are variable, the dimensions shown are typical. Actual dimensions and quantities for concrete and reinforcement shall be as required in the work. Quantities include volumes occupied by pipes.

Structural Steel shall be galvanized and shall conform to the requirements of Section 509.

TABLE ONE – BAR LIST FOR CURB INLETS, TYPE R

MARK	DIA in.	c.c. Spacing	TYPE	ALL INLETS L = 5' No. Req'd	ALL INLETS L = 5' Length	INLETS, H ≥ 5' L = 10' No. Req'd.	INLETS, H ≥ 5' L = 10' Length	INLETS, H ≥ 5' L = 15' No. Req'd.	INLETS, H ≥ 5' L = 15' Length	INLETS, H > 5' L = 10' No. Req'd	INLETS, H > 5' L = 10' Length	INLETS, H > 5' L = 15 No. Req'd.	INLETS, H > 5' L = 15 Length
401		11"	II	15	*	21	*	26	*	11	*	11	*
402		11"	II	7	*	13	*	18	*	7	*	7	*
403		9"	II	*	4'-0"	*	4'-0"	*	4'-0"	*	4'-0"	*	4'-0"
405		6"	VI	11	6'-10"	21	6'-10"	31	6'-10"	11	6'-10"	11	6'-10
406		6"	VIII	7	8'-10"	7	13'-10"	7	18'-10"	7	8'-10"	7	8'-10"
407	½"	9"	II	*	5'-10"	*	10'-10	*	15'-10"	*	5'-10"	*	5'-10"
408		12"	II	3	6'-0"	3	11'-0"	3	16'-0"	3	11'-0"	3	16'-0"
409		8"	II	6	5'-10"	6	10'-10"	6	15'-10"	6	10'-10"	6	15'-10"
410		11"	VII							3	*	3	*
411		11"	II							3	5'-2"	3	10'-2"
412		11"	II							3	2'-9"	3	2'-9"
413		9	II							7	10'10"	7	15'-10"
501		5½"	IV	11	3'-4"	22	3'-4"	33	3'-4"	22	3'-4"	33	3'-4"
502	⅜"	5½"	III							11	11'-5"	22	11'-5"
503		5½"	II	5	3'-6"	16	3'-6	27	3'-6"	6	3'-6"	6	3'-6"
601	⅝"	2½"	V	2	8'-10"	2	8'-10"	2	8'-10"	2	8'-10"	2	8'-10"
#BE 8.5	—	——	—	1	5'-10	1	10'-10"	1	15'-10"	1	10'-10"	1	15'-10"
▼				2 Bars, 1 Rod	——	4 Bars, 3 Rods	——	6 Bars, 5 Rods	——	4 Bars, 3 Rods	——	6 Bars, 5 Rods	——

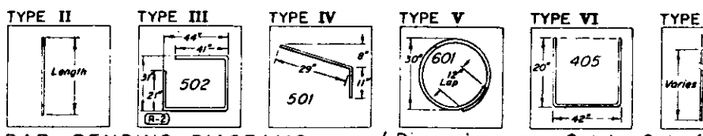
* Variable, refer to Table TWO.
# Include 18" No. 4 Bars (See Channel Layout Detail).
▼ See Curb Face Assembly on Sheet 1 and Channel Layout Details on this sheet.

REGULAR INLETS — DROP BOX INLETS

TABLE TWO – BARS AND QUANTITIES VARIABLE WITH H

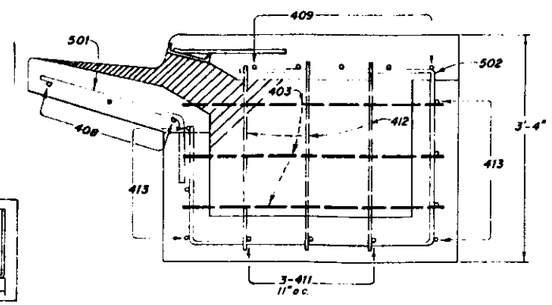
H	Length 401	Length 402	Length 410	No. Req'd Regular 403	No. Req'd Regular 407	No. Req'd Drop Box 403	No. Req'd Drop Box 407	L = 5' Cu.Yd Conc.	L = 5' Lb. Steel	L = 10' Cu.Yd Conc.	L = 10' Lb. Steel	L = 15' Cu.Yd Conc.	L = 15' Lb.Steel
5'-0"	2'-9"	1'-8"		10	7			3.2	285	5.3	497	7.4	706
5'-6"	3'-2"	2'-2"		10	7			3.4	305	5.7	528	7.9	747
4'-0"	3'-8"	2'-8"		12	9			3.7	326	6.0	559	8.4	786
4'-6"	4'-2"	3'-2"		12	9			3.9	334	6.4	571	8.8	803
5'-0"	4'-8"	3'-8"		14	11			4.1	354	6.7	602	9.3	844
5'-6"	5'-2"	4'-2"	3'-5"	16	13	15	6	4.4	375	6.0	607	7.5	840
6'-0"	5'-8"	4'-8"	3'-11"	16	13	16	6	4.6	382	6.2	616	7.7	850
6'-6"	6'-2"	5'-2"	4'-5"	18	15	18	8	4.8	402	6.4	637	7.9	870
7'-0"	6'-8"	5'-8"	4'-11"	20	17	19	10	5.0	423	6.6	654	8.1	887
7'-6"	7'-2"	6'-2"	5'-5"	20	17	20	10	5.3	430	6.9	664	8.4	897
8'-0"	7'-8"	6'-8"	5'-11"	22	19	22	12	5.5	451	7.1	684	8.6	917
8'-6"	8'-2"	7'-2"	6'-5"	24	21	23	14	5.7	471	7.3	702	8.8	934
9'-0"	8'-8"	7'-8"	6'-11"	24	21	24	14	6.0	479	7.6	711	9.1	944
9'-6"	9'-2"	8'-2"	7'-5"	26	23	26	16	6.2	499	7.8	732	9.3	964
10'-0"	9'-8"	8'-8"	7'-11"	28	25	27	18	6.4	520	8.0	749	9.5	982
10'-6"	10'-2"	9'-2"	8'-5"	28	25	28	18	6.7	527	8.3	759	9.8	991
11'-0"	10'-8"	9'-8"	8'-11"	30	27	30	20	6.9	547	8.5	779	10.0	1012

NOTE: For L=5', L=10 and L=15'.
REGULAR INLETS: Total quantities needed are OUTSIDE of the heavy black line.
DROP BOX INLETS: Total quantities needed are INSIDE of the heavy black line.
STEEL WEIGHTS DO NOT INCLUDE STRUCTURAL STEEL.



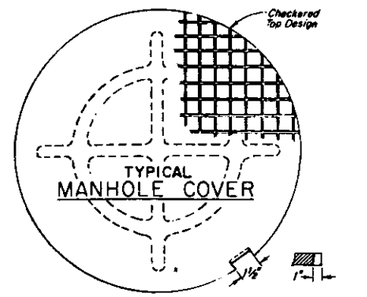
SECTION A-A INLET WITH DROP BOX – H>5'

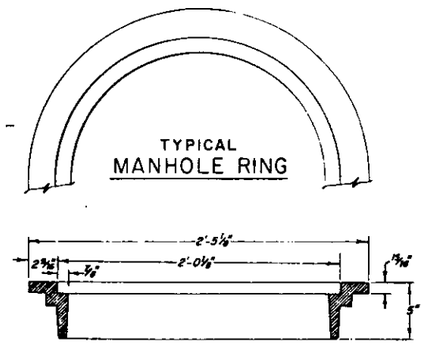
BAR BENDING DIAGRAMS – (Dimensions are Out-to-Out of Bar)



(Dotted Bars are in Section d-d)

SECTIONS C-C & d-d



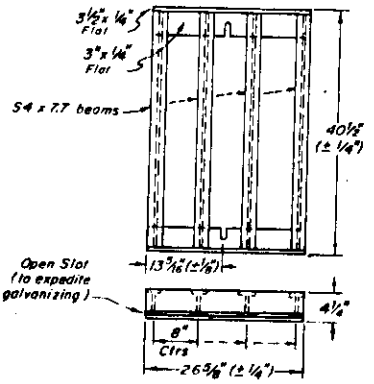


Approximate Weights:
Cover = 125 lbs.
Ring = 135 lbs.
TOTAL = 260 lbs.

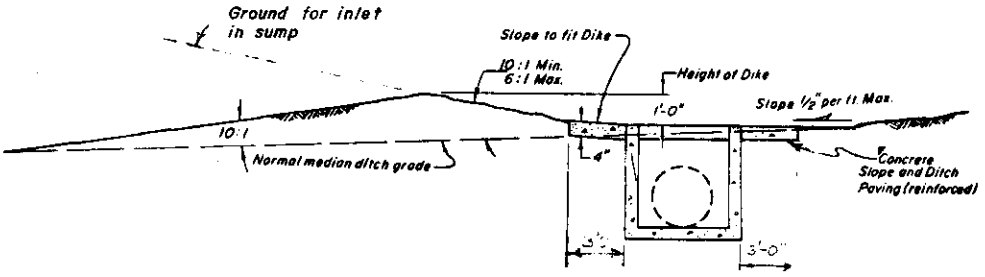
WRC, ENG.	REFERENCE: Colorado Department of Highways Standard M-604-R	BOULDER COUNTY STORM DRAINAGE CRITERIA MANUAL	CURB INLET TYPE R STANDARD DETAIL SD-1

B

GRATED INLET TYPE C

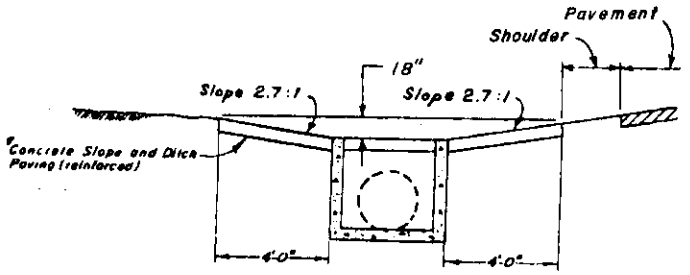


DETAIL OF GRATING

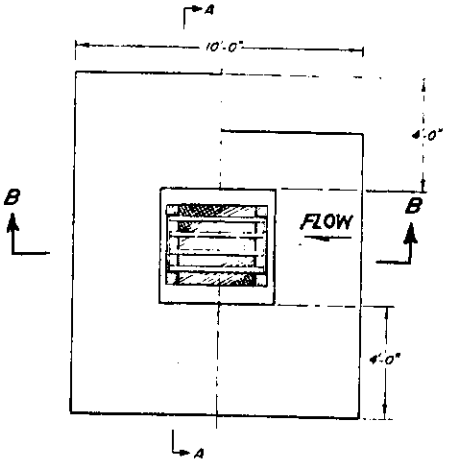


SECTION B – B

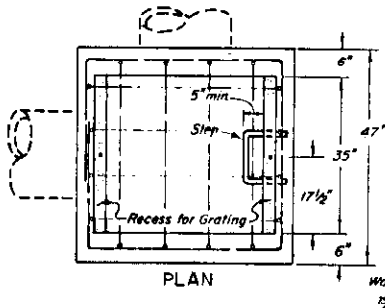
INLET FOR USE IN DITCH ON GRADE
(FLOW FROM ONE DIRECTION)



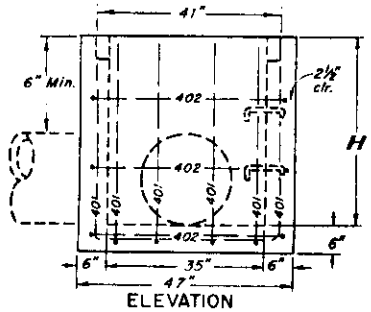
SECTION A – A



LAYOUT OF INLET IN ROADSIDE DITCH

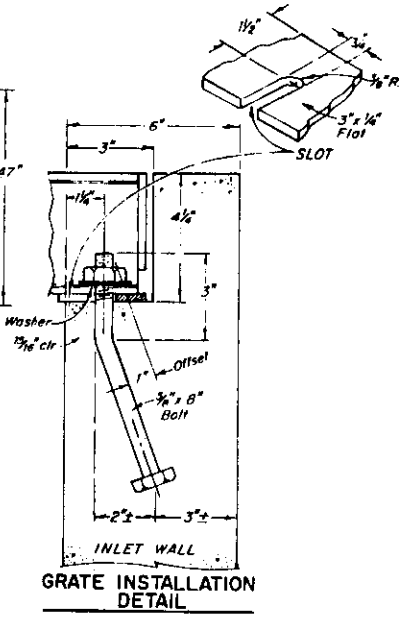


PLAN



ELEVATION

CONCRETE INLET



GRATE INSTALLATION DETAIL

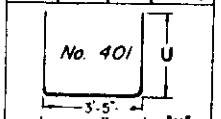
QUANTITIES FOR ONE INLET

H	CONCRETE *(CU. YDS.)	REINF. STEEL (LBS.)	NO. STEPS REQ'D.
2'-6"	0.9	75	0
3'-0"	1.0	80	0
3'-6"	1.2	96	0
4'-0"	1.3	101	1
4'-6"	1.4	116	2
5'-0"	1.5	122	2
5'-6"	1.7	137	2
6'-0"	1.8	142	3
6'-6"	1.9	158	3
7'-0"	2.0	163	3
7'-6"	2.2	179	4
8'-0"	2.3	184	4
8'-6"	2.4	199	4
9'-0"	2.5	205	5
9'-6"	2.7	220	5
10'-6"	3.0	235	6
11'-6"	3.4	251	6

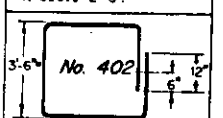
* Note: Includes Volume occupied by pipes.

BAR LIST FOR H=2'-6" AND BENDING DIAGRAM

MARK	NO. REQ'D	HGT. "U"	LENGTH
401	2	2'-3"	7'-11"
401	6	2'-7"	8'-7"
402	3		18'-0"



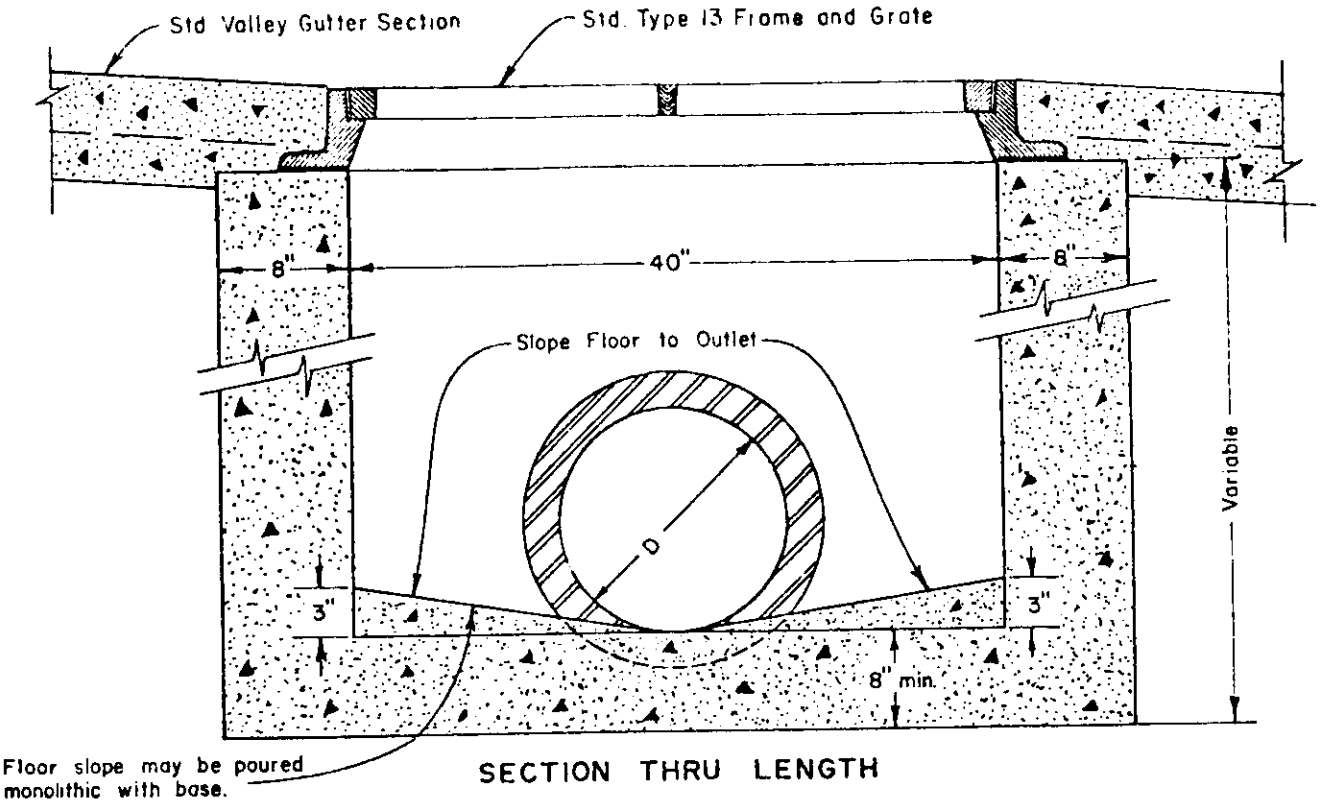
Increase dimension "U" 6" for each 6" increase of H above 2'-6".



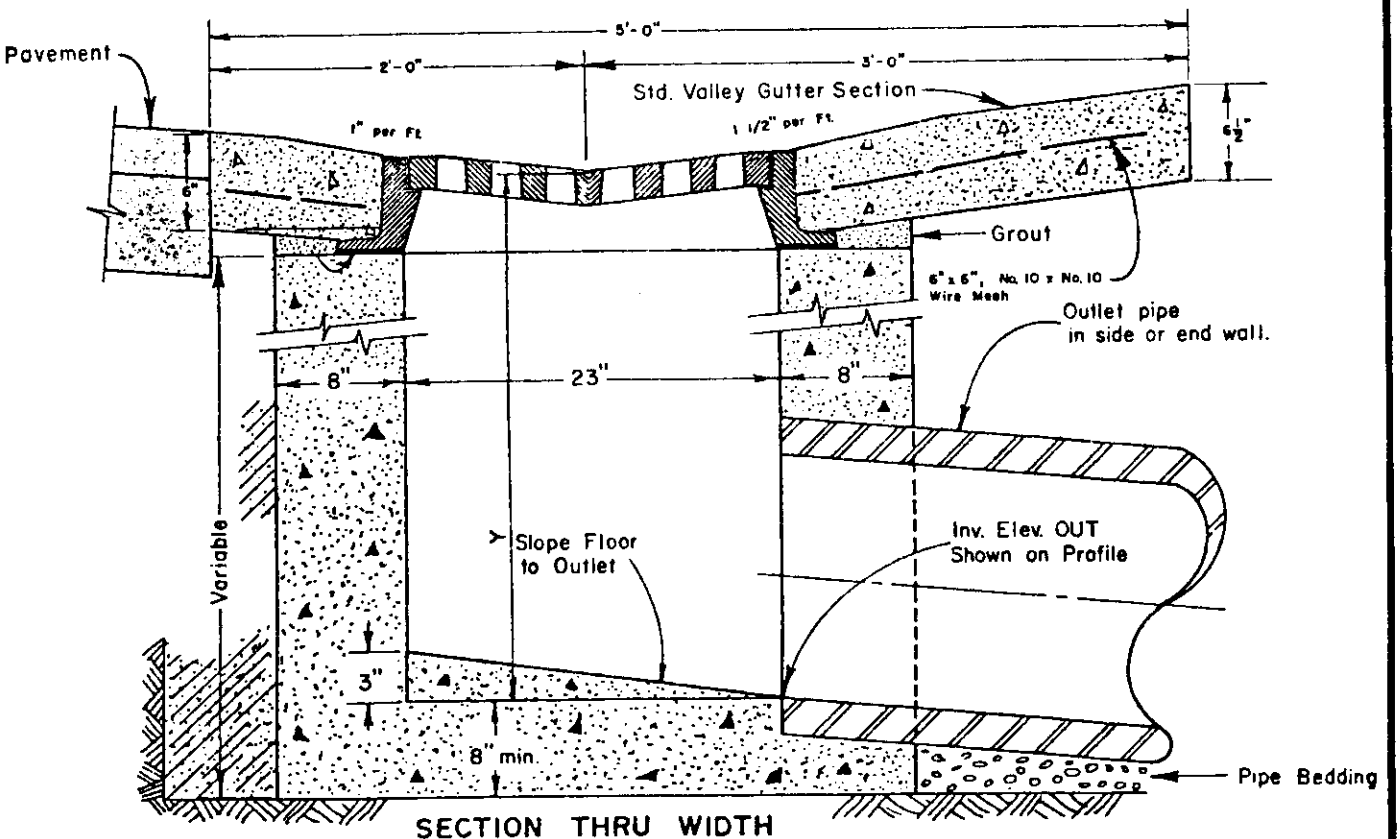
Add one bar for each foot increase of H above 2'-6".

All bars to be ½" Dia.—Cut or bend around pipes as required

GRATED INLET TYPE 13

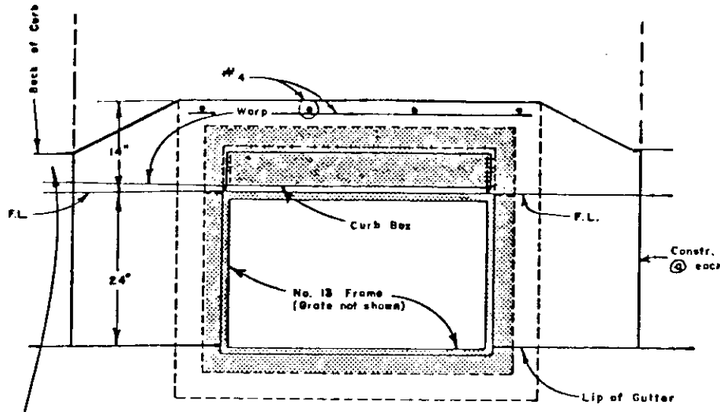


SECTION THRU LENGTH

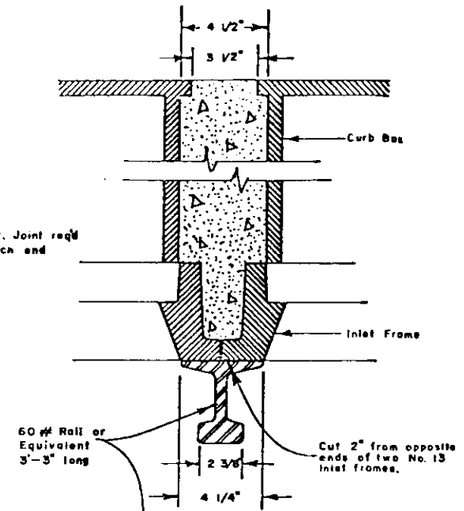


SECTION THRU WIDTH

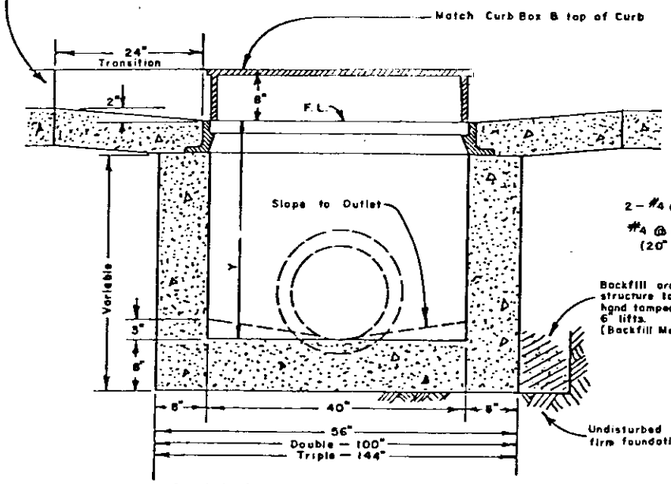
WRC ENG.	REFERENCE: City and County of Denver Standard S-34-31.b (with modifications)



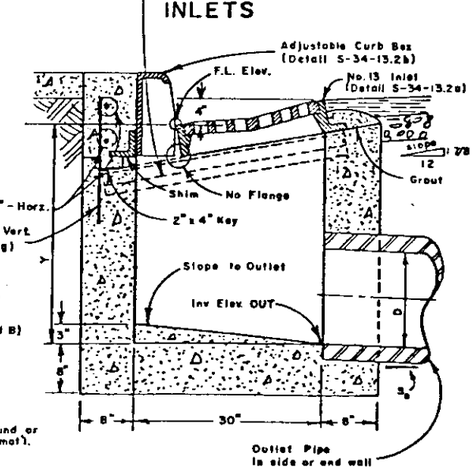
PLAN



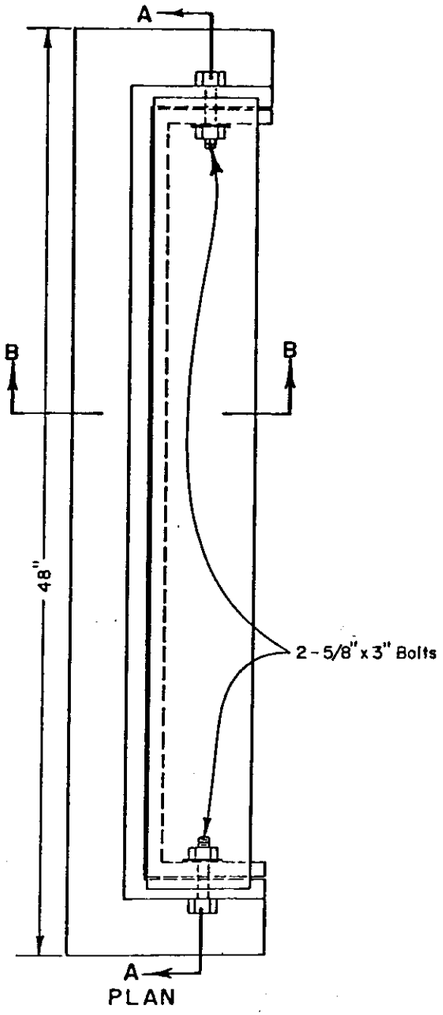
SECTION CENTER OF MULTIPLE INLETS



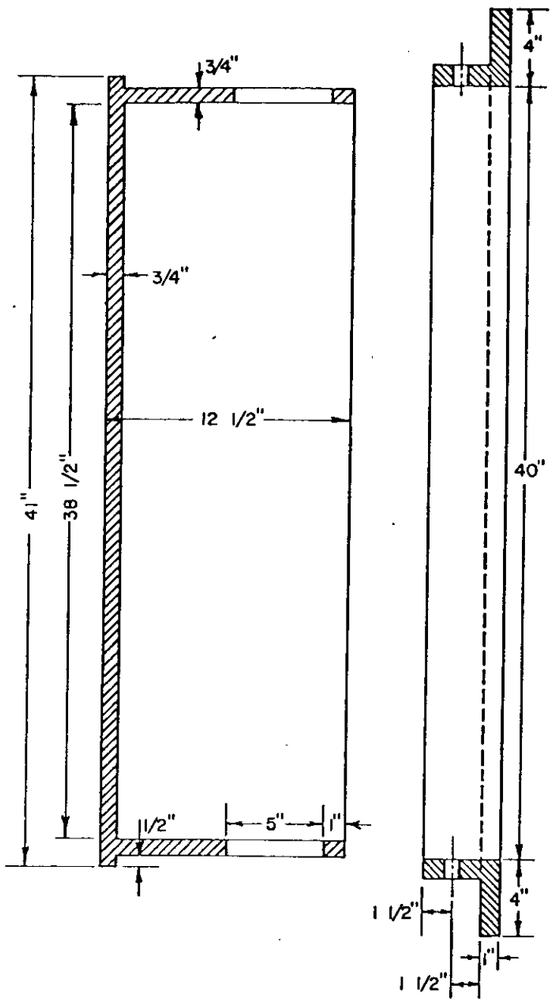
SECTION THRU LENGTH



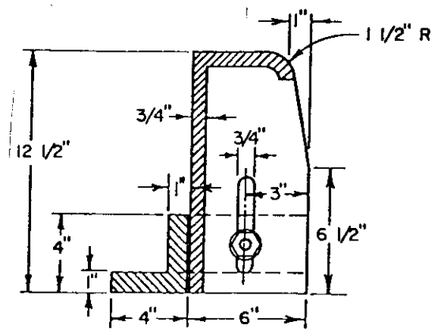
SECTION THRU WIDTH



PLAN



SECTION A-A



SECTION B-B

# OF INLETS	STD. DEPTH (Y)	MIN. DIA. (D)	MIN. SLOPE (S_o)
SINGLE	3'-6"	15"	1.0%
DOUBLE	4'-0"	18"	1.0%
TRIPLE	4'-6"	21"	1.0%

NOTES:

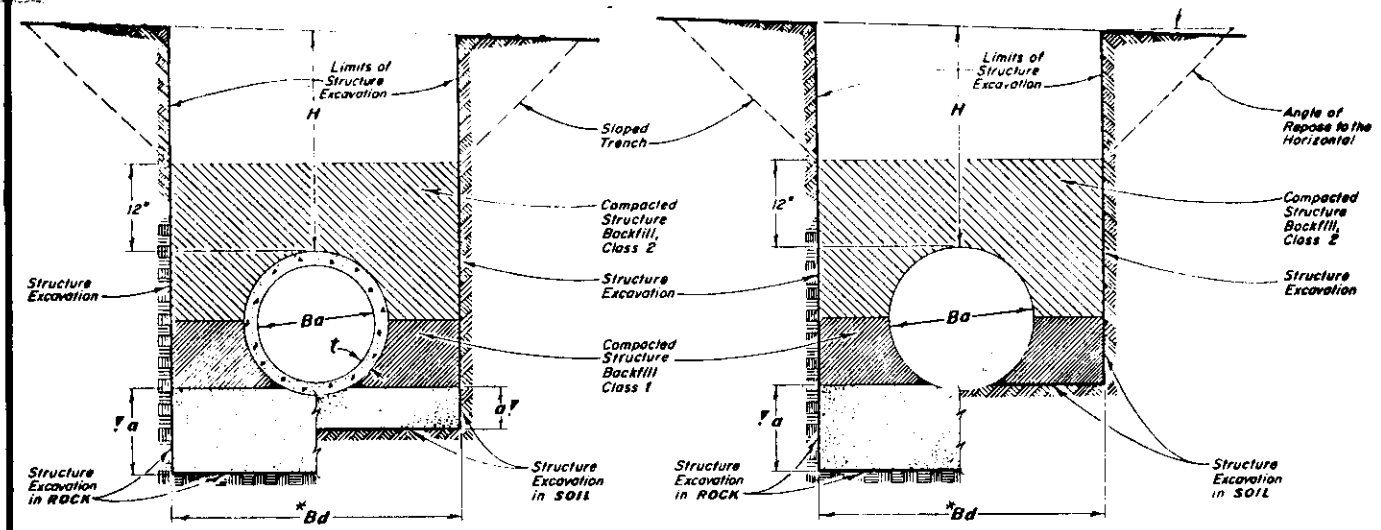
1. *For payment purposes, Inlet structures shall also include 2'-0" curb & gutter transition section at each end of inlet plus sidewalk sections where required behind Inlet structure and Transition sections.*
2. *Floor slope may be poured monolithic with base.*
3. *Outlet pipe(s) to be set flush with inside face of inlet wall.*
4. *Unless otherwise specified on the drawings or otherwise approved, all No. 13 Inlets shall be constructed with an adjustable C.I. curb box.*
5. *Std. Inlet depths and pipe size are noted in the following table. Deviations from these minimum requirements shall be substantiated with appropriate hydraulic analysis.*

NOTES:

1. *Casting Specifications: A.S.T.M. A-48, with a minimum tensile strength of 25 ksi (Class 25).*
2. *All castings to be dipped in asphalt base paint.*
3. *Minimum Curb Opening Area = 150 sq. in.*

WRC ENGINEERING, INC.	REFERENCE: City and County of Denver Standard Details S-34-13.1a and S-34-13.2b (with modifications)	BOULDER COUNTY STORM DRAINAGE CRITERIA MANUAL	COMBINATION INLET TYPE 13 STANDARD DETAIL SD-4

PIPE INSTALLATION IN TRENCH



RIGID PIPE **FLEXIBLE PIPE**

MAXIMUM HEIGHT OF FILL OVER TOP OF PIPE IN FEET

(FILL HEIGHTS GREATER THAN MAXIMUM WILL REQUIRE SPECIAL DESIGN)

REINFORCED CONCRETE

Ba in.	Bd ft.	.01 INCH CRACK D-LOAD 1000	1350	2000	3000
		PIPE CLASS II	III	IV	V
12	4.00	18	25	37	40+
15	4.25	18	25	37	40+
18	4.50	18	25	37	40+
21	4.75	18	25	37	40+
24	5.00	18	25	37	40+
27	5.25	18	25	37	40+
30	5.50	18	25	37	40+
33	5.75	18	25	40+	40+
36	6.00	18	25	40+	40+
42	6.50	18	25	40+	40+
48	7.00	18	25	40+	40+
54	7.50	18	25	40+	40+
60	8.00	18	25	40+	40+
66	8.50	18	25	40+	40+
72	9.00	18	25	40+	40+
78	9.50	18	25	40+	40+
84	10.00	18	25	40+	40+
90	10.50	18	25	40+	40+
96	11.00	18	25	40+	40+
102	11.50	18	25	40+	40+
108	12.00	18	25	40+	40+

RCP DESIGN CRITERIA:

Safety Factor = 1.33 on Ult.
Soil Weight = 120 lb. per cu. ft.
Load Factor = 1.9
Bedding = Class B (modified)

NOTE: Where trench widths cause transition to **embankment** condition, fill heights for projected pipe (Standard M-603-RC) are shown.

STEEL – 2 2/3" x 1/2" CORRUGATIONS

Ba in.	Bd ft.	H ABOVE TOP OF PIPE IN FEET 1-15	16-20	21-25	26-30	31-35	36-40
		THICKNESS IN INCHES					
12-48	4-7	.064	.064	.064	.064	.064	.064
54	7.50	.079	.079	.079	.079	.079	.079
60	8.00	.079	.079	.079	.079	.109	.109
66	8.50	.079	.079	.109	.109	.138	.138
72	9.00	.079	.109	.109	.138	.168	.168
78	9.50	.109	.138	.138	.168		
84	10.00	.109	.138	.168			

CSP DESIGN CRITERIA:

(3" x 1 CORRUGATIONS: 60" to 84" Pipe shall be .064" thick (16 gage) to H = 40 ft.)

Soil Weight = 120 lb. per cu. ft.
Safety Factor for Seam Strength = 2.00
Buckling Stress Level = 1/2 Yield Strength
Load Factor (Backfill) = 85% Standard Density, AASHTO-T 99 (K = 0.86)

LEGEND

H = Height of fill over top of pipe.
Ba = Inside diameter of pipe.
*Bd = Trench width.
t = Wall thickness of pipe.

a = Loose granular bedding, as follows:

I.D. of PIPE	a in sen	a in each
6" - 27"	3"	12"
30" - 60"	4"	12"
66" or >	6"	12"

* TRENCH WIDTHS
CSP, RCP & NRCP: Bd = Ba + 3'

† Bedding Material for SOIL shall be gravel, 3" Dia. max
Bedding Material for ROCK shall be gravel, 2" Dia. max

GENERAL NOTES

Minimum cover for prefabricated pipe shall be 2 feet.

Changes in design criteria will require compensating change in pipe design.

When pipe sewer is to be extended or replaced with pipe of different material, the connections shall conform to the detail shown on plans or be approved.

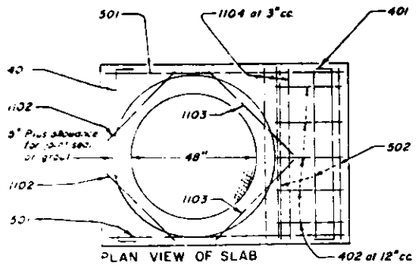
Spacing for multiple pipe sewer installations shall be 1/2" inside Dia. or span, or 3' max.

TRENCH INSTALLATION:

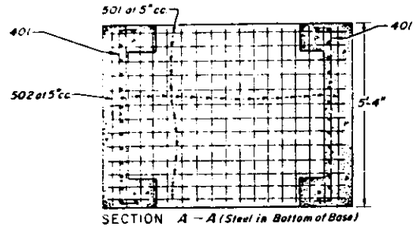
Trenches over 5 feet in depth shall be either shored or the trench walls shall be sloped to the angle of repose. If sloped, the bottom of the slope shall be a minimum of 1 foot above the top of the pipe.

Shoring will be required when the bottom of the slope is more than 3 feet above the bottom of the trench. Shoring shall extend a minimum of one foot above the bottom of the slope.

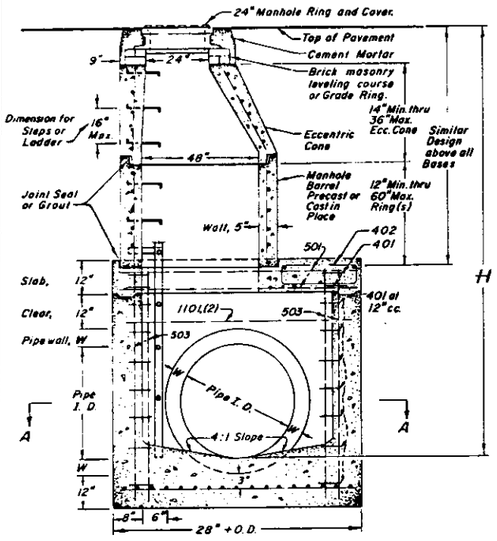
Timber sheeting or shoring may be cut off 1 foot above the top of the pipe after backfilling is complete.



PLAN VIEW OF SLAB

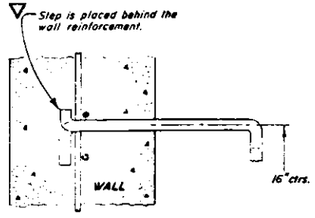


SECTION A – A (Steel in Bottom of Base)



CONCRETE MANHOLE AND BOX BASE

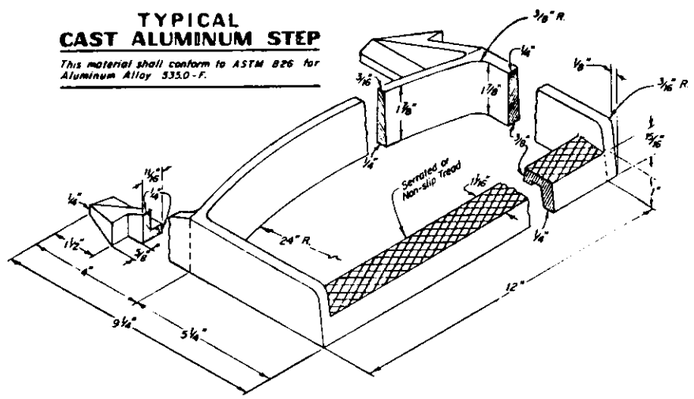
(Typical for Conduit 36" I.D and Larger)



TYPICAL STEP INSTALLATION FOR BAR STEPS

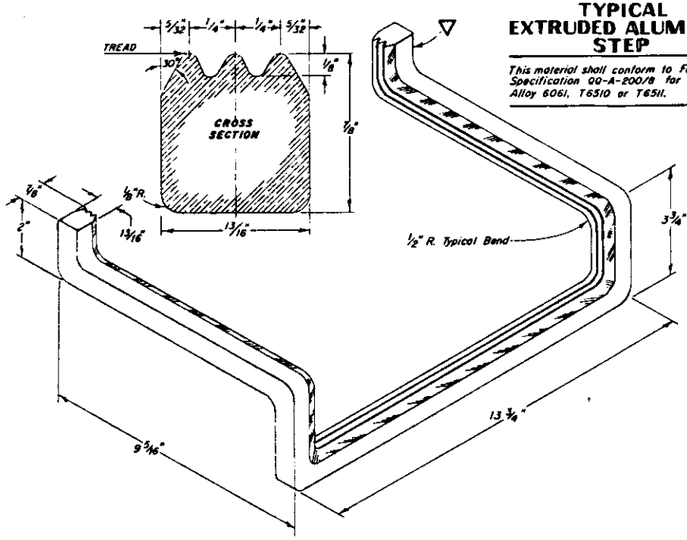
TYPICAL CAST ALUMINUM STEP

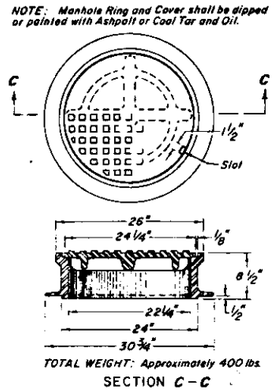
This material shall conform to ASTM B26 for Aluminum Alloy 535.0 - F.



TYPICAL EXTRUDED ALUMINUM STEP

This material shall conform to Federal Specification QQ-A-200/8 for Aluminum Alloy 6061, T6510 or T6511.





MANHOLE RING AND COVER

GENERAL NOTES

All work shall be done in accordance with the Standard Specifications applicable to the project.

Since all pipe entries into the base are variable, the dimensions shown are typical. Actual dimensions and quantities for concrete and reinforcement shall be as required in the work.

Design is based on straight runs of conduit or change in direction under 45°.

All bars shall be a minimum 2" clear.

Precast Manholes shall conform to ASTM Designation C 478.

Cast in place Manholes shall be Class A or B concrete

The following alternate materials for Manholes may be used when design details for construction are included in the plans:

MATERIAL	CONFORMANCE - DESIGNATION
Clay or Shale Brick	AASHTO M 91
Concrete Brick	ASTM C 55, Grade P-I or P-II
Concrete Masonry Block	ASTM C 139
Corrugated Steel Unit	AASHTO M 36

All pipe entries into the base of Manhole shall be connected by open gutter adjusted for pipe size, shape, slope and direction of flow.

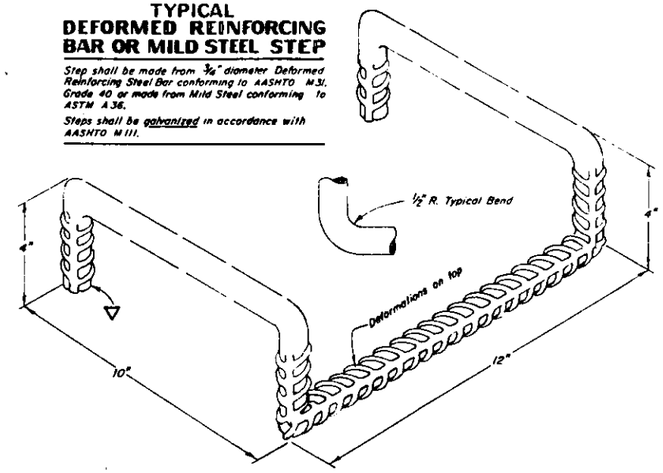
Alternate designs will be permitted after approval by the Division

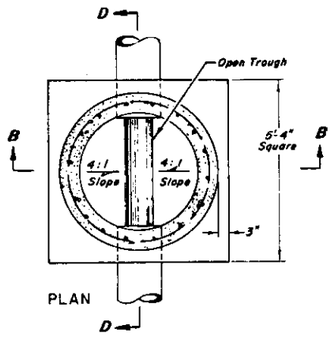
Steps or Ladder will be required when Manhole depth exceeds 3'-6".

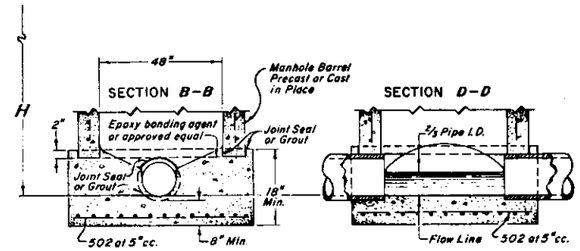
TYPICAL DEFORMED REINFORCING BAR OR MILD STEEL STEP

Step shall be made from 3/8" diameter Deformed Reinforcing Steel Bar conforming to AASHTO M 31, Grade 40 or made from Mild Steel conforming to ASTM A 36.

Steps shall be galvanized in accordance with AASHTO M 111.







CONCRETE SLAB BASE

(Typical for Conduit Smaller than 36" I.D.)

QUANTITIES FOR CONCRETE MANHOLE BOX BASE

MARK	SIZE	TYPE	Lb./Ft.	BARS	I.D. ⇩ 36"	48"	60"	72"	84"	96"
401	4	II	0.67	NO. REQ'D.	16	18	20	22	25	27
				LENGTH	6'-7"	6'-7"	6'-7"	6'-7"	6'-7"	6'-7"
				WEIGHT, lbs.	70.4	79.2	88.0	96.8	110.0	118.8
402	4	III	0.67	NO. REQ'D.	0	5	5	5	5	5
				LENGTH	0	4'-10"	6'-0"	7'-2"	8'-4"	9'-6"
				WEIGHT, lbs.	0	16.2	20.0	23.9	27.8	31.7
501	5	I	1.04	NO. REQ'D.	17	17	17	17	17	17
				LENGTH	5'-8"	6'-10"	8'-0"	9'-2"	10'-4"	11'-6"
				WEIGHT, lbs.	100.5	121.2	141.9	162.5	183.2	203.9
502	5	I	1.04	NO. REQ'D.	15	18	23	27	31	34
				LENGTH	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"
				WEIGHT, lbs.	78.2	99.1	120.0	140.8	161.7	177.3
503	5	I	1.04	NO. REQ'D.	30	30	30	30	30	30
				LENGTH	6'-2"	7'-4"	8'-6	9'-8"	10'-10"	12'-0"
				WEIGHT, lbs.	193.0	229.5	266.0	302.5	339.5	375.5
1101	11	I	5.31	NO. REQ'D.	4	4	4	4	4	4
				LENGTH	5'-8"	6'-10"	8'-0"	9'-2"	10'-4"	11'-6"
				WEIGHT, lbs.	120.5	145.2	170.0	194.8	219.6	244.4
1102	11	I	5.31	NO. REQ'D.	2	2	2	2	2	2
				LENGTH	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"	2'-6"
				WEIGHT, lbs.	26.6	26.6	26.6	26.6	26.6	26.6
1103	11	I	5.31	NO. REQ'D.	2	2	2	2	2	2
				LENGTH	3'-6"	3'-6"	3'-6"	3'-6"	3'-6"	3'-6"
				WEIGHT, lbs.	37.2	37.2	37.2	37.2	37.2	37.2
1104	11	I	5.31	NO. REQ'D.	3	3	3	3	3	3
				LENGTH	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"
				WEIGHT, lbs.	79.7	79.7	79.7	79.7	79.7	79.7
REINFORCING STEEL – Pounds – Total					706.1	833.9	949.1	1064.8	1185.3	1295.1
CONCRETE – Cubic Yards – Total					4.2	5.3	6.6	8.0	9.5	11.1

NOTE: Quantities are based on same size pipe entrance to and exit from base and a 4 ft. manhole entrance into top step of base.

FORMULAS

401 Number Bars Required	$\left(\frac{12 + I.D. + 2W}{6}\right) + 6$
402 Bar Length	I.D. + 2W
501 Bar Length	24" + I.D. + 2W
502 Number Bars Req'd.	$\left(\frac{17 + I.D. + 2W}{5}\right) + \left(\frac{I.D. - 36}{12}\right) + 3$
503 Bar Length	30" + I.D. + 2W
1101 Bar Length	24" + I.D. + 2W

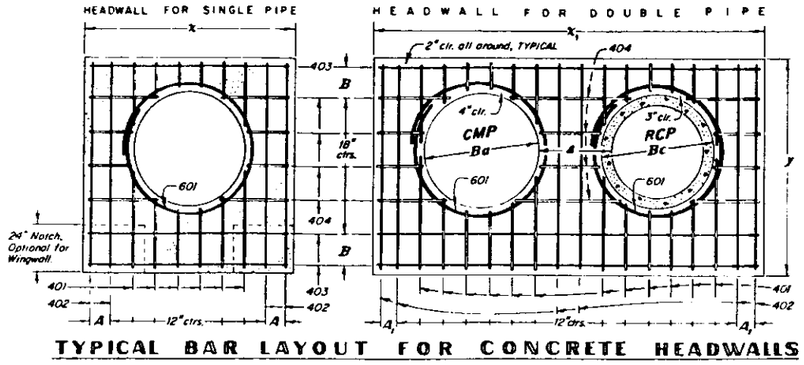
BENDING

TYPE I — Straight

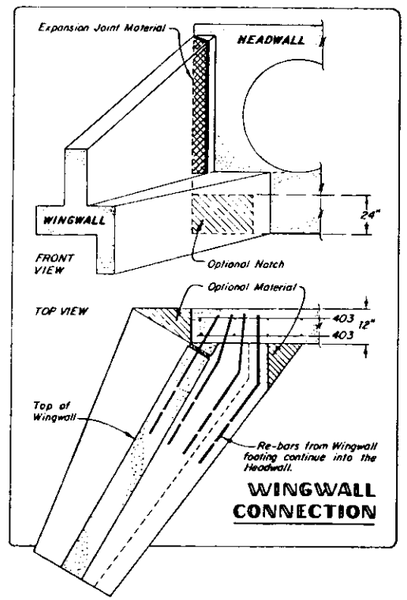
TYPE II — 59", 10"

TYPE III — I.D. + 2W – 38", 7", 12", 12"

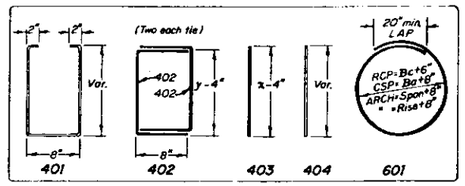
WRC ENGINEERING, INC.	REFERENCE: Colorado Department of Highways Standard M-604-E and M-604-DA	BOULDER COUNTY STORM DRAINAGE CRITERIA MANUAL	STORM SEWER MANHOLE STANDARD DETAIL SD-6



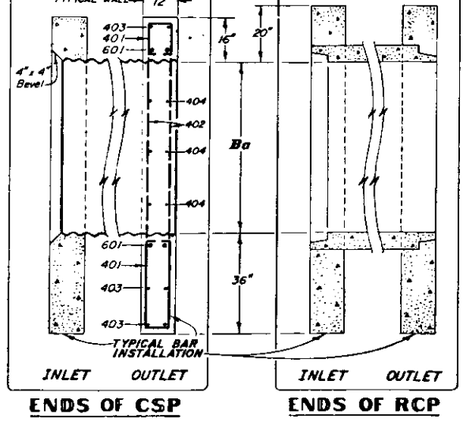
TYPICAL BAR LAYOUT FOR CONCRETE HEADWALLS



WINGWALL CONNECTION

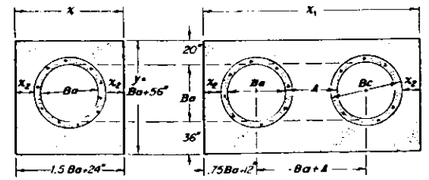


BAR BENDING



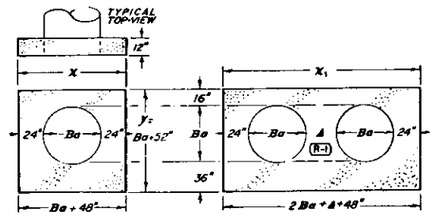
ENDS OF CSP

ENDS OF RCP



HEADWALL FOR RCP ⌭ ROUND

DIMENSIONS									QUANTITIES			
									CONCRETE		STEEL	
Ba in.	Bc in.	x ft-in.	A in.	x_1 ft-in.	A_1 in.	y ft-in.	B in.	x_2 in.	SGL cu.yd.	DBL cu.yd.	SGL lbs.	DBL lbs.
60	72	9-6	7	17-0	10	9-8	11	21	2.35	3.99	236	414
66	79	10-3	11½	18-6	7	10-2	14	22	2.60	4.44	249	453
72	86	11-0	10	20-0	10	10-8	17	23	2.85	4.91	270	478
78	93	11-9	8½	21-3	11	11-2	11	24	3.11	5.29	306	527
84	100	12-6	7	22-6	7	11-8	14	25	3.38	5.68	333	572
90	107	13-3	11½	23-9	8½	12-2	17	26	3.66	6.08	335	593
96	114	14-0	10	25-0	10	12-8	11	27	3.94	6.48	379	649
102	121	14-9	8½	26-3	11½	13-2	14	28	4.24	6.89	400	664
108	128	15-6	7	27-6	7	13-8	17	29	4.54	7.30	424	707



HEADWALL FOR CMP ⌭ ROUND

DIMENSIONS							QUANTITIES			
							CONCRETE		STEEL	
Ba in.	x ft-in.	A in.	x_1 ft-in.	A_1 in.	y ft-in.	B in.	SGL cu.yd.	DBL cu.yd.	SGL lbs.	DBL lbs.
60	9-0	10	16-6	7	9-4	18	2.38	4.25	217	396
66	9-6	7	17-9	8½	9-10	12	2.38	4.70	252	454
72	10-0	10	19-0	10	10-4	15	2.78	5.17	255	472
78	10-6	7	20-0	10	10-10	18	2.98	5.56	276	499
84	11-0	10	21-0	10	11-4	12	3.19	5.95	297	553
90	11-6	7	22-0	10	11-10	15	3.40	6.36	317	571
96	12-0	10	23-0	10	12-4	18	3.62	6.79	321	597
102	12-6	7	24-0	10	12-10	12	3.84	7.21	364	663
108	13-0	10	25-0	10	13-4	15	4.06	7.63	362	678

GENERAL NOTES

All work shall be done in accordance with the Standard Specifications applicable to the project.

Concrete shall be Class A or B.

Headwall shall be perpendicular to the culvert ℄ unless otherwise shown on the plans.

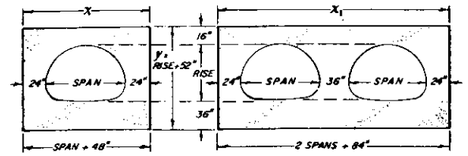
For Wingwall details, see Standard M-601-WW.

Volume occupied by pipe has been deducted from Steel and Concrete quantities.

When 2 or more conduits are laid side by side they shall be placed so that the adjacent pipes will be ½ Inside Diameter or ½ Inside Span or 3 feet apart (including wall thickness) whichever is less.

HEADWALL FOR CMP ~ ARCH

DIMENSIONS									QUANTITIES			
									CONCRETE		STEEL	
EQUIV. Ba in.	SPAN in.	RISE in.	x ft-in.	A in.	x_1 ft-in.	A_1 in.	y ft-in.	B in.	SGL cu.yd.	DBL cu.yd.	SGL lbs.	DBL lbs.
72	81	59	10-9	8½	20-6	7	9-3	17½	2.72	5.10	250	467
78	87	63	11-3	11½	21-6	7	9-7	10½	2.85	5.34	275	531
84	95	67	11-9	8½	22-10	9	9-11	12½	3.08	5.79	290	547
90	103	71	12-7	7½	24-2	11	10-3	15	3.30	6.21	321	591
96	112	75	13-4	12	25-8	9	10-7	16½	3.52	6.65	314	606
102	117	79	13-9	8½	26-6	7	10-11	9½	3.63	6.86	356	672
108	128	83	14-8	8	28-4	12	11-3	11½	3.96	7.51	376	699



HEADWALL FOR STRUCTURAL PLATE ~ ARCH

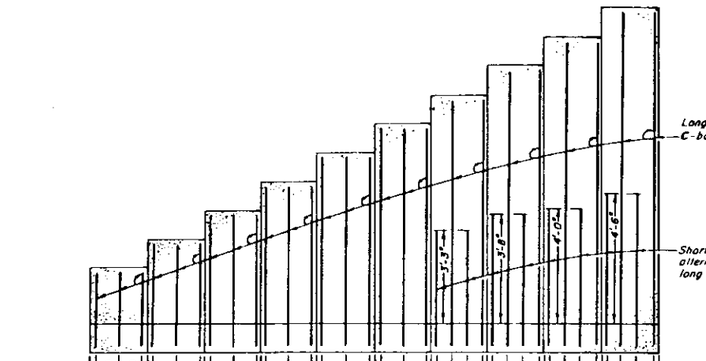
DIMENSIONS									QUANTITIES			
									CONCRETE		STEEL	
EQUIV. Ba in	SPAN ft-in.	RISE ft-in.	x ft-in.	A in.	x_1 ft-in.	A_1 in.	y ft-in.	B in.	SGL cu.yd.	DBL cu.yd.	SGL lbs.	DBL lbs.
66	6-1	4-7	10-1	10½	19-2	11	8-11	15½	2.58	4.70	232	424
75	7-0	5-1	11-0	10	21-0	10	9-5	9½	2.80	5.25	282	509
84	7-11	5-7	11-11	9½	22-10	9	9-11	12½	3.08	5.79	291	540
93	8-10	6-1	12-10	9	24-8	8	10-5	15½	3.36	6.33	309	622
102	9-9	6-7	13-9	8½	26-6	7	10-11	9½	3.63	6.86	379	673
111	10-11	7-1	14-11	9½	28-10	9	11-5	12½	4.05	7.67	377	711
120	11-10	7-7	15-10	9	30-8	8	11-11	15½	4.36	8.28	395	731
132	12-10	8-4½	16-10	9	32-8	8	12-8	11	4.75	9.03	441	839
141	14-1	8-9	18-1	10½	35-2	11	13-1	13½	5.17	9.86	448	931
150	15-4	9-3	19-4	12	37-8	8	13-7	16½	5.69	10.86	490	953
159	15-10	9-10	19-10	9	38-8	8	14-2	11	5.89	11.25	534	1019

*SKEW FACTOR TABLE

SKEW ANGLE A°	FACTOR (cosec A°)
90	1.000
85	1.004
80	1.015
75	1.035
70	1.064
65	1.103
60	1.154
55	1.221
50	1.305
45	1.414
40	1.558
35	1.743
30	2.000

*Multiply X (or X_1) dimension and all quantities by factor if Culvert Skew is less than 90° and Headwall remains parallel to the roadway ℄.

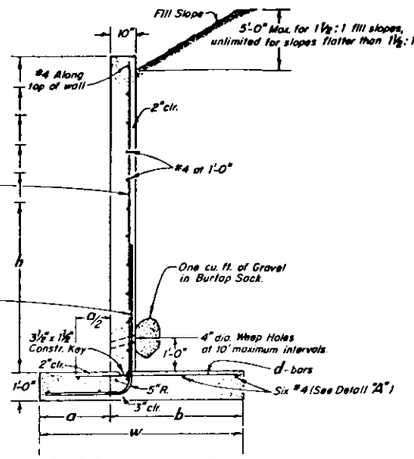
WRC ENGINEERING, INC.	REFERENCE: Colorado Department of Highways, Standard M-601-CH	BOULDER COUNTY STORM DRAINAGE CRITERIA MANUAL	HEADWALLS FOR PIPE CULVERTS STANDARD DETAIL 7



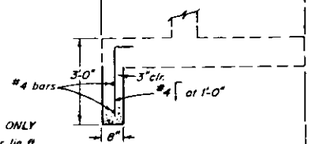
e =	1'-6"	1'-6"	1'-6"	1'-6"	1'-0"	0'-8½"	1'-0"	0'-9½"	0'-7"	0'-5½" ctrs.
h =	2'	3'	4'	5'	6'	7'	8'	9'	10'	11'
a =	1'-0"	1'-2"	1'-4"	1'-6"	1'-8"	1'-10"	2'-0"	2'-2"	2'-4"	2'-6"
b =	1'-8"	2'-0"	2'-4"	2'-8"	3'-0"	3'-4"	3'-8"	4'-0"	4'-4"	4'-8"
w =	2'-8"	3'-2"	3'-8"	4'-2"	4'-8"	5'-2"	5'-8"	6'-2"	6'-8"	7'-2"
c & d bars	#4 at 1'-6"	#4 at 1'-6"	#4 at 1'-6"	#4 at 1'-6"	#4 at 1'-0"	#4 at 8½"	#6 at 1'-0"	#6 at 9½"	#6 at 7"	#6 at 5½" ctrs.
*Conc. cu.yd/l.f.	0.161	0.210	0.259	0.308	0.358	0.407	0.457	0.506	0.556	0.604
*Reint. lb/l.f.	8.0	9.3	10.7	12.1	16.2	21.7	29.0	37.0	51.0	67.3

* Does not include Toe Wall quantities.

DESIGN TABLE

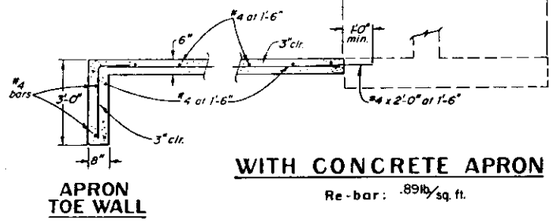


TYPICAL SECTION



WITH TOE WALL

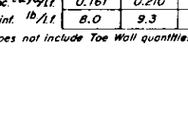
QUANTITIES FOR TOE WALL ONLY
Concrete 0.049 cu.yd. per lin.ft.
Reinforcement 3.4 lb. per lin.ft.

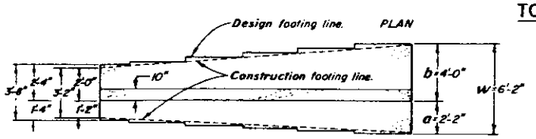


WITH CONCRETE APRON

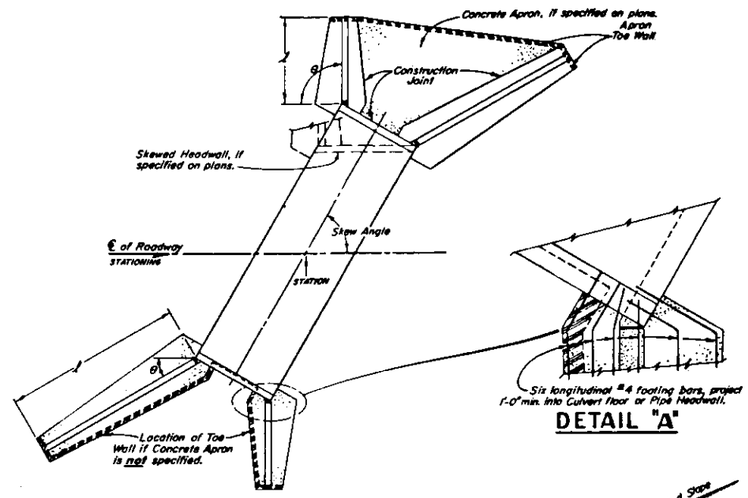
Re-bar: 89 lb/sq. ft.

APRON TOE WALL



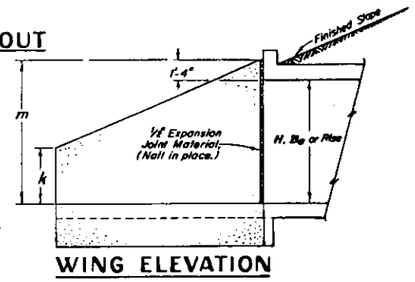


DESIGN EXAMPLE



DETAIL "A"

TYPICAL CULVERT LAYOUT



WING ELEVATION

m = H, Bo or Rise + (1'-4") unless otherwise shown on Plans.

GENERAL NOTES

All work shall be done in accordance with the Standard Specifications applicable to the project.

All exposed corners on concrete shall be chamfered ¾".

Wingwall footings and floor of Box Culvert shall be placed monolithically.

Expansion Joint Material shall conform to AASHTO M-213 and payment therefor shall be included in the price for Concrete, (Box Culvert) or (Wall).

Dimensions "H," "Bo," "Rise," "h," "2," "m" and angles for wingwalls shall be as shown on the plans.

The minimum splice length for common bar sizes shall be:

BAR SIZE	#4	#6
SPLICE LENGTH	1'-0"	1'-8"

DESIGN DATA:

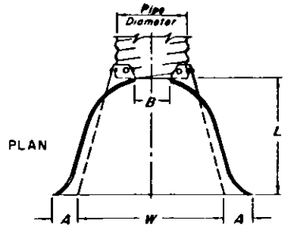
Unit Stresses: f_s = 20,000 psi
f_c = 1,200 psi
n = 10

Equivalent Fluid Pressure = 30 lbs./cu.ft.
Maximum Toe Pressure = 1 Ton/sq. ft.

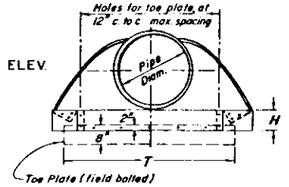
All construction joints shall be thoroughly cleaned before fresh concrete is poured.

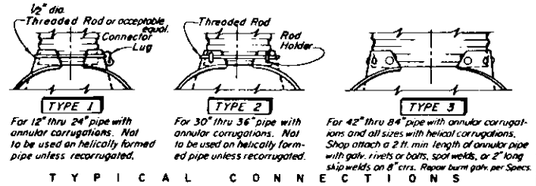
Wingwall Concrete shall be:
Concrete, Class A (Box Culvert) for CBC's.
Concrete, Class A, B or D (Wall) for Pipes.

WRC ENGINEERING, INC.	REFERENCE: Colorado Department of Highways, Standard M-601-WW	BOULDER COUNTY STORM DRAINAGE CRITERIA MANUAL	WINGWALLS STANDARD DETAIL 8



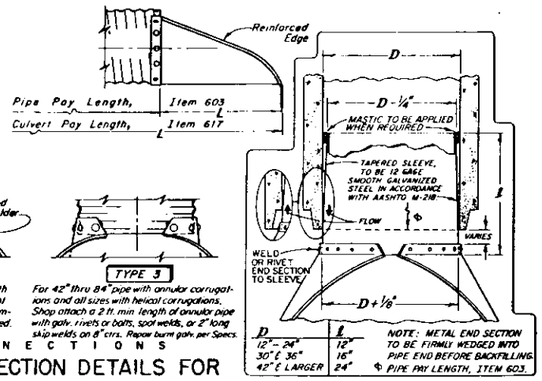
PIPE DIAM. in.	THICK-NESS in.	DIMENSIONS A (1" ±) in.	B (Max.) in.	H (1" ±) in.	L (1½" ±) in.	W (2" ±) in.	T in.
12	.064	6	6	6	21	24	34
15	.064	7	8	6	26	30	40
18	.064	8	10	6	31	36	46
21	.064	9	12	6	36	42	52
24	.064	10	13	6	41	48	58
30	.079	12	16	8	51	60	70
36	.079	14	19	9	60	72	84
42	.109	16	22	11	69	84	106
48	.109	18	27	12	78	90	112
54	.109	18	30	12	84	102	124
60	.109	18	33	12	87	114	136
66	.109	18	36	12	87	120	142
72	.109	18	39	12	87	126	148
78	.109	18	42	12	87	132	154
84	.109	18	45	12	87	138	160



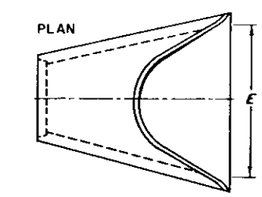


TYPICAL CONNECTIONS

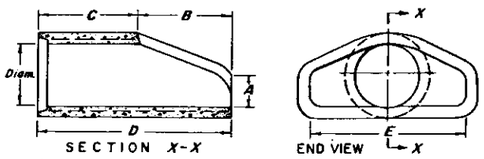
END SECTION AND CONNECTION DETAILS FOR ROUND CORRUGATED METAL PIPE CULVERTS



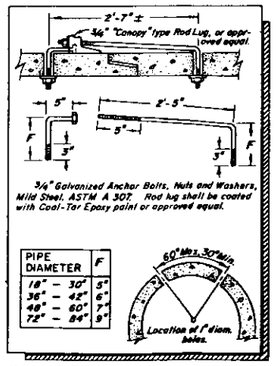
STEEL END SECTION FOR CONCRETE PIPE
(Alternate for Concrete End Section)



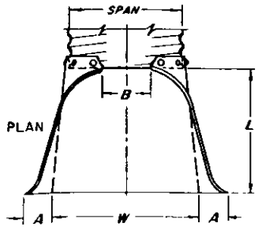
PIPE I.D. in.	DIMENSIONS A in.	B in.	C in.	D in.	E in.	
12	5½	25	49	72	24	
15	7	26	47	73	29	
18	11½	26	48	74	36	
24	12	43	54	97	48	
30	17	53	43	96	60	
36	18	60	37	97	71	
42	24	61	36	97	78	
48	28	70	28	98	84	
54	27	65	35	100	90	
60	36	58	40	98	96	
72	34½	75	21	96	108	



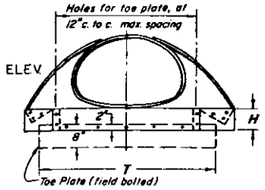
END SECTION FOR REINFORCED CONCRETE CIRCULAR PIPE

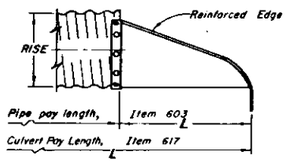


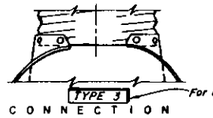
CONCRETE JOINT FASTENER



PIPE ARCH SPAN in.	× RISE in.	THICK-NESS in.	DIMENSIONS A (1" ±) in.	B (Max.) in.	H (1" ±) in.	L (1½" ±) in.	W (2" ±) in.	T in.
17	13	.064	7	9	6	18	30	40
21	15	.064	7	10	6	23	36	46
24	18	.064	8	12	6	28	42	58
28	20	.064	9	14	6	32	48	58
35	24	.079	10	16	6	39	60	70
42	29	.079	12	18	8	46	75	83
49	33	.109	13	21	9	53	85	105
57	38	.109	18	26	12	63	90	108
64	43	.109	18	30	12	70	102	120
71	47	.109	18	33	12	77	114	132





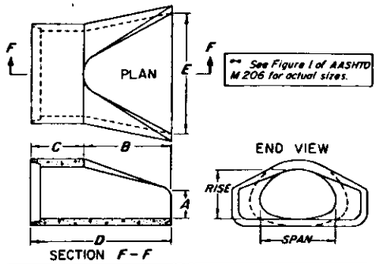


For all sizes of pipe with Annular or Helical corrugations.

CONNECTION

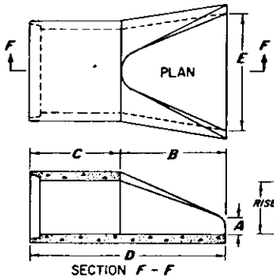
NOTE: End sections for pipe arches shall be shop attached to a minimum 2 ft. of pipe with galvanized rivets or bolts, or by welding.

END SECTION AND CONNECTION DETAIL FOR CORRUGATED METAL PIPE ARCH CULVERT



EQUIVALENT CIRCULAR DIAM (Inches)	NOMINAL (In) SPAN	RISE	DIMENSIONS (Inches) A	B	C	D	E
24	29	18	8½	39	33	72	48
30	36	22	9½	50	48	96	60
36	43	27	11⅛	60	36	96	72
42	50	31	15¾	60	36	96	78
48	58	36	21	60	36	96	84
54	65	40	25½	60	36	96	90
60	72	44	31	60	36	96	96
72	86	54	31	60	39	99	120

END SECTION FOR REINFORCED CONCRETE ARCH PIPE



EQUIVALENT CIRCULAR DIAM (Inches)	NOMINAL (In) SPAN	RISE	DIMENSIONS (Inches) A	B	C	D	E
24	30	19	8½	39	33	72	48
30	38	24	9½	54	48	96	60
36	45	29	11⅛	60	24	84	72
42	53	34	15¾	60	36	96	78
48	60	38	21	60	36	96	84
54	68	43	25½	60	36	96	90
60	76	48	30	60	36	96	96

END SECTION FOR REINFORCED CONCRETE ELLIPTICAL PIPE

GENERAL NOTES

All work shall be done in accordance with the Standard Specifications applicable to the project.

Concrete End Sections are to be furnished with tongue or groove as req'd.

Alternate equivalent designs for Concrete End Sections may be submitted to the Division for approval. Design length of culvert is based on length of End Section shown in table. Additional pipe required to provide the design length of the culvert shall be furnished by and at the expense of the Contractor.

Other sizes of concrete pipe and end sections may be available upon request; however, the designer should contact supplier prior to calling for sizes other than those shown on this standard.

Inside configuration and joint of concrete end section and pipe shall match.

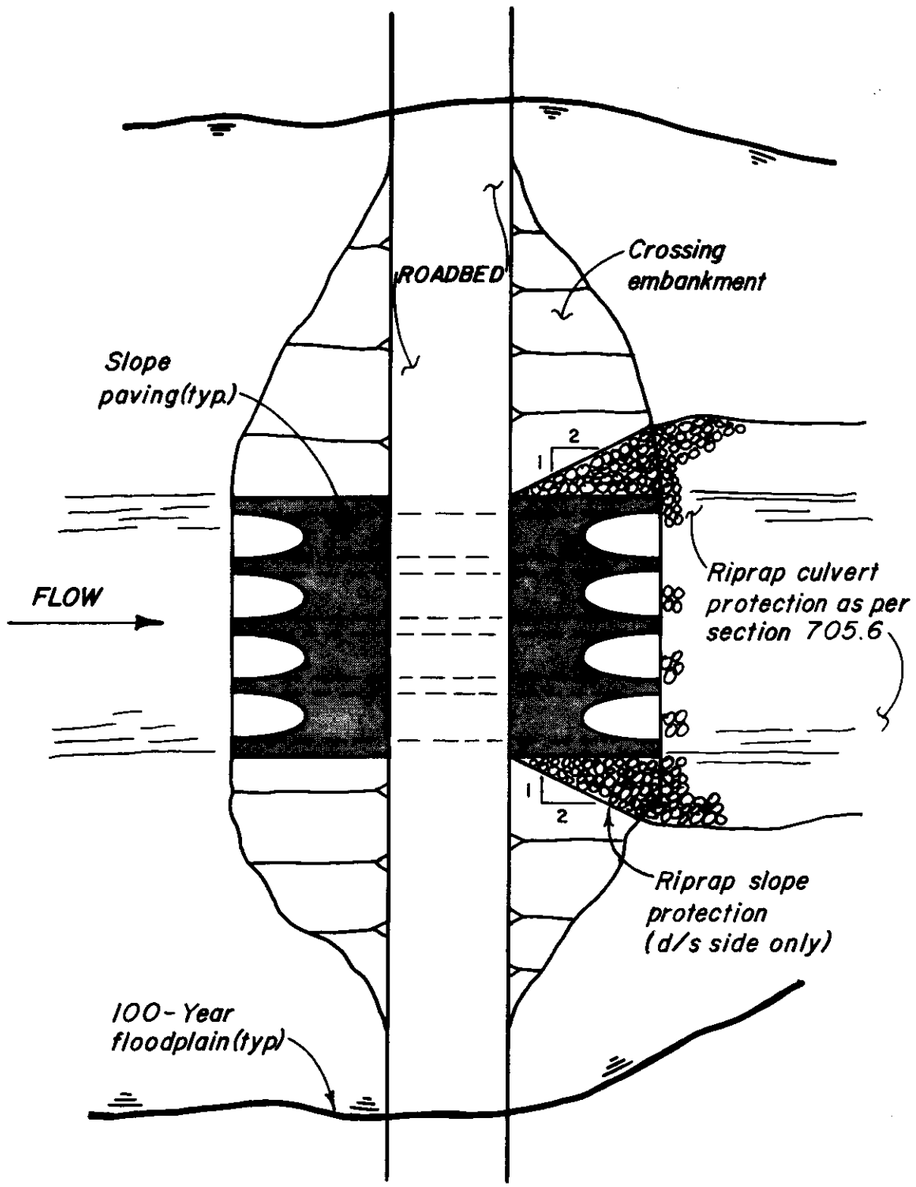
End sections for CMP Arch Culvert shall match the dimensions of the culvert shown on plans.

Galvanized Toe Plate as shown will be required on End Sections for corrugated steel pipe and shall be same thickness as End Sections. Toe Plate shall be field bolted to End Section with ⅝" galvanized bolts, nuts and washers.

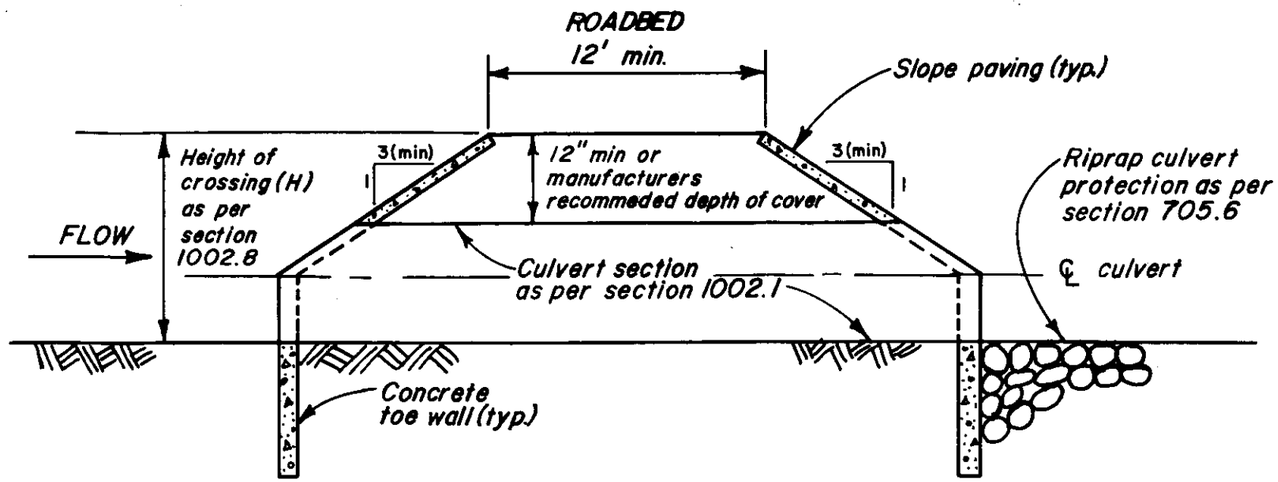
Designs for Aluminum End Sections for use on aluminum culverts shall be submitted to the Division for approval prior to use.

Concrete Pipe Joint Fasteners, where shown on plans, shall be installed so that a minimum of 15 linear feet of the outlet end of the pipe are mechanically locked together. End Section lengths, when used, will be included in the 15 l.f. requirement.

WRC ENGINEERING, INC.	REFERENCE: Colorado Department of Highways, Standard M-603-CA	BOULDER COUNTY STORM DRAINAGE CRITERIA MANUAL	CONCRETE OR METAL END SECTIONS STANDARD DETAIL 9

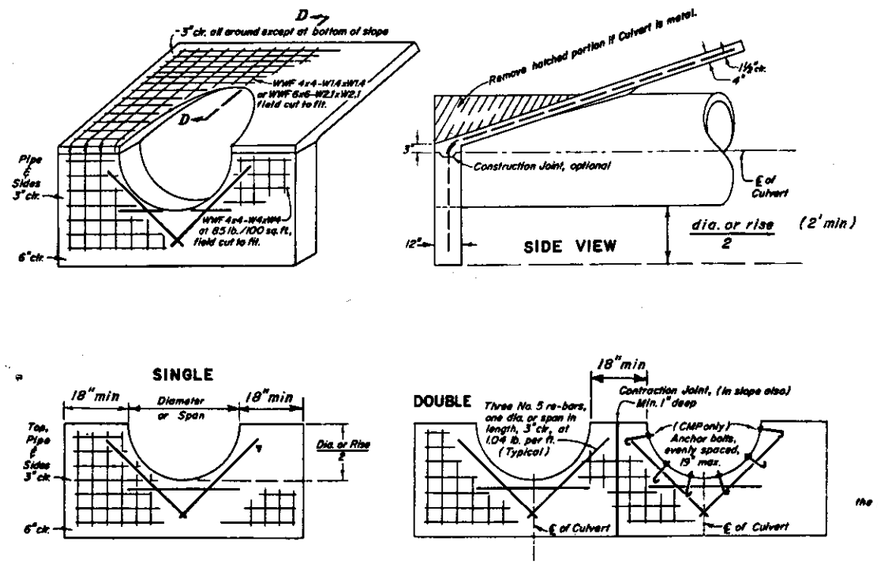


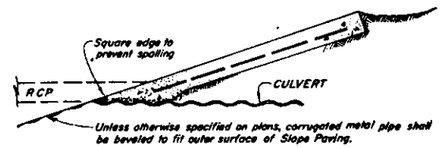
TYPICAL PLAN VIEW



TYPICAL SECTION

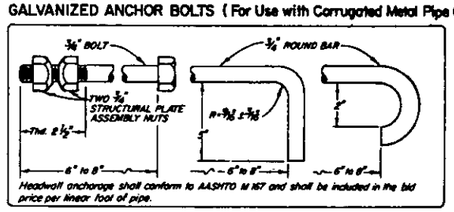
HEADWALL WITH SLOPE PAVING





SECTION D-D

TYPICAL
GALVANIZED ANCHOR BOLTS (For Use with Corrugated Metal Pipe Only)



Headwall anchorage shall conform to AASHTO M 167 and shall be included in the bid price per linear foot of pipe.

GENERAL NOTES

All work shall be done in accordance with the Standard Specifications applicable to the project.

Concrete shall be Class A or B.

Headwall shall be parallel to roadway centerline--(unless otherwise specified).

Exposed corners on concrete shall be chamfered ¾".

TYPE "S" HEADWALL AND SLOPE PAVING FOR ROUND PIPE OR ARCH PIPE

WRC ENGINEERING, INC.	REFERENCE: Colorado Department of Highways Standard M-601-KA (with modifications)	BOULDER COUNTY STORM DRAINAGE CRITERIA MANUAL	**LOW WATER CROSSING** STANDARD DETAIL SD-10