NAVAJO DIVISION OF TRANSPORTATION

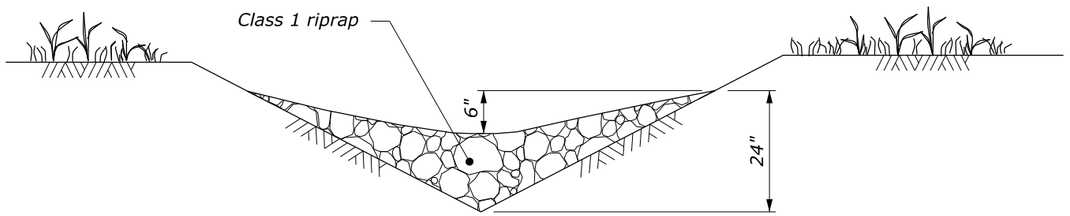
FEDERAL LANDS HIGHWAYS

STANDARD DETAILS FOR USE ON NAVAJO DOT PROJECTS

METRIC AND U.S. CONVENTIONAL UNITS

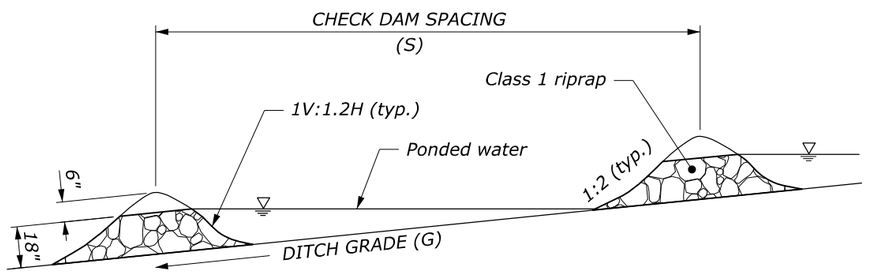
4/15/2026

PROJECT	SHEET NUMBER



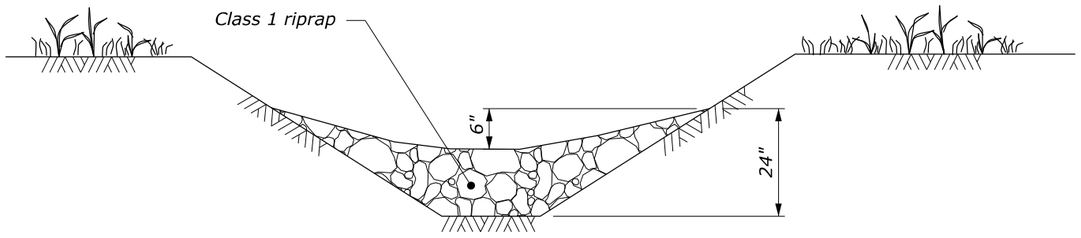
CROSS SECTION

V DITCH



PROFILE VIEW

DITCH



CROSS SECTION

TRAPEZOIDAL DITCH

DITCH GRADE (G)	*CHECK DAM SPACING S (ft)*
2%	*75*
3%	*50*
4%	*40*
5%	*30*
6%	*25*

** Do not use Check Dams below 2% or above 6% ditch grades.*

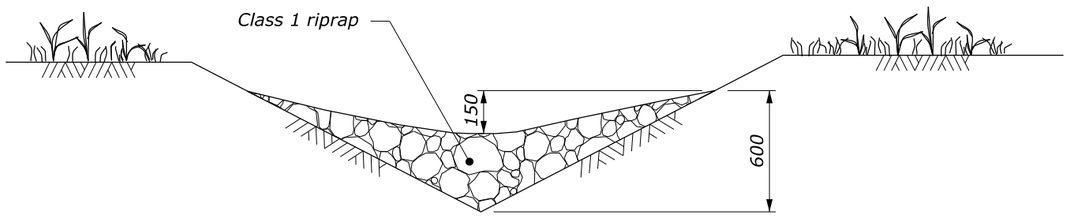
NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

CHECK DAM

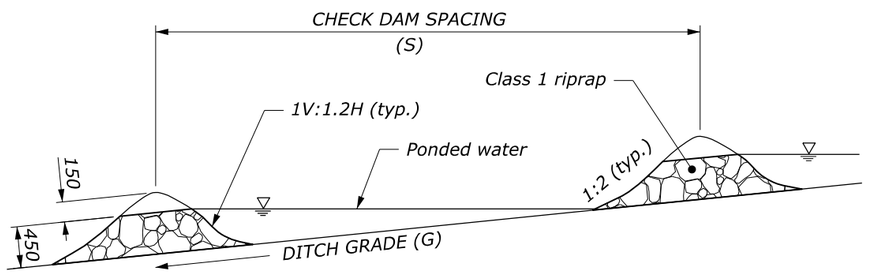
FLH STANDARD
157-6
SPECIFICATION
FP-24, FP-14
APPROVED FOR USE
1/2024

PROJECT	SHEET NUMBER



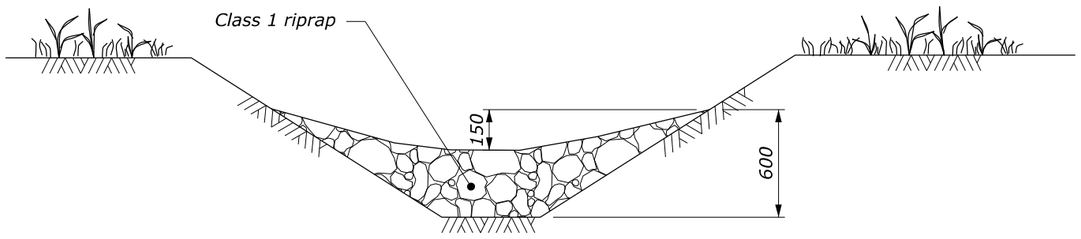
CROSS SECTION

V DITCH



PROFILE VIEW

DITCH



CROSS SECTION

TRAPEZOIDAL DITCH

DITCH GRADE (G)	*CHECK DAM SPACING S (m)*
2%	*23*
3%	*15*
4%	*12*
5%	*9*
6%	*7.5*

** Do not use Check Dams below 2% or above 6% ditch grades.*

*This drawing contains **Metric** units of measure. Dimensions without units are millimeters.*

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

CHECK DAM

FLH STANDARD
M157-6

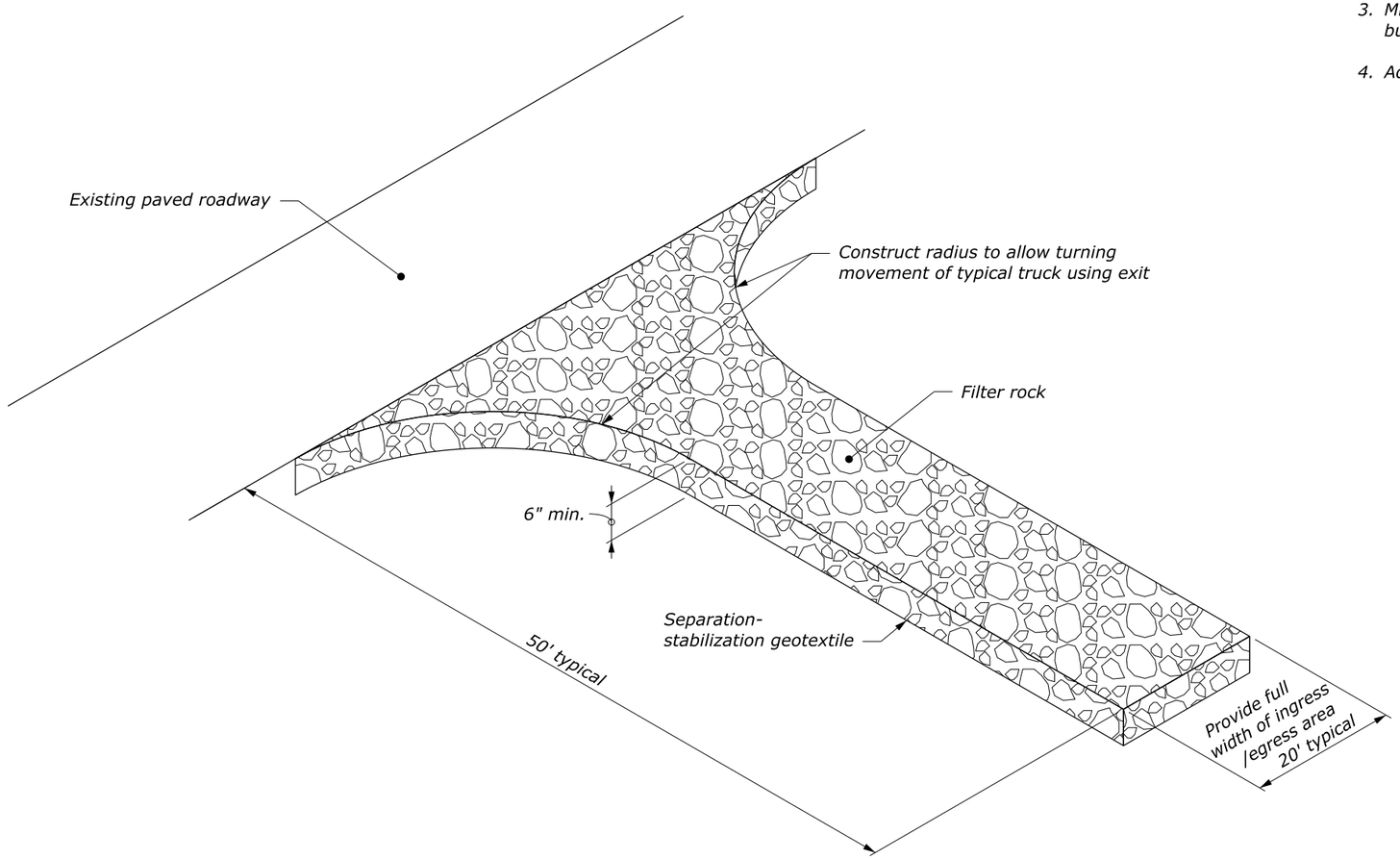
SPECIFICATION
FP-24, FP-14

APPROVED FOR USE
1/2024

PROJECT	SHEET NUMBER

NOTE:

1. *Use this entrance for construction vehicles only.*
2. *Construct drainage ditches along entrance as directed. Provide temporary drainage culvert where entrance crosses existing drainage ditches.*
3. *Minimize tracking onto paved roadway by removing built up sediment.*
4. *Adjust length to fit field conditions as approved.*



STABILIZED CONSTRUCTION EXIT

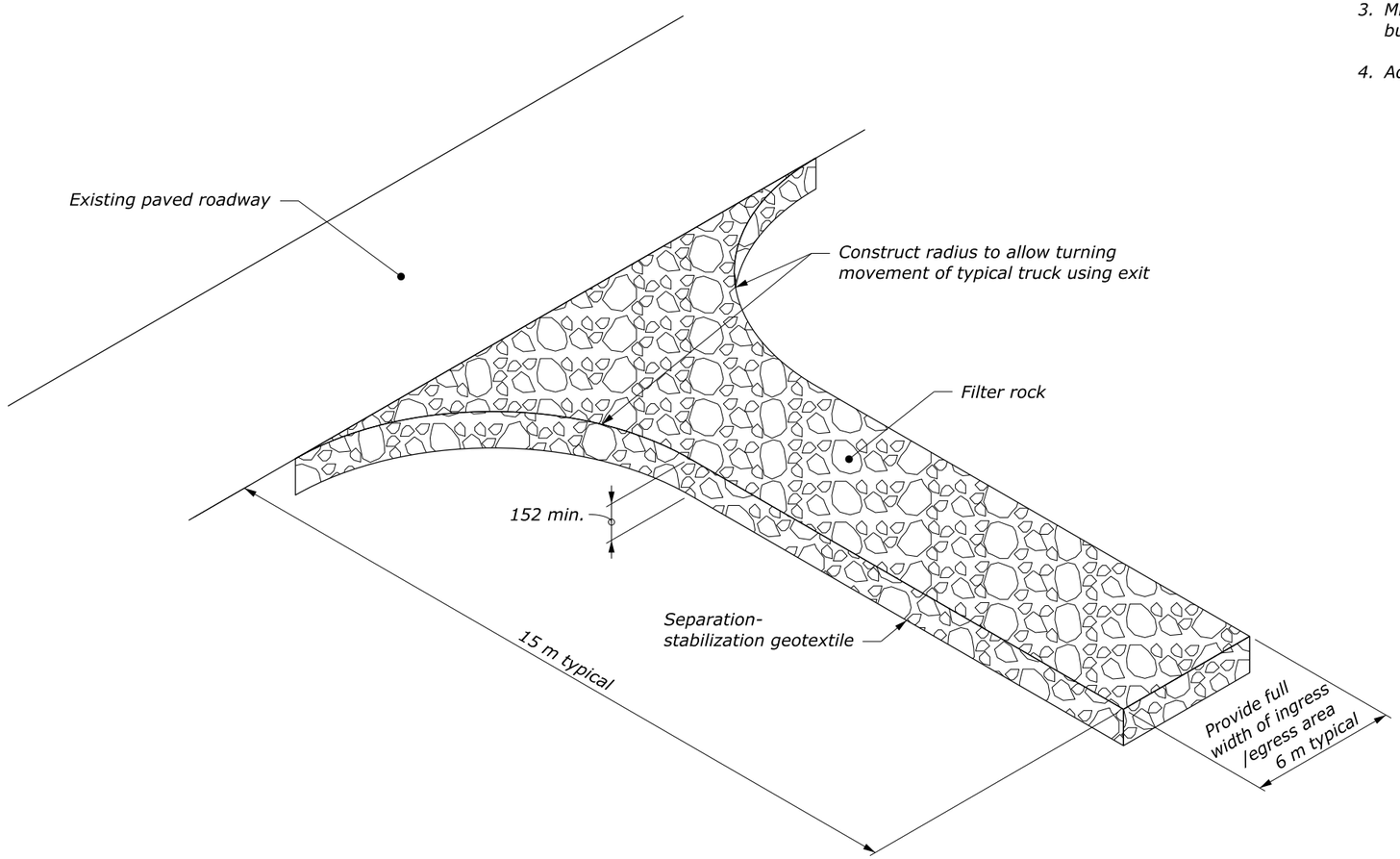
NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	WFL STANDARD W157-19
STABILIZED CONSTRUCTION EXIT	SPECIFICATION FP-24
	APPROVED FOR USE 7/2016

PROJECT	SHEET NUMBER

NOTE:

1. *Use this entrance for construction vehicles only.*
2. *Construct drainage ditches along entrance as directed. Provide temporary drainage culvert where entrance crosses existing drainage ditches.*
3. *Minimize tracking onto paved roadway by removing built up sediment.*
4. *Adjust length to fit field conditions as approved.*



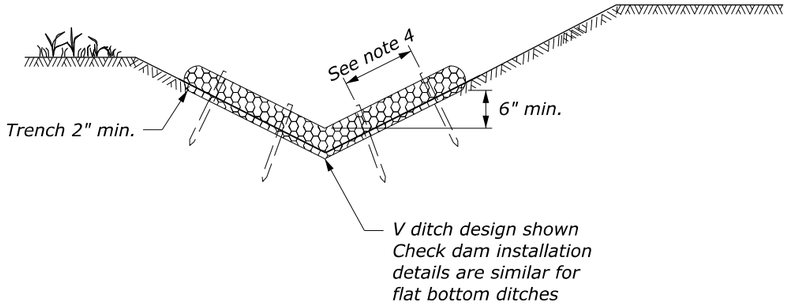
STABILIZED CONSTRUCTION EXIT

*This drawing contains **Metric** units of measure. Dimensions without units are millimeters.*

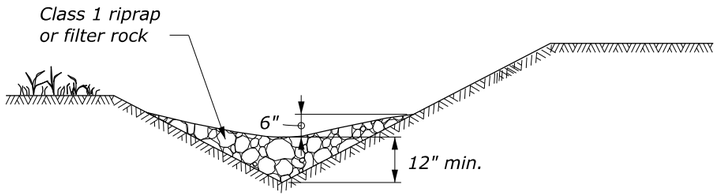
NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	WFL STANDARD WM157-19
STABILIZED CONSTRUCTION EXIT	SPECIFICATION FP-24
	APPROVED FOR USE 7/2016

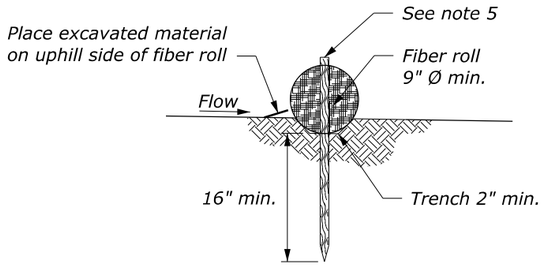
PROJECT	SHEET NUMBER
PROJECT NUMBER PROJECT NAME	



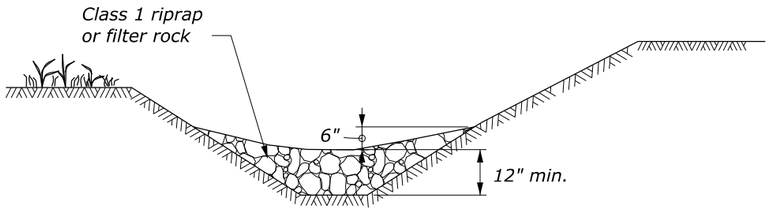
CROSS SECTION



V DITCH
CROSS SECTION



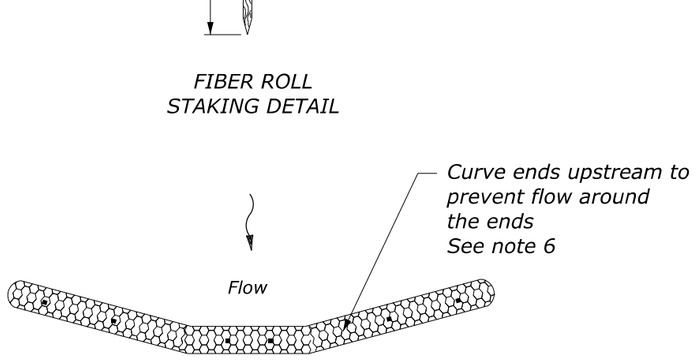
FIBER ROLL
STAKING DETAIL



FLAT BOTTOM
CROSS SECTION

NOTE:

1. *Check dams of fiber rolls, riprap, filter rock, or gravel bags may be used to meet the functional requirements of the check dam device.*
2. *Repair all rills and gullies and properly compact before installation.*
3. *Install check dams in ditches perpendicular to the flow line.*
4. *Stake fiber rolls in place with 1 1/8" x 1 1/8" wood stakes. Drive stakes at each end of the fiber roll and at 2-foot maximum spacing.*
5. *Drive stakes into undisturbed soil of trench bottom 16" minimum. Expose stakes a minimum of 2 inches above top of fiber roll.*
6. *Provide sufficient length to prevent water from flowing around the ends of the fiber roll.*
7. *Adjust check dam spacing based on site specific conditions.*



PLAN

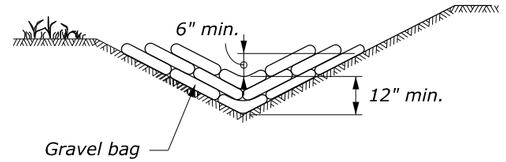
FIBER ROLL CHECK DAM SPACING* (See note 7)	
DITCH GRADE	MAX. CHECK DAM SPACING (ft)
2%	150
3%	100
4%	80
5%	60

*Spacing calculated based on 9" Ø min. fiber roll. Do not use fiber roll check dams on ditch grades steeper than 5%.

FIBER ROLL CHECK DAM

RIPRAP AND FILTER ROCK CHECK DAM SPACING (See note 7)	
DITCH GRADE	MAX. CHECK DAM SPACING (ft)
2%	150
3%	100
4%	80
5%	60
6%	50

RIPRAP OR FILTER ROCK CHECK DAM



CROSS SECTION

GRAVEL BAG CHECK DAM SPACING* (See note 7)	
DITCH GRADE	MAX. CHECK DAM SPACING (ft)
2%	150
3%	100
4%	80
5%	60
6%	50

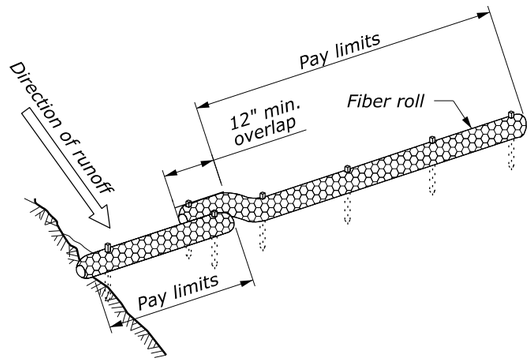
*Do not use gravel bag check dam on ditch grades steeper than 6%

GRAVEL BAG CHECK DAM

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	CFLHD DETAIL C157-53
CHECK DAM	SPECIFICATION FP-24
	APPROVED FOR USE DRAFT: 06/2024

PROJECT	SHEET NUMBER
PROJECT NUMBER PROJECT NAME	



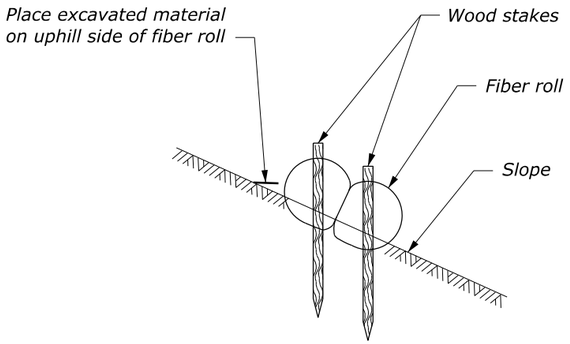
FIBER ROLL JOINT DETAIL

FIBER ROLL SPACING TABLE*	
Slope Gradient	9" ∅ Fiber Roll Maximum spacing (ft)
1V:4H or flatter	60
Between 1V:4H and 1V:3H	45
Between 1V:3H and 1V:2H	30
1V:2H and steeper	15

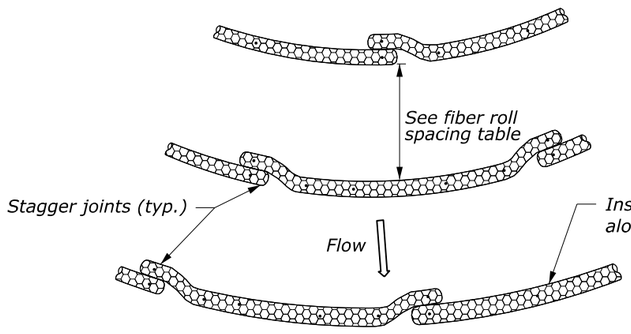
**Approximate spacing shown. Adjust spacing as needed due to site-specific conditions.*

NOTE:

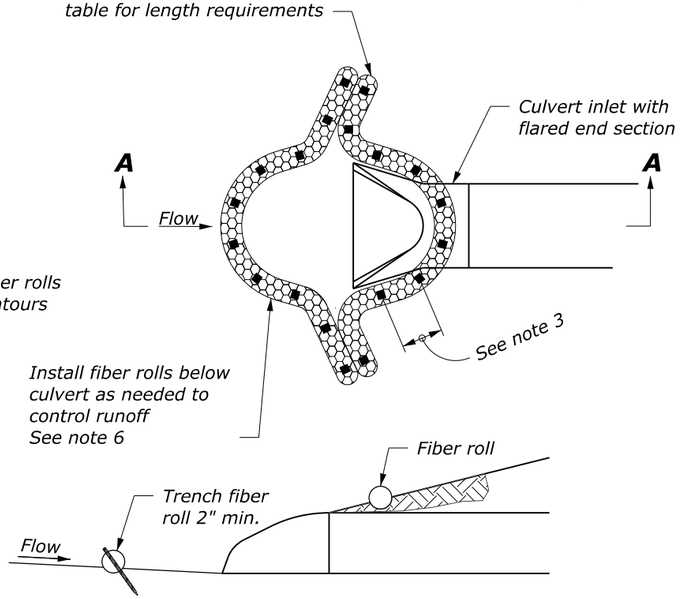
1. Repair all rills and gullies and properly compact before installation.
2. Install fiber rolls along slope contours. For any 20-foot section of fiber roll, do not allow the fiber roll to vary more than 5% from level.
3. Stake fiber rolls in place with 1-inch x 1-inch or 1-inch Ø wood stakes. Space stakes 4-foot o.c. max. on slopes and 2-foot o.c. max. at culverts. Stake fiber rolls 6 inches from each end.
4. Drive stakes into undisturbed soil at least 12 inches deep. Expose stakes 2 inches above top of fiber roll.
5. For fiber rolls on bare soil, construct trenches parallel to the contour. Place fiber rolls in continuous contact with trench bottom and sides. Tamp soil backfill against upstream side of fiber roll to ensure storm water is forced to flow through fiber roll rather than under it.
6. Place fiber rolls all the way around the inlet when the disturbance is on both the road and around the culvert and all water entering the culvert is crossing the disturbance.



FIBER ROLL LAPPING DETAIL

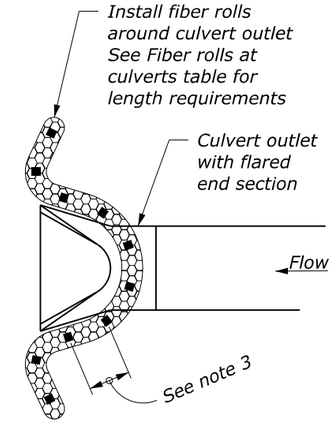


FIBER ROLL SLOPE LAYOUT

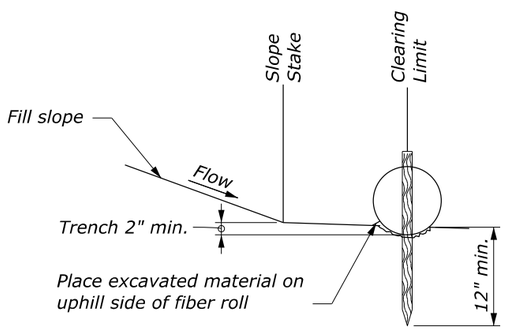


SECTION A-A

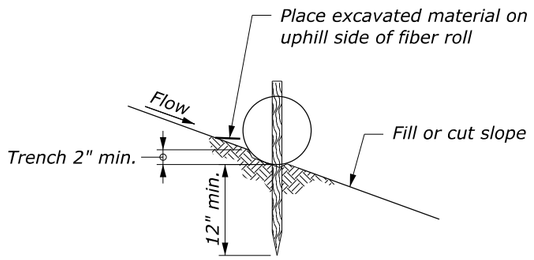
FIBER ROLL AT CULVERT INLET



FIBER ROLL AT CULVERT OUTLET



FIBER ROLL AS PERIMETER CONTROL INSTALLATION DETAIL



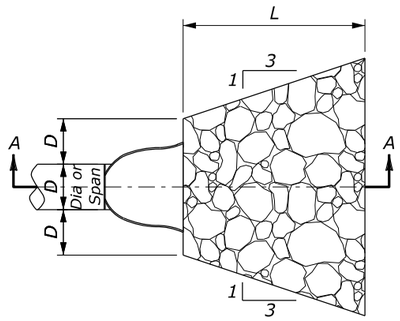
STAKE DETAIL

FIBER ROLL AT CULVERTS*	
Culvert Size	9" ∅ Fiber Roll length (ft)
24" or smaller	10
30" to 48"	20
54" or larger	30

**Approximate length shown for rolls across the top of the culvert inlet only. Adjust length as needed due to site-specific conditions.*

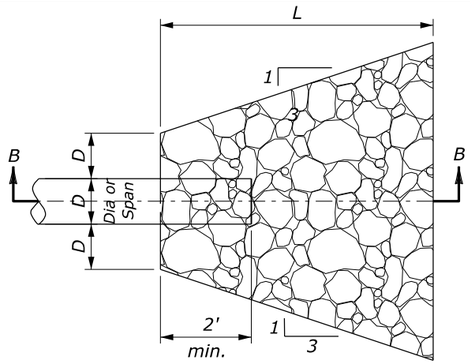
NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	CFLHD DETAIL C157-55
FIBER ROLL	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE DRAFT: 06/2024



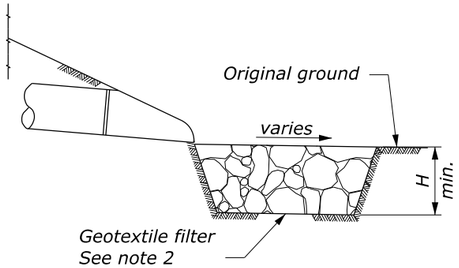
PLAN VIEW

CULVERT WITH STANDARD END SECTION

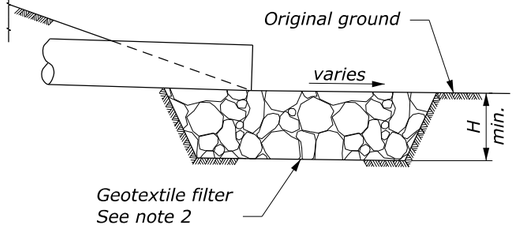


PLAN VIEW

CULVERT WITHOUT STANDARD END SECTION

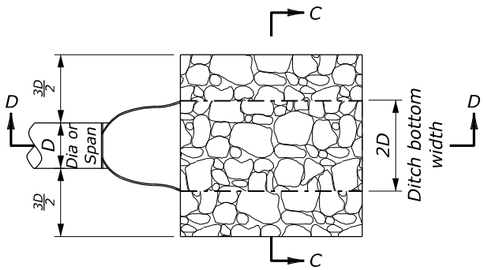


SECTION A-A



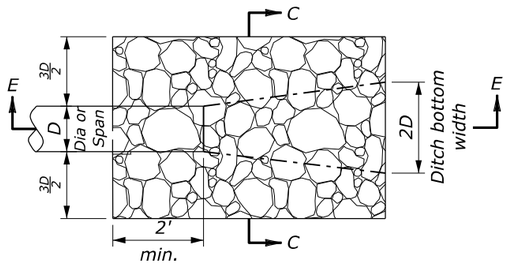
SECTION B-B

PROTECTIVE APRON AT CULVERT OUTLET WITHOUT DITCH



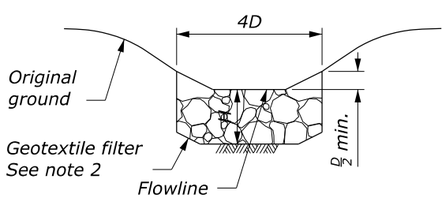
PLAN VIEW

CULVERT WITH STANDARD END SECTION

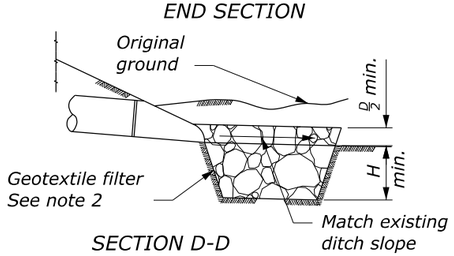


PLAN VIEW

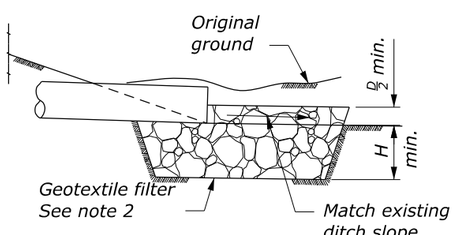
CULVERT WITHOUT STANDARD END SECTION



SECTION C-C



SECTION D-D



SECTION E-E

PROTECTIVE APRON AT CULVERT OUTLET WITH DITCH

NO SCALE

OUTLET WITHOUT DITCH
PROTECTIVE APRON DIMENSIONS AND ESTIMATED QUANTITIES

	CULVERT SIZE D (inches)	RIPRAP CLASS	LENGTH OF APRON L (feet)	DEPTH OF APRON H (feet)	ESTIMATED RIPRAP QUANTITY (CY)	ESTIMATED GEOTEXTILE QUANTITY (SY)
WITH END SECTION	12	2	4	1.5	1	5
	18	2	6	1.5	2.2	9
	24	2	8	1.5	3.9	14
	30	3	12.5	2	10.9	28
	36	3	16	2	15.6	37
	42	4	21	2.5	34.1	63
	48	4	24	2.5	44.5	79
WITHOUT END SECTION	12	2	6	1.5	1.7	8
	18	2	8	1.5	3.2	12
	24	2	10	1.5	5.2	17
	30	3	14.5	2	13.3	33
	36	3	17	2	18.5	43
	42	4	23	2.5	38.7	70
	48	4	26	2.5	49.8	87

OUTLET WITH DITCH
PROTECTIVE APRON DIMENSIONS AND ESTIMATED QUANTITIES

	CULVERT SIZE D (inches)	RIPRAP CLASS	LENGTH OF APRON L (feet)	DEPTH OF APRON H (feet)	ESTIMATED RIPRAP QUANTITY (CY)	ESTIMATED GEOTEXTILE QUANTITY (SY)
WITH END SECTION	12	2	4	1.5	0.9	5
	18	2	6	1.5	2	8
	24	2	8	1.5	3.6	13
	30	3	12.5	2	9.3	24
	36	3	16	2	13.4	32
	42	4	21	2.5	27.3	53
	48	4	24	2.5	35.6	65
WITHOUT END SECTION	12	2	6	1.5	1.4	6
	18	2	8	1.5	2.7	10
	24	2	10	1.5	4.5	15
	30	3	14.5	2	10.8	27
	36	3	17	2	15.2	36
	42	4	23	2.5	29.9	57
	48	4	26	2.5	38.6	70

NOTE:

1. Use for slopes serving culverts with slopes of less than 10%.
2. Furnish geotextile filter conforming to Subsection 714.01(c).
3. Excavation for placement of riprap will not be measured for payment.

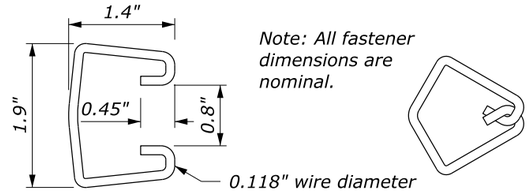
PROJECT	SHEET NUMBER
PROJECT NUMBER PROJECT NAME	

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

PLACED RIPRAP AT CULVERT OUTLETS

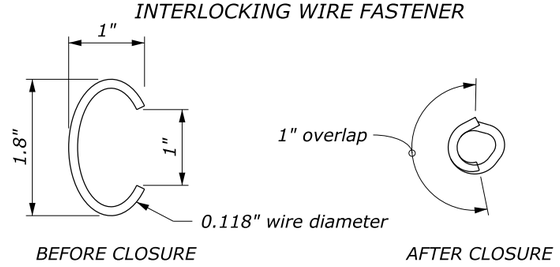
CFLHD DETAIL C251-50
SPECIFICATION FP-24
APPROVED FOR USE 06/2024

PROJECT	SHEET NUMBER



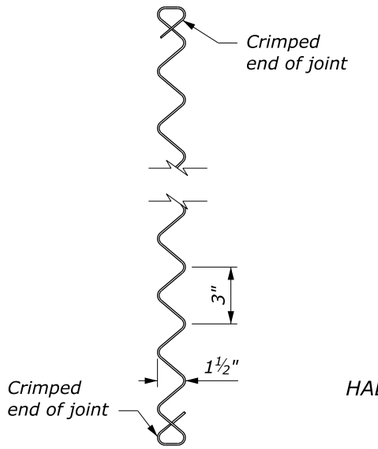
Note: All fastener dimensions are nominal.

INTERLOCKING WIRE FASTENER

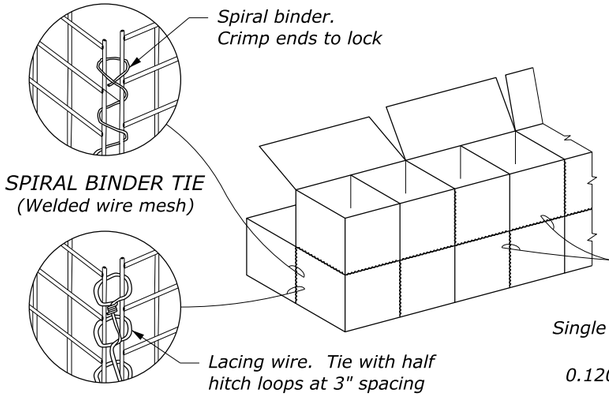


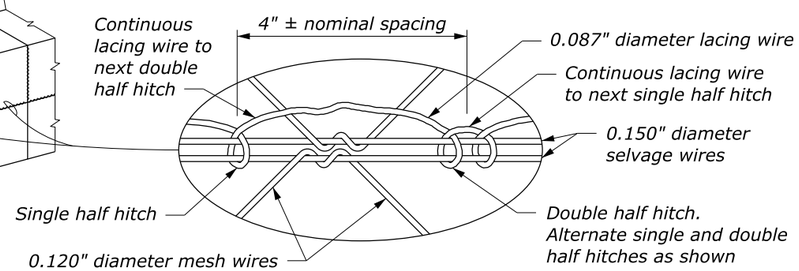
OVERLAPPING RING WIRE FASTENER
(Not allowed for basket to basket connection)

ALTERNATE TYING FASTENERS

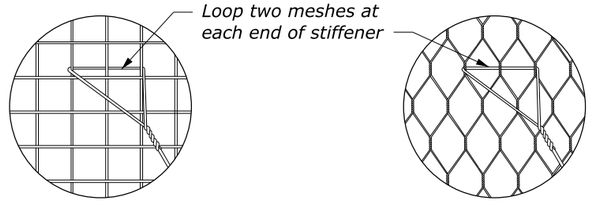


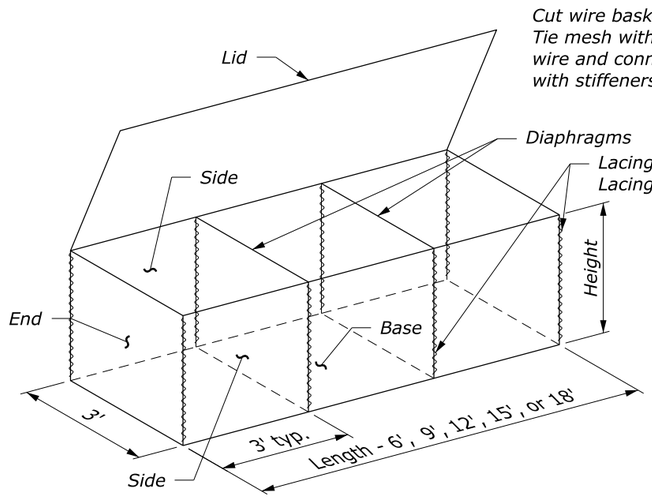
0.150" DIAMETER SPIRAL BINDER





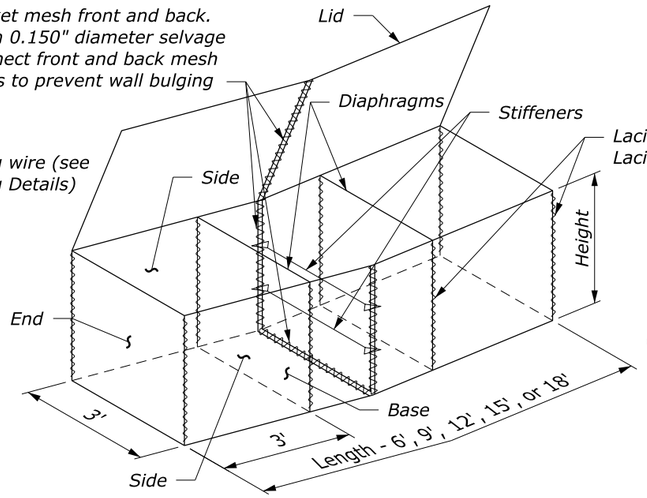
TYPICAL INSTALLATION GABION BASKETS



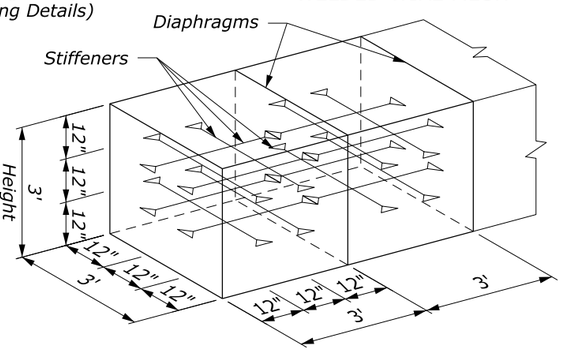


TYPICAL ASSEMBLED GABION BASKET

Cut wire basket mesh front and back. Tie mesh with 0.150" diameter selvage wire and connect front and back mesh with stiffeners to prevent wall bulging

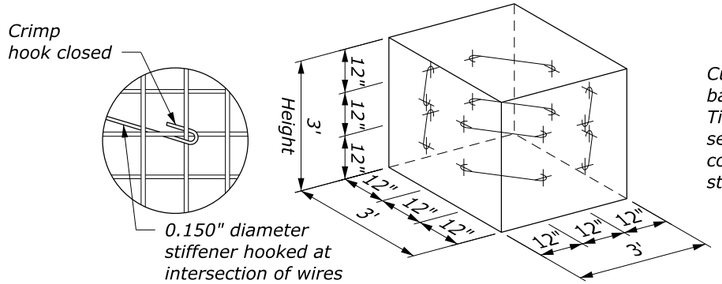


ASSEMBLED GABION BASKET IN WALL GRADE TRANSITION AREAS

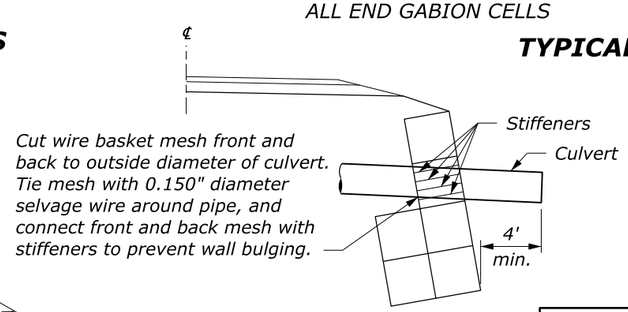


TYPICAL STIFFENERS

GABION BASKET NOMINAL SIZES AND CAPACITY				
Size Code Letter	Size in feet Length	Height	Diaphragm Partitions	Capacity (CUYD)
A	6	3.0	1	2.00
B	9	3.0	2	3.00
C	12	3.0	3	4.00
X	15	3.0	4	5.00
Y	18	3.0	5	6.00
D	6	1.5	1	1.00
E	9	1.5	2	1.50
F	12	1.5	3	2.00
G	6	1.0	1	0.67
H	9	1.0	2	1.00
I	12	1.0	3	1.33



OPTIONAL STIFFENERS WELDED WIRE GABION BASKET



TYPICAL CULVERT INSTALLATION

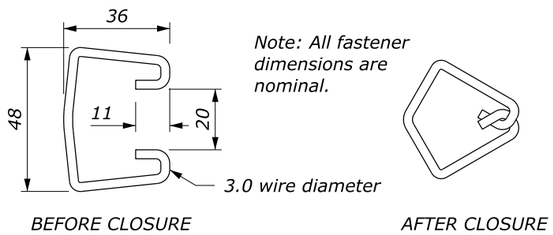
THROUGH GABION WALL

NO SCALE

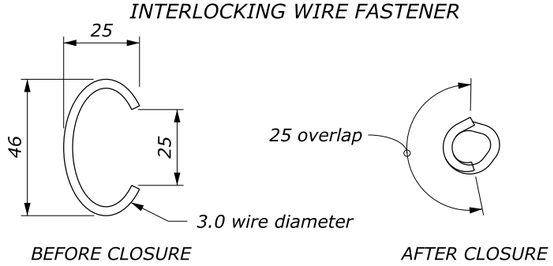
U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	WFL STANDARD W253-1
GABION BASKET	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 9/2011

c:\pw-work\dms\907441\W253-1.dgn [Std W253-1]
6 March 2025 11:45 AM

PROJECT	SHEET NUMBER

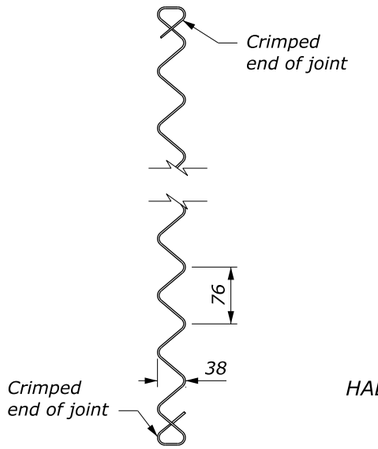


INTERLOCKING WIRE FASTENER

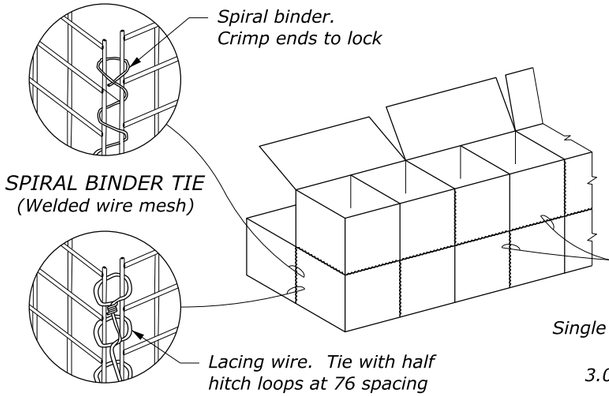


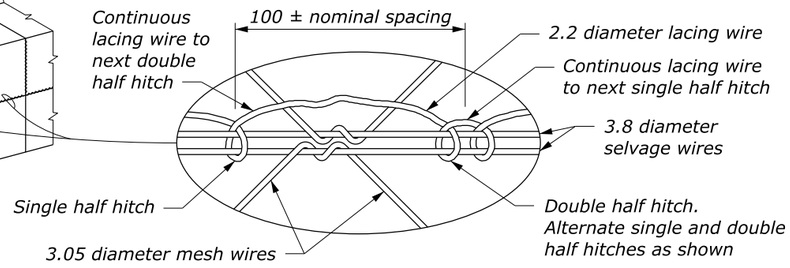
OVERLAPPING RING WIRE FASTENER
(Not allowed for basket to basket connection)

ALTERNATE TYING FASTENERS

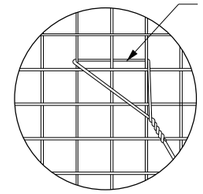


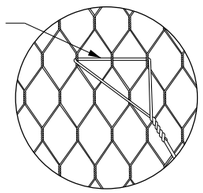
3.8 mm DIAMETER SPIRAL BINDER

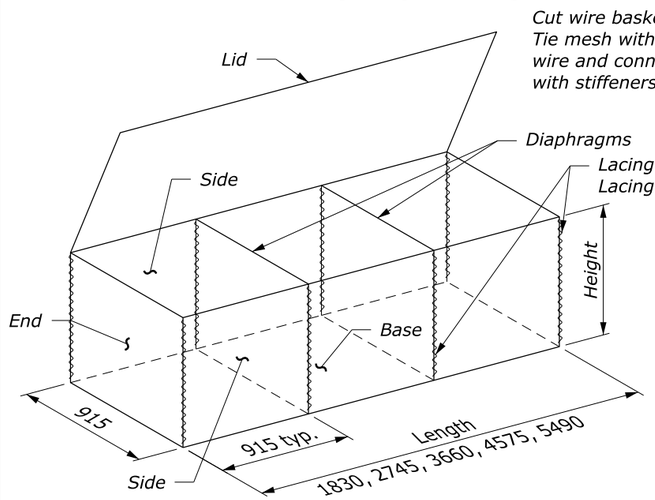




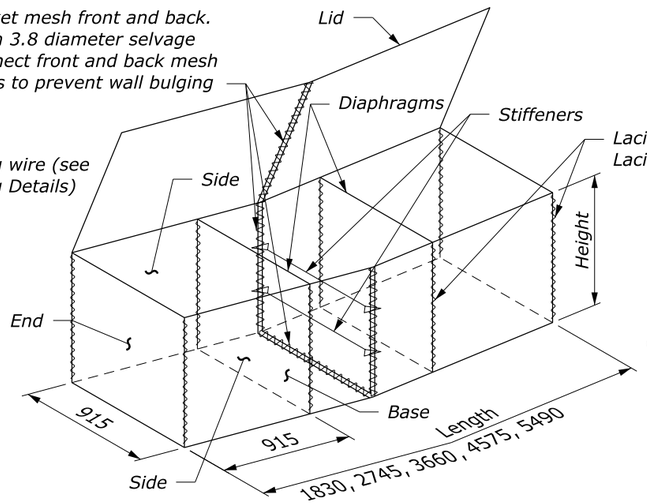
TYPICAL INSTALLATION GABION BASKETS



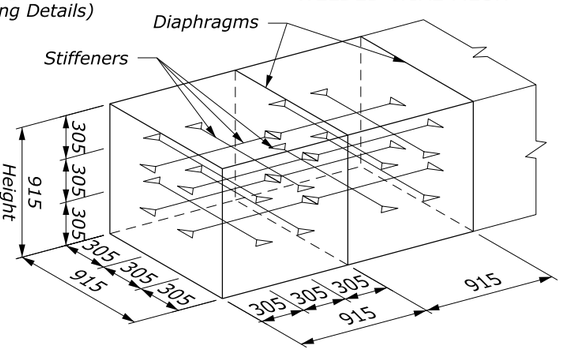




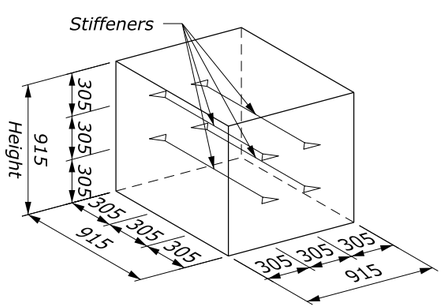
TYPICAL ASSEMBLED GABION BASKET



ASSEMBLED GABION BASKET IN WALL GRADE TRANSITION AREAS



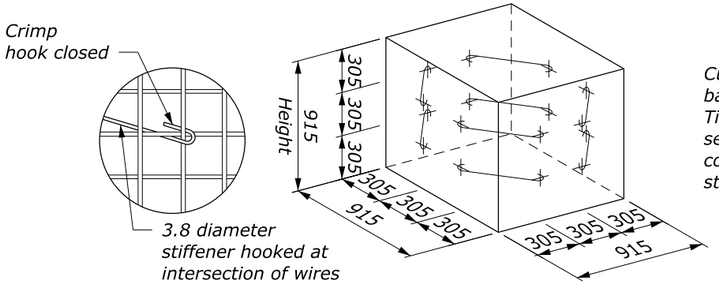
ALL END GABION CELLS



ALL INTERIOR GABION CELLS

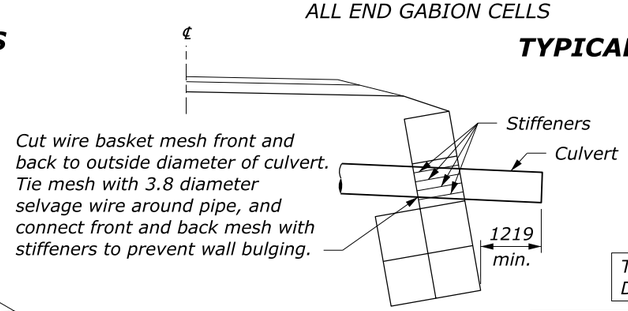
TYPICAL STIFFENERS

GABION BASKET NOMINAL SIZES AND CAPACITY				
Size Code Letter	Size in meters Length	Height	Diaphragm Partitions	Capacity (m3)
A	1.83	0.915	1	1.5
B	2.75	0.915	2	2.3
C	3.66	0.915	3	3.1
X	4.58	0.915	4	3.8
Y	5.49	0.915	5	4.6
D	1.83	0.45	1	0.8
E	2.75	0.45	2	1.1
F	3.66	0.45	3	1.5
G	1.83	0.30	1	0.5
H	2.75	0.30	2	0.8
I	3.66	0.30	3	1.0



ALL GABION CELLS

OPTIONAL STIFFENERS WELDED WIRE GABION BASKET



TYPICAL CULVERT INSTALLATION
THROUGH GABION WALL

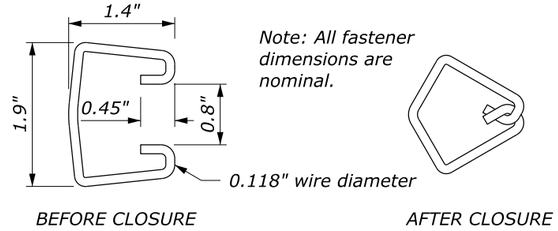
NO SCALE

This drawing contains **Metric** units of measure.
Dimensions without units are millimeters.

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	WFL STANDARD WM253-1
GABION BASKET	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 9/2011

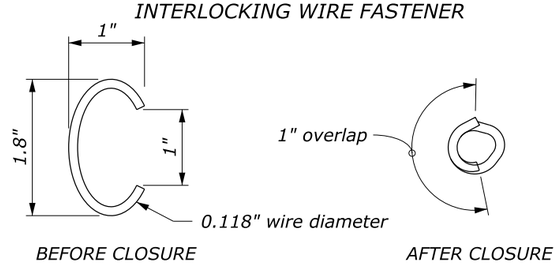
5 March 2025 10:43 AM c:\pw-work\d0413405\W253-1.dgn [Std WM253-1]

PROJECT	SHEET NUMBER



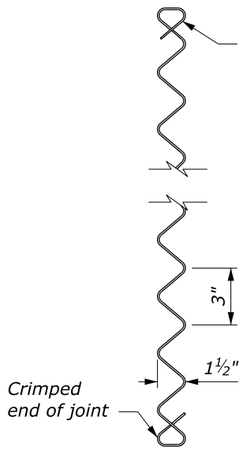
Note: All fastener dimensions are nominal.

INTERLOCKING WIRE FASTENER

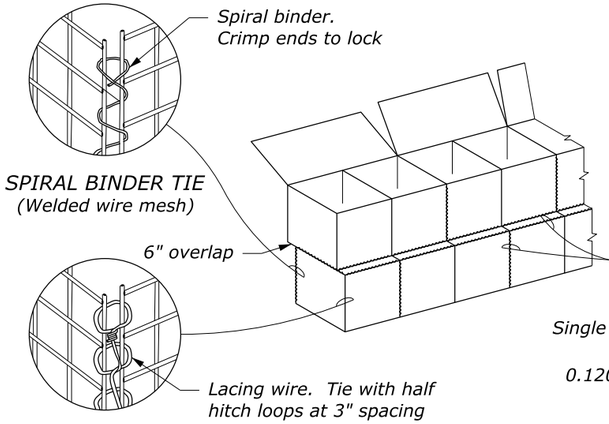


OVERLAPPING RING WIRE FASTENER

ALTERNATE TYING FASTENERS

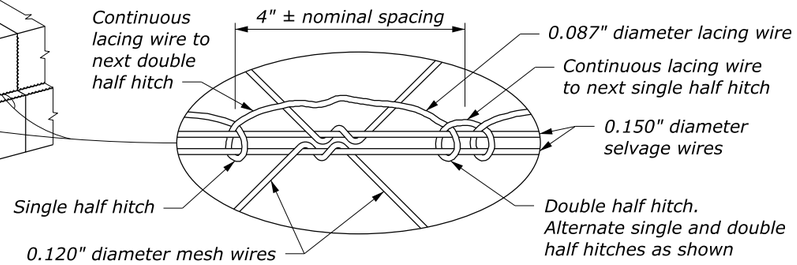


0.150" DIAMETER SPIRAL BINDER



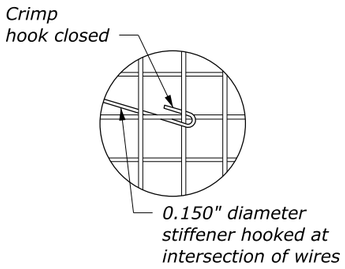
SPIRAL BINDER TIE
(Welded wire mesh)

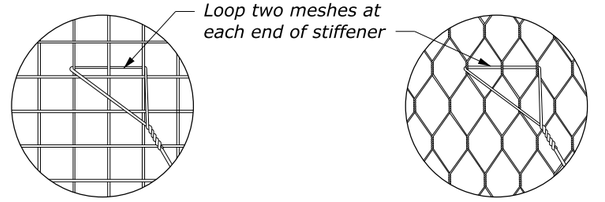
HALF HITCH LACING DETAIL
(Welded wire mesh)



HALF HITCH LACING DETAIL
(Twisted wire mesh)

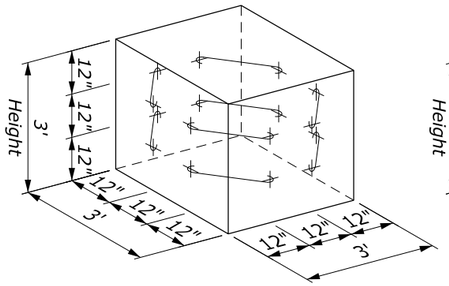
TYPICAL INSTALLATION GABION BASKETS



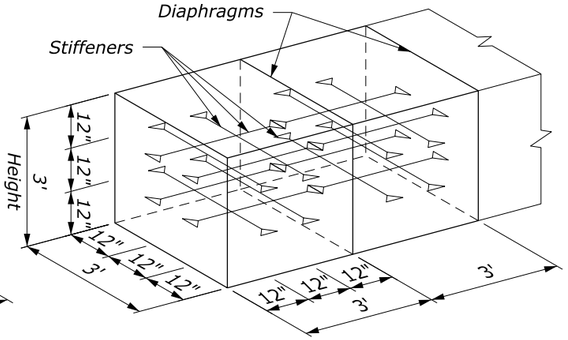


WELDED WIRE MESH

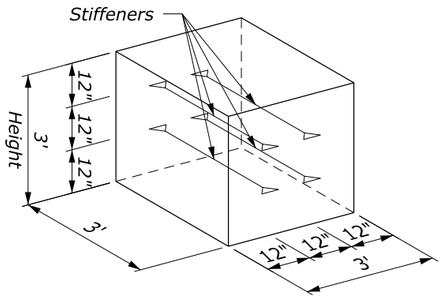
TWISTED WIRE MESH



ALL GABION CELLS



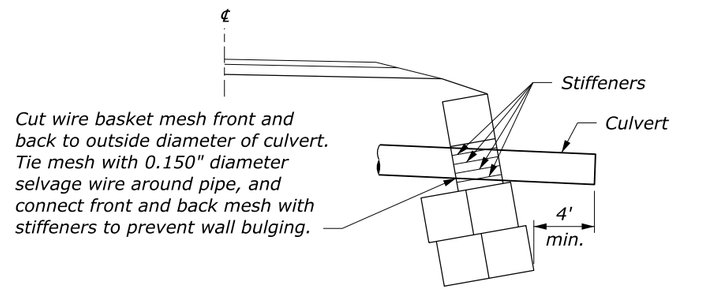
ALL END GABION CELLS



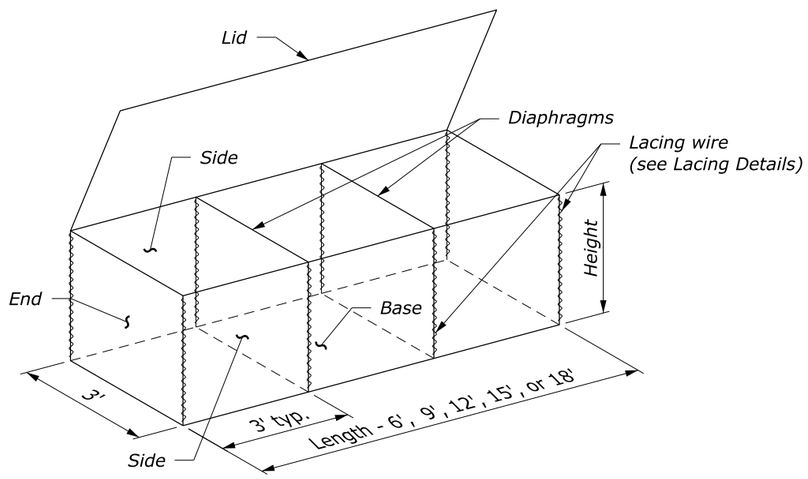
ALL INTERIOR GABION CELLS

OPTIONAL STIFFENERS
WELDED WIRE GABION BASKET

TYPICAL STIFFENERS



TYPICAL CULVERT INSTALLATION
THROUGH GABION WALL



TYPICAL ASSEMBLED GABION BASKET

GABION BASKET NOMINAL SIZES AND CAPACITY				
Size Code Letter	Size in feet Length	Height	Diaphragm Partitions	Capacity (CUYD)
A	6	3.0	1	2.00
B	9	3.0	2	3.00
C	12	3.0	3	4.00
X	15	3.0	4	5.00
Y	18	3.0	5	6.00

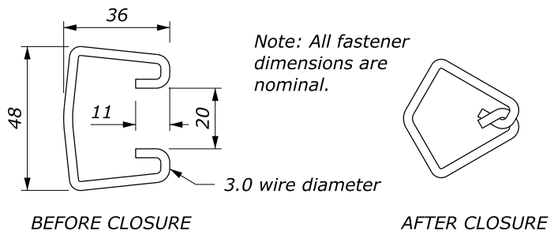
NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

GABION FACED WALL

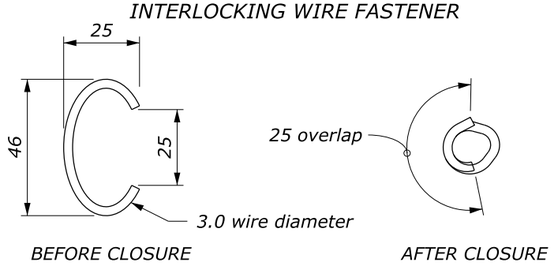
WFL STANDARD
W253-2
SPECIFICATION
FP-24, FP-14
APPROVED FOR USE
9/2011

PROJECT	SHEET NUMBER



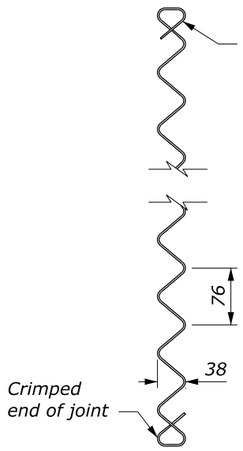
Note: All fastener dimensions are nominal.

INTERLOCKING WIRE FASTENER

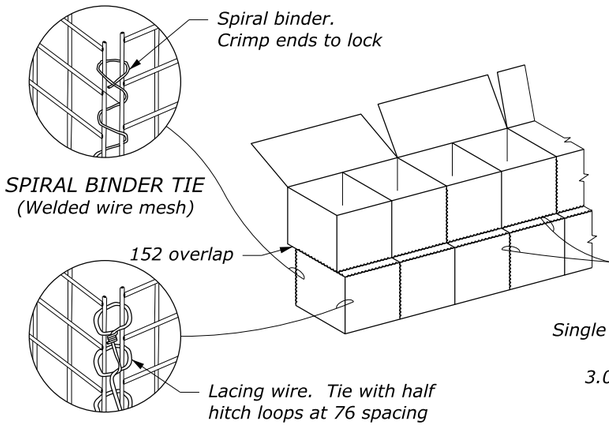


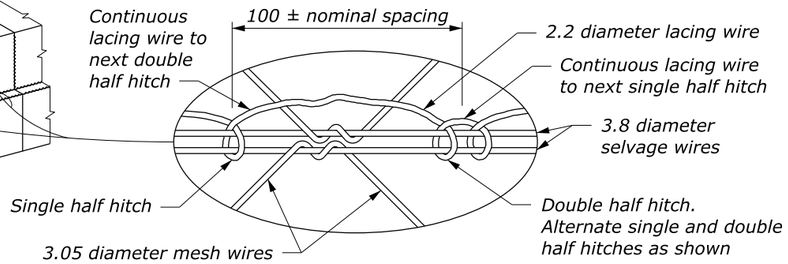
OVERLAPPING RING WIRE FASTENER

ALTERNATE TYING FASTENERS

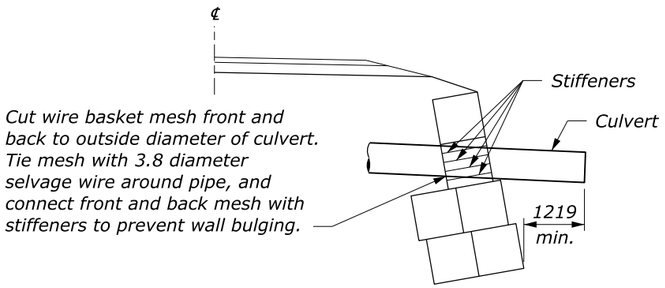


3.8 mm DIAMETER SPIRAL BINDER





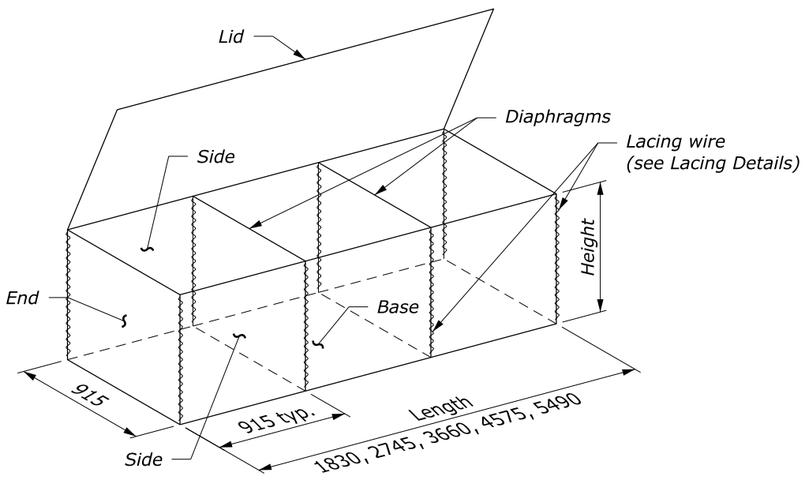
TYPICAL INSTALLATION GABION BASKETS



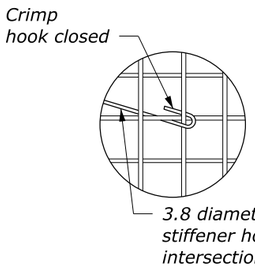
Cut wire basket mesh front and back to outside diameter of culvert. Tie mesh with 3.8 diameter selvage wire around pipe, and connect front and back mesh with stiffeners to prevent wall bulging.

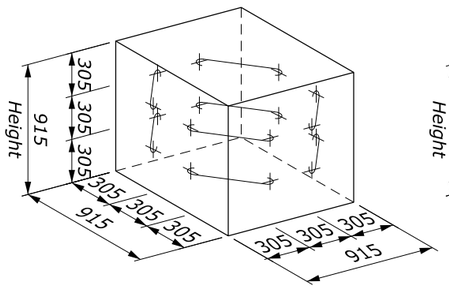
TYPICAL CULVERT INSTALLATION

THROUGH GABION WALL



TYPICAL ASSEMBLED GABION BASKET

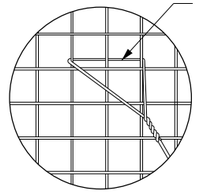




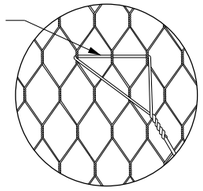
ALL GABION CELLS

OPTIONAL STIFFENERS WELDED WIRE GABION BASKET

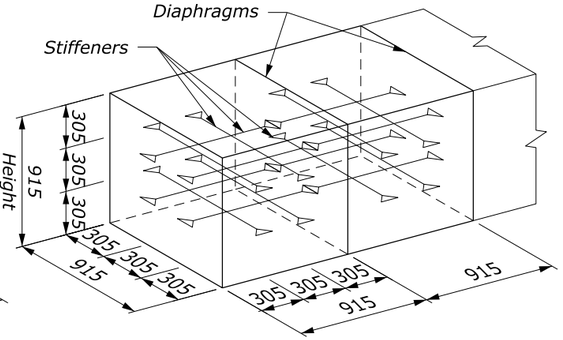
GABION BASKET NOMINAL SIZES AND CAPACITY				
Size Code Letter	Size in meters Length	Height	Diaphragm Partitions	Capacity (m3)
A	1.83	0.915	1	1.5
B	2.75	0.915	2	2.3
C	3.66	0.915	3	3.1
X	4.58	0.915	4	3.8
Y	5.49	0.915	5	4.6



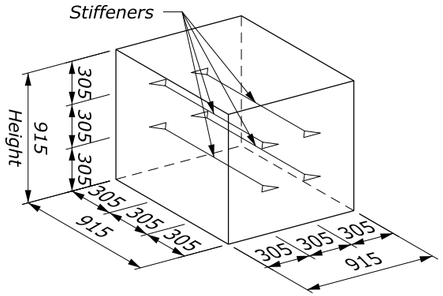
WELDED WIRE MESH



TWISTED WIRE MESH



ALL END GABION CELLS



ALL INTERIOR GABION CELLS

TYPICAL STIFFENERS

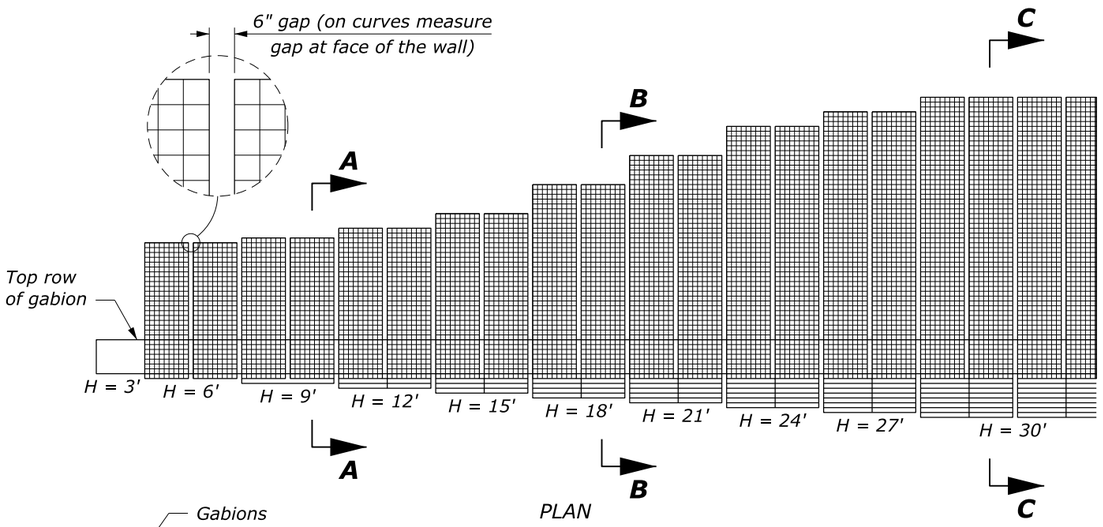
*This drawing contains **Metric** units of measure. Dimensions without units are millimeters.*

NO SCALE

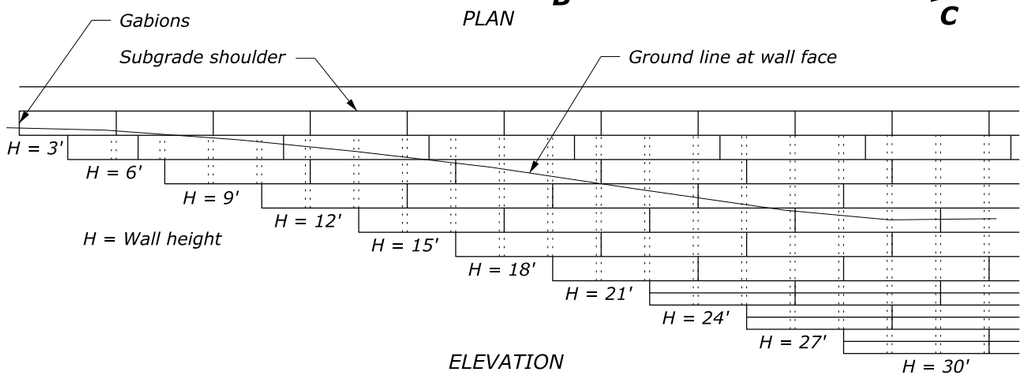
U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	WFL STANDARD WM253-2
GABION FACED WALL	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 9/2011

c:\pw~work\d0413405\W2253-2.dgn [Std WM253~2]
6 March 2025 11:50 AM

PROJECT	SHEET NUMBER

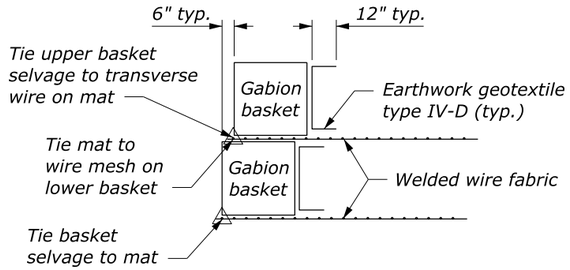


PLAN

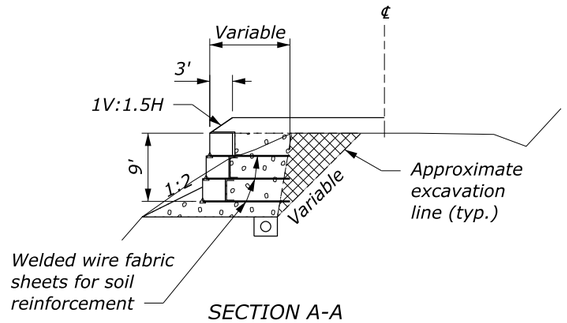


ELEVATION

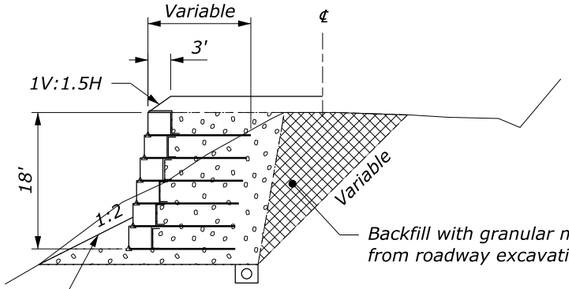
TYPICAL GABION WALL



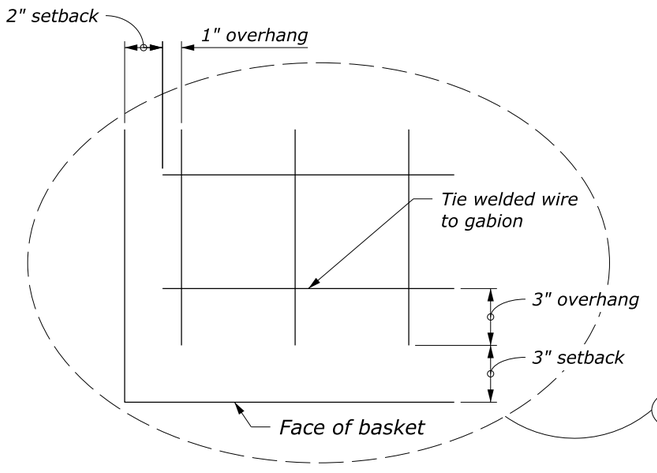
TYPICAL CONNECTION DETAIL

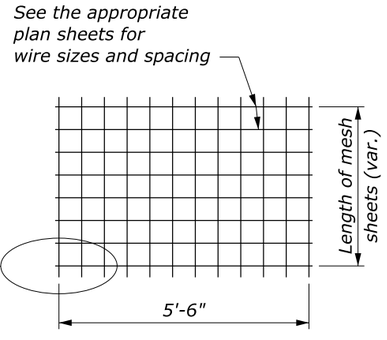


SECTION A-A

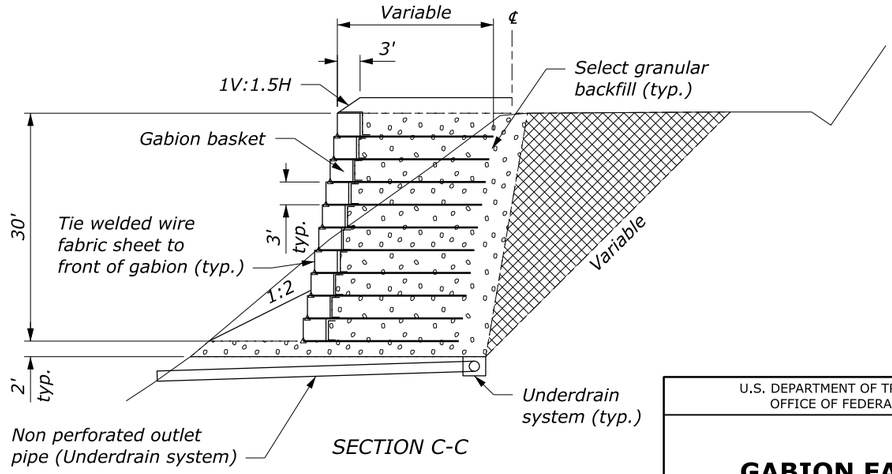


SECTION B-B





WELDED WIRE FABRIC SHEETS FOR SOIL REINFORCEMENT



SECTION C-C

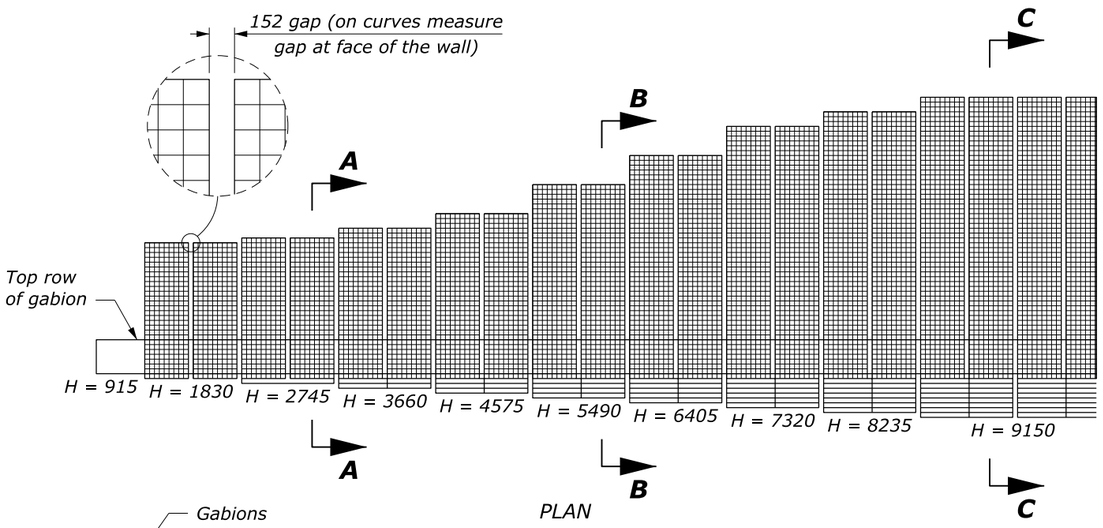
NO SCALE

NOTE:

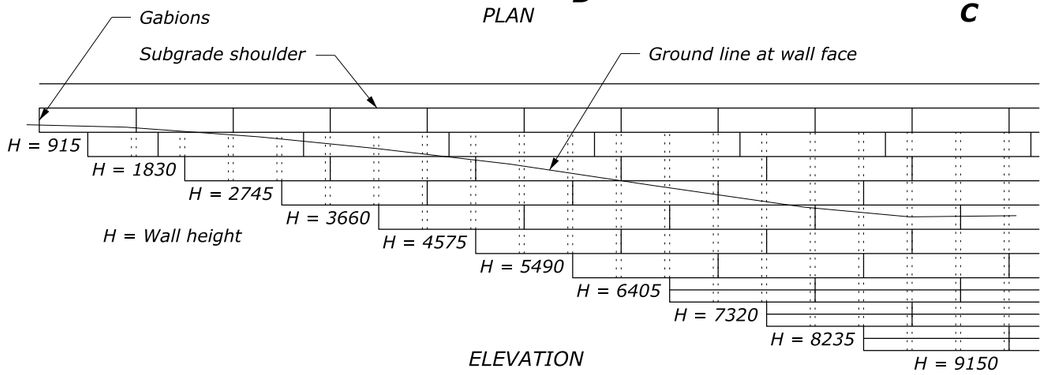
1. The welded wire fabric sheets vary in length within each wall. The height (H) of the vertical face of the wall determines the length of the welded wire fabric for the entire section. See other plan sheets for fabric lengths, wire sizes and spacing and number of mats. Where the wall construction requires the width of the welded wire fabric sheets to be less than 5.5 feet, the fabric wire may be field cut to fit. Cut fabric at center of mesh of welded wire fabric sheets.
2. Place layers of welded wire fabric sheets with 6 inch gaps between sheets. The 6 inch gaps are measure at the face of the wall. Connect the welded wire fabric sheets with spiral binders or tie wire to the front edge of each gabion basket.
3. The heights and quantities are subject to field adjustment. Any increase in wall heights over those shown on the plans require investigation to determine that the safe bearing pressure is not exceeded.
4. Average design assumption values. See the Geotechnical Report, if available, for site specific values.
   - Unit weight of backfill material 125 pcf
   - Unit weight of filled gabions 105 pcf
   - Ø angle = 35° for backfill material

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	WFL STANDARD W253-3
GABION FACED WALL	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 9/2011

PROJECT	SHEET NUMBER

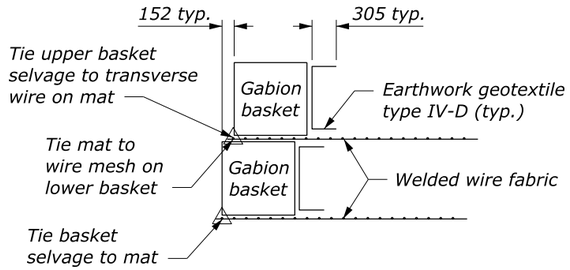


PLAN

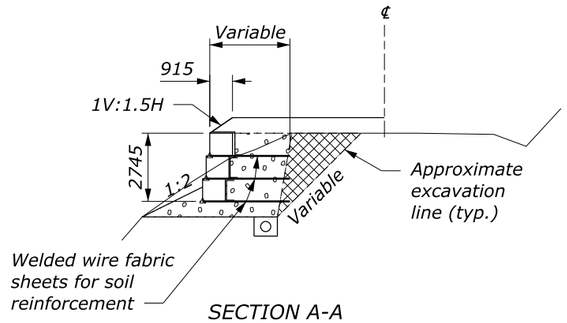


ELEVATION

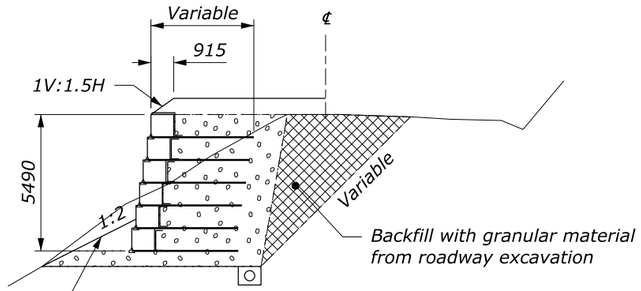
TYPICAL GABION WALL



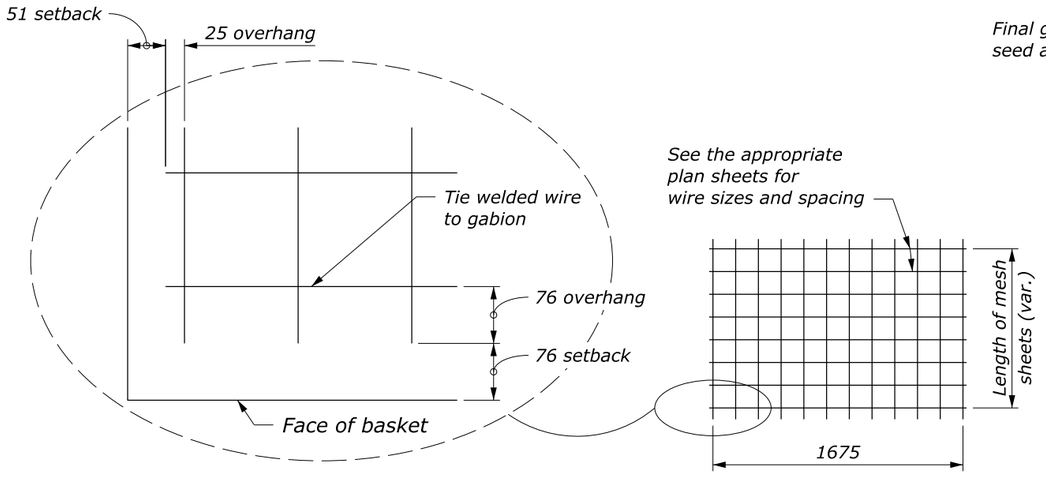
TYPICAL CONNECTION DETAIL



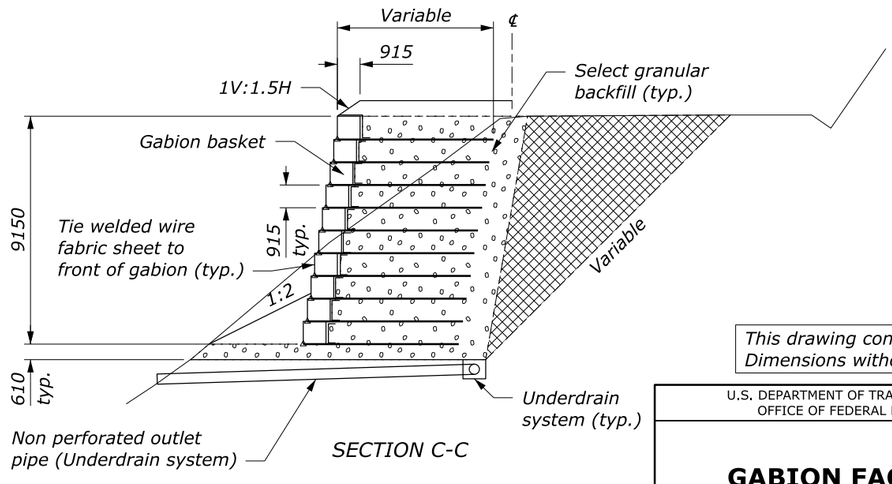
SECTION A-A



SECTION B-B



WELDED WIRE FABRIC SHEETS FOR SOIL REINFORCEMENT



SECTION C-C

NO SCALE

NOTE:

1. *The welded wire fabric sheets vary in length within each wall. The height (H) of the vertical face of the wall determines the length of the welded wire fabric for the entire section. See other plan sheets for fabric lengths, wire sizes and spacing and number of mats. Where the wall construction requires the width of the welded wire fabric sheets to be less than 1650 m, the fabric wire may be field cut to fit. Cut fabric at center of mesh of welded wire fabric sheets.*

2. *Place layers of welded wire fabric sheets with 150 mm gaps between sheets. The 150 mm gaps are measure at the face of the wall. Connect the welded wire fabric sheets with spiral binders or tie wire to the front edge of each gabion basket.*

3. *The heights and quantities are subject to field adjustment. Any increase in wall heights over those shown on the plans require investigation to determine that the safe bearing pressure is not exceeded.*

4. *Average design assumption values. See the Geotechnical Report, if available, for site specific values.*
   Unit weight of backfill material 20.8 kN/m3
   Unit weight of filled gabions 17.6 kN/m3
   Ø angle = 35° for backfill material

*This drawing contains **Metric** units of measure. Dimensions without units are millimeters.*

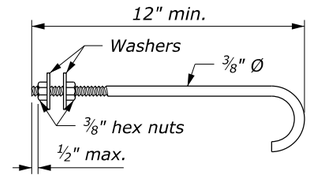
U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	WFLHD DETAIL WM253-3
GABION FACED WALL	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 9/2011

PROJECT	SHEET NUMBER

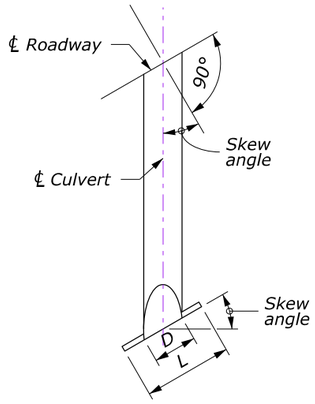
HEADWALL FOR DOUBLE PIPE CULVERT

DIMENSIONS, REINFORCING STEEL AND CONCRETE TABLE OF QUANTITIES

D	H	SQUARE HEADWALL					15° SKEW					30° SKEW					45° SKEW				
INCH	FEET	A FEET	B FEET	L FEET	CONC. CUYD	STEEL LB	A FEET	B FEET	L FEET	CONC. CUYD	STEEL LB	A FEET	B FEET	L FEET	CONC. CUYD	STEEL LB	A FEET	B FEET	L FEET	CONC. CUYD	STEEL LB
48	5.00	4.00	6.00	14.00	2.13	180	4.25	6.25	14.75	2.25	191	4.50	7.00	16.00	2.43	203	5.75	8.50	20.00	3.05	257
54	5.25	4.75	6.75	16.25	2.57	210	4.75	7.00	16.50	2.60	217	5.25	7.75	18.25	2.87	239	6.50	9.50	22.50	3.54	295
60	5.50	5.25	7.50	18.00	2.94	236	5.50	7.75	18.75	3.07	248	6.00	8.75	20.75	3.39	279	7.50	10.50	25.50	4.17	336
66	5.75	6.00	8.25	20.25	3.43	289	6.00	8.50	20.50	3.45	290	6.75	9.50	23.00	3.88	327	8.25	11.75	28.25	4.77	407
72	6.00	6.50	9.00	22.00	3.84	318	6.75	9.25	22.75	3.97	331	7.50	10.50	25.50	4.46	368	9.25	12.75	31.25	5.46	457
78	6.25	7.25	9.75	24.25	4.38	361	7.50	10.00	25.00	4.51	374	8.25	11.25	27.75	5.00	410	10.00	13.75	33.75	6.07	498
84	6.50	7.75	10.50	26.00	4.83	410	8.00	10.75	26.75	4.96	424	9.00	12.00	30.00	5.58	476	11.00	14.75	36.75	6.83	586
90	6.75	8.50	11.25	28.25	5.43	458	8.75	11.75	29.25	5.62	475	9.75	13.00	32.50	6.24	526	11.75	16.00	39.50	7.56	638
96	7.00	9.00	12.00	30.00	5.92	491	9.25	12.50	31.00	6.11	509	10.50	13.75	34.75	6.86	575	12.75	17.00	42.50	8.39	699
102	7.25	9.75	12.50	32.00	6.49	553	10.00	13.00	33.00	6.69	571	11.00	14.50	36.50	7.37	637	13.50	17.75	44.75	9.04	783
108	7.50	10.25	13.00	33.50	6.95	591	10.50	13.50	34.50	7.14	604	11.75	15.00	38.50	7.97	676	14.50	18.50	47.50	9.86	842
114	7.75	11.00	13.50	35.50	7.56	632	11.25	14.00	36.50	7.76	654	12.50	15.50	40.50	8.59	717	15.50	19.00	50.00	10.64	893
120	8.00	11.50	14.00	37.00	8.05	666	12.00	14.50	38.50	8.40	695	13.25	16.25	42.75	9.31	771	16.25	19.75	52.25	11.37	949
126	8.25	12.25	14.50	39.00	8.71	748	12.50	15.00	40.00	8.90	760	14.00	16.75	44.75	9.97	858	17.25	20.50	55.00	12.27	1053
132	8.50	12.75	15.00	40.50	9.23	775	13.25	15.50	42.00	9.58	805	14.75	17.25	46.75	10.65	902	18.00	21.25	57.25	13.05	1105
138	8.75	13.50	15.50	42.50	9.93	831	13.75	16.00	43.50	10.11	842	15.50	18.00	49.00	11.44	955	19.00	22.00	60.00	14.00	1173
144	9.00	14.00	16.00	44.00	10.48	902	14.50	16.50	45.50	10.83	922	16.25	18.50	51.00	12.16	1039	19.75	22.75	62.25	14.83	1281
150	9.25	14.75	16.50	46.00	11.21	950	15.25	17.00	47.50	11.57	981	17.00	19.00	53.00	12.91	1087	20.75	23.25	64.75	15.76	1341
156	9.50	15.25	17.00	47.50	11.80	991	15.75	17.50	49.00	12.15	1022	17.50	19.75	54.75	13.59	1144	21.50	24.00	67.00	16.62	1394
162	9.75	16.00	17.50	49.50	12.57	1077	16.50	18.00	51.00	12.93	1109	18.25	20.25	56.75	14.37	1236	22.50	24.75	69.75	17.69	1533
168	10.00	16.50	18.00	51.00	13.19	1121	17.00	18.75	52.75	13.63	1157	19.00	20.75	58.75	15.18	1288	23.25	25.50	72.00	18.60	1581
174	10.25	17.25	18.50	53.00	14.00	1173	17.75	19.25	54.75	14.45	1222	19.75	21.25	60.75	16.00	1353	24.25	26.25	74.75	19.73	1673
180	10.50	17.75	19.00	54.50	14.65	1218	18.50	19.75	56.75	15.29	1276	20.50	22.00	63.00	16.94	1411	25.00	26.75	76.75	20.59	1727



HOOK BOLT DETAIL



TYPICAL HALF PLAN

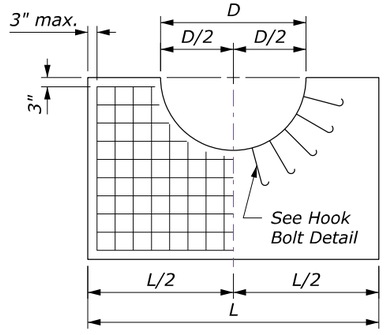
NOTE:

1. Pour concrete monolithically. Chamfer all exposed edges 3/4 inch and finish all exposed surfaces with a Class 1 ordinary finish.
2. Clearance for reinforcing steel is 2 inches unless otherwise noted.
3. Headwall dimension "H" may be reduced in solid rock provided the wall is keyed into the rock at least 1 foot.
4. Set hook bolts on nominal 18-inch centers around pipe perimeter at center of headwall. Hook bolts conform to ASTM A307. Galvanize according to ASTM A153.
5. For installations with more than two pipe culverts, increase the dimension "L" and all quantities shown for double pipe installation by adding a length equal to dimension "B" and the incremental change in quantities for each additional pipe culvert.
6. For skews other than those shown, multiply quantities and dimensions "A", "B" & "L" for square headwalls by secant of the skew angle.
7. Final quantities will be determined by using the tables on this standard.
8. Do not order materials until the length, skew angle, and slope bevel in the field have been approved.

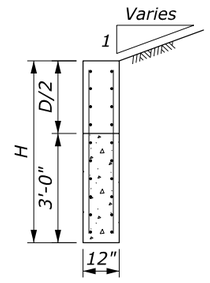
HEADWALL FOR SINGLE PIPE CULVERT

DIMENSIONS, REINFORCING STEEL AND CONCRETE TABLE OF QUANTITIES

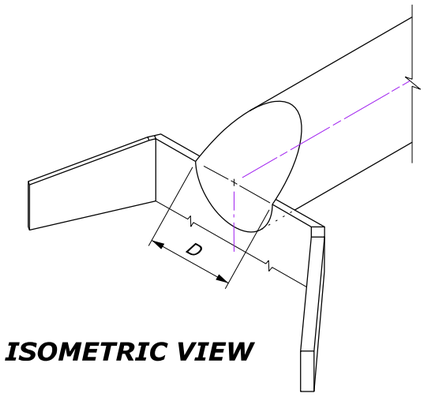
D	H	SQUARE HEADWALL			15° SKEW			30° SKEW			45° SKEW		
INCH	FEET	L FEET	CONC. CUYD	STEEL LB	L FEET	CONC. CUYD	STEEL LB	L FEET	CONC. CUYD	STEEL LB	L FEET	CONC. CUYD	STEEL LB
48	5.00	8.00	1.25	101	8.25	1.29	109	9.25	1.44	120	11.25	1.75	144
54	5.25	9.25	1.50	124	9.50	1.54	126	10.75	1.75	148	13.00	2.11	175
60	5.50	10.50	1.78	143	10.75	1.81	151	12.00	2.02	164	14.75	2.49	208
66	5.75	11.75	2.06	175	12.25	2.15	186	13.50	2.37	203	16.50	2.89	249
72	6.00	13.00	2.37	196	13.50	2.46	207	15.00	2.73	231	18.50	3.37	286
78	6.25	14.25	2.68	221	14.75	2.78	233	16.50	3.11	259	20.25	3.82	317
84	6.50	15.50	3.02	256	16.00	3.11	268	18.00	3.51	299	22.00	4.29	368
90	6.75	16.75	3.37	284	17.25	3.47	297	19.25	3.87	327	23.75	4.78	406
96	7.00	18.00	3.74	309	18.75	3.90	325	20.75	4.30	364	25.50	5.29	442
102	7.25	19.25	4.12	354	20.00	4.28	371	22.25	4.76	416	27.25	5.83	510
108	7.50	20.50	4.52	381	21.25	4.68	399	23.75	5.24	447	29.00	6.39	554
114	7.75	21.75	4.93	419	22.50	5.10	430	25.00	5.66	479	30.75	6.97	594
120	8.00	23.00	5.36	441	23.75	5.53	460	26.50	6.17	521	32.50	7.57	634
126	8.25	24.25	5.81	502	25.00	5.98	514	28.00	6.70	572	34.25	8.20	711
132	8.50	25.50	6.27	527	26.50	6.52	560	29.50	7.25	618	36.00	8.84	754
138	8.75	26.75	6.75	570	27.75	7.00	584	31.00	7.83	658	37.75	9.51	799
144	9.00	28.00	7.24	619	29.00	7.50	654	32.25	8.33	723	39.50	10.20	885
150	9.25	29.25	7.75	665	30.25	8.01	680	33.75	8.94	761	41.25	10.92	933
156	9.50	30.50	8.27	692	31.50	8.54	728	35.25	9.56	805	43.25	11.74	996
162	9.75	31.75	8.81	767	32.75	9.08	783	36.75	10.21	889	45.00	12.50	1094
168	10.00	33.00	9.37	796	34.25	9.73	838	38.00	10.78	919	46.75	13.28	1146
174	10.25	34.25	9.94	847	35.50	10.31	867	39.50	11.46	974	48.50	14.09	1197
180	10.50	35.50	10.53	877	36.75	10.90	920	41.00	12.17	1022	50.25	14.91	1260



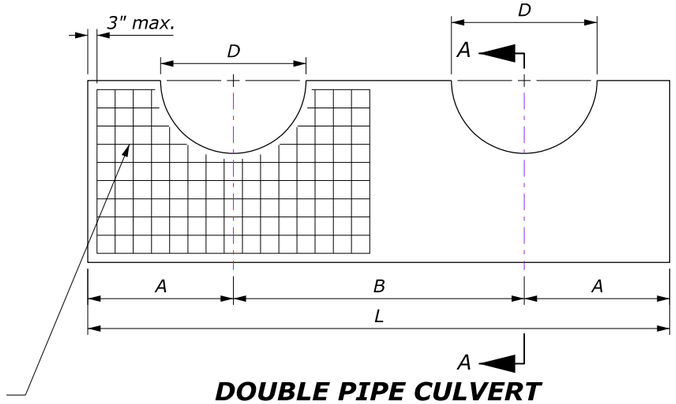
SINGLE PIPE CULVERT



SECTION A-A



ISOMETRIC VIEW



#4 bars at equal spacing
10" max. both faces

DOUBLE PIPE CULVERT HEADWALLS

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	FLH STANDARD 601-1
CONCRETE HEADWALLS	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 2/2024

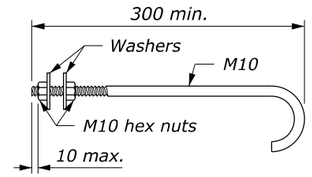
30 May 2024 10:09 AM c:\pw-work\d0147408\Std601-1.dgn [Std 601-1]

PROJECT	SHEET NUMBER

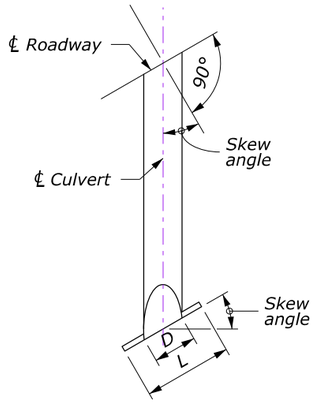
HEADWALL FOR DOUBLE PIPE CULVERT

DIMENSIONS, REINFORCING STEEL AND CONCRETE TABLE OF QUANTITIES

D mm	H m	SQUARE HEADWALL					15° SKEW					30° SKEW					45° SKEW				
		A m	B m	L m	CONC. m3	STEEL kg	A m	B m	L m	CONC. m3	STEEL kg	A m	B m	L m	CONC. m3	STEEL kg	A m	B m	L m	CONC. m3	STEEL kg
1200	1.500	1.2	1.8	4.2	1.55	80	1.2	1.9	4.3	1.58	81	1.4	2.1	4.9	1.81	92	1.7	2.5	5.9	2.18	111
1350	1.575	1.4	2.0	4.8	1.84	93	1.4	2.1	4.9	1.87	93	1.6	2.3	5.5	2.10	107	2.0	2.9	6.9	2.65	134
1500	1.650	1.6	2.3	5.5	2.19	110	1.6	2.3	5.5	2.17	109	1.8	2.6	6.2	2.46	124	2.2	3.2	7.6	3.01	149
1650	1.725	1.8	2.5	6.1	2.52	129	1.8	2.6	6.2	2.54	133	2.0	2.9	6.9	2.83	146	2.5	3.5	8.5	3.49	182
1800	1.800	2.0	2.7	6.7	2.85	147	2.0	2.8	6.8	2.88	147	2.3	3.1	7.7	3.28	168	2.8	3.8	9.4	4.00	204
1950	1.875	2.1	2.9	7.1	3.10	155	2.2	3.0	7.4	3.23	162	2.5	3.4	8.4	3.69	184	3.0	4.1	10.1	4.41	222
2100	1.950	2.3	3.2	7.8	3.52	183	2.4	3.3	8.1	3.66	191	2.7	3.6	9.0	4.07	213	3.3	4.5	11.1	5.02	263
2250	2.025	2.5	3.4	8.4	3.91	199	2.6	3.5	8.7	4.05	211	2.9	3.9	9.7	4.52	234	3.6	4.8	12.0	5.60	291
2400	2.100	2.7	3.6	9.0	4.31	219	2.8	3.7	9.3	4.45	227	3.1	4.2	10.4	4.98	252	3.8	5.1	12.7	6.08	311
2550	2.175	2.9	3.8	9.6	4.73	247	3.0	3.9	9.9	4.87	255	3.3	4.3	10.9	5.34	279	4.1	5.3	13.5	6.64	351
2700	2.250	3.1	3.9	10.1	5.10	265	3.2	4.0	10.4	5.24	271	3.6	4.5	11.7	5.91	309	4.3	5.5	14.1	7.09	369
2850	2.325	3.3	4.0	10.6	5.48	281	3.4	4.2	11.0	5.69	293	3.8	4.7	12.3	6.37	328	4.6	5.7	14.9	7.69	393
3000	2.400	3.5	4.2	11.2	5.94	304	3.6	4.3	11.5	6.08	309	4.0	4.8	12.8	6.77	344	4.9	5.9	15.7	8.31	424
3150	2.475	3.6	4.3	11.5	6.20	325	3.8	4.5	12.1	6.56	341	4.2	5.0	13.4	7.25	378	5.1	6.2	16.4	8.87	463
3300	2.550	3.8	4.5	12.1	6.69	345	4.0	4.7	12.7	7.06	366	4.4	5.2	14.0	7.75	402	5.4	6.4	17.2	9.53	494
3450	2.625	4.0	4.7	12.7	7.20	370	4.2	4.8	13.2	7.49	384	4.6	5.4	14.6	8.26	419	5.7	6.6	18.0	10.21	524
3600	2.700	4.2	4.8	13.2	7.64	403	4.3	5.0	13.6	7.85	410	4.8	5.5	15.1	8.70	454	5.9	6.8	18.6	10.75	565
3750	2.775	4.4	5.0	13.8	8.18	424	4.5	5.1	14.1	8.31	429	5.1	5.7	15.9	9.41	485	6.2	7.0	19.4	11.46	593
3900	2.850	4.6	5.1	14.3	8.64	444	4.7	5.3	14.7	8.86	456	5.3	5.9	16.5	9.97	512	6.5	7.2	20.2	12.20	630
4050	2.925	4.8	5.3	14.9	9.21	482	4.9	5.4	15.2	9.34	493	5.5	6.1	17.1	10.54	554	6.7	7.4	20.8	12.79	676
4200	3.000	5.0	5.4	15.4	9.70	503	5.1	5.6	15.8	9.92	516	5.7	6.2	17.6	11.04	574	7.0	7.6	21.6	13.56	706
4350	3.075	5.1	5.5	15.7	10.02	518	5.3	5.7	16.3	10.42	536	5.9	6.4	18.2	11.64	603	7.3	7.8	22.4	14.36	740
4500	3.150	5.3	5.7	16.3	10.63	542	5.5	5.9	16.9	11.03	560	6.1	6.6	18.8	12.26	627	7.5	8.1	23.1	15.08	773



HOOK BOLT DETAIL



TYPICAL HALF PLAN

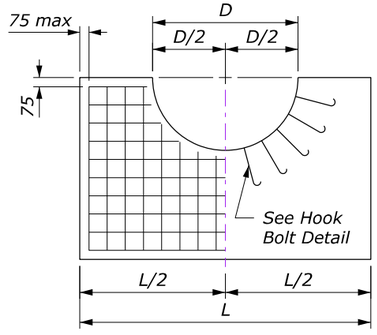
NOTE:

1. Pour concrete monolithically. Chamfer all exposed edges 20 mm and finish all exposed surfaces with a Class 1 ordinary finish.
2. Clearance for reinforcing steel is 50 mm unless otherwise noted.
3. Headwall dimension "H" may be reduced in solid rock provided the wall is keyed into the rock at least 300 mm.
4. Set hook bolts on nominal 450 mm centers around pipe perimeter at center of headwall. Hook bolts conform to ASTM A307. Galvanize according to ASTM A153.
5. For installations with more than two pipe culverts, increase the dimension "L" and all quantities shown for double pipe installation by adding a length equal to dimension "B" and the incremental change in quantities for each additional pipe culvert.
6. For skews other than those shown, multiply quantities and dimensions "A", "B" & "L" for square headwalls by secant of the skew angle.
7. Final quantities will be determined by using the tables on this standard.
8. Do not order materials until the length, skew angle, and slope bevel in the field have been approved.

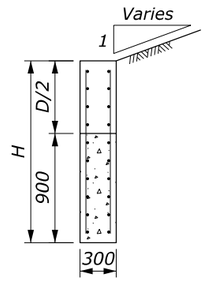
HEADWALL FOR SINGLE PIPE CULVERT

DIMENSIONS, REINFORCING STEEL AND CONCRETE TABLE OF QUANTITIES

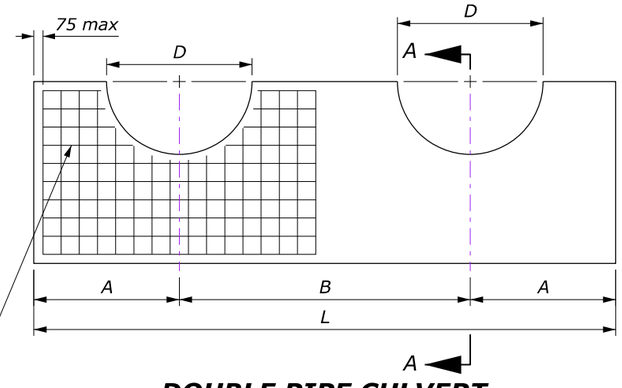
D mm	H m	SQUARE HEADWALL			15° SKEW			30° SKEW			45° SKEW		
		L m	CONC. m3	STEEL kg	L m	CONC. m3	STEEL kg	L m	CONC. m3	STEEL kg	L m	CONC. m3	STEEL kg
1200	1.500	2.4	0.91	45	2.5	0.95	49	2.8	1.06	54	3.4	1.29	65
1350	1.575	2.8	1.11	56	2.9	1.15	57	3.2	1.26	66	3.9	1.54	78
1500	1.650	3.2	1.32	67	3.3	1.36	68	3.6	1.48	73	4.5	1.85	94
1650	1.725	3.5	1.49	78	3.6	1.53	79	4.1	1.75	91	5.0	2.13	112
1800	1.800	3.9	1.72	87	4.0	1.76	92	4.5	1.99	103	5.5	2.43	127
1950	1.875	4.3	1.97	99	4.4	2.01	100	4.9	2.24	111	6.0	2.74	140
2100	1.950	4.7	2.23	119	4.8	2.27	120	5.4	2.56	134	6.6	3.13	164
2250	2.025	5.0	2.44	126	5.2	2.54	133	5.8	2.83	146	7.1	3.47	181
2400	2.100	5.4	2.72	138	5.6	2.83	145	6.2	3.12	162	7.6	3.83	196
2550	2.175	5.8	3.02	159	6.0	3.12	166	6.7	3.49	186	8.2	4.27	228
2700	2.250	6.2	3.33	175	6.4	3.43	179	7.1	3.80	199	8.7	4.66	247
2850	2.325	6.5	3.58	187	6.8	3.75	193	7.5	4.13	214	9.2	5.06	264
3000	2.400	6.9	3.91	197	7.1	4.01	205	8.0	4.54	234	9.8	5.56	284
3150	2.475	7.3	4.25	225	7.5	4.36	229	8.4	4.89	255	10.3	5.99	318
3300	2.550	7.7	4.61	241	7.9	4.72	244	8.8	5.25	275	10.8	6.45	337
3450	2.625	8.0	4.90	254	8.3	5.08	260	9.3	5.70	294	11.3	6.92	356
3600	2.700	8.4	5.28	276	8.7	5.47	292	9.7	6.09	323	11.9	7.48	396
3750	2.775	8.8	5.67	297	9.1	5.86	304	10.1	6.50	339	12.4	7.98	417
3900	2.850	9.2	6.07	315	9.5	6.27	326	10.6	6.99	360	12.9	8.50	437
4050	2.925	9.5	6.40	342	9.9	6.69	351	11.0	7.42	396	13.5	9.11	488
4200	3.000	9.9	6.83	355	10.2	7.03	372	11.4	7.86	410	14.0	9.66	511
4350	3.075	10.3	7.27	379	10.6	7.47	386	11.9	8.40	436	14.5	10.22	533
4500	3.150	10.7	7.73	399	11.0	7.93	410	12.3	8.87	456	15.1	10.90	563



SINGLE PIPE CULVERT



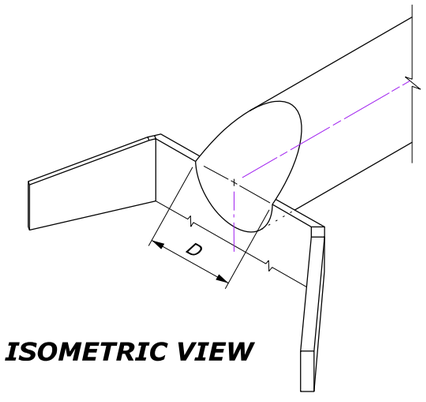
SECTION A-A



13 bars at equal spacing
250 mm max. both faces

DOUBLE PIPE CULVERT HEADWALLS

NO SCALE



ISOMETRIC VIEW

*This drawing contains **Metric** units of measure. Dimensions without units are millimeters.*

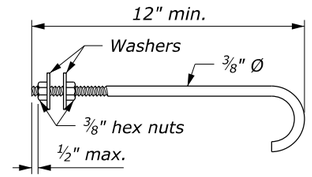
U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	FLH STANDARD M601-1
CONCRETE HEADWALLS	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 2/2024

PROJECT	SHEET NUMBER

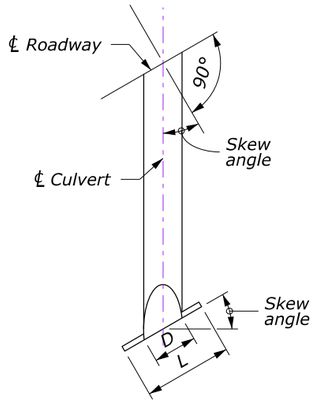
HEADWALL FOR DOUBLE PIPE CULVERT

DIMENSIONS, REINFORCING STEEL AND CONCRETE TABLE OF QUANTITIES

D	H	SQUARE HEADWALL					15° SKEW					30° SKEW					45° SKEW				
INCH	FEET	A FEET	B FEET	L FEET	CONC. CUYD	STEEL LB	A FEET	B FEET	L FEET	CONC. CUYD	STEEL LB	A FEET	B FEET	L FEET	CONC. CUYD	STEEL LB	A FEET	B FEET	L FEET	CONC. CUYD	STEEL LB
48	5.00	4.00	6.00	14.00	2.13	180	4.25	6.25	14.75	2.25	191	4.50	7.00	16.00	2.43	203	5.75	8.50	20.00	3.05	257
54	5.25	4.75	6.75	16.25	2.57	210	4.75	7.00	16.50	2.60	217	5.25	7.75	18.25	2.87	239	6.50	9.50	22.50	3.54	295
60	5.50	5.25	7.50	18.00	2.94	236	5.50	7.75	18.75	3.07	248	6.00	8.75	20.75	3.39	279	7.50	10.50	25.50	4.17	336
66	5.75	6.00	8.25	20.25	3.43	289	6.00	8.50	20.50	3.45	290	6.75	9.50	23.00	3.88	327	8.25	11.75	28.25	4.77	407
72	6.00	6.50	9.00	22.00	3.84	318	6.75	9.25	22.75	3.97	331	7.50	10.50	25.50	4.46	368	9.25	12.75	31.25	5.46	457
78	6.25	7.25	9.75	24.25	4.38	361	7.50	10.00	25.00	4.51	374	8.25	11.25	27.75	5.00	410	10.00	13.75	33.75	6.07	498
84	6.50	7.75	10.50	26.00	4.83	410	8.00	10.75	26.75	4.96	424	9.00	12.00	30.00	5.58	476	11.00	14.75	36.75	6.83	586
90	6.75	8.50	11.25	28.25	5.43	458	8.75	11.75	29.25	5.62	475	9.75	13.00	32.50	6.24	526	11.75	16.00	39.50	7.56	638
96	7.00	9.00	12.00	30.00	5.92	491	9.25	12.50	31.00	6.11	509	10.50	13.75	34.75	6.86	575	12.75	17.00	42.50	8.39	699
102	7.25	9.75	12.50	32.00	6.49	553	10.00	13.00	33.00	6.69	571	11.00	14.50	36.50	7.37	637	13.50	17.75	44.75	9.04	783
108	7.50	10.25	13.00	33.50	6.95	591	10.50	13.50	34.50	7.14	604	11.75	15.00	38.50	7.97	676	14.50	18.50	47.50	9.86	842
114	7.75	11.00	13.50	35.50	7.56	632	11.25	14.00	36.50	7.76	654	12.50	15.50	40.50	8.59	717	15.50	19.00	50.00	10.64	893
120	8.00	11.50	14.00	37.00	8.05	666	12.00	14.50	38.50	8.40	695	13.25	16.25	42.75	9.31	771	16.25	19.75	52.25	11.37	949
126	8.25	12.25	14.50	39.00	8.71	748	12.50	15.00	40.00	8.90	760	14.00	16.75	44.75	9.97	858	17.25	20.50	55.00	12.27	1053
132	8.50	12.75	15.00	40.50	9.23	775	13.25	15.50	42.00	9.58	805	14.75	17.25	46.75	10.65	902	18.00	21.25	57.25	13.05	1105
138	8.75	13.50	15.50	42.50	9.93	831	13.75	16.00	43.50	10.11	842	15.50	18.00	49.00	11.44	955	19.00	22.00	60.00	14.00	1173
144	9.00	14.00	16.00	44.00	10.48	902	14.50	16.50	45.50	10.83	922	16.25	18.50	51.00	12.16	1039	19.75	22.75	62.25	14.83	1281
150	9.25	14.75	16.50	46.00	11.21	950	15.25	17.00	47.50	11.57	981	17.00	19.00	53.00	12.91	1087	20.75	23.25	64.75	15.76	1341
156	9.50	15.25	17.00	47.50	11.80	991	15.75	17.50	49.00	12.15	1022	17.50	19.75	54.75	13.59	1144	21.50	24.00	67.00	16.62	1394
162	9.75	16.00	17.50	49.50	12.57	1077	16.50	18.00	51.00	12.93	1109	18.25	20.25	56.75	14.37	1236	22.50	24.75	69.75	17.69	1533
168	10.00	16.50	18.00	51.00	13.19	1121	17.00	18.75	52.75	13.63	1157	19.00	20.75	58.75	15.18	1288	23.25	25.50	72.00	18.60	1581
174	10.25	17.25	18.50	53.00	14.00	1173	17.75	19.25	54.75	14.45	1222	19.75	21.25	60.75	16.00	1353	24.25	26.25	74.75	19.73	1673
180	10.50	17.75	19.00	54.50	14.65	1218	18.50	19.75	56.75	15.29	1276	20.50	22.00	63.00	16.94	1411	25.00	26.75	76.75	20.59	1727



HOOK BOLT DETAIL



TYPICAL HALF PLAN

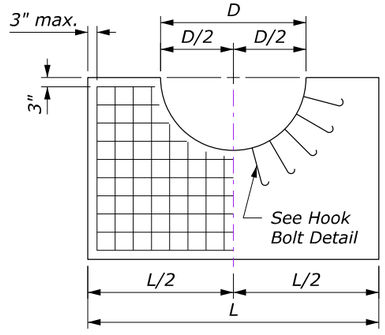
NOTE:

1. Pour concrete monolithically. Chamfer all exposed edges 3/4 inch and finish all exposed surfaces with a Class 1 ordinary finish.
2. Clearance for reinforcing steel is 2 inches unless otherwise noted.
3. Headwall dimension "H" may be reduced in solid rock provided the wall is keyed into the rock at least 1 foot.
4. Set hook bolts on nominal 18-inch centers around pipe perimeter at center of headwall. Hook bolts conform to ASTM A307. Galvanize according to ASTM A153.
5. For installations with more than two pipe culverts, increase the dimension "L" and all quantities shown for double pipe installation by adding a length equal to dimension "B" and the incremental change in quantities for each additional pipe culvert.
6. For skews other than those shown, multiply quantities and dimensions "A", "B" & "L" for square headwalls by secant of the skew angle.
7. Final quantities will be determined by using the tables on this standard.
8. Do not order materials until the length, skew angle, and slope bevel in the field have been approved.

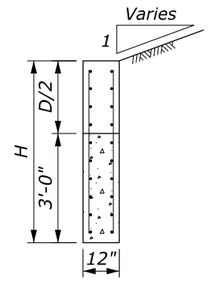
HEADWALL FOR SINGLE PIPE CULVERT

DIMENSIONS, REINFORCING STEEL AND CONCRETE TABLE OF QUANTITIES

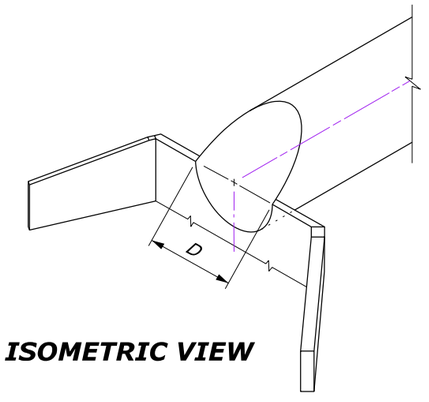
D	H	SQUARE HEADWALL			15° SKEW			30° SKEW			45° SKEW		
INCH	FEET	L FEET	CONC. CUYD	STEEL LB	L FEET	CONC. CUYD	STEEL LB	L FEET	CONC. CUYD	STEEL LB	L FEET	CONC. CUYD	STEEL LB
48	5.00	8.00	1.25	101	8.25	1.29	109	9.25	1.44	120	11.25	1.75	144
54	5.25	9.25	1.50	124	9.50	1.54	126	10.75	1.75	148	13.00	2.11	175
60	5.50	10.50	1.78	143	10.75	1.81	151	12.00	2.02	164	14.75	2.49	208
66	5.75	11.75	2.06	175	12.25	2.15	186	13.50	2.37	203	16.50	2.89	249
72	6.00	13.00	2.37	196	13.50	2.46	207	15.00	2.73	231	18.50	3.37	286
78	6.25	14.25	2.68	221	14.75	2.78	233	16.50	3.11	259	20.25	3.82	317
84	6.50	15.50	3.02	256	16.00	3.11	268	18.00	3.51	299	22.00	4.29	368
90	6.75	16.75	3.37	284	17.25	3.47	297	19.25	3.87	327	23.75	4.78	406
96	7.00	18.00	3.74	309	18.75	3.90	325	20.75	4.30	364	25.50	5.29	442
102	7.25	19.25	4.12	354	20.00	4.28	371	22.25	4.76	416	27.25	5.83	510
108	7.50	20.50	4.52	381	21.25	4.68	399	23.75	5.24	447	29.00	6.39	554
114	7.75	21.75	4.93	419	22.50	5.10	430	25.00	5.66	479	30.75	6.97	594
120	8.00	23.00	5.36	441	23.75	5.53	460	26.50	6.17	521	32.50	7.57	634
126	8.25	24.25	5.81	502	25.00	5.98	514	28.00	6.70	572	34.25	8.20	711
132	8.50	25.50	6.27	527	26.50	6.52	560	29.50	7.25	618	36.00	8.84	754
138	8.75	26.75	6.75	570	27.75	7.00	584	31.00	7.83	658	37.75	9.51	799
144	9.00	28.00	7.24	619	29.00	7.50	654	32.25	8.33	723	39.50	10.20	885
150	9.25	29.25	7.75	665	30.25	8.01	680	33.75	8.94	761	41.25	10.92	933
156	9.50	30.50	8.27	692	31.50	8.54	728	35.25	9.56	805	43.25	11.74	996
162	9.75	31.75	8.81	767	32.75	9.08	783	36.75	10.21	889	45.00	12.50	1094
168	10.00	33.00	9.37	796	34.25	9.73	838	38.00	10.78	919	46.75	13.28	1146
174	10.25	34.25	9.94	847	35.50	10.31	867	39.50	11.46	974	48.50	14.09	1197
180	10.50	35.50	10.53	877	36.75	10.90	920	41.00	12.17	1022	50.25	14.91	1260



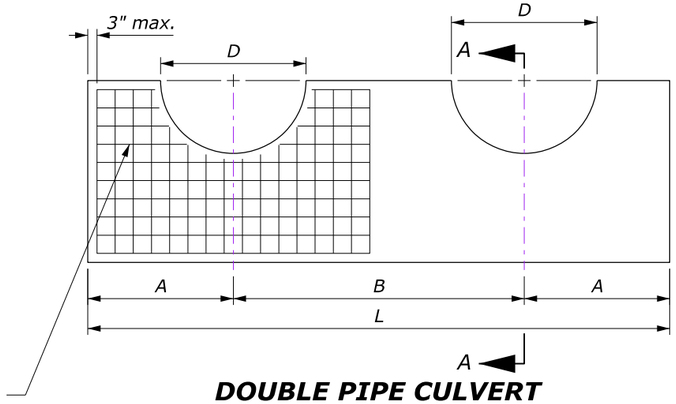
SINGLE PIPE CULVERT



SECTION A-A



ISOMETRIC VIEW



#4 bars at equal spacing
10" max. both faces

DOUBLE PIPE CULVERT HEADWALLS

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	FLH STANDARD 601-1
CONCRETE HEADWALLS	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 2/2024

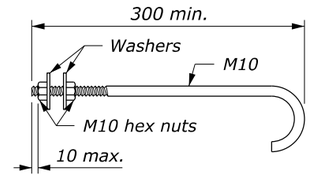
30 May 2024 10:09 AM c:\pw-work\d0147408\Std601-1.dgn [Std 601-1]

PROJECT	SHEET NUMBER

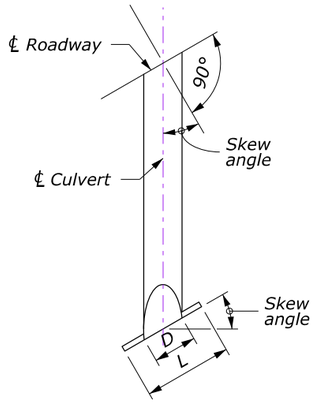
HEADWALL FOR DOUBLE PIPE CULVERT

DIMENSIONS, REINFORCING STEEL AND CONCRETE TABLE OF QUANTITIES

D mm	H m	SQUARE HEADWALL					15° SKEW					30° SKEW					45° SKEW				
		A m	B m	L m	CONC. m3	STEEL kg	A m	B m	L m	CONC. m3	STEEL kg	A m	B m	L m	CONC. m3	STEEL kg	A m	B m	L m	CONC. m3	STEEL kg
1200	1.500	1.2	1.8	4.2	1.55	80	1.2	1.9	4.3	1.58	81	1.4	2.1	4.9	1.81	92	1.7	2.5	5.9	2.18	111
1350	1.575	1.4	2.0	4.8	1.84	93	1.4	2.1	4.9	1.87	93	1.6	2.3	5.5	2.10	107	2.0	2.9	6.9	2.65	134
1500	1.650	1.6	2.3	5.5	2.19	110	1.6	2.3	5.5	2.17	109	1.8	2.6	6.2	2.46	124	2.2	3.2	7.6	3.01	149
1650	1.725	1.8	2.5	6.1	2.52	129	1.8	2.6	6.2	2.54	133	2.0	2.9	6.9	2.83	146	2.5	3.5	8.5	3.49	182
1800	1.800	2.0	2.7	6.7	2.85	147	2.0	2.8	6.8	2.88	147	2.3	3.1	7.7	3.28	168	2.8	3.8	9.4	4.00	204
1950	1.875	2.1	2.9	7.1	3.10	155	2.2	3.0	7.4	3.23	162	2.5	3.4	8.4	3.69	184	3.0	4.1	10.1	4.41	222
2100	1.950	2.3	3.2	7.8	3.52	183	2.4	3.3	8.1	3.66	191	2.7	3.6	9.0	4.07	213	3.3	4.5	11.1	5.02	263
2250	2.025	2.5	3.4	8.4	3.91	199	2.6	3.5	8.7	4.05	211	2.9	3.9	9.7	4.52	234	3.6	4.8	12.0	5.60	291
2400	2.100	2.7	3.6	9.0	4.31	219	2.8	3.7	9.3	4.45	227	3.1	4.2	10.4	4.98	252	3.8	5.1	12.7	6.08	311
2550	2.175	2.9	3.8	9.6	4.73	247	3.0	3.9	9.9	4.87	255	3.3	4.3	10.9	5.34	279	4.1	5.3	13.5	6.64	351
2700	2.250	3.1	3.9	10.1	5.10	265	3.2	4.0	10.4	5.24	271	3.6	4.5	11.7	5.91	309	4.3	5.5	14.1	7.09	369
2850	2.325	3.3	4.0	10.6	5.48	281	3.4	4.2	11.0	5.69	293	3.8	4.7	12.3	6.37	328	4.6	5.7	14.9	7.69	393
3000	2.400	3.5	4.2	11.2	5.94	304	3.6	4.3	11.5	6.08	309	4.0	4.8	12.8	6.77	344	4.9	5.9	15.7	8.31	424
3150	2.475	3.6	4.3	11.5	6.20	325	3.8	4.5	12.1	6.56	341	4.2	5.0	13.4	7.25	378	5.1	6.2	16.4	8.87	463
3300	2.550	3.8	4.5	12.1	6.69	345	4.0	4.7	12.7	7.06	366	4.4	5.2	14.0	7.75	402	5.4	6.4	17.2	9.53	494
3450	2.625	4.0	4.7	12.7	7.20	370	4.2	4.8	13.2	7.49	384	4.6	5.4	14.6	8.26	419	5.7	6.6	18.0	10.21	524
3600	2.700	4.2	4.8	13.2	7.64	403	4.3	5.0	13.6	7.85	410	4.8	5.5	15.1	8.70	454	5.9	6.8	18.6	10.75	565
3750	2.775	4.4	5.0	13.8	8.18	424	4.5	5.1	14.1	8.31	429	5.1	5.7	15.9	9.41	485	6.2	7.0	19.4	11.46	593
3900	2.850	4.6	5.1	14.3	8.64	444	4.7	5.3	14.7	8.86	456	5.3	5.9	16.5	9.97	512	6.5	7.2	20.2	12.20	630
4050	2.925	4.8	5.3	14.9	9.21	482	4.9	5.4	15.2	9.34	493	5.5	6.1	17.1	10.54	554	6.7	7.4	20.8	12.79	676
4200	3.000	5.0	5.4	15.4	9.70	503	5.1	5.6	15.8	9.92	516	5.7	6.2	17.6	11.04	574	7.0	7.6	21.6	13.56	706
4350	3.075	5.1	5.5	15.7	10.02	518	5.3	5.7	16.3	10.42	536	5.9	6.4	18.2	11.64	603	7.3	7.8	22.4	14.36	740
4500	3.150	5.3	5.7	16.3	10.63	542	5.5	5.9	16.9	11.03	560	6.1	6.6	18.8	12.26	627	7.5	8.1	23.1	15.08	773



HOOK BOLT DETAIL



TYPICAL HALF PLAN

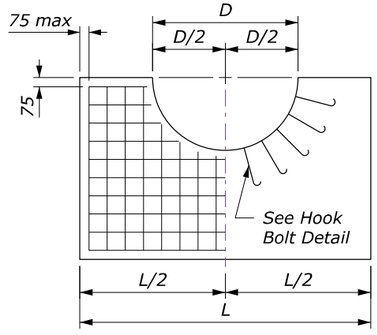
NOTE:

1. Pour concrete monolithically. Chamfer all exposed edges 20 mm and finish all exposed surfaces with a Class 1 ordinary finish.
2. Clearance for reinforcing steel is 50 mm unless otherwise noted.
3. Headwall dimension "H" may be reduced in solid rock provided the wall is keyed into the rock at least 300 mm.
4. Set hook bolts on nominal 450 mm centers around pipe perimeter at center of headwall. Hook bolts conform to ASTM A307. Galvanize according to ASTM A153.
5. For installations with more than two pipe culverts, increase the dimension "L" and all quantities shown for double pipe installation by adding a length equal to dimension "B" and the incremental change in quantities for each additional pipe culvert.
6. For skews other than those shown, multiply quantities and dimensions "A", "B" & "L" for square headwalls by secant of the skew angle.
7. Final quantities will be determined by using the tables on this standard.
8. Do not order materials until the length, skew angle, and slope bevel in the field have been approved.

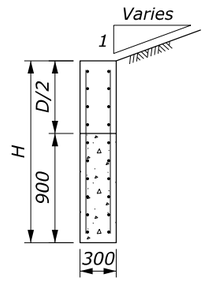
HEADWALL FOR SINGLE PIPE CULVERT

DIMENSIONS, REINFORCING STEEL AND CONCRETE TABLE OF QUANTITIES

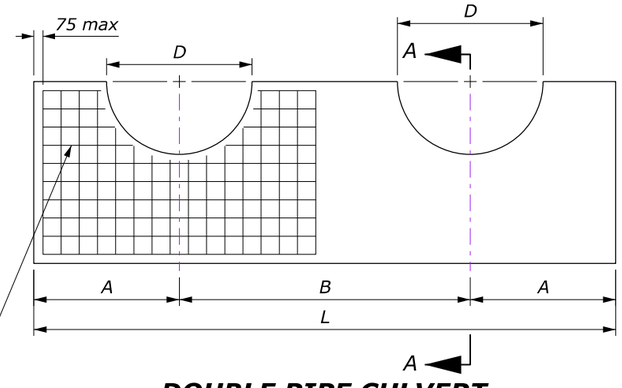
D mm	H m	SQUARE HEADWALL			15° SKEW			30° SKEW			45° SKEW		
		L m	CONC. m3	STEEL kg	L m	CONC. m3	STEEL kg	L m	CONC. m3	STEEL kg	L m	CONC. m3	STEEL kg
1200	1.500	2.4	0.91	45	2.5	0.95	49	2.8	1.06	54	3.4	1.29	65
1350	1.575	2.8	1.11	56	2.9	1.15	57	3.2	1.26	66	3.9	1.54	78
1500	1.650	3.2	1.32	67	3.3	1.36	68	3.6	1.48	73	4.5	1.85	94
1650	1.725	3.5	1.49	78	3.6	1.53	79	4.1	1.75	91	5.0	2.13	112
1800	1.800	3.9	1.72	87	4.0	1.76	92	4.5	1.99	103	5.5	2.43	127
1950	1.875	4.3	1.97	99	4.4	2.01	100	4.9	2.24	111	6.0	2.74	140
2100	1.950	4.7	2.23	119	4.8	2.27	120	5.4	2.56	134	6.6	3.13	164
2250	2.025	5.0	2.44	126	5.2	2.54	133	5.8	2.83	146	7.1	3.47	181
2400	2.100	5.4	2.72	138	5.6	2.83	145	6.2	3.12	162	7.6	3.83	196
2550	2.175	5.8	3.02	159	6.0	3.12	166	6.7	3.49	186	8.2	4.27	228
2700	2.250	6.2	3.33	175	6.4	3.43	179	7.1	3.80	199	8.7	4.66	247
2850	2.325	6.5	3.58	187	6.8	3.75	193	7.5	4.13	214	9.2	5.06	264
3000	2.400	6.9	3.91	197	7.1	4.01	205	8.0	4.54	234	9.8	5.56	284
3150	2.475	7.3	4.25	225	7.5	4.36	229	8.4	4.89	255	10.3	5.99	318
3300	2.550	7.7	4.61	241	7.9	4.72	244	8.8	5.25	275	10.8	6.45	337
3450	2.625	8.0	4.90	254	8.3	5.08	260	9.3	5.70	294	11.3	6.92	356
3600	2.700	8.4	5.28	276	8.7	5.47	292	9.7	6.09	323	11.9	7.48	396
3750	2.775	8.8	5.67	297	9.1	5.86	304	10.1	6.50	339	12.4	7.98	417
3900	2.850	9.2	6.07	315	9.5	6.27	326	10.6	6.99	360	12.9	8.50	437
4050	2.925	9.5	6.40	342	9.9	6.69	351	11.0	7.42	396	13.5	9.11	488
4200	3.000	9.9	6.83	355	10.2	7.03	372	11.4	7.86	410	14.0	9.66	511
4350	3.075	10.3	7.27	379	10.6	7.47	386	11.9	8.40	436	14.5	10.22	533
4500	3.150	10.7	7.73	399	11.0	7.93	410	12.3	8.87	456	15.1	10.90	563



SINGLE PIPE CULVERT



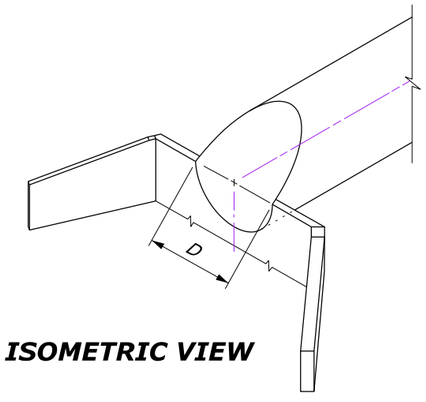
SECTION A-A



13 bars at equal spacing
250 mm max. both faces

DOUBLE PIPE CULVERT HEADWALLS

NO SCALE



ISOMETRIC VIEW

*This drawing contains **Metric** units of measure. Dimensions without units are millimeters.*

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	FLH STANDARD M601-1
CONCRETE HEADWALLS	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 2/2024

PROJECT	SHEET NUMBER

SLOPE PAVING FOR DOUBLE PIPE CULVERT

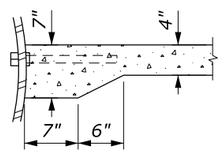
DIMENSIONS, REINFORCING STEEL AND CONCRETE TABLE OF QUANTITIES

D INCH	S FEET	SQUARE HEADWALL			15° SKEW			30° SKEW			45° SKEW		
		L FEET	CONC. CUYD	STEEL LB	L FEET	CONC. CUYD	STEEL LB	L FEET	CONC. CUYD	STEEL LB	L FEET	CONC. CUYD	STEEL LB
48	7.25	14.00	1.57	83	14.75	1.66	89	16.00	1.79	94	20.00	2.25	119
54	7.75	16.25	1.93	104	16.50	1.95	103	18.25	2.15	115	22.50	2.65	141
60	8.00	18.00	2.23	116	18.75	2.33	122	20.75	2.57	135	25.50	3.17	164
66	8.50	20.25	2.64	139	20.50	2.66	138	23.00	2.99	156	28.25	3.67	192
72	9.00	22.00	2.99	155	22.75	3.09	161	25.50	3.47	180	31.25	4.26	221
78	9.50	24.25	3.46	181	25.00	3.56	185	27.75	3.94	205	33.75	4.78	249
84	10.00	26.00	3.84	199	26.75	3.95	205	30.00	4.43	231	36.75	5.43	283
90	10.25	28.25	4.36	216	29.25	4.52	225	32.50	5.01	248	39.50	6.07	301
96	10.75	30.00	4.79	241	31.00	4.95	249	34.75	5.56	280	42.50	6.79	339
102	11.25	32.00	5.30	265	33.00	5.46	274	36.50	6.02	302	44.75	7.38	371
108	11.75	33.50	5.71	288	34.50	5.87	295	38.50	6.55	329	47.50	8.11	406
114	12.25	35.50	6.26	315	36.50	6.42	323	40.50	7.11	359	50.00	8.81	442
120	12.50	37.00	6.71	335	38.50	7.00	347	42.75	7.75	386	52.25	9.47	472
126	13.00	39.00	7.30	363	40.00	7.46	372	44.75	8.35	417	55.00	10.28	510
132	13.50	40.50	7.78	386	42.00	8.07	401	46.75	8.98	448	57.25	10.99	548
138	14.00	42.50	8.41	420	43.50	8.56	428	49.00	9.69	482	60.00	11.87	590
144	14.50	44.00	8.92	445	45.50	9.22	460	51.00	10.36	515	62.25	12.63	630
150	14.75	46.00	9.60	463	47.50	9.90	477	53.00	11.05	532	64.75	13.48	649
156	15.25	47.50	10.14	494	49.00	10.44	510	54.75	11.68	571	67.00	14.29	694
162	15.75	49.50	10.86	532	51.00	11.17	545	56.75	12.41	607	69.75	15.28	746
168	16.25	51.00	11.44	559	52.75	11.83	579	58.75	13.16	644	72.00	16.13	787
174	16.75	53.00	12.20	595	54.75	12.59	619	60.75	13.93	681	74.75	17.19	841
180	17.25	54.50	12.81	628	56.75	13.38	656	63.00	14.82	726	76.75	18.00	880

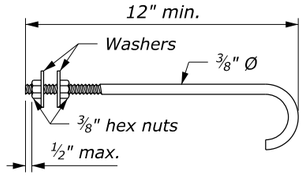
SLOPE PAVING FOR SINGLE PIPE CULVERT

DIMENSIONS, REINFORCING STEEL AND CONCRETE TABLE OF QUANTITIES

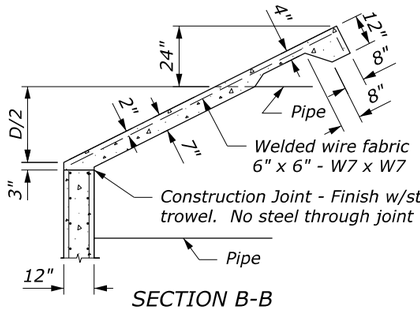
D INCH	S FEET	SQUARE HEADWALL			15° SKEW			30° SKEW			45° SKEW		
		L FEET	CONC. CUYD	STEEL LB	L FEET	CONC. CUYD	STEEL LB	L FEET	CONC. CUYD	STEEL LB	L FEET	CONC. CUYD	STEEL LB
48	7.25	8.00	0.93	48	8.25	0.96	50	9.25	1.08	57	11.25	1.31	69
54	7.75	9.25	1.14	60	9.50	1.17	61	10.75	1.33	70	13.00	1.60	83
60	8.00	10.50	1.37	69	10.75	1.39	72	12.00	1.56	79	14.75	1.92	98
66	8.50	11.75	1.61	82	12.25	1.68	86	13.50	1.85	94	16.50	2.25	115
72	9.00	13.00	1.87	95	13.50	1.94	98	15.00	2.15	109	18.50	2.66	136
78	9.50	14.25	2.14	110	14.75	2.22	113	16.50	2.48	126	20.25	3.05	157
84	10.00	15.50	2.44	123	16.00	2.51	128	18.00	2.83	143	22.00	3.46	175
90	10.25	16.75	2.75	134	17.25	2.82	139	19.25	3.15	154	23.75	3.90	190
96	10.75	18.00	3.07	150	18.75	3.21	159	20.75	3.54	174	25.50	4.35	213
102	11.25	19.25	3.41	170	20.00	3.55	174	22.25	3.95	196	27.25	4.83	239
108	11.75	20.50	3.77	186	21.25	3.91	193	23.75	4.38	217	29.00	5.34	263
114	12.25	21.75	4.15	206	22.50	4.29	212	25.00	4.76	235	30.75	5.86	291
120	12.50	23.00	4.54	220	23.75	4.69	230	26.50	5.23	255	32.50	6.42	313
126	13.00	24.25	4.95	244	25.00	5.10	249	28.00	5.72	278	34.25	6.99	343
132	13.50	25.50	5.38	263	26.50	5.59	272	29.50	6.22	303	36.00	7.59	371
138	14.00	26.75	5.82	286	27.75	6.04	296	31.00	6.75	329	37.75	8.21	401
144	14.50	28.00	6.28	306	29.00	6.50	316	32.25	7.23	354	39.50	8.85	431
150	14.75	29.25	6.75	320	30.25	6.98	333	33.75	7.79	370	41.25	9.52	452
156	15.25	30.50	7.25	347	31.50	7.48	357	35.25	8.38	401	43.25	10.29	493
162	15.75	31.75	7.76	373	32.75	7.99	384	36.75	8.99	433	45.00	11.00	526
168	16.25	33.00	8.28	397	34.25	8.60	413	38.00	9.53	458	46.75	11.74	565
174	16.75	34.25	8.83	424	35.50	9.15	438	39.50	10.17	488	48.50	12.50	600
180	17.25	35.50	9.39	449	36.75	9.72	469	41.00	10.84	521	50.25	13.29	641



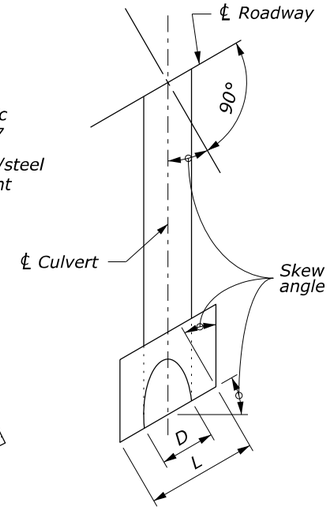
SECTION A-A



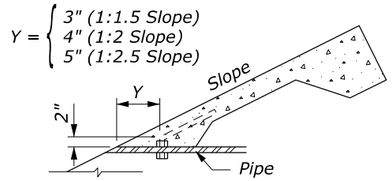
HOOK BOLT DETAIL



SECTION B-B



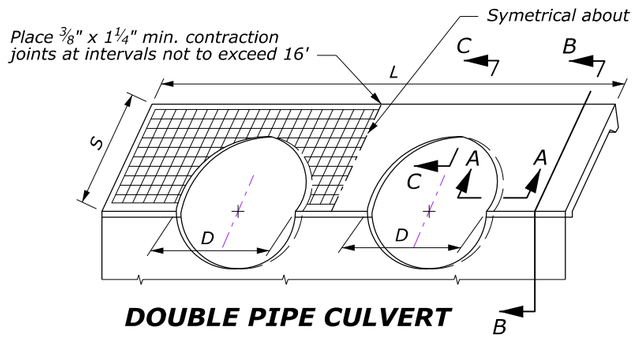
TYPICAL HALF PLAN



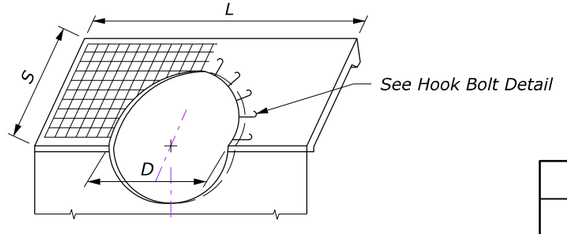
SECTION C-C

NOTE:

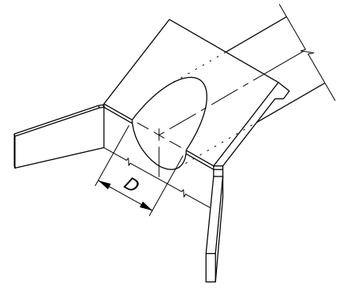
1. Chamfer all exposed edges ¾ inch and finish all exposed surfaces with a Class 1 ordinary finish.
2. Clearance for reinforcing steel is 2 inches unless otherwise noted.
3. Set hook bolts on nominal 18-inch centers around pipe perimeter. Hook bolts conform to ASTM A307. Galvanize according to ASTM A153.
4. For installations with more than two pipe culverts, increase the dimension "L" and all quantities shown for double pipe installation by adding a length equal to dimension "B" as shown on Standard 601-1 and the incremental change in quantities for each additional pipe culvert.
5. For skews other than those shown, multiply quantities and dimensions "A", "B" & "L" for square headwalls by secant of the skew angle.
6. For the skew angle shown, the dimension "S" and the quantities for slope paving are computed for a 1V:1.5H sideslope. To compute dimension "S" and slope paving quantities for a 1V:2H slope multiply the values for that particular skew by 1.24, and for a 1V:2.5H slope multiply by 1.49.
7. Final quantities will be determined by using the tables on this drawing.
8. Do not order materials until the length, skew angle, and slope bevel in the field have been approved.



DOUBLE PIPE CULVERT



SINGLE PIPE CULVERT



ISOMETRIC VIEW

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

SLOPE PAVING FOR CONCRETE HEADWALLS

FLH STANDARD	601-2
SPECIFICATION	FP-24, FP-14
APPROVED FOR USE	2/2024

c:\pw-work\d0147408\Std601-2.dgn [Std 601-2]
30 May 2024 10:18 AM

PROJECT	SHEET NUMBER

SLOPE PAVING FOR DOUBLE PIPE CULVERT

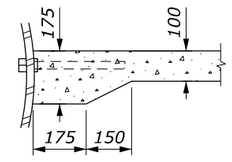
DIMENSIONS, REINFORCING STEEL AND CONCRETE TABLE OF QUANTITIES

D	S m	SQUARE HEADWALL			15° SKEW			30° SKEW			45° SKEW		
		L m	CONC. m3	STEEL kg	L m	CONC. m3	STEEL kg	L m	CONC. m3	STEEL kg	L m	CONC. m3	STEEL kg
1200	2.2	4.2	1.14	38	4.3	1.17	39	4.9	1.34	44	5.9	1.60	52
1350	2.3	4.8	1.38	45	4.9	1.40	46	5.5	1.57	51	6.9	1.99	64
1500	2.4	5.5	1.67	51	5.5	1.65	51	6.2	1.87	57	7.6	2.29	69
1650	2.6	6.1	1.94	62	6.2	1.96	63	6.9	2.18	70	8.5	2.69	86
1800	2.7	6.7	2.23	68	6.8	2.24	69	7.7	2.55	78	9.4	3.11	95
1950	2.8	7.1	2.44	74	7.4	2.55	77	8.4	2.91	89	10.1	3.47	106
2100	3.0	7.8	2.80	87	8.1	2.91	91	9.0	3.23	101	11.1	4.00	123
2250	3.1	8.4	3.14	97	8.7	3.25	101	9.7	3.63	111	12.0	4.50	138
2400	3.2	9.0	3.49	107	9.3	3.61	110	10.4	4.04	123	12.7	4.93	150
2550	3.4	9.6	3.86	120	9.9	3.98	122	10.9	4.36	134	13.5	5.42	166
2700	3.5	10.1	4.19	128	10.4	4.31	132	11.7	4.86	148	14.1	5.82	178
2850	3.7	10.6	4.54	140	11.0	4.71	146	12.3	5.27	162	14.9	6.36	195
3000	3.8	11.2	4.95	152	11.5	5.07	155	12.8	5.63	172	15.7	6.92	211
3150	3.9	11.5	5.19	153	12.1	5.50	163	13.4	6.07	180	16.4	7.43	219
3300	4.1	12.1	5.64	173	12.7	5.95	182	14.0	6.53	199	17.2	8.03	246
3450	4.2	12.7	6.10	183	13.2	6.35	190	14.6	7.00	209	18.0	8.65	259
3600	4.3	13.2	6.50	194	13.6	6.69	199	15.1	7.41	221	18.6	9.15	271
3750	4.5	13.8	7.00	210	14.1	7.10	214	15.9	8.06	241	19.4	9.81	293
3900	4.6	14.3	7.43	221	14.7	7.61	227	16.5	8.57	255	20.2	10.49	312
4050	4.7	14.9	7.96	235	15.2	8.06	239	17.1	9.11	270	20.8	11.04	326
4200	4.9	15.4	8.42	253	15.8	8.60	257	17.6	9.57	286	21.6	11.76	350
4350	5.0	15.7	8.72	260	16.3	9.07	270	18.2	10.14	300	22.4	12.51	370
4500	5.1	16.3	9.29	269	16.9	9.64	280	18.8	10.71	309	23.1	13.19	379

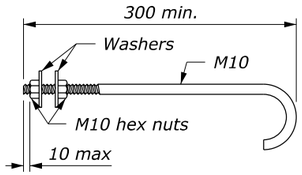
SLOPE PAVING FOR SINGLE PIPE CULVERT

DIMENSIONS, REINFORCING STEEL AND CONCRETE TABLE OF QUANTITIES

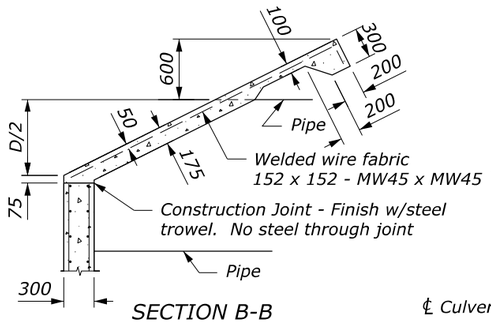
D	S m	SQUARE HEADWALL			15° SKEW			30° SKEW			45° SKEW		
		L m	CONC. m3	STEEL kg	L m	CONC. m3	STEEL kg	L m	CONC. m3	STEEL kg	L m	CONC. m3	STEEL kg
1200	2.2	2.4	0.68	22	2.5	0.71	23	2.8	0.79	26	3.4	0.96	31
1350	2.3	2.8	0.84	27	2.9	0.87	27	3.2	0.96	30	3.9	1.17	37
1500	2.4	3.2	1.02	30	3.3	1.05	31	3.6	1.14	34	4.5	1.43	43
1650	2.6	3.5	1.16	36	3.6	1.19	37	4.1	1.37	43	5.0	1.67	52
1800	2.7	3.9	1.36	41	4.0	1.39	42	4.5	1.57	47	5.5	1.92	58
1950	2.8	4.3	1.57	47	4.4	1.61	48	4.9	1.79	53	6.0	2.19	66
2100	3.0	4.7	1.80	54	4.8	1.83	56	5.4	2.07	63	6.6	2.52	77
2250	3.1	5.0	1.99	59	5.2	2.07	63	5.8	2.31	71	7.1	2.83	86
2400	3.2	5.4	2.24	67	5.6	2.32	69	6.2	2.57	77	7.6	3.15	93
2550	3.4	5.8	2.50	76	6.0	2.59	78	6.7	2.89	87	8.2	3.54	106
2700	3.5	6.2	2.78	83	6.4	2.87	86	7.1	3.18	95	8.7	3.89	117
2850	3.7	6.5	3.01	91	6.8	3.16	96	7.5	3.47	105	9.2	4.26	129
3000	3.8	6.9	3.31	99	7.1	3.40	102	8.0	3.84	115	9.8	4.71	141
3150	3.9	7.3	3.63	105	7.5	3.72	108	8.4	4.17	121	10.3	5.11	148
3300	4.1	7.7	3.95	119	7.9	4.04	120	8.8	4.50	134	10.8	5.53	165
3450	4.2	8.0	4.22	124	8.3	4.39	129	9.3	4.92	145	11.3	5.96	176
3600	4.3	8.4	4.58	134	8.7	4.74	139	9.7	5.29	155	11.9	6.49	190
3750	4.5	8.8	4.94	145	9.1	5.11	150	10.1	5.66	167	12.4	6.96	205
3900	4.6	9.2	5.32	156	9.5	5.49	161	10.6	6.13	179	12.9	7.44	218
4050	4.7	9.5	5.63	164	9.9	5.89	170	11.0	6.53	191	13.5	8.02	232
4200	4.9	9.9	6.04	176	10.2	6.21	182	11.4	6.95	203	14.0	8.54	249
4350	5.0	10.3	6.46	189	10.6	6.63	194	11.9	7.46	218	14.5	9.07	264
4500	5.1	10.7	6.89	197	11.0	7.06	201	12.3	7.90	224	15.1	9.71	276



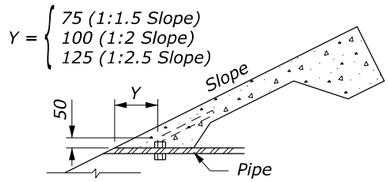
SECTION A-A



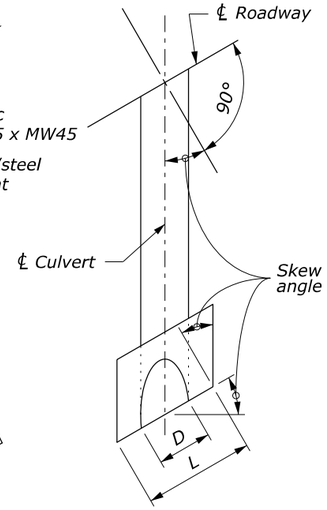
HOOK BOLT DETAIL



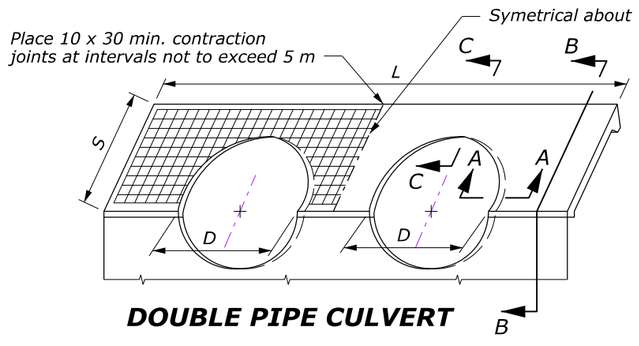
SECTION B-B



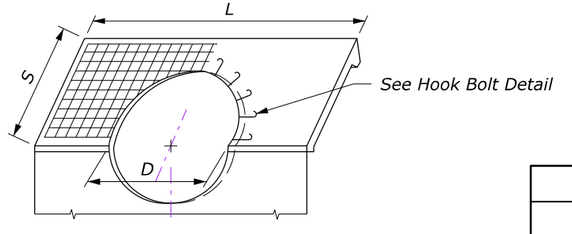
SECTION C-C



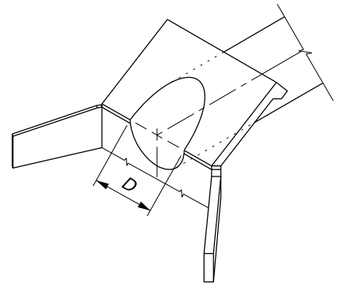
TYPICAL HALF PLAN



DOUBLE PIPE CULVERT



SINGLE PIPE CULVERT



ISOMETRIC VIEW

NOTE:

1. *Chamfer all exposed edges 20 mm and finish all exposed surfaces with a Class 1 ordinary finish.*
2. *Clearance for reinforcing steel is 50 mm unless otherwise noted.*
3. *Set hook bolts on nominal 450 mm centers around pipe perimeter. Hook bolts conform to ASTM A307. Galvanize according to ASTM A153.*
4. *For installations with more than two pipe culverts, increase the dimension "L" and all quantities shown for double pipe installation by adding a length equal to dimension "B" as shown on Standard M601-1 and the incremental change in quantities for each additional pipe culvert.*
5. *For skews other than those shown, multiply quantities and dimensions "A", "B" & "L" for square headwalls by secant of the skew angle.*
6. *For the skew angle shown, the dimension "S" and the quantities for slope paving are computed for a 1V:1.5H sideslope. To compute dimension "S" and slope paving quantities for a 1V:2H slope multiply the values for that particular skew by 1.24, and for a 1V:2.5H slope multiply by 1.49.*
7. *Final quantities will be determined by using the tables on this drawing.*
8. *Do not order materials until the length, skew angle, and slope bevel in the field have been approved.*

*This drawing contains **Metric** units of measure. Dimensions without units are millimeters.*

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

SLOPE PAVING FOR CONCRETE HEADWALLS

FLH STANDARD M601-2

SPECIFICATION FP-24, FP-14

APPROVED FOR USE 2/2024

PROJECT	SHEET NUMBER

WINGWALLS FOR CONCRETE HEADWALLS

DIMENSIONS, REINFORCING STEEL AND CONCRETE TABLE OF QUANTITIES

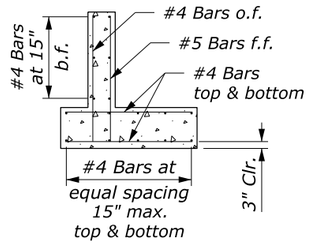
D	H	0° WINGWALL SKEW			15° WINGWALL SKEW			30° WINGWALL SKEW			45° WINGWALL SKEW			60° WINGWALL SKEW		
INCH	FEET	W FEET	CONC. CUYD	STEEL LB	W FEET	CONC. CUYD	STEEL LB	W FEET	CONC. CUYD	STEEL LB	W FEET	CONC. CUYD	STEEL LB	W FEET	CONC. CUYD	STEEL LB
48	5.00	6.00	2.81	178	6.00	2.78	178	6.00	2.76	178	6.00	2.74	178	6.00	2.73	178
54	5.25	6.00	2.86	180	6.00	2.82	180	6.00	2.80	180	6.00	2.78	180	6.75	3.06	202
60	5.50	6.25	2.90	181	6.00	2.86	181	6.00	2.84	181	6.00	2.82	181	7.50	3.39	224
66	5.75	7.00	2.94	183	6.00	2.90	183	6.00	2.87	183	6.00	2.85	183	8.25	3.74	241
72	6.00	7.50	2.98	185	6.00	2.94	185	6.00	2.91	185	6.50	3.09	202	9.00	4.09	263
78	6.25	8.25	3.02	186	6.00	2.98	186	6.00	2.95	186	7.00	3.34	213	9.75	4.45	285
84	6.50	8.75	3.06	188	6.00	3.02	188	6.25	3.09	197	7.50	3.59	232	10.50	4.81	311
90	6.75	9.50	3.11	190	6.00	3.06	190	6.50	3.24	207	8.00	3.84	246	11.25	5.18	329
96	7.00	10.00	3.15	191	6.25	3.21	200	7.00	3.49	218	8.50	4.10	260	12.00	5.56	350

RECOMMENDED WINGWALL SKEWS

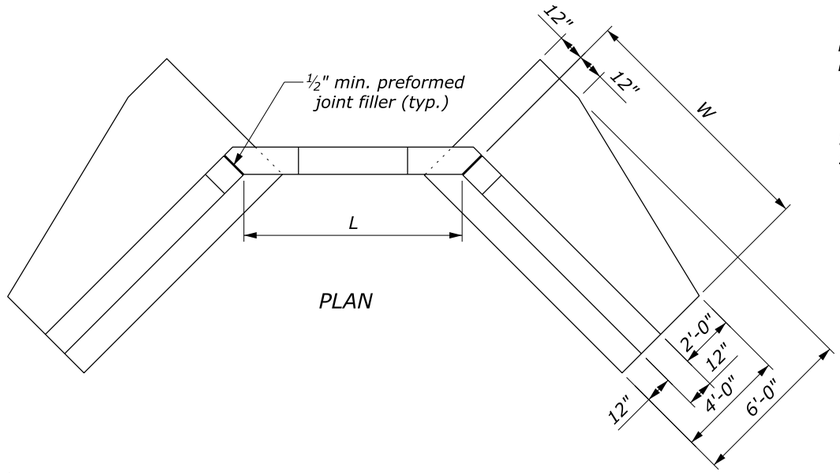
WINGWALL	PIPE SKEW			
	0°	15°	30°	45°
①	45°	45°	60°	60°
②	45°	30°	15°	0°
③	45°	30°	15°	0°
④	45°	45°	60°	60°

NOTE:

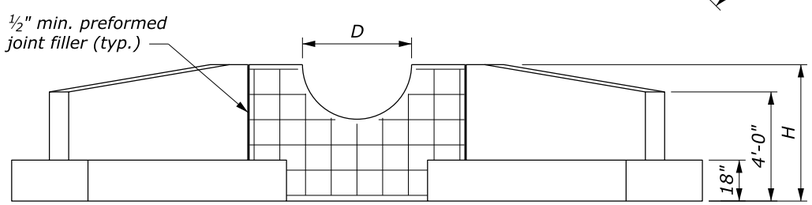
1. Chamfer all exposed edges ¾ inch and finish all exposed surfaces with a Class 1 ordinary finish.
2. Reinforcing steel clearance is 2 inches unless otherwise noted.
3. For skew angles shown in table, the length W and quantities for wingwalls are computed for a 1V:1.5H side slope. For 1V:2H or 1V:2.5H slopes compute length W with the following equation:
   W = D/2 × slope × secant (wingwall skew angle)
   Minimum W not less than 6 feet.
4. Quantities shown in table are for one wingwall only. For lengths W not shown in table, approximate the quantities by multiplying the quantities for 0° skew and a given height H by the factor: 1 + [(W-6.0) × 0.14].
5. See Standards 601-1 and 601-2 for headwall and slope paving dimensions.
6. Final quantities will be determined by using the tables on this drawing.
7. Do not order materials until the length, skew angle, and slope bevel in the field have been approved.



SECTION A-A

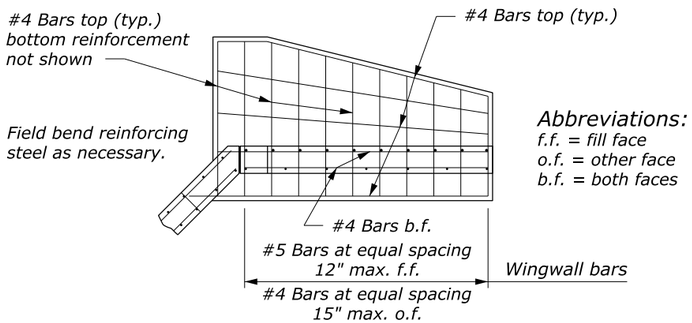


PLAN

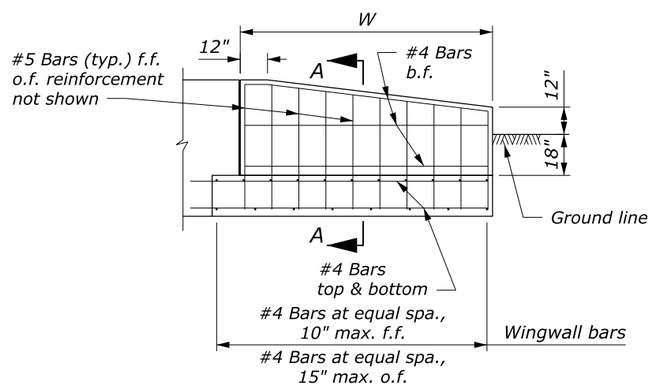


ELEVATION

HEADWALL AND WINGWALL



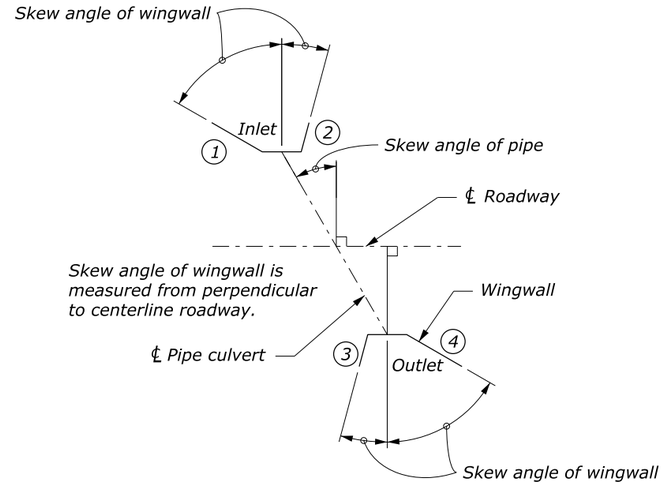
PLAN



ELEVATION

TYPICAL WINGWALL

Abbreviations:
f.f. = fill face
o.f. = other face
b.f. = both faces



WINGWALL LAYOUT

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	FLH STANDARD 601-3
WINGWALLS FOR CONCRETE HEADWALLS	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 2/2024

18 June 2024 10:49 AM c:\pw-work\d0147408\Std601-3.dgn [Std 601-3]

PROJECT	SHEET NUMBER

WINGWALLS FOR CONCRETE HEADWALLS

DIMENSIONS, REINFORCING STEEL AND CONCRETE TABLE OF QUANTITIES

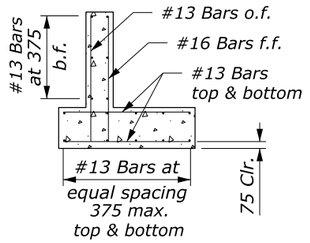
D	H	0° WINGWALL SKEW			15° WINGWALL SKEW			30° WINGWALL SKEW			45° WINGWALL SKEW			60° WINGWALL SKEW		
	m	W m	CONC. m3	STEEL kg	W m	CONC. m3	STEEL kg	W m	CONC. m3	STEEL kg	W m	CONC. m3	STEEL kg	W m	CONC. m3	STEEL kg
1200	1.500	1.8	2.05	80	1.8	2.03	80	1.8	2.01	80	1.8	2.00	80	1.8	1.99	80
1350	1.575	1.8	2.08	80	1.8	2.06	80	1.8	2.04	80	1.8	2.03	80	2.1	2.30	92
1500	1.650	1.8	2.11	81	1.8	2.09	81	1.8	2.07	81	1.8	2.05	81	2.3	2.52	101
1650	1.725	1.8	2.14	82	1.8	2.12	82	1.8	2.10	82	1.8	2.08	82	2.5	2.75	108
1800	1.800	1.8	2.17	82	1.8	2.15	82	1.8	2.12	82	2.0	2.30	92	2.7	2.98	117
1950	1.875	1.8	2.20	83	1.8	2.17	83	1.8	2.15	83	2.1	2.43	95	3.0	3.32	130
2100	1.950	1.8	2.23	84	1.8	2.20	84	1.9	2.28	88	2.3	2.66	104	3.2	3.56	140
2250	2.025	1.8	2.26	85	1.8	2.23	85	2.0	2.41	95	2.4	2.80	110	3.4	3.80	147
2400	2.100	1.8	2.30	85	1.9	2.36	90	2.1	2.54	97	2.6	3.04	117	3.6	4.05	156

RECOMMENDED WINGWALL SKEWS

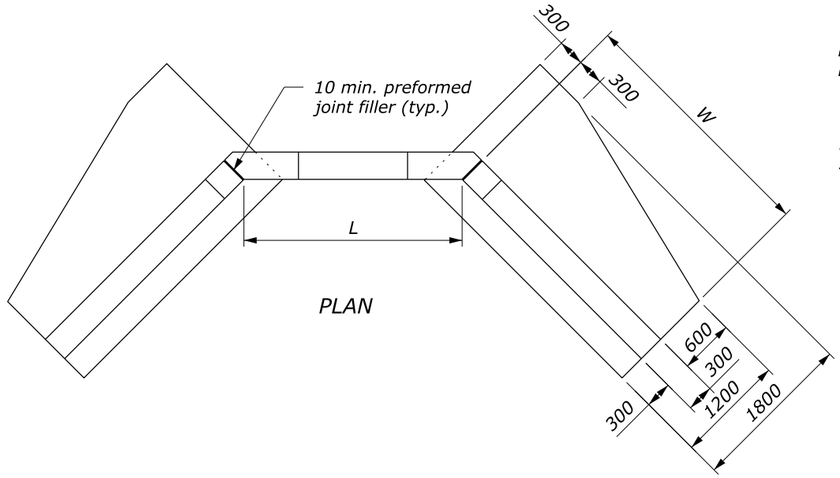
WINGWALL	PIPE SKEW			
	0°	15°	30°	45°
①	45°	45°	60°	60°
②	45°	30°	15°	0°
③	45°	30°	15°	0°
④	45°	45°	60°	60°

NOTE:

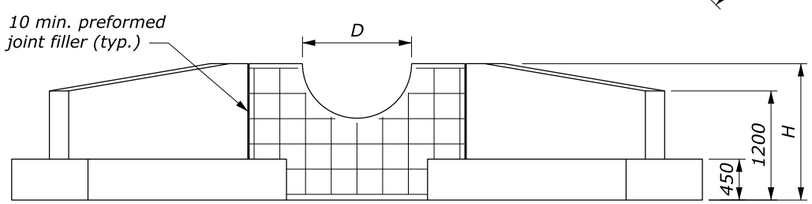
1. Chamfer all exposed edges 20 mm and finish all exposed surfaces with a Class 1 ordinary finish.
2. Reinforcing steel clearance is 50 mm unless otherwise noted.
3. For skew angles shown in table, the length W and quantities for wingwalls are computed for a 1V:1.5H side slope. For 1V:2H or 1V:2.5H slopes compute length W with the following equation:
   $W = D/2 \times \text{slope} \times \text{secant (wingwall skew angle)}$
   Minimum W not less than 1.8 meters.
4. Quantities shown in table are for one wingwall only. For lengths W not shown in table, approximate the quantities by multiplying the quantities for 0° skew and a given height H by the factor: $1 + [(W-1.8) \times 0.46]$.
5. See Standards M601-1 and M601-2 for headwall and slope paving dimensions.
6. Final quantities will be determined by using the tables on this drawing.
7. Do not order materials until the length, skew angle, and slope bevel in the field have been approved.



SECTION A-A

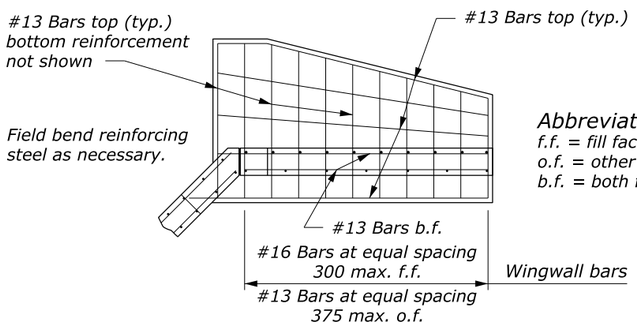


PLAN

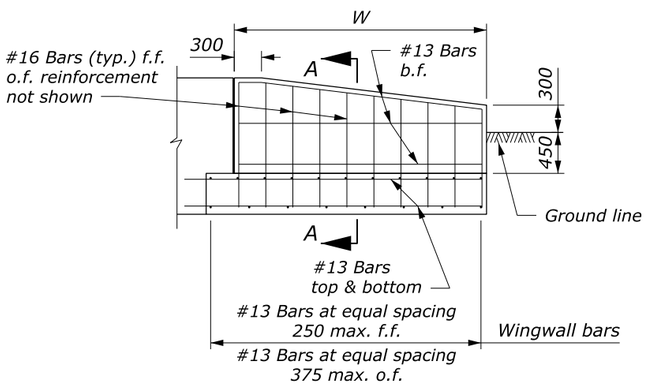


ELEVATION

HEADWALL AND WINGWALL



PLAN



ELEVATION

TYPICAL WINGWALL

Abbreviations:
f.f. = fill face
o.f. = other face
b.f. = both faces

WINGWALL LAYOUT

*This drawing contains **Metric** units of measure.*
Dimensions without units are millimeters.

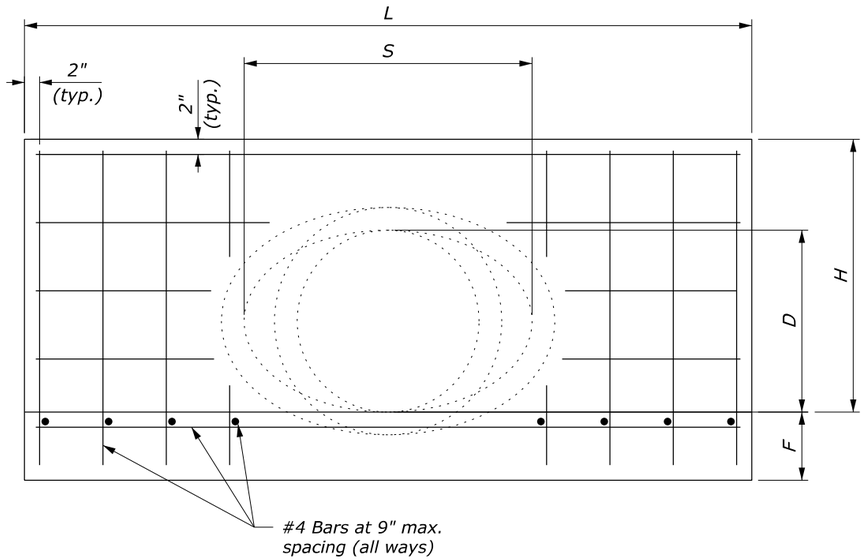
NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

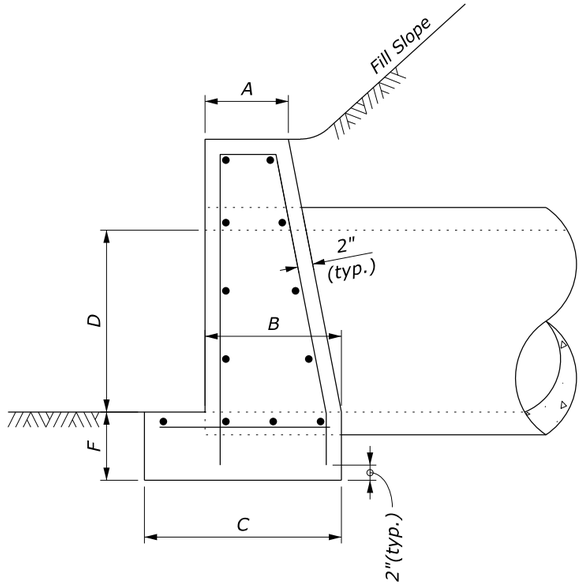
WINGWALLS FOR CONCRETE HEADWALLS

FLH STANDARD
M601-3
SPECIFICATION
FP-24, FP-14
APPROVED FOR USE
2/2024

PROJECT	SHEET NUMBER



FRONT ELEVATION



SIDE ELEVATION

NOTE:

1. *Prepare foundation according to Section 209. Place headwalls on 6 inches of foundation fill.*
2. *Orient all headwalls parallel to the roadway centerline unless otherwise shown in the plans or as directed.*
3. *When pipes are on a skew, adapt and lengthen headwalls as directed.*
4. *Chamfer all exposed corners not rounded to ¾ inch.*
5. *Quantities shown are for one headwall with pipe at right angles.*

HEADWALL FOR ELLIPTICAL PIPE

SIZE OF ELLIPTICAL PIPE CULVERT (SPAN x RISE)										
	23" x 14"	30" x 19"	34" x 22"	38" x 24"	42" x 27"	45" x 29"	49" x 32"	53" x 34"	60" x 38"	68" x 43"
A	0'-8"	0'-9"	0'-10"	0'-10"	0'-11"	1'-0"	1'-0"	1'-0"	1'-0"	1'-0"
B	1'-2"	1'-5"	1'-6"	1'-8"	1'-9"	1'-10"	1'-11"	1'-11"	1'-11"	2'-0"
C	1'-8"	1'-11"	2'-1"	2'-4"	2'-5"	2'-7"	2'-8"	2'-9"	3'-3"	3'-6"
D	1'-2"	1'-7"	1'-10"	2'-0"	2'-3"	2'-5"	2'-8"	2'-10"	3'-2"	3'-7"
F	0'-8"	0'-8"	0'-9"	0'-9"	0'-9"	0'-9"	0'-9"	0'-9"	0'-9"	0'-9"
H	2'-10"	3'-3"	3'-7"	3'-9"	4'-0"	4'-2"	4'-5"	4'-7"	4'-11"	5'-4"
L	5'-5"	7'-2"	8'-6"	9'-2"	10'-2"	10'-11"	12'-1"	12'-11"	13'-0"	13'-0"
S	1'-11"	2'-6"	2'-10"	3'-2"	3'-6"	3'-9"	4'-1"	4'-5"	5'-0"	5'-8"
CUBIC YARDS OF CONCRETE										
Conc. Pipe	0.502	0.855	1.236	1.500	1.811	2.101	2.512	2.801	2.969	2.904

HEADWALL FOR CIRCULAR PIPE

DIAMETER OF PIPE CULVERT (D)						
	6"	15"	18"	21" or 24"	27" or 30"	33" or 36"
A	0'-6"	0'-8"	0'-9"	0'-11"	1'-0"	1'-0"
B	0'-9"	1'-1"	1'-3"	1'-6"	1'-9"	2'-0"
C	1'-2"	1'-7"	1'-9"	2'-2"	2'-6"	2'-9"
F	0'-6"	0'-8"	0'-8"	0'-9"	0'-9"	0'-9"
H	2'-0"	2'-11"	3'-2"	3'-9"	4'-3"	4'-9"
L	3'-8"	5'-0"	6'-0"	8'-0"	10'-0"	12'-0"
CUBIC YARDS OF CONCRETE						
Conc. Pipe	0.241	0.492	0.697	1.319	2.067	2.947
C.M. Pipe	0.257	0.521	0.739	1.398	2.198	3.145

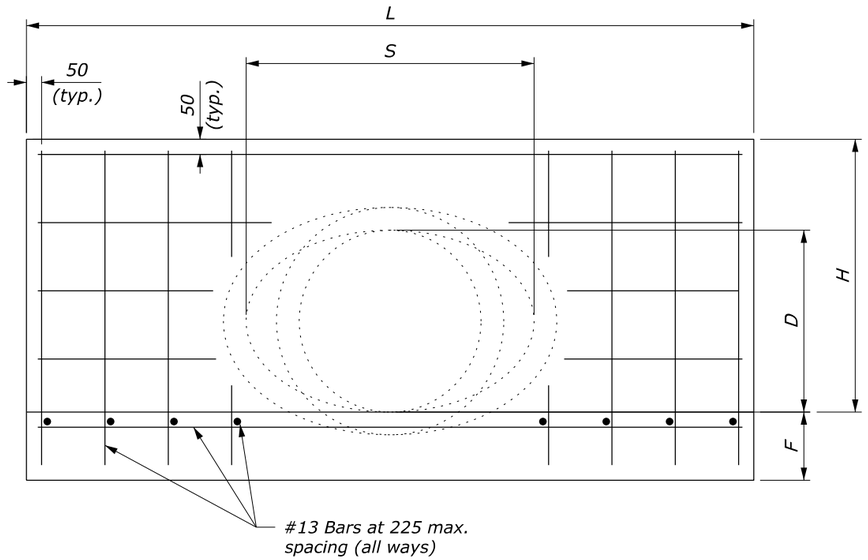
NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

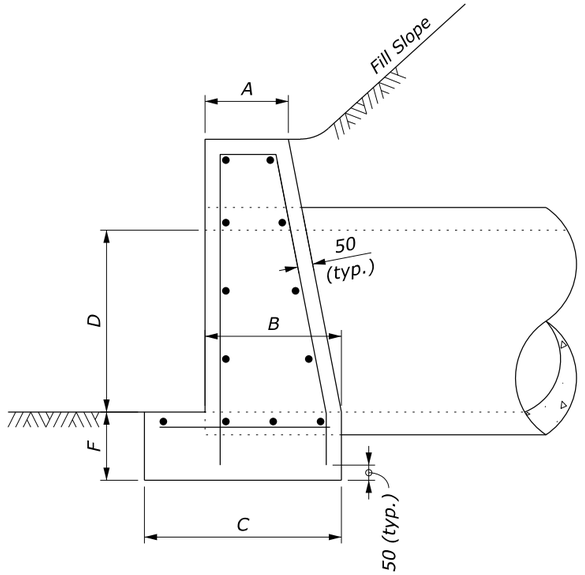
CONCRETE HEADWALL FOR SMALL PIPE CULVERT

FLH STANDARD
601-4
SPECIFICATION
FP-24, FP-14
APPROVED FOR USE
2/2024

PROJECT	SHEET NUMBER



FRONT ELEVATION



SIDE ELEVATION

NOTE:

1. *Prepare foundation according to Section 209. Place headwalls on 150 mm of foundation fill.*
2. *Orient all headwalls parallel to the roadway centerline unless otherwise shown in the plans or as directed.*
3. *When pipes are on a skew, adapt and lengthen headwalls as directed.*
4. *Chamfer all exposed corners not rounded to 20 mm.*
5. *Quantities shown are for one headwall with pipe at right angles.*

HEADWALL FOR ELLIPTICAL PIPE

SIZE OF ELLIPTICAL PIPE CULVERT (SPAN x RISE)										
	575 x 350	750 x 475	850 x 550	950 x 600	1050 x 675	1125 x 725	1225 x 800	1325 x 850	1500 x 950	1700 x 1075
A	200	225	250	275	275	300	300	300	300	300
B	350	425	450	500	525	550	575	575	575	600
C	500	575	625	700	725	775	800	825	975	1050
D	350	475	550	600	675	725	800	850	950	1075
F	200	200	225	225	225	225	225	225	225	225
H	850	975	1075	1125	1200	1250	1325	1375	1475	1600
L	1625	2150	2550	2750	3050	3275	3625	3875	3900	3900
S	575	750	850	950	1050	1125	1225	1325	1500	1700
CUBIC METERS OF CONCRETE										
Conc. Pipe	0.378	0.639	0.913	1.119	1.352	1.569	1.876	2.074	2.241	2.363

HEADWALL FOR CIRCULAR PIPE

DIAMETER OF PIPE CULVERT (D)						
	150	375	450	525 or 600	675 or 750	825 or 900
A	150	200	225	275	300	300
B	225	325	375	450	525	600
C	350	475	525	650	750	825
F	150	200	200	225	225	225
H	600	875	950	1125	1275	1425
L	1100	1500	1800	2400	3000	3600
CUBIC METERS OF CONCRETE						
Conc. Pipe	0.127	0.359	0.516	0.974	1.528	2.185
C.M. Pipe	0.137	0.379	0.546	1.032	1.624	2.326

*This drawing contains **Metric** units of measure. Dimensions without units are millimeters.*

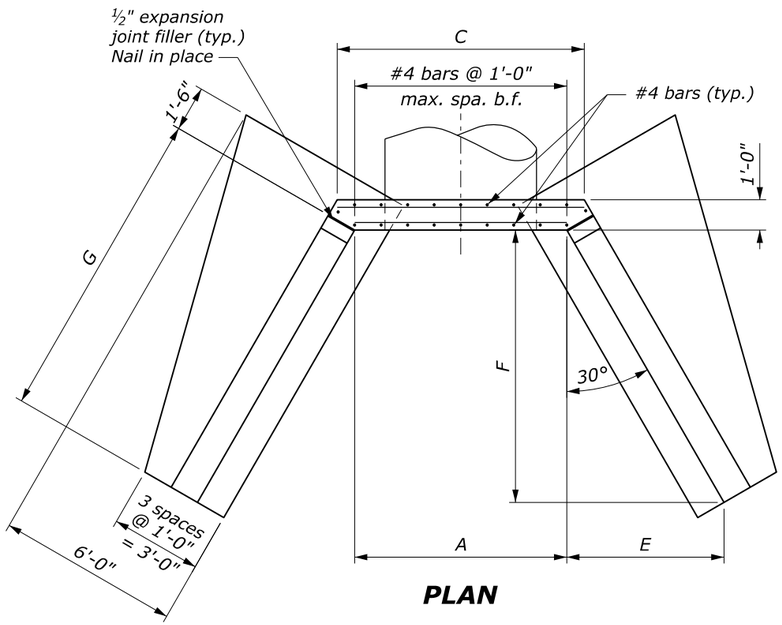
NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

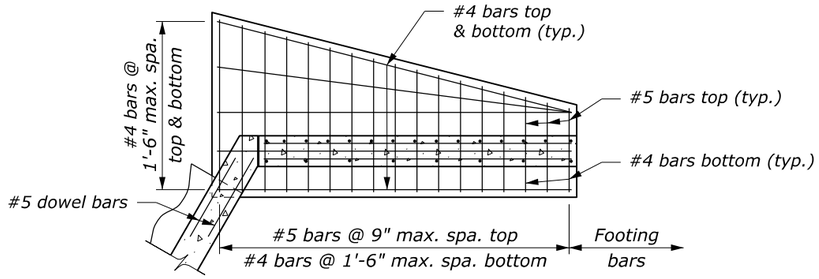
CONCRETE HEADWALL FOR SMALL PIPE CULVERT

FLH STANDARD
M601-4
SPECIFICATION
FP-24, FP-14
APPROVED FOR USE
2/2024

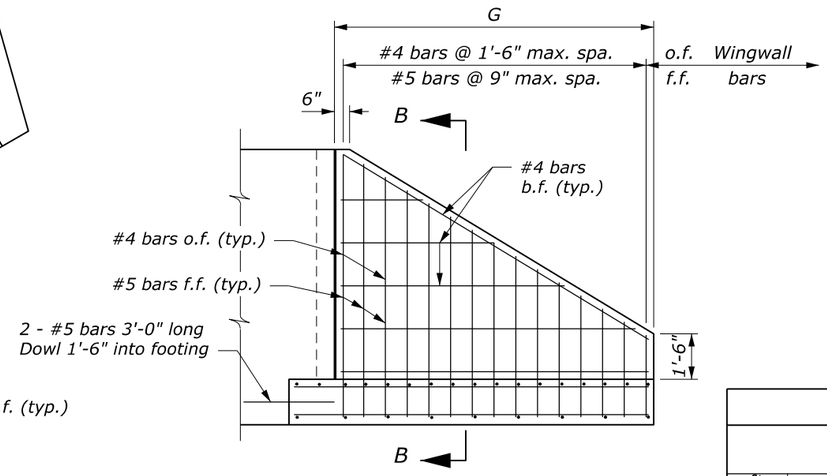
PROJECT	SHEET NUMBER



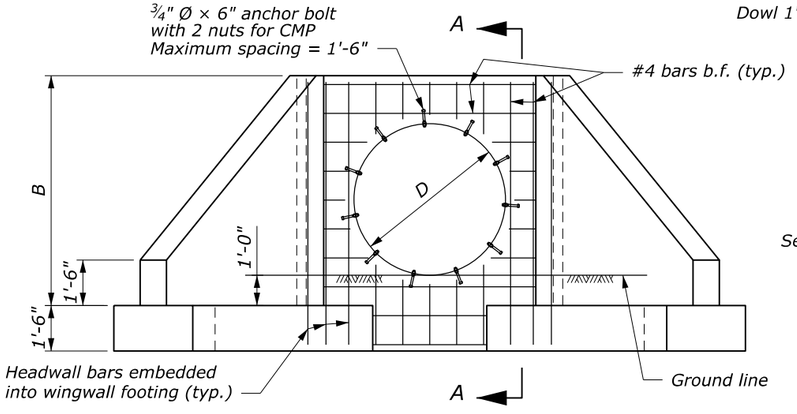
PLAN



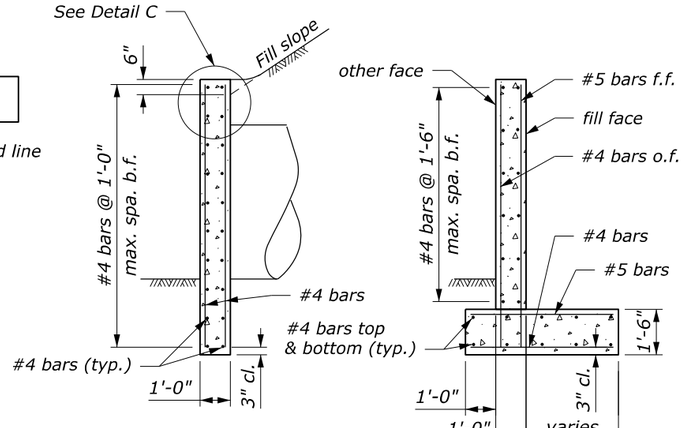
WINGWALL PLAN



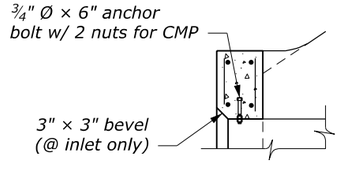
WINGWALL ELEVATION



FRONT ELEVATION
(Showing headwall reinforcement)



SECTION A-A **SECTION B-B**



DETAIL C
(For Metal Pipes)

NOTE:

1. *This drawing applies for normal crossings and skews up to 15°.*
2. *Prepare foundation according to Section 209. Place headwall/wingwalls on 6 inches of foundation fill.*
3. *On shallow fill where headwall is 2 feet or less below shoulder line, construct the headwall parallel to line and grade of the shoulder.*
4. *Do not allow top of wingwall to project above fill slope, ditch slope or shoulder.*
5. *Chamfer all exposed edges ¾ inch and finish all exposed surfaces with a Class 1 ordinary surface finish. Provide joint filler conforming to AASHTO M 213.*
6. *Bell end of concrete pipe may replace bevel at inlet headwall.*
7. *Quantities shown in table are for one headwall and two wingwalls and are based on CMP. Concrete and steel quantities shown will be used as basis for final payment for headwall/wingwalls constructed according to this drawing.*
8. *Reinforcing steel clearance is 2 inches unless shown otherwise.*
9. *Provide anchor bolts conforming to ASTM A307. Galvanize bolts and nuts according to ASTM A153.*

DIMENSIONS AND QUANTITIES

		Diameter of Pipe Culvert (D)							
		42"	48"	54"	60"	66"	72"	78"	84"
1V:1.5H fill slope	A	5'-6"	6'-0"	6'-6"	7'-0"	7'-6"	8'-0"	8'-6"	9'-0"
	B	5'-11½"	6'-5½"	6'-11½"	7'-5½"	7'-11½"	8'-5½"	8'-11½"	9'-5½"
	C	6'-7¾"	7'-1¾"	7'-7¾"	8'-1¾"	8'-7¾"	9'-1¾"	9'-7¾"	10'-1¾"
	E	3'-10½"	4'-3¾"	4'-9"	5'-2¼"	5'-7¼"	6'-0¾"	6'-5¾"	6'-11"
	F	6'8¾"	7'-5¾"	8'-2½"	8'-11¾"	9'-8½"	10'-5¾"	11'-2¾"	12'-0"
	G	7'-9"	8'-7½"	9'-6"	10'-4½"	11'-2¾"	12'-1¼"	12'-11½"	13'-10¼"
Conc. (CUYD)		8.0	9.0	10.1	11.1	12.2	13.4	14.5	15.8
Steel (LB)		651	738	818	878	977	1040	1152	1249
1V:2H fill slope	A	5'-6"	6'-0"	6'-6"	7'-0"	7'-6"	8'-0"	8'-6"	9'-0"
	B	5'-11½"	6'-5½"	6'-11½"	7'-5½"	7'-11½"	8'-5½"	8'-11½"	9'-5½"
	C	6'-7¾"	7'-1¾"	7'-7¾"	8'-1¾"	8'-7¾"	9'-1¾"	9'-7¾"	10'-1¾"
	E	5'-2"	5'-9"	6'-3¾"	6'-11"	7'-5¾"	8'-0¾"	8'-7¾"	9'-2¾"
	F	8'-11½"	9'-11¾"	10'-11½"	11'-11¾"	12'-11½"	13'-11¾"	14'-11½"	15'-11¾"
	G	10'-4"	11'-6¼"	12'-7¾"	13'-10"	14'-11½"	16'-1¾"	17'-3¼"	18'-5½"
Conc. (CUYD)		10.0	11.3	12.6	14.0	15.4	16.9	18.3	19.9
Steel (LB)		798	911	1001	1104	1206	1315	1417	1554

Abbreviations:
f.f. = Fill face
o.f. = Other face
b.f. = Both faces

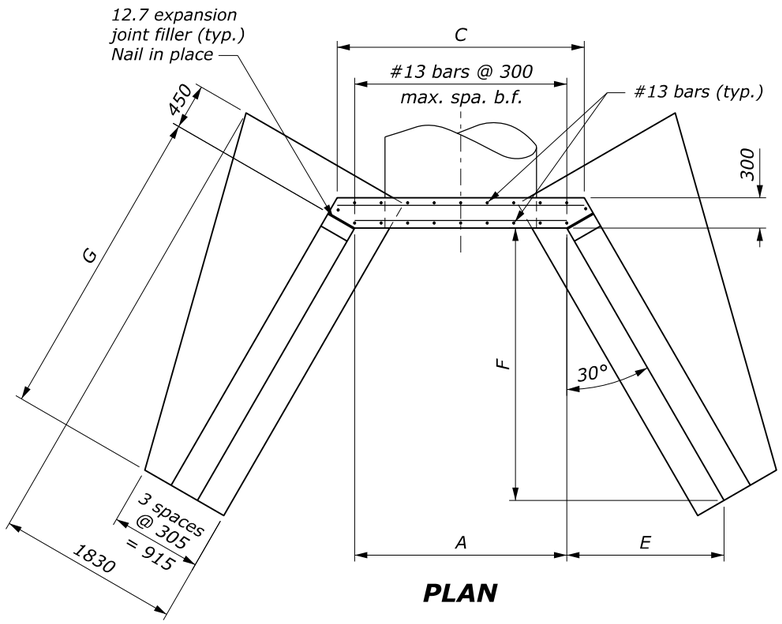
NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

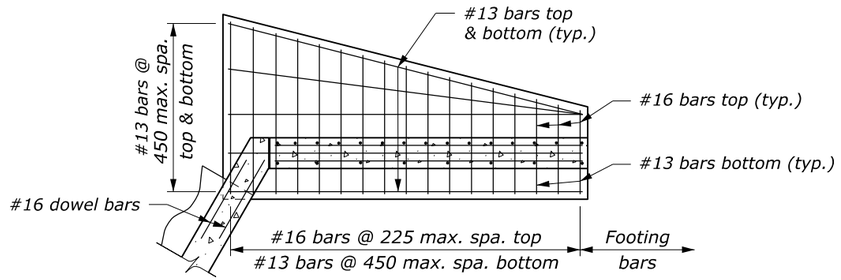
CONCRETE HEADWALL/WINGWALL FOR SINGLE NORMAL 42" TO 84" PIPE CULVERT

FLH STANDARD	601-5
SPECIFICATION	FP-24, FP-14
APPROVED FOR USE	2/2024

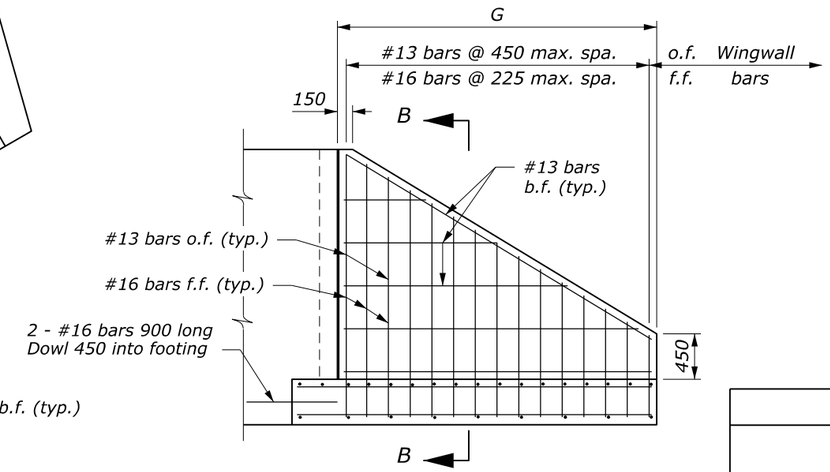
PROJECT	SHEET NUMBER



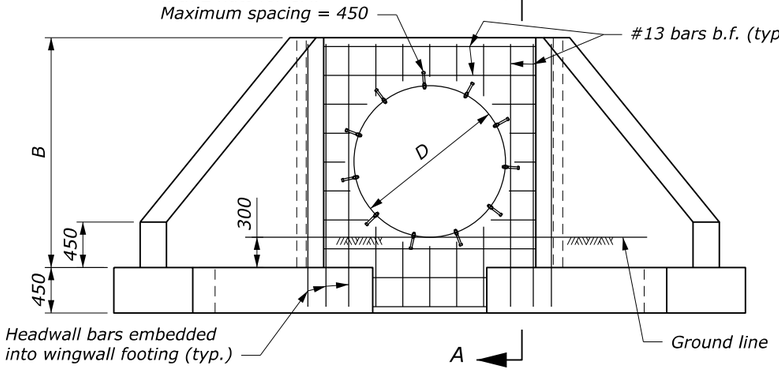
PLAN



WINGWALL PLAN

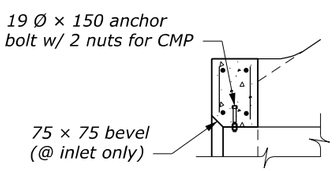


WINGWALL ELEVATION



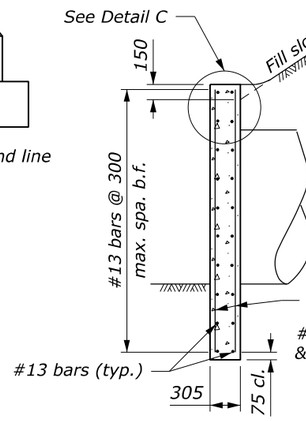
FRONT ELEVATION

(Showing headwall reinforcement)

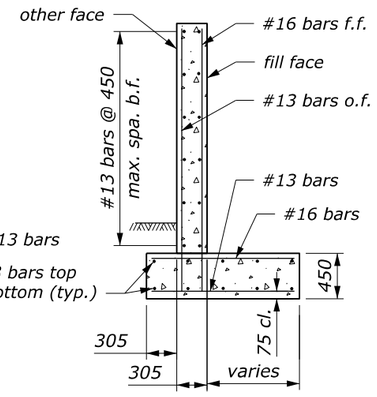


DETAIL C

(For Metal Pipes)



SECTION A-A



SECTION B-B

NOTE:

1. *This drawing applies for normal crossings and skews up to 15°.*
2. *Prepare foundation according to Section 209. Place headwall/wingwalls on 150 mm of foundation fill.*
3. *On shallow fill where headwall is 600 mm or less below shoulder line, construct the headwall parallel to line and grade of the shoulder.*
4. *Do not allow top of wingwall to project above fill slope, ditch slope or shoulder.*
5. *Chamfer all exposed edges 20 mm and finish all exposed surfaces with a Class 1 ordinary surface finish. Provide joint filler conforming to AASHTO M 213.*
6. *Bell end of concrete pipe may replace bevel at inlet headwall.*
7. *Quantities shown in table are for one headwall and two wingwalls and are based on CMP. Concrete and steel quantities shown will be used as basis for final payment for headwall/wingwalls constructed according to this drawing.*
8. *Reinforcing steel clearance is 50 mm unless shown otherwise.*
9. *Provide anchor bolts conforming to ASTM A307. Galvanize bolts and nuts according to ASTM A153.*

DIMENSIONS AND QUANTITIES

		Diameter of Pipe Culvert (D)							
		1050	1200	1350	1500	1650	1800	1950	2100
1V:1.5H fill slope	A	1675	1830	1980	2135	2285	2440	2590	2745
	B	1815	1970	2120	2275	2425	2580	2730	2885
	C	2025	2180	2330	2485	2635	2790	2940	3095
	E	1180	1315	1450	1580	1710	1845	1975	2110
	F	2050	2280	2505	2735	2960	3195	3420	3655
	G	2365	2630	2895	3160	3420	3690	3950	4220
Conc. (m³)		6.1	6.9	7.7	8.5	9.4	10.2	11.1	12.1
Steel (kg)		295	334	371	398	443	471	522	567
1V:2H fill slope	A	1675	1830	1980	2135	2285	2440	2590	2745
	B	1815	1970	2120	2275	2425	2580	2730	2885
	C	2025	2180	2330	2485	2635	2790	2940	3095
	E	1575	1755	1925	2110	2280	2460	2635	2815
	F	2730	3040	3340	3650	3950	4260	4560	4870
	G	3150	3510	3855	4215	4560	4920	5265	5625
Conc. (m³)		7.7	8.6	9.6	10.7	11.8	12.9	14.0	15.2
Steel (kg)		362	413	454	501	547	596	642	705

Abbreviations:
f.f. = Fill face
o.f. = Other face
b.f. = Both faces

NO SCALE

*This drawing contains **Metric** units of measure. Dimensions without units are millimeters.*

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

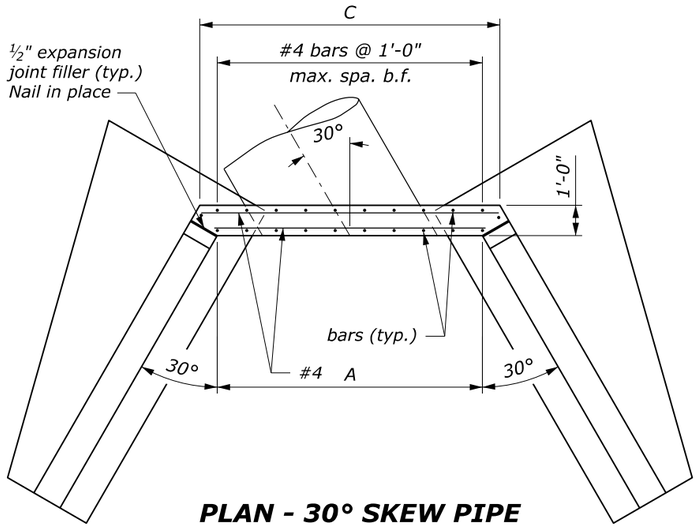
CONCRETE HEADWALL/WINGWALL FOR SINGLE NORMAL 1050 TO 2100 PIPE CULVERT

FLH STANDARD M601-5

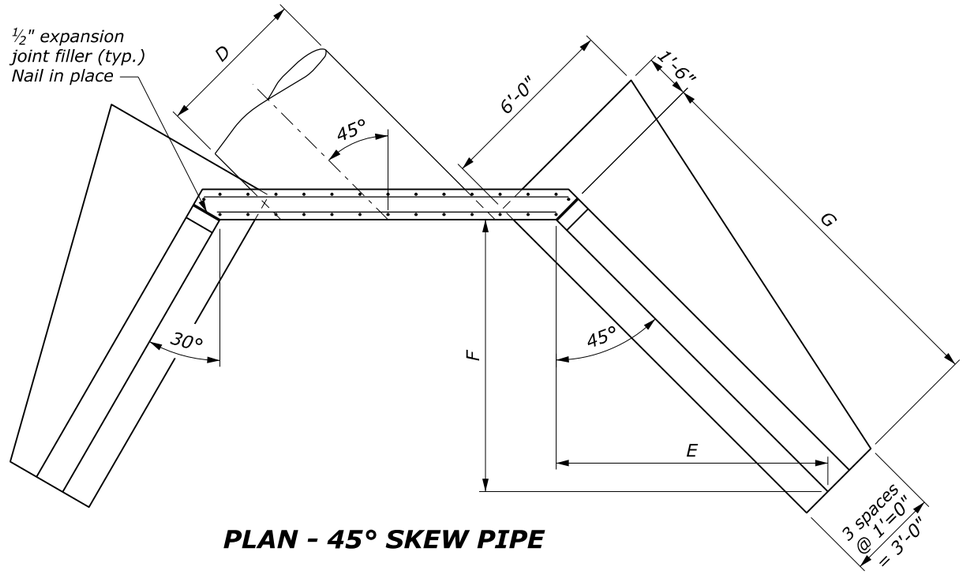
SPECIFICATION FP-24, FP-14

APPROVED FOR USE 2/2024

PROJECT	SHEET NUMBER



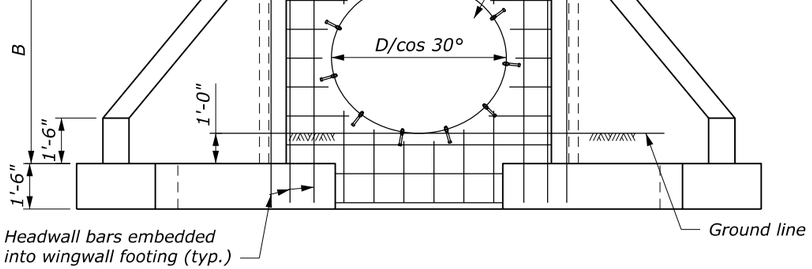
PLAN - 30° SKEW PIPE



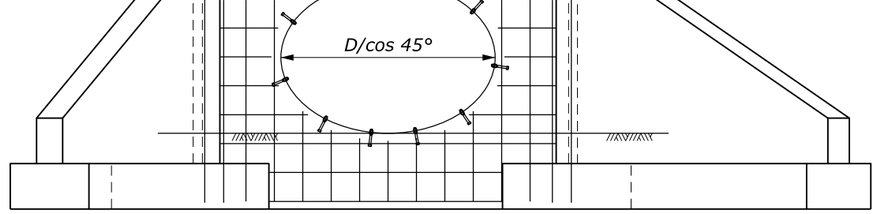
PLAN - 45° SKEW PIPE

NOTE:

1. *Use the 30° Skew Detail for skews greater than 15° to 37°30'. Use the 45° Skew Detail for skews greater than 37°30' to 45°.*
2. *Prepare foundation according to Section 209. Place headwall/wingwalls on 6 inches of foundation fill.*
3. *Quantities shown in table are for one headwall and two wingwalls and are based on CMP. Concrete and steel quantities shown will be used as basis for final payment for headwall/wingwalls constructed according to this standard.*
4. *For dimensions and reinforcing details not shown, see Standard 601-5.*



FRONT ELEVATION - 30° SKEW PIPE
(Showing headwall reinforcement)



FRONT ELEVATION - 45° SKEW PIPE
(Showing headwall reinforcement)

DIMENSIONS AND QUANTITIES FOR 30° SKEW PIPE

		Diameter of Pipe Culvert (D)							
		42"	48"	54"	60"	66"	72"	78"	84"
	A	7'-0¼"	7'-7¼"	8'-2"	8'-9"	9'-4"	9'-11"	10'-5¾"	11'-0¾"
	C	8'-2"	8'-9"	9'-4"	9'-11"	10'-5¾"	11'-0¾"	11'-7¾"	12'-2-¾"
1V:1.5H fill slope	Conc. (CUYD)	8.4	9.4	10.5	11.6	12.7	13.9	15.1	16.4
	Steel (LB)	682	764	853	908	1016	1080	1196	1294
1V:2H fill slope	Conc. (CUYD)	10.4	11.7	13.0	14.5	15.9	17.4	18.9	20.5
	Steel (LB)	829	938	1036	1135	1245	1355	1461	1598

DIMENSIONS AND QUANTITIES FOR 45° SKEW PIPE

		Diameter of pipe culvert (D)							
		42"	48"	54"	60"	66"	72"	78"	84"
	A	8'-11¼"	9'-8"	10'-4¼"	11'-0¾"	11'-9¼"	12'-6"	13'-2¼"	13'-11"
	C	9'-11¼"	10'-8"	11'-4¼"	12'-1"	12'-9¼"	13'-6"	14'-2¼"	14'-11"
1V:1.5H fill slope	E	6'-8¾"	7'-5¾"	8'-2½"	8'-11¾"	9'-8½"	10'-5¾"	11'-2¾"	12'-0"
	F	6'-8¾"	7'-5¾"	8'-2½"	8'-11¾"	9'-8½"	10'-5¾"	11'-2¾"	12'-0"
	G	9'-6"	10'-7"	11'-7½"	12'-8¼"	13'-9"	14'-10"	15'-10¼"	16'-11¼"
	Conc. (CUYD)	9.5	10.6	11.8	13.1	14.4	15.7	17.1	18.5
	Steel (LB)	787	868	977	1051	1177	1249	1370	1490
1V:2H fill slope	E	8'-11½"	9'-11¾"	10'-11½"	11'-11¾"	12'-11½"	13'-11¾"	14'-11½"	15'-11¾"
	F	8'-11½"	9'-11¾"	10'-11½"	11'-11¾"	12'-11½"	13'-11¾"	14'-11½"	15'-11¾"
	G	12'-8"	14'-1¼"	15'-6"	16'-11¼"	18'-4"	19'-9¼"	21'-2"	22'-7"
	Conc. (CUYD)	11.7	13.2	14.7	16.3	17.9	19.6	21.3	23.1
	Steel (LB)	951	1070	1190	1303	1440	1559	1695	1846

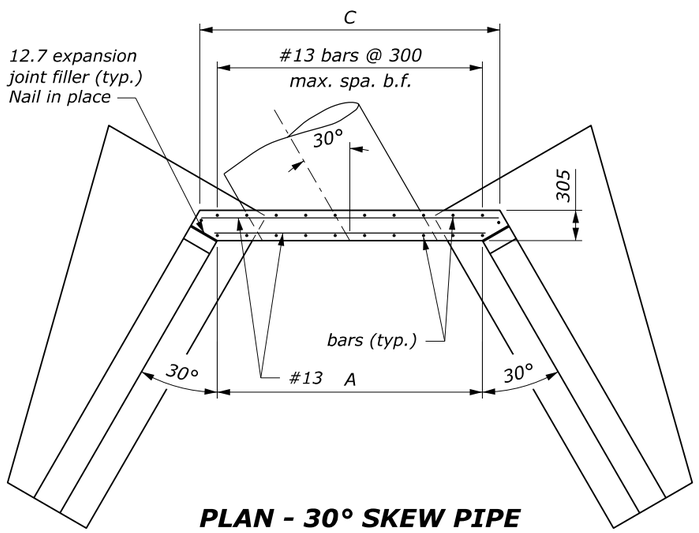
NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

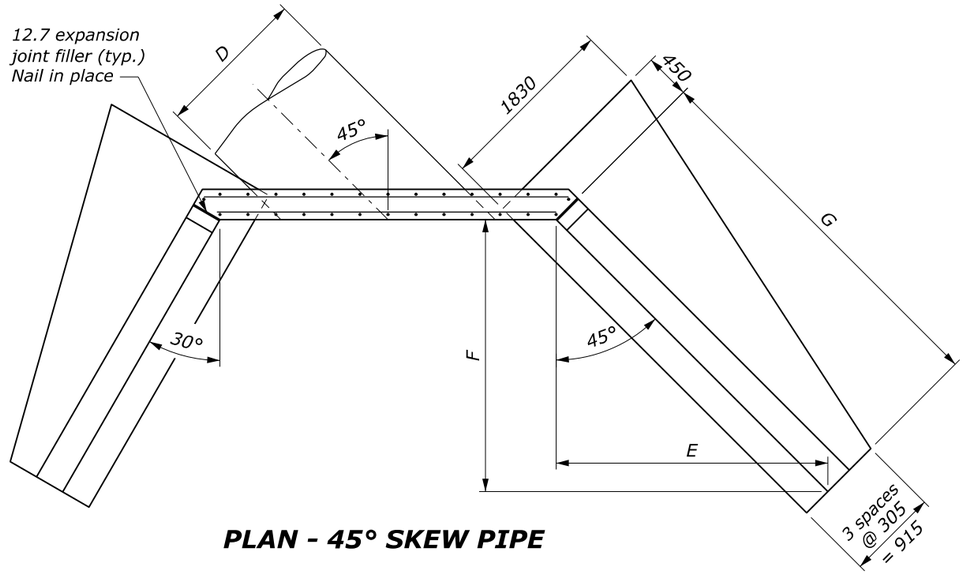
CONCRETE HEADWALL/WINGWALL FOR SINGLE SKEW 42" TO 84" PIPE CULVERT

FLH STANDARD	601-6
SPECIFICATION	FP-24, FP-14
APPROVED FOR USE	2/2024

PROJECT	SHEET NUMBER



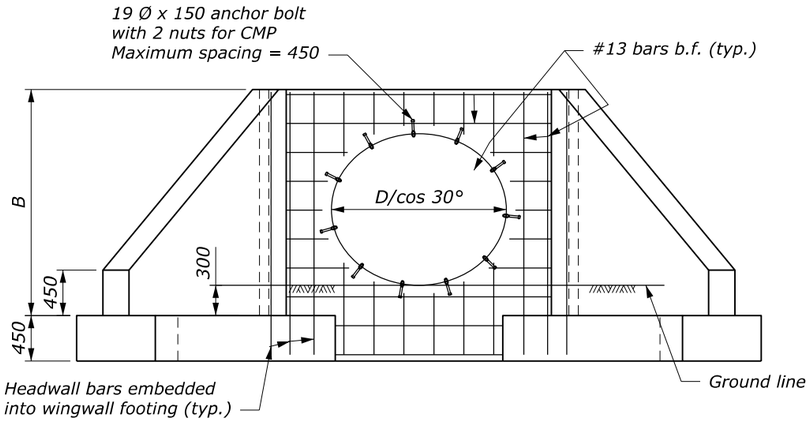
PLAN - 30° SKEW PIPE



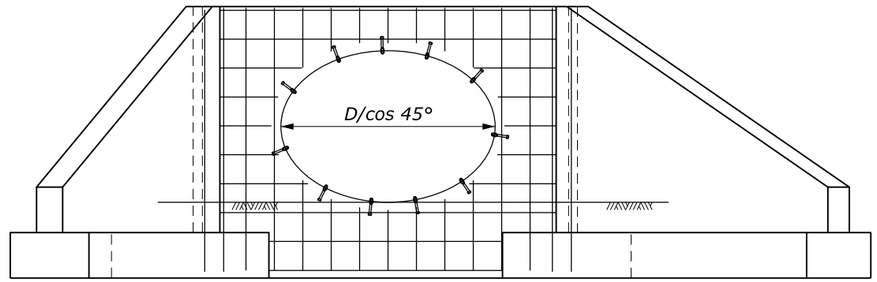
PLAN - 45° SKEW PIPE

NOTE:

1. *Use the 30° Skew Detail for skews greater than 15° to 37°30'. Use the 45° Skew Detail for skews greater than 37°30' to 45°.*
2. *Prepare foundation according to Section 209. Place headwall/wingwalls on 150 mm of foundation fill.*
3. *Quantities shown in table are for one headwall and two wingwalls and are based on CMP. Concrete and steel quantities shown will be used as basis for final payment for headwall/wingwalls constructed according to this standard.*
4. *For dimensions and reinforcing details not shown, see Standard M601-5.*



FRONT ELEVATION - 30° SKEW PIPE
(Showing headwall reinforcement)



FRONT ELEVATION - 45° SKEW PIPE
(Showing headwall reinforcement)

DIMENSIONS AND QUANTITIES FOR 30° SKEW PIPE

		Diameter of Pipe Culvert (D)							
		1050	1200	1350	1500	1650	1800	1950	2100
	A	2140	2320	2490	2670	2845	3025	3195	3375
	C	2490	2670	2845	3025	3195	3375	3550	3725
1V:1.5H fill slope	Conc. (m³)	6.4	7.2	8.0	8.9	9.7	10.7	11.6	12.5
	Steel (kg)	309	346	387	412	461	490	542	587
1V:2H fill slope	Conc. (m³)	7.9	9.0	10.0	11.1	12.1	13.3	14.5	15.7
	Steel (kg)	376	425	470	515	565	614	662	725

DIMENSIONS AND QUANTITIES FOR 45° SKEW PIPE

		Diameter of pipe culvert (D)							
		1050	1200	1350	1500	1650	1800	1950	2100
	A	2725	2945	3155	3375	3590	3810	4020	4240
	C	3030	3250	3460	3680	3895	4115	4325	4545
1V:1.5H fill slope	E	2050	2280	2505	2735	2960	3195	3420	3655
	F	2050	2280	2505	2735	2960	3195	3420	3655
	G	2895	3225	3545	3870	4190	4520	4835	5165
	Conc. (m³)	7.2	8.1	9.1	10.0	11.0	12.0	13.1	14.2
	Steel (kg)	357	394	443	477	534	566	621	676
1V:2H fill slope	E	2730	3040	3340	3650	3950	4260	4560	4870
	F	2730	3040	3340	3650	3950	4260	4560	4870
	G	3860	4300	4725	5160	5585	6025	6450	6885
	Conc. (m3)	8.9	10.1	11.2	12.4	13.7	15.0	16.3	17.7
	Steel (kg)	431	485	539	591	653	707	768	837

*This drawing contains **Metric** units of measure. Dimensions without units are millimeters.*

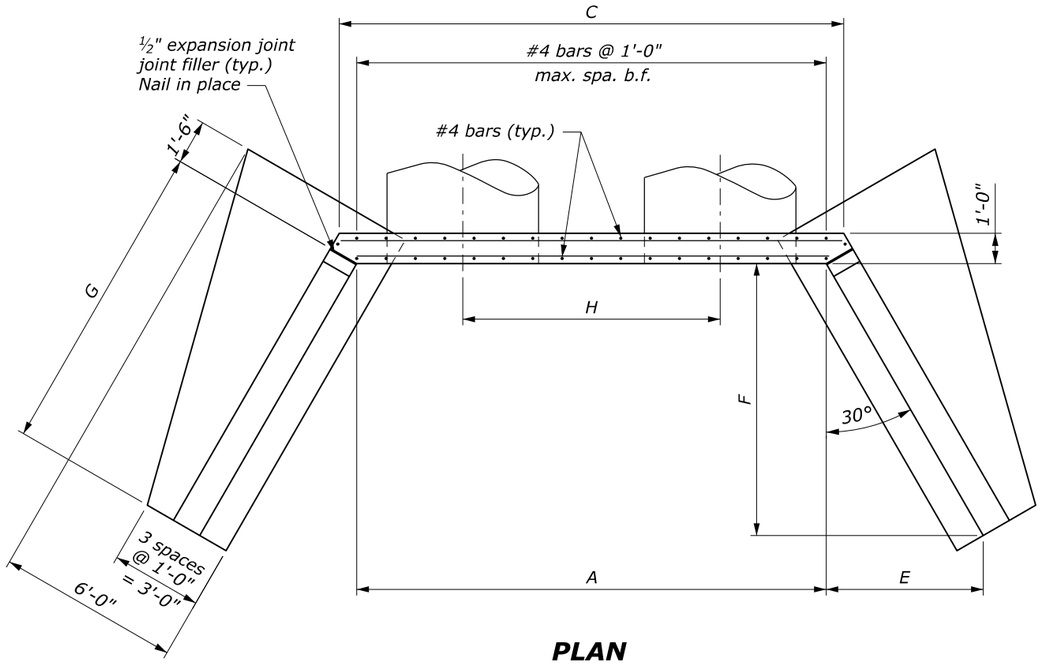
NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

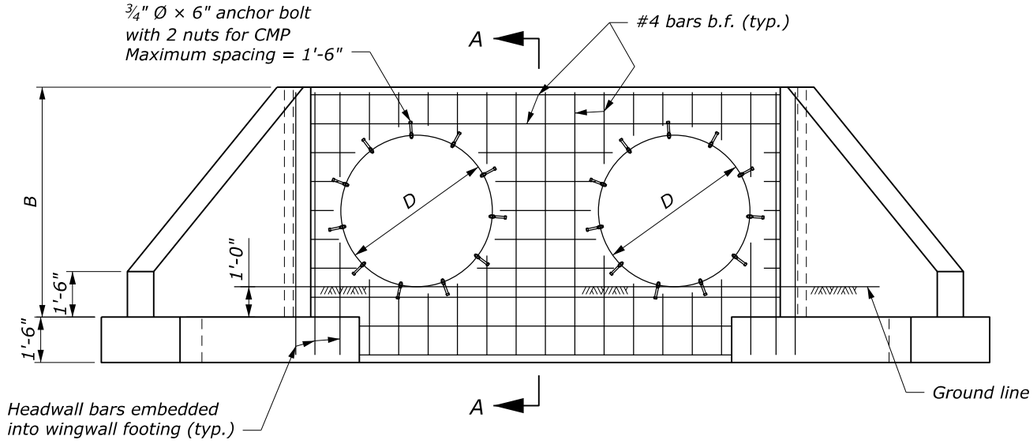
CONCRETE HEADWALL/WINGWALL FOR SINGLE SKEW 1050 TO 2100 PIPE CULVERT

FLH STANDARD
M601-6
SPECIFICATION
FP-24, FP-14
APPROVED FOR USE
2/2024

PROJECT	SHEET NUMBER



PLAN



FRONT ELEVATION
(Showing headwall reinforcement)

NOTE:

1. This drawing applies for normal crossings and skews up to 15°.
2. Prepare foundation according to Section 209. Place headwall/wingwalls on 6 inches of foundation fill.
3. Quantities shown in table are for one headwall and two wingwalls and are based on CMP. Concrete and steel quantities shown will be used as basis for final payment for headwall/wingwalls constructed according to this drawing.
4. For dimensions and reinforcing details not shown, see Standard 601-5.

DIMENSIONS AND QUANTITIES

		Diameter of Pipe Culvert (D)							
		42"	48"	54"	60"	66"	72"	78"	84"
	A	11'-6"	12'-10¼"	14'-2"	15'-6"	16'-10"	18'-2"	19'-5¾"	20'-10"
	C	12'-7¾"	14'-0"	15'-3¾"	16'-7¾"	17'-11¾"	19'-4"	20'-7¾"	21'-11¾"
	H	6'-0"	6'-10"	7'-8"	8'-6"	9'-4"	10'-2"	11'-0"	11'-10"
1V:1.5H fill slope	Conc. (CUYD)	9.3	10.6	11.9	13.2	14.6	16.1	17.6	19.2
	Steel (LB)	752	850	961	1020	1166	1228	1380	1488
1V:2H fill slope	Conc. (CUYD)	11.3	12.9	14.4	16.1	17.8	19.6	21.4	23.3
	Steel (LB)	900	1023	1144	1247	1395	1503	1644	1793
Add. Conc. per pipe (CUYD)		1.3	1.6	1.8	2.1	2.4	2.7	3.0	3.4
Add. Steel per pipe (LB)		120	122	154	165	202	213	254	267

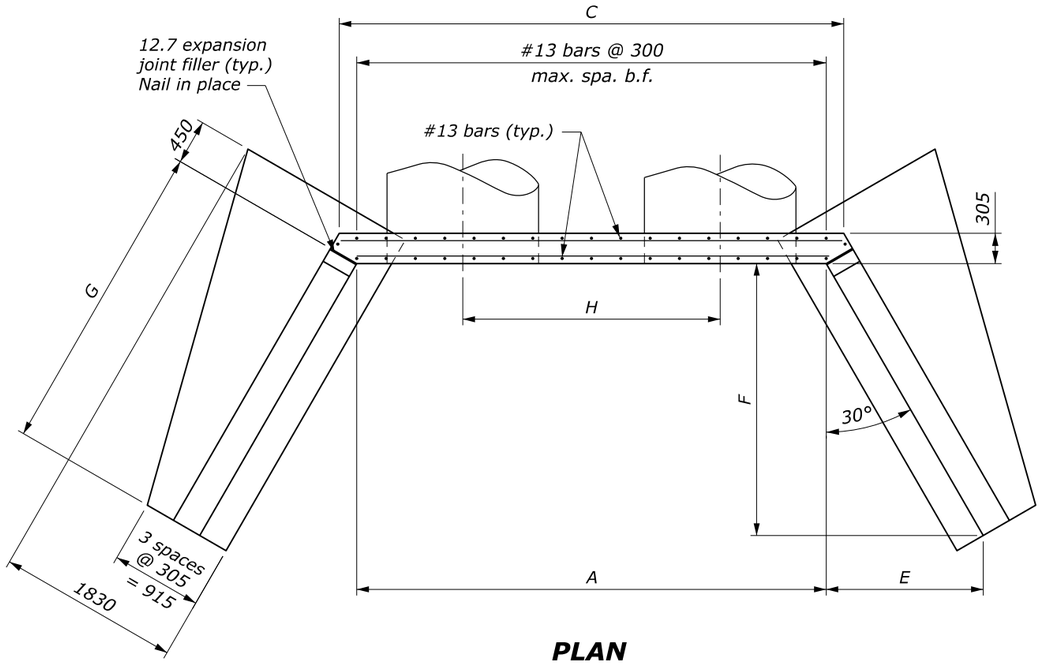
NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

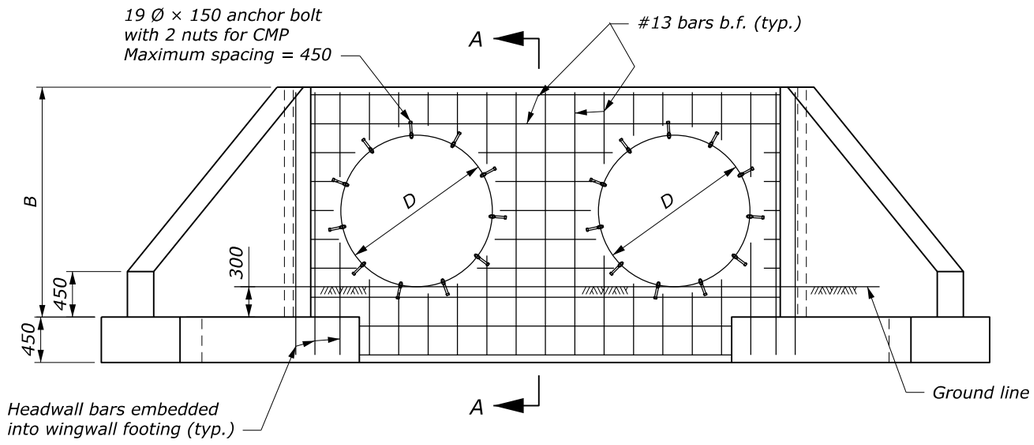
CONCRETE HEADWALL/WINGWALL FOR MULTIPLE NORMAL 42" TO 84" PIPE CULVERT

FLH STANDARD
601-7
SPECIFICATION
FP-24, FP-14
APPROVED FOR USE
2/2024

PROJECT	SHEET NUMBER



PLAN



FRONT ELEVATION
(Showing headwall reinforcement)

NOTE:

1. *This drawing applies for normal crossings and skews up to 15°.*
2. *Prepare foundation according to Section 209. Place headwall/wingwalls on 150 mm of foundation fill.*
3. *Quantities shown in table are for one headwall and two wingwalls and are based on CMP. Concrete and steel quantities shown will be used as basis for final payment for headwall/wingwalls constructed according to this drawing.*
4. *For dimensions and reinforcing details not shown, see Standard M601-5.*

DIMENSIONS AND QUANTITIES

		Diameter of Pipe Culvert (D)							
		1050	1200	1350	1500	1650	1800	1950	2100
	A	3505	3915	4315	4725	5130	5540	5940	6350
	C	3855	4265	4665	5075	5480	5890	6290	6700
	H	1830	2085	2335	2590	2845	3100	3350	3605
1V:1.5H fill slope	Conc. (m³)	7.1	8.1	9.1	10.1	11.2	12.3	13.4	14.6
	Steel (kg)	341	385	436	462	529	557	625	675
1V:2H fill slope	Conc. (m³)	8.6	9.8	11.0	12.3	13.6	15.0	16.3	17.8
	Steel (kg)	408	464	518	565	633	681	746	813
Add. Conc. per pipe (m³)		1.0	1.2	1.4	1.6	1.8	2.1	2.3	2.6
Add. Steel per pipe (kg)		55	55	70	75	91	97	115	121

*This drawing contains **Metric** units of measure. Dimensions without units are millimeters.*

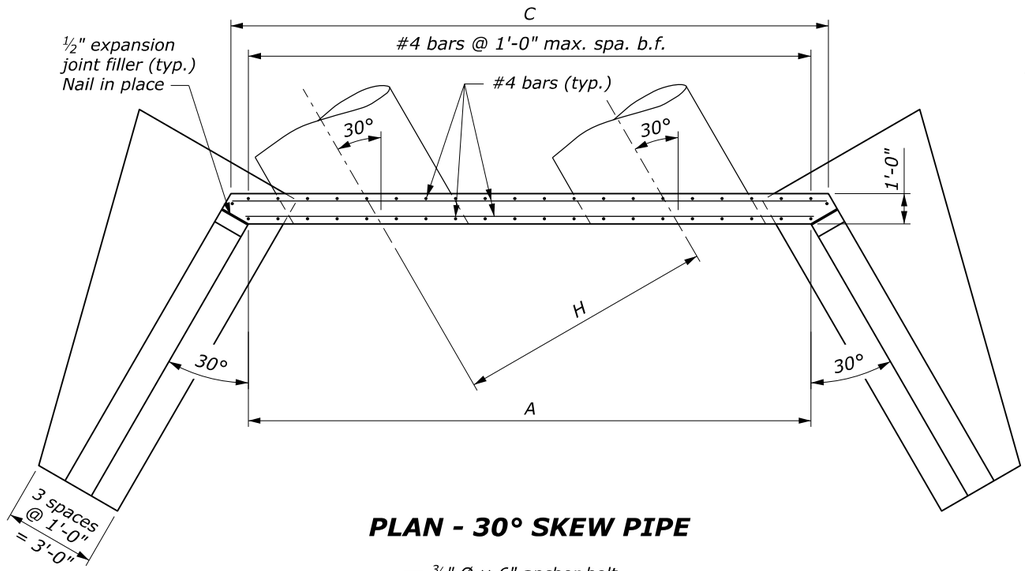
NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

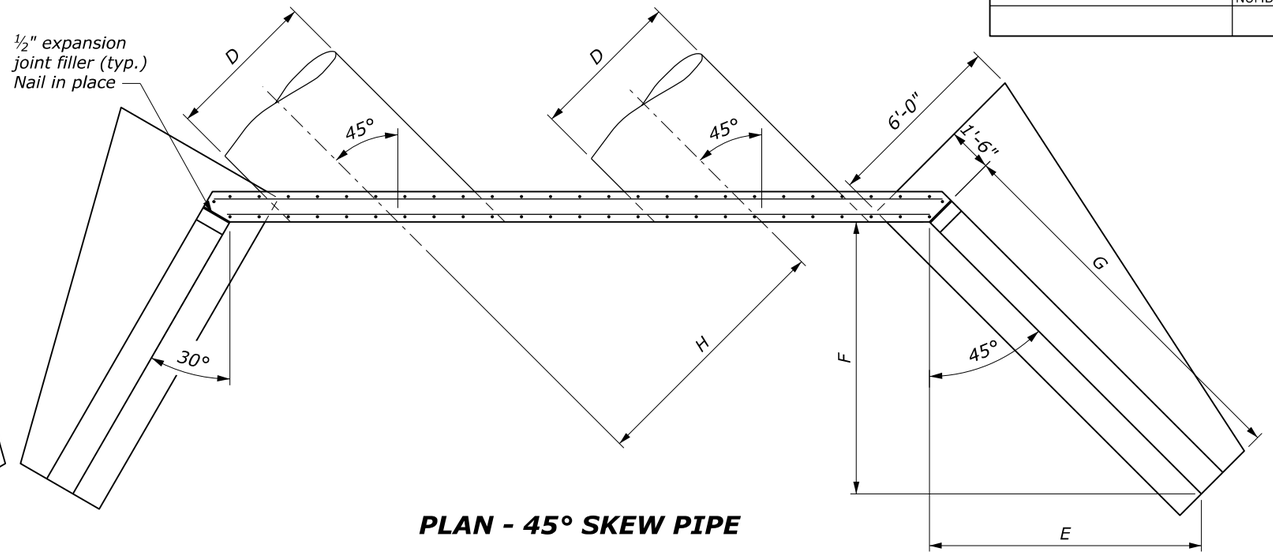
CONCRETE HEADWALL/WINGWALL FOR MULTIPLE NORMAL 1050 TO 2100 PIPE CULVERT

FLH STANDARD	M601-7
SPECIFICATION	FP-24, FP-14
APPROVED FOR USE	2/2024

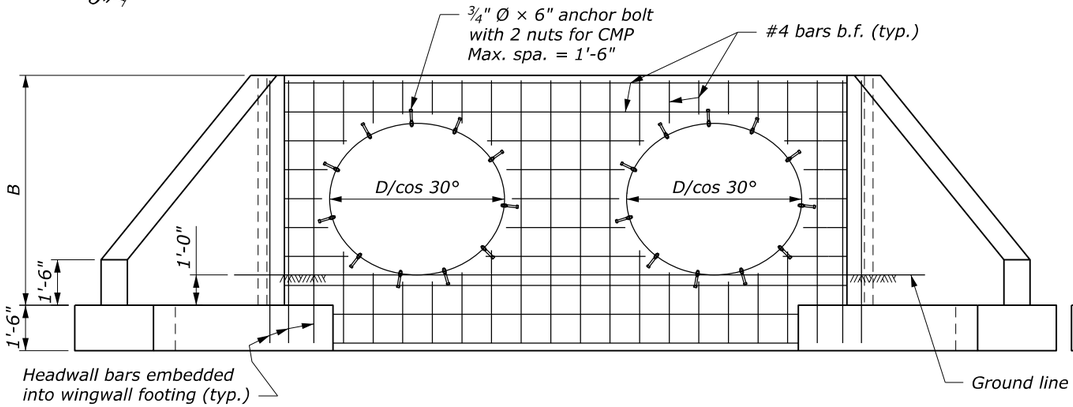
PROJECT	SHEET NUMBER



PLAN - 30° SKEW PIPE

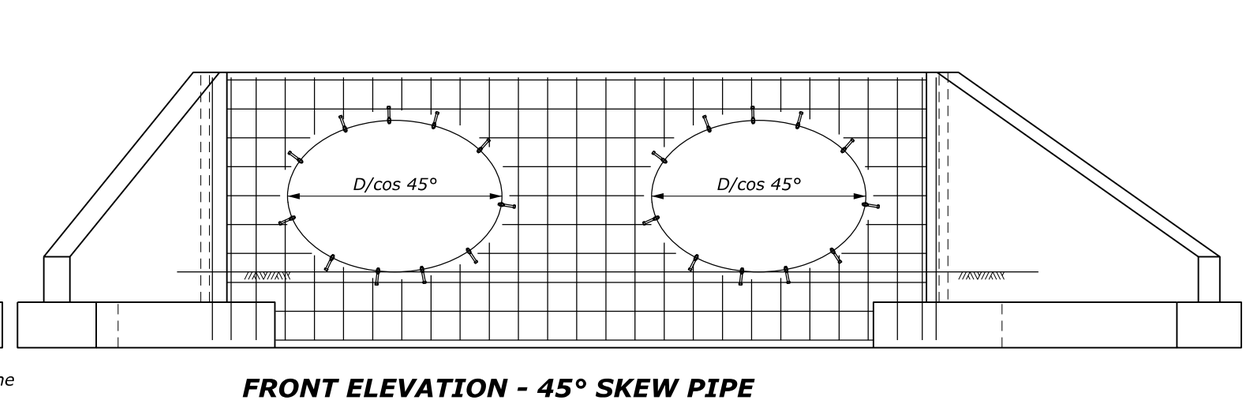


PLAN - 45° SKEW PIPE



FRONT ELEVATION - 30° SKEW PIPE

(Showing headwall reinforcement)



FRONT ELEVATION - 45° SKEW PIPE

(Showing headwall reinforcement)

DIMENSIONS AND QUANTITIES FOR 30° SKEW PIPE

		Diameter of Pipe Culvert (D)							
		42"	48"	54"	60"	66"	72"	78"	84"
	A	13'-11½"	15'-6"	17'-0¼"	18'-6¾"	20'-1¼"	21'-8"	23'-2¼"	24'-8¾"
	C	15'-1¼"	16'-7¾"	18'-2"	19'-8½"	21'-3"	22'-9¾"	24'-4"	25'-10¾"
	H	6'-0"	6'-10"	7'-8"	8'-6"	9'-4"	10'-2"	11'-0"	11'-10"
1V:1.5H fill slope	Conc. (CUYD)	9.9	11.2	12.6	14.0	15.5	17.1	18.6	20.3
	Steel (LB)	797	896	1014	1086	1227	1303	1463	1573
1V:2H fill slope	Conc. (CUYD)	11.9	13.5	15.1	16.9	18.6	20.5	22.4	24.4
	Steel (LB)	945	1070	1196	1313	1456	1578	1728	1877
Add. Conc. per pipe (CUYD)		1.5	1.8	2.1	2.4	2.8	3.1	3.5	3.9
Add. Steel per pipe (LB)		135	152	171	190	223	236	280	293

DIMENSIONS AND QUANTITIES FOR 45° SKEW PIPE

		Diameter of Pipe Culvert (D)							
		42"	48"	54"	60"	66"	72"	78"	84"
	A	17'-5¼"	19'-4"	21'-2¼"	23'-1¼"	24'-11½"	26'-10½"	28'-9"	30'-7¾"
	C	18'-5¼"	20'-4"	22'-2¼"	24'-1¼"	25'-11½"	27'-10½"	29'-9"	31'-7¾"
	H	6'-0"	6'-10"	7'-8"	8'-6"	9'-4"	10'-2"	11'-0"	11'-10"
1V:1.5H fill slope	Conc. (CUYD)	11.3	12.8	14.4	16.1	17.7	19.5	21.3	23.3
	Steel (LB)	926	1037	1180	1269	1453	1541	1708	1843
1V:2H fill slope	Conc. (CUYD)	13.5	15.4	17.2	19.2	21.2	23.4	25.6	27.9
	Steel (LB)	1091	1239	1393	1521	1716	1852	2032	2199
Add. Conc. per pipe (CUYD)		1.8	2.2	2.6	3.0	3.4	3.8	4.3	4.8
Add. Steel per pipe (LB)		158	178	224	241	288	305	350	367

NOTE:

1. Use the 30° Skew Detail for skews greater than 15° to 37°30'. Use the 45° Skew Detail for skews greater than 37°30' to 45°.
2. Prepare foundation according to Section 209. Place headwall/wingwalls on 6 inches of foundation fill.
3. Quantities shown in table are for one headwall and two wingwalls and are based on CMP. Concrete and steel quantities shown will be used as basis for final payment for headwall/wingwalls constructed according to this standard.
4. For dimensions and reinforcing details not shown, see Standards 601-5 and 6.

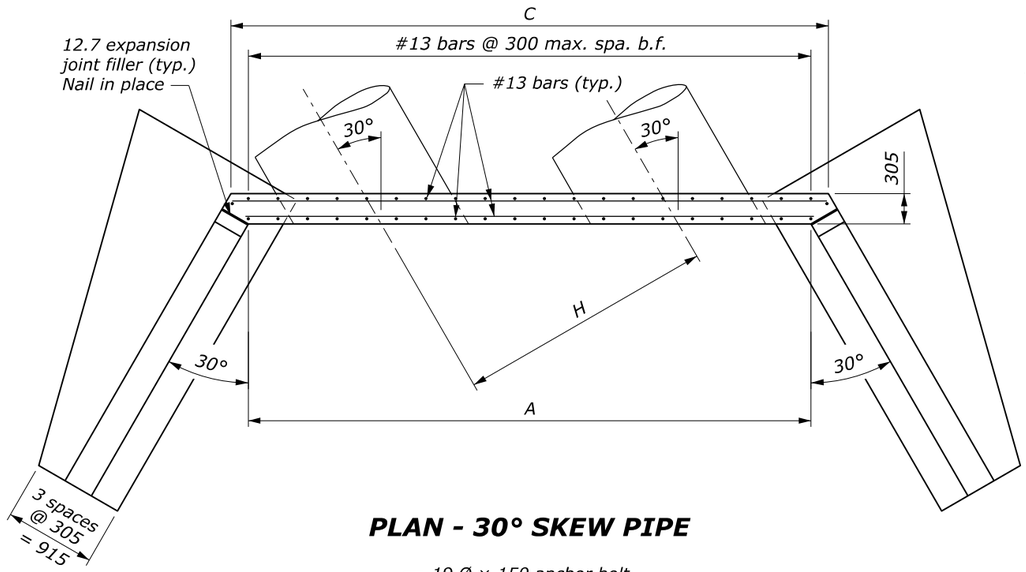
NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

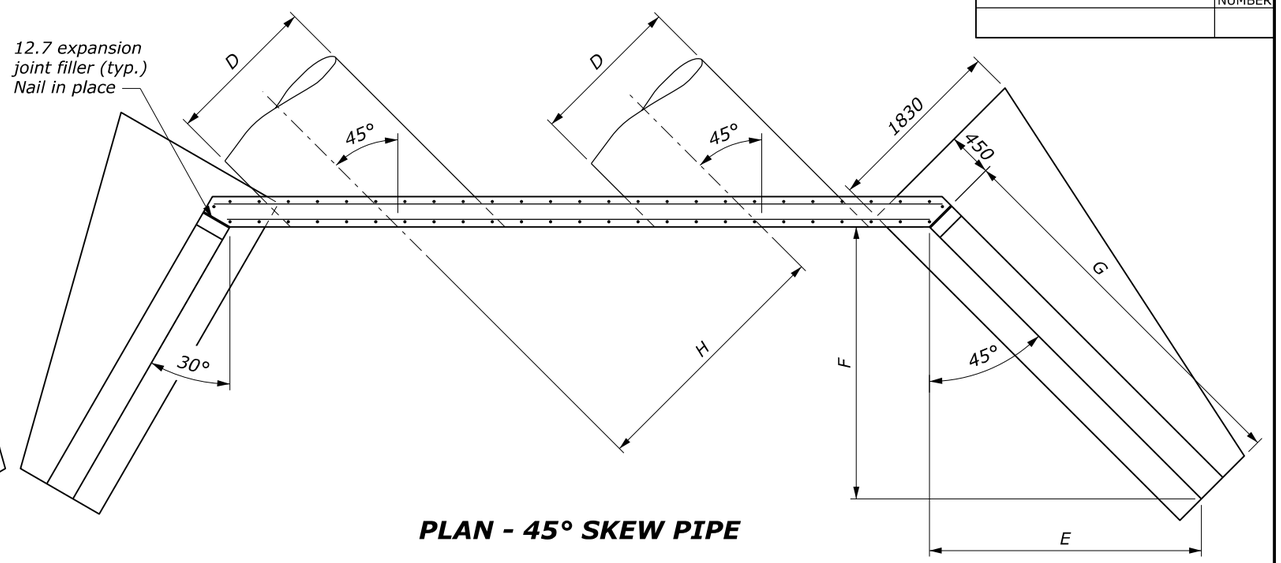
CONCRETE HEADWALL/WINGWALL FOR MULTIPLE SKEW 42" TO 84" PIPE CULVERT

FLH STANDARD	601-8
SPECIFICATION	FP-24, FP-14
APPROVED FOR USE	2/2024

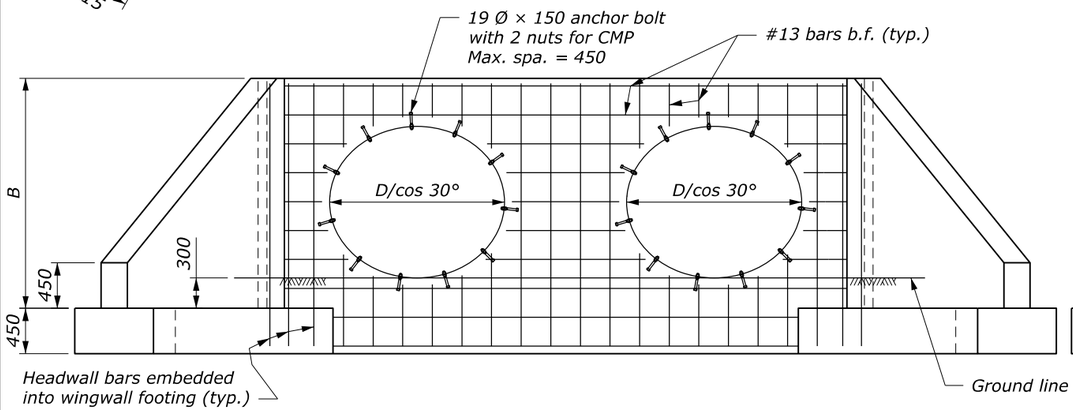
PROJECT	SHEET NUMBER



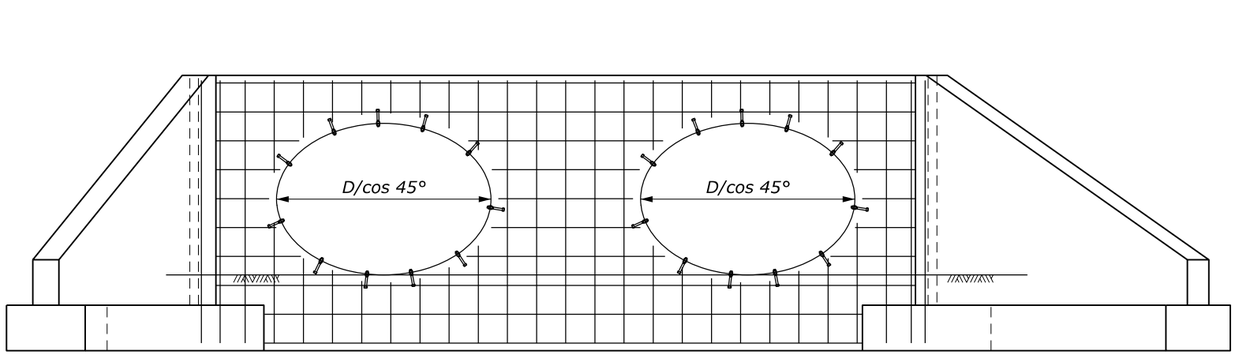
PLAN - 30° SKEW PIPE



PLAN - 45° SKEW PIPE



FRONT ELEVATION - 30° SKEW PIPE
(Showing headwall reinforcement)



FRONT ELEVATION - 45° SKEW PIPE
(Showing headwall reinforcement)

DIMENSIONS AND QUANTITIES FOR 30° SKEW PIPE

		Diameter of Pipe Culvert (D)							
		1050	1200	1350	1500	1650	1800	1950	2100
	A	4255	4725	5190	5660	6130	6605	7065	7540
	C	4605	5075	5540	6010	6480	6955	7415	7890
	H	1830	2085	2335	2590	2845	3100	3350	3605
1V:1.5H fill slope	Conc. (m³)	7.6	8.6	9.6	10.7	11.8	13.0	14.2	15.5
	Steel (kg)	362	406	460	493	557	591	663	713
1V:2H fill slope	Conc. (m³)	9.1	10.3	11.6	12.9	14.2	15.7	17.1	18.7
	Steel (kg)	428	485	542	595	660	715	783	851
Add. Conc. per pipe (m³)		1.2	1.4	1.6	1.8	2.1	2.4	2.7	3.0
Add. Steel per pipe (kg)		61	69	78	86	101	107	127	133

DIMENSIONS AND QUANTITIES FOR 45° SKEW PIPE

		Diameter of Pipe Culvert (D)							
		1050	1200	1350	1500	1650	1800	1950	2100
	A	5315	5895	6460	7040	7610	8190	8760	9340
	C	5620	6200	6765	7345	7915	8495	9065	9645
	H	1830	2085	2335	2590	2845	3100	3350	3605
1V:1.5H fill slope	Conc. (m³)	8.6	9.8	11.0	12.3	13.6	14.9	16.3	17.8
	Steel (kg)	420	470	535	575	659	699	774	836
1V:2H fill slope	Conc. (m³)	10.3	11.7	13.2	14.7	16.2	17.9	19.6	21.3
	Steel (kg)	494	562	631	690	778	840	921	997
Add. Conc. per pipe (m³)		1.4	1.7	2.0	2.3	2.6	2.9	3.3	3.6
Add. Steel per pipe (kg)		72	81	102	109	131	138	159	166

NOTE:

1. Use the 30° Skew Detail for skews greater than 15° to 37°30'. Use the 45° Skew Detail for skews greater than 37°30' to 45°.
2. Prepare foundation according to Section 209. Place headwall/wingwalls on 150 mm of foundation fill.
3. Quantities shown in table are for one headwall and two wingwalls and are based on CMP. Concrete and steel quantities shown will be used as basis for final payment for headwall/wingwalls constructed according to this standard.
4. For dimensions and reinforcing details not shown, see Standards M601-5 and 6.

This drawing contains **Metric** units of measure. Dimensions without units are millimeters.

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

CONCRETE HEADWALL/WINGWALL FOR MULTIPLE SKEW 1050 TO 2100 PIPE CULVERT

FLH STANDARD M601-8

SPECIFICATION FP-24, FP-14

APPROVED FOR USE 2/2024

PROJECT	SHEET NUMBER

METAL ROUND PIPE CULVERT

FILL HEIGHT AND METAL THICKNESS TABLE FOR HELICAL LOCKSEAM AND WELDED SEAM PIPE CULVERT

STEEL

PIPE SIZE DIAMETER INCHES	MINIMUM COVER INCHES	2⅔" x ½" CORRUGATIONS					3" x 1" CORRUGATIONS					5" x 1" CORRUGATIONS				
		METAL THICKNESS (INCH/GAGE)														
		0.064/16	0.079/14	0.109/12	0.138/10	0.168/8	0.064/16	0.079/14	0.109/12	0.138/10	0.168/8	0.064/16	0.079/14	0.109/12	0.138/10	0.168/8
		MAXIMUM FILL HEIGHT ABOVE TOP OF PIPE (FEET)														
12	12	100	100	100	100	100										
15	12	100	100	100	100	100										
18	12	100	100	100	100	100										
21	12	100	100	100	100	100										
24	12	100	100	100	100	100										
30	12	85	100	100	100	100										
36	12	71	89	100	100	100	81	100	100	100	100					
42	12	61	76	100	100	100	70	87	100	100	100					
48	12	53	66	93	100	100	61	76	100	100	100	54	68	95	100	100
54	12		59	83	100	100	54	68	95	100	100	48	60	85	100	100
60	12			74	97	100	49	61	86	100	100	43	54	76	98	100
66	12				87	100	44	55	78	100	100	39	49	69	89	100
72	12				80	97	40	51	71	92	100	36	45	63	82	100
78	12					87	37	47	66	85	100	33	42	58	75	92
84	12					75	35	43	61	78	96	31	39	54	70	86
90	12						32	40	57	73	90	29	36	51	65	80
96	12							38	53	69	84		34	48	61	75
102	18							36	50	65	79		32	45	57	71
108	18								47	61	75			42	54	67
114	18								45	58	71			40	52	63
120	18								43	55	67			38	49	60
126	18									52	64				47	57
132	18									50	61				44	54
138	18									48	58				42	52
144	18										56					50

ALUMINUM

PIPE SIZE DIAMETER INCHES	MINIMUM COVER INCHES	2⅔" x ½" CORRUGATIONS					3" x 1" CORRUGATIONS				
		METAL THICKNESS (INCH/GAGE)									
		0.060/16	0.075/14	0.105/12	0.135/10	0.164/8	0.060/16	0.075/14	0.105/12	0.135/10	0.164/8
		MAXIMUM FILL HEIGHT ABOVE TOP OF PIPE (FEET)									
12	12	100	100	100	100	100					
15	12	100	100	100	100	100					
18	12	100	100	100	100	100					
21	12	88	100	100	100	100					
24	12	77	97	100	100	100					
30	12	62	77	100	100	100	71	89	100	100	100
36	12	52	64	90	100	100	59	74	100	100	100
42	12	44	55	77	99	100	51	64	89	100	100
48	12			67	87	100	44	56	78	100	100
54	18			54	71	88	39	50	69	93	100
60	18				57	72	35	45	62	83	98
66	18					58	32	40	56	76	89
72	18					45	30	37	55	70	82
78	24							34	48	64	75
84	24								44	59	70
90	24								41	62	65
96	24								38	51	61
102	24									46	55
108	24									42	50
114	24										45
120	24										40

NOTE:

1. When directed, camber pipe culverts upward from a chord through the inlet and outlet inverts an ordinate amount equal to 1% of the pipe length. Develop camber on a parabolic curve. If the midpoint elevation on the parabolic curve as designed exceeds the elevation of the inlet invert, reduce the amount of camber or increase the pipe culvert gradient.
2. Fill heights exceeding 100 feet require special analysis by the CO.
3. The fill heights in the table are for helical lockseam and welded seam pipe only. Fill heights for culvert pipe with annular corrugations are more restrictive than those of helical lockseam and welded seam pipe. Obtain approval before furnishing annular corrugation pipe.
4. For flexible pavement and aggregate surface roadways, measure minimum cover from the top of the pipe culvert to the bottom of the roadway subgrade. For rigid pavements, measure minimum cover from the top of the pipe culvert to the top of the pavement. For all roadway surface types, measure maximum fill height from the top of the pipe culvert to the top of the pavement.

METAL PIPE ARCH CULVERT

FILL HEIGHT AND METAL THICKNESS TABLE FOR HELICAL LOCKSEAM AND WELDED SEAM PIPE CULVERT

STEEL

PIPE ARCH SIZE SPAN x RISE INCHES	EQUI-VALENT DIAMETER INCHES	MINIMUM CORNER RADIUS INCHES	MINIMUM COVER INCHES	2⅔" x ½" CORRUGATIONS					3" x 1" CORRUGATIONS					5" x 1" CORRUGATIONS				
				METAL THICKNESS (INCH/GAGE)														
				0.064/16	0.079/14	0.109/12	0.138/10	0.168/8	0.079/14	0.109/12	0.138/10	0.168/8		0.079/14	0.109/12	0.138/10	0.168/8
				MAXIMUM FILL HEIGHT ABOVE TOP OF PIPE (FEET)														
17 x 13	15	3	12	13														
21 x 15	18	3	12	12														
24 x 18	21	3	12	13														
28 x 20	24	3	12	13														
35 x 24	30	3	12	12														
42 x 29	36	3.5	12	12														
49 x 33	42	4	12		12													
57 x 38	48	5	12			12												
60 x 46	54	8	15							21					21			
64 x 43	54	6	12			12												
66 x 51	60	9	15							21					21			
71 x 47	60	7	12				12											
73 x 55	66	12	18							20					20			
77 x 52	66	8	12					12										
81 x 59	72	14	18						17					17				
83 x 57	72	9	12					12										
87 x 63	78	14	18						17					17				
95 x 67	84	16	18						17					17				
103 x 71	90	16	18							17				17				
112 x 75	96	18	21							16					16			
117 x 79	102	18	21							16					16			
128 x 83	108	18	24								16					16		
137 x 87	114	18	24								16					16		
142 x 91	120	18	24									16						16

ALUMINUM

PIPE ARCH SIZE SPAN x RISE INCHES	EQUI-VALENT DIAMETER INCHES	MINIMUM CORNER RADIUS INCHES	MINIMUM COVER INCHES	2⅔" x ½" CORRUGATIONS				3" x 1" CORRUGATIONS			
				METAL THICKNESS (INCH/GAGE)							
				0.060/16	0.075/14	0.105/12	0.135/10	0.060/16	0.075/14	0.105/12	0.135/10
				MAXIMUM FILL HEIGHT ABOVE TOP OF PIPE (FEET)							
17 x 13	15	3	12	13							
21 x 15	18	3	12	12							
24 x 18	21	3	12	13							
28 x 20	24	3	12		13						
35 x 24	30	3	12		12						
42 x 29	36	3.5	15			12					
49 x 33	42	4	15			12					
57 x 38	48	5	15				12				
60 x 46	54	8	15					21			
64 x 43	54	6	18				12				
66 x 51	60	9	18					21			
73 x 55	66	12	18						20		
81 x 59	72	14	21							17	
87 x 63	78	14	21							17	
95 x 67	84	16	24							17	
103 x 71	90	16	24								17

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	FLH STANDARD 602-1
METAL PIPE CULVERT	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 8/2024

PROJECT	SHEET NUMBER

METAL ROUND PIPE CULVERT

FILL HEIGHT AND METAL THICKNESS TABLE FOR HELICAL LOCKSEAM AND WELDED SEAM PIPE CULVERT

STEEL

PIPE SIZE DIAMETER	MINIMUM COVER	68 x 13 CORRUGATIONS					75 x 25 CORRUGATIONS					125 x 25 CORRUGATIONS				
		METAL THICKNESS														
		1.63	2.01	2.77	3.51	4.27	1.63	2.01	2.77	3.51	4.27	1.63	2.01	2.77	3.51	4.27
		MAXIMUM FILL HEIGHT ABOVE TOP OF PIPE (METERS)														
300	300	30.0	30.0	30.0	30.0	30.0										
375	300	30.0	30.0	30.0	30.0	30.0										
450	300	30.0	30.0	30.0	30.0	30.0										
525	300	30.0	30.0	30.0	30.0	30.0										
600	300	30.0	30.0	30.0	30.0	30.0										
750	300	25.9	30.0	30.0	30.0	30.0										
900	300	21.6	27.0	30.0	30.0	30.0	24.8	30.0	30.0	30.0	30.0					
1050	300	18.5	23.1	30.0	30.0	30.0	21.2	26.6	30.0	30.0	30.0					
1200	300	16.2	20.2	28.4	30.0	30.0	18.5	23.2	30.0	30.0	30.0	16.5	20.7	29.0	30.0	30.0
1350	300		18.0	25.2	30.0	30.0	16.5	20.6	29.0	30.0	30.0	14.7	18.4	25.8	30.0	30.0
1500	300			22.7	29.5	30.0	14.8	18.6	26.1	30.0	30.0	13.2	16.5	23.2	29.9	30.0
1650	300				26.5	30.0	13.5	16.9	23.7	30.0	30.0	12.0	15.0	21.1	27.1	30.0
1800	300				24.3	29.7	12.3	15.4	21.7	28.0	30.0	11.0	13.8	19.3	24.9	30.0
1950	300					26.4	11.4	14.3	20.0	25.8	30.0	10.1	12.7	17.8	23.0	28.1
2100	300					22.8	10.6	13.2	18.6	23.9	29.3	9.4	11.8	16.5	21.3	26.1
2250	300						9.8	12.3	17.3	22.3	27.4	8.8	11.0	15.4	19.9	24.3
2400	300							11.6	16.2	20.9	25.7		10.3	14.5	18.6	22.8
2550	450							10.9	15.3	19.7	24.1		9.7	13.6	17.5	21.5
2700	450								14.4	18.6	22.8			12.8	16.6	20.3
2850	450								13.7	17.6	21.6			12.2	15.7	19.2
3000	450								13.0	16.7	20.5			11.6	14.9	18.2
3150	450									15.9	19.5				14.2	17.4
3300	450									15.2	18.6				13.5	16.6
3450	450									14.5	17.8				12.9	15.8
3600	450										17.1					15.2

ALUMINUM

PIPE SIZE DIAMETER	MINIMUM COVER	68 x 13 CORRUGATIONS					75 x 25 CORRUGATIONS				
		METAL THICKNESS									
		1.52	1.91	2.67	3.43	4.17	1.52	1.91	2.67	3.43	4.17
		MAXIMUM FILL HEIGHT ABOVE TOP OF PIPE (METERS)									
300	300	30.0	30.0	30.0	30.0	30.0					
375	300	30.0	30.0	30.0	30.0	30.0					
450	300	30.0	30.0	30.0	30.0	30.0					
525	300	26.9	30.0	30.0	30.0	30.0					
600	300	23.6	29.5	30.0	30.0	30.0					
750	300	18.8	23.6	30.0	30.0	30.0	21.7	27.2	30.0	30.0	30.0
900	300	15.7	19.6	27.5	30.0	30.0	18.0	22.7	30.0	30.0	30.0
1050	300	13.4	16.8	23.6	30.3	30.0	15.5	19.4	27.1	30.0	30.0
1200	300			20.3	26.4	30.0	13.5	17.0	23.7	30.0	30.0
1350	450			16.5	21.6	26.7	12.0	15.1	21.1	28.2	30.0
1500	450				17.5	21.8	10.8	13.6	19.0	25.4	29.9
1650	450					17.6	9.8	12.3	17.2	23.1	27.2
1800	450					13.8	9.0	11.3	16.8	21.2	24.9
1950	600							10.4	14.6	19.5	23.0
2100	600								13.5	18.1	21.4
2250	600								12.6	18.9	19.9
2400	600								11.6	15.6	18.5
2550	600									14.1	16.7
2700	600									12.7	15.1
2850	600										13.6
3000	600										12.2

NOTE:

1. *When directed, camber pipe culverts upward from a chord through the inlet and outlet inverts an ordinate amount equal to 1% of the pipe length. Develop camber on a parabolic curve. If the midpoint elevation on the parabolic curve as designed exceeds the elevation of the inlet invert, reduce the amount of camber or increase the pipe culvert gradient.*
2. *Fill heights exceeding 30 meters require special analysis by the CO.*
3. *The fill heights in the table are for helical lockseam and welded seam pipe only. Fill heights for culvert pipe with annular corrugations are more restrictive than those of helical lockseam and welded seam pipe. Obtain approval before furnishing annular corrugation pipe.*
4. *For flexible pavement and aggregate surface roadways, measure minimum cover from the top of the pipe culvert to the bottom of the roadway subgrade. For rigid pavements, measure minimum cover from the top of the pipe culvert to the top of the pavement. For all roadway surface types, measure maximum fill height from the top of the pipe culvert to the top of the pavement.*

METAL PIPE ARCH CULVERT

FILL HEIGHT AND METAL THICKNESS TABLE FOR HELICAL LOCKSEAM AND WELDED SEAM PIPE CULVERT

STEEL

PIPE ARCH SIZE SPAN x RISE	EQUI-VALENT DIAMETER	MINIMUM CORNER RADIUS	MINIMUM COVER	68 x 13 CORRUGATIONS					75 x 25 CORRUGATIONS				125 x 25 CORRUGATIONS			
				METAL THICKNESS												
				1.63	2.01	2.77	3.51	4.27	2.01	2.77	3.51	4.27	2.01	2.77	3.51	4.27
				MAXIMUM FILL HEIGHT ABOVE TOP OF PIPE (METERS)												
430 x 330	375	75	300	4.0												
530 x 380	450	75	300	3.7												
610 x 460	525	75	300	4.0												
710 x 510	600	75	300	4.0												
890 x 610	750	75	300	3.7												
1070 x 740	900	90	300	3.7												
1240 x 840	1050	100	300		3.7											
1450 x 970	1200	125	300			3.7										
1520 x 1170	1350	205	375							6.4				6.4		
1630 x 1090	1350	150	300			3.7										
1680 x 1300	1500	230	375							6.4				6.4		
1800 x 1190	1500	180	300				3.7									
1850 x 1400	1650	305	450							6.1				6.1		
1960 x 1320	1650	205	300					3.7								
2060 x 1500	1800	355	450						5.2				5.2			
2110 x 1450	1800	230	300					3.7								
2210 x 1600	1950	355	450						5.2				5.2			
2410 x 1700	2100	405	450						5.2				5.2			
2620 x 1800	2250	405	450							5.2			5.2			
2840 x 1910	2400	455	525							4.9				4.9		
2970 x 2010	2550	455	525							4.9				4.9		
3250 x 2110	2700	455	600								4.9				4.9	
3480 x 2210	2850	455	600								4.9				4.9	
3610 x 2310	3000	455	600									4.9				4.9

ALUMINUM

PIPE ARCH SIZE SPAN x RISE	EQUI-VALENT DIAMETER	MINIMUM CORNER RADIUS	MINIMUM COVER	68 x 13 CORRUGATIONS				75 x 25 CORRUGATIONS			
				METAL THICKNESS							
				1.52	1.91	2.67	3.43	1.52	1.91	2.67	3.43
				MAXIMUM FILL HEIGHT ABOVE TOP OF PIPE (METERS)							
430 x 330	375	75	300	4.0							
530 x 380	450	75	300	3.7							
610 x 460	525	75	300	4.0							
710 x 510	600	75	300		4.0						
890 x 610	750	75	300		3.7						
1070 x 740	900	90	375			3.7					
1240 x 840	1050	100	375			3.7					
1450 x 970	1200	125	375				3.7				
1520 x 1170	1350	205	375					6.4			
1630 x 1090	1350	150	450				3.7				
1680 x 1300	1500	230	450					6.4			
1850 x 1400	1650	305	450						6.1		
2060 x 1500	1800	355	525							5.2	
2210 x 1600	1950	355	525							5.2	
2410 x 1700	2100	405	600							5.2	
2620 x 1800	2250	405	600								5.2

*This drawing contains **Metric** units of measure. Dimensions without units are millimeters.*

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

METAL PIPE CULVERT

FLH STANDARD M602-1

SPECIFICATION FP-24, FP-14

APPROVED FOR USE 8/2024

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12 August 2024 3:12 PM

PROJECT	SHEET NUMBER

COUPLING BANDS FOR METAL PIPE CULVERT [1]

CORRUGATION SIZE [2] INCHES	ROUND PIPE DIAMETER INCHES	PIPE ARCH SPAN × RISE INCHES	MINIMUM BAND WIDTH (INCHES)		
			ANNULAR CORRUGATED BANDS [3]	HELICALLY CORRUGATED BANDS [4]	SEMI-CORRUGATED BANDS [5]
1½ × ¼	underline [6]	-	10.5	7	10.5
2⅔ × ½	12 to 36	17 × 13 to 42 × 29	7	12	
	42 to 72	49 × 33 to 83 × 57	10.5	12	
	78 to 84	-	10.5	12	10.5
3 × 1	36 to 72	60 × 46 to 81 × 59	12	14	10.5
	78 to 144	87 × 64 to 142 × 91	12	14	10.5
5 × 1	36 to 72	60 × 46 to 81 × 59	20	22	
	78 to 144	87 × 64 to 142 × 91	20	22	

[1] Fabricate annular, helical and semi-corrugated type coupling bands from the same metal as the connecting pipe. Provide coupling bands not more than 3 nominal sheet thicknesses thinner than the thickness of the pipe to be connected, and no thinner than 0.052 inch for steel or 0.048 inch for aluminum. Fasten coupling bands with the following diameter of bolt:
⅜" for 18" round culvert (21" × 15" pipe arch) or less
½" for 21" round culvert (24" × 18" pipe arch) or more

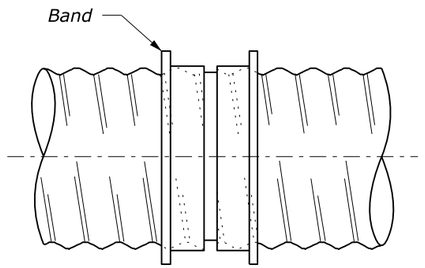
[2] For helically corrugated pipe with rerolled ends, the nominal corrugations size refers to the dimension of the end corrugation in the pipe.

[3] Use annular corrugated bands with pipes having annular corrugations or with helical pipe having rerolled end to form annular corrugations. A 10.5 inch band is acceptable on pipe ends rerolled with 2⅔" × ½" corrugations. A 12 inch band is acceptable on pipe ends rerolled with 3" × 1" pipe corrugations.

[4] Use helical corrugated bands with pipes having helically corrugated ends.

[5] The minimum band widths shown for 3" × 1" and 5" × 1" corrugated sizes apply to 2⅔" × ½" corrugations on rerolled pipe ends.

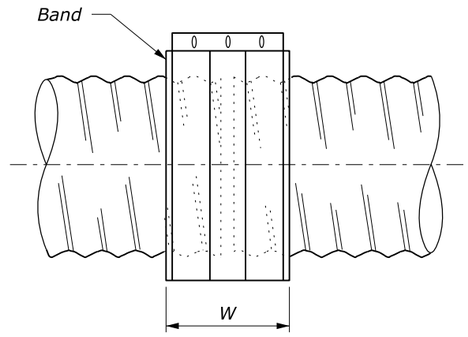
[6] Smooth sleeve-type couplers and flat bands may be used for pipe diameters of 12" or less. Use a matching metal having a nominal thickness of not less than 0.040 inch for steel, or 0.036 inch for aluminum, or a plastic with an equivalent strength to metal.



SLEEVE JOINT

Smoother sleeve with center stop.
Stab type joint

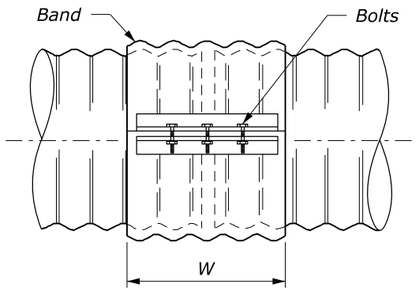
SMOOTH SLEEVE BAND



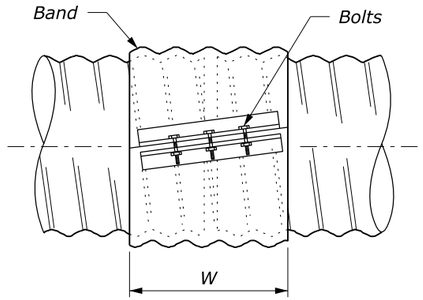
FLAT BAND

NOTE:

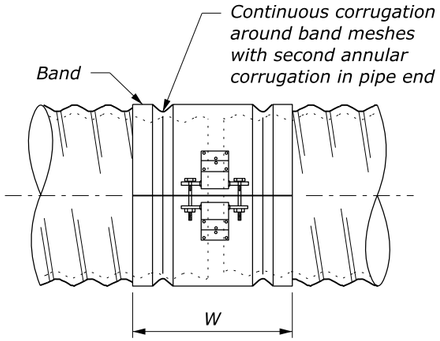
1. Other types of coupling bands or fastening devices that comply with the joint performance criteria of AASHTO Standard specifications for Highway Bridges, Division II Section 26 may be used.



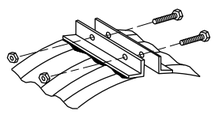
SIDE VIEW



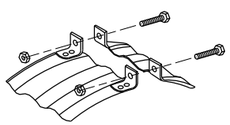
SIDE VIEW



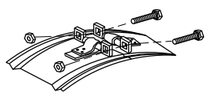
SIDE VIEW



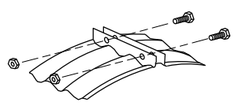
Band Angle



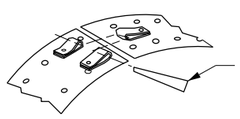
Oval Lug



Bar & Strap

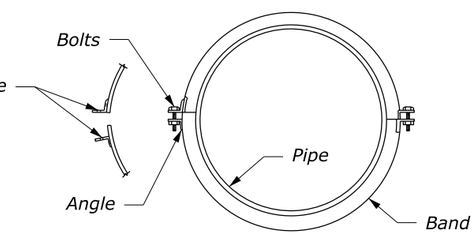


Integral Flange



Wedge and Strap

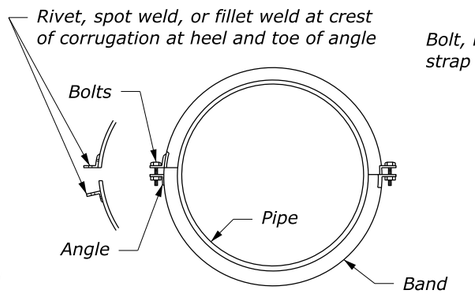
STANDARD BAND CONNECTIONS



END VIEW

Second angle connection optional to 42" diameter, required above 42" diameter

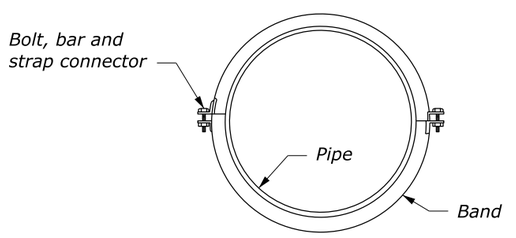
ANNULAR BAND



END VIEW

Second angle connection optional to 42" diameter, required above 42" diameter

HELICAL BAND



END VIEW

SEMI-CORRUGATED BAND

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	FLH STANDARD 602-2
METAL PIPE CULVERT COUPLING BAND	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 1/2024

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24 July 2024 9:28 AM

PROJECT	SHEET NUMBER

COUPLING BANDS FOR METAL PIPE CULVERT [1]

CORRUGATION SIZE [2]	ROUND PIPE DIAMETER	PIPE ARCH SPAN × RISE	ANNULAR CORRUGATED BANDS [3]	HELICALLY CORRUGATED BANDS [4]	SEMI-CORRUGATED BANDS [5]
38 × 6.5	underline [6]	-	265	180	265
68 × 13	300 to 900	430 × 330 to 1060 × 740	180	300	
	1050 to 1800	1240 × 840 to 2100 × 1450	265	300	
	1950 to 2100	-	265	300	265
75 × 25	900 to 1800	1520 × 1170 to 2050 × 1500	300	350	265
	1950 to 3600	2200 × 1620 to 3600 × 2320	300	350	265
125 × 25	900 to 1800	1520 × 1170 to 2050 × 1500	500	560	
	1950 to 3600	2200 × 1620 to 3600 × 2320	500	560	

[1] Fabricate annular, helical and semi-corrugated type coupling bands from the same metal as the connecting pipe. Provide coupling bands not more than 3 nominal sheet thicknesses thinner than the thickness of the pipe to be connected, and no thinner than 1.32 mm for steel or 1.2 mm for aluminum. Fasten coupling bands with the following diameter of bolt:
M10 for 450 round culvert (530 × 380 pipe arch) or less
M12 for 525 round culvert (610 × 460 pipe arch) or more

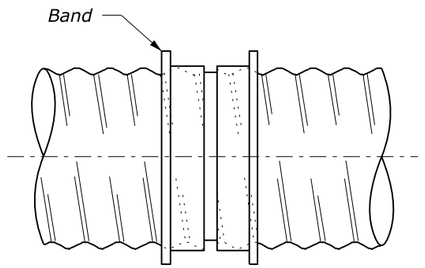
[2] For helically corrugated pipe with rerolled ends, the nominal corrugations size refers to the dimension of the end corrugation in the pipe.

[3] Use annular corrugated bands with pipes having annular corrugations or with helical pipe having rerolled end to form annular corrugations. A 265 mm band is acceptable on pipe ends rerolled with 68 × 13 corrugations. A 300 mm band is acceptable on pipe ends rerolled with 75 × 25 pipe corrugations.

[4] Use helical corrugated bands with pipes having helically corrugated ends.

[5] The minimum band widths shown for 75 × 25 and 125 × 25 corrugated sizes apply to 68 × 13 corrugations on rerolled pipe ends.

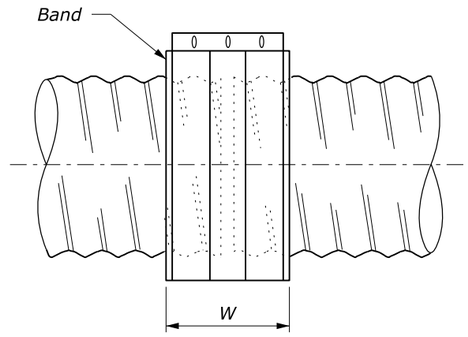
[6] Smooth sleeve-type couplers and flat bands may be used for pipe diameters of 300 or less. Use a matching metal having a nominal thickness of not less than 1.02 mm for steel, or 0.91 mm for aluminum, or a plastic with an equivalent strength to metal.



SLEEVE JOINT

Smoother sleeve with center stop.
Stab type joint

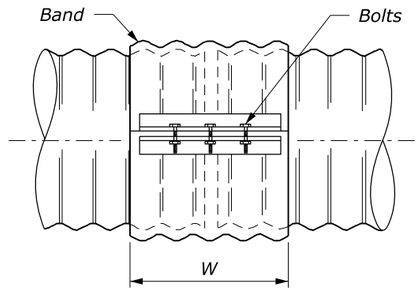
SMOOTH SLEEVE BAND



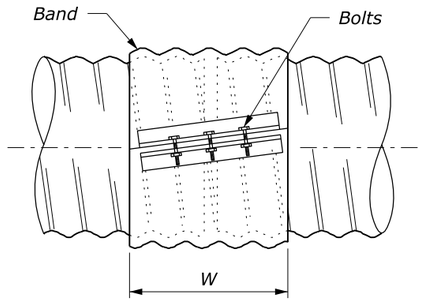
FLAT BAND

NOTE:

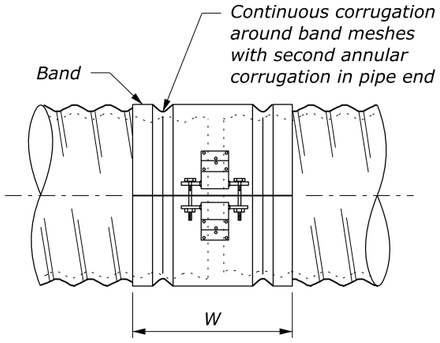
1. Other types of coupling bands or fastening devices that comply with the joint performance criteria of AASHTO Standard specifications for Highway Bridges, Division II Section 26 may be used.



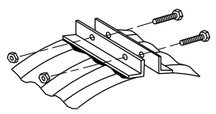
SIDE VIEW



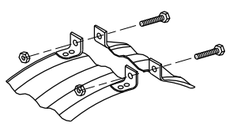
SIDE VIEW



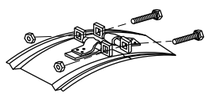
SIDE VIEW



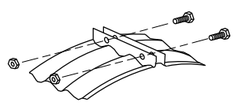
Band Angle



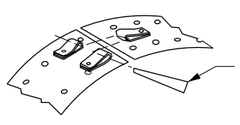
Oval Lug



Bar & Strap

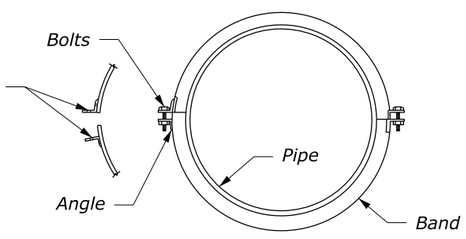


Integral Flange



Wedge and Strap

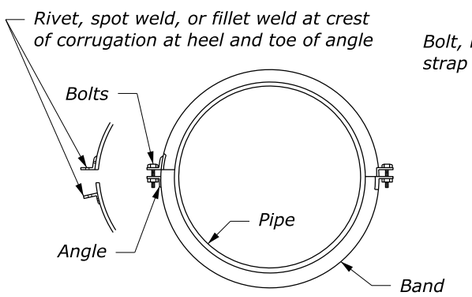
STANDARD BAND CONNECTIONS



END VIEW

Second angle connection optional to 1050 diameter, required above 1050 diameter

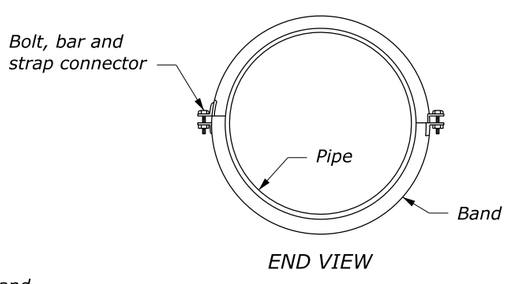
ANNULAR BAND



END VIEW

Second angle connection optional to 1050 diameter, required above 1050 diameter

HELICAL BAND



END VIEW

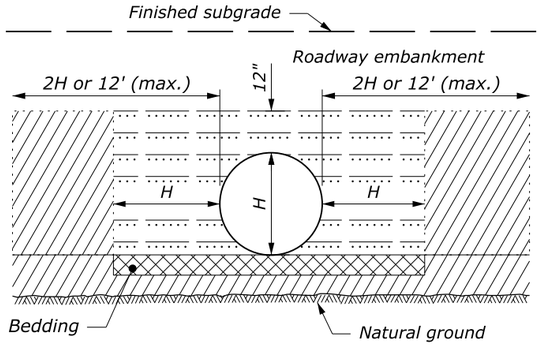
SEMI-CORRUGATED BAND

This drawing contains **Metric** units of measure.
Dimensions without units are millimeters.

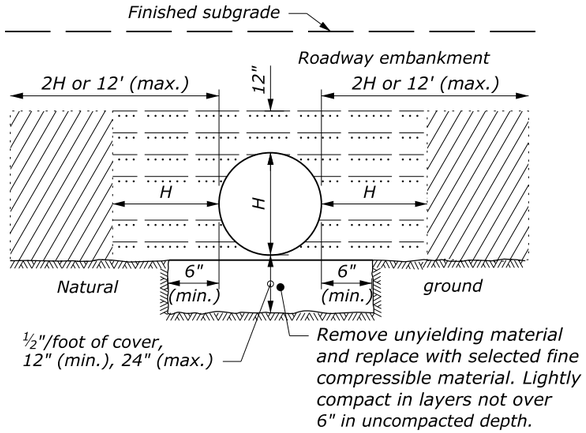
NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	FLH STANDARD M602-2
METAL PIPE CULVERT COUPLING BAND	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 1/2024

PROJECT	SHEET NUMBER

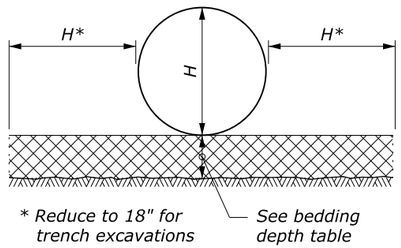


ABOVE NATURAL GROUND



ON UNYIELDING MATERIAL

BEDDING DEPTH	
PIPE SIZE (H)	DEPTH
12" to 54"	4"
> 54"	6"



PIPE BEDDING

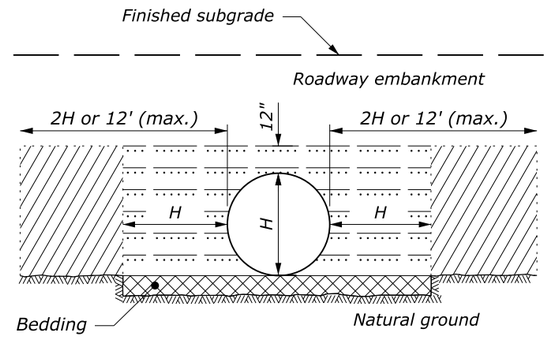
NOTE:

1. When directed, camber pipe culverts upward from a chord through the inlet and outlet inverts an ordinate amount equal to 1% of the pipe length. Develop camber on a parabolic curve. If the midpoint elevation on the parabolic curve as designed exceeds the elevation of the inlet invert, reduce the amount of camber or increase the pipe culvert gradient.

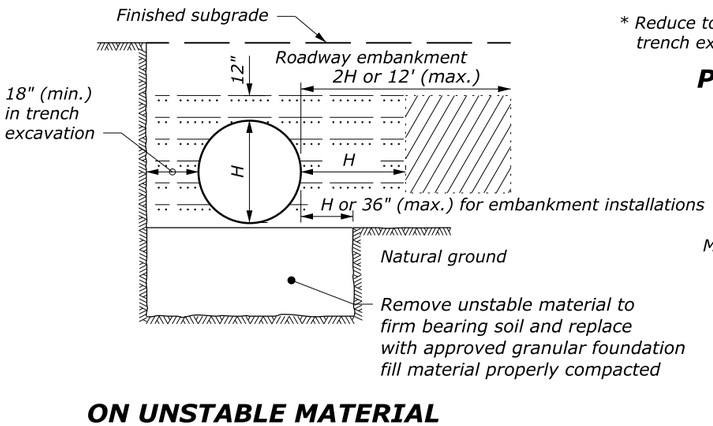
2. H equals the diameter of all round pipe culverts or the rise dimension of all pipe arch culverts.

3. See Section 704 for bedding and backfill requirements.

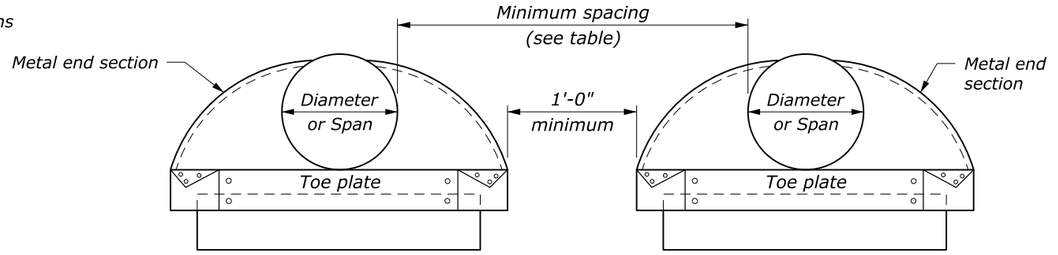
MINIMUM SPACING	
DIAMETER or SPAN	SPACING
UP to 48"	24"
48" and UP	Half diameter or span or 36", whichever is less



ON NATURAL GROUND

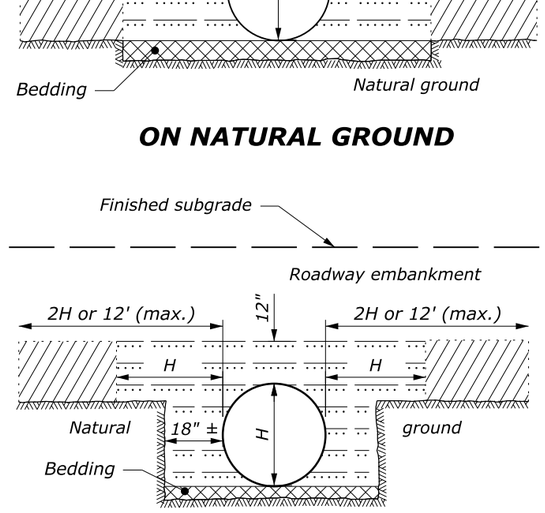


ON UNSTABLE MATERIAL

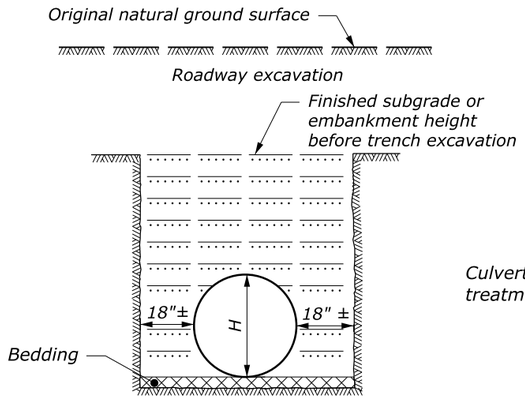


ELEVATION

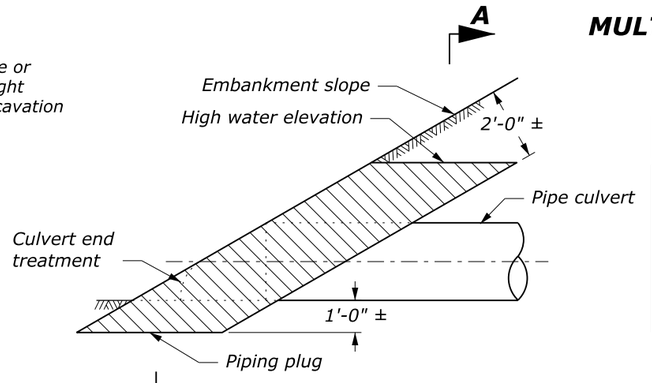
MULTIPLE PIPE INSTALLATION

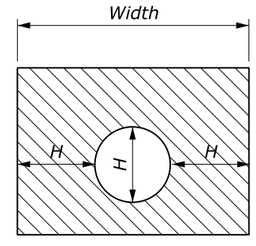


ABOVE AND BELOW NATURAL GROUND



BELOW NATURAL GROUND OR TRENCH EXCAVATION IN EMBANKMENT





SECTION A-A

Construct piping plug of impermeable backfill material at the pipe culvert inlet where granular material is used for backfill. Width may be adjusted to tie into impervious material.

PIPING PLUG

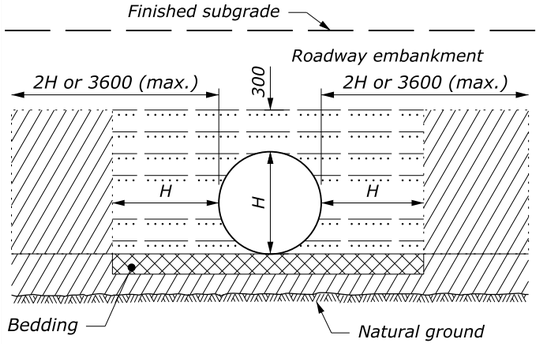
LEGEND:

- Bedding material (uncompacted)
- Embankment material placed in layers not exceeding 6" compacted depth.
- Compacted backfill material placed in layers not exceeding 6" compacted depth; or flowable backfill according to Section 614.
- Impermeable backfill material.

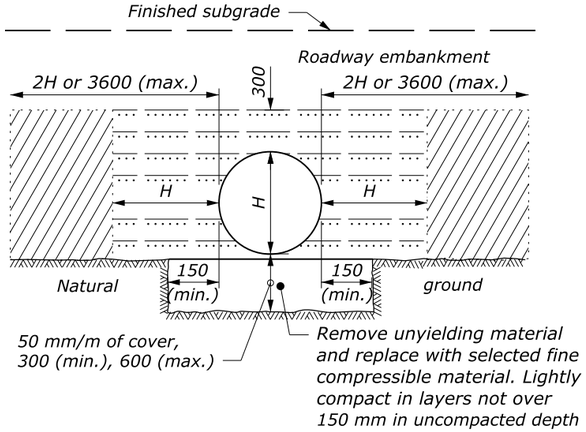
NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	FLH STANDARD 602-3
METAL AND PLASTIC PIPE CULVERT BEDDING	SPECIFICATION FP-24
	APPROVED FOR USE 1/2024

PROJECT	SHEET NUMBER

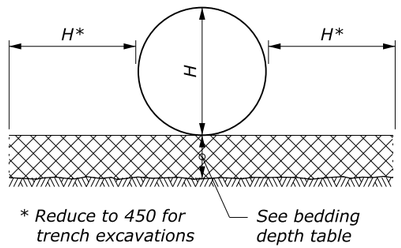


ABOVE NATURAL GROUND



ON UNYIELDING MATERIAL

BEDDING DEPTH	
PIPE SIZE (H)	DEPTH
300 to 1350	100
> 1350	150

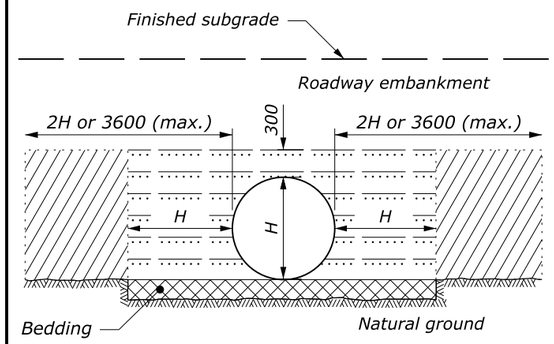


PIPE BEDDING

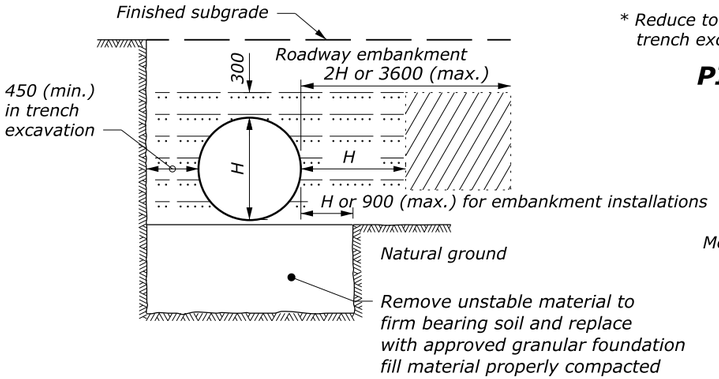
NOTE:

1. When directed, camber pipe culverts upward from a chord through the inlet and outlet inverts an ordinate amount equal to 1% of the pipe length. Develop camber on a parabolic curve. If the midpoint elevation on the parabolic curve as designed exceeds the elevation of the inlet invert, reduce the amount of camber or increase the pipe culvert gradient.
2. H equals the diameter of all round pipe culverts or the rise dimension of all pipe arch culverts.
3. See Section 704 for bedding and backfill requirements.

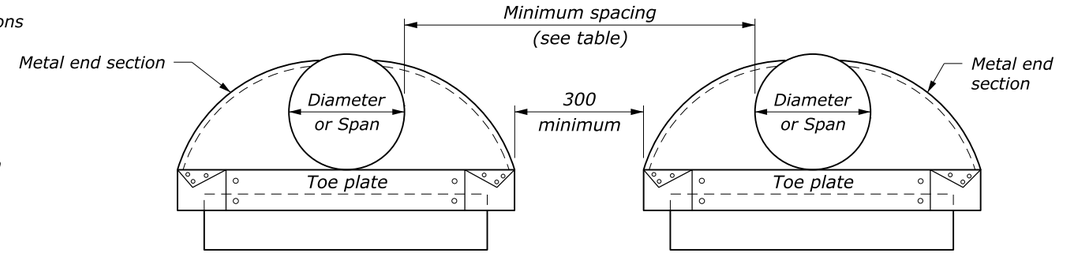
MINIMUM SPACING	
DIAMETER or SPAN	SPACING
UP to 1200	610
1200 and UP	Half diameter or span or 900, whichever is less



ON NATURAL GROUND

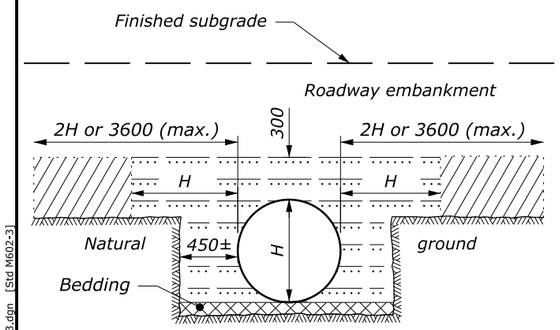


ON UNSTABLE MATERIAL

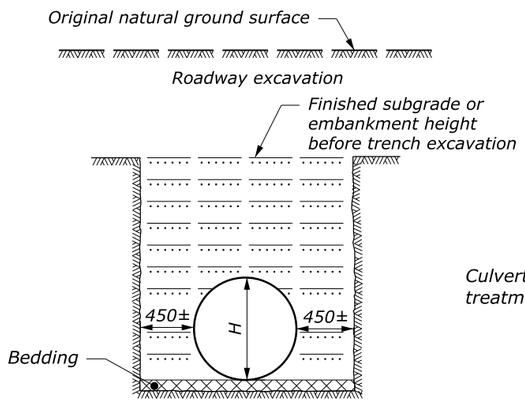


ELEVATION

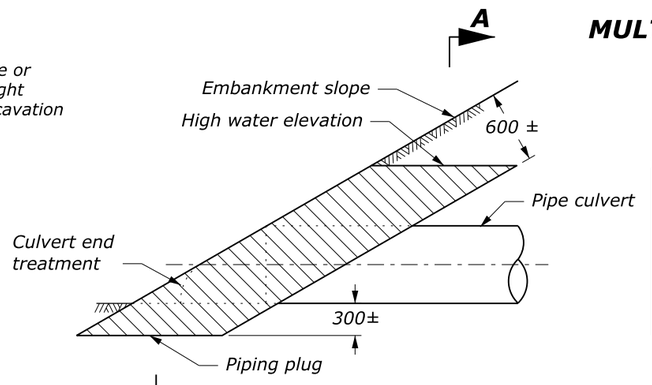
MULTIPLE PIPE INSTALLATION

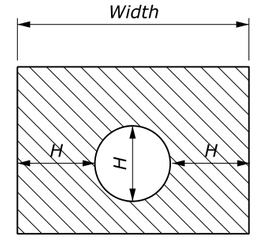


ABOVE AND BELOW NATURAL GROUND



BELOW NATURAL GROUND OR TRENCH EXCAVATION IN EMBANKMENT





SECTION A-A

Construct piping plug of impermeable backfill material at the pipe culvert inlet where granular material is used for backfill. Width may be adjusted to tie into impervious material.

PIPING PLUG

NO SCALE

LEGEND:

- Bedding material (uncompacted)
- Embankment material placed in layers not exceeding 150 mm compacted depth.
- Compacted backfill material placed in layers not exceeding 150 mm compacted depth; or lean concrete backfill according to Section 614.
- Impermeable backfill material.

This drawing contains **Metric** units of measure. Dimensions without units are millimeters.

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

METAL AND PLASTIC PIPE CULVERT BEDDING

FLH STANDARD
M602-3
SPECIFICATION
FP-24
APPROVED FOR USE
1/2024

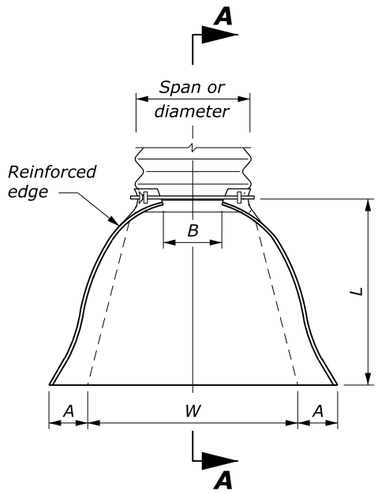
PROJECT	SHEET NUMBER

END SECTIONS FOR ROUND PIPE CULVERT

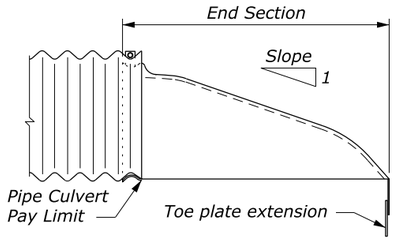
PIPE SIZE DIAMETER INCHES	METAL THICKNESS				DIMENSIONS INCHES					SLOPE
	STEEL		ALUMINUM							
	INCHES	GAGE	INCHES	GAGE	A (min)	B (max)	H (min)	L (±2")	W (max)	Approx.
12	0.064	16	0.060	16	5	7	6	21	44	2¼
15	0.064	16	0.060	16	6	8	6	26	52	2¼
18	0.064	16	0.060	16	7	10	6	31	58	2⅛
21	0.064	16	0.060	16	8	12	6	36	66	2⅛
24	0.064	16	0.060	16	9	13	6	41	72	2⅛
30	0.079	14	0.075	14	11	16	8	51	88	2⅛
36	0.079	14	0.075	14	13	19	9	60	105	2
42	0.109	12	0.105	12	15	25	10	69	122	2⅛
48	0.109	12	0.105	12	17	29	12	78	131	2
54	0.109	12	0.105	12	17	33	12	84	143	2
60	0.109	12	0.105	12	17	36	12	87	157	1⅞
66	0.109	12	0.105	12	17	39	12	87	162	1⅝
72	0.109	12	0.105	12	17	44	12	87	169	1½
78	0.109	12	0.105	12	17	48	12	87	178	1⅜
84	0.109	12	0.105	12	17	52	12	87	184	1⅓
90	0.109	12	0.105	12	17	58	12	87	188	1¼
96	0.109	12	0.105	12	17	58	12	87	197	1⅛

END SECTIONS FOR PIPE ARCH CULVERT

PIPE SIZE SPAN × RISE INCHES	EQUI-VALENT DIAM. (INCHES)	METAL THICKNESS				DIMENSIONS INCHES					SLOPE
		STEEL		ALUMINUM							
		INCHES	GAGE	INCHES	GAGE	A (min)	B (max)	H (min)	L (±2")	W (max)	Approx.
17 × 13	15	0.064	16	0.060	16	7	9	6	19	30	2½
21 × 15	18	0.064	16	0.060	16	7	10	6	23	36	2½
24 × 18	21	0.064	16	0.060	16	8	12	6	28	42	2½
28 × 20	24	0.064	16	0.060	16	9	14	6	32	48	2½
35 × 24	30	0.079	14	0.075	14	10	16	8	39	60	2½
42 × 29	36	0.079	14	0.075	14	12	18	9	46	75	2½
49 × 33	42	0.109	12	0.105	12	13	21	12	53	85	2½
57 × 38	48	0.109	12	0.105	12	18	26	12	63	90	2½
60 × 46	54	0.109	12	0.105	12	18	34	12	70	102	2
64 × 43	54	0.109	12	0.105	12	18	30	12	70	102	2
66 × 51	60	0.109	12	0.105	12	18	33	12	77	116	1½
71 × 47	60	0.109	12	0.105	12	18	33	12	77	114	1½
73 × 55	66	0.109	12	0.105	12	18	36	12	77	126	1½
77 × 52	66	0.109	12	0.105	12	18	36	12	77	126	1½
81 × 59	72	0.109	12	0.105	12	18	39	12	77	138	1½
83 × 57	72	0.109	12	0.105	12	18	39	12	77	138	1½
87 × 63	78	0.109	12	0.105	12	20	38	12	77	148	1½
95 × 67	84	0.109	12	0.105	12	20	34	12	87	162	1½
103 × 71	90	0.109	12	0.105	12	20	38	12	87	174	1½
112 × 75	96	0.109	12	0.105	12	20	40	12	87	174	1½



PLAN

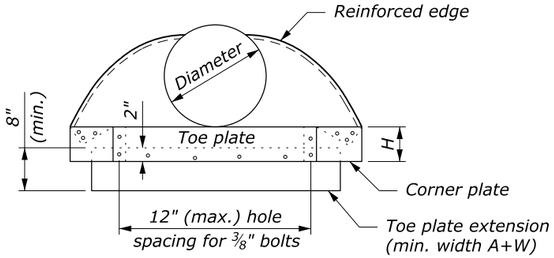


SECTION A-A

ROUND OR PIPE ARCH CULVERT

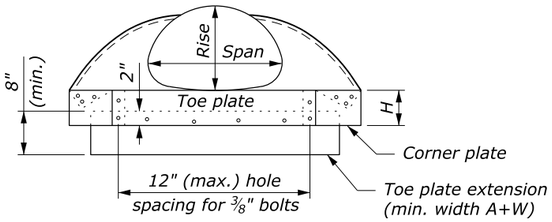
NOTE:

1. Variations in design and dimensions are permitted to allow for manufacturer's standards.
2. Fabricate the diameter of the end section of Design B to match the inside diameter of the concrete pipe culvert.
3. Design C may be used in lieu of design A for all metal pipe culvert sizes. Coupling bands may be any acceptable type for the pipe culvert specified.
4. Fabricate multiple piece bodies with lap seams tightly joined by ⅜" rivets or bolts. Fabricate end section center panels for 60" and larger diameter pipe and equivalent pipe arch from 0.138 inch steel or 0.135 inch aluminum.
5. On end section center panels for 66" and larger equivalent pipe arch provide 2½" × 2½" × ¼" angle reinforcement bolted or riveted under the center panel seam.
6. Supplement the reinforced edges of end sections for 60" and larger diameter pipe and 66" and larger equivalent pipe arch with 2½" × 2½" × ¼" stiffener angles attached with bolts or rivets.
7. Fabricate connector section, corner plate and toe plate extensions from the same metal thickness as the panel body. Use toe plate extension where shown on the plans.
8. Warp embankment slopes to match the slope of the flared end sections.



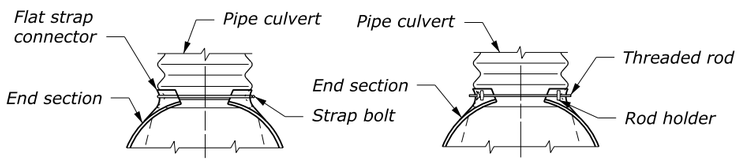
ELEVATION

ROUND PIPE CULVERT



ELEVATION

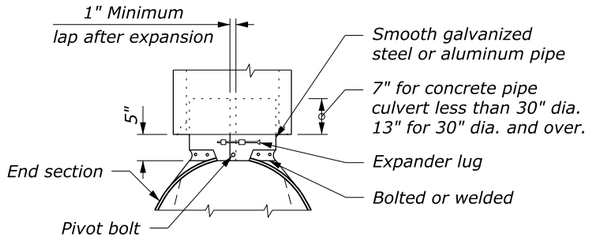
PIPE ARCH CULVERT



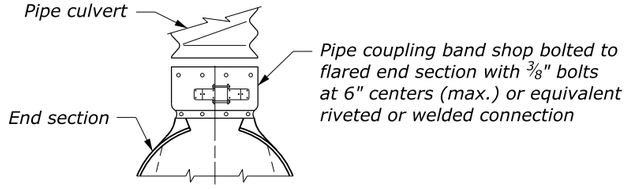
For 12" thru 24" round pipe and 17" × 13" thru 28" × 20" pipe arch

For 30" thru 60" round pipe and 35" × 24" thru 66" × 51" pipe arch

DESIGN A
CONNECTION TO ANNULAR CORRUGATED METAL PIPE



DESIGN B
CONNECTION TO CONCRETE PIPE INLET END



For all sizes of round pipe and pipe arch

DESIGN C
CONNECTION TO METAL PIPE OR OUTLET END OF CONCRETE PIPE

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	FLH STANDARD 602-4
METAL END SECTIONS	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 1/2024

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24 July 2024 11:27 AM

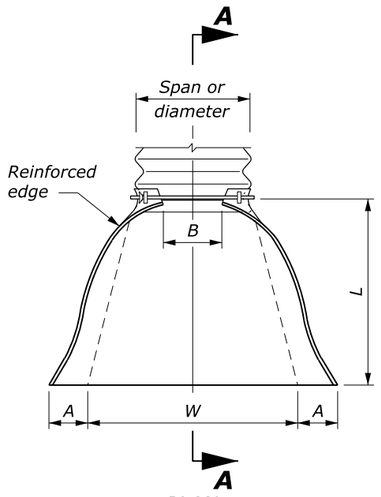
PROJECT	SHEET NUMBER

END SECTIONS FOR ROUND PIPE CULVERT

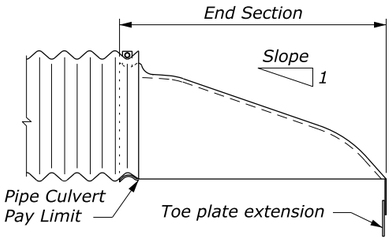
PIPE SIZE DIAMETER	METAL THICKNESS		DIMENSIONS					SLOPE Approx.
	STEEL	ALUMINUM	A (min)	B (max)	H (min)	L (±50)	W (max)	
300	1.63	1.52	125	175	150	525	1100	2¼
375	1.63	1.52	150	200	150	650	1300	2¼
450	1.63	1.52	175	250	150	775	1450	2⅛
525	1.63	1.52	200	300	150	900	1650	2⅛
600	1.63	1.52	225	325	150	1025	1800	2⅛
750	2.01	1.91	275	400	200	1275	2200	2⅛
900	2.01	1.91	325	475	225	1500	2625	2
1050	2.77	2.67	375	625	250	1725	3050	2⅛
1200	2.77	2.67	425	725	300	1950	3275	2
1350	2.77	2.67	425	825	300	2100	3575	2
1500	2.77	2.67	425	900	300	2175	3925	1⅞
1650	2.77	2.67	425	975	300	2175	4050	1⅝
1800	2.77	2.67	425	1100	300	2175	4225	1½
1950	2.77	2.67	425	1200	300	2175	4450	1⅜
2100	2.77	2.67	425	1300	300	2175	4600	1⅓
2250	2.77	2.67	425	1450	300	2175	4700	1¼
2400	2.77	2.67	425	1450	300	2175	4925	1⅛

END SECTIONS FOR PIPE ARCH CULVERT

PIPE SIZE SPAN × RISE	EQUI-VALENT DIAM.	METAL THICKNESS		DIMENSIONS					SLOPE Approx.
		STEEL	ALUMINUM	A (min)	B (max)	H (min)	L (±50)	W (max)	
430 × 330	375	1.63	1.52	175	225	150	475	750	2½
530 × 380	450	1.63	1.52	175	250	150	575	900	2½
610 × 460	525	1.63	1.52	200	300	150	700	1050	2½
710 × 510	600	1.63	1.52	225	350	150	800	1200	2½
890 × 610	750	2.01	1.91	250	400	200	975	1500	2½
1070 × 740	900	2.01	1.91	300	450	225	1150	1875	2½
1240 × 840	1050	2.77	2.67	325	525	300	1325	2125	2½
1450 × 970	1200	2.77	2.67	450	650	300	1575	2250	2½
1520 × 1170	1350	2.77	2.67	450	850	300	1750	2550	2
1630 × 1090	1350	2.77	2.67	450	750	300	1750	2550	2
1680 × 1300	1500	2.77	2.67	450	825	300	1925	2900	1½
1800 × 1190	1500	2.77	2.67	450	825	300	1925	2850	1½
1850 × 1400	1650	2.77	2.67	450	900	300	1925	3150	1½
1960 × 1320	1650	2.77	2.67	450	900	300	1925	3150	1½
2060 × 1500	1800	2.77	2.67	450	975	300	1925	3450	1½
2110 × 1450	1800	2.77	2.67	450	975	300	1925	3450	1½
2210 × 1600	1950	2.77	2.67	500	950	300	1925	3700	1½
2410 × 1700	2100	2.77	2.67	500	850	300	2175	4050	1½
2620 × 1800	2250	2.77	2.67	500	950	300	2175	4350	1½
2840 × 1910	2400	2.77	2.67	500	1000	300	2175	4350	1½



PLAN

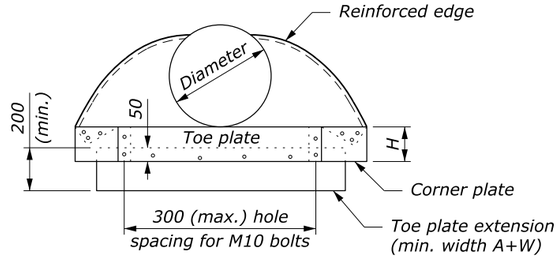


SECTION A-A

ROUND OR PIPE ARCH CULVERT

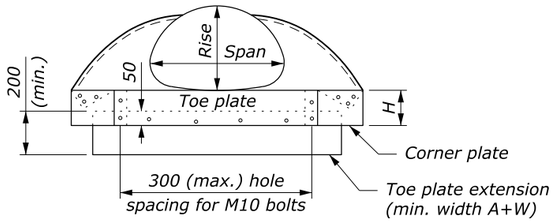
NOTE:

1. Variations in design and dimensions are permitted to allow for manufacturer's standards.
2. Fabricate the diameter of the end section of Design B to match the inside diameter of the concrete pipe culvert.
3. Design C may be used in lieu of design A for all metal pipe culvert sizes. Coupling bands may be any acceptable type for the pipe culvert specified.
4. Fabricate multiple piece bodies with lap seams tightly joined by M10 rivets or bolts. Fabricate end section center panels for 1500 mm and larger diameter pipe and equivalent pipe arch from 3.51 mm steel or 3.43 mm aluminum.
5. On end section center panels for 1650 mm and larger equivalent pipe arch provide 64 × 64 × 6.4 angle reinforcement bolted or riveted under the center panel seam.
6. Supplement the reinforced edges of end sections for 1500 mm and larger diameter pipe and 1650 mm and larger equivalent pipe arch with 51 × 51 × 6.4 stiffener angles attached with bolts or rivets.
7. Fabricate connector section, corner plate and toe plate extensions from the same metal thickness as the panel body. Use toe plate extension where shown on the plans.
8. Warp embankment slopes to match the slope of the flared end sections.



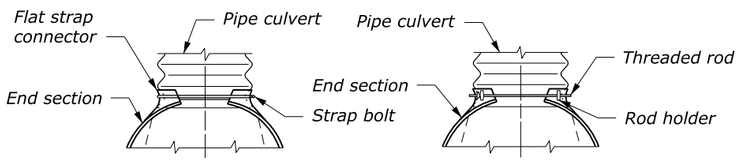
ELEVATION

ROUND PIPE CULVERT



ELEVATION

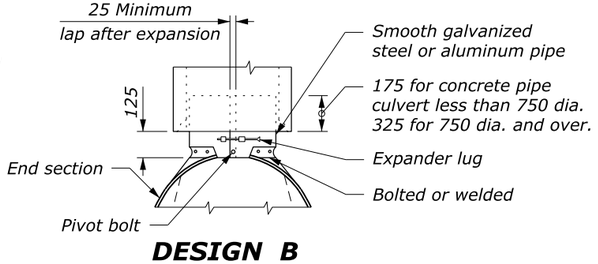
PIPE ARCH CULVERT



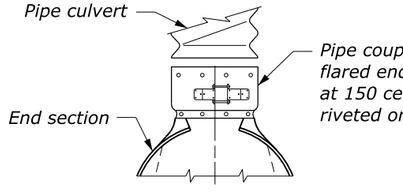
For 300 thru 600 mm round pipe and 430 × 330 mm thru 710 × 510 mm pipe arch

For 750 thru 1500 mm round pipe and 890 × 610 mm thru 1670 × 1290 mm pipe arch

DESIGN A
CONNECTION TO ANNULAR CORRUGATED METAL PIPE



DESIGN B
CONNECTION TO CONCRETE PIPE INLET END



For all sizes of round pipe and pipe arch

DESIGN C
CONNECTION TO METAL PIPE OR OUTLET END OF CONCRETE PIPE

NO SCALE

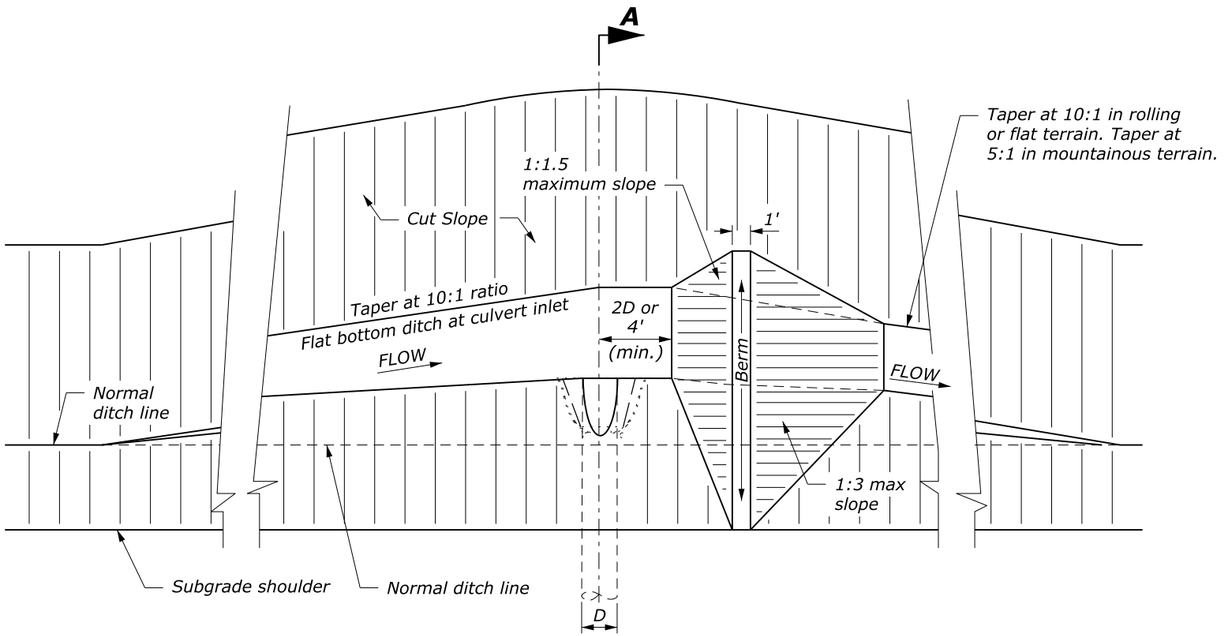
*This drawing contains **Metric** units of measure. Dimensions without units are millimeters.*

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	FLH STANDARD M602-4
METAL END SECTIONS	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 1/2024

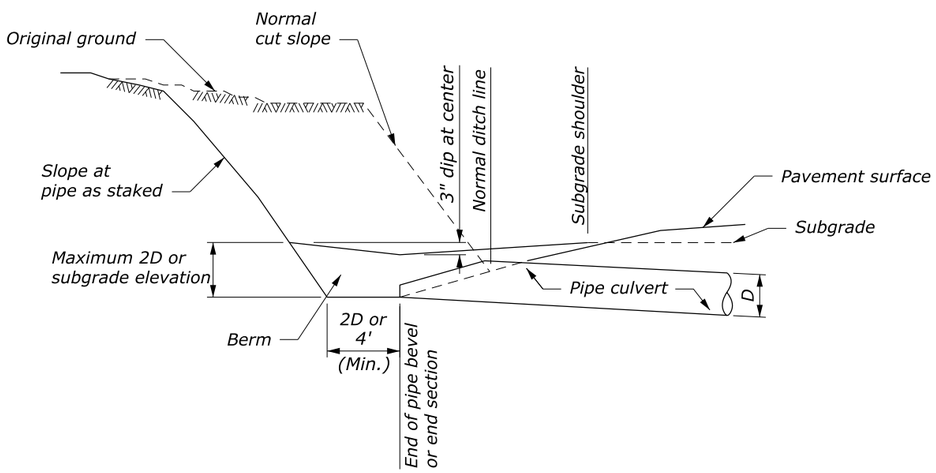
PROJECT	SHEET NUMBER

NOTE:

1. *D equals the diameter of all round pipe or the rise dimension of all pipe arch culverts.*

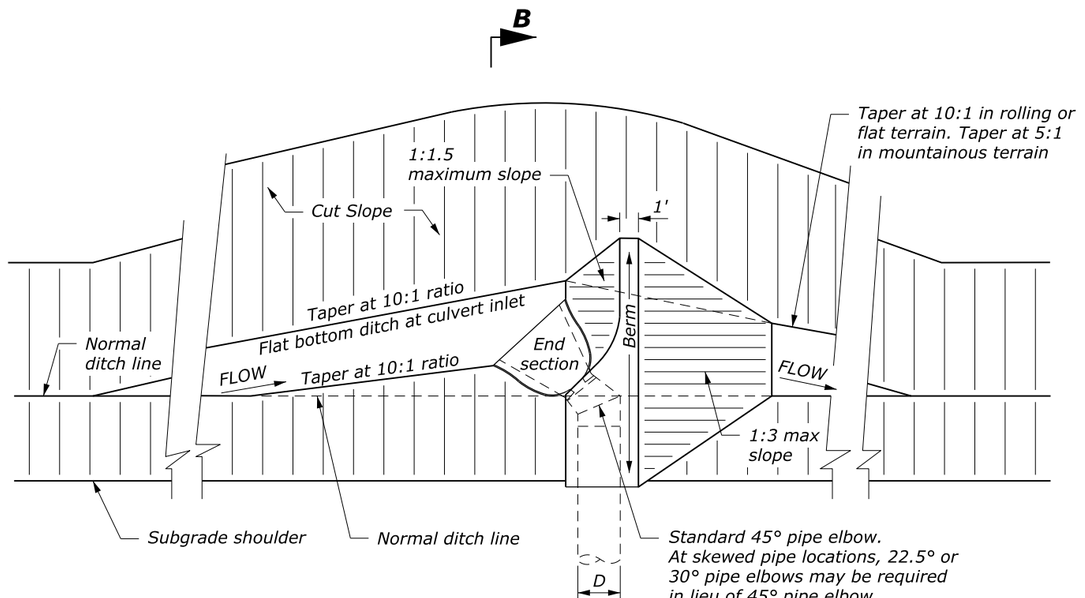


PLAN

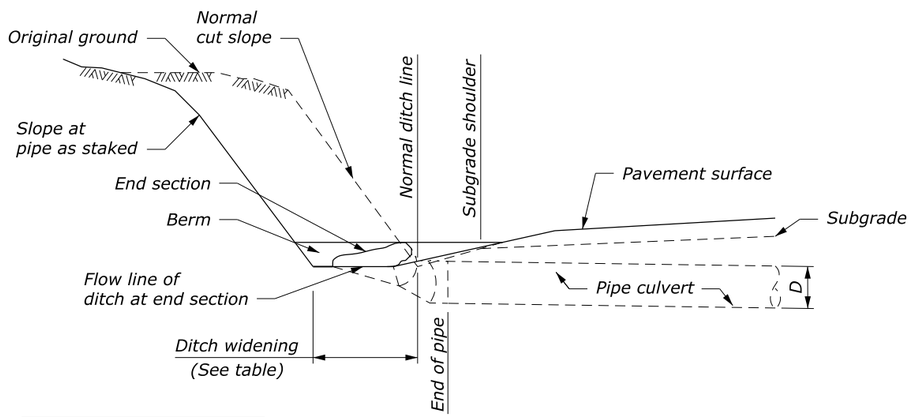


SECTION A-A

TYPE I



PLAN



SECTION B-B

TYPE II

DITCH WIDENING	
PIPE SIZE (D)	*WIDENING*
18"	*5'*
24"	*6'*
30"	*7'*

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

PIPE CULVERT INLET TREATMENT IN CUT SLOPES

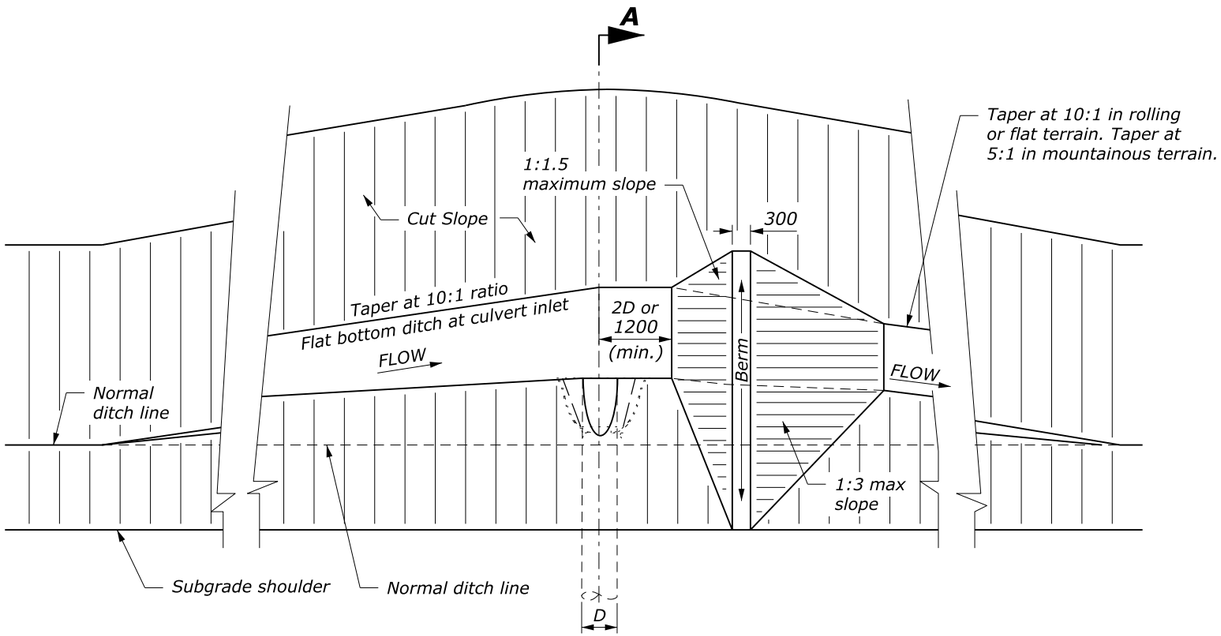
FLH STANDARD	602-6
SPECIFICATION	FP-24, FP-14
APPROVED FOR USE	1/2024

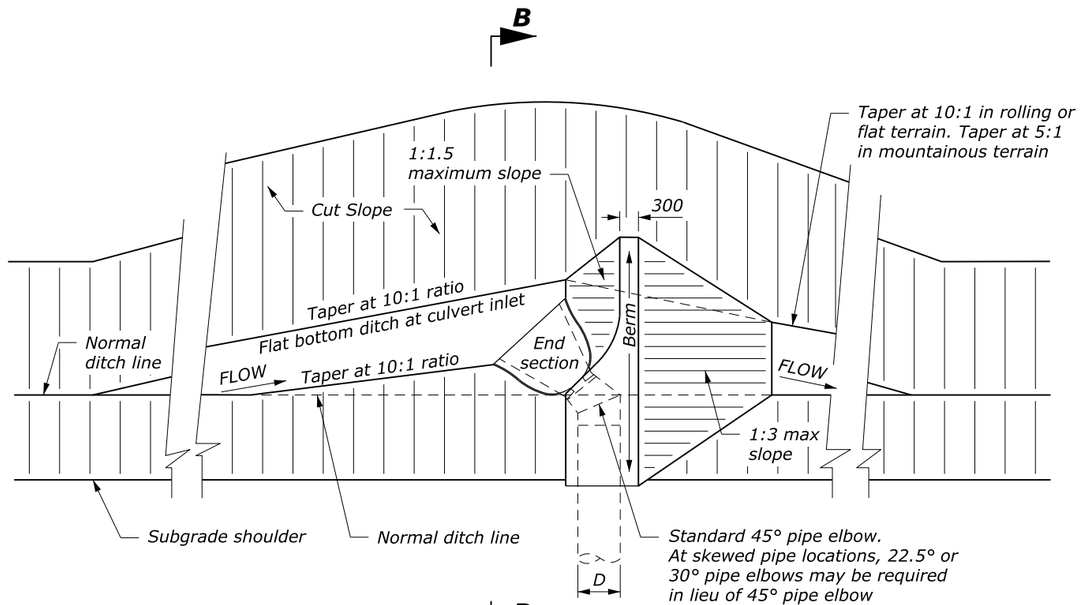
PROJECT	SHEET NUMBER

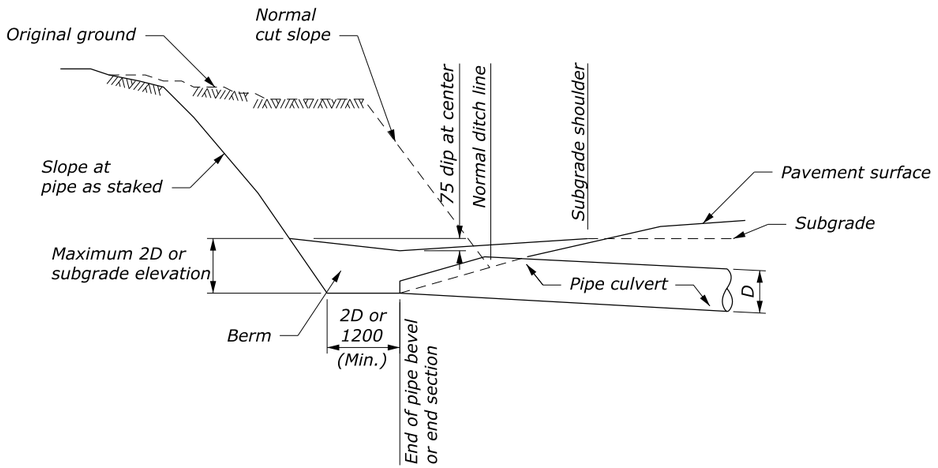
NOTE:

1. *D equals the diameter of all round pipe or the rise dimension of all pipe arch culverts.*

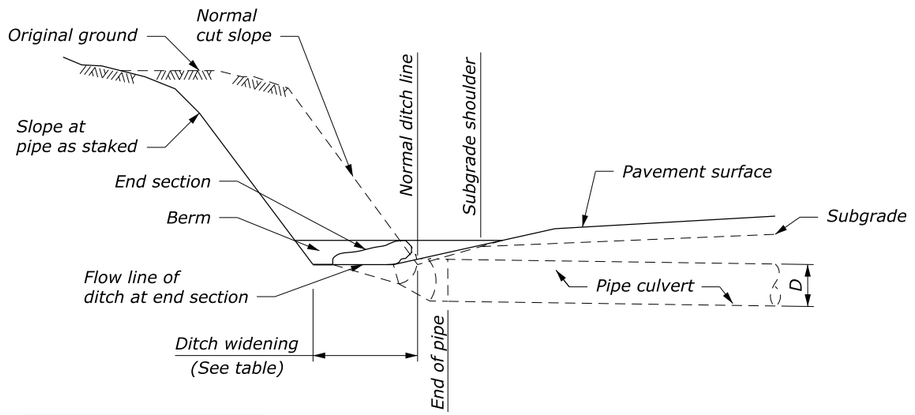
2. *Dimensions without units are millimeters.*







SECTION A-A
TYPE I



DITCH WIDENING	
PIPE SIZE (D)	WIDENING
450	1500
600	1800
750	2100

SECTION B-B
TYPE II

*This drawing contains **Metric** units of measure.*
Dimensions without units are millimeters.

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

PIPE CULVERT INLET TREATMENT IN CUT SLOPES

FLH STANDARD
M602-6
SPECIFICATION
FP-24, FP-14
APPROVED FOR USE
1/2024

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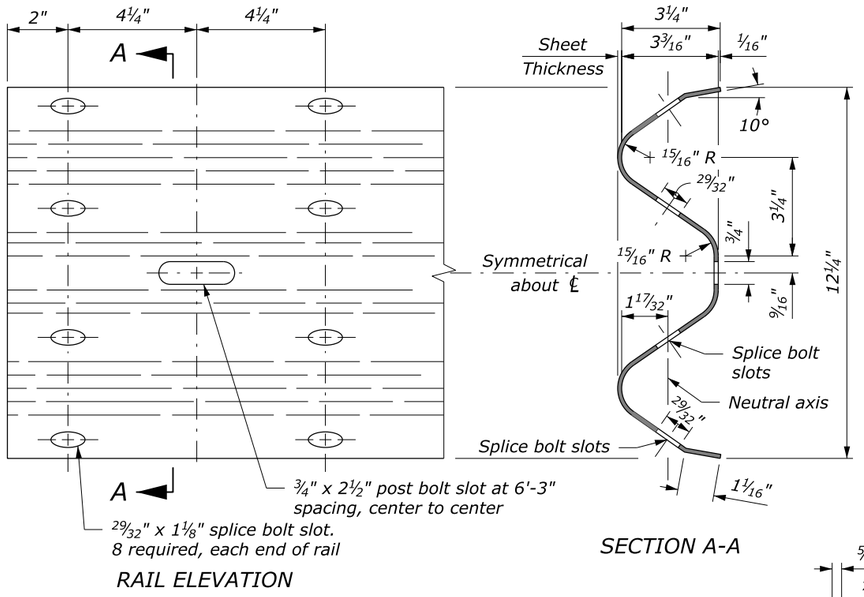
19 January 2024 7:51 AM

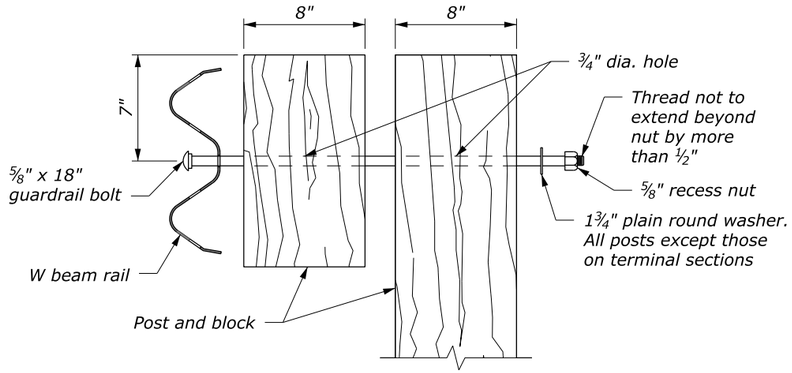
STATE	PROJECT	SHEET NUMBER



RAIL ELEVATION

SECTION A-A

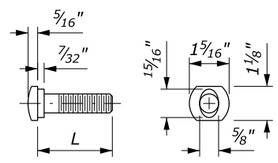
W BEAM RAIL



POST BOLT ASSEMBLY

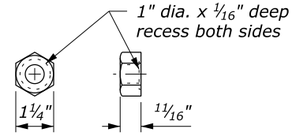
NOTE:

1. When encountering impenetrable material, see Standards 617-13 or 617-24.
2. See Special Contract Requirements when 7 foot or longer posts are specified.
3. See Special Contract Requirements when the alternative hole arrangement is specified.
4. Install delineator every fourth post. Fasten delineator to post using two 2" x ⅜" lag screws with washers, along centerline of post; or fasten as specified by the manufacturer.
5. Dimensional tolerances not shown or implied are intended to be those consistent with the proper functioning of the part, including its appearance, and accepted manufacturing practices.



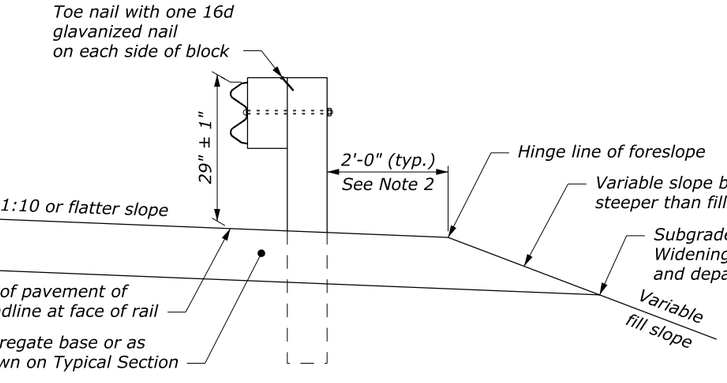
⅝" GUARDRAIL BOLT

L	Thread Length
1¼"	1⅛" minimum
2"	1¾" minimum
10"	4" minimum
18"	4" minimum
25"	4" minimum



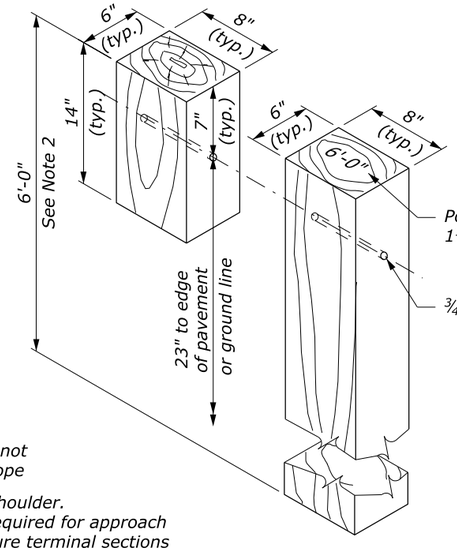
⅝" RECESS NUT

GUARDRAIL BOLT AND RECESS NUT

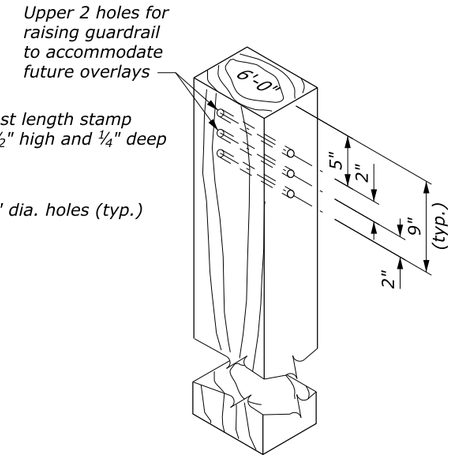


POST SPACING
STANDARD POST SECTION

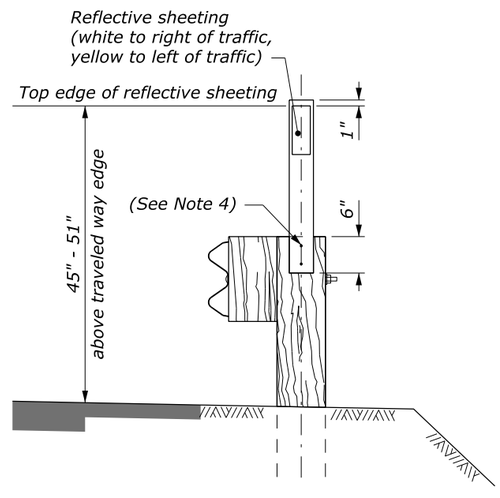
TYPICAL GUARDRAIL CROSS SECTION



STANDARD HOLE ARRANGEMENT POST AND BLOCK DETAIL



ALTERNATE HOLE ARRANGEMENT POST AND BLOCK DETAIL



FLEXIBLE GUIDE POST GUARDRAIL MOUNT

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
FEDERAL LANDS HIGHWAY

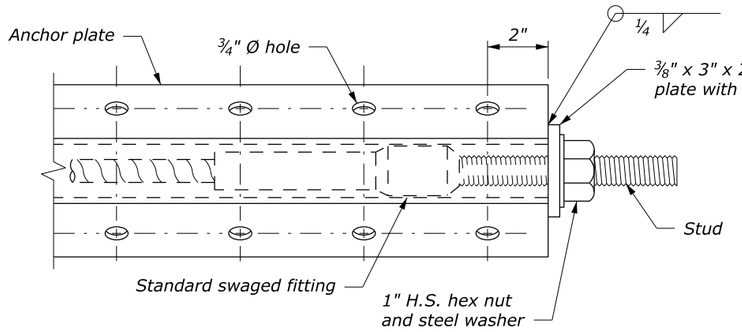
U.S. CUSTOMARY STANDARD

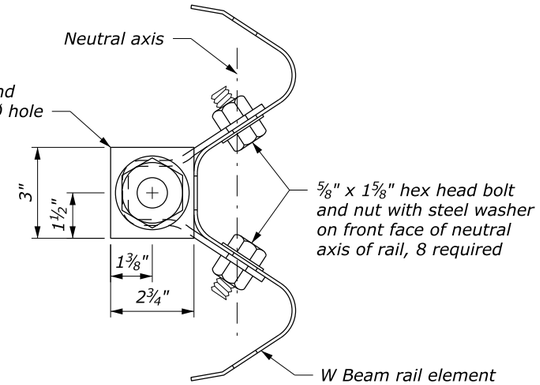
G4 W-BEAM GUARDRAIL WOOD POSTS

STANDARD APPROVED FOR USE 1/1994
REVISED: 4/1994 6/2005
DRAFT: 9/2017

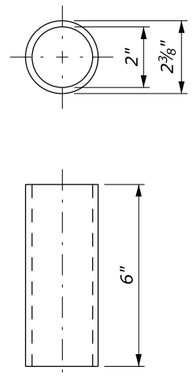
STANDARD 617-10

STATE	PROJECT	SHEET NUMBER





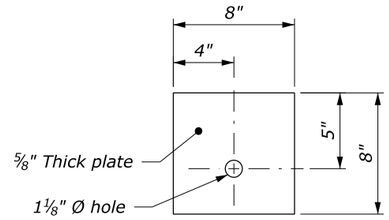
ANCHOR PLATE DETAILS FOR LST ANCHORAGE ASSEMBLY



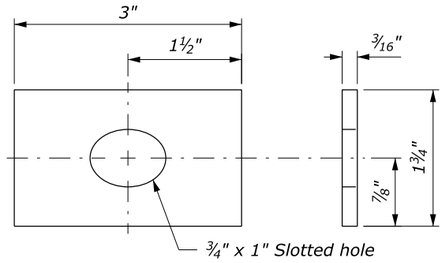
POST SLEEVE

NOTE:

1. Dimensional tolerances not shown or implied are intended to be those consistent with the proper functioning of the part, including its appearance, and accepted manufacturing practices.

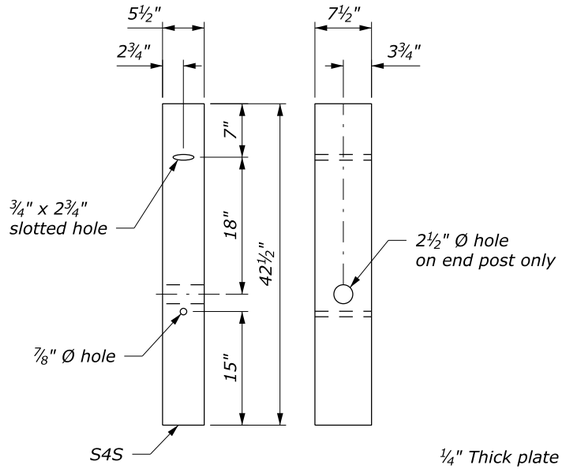


BEARING PLATE

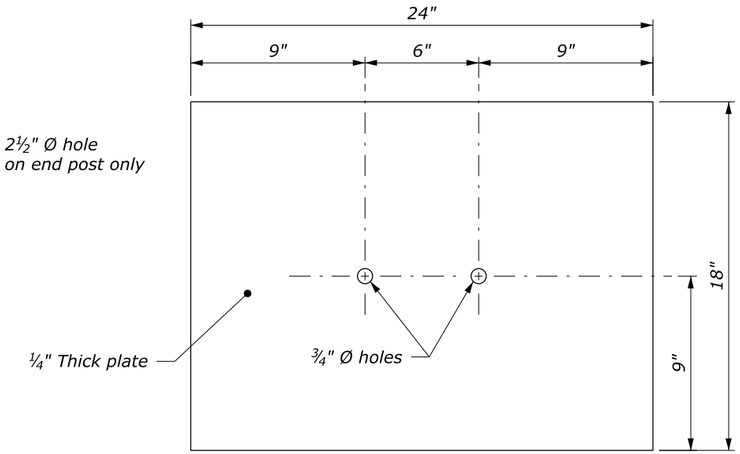


RECTANGULAR PLATE WASHER

(Use to attach the section to the post of anchorage assembly)

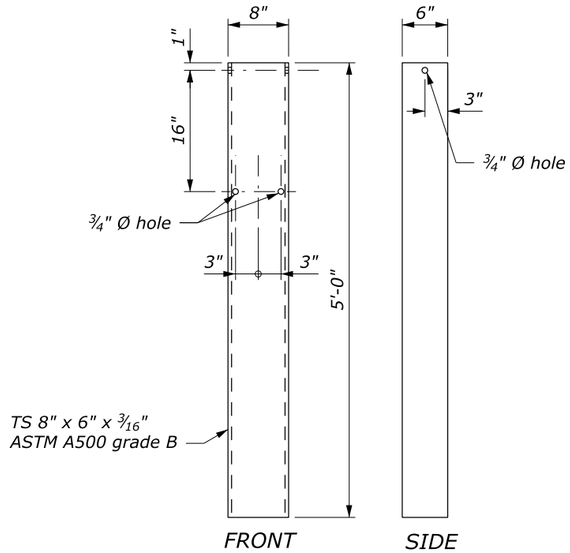


TERMINAL POST

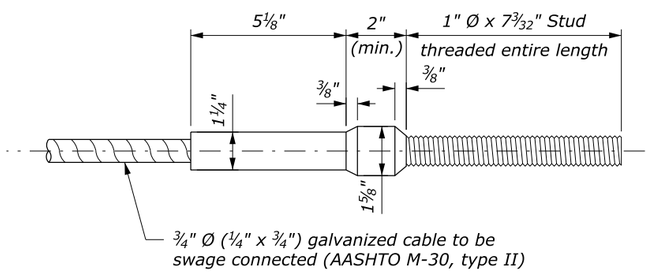


SOIL PLATE

(2 REQUIRED)

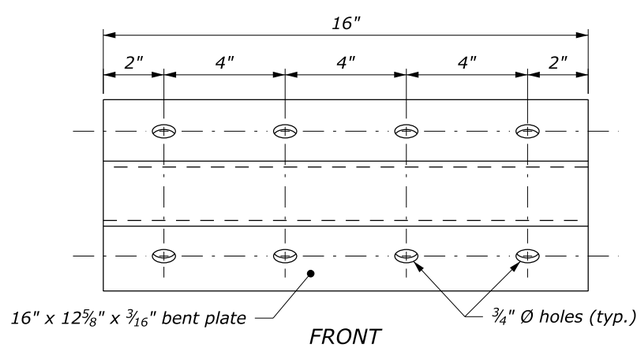


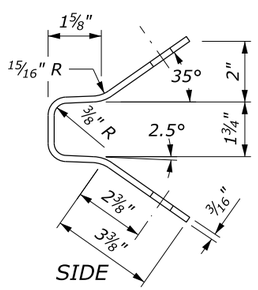
STEEL TUBE ANCHOR



CABLE ASSEMBLY

(Standard swaged fitting and stud)





GUARDRAIL ANCHOR PLATE

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
FEDERAL LANDS HIGHWAY

U.S. CUSTOMARY STANDARD

G4 W-BEAM GUARDRAIL MELT, LST & CRT ANCHORAGE ASSEMBLY DETAILS

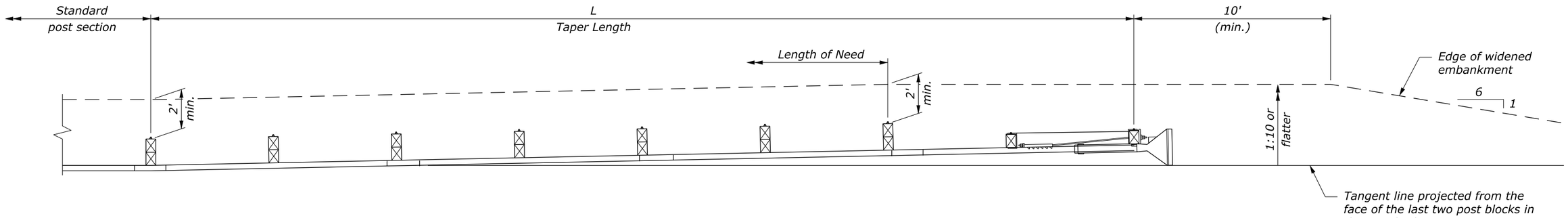
STANDARD APPROVED FOR USE 1/1994
REVISED: 4/1994 6/2005
DRAFT: 5/2014

STANDARD 617-15

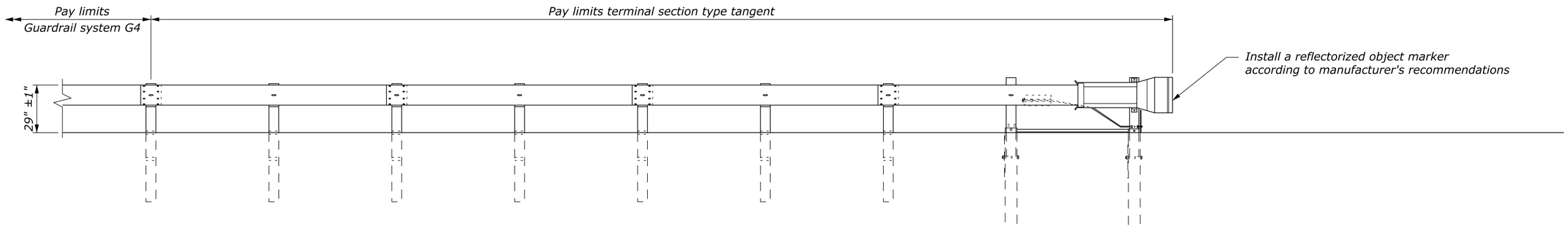
STATE	PROJECT	SHEET NUMBER

NOTE:

1. *Use details shown as a general guide since manufacturer's details may vary. Install a tangent G4 W-beam guardrail terminal that meets NCHRP-350 or MASH requirements per manufacturer's recommendations. Ensure that terminal meets appropriate test level for the project.*
2. *Install terminal at a 1:25 taper or flatter, to position the end farther away from the edge of the shoulder, or use a taper per manufacturer's recommendations.*
3. *See manufacturer's drawings for other details.*



PLAN



ELEVATION

TEST LEVEL	*L (ft)*
2 (≤ 45 mph)	*25*
3 (> 45 mph)	*37.5 or 50*

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
FEDERAL LANDS HIGHWAY

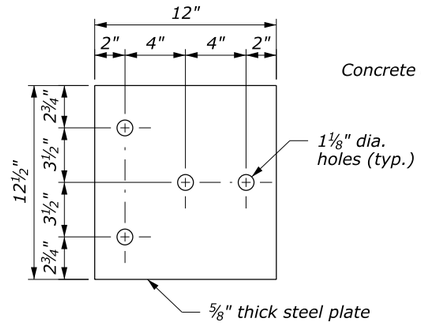
U.S. CUSTOMARY STANDARD

G4 W-BEAM GUARDRAIL TYPE TANGENT TERMINAL

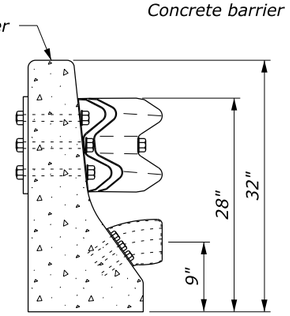
STANDARD APPROVED FOR USE 6/2005
REVISED:
DRAFT: 3/2016

STANDARD
617-20

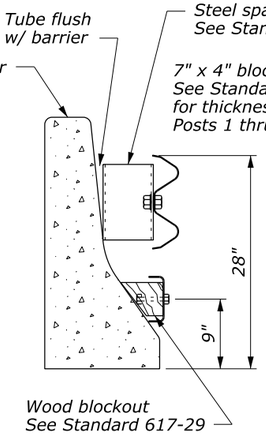
REG	STATE	PROJECT	SHEET NO.	SHEET NO.
REG	STATE	PROJECT	SHEET NO.	SHEET NO.



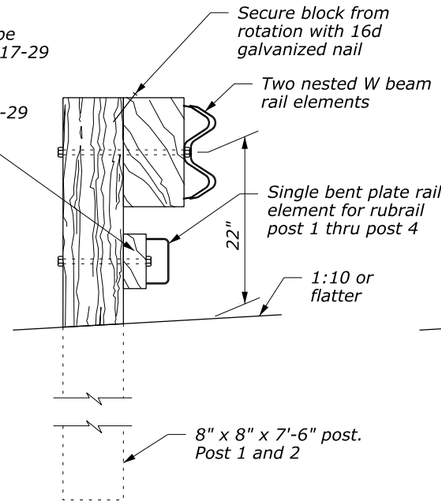
BEARING PLATE



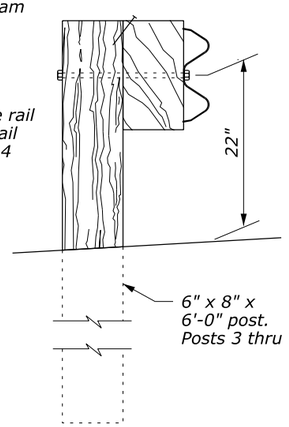
SECTION A-A



SECTION B-B



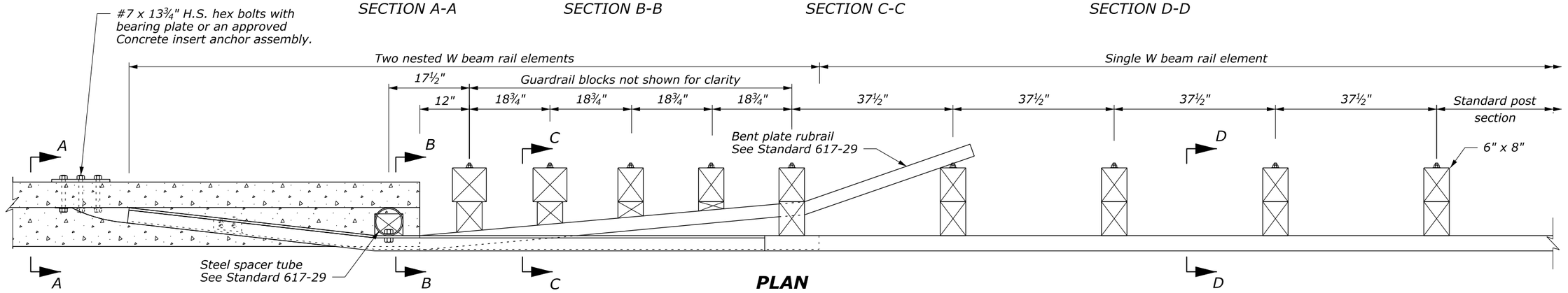
SECTION C-C



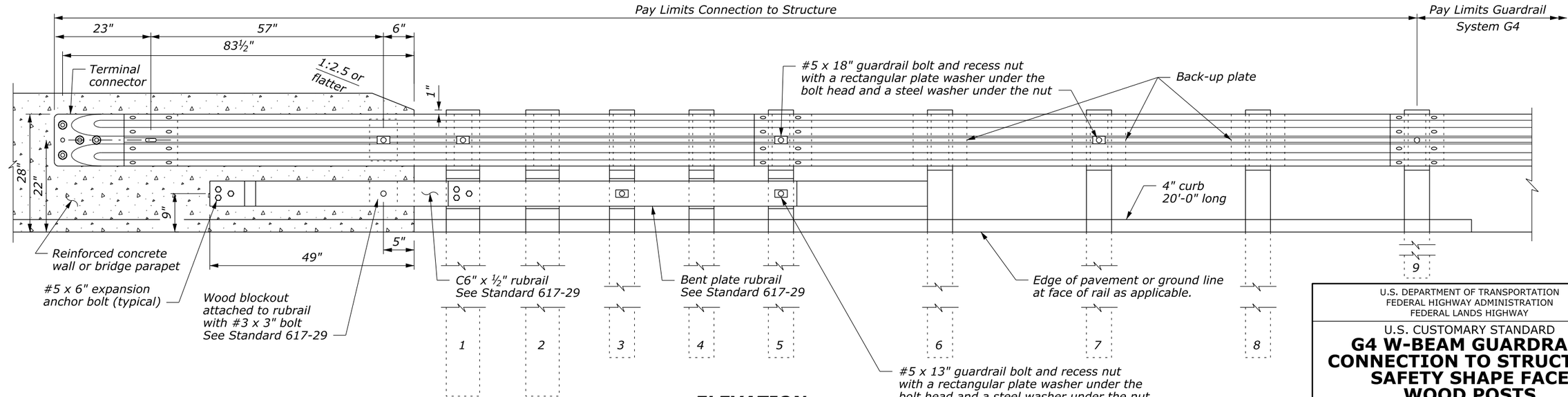
SECTION D-D

NOTE:

1. Posts 1 through 5 require an additional hole to attach lower wood blocks and/or rubrail.
2. Center drill wood blocks for rubrail located on posts 1 through 4. Secure blocks to posts 2 and 4. Secure rubrail and blocks to posts 1, 3, and 5 using ⅝" carriage bolts.
3. Do not bolt W beam to posts and blocks at posts 2 and 4.
4. Reinforced concrete wall or bridge parapet must be capable of developing a 59.6 kip pull out strength.



PLAN



ELEVATION

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
FEDERAL LANDS HIGHWAY

U.S. CUSTOMARY STANDARD

G4 W-BEAM GUARDRAIL CONNECTION TO STRUCTURE SAFETY SHAPE FACE WOOD POSTS

STANDARD APPROVED FOR USE --/----

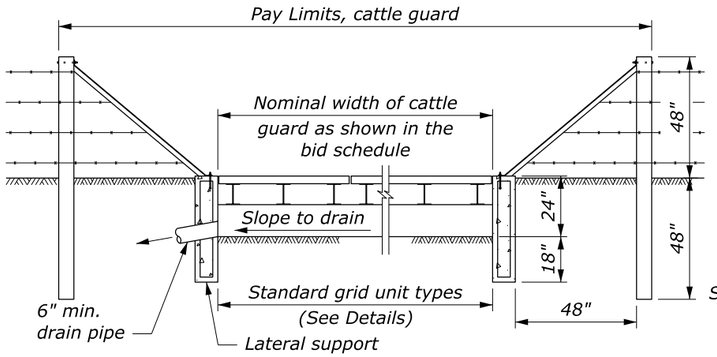
REVISED:

DRAFT: 9/2013

STANDARD 617-27

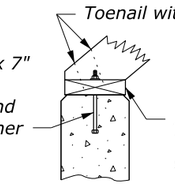
30 September 2013 10:45 AM c:\myfiles\pw_production\dms67487\Standard_617-27.DRAFT.dgn [USC]

PROJECT	SHEET NUMBER

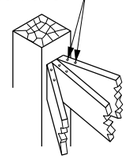


SECTION VIEW

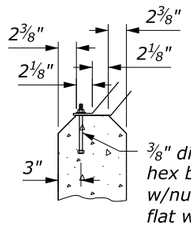
½" dia. x 7" hex bolt w/nut and flat washer



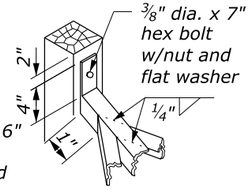
DETAIL A



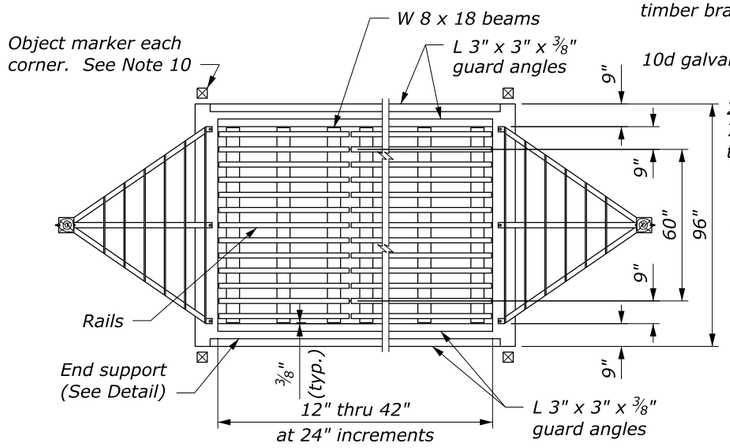
DETAIL B



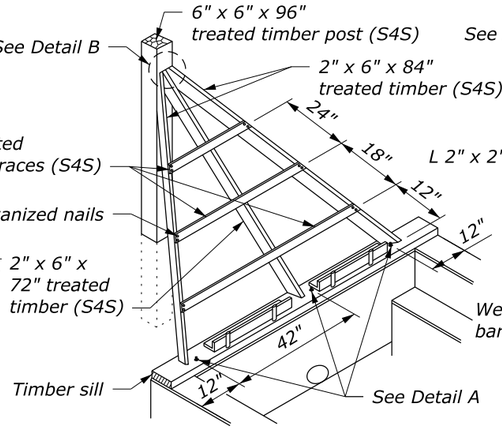
DETAIL C



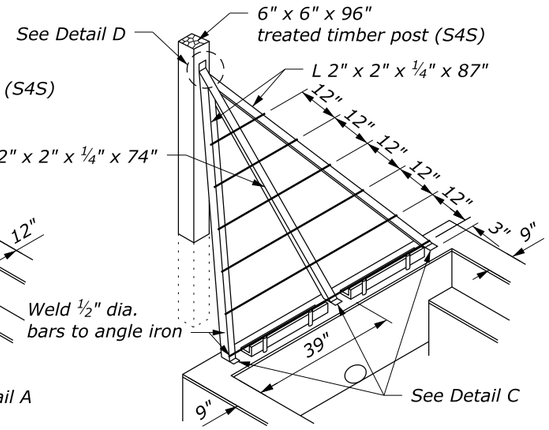
DETAIL D



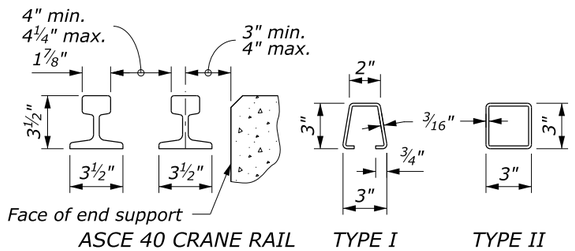
PLAN



WOOD WING GUARD



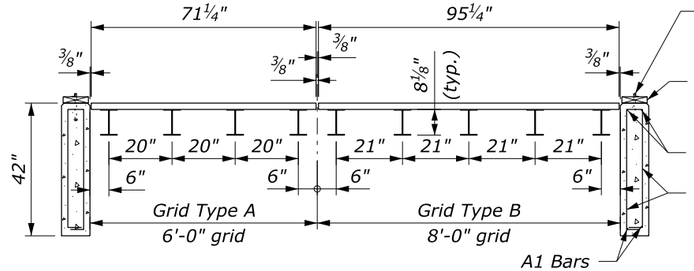
ANGLE IRON WING GUARD



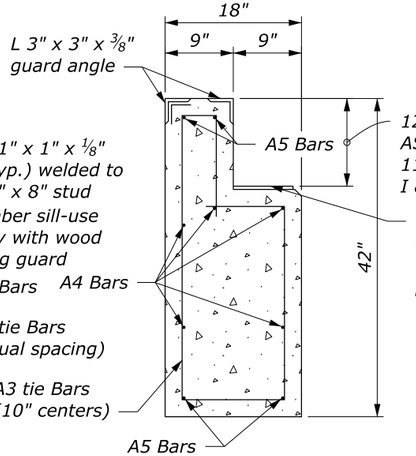
ASCE 40 CRANE RAIL

TYPE I TYPE II

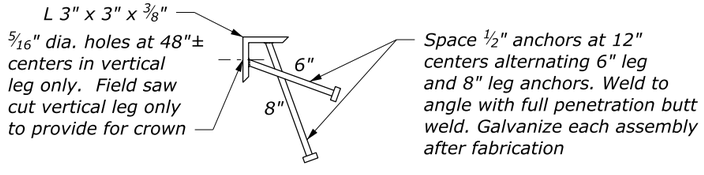
ACCEPTABLE ALTERNATE RAIL



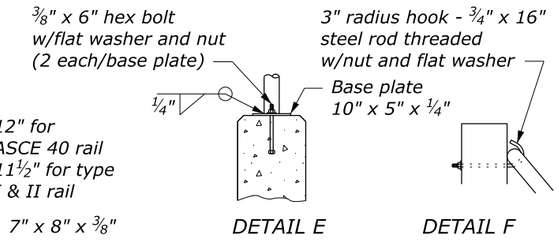
STANDARD GRID UNIT TYPES



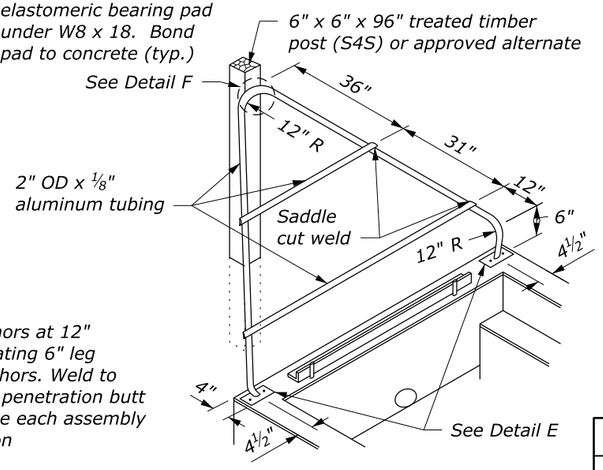
END SUPPORT DETAIL
(#4 Reinforcing Bars)



GUARD ANGLE DETAIL
(4 required per cattle guard)



DETAIL E DETAIL F



ALUMINUM TUBING WING GUARD

NO SCALE

NOTE:

1. LOADING: AASHTO HL-93.
2. CONCRETE: Chamfer exposed edges ¾" unless otherwise shown. Give all concrete surfaces a Class 1 finish.
3. STRUCTURAL STEEL: Provide rails conforming to the requirements for ASCE 40 crane rail. Provide structural steel for alternate sections conforming to ASTM A 500, Grade B, Copper Steel or ASTM A 618, Grade 2. If the steel does not contain a minimum of 0.2 percent copper, galvanize the alternate sections. All other structural steel conforms to AASHTO ASTM A36 and is coated.
4. Provide 2" minimum concrete cover to the face of any bar unless otherwise shown. All bars are #4.
5. All welds are continuous ¼" fillet shop welds. Weld rail or alternate sections on both sides to the W 8 x 18 beams at each intersection. Weld according to Section 555.
6. Use aluminum alloy 6061-T6 or 6063-T6 for aluminum tubing.
7. Provide timber conforming to AASHTO M 168. Treat timber with chromated copper arsenate according to AASHTO M 133.
8. Galvanize all hardware according to AASHTO M 111.
9. Construct the cattle guard to conform with the finished roadway grade and template.
10. Mount object markers on posts with a minimum height of 48 inches, measured from the bottom of the object marker to the elevation of the nearest edge of the traveled way.
11. Install drain pipe as shown where required. Include drain pipe with cattle guard unless otherwise shown.
12. Unless otherwise shown in the special contract requirements, shop apply coating according to Section 563. Use SAE-AMS-STD-595, Gray, 36231 for the top coat. Repair any damage to the coating installation.
13. Install channels and wood blocking on cattle guards wider than 16 feet to maintain grate spacing as shown on Standard 619-2.
14. See Standard 619-3 for optional precast foundation details.

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	FLH STANDARD 619-1
CATTLE GUARD	SPECIFICATION FP-24
	APPROVED FOR USE 2/2026

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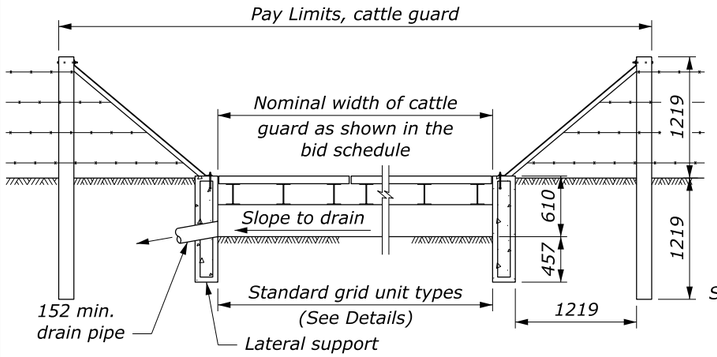
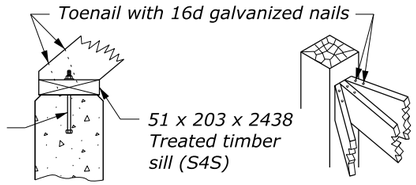
31 March 2026 11:39 AM

PROJECT	SHEET NUMBER

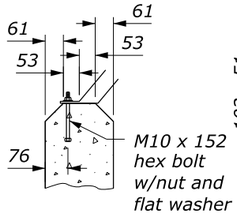


SECTION VIEW

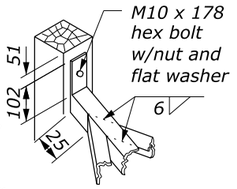


DETAIL A

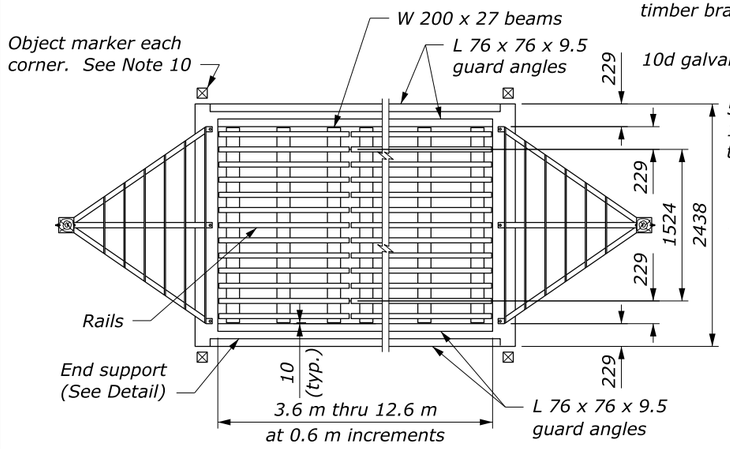
DETAIL B



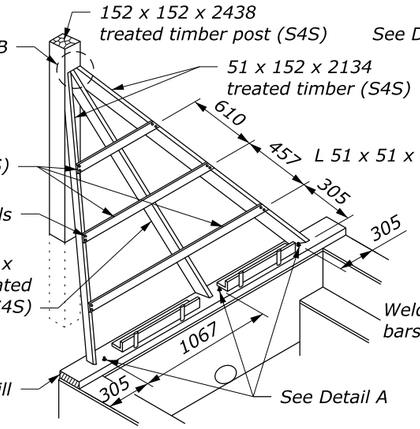
DETAIL C



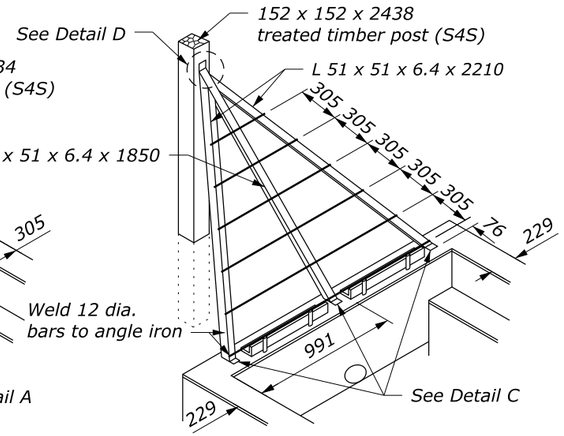
DETAIL D



PLAN

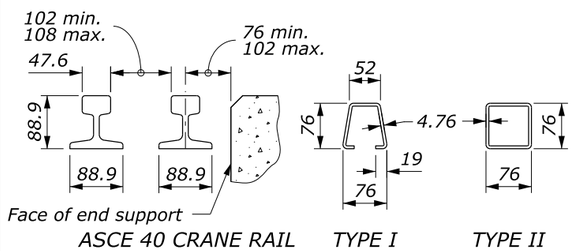


WOOD WING GUARD



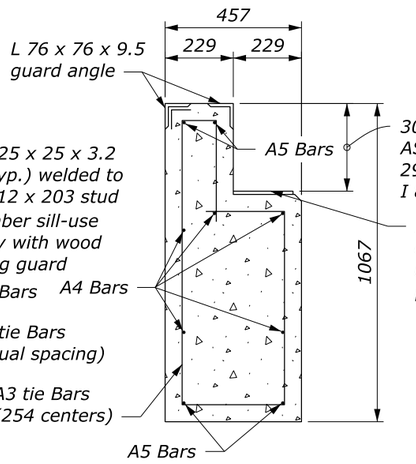
ANGLE IRON WING GUARD

STANDARD GRID UNIT TYPES

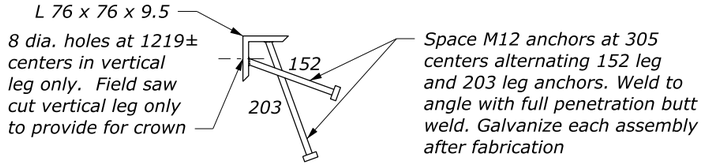


TYPE I TYPE II

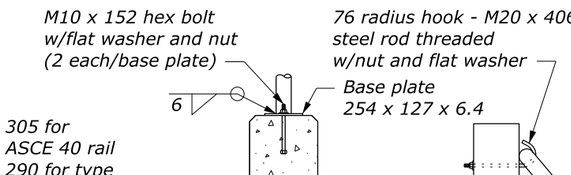
ACCEPTABLE ALTERNATE RAIL



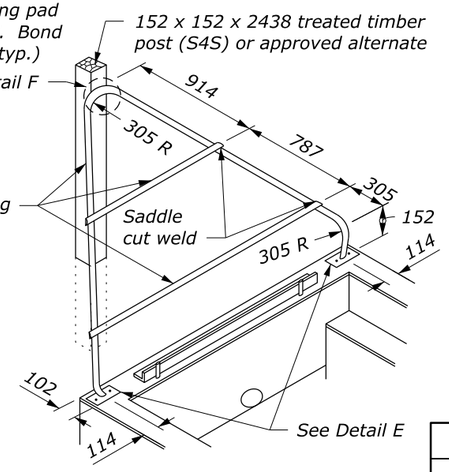
END SUPPORT DETAIL
(#13 Reinforcing Bars)



GUARD ANGLE DETAIL
(4 required per cattle guard)



DETAIL E DETAIL F



ALUMINUM TUBING WING GUARD

NO SCALE

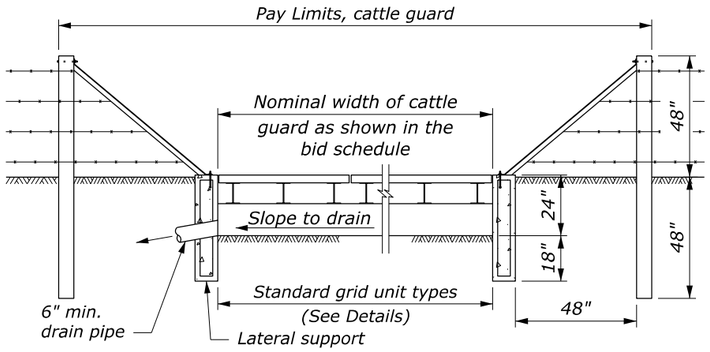
NOTE:

1. LOADING: AASHTO HL-93.
2. CONCRETE: Chamfer exposed edges 19 mm unless otherwise shown. Give all concrete surfaces a Class 1 finish.
3. STRUCTURAL STEEL: Provide rails conforming to the requirements for ASCE 40 crane rail. Provide structural steel for alternate sections conforming to ASTM A 500, Grade B, Copper Steel or ASTM A 618, Grade 2. If the steel does not contain a minimum of 0.2 percent copper, galvanize the alternate sections. All other structural steel conforms to AASHTO ASTM A36 and is coated.
4. Provide 51 mm minimum concrete cover to the face of any bar unless otherwise shown. All bars are #13.
5. All welds are continuous 6 mm fillet shop welds. Weld rail or alternate sections on both sides to the W 200 x 27 beams at each intersection. Weld according to Section 555.
6. Use aluminum alloy 6061-T6 or 6063-T6 for aluminum tubing.
7. Provide timber conforming to AASHTO M 168. Treat timber with chromated copper arsenate according to AASHTO M 133.
8. Galvanize all hardware according to AASHTO M 111.
9. Construct the cattle guard to conform with the finished roadway grade and template.
10. Mount object markers on posts with a minimum height of 1220 mm, measured from the bottom of the object marker to the elevation of the nearest edge of the traveled way.
11. Install drain pipe as shown where required. Include drain pipe with cattle guard unless otherwise shown.
12. Unless otherwise shown in the special contract requirements, shop apply coating according to Section 563. Use SAE-AMS-STD-595, Gray, 36231 for the top coat. Repair any damage to the coating installation.
13. Install channels and wood blocking on cattle guards wider than 4.8 m to maintain grate spacing as shown on Standard M619-2.
14. See Standard M619-3 for optional precast foundation details.

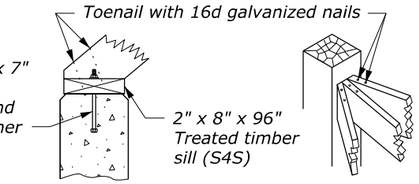
*This drawing contains **Metric** units of measure. Dimensions without units are millimeters.*

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	FLH STANDARD M619-1
CATTLE GUARD	SPECIFICATION FP-24
	APPROVED FOR USE 2/2026

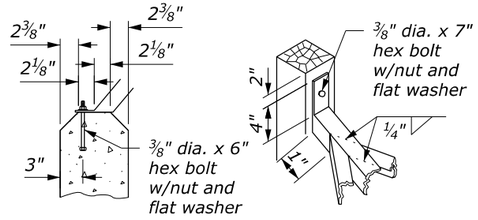
PROJECT	SHEET NUMBER



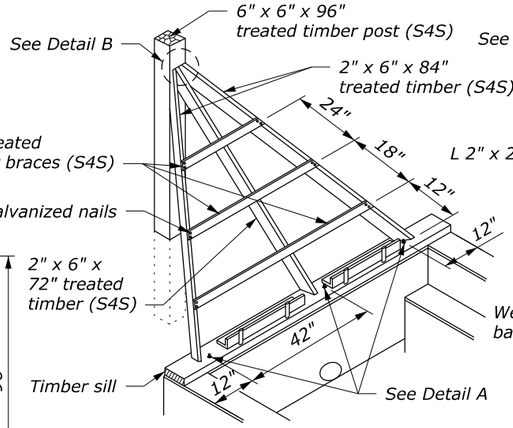
SECTION VIEW



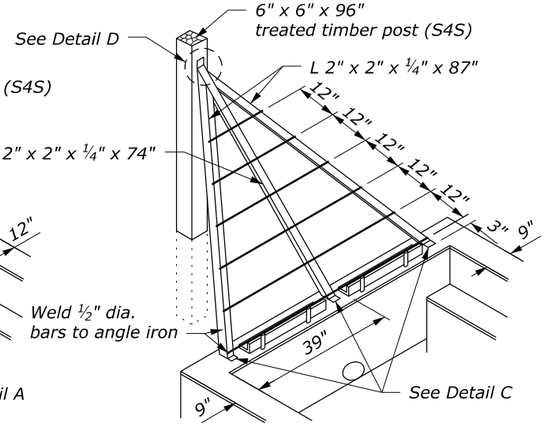
DETAIL A DETAIL B



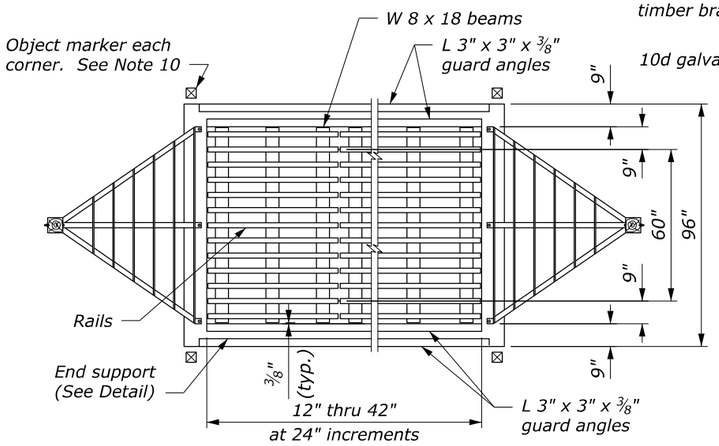
DETAIL C DETAIL D



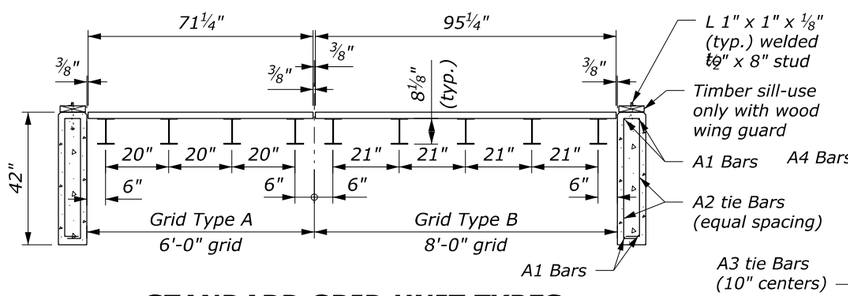
WOOD WING GUARD



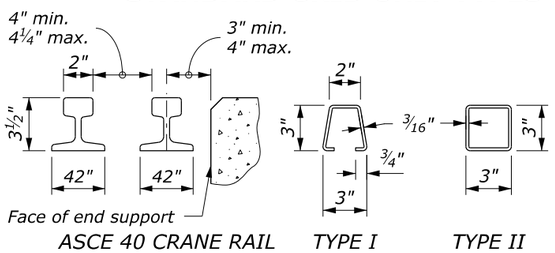
ANGLE IRON WING GUARD



PLAN

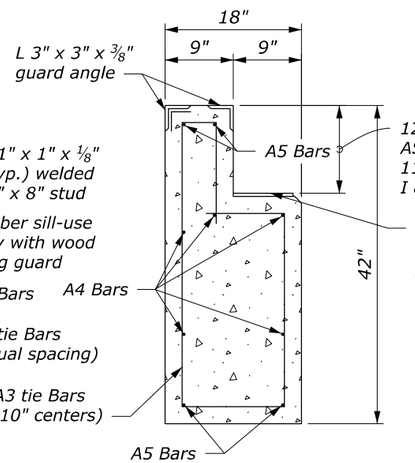


STANDARD GRID UNIT TYPES

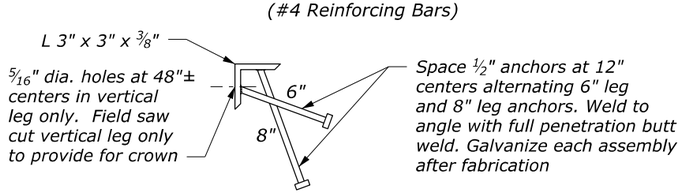


ASCE 40 CRAIL TYPE I TYPE II

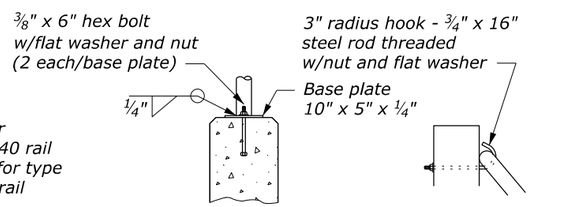
ACCEPTABLE ALTERNATE RAIL



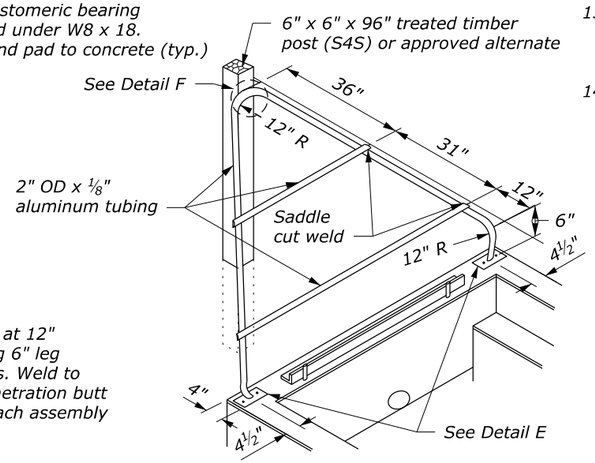
END SUPPORT DETAIL
(#4 Reinforcing Bars)



GUARD ANGLE DETAIL
(4 required per cattle guard)



DETAIL E DETAIL F



ALUMINUM TUBING WING GUARD

NO SCALE

NOTE:

1. LOADING: AASHTO HS20.
2. CONCRETE: Chamfer exposed edges ¾" unless otherwise shown. Give all concrete surfaces a Class 1 finish.
3. STRUCTURAL STEEL: Provide rails conforming to the requirements for ASCE 40 crane rail. Provide structural steel for alternate sections conforming to ASTM A 500, Grade B, Copper Steel or ASTM A 618, Grade 2. If the steel does not contain a minimum of 0.2 percent copper, galvanize the alternate sections. All other structural steel conforms to AASHTO ASTM A36 and is painted.
4. Provide 2" minimum concrete cover to the face of any bar unless otherwise shown. All bars are #4.
5. All welds are continuous ¼" fillet shop welds. Weld rail or alternate sections on both sides to the W 8 x 18 beams at each intersection. Weld according to Section 555.
6. Use aluminum alloy 6061-T6 or 6063-T6 for aluminum tubing.
7. Provide timber conforming to AASHTO M 168. Treat timber with chromated copper arsenate according to AASHTO M 133.
8. Galvanize all hardware according to AASHTO M 111.
9. Construct the cattle guard to conform with the finished roadway grade and template.
10. Place one object marker at each corner of the cattle guard as shown. Mount object markers on 4" x 4" x 6'-0" posts with the reflector located 42" above the elevation of the lateral support concrete.
11. Install drain pipe as shown where required. Include drain pipe with cattle guard unless otherwise shown.
12. Unless otherwise shown in the Special Contract Requirements, shop apply paint system 2 according to Section 555 and color the top coat according to Federal Standard 595B, Gray, 36231. Repair any damage to the paint system during installation.
13. Install channels and wood blocking on cattle guards wider than 16 feet to maintain grate spacing as shown on Standard 619-2.
14. See Standard 619-3 for optional precast foundation details.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
OFFICE OF FEDERAL LANDS HIGHWAY

FLH STANDARD

CATTLE GUARD

STANDARD APPROVED FOR USE 6/2005	STANDARD
REVISED: DRAFT: 10/2016	619-1

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22 February 2023 12:58 PM

PROJECT	SHEET NUMBER

CATTLE GUARD

REINFORCING STEEL, CONCRETE, STRUCTURAL STEEL, AND GRID UNIT TABLE OF QUANTITIES

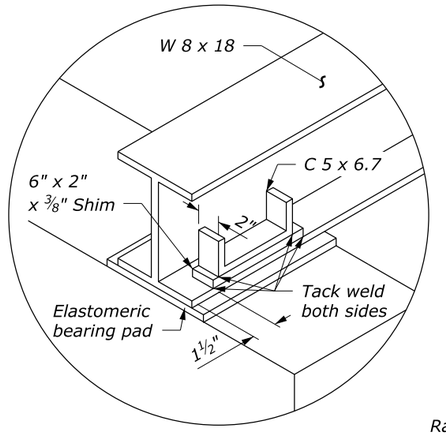
	DESCRIPTION	NOMINAL CATTLE GUARD WIDTH																														REMARKS
		12'		14'		16'		18'		20'		22'		24'		26'		28'		30'		32'		34'		36'		38'		40'		42'		
		QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	
	#4 Reinforcing bars, A1	8	92"	8	92"	8	92"	8	92"	8	92"	8	92"	8	92"	8	92"	8	92"	8	92"	8	92"	8	92"	8	92"	8	92"	8	92"	
	#4 Reinforcing bars, A2	20	86"	20	86"	20	86"	20	86"	20	86"	20	86"	20	86"	20	86"	20	86"	20	86"	20	86"	20	86"	20	86"	20	86"	20	86"	See Bar Bending Detail
	#4 Reinforcing bars, A3	32	108"	36	108"	40	108"	46	108"	50	108"	54	108"	60	108"	64	108"	70	108"	74	108"	80	108"	84	107"	90	108"	94	108"	98	108"	102	108"	See Bar Bending Detail
	#4 Reinforcing bars, A4	10	156"	10	180"	10	204"	10	228"	10	252"	10	276"	10	300"	10	324"	10	348"	10	372"	100	396"	10	420"	10	444"	10	468"	10	492"	10	516"	
	#4 Reinforcing bars, A5	8	140"	8	164"	8	188"	8	212"	8	236"	8	260"	8	284"	8	308"	8	332"	8	356"	8	380"	8	404"	8	428"	8	452"	8	476"	8	500"	
	Grid unit A (6 ft)	2		1				3		2		1				3		2		5				3		6		1				7		See Grid Unit List of Materials
	Grid unit B (8 ft)			1		2				1		2		3		1		2				4		2				4		5				See Grid Unit List of Materials
	Concrete lateral supports, yd3	1.56		1.56		1.56		1.56		1.56		1.56		1.56		1.56		1.56		1.56		1.56		1.56		1.56		1.56		1.56		
	Concrete end supports, yd3	4.03		4.70		5.37		6.04		6.71		7.38		8.05		8.73		9.40		10.07		10.74		11.41		12.08		12.75		13.42		14.10		
	Total concrete, yd3	5.59		6.26		6.93		7.60		8.27		8.94		9.61		10.29		10.96		11.63		12.30		12.97		13.64		14.31		14.98		15.66		
*Structural steel, lb	W 8 x 18 beams	936		1053		1170		1404		1521		1638		1755		1989		2106		2340		2340		2574		2808		2808		2925		3276		Beams 18 lb/ft
*Structural steel, lb	Rail, ASCE 40	2052		2398		2744		3078		3424		3770		4116		4450		4796		5130		5488		5822		6156		6514		6860		7182		13.30 lb/ft
*Structural steel, lb	Rail, Type I	806		942		1078		1209		1345		1481		1617		1748		1884		2015		2156		2287		2418		2559		2695		2821		Approx. 5.22 lb/ft
*Structural steel, lb	Rail, Type II	1060		1238		1416		1590		1768		1946		2124		2298		2476		2650		2832		3006		3180		3362		3540		3710		6.86 lb/ft
*Structural steel, lb	Reinforcing steel, lb	478		526		574		634		683		731		791		839		899		947		1007		1055		1115		1164		1212		1260		0.668 lb/ft

* Structural steel weights do not include hardware or guard angle.

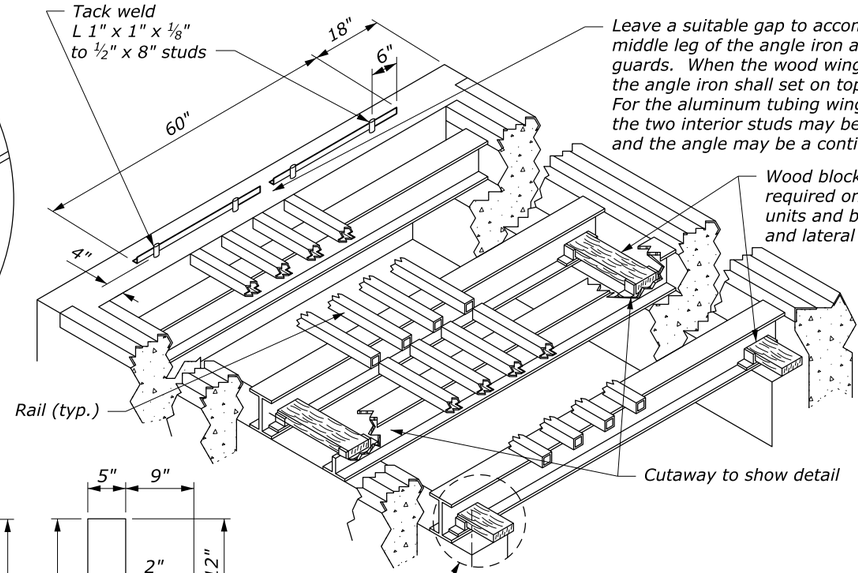
CATTLE GUARD WING

LIST OF MATERIALS PER WING
(TWO REQUIRED PER INSTALLATION)

PART DESCRIPTION	WOOD WING	ANGLE IRON WING	ALUMINUM TUBING WING
Outside diagonal supports	Two 2" x 6" x 84" treated S4S	Two 2" x 2" x ¼" x 87" galvanized steel angle	One 2" OD x ⅛" x 165" aluminum tubing
Middle support	One 2" x 6" x 72" treated S4S	One 2" x 2" x ¼" x 73" galvanized steel angle	
Horizontal brace No. 1	One 2" x 6" x 66" treated S4S	One ½" x 78" galvanized steel bar	One 2" OD x ⅛" x 72" aluminum tubing
No. 2	One 2" x 6" x 48" treated S4S	One ½" x 66" galvanized steel bar	One 2" OD x ⅛" x 30" aluminum tubing
No. 3	One 2" x 6" x 18" treated S4S	One ½" x 54" galvanized steel bar	None
No. 4	None	One ½" x 39" galvanized steel bar	None
No. 5	None	One ½" x 24" galvanized steel bar	None
No. 6	None	One ½" x 9" galvanized steel bar	None
Post	6" x 6" x 96" treated S4S	One 6" x 6" x 84" treated S4S or approved alternate	One 6" x 6" x 96" treated S4S or approved alternate
Top anchor assembly	Toenail diagonal supports to the post with 16d galvanized nails as required	⅜" dia. x 6" galvanized hex bolt w/nut and flat washer	¾" dia. x 16" galvanized steel rod threaded on one end w/nut and washers & 3" radius hook in other end
Bottom anchor assembly	2" x 8" x 96" treated S4S sill attached to concrete w/ 3 each ½" dia. x 7" hex bolts w/nuts & washers embedded in concrete. Toenail diagonal supports to wooden sill w/16d galvanized nails	3 each ⅜" dia. x 6" galvanized hex bolts embeded in concrete. Attach steel L iron to bolt w/flat washer and nut	2 each ¼" x 5" x 10" flat irons welded to 4" tubing. 4 each ¾" dia. x 6" galvanized hex bolts embedded in concrete. Attach the flat iron plates to the bolts with washer & nuts



DETAIL A

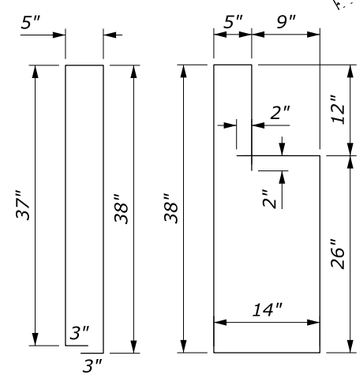


Leave a suitable gap to accommodate the middle leg of the angle iron and wood wing guards. When the wood wing guard is used, the angle iron shall set on top of the wood sill. For the aluminum tubing wing guard, the two interior studs may be eliminated and the angle may be a continuous section.

Wood block and channel required only between grid units and between grid unit and lateral supports.

ISOMETRIC VIEW

GRID UNIT LIST OF MATERIALS
GRID UNIT TYPE A
4 each W 8 x 18 x 77" long 13 each ASCE 40 crane rail (with minimum spacing), or II tubular cross bar sections, (with minimum spacing), type I or type II, 71¼"
GRID UNIT TYPE B
5 each W 8 x 18 x 77" long 13 each ASCE 40 crane rail (with minimum spacing), or II tubular cross bar sections, (with minimum spacing), type I or type II, 95¼"



BAR BENDING DETAIL

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	FLH STANDARD 619-2
CATTLE GUARD	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 1/2024

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13 June 2024 10:15 AM

PROJECT	SHEET NUMBER

CATTLE GUARD

REINFORCING STEEL, CONCRETE, STRUCTURAL STEEL, AND GRID UNIT TABLE OF QUANTITIES

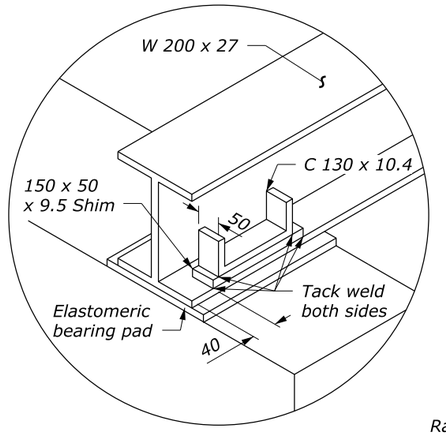
	DESCRIPTION	NOMINAL CATTLE GUARD WIDTH																														REMARKS
		3.6 m		4.2 m		4.8 m		5.4 m		6.0 m		6.6 m		7.2 m		7.8 m		8.4 m		9.0 m		9.6 m		10.2 m		10.8 m		11.4 m		12.0 m		12.6 m		
		QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	
	#13 Reinforcing bars, A1	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	
	#13 Reinforcing bars, A2	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	See Bar Bending Detail
	#13 Reinforcing bars, A3	32	2700	36	2700	40	2700	46	2700	50	2700	54	2700	60	2700	64	2700	70	2700	74	2700	80	2700	84	2700	90	2700	94	2700	98	2700	102	2700	See Bar Bending Detail
	#13 Reinforcing bars, A4	10	3900	10	4500	10	5100	10	5700	10	6300	10	6900	10	7500	10	8100	10	8700	10	9300	100	9900	10	10500	10	11100	10	11300	10	12300	10	12900	
	#13 Reinforcing bars, A5	8	3500	8	4100	8	4700	8	5300	8	5900	8	6500	8	7100	8	7700	8	8300	8	8900	8	9500	8	10100	8	10700	8	11700	8	11900	8	12500	
	Grid unit A (1.8 m)	2		1				3		2		1				3		2		5				3		6		1				7		See Grid Unit List of Materials
	Grid unit B (2.4 m)			1		2				1		2		3		1		2				4		2				4		5				See Grid Unit List of Materials
	Concrete lateral supports, m3	1.19		1.19		1.19		1.19		1.19		1.19		1.19		1.19		1.19		1.19		1.19		1.19		1.19		1.19		1.19		1.15		
	Concrete end supports, m3	3.07		3.59		4.11		4.62		5.12		5.66		6.16		6.67		7.19		7.71		8.21		8.73		9.24		9.76		10.26		10.78		
	Total concrete, m3	4.26		4.78		5.30		5.81		6.31		6.85		7.35		7.86		8.38		8.90		9.40		9.92		10.43		10.95		11.45		11.93		
*Structural steel, kg	W 200 x 27 beams	416		468		540		624		676		728		780		884		936		1040		1040		1144		1248		1248		1300		1456		Beams 27 kg/m
*Structural steel, kg	Rail, ASCE 40	920		1073		1226		1380		1533		1686		1839		1993		2146		2300		2452		2606		2760		2912		3065		3220		19.82 kg/m
*Structural steel, kg	Rail, Type I	360		420		480		540		600		660		720		780		840		900		960		1020		1080		1140		1200		1260		Approx. 7.77 kg/m
*Structural steel, kg	Rail, Type II	472		552		632		708		788		868		945		1024		1104		1180		1264		1340		1416		1500		1580		1652		10.2 kg/m
	Reinforcing steel, kg	101.0		109.5		118.0		126.5		135.0		143.5		152.0		160.5		169.0		177.5		186.0		194.5		203.0		211.5		220.0		493		0.994 kg/m

* Structural steel weights do not include hardware or guard angle.

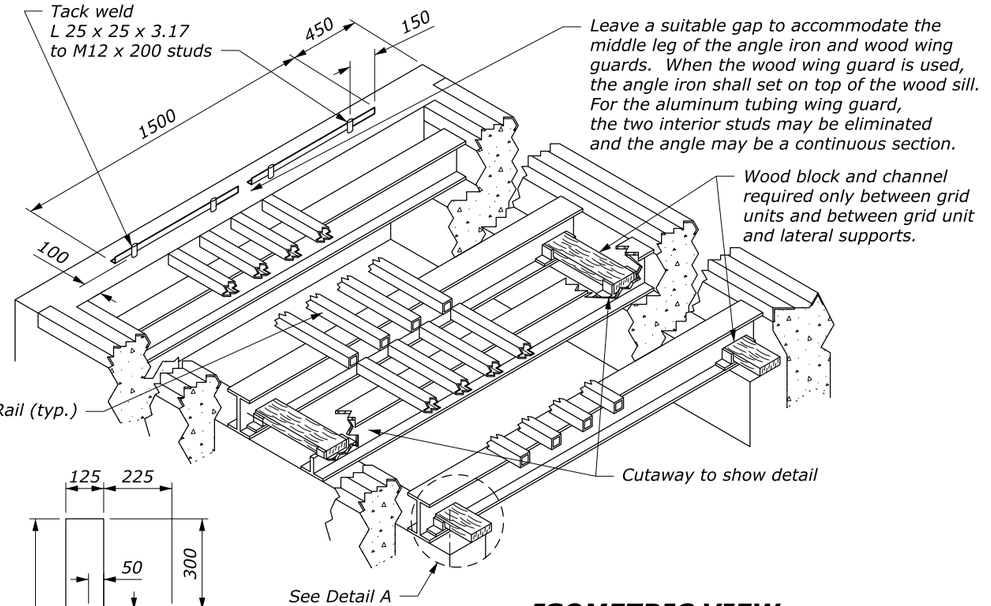
CATTLE GUARD WING

LIST OF MATERIALS PER WING
(TWO REQUIRED PER INSTALLATION)

PART DESCRIPTION	WOOD WING	ANGLE IRON WING	ALUMINUM TUBING WING
Outside diagonal supports	Two 50 x 150 x 2100 mm treated S4S	Two 51 x 51 x 6.4 x 2210 mm galvanized steel angle	One 50 mm OD x 3.17 x 4200 mm aluminum tubing
Middle support	One 50 x 150 x 1800 mm treated S4S	One 51 x 51 x 6.4 x 1850 mm galvanized steel angle	
Horizontal brace No. 1	One 50 x 150 x 1675 mm treated S4S	One 12 x 1980 mm galvanized steel bar	One 50 mm OD x 3.17 x 1830 mm aluminum tubing
No. 2	One 50 x 150 x 1220 mm treated S4S	One 12 x 1675 mm galvanized steel bar	One 50 mm OD x 3.17 x 760 mm aluminum tubing
No. 3	One 50 x 150 x 455 mm treated S4S	One 12 x 1370 mm galvanized steel bar	None
No. 4	None	One 12 x 990 mm galvanized steel bar	None
No. 5	None	One 12 x 610 mm galvanized steel bar	None
No. 6	None	One 12 x 225 mm galvanized steel bar	None
Post	150 x 150 x 2400 mm treated S4S	One 150 x 150 x 2100 mm treated S4S or approved alternate	One 150 x 150 x 2400 mm treated S4S or approved alternate
Top anchor assembly	Toenail diagonal supports to the post with 16d galvanized nails as required	M10 x 150 mm galvanized hex bolt w/nut and flat washer	M20 x 400 mm galvanized steel rod threaded on one end w/nut and washers & 75 mm radius hook in other end
Bottom anchor assembly	50 x 200 x 2400 mm treated S4S sill attached to concrete w/ 3 each M12 x 175 mm hex bolts w/nuts & washers embedded in concrete. Toenail diagonal supports to wooden sill w/16d galvanized nails	3 each M10 x 150 mm galvanized hex bolts embeded in concrete. Attach steel L iron to bolt w/flat washer and nut	2 each 6.4 x 125 x 250 mm flat irons welded to 100 mm tubing. 4 each M10 x 150 mm galvanized hex bolts embedded in concrete. Attach the flat iron plates to the bolts with washer & nuts



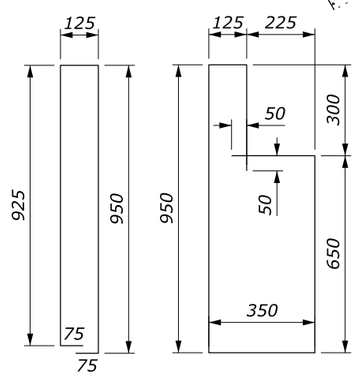
DETAIL A



ISOMETRIC VIEW

GRID UNIT LIST OF MATERIALS

GRID UNIT TYPE A
4 each W 200 x 27 x 1925 mm long 13 each ASCE 40 crane rail (with minimum spacing), or II tubular cross bar sections, (with minimum spacing), type I or type II, 1780 mm
GRID UNIT TYPE B
5 each W 200 x 27 x 1925 mm long 13 each ASCE 40 crane rail (with minimum spacing), or II tubular cross bar sections, (with minimum spacing), type I or type II, 2380 mm



BAR BENDING DETAIL

NO SCALE

*This drawing contains **Metric** units of measure. Dimensions without units are millimeters.*

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	FLH STANDARD M619-2
CATTLE GUARD	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 1/2024

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19 January 2024 8:25 AM

PROJECT	SHEET NUMBER

CATTLE GUARD

REINFORCING STEEL, CONCRETE, STRUCTURAL STEEL, AND GRID UNIT TABLE OF QUANTITIES

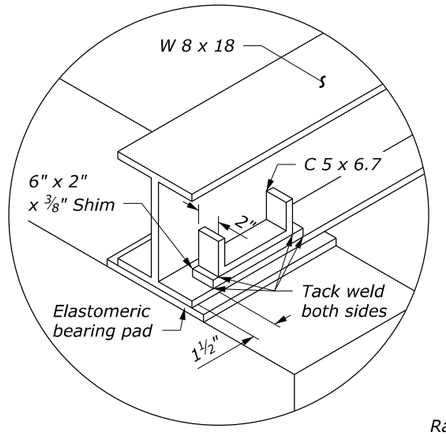
	DESCRIPTION	NOMINAL CATTLE GUARD WIDTH																														REMARKS
		12'		14'		16'		18'		20'		22'		24'		26'		28'		30'		32'		34'		36'		38'		40'		42'		
		QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	QTY	LENGTH	
	#4 Reinforcing bars, A1	8	92"	8	92"	8	92"	8	92"	8	92"	8	92"	8	92"	8	92"	8	92"	8	92"	8	92"	8	92"	8	92"	8	92"	8	92"	
	#4 Reinforcing bars, A2	20	86"	20	86"	20	86"	20	86"	20	86"	20	86"	20	86"	20	86"	20	86"	20	86"	20	86"	20	86"	20	86"	20	86"	20	86"	See Bar Bending Detail
	#4 Reinforcing bars, A3	32	108"	36	108"	40	108"	46	108"	50	108"	54	108"	60	108"	64	108"	70	108"	74	108"	80	108"	84	107"	90	108"	94	108"	98	108"	102	108"	See Bar Bending Detail
	#4 Reinforcing bars, A4	10	156"	10	180"	10	204"	10	228"	10	252"	10	276"	10	300"	10	324"	10	348"	10	372"	100	396"	10	420"	10	444"	10	468"	10	492"	10	516"	
	#4 Reinforcing bars, A5	8	140"	8	164"	8	188"	8	212"	8	236"	8	260"	8	284"	8	308"	8	332"	8	356"	8	380"	8	404"	8	428"	8	452"	8	476"	8	500"	
	Grid unit A (6 ft)	2		1				3		2		1				3		2		5				3		6		1				7		See Grid Unit List of Materials
	Grid unit B (8 ft)			1		2				1		2		3		1		2				4		2				4		5				See Grid Unit List of Materials
	Concrete lateral supports, yd3	1.56		1.56		1.56		1.56		1.56		1.56		1.56		1.56		1.56		1.56		1.56		1.56		1.56		1.56		1.56		
	Concrete end supports, yd3	4.03		4.70		5.37		6.04		6.71		7.38		8.05		8.73		9.40		10.07		10.74		11.41		12.08		12.75		13.42		14.10		
	Total concrete, yd3	5.59		6.26		6.93		7.60		8.27		8.94		9.61		10.29		10.96		11.63		12.30		12.97		13.64		14.31		14.98		15.66		
*Structural steel, lb	W 8 x 18 beams	936		1053		1170		1404		1521		1638		1755		1989		2106		2340		2340		2574		2808		2808		2925		3276		Beams 18 lb/ft
*Structural steel, lb	Rail, ASCE 40	2052		2398		2744		3078		3424		3770		4116		4450		4796		5130		5488		5822		6156		6514		6860		7182		13.30 lb/ft
*Structural steel, lb	Rail, Type I	806		942		1078		1209		1345		1481		1617		1748		1884		2015		2156		2287		2418		2559		2695		2821		Approx. 5.22 lb/ft
*Structural steel, lb	Rail, Type II	1060		1238		1416		1590		1768		1946		2124		2298		2476		2650		2832		3006		3180		3362		3540		3710		6.86 lb/ft
*Structural steel, lb	Reinforcing steel, lb	478		526		574		634		683		731		791		839		899		947		1007		1055		1115		1164		1212		1260		0.668 lb/ft

* Structural steel weights do not include hardware or guard angle.

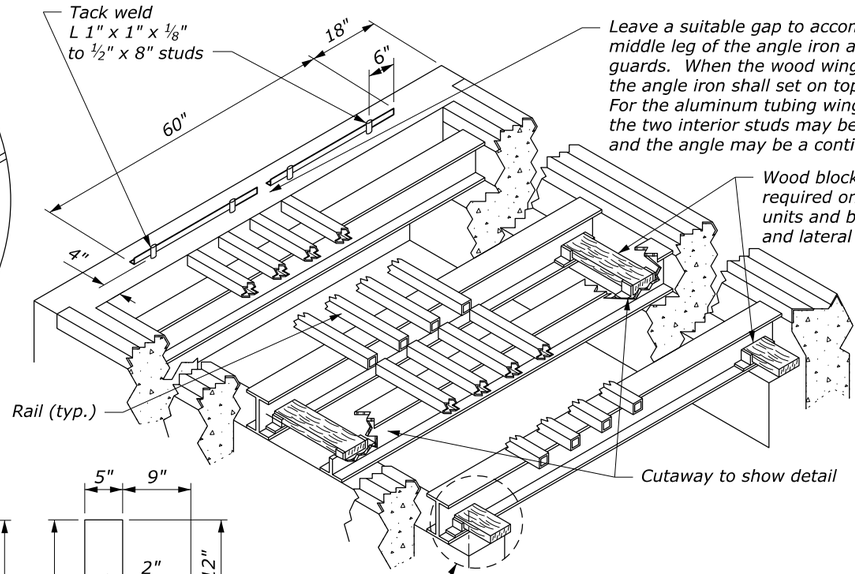
CATTLE GUARD WING

LIST OF MATERIALS PER WING
(TWO REQUIRED PER INSTALLATION)

PART DESCRIPTION	WOOD WING	ANGLE IRON WING	ALUMINUM TUBING WING
Outside diagonal supports	Two 2" x 6" x 84" treated S4S	Two 2" x 2" x ¼" x 87" galvanized steel angle	One 2" OD x ⅛" x 165" aluminum tubing
Middle support	One 2" x 6" x 72" treated S4S	One 2" x 2" x ¼" x 73" galvanized steel angle	
Horizontal brace No. 1	One 2" x 6" x 66" treated S4S	One ½" x 78" galvanized steel bar	One 2" OD x ⅛" x 72" aluminum tubing
No. 2	One 2" x 6" x 48" treated S4S	One ½" x 66" galvanized steel bar	One 2" OD x ⅛" x 30" aluminum tubing
No. 3	One 2" x 6" x 18" treated S4S	One ½" x 54" galvanized steel bar	None
No. 4	None	One ½" x 39" galvanized steel bar	None
No. 5	None	One ½" x 24" galvanized steel bar	None
No. 6	None	One ½" x 9" galvanized steel bar	None
Post	6" x 6" x 96" treated S4S	One 6" x 6" x 84" treated S4S or approved alternate	One 6" x 6" x 96" treated S4S or approved alternate
Top anchor assembly	Toenail diagonal supports to the post with 16d galvanized nails as required	⅜" dia. x 6" galvanized hex bolt w/nut and flat washer	¾" dia. x 16" galvanized steel rod threaded on one end w/nut and washers & 3" radius hook in other end
Bottom anchor assembly	2" x 8" x 96" treated S4S sill attached to concrete w/ 3 each ½" dia. x 7" hex bolts w/nuts & washers embedded in concrete. Toenail diagonal supports to wooden sill w/16d galvanized nails	3 each ⅜" dia. x 6" galvanized hex bolts embeded in concrete. Attach steel L iron to bolt w/flat washer and nut	2 each ¼" x 5" x 10" flat irons welded to 4" tubing. 4 each ¾" dia. x 6" galvanized hex bolts embedded in concrete. Attach the flat iron plates to the bolts with washer & nuts



DETAIL A

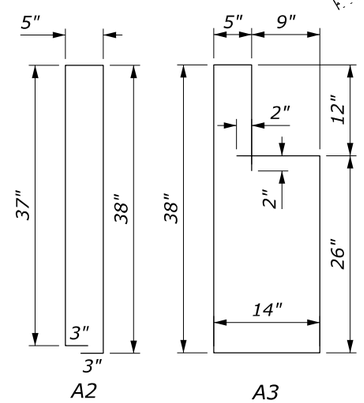


Leave a suitable gap to accommodate the middle leg of the angle iron and wood wing guards. When the wood wing guard is used, the angle iron shall set on top of the wood sill. For the aluminum tubing wing guard, the two interior studs may be eliminated and the angle may be a continuous section.

Wood block and channel required only between grid units and between grid unit and lateral supports.

ISOMETRIC VIEW

GRID UNIT LIST OF MATERIALS
GRID UNIT TYPE A
4 each W 8 x 18 x 77" long 13 each ASCE 40 crane rail (with minimum spacing), or II tubular cross bar sections, (with minimum spacing), type I or type II, 71¼"
GRID UNIT TYPE B
5 each W 8 x 18 x 77" long 13 each ASCE 40 crane rail (with minimum spacing), or II tubular cross bar sections, (with minimum spacing), type I or type II, 95¼"



BAR BENDING DETAIL

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
OFFICE OF FEDERAL LANDS HIGHWAY

FLH STANDARD

CATTLE GUARD

STANDARD APPROVED FOR USE 6/2005	STANDARD
REVISED: DRAFT: 5/2008	619-2

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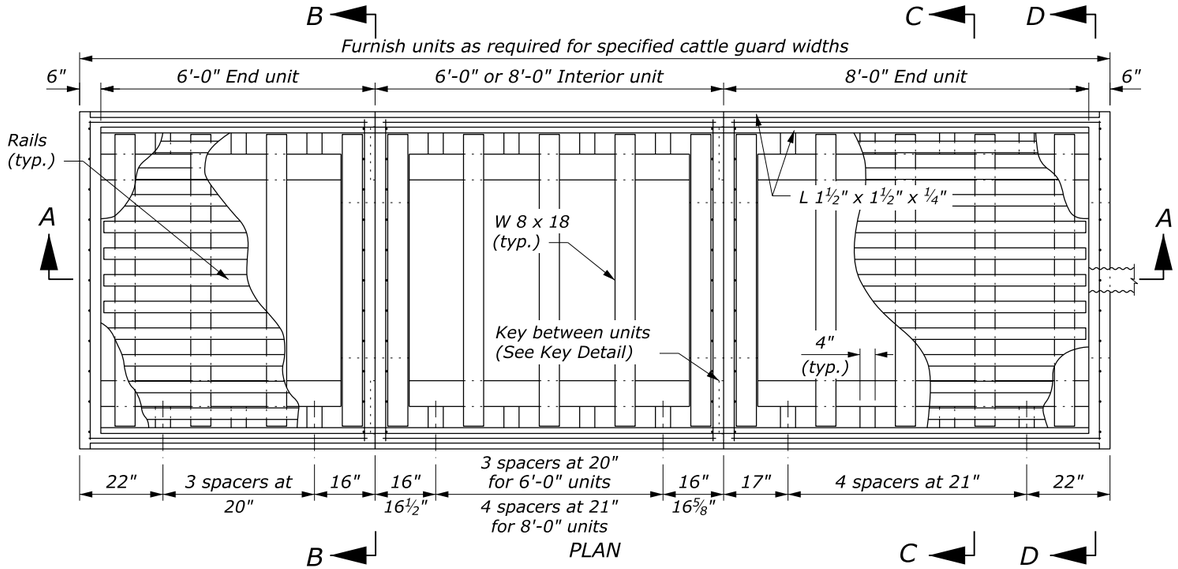
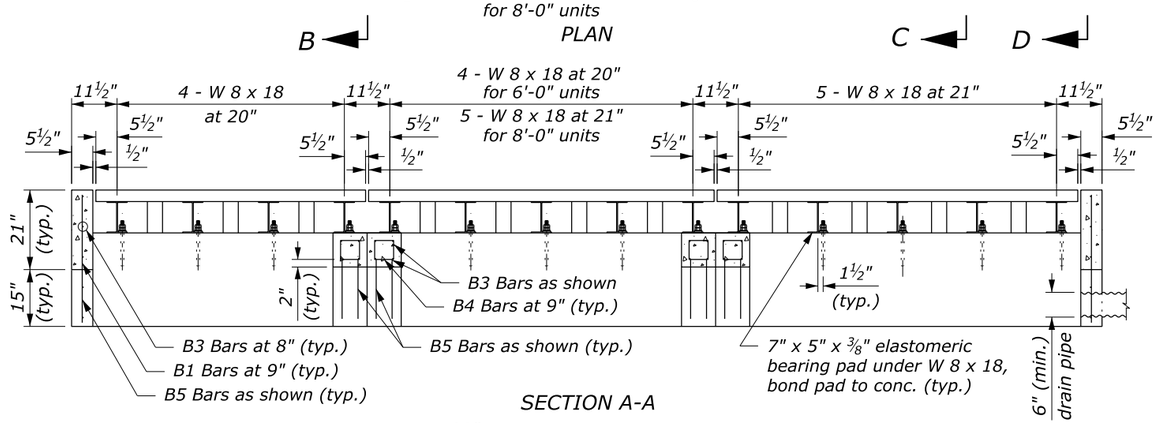
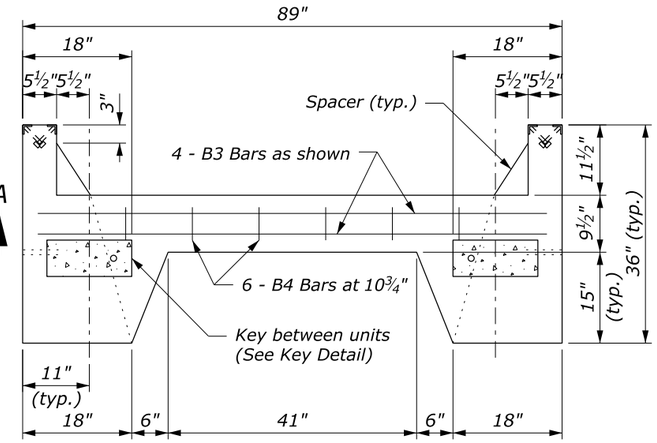
22 February 2023 12:58 PM

PROJECT	SHEET NUMBER

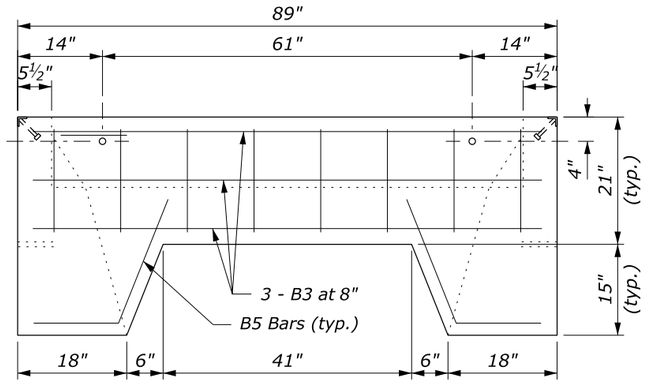




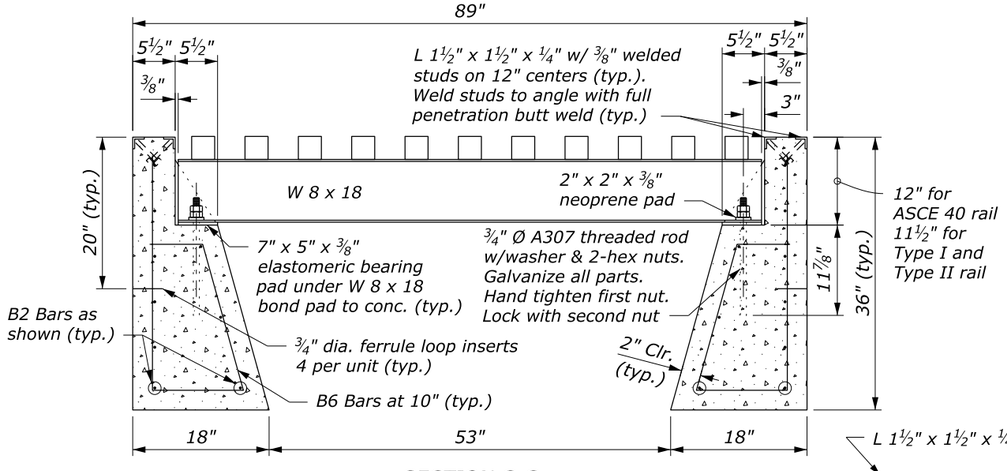
SECTION A-A



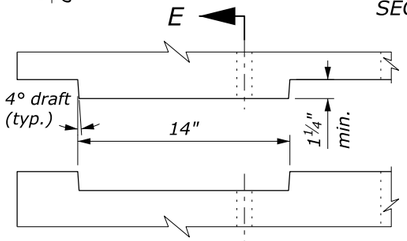
SECTION B-B

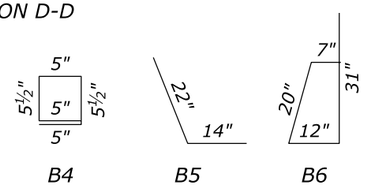


SECTION D-D

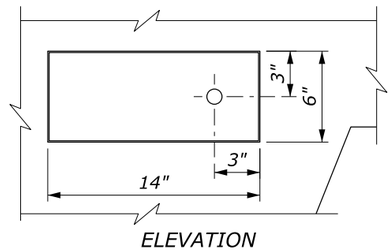


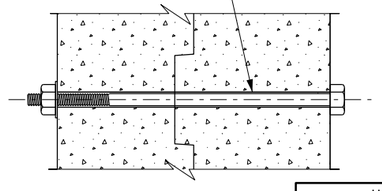
SECTION C-C





BAR BENDING DETAIL





KEY DETAIL

GUARD ANGLE DETAIL

NOTE:

1. See Standard 619-1 for reinforcing steel size and grade.
2. See Standard 619-1 and 2 for cattle guard wing details. Fabricate end units to accommodate selected cattle guard wing.
3. Minimum soil bearing 4,000 lb/ft². Place units in fine aggregate bed 3-inch thick over hand leveled soil compacted to not less than 95% density.
4. Chamfer exposed concrete edges ¾" unless otherwise shown. Give all concrete surfaces a Class 1 finish.
5. Approved alternate designs may be used.

PRECAST CATTLE GUARD

REINFORCING STEEL AND CONCRETE

UNIT	No. of BARS	BAR MARK	LENGTH	MASS LB	CONCRETE CUYD
6'-0" END	7	B3	85"	33.1	1.89
	10	B2	74"	41.2	
	8	B1	17"	7.6	
	6	B4	26"	8.7	
	18	B6	70"	70.1	
	6	B5	36"	12.0	
6'-0" INTERIOR	8	B3	85"	37.9	1.90
	10	B2	68"	37.9	
	12	B4	26"	17.4	
	18	B6	70"	70.1	
	8	B5	36"	16.0	
8'-0" INTERIOR	8	B3	85"	37.9	2.34
	10	B2	92"	51.2	
	12	B4	26"	17.4	
	20	B6	70"	77.9	
	8	B5	36"	16.0	
8'-0" END	7	B3	85"	33.1	2.32
	10	B2	98"	54.6	
	8	B1	17"	7.6	
	6	B4	26"	8.7	
	20	B6	70"	77.9	
	6	B5	36"	12.0	

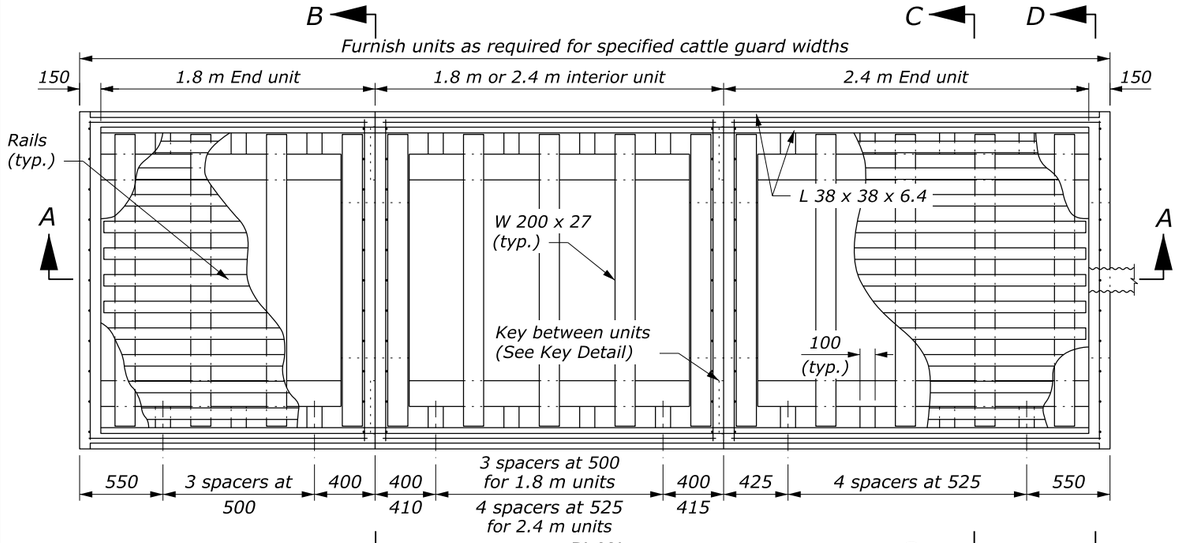
NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

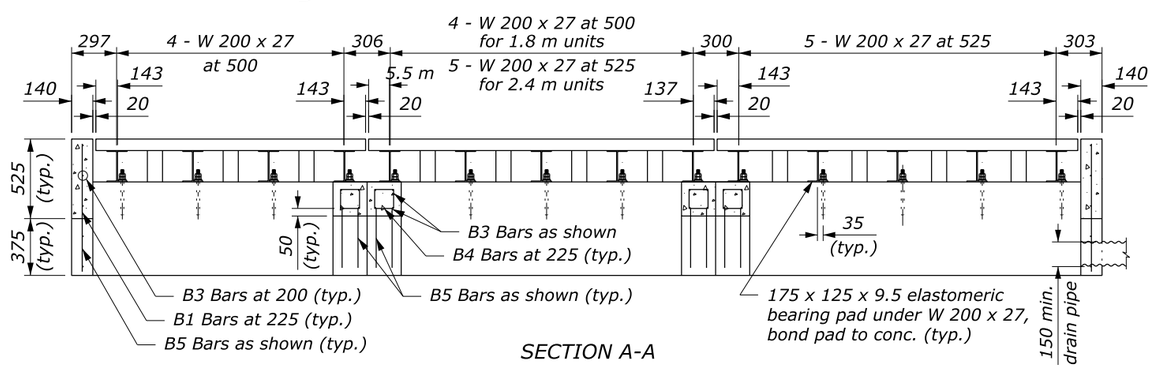
CATTLE GUARD PRECAST FOUNDATION

FLH STANDARD 619-3
SPECIFICATION FP-24, FP-14
APPROVED FOR USE 1/2024

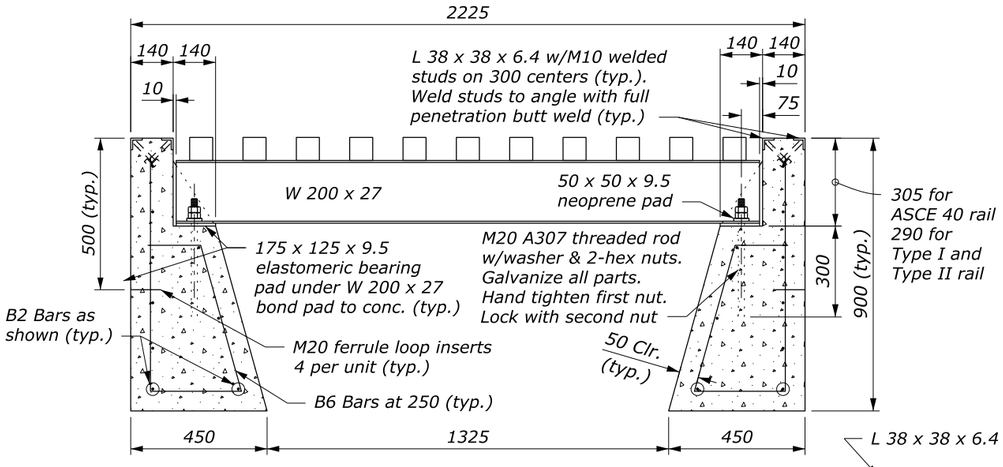
PROJECT	SHEET NUMBER



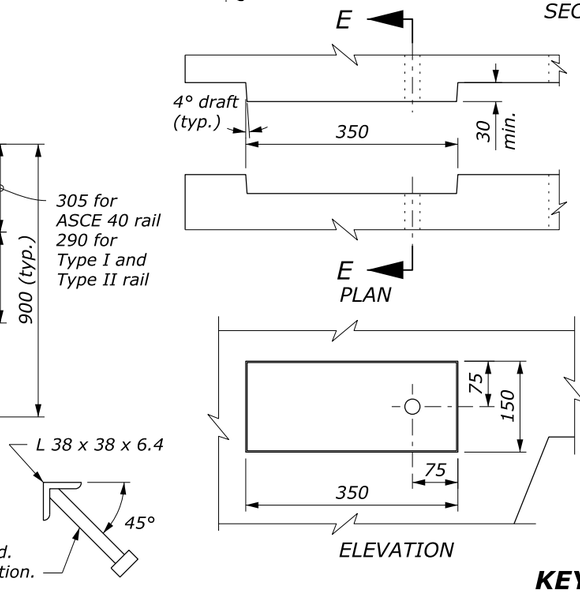
PLAN



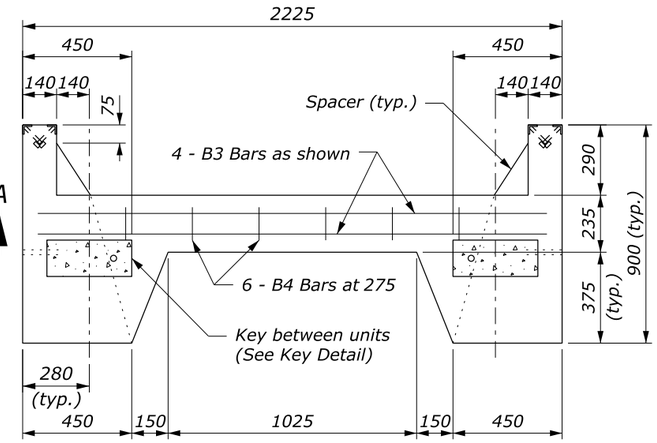
SECTION A-A



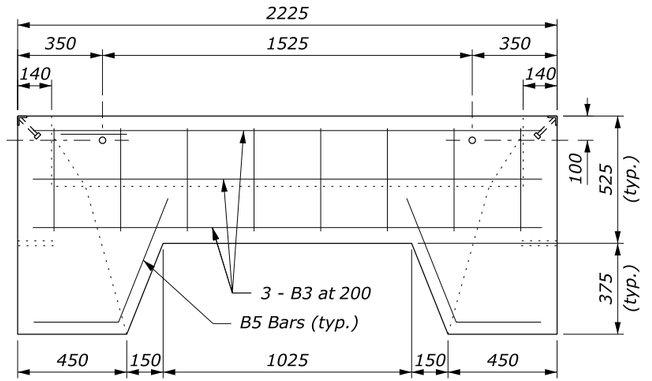
SECTION C-C



GUARD ANGLE DETAIL

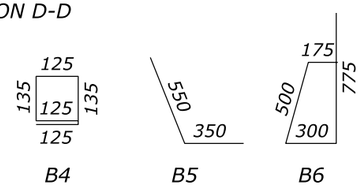


SECTION B-B



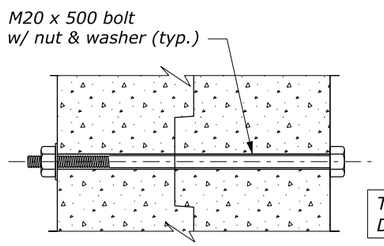
SECTION D-D

PLAN



BAR BENDING DETAIL

ELEVATION



SECTION E-E

KEY DETAIL

NOTE:

1. See Standard M619-1 for reinforcing steel size and grade.
2. See Standard M619-1 and 2 for cattle guard wing details. Fabricate end units to accommodate selected cattle guard wing.
3. Minimum soil bearing 19,500 kg/m². Place units in fine aggregate bed 75 mm thick over hand leveled soil compacted to not less than 95% density.
4. Chamfer exposed concrete edges 20 mm unless otherwise shown. Give all concrete surfaces a Class 1 finish.
5. Approved alternate designs may be used.

PRECAST CATTLE GUARD

REINFORCING STEEL AND CONCRETE

UNIT	No. of BARS	BAR MARK	LENGTH	MASS kg	CONCRETE m³
1.8 m END	7	B3	2100	14.6	1.40
	10	B2	1850	18.4	
	8	B1	425	3.4	
	6	B4	650	3.9	
	18	B6	1750	31.3	
	6	B5	900	5.4	
1.8 m INTERIOR	8	B3	2100	16.7	1.41
	10	B2	1650	16.4	
	12	B4	650	7.8	
	18	B6	1750	31.3	
	8	B5	900	7.2	
2.4 m INTERIOR	8	B3	2100	16.7	1.73
	10	B2	2250	22.4	
	12	B4	650	7.8	
	20	B6	1750	34.8	
	8	B5	900	7.2	
2.4 m END	7	B3	2100	14.6	1.72
	10	B2	2450	24.4	
	8	B1	425	3.4	
	6	B4	650	3.9	
	20	B6	1750	34.8	
	6	B5	900	5.4	

*This drawing contains **Metric** units of measure. Dimensions without units are millimeters.*

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

CATTLE GUARD PRECAST FOUNDATION

FLH STANDARD M619-3

SPECIFICATION FP-24, FP-14

APPROVED FOR USE 1/2024

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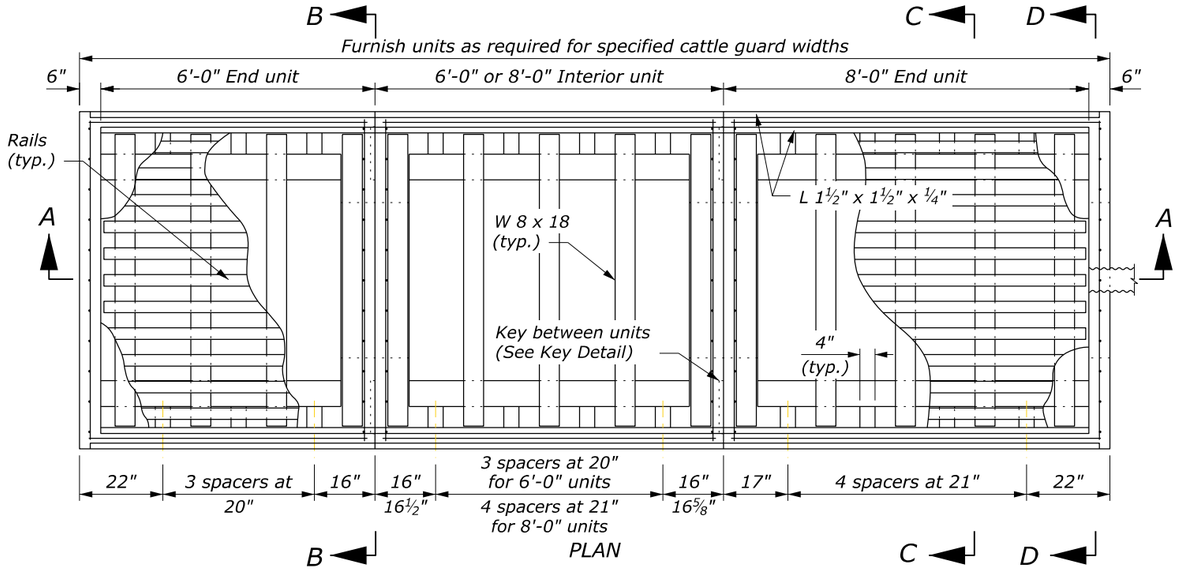
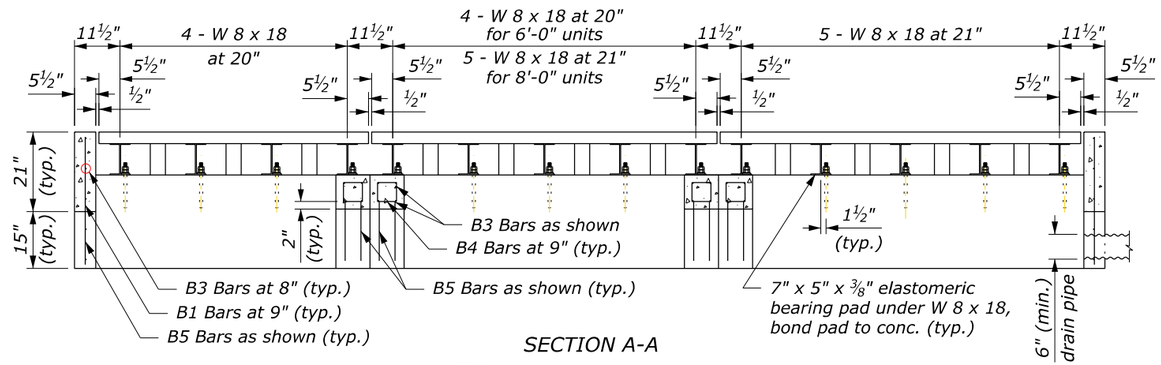
19 January 2024 8:29 AM

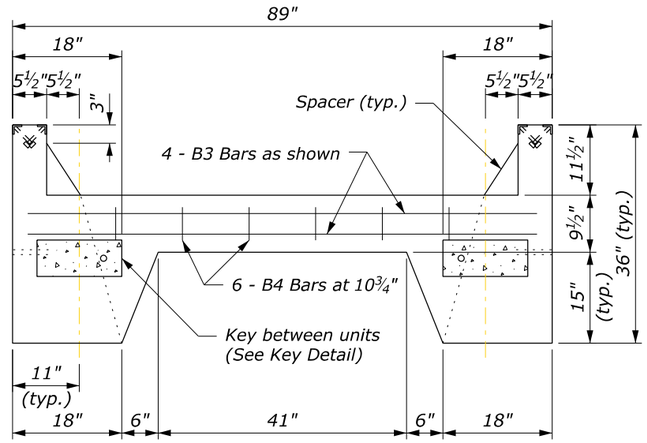
PROJECT	SHEET NUMBER



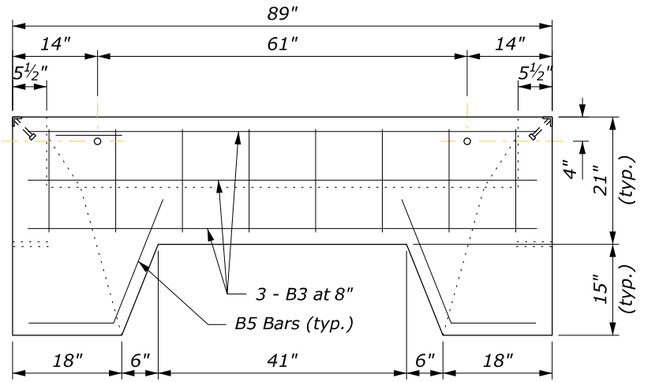
PLAN



SECTION A-A



SECTION B-B



SECTION D-D

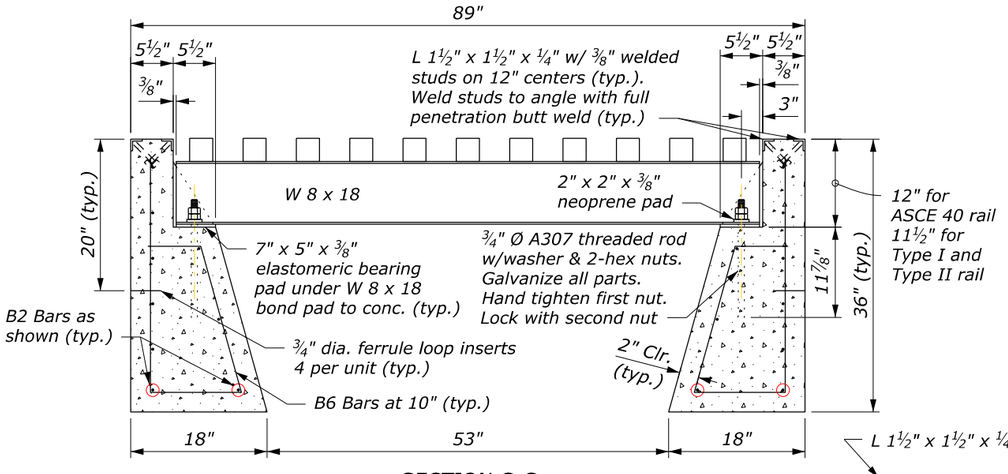
NOTE:

1. See Standard 619-1 for reinforcing steel size and grade.
2. See Standard 619-1 and 2 for cattle guard wing details. Fabricate end units to accommodate selected cattle guard wing.
3. Minimum soil bearing 4,000 lb/ft². Place units in fine aggregate bed 3 inch thick over hand leveled soil compacted to not less than 95% density.
4. Chamfer exposed concrete edges ¾" unless otherwise shown. Give all concrete surfaces a Class 1 finish.
5. Approved alternate designs may be used.

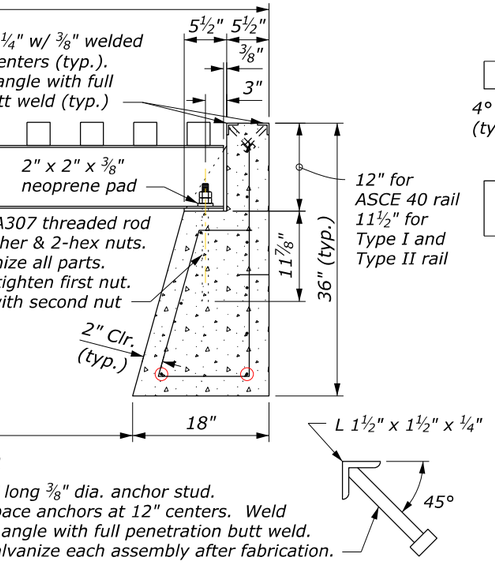
PRECAST CATTLE GUARD

REINFORCING STEEL AND CONCRETE

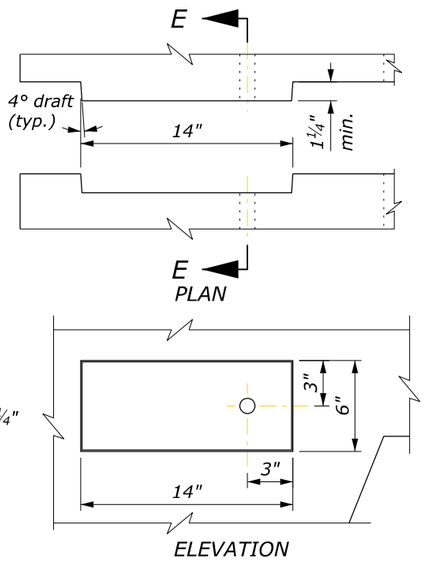
UNIT	No. of BARS	BAR MARK	LENGTH	MASS LB	CONCRETE CUYD
6'-0" END	7	B3	85"	33.1	1.89
	10	B2	74"	41.2	
	8	B1	17"	7.6	
	6	B4	26"	8.7	
	18	B6	70"	70.1	
	6	B5	36"	12.0	
6'-0" INTERIOR	8	B3	85"	37.9	1.90
	10	B2	68"	37.9	
	12	B4	26"	17.4	
	18	B6	70"	70.1	
	8	B5	36"	16.0	
8'-0" INTERIOR	8	B3	85"	37.9	2.34
	10	B2	92"	51.2	
	12	B4	26"	17.4	
	20	B6	70"	77.9	
	8	B5	36"	16.0	
8'-0" END	7	B3	85"	33.1	2.32
	10	B2	98"	54.6	
	8	B1	17"	7.6	
	6	B4	26"	8.7	
	20	B6	70"	77.9	
	6	B5	36"	12.0	



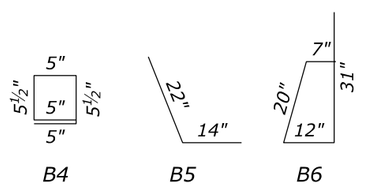
SECTION C-C



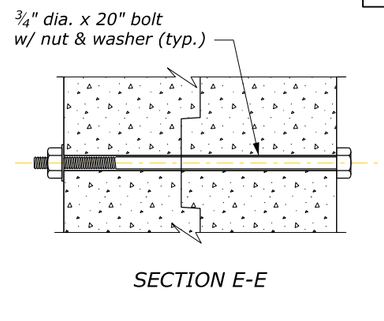
GUARD ANGLE DETAIL



KEY DETAIL



BAR BENDING DETAIL



SECTION E-E

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
OFFICE OF FEDERAL LANDS HIGHWAY

FLH STANDARD

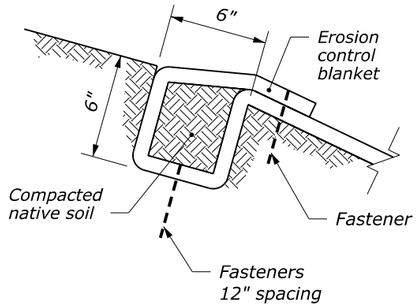
CATTLE GUARD PRECAST FOUNDATION

STANDARD APPROVED FOR USE 6/2005	STANDARD
REVISED: DRAFT: 10/2016	619-3

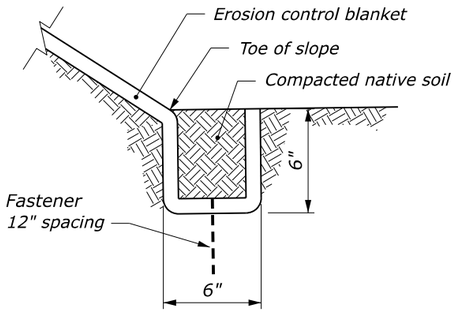
PROJECT	SHEET NUMBER

NOTE:

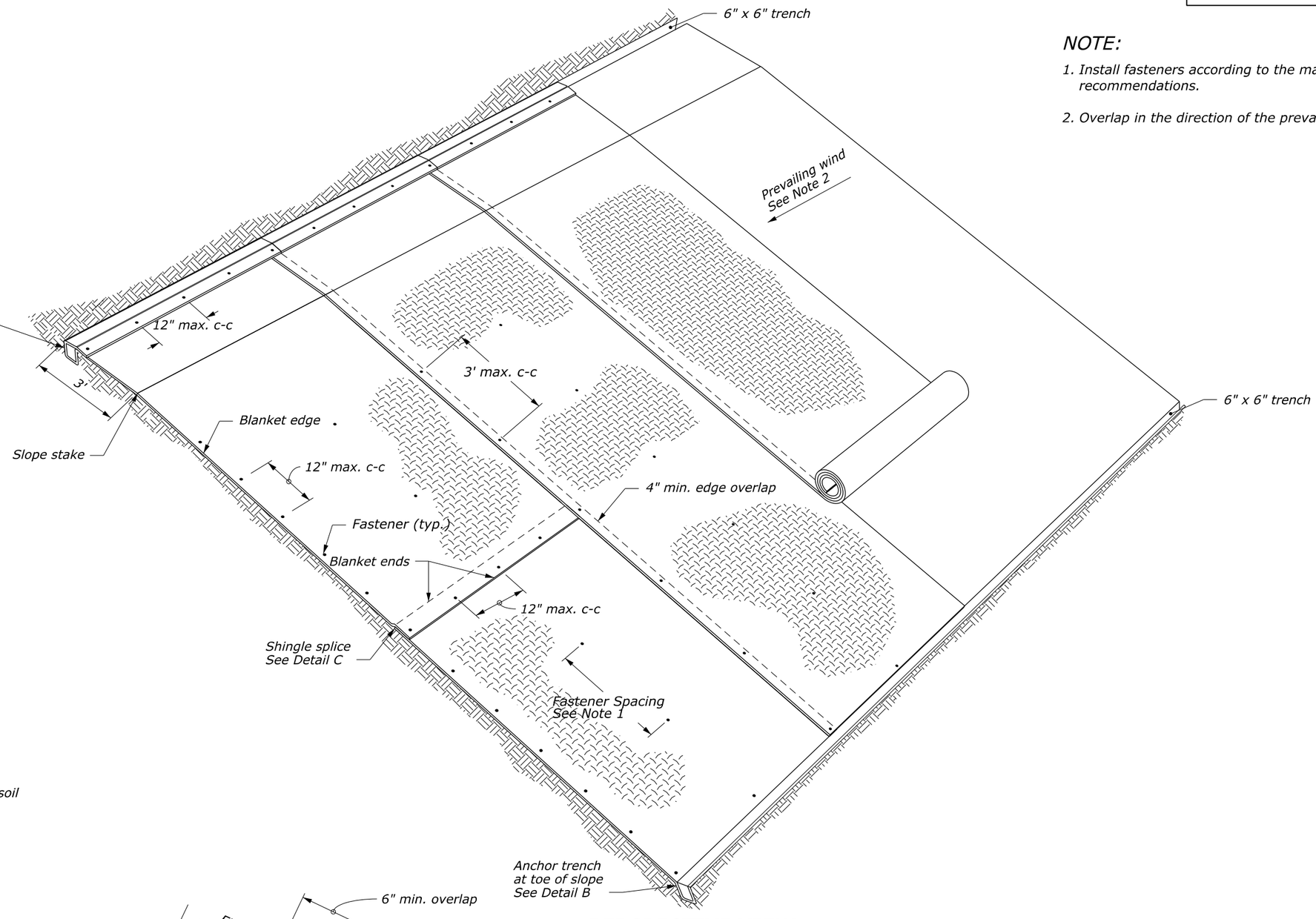
1. Install fasteners according to the manufacturer's recommendations.
2. Overlap in the direction of the prevailing wind.



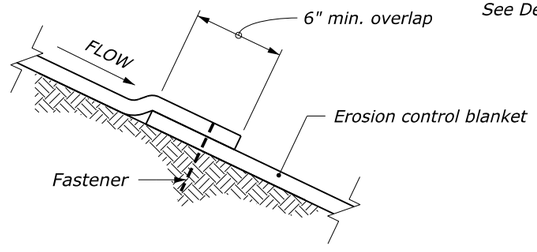
DETAIL A
ANCHOR TRENCH
AT TOP OF SLOPE



DETAIL B
ANCHOR TRENCH
AT TOE OF SLOPE



PERSPECTIVE VIEW



DETAIL C
SHINGLE SPLICE

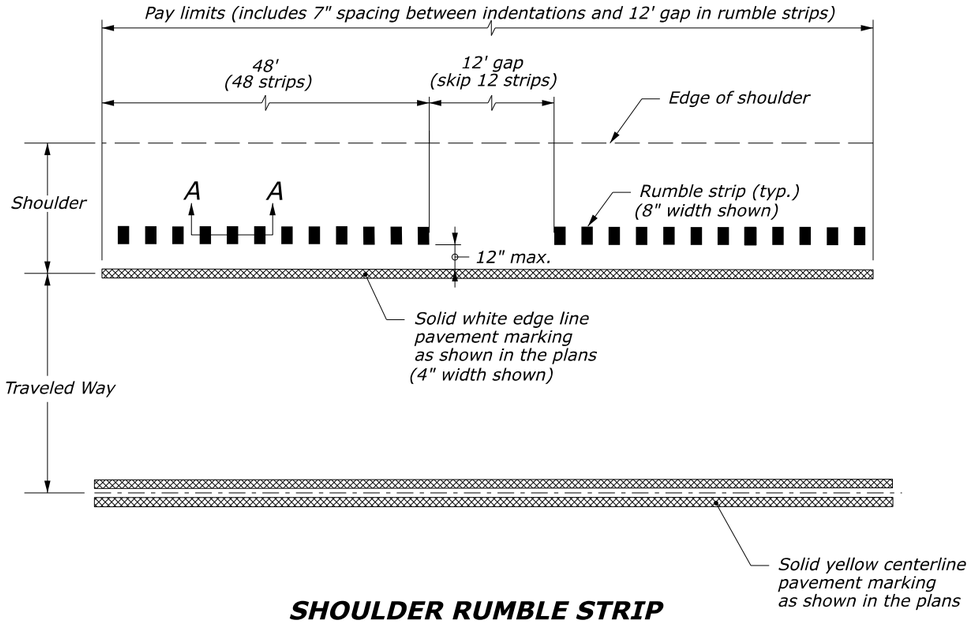
NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	CFL STANDARD C629-50
ROLLED EROSION CONTROL PRODUCT ON SLOPES	SPECIFICATION FP-24
	APPROVED FOR USE 06/2024

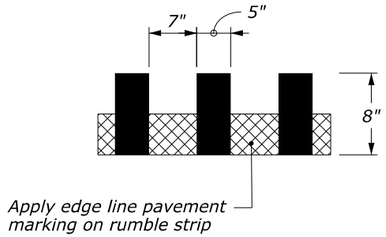
K:\CADD_Coordinator\ORD Drawings\Details\C629-50.dgn [Det C629-50]

1 April 2026 6:50 AM

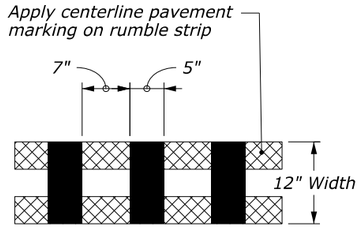
PROJECT	SHEET NUMBER



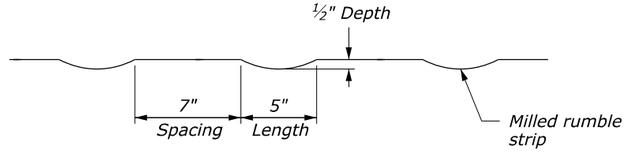
SHOULDER RUMBLE STRIP



DETAIL A



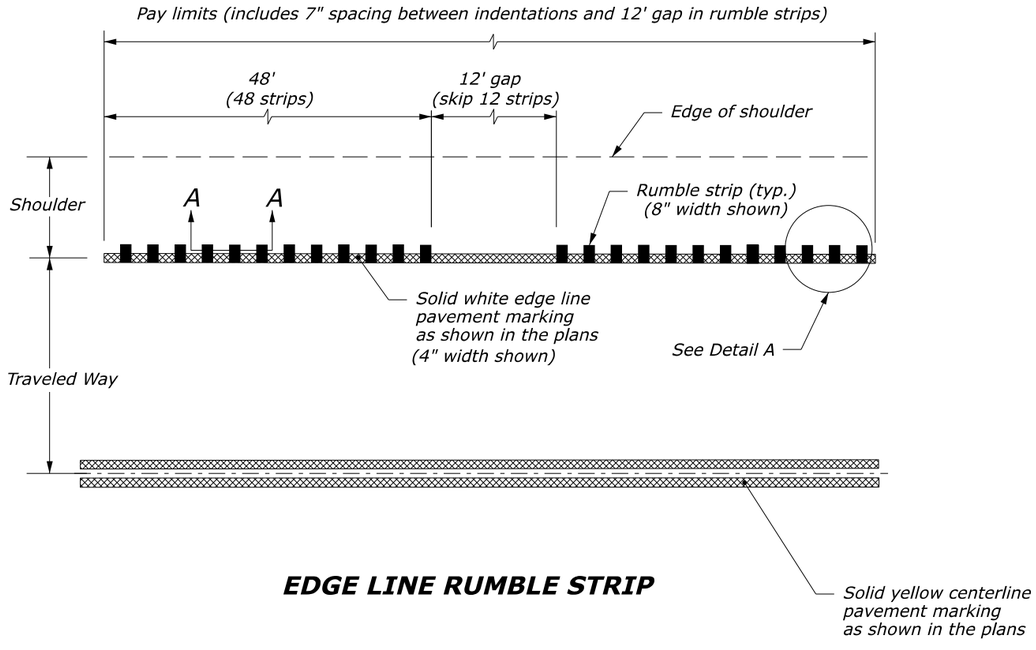
DETAIL B



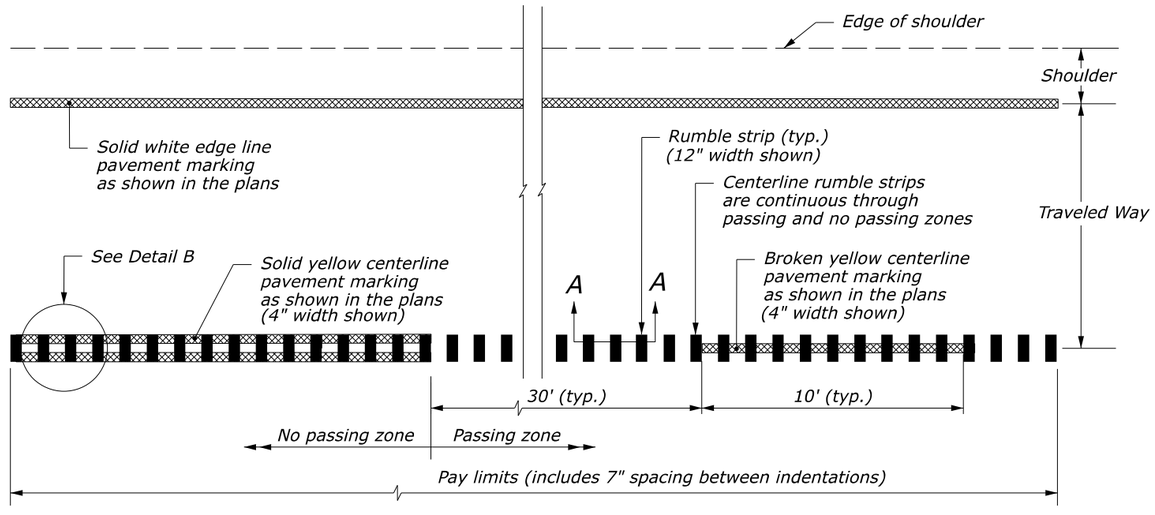
SECTION A-A

NOTE:

1. *See plans for location of shoulder rumble strip gaps at turn lanes, auxiliary lanes, and approach roads.*
2. *Do not construct rumble strips on structures or approach slabs.*



EDGE LINE RUMBLE STRIP

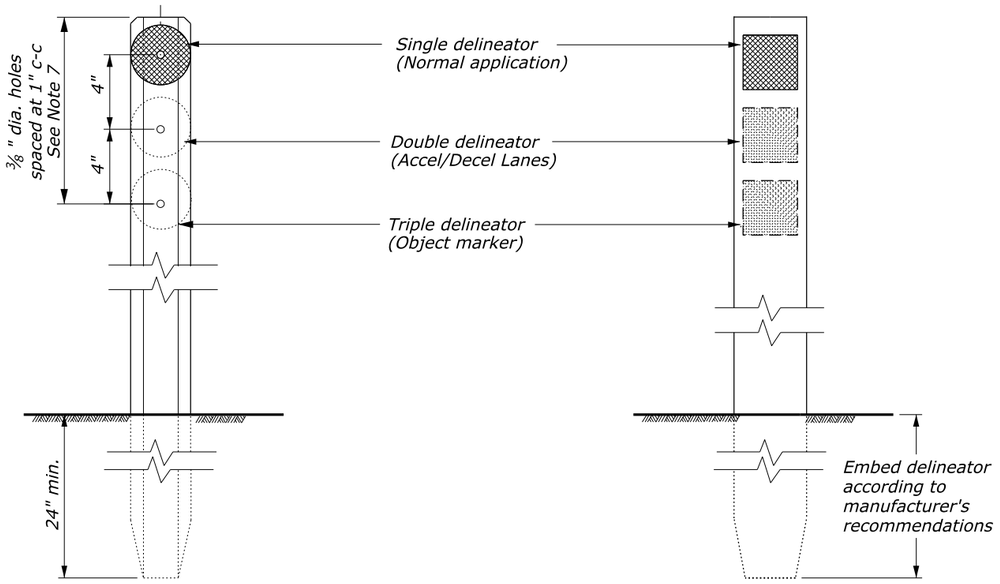


CENTERLINE RUMBLE STRIP

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	CFL STANDARD C633-50
RUMBLE STRIPS	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 06/2024

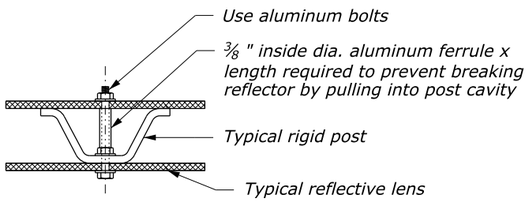
STATE	PROJECT	SHEET NUMBER



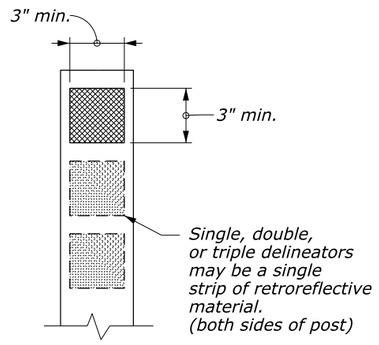
DELINEATOR (RIGID)
(TYPE 1 - acrylic plastic lens)

DELINEATOR (FLEXIBLE)
(TYPE 2 - retroreflective sheeting)

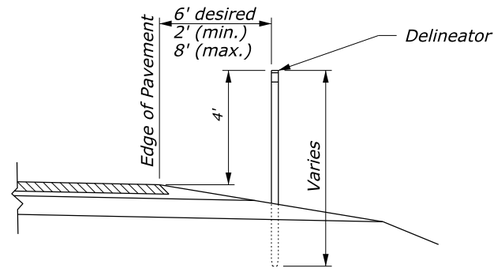
POST DETAILS



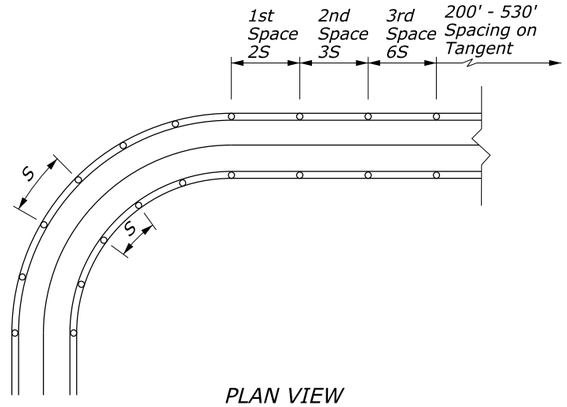
ATTACHMENT DETAIL
(for rigid metal posts)



RETROREFLECTIVE SHEETING DETAIL



LOCATION OF DELINEATOR



PLAN VIEW

DELINEATOR SPACING

DELINEATOR SPACING ON CURVES

RADIUS OF CURVE (R)	SPACING ON CURVE (S)	SPACING ON TANGENTS AT CURVE ENDS		
		1st Space (2 S)	2nd Space (3 S)	3rd Space (6 S)
(feet)	(feet)	(feet)	(feet)	(feet)
50	20	40	60	120
115	25	50	75	150
180	35	70	105	210
250	40	80	120	240
300	50	100	150	300
400	55	110	165	300
500	65	130	195	300
600	70	140	210	300
700	75	150	225	300
800	80	160	240	300
900	85	170	255	300
1,000	90	180	270	300

DELINEATOR SPACING NOTES

1. *Spacing for specific radii may be interpolated from the table.*
2. *Values shown for S in the table are computed from the formula $S = 3\sqrt{R-50}$, where S = delineator spacing and R = horizontal curve radius. Values are rounded to the nearest 5 feet.*

NOTE:

1. *Match the color of the reflective element with the edge line.*
2. *Use yellow reflective elements for triple delineators installed to mark obstructions.*
3. *Install double delineators on 100-foot spacing for acceleration and deceleration lanes or to mark changes in width.*
4. *Install reflective elements according to the manufacturer's recommendations.*
5. *Alternate delineator types may be used with approval of the CO. Provide delineators conforming to the MUTCD and install according to the manufacturer's recommendations.*
6. *Place delineators at a constant distance from the edge of the pavement. Where guardrail intrudes into the space between the edge of pavement and the delineator offset, locate the delineator immediately behind the guardrail.*
7. *A minimum of 12 holes spaced on 1" centers are required for all rigid posts. See Subsection 718.04.*
8. *Furnish anti-theft hardware for mounting retroreflectors as required.*
9. *See Subsection 718.05 for rigid post requirements.*

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

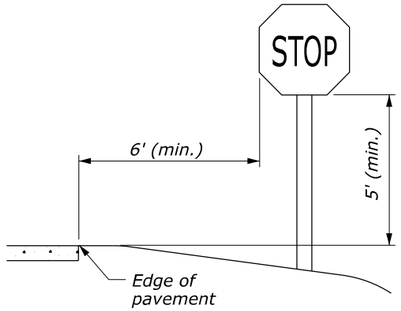
U.S. CUSTOMARY DETAIL

DELINEATORS

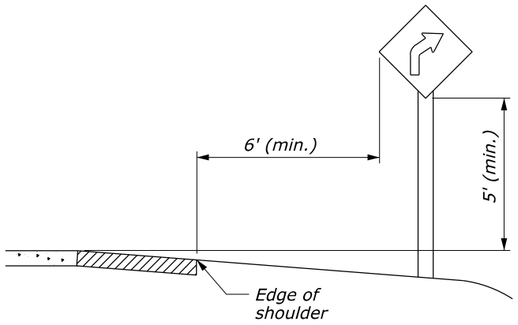
DETAIL APPROVED FOR USE 03/2011
REVISED: 08/2014

DETAIL
C633-51

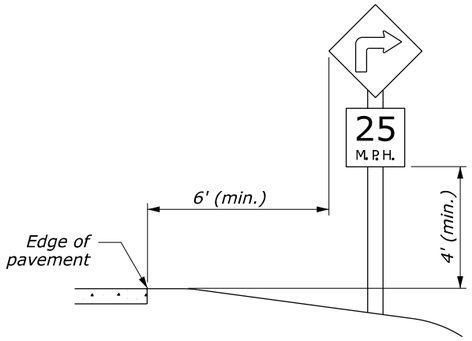
PROJECT	SHEET NUMBER



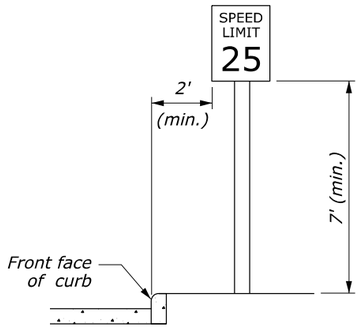
WITHOUT SHOULDER



WITH SHOULDER

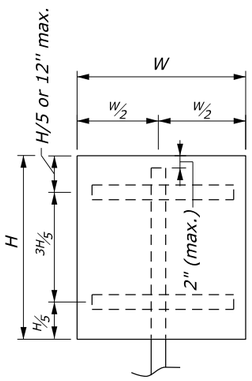


WITH ADVISORY SPEED PLAQUE

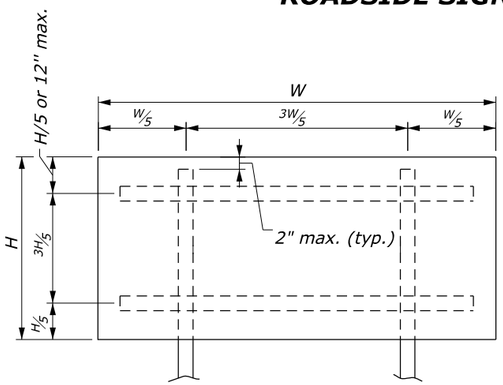


ROADSIDE SIGN IN BUSINESS OR RESIDENTIAL DISTRICT

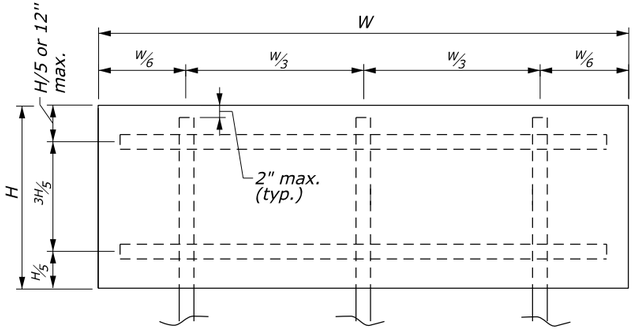
ROADSIDE SIGN IN RURAL DISTRICT



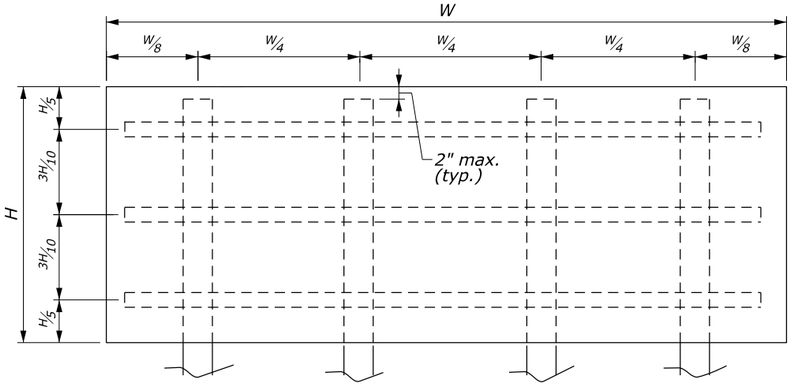
SINGLE POST



DOUBLE POST



TRIPLE POST



QUADRUPLE POST

NOTES:

1. Locate and set sign height according to the "Manual on Uniform Traffic Control Devices" (MUTCD), latest edition.
2. For U-channel, square tubular, and corrosion resistant steel posts for which the sign panel area is 10 square feet or less but W is over 4 feet, use double posts.
3. For square tabular steel double posts for which the sign panel area is equal to 24 square feet, use slip base according to manufacturer's recommendations.
4. Refer to Detail E633-02 for breakaway support details for corrosion resistant steel posts.
5. Refer to Detail E633-03 for breakaway support details for wood, U-channel steel and square tubular steel posts.
6. Refer to Detail E633-04 for bracing details for wood, U-channel steel and square tubular steel posts.
7. Refer to Section 2A.18 of the MUTCD, latest edition, for additional information.

POST SIZE TABLE

POST TYPE	POST SIZE	MAXIMUM SIGN AREA (SQFT)			
		SINGLE POST	DOUBLE POST	TRIPLE POST	QUADRUPLE POST
Wood	4" x 4"	10	20		
	4" x 6"	15	35	45	60
	6" x 6"	20	50	75	100
U-Channel Steel		10*	24	30	
Square Tubular Steel	2" 12 ga.	10*	16		
	2" 12 ga.	10*	24**		
Corrosion Resistant Steel	2" x 2" 10 ga. Class B	10*	24		

* See Note 2
** See Note 3

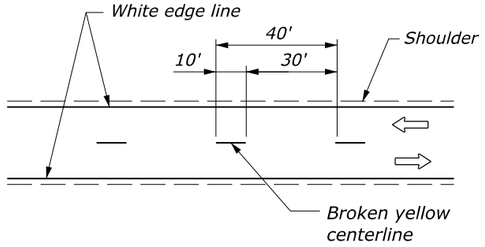
NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

SIGN STRUCTURES

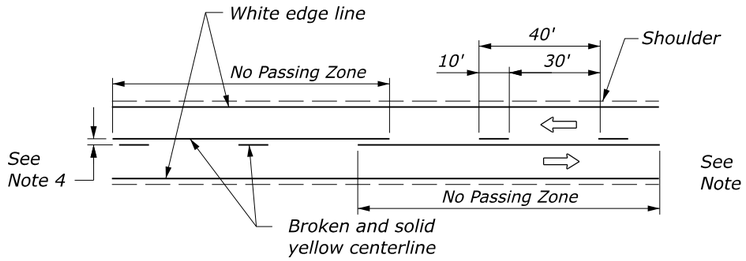
EFLHD DETAIL	SPECIFICATION	APPROVED FOR USE
E633-01	FP-24, FP-14	06/2024

PROJECT	SHEET NUMBER



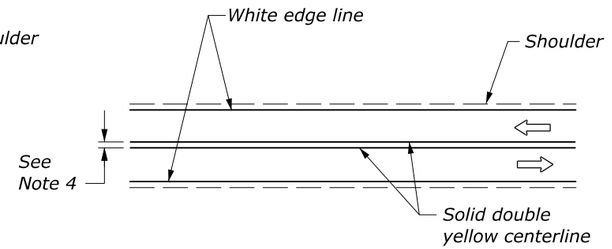
DETAIL A

Passing zone both directions
Two-way traffic



DETAIL B

No passing zone single lane direction
Two-way traffic

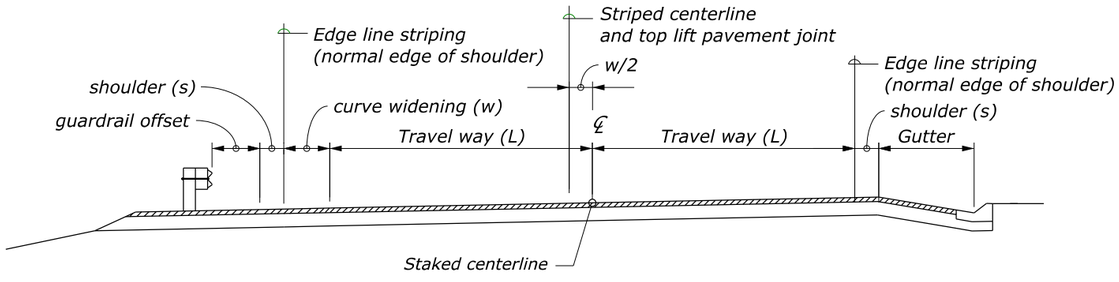


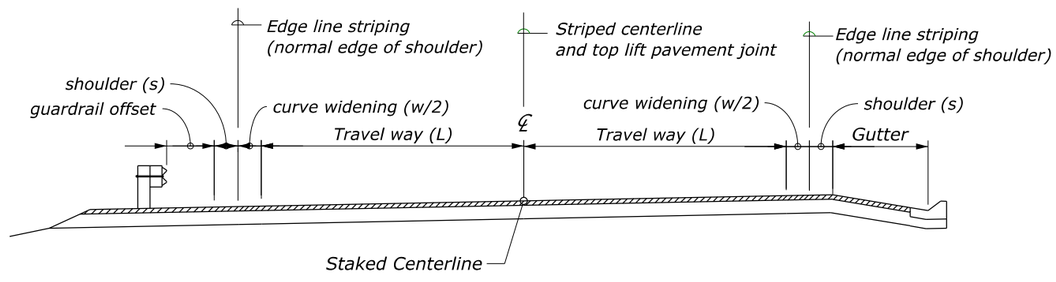
DETAIL C

No passing zone both directions
Two-way traffic

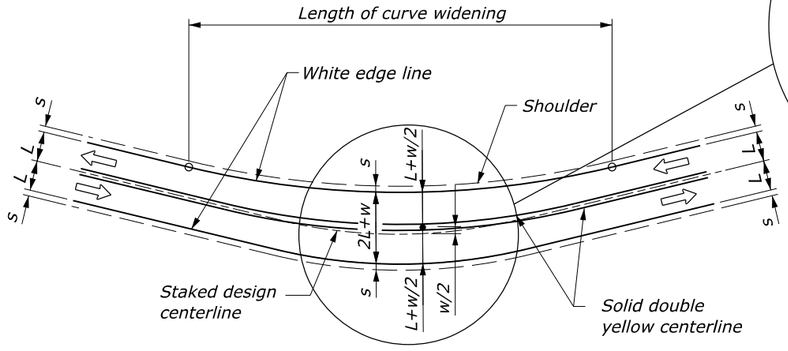
NOTE:

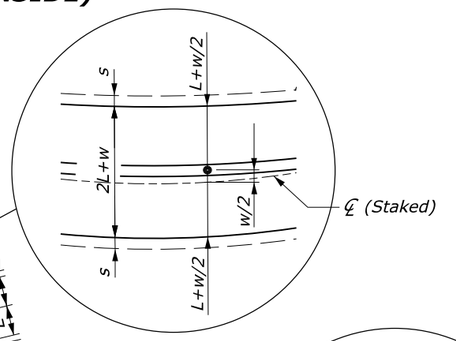
1. *See Summary for tables showing station ranges and quantities for pavement markings.*
2. *Paint centerline striping on curves with curve widening to achieve equal lane widths within the traveled way. Shoulder widths remain constant throughout the curve widening.*
3. *Centerline offset striping is only applicable to curve widening on simple curves.*
4. *Use 4-inch spacing between lines, or as required by the state.*
5. *Paint the edge line striping outside the travel way and curve widening, 2-inch maximum from the normal edge of shoulder.*

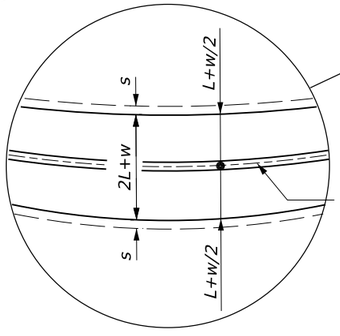




CURVE WIDENING ON SIMPLE CURVES (INSIDE)



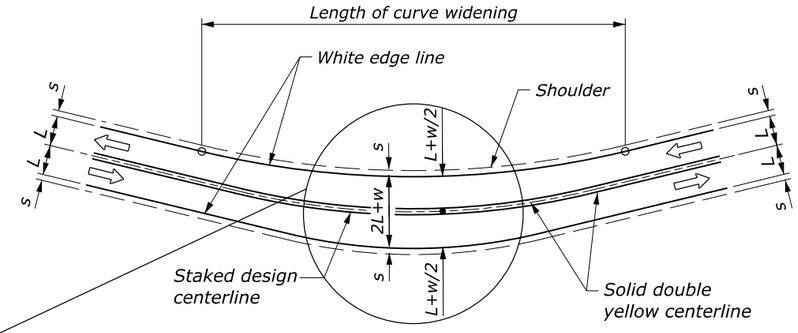




PAVEMENT MARKING DETAIL ON SIMPLE CURVES

To be used on curves where curve widening is applied. See note 2

CURVE WIDENING ON SPIRAL CURVES



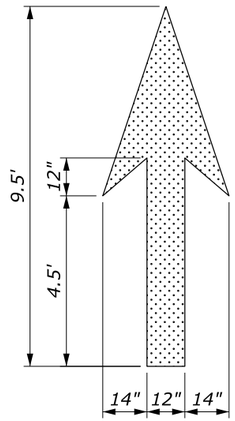
PAVEMENT MARKING DETAIL ON SPIRAL CURVES

To be used on curves where curve widening is applied. See Note 2

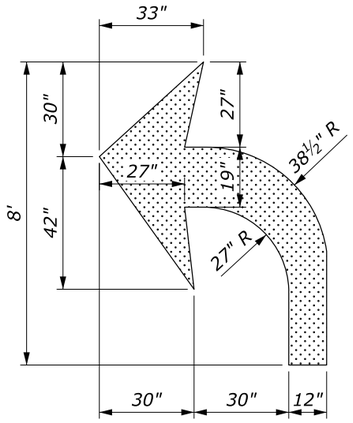
NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	CFL STANDARD C634-50
LINEAR PAVEMENT MARKINGS	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 06/2024

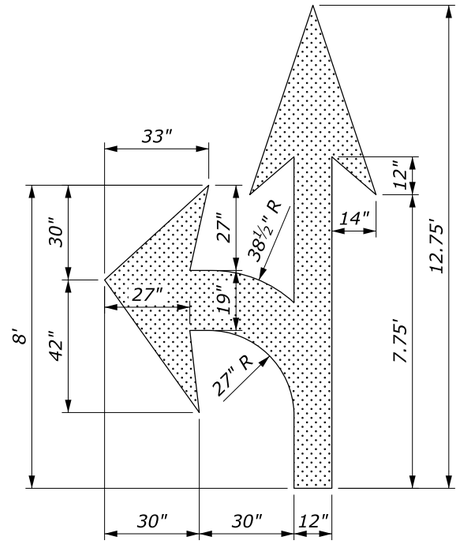
PROJECT	SHEET NUMBER



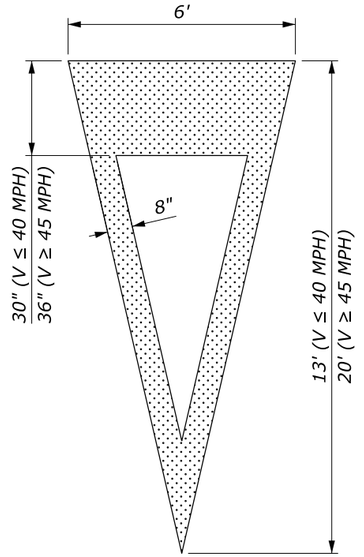
THROUGH LANE-USE ARROW



TURN LANE-USE ARROW



TURN AND THROUGH LANE-USE ARROW

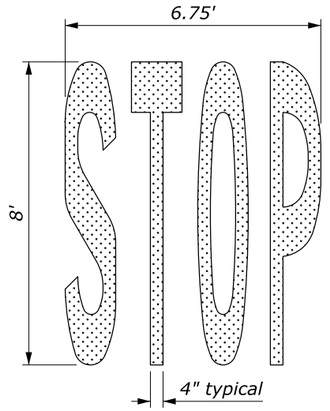


YIELD AHEAD TRIANGLE SYMBOL

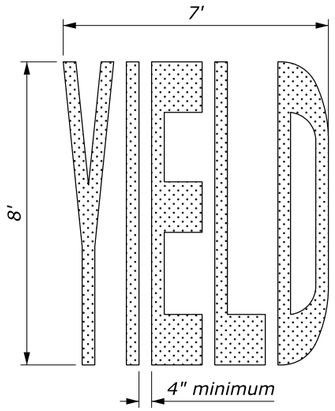
NOTE:

1. *Place pavement word and symbol markings in accordance with the "Manual on Uniform Traffic Control Devices" (MUTCD), current edition.*
2. *Use the current edition of the "Standard Highway Signs" to size all letters, numerals and symbols.*
3. *The Accessibility Parking Space marking only includes the accessibility symbol unless a border is shown in the Striping Plans.*

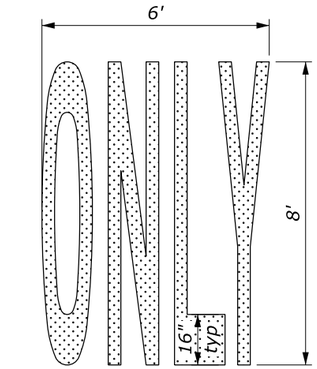
PAVEMENT MARKING AREAS	
TYPE	*SQFT*
Through Lane-Use Arrow	*12*
Turn Lane-Use Arrow	*16*
Turn and Through Lane-Use Arrow	*26*
Yield Ahead Triangle (V≤40 MPH)	*26*
Yield Ahead Triangle (V≥45 MPH)	*37*
Accessibility Marking (symbol only)	*2*
Accessibility Marking w/ border (White)	*5*
Accessibility Marking w/ border (Blue)	*9*
AHEAD Word Marking	*30*
ONLY Word Marking	*21*
SCHOOL Word Marking	*33*
STOP Word Marking	*22*
YIELD Word Marking	*24*



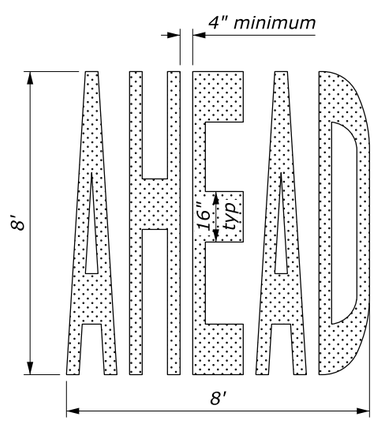
"STOP" WORD MARKING



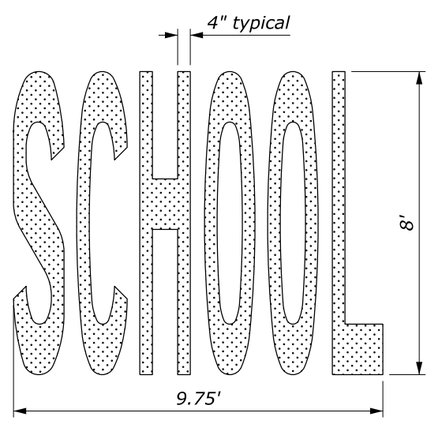
"YIELD" WORD MARKING



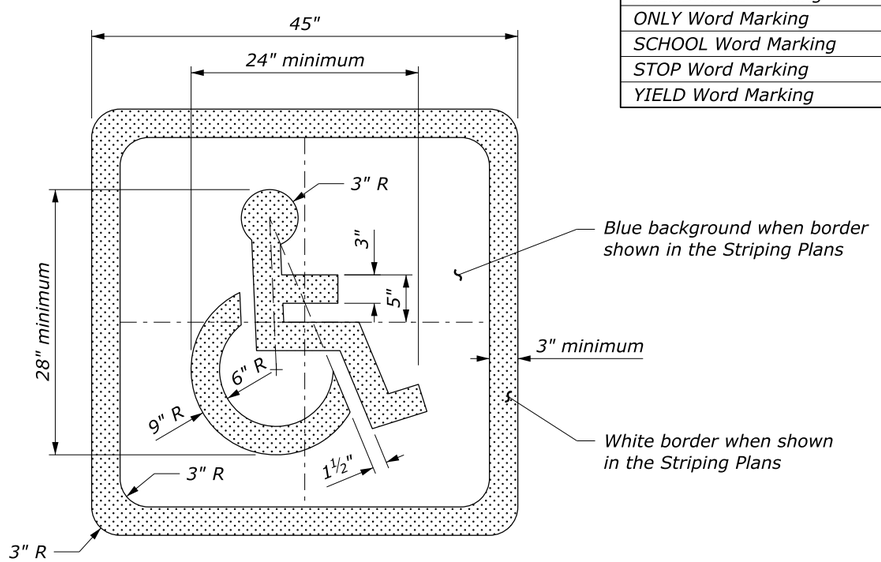
"ONLY" WORD MARKING



"AHEAD" WORD MARKING



"SCHOOL" WORD MARKING

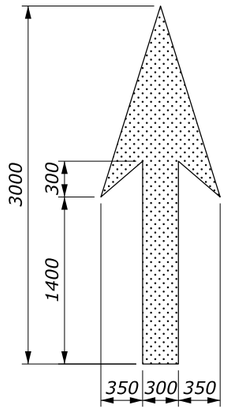


ACCESSIBILITY PARKING SPACE MARKING

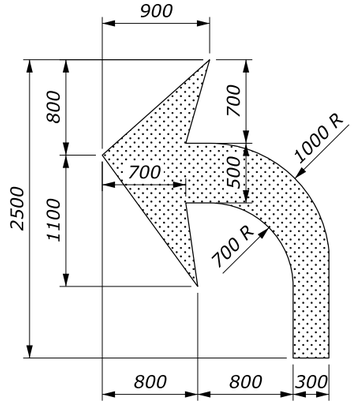
NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	WFL STANDARD W634-1
PAVEMENT MARKINGS SYMBOLS AND WORDS	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 9/2024

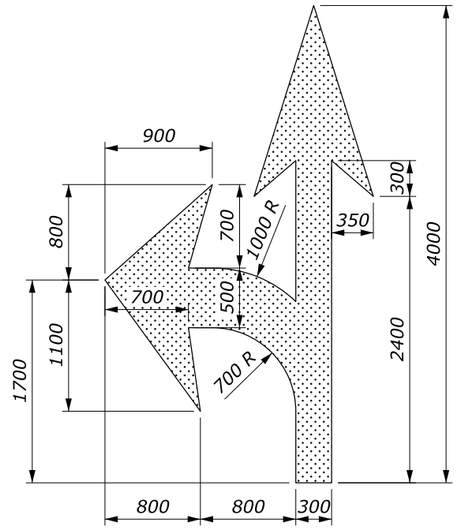
PROJECT	SHEET NUMBER



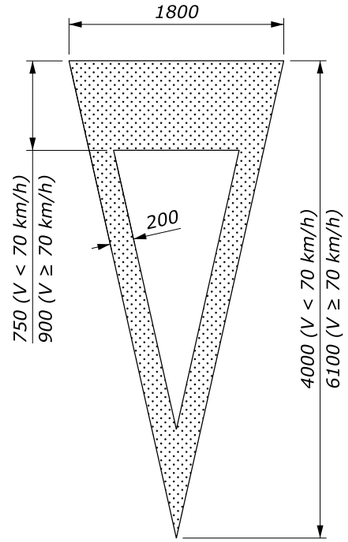
THROUGH LANE-USE ARROW



TURN LANE-USE ARROW



TURN AND THROUGH LANE-USE ARROW

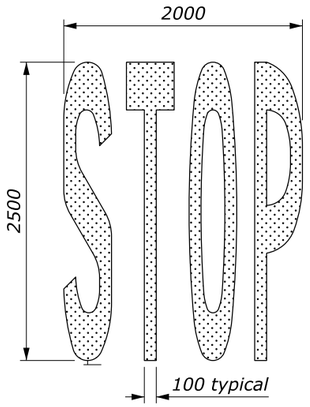


YIELD AHEAD TRIANGLE SYMBOL

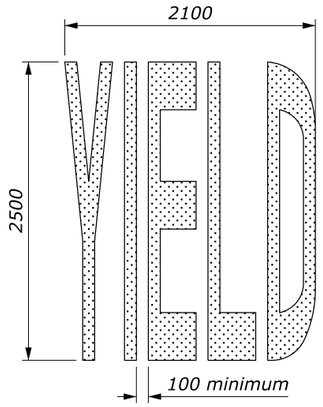
NOTE:

1. *Place pavement word and symbol markings in accordance with the "Manual on Uniform Traffic Control Devices" (MUTCD), current edition.*
2. *Use the current edition of the "Standard Highway Signs" to size all letters, numerals and symbols.*
3. *The Accessibility Parking Space marking only includes the accessibility symbol unless a border is shown in the Striping Plans.*

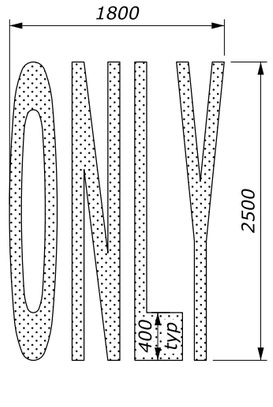
PAVEMENT MARKING AREAS	
TYPE	m^2
Through Lane-Use Arrow	1.1
Turn Lane-Use Arrow	1.5
Turn and Through Lane-Use Arrow	2.5
Yield Ahead Triangle (V<70 km/h)	2.4
Yield Ahead Triangle (V≥70 km/h)	3.3
Accessibility Marking (symbol only)	0.1
Accessibility Marking w/ border (White)	0.5
Accessibility Marking w/ border (Blue)	0.8
AHEAD Word Marking	2.8
ONLY Word Marking	2.0
SCHOOL Word Marking	3.1
STOP Word Marking	2.0
YIELD Word Marking	2.2



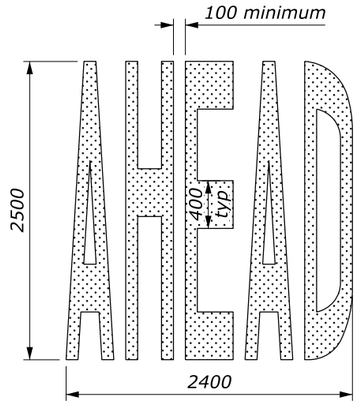
"STOP" WORD MARKING



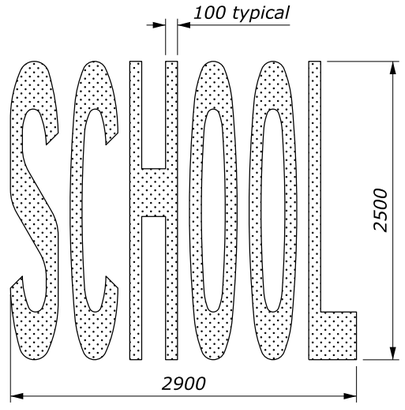
"YIELD" WORD MARKING



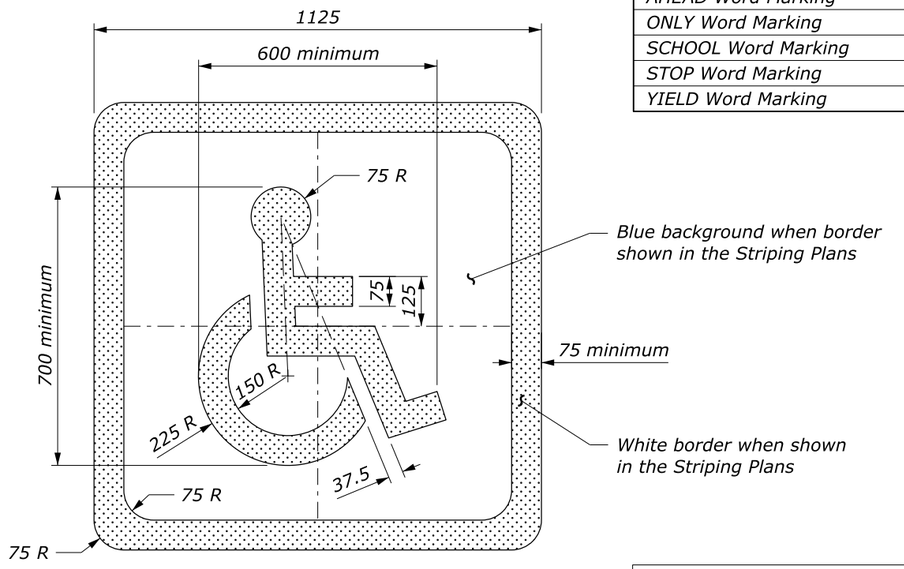
"ONLY" WORD MARKING



"AHEAD" WORD MARKING



"SCHOOL" WORD MARKING



ACCESSIBILITY PARKING SPACE MARKING

*This drawing contains **Metric** units of measure. Dimensions without units are millimeters.*

NO SCALE

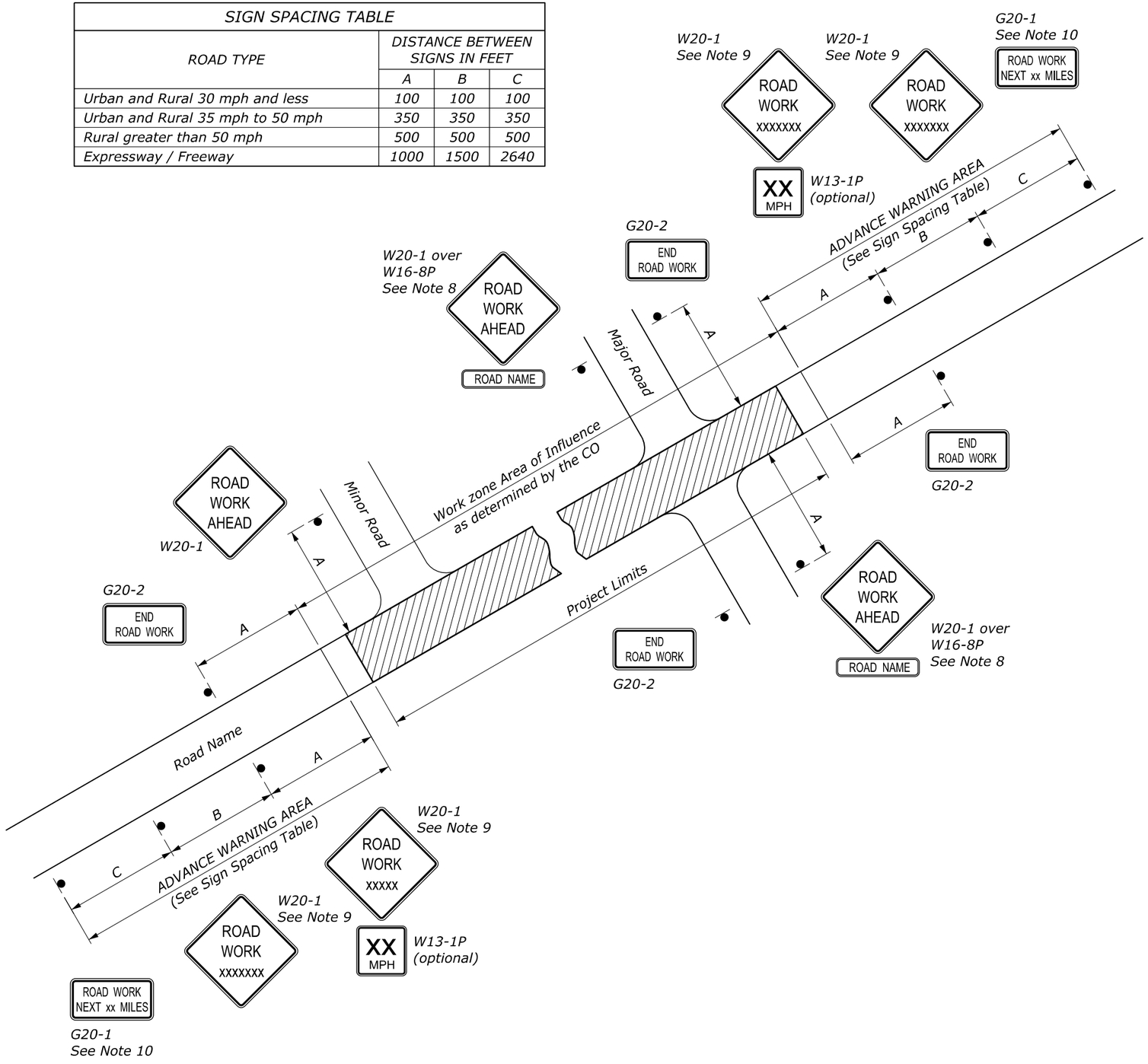
U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

PAVEMENT MARKINGS SYMBOLS AND WORDS

WFL STANDARD	WM634-1
SPECIFICATION	FP-24, FP-14
APPROVED FOR USE	9/2024

PROJECT	SHEET NUMBER

SIGN SPACING TABLE			
ROAD TYPE	DISTANCE BETWEEN SIGNS IN FEET		
	A	B	C
Urban and Rural 30 mph and less	100	100	100
Urban and Rural 35 mph to 50 mph	350	350	350
Rural greater than 50 mph	500	500	500
Expressway / Freeway	1000	1500	2640



NOTE:

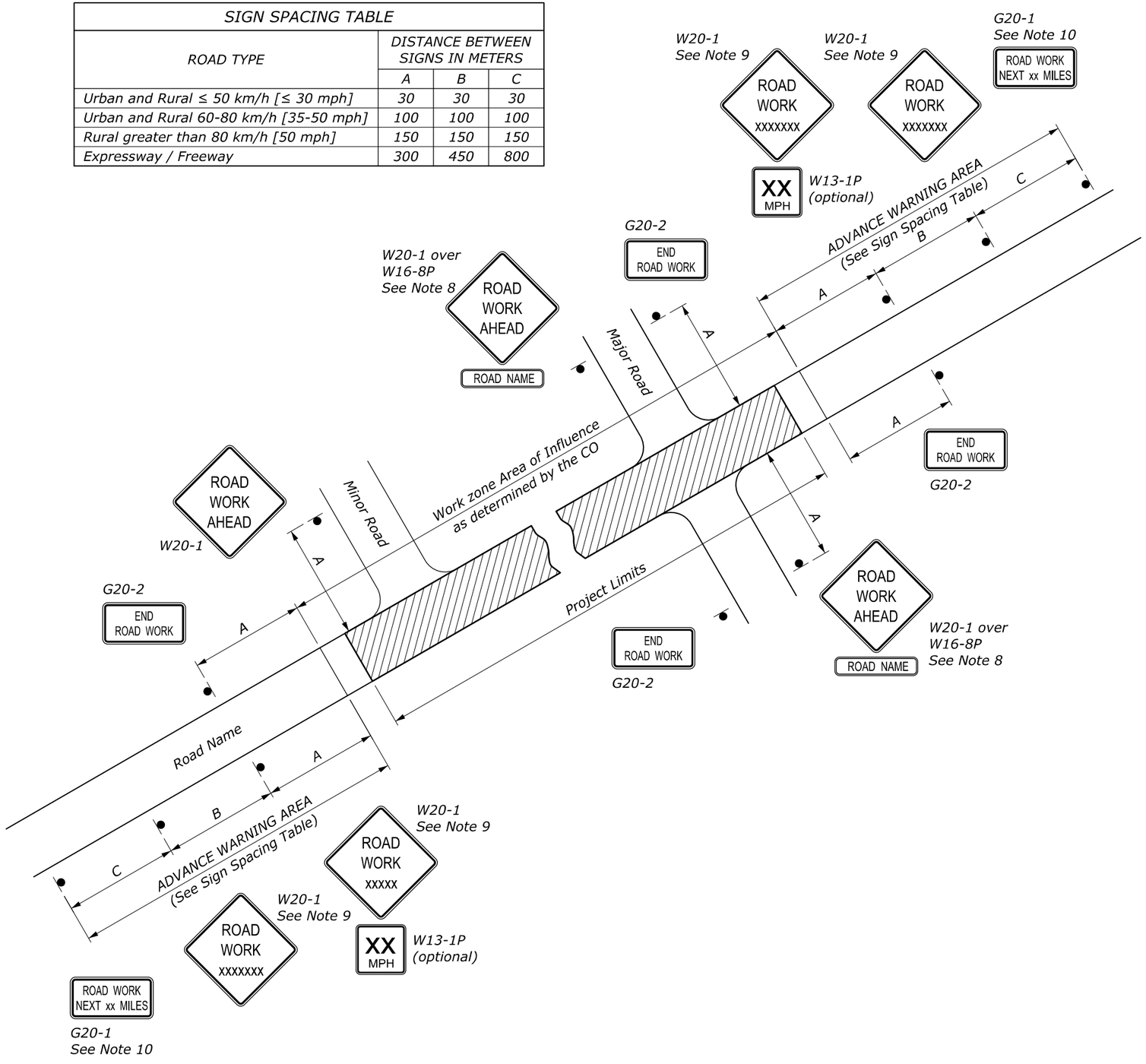
1. *Erect all project advance warning signs before starting construction work.*
2. *Not all details shown on the temporary traffic control sheets may be applicable to this project. The Contractor may add or delete information and details in this traffic control plan as necessary to accommodate actual operations.*
3. *Where advance warning signs, placed as shown, interfere with permanent signs, locate the warning signs to fit field conditions as approved. Vary messages as required.*
4. *Install advisory speed plaques under the W20 series warning signs as needed to indicate a maximum recommended speed through the construction area.*
5. *Ensure all sign supports exposed to traffic are crashworthy.*
6. *Maintain two-way traffic during all non-work hours except as approved.*
7. *Do not store traffic control devices along the roadway when not in use. Cover post-mounted signs when not applicable.*
8. *If W20-1 is placed on a roadway other than that on which the actual construction work occurs, include a supplementary plaque indicating the name of the road on which the construction does occur (applies to major roads only).*
9. *The message on the W20-1 signs may be ROAD WORK AHEAD or may specify the distance to the work area in feet or in miles. Install an additional W20-1 sign when approach speeds exceed 50 mph. When used, place the two W20-1 signs "B" feet apart according to the Sign Spacing Table.*
10. *For work zones that are 2 miles or more in length, install G20-1 signs at each end of the project. Show the distance on the G20-1 sign to the nearest whole mile.*
11. *If signing on a roadway under a jurisdiction other than the client agency, verify that an encroachment permit has been obtained.*
12. *State standards may be used as an alternative if approved.*

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	FLH STANDARD 635-1
TEMPORARY TRAFFIC CONTROL ADVANCE SIGNING	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 2/2024

PROJECT	SHEET NUMBER

SIGN SPACING TABLE			
ROAD TYPE	DISTANCE BETWEEN SIGNS IN METERS		
	A	B	C
Urban and Rural ≤ 50 km/h [≤ 30 mph]	30	30	30
Urban and Rural 60-80 km/h [35-50 mph]	100	100	100
Rural greater than 80 km/h [50 mph]	150	150	150
Expressway / Freeway	300	450	800



NOTE:

1. *Erect all project advance warning signs before starting construction work.*
2. *Not all details shown on the temporary traffic control sheets may be applicable to this project. The Contractor may add or delete information and details in this traffic control plan as necessary to accommodate actual operations.*
3. *Where advance warning signs, placed as shown, interfere with permanent signs, locate the warning signs to fit field conditions as approved. Vary messages as required.*
4. *Install advisory speed plaques under the W20 series warning signs as needed to indicate a maximum recommended speed through the construction area.*
5. *Ensure all sign supports exposed to traffic are crashworthy.*
6. *Maintain two-way traffic during all non-work hours except as approved.*
7. *Do not store traffic control devices along the roadway when not in use. Cover post-mounted signs when not applicable.*
8. *If W20-1 is placed on a roadway other than that on which the actual construction work occurs, include a supplementary plaque indicating the name of the road on which the construction does occur (applies to major roads only).*
9. *The message on the W20-1 signs may be ROAD WORK AHEAD or may specify the distance to the work area in feet or in miles. Install an additional W20-1 sign when approach speeds exceed 80 km/h [50 mph]. When used, place the two W20-1 signs "B" meters apart according to the Sign Spacing Table.*
10. *For work zones that are greater than 3 km in length, install G20-1 signs at each end of the project. Show the distance on the G20-1 sign to the nearest whole mile.*
11. *If signing on a roadway under a jurisdiction other than the client agency, verify that an encroachment permit has been obtained.*
12. *State standards may be used as an alternative if approved.*

*This drawing contains **Metric** units of measure. Dimensions without units are millimeters.*

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

TEMPORARY TRAFFIC CONTROL ADVANCE SIGNING

FLH STANDARD	M635-1
SPECIFICATION	FP-24, FP-14
APPROVED FOR USE	2/2024

PROJECT	SHEET NUMBER

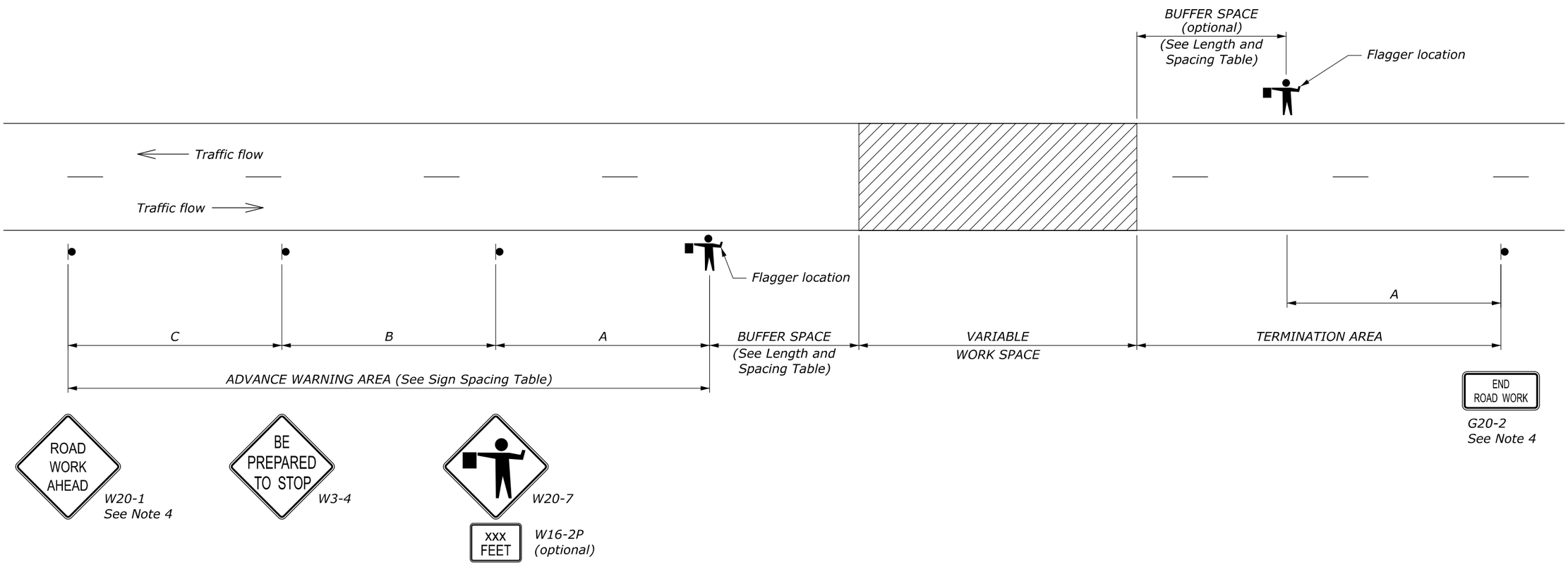
LENGTH AND SPACING TABLE	
APPROACH SPEED* MPH	BUFFER SPACE LENGTH FEET
20	115
25	155
30	200
35	250
40	305
45	360
50	425
55	495
60	570
65	645
70	730

* Approach speed based on the regulatory posted speed, not the advisory speed.

SIGN SPACING TABLE			
ROAD TYPE	DISTANCE BETWEEN SIGNS IN FEET		
	A	B	C
Urban and Rural 30 mph and less	100	100	100
Urban and Rural 35 mph to 50 mph	350	350	350
Rural greater than 50 mph	500	500	500
Expressway / Freeway	1000	1500	2640

NOTE:

1. Signs are shown for one direction of travel only. Place signs similar to those depicted for the opposite direction of travel.
2. Final location and spacing of devices may be changed to fit field conditions as approved.
3. For pilot car operation, mount the PILOT CAR FOLLOW ME (G20-4) sign at a conspicuous location on the rear of vehicle. Prominently display the name of the Contractor on the pilot car.
4. If closure is completely within the project limits, eliminate the ROAD WORK AHEAD (W20-1) and END ROAD WORK (G20-2) signs.
5. Do not allow equipment, materials, or vehicles to be parked or stored in the buffer space.



NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	FLH STANDARD 635-5
TEMPORARY TRAFFIC CONTROL ROAD CLOSURE LAYOUT (WITH FLAGGERS)	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 2/2024

PROJECT	SHEET NUMBER

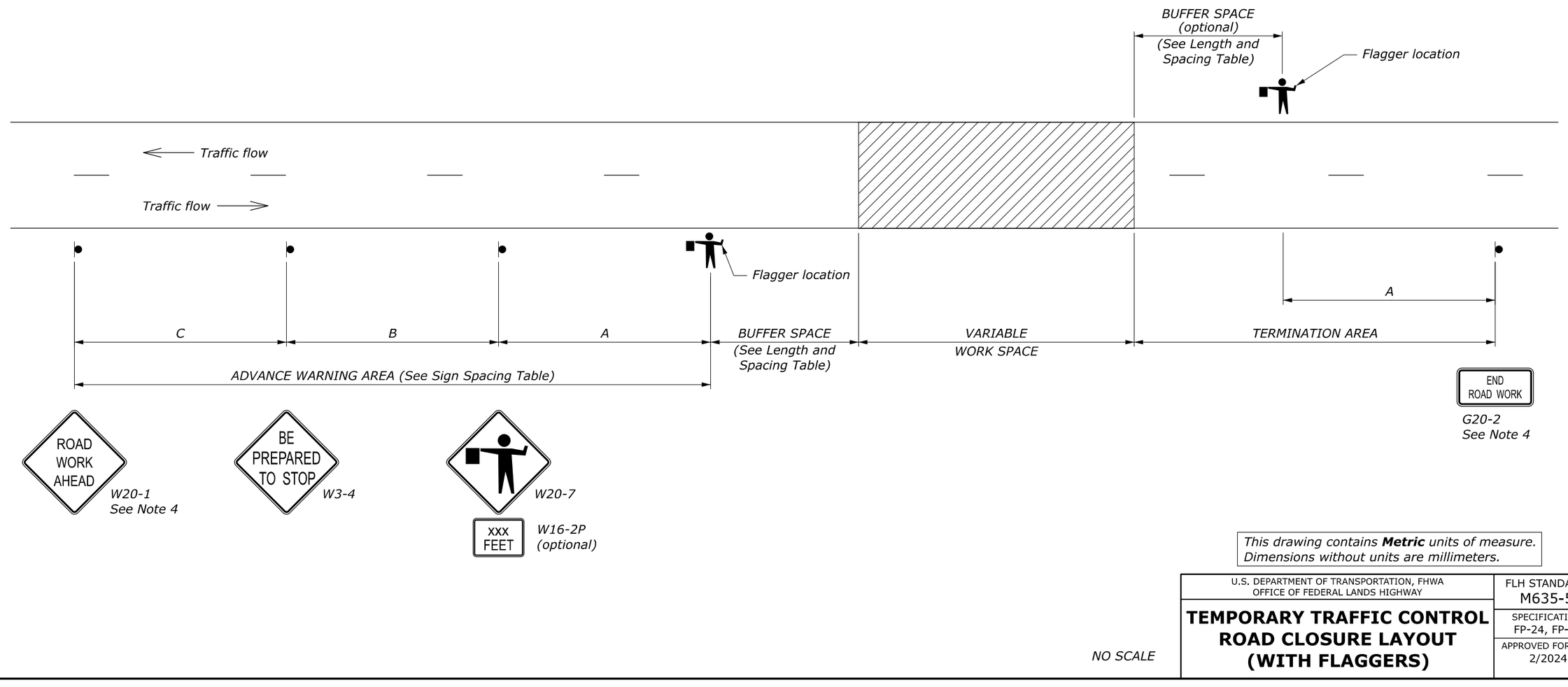
LENGTH AND SPACING TABLE		
APPROACH SPEED*		BUFFER SPACE LENGTH
mph	km/h	m
20	30	35
25	40	45
30	50	60
35	55	75
40	65	95
45	70	110
50	80	130
55	90	150
60	95	175
65	105	195
70	115	225

* Approach speed based on the regulatory posted speed, not the advisory speed.

SIGN SPACING TABLE			
ROAD TYPE	DISTANCE BETWEEN SIGNS IN METERS		
	A	B	C
Urban and Rural ≤ 50 km/h [≤ 30 mph]	30	30	30
Urban and Rural 60-80 km/h [35-50 mph]	100	100	100
Rural greater than 80 km/h [50 mph]	150	150	150
Expressway / Freeway	300	450	800

NOTE:

1. Signs are shown for one direction of travel only. Place signs similar to those depicted for the opposite direction of travel.
2. Final location and spacing of devices may be changed to fit field conditions as approved.
3. For pilot car operation, mount the PILOT CAR FOLLOW ME (G20-4) sign at a conspicuous location on the rear of vehicle. Prominently display the name of the Contractor on the pilot car.
4. If closure is completely within the project limits, eliminate the ROAD WORK AHEAD (W20-1) and END ROAD WORK (G20-2) signs.
5. Do not allow equipment, materials, or vehicles to be parked or stored in the buffer space.



This drawing contains **Metric** units of measure. Dimensions without units are millimeters.

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

TEMPORARY TRAFFIC CONTROL ROAD CLOSURE LAYOUT (WITH FLAGGERS)

FLH STANDARD M635-5

SPECIFICATION FP-24, FP-14

APPROVED FOR USE 2/2024

PROJECT	SHEET NUMBER

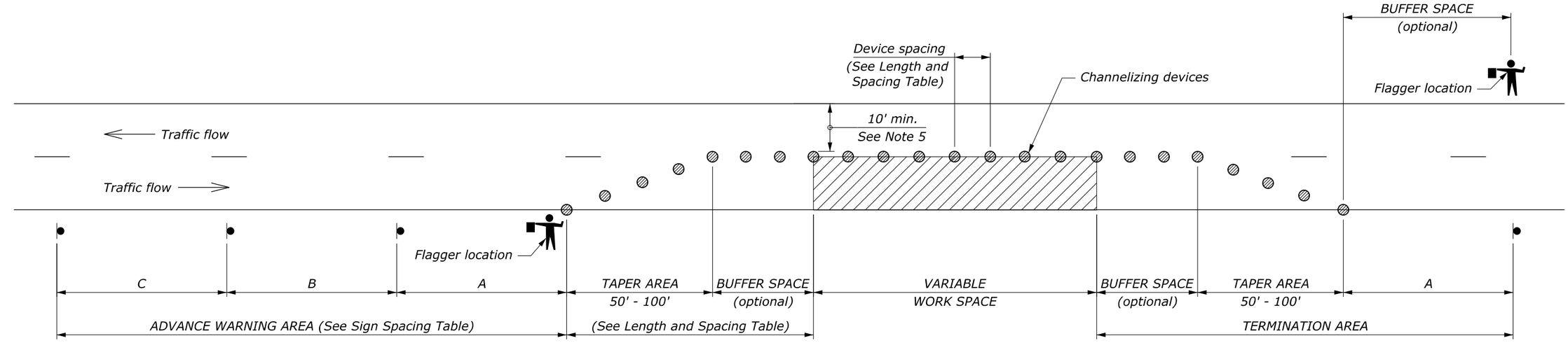
LENGTH AND SPACING TABLE				
APPROACH SPEED* MPH	BUFFER SPACE LENGTH FEET	CHANNELIZING DEVICE SPACING IN FEET		
		TAPER AREA	BUFFER SPACE	WORK SPACE
20	115	20	40	40
25	155	20	50	50
30	200	20	60	60
35	250	20	70	70
40	305	20	80	80
45	360	20	90	90
50	425	20	100	100
55	495	20	110	110
60	570	20	120	120
65	645	20	130	130
70	730	20	140	140

* Approach speed based on the regulatory posted speed, not the advisory speed.

SIGN SPACING TABLE			
ROAD TYPE	DISTANCE BETWEEN SIGNS IN FEET		
	A	B	C
Urban and Rural 30 mph and less	100	100	100
Urban and Rural 35 mph to 50 mph	350	350	350
Rural greater than 50 mph	500	500	500
Expressway / Freeway	1000	1500	2640

NOTE:

1. Signs are shown for one direction of travel only. Place signs similar to those depicted for the opposite direction of travel.
2. Final location and spacing of devices may be changed to fit field conditions as approved.
3. For pilot car operation, mount the PILOT CAR FOLLOW ME (G20-4) sign at a conspicuous location on the rear of vehicle. Prominently display the name of the Contractor on the pilot car.
4. If closure is completely within the project limits, eliminate the ROAD WORK AHEAD (W20-1) and END ROAD WORK (G20-2) signs.
5. For project specific minimum width, refer to the Special Contract Requirements, Section 156.
6. Do not allow equipment, materials, or vehicles to be parked or stored in the buffer space.



W20-1
See Note 4

W20-4

W13-1P
(optional)

W20-7

W16-2P

G20-2
See Note 4

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	FLH STANDARD 635-6
TEMPORARY TRAFFIC CONTROL SINGLE LANE CLOSURE LAYOUT (WITH FLAGGERS)	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 2/2024

PROJECT	SHEET NUMBER

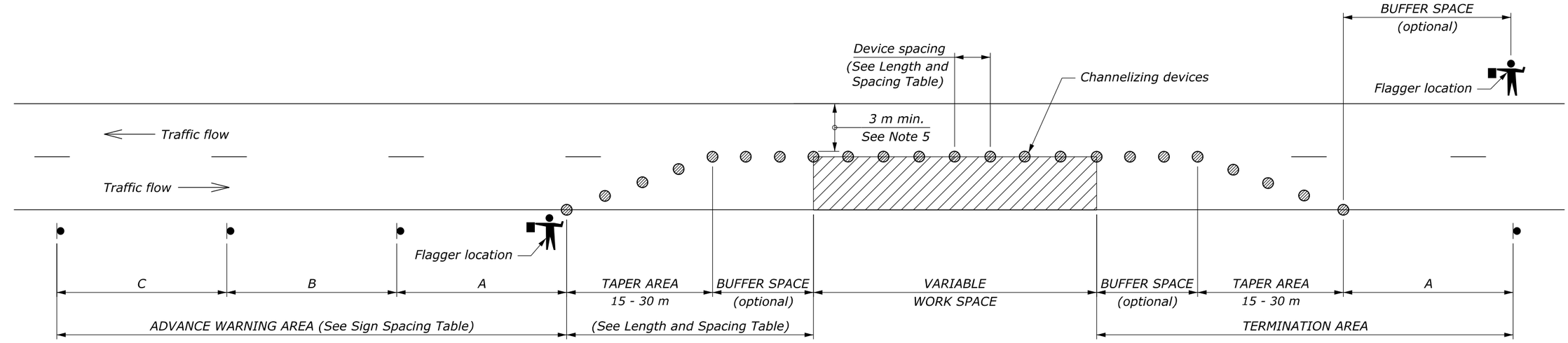
LENGTH AND SPACING TABLE					
APPROACH SPEED*		BUFFER SPACE LENGTH	CHANNELIZING DEVICE SPACING IN METERS		
			TAPER	BUFFER	WORK
mph	km/h	m	AREA	SPACE	SPACE
20	30	35	6	12	12
25	40	45	6	15	15
30	50	60	6	18	18
35	55	75	6	21	21
40	65	95	6	24	24
45	70	110	6	27	27
50	80	130	6	30	30
55	90	150	6	34	34
60	95	175	6	37	37
65	105	195	6	40	40
70	115	225	6	43	43

* Approach speed based on the regulatory posted speed, not the advisory speed.

SIGN SPACING TABLE			
ROAD TYPE	DISTANCE BETWEEN SIGNS IN METERS		
	A	B	C
Urban and Rural ≤ 50 km/h [≤ 30 mph]	30	30	30
Urban and Rural 60-80 km/h [35-50 mph]	100	100	100
Rural greater than 80 km/h [50 mph]	150	150	150
Expressway / Freeway	300	450	800

NOTE:

1. Signs are shown for one direction of travel only. Place signs similar to those depicted for the opposite direction of travel.
2. Final location and spacing of devices may be changed to fit field conditions as approved.
3. For pilot car operation, mount the PILOT CAR FOLLOW ME (G20-4) sign at a conspicuous location on the rear of vehicle. Prominently display the name of the Contractor on the pilot car.
4. If closure is completely within the project limits, eliminate the ROAD WORK AHEAD (W20-1) and END ROAD WORK (G20-2) signs.
5. For project specific minimum width, refer to the Special Contract Requirements, Section 156.
6. Do not allow equipment, materials, or vehicles to be parked or stored in the buffer space.



W20-1
See Note 4

W20-4

W13-1P
(optional)

W20-7

W16-2P

G20-2
See Note 4

*This drawing contains **Metric** units of measure. Dimensions without units are millimeters.*

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

TEMPORARY TRAFFIC CONTROL SINGLE LANE CLOSURE LAYOUT (WITH FLAGGERS)

FLH STANDARD	
M635-6	
SPECIFICATION	
FP-24, FP-14	
APPROVED FOR USE	
2/2024	

PROJECT	SHEET NUMBER

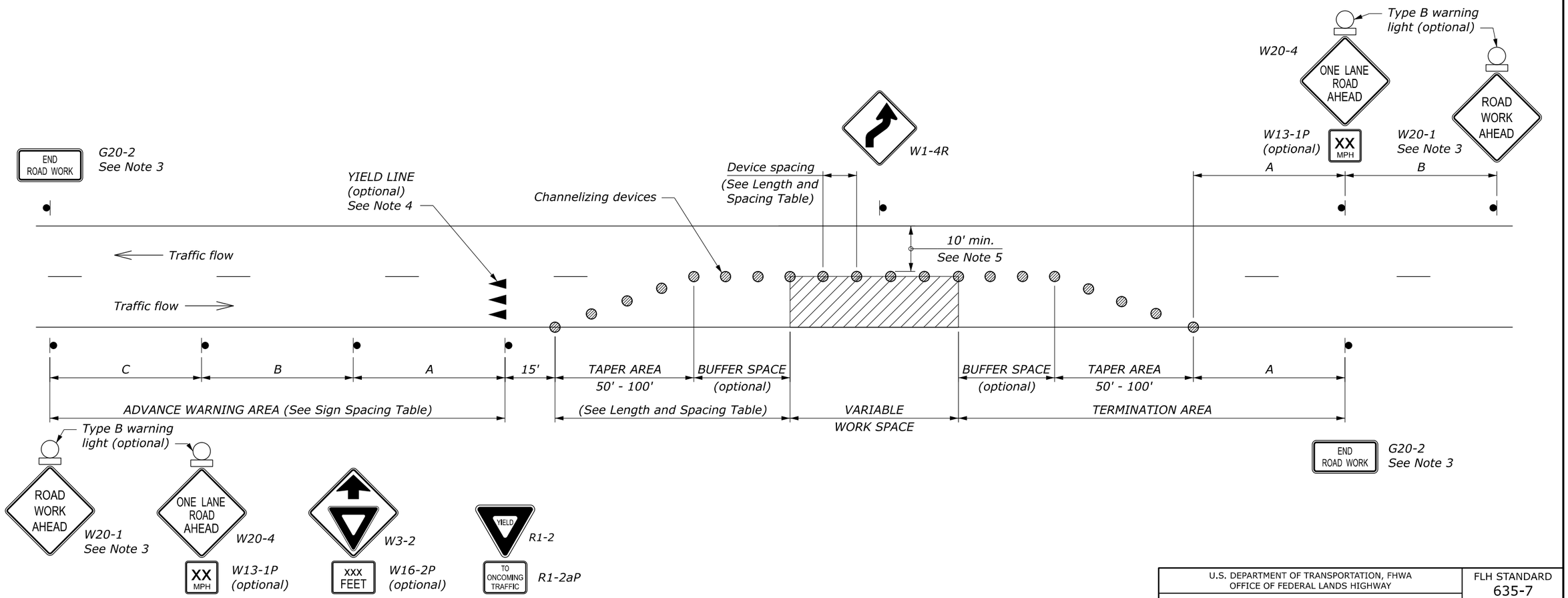
LENGTH AND SPACING TABLE				
APPROACH SPEED* MPH	BUFFER SPACE LENGTH FEET	CHANNELIZING DEVICE SPACING IN FEET		
		TAPER AREA	BUFFER SPACE	WORK SPACE
20	115	20	40	40
25	155	20	50	50
30	200	20	60	60
35	250	20	70	70
40	305	20	80	80
45	360	20	90	90
50	425	20	100	100
55	495	20	110	110
60	570	20	120	120
65	645	20	130	130
70	730	20	140	140

* Approach speed based on the regulatory posted speed, not the advisory speed.

SIGN SPACING TABLE			
ROAD TYPE	DISTANCE BETWEEN SIGNS IN FEET		
	A	B	C
Urban and Rural 30 mph and less	100	100	100
Urban and Rural 35 mph to 50 mph	350	350	350
Rural greater than 50 mph	500	500	500
Expressway / Freeway	1000	1500	2640

NOTE:

1. Use this layout only if sufficient gaps in oncoming traffic exist for traffic that must yield, and if drivers from both directions are able to see approaching traffic through and beyond the work site.
2. Final location and spacing of devices may be changed to fit field conditions as approved.
3. If closure is completely within the project limits, eliminate the ROAD WORK AHEAD (W20-1) and END ROAD WORK (G20-2) signs.
4. If the surface is paved, install yield lines that comply with the MUTCD.
5. For project specific minimum width, refer to Special Contract Requirements, Section 156.
6. Do not allow equipment, materials, or vehicles to be parked or stored in the buffer space.



NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	FLH STANDARD 635-7
TEMPORARY TRAFFIC CONTROL SINGLE LANE CLOSURE LAYOUT (WITH YIELD SIGN)	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 2/2024

PROJECT	SHEET NUMBER

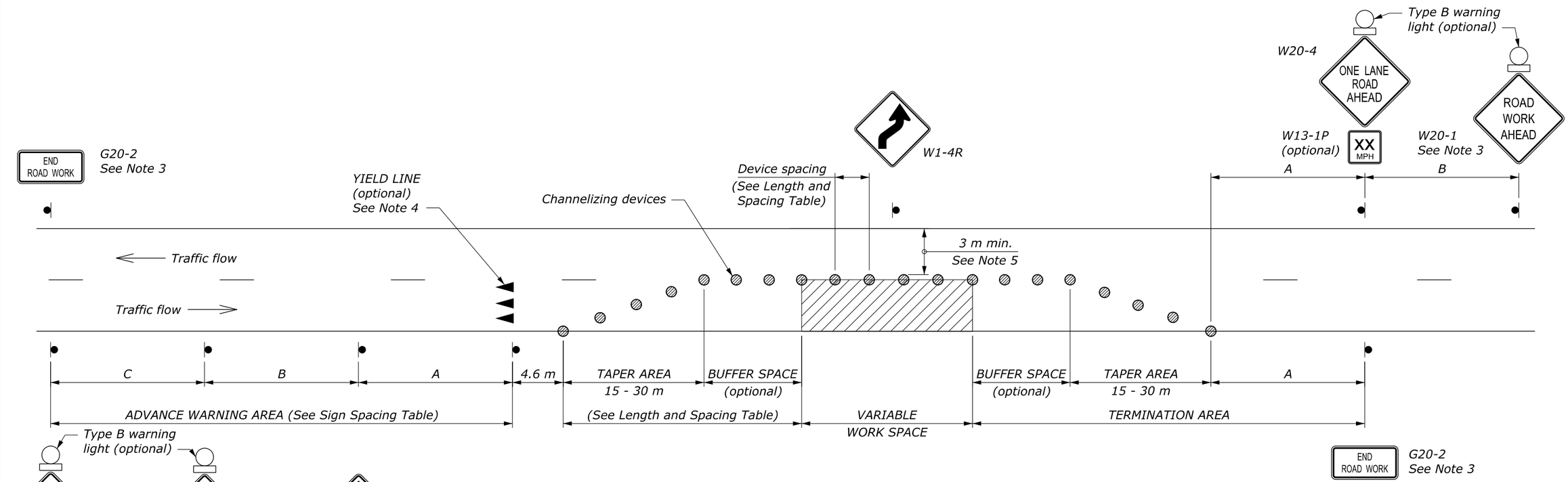
LENGTH AND SPACING TABLE					
APPROACH SPEED*		BUFFER SPACE LENGTH	CHANNELIZING DEVICE SPACING IN METERS		
			TAPER AREA	BUFFER SPACE	WORK SPACE
mph	km/h	m			
20	30	35	6	12	12
25	40	45	6	15	15
30	50	60	6	18	18
35	55	75	6	21	21
40	65	95	6	24	24
45	70	110	6	27	27
50	80	130	6	30	30
55	90	150	6	34	34
60	95	175	6	37	37
65	105	195	6	40	40
70	115	225	6	43	43

* Approach speed based on the regulatory posted speed, not the advisory speed.

SIGN SPACING TABLE			
ROAD TYPE	DISTANCE BETWEEN SIGNS IN METERS		
	A	B	C
Urban and Rural ≤ 50 km/h [≤ 30 mph]	30	30	30
Urban and Rural 60-80 km/h [35-50 mph]	100	100	100
Rural greater than 80 km/h [50 mph]	150	150	150
Expressway / Freeway	300	450	800

NOTE:

1. Use this layout only if sufficient gaps in oncoming traffic exist for traffic that must yield, and if drivers from both directions are able to see approaching traffic through and beyond the work site.
2. Final location and spacing of devices may be changed to fit field conditions as approved.
3. If closure is completely within the project limits, eliminate the ROAD WORK AHEAD (W20-1) and END ROAD WORK (G20-2) signs.
4. If the surface is paved, install yield lines that comply with the MUTCD.
5. For project specific minimum width, refer to Special Contract Requirements, Section 156.
6. Do not allow equipment, materials, or vehicles to be parked or stored in the buffer space.



This drawing contains **Metric** units of measure. Dimensions without units are millimeters.

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

TEMPORARY TRAFFIC CONTROL SINGLE LANE CLOSURE LAYOUT (WITH YIELD SIGN)

FLH STANDARD M635-7

SPECIFICATION FP-24, FP-14

APPROVED FOR USE 2/2024

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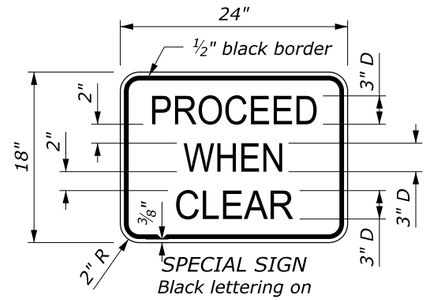
3 June 2024 1:13 PM

PROJECT	SHEET NUMBER

LENGTH AND SPACING TABLE				
APPROACH SPEED* MPH	BUFFER SPACE LENGTH FEET	CHANNELIZING DEVICE SPACING IN FEET		
		TAPER AREA	BUFFER SPACE	WORK SPACE
20	115	20	40	40
25	155	20	50	50
30	200	20	60	60
35	250	20	70	70
40	305	20	80	80
45	360	20	90	90
50	425	20	100	100
55	495	20	110	110
60	570	20	120	120
65	645	20	130	130
70	730	20	140	140

* Approach speed based on the regulatory posted speed, not the advisory speed.

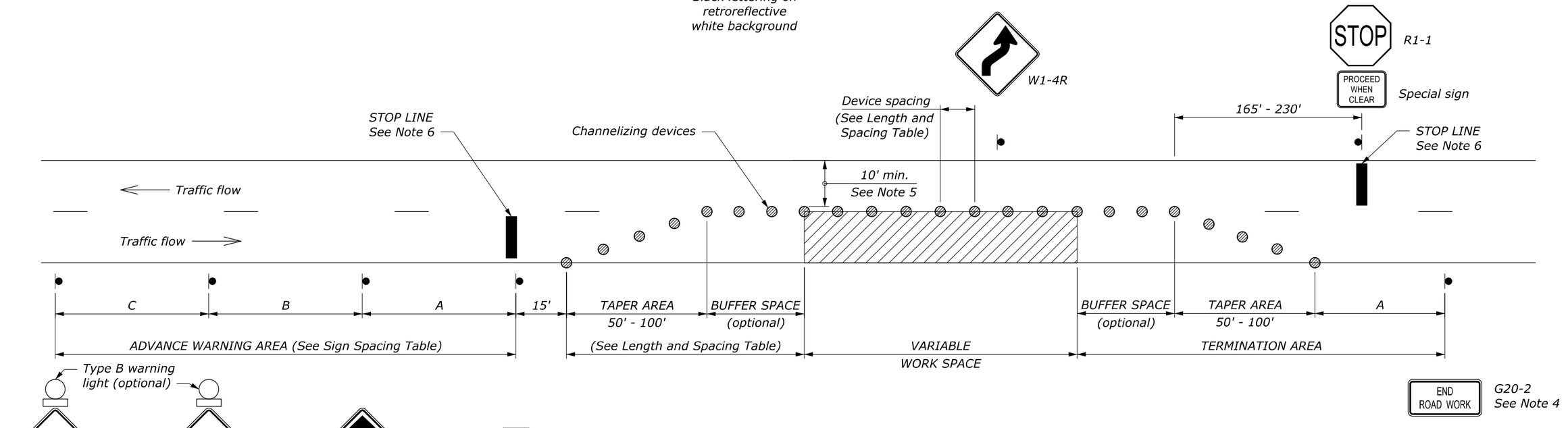
SIGN SPACING TABLE			
ROAD TYPE	DISTANCE BETWEEN SIGNS IN FEET		
	A	B	C
Urban and Rural 30 mph and less	100	100	100
Urban and Rural 35 mph to 50 mph	350	350	350
Rural greater than 50 mph	500	500	500
Expressway / Freeway	1000	1500	2640



SPECIAL SIGN
Black lettering on retroreflective white background

NOTE:

1. Use this layout only if road users from both directions are able to see approaching vehicular traffic through and beyond the work site and have sufficient visibility of approaching vehicles.
2. Signs are shown for one direction of travel only. Place signs similar to those depicted for the opposite direction of travel.
3. Final location and spacing of devices may be changed to fit field conditions as approved.
4. If closure is completely within the project limits, eliminate the ROAD WORK AHEAD (W20-1) and END ROAD WORK (G20-2) signs.
5. For project specific minimum width, refer to Special Contract Requirements, Section 156.
6. If the roadway surface is paved, install stop lines that comply with the MUTCD.
7. Do not allow equipment, materials, or vehicles to be parked or stored in the buffer space.



NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

TEMPORARY TRAFFIC CONTROL SINGLE LANE CLOSURE LAYOUT (WITH STOP SIGNS)

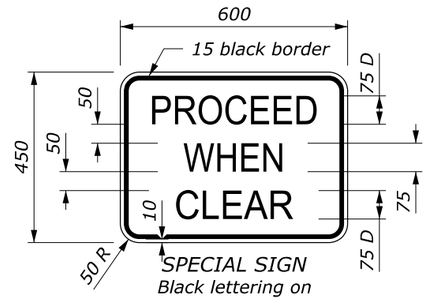
FLH STANDARD	635-8
SPECIFICATION	FP-24, FP-14
APPROVED FOR USE	2/2024

PROJECT	SHEET NUMBER

LENGTH AND SPACING TABLE					
APPROACH SPEED*		BUFFER SPACE LENGTH	CHANNELIZING DEVICE SPACING IN METERS		
			TAPER	BUFFER	WORK
mph	km/h	m	AREA	SPACE	SPACE
20	30	35	6	12	12
25	40	45	6	15	15
30	50	60	6	18	18
35	55	75	6	21	21
40	65	95	6	24	24
45	70	110	6	27	27
50	80	130	6	30	30
55	90	150	6	34	34
60	95	175	6	37	37
65	105	195	6	40	40
70	115	225	6	43	43

* Approach speed based on the regulatory posted speed, not the advisory speed.

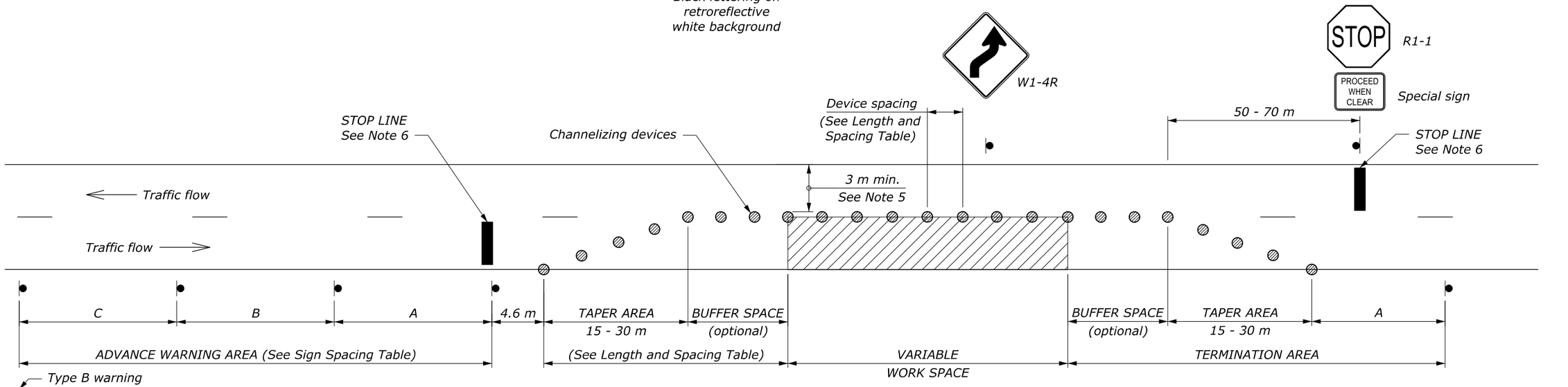
SIGN SPACING TABLE			
ROAD TYPE	DISTANCE BETWEEN SIGNS IN METERS		
	A	B	C
Urban and Rural ≤ 50 km/h [≤ 30 mph]	30	30	30
Urban and Rural 60-80 km/h [35-50 mph]	100	100	100
Rural greater than 80 km/h [50 mph]	150	150	150
Expressway / Freeway	300	450	800



SPECIAL SIGN
Black lettering on retroreflective white background

NOTE:

1. Use this layout only if road users from both directions are able to see approaching vehicular traffic through and beyond the work site and have sufficient visibility of approaching vehicles.
2. Signs are shown for one direction of travel only. Place signs similar to those depicted for the opposite direction of travel.
3. Final location and spacing of devices may be changed to fit field conditions as approved.
4. If closure is completely within the project limits, eliminate the ROAD WORK AHEAD (W20-1) and END ROAD WORK (G20-2) signs.
5. For project specific minimum width, refer to Special Contract Requirements, Section 156.
6. If the roadway surface is paved, install stop lines that comply with the MUTCD.
7. Do not allow equipment, materials, or vehicles to be parked or stored in the buffer space.



NO SCALE

*This drawing contains **Metric** units of measure. Dimensions without units are millimeters.*

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	FLH STANDARD M635-8
TEMPORARY TRAFFIC CONTROL SINGLE LANE CLOSURE LAYOUT (WITH STOP SIGNS)	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 2/2024

15 February 2024 10:21 AM c:\pw-work\d0588909\Std635-8.dgn [Std M635-8]

PROJECT	SHEET NUMBER

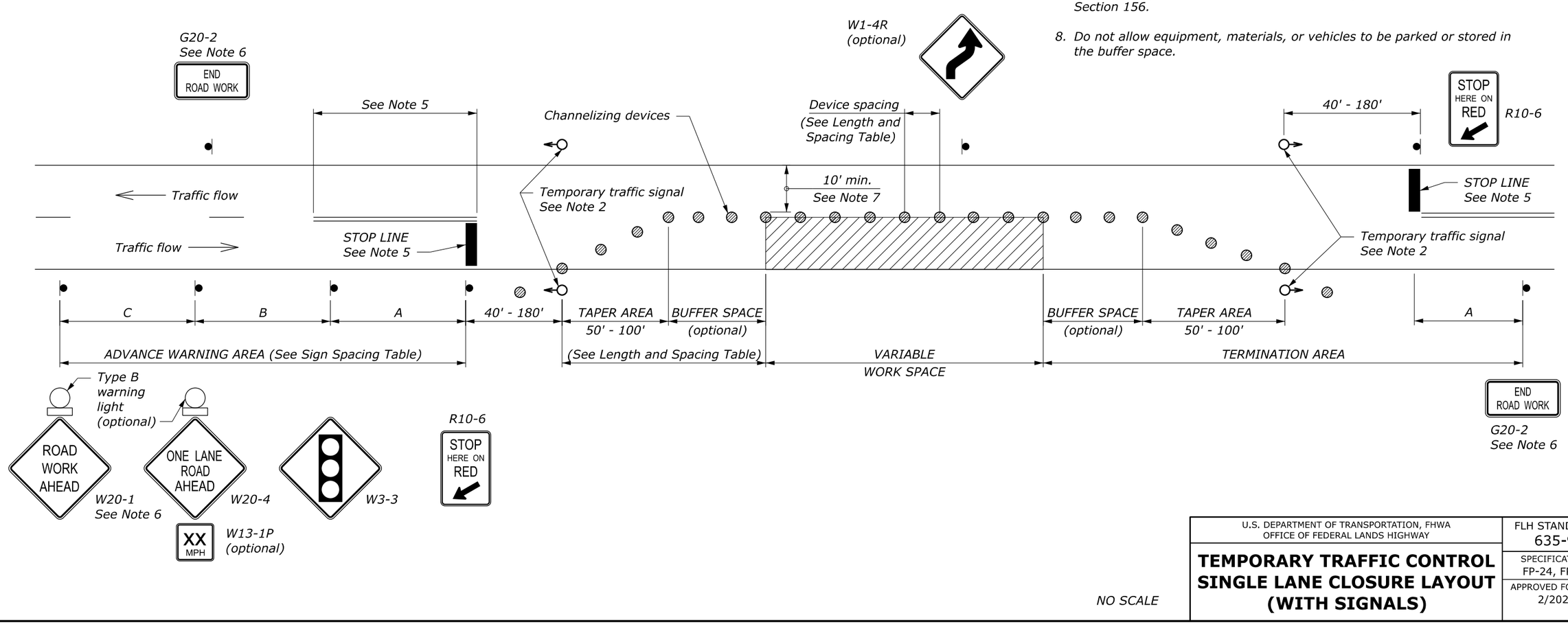
LENGTH AND SPACING TABLE				
APPROACH SPEED* MPH	BUFFER SPACE LENGTH FEET	CHANNELIZING DEVICE SPACING IN FEET		
		TAPER AREA	BUFFER SPACE	WORK SPACE
20	115	20	40	40
25	155	20	50	50
30	200	20	60	60
35	250	20	70	70
40	305	20	80	80
45	360	20	90	90
50	425	20	100	100
55	495	20	110	110
60	570	20	120	120
65	645	20	130	130
70	730	20	140	140

* Approach speed based on the regulatory posted speed, not the advisory speed.

SIGN SPACING TABLE			
ROAD TYPE	DISTANCE BETWEEN SIGNS IN FEET		
	A	B	C
Urban and Rural 30 mph and less	100	100	100
Urban and Rural 35 mph to 50 mph	350	350	350
Rural greater than 50 mph	500	500	500
Expressway / Freeway	1000	1500	2640

NOTE:

1. Signs are shown for one direction of travel only. Place signs similar to those depicted for the opposite direction of travel.
2. A single signal installation is acceptable, on the right-hand side of the road, if it has two signal faces that are at least 8 feet apart and meets the other requirements of the MUTCD.
3. Install and operate temporary traffic control signals in accordance with the requirements of the MUTCD. Establish signal timing using a qualified engineer. When the signal is changed to the flashing mode either manually or automatically, ensure red signal indications are flashed to both approaches.
4. Final location and spacing of devices may be changed to fit field conditions as approved. If signals are moved, determine revised signal timing using a qualified engineer.
5. For paved roadway surfaces, install stop lines complying with the MUTCD. Remove existing conflicting pavement markings and raised markers between the work space and the stop line. Add no-passing lines in advance of the stop line that comply with the MUTCD. Removable pavement markings may be used for stop lines and no-passing pavement markings.
6. If closure is completely within the project limits, eliminate the ROAD WORK AHEAD (W20-1) and END ROAD WORK (G20-2) signs.
7. For project specific minimum width, refer to Special Contract Requirements, Section 156.
8. Do not allow equipment, materials, or vehicles to be parked or stored in the buffer space.



NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA OFFICE OF FEDERAL LANDS HIGHWAY	FLH STANDARD 635-9
TEMPORARY TRAFFIC CONTROL SINGLE LANE CLOSURE LAYOUT (WITH SIGNALS)	SPECIFICATION FP-24, FP-14
	APPROVED FOR USE 2/2024

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3 June 2024 2:10 PM

PROJECT	SHEET NUMBER

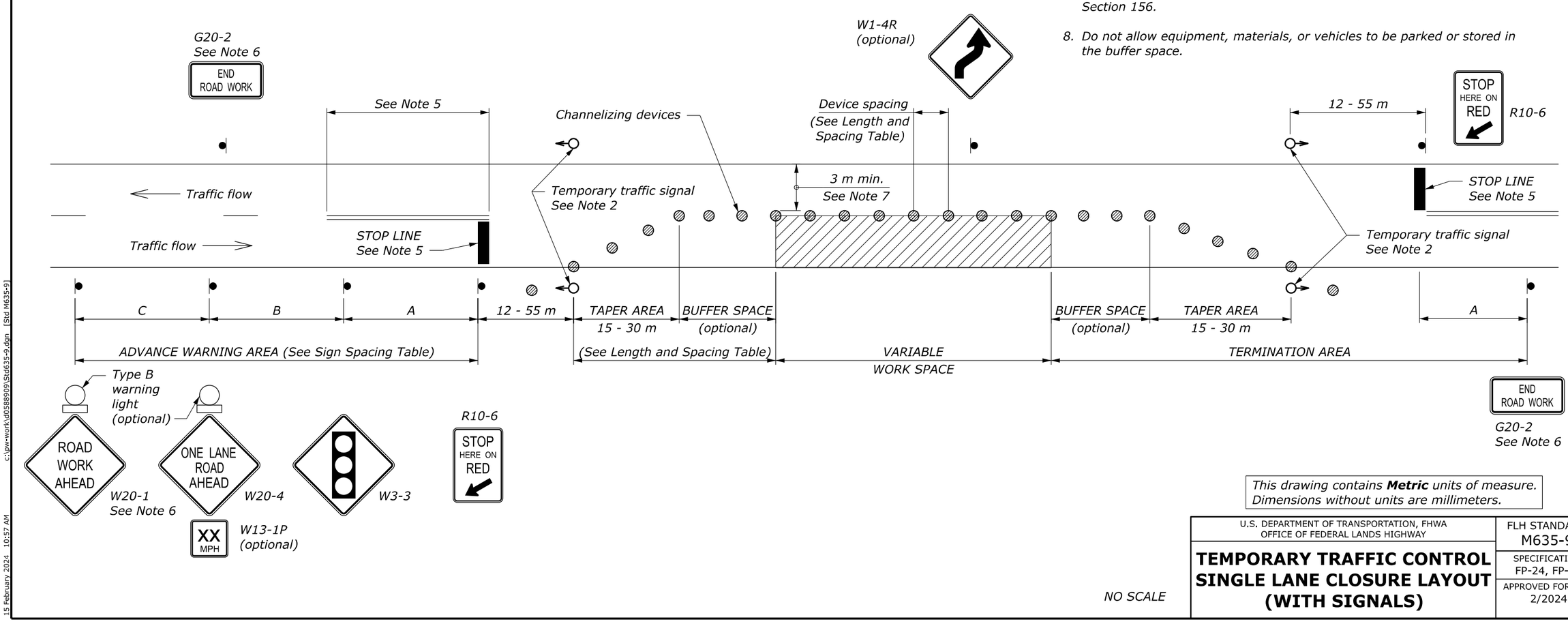
LENGTH AND SPACING TABLE					
APPROACH SPEED*		BUFFER SPACE LENGTH	CHANNELIZING DEVICE SPACING IN METERS		
			TAPER	BUFFER	WORK
mph	km/h	m	AREA	SPACE	SPACE
20	30	35	6	12	12
25	40	45	6	15	15
30	50	60	6	18	18
35	55	75	6	21	21
40	65	95	6	24	24
45	70	110	6	27	27
50	80	130	6	30	30
55	90	150	6	34	34
60	95	175	6	37	37
65	105	195	6	40	40
70	115	225	6	43	43

* Approach speed based on the regulatory posted speed, not the advisory speed.

SIGN SPACING TABLE			
ROAD TYPE	DISTANCE BETWEEN SIGNS IN METERS		
	A	B	C
Urban and Rural ≤ 50 km/h [≤ 30 mph]	30	30	30
Urban and Rural 60-80 km/h [35-50 mph]	100	100	100
Rural greater than 80 km/h [50 mph]	150	150	150
Expressway / Freeway	300	450	800

NOTE:

1. Signs are shown for one direction of travel only. Place signs similar to those depicted for the opposite direction of travel.
2. A single signal installation is acceptable, on the right-hand side of the road, if it has two signal faces that are at least 2.4 m apart and meets the other requirements of the MUTCD.
3. Install and operate temporary traffic control signals in accordance with the requirements of the MUTCD. Establish signal timing using a qualified engineer. When the signal is changed to the flashing mode either manually or automatically, ensure red signal indications are flashed to both approaches.
4. Final location and spacing of devices may be changed to fit field conditions as approved. If signals are moved, determine revised signal timing using a qualified engineer.
5. For paved roadway surfaces, install stop lines complying with the MUTCD. Remove existing conflicting pavement markings and raised markers between the work space and the stop line. Add no-passing lines in advance of the stop line that comply with the MUTCD. Removable pavement markings may be used for stop lines and no-passing pavement markings.
6. If closure is completely within the project limits, eliminate the ROAD WORK AHEAD (W20-1) and END ROAD WORK (G20-2) signs.
7. For project specific minimum width, refer to Special Contract Requirements, Section 156.
8. Do not allow equipment, materials, or vehicles to be parked or stored in the buffer space.



*This drawing contains **Metric** units of measure. Dimensions without units are millimeters.*

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION, FHWA
OFFICE OF FEDERAL LANDS HIGHWAY

TEMPORARY TRAFFIC CONTROL SINGLE LANE CLOSURE LAYOUT (WITH SIGNALS)

FLH STANDARD
M635-9
SPECIFICATION
FP-24, FP-14
APPROVED FOR USE
2/2024