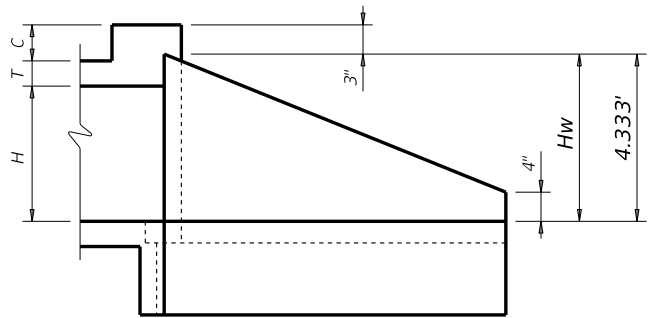
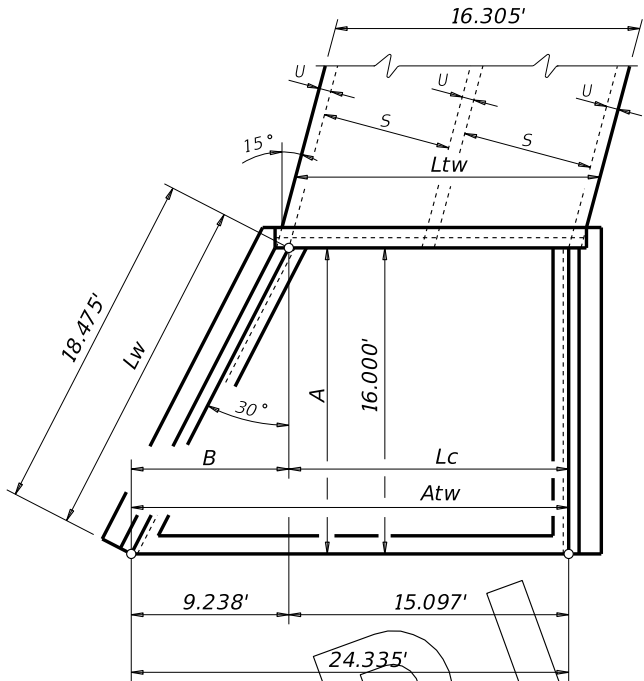


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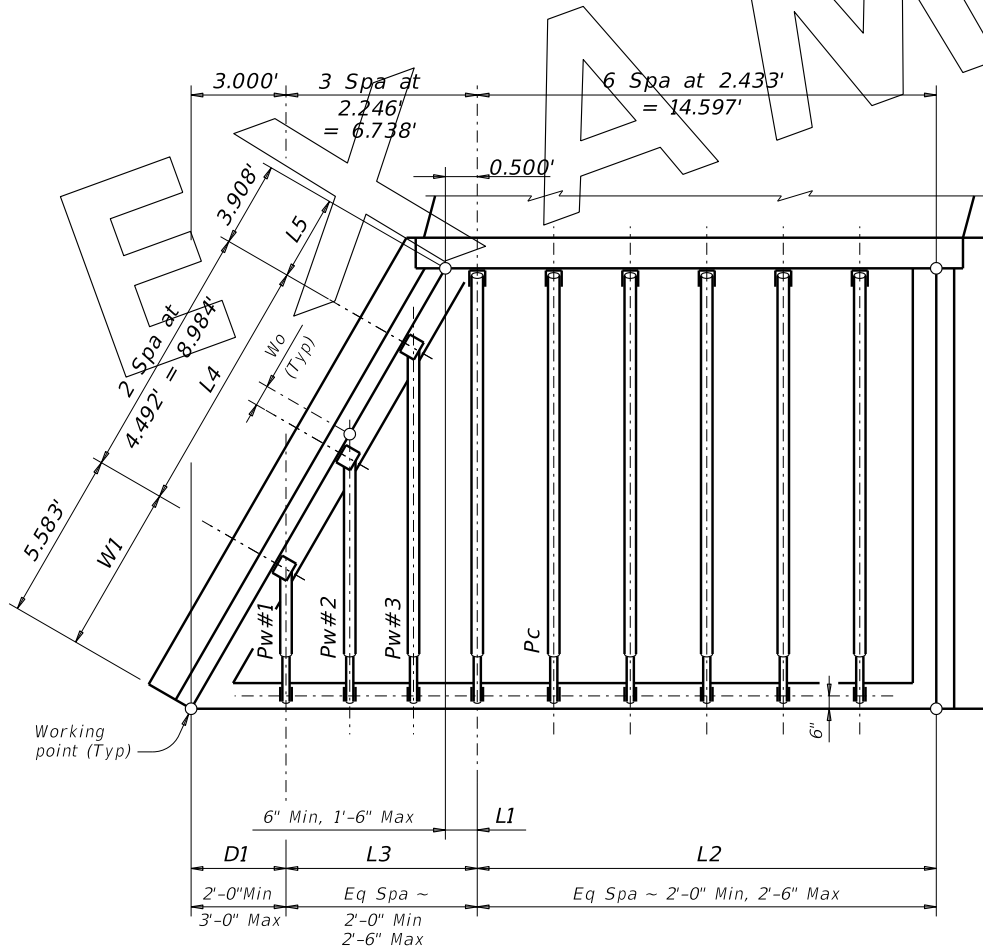
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WINGWALL ELEVATION



FLARED END PLAN



PIPE RUNNER PLAN

CONCRETE DIMENSIONS:

$$\begin{aligned} Hw &= H + T + C - 0.250' \\ &= (3.000') + (0.583') + (1.000') - (0.250') \\ &= 4.333' \\ A &= (Hw - 0.333') (SL) \\ &= (4.333' - 0.333') (4) \\ &= 16.000' \\ B &= (A) [\tan (15^\circ + \theta)] \\ &= (16.000') (\tan (30^\circ)) \\ &= 9.238' \\ Lw &= (A) \div [\cos (15^\circ + \theta)] \\ &= (16.000') \div (\cos (30^\circ)) \\ &= 18.475' \\ Ltw &= [(N) (S) + (N + 1) (U)] \div (\cos (15^\circ)) \\ &= [(2) (7.000') + (2 + 1) (0.583')] \div (\cos (15^\circ)) \\ &= 16.305' \\ Lc &= (Ltw) - (2U) \div (\cos \theta) \\ &= (16.305') - (2) (0.583') \div (\cos 15^\circ) \\ &= 15.097' \\ Atw &= (Lc) + (B) \\ &= (15.097') + (9.238') \\ &= 24.335' \\ \text{Long Wing Area} &= (Lw) (Hw - 0.333') (0.5) + (Lw) (0.333') \\ &= (18.475') (4.333' - 0.333') (0.5) + (18.475') (0.333') \\ &= 43.102 \text{ SF} \\ \text{Short Wing Area} &= (A) (Hw - 0.333') (0.5) + (A) (0.333') \\ &= (16.000') (4.333' - 0.333') (0.5) + (16.000') (0.333') \\ &= 37.328 \text{ SF} \\ \text{Total Wing Area} &= (\text{Long Wing Area}) + (\text{Short Wing Area}) \\ &= (43.102 \text{ SF}) + (37.328 \text{ SF}) \\ &= 80.430 \text{ SF (Two Wings)} \end{aligned}$$

PIPE LOCATIONS AND DIMENSIONS:

Establish Pipe Runner Spacing
Determine curb pipe spacing - Try:
(Lc) - (0.500' Min)
= 14.597'
(14.597') $\div$ (2.500' Max)
= 5.8 ~ 6 spaces
Try 5 spaces:
(2.500' spacing) (5 spaces)
= 12.500'
(Lc) - (12.500')
= (15.097') - (12.500')
= 2.597'
Test: (1.500') > (2.597') > (0.500')
= no, use 6 spaces and 0.500'
(14.597') $\div$ (6 spaces)
= 2.433'
Determine wingwall pipe spacing - Try:
(B) + (0.500') - (3.000' max outside space at toewall)
= (9.238') + (0.500') - (3.000')
= 6.738'
(6.738') $\div$ (2.500' Max)
= 2.7 ~ 3 spaces
(6.738') $\div$ (3 spaces)
= 2.246'
Use:
D1 = outside space at toewall = 3.000'
L3 = runner spacing at wingwall = 3 spa at 2.246' = 6.738'
L1 = outside space at curb = 0.500'
L2 = runner spacing at curb = 6 spa at 2.433' = 14.597'
W1 = (K3) (D1) - (Wo)
= (2.000') (3.000') - (0.417')
= 5.583'
L4 = (L3 - one space) (K3)
= (6.738' - 2.246') (2.000)
= 8.984'
Determine spacing:
= (L4) $\div$ (number of L3 spaces - one space)
= (8.984') $\div$ (3 - 1)
= 2 spa at 4.492'
L5 = (Lw) - (W1) - (L4)
= (18.475') - (5.583') - (8.984')
= 3.908'
Establish Pipe Runner Lengths and Sizes
Pw#1 shortest wing pipe runner = (D1) (K2) - (2.063' end of pipe clearance)
= (3.000') (1.785) - (2.063')
= 3.292'
Test: (1.750' min sliding runner) < (3.292')
= yes, use normal sliding runner for Pw#1
Pw#3 longest wing pipe runner = (D1 + L3 - one L3 space) (K2) - (2.063')
= (3.000' + 6.738' - 2.246') (1.785) - (2.063')
= 11.310'
Pc = (A) (K1) - (1.688' end of pipe clearance)
= (16.000') (1.031) - (1.688')
= 14.808'
Test: (Pc) > (9.333' max length 3" pipe runner)
= (14.808') > (9.333')
= yes, do not use 3" pipe runner
Test: (Pc) > (19.000' max length 4" pipe runner)
= (14.808') > (19.000')
= no, use 4" upper pipe runner and 3" anchor pipe

BOX CULVERT PARAMETERS:

2 ~ 7' x 3' multi-box culvert with 8' fill,
4:1 slope, 15° skew, and 1.000' curb (C).
From MC-7-10 Std: H = 3.000', T = 0.583',
and U = 0.583'.

DEFINITIONS:

θ = Culvert skew
Hw = Wingwall height (at tallest point) (feet)
H = Interior height of culvert box (feet)
T = Culvert slab thickness (feet)
C = Height of curb above top of top slab CS-MD
A = Horizontal distance between face of anchor
toewall and face of culvert curb (feet)
SL:1 = Side slope ratio (horizontal : 1 vertical)
SL:1 Slope Angle
3:1 = 18.4349°
4:1 = 14.0362°
6:1 = 9.4623°
K = Constant values for use in formulas
SL:1 K1 K2-15° Skew K2-30° Skew
3:1 ~ 1.054 ~ 1.826 ~ 1.054
4:1 ~ 1.031 ~ 1.785 ~ 1.031
6:1 ~ 1.014 ~ 1.756 ~ 1.014
Note: K1 = (1 + cos(slope angle))
K2 = (K1) [tan (75° - θ)]
K3 = 15° skew ~ 2.000
30° skew ~ 1.414
Note: K3 = 1/[sin(skew + 15°)]
B = Horizontal offset of tip of wing from
perpendicular (feet)
Lw = Length of wingwall (along bottom inside
face of wing) (feet)
Atw = Anchor toewall length (along outside face
of toewall) (feet)
N = Number of culvert spans
S = Interior width of culvert span (feet)
U = Thickness of culvert wall (feet)
Ltw = Length of culvert toewall (feet)
Lc = Length of culvert curb between wings (feet)
Wo = Wing anchor bracket offset (feet)
Wo = (3 1/2') $\div$ [tan (skew + 15°)] - (1")
Skew Wo
15° ~ 5"
30° ~ 2 1/2"
Pw = Length of pipe runner on wingwall (feet)
Pc = Length of pipe runner on curb (feet)

NOT A STANDARD

NOT FOR INCLUSION
IN THE PLANS

SHEET 1 OF 2



Texas Department of Transportation

Bridge Division Standard

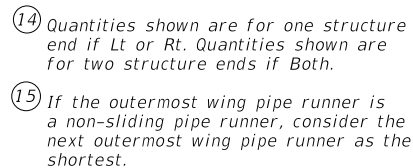
EXAMPLE

CALCULATIONS FOR

SETB-FW-S STANDARD

FILE: CD-EX-SETB-FWS-20.dgn	DN: GAF	CK: CAT	DW: TxDOT	CK: TxDOT
©TxDOT February 2020	CONT	SECT	JOB	HIGHWAY
REVISIONS	DIST	COUNTY		SHEET NO.

DATE: _____
FILE: _____

A grid with 10 columns and 10 rows. The word "NEW" is drawn in a simple, outlined font. The 'N' is formed by two vertical lines and a diagonal line connecting them. The 'E' is formed by a vertical line and three horizontal lines. The 'W' is formed by two vertical lines and two diagonal lines. The letters are positioned such that they span across several grid cells.

Note that the tabular quantities are given for estimating purposes only. It is likely that these quantities will change due to field conditions. Therefore, all dimensions must be verified by the Contractor in the field prior to fabrication of the safety end treatment components.

Note: Left forward culvert skew shown,
actual culvert skew may be opposite hand.

NOT FOR INCLUSION
IN THE PLANS

EXAMPLE
CALCULATIONS FOR
SETB-FW-S STANDARD

FILE: CD-EX-SETB-FWS-20.dgn		DN: TxDOT		CK: TxDOT		DW: TxDOT		CK: TxDOT	
©TxDOT February 2020		CONT SECT		JOB		HIGHWAY			
REVISIONS									
		DIST		COUNTY			SHEET NO.		