The Foothills

Pino Arroyo Roll Wave Heights Table

STA	BOTTOM WIDTH b (ft)	SIDE SLOPES z	WATER DEPTH[1] y (ft)	VELOCITY[1] V_1 (ft/s)	Channel Slope S_0	Froude Number F_2 [1]	Flow Area[1] A_1 (ft^2)	Reynold's Number [2] Re
19+60.26	55.01	0.001	2.69	22.68	0.0295	2.7	148.0	6496.4
19+42.35	52.15	0.001	2.90	22.98	0.0244	2.6	151.2	5805.2
18+99.08	47.33	0.001	2.63	25.42	0.0257	2.9	124.5	5533.8
18+87.96	45.47	0.001	2.64	25.88	0.0295	3.0	120.0	6391.0
18+58.11	39.26	0.001	2.77	26.89	0.0298	3.0	108.8	6772.2
18+54.79	38.51	0.001	2.79	26.99	0.0298	3.0	107.5	6820.6
18+50.00	37.43	0.001	2.80	27.13	0.0297	3.0	104.8	6806.1
18+28.98	32.7	0.001	3.22	27.65	0.0282	2.8	105.3	7453.8
18+07.37	27.5	0.001	3.54	28.29	0.0267	2.8	97.4	7742.2
17+70.07	21.7	0.001	3.25	30.20	0.0293	3.0	70.5	7796.0
17+65.90	21.16	0.001	3.31	30.28	0.0322	3.0	70.1	8749.5
17+63.38	20.86	**0.001**	3.41	30.28	0.0313	2.9	71.1	8760.3
17+50.00	19.7	0.001	4.09	30.10	0.0284	2.6	80.6	9520.6

STA	ESTIMATED ROLL WAVE HEIGHT (ft)	y_2 [3a] (ft)	A_2 [3b] (ft^2)	k[3c]	Y* [3d]	F_1 [3e]	WAVE VELOCITY V_w [3f] (ft/s)	VELOCITY BEHIND WAVE V_2 [3g] (ft/s)	WAVE CELERITY C[3h] (ft/s)	CALCULATED ROLL WAVE HEIGHT h[3i] (ft)
19+60.26	1.76	4.45	244.8	1.0	0.0	1.6	36.5	28.1	8.3	**1.76**
19+42.35	1.66	4.56	237.8	1.0	0.1	1.7	36.7	28.0	8.7	**1.67**
18+99.08	1.91	4.54	214.9	1.0	0.1	1.7	39.5	31.4	8.2	**1.91**
18+87.96	1.94	4.58	208.3	1.0	0.1	1.7	40.1	31.9	8.2	**1.94**
18+58.11	2.02	4.79	188.1	1.0	0.1	1.7	41.4	33.0	8.4	**2.02**
18+54.79	2.01	4.80	184.9	1.0	0.1	1.7	41.5	33.1	8.4	**2.02**
18+50.00	2.00	4.80	179.7	1.0	0.1	1.7	41.6	33.2	8.4	**2.00**
18+28.98	2.05	5.27	172.4	1.0	0.1	1.8	42.6	33.5	9.1	**2.06**
18+07.37	2.06	5.60	154.0	1.0	0.1	1.9	43.5	33.9	9.6	**2.07**
17+70.07	2.14	5.39	117.0	1.0	0.1	1.9	45.4	36.2	9.2	**2.14**
17+65.90	2.05	5.36	113.4	1.0	0.2	2.0	45.3	36.0	9.3	**2.05**
17+63.38	2.01	5.42	113.1	1.0	0.2	2.0	45.3	35.9	9.5	**2.02**
17+50.00	1.54	5.63	110.9	1.0	0.2	2.1	44.8	34.1	10.7	**1.54**

1) From HEC-RAS Calcs
2) Reynold's Number
   Re = VD/υ
   where: υ=kinematic viscosity (ft^2/s) = 1.22E-05
3) Roll wave heights (per "Slug and Pulsating Flow in High Gradient Channel" by James Guo, Journal of IWRA Water International, Vol. 24, No. 1, March 1999)
   a) $y_2=h+y_1$ (Eq. 12 modified) where: h=estimated roll wave height (ft)
      y_1=water depth without roll wave
   b) $A_2=y_2(b+y_2z)$ (basic trapezoid area)
      where: b= bottom width
      z=channel side slope (x:1)
   c) $k = (1+z^2)^{1/2}$ (Eq. 3)
   d) $Y^* = y/b$ (Eq. 6) where: y=water depth
   e) $$F_1 = \frac{3[(1+2kY^*)(1+2zY^*)]}{2[1+2zY^*+2kzY^{*2}]}$$ (Eq. 5)
   f) $$V_w=V_1+\left[\frac{(A_2c_2-A_1c_1)g}{A_1(1-A_1/A_2)}\right]^{1/2}$$ (Eq. 11)
      where: Subscript $_1$= design condition from HEC-RAS
      Subscript $_2$= design condition including roll waves
      V=velocity
      A=flow area
      c=depth to centroid of flow (approximated by 0.5y)
      g=32.2 ft/s^2
   g) $V_2=[(V_1-V_w)A_1+V_wA_2]/A_2$ (Eq. 9)
   h) $C=V_w-V_2$ (Eq. 13)
   i) $$h=\frac{C^2 2y_1(F_2-F_1)}{g\,(y_1+y_2)}$$ (Eq. 14)