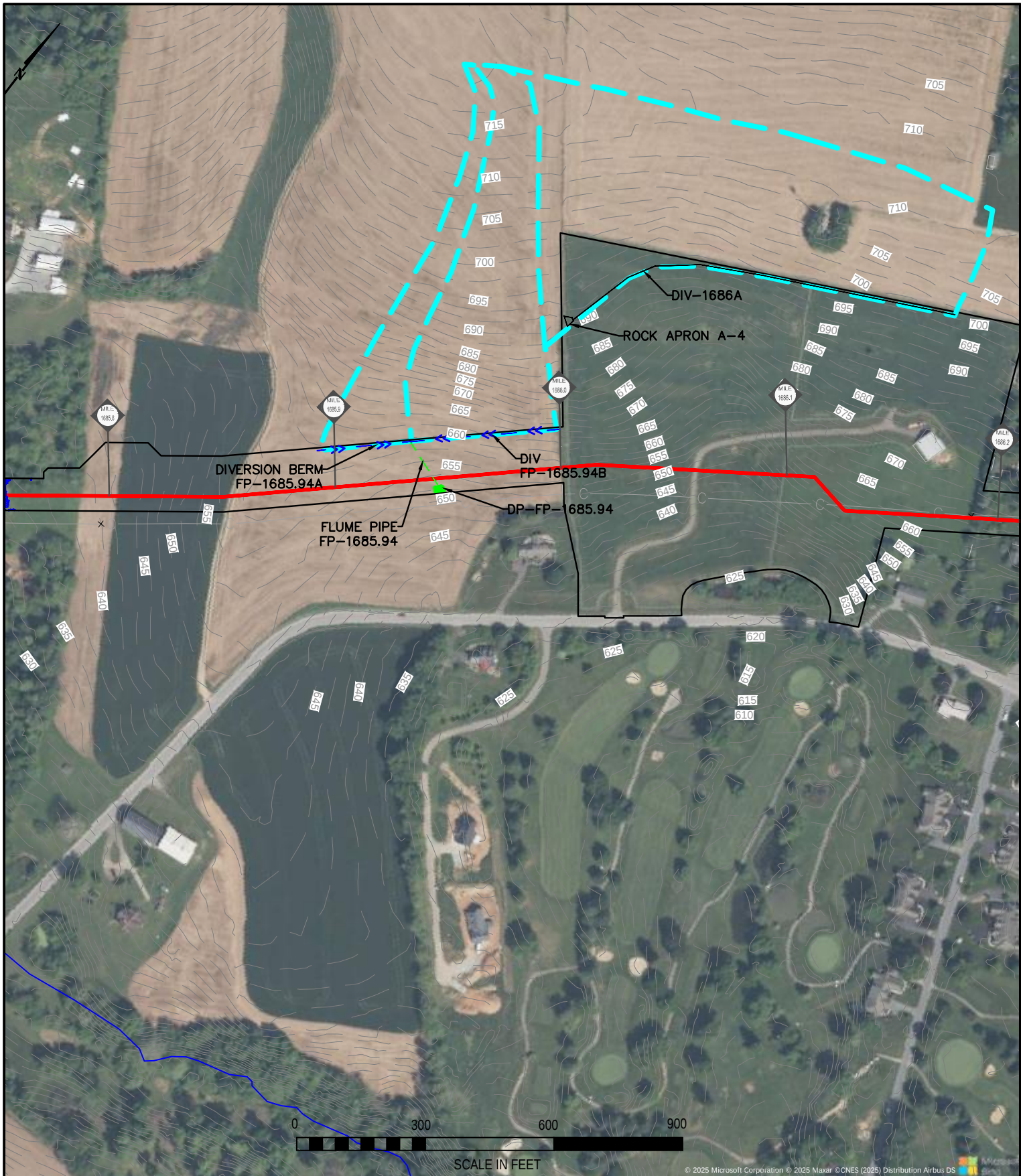




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AECOM

625 WEST RIDGE PIKE, SUITE E-100
CONSHOHOCKEN, PA 19428
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LEGEND

DIVERSION BERM

FLUME PIPE AND RIP RAP OUTLET BASIN

FLUME PIPE DRAINAGE AREA

TRANSCONTINENTAL GAS PIPE LINE COMPANY, LLC.
NORTHEAST SUPPLY ENHANCEMENT PROJECT
PROPOSED 42" QUARRYVILLE LOOP



BYPASS FLUME PIPE DRAINAGE AREA MAP
LANCASTER COUNTY, PENNSYLVANIA

REVISIONS						DRAWN BY: CB		DATE: 03/01/18		ISSUED FOR BID: TBD		SCALE: AS SHOWN	
NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.	CHECKED BY: PPH	DATE: 03/01/18	ISSUED FOR CONSTRUCTION: TBD		REVISION: 0		
0	03/01/2018	CB	REVISED PER LCCD CHAPTER 102 REVIEW	1185726	PPH	PPH	APPROVED BY: PPH	DATE: 03/01/18	DRAWING NUMBER: FP-1685.94				
1	07/08/2025	ZPH	REVISED PER DEP COMMENTS	1185726	MG	PPH							
2	08/22/2025	ZPH	REVISED PER DEP COMMENTS	1185726	MG	PPH		NO. 1185726					
3	09/05/2025	ZPH	REVISED PER DEP COMMENTS	1185726	MG	PPH							

DRAWING NUMBER: FP-1685.94

STANDARD E&S WORKSHEET #9

Determination of Time of Concentration (T_c)

PROJECT NAME: Northeast Supply Enhancement - Quarryville Loop
 LOCATION: Drumore Township, Lancaster County, PA
 PREPARED BY: CRB DATE: 2/21/18
 REVISED BY: MAG DATE: 9/5/25

FP-1685.94B

OVERLAND FLOW:

PATH NUMBER	Length L (ft)	"n" VALUE	AVG. SLOPE (S) (ft/ft)	TIME (minutes)
A-B	100	0.4	0.01	13.60

$$T_{c(\text{sheet flow})} = \left[\frac{2.48 L^{0.76}}{S^{0.48}} \right]^{0.4673}$$

n Type of Cover
 0.02 smooth pavement
 0.1 bare parched soil
 0.3 poor grass cover
 0.4 average grass cover
 0.8 dense grass cover
 (L = 150' maximum)

SHALLOW CONCENTRATED FLOW:

PATH NUMBER	Length (ft)	TYPE OF COVER	AVG. SLOPE (ft/ft)	V (ft/sec)	TIME (minutes)
B-C	195	Meadow	0.06	1.60	2.03
D-F	775	Meadow	0.07	1.80	7.18

CHANNEL FLOW:

PATH NUMBER	Length (ft)	AREA (sq. ft.)	AVG. SLOPE (ft/ft)	WETTED PERIMETER (ft)	HYDRAULIC RADIUS (ft)	MANNING'S n	V (ft/sec)	CHANNEL TIME (minutes)	T_c^* (minutes)
C-D	810	7.75	0.01	27	0.56	0.034	3.12	4.33	27.90
F-G	160	7.75	0.01	27	0.56	0.029	3.49	0.76	

CHANNEL DIMENSIONS:

PATH NUMBER	BOTTOM WIDTH (ft)	LEFT SIDE SLOPE (H:V)	RIGHT SIDE SLOPE (H:V)	TOTAL DEPTH (ft)	TOP WIDTH (ft)
D-E	2	1.5	10	1.5	19.3
F-G	2	1.5	10	1.5	19.3

STANDARD E&S WORKSHEET #10 (Modified)

Determination of Peak Runoff (Q) Using the Rational Formula

PROJECT NAME: Northeast Supply Enhancement - Quarryville Loop

LOCATION: Drumore Township, Lancaster County, PA

PREPARED BY: CRB DATE: 2/21/18

REVISED BY: MAG DATE: 9/5/25

DETERMINE WATERSHED "C" VALUES

DRAINAGE AREA	DRAINAGE AREA NUMBER	TYPE OF COVER	C VALUE	AREA (acres)	(C x A)	C _w
FP-1685.94B	A	Meadow	0.30	2.60	0.78	0.30
	B	Meadow (DIV-168A)	0.30	8.26	2.48	
	C					
	TOTAL			10.86	3.26	

DETERMINE RAINFALL INTENSITY

DRAINAGE AREA	T _c	Rainfall Depth R ₂	R ₅	R ₁₀	Rainfall Intensity I ₂	I ₅	I ₁₀
FP-1685.94B	27.90		1.10			2.9	3.3

DETERMINE PEAK FLOW RATES (Q = C x I x A)

DRAINAGE AREA	C _w	A (acres)	Q ₂ (cfs)	Q ₅ (cfs)	Q ₁₀ (cfs)
FP-1685.94B	0.30	10.86		9.38	10.88

STANDARD E&S WORKSHEET #11

Channel Design Data

PROJECT NAME: Northeast Supply Enhancement - Quarryville Loop
LOCATION: Lancaster County, PA
PREPARED BY: CRB DATE: 2/21/2018
REVISED BY: MAG DATE: 9/5/2025

CHANNEL OR CHANNEL SECTION		BYPASS FLUME PIPE FP - 1685.94	
TEMPORARY OR PERMANENT	(T OR P)	T	T
DESIGN STORM	(2, 5, 10 OR 25 YR)	5	5
ACRES	(AC)	0.85	10.86
MULTIPLIER	(1.6, 2.25. or 2.75) ¹	N/A	N/A
Q _r (REQUIRED CAPACITY)	(CFS)	0.84	9.38
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	0.84	9.38
PROTECTIVE LINING ²		P300	P300
n (MANNING'S COEFFICIENT) ²		0.034	0.031
V _a (ALLOWABLE VELOCITY)	(FPS)	9.0	9.0
V (CALCULATED AT FLOW DEPTH d)	(FPS)	1.3	3.1
τ _a (MAX ALLOWABLE SHEAR STRESS)	(LB/FT ²)	3.0	3.0
τ _d (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT ²)	N/A	N/A
CHANNEL BOTTOM WIDTH	(FT)	0.0	2.0
Z ₁ - CHANNEL SIDE SLOPES	(H:V)	1.5	1.5
Z ₂ - CHANNEL SIDE SLOPES	(H:V)	10	3
D (TOTAL DEPTH)	(FT)	1.5	1.5
CHANNEL TOP WIDTH @ D	(FT)	17.3	8.8
d (CALCULATED FLOW DEPTH)	(FT)	0.33	0.80
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	3.8	5.6
BOTTOM WIDTH:FLOW DEPTH RATIO	(12:1 MAX)	0.00	2.49
d ₅₀ STONE SIZE	(IN)	N/A	N/A
A (CROSS-SECTIONAL AREA)	(SQ. FT)	0.64	3.07
R - HYDRAULIC RADIUS		0.16	0.51
S (BED SLOPE) ³	(FT/FT)	0.01	0.01
S _c (CRITICAL SLOPE)	(FT/FT)	0.0318	0.0188
0.7S _c	(FT/FT)	0.0223	0.0132
1.3S _c	(FT/FT)	0.0413	0.0245
STABLE FLOW?	(Y/N)	Y	Y
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	0.03	0.18
FREEBOARD BASED ON STABLE FLOW	(FT)	0.08	0.20
MINIMUM REQUIRED FREEBOARD ⁴	(FT)	0.50	0.50
PROVIDED FREEBOARD	(FT)	1.17	0.70
DESIGN METHOD FOR PROTECTIVE LINING ⁵		V	V
PERMISSABLE VELOCITY(V) OR SHEAR STRESS (S)			

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in separate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft or 1/4 Total Channel Depth, whichever is greater.
5. Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

FLUME PIPE SUMMARY

PROJECT NAME:	Northeast Supply Enhancement - Quarryville Loop		
LOCATION:	Lancaster County, PA		
PREPARED BY:	MAG		DATE: 7/8/2025
REVISED BY:	MAG		DATE: 9/5/2025

FLUME PIPE NO.	LENGTH (FT)	INV. IN. (ELEV)	INV. OUT. (ELEV)	PIPE SLOPE (%)	MATERIAL	MANNING'S "n" FOR PIPE	# OF PIPES	PIPE DIA. D _o (IN.)	FLOW DEPTH d (IN.)	V (FPS)	Q CAPACITY (CFS)	Q REQUIRED (5-YR) (CFS)	Q REQUIRED (10-YR) (CFS)
FP-1681.00	336	484.50	475.00	2.8%	HDPE	0.012	1	12	12	8.3	6.51	2.46	2.83
FP-1682.07	68	608.00	596.50	16.9%	HDPE	0.012	3	12	12	6.8	15.92	0.62	0.71
FP-1682.18	79	618.00	608.00	12.7%	HDPE	0.012	2	12	12	8.8	13.77	0.29	0.33
FP-1682.25	96	611.00	603.00	8.3%	HDPE	0.012	2	12	12	7.1	11.17	2.90	3.30
FP-1682.82	118	599.00	597.00	1.7%	HDPE	0.012	2	18	18	4.2	14.85	10.06	11.67
FP-1683.19	113	607.50	602.50	4.4%	HDPE	0.012	2	12	12	5.2	8.14	0.81	0.93
FP-1683.61	127	545.00	539.00	4.7%	HDPE	0.012	2	12	12	5.4	8.41	0.47	0.53
FP-1683.71	100	543.00	523.00	20.0%	HDPE	0.012	3	12	12	7.3	17.31	2.87	3.27
FP-1683.79	192	542.00	532.00	5.2%	HDPE	0.012	2	18	18	7.4	26.04	10.34	11.76
FP-1684.12	123	608.00	599.00	7.3%	HDPE	0.012	2	12	12	6.7	10.47	3.36	3.80
FP-1684.28	153	632.00	627.00	3.3%	HDPE	0.012	1	12	12	8.9	7.00	0.99	1.13
FP-1685.94	125	659.50	652.50	5.6%	HDPE	0.012	2	18	18	7.6	27.00	10.22	11.85
FP-1686.75	238	624.00	621.00	1.3%	HDPE	0.012	1	12	12	5.5	4.35	1.19	1.40
FP-1686.89	110	638.50	631.00	6.8%	HDPE	0.012	2	12	12	6.4	10.11	0.84	0.98
FP-1686.96	105	650.00	640.00	9.5%	HDPE	0.012	2	12	12	7.6	11.94	0.30	0.35
FP-1687.08	110	652.00	646.50	5.0%	HDPE	0.012	2	12	12	5.5	8.65	1.62	1.86
FP-1688.05	162	654.50	651.50	1.9%	HDPE	0.012	1	18	18	8.8	15.53	5.84	6.93
FP-1689.86	101	648.00	643.00	5.0%	HDPE	0.012	2	18	18	7.2	25.39	9.57	11.26
FP-1690.53	166	608.50	605.00	2.1%	HDPE	0.012	1	12	12	7.2	5.62	1.33	1.48
FP-1683.40	220	605.00	580.00	11.4%	HDPE	0.012	2	12	12	8.3	13.05	5.92	6.39

STANDARD E & S CONSTRUCTION DETAIL # 8-6

Rip Rap Outlet Basin - 10 Year Storm

PROJECT NAME: Northeast Supply Enhancement - Quarryville Loop

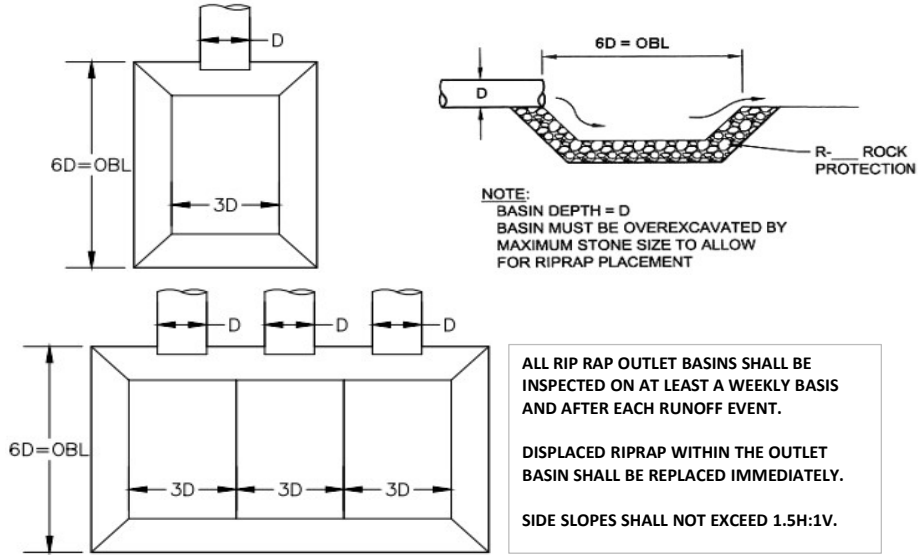
LOCATION: Lancaster County, PA

PREPARED BY: MAG

DATE: 7/8/2025

REVISED BY: MAG

DATE: 9/5/2025



OUTLET NO.	PIPE DIA. D (ft)	# OF PIPES	BASIN LENGTH 6D = OBL	BASIN WIDTH 3D (ft)	BASIN DEPTH D (ft)	RIP RAP SIZE	RIP RAP THICKNESS (ft)	INFLOW VELOCITY (ft/s)		OUTFLOW VELOCITY (ft/s)		FLOW RATE (ft ³ /s)	H (ft)	OUTFLOW SHEAR STRESS (lb/ft ²)	
								ACTUAL	MAX	ACTUAL ¹	MAX			ACTUAL ²	MAX
FP-1681.00	1.0	1	6.0	3.0	1.0	R-4	1.50	8.3	9.0	1.8	3.0	2.83	0.52	N/A	1.0
FP-1682.07	1.0	3	6.0	9.0	1.0	R-4	1.50	6.8	9.0	0.8	3.0	0.71	0.10	0.7	1.0
FP-1682.18	1.0	2	6.0	6.0	1.0	R-4	1.50	8.8	9.0	0.7	3.0	0.33	0.08	N/A	1.0
FP-1682.25	1.0	2	6.0	6.0	1.0	R-4	1.50	7.1	9.0	1.5	3.0	3.30	0.36	N/A	1.0
FP-1682.82	1.5	2	9.0	9.0	1.5	R-3	0.75	4.2	6.5	2.0	3.0	11.67	0.65	N/A	1.0
FP-1683.19	1.0	2	6.0	6.0	1.0	R-3	0.75	5.2	6.5	1.0	3.0	0.93	0.16	N/A	1.0
FP-1683.61	1.0	2	6.0	6.0	1.0	R-3	0.75	5.4	6.5	0.8	3.0	0.53	0.11	N/A	1.0
FP-1683.71	1.0	3	6.0	9.0	1.0	R-4	1.50	7.3	9.0	1.3	3.0	3.27	0.28	N/A	1.0
FP-1683.79	1.5	2	9.0	9.0	1.5	R-4	1.50	7.4	9.0	2.0	3.0	11.76	0.65	N/A	1.0
FP-1684.12	1.0	2	6.0	6.0	1.0	R-4	1.50	6.7	9.0	1.6	3.0	3.80	0.40	N/A	1.0
FP-1684.28	1.0	1	6.0	3.0	1.0	R-4	1.50	8.9	9.0	1.3	3.0	1.13	0.28	N/A	1.0
FP-1685.94	1.5	2	9.0	9.0	1.5	R-4	1.50	7.6	9.0	2.0	3.0	11.85	0.65	N/A	1.0
FP-1686.75	1.0	1	6.0	3.0	1.0	R-3	0.75	5.5	6.5	1.4	3.0	1.40	0.33	N/A	1.0
FP-1686.89	1.0	2	6.0	6.0	1.0	R-3	0.75	6.4	6.5	1.0	3.0	0.98	0.16	N/A	1.0
FP-1686.96	1.0	2	6.0	6.0	1.0	R-4	1.50	7.6	9.0	0.7	3.0	0.35	0.08	N/A	1.0
FP-1687.08	1.0	2	6.0	6.0	1.0	R-3	0.75	5.5	6.5	1.2	3.0	1.86	0.25	N/A	1.0
FP-1688.05	1.5	1	9.0	4.5	1.5	R-4	1.50	8.8	9.0	2.1	3.0	6.93	0.72	N/A	1.0
FP-1689.86	1.5	2	9.0	9.0	1.5	R-4	1.50	7.2	9.0	2.0	3.0	11.26	0.63	N/A	1.0
FP-1690.53	1.0	1	6.0	3.0	1.0	R-4	1.50	7.2	9.0	1.5	3.0	1.48	0.34	N/A	1.0
FP-1683.40	1.0	2	6.0	6.0	1.0	R-4	1.50	8.3	9.0	1.8	3.0	5.92	0.54	N/A	1.0

1. $V = Q \times A$

WHERE Q = REQUIRED CAPACITY (FROM FLUME PIPE CALCS), A = W (OUTLET BASIN WIDTH) X H (FLOW DEPTH)

H IS SOLVED FOR USING THE BROAD CRESTED WEIR EQUATION $Q = C L H^{1.5}$, WHERE Q = REQUIRED CAPACITY (FROM FLUME PIPE CALCS), C = 2.5, L = W (OUTLET BASIN WIDTH)

2. OUTFLOW SHEAR STRESS = $62.4H \times \text{slope}$ (E&S Manual, ch.6)