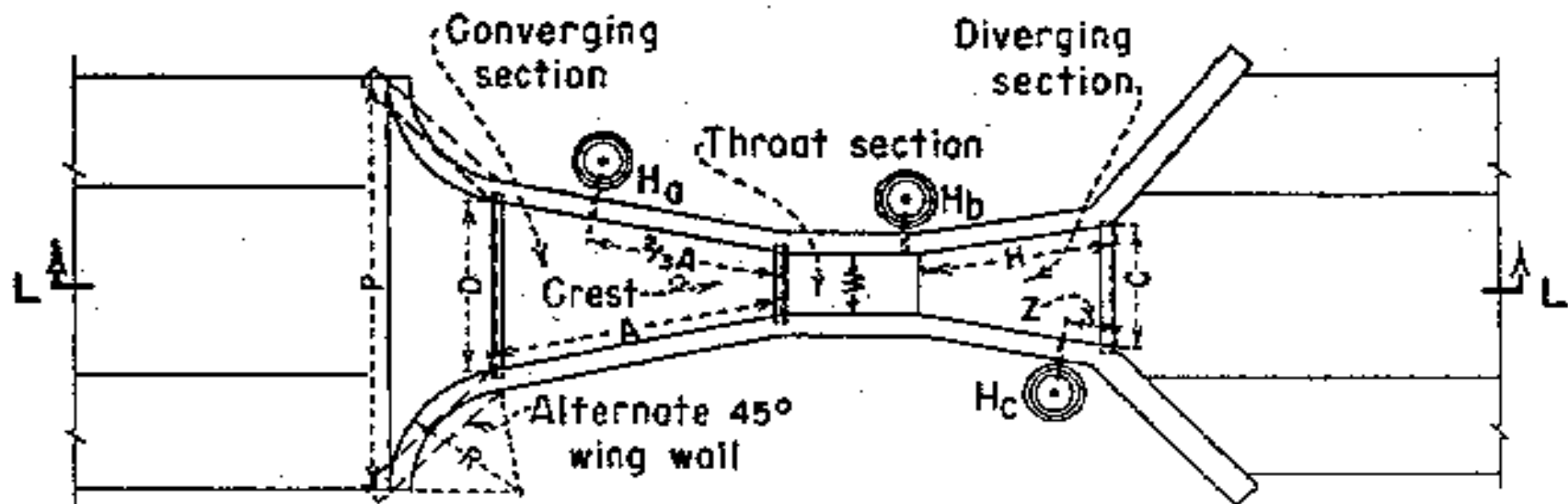


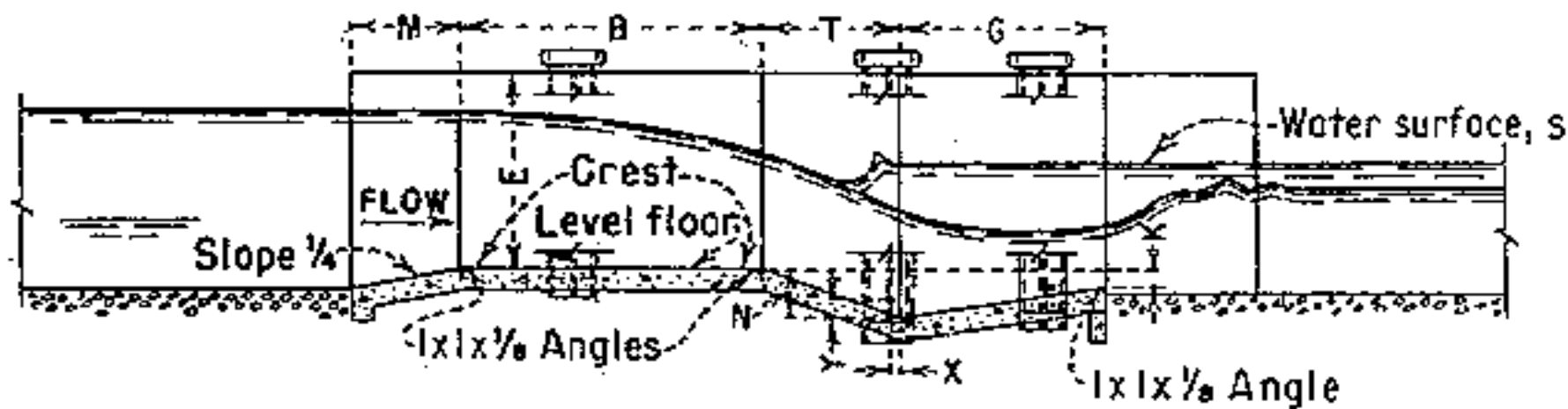
FLOW MEASUREMENT CALIBRATION CHECKS

NPDES INSPECTION WORKSHOP





PLAN



SECTION L-L

	W		A		2/3A		B		C		D		E		T		G		H		K		M		N		P		R		X		Y		Z		FREE-FLOW CAPACITY	
																																			MINIMUM		MAXIMUM	
	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.	SEC.-FT.	SEC.-FT.
2'	0	1 ^{1/2}	1	2 ^{3/32}	0	9 ^{17/32}	1	2	0	3 ^{31/32}	0	6 ^{13/32}	0	6 ^{10/9}	0	3	0	8	0	8 ^{1/8}	0	7/8	-	-	0	1 ^{1/8}	-	-	0	5/16	0	1/2	0	1/8	0.01	0.19		
		2 ^{1/2}	1	4 ^{5/16}	1	10 ^{7/8}	1	4		5 ^{5/8}		8 ^{13/32}		6 ^{10/10}		4 ^{1/2}		10		10 ^{1/8}		7/8	-	-		1 ^{11/16}	-	-		5/8		1	1/4	.02	.47			
		3 ^{1/2}	1	6 ^{3/8}	1	1 ^{1/4}	1	6		7		10 ^{7/16}		1 ^{10/16}		6		1		1	1 ^{5/32}		1	-	-		2 ^{1/4}	-	-		1		1 ^{1/2}	1/2	.03	1.13		
3'	0	6	2	1 ^{7/16}	1	4 ^{5/8}	2	0	1	3 ^{1/2}	1	3 ^{5/8}	2	0	1	0	2	0	-	0	3	1	0	0	4 ^{1/2}	2	11 ^{1/2}	1	4	0	2	0	3	-	.05	3.9		
		9	2	10 ^{5/8}	1	11 ^{1/8}	2	10	1	3	1	10 ^{5/8}	2	6	1	0	1	6	-	0	3	1	0		4 ^{1/2}	3	6 ^{1/2}	1	4	2	2	3	-	.09	8.9			
		1	0	4	6	3	0	4	4 ^{7/8}	2	0	2	9 ^{1/4}	3	0	2	0	3	0	-	3	1	3		9	4	10 ^{3/4}	1	8	2	2	3	-	.11	16.1			
		1	6	4	9	3	2	4	7 ^{7/8}	2	6	3	4 ^{3/8}	3	0	2	0	3	0	-	3	1	3		9	5	6	1	8	2	2	3	-	.15	24.6			
		2	0	5	0	3	4	4	10 ^{7/8}	3	0	3	11 ^{1/2}	3	0	2	0	3	0	-	3	1	3		9	6	1	1	8	2	2	3	-	.42	33.1			
		3	0	5	6	3	8	5	4 ^{3/4}	4	0	5	1 ^{7/8}	3	0	2	0	3	0	-	3	1	3		9	7	3 ^{1/2}	1	8	2	2	3	-	.61	50.4			
		4	0	6	0	4	0	5	10 ^{5/8}	5	0	6	4 ^{1/4}	3	0	2	0	3	0	-	3	1	6		9	8	10 ^{3/4}	2	0	2	2	3	-	1.3	67.9			
		5	0	6	6	4	4	6	4 ^{1/2}	6	0	7	6 ^{5/8}	3	0	2	0	3	0	-	3	1	6		9	10	1 ^{1/4}	2	0	2	2	3	-	1.6	85.6			
		6	0	7	0	4	8	6	10 ^{3/8}	7	0	8	9	3	0	2	0	3	0	-	3	1	6		9	11	3 ^{1/2}	2	0	2	2	3	-	2.6	103.5			
	7	0	7	6	5	0	7	4 ^{1/2}	8	0	9	11 ^{5/8}	3	0	2	0	3	0	-	3	1	6		9	12	6	2	0	2	2	3	-	3.0	121.4				
	8	0	8	0	5	4	7	10 ^{1/8}	9	0	11	1 ^{3/4}	3	0	2	0	3	0	-	3	1	6		9	13	8 ^{1/4}	2	0	2	2	3	-	3.5	139.5				
4'	10	0	-		6	0	14	0	12	0	15	7 ^{1/4}	4	0	3	0	6	0	-	0	6	-		1	1 ^{1/2}	-	-	0	9	1	0	-	6	200				
		12	0	-		6	8	16	0	14	8	18	4 ^{3/4}	5	0	3	0	8	0	-	6	-		1	1 ^{1/2}	-	-		9	1	0	-	8	350				
		15	0	-		7	8	25	0	18	4	25	0	6	0	4	0	10	0	-	9	-		1	6	-	-		9	1	0	-	8	600				
		20	0	-		9	4	25	0	24	0	30	0	7	0	6	0	12	0	-	1	0	-		2	3	-	-		9	1	0	-	10	1000			
		25	0	-		11	0	25	0	29	4	35	0	7	0	6	0	13	0	-	1	0	-		2	3	-	-		9	1	0	-	15	1200			
		30	0	-		12	8	26	0	34	8	40	4 ^{3/4}	7	0	6	0	14	0	-	1	0	-		2	3	-	-		9	1	0	-	15	1500			
		40	0	-		16	0	27	0	45	4	50	9 ^{1/2}	7	0	6	0	16	0	-	1	0	-		2	3	-	-		9	1	0	-	20	2000			
	50	0	-		19	4	27	0	56	8	60	9 ^{1/2}	7	0	6	0	20	0	-	1	0	-		2	3	-	-		9	1	0	-	25	3000				

1 Tolerance on throat width (w) ± 1/64 inch; tolerance on other dimensions ± 1/32 inch.
Sidewalls of throat must be parallel and vertical.

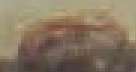
2 From U.S. Department of Agriculture Soil Conservation Circular No. 843.

3 From Colorado State University Technical Bulletin No. 61.

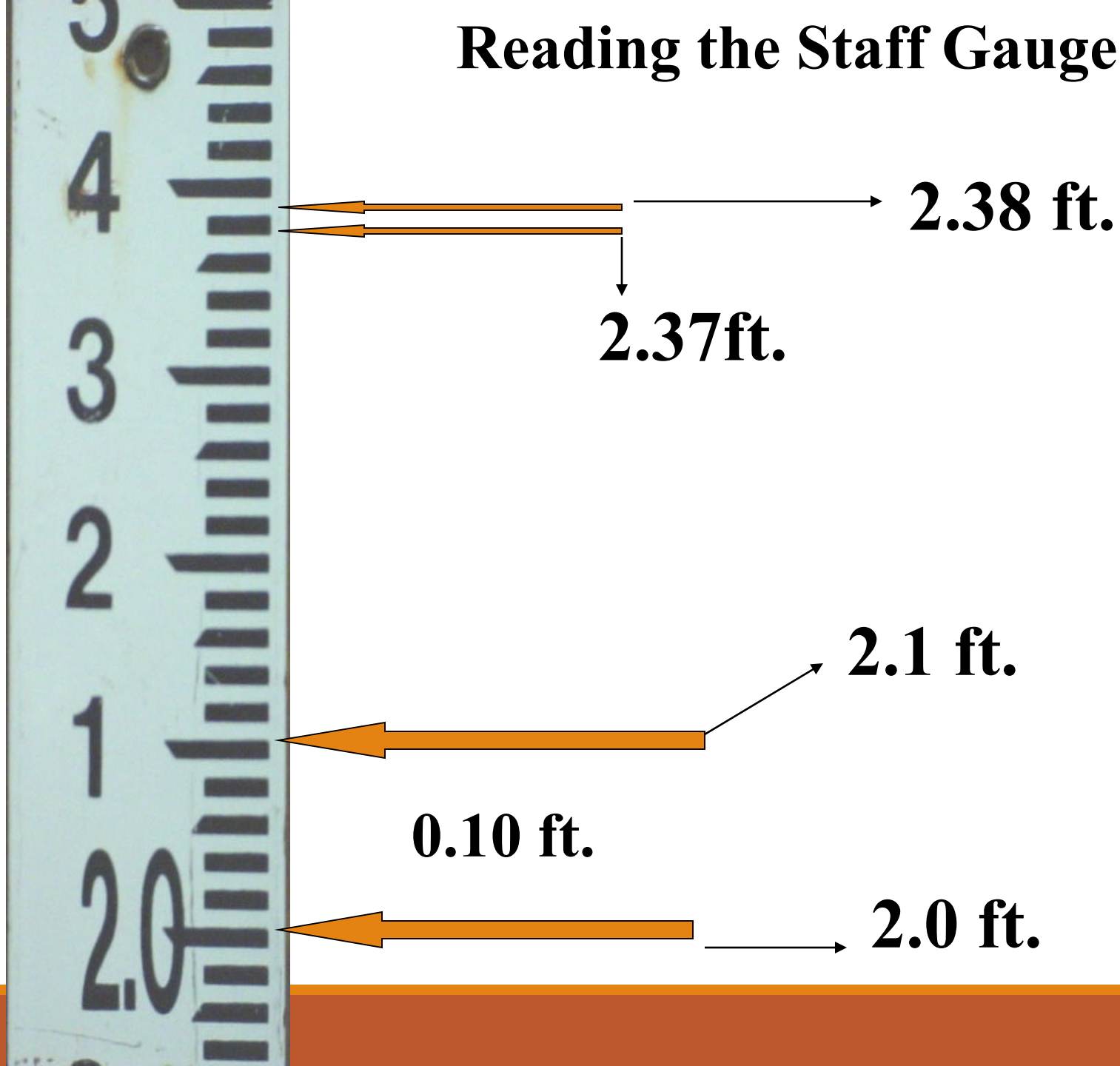
4 From Colorado State University Bulletin No. 426-A

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Reading the Staff Gauge



12-9: 3 ft. Parshall Flume Discharge Table (Continued)

Formulas: $CFS = 12.00H^{1.566}$

$GPM = CFS \times 448.8$

$GPS = CFS \times 7.481$

$MGD = CFS \times 0.6463$

Head Feet	CFS	GPS	GPM	MGD	Head Feet	CFS	GPS	GPM	MGD
2.01	35.81	267.9	16070	23.14	2.51	50.71	379.3	22760	32.77
2.02	36.09	270.0	16200	23.32	2.52	51.02	381.7	22900	32.98
2.03	36.37	272.1	16320	23.50	2.53	51.34	384.1	23040	33.18
2.04	36.65	274.2	16450	23.69	2.54	51.66	386.5	23180	33.39
2.05	36.93	276.3	16570	23.87	2.55	51.98	388.9	23330	33.59
2.06	37.21	278.4	16700	24.05	2.56	52.30	391.2	23470	33.80
2.07	37.50	280.5	16830	24.23	2.57	52.62	393.6	23620	34.01
2.08	37.78	282.6	16960	24.42	2.58	52.94	396.0	23760	34.21
2.09	38.07	284.8	17080	24.60	2.59	53.26	398.4	23900	34.42
2.10	38.35	286.9	17210	24.79	2.60	53.58	400.9	24050	34.63
2.11	38.64	289.0	17340	24.97	2.61	53.91	403.2	24200	34.84

Flow Measurement Problem # 1

Primary device : 3 ft. Parshall flume

Head measurement location : 40 " upstream
from throat

Head (actual) : SEE BELOW

Instantaneous flow from display : 20.67 mgd

Determine –

Correct head measurement location _____

Correct instantaneous flow (mgd) _____

Percent error of flow meter (%) _____



Water level

$\% \text{ error} = \frac{\text{actual flow} - \text{displayed flow}}{\text{actual flow}} \times 100$

Flow Measurement Problem # 1

Primary device : 3 ft. Parshall flume

Head measurement location : 40 " upstream
from throat

Head (actual) : SEE BELOW

Instantaneous flow from display : 20.67 mgd

Determine –

Correct head measurement location = **44 "**

Correct instantaneous flow = **23.69 mgd**

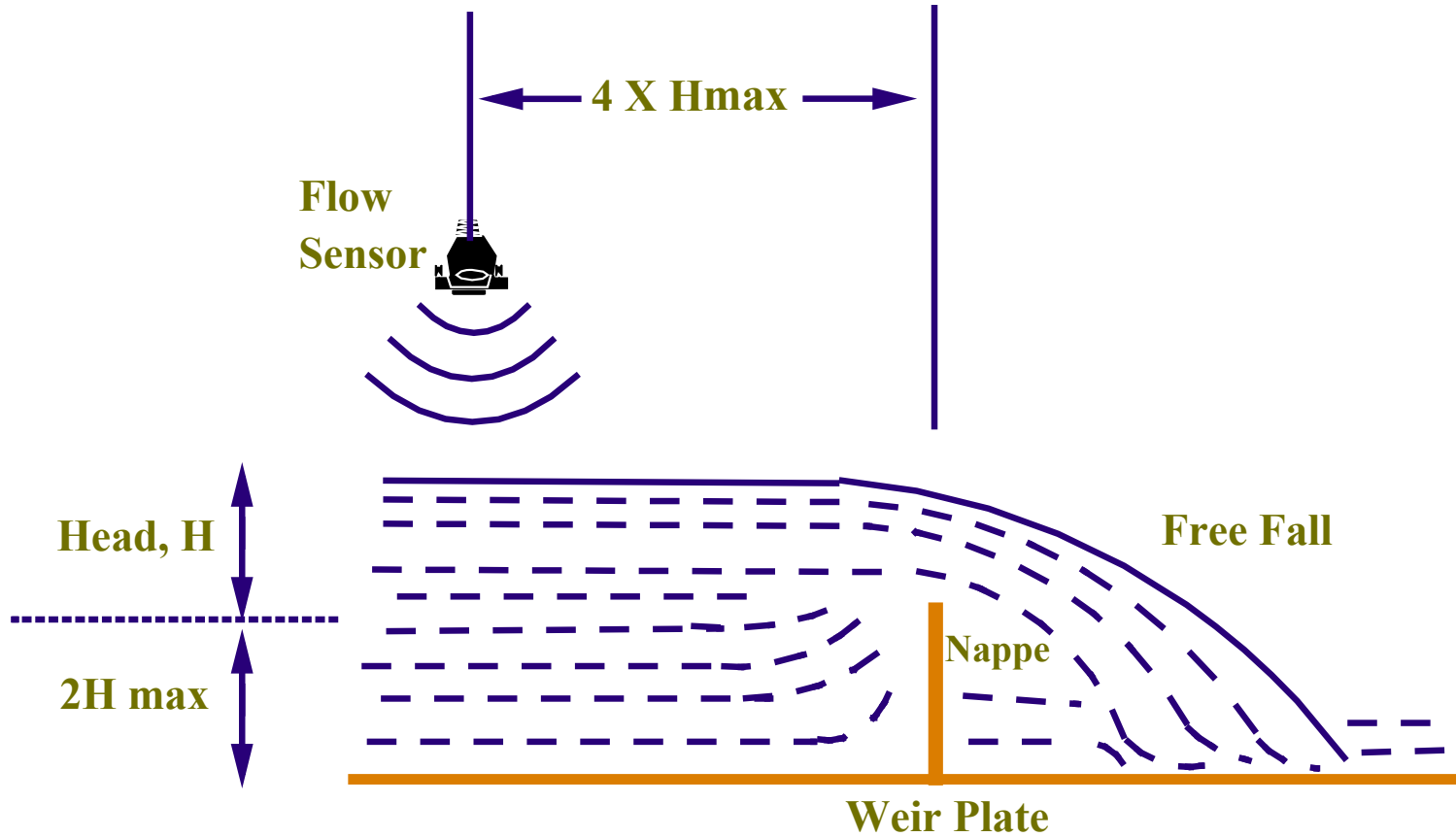
Percent error of flow meter = **12.7 %**



Water level = **2.04 ft.**

$$(23.69 - 20.67) / 23.69 = .127 * 100$$
$$= \mathbf{12.7 \% \text{ low}}$$

Standard Weir Specifications





Flow Measurement Problem # 2

Primary device : 90 degree V – notch weir
Head measurement location : 3 ft. upstream of
weir

Head (actual) : SEE BELOW

Instantaneous flow from display : 9.02 mgd

Determine –

Correct head measurement location _____

Correct instantaneous flow (mgd) _____

Percent error of flow meter (%) _____

$\% \text{ error} = \frac{\text{actual flow} - \text{displayed flow}}{\text{actual flow}} \times 100$



Water level

Flow Measurement Problem # 2

Primary device : 90 degree V – notch weir
Head measurement location : 3 ft. upstream of
weir

Head (actual) : SEE BELOW

Instantaneous flow from display : 9.02 mgd

Determine –

Correct head measurement location = **7.8 ft.**

Correct instantaneous flow = **8.58 mgd**

Percent error of flow meter = **5 % high**

$$(9.02 - 8.58) / 8.58 = 0.05$$

$$0.05 * 100 = 5 \%$$



Water level = **1.95 ft**

8-5: 90° V-notch Weir Discharge Table (Continued)

Formulas: CFS = 2.500H^{2.5}
 GPM = CFS x 448.8

GPS = CFS x 7.481
 MGD = CFS x 0.6463

Head Feet	CFS	GPS	GPM	MGD	Head Feet	CFS	GPS	GPM	MGD
1.25	4.367	32.67	1980	2.823	1.75	10.13	75.77	4546	6.546
1.26	4.455	33.33	1999	2.879	1.76	10.27	76.86	4611	6.640
1.27	4.544	33.99	2039	2.937	1.77	10.42	77.95	4677	6.735
1.28	4.634	34.67	2080	2.995	1.78	10.57	79.06	4743	6.830
1.29	4.725	35.35	2121	3.054	1.79	10.72	80.17	4810	6.926
1.30	4.817	36.04	2162	3.113	1.80	10.87	81.30	4877	7.024
1.31	4.910	36.73	2204	3.174	1.81	11.02	82.43	4945	7.121
1.32	5.005	37.44	2246	3.235	1.82	11.17	83.58	5014	7.220
1.33	5.100	38.15	2289	3.296	1.83	11.33	84.73	5083	7.320
1.34	5.196	38.87	2332	3.358	1.84	11.48	85.89	5153	7.420
1.35	5.294	39.60	2376	3.421	1.85	11.64	87.06	5223	7.521
1.36	5.392	40.34	2420	3.485	1.86	11.80	88.24	5294	7.624
1.37	5.492	41.09	2465	3.550	1.87	11.95	89.43	5365	7.726
1.38	5.593	41.84	2510	3.615	1.88	12.12	90.63	5437	7.830
1.39	5.695	42.60	2556	3.681	1.89	12.28	91.84	5510	7.935
1.40	5.798	43.37	2602	3.747	1.90	12.44	93.06	5583	8.040
1.41	5.902	44.15	2649	3.814	1.91	12.60	94.29	5657	8.146
1.42	6.007	44.94	2696	3.882	1.92	12.77	95.53	5731	8.253
1.43	6.113	45.73	2744	3.951	1.93	12.94	96.78	5806	8.361
1.44	6.221	46.54	2792	4.021	1.94	13.11	98.04	5882	8.470
1.45	6.329	47.35	2841	4.091	1.95	13.27	99.31	5958	8.579
1.46	6.439	48.17	2890	4.162	1.96	13.45	100.6	6034	8.690
1.47	6.550	49.00	2940	4.233	1.97	13.62	101.9	6112	8.801
1.48	6.662	49.84	2990	4.306	1.98	13.79	103.2	6190	8.913
1.49	6.775	50.68	3041	4.379	1.99	13.97	104.5	6268	9.026
1.50	6.889	51.54	3092	4.452	2.00	14.14	105.8	6347	9.140

