


January 1988

Friction Factor Tests on High Density Polyethylene Pipe

Steven L. Barfuss

J. Paul Tullis

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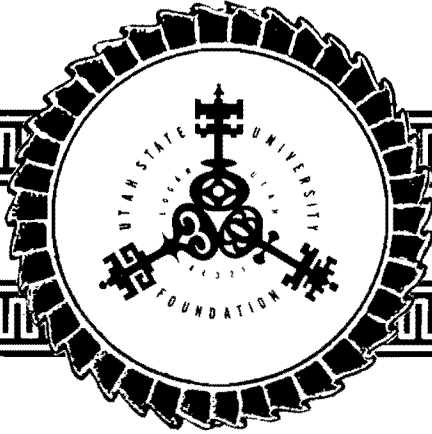
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Utah State University Foundation

Report on

FRICION FACTOR TESTS ON HIGH DENSITY POLYETHYLENE PIPE

Submitted to:

Prinsco, Inc.
W Hwy 7
Prinsburg, MN 56281

By:

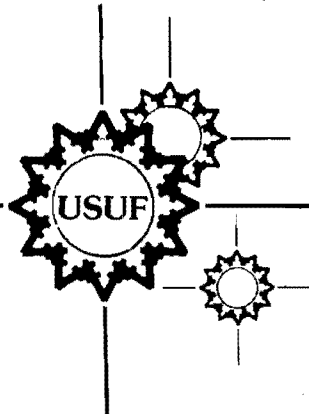
Steven L. Barfuss

Utah Water Research Laboratory

Utah State University Foundation
Logan, Utah 84322-9300

October 1988

Hydraulics Report No. 204



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INTRODUCTION

Friction factor tests were conducted at the Utah Water Research Laboratory, at Utah State University on 12 inch, 15 inch and 18 inch diameter high-density polyethylene pipe (HDPE) with a ribbed interior. The pipe was furnished in 20 ft lengths. Pipe joints were sealed using Canusa heat shrink wrap. The heat shrink wrap was also used to connect the HDPE pipe to steel pipe in the laboratory to prevent leakage during testing. The pipes were tested for full pipe flow at velocities between about 2 and 15 fps.

FACILITIES AND PROCEDURES

One hundred-twenty feet of 18 inch, one hundred feet of 15 inch, and eighty feet of 12 inch HDPE pipe was tested. Figures A through C illustrate a schematic drawing of the installation. The pipe was connected to the 48 inch supply line reduced to 18 inch steel pipe at the laboratory. Water was supplied by gravity flow from a small reservoir. Pressure was controlled to remain within a 4 psi maximum. Flow was controlled with a downstream 16 inch butterfly valve in addition to the main upstream 48 inch supply valve.

Three sets of piezometer taps were installed as shown in figures A through C. The first set of pressure taps was installed downstream from the first 40 ft, 24 ft, and 37 ft of the 12, 15, and 18 inch pipes respectively. This allowed adequate length to establish the velocity distribution in the pipe. Friction loss

measurements were taken between taps 1 and 2, 2 and 3, and 1 and 3.

The flow rate was measured using the laboratory ultrasonic meter, which has been calibrated against the volumetric tanks. The volumetric tanks are traceable to the U.S. Bureau of Standards. The pressure differentials were measured with differential manometers containing a blue fluid (specific gravity = 1.75), and mercury (specific gravity = 13.56). The data were immediately processed with a computer to check the results before flow conditions were changed. At each pressure measurement location, two piezometers were installed in the pipe on opposite sides. A plexiglass block, fitted with a 1/4" brass fitting was connected to the thin pipe wall with body putty. An 1/8" tap hole was drilled through the pipe, and the interior surface carefully ground smooth with the inside of the pipe. Since the inside surface of the pipe was ribbed, the piezometer taps were drilled on the smooth stretch between ribs, with the hole nearer the downstream rib.

RESULTS

Experimental data are listed in Tables 1 through 3, and graphically displayed for Mannings "n", and friction factor "f" versus velocity in figures 1 through 6. For the 12, 15, and 18 inch pipe an average Manning "n" of 0.0119, 0.0148, and 0.0123, and an average friction factor "f" of 0.0262, 0.0378, and 0.0243 was found respectively.

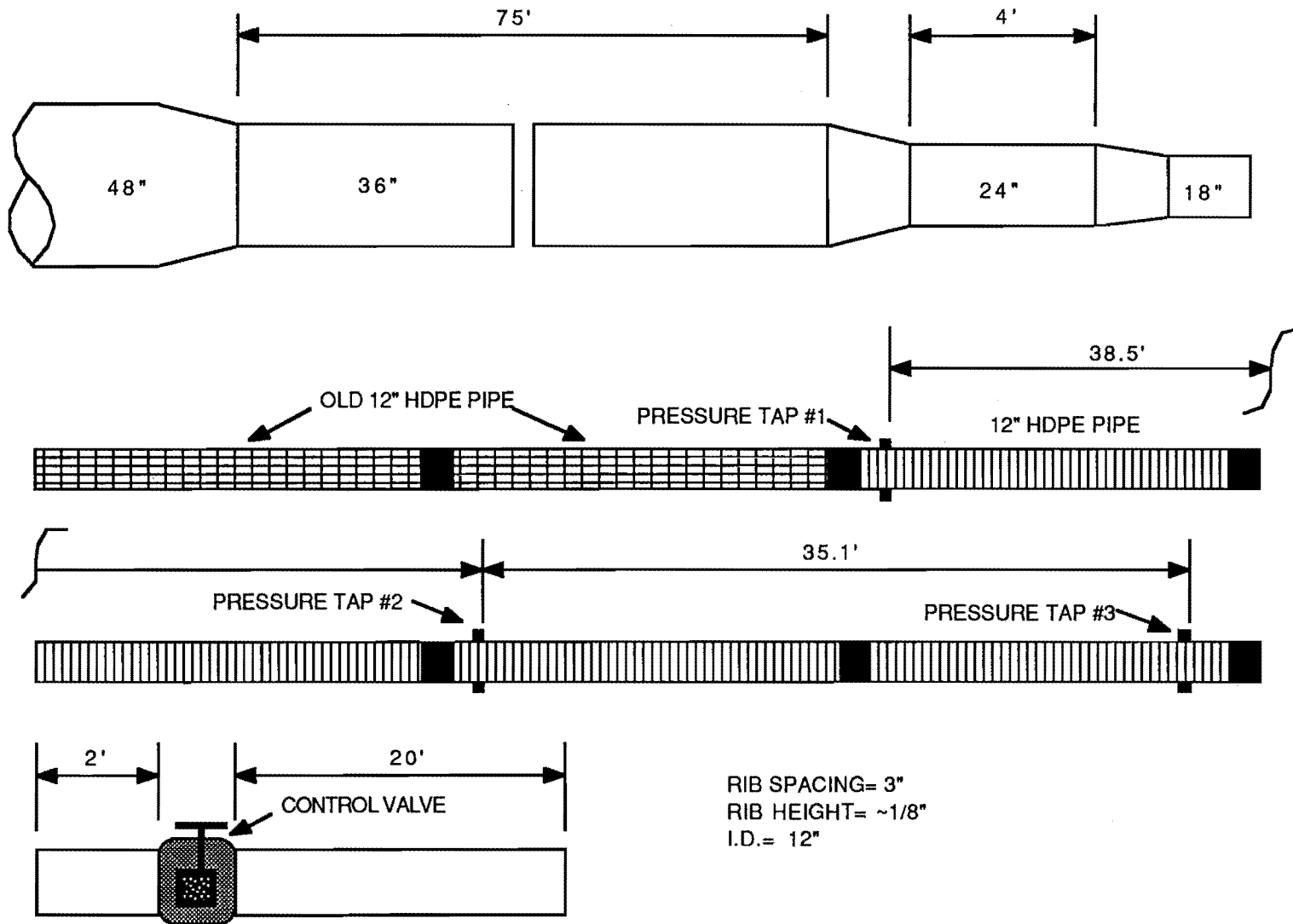


FIG A. 12" HDPE PIPE SETUP

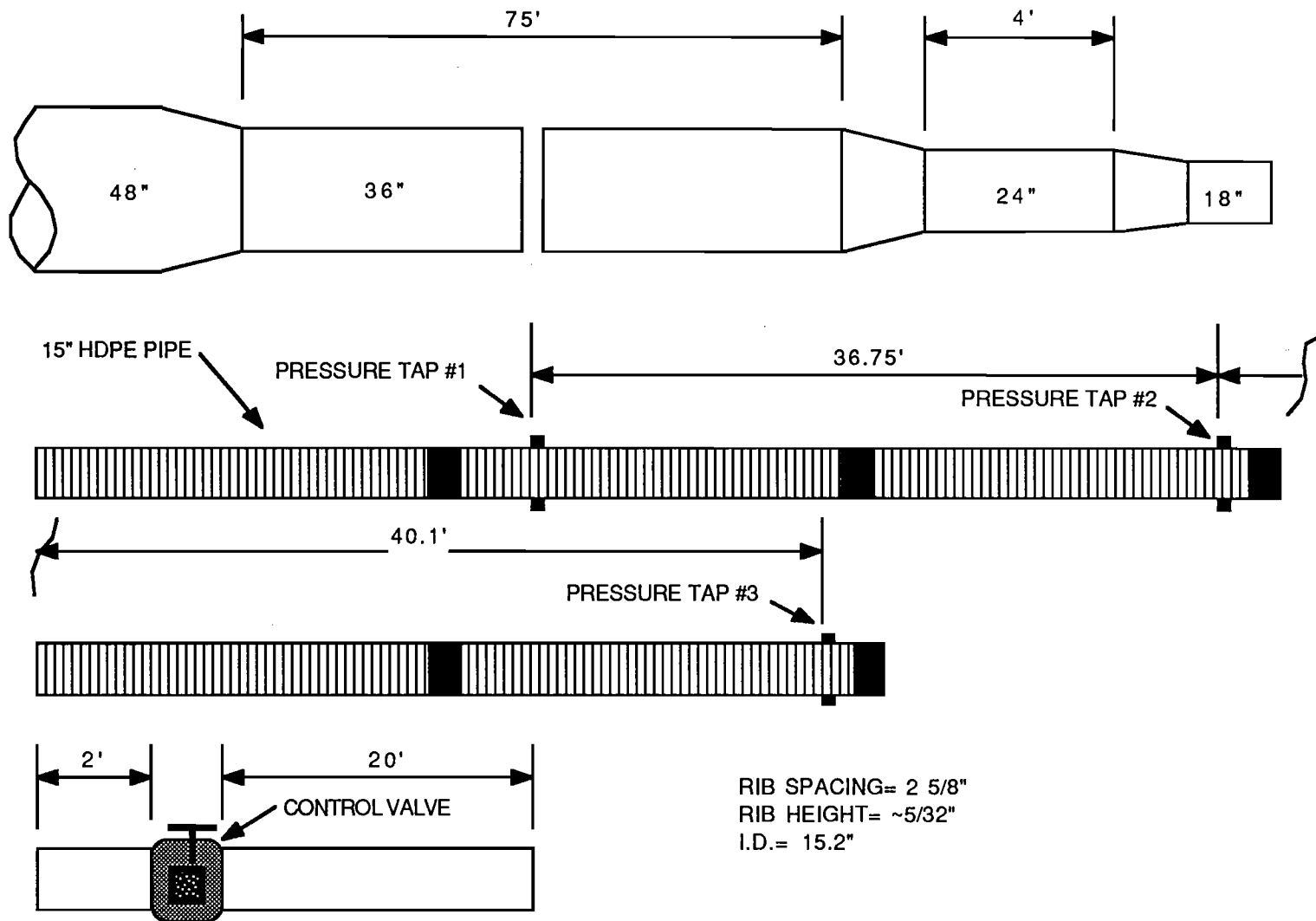


FIG B. 15" HDPE PIPE SETUP

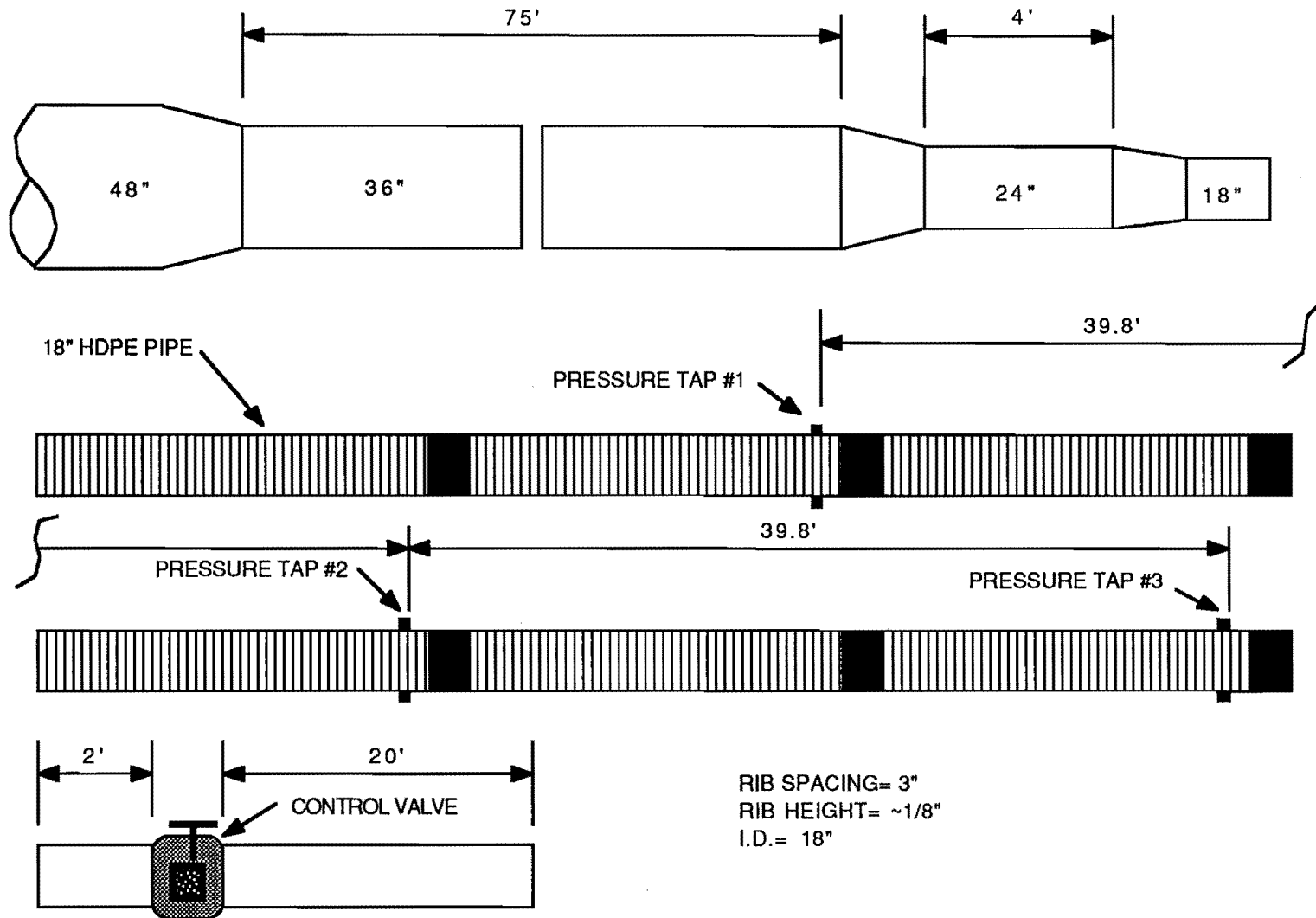


FIG C. 18" HDPE PIPE SETUP

TABLE 1 Test data for friction test on 12" plastic pipe.
 UTAH WATER RESEARCH LABORATORY
 DATA SHEET FOR FRICTION LOSS TEST

Prinsco, Inc.

PIPE: 12" HDPE

Date: 7-Oct-88

Tested by: Steven L. Barfuss

pipe dia.= 12.0 in.

Area= 0.79 ft sq

length1= 38.5 ft.

length2= 40.1 ft.

length3= 78.6 ft.

Run No.	Sonic Q ave. cfs	Diff	Mano	Mano	DP feet	Actual	V FPS	Darcy f	Manning n
		LEFT cm.	RIGHT cm.	Conv to feet		Q cfs			
1	3.97	3	9.3	0.0246	0.30	3.67	4.67	0.0232	0.0112
	3.97	4.8	10.5	0.0246	0.38	3.67	4.67	0.0277	0.0123
	3.97	17.2	14.1	0.0246	0.77	3.67	4.67	0.0290	0.0125
						Average		0.0266	0.0120
2	5.56	13.4	19.4	0.0246	0.81	5.22	6.65	0.0306	0.0129
	5.56	12.1	18	0.0246	0.74	5.22	6.65	0.0269	0.0121
	5.56	32.6	29.8	0.0246	1.54	5.22	6.65	0.0285	0.0124
						Average		0.0287	0.0125
3	5.59	13.6	19.1	0.0246	0.80	5.25	6.68	0.0301	0.0128
	5.59	12.1	17.6	0.0246	0.73	5.25	6.68	0.0263	0.0119
	5.59	32.5	29.5	0.0246	1.53	5.25	6.68	0.0280	0.0123
						Average		0.0281	0.0124
4	4.49	6.7	12.5	0.0246	0.47	4.17	5.32	0.0280	0.0123
	4.49	6	11.8	0.0246	0.44	4.17	5.32	0.0249	0.0116
	4.49	20.2	17.2	0.0246	0.92	4.17	5.32	0.0267	0.0120
						Average		0.0265	0.0120
5	5.11	9.8	15.7	0.0246	0.63	4.78	6.09	0.0283	0.0124
	5.11	9.9	14.9	0.0246	0.61	4.78	6.09	0.0265	0.0120
	5.11	26.5	23.5	0.0246	1.23	4.78	6.09	0.0272	0.0122
						Average		0.0273	0.0122
6	7.23	23.1	28.5	0.0246	1.27	6.85	8.72	0.0279	0.0123
	7.23	21.3	26.3	0.0246	1.17	6.85	8.72	0.0247	0.0116
	7.23	51.3	47.8	0.0246	2.44	6.85	8.72	0.0263	0.0119
						Average		0.0263	0.0119
7	9.03	36.6	41.3	0.0246	1.92	8.61	10.96	0.0267	0.0120
	9.03	32.9	37.6	0.0246	1.73	8.61	10.96	0.0232	0.0112
	9.03	2.6	6.2	0.4121	3.63	8.61	10.96	0.0247	0.0116
						Average		0.0249	0.0116
8	7.86	27.7	32.5	0.0246	1.48	7.47	9.51	0.0274	0.0122
	7.86	24.6	29.8	0.0246	1.34	7.47	9.51	0.0238	0.0114
	7.86	1.6	5.2	0.4121	2.80	7.47	9.51	0.0254	0.0117
						Average		0.0255	0.0118
9	9.96	43.7	48	0.0246	2.26	9.52	12.12	0.0257	0.0118
	9.96	38.6	43.7	0.0246	2.02	9.52	12.12	0.0221	0.0110
	9.96	3.4	7	0.4121	4.29	9.52	12.12	0.0239	0.0114
						Average		0.0239	0.0114
10	11.58	61.5	65.1	0.0246	3.11	11.10	14.14	0.0261	0.0119
	11.58	54.8	59.9	0.0246	2.82	11.10	14.14	0.0227	0.0111
	11.58	5.3	9	0.4121	5.89	11.10	14.14	0.0242	0.0115
						Average		0.0243	0.0115

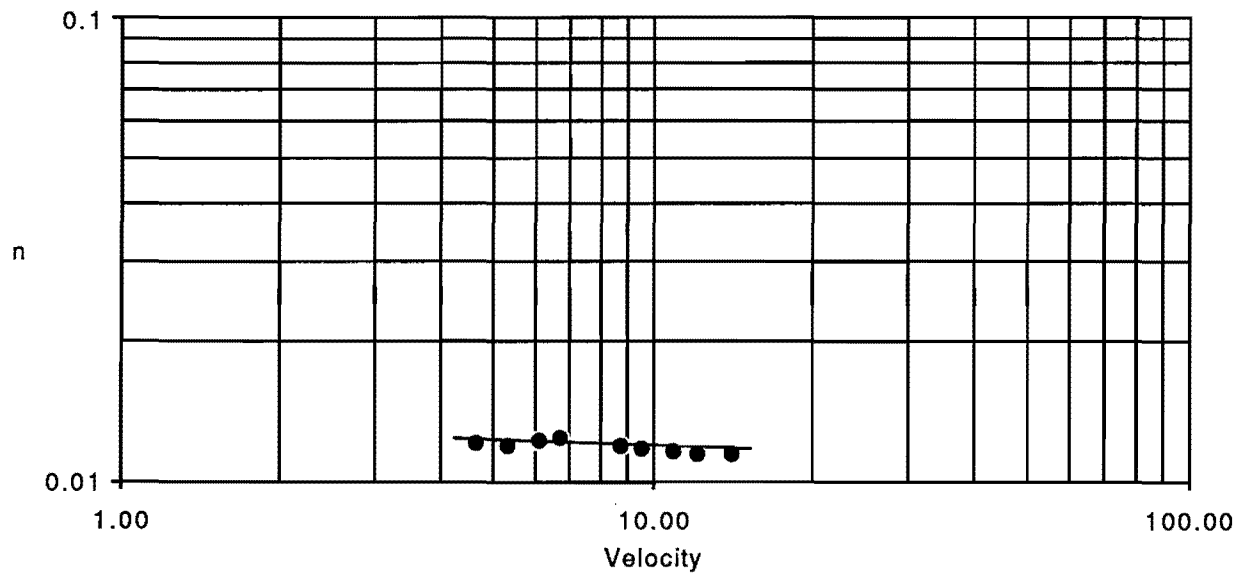


Fig 1. Mannings n vs. velocity for 12" diameter HDPE pipe.

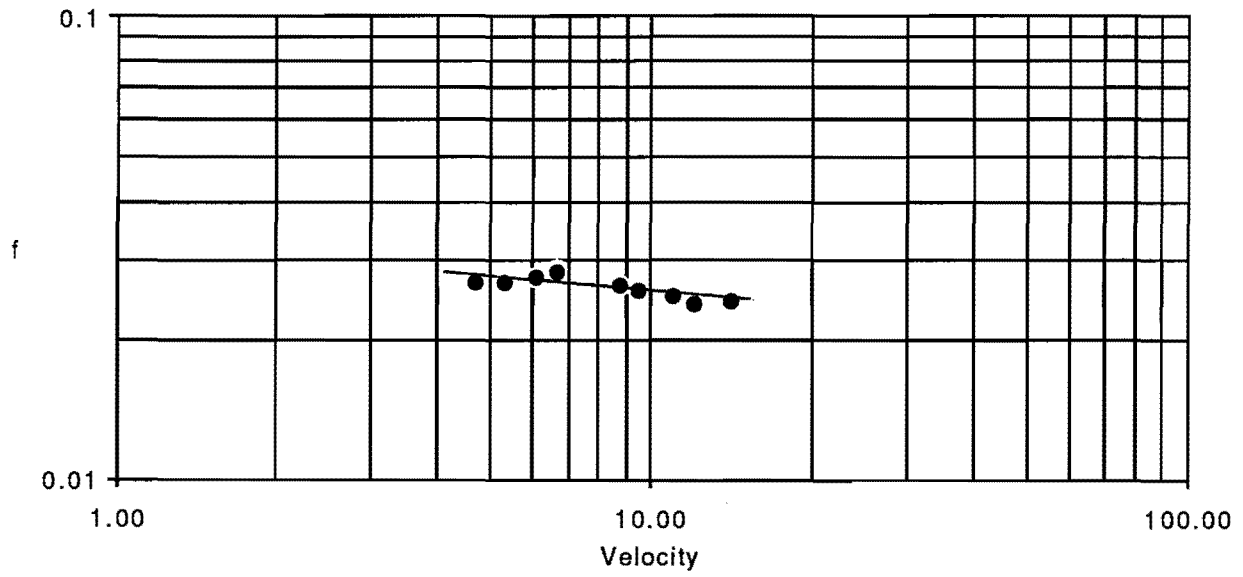


Fig 2. Friction f vs. velocity for 12" diameter HDPE pipe.

TABLE 2 Test data for friction test on 15" plastic pipe.
 UTAH WATER RESEARCH LABORATORY
 DATA SHEET FOR FRICTION LOSS TEST

Prinsco, Inc.

PIPE: 15" HDPE

Date: 4-Oct-88

Tested by: Steven L. Barfuss

pipe dia.= 15.2 in.

Area= 1.26 ft sq

length1= 36.8 ft.

length2= 40.1 ft.

length3= 76.9 ft.

Run No.	Sonic Q ave. cfs	Diff	Mano	Mano	DP feet	Actual	V FPS	Darcy f	Manning n
		LEFT cm.	RIGHT cm.	Conv to feet		Q cfs			
1	3.53	2.3	2.6	0.0246	0.12	3.24	2.57	0.0404	0.0154
	3.53	-0.4	5.3	0.0246	0.12	3.24	2.57	0.0370	0.0147
	3.53	6.4	3.3	0.0246	0.24	3.24	2.57	0.0382	0.0150
								Average 0.0385	0.0150
2	5.34	6	6.2	0.0246	0.30	5.01	3.98	0.0421	0.0157
	5.34	3.1	9	0.0246	0.30	5.01	3.98	0.0382	0.0150
	5.34	13.5	10.5	0.0246	0.59	5.01	3.98	0.0395	0.0152
								Average 0.0399	0.0153
3	4.67	4.6	4.7	0.0246	0.23	4.35	3.46	0.0424	0.0158
	4.67	2.1	7.9	0.0246	0.25	4.35	3.46	0.0418	0.0157
	4.67	11.2	8.2	0.0246	0.48	4.35	3.46	0.0423	0.0158
								Average 0.0422	0.0157
4	8.24	15.4	15.1	0.0246	0.75	7.84	6.23	0.0429	0.0159
	8.24	12.7	18.5	0.0246	0.77	7.84	6.23	0.0402	0.0154
	8.24	32	29.4	0.0246	1.51	7.84	6.23	0.0413	0.0156
								Average 0.0414	0.0156
5	9.55	18.9	18.5	0.0246	0.92	9.12	7.25	0.0388	0.0151
	9.55	16.2	21.9	0.0246	0.94	9.12	7.25	0.0362	0.0146
	9.55	39	36.4	0.0246	1.85	9.12	7.25	0.0374	0.0148
								Average 0.0375	0.0148
6	12.19	30.2	29.4	0.0246	1.47	11.70	9.30	0.0376	0.0149
	12.19	27.6	33.2	0.0246	1.50	11.70	9.30	0.0351	0.0144
	12.19	61.4	58.9	0.0246	2.96	11.70	9.30	0.0363	0.0146
								Average 0.0363	0.0146
7	15.27	44.2	43.1	0.0246	2.15	14.71	11.69	0.0349	0.0143
	15.27	42	47.2	0.0246	2.19	14.71	11.69	0.0326	0.0138
	15.27	3.4	7	0.4121	4.29	14.71	11.69	0.0333	0.0140
								Average 0.0336	0.0140
8	15.75	47	45.5	0.0246	2.28	15.18	12.06	0.0347	0.0143
	15.75	44.6	49.8	0.0246	2.32	15.18	12.06	0.0324	0.0138
	15.75	3.7	7.4	0.4121	4.57	15.18	12.06	0.0333	0.0140
								Average 0.0335	0.0140
9	17.17	55.9	54.4	0.0246	2.71	16.56	13.17	0.0347	0.0143
	17.17	53.6	58.9	0.0246	2.77	16.56	13.17	0.0324	0.0138
	17.17	4.8	8.4	0.4121	5.44	16.56	13.17	0.0333	0.0140
								Average 0.0335	0.0140
10	7.27	11.8	11.6	0.0246	0.58	6.89	5.48	0.0426	0.0158
	7.27	9.2	14.6	0.0246	0.59	6.89	5.48	0.0396	0.0153
	7.27	25	22.2	0.0246	1.16	6.89	5.48	0.0410	0.0155
								Average 0.0411	0.0155

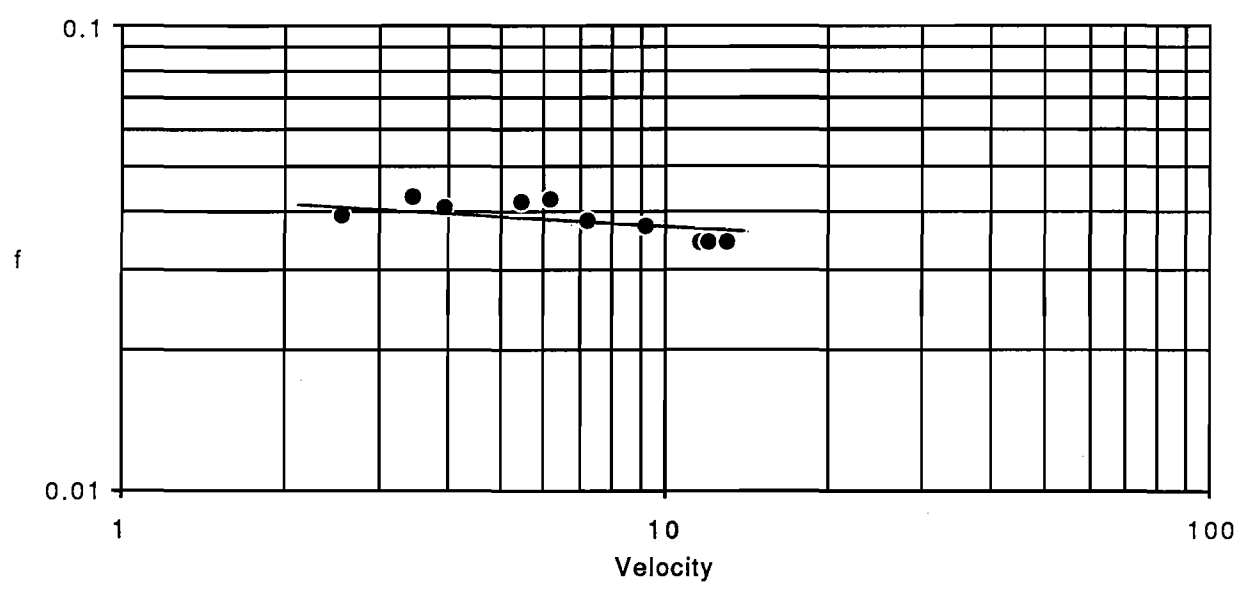


Fig 4. Friction f vs. velocity for 15" diameter HDPE pipe.

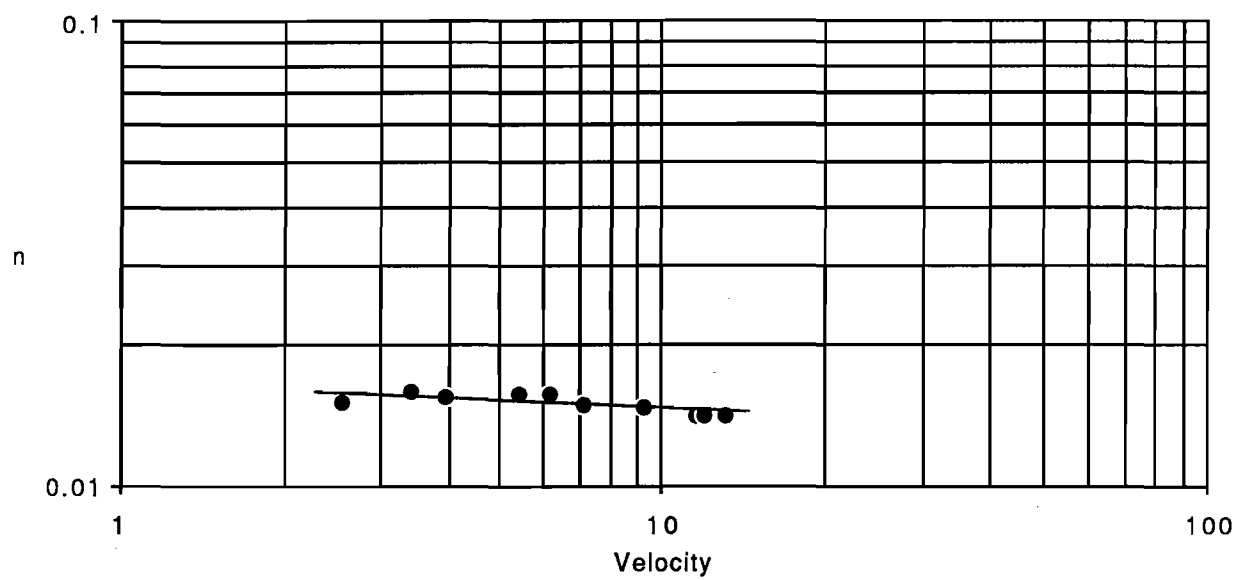


Fig 3. Manning n vs. velocity for 15" diameter HDPE pipe.

**TABLE 3 Test data for friction test on 18" plastic pipe.
UTAH WATER RESEARCH LABORATORY
DATA SHEET FOR FRICTION LOSS TEST**

Prinsco, Inc.

PIPE: 18" HDPE

Date: 2-Oct-88

Tested by: Steven L. Barfuss

pipe dia.= 18.0 in.

Area= 1.8 ft sq

length1= 39.8 ft.

length2= 39.8 ft.

length3= 79.5 ft.

Run No.	Sonic Q ave. cfs	Diff		Mano Conv to feet	DP feet	Actual		Darcy f	Manning n	
		LEFT cm.	RIGHT cm.			Q cfs	V FPS			
1	8.72	6.05	3.4	0.0246	0.23	8.31	4.70	0.0256	0.0126	
	8.72	-3.1	10.5	0.0246	0.18	8.31	4.70	0.0200	0.0112	
	8.72	-0.1	16.4	0.0246	0.40	8.31	4.70	0.0220	0.0117	
Average									0.0225	0.0118
2	11.48	9.4	6.6	0.0246	0.39	11.00	6.23	0.0247	0.0124	
	11.48	-0.3	13.4	0.0246	0.32	11.00	6.23	0.0202	0.0112	
	11.48	6.25	22.75	0.0246	0.71	11.00	6.23	0.0224	0.0118	
Average									0.0224	0.0118
3	14.32	14.6	11.3	0.0246	0.64	13.78	7.80	0.0255	0.0126	
	14.32	4	17.6	0.0246	0.53	13.78	7.80	0.0212	0.0115	
	14.32	15.2	31.8	0.0246	1.16	13.78	7.80	0.0231	0.0120	
Average									0.0233	0.0120
Oct.3										
1	5.47	3.1	0.7	0.0246	0.09	5.13	2.90	0.0269	0.0129	
	5.47	-4.8	8.8	0.0246	0.10	5.13	2.90	0.0284	0.0133	
	5.47	-3.9	12.1	0.0246	0.20	5.13	2.90	0.0291	0.0134	
Average									0.0281	0.0132
2	8.55	6.3	3.6	0.0246	0.24	8.14	4.61	0.0279	0.0132	
	8.55	-1.8	11.6	0.0246	0.24	8.14	4.61	0.0276	0.0131	
	8.55	1.75	17.8	0.0246	0.48	8.14	4.61	0.0275	0.0131	
Average									0.0277	0.0131
3	10.50	8.2	5.5	0.0246	0.34	10.05	5.69	0.0253	0.0125	
	10.50	0	13.6	0.0246	0.33	10.05	5.69	0.0252	0.0125	
	10.50	5.6	21.8	0.0246	0.67	10.05	5.69	0.0253	0.0125	
Average									0.0253	0.0125
4	13.60	12.1	9.2	0.0246	0.52	13.08	7.40	0.0233	0.0120	
	13.60	4.2	17.8	0.0246	0.54	13.08	7.40	0.0240	0.0122	
	13.60	13.4	29.6	0.0246	1.06	13.08	7.40	0.0235	0.0121	
Average									0.0236	0.0121
5	16.33	17	13.7	0.0246	0.76	15.74	8.91	0.0231	0.0120	
	16.33	8.9	22.5	0.0246	0.77	15.74	8.91	0.0237	0.0121	
	16.33	22.7	39.2	0.0246	1.52	15.74	8.91	0.0233	0.0120	
Average									0.0234	0.0120
6	18.92	21.2	17.9	0.0246	0.96	18.27	10.34	0.0219	0.0117	
	18.92	13.6	27.1	0.0246	1.00	18.27	10.34	0.0228	0.0119	
	18.92	31.7	48	0.0246	1.96	18.27	10.34	0.0223	0.0118	
Average									0.0223	0.0118

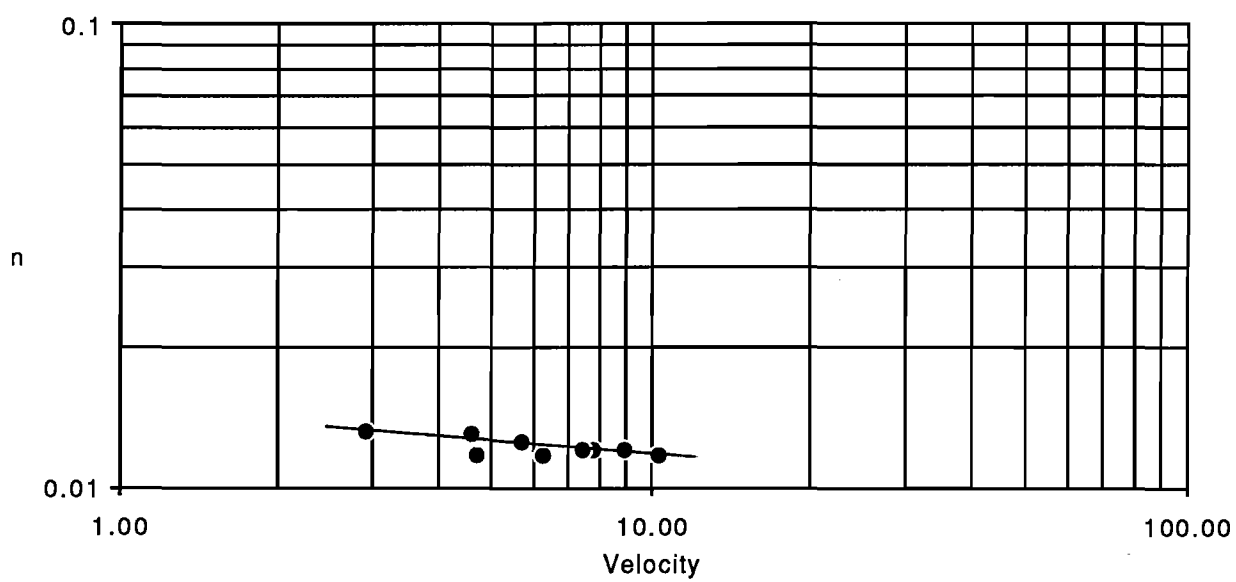


Fig 5. Manning n vs. velocity for 18" diameter HDPE pipe.

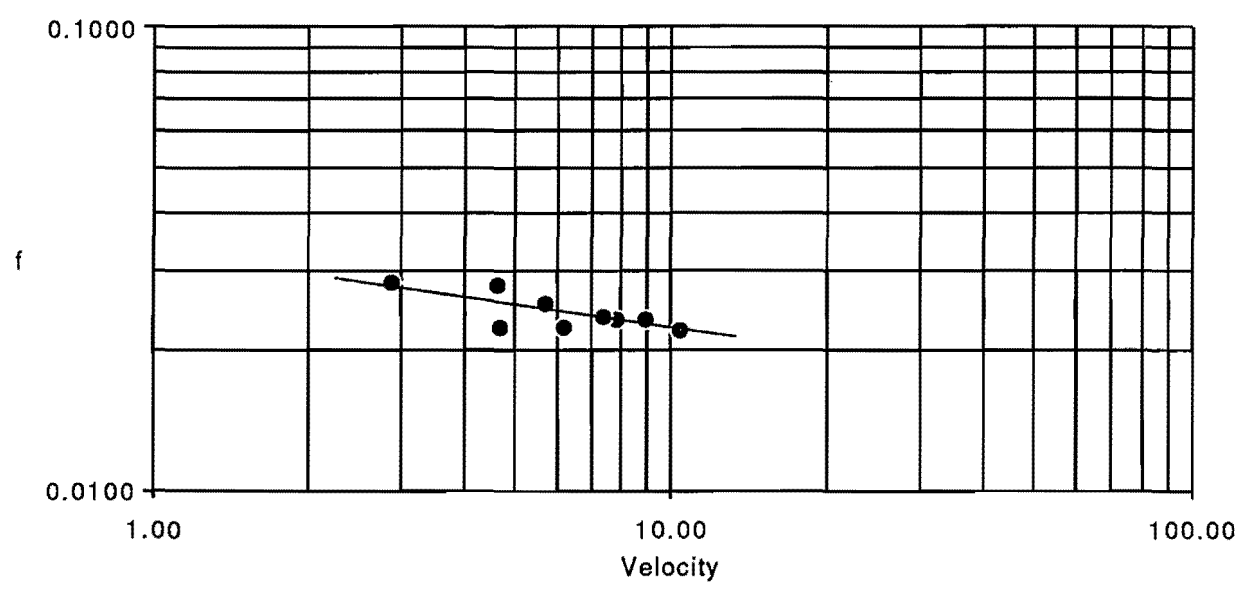


Fig 6. Friction f vs. velocity for 18" diameter HDPE pipe.