



**THE REGIONAL MUNICIPALITY OF DURHAM**

# **APPENDICES**

**WORKS DEPARTMENT**

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**REGION OF DURHAM WORKS DEPARTMENT  
DEVELOPMENT APPROVALS  
SUBDIVISION AGREEMENT INFORMATION CHECKLIST**

Complete and submit this checklist with final submission prior to agreement preparation.

- 1 Legal name of subdivider, address, phone no., fax no., email and contact person:  
(Note: The agreement will be with the owner of the property.)

Subdivider: \_\_\_\_\_  
 Address: \_\_\_\_\_  
 \_\_\_\_\_  
 Phone No: \_\_\_\_\_  
 Fax No: \_\_\_\_\_  
 Email: \_\_\_\_\_  
 Contact name: \_\_\_\_\_

- 2 a) Date of rezoning application \_\_\_\_\_  
 b) Date or rezoning approval by area municipality \_\_\_\_\_

- 3 If residential, number of units contained within all lots and blocks shown on the M-Plan:
- |                                  |       |
|----------------------------------|-------|
| Single family units              | _____ |
| Semidetached units               | _____ |
| Townhouse units                  | _____ |
| 2 Bedroom and larger apartments  | _____ |
| 1 Bedroom and smaller apartments | _____ |

- 4 If residential, number of units for which Development Charge credits apply (proof required):
- |                                      |       |
|--------------------------------------|-------|
| Existing units to remain             | _____ |
| Existing units to be demolished      | _____ |
| Units demolished with last ten years | _____ |

- 5 Are all sight triangles, widenings and reserves provided in accordance with the Conditions of Draft Approval?

- 6 Are easement R-Plans final and consistent with M-Plan?

- 7 Are subdivision or phase limits shown on General Plan consistent with M-Plan?

- 8 Are lot and block nos. consistent between General Plan, M-Plan and R-Plans?

- 9 Are phased construction limits defined by plugs on the General Plan?

- 10 Are sewer lengths on General Plan consistent with phased construction limits?

- 11 Are cost estimate quantities consistent with engineering drawings?

- 12 Is the cost estimate based on tender prices if Region cost sharing applies?

- 13 Is a separate sewer design sheet provided to determine the minimum sewer size for cost sharing calculations (if applicable)?

- 14 Are there any private arrangements with external landowners?  
If yes, then provide letter from developer.

**REGION OF DURHAM WORKS DEPARTMENT  
DEVELOPMENT APPROVALS  
SERVICING AGREEMENT INFORMATION CHECKLIST**

Complete and submit this checklist with final submission prior to agreement preparation.

- 1 Legal name of registered owner, address, phone no., fax no., email and contact person:  
(Note: The agreement will be with the owner of the property.)

Owner: \_\_\_\_\_  
 Address: \_\_\_\_\_  
 \_\_\_\_\_  
 Phone No: \_\_\_\_\_  
 Fax No: \_\_\_\_\_  
 Email: \_\_\_\_\_  
 Contact name: \_\_\_\_\_

- 2 a) Date of rezoning application, if applicable \_\_\_\_\_  
 b) Date or rezoning approval by area municipality, if applicable \_\_\_\_\_

- 3 a) Date of Site Plan Application, if applicable \_\_\_\_\_  
 b) Date of Site Plan Approval by area municipality, if applicable \_\_\_\_\_

- 4 If residential, number of units contained within this development:  
     Single family units \_\_\_\_\_  
     Semidetached units \_\_\_\_\_  
     Townhouse units \_\_\_\_\_  
     2 Bedroom and larger apartments \_\_\_\_\_  
     1 Bedroom and smaller apartments \_\_\_\_\_

- 5 If residential, number of units for which Development Charge credits apply (proof required):  
     Existing units to remain \_\_\_\_\_  
     Existing units to be demolished \_\_\_\_\_  
     Units demolished with last ten years \_\_\_\_\_

- 6 Has R-Plan (or R-Plans) been submitted to describe the following:  
     Owner's land relating to the agreement   
     Lands to be conveyed to the Region or Town   
     (widenings, reserves, sight triangles, easements)

- 7 Is (are) the R-Plan (s) registered?

- 8 Are development limits shown on engineering drawings consistent with the R-Plan?

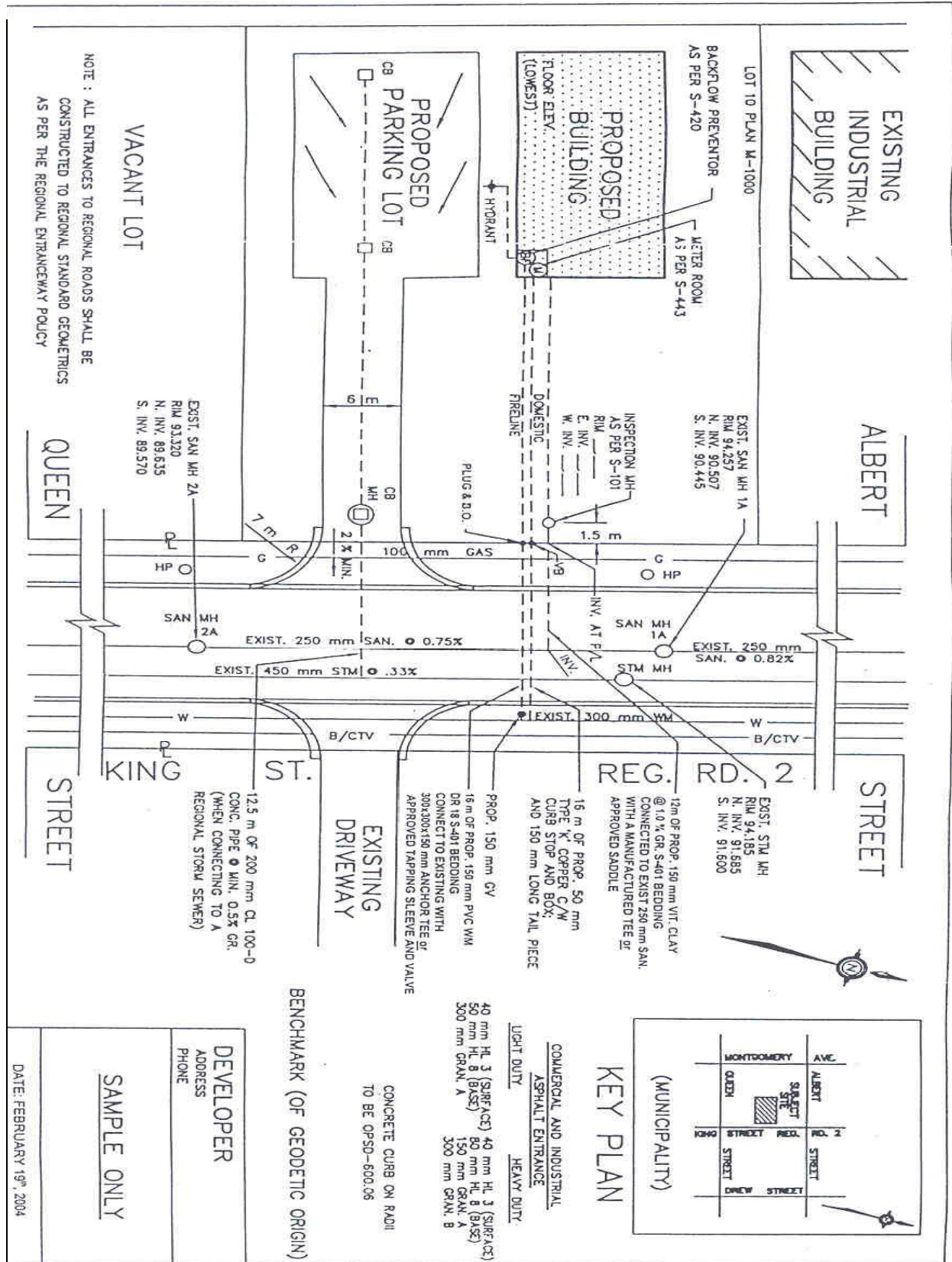
- 9 Are cost estimate quantities consistent with engineering drawings?

- 10 Does cost estimate include Regional services and exclude private services?

- 11 Is the cost estimate based on tender prices if Region cost sharing applies?

- 12 Is a separate sewer design sheet provided to determine the minimum sewer size for cost sharing calculations (if applicable)?

- 13 Are there any private cost sharing arrangements with external landowners?  
 If yes, then provide letter from developer.



# CAPACITY & VELOCITY OF CIRCULAR CONCRETE PIPES BY MANNING'S FORMULA

$$V = \frac{1.0}{n} \times R^{2/3} \times S^{1/2} \text{ (m/sec)}$$

$$Q = V \times A \text{ (m}^3\text{/sec)}$$
$$= 10^3 \times V \times A \text{ (L/sec)}$$

**V:** velocity in m/sec. (meters/second)

**Q:** capacity in L/sec. (liters/second)

**A:** cross sectional area in m<sup>2</sup>

**R:** hydraulic radius D/4 with D in m

**S:** slope of hydraulic grade line m/m

**n:** roughness coefficient = 0.013

**V and Q are based on actual diameter**

**n=0.013**

nom D	150 mm		200 mm		250 mm		300 mm		375 mm		450 mm		nom D
act D	152.4 mm		203.2 mm		254.0 mm		304.8 mm		381.0 mm		457.2 mm		act D
GRADE %	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	GRADE %
	(L/s)	(m/s)	(L/s)	(m/s)	(L/s)	(m/s)	(L/s)	(m/s)	(L/s)	(m/s)	(L/s)	(m/s)	
0.05	3.55	0.19	7.65	0.24	13.87	0.27	22.56	0.31	40.90	0.36	66.51	0.41	0.05
0.06	3.89	0.21	8.38	0.26	15.20	0.30	24.71	0.34	44.80	0.39	72.86	0.44	0.06
0.07	4.20	0.23	9.05	0.28	16.41	0.32	26.69	0.37	48.39	0.42	78.69	0.48	0.07
0.08	4.49	0.25	9.68	0.30	17.55	0.35	28.53	0.39	51.74	0.45	84.13	0.51	0.08
0.09	4.77	0.26	10.26	0.32	18.61	0.37	30.26	0.41	54.87	0.48	89.23	0.54	0.09
0.10	5.02	0.28	10.82	0.33	19.62	0.39	31.90	0.44	57.84	0.51	94.06	0.57	0.10
0.11	5.27	0.29	11.35	0.35	20.58	0.41	33.46	0.46	60.66	0.53	98.65	0.60	0.11
0.12	5.50	0.30	11.85	0.37	21.49	0.42	34.95	0.48	63.36	0.56	103.03	0.63	0.12
0.13	5.73	0.31	12.34	0.38	22.37	0.44	36.37	0.50	65.95	0.58	107.24	0.65	0.13
0.14	5.94	0.33	12.80	0.39	23.21	0.46	37.75	0.52	68.44	0.60	111.29	0.68	0.14
0.15	6.15	0.34	13.25	0.41	24.03	0.47	39.07	0.54	70.84	0.62	115.20	0.70	0.15
0.16	6.36	0.35	13.69	0.42	24.82	0.49	40.35	0.55	73.16	0.64	118.97	0.72	0.16
0.17	6.55	0.36	14.11	0.44	25.58	0.50	41.59	0.57	75.42	0.66	122.63	0.75	0.17
0.18	6.74	0.37	14.52	0.45	26.32	0.52	42.80	0.59	77.60	0.68	126.19	0.77	0.18
0.19	6.93	0.38	14.91	0.46	27.04	0.53	43.97	0.60	79.73	0.70	129.65	0.79	0.19
0.20	7.11	0.39	15.30	0.47	27.74	0.55	45.12	0.62	81.80	0.72	133.02	0.81	0.20
0.21	7.28	0.40	15.68	0.48	28.43	0.56	46.23	0.63	83.82	0.74	136.30	0.83	0.21
0.22	7.45	0.41	16.05	0.49	29.10	0.57	47.32	0.65	85.79	0.75	139.51	0.85	0.22
0.23	7.62	0.42	16.41	0.51	29.75	0.59	48.38	0.66	87.72	0.77	142.64	0.87	0.23
0.24	7.78	0.43	16.76	0.52	30.39	0.60	49.42	0.68	89.61	0.79	145.71	0.89	0.24
0.25	7.94	0.44	17.11	0.53	31.02	0.61	50.44	0.69	91.46	0.80	148.72	0.91	0.25
0.26	8.10	0.44	17.45	0.54	31.63	0.62	51.44	0.70	93.27	0.82	151.66	0.92	0.26
0.27	8.26	0.45	17.78	0.55	32.24	0.64	52.42	0.72	95.04	0.83	154.55	0.94	0.27
0.28	8.41	0.46	18.11	0.56	32.83	0.65	53.38	0.73	96.79	0.85	157.39	0.96	0.28
0.29	8.56	0.47	18.43	0.57	33.41	0.66	54.33	0.74	98.50	0.86	160.17	0.98	0.29
0.30	8.70	0.48	18.74	0.58	33.98	0.67	55.26	0.76	100.18	0.88	162.91	0.99	0.30
0.31	8.85	0.48	19.05	0.59	34.54	0.68	56.17	0.77	101.84	0.89	165.60	1.01	0.31
0.32	8.99	0.49	19.36	0.60	35.09	0.69	57.07	0.78	103.47	0.91	168.25	1.02	0.32
0.33	9.13	0.50	19.66	0.61	35.64	0.70	57.95	0.79	105.07	0.92	170.86	1.04	0.33
0.34	9.26	0.51	19.95	0.62	36.17	0.71	58.82	0.81	106.65	0.94	173.43	1.06	0.34
0.35	9.40	0.52	20.24	0.62	36.70	0.72	59.68	0.82	108.21	0.95	175.96	1.07	0.35
0.36	9.53	0.52	20.53	0.63	37.22	0.73	60.53	0.83	109.75	0.96	178.46	1.09	0.36
0.37	9.66	0.53	20.81	0.64	37.74	0.74	61.36	0.84	111.26	0.98	180.92	1.10	0.37
0.38	9.79	0.54	21.09	0.65	38.24	0.75	62.19	0.85	112.75	0.99	183.35	1.12	0.38
0.39	9.92	0.54	21.37	0.66	38.74	0.76	63.00	0.86	114.23	1.00	185.75	1.13	0.39
0.40	10.05	0.55	21.64	0.67	39.24	0.77	63.80	0.87	115.68	1.01	188.11	1.15	0.40
0.41	10.17	0.56	21.91	0.68	39.72	0.78	64.60	0.89	117.12	1.03	190.45	1.16	0.41
0.42	10.30	0.56	22.17	0.68	40.21	0.79	65.38	0.90	118.54	1.04	192.76	1.17	0.42
0.43	10.42	0.57	22.44	0.69	40.68	0.80	66.15	0.91	119.94	1.05	195.04	1.19	0.43
0.44	10.54	0.58	22.70	0.70	41.15	0.81	66.92	0.92	121.33	1.06	197.30	1.20	0.44
0.45	10.66	0.58	22.95	0.71	41.62	0.82	67.67	0.93	122.70	1.08	199.52	1.22	0.45
0.46	10.78	0.59	23.21	0.72	42.08	0.83	68.42	0.94	124.06	1.09	201.73	1.23	0.46
0.47	10.89	0.60	23.46	0.72	42.53	0.84	69.16	0.95	125.40	1.10	203.91	1.24	0.47
0.48	11.01	0.60	23.71	0.73	42.98	0.85	69.89	0.96	126.72	1.11	206.07	1.26	0.48
0.49	11.12	0.61	23.95	0.74	43.43	0.86	70.62	0.97	128.04	1.12	208.20	1.27	0.49
0.50	11.23	0.62	24.19	0.75	43.87	0.87	71.33	0.98	129.34	1.13	210.32	1.28	0.50
0.51	11.35	0.62	24.44	0.75	44.30	0.87	72.04	0.99	130.62	1.15	212.41	1.29	0.51
0.52	11.46	0.63	24.67	0.76	44.74	0.88	72.75	1.00	131.90	1.16	214.48	1.31	0.52
0.53	11.57	0.63	24.91	0.77	45.16	0.89	73.44	1.01	133.16	1.17	216.53	1.32	0.53
0.54	11.68	0.64	25.14	0.78	45.59	0.90	74.13	1.02	134.41	1.18	218.57	1.33	0.54
0.55	11.78	0.65	25.38	0.78	46.01	0.91	74.82	1.03	135.65	1.19	220.58	1.34	0.55
0.56	11.89	0.65	25.61	0.79	46.43	0.92	75.49	1.03	136.88	1.20	222.58	1.36	0.56
0.57	12.00	0.66	25.83	0.80	46.84	0.92	76.16	1.04	138.09	1.21	224.56	1.37	0.57
0.58	12.10	0.66	26.06	0.80	47.25	0.93	76.83	1.05	139.30	1.22	226.52	1.38	0.58
0.59	12.20	0.67	26.28	0.81	47.65	0.94	77.49	1.06	140.50	1.23	228.46	1.39	0.59
0.60	12.31	0.67	26.50	0.82	48.06	0.95	78.14	1.07	141.68	1.24	230.39	1.40	0.60
0.61	12.41	0.68	26.72	0.82	48.45	0.96	78.79	1.08	142.86	1.25	232.30	1.41	0.61
0.62	12.51	0.69	26.94	0.83	48.85	0.96	79.43	1.09	144.02	1.26	234.20	1.43	0.62
0.63	12.61	0.69	27.16	0.84	49.24	0.97	80.07	1.10	145.18	1.27	236.08	1.44	0.63
0.64	12.71	0.70	27.37	0.84	49.63	0.98	80.71	1.11	146.33	1.28	237.95	1.45	0.64
0.65	12.81	0.70	27.59	0.85	50.02	0.99	81.33	1.11	147.47	1.29	239.80	1.46	0.65
0.66	12.91	0.71	27.80	0.86	50.40	0.99	81.96	1.12	148.60	1.30	241.64	1.47	0.66
0.67	13.00	0.71	28.01	0.86	50.78	1.00	82.58	1.13	149.72	1.31	243.46	1.48	0.67
0.68	13.10	0.72	28.22	0.87	51.16	1.01	83.19	1.14	150.83	1.32	245.27	1.49	0.68
0.69	13.20	0.72	28.42	0.88	51.53	1.02	83.80	1.15	151.94	1.33	247.07	1.50	0.69
0.70	13.29	0.73	28.63	0.88	51.91	1.02	84.40	1.16	153.03	1.34	248.85	1.52	0.70
0.71	13.39	0.73	28.83	0.89	52.27	1.03	85.00	1.16	154.12	1.35	250.62	1.53	0.71
0.72	13.48	0.74	29.03	0.90	52.64	1.04	85.60	1.17	155.21	1.36	252.38	1.54	0.72
0.73	13.57	0.74	29.23	0.90	53.01	1.05	86.19	1.18	156.28	1.37	254.13	1.55	0.73
0.74	13.67	0.75	29.43	0.91	53.37	1.05	86.78	1.19	157.35	1.38	255.86	1.56	0.74
0.75	13.76	0.75	29.63	0.91	53.73	1.06	87.37	1.20	158.41	1.39	257.58	1.57	0.75
0.76	13.85	0.76	29.83	0.92	54.08	1.07	87.95	1.21	159.46	1.40	259.30	1.58	0.76
0.77	13.94	0.76	30.02	0.93	54.44	1.07	88.52	1.21	160.50	1.41	261.00	1.59	0.77
0.78	14.03	0.77	30.22	0.93	54.79	1.08	89.10	1.22	161.54	1.42	262.69	1.60	0.78
0.79	14.12	0.77	30.41	0.94	55.14	1.09	89.67	1.23	162.57	1.43	264.36	1.61	0.79
0.80	14.21	0.78	30.60	0.94	55.49	1.10	90.23	1.24	163.60	1.43	266.03	1.62	0.80
0.81	14.30	0.78	30.79	0.95	55.83	1.10	90.79	1.24	164.62	1.44	267.69	1.63	0.81
0.82	14.39	0.79	30.98	0.96	56.18	1.11	91.35	1.25	165.63	1.45	269.34	1.64	0.82
0.83	14.47	0.79	31.17	0.96	56.52	1.12	91.91	1.26	166.64	1.46	270.97	1.65	0.83
0.84	14.56	0.80	31.36	0.97	56.86	1.12	92.46	1.27	167.64	1.47	272.60	1.66	0.84
0.85	14.65	0.80	31.55	0.97	57.20	1.13	93.01	1.27	168.64	1.48	274.22	1.67	0.85
0.86	14.73	0.81	31.73	0.98	57.53	1.14	93.55	1.28	169.62	1.49	275.83	1.68	0.86
0.87	14.82	0.81	31.92	0.98	57.87	1.14	94.10	1.29	170.61	1.50	277.43	1.69	0.87
0.88	14.90	0.82	32.10	0.99	58.20	1.15	94.64	1.30	171.59	1.51	279.02	1.70	0.88
0.89	14.99	0.82	32.28	1.00	58.53	1.16	95.17	1.30	172.56	1.51	280.60	1.71	0.89
0.90	15.07	0.83	32.46	1.00	58.86	1.16	95.70	1.31	173.52	1.52	282.17	1.7	

n=0.013

nom D	150 mm		200 mm		250 mm		300 mm		375 mm		450 mm		nom D
act D	152.4 mm		203.2 mm		254.0 mm		304.8 mm		381.0 mm		457.2 mm		act D
GRADE %	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	GRADE %
	(L/s)	(m/s)	(L/s)	(m/s)	(L/s)	(m/s)	(L/s)	(m/s)	(L/s)	(m/s)	(L/s)	(m/s)	
1.00	15.89	0.87	34.22	1.06	62.04	1.22	100.88	1.38	182.91	1.60	297.43	1.81	1.00
1.02	16.05	0.88	34.56	1.07	62.66	1.24	101.89	1.40	184.73	1.62	300.39	1.83	1.02
1.04	16.20	0.89	34.89	1.08	63.27	1.25	102.88	1.41	186.53	1.64	303.32	1.85	1.04
1.06	16.36	0.90	35.23	1.09	63.87	1.26	103.86	1.42	188.32	1.65	306.23	1.87	1.06
1.08	16.51	0.91	35.56	1.10	64.47	1.27	104.84	1.44	190.09	1.67	309.10	1.88	1.08
1.10	16.66	0.91	35.89	1.11	65.07	1.28	105.81	1.45	191.84	1.68	311.95	1.90	1.10
1.12	16.81	0.92	36.21	1.12	65.66	1.30	106.76	1.46	193.57	1.70	314.77	1.92	1.12
1.14	16.96	0.93	36.53	1.13	66.24	1.31	107.71	1.48	195.30	1.71	317.57	1.93	1.14
1.16	17.11	0.94	36.85	1.14	66.82	1.32	108.65	1.49	197.00	1.73	320.35	1.95	1.16
1.18	17.26	0.95	37.17	1.15	67.39	1.33	109.59	1.50	198.69	1.74	323.10	1.97	1.18
1.20	17.40	0.95	37.48	1.16	67.96	1.34	110.51	1.51	200.37	1.76	325.82	1.98	1.20
1.22	17.55	0.96	37.79	1.17	68.52	1.35	111.43	1.53	202.03	1.77	328.53	2.00	1.22
1.24	17.69	0.97	38.10	1.17	69.08	1.36	112.34	1.54	203.68	1.79	331.21	2.02	1.24
1.26	17.83	0.98	38.41	1.18	69.64	1.37	113.24	1.55	205.32	1.80	333.87	2.03	1.26
1.28	17.98	0.99	38.71	1.19	70.19	1.39	114.13	1.56	206.94	1.82	336.51	2.05	1.28
1.30	18.11	0.99	39.01	1.20	70.74	1.40	115.02	1.58	208.55	1.83	339.13	2.07	1.30
1.32	18.25	1.00	39.31	1.21	71.28	1.41	115.90	1.59	210.15	1.84	341.73	2.08	1.32
1.34	18.39	1.01	39.61	1.22	71.82	1.42	116.78	1.60	211.73	1.86	344.30	2.10	1.34
1.36	18.53	1.02	39.90	1.23	72.35	1.43	117.65	1.61	213.31	1.87	346.86	2.11	1.36
1.38	18.66	1.02	40.20	1.24	72.88	1.44	118.51	1.62	214.87	1.88	349.41	2.13	1.38
1.40	18.80	1.03	40.49	1.25	73.41	1.45	119.37	1.64	216.42	1.90	351.93	2.14	1.40
1.42	18.93	1.04	40.77	1.26	73.93	1.46	120.21	1.65	217.96	1.91	354.43	2.16	1.42
1.44	19.07	1.05	41.06	1.27	74.45	1.47	121.06	1.66	219.49	1.93	356.92	2.17	1.44
1.46	19.20	1.05	41.34	1.27	74.96	1.48	121.90	1.67	221.01	1.94	359.39	2.19	1.46
1.48	19.33	1.06	41.63	1.28	75.47	1.49	122.73	1.68	222.52	1.95	361.84	2.20	1.48
1.50	19.46	1.07	41.91	1.29	75.98	1.50	123.55	1.69	224.02	1.96	364.28	2.22	1.50
1.52	19.59	1.07	42.19	1.30	76.49	1.51	124.38	1.70	225.51	1.98	366.70	2.23	1.52
1.54	19.72	1.08	42.46	1.31	76.99	1.52	125.19	1.72	226.99	1.99	369.11	2.25	1.54
1.56	19.84	1.09	42.74	1.32	77.49	1.53	126.00	1.73	228.46	2.00	371.49	2.26	1.56
1.58	19.97	1.09	43.01	1.33	77.98	1.54	126.81	1.74	229.92	2.02	373.87	2.28	1.58
1.60	20.10	1.10	43.28	1.33	78.47	1.55	127.61	1.75	231.37	2.03	376.23	2.29	1.60
1.62	20.22	1.11	43.55	1.34	78.96	1.56	128.40	1.76	232.81	2.04	378.57	2.31	1.62
1.64	20.35	1.12	43.82	1.35	79.45	1.57	129.19	1.77	234.24	2.05	380.90	2.32	1.64
1.66	20.47	1.12	44.08	1.36	79.93	1.58	129.98	1.78	235.66	2.07	383.22	2.33	1.66
1.68	20.59	1.13	44.35	1.37	80.41	1.59	130.76	1.79	237.08	2.08	385.52	2.35	1.68
1.70	20.72	1.14	44.61	1.38	80.89	1.60	131.53	1.80	238.49	2.09	387.81	2.36	1.70
1.72	20.84	1.14	44.87	1.38	81.36	1.61	132.31	1.81	239.89	2.10	390.08	2.38	1.72
1.74	20.96	1.15	45.13	1.39	81.83	1.62	133.07	1.82	241.28	2.12	392.34	2.39	1.74
1.76	21.08	1.16	45.39	1.40	82.30	1.62	133.83	1.83	242.66	2.13	394.59	2.40	1.76
1.78	21.20	1.16	45.65	1.41	82.77	1.63	134.59	1.84	244.03	2.14	396.83	2.42	1.78
1.80	21.32	1.17	45.91	1.42	83.23	1.64	135.35	1.85	245.40	2.15	399.05	2.43	1.80
1.82	21.43	1.18	46.16	1.42	83.69	1.65	136.10	1.87	246.76	2.16	401.26	2.44	1.82
1.84	21.55	1.18	46.41	1.43	84.15	1.66	136.84	1.88	248.11	2.18	403.46	2.46	1.84
1.86	21.67	1.19	46.67	1.44	84.61	1.67	137.58	1.89	249.46	2.19	405.65	2.47	1.86
1.88	21.78	1.19	46.92	1.45	85.06	1.68	138.32	1.90	250.79	2.20	407.82	2.48	1.88
1.90	21.90	1.20	47.16	1.45	85.51	1.69	139.06	1.91	252.13	2.21	409.98	2.50	1.90
1.92	22.01	1.21	47.41	1.46	85.96	1.70	139.79	1.92	253.45	2.22	412.14	2.51	1.92
1.94	22.13	1.21	47.66	1.47	86.41	1.71	140.51	1.93	254.77	2.23	414.28	2.52	1.94
1.96	22.24	1.22	47.90	1.48	86.85	1.71	141.23	1.94	256.08	2.25	416.41	2.54	1.96
1.98	22.36	1.23	48.15	1.48	87.30	1.72	141.95	1.95	257.38	2.26	418.53	2.55	1.98
2.00	22.47	1.23	48.39	1.49	87.74	1.73	142.67	1.96	258.68	2.27	420.63	2.56	2.00
2.02	22.58	1.24	48.63	1.50	88.17	1.74	143.38	1.97	259.97	2.28	422.73	2.57	2.02
2.04	22.69	1.24	48.87	1.51	88.61	1.75	144.09	1.97	261.25	2.29	424.82	2.59	2.04
2.06	22.80	1.25	49.11	1.51	89.04	1.76	144.79	1.98	262.53	2.30	426.90	2.60	2.06
2.08	22.91	1.26	49.35	1.52	89.47	1.77	145.49	1.99	263.80	2.31	428.96	2.61	2.08
2.10	23.02	1.26	49.58	1.53	89.90	1.77	146.19	2.00	265.06	2.32	431.02	2.63	2.10
2.12	23.13	1.27	49.82	1.54	90.33	1.78	146.89	2.01	266.32	2.34	433.07	2.64	2.12
2.14	23.24	1.27	50.05	1.54	90.75	1.79	147.58	2.02	267.58	2.35	435.11	2.65	2.14
2.16	23.35	1.28	50.29	1.55	91.18	1.80	148.27	2.03	268.82	2.36	437.14	2.66	2.16
2.18	23.46	1.29	50.52	1.56	91.60	1.81	148.95	2.04	270.06	2.37	439.16	2.67	2.18
2.20	23.57	1.29	50.75	1.56	92.02	1.82	149.63	2.05	271.30	2.38	441.17	2.69	2.20
2.22	23.67	1.30	50.98	1.57	92.44	1.82	150.31	2.06	272.53	2.39	443.17	2.70	2.22
2.24	23.78	1.30	51.21	1.58	92.85	1.83	150.99	2.07	273.76	2.40	445.16	2.71	2.24
2.26	23.88	1.31	51.44	1.59	93.26	1.84	151.66	2.08	274.98	2.41	447.14	2.72	2.26
2.28	23.99	1.32	51.67	1.59	93.68	1.85	152.33	2.09	276.19	2.42	449.11	2.74	2.28
2.30	24.10	1.32	51.89	1.60	94.09	1.86	152.99	2.10	277.40	2.43	451.08	2.75	2.30
2.32	24.20	1.33	52.12	1.61	94.49	1.86	153.66	2.11	278.60	2.44	453.04	2.76	2.32
2.34	24.30	1.33	52.34	1.61	94.90	1.87	154.32	2.11	279.80	2.45	454.99	2.77	2.34
2.36	24.41	1.34	52.56	1.62	95.31	1.88	154.98	2.12	280.99	2.46	456.93	2.78	2.36
2.38	24.51	1.34	52.79	1.63	95.71	1.89	155.63	2.13	282.18	2.48	458.86	2.79	2.38
2.40	24.61	1.35	53.01	1.63	96.11	1.90	156.29	2.14	283.36	2.49	460.78	2.81	2.40
2.42	24.72	1.35	53.23	1.64	96.51	1.90	156.94	2.15	284.54	2.50	462.70	2.82	2.42
2.44	24.82	1.36	53.45	1.65	96.91	1.91	157.58	2.16	285.72	2.51	464.61	2.83	2.44
2.46	24.92	1.37	53.67	1.65	97.30	1.92	158.23	2.17	286.88	2.52	466.51	2.84	2.46
2.48	25.02	1.37	53.88	1.66	97.70	1.93	158.87	2.18	288.05	2.53	468.40	2.85	2.48
2.50	25.12	1.38	54.10	1.67	98.09	1.94	159.51	2.19	289.21	2.54	470.28	2.86	2.50
2.52	25.22	1.38	54.32	1.67	98.48	1.94	160.14	2.19	290.36	2.55	472.16	2.88	2.52
2.54	25.32	1.39	54.53	1.68	98.87	1.95	160.78	2.20	291.51	2.56	474.03	2.89	2.54
2.56	25.42	1.39	54.75	1.69	99.26	1.96	161.41	2.21	292.66	2.57	475.89	2.90	2.56
2.58	25.52	1.40	54.96	1.69	99.65	1.97	162.04	2.22	293.80	2.58	477.75	2.91	2.58
2.60	25.62	1.40	55.17	1.70	100.03	1.97	162.67	2.23	294.94	2.59	479.60	2.92	2.60
2.62	25.72	1.41	55.38	1.71	100.42	1.98	163.29	2.24	296.07	2.60	481.44	2.93	2.62
2.64	25.81	1.42	55.60	1.71	100.80	1.99	163.91	2.25	297.20	2.61	483.27	2.94	2.64
2.66	25.91	1.42	55.81	1.72	101.18	2.00	164.53	2.25	298.32	2.62	485.10	2.95	2.66
2.68	26.01	1.43	56.01	1.73	101.56	2.00	165.15	2.26	299.44	2.63</			



**n=0.013**

nom D	150 mm		200 mm		250 mm		300 mm		375 mm		450 mm		nom D
act D	152.4 mm		203.2 mm		254.0 mm		304.8 mm		381.0 mm		457.2 mm		act D
GRADE %	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	GRADE %
3.00	27.52	1.51	59.26	1.83	107.45	2.12	174.73	2.39	316.81	2.78	515.17	3.14	3.00
3.10	27.97	1.53	60.24	1.86	109.23	2.16	177.62	2.43	322.05	2.82	523.69	3.19	3.10
3.20	28.42	1.56	61.21	1.89	110.98	2.19	180.46	2.47	327.20	2.87	532.07	3.24	3.20
3.30	28.86	1.58	62.16	1.92	112.70	2.22	183.26	2.51	332.27	2.91	540.31	3.29	3.30
3.40	29.30	1.61	63.09	1.95	114.39	2.26	186.02	2.55	337.27	2.96	548.44	3.34	3.40
3.50	29.72	1.63	64.01	1.97	116.06	2.29	188.73	2.59	342.20	3.00	556.45	3.39	3.50
3.60	30.15	1.65	64.92	2.00	117.71	2.32	191.41	2.62	347.05	3.04	564.34	3.44	3.60
3.70	30.56	1.68	65.82	2.03	119.33	2.36	194.05	2.66	351.84	3.09	572.12	3.48	3.70
3.80	30.97	1.70	66.70	2.06	120.94	2.39	196.65	2.70	356.56	3.13	579.80	3.53	3.80
3.90	31.38	1.72	67.57	2.08	122.52	2.42	199.23	2.73	361.22	3.17	587.38	3.58	3.90
4.00	31.78	1.74	68.43	2.11	124.08	2.45	201.76	2.77	365.82	3.21	594.87	3.62	4.00
4.10	32.17	1.76	69.28	2.14	125.62	2.48	204.27	2.80	370.37	3.25	602.26	3.67	4.10
4.20	32.56	1.78	70.12	2.16	127.14	2.51	206.75	2.83	374.86	3.29	609.56	3.71	4.20
4.30	32.95	1.81	70.95	2.19	128.65	2.54	209.19	2.87	379.29	3.33	616.77	3.76	4.30
4.40	33.33	1.83	71.77	2.21	130.13	2.57	211.61	2.90	383.68	3.37	623.90	3.80	4.40
4.50	33.70	1.85	72.58	2.24	131.60	2.60	214.00	2.93	388.01	3.40	630.95	3.84	4.50
4.60	34.08	1.87	73.39	2.26	133.06	2.63	216.37	2.97	392.30	3.44	637.92	3.89	4.60
4.70	34.44	1.89	74.18	2.29	134.50	2.65	218.71	3.00	396.54	3.48	644.82	3.93	4.70
4.80	34.81	1.91	74.96	2.31	135.92	2.68	221.02	3.03	400.74	3.51	651.64	3.97	4.80
4.90	35.17	1.93	75.74	2.34	137.33	2.71	223.31	3.06	404.89	3.55	658.40	4.01	4.90
5.00	35.53	1.95	76.51	2.36	138.72	2.74	225.58	3.09	409.00	3.59	665.08	4.05	5.00
5.10	35.88	1.97	77.27	2.38	140.10	2.76	227.82	3.12	413.07	3.62	671.70	4.09	5.10
5.20	36.23	1.99	78.03	2.41	141.47	2.79	230.05	3.15	417.10	3.66	678.25	4.13	5.20
5.30	36.58	2.01	78.77	2.43	142.82	2.82	232.25	3.18	421.09	3.69	684.74	4.17	5.30
5.40	36.92	2.02	79.51	2.45	144.17	2.85	234.43	3.21	425.05	3.73	691.17	4.21	5.40
5.50	37.26	2.04	80.24	2.47	145.49	2.87	236.59	3.24	428.96	3.76	697.54	4.25	5.50
5.60	37.60	2.06	80.97	2.50	146.81	2.90	238.73	3.27	432.85	3.80	703.86	4.29	5.60
5.70	37.93	2.08	81.69	2.52	148.12	2.92	240.85	3.30	436.69	3.83	710.11	4.33	5.70
5.80	38.26	2.10	82.40	2.54	149.41	2.95	242.96	3.33	440.51	3.86	716.31	4.36	5.80
5.90	38.59	2.12	83.11	2.56	150.69	2.97	245.04	3.36	444.29	3.90	722.46	4.40	5.90
6.00	38.92	2.13	83.81	2.58	151.96	3.00	247.11	3.39	448.04	3.93	728.56	4.44	6.00
6.10	39.24	2.15	84.51	2.61	153.22	3.02	249.16	3.41	451.76	3.96	734.61	4.47	6.10
6.20	39.56	2.17	85.20	2.63	154.48	3.05	251.19	3.44	455.44	3.99	740.60	4.51	6.20
6.30	39.88	2.19	85.88	2.65	155.72	3.07	253.21	3.47	459.10	4.03	746.55	4.55	6.30
6.40	40.19	2.20	86.56	2.67	156.95	3.10	255.21	3.50	462.73	4.06	752.45	4.58	6.40
6.50	40.51	2.22	87.24	2.69	158.17	3.12	257.20	3.52	466.33	4.09	758.31	4.62	6.50
6.60	40.82	2.24	87.90	2.71	159.38	3.15	259.17	3.55	469.91	4.12	764.12	4.65	6.60
6.70	41.12	2.25	88.57	2.73	160.58	3.17	261.13	3.58	473.45	4.15	769.89	4.69	6.70
6.80	41.43	2.27	89.23	2.75	161.78	3.19	263.07	3.61	476.97	4.18	775.61	4.72	6.80
6.90	41.73	2.29	89.88	2.77	162.96	3.22	264.99	3.63	480.47	4.21	781.29	4.76	6.90
7.00	42.04	2.30	90.53	2.79	164.14	3.24	266.91	3.66	483.94	4.24	786.93	4.79	7.00
7.10	42.33	2.32	91.17	2.81	165.31	3.26	268.81	3.68	487.38	4.27	792.54	4.83	7.10
7.20	42.63	2.34	91.81	2.83	166.47	3.29	270.69	3.71	490.80	4.30	798.10	4.86	7.20
7.30	42.93	2.35	92.45	2.85	167.62	3.31	272.57	3.74	494.20	4.33	803.62	4.89	7.30
7.40	43.22	2.37	93.08	2.87	168.76	3.33	274.43	3.76	497.57	4.36	809.11	4.93	7.40
7.50	43.51	2.39	93.71	2.89	169.90	3.35	276.28	3.79	500.92	4.39	814.56	4.96	7.50
7.60	43.80	2.40	94.33	2.91	171.03	3.38	278.11	3.81	504.25	4.42	819.97	4.99	7.60
7.70	44.09	2.42	94.95	2.93	172.15	3.40	279.94	3.84	507.56	4.45	825.34	5.03	7.70
7.80	44.37	2.43	95.56	2.95	173.26	3.42	281.75	3.86	510.84	4.48	830.69	5.06	7.80
7.90	44.66	2.45	96.17	2.97	174.37	3.44	283.55	3.89	514.11	4.51	835.99	5.09	7.90
8.00	44.94	2.46	96.78	2.98	175.47	3.46	285.34	3.91	517.35	4.54	841.27	5.12	8.00
8.10	45.22	2.48	97.38	3.00	176.57	3.48	287.11	3.93	520.57	4.57	846.51	5.16	8.10
8.20	45.50	2.49	97.98	3.02	177.65	3.51	288.88	3.96	523.78	4.59	851.72	5.19	8.20
8.30	45.77	2.51	98.58	3.04	178.73	3.53	290.64	3.98	526.96	4.62	856.90	5.22	8.30
8.40	46.05	2.52	99.17	3.06	179.81	3.55	292.38	4.01	530.13	4.65	862.04	5.25	8.40
8.50	46.32	2.54	99.76	3.08	180.87	3.57	294.12	4.03	533.27	4.68	867.16	5.28	8.50
8.60	46.59	2.55	100.34	3.09	181.93	3.59	295.84	4.05	536.40	4.70	872.25	5.31	8.60
8.70	46.86	2.57	100.92	3.11	182.99	3.61	297.56	4.08	539.51	4.73	877.30	5.34	8.70
8.80	47.13	2.58	101.50	3.13	184.04	3.63	299.26	4.10	542.60	4.76	882.33	5.37	8.80
8.90	47.40	2.60	102.08	3.15	185.08	3.65	300.96	4.12	545.68	4.79	887.33	5.40	8.90
9.00	47.66	2.61	102.65	3.17	186.12	3.67	302.65	4.15	548.73	4.81	892.30	5.44	9.00
9.10	47.93	2.63	103.22	3.18	187.15	3.69	304.32	4.17	551.77	4.84	897.24	5.47	9.10
9.20	48.19	2.64	103.78	3.20	188.17	3.71	305.99	4.19	554.80	4.87	902.16	5.50	9.20
9.30	48.45	2.66	104.35	3.22	189.19	3.73	307.65	4.22	557.80	4.89	907.05	5.52	9.30
9.40	48.71	2.67	104.91	3.23	190.21	3.75	309.30	4.24	560.79	4.92	911.91	5.55	9.40
9.50	48.97	2.68	105.46	3.25	191.22	3.77	310.94	4.26	563.77	4.94	916.75	5.58	9.50
9.60	49.23	2.70	106.02	3.27	192.22	3.79	312.57	4.28	566.73	4.97	921.56	5.61	9.60
9.70	49.48	2.71	106.57	3.29	193.22	3.81	314.19	4.31	569.67	5.00	926.35	5.64	9.70
9.80	49.74	2.73	107.11	3.30	194.21	3.83	315.81	4.33	572.60	5.02	931.11	5.67	9.80
9.90	49.99	2.74	107.66	3.32	195.20	3.85	317.42	4.35	575.52	5.05	935.85	5.70	9.90
10.00	50.24	2.75	108.20	3.34	196.18	3.87	319.02	4.37	578.42	5.07	940.57	5.73	10.00
10.10	50.49	2.77	108.74	3.35	197.16	3.89	320.61	4.39	581.30	5.10	945.26	5.76	10.10
10.20	50.74	2.78	109.28	3.37	198.14	3.91	322.19	4.42	584.17	5.12	949.93	5.79	10.20
10.30	50.99	2.80	109.81	3.39	199.10	3.93	323.77	4.44	587.03	5.15	954.57	5.81	10.30
10.40	51.24	2.81	110.35	3.40	200.07	3.95	325.33	4.46	589.87	5.17	959.19	5.84	10.40
10.50	51.48	2.82	110.87	3.42	201.03	3.97	326.89	4.48	592.70	5.20	963.79	5.87	10.50
10.60	51.73	2.84	111.40	3.44	201.98	3.99	328.45	4.50	595.52	5.22	968.37	5.90	10.60
10.70	51.97	2.85	111.93	3.45	202.93	4.00	329.99	4.52	598.32	5.25	972.93	5.93	10.70
10.80	52.21	2.86	112.45	3.47	203.88	4.02	331.53	4.54	601.11	5.27	977.47	5.95	10.80
10.90	52.45	2.88	112.97	3.48	204.82	4.04	333.06	4.56	603.88	5.30	981.98	5.98	10.90
11.00	52.69	2.89	113.48	3.50	205.76	4.06	334.59	4.59	606.65	5.32	986.48	6.01	11.00
11.10	52.93	2.90	114.00	3.52	206.69	4.08	336.10	4.61	609.40	5.35	990.95	6.04	11.10
11.20	53.17	2.91	114.51	3.53	207.62	4.10	337.62	4.63	612.14	5.37	995.40	6.06	11.20
11.30	53.41	2.93	115.02	3.55	208.55	4.12	339.12	4.65	614.86	5.39	999.84	6.09	11.30
11.40	53.64	2.94	115.53										

**n=0.013**

nom D	525 mm		600 mm		675 mm		750 mm		825 mm		900 mm		nom D
act D	533.4 mm		609.6 mm		685.8 mm		762.0 mm		838.2 mm		914.4 mm		act D
GRADE %	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	GRADE %
0.05	100.32	0.45	143.23	0.49	196.09	0.53	259.70	0.57	334.85	0.61	422.30	0.64	0.05
0.06	109.90	0.49	156.90	0.54	214.80	0.58	284.49	0.62	366.81	0.66	462.61	0.70	0.06
0.07	118.70	0.53	169.48	0.58	232.01	0.63	307.28	0.67	396.20	0.72	499.67	0.76	0.07
0.08	126.90	0.57	181.18	0.62	248.03	0.67	328.50	0.72	423.56	0.77	534.17	0.81	0.08
0.09	134.60	0.60	192.17	0.66	263.08	0.71	348.42	0.76	449.25	0.81	566.58	0.86	0.09
0.10	141.88	0.63	202.56	0.69	277.31	0.75	367.27	0.81	473.55	0.86	597.22	0.91	0.10
0.11	148.80	0.67	212.45	0.73	290.85	0.79	385.20	0.84	496.66	0.90	626.37	0.95	0.11
0.12	155.42	0.70	221.90	0.76	303.78	0.82	402.33	0.88	518.75	0.94	654.22	1.00	0.12
0.13	161.77	0.72	230.96	0.79	316.18	0.86	418.75	0.92	539.93	0.98	680.94	1.04	0.13
0.14	167.87	0.75	239.68	0.82	328.12	0.89	434.56	0.95	560.31	1.02	706.64	1.08	0.14
0.15	173.76	0.78	248.09	0.85	339.63	0.92	449.81	0.99	579.98	1.05	731.45	1.11	0.15
0.16	179.46	0.80	256.22	0.88	350.77	0.95	464.56	1.02	599.00	1.09	755.43	1.15	0.16
0.17	184.99	0.83	264.11	0.90	361.57	0.98	478.86	1.05	617.44	1.12	778.68	1.19	0.17
0.18	190.35	0.85	271.77	0.93	372.05	1.01	492.75	1.08	635.34	1.15	801.26	1.22	0.18
0.19	195.57	0.88	279.21	0.96	382.25	1.03	506.25	1.11	652.75	1.18	823.21	1.25	0.19
0.20	200.65	0.90	286.47	0.98	392.18	1.06	519.40	1.14	669.70	1.21	844.60	1.29	0.20
0.21	205.60	0.92	293.54	1.01	401.86	1.09	532.23	1.17	686.24	1.24	865.46	1.32	0.21
0.22	210.44	0.94	300.45	1.03	411.32	1.11	544.75	1.19	702.39	1.27	885.82	1.35	0.22
0.23	215.17	0.96	307.20	1.05	420.56	1.14	556.99	1.22	718.18	1.30	905.73	1.38	0.23
0.24	219.80	0.98	313.81	1.08	429.61	1.16	568.97	1.25	733.62	1.33	925.21	1.41	0.24
0.25	224.33	1.00	320.28	1.10	438.47	1.19	580.71	1.27	748.75	1.36	944.29	1.44	0.25
0.26	228.77	1.02	326.62	1.12	447.15	1.21	592.21	1.30	763.58	1.38	962.99	1.47	0.26
0.27	233.13	1.04	332.84	1.14	455.67	1.23	603.49	1.32	778.12	1.41	981.34	1.49	0.27
0.28	237.41	1.06	338.95	1.16	464.03	1.26	614.56	1.35	792.40	1.44	999.35	1.52	0.28
0.29	241.61	1.08	344.95	1.18	472.24	1.28	625.44	1.37	806.43	1.46	1,017.03	1.55	0.29
0.30	245.74	1.10	350.85	1.20	480.32	1.30	636.13	1.39	820.21	1.49	1,034.42	1.58	0.30
0.31	249.80	1.12	356.65	1.22	488.26	1.32	646.65	1.42	833.77	1.51	1,051.52	1.60	0.31
0.32	253.80	1.14	362.36	1.24	496.07	1.34	656.99	1.44	847.11	1.54	1,068.34	1.63	0.32
0.33	257.73	1.15	367.97	1.26	503.76	1.36	667.18	1.46	860.25	1.56	1,084.91	1.65	0.33
0.34	261.61	1.17	373.51	1.28	511.34	1.38	677.21	1.48	873.19	1.58	1,101.22	1.68	0.34
0.35	265.43	1.19	378.96	1.30	518.80	1.40	687.10	1.51	885.93	1.61	1,117.30	1.70	0.35
0.36	269.19	1.20	384.34	1.32	526.16	1.42	696.85	1.53	898.50	1.63	1,133.15	1.73	0.36
0.37	272.91	1.22	389.64	1.33	533.42	1.44	706.46	1.55	910.89	1.65	1,148.78	1.75	0.37
0.38	276.57	1.24	394.87	1.35	540.58	1.46	715.94	1.57	923.12	1.67	1,164.20	1.77	0.38
0.39	280.19	1.25	400.03	1.37	547.64	1.48	725.30	1.59	935.19	1.69	1,179.42	1.80	0.39
0.40	283.76	1.27	405.13	1.39	554.62	1.50	734.54	1.61	947.10	1.72	1,194.45	1.82	0.40
0.41	287.28	1.29	410.16	1.41	561.51	1.52	743.67	1.63	958.87	1.74	1,209.28	1.84	0.41
0.42	290.76	1.30	415.13	1.42	568.32	1.54	752.68	1.65	970.49	1.76	1,223.94	1.86	0.42
0.43	294.20	1.32	420.04	1.44	575.04	1.56	761.59	1.67	981.98	1.78	1,238.43	1.89	0.43
0.44	297.61	1.33	424.90	1.46	581.69	1.57	770.39	1.69	993.33	1.80	1,252.75	1.91	0.44
0.45	300.97	1.35	429.70	1.47	588.26	1.59	779.10	1.71	1,004.55	1.82	1,266.90	1.93	0.45
0.46	304.29	1.36	434.45	1.49	594.76	1.61	787.71	1.73	1,015.65	1.84	1,280.90	1.95	0.46
0.47	307.58	1.38	439.15	1.50	601.20	1.63	796.22	1.75	1,026.63	1.86	1,294.75	1.97	0.47
0.48	310.84	1.39	443.79	1.52	607.56	1.64	804.65	1.76	1,037.50	1.88	1,308.45	1.99	0.48
0.49	314.06	1.41	448.39	1.54	613.85	1.66	812.99	1.78	1,048.25	1.90	1,322.01	2.01	0.49
0.50	317.25	1.42	452.94	1.55	620.09	1.68	821.24	1.80	1,058.89	1.92	1,335.43	2.03	0.50
0.51	320.41	1.43	457.45	1.57	626.26	1.70	829.41	1.82	1,069.43	1.94	1,348.72	2.05	0.51
0.52	323.53	1.45	461.91	1.58	632.37	1.71	837.51	1.84	1,079.86	1.96	1,361.88	2.07	0.52
0.53	326.63	1.46	466.33	1.60	638.42	1.73	845.52	1.85	1,090.20	1.98	1,374.91	2.09	0.53
0.54	329.69	1.48	470.71	1.61	644.41	1.74	853.46	1.87	1,100.43	1.99	1,387.82	2.11	0.54
0.55	332.73	1.49	475.05	1.63	650.35	1.76	861.33	1.89	1,110.58	2.01	1,400.61	2.13	0.55
0.56	335.74	1.50	479.35	1.64	656.24	1.78	869.12	1.91	1,120.63	2.03	1,413.29	2.15	0.56
0.57	338.73	1.52	483.61	1.66	662.07	1.79	876.85	1.92	1,130.59	2.05	1,425.85	2.17	0.57
0.58	341.69	1.53	487.84	1.67	667.85	1.81	884.51	1.94	1,140.46	2.07	1,438.30	2.19	0.58
0.59	344.62	1.54	492.02	1.69	673.59	1.82	892.10	1.96	1,150.25	2.08	1,450.65	2.21	0.59
0.60	347.53	1.56	496.18	1.70	679.27	1.84	899.63	1.97	1,159.96	2.10	1,462.89	2.23	0.60
0.61	350.41	1.57	500.29	1.71	684.91	1.85	907.09	1.99	1,169.59	2.12	1,475.03	2.25	0.61
0.62	353.27	1.58	504.38	1.73	690.50	1.87	914.50	2.01	1,179.13	2.14	1,487.07	2.26	0.62
0.63	356.11	1.59	508.43	1.74	696.04	1.88	921.84	2.02	1,188.60	2.15	1,499.02	2.28	0.63
0.64	358.93	1.61	512.45	1.76	701.55	1.90	929.13	2.04	1,198.00	2.17	1,510.87	2.30	0.64
0.65	361.72	1.62	516.44	1.77	707.01	1.91	936.36	2.05	1,207.32	2.19	1,522.63	2.32	0.65
0.66	364.49	1.63	520.39	1.78	712.42	1.93	943.54	2.07	1,216.58	2.20	1,534.29	2.34	0.66
0.67	367.24	1.64	524.32	1.80	717.80	1.94	950.66	2.08	1,225.76	2.22	1,545.87	2.35	0.67
0.68	369.97	1.66	528.22	1.81	723.14	1.96	957.73	2.10	1,234.87	2.24	1,557.37	2.37	0.68
0.69	372.68	1.67	532.09	1.82	728.44	1.97	964.74	2.12	1,243.92	2.25	1,568.78	2.39	0.69
0.70	375.37	1.68	535.93	1.84	733.69	1.99	971.71	2.13	1,252.90	2.27	1,580.10	2.41	0.70
0.71	378.05	1.69	539.75	1.85	738.92	2.00	978.62	2.15	1,261.82	2.29	1,591.35	2.42	0.71
0.72	380.70	1.70	543.53	1.86	744.10	2.01	985.49	2.16	1,270.67	2.30	1,602.52	2.44	0.72
0.73	383.33	1.72	547.29	1.88	749.25	2.03	992.31	2.18	1,279.46	2.32	1,613.61	2.46	0.73
0.74	385.95	1.73	551.03	1.89	754.37	2.04	999.08	2.19	1,288.20	2.33	1,624.62	2.47	0.74
0.75	388.55	1.74	554.74	1.90	759.45	2.06	1,005.81	2.21	1,296.87	2.35	1,635.56	2.49	0.75
0.76	391.13	1.75	558.43	1.91	764.49	2.07	1,012.50	2.22	1,305.49	2.37	1,646.43	2.51	0.76
0.77	393.70	1.76	562.09	1.93	769.51	2.08	1,019.14	2.23	1,314.05	2.38	1,657.23	2.52	0.77
0.78	396.24	1.77	565.73	1.94	774.49	2.10	1,025.73	2.25	1,322.56	2.40	1,667.95	2.54	0.78
0.79	398.78	1.78	569.34	1.95	779.44	2.11	1,032.29	2.26	1,331.01	2.41	1,678.61	2.56	0.79
0.80	401.29	1.80	572.93	1.96	784.35	2.12	1,038.80	2.28	1,339.41	2.43	1,689.20	2.57	0.80
0.81	403.79	1.81	576.50	1.98	789.24	2.14	1,045.27	2.29	1,347.75	2.44	1,699.73	2.59	0.81
0.82	406.28	1.82	580.05	1.99	794.10	2.15	1,051.70	2.31	1,356.04	2.46	1,710.19	2.60	0.82
0.83	408.75	1.83	583.58	2.00	798.92	2.16	1,058.10	2.32	1,364.29	2.47	1,720.58	2.62	0.83
0.84	411.20	1.84	587.08	2.01	803.72	2.18	1,064.45	2.33	1,372.48	2.49	1,730.92	2.64	0.84
0.85	413.64	1.85	590.57	2.02	808.49	2.19	1,070.77	2.35	1,380.63	2.50	1,741.19	2.65	0.85
0.86	416.07	1.86	594.03	2.04	813.23	2.20	1,077.05	2.36	1,388.72	2.52	1,751.40	2.67	0.

n=0.013

nom D	525 mm		600 mm		675 mm		750 mm		825 mm		900 mm		nom D
act D	533.4 mm		609.6 mm		685.8 mm		762.0 mm		838.2 mm		914.4 mm		act D
GRADE %	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	GRADE %
	(L/s)	(m/s)	(L/s)	(m/s)	(L/s)	(m/s)	(L/s)	(m/s)	(L/s)	(m/s)	(L/s)	(m/s)	
1.00	448.66	2.01	640.56	2.19	876.93	2.37	1,161.41	2.55	1,497.50	2.71	1,888.58	2.88	1.00
1.02	453.12	2.03	646.93	2.22	885.66	2.40	1,172.97	2.57	1,512.40	2.74	1,907.38	2.90	1.02
1.04	457.54	2.05	653.25	2.24	894.30	2.42	1,184.41	2.60	1,527.16	2.77	1,925.99	2.93	1.04
1.06	461.92	2.07	659.50	2.26	902.86	2.44	1,195.75	2.62	1,541.77	2.79	1,944.42	2.96	1.06
1.08	466.26	2.09	665.69	2.28	911.34	2.47	1,206.98	2.65	1,556.25	2.82	1,962.67	2.99	1.08
1.10	470.56	2.11	671.82	2.30	919.74	2.49	1,218.10	2.67	1,570.59	2.85	1,980.76	3.02	1.10
1.12	474.81	2.12	677.90	2.32	928.06	2.51	1,229.12	2.70	1,584.81	2.87	1,998.69	3.04	1.12
1.14	479.03	2.14	683.93	2.34	936.31	2.53	1,240.05	2.72	1,598.89	2.90	2,016.46	3.07	1.14
1.16	483.22	2.16	689.90	2.36	944.49	2.56	1,250.88	2.74	1,612.86	2.92	2,034.07	3.10	1.16
1.18	487.37	2.18	695.83	2.38	952.59	2.58	1,261.62	2.77	1,626.70	2.95	2,051.53	3.12	1.18
1.20	491.48	2.20	701.70	2.40	960.63	2.60	1,272.26	2.79	1,640.43	2.97	2,068.84	3.15	1.20
1.22	495.56	2.22	707.52	2.42	968.60	2.62	1,282.82	2.81	1,654.04	3.00	2,086.01	3.18	1.22
1.24	499.60	2.24	713.30	2.44	976.51	2.64	1,293.29	2.84	1,667.55	3.02	2,103.04	3.20	1.24
1.26	503.62	2.25	719.03	2.46	984.36	2.66	1,303.68	2.86	1,680.94	3.05	2,119.93	3.23	1.26
1.28	507.60	2.27	724.71	2.48	992.14	2.69	1,313.99	2.88	1,694.23	3.07	2,136.69	3.25	1.28
1.30	511.55	2.29	730.35	2.50	999.86	2.71	1,324.21	2.90	1,707.41	3.09	2,153.32	3.28	1.30
1.32	515.47	2.31	735.95	2.52	1,007.52	2.73	1,334.36	2.93	1,720.50	3.12	2,169.82	3.30	1.32
1.34	519.36	2.32	741.50	2.54	1,015.12	2.75	1,344.43	2.95	1,733.48	3.14	2,186.19	3.33	1.34
1.36	523.22	2.34	747.01	2.56	1,022.67	2.77	1,354.43	2.97	1,746.37	3.16	2,202.45	3.35	1.36
1.38	527.05	2.36	752.49	2.58	1,030.16	2.79	1,364.35	2.99	1,759.16	3.19	2,218.58	3.38	1.38
1.40	530.86	2.38	757.92	2.60	1,037.60	2.81	1,374.20	3.01	1,771.87	3.21	2,234.60	3.40	1.40
1.42	534.64	2.39	763.32	2.62	1,044.99	2.83	1,383.98	3.03	1,784.48	3.23	2,250.51	3.43	1.42
1.44	538.39	2.41	768.67	2.63	1,052.32	2.85	1,393.69	3.06	1,797.00	3.26	2,266.30	3.45	1.44
1.46	542.11	2.43	773.99	2.65	1,059.60	2.87	1,403.34	3.08	1,809.44	3.28	2,281.99	3.47	1.46
1.48	545.81	2.44	779.27	2.67	1,066.84	2.89	1,412.92	3.10	1,821.79	3.30	2,297.56	3.50	1.48
1.50	549.49	2.46	784.52	2.69	1,074.02	2.91	1,422.43	3.12	1,834.06	3.32	2,313.03	3.52	1.50
1.52	553.14	2.48	789.74	2.71	1,081.16	2.93	1,431.89	3.14	1,846.24	3.35	2,328.40	3.55	1.52
1.54	556.77	2.49	794.91	2.72	1,088.25	2.95	1,441.27	3.16	1,858.35	3.37	2,343.67	3.57	1.54
1.56	560.37	2.51	800.06	2.74	1,095.29	2.97	1,450.60	3.18	1,870.38	3.39	2,358.84	3.59	1.56
1.58	563.95	2.52	805.17	2.76	1,102.29	2.98	1,459.87	3.20	1,882.33	3.41	2,373.91	3.61	1.58
1.60	567.51	2.54	810.25	2.78	1,109.24	3.00	1,469.08	3.22	1,894.20	3.43	2,388.89	3.64	1.60
1.62	571.05	2.56	815.30	2.79	1,116.15	3.02	1,478.24	3.24	1,906.01	3.45	2,403.78	3.66	1.62
1.64	574.56	2.57	820.32	2.81	1,123.02	3.04	1,487.33	3.26	1,917.74	3.48	2,418.57	3.68	1.64
1.66	578.05	2.59	825.30	2.83	1,129.85	3.06	1,496.38	3.28	1,929.39	3.50	2,433.27	3.71	1.66
1.68	581.53	2.60	830.26	2.84	1,136.64	3.08	1,505.36	3.30	1,940.98	3.52	2,447.89	3.73	1.68
1.70	584.98	2.62	835.19	2.86	1,143.38	3.10	1,514.30	3.32	1,952.50	3.54	2,462.41	3.75	1.70
1.72	588.41	2.63	840.09	2.88	1,150.09	3.11	1,523.18	3.34	1,963.95	3.56	2,476.86	3.77	1.72
1.74	591.82	2.65	844.96	2.90	1,156.75	3.13	1,532.01	3.36	1,975.34	3.58	2,491.21	3.79	1.74
1.76	595.21	2.66	849.80	2.91	1,163.38	3.15	1,540.79	3.38	1,986.66	3.60	2,505.49	3.82	1.76
1.78	598.58	2.68	854.61	2.93	1,169.97	3.17	1,549.52	3.40	1,997.91	3.62	2,519.69	3.84	1.78
1.80	601.94	2.69	859.40	2.94	1,176.53	3.19	1,558.20	3.42	2,009.11	3.64	2,533.80	3.86	1.80
1.82	605.27	2.71	864.16	2.96	1,183.05	3.20	1,566.83	3.44	2,020.24	3.66	2,547.84	3.88	1.82
1.84	608.59	2.72	868.90	2.98	1,189.53	3.22	1,575.42	3.45	2,031.31	3.68	2,561.80	3.90	1.84
1.86	611.89	2.74	873.61	2.99	1,195.98	3.24	1,583.96	3.47	2,042.32	3.70	2,575.69	3.92	1.86
1.88	615.17	2.75	878.29	3.01	1,202.39	3.26	1,592.45	3.49	2,053.27	3.72	2,589.50	3.94	1.88
1.90	618.43	2.77	882.95	3.03	1,208.77	3.27	1,600.90	3.51	2,064.16	3.74	2,603.23	3.96	1.90
1.92	621.68	2.78	887.59	3.04	1,215.11	3.29	1,609.30	3.53	2,075.00	3.76	2,616.90	3.98	1.92
1.94	624.91	2.80	892.20	3.06	1,221.43	3.31	1,617.66	3.55	2,085.78	3.78	2,630.49	4.01	1.94
1.96	628.12	2.81	896.78	3.07	1,227.71	3.32	1,625.98	3.57	2,096.50	3.80	2,644.02	4.03	1.96
1.98	631.32	2.83	901.35	3.09	1,233.95	3.34	1,634.25	3.58	2,107.17	3.82	2,657.47	4.05	1.98
2.00	634.50	2.84	905.89	3.10	1,240.17	3.36	1,642.49	3.60	2,117.79	3.84	2,670.86	4.07	2.00
2.02	637.66	2.85	910.41	3.12	1,246.36	3.37	1,650.68	3.62	2,128.35	3.86	2,684.18	4.09	2.02
2.04	640.81	2.87	914.90	3.13	1,252.51	3.39	1,658.83	3.64	2,138.86	3.88	2,697.44	4.11	2.04
2.06	643.94	2.88	919.38	3.15	1,258.64	3.41	1,666.94	3.66	2,149.32	3.90	2,710.63	4.13	2.06
2.08	647.06	2.90	923.83	3.17	1,264.73	3.42	1,675.01	3.67	2,159.73	3.91	2,723.76	4.15	2.08
2.10	650.17	2.91	928.26	3.18	1,270.80	3.44	1,683.05	3.69	2,170.08	3.93	2,736.82	4.17	2.10
2.12	653.25	2.92	932.67	3.20	1,276.83	3.46	1,691.04	3.71	2,180.39	3.95	2,749.82	4.19	2.12
2.14	656.33	2.94	937.06	3.21	1,282.84	3.47	1,699.00	3.73	2,190.65	3.97	2,762.76	4.21	2.14
2.16	659.39	2.95	941.43	3.23	1,288.82	3.49	1,706.92	3.74	2,200.87	3.99	2,775.64	4.23	2.16
2.18	662.43	2.96	945.78	3.24	1,294.78	3.51	1,714.80	3.76	2,211.03	4.01	2,788.46	4.25	2.18
2.20	665.47	2.98	950.10	3.26	1,300.70	3.52	1,722.65	3.78	2,221.15	4.03	2,801.22	4.27	2.20
2.22	668.48	2.99	954.41	3.27	1,306.60	3.54	1,730.47	3.79	2,231.23	4.04	2,813.93	4.28	2.22
2.24	671.49	3.00	958.70	3.28	1,312.47	3.55	1,738.24	3.81	2,241.25	4.06	2,826.57	4.30	2.24
2.26	674.48	3.02	962.97	3.30	1,318.32	3.57	1,745.99	3.83	2,251.24	4.08	2,839.17	4.32	2.26
2.28	677.46	3.03	967.22	3.31	1,324.14	3.58	1,753.69	3.85	2,261.18	4.10	2,851.70	4.34	2.28
2.30	680.42	3.04	971.46	3.33	1,329.93	3.60	1,761.37	3.86	2,271.07	4.12	2,864.18	4.36	2.30
2.32	683.37	3.06	975.67	3.34	1,335.70	3.62	1,769.01	3.88	2,280.92	4.13	2,876.61	4.38	2.32
2.34	686.31	3.07	979.87	3.36	1,341.45	3.63	1,776.62	3.90	2,290.74	4.15	2,888.98	4.40	2.34
2.36	689.24	3.08	984.05	3.37	1,347.17	3.65	1,784.20	3.91	2,300.50	4.17	2,901.30	4.42	2.36
2.38	692.15	3.10	988.21	3.39	1,352.87	3.66	1,791.74	3.93	2,310.23	4.19	2,913.57	4.44	2.38
2.40	695.06	3.11	992.35	3.40	1,358.54	3.68	1,799.25	3.95	2,319.92	4.20	2,925.78	4.46	2.40
2.42	697.95	3.12	996.48	3.41	1,364.19	3.69	1,806.73	3.96	2,329.56	4.22	2,937.95	4.47	2.42
2.44	700.82	3.14	1,000.59	3.43	1,369.81	3.71	1,814.18	3.98	2,339.17	4.24	2,950.06	4.49	2.44
2.46	703.69	3.15	1,004.68	3.44	1,375.42	3.72	1,821.60	3.99	2,348.74	4.26	2,962.13	4.51	2.46
2.48	706.55	3.16	1,008.75	3.46	1,381.00	3.74	1,828.99	4.01	2,358.27	4.27	2,974.15	4.53	2.48
2.50	709.39	3.17	1,012.81	3.47	1,386.55	3.75	1,836.35	4.03	2,367.76	4.29	2,986.11	4.55	2.50
2.52	712.22	3.19	1,016.86	3.48	1,392.09	3.77	1,843.69	4.04	2,377.21	4.31	2,998.04	4.57	2.52
2.54	715.04	3.20	1,020.88	3.50	1,397.60	3.78	1,850.99	4.06	2,386.62	4.33	3,009.91	4.58	2.54
2.56	717.85	3.21	1,024.90	3.51	1,403.09	3.80	1,858.26	4.07	2,396.00	4			

**n=0.013**

nom D	525 mm		600 mm		675 mm		750 mm		825 mm		900 mm		nom D
act D	533.4 mm		609.6 mm		685.8 mm		762.0 mm		838.2 mm		914.4 mm		act D
GRADE %	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	GRADE %
3.00	777.10	3.48	1,109.48	3.80	1,518.89	4.11	2,011.63	4.41	2,593.75	4.70	3,271.12	4.98	3.00
3.10	789.94	3.54	1,127.82	3.86	1,544.00	4.18	2,044.88	4.48	2,636.62	4.78	3,325.20	5.06	3.10
3.20	802.58	3.59	1,145.87	3.93	1,568.71	4.25	2,077.60	4.56	2,678.81	4.85	3,378.40	5.14	3.20
3.30	815.03	3.65	1,163.63	3.99	1,593.03	4.31	2,109.81	4.63	2,720.34	4.93	3,430.78	5.22	3.30
3.40	827.28	3.70	1,181.13	4.05	1,616.98	4.38	2,141.54	4.70	2,761.25	5.00	3,482.38	5.30	3.40
3.50	839.36	3.76	1,198.38	4.11	1,640.59	4.44	2,172.80	4.76	2,801.57	5.08	3,533.22	5.38	3.50
3.60	851.27	3.81	1,215.38	4.16	1,663.86	4.50	2,203.63	4.83	2,841.31	5.15	3,583.34	5.46	3.60
3.70	863.01	3.86	1,232.14	4.22	1,686.81	4.57	2,234.02	4.90	2,880.50	5.22	3,632.77	5.53	3.70
3.80	874.59	3.91	1,248.68	4.28	1,709.46	4.63	2,264.01	4.96	2,919.17	5.29	3,681.53	5.61	3.80
3.90	886.03	3.97	1,265.00	4.33	1,731.80	4.69	2,293.61	5.03	2,957.33	5.36	3,729.66	5.68	3.90
4.00	897.31	4.02	1,281.12	4.39	1,753.87	4.75	2,322.82	5.09	2,995.00	5.43	3,777.17	5.75	4.00
4.10	908.46	4.07	1,297.03	4.44	1,775.65	4.81	2,351.68	5.16	3,032.21	5.50	3,824.09	5.82	4.10
4.20	919.47	4.11	1,312.76	4.50	1,797.18	4.87	2,380.19	5.22	3,068.96	5.56	3,870.45	5.89	4.20
4.30	930.36	4.16	1,328.29	4.55	1,818.45	4.92	2,408.36	5.28	3,105.28	5.63	3,916.25	5.96	4.30
4.40	941.11	4.21	1,343.65	4.60	1,839.47	4.98	2,436.20	5.34	3,141.18	5.69	3,961.53	6.03	4.40
4.50	951.75	4.26	1,358.83	4.66	1,860.26	5.04	2,463.73	5.40	3,176.68	5.76	4,006.29	6.10	4.50
4.60	962.26	4.31	1,373.85	4.71	1,880.81	5.09	2,490.95	5.46	3,211.78	5.82	4,050.56	6.17	4.60
4.70	972.67	4.35	1,388.70	4.76	1,901.15	5.15	2,517.88	5.52	3,246.50	5.88	4,094.35	6.23	4.70
4.80	982.96	4.40	1,403.40	4.81	1,921.26	5.20	2,544.53	5.58	3,280.86	5.95	4,137.68	6.30	4.80
4.90	993.14	4.44	1,417.94	4.86	1,941.17	5.26	2,570.90	5.64	3,314.86	6.01	4,180.56	6.37	4.90
5.00	1,003.23	4.49	1,432.34	4.91	1,960.88	5.31	2,597.00	5.69	3,348.51	6.07	4,223.00	6.43	5.00
5.10	1,013.21	4.53	1,446.59	4.96	1,980.39	5.36	2,622.84	5.75	3,381.83	6.13	4,265.02	6.49	5.10
5.20	1,023.10	4.58	1,460.70	5.00	1,999.72	5.41	2,648.43	5.81	3,414.83	6.19	4,306.64	6.56	5.20
5.30	1,032.89	4.62	1,474.68	5.05	2,018.85	5.47	2,673.77	5.86	3,447.50	6.25	4,347.85	6.62	5.30
5.40	1,042.58	4.67	1,488.53	5.10	2,037.81	5.52	2,698.88	5.92	3,479.88	6.31	4,388.67	6.68	5.40
5.50	1,052.19	4.71	1,502.25	5.15	2,056.59	5.57	2,723.75	5.97	3,511.95	6.36	4,429.12	6.74	5.50
5.60	1,061.72	4.75	1,515.84	5.19	2,075.20	5.62	2,748.40	6.03	3,543.73	6.42	4,469.21	6.81	5.60
5.70	1,071.15	4.79	1,529.32	5.24	2,093.65	5.67	2,772.83	6.08	3,575.23	6.48	4,508.93	6.87	5.70
5.80	1,080.51	4.84	1,542.67	5.29	2,111.93	5.72	2,797.05	6.13	3,606.46	6.54	4,548.31	6.93	5.80
5.90	1,089.78	4.88	1,555.91	5.33	2,130.06	5.77	2,821.06	6.19	3,637.42	6.59	4,587.36	6.99	5.90
6.00	1,098.98	4.92	1,569.04	5.38	2,148.04	5.82	2,844.87	6.24	3,668.11	6.65	4,626.07	7.04	6.00
GRADE %	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	GRADE %
act D	533.4 mm		609.6 mm		685.8 mm		762.0 mm		838.2 mm		914.4 mm		act D
nom D	525 mm		600 mm		675 mm		750 mm		825 mm		900 mm		nom D

n=0.013

nom D	975 mm		1050 mm		1200 mm		1350 mm		1500 mm		1650 mm		nom D
act D	990.6 mm		1066.8 mm		1219.2 mm		1371.6 mm		1524.0 mm		1676.4 mm		act D
GRADE %	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	GRADE %
0.01	233.80	0.30	284.88	0.32	406.73	0.35	556.82	0.38	737.45	0.40	950.85	0.43	0.01
0.02	330.64	0.43	402.88	0.45	575.20	0.49	787.46	0.53	1,042.91	0.57	1,344.71	0.61	0.02
0.03	404.94	0.53	493.43	0.55	704.48	0.60	964.44	0.65	1,277.30	0.70	1,646.93	0.75	0.03
0.04	467.59	0.61	569.76	0.64	813.46	0.70	1,113.64	0.75	1,474.90	0.81	1,901.71	0.86	0.04
0.05	522.78	0.68	637.01	0.71	909.48	0.78	1,245.08	0.84	1,648.99	0.90	2,126.17	0.96	0.05
0.06	572.68	0.74	697.81	0.78	996.28	0.85	1,363.92	0.92	1,806.38	0.99	2,329.11	1.06	0.06
0.07	618.56	0.80	753.72	0.84	1,076.11	0.92	1,473.20	1.00	1,951.11	1.07	2,515.72	1.14	0.07
0.08	661.27	0.86	805.76	0.90	1,150.41	0.99	1,574.92	1.07	2,085.83	1.14	2,689.42	1.22	0.08
0.09	701.39	0.91	854.64	0.96	1,220.19	1.05	1,670.45	1.13	2,212.35	1.21	2,852.56	1.29	0.09
0.10	739.33	0.96	900.87	1.01	1,286.19	1.10	1,760.81	1.19	2,332.02	1.28	3,006.86	1.36	0.10
0.11	775.41	1.01	944.84	1.06	1,348.97	1.16	1,846.76	1.25	2,445.85	1.34	3,153.62	1.43	0.11
0.12	809.89	1.05	986.85	1.10	1,408.95	1.21	1,928.87	1.31	2,554.60	1.40	3,293.85	1.49	0.12
0.13	842.96	1.09	1,027.15	1.15	1,466.49	1.26	2,007.64	1.36	2,658.92	1.46	3,428.35	1.55	0.13
0.14	874.78	1.14	1,065.92	1.19	1,521.85	1.30	2,083.42	1.41	2,759.29	1.51	3,557.77	1.61	0.14
0.15	905.48	1.17	1,103.33	1.23	1,575.26	1.35	2,156.55	1.46	2,856.14	1.57	3,682.64	1.67	0.15
0.16	935.18	1.21	1,139.52	1.27	1,626.92	1.39	2,227.27	1.51	2,949.80	1.62	3,803.41	1.72	0.16
0.17	963.96	1.25	1,174.59	1.31	1,676.99	1.44	2,295.82	1.55	3,040.59	1.67	3,920.47	1.78	0.17
0.18	991.91	1.29	1,208.64	1.35	1,725.61	1.48	2,362.38	1.60	3,128.74	1.72	4,034.13	1.83	0.18
0.19	1,019.09	1.32	1,241.76	1.39	1,772.90	1.52	2,427.11	1.64	3,214.47	1.76	4,144.67	1.88	0.19
0.20	1,045.56	1.36	1,274.02	1.43	1,818.95	1.56	2,490.17	1.69	3,297.98	1.81	4,252.35	1.93	0.20
0.21	1,071.38	1.39	1,305.48	1.46	1,863.87	1.60	2,551.66	1.73	3,379.42	1.85	4,357.36	1.97	0.21
0.22	1,096.60	1.42	1,336.20	1.49	1,907.73	1.63	2,611.71	1.77	3,458.95	1.90	4,459.90	2.02	0.22
0.23	1,121.24	1.45	1,366.23	1.53	1,950.61	1.67	2,670.40	1.81	3,536.69	1.94	4,560.13	2.07	0.23
0.24	1,145.36	1.49	1,395.62	1.56	1,992.56	1.71	2,727.84	1.85	3,612.76	1.98	4,658.21	2.11	0.24
0.25	1,168.98	1.52	1,424.40	1.59	2,033.65	1.74	2,784.09	1.88	3,687.25	2.02	4,754.27	2.15	0.25
0.26	1,192.13	1.55	1,452.61	1.63	2,073.93	1.78	2,839.23	1.92	3,760.28	2.06	4,848.42	2.20	0.26
0.27	1,214.83	1.58	1,480.28	1.66	2,113.43	1.81	2,893.31	1.96	3,831.91	2.10	4,940.78	2.24	0.27
0.28	1,237.13	1.61	1,507.44	1.69	2,152.21	1.84	2,946.40	1.99	3,902.22	2.14	5,031.44	2.28	0.28
0.29	1,259.03	1.63	1,534.12	1.72	2,190.31	1.88	2,998.56	2.03	3,971.29	2.18	5,120.50	2.32	0.29
0.30	1,280.55	1.66	1,560.35	1.75	2,227.75	1.91	3,049.82	2.06	4,039.18	2.21	5,208.04	2.36	0.30
0.31	1,301.72	1.69	1,586.14	1.77	2,264.58	1.94	3,100.23	2.10	4,105.95	2.25	5,294.13	2.40	0.31
0.32	1,322.54	1.72	1,611.52	1.80	2,300.81	1.97	3,149.84	2.13	4,171.65	2.29	5,378.84	2.44	0.32
0.33	1,343.05	1.74	1,636.51	1.83	2,336.49	2.00	3,198.67	2.16	4,236.33	2.32	5,462.24	2.47	0.33
0.34	1,363.25	1.77	1,661.12	1.86	2,371.62	2.03	3,246.78	2.20	4,300.04	2.36	5,544.38	2.51	0.34
0.35	1,383.15	1.79	1,685.37	1.89	2,406.25	2.06	3,294.18	2.23	4,362.82	2.39	5,625.33	2.55	0.35
0.36	1,402.77	1.82	1,709.28	1.91	2,440.38	2.09	3,340.91	2.26	4,424.71	2.43	5,705.12	2.58	0.36
0.37	1,422.12	1.85	1,732.85	1.94	2,474.04	2.12	3,386.99	2.29	4,485.74	2.46	5,783.82	2.62	0.37
0.38	1,441.21	1.87	1,756.12	1.96	2,507.25	2.15	3,432.46	2.32	4,545.95	2.49	5,861.45	2.66	0.38
0.39	1,460.05	1.89	1,779.07	1.99	2,540.03	2.18	3,477.33	2.35	4,605.38	2.52	5,938.08	2.69	0.39
0.40	1,478.65	1.92	1,801.74	2.02	2,572.39	2.20	3,521.63	2.38	4,664.05	2.56	6,013.73	2.72	0.40
0.41	1,497.02	1.94	1,824.12	2.04	2,604.34	2.23	3,565.37	2.41	4,721.99	2.59	6,088.43	2.76	0.41
0.42	1,515.17	1.97	1,846.23	2.07	2,635.91	2.26	3,608.59	2.44	4,779.23	2.62	6,162.23	2.79	0.42
0.43	1,533.10	1.99	1,868.08	2.09	2,667.11	2.28	3,651.30	2.47	4,835.79	2.65	6,235.16	2.82	0.43
0.44	1,550.82	2.01	1,889.68	2.11	2,697.94	2.31	3,693.51	2.50	4,891.70	2.68	6,307.25	2.86	0.44
0.45	1,568.35	2.03	1,911.03	2.14	2,728.43	2.34	3,735.25	2.53	4,946.97	2.71	6,378.52	2.89	0.45
0.46	1,585.68	2.06	1,932.15	2.16	2,758.58	2.36	3,776.52	2.56	5,001.64	2.74	6,449.00	2.92	0.46
0.47	1,602.82	2.08	1,953.04	2.19	2,788.40	2.39	3,817.35	2.58	5,055.71	2.77	6,518.72	2.95	0.47
0.48	1,619.78	2.10	1,973.70	2.21	2,817.91	2.41	3,857.75	2.61	5,109.21	2.80	6,587.71	2.98	0.48
0.49	1,636.57	2.12	1,994.16	2.23	2,847.11	2.44	3,897.72	2.64	5,162.16	2.83	6,655.97	3.02	0.49
0.50	1,653.18	2.15	2,014.40	2.25	2,876.02	2.46	3,937.30	2.66	5,214.57	2.86	6,723.55	3.05	0.50
0.51	1,669.63	2.17	2,034.45	2.28	2,904.63	2.49	3,976.47	2.69	5,266.45	2.89	6,790.45	3.08	0.51
0.52	1,685.92	2.19	2,054.30	2.30	2,932.97	2.51	4,015.27	2.72	5,317.83	2.92	6,856.70	3.11	0.52
0.53	1,702.05	2.21	2,073.95	2.32	2,961.04	2.54	4,053.70	2.74	5,368.72	2.94	6,922.32	3.14	0.53
0.54	1,718.04	2.23	2,093.43	2.34	2,988.84	2.56	4,091.76	2.77	5,419.14	2.97	6,987.32	3.17	0.54
0.55	1,733.87	2.25	2,112.72	2.36	3,016.39	2.58	4,129.47	2.79	5,469.08	3.00	7,051.72	3.19	0.55
0.56	1,749.56	2.27	2,131.84	2.39	3,043.69	2.61	4,166.84	2.82	5,518.58	3.03	7,115.54	3.22	0.56
0.57	1,765.11	2.29	2,150.79	2.41	3,070.75	2.63	4,203.88	2.85	5,567.63	3.05	7,178.79	3.25	0.57
0.58	1,780.53	2.31	2,169.58	2.43	3,097.56	2.65	4,240.60	2.87	5,616.26	3.08	7,241.48	3.28	0.58
0.59	1,795.81	2.33	2,188.20	2.45	3,124.15	2.68	4,277.00	2.89	5,664.47	3.11	7,303.64	3.31	0.59
0.60	1,810.97	2.35	2,206.67	2.47	3,150.52	2.70	4,313.09	2.92	5,712.27	3.13	7,365.28	3.34	0.60
0.61	1,826.00	2.37	2,224.98	2.49	3,176.66	2.72	4,348.89	2.94	5,759.68	3.16	7,426.40	3.36	0.61
0.62	1,840.90	2.39	2,243.14	2.51	3,202.60	2.74	4,384.39	2.97	5,806.69	3.18	7,487.03	3.39	0.62
0.63	1,855.69	2.41	2,261.16	2.53	3,228.32	2.77	4,419.60	2.99	5,853.34	3.21	7,547.17	3.42	0.63
0.64	1,870.36	2.43	2,279.04	2.55	3,253.84	2.79	4,454.54	3.01	5,899.61	3.23	7,606.83	3.45	0.64
0.65	1,884.92	2.45	2,296.77	2.57	3,279.16	2.81	4,489.21	3.04	5,945.52	3.26	7,666.03	3.47	0.65
0.66	1,899.36	2.46	2,314.37	2.59	3,304.29	2.83	4,523.61	3.06	5,991.08	3.28	7,724.77	3.50	0.66
0.67	1,913.70	2.48	2,331.84	2.61	3,329.23	2.85	4,557.75	3.08	6,036.30	3.31	7,783.07	3.53	0.67
0.68	1,927.92	2.50	2,349.18	2.63	3,353.98	2.87	4,591.64	3.11	6,081.18	3.33	7,840.94	3.55	0.68
0.69	1,942.05	2.52	2,366.39	2.65	3,378.55	2.89	4,625.28	3.13	6,125.73	3.36	7,898.38	3.58	0.69
0.70	1,956.07	2.54	2,383.47	2.67	3,402.95	2.91	4,658.67	3.15	6,169.96	3.38	7,955.41	3.60	0.70
0.71	1,969.99	2.56	2,400.44	2.69	3,427.17	2.94	4,691.83	3.18	6,213.87	3.41	8,012.03	3.63	0.71
0.72	1,983.82	2.57	2,417.28	2.70	3,451.22	2.96	4,724.76	3.20	6,257.48	3.43	8,068.26	3.66	0.72
0.73	1,997.55	2.59	2,434.01	2.72	3,475.10	2.98	4,757.45	3.22	6,300.78	3.45	8,124.10	3.68	0.73
0.74	2,011.18	2.61	2,450.63	2.74	3,498.83	3.00	4,789.93	3.24	6,343.79	3.48	8,179.55	3.71	0.74
0.75	2,024.72	2.63	2,467.13	2.76	3,522.39	3.02	4,822.18	3.26	6,386.51	3.50	8,234.63	3.73	0.75
0.76	2,038.18	2.64	2,483.52	2.78	3,545.79	3.04	4,854.23	3.29	6,428.95	3.52	8,289.35	3.76	0.76
0.77	2,051.54	2.66	2,499.81	2.80	3,569.04	3.06	4,886.06	3.31	6,471.11	3.55	8,343.71	3.78	0.77
0.78	2,064.82	2.68	2,515.99	2.81									

n=0.013

nom D	975 mm		1050 mm		1200 mm		1350 mm		1500 mm		1650 mm		nom D
act D	990.6 mm		1066.8 mm		1219.2 mm		1371.6 mm		1524.0 mm		1676.4 mm		act D
GRADE %	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	GRADE %
	(L/s)	(m/s)	(L/s)	(m/s)	(L/s)	(m/s)	(L/s)	(m/s)	(L/s)	(m/s)	(L/s)	(m/s)	
1.00	2,337.95	3.03	2,848.80	3.19	4,067.30	3.48	5,568.18	3.77	7,374.51	4.04	9,508.53	4.31	1.00
1.01	2,349.61	3.05	2,863.00	3.20	4,087.59	3.50	5,595.95	3.79	7,411.29	4.06	9,555.96	4.33	1.01
1.02	2,361.21	3.06	2,877.14	3.22	4,107.77	3.52	5,623.58	3.81	7,447.89	4.08	9,603.15	4.35	1.02
1.03	2,372.76	3.08	2,891.21	3.23	4,127.86	3.54	5,651.08	3.82	7,484.31	4.10	9,650.11	4.37	1.03
1.04	2,384.25	3.09	2,905.21	3.25	4,147.85	3.55	5,678.45	3.84	7,520.55	4.12	9,696.84	4.39	1.04
1.05	2,395.69	3.11	2,919.15	3.27	4,167.74	3.57	5,705.68	3.86	7,556.62	4.14	9,743.35	4.41	1.05
1.06	2,407.07	3.12	2,933.01	3.28	4,187.54	3.59	5,732.79	3.88	7,592.52	4.16	9,789.64	4.44	1.06
1.07	2,418.40	3.14	2,946.82	3.30	4,207.25	3.60	5,759.77	3.90	7,628.25	4.18	9,835.71	4.46	1.07
1.08	2,429.67	3.15	2,960.55	3.31	4,226.86	3.62	5,786.62	3.92	7,663.81	4.20	9,881.56	4.48	1.08
1.09	2,440.89	3.17	2,974.23	3.33	4,246.39	3.64	5,813.35	3.93	7,699.21	4.22	9,927.20	4.50	1.09
1.10	2,452.06	3.18	2,987.84	3.34	4,265.82	3.65	5,839.95	3.95	7,734.45	4.24	9,972.64	4.52	1.10
1.11	2,463.18	3.20	3,001.39	3.36	4,285.17	3.67	5,866.44	3.97	7,769.53	4.26	10,017.86	4.54	1.11
1.12	2,474.25	3.21	3,014.88	3.37	4,304.43	3.69	5,892.81	3.99	7,804.45	4.28	10,062.89	4.56	1.12
1.13	2,485.28	3.22	3,028.31	3.39	4,323.60	3.70	5,919.05	4.01	7,839.21	4.30	10,107.71	4.58	1.13
1.14	2,496.25	3.24	3,041.68	3.40	4,342.69	3.72	5,945.19	4.02	7,873.82	4.32	10,152.34	4.60	1.14
1.15	2,507.17	3.25	3,054.99	3.42	4,361.70	3.74	5,971.21	4.04	7,908.28	4.34	10,196.77	4.62	1.15
1.16	2,518.05	3.27	3,068.25	3.43	4,380.62	3.75	5,997.11	4.06	7,942.59	4.35	10,241.01	4.64	1.16
1.17	2,528.88	3.28	3,081.44	3.45	4,399.46	3.77	6,022.91	4.08	7,976.75	4.37	10,285.05	4.66	1.17
1.18	2,539.66	3.30	3,094.58	3.46	4,418.22	3.78	6,048.59	4.09	8,010.77	4.39	10,328.91	4.68	1.18
1.19	2,550.40	3.31	3,107.67	3.48	4,436.90	3.80	6,074.17	4.11	8,044.64	4.41	10,372.59	4.70	1.19
1.20	2,561.10	3.32	3,120.70	3.49	4,455.51	3.82	6,099.63	4.13	8,078.37	4.43	10,416.08	4.72	1.20
1.21	2,571.75	3.34	3,133.67	3.51	4,474.03	3.83	6,125.00	4.15	8,111.96	4.45	10,459.39	4.74	1.21
1.22	2,582.35	3.35	3,146.60	3.52	4,492.48	3.85	6,150.25	4.16	8,145.41	4.47	10,502.52	4.76	1.22
1.23	2,592.91	3.36	3,159.47	3.53	4,510.86	3.86	6,175.41	4.18	8,178.73	4.48	10,545.48	4.78	1.23
1.24	2,603.43	3.38	3,172.28	3.55	4,529.16	3.88	6,200.46	4.20	8,211.91	4.50	10,588.26	4.80	1.24
1.25	2,613.91	3.39	3,185.05	3.56	4,547.38	3.90	6,225.41	4.21	8,244.95	4.52	10,630.87	4.82	1.25
1.26	2,624.34	3.41	3,197.76	3.58	4,565.54	3.91	6,250.26	4.23	8,277.87	4.54	10,673.30	4.84	1.26
1.27	2,634.74	3.42	3,210.43	3.59	4,583.62	3.93	6,275.02	4.25	8,310.65	4.56	10,715.57	4.85	1.27
1.28	2,645.09	3.43	3,223.04	3.61	4,601.63	3.94	6,299.67	4.26	8,343.30	4.57	10,757.68	4.87	1.28
1.29	2,655.40	3.45	3,235.61	3.62	4,619.57	3.96	6,324.23	4.28	8,375.83	4.59	10,799.62	4.89	1.29
1.30	2,665.67	3.46	3,248.13	3.63	4,637.44	3.97	6,348.70	4.30	8,408.23	4.61	10,841.40	4.91	1.30
1.31	2,675.91	3.47	3,260.60	3.65	4,655.24	3.99	6,373.07	4.31	8,440.51	4.63	10,883.02	4.93	1.31
1.32	2,686.10	3.49	3,273.02	3.66	4,672.97	4.00	6,397.35	4.33	8,472.67	4.64	10,924.47	4.95	1.32
1.33	2,696.26	3.50	3,285.39	3.68	4,690.64	4.02	6,421.54	4.35	8,504.70	4.66	10,965.78	4.97	1.33
1.34	2,706.37	3.51	3,297.72	3.69	4,708.24	4.03	6,445.63	4.36	8,536.61	4.68	11,006.92	4.99	1.34
1.35	2,716.45	3.52	3,310.00	3.70	4,725.78	4.05	6,469.64	4.38	8,568.41	4.70	11,047.92	5.01	1.35
1.36	2,726.50	3.54	3,322.24	3.72	4,743.25	4.06	6,493.56	4.39	8,600.08	4.71	11,088.76	5.02	1.36
1.37	2,736.50	3.55	3,334.43	3.73	4,760.65	4.08	6,517.39	4.41	8,631.64	4.73	11,129.45	5.04	1.37
1.38	2,746.47	3.56	3,346.58	3.74	4,778.00	4.09	6,541.13	4.43	8,663.09	4.75	11,170.00	5.06	1.38
1.39	2,756.40	3.58	3,358.68	3.76	4,795.28	4.11	6,564.79	4.44	8,694.42	4.77	11,210.40	5.08	1.39
1.40	2,766.30	3.59	3,370.74	3.77	4,812.50	4.12	6,588.36	4.46	8,725.64	4.78	11,250.65	5.10	1.40
1.41	2,776.16	3.60	3,382.76	3.78	4,829.65	4.14	6,611.85	4.47	8,756.74	4.80	11,290.76	5.12	1.41
1.42	2,785.99	3.61	3,394.73	3.80	4,846.75	4.15	6,635.25	4.49	8,787.74	4.82	11,330.73	5.13	1.42
1.43	2,795.78	3.63	3,406.66	3.81	4,863.79	4.17	6,658.57	4.51	8,818.63	4.83	11,370.55	5.15	1.43
1.44	2,805.54	3.64	3,418.55	3.82	4,880.76	4.18	6,681.81	4.52	8,849.41	4.85	11,410.24	5.17	1.44
1.45	2,815.27	3.65	3,430.40	3.84	4,897.68	4.20	6,704.97	4.54	8,880.08	4.87	11,449.79	5.19	1.45
1.46	2,824.96	3.67	3,442.21	3.85	4,914.54	4.21	6,728.06	4.55	8,910.65	4.88	11,489.21	5.21	1.46
1.47	2,834.61	3.68	3,453.98	3.86	4,931.34	4.22	6,751.06	4.57	8,941.12	4.90	11,528.49	5.22	1.47
1.48	2,844.24	3.69	3,465.71	3.88	4,948.09	4.24	6,773.98	4.58	8,971.48	4.92	11,567.63	5.24	1.48
1.49	2,853.83	3.70	3,477.40	3.89	4,964.77	4.25	6,796.83	4.60	9,001.74	4.93	11,606.65	5.26	1.49
1.50	2,863.39	3.72	3,489.05	3.90	4,981.41	4.27	6,819.60	4.62	9,031.89	4.95	11,645.53	5.28	1.50
1.51	2,872.92	3.73	3,500.66	3.92	4,997.98	4.28	6,842.29	4.63	9,061.95	4.97	11,684.28	5.29	1.51
1.52	2,882.42	3.74	3,512.23	3.93	5,014.51	4.30	6,864.91	4.65	9,091.91	4.98	11,722.91	5.31	1.52
1.53	2,891.89	3.75	3,523.76	3.94	5,030.97	4.31	6,887.46	4.66	9,121.76	5.00	11,761.41	5.33	1.53
1.54	2,901.32	3.76	3,535.26	3.96	5,047.39	4.32	6,909.93	4.68	9,151.53	5.02	11,799.78	5.35	1.54
1.55	2,910.73	3.78	3,546.72	3.97	5,063.75	4.34	6,932.33	4.69	9,181.19	5.03	11,838.03	5.36	1.55
1.56	2,920.10	3.79	3,558.14	3.98	5,080.06	4.35	6,954.65	4.71	9,210.76	5.05	11,876.16	5.38	1.56
1.57	2,929.44	3.80	3,569.53	3.99	5,096.31	4.37	6,976.91	4.72	9,240.23	5.07	11,914.16	5.40	1.57
1.58	2,938.76	3.81	3,580.88	4.01	5,112.52	4.38	6,999.09	4.74	9,269.61	5.08	11,952.04	5.41	1.58
1.59	2,948.04	3.83	3,592.19	4.02	5,128.67	4.39	7,021.21	4.75	9,298.90	5.10	11,989.81	5.43	1.59
1.60	2,957.30	3.84	3,603.47	4.03	5,144.78	4.41	7,043.25	4.77	9,328.10	5.11	12,027.45	5.45	1.60
1.61	2,966.53	3.85	3,614.72	4.04	5,160.83	4.42	7,065.23	4.78	9,357.20	5.13	12,064.98	5.47	1.61
1.62	2,975.73	3.86	3,625.92	4.06	5,176.83	4.43	7,087.13	4.80	9,386.22	5.15	12,102.39	5.48	1.62
1.63	2,984.90	3.87	3,637.10	4.07	5,192.78	4.45	7,108.97	4.81	9,415.14	5.16	12,139.68	5.50	1.63
1.64	2,994.04	3.88	3,648.24	4.08	5,208.69	4.46	7,130.75	4.83	9,443.98	5.18	12,176.87	5.52	1.64
1.65	3,003.15	3.90	3,659.34	4.09	5,224.54	4.48	7,152.45	4.84	9,472.73	5.19	12,213.93	5.53	1.65
1.66	3,012.24	3.91	3,670.42	4.11	5,240.35	4.49	7,174.10	4.86	9,501.39	5.21	12,250.89	5.55	1.66
1.67	3,021.30	3.92	3,681.45	4.12	5,256.11	4.50	7,195.67	4.87	9,529.97	5.22	12,287.74	5.57	1.67
1.68	3,030.33	3.93	3,692.46	4.13	5,271.83	4.52	7,217.18	4.88	9,558.46	5.24	12,324.47	5.58	1.68
1.69	3,039.34	3.94	3,703.43	4.14	5,287.49	4.53	7,238.63	4.90	9,586.86	5.26	12,361.10	5.60	1.69
1.70	3,048.32	3.96	3,714.37	4.16	5,303.11	4.54	7,260.02	4.91	9,615.18	5.27	12,397.61	5.62	1.70
1.71	3,057.27	3.97	3,725.28	4.17	5,318.69	4.56	7,281.34	4.93	9,643.42	5.29	12,434.02	5.63	1.71
1.72	3,066.19	3.98	3,736.16	4.18	5,334.22	4.57	7,302.60	4.94	9,671.58	5.30	12,470.33	5.65	1.72
1.73	3,075.09	3.99	3,747.00	4.19	5,349.70	4.58	7,323.80	4.96	9,699.65	5.32	12,506.53	5.67	1.73
1.74	3,083.97	4.00	3,757.82	4.20	5,365.14	4.60	7,344.93	4.97	9,727.65	5.33	12,542.62	5.68	1.74
1.75	3,092.82	4.01	3,768.60	4.22	5,380.53	4.61	7,366.01	4.99	9,755.56	5.35	12,578.61	5.70	1.75
1.76	3,1												

n=0.013

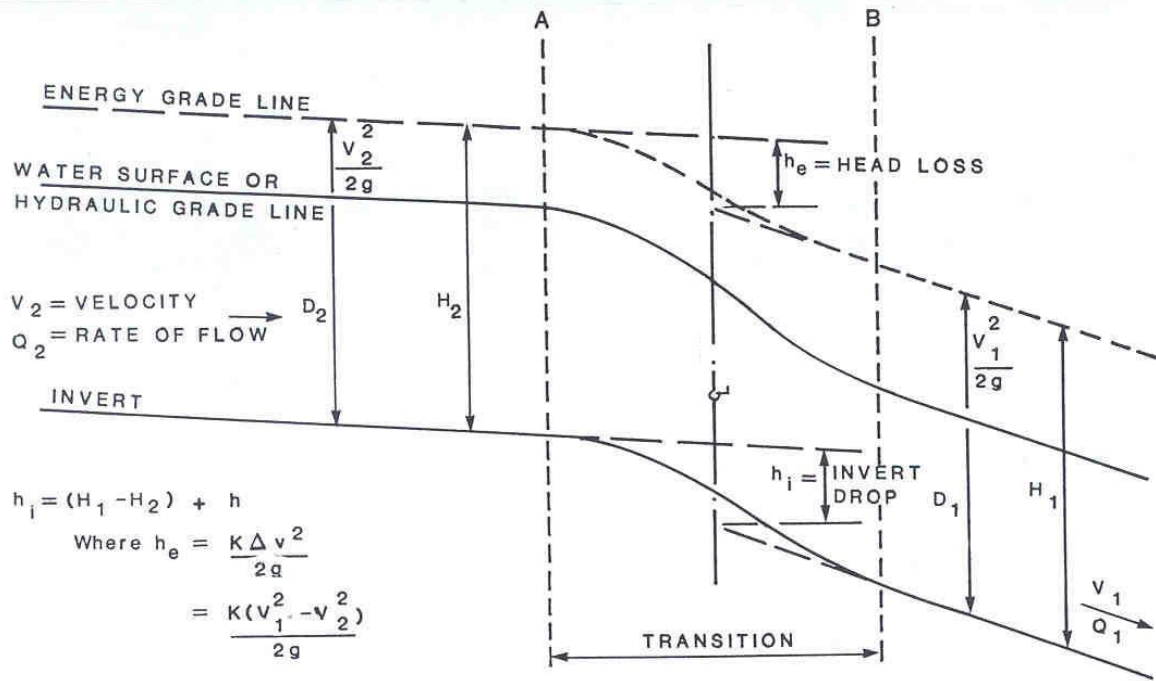
nom D	1800 mm		1950 mm		2100 mm		2250 mm		2400 mm		2550 mm		nom D
act D	1828.8 mm		1981.2 mm		2133.6 mm		2286.0 mm		2438.4 mm		2590.8 mm		act D
GRADE %	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	Q (L/s)	V (m/s)	GRADE %
0.01	1,199.18	0.46	1,484.51	0.48	1,808.87	0.51	2,174.25	0.53	2,582.58	0.55	3,035.73	0.58	0.01
0.02	1,695.89	0.65	2,099.41	0.68	2,558.13	0.72	3,074.86	0.75	3,652.31	0.78	4,293.17	0.81	0.02
0.03	2,077.03	0.79	2,571.24	0.83	3,133.06	0.88	3,765.91	0.92	4,473.15	0.96	5,258.04	1.00	0.03
0.04	2,398.35	0.91	2,969.01	0.96	3,617.74	1.01	4,348.50	1.06	5,165.15	1.11	6,071.47	1.15	0.04
0.05	2,681.44	1.02	3,319.46	1.08	4,044.76	1.13	4,861.77	1.18	5,774.81	1.24	6,788.11	1.29	0.05
0.06	2,937.37	1.12	3,636.28	1.18	4,430.81	1.24	5,325.81	1.30	6,325.99	1.35	7,436.00	1.41	0.06
0.07	3,172.72	1.21	3,927.63	1.27	4,785.83	1.34	5,752.53	1.40	6,832.85	1.46	8,031.79	1.52	0.07
0.08	3,391.78	1.29	4,198.82	1.36	5,116.26	1.43	6,149.71	1.50	7,304.63	1.56	8,586.35	1.63	0.08
0.09	3,597.53	1.37	4,453.52	1.44	5,426.62	1.52	6,522.75	1.59	7,747.73	1.66	9,107.20	1.73	0.09
0.10	3,792.13	1.44	4,694.42	1.52	5,720.16	1.60	6,875.59	1.68	8,166.82	1.75	9,599.83	1.82	0.10
0.11	3,977.22	1.51	4,923.55	1.60	5,999.35	1.68	7,211.18	1.76	8,565.43	1.83	10,068.39	1.91	0.11
0.12	4,154.07	1.58	5,142.48	1.67	6,266.12	1.75	7,531.83	1.84	8,946.30	1.92	10,516.09	1.99	0.12
0.13	4,323.69	1.65	5,352.46	1.74	6,521.98	1.82	7,839.38	1.91	9,311.61	1.99	10,945.49	2.08	0.13
0.14	4,486.91	1.71	5,554.51	1.80	6,768.18	1.89	8,135.30	1.98	9,663.11	2.07	11,358.67	2.15	0.14
0.15	4,644.39	1.77	5,749.47	1.87	7,005.73	1.96	8,420.84	2.05	10,002.27	2.14	11,757.34	2.23	0.15
0.16	4,796.71	1.83	5,938.03	1.93	7,235.49	2.02	8,697.01	2.12	10,330.30	2.21	12,142.93	2.30	0.16
0.17	4,944.33	1.88	6,120.78	1.99	7,458.17	2.09	8,964.67	2.18	10,648.23	2.28	12,516.65	2.37	0.17
0.18	5,087.67	1.94	6,298.23	2.04	7,674.39	2.15	9,224.57	2.25	10,956.94	2.35	12,879.52	2.44	0.18
0.19	5,227.09	1.99	6,470.81	2.10	7,884.69	2.21	9,477.34	2.31	11,257.19	2.41	13,232.45	2.51	0.19
0.20	5,362.88	2.04	6,638.91	2.15	8,089.52	2.26	9,723.55	2.37	11,549.63	2.47	13,576.21	2.58	0.20
0.21	5,495.32	2.09	6,802.86	2.21	8,289.29	2.32	9,963.67	2.43	11,834.85	2.53	13,911.48	2.64	0.21
0.22	5,624.64	2.14	6,962.95	2.26	8,484.36	2.37	10,198.14	2.48	12,113.35	2.59	14,238.85	2.70	0.22
0.23	5,751.05	2.19	7,119.44	2.31	8,675.05	2.43	10,427.34	2.54	12,385.60	2.65	14,558.86	2.76	0.23
0.24	5,874.74	2.24	7,272.57	2.36	8,861.63	2.48	10,651.61	2.60	12,651.99	2.71	14,871.99	2.82	0.24
0.25	5,995.88	2.28	7,422.53	2.41	9,044.36	2.53	10,871.26	2.65	12,912.88	2.77	15,178.66	2.88	0.25
0.26	6,114.62	2.33	7,569.53	2.46	9,223.47	2.58	11,086.55	2.70	13,168.60	2.82	15,479.26	2.94	0.26
0.27	6,231.10	2.37	7,713.72	2.50	9,399.18	2.63	11,297.74	2.75	13,419.46	2.87	15,774.13	2.99	0.27
0.28	6,345.45	2.42	7,855.27	2.55	9,571.65	2.68	11,505.06	2.80	13,665.71	2.93	16,063.59	3.05	0.28
0.29	6,457.76	2.46	7,994.31	2.59	9,741.07	2.72	11,708.70	2.85	13,907.60	2.98	16,347.92	3.10	0.29
0.30	6,568.16	2.50	8,130.98	2.64	9,907.60	2.77	11,908.87	2.90	14,145.35	3.03	16,627.39	3.15	0.30
0.31	6,676.73	2.54	8,265.38	2.68	10,071.37	2.82	12,105.72	2.95	14,379.17	3.08	16,902.25	3.21	0.31
0.32	6,783.57	2.58	8,397.64	2.72	10,232.53	2.86	12,299.42	3.00	14,609.25	3.13	17,172.70	3.26	0.32
0.33	6,888.74	2.62	8,527.84	2.77	10,391.18	2.91	12,490.12	3.04	14,835.77	3.18	17,438.96	3.31	0.33
0.34	6,992.34	2.66	8,656.08	2.81	10,547.45	2.95	12,677.96	3.09	15,058.87	3.22	17,701.21	3.36	0.34
0.35	7,094.42	2.70	8,782.46	2.85	10,701.43	2.99	12,863.05	3.13	15,278.72	3.27	17,959.64	3.41	0.35
0.36	7,195.06	2.74	8,907.04	2.89	10,853.23	3.04	13,045.51	3.18	15,495.45	3.32	18,214.40	3.46	0.36
0.37	7,294.31	2.78	9,029.90	2.93	11,002.94	3.08	13,225.46	3.22	15,709.19	3.36	18,465.64	3.50	0.37
0.38	7,392.22	2.81	9,151.11	2.97	11,150.64	3.12	13,402.99	3.27	15,920.07	3.41	18,713.51	3.55	0.38
0.39	7,488.85	2.85	9,270.74	3.01	11,296.40	3.16	13,578.20	3.31	16,128.18	3.45	18,958.15	3.60	0.39
0.40	7,584.26	2.89	9,388.84	3.05	11,440.31	3.20	13,751.17	3.35	16,333.64	3.50	19,199.66	3.64	0.40
0.41	7,678.48	2.92	9,505.48	3.08	11,582.43	3.24	13,922.00	3.39	16,536.55	3.54	19,438.18	3.69	0.41
0.42	7,771.55	2.96	9,620.70	3.12	11,722.83	3.28	14,090.76	3.43	16,737.00	3.58	19,673.80	3.73	0.42
0.43	7,863.53	2.99	9,734.56	3.16	11,861.57	3.32	14,257.32	3.47	16,935.08	3.63	19,906.63	3.78	0.43
0.44	7,954.44	3.03	9,847.10	3.19	11,998.70	3.36	14,422.35	3.51	17,130.87	3.67	20,136.77	3.82	0.44
0.45	8,044.32	3.06	9,958.37	3.23	12,134.28	3.39	14,585.32	3.55	17,324.44	3.71	20,364.32	3.86	0.45
0.46	8,133.21	3.10	10,068.41	3.27	12,268.37	3.43	14,746.49	3.59	17,515.88	3.75	20,589.34	3.91	0.46
0.47	8,221.14	3.13	10,177.26	3.30	12,401.00	3.47	14,905.92	3.63	17,705.25	3.79	20,811.94	3.95	0.47
0.48	8,308.14	3.16	10,284.96	3.34	12,532.23	3.51	15,063.66	3.67	17,892.61	3.83	21,032.18	3.99	0.48
0.49	8,394.24	3.20	10,391.54	3.37	12,662.11	3.54	15,219.76	3.71	18,078.03	3.87	21,250.13	4.03	0.49
0.50	8,479.46	3.23	10,497.04	3.41	12,790.66	3.58	15,374.28	3.75	18,261.57	3.91	21,465.87	4.07	0.50
0.51	8,563.83	3.26	10,601.50	3.44	12,917.93	3.61	15,527.26	3.78	18,443.28	3.95	21,679.47	4.11	0.51
0.52	8,647.38	3.29	10,704.93	3.47	13,043.96	3.65	15,678.75	3.82	18,623.22	3.99	21,890.98	4.15	0.52
0.53	8,730.14	3.32	10,807.37	3.51	13,168.79	3.68	15,828.79	3.86	18,801.44	4.03	22,100.47	4.19	0.53
0.54	8,812.11	3.35	10,908.85	3.54	13,292.44	3.72	15,977.42	3.89	18,977.98	4.06	22,307.99	4.23	0.54
0.55	8,893.33	3.39	11,009.39	3.57	13,414.95	3.75	16,124.68	3.93	19,152.89	4.10	22,513.60	4.27	0.55
0.56	8,973.82	3.42	11,109.03	3.60	13,536.36	3.79	16,270.61	3.96	19,326.23	4.14	22,717.35	4.31	0.56
0.57	9,053.58	3.45	11,207.78	3.64	13,656.69	3.82	16,415.24	4.00	19,498.02	4.18	22,919.28	4.35	0.57
0.58	9,132.66	3.48	11,305.66	3.67	13,775.96	3.85	16,558.61	4.03	19,668.31	4.21	23,119.45	4.39	0.58
0.59	9,211.05	3.51	11,402.71	3.70	13,894.21	3.89	16,700.74	4.07	19,837.14	4.25	23,317.91	4.42	0.59
0.60	9,288.78	3.54	11,498.94	3.73	14,011.46	3.92	16,841.68	4.10	20,004.55	4.28	23,514.69	4.46	0.60
0.61	9,365.87	3.57	11,594.37	3.76	14,127.74	3.95	16,981.45	4.14	20,170.56	4.32	23,709.83	4.50	0.61
0.62	9,442.33	3.59	11,689.01	3.79	14,243.07	3.98	17,120.07	4.17	20,335.22	4.35	23,903.39	4.53	0.62
0.63	9,518.17	3.62	11,782.90	3.82	14,357.48	4.02	17,257.59	4.20	20,498.56	4.39	24,095.38	4.57	0.63
0.64	9,593.41	3.65	11,876.05	3.85	14,470.98	4.05	17,394.01	4.24	20,660.61	4.42	24,285.86	4.61	0.64
0.65	9,668.07	3.68	11,968.47	3.88	14,583.59	4.08	17,529.38	4.27	20,821.39	4.46	24,474.86	4.64	0.65
0.66	9,742.16	3.71	12,060.19	3.91	14,695.35	4.11	17,663.70	4.30	20,980.94	4.49	24,662.41	4.68	0.66
0.67	9,815.68	3.74	12,151.21	3.94	14,806.26	4.14	17,797.02	4.34	21,139.29	4.53	24,848.55	4.71	0.67
0.68	9,888.66	3.76	12,241.55	3.97	14,916.34	4.17	17,929.34	4.37	21,296.47	4.56	25,033.30	4.75	0.68
0.69	9,961.11	3.79	12,331.24	4.00	15,025.62	4.20	18,060.69	4.40	21,452.49	4.59	25,216.69	4.78	0.69
0.70	10,033.03	3.82	12,420.27	4.03	15,134.11	4.23	18,191.09	4.43	21,607.38	4.63	25,398.76	4.82	0.70
0.71	10,104.44	3.85	12,508.67	4.06	15,241.83	4.26	18,320.57	4.46	21,761.17	4.66	25,579.54	4.85	0.71
0.72	10,175.35	3.87	12,596.45	4.09	15,348.79	4.29	18,449.14	4.50	21,913.88	4.69	25,759.05	4.89	0.72
0.73	10,245.77	3.90	12,683.63	4.11	15,455.01	4.32	18,576.81	4.53	22,065.54	4.73	25,937.31	4.92	0.73
0.74	10,315.71	3.93	12,770.21	4.14	15,560.51	4.35	18,703.62	4.56	22,216.16	4.76	26,114.36	4.95	0.74
0.75	10,385.17	3.95	12,856.20	4.17	15,665.29	4.38	18,829.57	4.59	22,365.76	4.79	26,290.22	4.99	0.75
0.76	10,454.18	3.98	12,941.63										

n=0.013

nom D	1800 mm		1950 mm		2100 mm		2250 mm		2400 mm		2550 mm		nom D
act D	1828.8 mm		1981.2 mm		2133.6 mm		2286.0 mm		2438.4 mm		2590.8 mm		act D
GRADE	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	GRADE
%	(L/s)	(m/s)	(L/s)	(m/s)	(L/s)	(m/s)	(L/s)	(m/s)	(L/s)	(m/s)	(L/s)	(m/s)	%
1.00	11,991.76	4.57	14,845.06	4.82	18,088.72	5.06	21,742.52	5.30	25,825.76	5.53	30,357.33	5.76	1.00
1.01	12,051.57	4.59	14,919.10	4.84	18,178.94	5.08	21,850.96	5.32	25,954.56	5.56	30,508.74	5.79	1.01
1.02	12,111.09	4.61	14,992.78	4.86	18,268.71	5.11	21,958.87	5.35	26,062.74	5.59	30,659.40	5.82	1.02
1.03	12,170.31	4.63	15,066.09	4.89	18,358.05	5.13	22,066.24	5.38	26,170.28	5.61	30,809.32	5.84	1.03
1.04	12,229.25	4.66	15,139.05	4.91	18,446.95	5.16	22,173.10	5.40	26,277.21	5.64	30,958.52	5.87	1.04
1.05	12,287.90	4.68	15,211.66	4.93	18,535.42	5.18	22,279.45	5.43	26,383.53	5.67	31,107.01	5.90	1.05
1.06	12,346.28	4.70	15,283.93	4.96	18,623.48	5.21	22,385.29	5.46	26,489.24	5.69	31,254.78	5.93	1.06
1.07	12,404.38	4.72	15,355.85	4.98	18,711.12	5.23	22,490.63	5.48	26,594.37	5.72	31,401.87	5.96	1.07
1.08	12,462.21	4.74	15,427.44	5.00	18,798.35	5.26	22,595.49	5.51	26,698.91	5.75	31,548.26	5.98	1.08
1.09	12,519.77	4.77	15,498.70	5.03	18,885.18	5.28	22,699.85	5.53	26,802.88	5.77	31,693.98	6.01	1.09
1.10	12,577.07	4.79	15,569.63	5.05	18,971.61	5.31	22,803.74	5.56	27,006.28	5.80	31,839.04	6.04	1.10
1.11	12,634.11	4.81	15,640.24	5.07	19,057.65	5.33	22,907.16	5.58	27,209.12	5.83	31,983.43	6.07	1.11
1.12	12,690.89	4.83	15,710.54	5.10	19,143.30	5.35	23,010.12	5.61	27,311.41	5.85	32,127.18	6.09	1.12
1.13	12,747.42	4.85	15,780.52	5.12	19,228.57	5.38	23,112.61	5.63	27,453.16	5.88	32,270.28	6.12	1.13
1.14	12,803.70	4.87	15,850.19	5.14	19,313.47	5.40	23,214.65	5.66	27,574.36	5.90	32,412.76	6.15	1.14
1.15	12,859.74	4.90	15,919.56	5.16	19,397.99	5.43	23,316.25	5.68	27,695.04	5.93	32,554.61	6.18	1.15
1.16	12,915.53	4.92	15,988.62	5.19	19,482.15	5.45	23,417.41	5.71	27,815.19	5.96	32,695.84	6.20	1.16
1.17	12,971.08	4.94	16,057.39	5.21	19,565.94	5.47	23,518.13	5.73	27,934.83	5.98	32,836.47	6.23	1.17
1.18	13,026.39	4.96	16,125.87	5.23	19,649.38	5.50	23,618.42	5.75	28,053.95	6.01	32,976.50	6.26	1.18
1.19	13,081.47	4.98	16,194.05	5.25	19,732.47	5.52	23,718.29	5.78	28,172.58	6.03	33,115.94	6.28	1.19
1.20	13,136.32	5.00	16,261.95	5.28	19,815.20	5.54	23,817.73	5.80	28,290.70	6.06	33,254.79	6.31	1.20
1.21	13,190.94	5.02	16,329.57	5.30	19,897.59	5.57	23,916.77	5.83	28,408.33	6.08	33,393.06	6.33	1.21
1.22	13,245.34	5.04	16,396.91	5.32	19,979.65	5.59	24,015.39	5.85	28,525.48	6.11	33,530.77	6.36	1.22
1.23	13,299.51	5.06	16,463.97	5.34	20,061.36	5.61	24,113.62	5.88	28,642.15	6.13	33,667.91	6.39	1.23
1.24	13,353.46	5.08	16,530.76	5.36	20,142.75	5.63	24,211.44	5.90	28,758.35	6.16	33,804.49	6.41	1.24
1.25	13,407.20	5.10	16,597.29	5.38	20,223.81	5.66	24,308.87	5.92	28,874.07	6.18	33,940.53	6.44	1.25
1.26	13,460.72	5.12	16,663.54	5.41	20,304.54	5.68	24,405.91	5.95	28,989.34	6.21	34,076.02	6.46	1.26
1.27	13,514.03	5.14	16,729.54	5.43	20,384.95	5.70	24,502.57	5.97	29,104.15	6.23	34,210.97	6.49	1.27
1.28	13,567.13	5.16	16,795.27	5.45	20,465.05	5.72	24,598.85	5.99	29,218.51	6.26	34,345.40	6.51	1.28
1.29	13,620.03	5.19	16,860.75	5.47	20,544.84	5.75	24,694.75	6.02	29,332.42	6.28	34,479.30	6.54	1.29
1.30	13,672.72	5.21	16,925.98	5.49	20,624.32	5.77	24,790.28	6.04	29,445.89	6.31	34,612.68	6.57	1.30
1.31	13,725.20	5.23	16,990.95	5.51	20,703.49	5.79	24,885.45	6.06	29,558.93	6.33	34,745.55	6.59	1.31
1.32	13,777.49	5.25	17,055.68	5.53	20,782.36	5.81	24,980.25	6.09	29,671.54	6.35	34,877.92	6.62	1.32
1.33	13,829.58	5.26	17,120.16	5.55	20,860.93	5.83	25,074.69	6.11	29,783.72	6.38	35,009.78	6.64	1.33
1.34	13,881.47	5.28	17,184.40	5.57	20,939.21	5.86	25,168.78	6.13	29,895.48	6.40	35,141.15	6.67	1.34
1.35	13,933.17	5.30	17,248.40	5.60	21,017.20	5.88	25,262.52	6.16	30,006.82	6.43	35,272.03	6.69	1.35
1.36	13,984.68	5.32	17,312.17	5.62	21,094.89	5.90	25,355.91	6.18	30,117.75	6.45	35,402.43	6.72	1.36
1.37	14,036.00	5.34	17,375.70	5.64	21,172.31	5.92	25,448.96	6.20	30,228.27	6.47	35,532.34	6.74	1.37
1.38	14,087.13	5.36	17,439.00	5.66	21,249.44	5.94	25,541.67	6.22	30,338.40	6.50	35,661.79	6.76	1.38
1.39	14,138.08	5.38	17,502.07	5.68	21,326.29	5.96	25,634.05	6.25	30,448.12	6.52	35,790.76	6.79	1.39
1.40	14,188.85	5.40	17,564.92	5.70	21,402.86	5.99	25,726.09	6.27	30,557.45	6.54	35,919.28	6.81	1.40
1.41	14,239.43	5.42	17,627.54	5.72	21,479.17	6.01	25,817.81	6.29	30,666.39	6.57	36,047.33	6.84	1.41
1.42	14,289.84	5.44	17,689.93	5.74	21,555.20	6.03	25,909.20	6.31	30,774.94	6.59	36,174.93	6.86	1.42
1.43	14,340.07	5.46	17,752.11	5.76	21,630.96	6.05	26,000.27	6.33	30,883.11	6.61	36,302.09	6.89	1.43
1.44	14,390.12	5.48	17,814.08	5.78	21,706.47	6.07	26,091.02	6.36	30,990.91	6.64	36,428.80	6.91	1.44
1.45	14,440.00	5.50	17,875.82	5.80	21,781.71	6.09	26,181.46	6.38	31,098.33	6.66	36,555.07	6.93	1.45
1.46	14,489.70	5.52	17,937.36	5.82	21,856.69	6.11	26,271.58	6.40	31,205.38	6.68	36,680.90	6.96	1.46
1.47	14,539.24	5.54	17,998.68	5.84	21,931.41	6.13	26,361.40	6.42	31,312.07	6.71	36,806.31	6.98	1.47
1.48	14,588.61	5.55	18,059.80	5.86	22,005.88	6.15	26,450.91	6.44	31,418.39	6.73	36,931.29	7.01	1.48
1.49	14,637.81	5.57	18,120.71	5.88	22,080.10	6.18	26,540.12	6.47	31,524.35	6.75	37,055.84	7.03	1.49
1.50	14,686.85	5.59	18,181.42	5.90	22,154.07	6.20	26,629.04	6.49	31,629.96	6.77	37,179.98	7.05	1.50
1.51	14,735.73	5.61	18,241.92	5.92	22,227.79	6.22	26,717.65	6.51	31,735.22	6.80	37,303.71	7.08	1.51
1.52	14,784.44	5.63	18,302.22	5.94	22,301.27	6.24	26,805.97	6.53	31,840.13	6.82	37,427.03	7.10	1.52
1.53	14,832.99	5.65	18,362.33	5.96	22,374.51	6.26	26,894.01	6.55	31,944.70	6.84	37,549.94	7.12	1.53
1.54	14,881.39	5.67	18,422.24	5.98	22,447.51	6.28	26,981.75	6.57	32,048.92	6.86	37,672.46	7.15	1.54
1.55	14,929.63	5.68	18,481.95	6.00	22,520.28	6.30	27,069.21	6.60	32,152.81	6.89	37,794.57	7.17	1.55
1.56	14,977.71	5.70	18,541.48	6.01	22,592.81	6.32	27,156.39	6.62	32,256.36	6.91	37,916.29	7.19	1.56
1.57	15,025.64	5.72	18,600.81	6.03	22,665.10	6.34	27,243.29	6.64	32,359.58	6.93	38,037.63	7.22	1.57
1.58	15,073.41	5.74	18,659.96	6.05	22,737.17	6.36	27,329.92	6.66	32,462.47	6.95	38,158.57	7.24	1.58
1.59	15,121.04	5.76	18,718.91	6.07	22,809.01	6.38	27,416.27	6.68	32,565.04	6.97	38,279.14	7.26	1.59
1.60	15,168.52	5.77	18,777.68	6.09	22,880.62	6.40	27,502.35	6.70	32,667.29	7.00	38,399.32	7.28	1.60
1.61	15,215.84	5.79	18,836.27	6.11	22,952.01	6.42	27,588.16	6.72	32,769.21	7.02	38,519.13	7.31	1.61
1.62	15,263.02	5.81	18,894.68	6.13	23,023.18	6.44	27,673.71	6.74	32,870.82	7.04	38,638.57	7.33	1.62
1.63	15,310.06	5.83	18,952.91	6.15	23,094.13	6.46	27,758.99	6.76	32,972.12	7.06	38,757.64	7.35	1.63
1.64	15,356.95	5.85	19,010.96	6.17	23,164.87	6.48	27,844.01	6.78	33,073.11	7.08	38,876.35	7.37	1.64
1.65	15,403.70	5.86	19,068.83	6.19	23,235.38	6.50	27,928.77	6.80	33,173.79	7.10	38,994.70	7.40	1.65
1.66	15,450.31	5.88	19,126.53	6.20	23,305.69	6.52	28,013.27	6.83	33,274.16	7.13	39,112.68	7.42	1.66
1.67	15,496.78	5.90	19,184.05	6.22	23,375.78	6.54	28,097.52	6.85	33,374.23	7.15	39,230.32	7.44	1.67
1.68	15,543.10	5.92	19,241.40	6.24	23,445.66	6.56	28,181.52	6.87	33,474.01	7.17	39,347.60	7.46	1.68
1.69	15,589.29	5.93	19,298.58	6.26	23,515.34	6.58	28,265.27	6.89	33,573.48	7.19	39,464.53	7.49	1.69
1.70	15,635.35	5.95	19,355.59	6.28	23,584.81	6.60	28,348.77	6.91	33,672.67	7.21	39,581.12	7.51	1.70
1.71	15,681.27	5.97	19,412.44	6.30	23,654.07	6.62	28,432.03	6.93	33,771.56	7.23	39,697.36	7.53	1.71
1.72	15,727.05	5.99	19,469.12	6.32	23,723.14	6.64	28,515.04	6.95	33,870.16	7.25	39,813.26	7.55	1.72
1.73	15,772.70	6.00	19,525.63	6.33	23,792.00	6.65	28,597.82	6.97					



**CRITERIA AND BASIS OF DESIGN**



K= 0.1 FOR INCREASING VELOCITY CHANGE

K= 0.2 FOR DECREASING VELOCITY CHANGE

**ASSUMPTION**

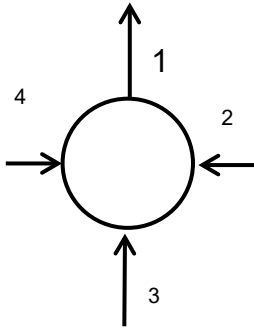
Maintenance hole length is relatively short so that  $h_i$  can effectively be taken to be the actual drop in inverts at the extremes of the maintenance hole.

**METHOD**

1. Each incoming pipe must be analyzed separately together with the outgoing pipe.
2. Employ Hydraulic Elements Chart (Figure 1) for % depth of flow and % velocity.
3. The designer should, wherever possible, restrict the change in velocity to not more than 0.6 m/s in special cases, consideration should be given to bellmouth entrances.
4. Complete the hydraulic calculations outlined in the following.

Location Maintenance Hole No ..... Design by: .....  
At ..... Checked by: .....

Date .....

	PIPE NO.	DIAM.	GRADE (%)	CAPACITY (Qcap)	ACTUAL FLOW (Qact)
	1				
	2				
	3				
	4				

Pipe No. 1  $Q_1 \text{ cap} =$  \_\_\_\_\_  $Q_1 \text{ act} =$  \_\_\_\_\_  $\frac{Q_1 \text{ act}}{Q_1 \text{ cap}} =$  \_\_\_\_\_

From Fig. 1 read Depth of Flow = \_\_\_\_\_ %

$V_1 \text{ cap} =$  \_\_\_\_\_ from above depth of flow and

Fig. 1 read ratio of  $V_1 \text{ act}/V_1 \text{ cap} =$  \_\_\_\_\_

$$\square V_1 \text{ act} = V_1 \text{ cap} \times \frac{\text{ } \%}{100} = \text{ } \times \frac{\text{ }}{100} = \text{ }$$

$$H_1 = \text{pipe diameter} \times \% \text{ depth} = \frac{(V_1 \text{ act})^2}{2g} =$$

$$\text{ } + \text{ } \times \text{ } + \text{ } = \text{ }$$

Pipe No. 2  $Q_2 \text{ cap} = \underline{\hspace{2cm}}$   $Q_2 \text{ act} = \underline{\hspace{2cm}}$   $\frac{Q_2 \text{ act}}{Q_2 \text{ cap}} = \underline{\hspace{2cm}}$

From Fig. 1 read Depth of Flow = %

$V_2 \text{ cap} = \underline{\hspace{2cm}}$  from above depth of flow and  
Fig. 1 read ratio of  $V_2 \text{ act}/V_2 \text{ cap} = \underline{\hspace{2cm}}$

$\square V_2 \text{ act} = V_2 \text{ cap} \times \frac{\hspace{1cm}}{100} \% = \hspace{1cm} \times \frac{\hspace{1cm}}{100} = \underline{\hspace{2cm}}$

$H_2 = \text{pipe diameter} \times \% \text{ depth} + \frac{(V_2 \text{ act})^2}{2g} +$   
 $\hspace{1cm} \times \hspace{1cm} + \hspace{1cm} = \underline{\hspace{2cm}}$

Pipe No. 3  $Q_3 \text{ cap} = \underline{\hspace{2cm}}$   $Q_3 \text{ act} = \underline{\hspace{2cm}}$   $\frac{Q_3 \text{ act}}{Q_3 \text{ cap}} = \underline{\hspace{2cm}}$

From Fig. 1 read Depth of Flow = %

$V_3 \text{ cap} = \underline{\hspace{2cm}}$  from above depth of flow and  
Fig. 1 read ratio of  $V_3 \text{ act}/V_3 \text{ cap} = \underline{\hspace{2cm}}$

$\square V_3 \text{ act} = V_3 \text{ cap} \times \frac{\hspace{1cm}}{100} \% = \hspace{1cm} \times \frac{\hspace{1cm}}{100} = \underline{\hspace{2cm}}$

$H_3 = \text{pipe diameter} \times \% \text{ depth} + \frac{(V_3 \text{ act})^2}{2g} =$   
 $\hspace{1cm} + \hspace{1cm} + \hspace{1cm} = \underline{\hspace{2cm}}$

Pipe No. 4  $Q_4 \text{ cap} = \underline{\hspace{2cm}}$   $Q_4 \text{ act} = \underline{\hspace{2cm}}$   $\frac{Q_4 \text{ act}}{Q_4 \text{ cap}} = \underline{\hspace{2cm}}$

From Fig. 1 read Depth of Flow = %

$V_4 \text{ cap} = \underline{\hspace{2cm}}$  from above depth of flow and  
Fig. 1 read ratio of  $V_4 \text{ act}/V_4 \text{ cap} = \underline{\hspace{2cm}}$

$\square V_4 \text{ act} = V_4 \text{ cap} \times \frac{\hspace{1cm}}{100} \% = \hspace{1cm} \times \frac{\hspace{1cm}}{100} = \underline{\hspace{2cm}}$

$H_4 = \text{pipe diameter} \times \% \text{ depth} + \frac{(V_4 \text{ act})^2}{2g} +$   
 $\hspace{1cm} \times \hspace{1cm} + \hspace{1cm} = \underline{\hspace{2cm}}$

**HEAD LOSS**

$$h_e = \frac{K (V_2^2 - V_1^2)}{2g} \text{ for pipes 1 and 2}$$

Select K = 0.1 or 0.2 as above

$$\text{For pipes 1 and 2 } h_e = \underline{\hspace{2cm}} (\underline{\hspace{2cm}} - \underline{\hspace{2cm}}) \\ = \underline{\hspace{2cm}}$$

$$\text{For pipes 1 and 3 } h_e = \underline{\hspace{2cm}} (\underline{\hspace{2cm}} - \underline{\hspace{2cm}}) \\ = \underline{\hspace{2cm}}$$

$$\text{For pipes 1 and 4 } h_e = \underline{\hspace{2cm}} (\underline{\hspace{2cm}} - \underline{\hspace{2cm}}) \\ = \underline{\hspace{2cm}}$$

$$\text{for pipes 1 and 2 } h_i = (H_1 - H_2) + h_e$$

$$h_i = \underline{\hspace{2cm}} - \underline{\hspace{2cm}} + \underline{\hspace{2cm}} \\ = \underline{\hspace{2cm}} \text{ drop}$$

$$\text{For pipes 1 and 3 } h_i = \underline{\hspace{2cm}} - \underline{\hspace{2cm}} + \underline{\hspace{2cm}} \\ = \underline{\hspace{2cm}} \text{ drop}$$

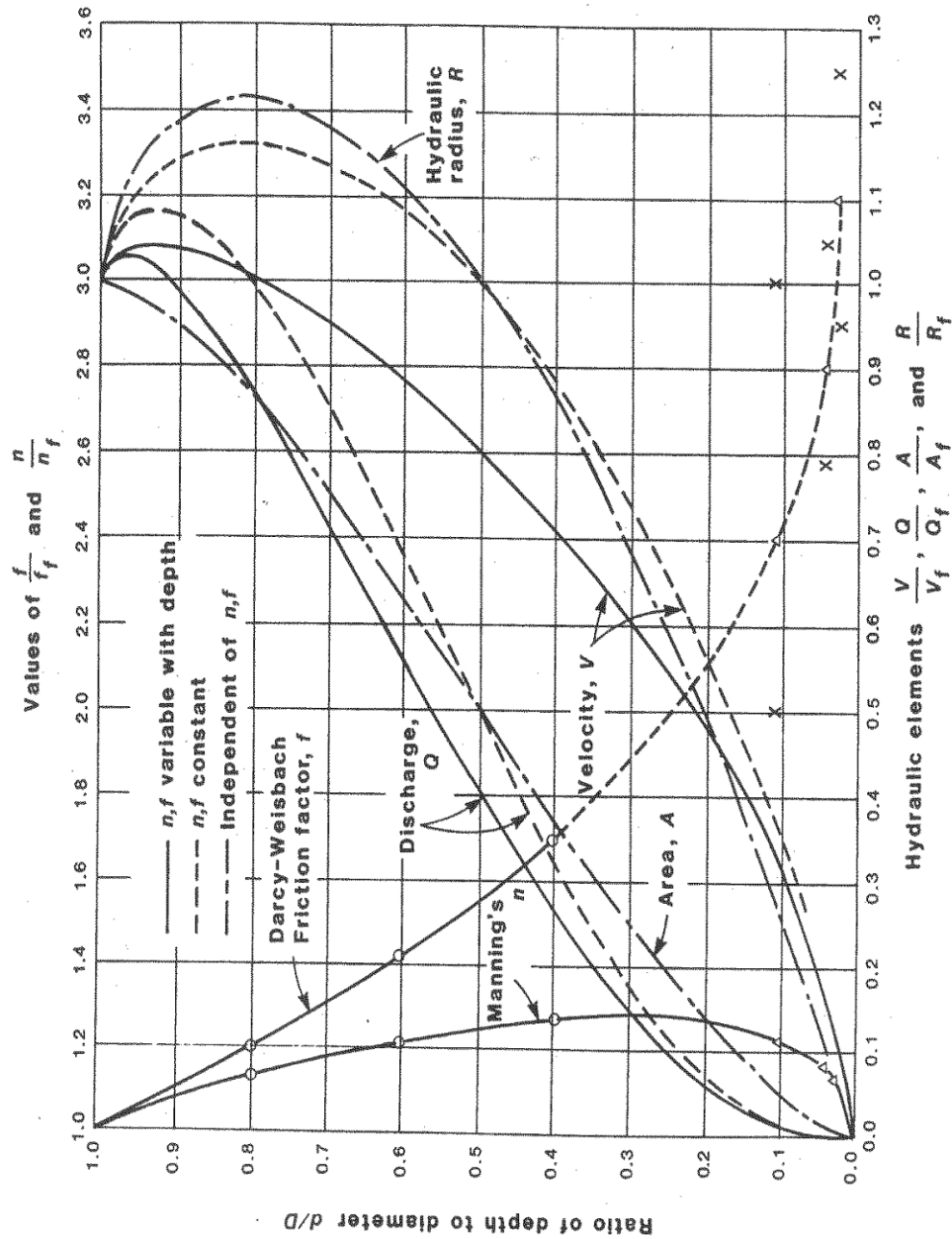
$$\text{For pipes 1 and 4 } h_i = \underline{\hspace{2cm}} - \underline{\hspace{2cm}} + \underline{\hspace{2cm}} \\ = \underline{\hspace{2cm}} \text{ drop}$$

**SUMMARY**

Take a maximum condition of the above three cases as the governing factor which sets the required maximum drop through the maintenance hole.

FIGURE 1

HYDRAULIC - ELEMENTS GRAPH FOR CIRCULAR SEWERS





## **DESIGN CALCULATIONS**

When submitting applications to the Ministry of the Environment for approval, they should be accompanied by sewer design calculations presenting in tabular form the required capacity, sewer size, sewer slope, roughness coefficient used, pipe capacity provided, flow velocity when flowing full, and depth of flow and actual flow velocity at peak flow if depth of flow is less than 0.3 of the pipe diameter.

A typical sewer design sheet is shown in Appendix.

## **SEWER SYSTEM LAYOUT**

For general discussions of sanitary sewer layout techniques, the designer should refer to such design manuals and texts as the following:

- “Design Manual for Sewers and Watermains”- sponsored by the Municipal Engineers Association and the Ministry of the Environment.



# REGIONAL MUNICIPALITY OF DURHAM SANITARY SEWER DESIGN SHEET (METRIC)

MUNICIPALITY:  
PROJECT:  
FROM:  
TO:  
CONTRACT NO.:

DESIGNED BY:  
CHECKED BY:  
MANNING'S "n": 0.013  
DATE: 04/18/13 TIME: 11:26 AM

- NOTES:**
- 1) MINIMUM VELOCITY = 0.60 m/s
  - 2) MAXIMUM VELOCITY = 3.65 m/s
  - 3) INFILTRATION 0.26 l/s = 22.5 m<sup>3</sup>/Ha/DAY
  - 4) INDUSTRIAL 2.08 l/s (local sewers) 1.04 l/s (trunk sewers)
  - 5) EXISTING CONDITION INCLUDES COMMITTED DEVELOPMENT
  - 6) USE ACTUAL METRIC I.D. PIPE SIZE IN mm
  - 7) COMMERCIAL FLOOR SPACE INDEX=50% UNLESS OTHERWISE KNOWN

SUBDIVISION AREA	RESIDENTIAL				COMMERCIAL			INDUST.	INSTIT.	FLOW IN LITRES PER SECOND					PROPOSED SEWER				PRESENT CONDITION	
	GROSS AREA (Ha)	POP. DENSITY (PERSONS PER Ha)	POP.	PEAK FLOW FACTOR	LOT AREA (Ha)	FLOOR SPACE INDEX	FLOOR AREA (Ha)	LOT AREA (Ha)	LOT AREA (Ha)	RESIDENTIAL FLOW		COMM. 2.08 l/s	INDUS. 2.08 l/s	INSTIT. 1.30 l/s	TOTAL FLOW l/s	ACT. PIPE SIZE (mm)	SLOPE %	Q l/s	V m/s	SURCHARGED %
										INFIL. 0.26 l/s	SEWAGE 0.0042 l/s									
MAINTENANCE HOLE						see note 7				see note 3		see note 4								
			0			0.00											0.00	0.00		0.00
			0			0.00											0.00	0.00		0.00
			0			0.00											0.00	0.00		0.00
			0			0.00											0.00	0.00		0.00
	0.00		0	0.00		0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00			0.00	0.00		0.00
			0			0.00											0.00	0.00		0.00
			0			0.00											0.00	0.00		0.00
			0			0.00											0.00	0.00		0.00
	0.00		0	0.00		0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00			0.00	0.00		0.00
			0			0.00											0.00	0.00		0.00
			0			0.00											0.00	0.00		0.00
			0			0.00											0.00	0.00		0.00
	0.00		0	0.00		0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00			0.00	0.00		0.00
			0			0.00											0.00	0.00		0.00
			0			0.00											0.00	0.00		0.00
			0			0.00											0.00	0.00		0.00
	0.00		0	0.00		0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00			0.00	0.00		0.00
			0			0.00											0.00	0.00		0.00
			0			0.00											0.00	0.00		0.00
			0			0.00											0.00	0.00		0.00
	0.00		0	0.00		0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00			0.00	0.00		0.00





**NOTE: Refer to Engineering Submission/As Built Forms Section of this manual, for information required.**

THE REGIONAL MUNICIPALITY OF DURHAM  
FINAL MEASUREMENT FORM FOR SKETCHES



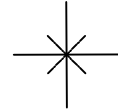
Location: \_\_\_\_\_ Street: \_\_\_\_\_  
(Municipality) (Community)

Contract No.: \_\_\_\_\_ Drawing Number: \_\_\_\_\_  
(Reg./Mun./Sub.)

Consultant: \_\_\_\_\_ Inspector's Name: \_\_\_\_\_  
(Please Print)

Description: Main Line  or Service Connection  : San  Storm  Water

Diameter \_\_\_\_\_ mm Class \_\_\_\_\_ Material Type \_\_\_\_\_ Date: \_\_\_\_\_



**Final Sketch**  
**to be 8 1/2 x 14**  
**(Contact Construction Management Services for sample**  
**copy or electronic file at 905-668-7711.)**



# THE REGIONAL MUNICIPALITY OF DURHAM LATERAL LOCATION SHEET

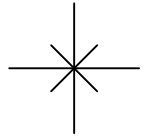
Location: \_\_\_\_\_  
(Municipality) (Community)

Street: \_\_\_\_\_ Civic # : \_\_\_\_\_ Lot # : \_\_\_\_\_

Contract No.: \_\_\_\_\_ Consultant: \_\_\_\_\_ Drawing No.: \_\_\_\_\_  
(Reg./Mun./Sub.)

Inspector's Name: \_\_\_\_\_ Date: \_\_\_\_\_  
(Please Print)

## AS CONSTRUCTED SERVICE LOCATION



San  Storm  Water

Remarks \_\_\_\_\_

Length of Lateral \_\_\_\_\_ m

\_\_\_\_\_

Diameter of Lateral \_\_\_\_\_ mm

\_\_\_\_\_

Material & Class of Lateral \_\_\_\_\_

\_\_\_\_\_

Lateral Inv. Elev. @ Main (± 50mm) \_\_\_\_\_  
(San, Storm)

Invert Elevation @ P/L \_\_\_\_\_

Approximate Depth @ P/L (± 300mm) \_\_\_\_\_ m

**NOTE:** The location and elevation of the lateral at the property line must be confirmed prior to installation on private property.

I agree that the service connection should be as shown.

\_\_\_\_\_  
Occupant's Name

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

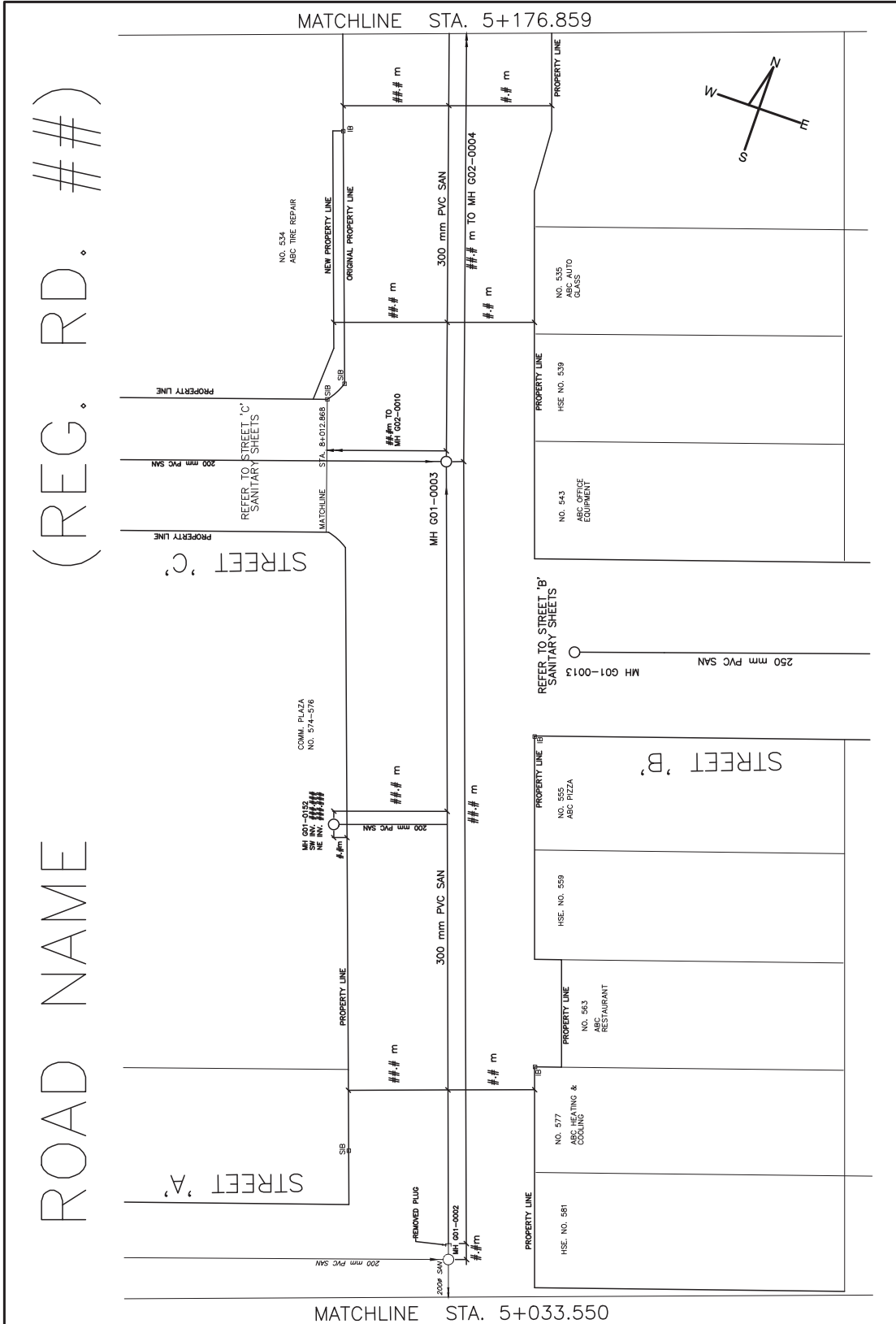
NOTE: Refer to Engineering Submission/As Built Forms Section of this manual, for information required.

THE REGIONAL MUNICIPALITY OF DURHAM  
FINAL MEASUREMENT FORM FOR SKETCHES

**SAMPLE 1**



Location: City of Oshawa (Municipality) Street:                      Road Name (REG. RD. ##)                       
 Contract No.: D2012-### (Reg./Mun./Sub.) Drawing Number: O-12-SW-1234, O-12-SW-1235  
 Consultant:                      Inspector's Name: John Smith (Please Print)  
 Description: Main Line  or Service Connection  : San  Storm  Water   
 Diameter 200 mm Class SDR 35 Material Type P.V.C. Date: June 1, 2011  
300 mm SDR 35 P.V.C.



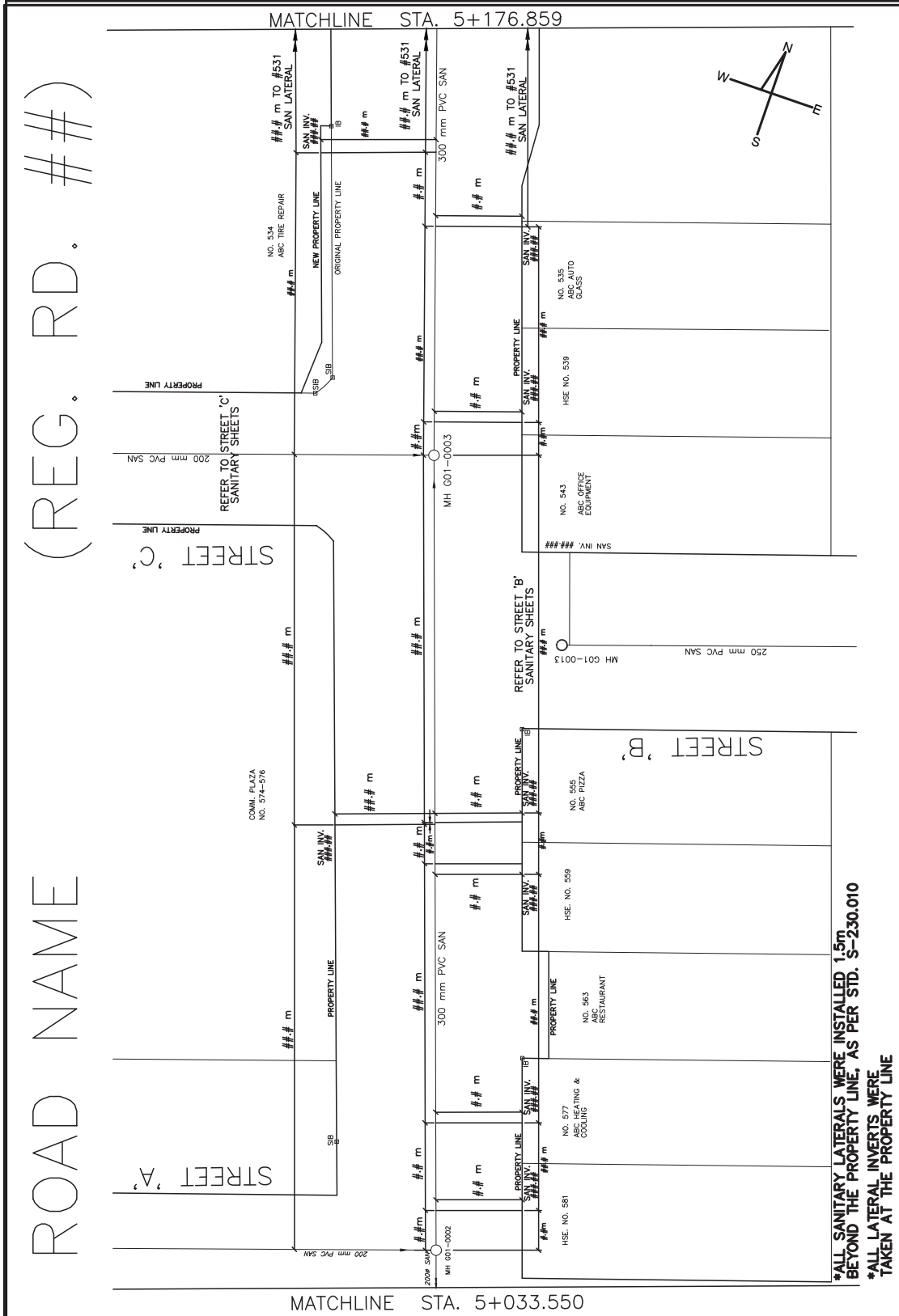
NOTE: Refer to Engineering Submission/As Built Forms Section of this manual, for information required.

THE REGIONAL MUNICIPALITY OF DURHAM  
FINAL MEASUREMENT FORM FOR SKETCHES

**SAMPLE 2**



Location: City of Oshawa (Municipality) Street: Road Name (REG. RD. ##) (Community)  
 Contract No.: D2012-### (Reg./Mun./Sub.) Drawing Number: O-12-SW-1234, O-12-SW-1235  
 Consultant: Inspector's Name: John Smith (Please Print)  
 Description: Main Line  or Service Connection  : San  Storm  Water   
 Diameter 100 mm Class SDR 28 Material Type P.V.C. Date: June 1, 2012



\*ALL SANITARY LATERALS WERE INSTALLED 1.5m BEYOND THE PROPERTY LINE, AS PER STD. S-230.010  
 \*ALL LATERAL INVERTS WERE TAKEN AT THE PROPERTY LINE

NOTE: Refer to Engineering Submission/As Built Forms Section of this manual, for information required.

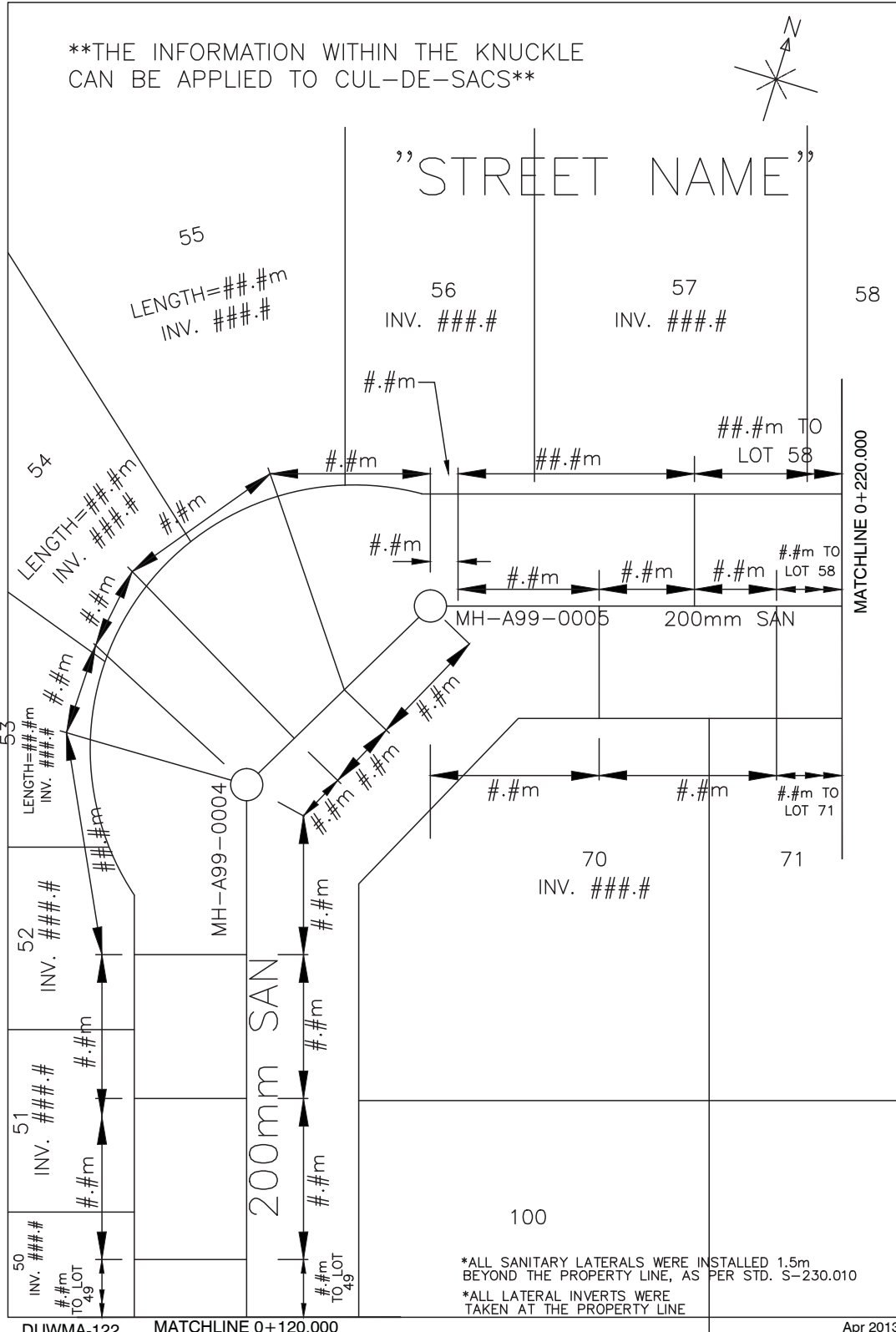
# SAMPLE 3

THE REGIONAL MUNICIPALITY OF DURHAM  
FINAL MEASUREMENT FORM FOR SKETCHES



Location: WHITBY (Municipality) BROOKLIN (Community) Street:                      "Add Name"  
 Contract No.: 2016-W-100 (Fig./Plan/Sheet) Drawing Number:                      "Add Number"  
 Consultant:                      "Add Number" Inspector's Name:                      "Add Name"  
 (Please Print)  
 Description: Main Line  or Service Connection  : San  Storm  Water   
 Diameter: 100 mm Class SDR-28 Material Type PVC Date:                      "Add Date"

\*\*THE INFORMATION WITHIN THE KNUCKLE  
CAN BE APPLIED TO CUL-DE-SACS\*\*



\*ALL SANITARY LATERALS WERE INSTALLED 1.5m  
BEYOND THE PROPERTY LINE, AS PER STD. S-230.010  
 \*ALL LATERAL INVERTS WERE  
TAKEN AT THE PROPERTY LINE

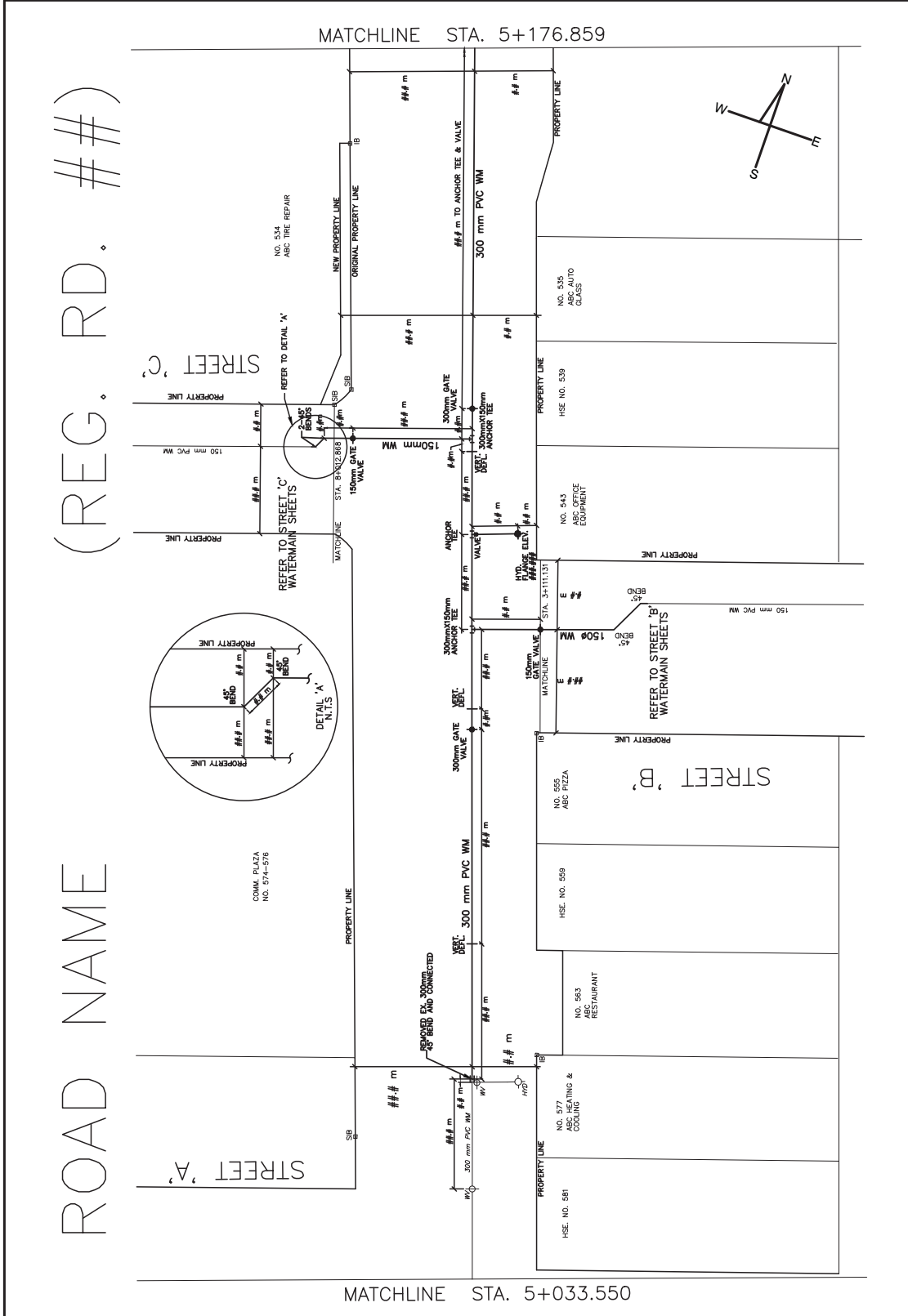
NOTE: Refer to Engineering Submission/As Built Forms Section of this manual, for information required.

THE REGIONAL MUNICIPALITY OF DURHAM  
FINAL MEASUREMENT FORM FOR SKETCHES

**SAMPLE 4**



Location: City of Oshawa (Municipality) Street: Road Name (REG. RD. ##) (Community)  
 Contract No.: D2012-### (Reg./Mun./Sub.) Drawing Number: O-12-SW-1234, O-12-SW-1235  
 Consultant: Inspector's Name: John Smith (Please Print)  
 Description: Main Line  or Service Connection  : San  Storm  Water   
 Diameter 300 mm Class C-900 CL-150 Material Type P.V.C. Date: June 1, 2012  
 150 mm C-900 CL-150 P.V.C.



ROAD NAME (REG. RD. ##)





NOTE: Refer to Engineering Submission/As Built Forms Section of this manual, for information required.

# SAMPLE 6

THE REGIONAL MUNICIPALITY OF DURHAM  
FINAL MEASUREMENT FORM FOR SKETCHES



Location: WHITBY (Municipality) BROOKLIN (Community) Street: \_\_\_\_\_ "Add Name"  
 Contract No.: 2016-W-100 (Reg. Mun. SUB) Drawing Number: \_\_\_\_\_ "Add Number"  
 Consultant: \_\_\_\_\_ "Add Name" Inspector's Name: \_\_\_\_\_ "Add Name" (Please Print)  
 Description: Main Line  or Service Connection  : San  Storm  Water   
 Diameter: 19 mm Class TYPE 'K' Material Type COPPER Date: "Add Date"

