Volume II

Appendices

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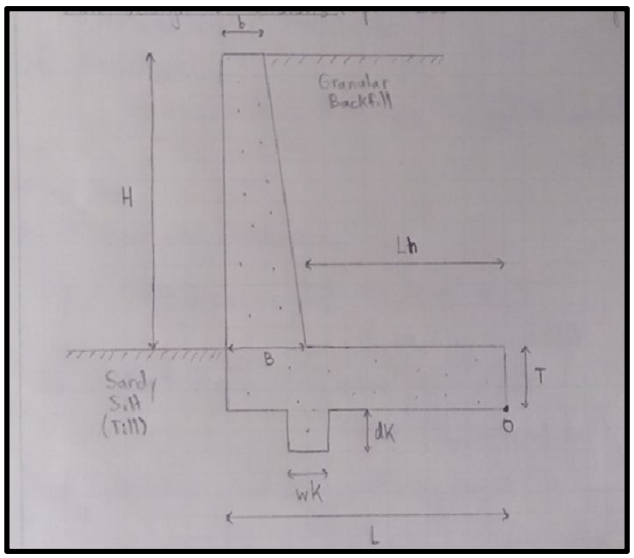
APPENDIX A: Retaining Wall Design

Retaining Wall Design Spreadsheet (External Stability)

This spreadsheet provides initial sizing of a retaining wall based on overturning and sliding failure analysis. The input sections are Design Unit Weights, Design Dimensions, and Soil Internal Angle of Friction. The structural design is to be performed seperately in the other tabs.



Design Unit Weights:		
Concrete:	24	kN/m3
Masonry:	4.4	kPa
Backfill:	19	kN/m3
Natural Soil:	15	kN/m3

Design Dimensions (See above figure):		
Stem Height (H):	3.5	m
Footing Thickness (T):	0.4	m
Stem Thickness at Top (b):	0.2	m
Stem Thickness at Base(B):	0.4	m
Footing Width (L):	2.4	m
Length of Heel (Lh):	2	m
Depth of Footing (dF):	0	m
Depth of Key (dK):	0.2	m
Width of Key (wK):	0.1	m

Soil Internal Angle of Friction (f):					
Backfill:	30	degrees		Backfill ka:	0.33
Natural Soil:	33	degrees		Natural Soil kp:	3.39

Load Calculation (per 1 m of wall segment):		
Weight of Stem (W1):	25.2	kN
Weight of Footing (W2):	23.04	kN
Weight of Soil above toe (W3):	0	kN
Weight of Shear Key (W4):	0.48	kN
Weight of Backfill above Heel (W5):	133	kN
Active Earth Force (Fa):	48.2	kN
Passive Earth Force (Fp)(Allowable):	2.0	kN
Friction Force (FFr):	73.4	kN
Shear Key Force (Fs):	12.4	kN
Static Seismic Force(Fe):	52.0	kN

using PGA=0.48g for Maple Ridge

Footing Bearing Pressure Calculation:			
Total Weight (W1+W2+W3+W4+W5=WT):	181.72	kN	
Distance of Resultant from O (d):	1.19	m	
Heel Pressure (SPh):	11.6	kPa	
Toe Pressure (SPt):	139.9	kPa	
Location of Resultant(xbar):	0.86	m	(from front of wall)

Analysis Results:			
	Actual	**Recommended**	**OK?**
Sliding FS:	1.82	1.5	Acceptable
Overturning FS:	3.50	2	Acceptable
Bearing FS	3.42	3	Acceptable

Additional Seismic Analysis Results:			
	Actual	**Recommended**	**OK?**
Sliding FS:	1.12	1.1	Acceptable
Overturning FS:	1.27	1.2	Acceptable

Footing Reinforcement Design

(non-conservative approach)

Net M (CW):
156.49 kN-m

xbar=	0.86 m	Footing Middle Third Check (ensures pressure distribution is trapezoidal)	
		0.8 m	Yes

eccentricity=	0.34 m

Moment due to eccentricity (Me)	=	61.57	kN-m

SP1=	95.32	kN/m
SP2=	63.25	kN/m

Uniform Load=	64.52344 kN/m

M1=	65.50	kN-m	CW	V1=	33.72	kN	(downwards)
M2=	21.72	kN-m	CW	V1 =	129.05	kN	(neglecting soil pressure)

Mu=	78.60	kN-m	(dead load factor of 1.2)
Mu(conservative)=	154.86	kN-m	
Vu=	40.47	kN	
Vu (conservative)=	154.86	kN	
Vr=	167.14	kN	(adequate)
Mr=	150.65	kN-m	

Result: 20M @ 225 (due to crack control req'ments)

Development Length Check:			
kd=	71.2		
ψt=	1.3	(top bars)	
ψe=	1	(uncoated)	
ψs=	0.8	(20M bars or smaller)	
λ=	1	(normal-density concrete)	
c=	85	mm	(cover of bar)
ktr=	0	(conservative)	
Check [(c+ktr)/db]<=2.5:	4.25	(use 2.5)	
Ker=Asreq'd/As provided:	0.545		
Development length(ld):	322.8493	mm	< 400 mm (B)
Result: Don't need to increase the toe of wall beyond the stem face.			

Crack Control Parameter Check:				
z=	23476.18	N/mm	<	25000
Where:	dc=	85	mm	
	A=	42500	mm^2	
	fs=	153	Mpa	
	(service level force in steel)			

Longitudinal Reinforcement:			
req'd As=	1728	mm^2	(in entire footing)
Result: Use 9-15M bars (As= 1800 mm^2) or 6-20M			

Shear Key Force Check :			
Max. Fs= Vf=	39.54077	kN	
Vr=	61.72018	kN	(Adequate)
Don't need to design flex. reinf. in key due to stem bars extending into key			

Stem Reinforcement Design

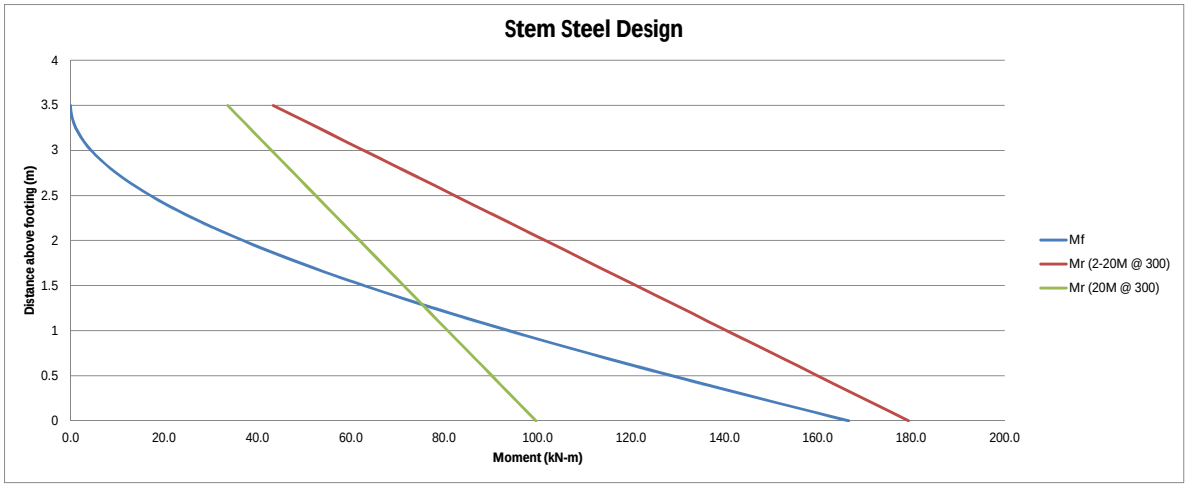
EFP=	22.17	kN/m

EQP=	29.72	kN/m

Stem width at bottom (B):	400	mm
Stem width at top(b):	200	mm
concrete cover :	75	mm

From Mathcad:	From Mathcad:
a=52.3 mm	a=26.15 mm
Tr=6.8 * 10 ^ 5 N	Tr=3.4 * 10 ^ 5 N

y (m)	Vf (kN)	Mf (kN-m)		d (mm)	dv (mm)	Vr = Vc (kN)	Mr (kN-m) (2-20M at 300)	Mr (kN-m) (20M at 300)
0	90.8	166.6		290.0	288.0	167.1	179.4	99.6
0.1	88.2	158.9		284.3	283.9	165.3	175.5	97.7
0.2	85.6	151.2		278.6	279.8	163.4	171.6	95.9
0.3	83.0	143.6		272.9	275.7	161.5	167.8	94.0
0.4	80.4	136.2		267.1	271.5	159.6	163.9	92.1
0.5	77.8	128.8		261.4	267.4	157.7	160.0	90.2
0.6	75.2	121.5		255.7	263.3	155.8	156.1	88.3
0.7	72.6	114.4		250.0	259.2	153.9	152.2	86.4
0.8	70.1	107.4		244.3	255.1	151.9	148.3	84.5
0.9	67.5	100.6		238.6	251.0	150.0	144.4	82.7
1	64.9	93.9		232.9	246.9	148.0	140.6	80.8
1.1	62.3	87.3		227.1	242.7	146.0	136.7	78.9
1.2	59.7	80.9		221.4	238.6	144.0	132.8	77.0
1.3	57.1	74.7		215.7	234.5	142.0	128.9	75.1
1.4	54.5	68.7		210.0	230.4	140.0	125.0	73.2
1.5	51.9	62.9		204.3	226.3	137.9	121.1	71.3
1.6	49.3	57.3		198.6	222.2	135.9	117.2	69.5
1.7	46.7	51.9		192.9	218.1	133.8	113.4	67.6
1.8	44.1	46.7		187.1	213.9	131.7	109.5	65.7
1.9	41.5	41.7		181.4	209.8	129.6	105.6	63.8
2	38.9	37.0		175.7	205.7	127.5	101.7	61.9
2.1	36.3	32.5		170.0	201.6	125.4	97.8	60.0
2.2	33.7	28.3		164.3	197.5	123.3	93.9	58.1
2.3	31.1	24.3		158.6	193.4	121.1	90.0	56.3
2.4	28.5	20.6		152.9	189.3	119.0	86.2	54.4
2.5	25.9	17.1		147.1	185.1	116.8	82.3	52.5
2.6	23.4	14.0		141.4	181.0	114.6	78.4	50.6
2.7	20.8	11.2		135.7	176.9	112.4	74.5	48.7
2.8	18.2	8.6		130.0	172.8	110.1	70.6	46.8
2.9	15.6	6.4		124.3	168.7	107.9	66.7	44.9
3	13.0	4.5		118.6	164.6	105.6	62.8	43.1
3.1	10.4	2.9		112.9	160.5	103.4	59.0	41.2
3.2	7.8	1.6		107.1	156.3	101.1	55.1	39.3
3.3	5.2	0.7		101.4	152.2	98.8	51.2	37.4
3.4	2.6	0.2		95.7	148.1	96.4	47.3	35.5
3.5	0.0	0.0		90.0	144.0	94.1	43.4	33.6



Crack Control Parameter Check:				
At y=1.3 m:				
z=	8316	N/mm	<	25000
Where:	dc=	85 mm		
	A=	51000 mm^2		
	fs=	51 Mpa		
	(service level force in steel)		(NO eq moment = 12 kN-m)	
At y=0 m:				
z=	0	N/mm	<	25000
Where:	dc=	87.5 mm		
	A=	52500 mm^2		
	fs=	120 Mpa		
	(service level force in steel)		(NO eq moment = 46 kN-m)	

Development Length Check:			
kd=	71.2		
ψt=	1	(not top bars)	
ψe=	1	(uncoated)	
ψs=	0.8	(20M bars or smaller)	
λ=	1	(normal-density concrete)	
c=	85	mm	(cover of bar)
ktr=	0	(conservative)	
Check [(c+ktr)/db]<=2.5:	4.25	(use 2.5)	
Ker=Asreq'd/As provided:	0.9045		
Development length(ld):	412.16256	mm	> 400 mm (T)
Result: Extend bars into the shear key to within 75 mm of bottom of key.			

Stem Face Steel Design:				
(use 10M bars)			Ab= 100	mm^2
(Use Avg. Stem Thickness)				
Horizontal (per m of height of wall):	Max. As=	400	mm^2	
	Min. As=	300	mm^2	
	Req'd s=	250	mm	
	Use s=	250	mm	
	As=	400	mm^2	
Result: Use 10M at 250				
Vertical (per m of length of wall):	Max. As=	320	mm^2	
	Min. As=	240	mm^2	
	Req'd s=	312.5	mm	
	Use s=	400	mm	
	As=	250	mm^2	
Result: Use 10M at 400				
Rear face of wall (not exposed)				
Horizontal (per m of height of wall):	Min. As=	200	mm^2	
	Req'd s=	500	mm	
	Use s=	500	mm	
	As=	200	mm^2	
Result: Use 10M at 500				

Bearing Capacity Analysis

(for shallow strip footings - symmetric loading)

Soil Conditions:		
Maximum Bearing Pressure:	139.9	kPa
cohesion c:	0	kPa
Footing Depth (dF):	0	m
Unit Weight of Soil:	15	kN/m3

Meyerhof Bearing Capacity Factors (f=33 degrees):		
N_c	N_q	N_γ
38.95	26.3	26.6

Results:		
Ultimate Bearing Capacity (Qu):	478.8	kPa
Allowable Bearing Capacity (Qa):	159.6	kPa
(greater than max. bearing pressure)		

Dowel Design

(Use a depressed key formed by 2 x 6 plank) Added FS
Shear-friction design method of ACI Code Section 11.7

Dowel Spacing:		
$V_n = A_{vf} * f_y * \mu$		$V_u = \phi * V_n$
Avf=area of dowels (shear friction reinf.)		
μ=1		
Req'd Avf=	302.7	mm^2/m
Use 2-10M dowels:		
Ab=	200.0	mm^2
Req'd s=	660.7	mm
Use s=	400.0	mm
(controlled by limited development length space)		
Avf=	500.0	mm^2/m
Vu=	90.8	kN
Vn=	200.0	kN
controlling max Vn =	200	kN
multiplied by ϕ =	150	kN
Greater than Vu = adequate		

Development Length Check:		
kd=	71.2	
ψt=	1	(not top bars)
ψe=	1	(uncoated)
ψs=	0.8	(20M bars or smaller)
λ=	1	(normal-density concrete)
c=	80	mm
ktr=	0	(conservative)
Check [(c+ktr)/db]<=2.5:	4.0	(use 2.5)
Ker=Asreq'd/As provided:	0.605	
Development length(ld):	275.9	mm
Results: Don't need to increase the footing depth, < 400 mm (T)		
Note: ld extends in both directions for dowels.		
2-10M dowels at 400 spacing (length = 600 mm ea.)		

Flexural Steel Design of Cantilever Retaining Wall

M1=		65.4978	kN-m	cw	V1=	33.72326	kN
M2=		21.71946	kN-m	cw	V1 (neglecting soil pressure)=	129.0469	kN

Mu=		78.59736	kN-m
Mu (conservative)=		154.8563	kN-m
Vu=		40.46792	kN
Vu (conservative)=		154.8563	kN
Vr=		167.1429	kN
Mr=		122.1	kN-m

"H:/capstone project/footingvalues.bmp"

Material Properties:

fc := 25MPa

fy := 400MPa

Footing Flexural Design

Footing Dimensions:

b := 1000mm df := 400mm

cover := 75mm

20 M bar sizes: $bardia1 := 20mm$ $Ab1 := 300mm^2$

15M bar sizes $bardia2 := 15mm$ $Ab2 := 200mm^2$

Front of Footing (Location 1)

$Mb := 69.3kN \cdot m$

$d := df - cover - \frac{bardia1}{2}$

$d = 315 \cdot mm$

$requiredAs := 0.0015 \cdot fc \cdot b \cdot \left(d - \sqrt{d^2 - 3.85 \cdot \frac{Mb}{fc \cdot b}} \right) = 653.317\ N$ (empirical equation)

As min: $0.002 \cdot df \cdot b = 800 \cdot mm^2$

As max: $0.022 \cdot d \cdot b = 6.93 \times 10^3 \cdot mm^2$

Bar Spacing:

$b \cdot \frac{Ab1}{654mm^2} = 0.459\ m$ (maximum spacing)

Try:

$s := 225mm = 0.225\ m$ $As := \frac{b \cdot Ab1}{s} = 1.333 \times 10^3 \cdot mm^2$

(Due to crack control)

Check that steel has yielded:

$$Tr := 0.5 \cdot 0.85 As \cdot fy = 2.267 \times 10^{5}\,N$$

$$a := \frac{Tr}{(0.8 \cdot 0.65 \cdot fc \cdot b)} = 17.436 \cdot mm$$

$$cNA := \frac{a}{0.8} = 21.795 \cdot mm$$

$$steelstrain := 0.0035 \cdot \frac{(d - cNA)}{d} = 3.258 \times 10^{-3}$$

$$steelstrain > 0.002$$

$$Tr \cdot \left(d - \frac{a}{2}\right) = 69.424 \cdot kN \cdot m$$

Flexural Steel Design of Cantilever Retaining Wall

y (m)	Vf (kN)	Mf (kN-m)
0	90.8	166.6
0.1	88.2	158.9
0.2	85.6	151.2
0.3	83.0	143.6
0.4	80.4	136.2
0.5	77.8	128.8
0.6	75.2	121.5
0.7	72.6	114.4
0.8	70.1	107.4
0.9	67.5	100.6
1	64.9	93.9
1.1	62.3	87.3
1.2	59.7	80.9
1.3	57.1	74.7
1.4	54.5	68.7

"H:/capstone project/stemvalues.bmp"

Material Properties:

fc := 25MPa

fy := 400MPa

Stem Flexural Design

Bottom of Stem Dimensions:

b := 1000mm df := 400mm

cover := 75mm

25 M bar sizes: $bardia1 := 25mm$ $Ab1 := 500mm^2$

20M bar sizes $bardia2 := 20mm$ $Ab2 := 300mm^2$

$barspacing := 30mm$ (2layers)

Front of Footing (Location 1)

$Mb := 166.6kN \cdot m$

$d := df - cover - bardia2 - \frac{barspacing}{2} = 290 \cdot mm$

$requiredAs := 0.0015 \cdot fc \cdot b \cdot \left(d - \sqrt{d^2 - 3.85 \cdot \frac{Mb}{fc \cdot b}} \right) = 1.809 \times 10^3 N$ (empirical equation)

As min: As max:

$0.002 \cdot df \cdot b = 800 \cdot mm^2$ $0.022 \cdot d \cdot b = 6.38 \times 10^3 \cdot mm^2$

Bar Spacing:

$b \cdot \frac{2Ab2}{\left(1809mm^2\right)} = 0.332\,m$ (maximum spacing)

Try:

$s := 300mm = 0.3\,m$ $As := \frac{b \cdot 2 \cdot Ab2}{s} = 2 \times 10^3 \cdot mm^2$

Check that steel has yielded:

$$Tr := 0.85As \cdot fy = 6.8 \times 10^{5}\,N$$

$$a := \frac{Tr}{(0.8 \cdot 0.65 \cdot fc \cdot b)} = 52.308 \cdot mm$$

$$cNA := \frac{a}{0.8} = 65.385 \cdot mm$$

$$steelstrain := 0.0035 \cdot \frac{(d - cNA)}{d} = 2.711 \times 10^{-3}$$

$$steelstrain > 0.002$$

Flexural Steel Design of Cantilever Retaining Wall

y (m)	Vf (kN)	Mf (kN-m)
0	90.8	166.6
0.1	88.2	158.9
0.2	85.6	151.2
0.3	83.0	143.6
0.4	80.4	136.2
0.5	77.8	128.8
0.6	75.2	121.5
0.7	72.6	114.4
0.8	70.1	107.4
0.9	67.5	100.6
1	64.9	93.9
1.1	62.3	87.3
1.2	59.7	80.9
1.3	57.1	74.7

"H:/capstone project/stemvalues.bmp"

Material Properties:

fc := 25MPa

fy := 400MPa

Stem Flexural Design

Mid-Stem Dimensions:

b := 1000mm df := 340mm

cover := 75mm

25 M bar sizes: $bardia1 := 25mm$ $Ab1 := 500mm^2$

20M bar sizes $bardia2 := 20mm$ $Ab2 := 300mm^2$

$barspacing := 30mm$ (2layers)

MidStem (y=1.3 m)

$Mb := 80.6kN \cdot m$

$d := df - cover - \frac{bardia2}{2} = 255 \cdot mm$

$requiredAs := 0.0015 \cdot fc \cdot b \cdot \left(d - \sqrt{d^2 - 3.85 \cdot \frac{Mb}{fc \cdot b}} \right) = 960.961\ N$ (empirical equation)

As min: As max:

$0.002 \cdot df \cdot b = 680 \cdot mm^2$ $0.022 \cdot d \cdot b = 5.61 \times 10^3 \cdot mm^2$

Bar Spacing:

$b \cdot \frac{Ab2}{\left(\left(961mm^2 \right) \right)} = 0.312\ m$ (maximum spacing)

Try:

$s := 300mm = 0.3\ m$ $As := \frac{b \cdot Ab2}{s} = 1 \times 10^3 \cdot mm^2$

Check that steel has yielded:

$$Tr := 0.85As \cdot fy = 3.4 \times 10^{5}\,N$$

$$a := \frac{Tr}{(0.8 \cdot 0.65 \cdot fc \cdot b)} = 26.154 \cdot mm$$

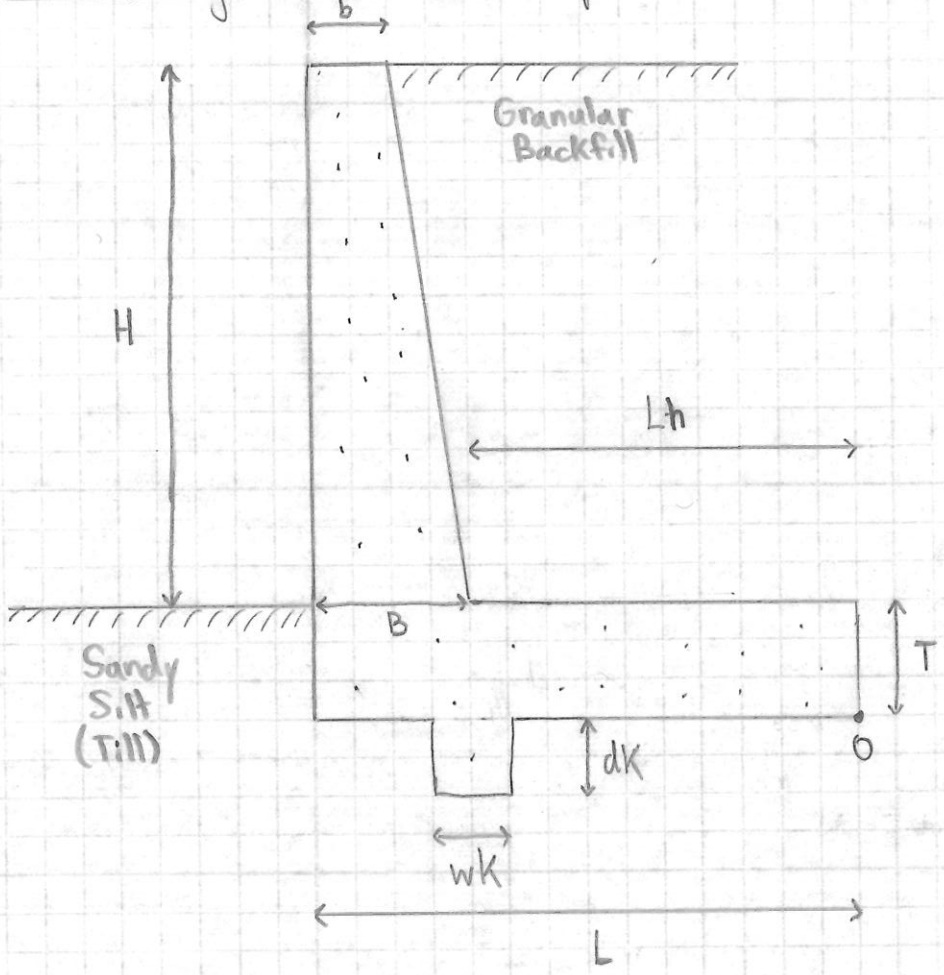
$$cNA := \frac{a}{0.8} = 32.692 \cdot mm$$

$$steelstrain := 0.0035 \cdot \frac{(d - cNA)}{d} = 3.051 \times 10^{-3}$$

$$steelstrain > 0.002$$

$$Tr \cdot \left(d - \frac{a}{2}\right) = 82.254 \cdot kN \cdot m$$

Wall Design Dimensions (Optimized from Excel Spreadsheet)



Stem Height (H) = 3.5 m

Footing Thickness (T) = 0.4 m

Stem Thickness at Base (B) = 0.4 m

Stem Thickness at Top (b) = 0.2 m

Footing Width (L) = 2.4 m

Length of Heel (Lh) = 2 m

Depth of Footing (dF) = 0 m (as shown above)

Depth of Key (dK) = 0.2 m

Width of Key (wK) = 0.2 m

Design Unit Weights:

Concrete = 24 KN/m^3 = γ_c

Backfill = 19 KN/m^3 = γ_b

Natural Soil = 15 KN/m^3 = γ_s

Soil Paramaters:

ϕ' - Internal Angle of Friction (See pg. 546, Caduto)

Backfill	30°
Natural Soil	33°

Earth Pressure Coefficients:

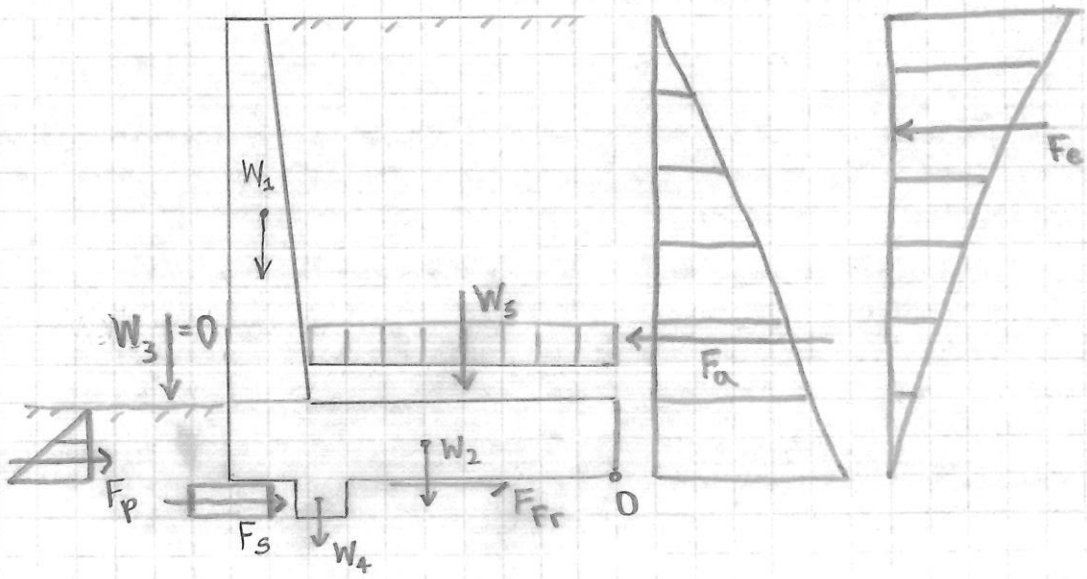
Active Earth Pressure (Ka) = $\tan^2(45° - \phi'/2)$

= 0.333 (for backfill)

Passive Earth Pressure (Kp) = $\tan^2(45° + \phi'/2)$

= 3.392 (for natural soil)

Load Calculation (for 1 m wall segment):



See diagram on prev. pg. for loads.

Weight of Stem (W_1) $= \left(\frac{B+b}{2}\right) \cdot H \cdot \gamma_c = 25.2$ KN

Weight of Ftg. (W_2) $= T \cdot L \cdot \gamma_c = 23.04$ KN

Weight of Soil above Toe (W_3) $= 0$ KN (L-shaped design)

Weight of Shear Key (W_4) $= dK \cdot wK \cdot \gamma_c = 0.96$ KN

Weight of Soil above Heel (W_5) $= Lh \cdot H \cdot \gamma_b = 133$ KN

Active Earth Force (F_a) $= \frac{1}{2} K_a \gamma_b \cdot (H+T)^2 = 48.2$ KN

Passive Earth Force (F_p) $= \frac{1}{2} K_p \gamma_s \cdot (dF+T)^2 = 4.0$ KN

Allowable $F_p = F_p/2 = 2.0$ KN

Frictional Force (F_{Fr}) $= W_T \cdot \tan\left(\frac{2}{3}\phi'\right) = 73.6$ KN

where:

$W_T = \sum_{i=1}^{5} W_i$ = Total Weight $= 182.2$ KN

ϕ' = effective friction angle of natural soil

Shear Key Force (F_s) $= \frac{1}{4} K_p \cdot \gamma_s (dK)^2 + \frac{1}{2} SP_K \cdot dK$

$= 12.4$ KN

where:

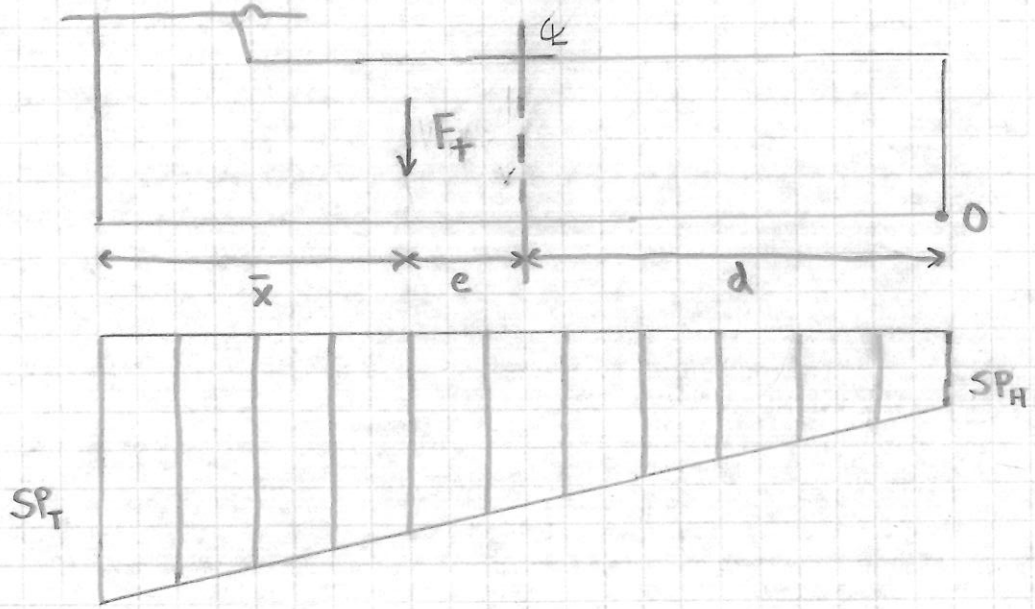
SP_K = soil pressure at Key location

Equiv. Static Seismic Force (F_e) $= \frac{3}{8} (PGA/g) \cdot \gamma_b \cdot (H+T)^2$
(Seed & Whitman, 1970) $= 52.0$ KN

where: PGA $= 0.48g$ (Maple Ridge Building Bylaw)

Footing Bearing Pressure Calculation:

This bearing pressure calculation does NOT include the equiv. seismic load, F_e, which is not a typical load on the structure.



Net Moment $= (W_T \cdot d) - \frac{1}{3} F_a (H+T) = 156.75$ KN-m

$\bar{x}$ = Net M / W_T = 0.86 m (Within footing's middle third → resulting pressure distribution is trapezoidal) ✓

e = location of F_T (total forces acting on wall)
$= \frac{L}{2} - \bar{x} = 0.34$ m

Moment due to eccentricity (Me) $= W_T \cdot e = 61.89$ KN-m

$$p = \frac{W_T}{A} \pm \frac{M_e}{S} = 75.9 \text{ KPa} \pm 64.5 \text{ KPa} \rightarrow SP_T = 140.4 \text{ KPa}$$

$SP_H = 11.5$ KPa

Where:
A = Area of ftg. S = section modulus of ftg. = $= L^2/6$

Bearing Capacity Analysis: (for shallow strip footings)

Use Terzaghi's Ultimate Bearing Capacity Theory:
(assume even loading on footing of wall → see Recommendations of Retaining Wall Design in Vol. 1 for corrective measures.)

$$Q_u = c \cdot N_c + dF \cdot \gamma_s \cdot N_q + \tfrac{1}{2} \gamma_s \cdot L \cdot N_\gamma$$

conservative → $dF = 0$ m and $c = 0$ KPa (cohesionless)

$N_\gamma = 26.6$ for $\phi' = 33°$

$\therefore Q_u = 518.25$ KPa

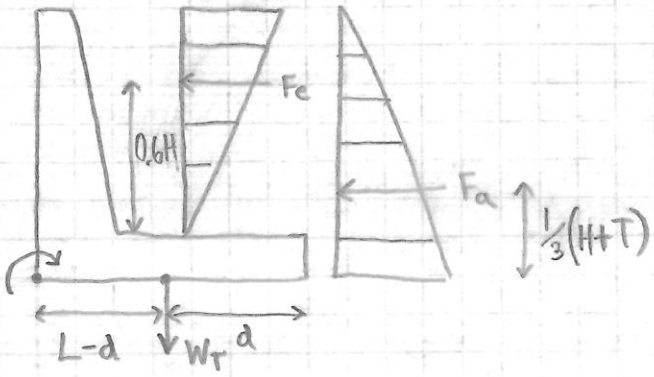
Allowable $Q = \frac{Q_u}{3} = 173$ KPa > 147.4 KPa $= SP_T$ ✓
(max. bearing pressure)

Overturning Analysis:

$$FS_{overturning} = \frac{W_T \cdot (L-d)}{\frac{1}{3} F_a \cdot (H+T)} = 3.50 > 2.00 \quad \text{(Acceptable)}$$

With equivalent EQ load:

$$FS_{ot} = \frac{W_T \cdot (L-d)}{\frac{1}{3} F_a \cdot (H+T) + 0.6 F_e \cdot H} = 1.27 > 1.2$$
(Acceptable)



Sliding Analysis:

$$FS_{sliding} = \frac{F_p + F_s + F_{FR}}{F_a} = 1.82 > 1.5 \quad \text{(acceptable)}$$

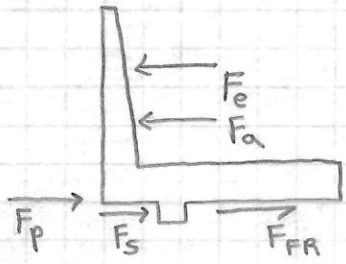
With equivalent EQ load:

$$FS_s = \frac{\left(2 \cdot \frac{4}{3} \cdot F_p\right) + F_{FR} + \left(2 \cdot \frac{4}{3} \cdot F_s\right)}{F_a + F_e} = 1.12 > 1.1$$

(acceptale)

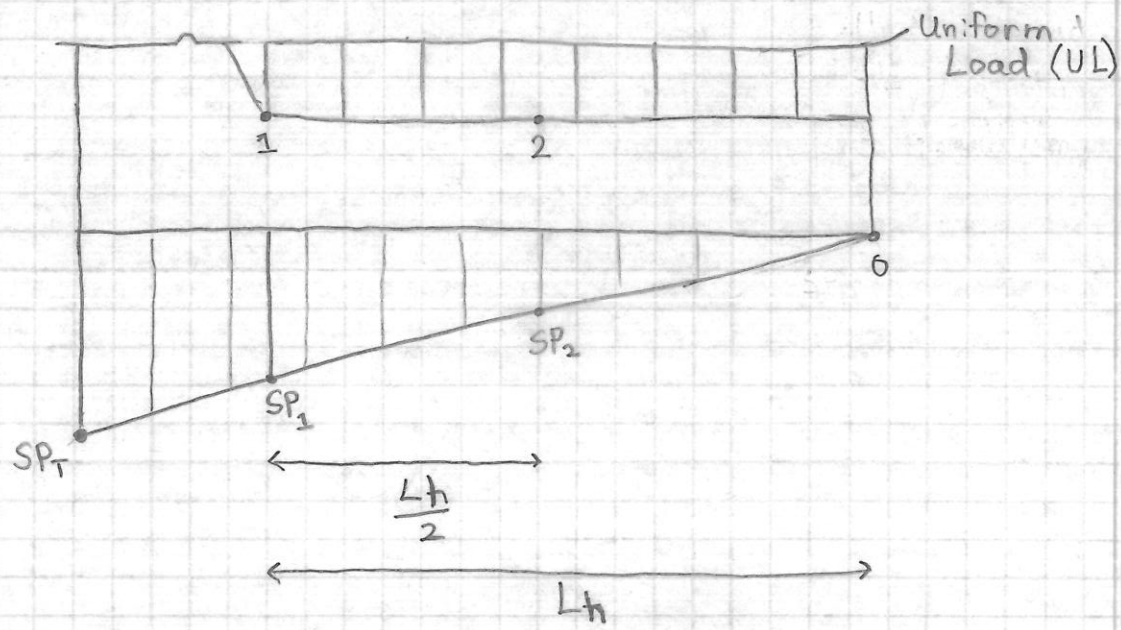
Note: Allowed 1/3 increase in passive resistance and increased from allowable passive resistance to normal by multiplying by 2. The 1/3 increase ...

(R.W. Day)



Footing Design:

The wall footing reinforcement was designed for flexure due to the load on the heel and the underlying soil pressure. A non-conservative approach was considered by reducing the bending moment and shear on the heel through accounting for the effect of the relieving soil pressure. (See below figure).



$$\text{Uniform Load} = (\gamma_b \cdot H) + \underbrace{(\gamma_c \cdot T)}_{\text{heel self-weight}} - SP_H = 64.5 \text{ KN/m}$$

$$SP_1 = \frac{(SP_T - SP_H)\cdot(L - B)}{L} - SP_H = \underline{\underline{95.3 \text{ KN/m}}}$$

$$SP_2 = 63.2 \text{ KN/m}$$

Location 1 is the critical location to design footing for M and V.

$$M_1 = \frac{(UL)\cdot(Lh)^2}{2} - \frac{1}{3}\frac{SP_1\cdot(Lh)^2}{2} = 65.5 \text{ KN-m (CW)}$$

$$V_1 = (UL)(Lh) - \frac{SP_1\cdot(Lh)}{2} = 33.7 \text{ KN (downwards)}$$

$M_u = 1.2(M_1) = 78.6$ KN-m

1.2 → dead load factor

$V_u = 40.5$ KN

Shear Check:

$$V_R = V_c = \phi_c \lambda \beta \cdot \sqrt{f_c'} \cdot b_w \cdot d_v \quad \text{(CSA A23.3. Eq. 11.6)}$$

where:

$\lambda = 1$

$\phi_c = 0.65$

$f_c' = 25$ MPa

$b_w = 1000$ mm

d_v = greater of: $0.9d$ or $0.72h$

$= 283.5$ mm $\quad 0.72 \cdot 400$ mm $= 288$ mm ✓

$d = 400 \text{ mm} - 75 \text{ mm} - d_b/2$

75 mm → clear cover (CSA A23.1-04 Table 17)

$d_b/2$ → 20 mm bars

$$\beta = \frac{230}{1000 + d_v} = 0.179 \text{ (CSA A23.3 Cl.11.3.6.3)}$$

d_v → 288

→ No transverse reinf.

$\rightarrow V_R = 167.1$ KN (for 1-m wall section)

$\therefore$ 400 mm footing thickness is more than adequate.

V_u (conservative) $= 154.9$ KN $< V_R$ ✓

↳ neglecting soil pressure

Flexural Design:

See MathCAD printout.

Spacing of 20M @ 400 is adequate to resist M_u. However, due to crack control limits, specify 20M @ 225 flexural reinforcement in footing. Crack control requirements calculation follows.

Cracking Control Requirements:

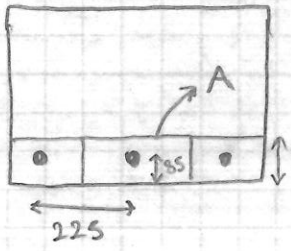
A23.3 Eq. 10.6 $\quad z = f_s \sqrt[3]{d_c \cdot A}$ (N/mm)

where:

$d_c = (75 + 10)\text{mm} = 85$ mm

f_s = stress in steel at max. service load

$A = (170 \cdot 225)\text{mm}^2 = 38{,}250\ \text{mm}^2$



Footing Section (steel at top)

Using MathCAD file:

$f_s = (0.48)(\phi_s) A_s f_y = 163.2$ MPa

(corresponds to $M_R = M_1$)

$\rightarrow z = 24{,}177$ N/mm $< 25{,}000$ N/mm

(CSA A23.3 Cl. 10.6.1)

→ upper limit for z in exterior exposure

Development Length Check: (See stem flexural reinf. design for detailed calcs.)

Development Length: $l_d = 323\ mm < 400\ mm$

400 mm: stem thickness at footing

Result: Adequate space for footing reinf. to extend beneath stem, don't need to extend toe of wall.

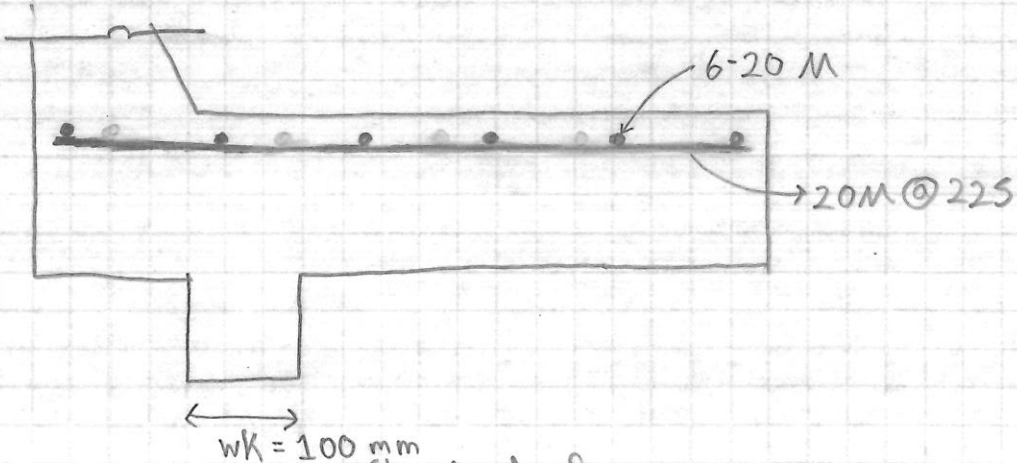
Longitudinal Reinf. Requirements:

Based on absolute minimum of shrinkage and temp. steel required for structural slabs (ACI Section 7.12)

$$A_{s\,req'd} = 0.0018TL$$
$$= 0.0018(400\ mm)(2400\ mm)$$
$$= 1728\ mm^2$$

∴ Use 6-20M bars ($A_s = 1800\ mm^2$)

Sketch of Footing Results:



Checked for shear

$V_R = V_c > \text{Max. } F_S = V_F$

$61.7\ KN > (1.6)(2)F_S = 39.5\ KN$

Stem Design:

The stem's flexural reinf. was design to withstand M and V due to the unfactored soil horizontal load and equivalent seismic load (static). It involved a combination of the MathCAD and Excel file.

Equivalent Fluid Pressure (EFP) = $K_a \cdot \gamma_b \cdot H$
= 22.2 KN/m

Approx. EQ top of stem load:

$$EQP = \frac{Fe \cdot 2}{H} = 29.72 \text{ KN/m}$$

Loads on Stem:

In Excel:

y (m)	V_f (KN)	M_f (KN-m)
0	90.8	166.6
⋮	⋮	⋮
bar cut-off → 1.3	57.1	74.7
point ⋮	⋮	⋮
(used later) ⋮	⋮	⋮
3.5	0	0

$$V_f(y) = \frac{EFP \cdot (H-y)}{2} + \frac{EQP(H-y)}{2}$$

$$M_f(y) = \frac{EFP \cdot (H-y)^2}{6} + \frac{EQP \cdot (H-y)^2}{2} - \frac{EQP \cdot (H-y)^3}{6H}$$

Shear Check:

$$V_R = V_c = \phi_c \lambda \beta \cdot \sqrt{f'_c} \cdot b_w \cdot d_v$$

Note: d_v gets smaller as y increases (see spreadsheet)

at crit. location ($y = 0$ m):

$d_v = 288$ mm and $V_c = V_R = 167.1$ KN $> V_f(0) = 90.8$ KN ✓

Flexural Reinf. Design:

The flexural reinf. design can be seen in MathCAD printout. Results are shown here.

Critical section at $y = 0$ m:

2 layers of 20M bars specified (spacing = 30 mm).

$$d = 400 - 75 - \underbrace{20\text{ mm}}_{d_b} - \frac{30\text{ mm}}{2} = 290\text{ mm}$$

$M_f = 166.6$ KN-m

→ **2-20M @ 300 is sufficient**

(steel yields)

$M_R = \underline{179.4\text{ KN-m}} > M_f$

Theoretical Cut-off Point at $y = 1.3$ m:

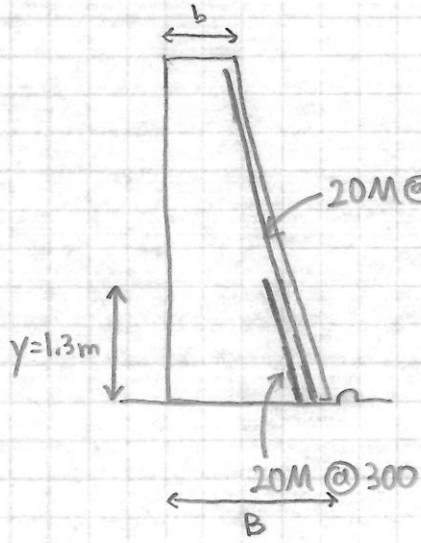
$M_f = 74.7$ KN-m

→ **20M @ 300 is sufficient**

(steel yields)

$M_R = \underline{75.1 \text{ KN-m}} > M_f =$

Sketch of Results: (Main Flexural Reinf.)



Check Cracking Control Requirements:

at $y = 0$ m:

$$z = f_s \sqrt[3]{d_c \cdot A} = 120 \text{ MPa} \cdot \sqrt[3]{(87.5)(52{,}500)}$$

$$= 19{,}756 \text{ N/mm} < 25{,}000 \checkmark$$

at $y = 1.3$ m:

$$z = f_s \cdot \sqrt[3]{d_c \cdot A} = 51 \text{ MPa} \cdot \sqrt[3]{(85)(51{,}000)}$$

$$= 8315 \text{ N/mm} < 25{,}000 \checkmark$$

f_s = service level stress in steel (No EQ load)

See footing flex. design for detailed cracking calcs.

Check Stem Reinf. Development Length:

$$l_d = K_D \cdot \left[\frac{\psi_t \psi_e \psi_s \lambda}{\left(\frac{c + K_{tr}}{d_b} \right)} \right] K_{ER} d_b \quad \text{(ACI Equation 12-1)}$$

where:

$\psi_t = 1$ (not top bars)

$\psi_e = 1$ (uncoated bars)

$\psi_s = 0.8$ (20 M bar size or smaller)

$\lambda = 1$ (normal-density concrete)

$K_D = 71.2$ (Table 5-1, Limbrunner)

$= \frac{3}{40} \frac{f_y}{\sqrt{f'_c}}$ ← convert to psi

$K_{TR} = 0$ (conservative)

$c = 85$ mm (bar cover)

$d_b = 20$ mm

$K_{ER} = \frac{A_{s\,req'd}}{A_{s\,provided}} = 0.9045$ (at $y = 0$ m)

Check:

$\frac{c + K_{tr}}{d_b} \leq 2.5$ ✗

→ Use 2.5

→ $\boxed{l_d = 412 \text{ mm}} > T = 400$ mm

∴ Extend reinf. bars into shear key.

Stem Face Steel: (Use 10M bars)

Horizontal (per m of height of wall):

ACI Code Section 14.3.5.

- spacing must not exceed 3 times wall thickness or 18 in. = 500 mm

Max. $A_s = 0.002(1000\text{ mm})(300\text{ mm})\cdot\frac{2}{3} = 400\text{ mm}^2$

(300 mm ↓ avg. stem thickness)

Min. $A_s = 0.002(1000)(300)\cdot\frac{1}{2} = 300\text{ mm}^2$

Use 10M @ 250 → $A_s = 400\text{ mm}^2$

Vertical:

Max. $A_s = 0.0012(1000)(300) = 240\text{ mm}^2$

Use 10M @ 400 → $A_s = 250$

Horizontal, Rear Face of Wall:

Min. $A_s = 0.002(1000)(300)(\frac{1}{3}) = 200\text{ mm}^2$

Use 10M @ 500 → $A_s = 200$

Results of Face/Horizontal Stem Steel shown in Drawings → Retaining Wall.

Stem / Footing Interface Dowel Design:

$V_F = 90.8\ KN = V_u = \phi V_N$ ($\phi \rightarrow 0.75$)

where V_N = Nominal Shear Strength

$V_N = A_{VF} f_y \cdot \mu$ (ACI Eq. 11-25)

where:

A_{VF} = area of shear-friction reinf.

μ = coefficient of friction
(ACI Code, Section 11.7.4.3)
= 1.0, normal-weight concrete placed against rough, hardened concrete

$$A_{VF\ req'd} = \frac{\phi V_u}{\phi f_y \cdot \mu} = \frac{(90.8)\ KN}{(400\ MPa)(1)(0.75)} = 302.7\ mm^2/m$$

Using 2-10M dowels:

$A_b = 200\ mm^2$

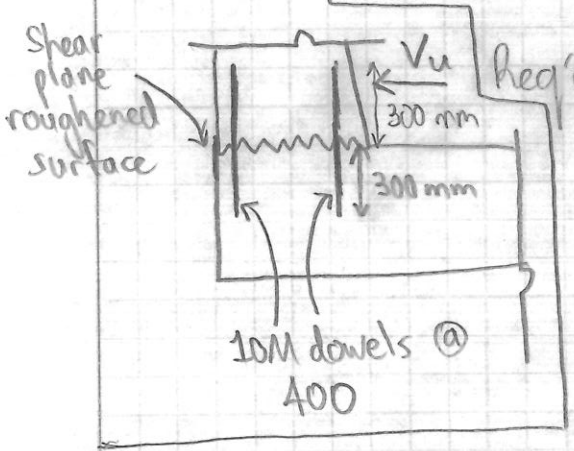
$$req'd\ s = \frac{(1000)\cdot(A_b)}{A_{VF\ req'd}} = 661\ mm$$

Use $s = 400$ mm (controlled by limited development length)

$\rightarrow A_{VF} = 500\ mm^2$

$\phi V_N = 150\ KN > V_u$ ✓ OK

Result:



Tension members so:

$l_d = 276$ mm (extends in both directions)

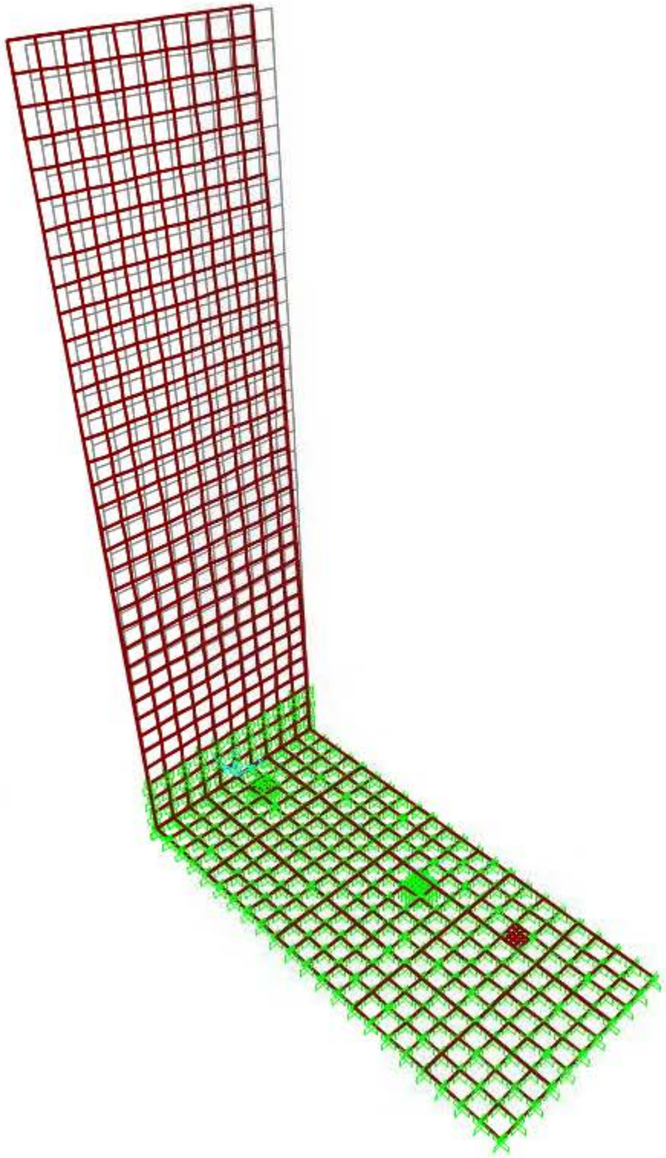
See Stem design development length for detailed calcs.

SAP2000 v17.1.1 Ultimate - sapmodelwall4

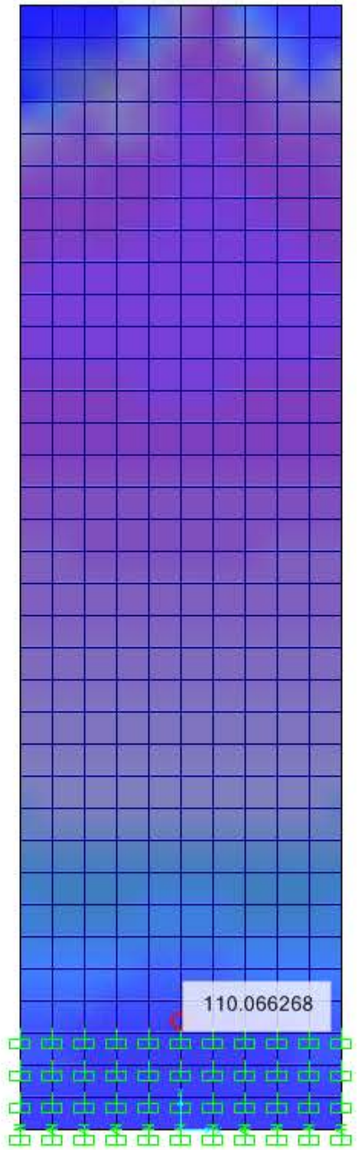
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help

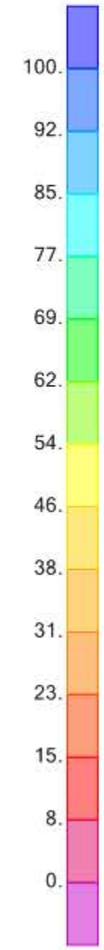
xy xz yz

Deformed Shape (DEAD)



Resultant VMAX Diagram (DEAD)





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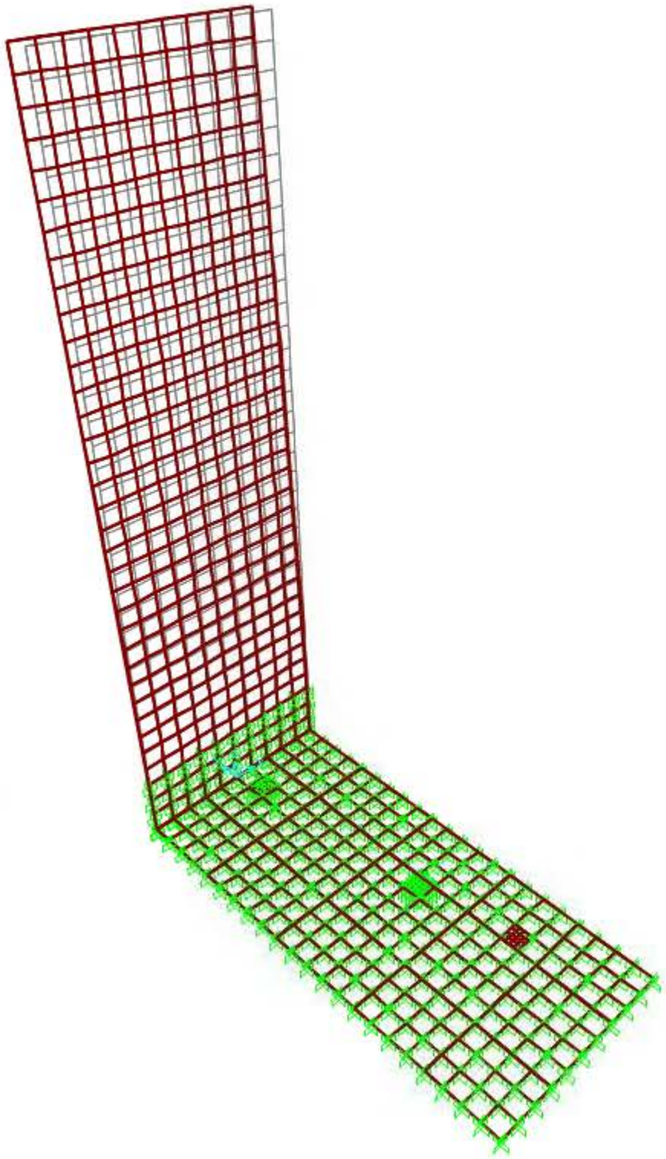
GLOBAL KN, m, C

SAP2000 v17.1.1 Ultimate - sapmodelwall4

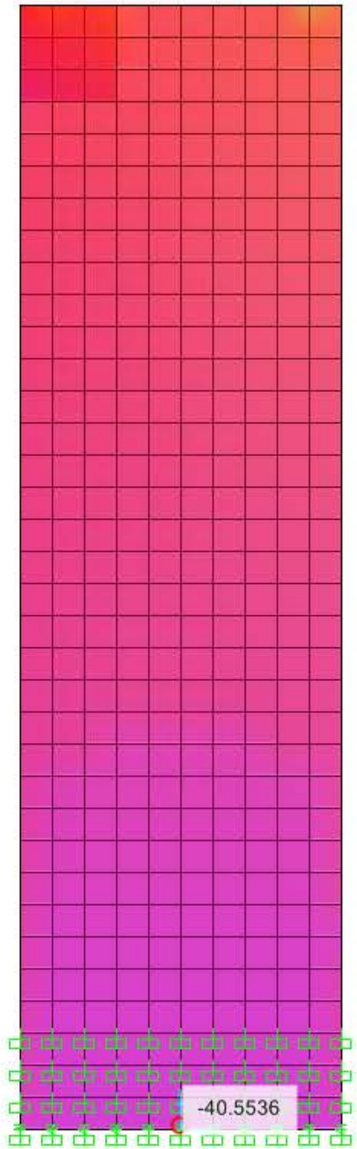
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help

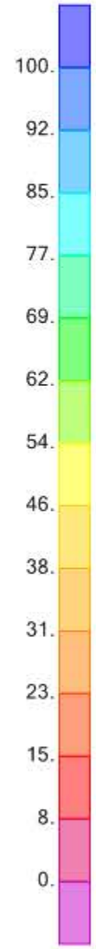
xy xz yz

Deformed Shape (DEAD)



Resultant MMAX Diagram (DEAD)





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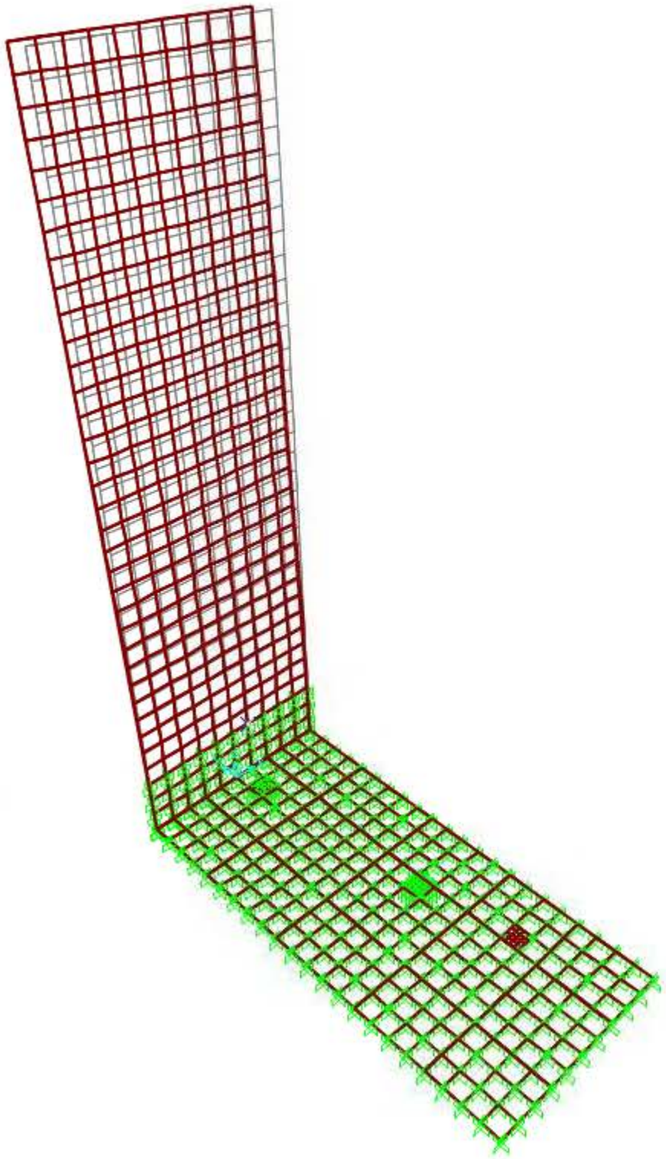
GLOBAL KN, m, C

SAP2000 v17.1.1 Ultimate - sapmodelwall4

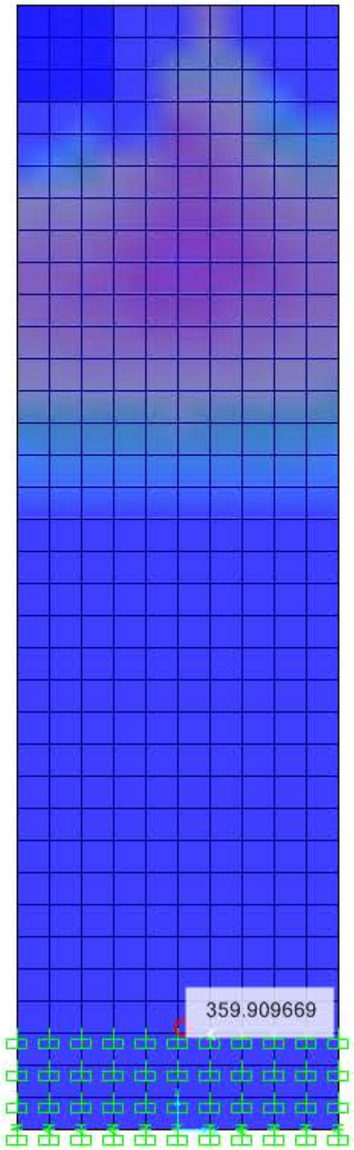
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help

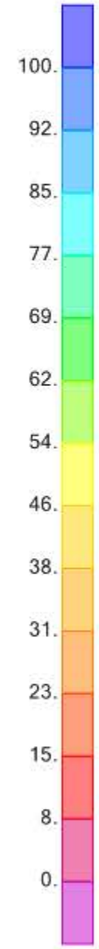
xy xz yz

Deformed Shape (DEAD)



Resultant VMAX Diagram (MODAL) - Mode 1; Period 0.14254





1 Points Selected

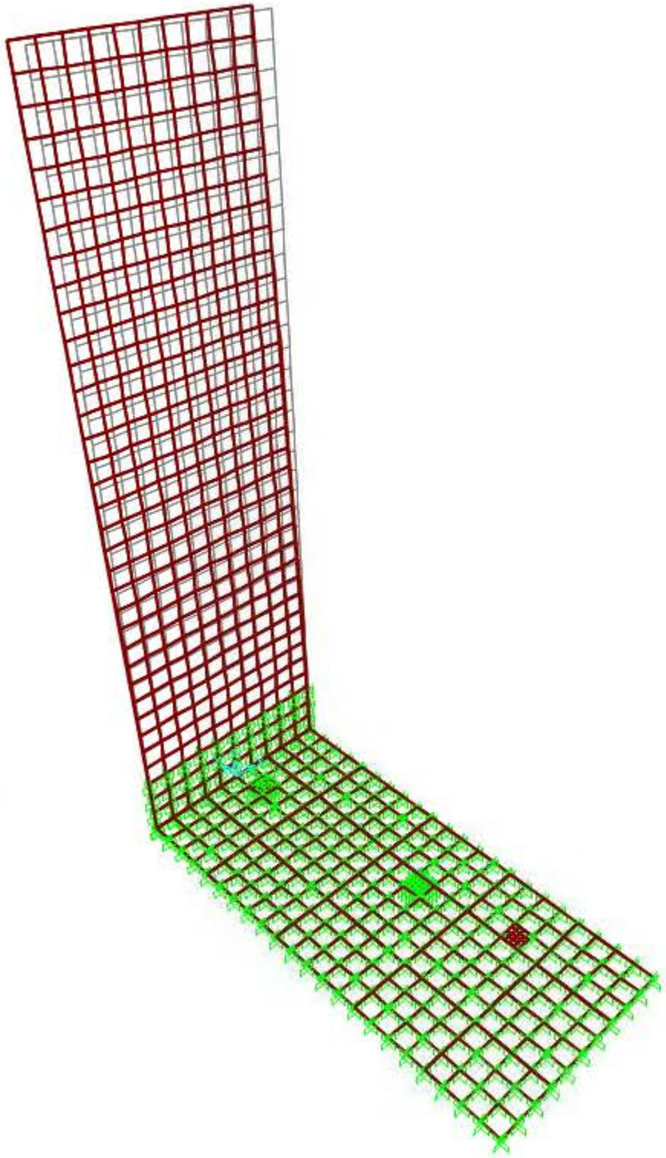
GLOBAL KN, m, C

SAP2000 v17.1.1 Ultimate - sapmodelwall4

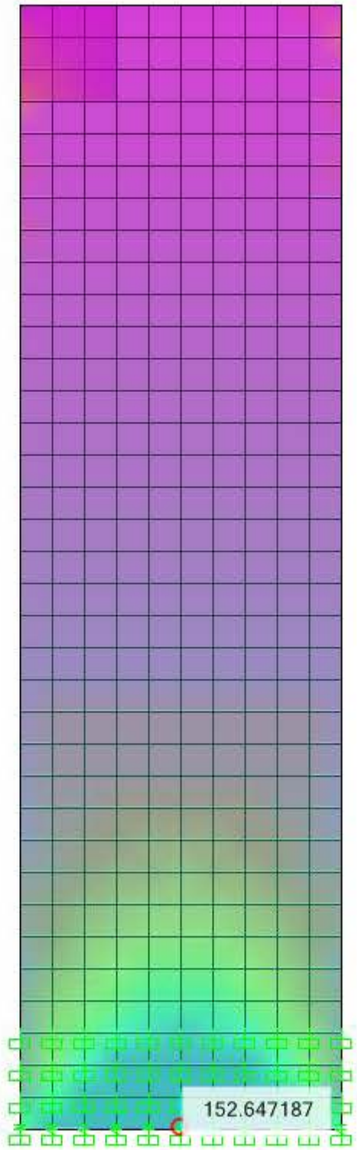
File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help

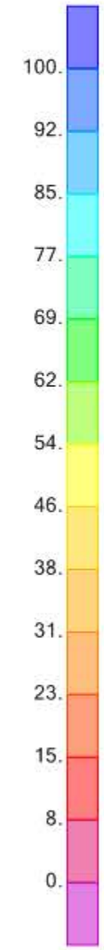
xy xz yz

Deformed Shape (DEAD)



Resultant M11 Diagram (MODAL) - Mode 1; Period 0.14254





MIN=-111.083, MAX=154.813, Right Click on any Area Element for detailed diagram

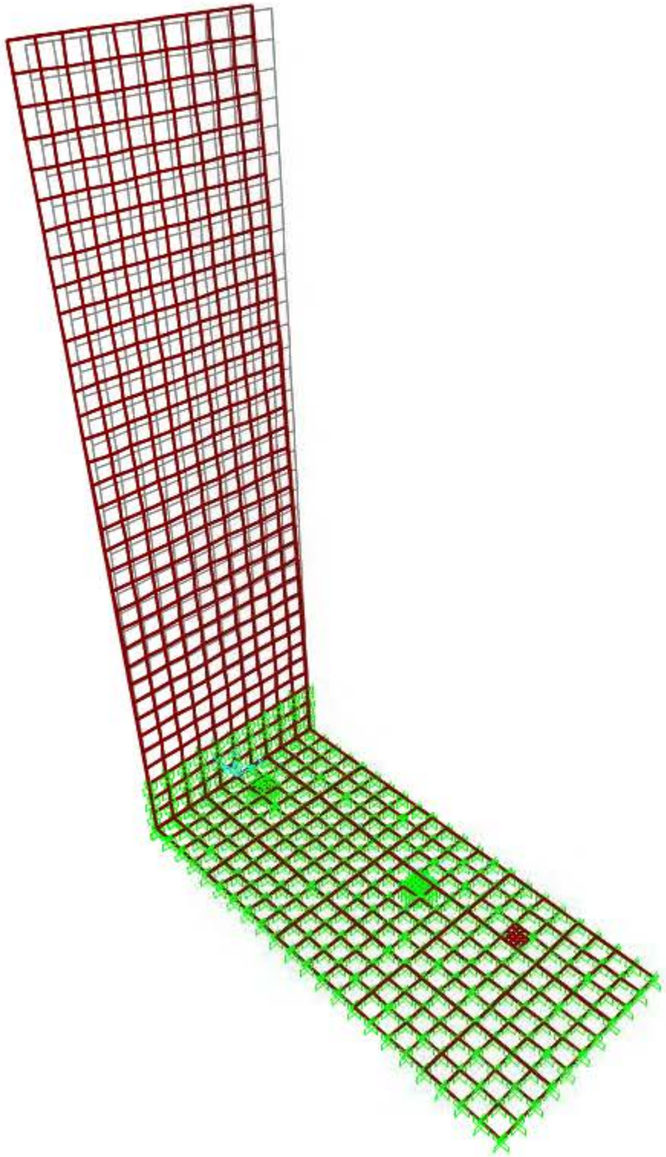
GLOBAL KN, m, C

SAP2000 v17.1.1 Ultimate - sapmodelwall4

File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help

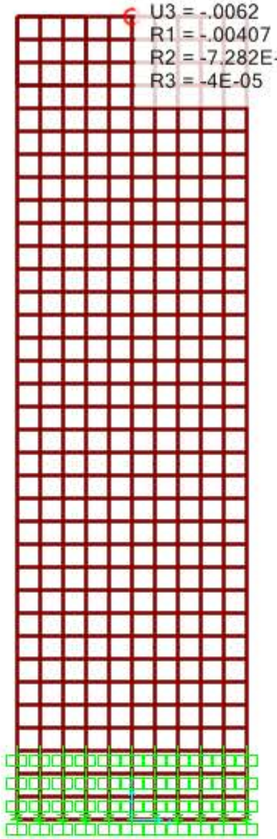
xy xz yz

Deformed Shape (DEAD)



Deformed Shape (COMB1)

U2 = 10.8179
U3 = -.0062
R1 = -.00407
R2 = -7.282E-07
R3 = -4E-05



Right Click on any joint for displacement values

Start Animation

GLOBAL

KN, mm, C

APPENDIX B: Water Main Design

WATERMAIN CALCULATIONS

FROM CITY OF SURREY DESIGN CRITERIA MANUAL:

PER CAPITA DEMAND

AVERAGE DAY WATER DEMAND / PERSON	A = 500 L/d
MAXIMUM DAY WATER DEMAND / PERSON	D = 1000 L/d
PEAK DAY WATER DEMAND / PERSON	H = 2000 L/d

C = 100 FOR MAIN < 200mm Ø C = 125 FOR MAIN > 250mm Ø

MINIMUM HYDRAULIC HEAD @ NODE = 28m

Q_{DESIGN} = GREATER OF D + F OR H WITH F = 60 L/S

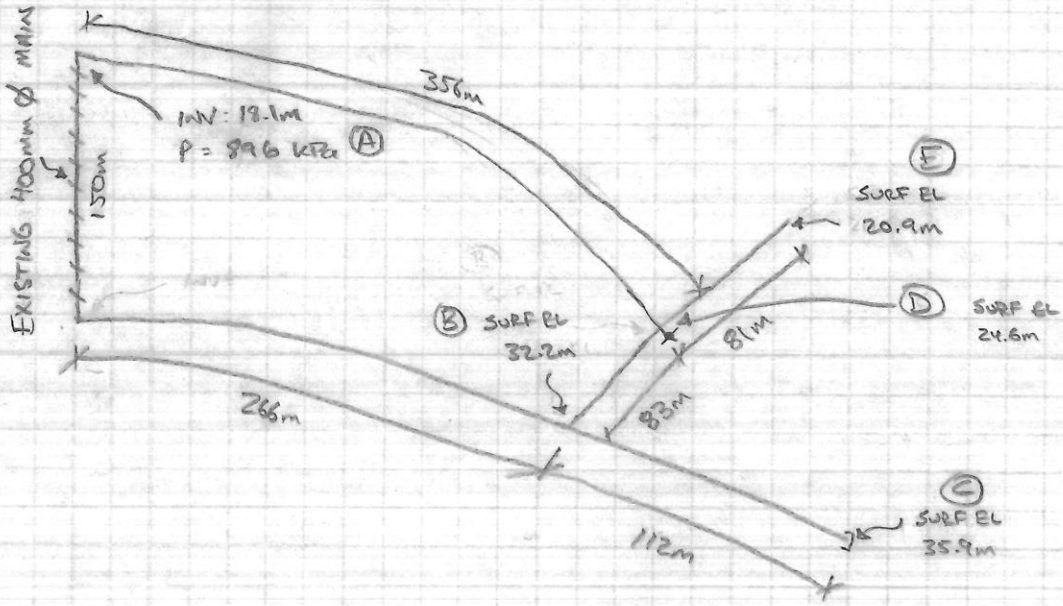
MINIMUM WATER MAIN Ø: 200mm DENSITY = 3.4 PERSONS / DWELLING

DEPTH OF PIPE = 1m to 1.5m SLOPE: 0.1% TO 10%

⇒ GATE VALVES & FIRE HYDRATENTS REQUIRED EVERY 200m

WATER MAIN HORIZONTAL LAYOUT

* USE CLEAR COVER OF 1m TO THE TOP OF PIPE



EXISTING ELEVATIONS AND PRESSURES GIVEN BY URBAN SYSTEMS

TOTAL NUMBER OF LOTS IN SUBDIVISION: 65

Q_{DESIGN} = 2000 L/d × 65 LOTS × 3.4 PERSONS/DWELLING = 5.18 L/S [H]

OR

Q_{DESIGN} = 1000 L/d × 65 LOTS × 3.4 PERSONS/DWELLING = 2.56 L/S [D]

+ 60 L/S [F]

62.6 L/S

D+F > H ∴ Q_{DESIGN} = 62.6 L/S

TRY 200mm Ø DUCTILE IRON PIPE

EQUIVALENT LENGTH OF EXISTING PIPE

HAZEN-WILLIAMS EQUATION $Q = 0.28 C D^{2.63} \left(\frac{h_L}{L}\right)^{0.54}$

EXISTING: $Q = 0.28\,(125)\,(0.4m)^{2.63} \left(\frac{h_L}{150m}\right)^{0.54}$

EQUIVALENT 200mm Ø: $Q = 0.28\,(100)\,(0.2m)^{2.63} \left(\frac{h_L}{L_e}\right)^{0.54}$

SOLVING FOR EQUIVALENT LENGTH YIELDS: L_e = 3.4m

⇒ CHECK POINT (B) FROM POINT (A)

CCW DIRECTION LENGTH = 3.4m + 266m = 269.4m

CW DIRECTION LENGTH = 356m + 83m = 439m

USING HAZEN-WILLIAMS EQUATION

$Q_{CCW} = 0.28 C D^{2.63} \left(\frac{h_L}{269.4m}\right)^{0.54}$ ⇒ $\frac{Q_{CCW}}{Q_{CW}} = \left(\frac{439m}{269.4m}\right)^{0.54} = 1.30$

$Q_{CW} = 0.28 C D^{2.63} \left(\frac{h_L}{439m}\right)^{0.54}$

⇒ $Q_{CCW} = 1.30\,Q_{CW}$ AND $Q_{CCW} + Q_{CW} = 62.6$ L/S

⇒ SOLVING YIELDS Q_{CCW} = 24.1 L/S Q_{CW} = 38.5 L/S

∴ $Q_{CW} = 24.1 \times 10^{-3}\ m^3/s = 0.28\,(100)(0.2m)^{2.63} \left(\frac{h_L}{439m}\right)^{0.54}$

⇒ h_L = 2.4m FROM (A) TO (B)

WATERMAIN CALCULATIONS

@ POINT (B) EXISTING SURFACE ELEVATION = 32.2m

$\Rightarrow$ INVERT ELEVATION = 32.2m − 1m (COVER) − 0.2m (PIPE DIAMETER) − 0.1m (WALL THICKNESS) = 30.9m

→ CHECK PRESSURE USING BERNOULLI'S EQUATION

$$\frac{P_1}{\gamma} + Z_1 + \frac{V_1^2}{2g} = \frac{P_2}{\gamma} + Z_2 + \frac{V_2^2}{2g} + h_L$$

$$\frac{896\ kPa}{9.81\ kN/m^3} + 18.1m = \frac{P_2}{\gamma} + 30.9m + 2.4m$$

$$\frac{P_2}{\gamma} = 76.1m > 28m \Rightarrow \text{SUFFICIENT PRESSURE } \surd OK$$

CHECK POINT (C) EL = 35.9m − 1m − 0.2m − 0.1m = 34.6m

CHECK USING H BECAUSE NO HYDRANT OFF OF LOOP

$H = 5.18\ L/s$

$\Rightarrow$ FIND HEAD LOSS

$$Q = 5.18\times10^{-3}\ m^3/s = 0.28(100)(0.2m)^{2.63}\left(\frac{h_L}{112m}\right)^{0.54} \Rightarrow h_L = 0.1m$$

→ CHECK PRESSURE USING BERNOULLI'S EQUATION

$$\frac{P_1}{\gamma} + Z_1 + \frac{V_1^2}{2g} = \frac{P_2}{\gamma} + Z_2 + \frac{V_2^2}{2g} + h_L$$

$$76.1m + 30.9m = \frac{P_2}{\gamma} + 34.6m + 0.1m$$

$$\frac{P_2}{\gamma} = 72.3m > 28m \Rightarrow \text{SUFFICIENT PRESSURE } \surd OK$$

→ CHECK POINT (D) FROM (B) EL = 24.6m − 1m − 0.2m − 0.1m = 23.3m

$$\frac{P_1}{\gamma} + Z_1 + \frac{V_1^2}{2g} = \frac{P_2}{\gamma} + Z_2 + \frac{V_2^2}{2g}$$

$$76.1m + 30.9m = \frac{P_2}{\gamma} + 23.3m$$

$$\frac{P_2}{\gamma} = 83.7m > 28m \Rightarrow \text{SUFFICIENT PRESSURE } \surd OK$$

⇒ CHECK POINT (E) FROM POINT (D) EL 20.9m − 1m − 0.2m − 0.1m = 19.6m

$$Q = 5.18 \times 10^{-3} \frac{m^3}{s} = 0.28\,(100)(0.2m)^{2.63}\left(\frac{h_L}{81m}\right)^{0.54}$$

$$h_L = 0$$

$$\frac{P_1}{\gamma} + z_1 + \frac{v_1^2}{2g} = \frac{P_2}{\gamma} + z_2 + \frac{v_2^2}{2g}$$

$$83.7m + 23.3m = \frac{P_2}{\gamma} + 19.6m$$

$$\frac{P_2}{\gamma} = 87.4m > 28m \Rightarrow \text{SUFFICIENT PRESSURE YOK}$$

∴ USE A 200mm ø DUCTILE IRON PIPE FOR WATERMAIN THROUGHOUT THE SUBDIVISION

APPENDIX C: Sanitary Main Design

Sanitary System Calculations

Pipe Roughness Coeffecient: n= 0.013

Design Flow Calculation									Pipe Slope and Flow Capacity Check								Flow Velocity Check				
From	To	Area (Ha.)	Lots Serviced	Population	Peaking Factor	Infiltration Inflow (L/s)	ADWF	Qdesign (L/s)	Invert Upstream (m)	Invert Downstream	Length(m)	Slope (m/m)	Diameter (m)	Qcapacity (L/s)	Q50% Capacity (L/s)	OK?	theta (rad.)	Q(L/s)	Area of Flow (m^2)	Velocity (m/s)	Within Range?
S-6	S-5	1.87	19	76	4.27	0.24	0.31	1.56	33.55	30.55	96.00	0.031	0.2	57.67	28.83	Adequate	1.370	1.558	0.00195	0.799	Adequate
S-5	S-4	2.28	23	92	4.25	0.30	0.37	1.88	30.55	29.50	84.00	0.013	0.2	36.47	18.24	Adequate	1.613	1.880	0.00307	0.613	Adequate
S-4	S-3	2.95	28	112	4.23	0.38	0.45	2.30	29.50	28.50	84.00	0.012	0.2	35.59	17.80	Adequate	1.710	2.300	0.00360	0.640	Adequate
S-3	S-2	3.46	32	128	4.21	0.45	0.52	2.63	28.50	25.90	58.00	0.045	0.2	69.07	34.53	Adequate	1.493	2.633	0.00248	1.061	Adequate
S-2	S-11	3.75	35	140	4.20	0.49	0.57	2.87	25.84	23.71	76.00	0.028	0.2	54.61	27.31	Adequate	1.621	2.869	0.00311	0.923	Adequate
S-11	S-10	4.07	38	152	4.19	0.53	0.62	3.11	20.86	15.30	75.00	0.074	0.2	88.82	44.41	Adequate	1.461	3.107	0.00234	1.329	Adequate
S-12	S-7	0.43	4	16	4.39	0.06	0.06	0.34	28.71	23.52	50.00	0.104	0.2	105.10	52.55	Adequate	0.821	0.341	0.00045	0.765	Adequate
S-7	S-8	1.31	13	52	4.31	0.17	0.21	1.08	23.32	17.27	122.00	0.050	0.2	72.64	36.32	Adequate	1.182	1.077	0.00128	0.840	Adequate
S-13	S-14	0.72	8	32	4.35	0.09	0.13	0.66	22.14	18.92	63.80	0.050	0.2	73.29	36.64	Adequate	1.046	0.657	0.00090	0.727	Adequate
S-14	S-15	0.89	9	36	4.34	0.12	0.15	0.75	18.86	17.47	53.00	0.026	0.2	52.83	26.41	Adequate	1.169	0.749	0.00124	0.602	Adequate
S-15	S-16	0.94	9	36	4.34	0.12	0.15	0.76	17.44	16.38	41.00	0.026	0.2	52.45	26.23	Adequate	1.174	0.756	0.00126	0.601	Adequate
S-16	S-17	0.97	9	36	4.34	0.13	0.15	0.76	16.35	15.53	31.00	0.026	0.2	53.05	26.53	Adequate	1.172	0.759	0.00125	0.607	Adequate
S-17	S-8	1.06	9	36	4.34	0.14	0.15	0.77	15.47	14.00	58.00	0.025	0.2	51.93	25.97	Adequate	1.182	0.771	0.00128	0.600	Adequate
S-8	S-9	3.13	29	116	4.23	0.41	0.47	2.39	13.94	13.00	95.00	0.010	0.2	32.45	16.22	Adequate	1.769	2.391	0.00394	0.606	Adequate
S-18	S-10	0.19	2	8	4.42	0.02	0.03	0.17	17.01	14.00	28.00	0.108	0.2	106.96	53.48	Adequate	0.692	0.168	0.00027	0.625	Adequate
S-10	S-9	5.28	51	204	4.14	0.68	0.83	4.11	14.00	13.00	99.00	0.010	0.2	32.79	16.39	Adequate	2.041	4.110	0.00574	0.715	Adequate
S-9	Pump Station	8.41	80	320	4.07	1.09	1.30	6.36	12.94	12.50	13.00	0.034	0.2	60.01	30.01	Adequate	1.949	6.360	0.00510	1.248	Adequate

Existing Main Capacity Check:

From	To	Area (Ha.)	Lots Serviced	Population	Peaking Factor	Infiltration Inflow (L/s)	ADWF	Qdesign (L/s)	Invert Upstream (m)	Invert Downstream	Length(m)	Slope (m/m)	Diameter (m)	Qcapacity (L/s)	Q50% Capacity (L/s)	OK?	theta (rad.)	Q(L/s)	Area of Flow (m^2)	Velocity (m/s)	Within Range?
Existing Pipe		52.6	N / A	2000	3.59	6.82	8.10	60.87	N / A	N / A	N / A	0.03	0.3	166.58	83.29	Adequate	2.808	60.870	0.02790	2.181	Adequate

(with 25 L/s from pump station added)

APPENDIX D: Pump Station Design

Pump Station Design Calculations

Wet Well Dimensions (Circular-Type)	
Wet Well Diameter:	2 m
Area of Wet Well:	3.14 m^2
Wet Well Depth:	3 m
Wet Well Storage:	9.42 m^3
Storage Required:	28 m^3 (6 hrs. at ADWF)

Will be provided for in emergency storage chamber.

Water Level Estimation	
Existing Sanitary Invert Elevation:	17.5 m
Low Water Level:	12.62 m (minimum of 0.6D above invert of pipe)
High Water Level (Avg. Flow. for 10 mins.):	13.83 m
High Water Level (Peak Flow. for 10 mins.):	12.87 m
Assumed Pump Elevation (at invert of inlet):	12.5 m

Force Main Design	
Notes:	
max v=1.8 m/s, min. = 0.6 m/s, peak daily velocity of 1.1 m/s is desirable	
Pump On Time (Preliminary):	1 min.
Pump Cycle Period:	10 min.
Qmax (pumped) for 1 min.:	63.62 L/s
Qavg. (pumped) for 1 min.:	12.96 L/s
Prelim. Diameter (mm)	200 mm
Area of force main:	0.0314 m^2
vmax=	2.02 m/s
vavg=	0.41 m/s
Qdesign=	25.00 L/s
vdesign=	0.80 m/s
Length=	155.00 m
C(worst-case = 120)	120.00
C(best-case =145)	145.00
hL at Qdesign (in force main only):	0.63 m
Worst Case Static Head =	4.88 m
Best Case Static Head =	3.67 m

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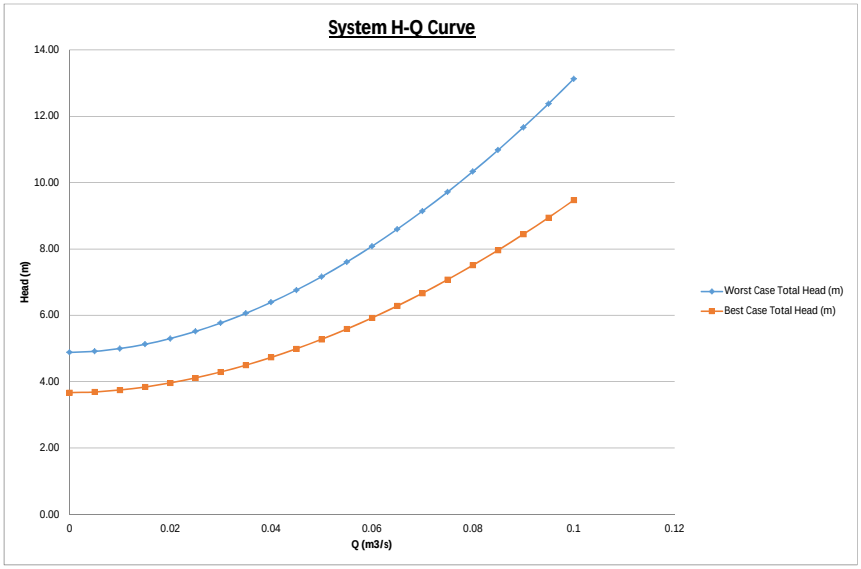
System Curve Graph Data		
Q (m^3/s)	Worst Case Total Head (m)	Best Case Total Head (m)
0	4.88	3.67
0.005	4.91	3.69
0.01	5.00	3.75
0.015	5.13	3.84
0.02	5.30	3.96
0.025	5.51	4.11
0.03	5.77	4.29
0.035	6.06	4.50
0.04	6.39	4.73
0.045	6.76	4.99
0.05	7.16	5.27
0.055	7.60	5.58
0.06	8.08	5.92
0.065	8.59	6.28
0.07	9.14	6.66
0.075	9.72	7.07
0.08	10.33	7.51
0.085	10.98	7.96
0.09	11.66	8.44
0.095	12.38	8.95
0.1	13.12	9.47



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Pump Selected: NP 3102 MT 3~ 465

Pumps running /System	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
1	60 Hz	25.4 l/s	6.04 m	2.28 kW	25.4 l/s	6.04 m	2.28 kW	66 %	0.029 kWh/m³	2.87 m
1	55 Hz	18.9 l/s	5.52 m	1.58 kW	18.9 l/s	5.52 m	1.58 kW	64.8 %	0.0275 kWh/m³	2.42 m
1	50 Hz	13.4 l/s	5.2 m	1.13 kW	13.4 l/s	5.2 m	1.13 kW	60.1 %	0.0289 kWh/m³	2.07 m
1	45 Hz	7.25 l/s	4.97 m	0.762 kW	7.25 l/s	4.97 m	0.762 kW	46.4 %	0.0384 kWh/m³	1.87 m
1	40 Hz	0.0276 l/s	4.88 m	0.453 kW	0.0276 l/s	4.88 m	0.453 kW	0.291 %	6.83 kWh/m³	

Estimate of Energy Requirements Based on Manufacturer Supplied Data (See above table)
Notes:
Head includes force main local losses within pump station.

Q (m^3/s)	Head (m)	Approx. Duration of Flow (s)	Shaft Power (kW)	Energy (kWh)
0.025	6.06	72.7	2.28	0.039
0.019	5.55	60.3	1.58	0.023
0.013	5.23	219.4	1.13	0.058
0.007	4.99		0.762	
	Totals:	352.4		0.119

Energy per day (kWh)=	17.182
Energy cost per day.=	$ 1.74
Energy cost per year=	**$ 634.66**

NPSH Available Calculation	
Ha=	10.47 m
Hz=	0.37 m
Hf=	0.00 m
Hvp=	0.23 m
NPSH available=	10.60 m
NPSH req'd=	2.87 m
Safety Margin=	3.00 m

Local Loss Calculation	
ζ =	1.06
v=	3.18 m/s
hL_L=	0.55 m
(Good assumption to add 0.5 of additional hL to pump curve)	

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APPENDIX E: Storm Sewer Summary Calculations

Summary Calculations of the Rational Method & Manning's Equation

Peak Flow Design									Sewer Design						
Manhole		Area (ha)	Runoff Coefficient	C*A (ha)	Total C*A (ha)	Time of Concentration (min)	Rainfall Intensity (mm/hr)	Peak Flow (m^3/s)	Slope (m/m)	Manning's Coefficient	Diameter Required (m)	Diameter Used (m)	Velocity (m/s)	Pipe Length (m)	Incr. Travel Time to Downstream Manhole (min)
From	To														
D1	D2	0.370	0.6	0.222	0.222	10.23	52.8	0.033	0.0239	0.013	0.169	0.375	2.45	132.05	0.897
D2	D3	0.982	0.6	0.589	0.811	11.13	35.6	0.080	0.0358	0.013	0.220	0.375	3.00	132.06	0.733
D3	D4	0.479	0.6	0.287	1.099	11.86	34.5	0.105	0.0078	0.013	0.324	0.375	1.40	60.25	0.716
D4	D5	0.308	0.6	0.185	1.283	12.58	33.5	0.119	0.0353	0.013	0.256	0.375	2.98	70.65	0.395
D5	D6	0.197	0.6	0.118	1.402	12.97	33.0	0.128	0.0337	0.013	0.266	0.375	2.91	82.02	0.469
D6	D7	1.360	0.6	0.816	2.218	13.44	32.4	0.200	0.0297	0.013	0.321	0.375	2.74	94.53	0.576
D7	Pond				4.127	14.02	31.7	0.364	0.0199	0.013	0.433	0.500	2.71	30.64	
D8	D9	0.531	0.6	0.319	0.319	10.00	37.5	0.033	0.0824	0.013	0.135	0.200	3.00	38.23	0.213
D9	D10	0.604	0.6	0.362	0.681	10.21	37.1	0.070	0.0567	0.013	0.192	0.250	2.88	111.25	0.643
D10	D7	0.952	0.6	0.571	1.910	12.44	33.7	0.179	0.0206	0.013	0.330	0.375	2.28	111.35	0.815
D11	D12	0.734	0.6	0.440	0.440	10.00	37.5	0.046	0.0505	0.013	0.167	0.200	2.35	50.76	0.361
D12	D13				0.440	10.36	36.8	0.045	0.0276	0.013	0.186	0.200	1.73	47.43	0.456
D13	D14	0.242	0.6	0.145	0.586	10.82	36.1	0.059	0.0037	0.013	0.300	0.375	0.97	40.95	0.707
D14	D15	0.06	0.6	0.036	0.622	11.52	35.0	0.060	0.0342	0.013	0.200	0.375	2.94	31.01	0.176
D15	D7	0.06	0.6	0.036	0.658	11.70	34.7	0.063	0.0054	0.013	0.287	0.375	1.17	51.70	0.739

APPENDIX F: Catch Basin Sample Calculations

AMBAD

COMPUTE DESIGN FLOWS FOR INLETS

ASSUME DRAINAGE AREAS OF ROADWAYS & SIDEWALKS ONLY, $C = 0.90$

AS PER CITY OF SURREY GUIDELINES SECTION 5.4.F CATCH BASIN SPACING, MAX DRAINAGE AREA AS FOLLOWS:

$350\ m^2$ ON ROAD GRADES GREATER THAN 3%
$500\ m^2$ ON ROAD GRADES UP TO 3%

ASSUME TIME OF CONCENTRATION = 5 min $\Rightarrow i = 52.8\ mm/hr$

$$Q_1 = \frac{CiA_1}{360} = \frac{(0.9)(52.8)(0.0350)}{360} = \underline{0.00462\ m^3/s}$$

$$Q_2 = \frac{CiA_2}{360} = \frac{(0.9)(52.8)(0.0500)}{360} = \underline{0.00660\ m^3/s}$$

PERFORM GUTTER CAPACITY CHECK

FROM TABLE 5.4(g) OF CITY OF SURREY GUIDELINES, MINIMUM GUTTER FLOW FOR 2.0% CROSSFALL & 0.5% HIGHWAY GRADIENT:

$Q = 0.012\ m^3/s > Q_1 = 0.00462\ m^3/s$

$Q = 0.012\ m^3/s > Q_2 = 0.00660\ m^3/s$

$\therefore$ ADEQUACY OF GUTTERS FOR $350\ m^2$ & $500\ m^2$ AREAS IS SATISFIED

PERFORM CB CAPACITY CHECK

ASSUME DEPTH OF PONDING = ROAD DEPRESSION DEPTH AT CB GRATE = 25mm

$Q = 0.5CA\sqrt{2gh}$

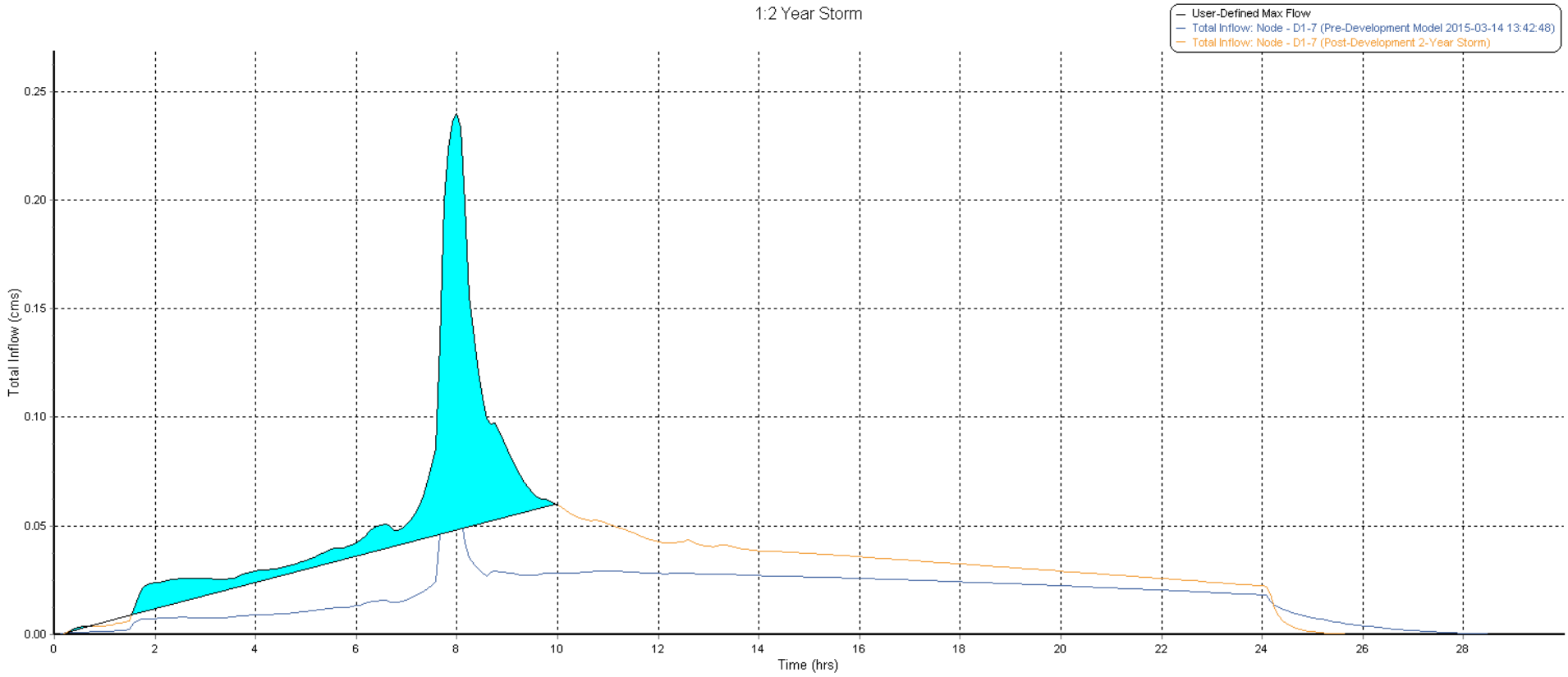
WHERE $C = 0.8$, $A = 0.068\ m^2$ FOR DOMEY B-23 GRATE, $h = 0.025\ m$

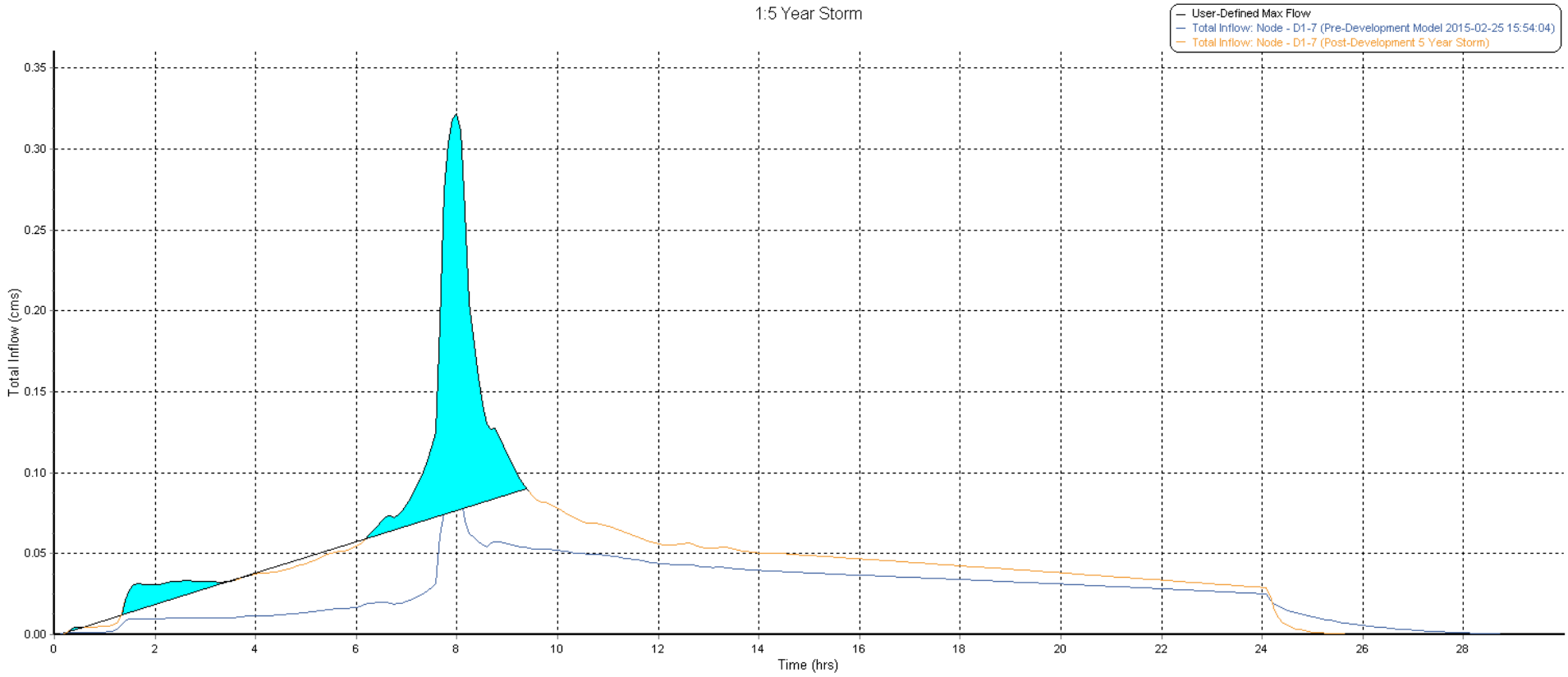
$Q = (0.5)(0.8)(0.068)\sqrt{(2)(9.81)(0.025)}$

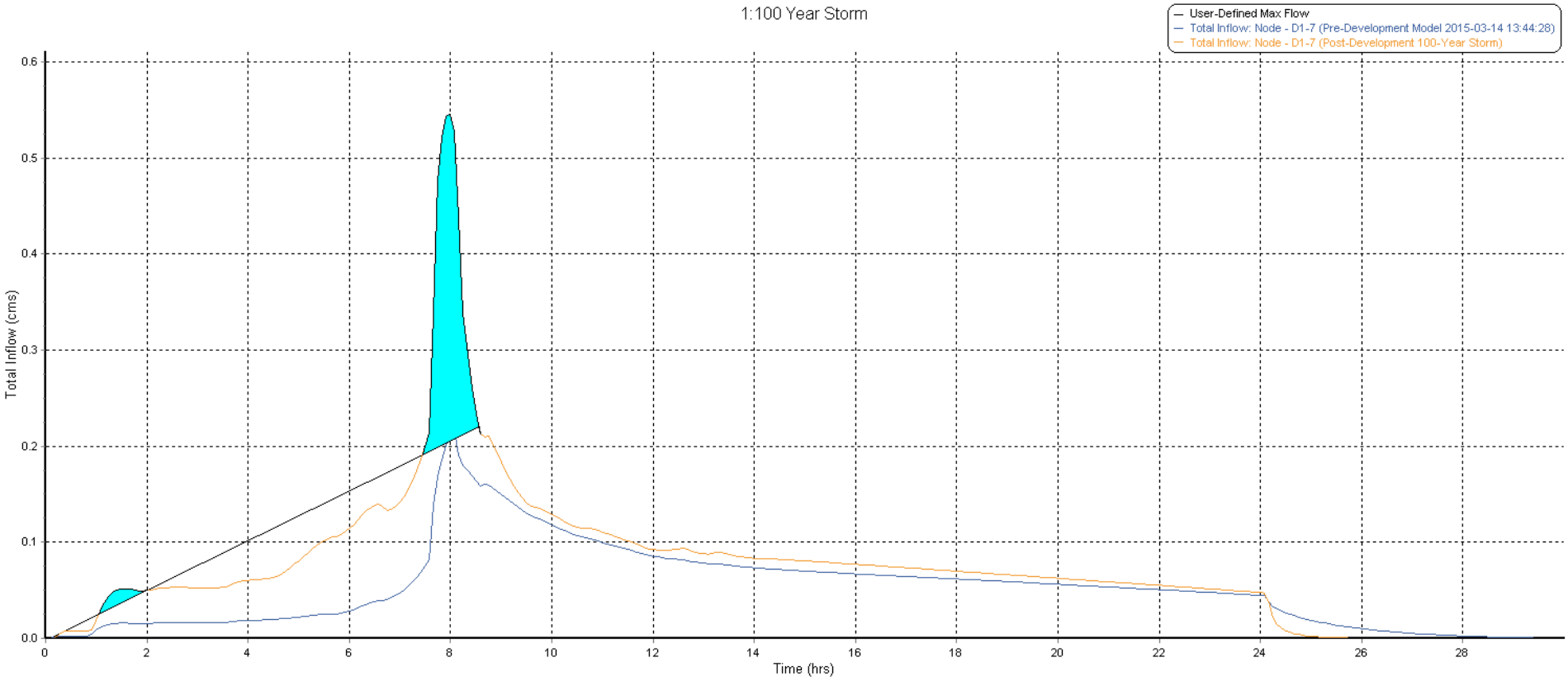
$\Rightarrow Q = 0.0190\ m^3/s > Q_1 = 0.00462\ m^3/s$, $> Q_2 = 0.00660\ m^3/s$

$\therefore$ SPACING OF CB's SHALL BE AT MAX DRAINAGE AREAS WHERE APPROPRIATE

APPENDIX G: Hydrographs

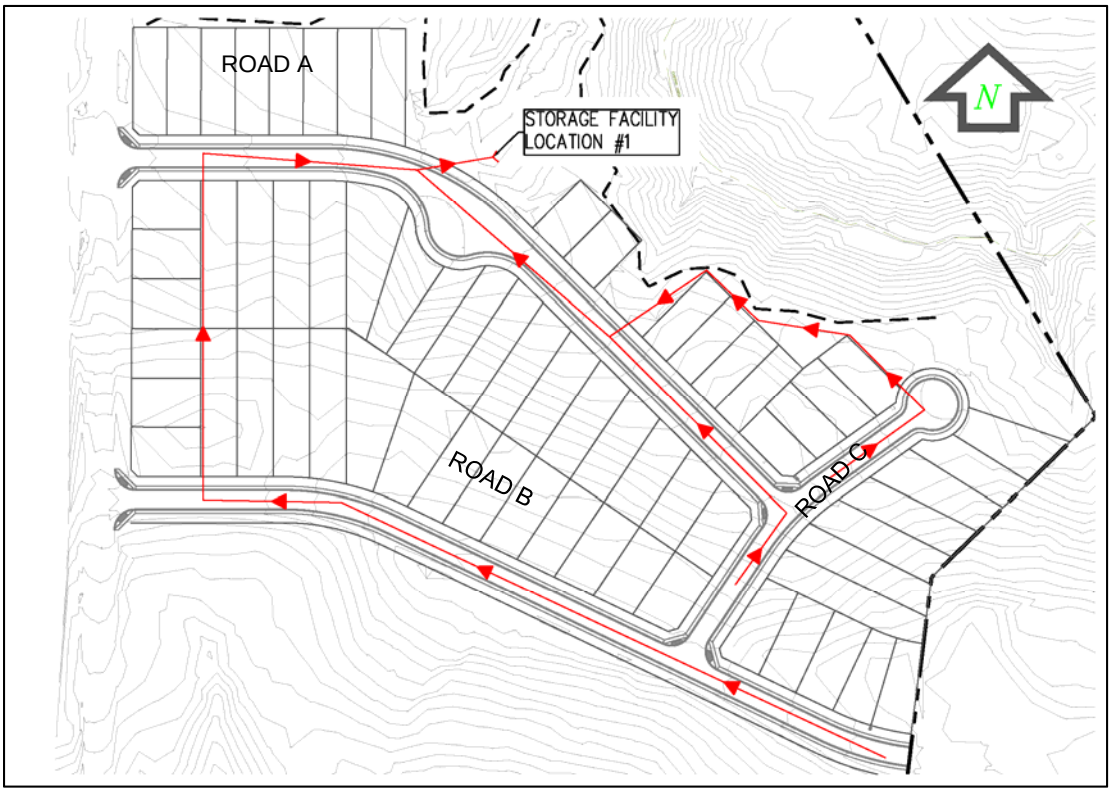

1:2 Year Storm
User-Defined Max Flow
Total Inflow: Node - D1-7 (Pre-Development Model 2015-03-14 13:42:48)
Total Inflow: Node - D1-7 (Post-Development 2-Year Storm)
Total Inflow (cms)
0.25
0.20
0.15
0.10
0.05
0.00
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
Time (hrs)


1:5 Year Storm
User-Defined Max Flow
Total Inflow: Node - D1-7 (Pre-Development Model 2015-02-25 15:54:04)
Total Inflow: Node - D1-7 (Post-Development 5 Year Storm)
Total Inflow (cms)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
Time (hrs)

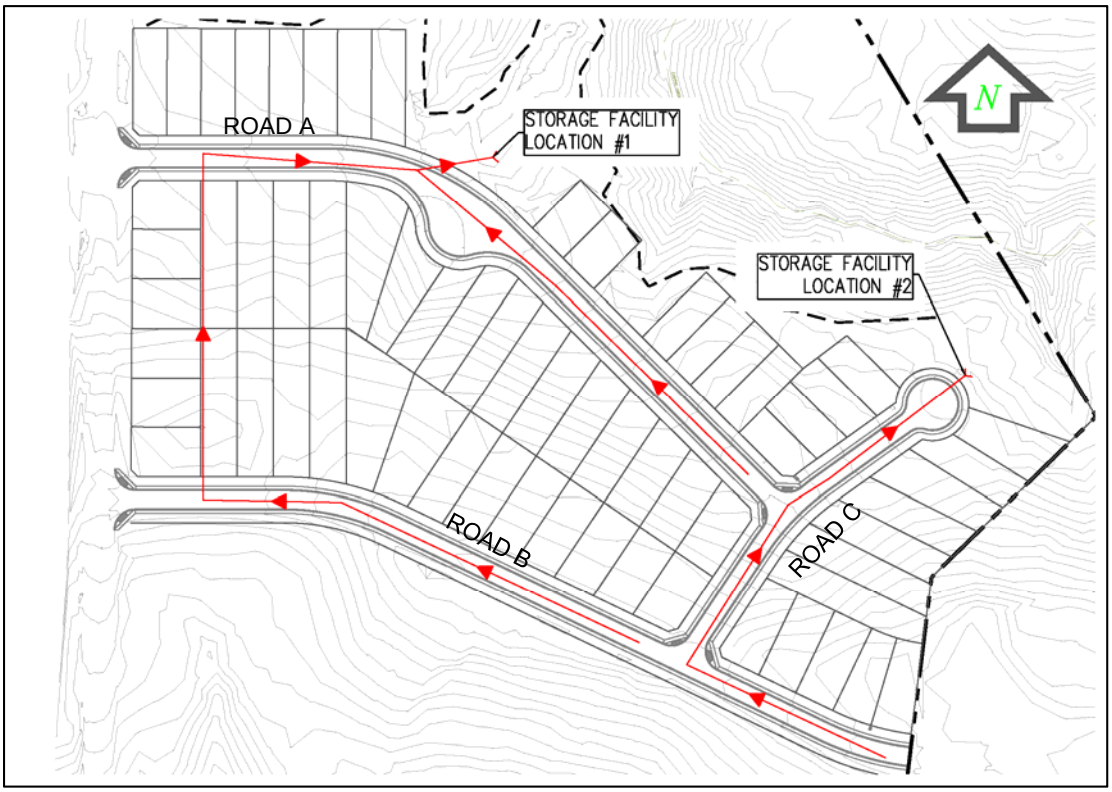

1:100 Year Storm
User-Defined Max Flow
Total Inflow: Node - D1-7 (Pre-Development Model 2015-03-14 13:44:28)
Total Inflow: Node - D1-7 (Post-Development 100-Year Storm)
Total Inflow (cms)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
Time (hrs)

APPENDIX H: Storm Sewer Layout Options

Storm Sewer Option 1:



Storm Sewer Option 2:



APPENDIX I: Pond Data Summary

Pond Data Summary					
LEVEL LOCATION	**SURFACE AREA (m^2)**	**VOLUME (m^3)**	**DEPTH (m)**	**ELEVATION (m)**	**DISCHARGE (m^3/s)**
BOTTOM	265	-	0.00	13.00	-
1:2-YEAR	1470	1490	0.56	13.56	0.081
1:5-YEAR	1633	1869	0.77	13.77	0.095
1:100-YEAR	1780	2212	0.96	13.96	0.106
EMBANKMENT TOP	2197	2226	1.50	14.50	-

TOTAL CATCHMENT AREA: 6.88 Ha

ALLOWABLE 5-YEAR LEVEL OUTFLOW RATE: 0.09 m^3/s
CONTROLLED 5-YEAR LEVEL OUTFLOW RATE: 0.095 m^3/s

NUMBER OF INLETS: 1
SIZE OF INLETS: 525 mm
INLET INVERT ELEVATION: 13.00 m

NUMBER OF OUTLETS: 1
SIZE OF OUTLETS: 225 mm
OUTLET INVERT ELEVATION: 12.50 m

APPENDIX J: Construction Cost Estimate

CAPSTONE SITE SERVICING IN MAPLE RIDGE, BC
West Coast Civil Consultants

ITEM NO.	ITEM	Unit	QTY	Unit Price	PRICE
Section 0.0 General					
0.1	Mobilization & Demobilization	L.S.			50,000.00
0.2	Performance Bond	L.S.			350,000.00
0.3	Labour and Material Bond	L.S.			350,000.00
	Subtotal Section 0.0				**750,000.00**
Section 1.0 Earthworks					
1.1	Siltation/Erosion Control System	L.S.			19,000.00
1.2	Siltation Control Maintenance	L.S.			3,000.00
1.3	Siltation System Clean up	L.S.			1,500.00
	Subtotal Section 1.0				**23,500.00**
Section 2.0 Roadworks					
2.0	Excavation and Dispose (All of Site)	Load	935	240	224,400.00
2.1	Subgrade Preparation	m2	11000	$2.51	27,609.34
2.2	Road Structure (Subbase)	m2	11000	$15.06	165,656.06
2.3	Road Structure (Base)	m2	11000	$8.03	88,349.90
2.4	Asphalt Base Lift Lane/Road	m2	11000	$11.04	121,481.11
2.5	Asphalt Surface Lift Lane/Road	m2	11000	$9.04	99,393.64
2.6	Curb and Gutter	lin.m.	2000	$43.36	86,722.69
2.8	Streetlights	each	18	$5,000.00	90,000.00
2.9	Sidewalk	m2	3000	$14.56	43,688.10
2.10	Boulevard and Street Preparation	m2	9000	$2.01	18,072.29
2.11	Driveway and Road Access Locations	each	66	$714.50	47,157.25
	Subtotal Section 2.0a				**1,012,530.39**
Section 3.0a Water System - Onsite					
3.1	Watermain - 200	lin.m.	1000	$153.45	153,453.77
3.2	Valves -200 mm	each	20	$1,350.00	27,000.00
3.3	Services	each	66	$2,600.00	171,600.00
3.4	Blow-offs	each	2	$600.00	1,200.00
3.5	Tie in to Offsite	each	2	$2,300.00	4,600.00
3.6	Hydrants - Includes all hydrant appurtenances from main	each	6	$5,200.00	31,200.00
3.7	Pressure Reducing Valves	each	2	$2,500.00	5,000.00
	Subtotal Section 3.0a				**394,053.77**
Section 4.0 a Drainage System					
4.1	Storm Sewer Main -200 mm	lin.m.	135	$115.38	15,576.97
4.2	250 mm	lin.m.	111	$174.00	19,314.23
4.3	375 mm	lin.m.	828	$198.79	130,646.37
4.4	500 mm	lin.m.	51	$279.45	14,251.98
4.5	Manholes	ea.	15	$3,600.00	54,000.00
4.6	Services	each	66	$900.00	59,400.00
4.7	Catchbasins including leads	each	28	$1,600.00	44,800.00

4.8	Lawnbasins including leads	each	66	$850.00	56,100.00
4.9	Headwall	each	2	$400.00	800.00
	Subtotal Section 4.0 a				**394,889.54**
Section 5.0a Sanitary System On Site					
5.1	Sanitary Sewer Main - 200mm	lin.m.	1000	$173.33	173,334.13
5.2	Services	each	66	$800.00	52,800.00
5.3	Manholes	each	15	$3,000.00	105,000.00
5.4	Tie in to offsite	each	1	$500.00	500.00
	Subtotal Section 5.0				**331,634.13**
Section 6.0 Provisional Items					
6.1	Sod and Topsoil Boulevards	m2	9000	$12.95	116,574.72
6.3	Street Trees	each	120	$409.90	49,188.12
6.5	Retaining Wall	m2	790	$804.76	635,760.40
	Subtotal Section 6.0				**801,523.24**
Section 7.0	**Additional Items**				
7.1	Pump Station	L.S.			73,000.00
7.2	Detention Pond	L.S.			150,000.00
	Subtotal Section 7.0				**223,000.00**

SUMMARY OF WORKS

0.0	**GENERAL**	**750,000.00**
1.0	**EARTHWORKS**	**23,500.00**
2 b	**ROADWORKS**	**1,012,530.39**
3 b	**WATERWORKS**	**394,053.77**
4b	**DRAINAGE SYSTEM**	**394,889.54**
5b	**SANITARY SYSTEM**	**331,634.13**
6b	**PROVISIONAL ITEMS**	**801,523.24**
7b	**ATTITIONAL ITEMS**	**223,000.00**
	Subtotal	**$3,931,131.07**
	GST (5%)	**$196,556.55**
	GRAND TOTAL	**$4,127,687.63**

APPENDIX K: CLA-VAL PRV Brochure

CLA-VAL®

MODEL **90-01** (Full Internal Port)
690-01 (Reduced Internal Port)

Pressure Reducing Valve

- **Sensitive and Accurate Pressure Control**
- **Easy Adjustment and Maintenance**
- **Tamper Resistant**
- **Optional Check Feature**
- **Fully Supported Frictionless Diaphragm**

The Cla-Val Model 90-01/690-01 Pressure Reducing Valve automatically reduces a higher inlet pressure to a steady lower downstream pressure, regardless of changing flow rate and/or varying inlet pressure. This valve is an accurate, pilot-operated regulator capable of holding downstream pressure to a pre-determined limit. When downstream pressure exceeds the pressure setting of the control pilot, the main valve and pilot valve close drip-tight.

If a check feature is added, and a pressure reversal occurs, the downstream pressure is admitted in the main valve cover chamber, closing the valve to prevent return flow.

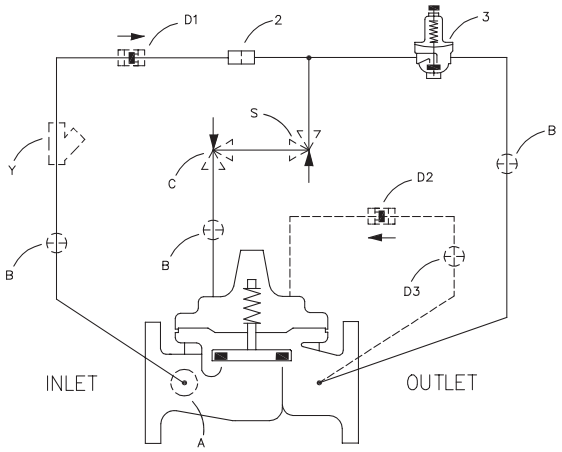
Schematic Diagram

Item	Description
1	Hytrol (Main Valve)
2	X58 Restriction Fitting
3	CRD Pressure Reducing Control

Optional Features

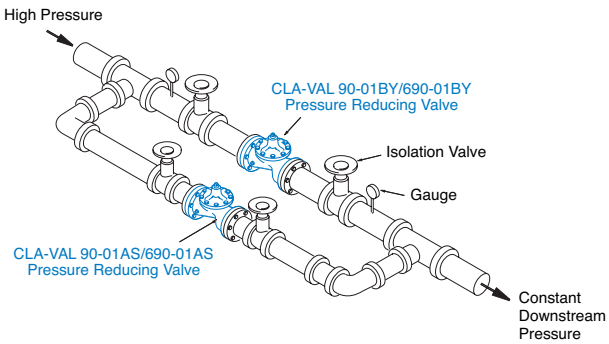
Item	Description
A	X46A Flow Clean Strainer
B	CK2 (Isolation Valve)
C	CV Flow Control (Closing)*
D	Check Valves with Isolation Valve
S	CV Flow Control (Opening)
Y	X43 "Y" Strainer

*The closing speed control (optional) on this valve should always be open at least three (3) turns off its seat.



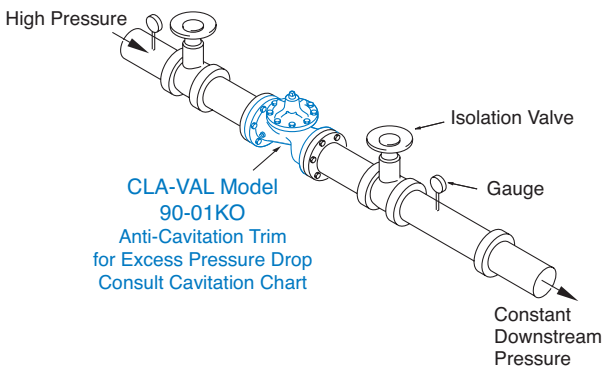
Typical Applications

Typical applications include pressure reducing valve station using Model 90-01BY/690-01BY and Model 90-01AS/690-01AS in parallel to handle wide range of flow rates. Larger Model 90-01BY/690-01BY valve meets requirements of peak loads and smaller Model 90-01AS/690-01AS handles low flows.



Cla-Val Model 90-01KO/690-01KO Pressure Reducing Valve with Anti-Cavitation Trim provides for optimum downstream pressure control while reducing noise and eliminating damage associated with cavitation.

See Cavitation Guide to determine if the valve is a candidate for the KO Anti-Cavitation Trim.



Model 90-01 (Uses Basic Valve Model 100-01)

Pressure Ratings (Recommended Maximum Pressure - psi)

Valve Body & Cover		Pressure Class			
		Flanged			Threaded
Grade	Material	ANSI Standards*	150 lb.	300 lb.	End** Details
ASTM A536	Ductile Iron	B16.42	250	400	400
ASTM A216-WCB	Cast Steel	B16.5	285	400	400
ASTM B62	Bronze	B16.24	225	400	400

Note: * ANSI standards are for flange dimensions only.
Flanged valves are available faced but not drilled.
** End Details machined to ANSI B2.1 specifications.

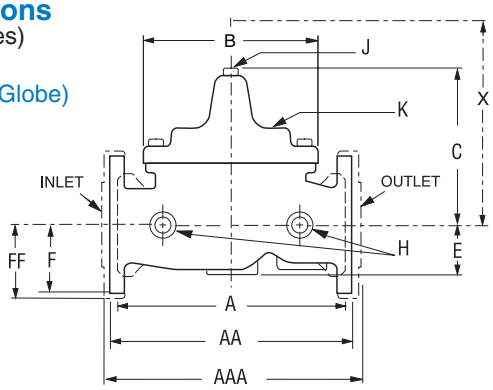
Materials

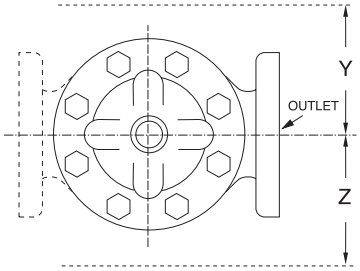
Component	Standard Material Combinations		
Body & Cover	Ductile Iron	Cast Steel	Bronze
Available Sizes	1¼" - 36"	1¼" - 16"	1¼" - 16"
Disc Retainer & Diaphragm Washer	Cast Iron	Cast Steel	Bronze
Trim: Disc Guide, Seat & Cover Bearing	Bronze is Standard Stainless Steel is Optional		
Disc	Buna-N® Rubber		
Diaphragm	Nylon Reinforced Buna-N® Rubber		
Stem, Nut & Spring	Stainless Steel		

For material options not listed, consult factory.
Cla-Val manufactures valves in more than 50 different alloys.

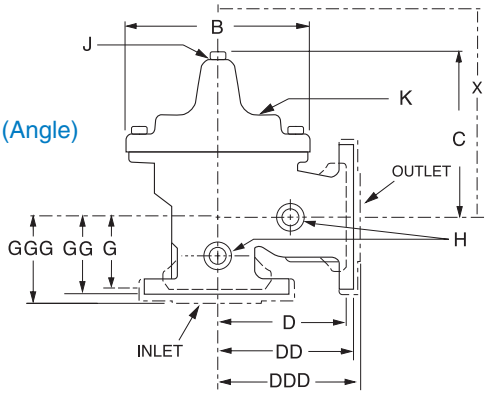
Dimensions
(In inches)

100-01 (Globe)





100-01 (Angle)



Model 90-01 Dimensions (In Inches)

***Consult Factory

Valve Size (Inches)	**1¼-1½**	**2**	**2 ½**	**3**	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**20**	**24**	**30*** **	**36*** **
A Threaded	7.25	9.38	11.00	12.50	—	—	—	—	—	—	—	—	—	—	—
AA 150 ANSI	8.50*	9.38	11.00	12.00	15.00	20.00	25.38	29.75	34.00	39.00	41.38	52.00	61.50	63.00	76.00
AAA 300 ANSI	9.00*	10.00	11.62	13.25	15.62	21.00	26.38	31.12	35.50	40.50	43.50	53.62	63.24	64.50	78.00
B Dia.	5.62	6.62	8.00	9.12	11.50	15.75	20.00	23.62	28.00	32.75	35.50	45.00	53.16	56.00	66.00
C Max.	5.50	6.50	7.56	8.19	10.62	13.38	16.00	17.12	20.88	24.19	25.00	41.90	43.93	54.60	61.50
D Threaded	3.25	4.75	5.50	6.25	—	—	—	—	—	—	—	—	—	—	—
DD 150 ANSI	4.00*	4.75	5.50	6.00	7.50	10.00	12.75	14.88	17.00	19.50	20.81	—	—	—	—
DDD 300 ANSI	4.25*	5.00	5.88	6.38	7.88	10.50	13.25	15.56	17.75	20.25	21.62	—	—	—	—
E	1.12	1.50	1.69	2.06	3.19	4.31	5.31	9.25	10.75	12.62	15.50	15.00	17.75	21.31	24.56
F 150 ANSI	2.50	3.00	3.50	3.75	4.50	5.50	6.75	8.00	9.50	10.50	11.75	16.50	19.25	22.50	25.60
FF 300 ANSI	3.06	3.25	3.75	4.13	5.00	6.25	7.50	8.75	10.25	11.50	12.75	16.50	19.25	24.00	25.60
G Threaded	1.88	3.25	4.00	4.50	—	—	—	—	—	—	—	—	—	—	—
GG 150 ANSI	4.00*	3.25	4.00	4.00	5.00	6.00	8.00	8.62	13.75	14.88	15.69	—	—	—	—
GGG 300 ANSI	4.25*	3.50	4.31	4.38	5.31	6.50	8.50	9.31	14.50	15.62	16.50	—	—	—	—
H NPT Body Tapping	⅜	⅜	½	½	¾	¾	1	1	1	1	1	1	1	2	2
J NPT Cover Center Plug	¼	½	½	½	¾	¾	1	1	1¼	1½	2	1½	1½	2	2
K NPT Cover Tapping	⅜	⅜	½	½	¾	¾	1	1	1	1	1	1	1	2	2
Valve Stem Internal Thread UNF	10-32	10-32	10-32	¼-28	¼-28	⅜-24	⅜-24	⅜-24	⅜-24	⅜-24	½-20	¾-16	¾-16	¾-16	¾-16
Stem Travel	0.4	0.6	0.7	0.8	1.1	1.7	2.3	2.8	3.4	4.0	4.5	5.63	6.75	7.5	8.5
Approx. Ship Wt. Lbs.	15	35	50	70	140	285	500	780	1165	1600	2265	3900	6200	7703	11720
X Pilot System	11.00	13.00	14.00	15.00	17.00	29.00	31.00	33.00	36.00	40.00	40.00	47.00	68.00	79.00	85.00
Y Pilot System	9.00	9.00	10.00	11.00	12.00	20.00	22.00	24.00	26.00	29.00	30.00	34.00	39.00	40.00	45.00
Z Pilot System	9.00	9.00	10.00	11.00	12.00	20.00	22.00	24.00	26.00	29.00	30.00	34.00	39.00	42.00	47.00

*1½" Size Only

Note: The top two flange holes on valve size 36 are threaded to 1 1/2"-6 UNC.

Model 690-01 (Uses Basic Valve Model 100-20)

Pressure Ratings (Recommended Maximum Pressure - psi)

Valve Body & Cover		Pressure Class		
		Flanged		
Grade	Material	ANSI Standards*	150 lb.	300 lb.
ASTM A536	Ductile Iron	B16.42	250	400
ASTM A216-WCB	Cast Steel	B16.5	285	400
ASTM B62	Bronze	B16.24	225	400

Note: *ANSI standards are for flange dimensions only.
Flanged valves are available faced but not drilled.

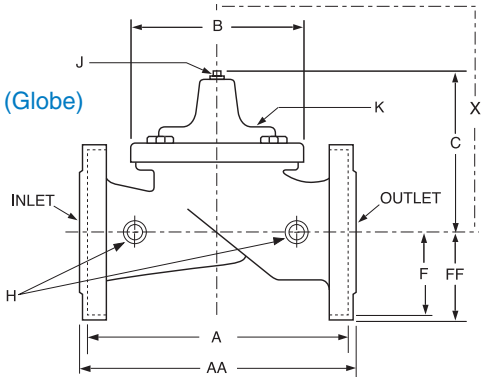
Materials

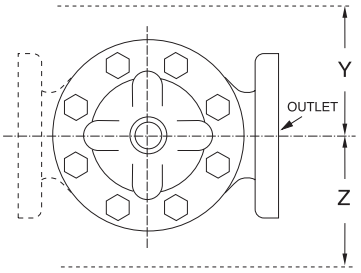
Component	Standard Material Combinations		
Body & Cover	Ductile Iron	Cast Steel	Bronze
Available Sizes	3" - 48"	3" - 16"	3" - 16"
Disc Retainer & Diaphragm Washer	Cast Iron	Cast Steel	Bronze
Trim: Disc Guide, Seat & Cover Bearing	Bronze is Standard Stainless Steel is Optional		
Disc	Buna-N® Rubber		
Diaphragm	Nylon Reinforced Buna-N® Rubber		
Stem, Nut & Spring	Stainless Steel		

For material options not listed, consult factory.
Cla-Val manufactures valves in more than 50 different alloys.

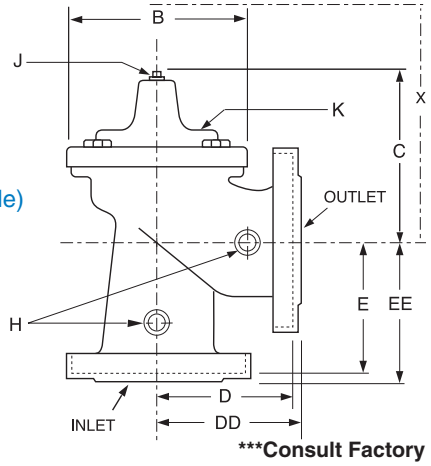
Dimensions
(In inches)

100-20 (Globe)





100-20 (Angle)



***Consult Factory

Model 690-01 Dimensions (In Inches)

Valve Size (Inches)	**3**	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**24**	**30**	**36*** **	**42*** **	**48*** **
A 150 ANSI	10.25	13.88	17.75	21.38	26.00	30.00	34.25	35.00	42.12	48.00	48.00	63.25	65.00	76.00	94.50
AA 300 ANSI	11.00	14.50	18.62	22.38	27.38	31.50	—	36.62	43.63	49.62	49.75	63.75	67.00	76.00	94.50
B Dia.	6.62	9.12	11.50	15.75	20.00	23.62	24.47	28.00	35.44	35.44	35.44	53.19	56.00	66.00	66.00
C Max.	7.00	8.62	11.62	15.00	17.88	21.00	20.88	25.75	25.00	31.50	31.50	43.94	54.60	61.50	61.50
D 150 ANSI	—	6.94	8.88	10.69	—	—	—	—	—	—	—	—	—	—	—
DD 300 ANSI	—	7.25	9.38	11.19	—	—	—	—	—	—	—	—	—	—	—
E 150 ANSI	—	5.50	6.75	7.25	—	—	—	—	—	—	—	—	—	—	—
EE 300 ANSI	—	5.81	7.25	7.75	—	—	—	—	—	—	—	—	—	—	—
F 150 ANSI	3.75	4.50	5.50	6.75	8.00	9.50	11.00	11.75	15.88	14.56	17.00	19.88	25.50	28.00	31.50
FF 300 ANSI	4.12	5.00	6.25	7.50	8.75	10.25	—	12.75	15.88	16.06	19.00	22.00	27.50	28.00	31.50
H NPT Body Tapping	⅜	½	¾	¾	1	1	1	1	1	1	1	1	2	2	2
J NPT Cover Center Plug	½	½	¾	¾	1	1	1 ¼	1 ¼	2	2	2	2	2	2	2
K NPT Cover Tapping	⅜	½	¾	¾	1	1	1	1	1	1	1	1	2	2	2
Valve Stem Internal Thread UNF	10-32	¼-28	¼-28	⅜-24	⅜-24	⅜-24	⅜-24	⅜-24	½-20	½-20	½-20	¾-16	¾-16	M20	M20
Stem Travel	0.6	0.8	1.1	1.7	2.3	2.8	3.4	3.4	3.4	4.5	4.5	6.5	7.5	8.5	8.5
Approx. Ship Wt. Lbs.	45	85	195	330	625	900	1250	1380	1500	2551	2733	6500	8545	12450	13100
X Pilot System	13.00	15.00	27.00	30.00	33.00	36.00	36.00	41.00	40.00	46.00	55.00	68.00	79.00	85.00	86.00
Y Pilot System	10.00	11.00	18.00	20.00	22.00	24.00	26.00	26.00	30.00	30.00	30.00	39.00	40.00	45.00	47.00
Z Pilot System	10.00	11.00	18.00	20.00	22.00	24.00	26.00	26.00	30.00	30.00	30.00	39.00	42.00	47.00	49.00

Note: The top two flange holes on valve sizes 36 thru 48 are threaded to 1 1/2"-6 UNC.

Valve Selection

			These Symbols and Indicate Available Sizes																		
		Inches	1¼	1½	2	2½	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48
		mm	32	40	50	65	80	100	150	200	250	300	350	400	450	500	600	750	900	1000	1200
		End Detail	Threaded	Threaded & Flanged				Flanged													
Model 90-01	Basic Valve 100-01	Globe	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		
		Angle	●	●	●	●	●	●	●	●	●	●	●	●							
	Suggested Flow (gpm)	Max. Continuous	93	125	210	300	460	800	1800	3100	4900	7000	8400	11000		17000	25000	42000	50000		
		Max. Intermittent	120	160	260	370	580	990	2250	3900	6150	8720	10540	13700		21700	31300	48000	62500		
		Min. Continuous	10	10	15	20	30	50	115	200	300	400	500	650		900	1750	2100	2900		
	Suggested Flow (Liters/Sec)	Max. Continuous	6	8	13	19	29	50	113	195	309	442	530	694		1073	1577	2650	3150		
		Max. Intermittent	7.6	10	16	23	37	62	142	246	387	549	664	863		1369	1972	3028	3940		
		Min. Continuous	.6	.6	.9	1.3	1.9	3.2	7.2	13	19	25	32	41		57	110	132	180		
																				Contact Factory for Sizes not Shown	
Model 690-01	Basic Valve 100-20	Globe					●**	●	●	●	●	●	●	●	●	●	●	●	●	●	●
		Angle						●	●	●											
	Suggested Flow (gpm)	Max. Continuous					260	580	1025	2300	4100	6400	9230	9230	16500	16500	16500	28000	33500	33500	33500
		Min. Continuous					15	30	50	115	200	300	500	500	900	900	900	1850	2100	3860	5465
	Suggested Flow (Liters/Sec)	Max. Continuous					16	37	65	145	258	403	581	581	1040	1040	1040	1764	2115	2115	2115
		Min. Continuous					.9	1.9	3.2	7.2	13	19	32	32	57	57	57	117	132	244	345

**Flanged End Detail Only

690-01 is the reduced internal port size version of the 90-01.

For 100-01 basic valves, suggested flow calculations were based on flow through Schedule 40 Pipe. Maximum continuous flow is approx. 20 ft/sec (6.1 meters/sec) & maximum intermittent is approx. 25 ft/sec (7.6 meters/sec) and minimum continuous flow is approx. 1 ft/sec (.3 meters/sec). For 100-20 basic valves, suggested flow calculations were based on flow through the valve seat. Approx. 26 ft/sec (7.9 meters/sec) was used for maximum continuous flow & 1 ft/sec (.3 meters/sec) is used for minimum continuous flow. Maximum continuous flow through the valve seat for the 30" 100-20 is approx. 20 ft/sec (6.1 meters/sec). Maximum continuous flow through the valve seat for the 36", 42", 48" 100-20 is approx. 15.8 ft/sec. (4.8 meters/sec).

Many factors should be considered in sizing pressure reducing valves including inlet pressure, outlet pressure and flow rates. For sizing questions or cavitation analysis, consult Cla-Val with system details.

Pilot System Specifications

Adjustment Ranges

2	to	30 psi
15	to	75 psi
20	to	105 psi
30	to	300 psi*

*Supplied unless otherwise specified
Other ranges available, please consult factory

Temperature Range

Water: to 180°F

Materials

Standard Pilot System Materials

Pilot Control: Bronze ASTM B62
Trim: Stainless Steel Type 303
Rubber: Buna-N® Synthetic Rubber

Optional Pilot System Materials

Pilot Systems are available with optional Aluminum, Stainless Steel or Monel materials at additional cost.

Note: Available with remote sensing control.

When Ordering, Please Specify

1. Catalog No. 90-01 or No. 690-01
2. Valve Size
3. Pattern - Globe or Angle
4. Pressure Class
5. Threaded or Flanged
6. Trim Material
7. Adjustment Range
8. Desired Options
9. When Vertically Installed

CLA-VAL®

CLA-VAL
PO Box 1325 Newport Beach CA 92659-0325
Phone: 949-722-4800 • Fax: 949-548-5441

CLA-VAL CANADA
4687 Christie Drive
Beamsville, Ontario
Canada L0R 1B4
Phone: 905-563-4963
Fax: 905-563-4040

CLA-VAL EUROPE
Chemin dés Mesanges 1
CH-1032 Romanel/
Lausanne, Switzerland
Phone: 41-21-643-15-55
Fax: 41-21-643-15-50

www.cla-val.com

E-90-01/690-01 (R-8/09)

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Specifications subject to change without notice.

Represented By:

APPENDIX L: Surficial Geological Map of Lower Mainland

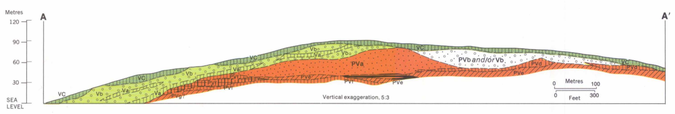
GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES

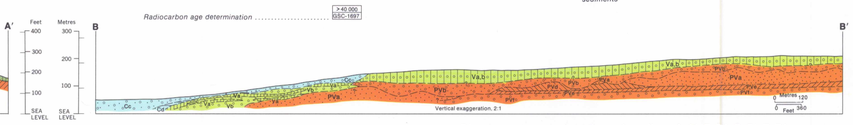
LEGEND

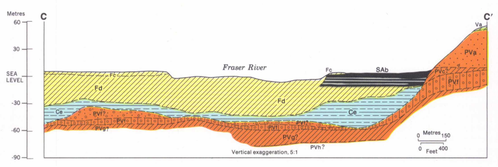
For detailed lithology of cross-sections, see table of lithologic units on reverse

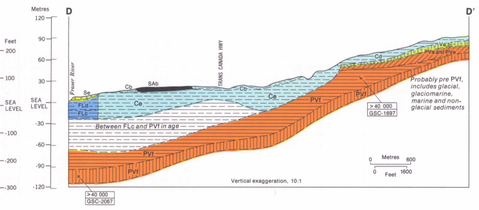
Glacial sediments | Glacial and glacio-fluvial sediments | Glaciofluvial sediments; mainly gravel | Glaciofluvial sediments | Glaciofluvial sediments; mainly sand | Glaciofluvial and glacio-marine sediments | Marine sediments; offshore beach and intertidal | Glaciomarine and/or marine sediments | Glaciomarine sediments | Fluvial sediments | Fluvial sediments with inter-bedded organic sediments | Glacial, glaciofluvial, glacio-lacustrine, glaciomarine sediments | Glaciolacustrine and glacio-marine sediments

Radiocarbon age determination ..... > 40 000 GSC-1897









Diagrammatic cross-sections along lines A-A′, B-B′, C-C′, D-D′

123°00′ 55′ 50′ 45′ 40′ 35′ 122°30′ — 49°20′ — 15′ — 10′ — 05′ — 49°00′

LEGEND

QUATERNARY

POSTGLACIAL

SALISH SEDIMENTS

SAa — *Landfill including sand, gravel, till, crushed stone, and refuse*

SAb-e — *Bog, swamp, and shallow lake deposits:* SAb, *lowland peat up to 14 m thick, in part overlying* Fb, c; SAc, *lowland peat up to 1 m thick underlying* Fb *(up to 2 m thick);* SAd, *lowland organic sandy loam to clay loam 15 to 45 cm thick overlying* SAg *and* Fd; SAe, *upland peat up to 8 m or more thick*

SAf, g — *Marine shore sediments (beach deposits):* SAf, *sand to sandy loam up to 2 m thick overlying estuarine, fossiliferous, fine sand and clayey silt, 10 to 185 m thick (Fe of Lithologic Units and Environments of Deposition);* SAg, *medium to coarse sand and gravel up to 8 m thick*

SAh-k — *Lowland and mountain stream deltaic, channel fill, and overbank sediments:* SAh, *lowland stream channel fill and overbank sandy loam to clay loam, also organic sediments up to 8 m thick;* SAi, *mountain stream marine deltaic medium to coarse gravel and minor sand up to 15 m or more thick;* SAj, *mountain stream channel fill sand and gravel up to 8 m thick;* SAk, *lowland stream channel fill sand to gravel and minor silt and clay up to 5 m thick*

FRASER RIVER SEDIMENTS

Fa-d — *Deltaic and distributary channel fill sediments overlying and cutting estuarine sediments and overlain in part of the area by overbank sediments:* Fa, *channel deposits, fine to medium sand and minor silt occurring along present day river channels;* Fb, *overbank sandy to silt loam up to 2 m thick overlying 15 m or more of* Fd; Fc, *overbank silty to silt clay loam normally up to 2 m thick overlying 15 m or more of* Fd; Fd′, *deltaic and distributary channel fill (includes tidal flat deposits) sandy to silt loam, 10 to 40 m thick interbedded fine to medium sand and minor silt beds; may also contain organic and fossiliferous material*

POSTGLACIAL AND PLEISTOCENE

SA-C — *Marine shore and fluvial sand up to 8 m thick,* Cb *in part has been reworked and redeposited by lowland streams* (SAh)

PLEISTOCENE

SUMAS DRIFT

Sa-e — *Outwash, ice-contact, and deltaic deposits:* Sa, *outwash sand and gravel up to 30 m thick;* Sb, *ice-contact gravel and sand containing till lenses and clasts of glaciomarine stony clayey silt, 2 to 5 m thick overlying* FLc, d; Sc, *ice-contact gravel and sand containing till lenses and clasts of glaciomarine stony clayey silt, 2 to 5 m thick overlying* FLb, e; Sd, *ice-contact gravel and sand containing till lenses and clasts of glaciomarine stony clayey silt, more than 5 m thick;* Se, *raised proglacial deltaic gravel and sand up to 40 m thick*

FORT LANGLEY FORMATION

FLa-e — *Glacial and deltaic sediments:* FLa, *lodgment and flow till with sandy loam matrix containing clasts of* FLc; FLb, *outwash and ice-contact gravel and sand containing clasts of* FLa, c; FLc, *glaciomarine stony clayey silt to silty sand 8 to 90 m thick, commonly thinly bedded and containing marine shells;* FLd, *marine silty clay to fine sand commonly containing marine shells;* FLe, *proglacial deltaic gravel and sand*

CAPILANO SEDIMENTS *(Chronologically equivalent to Sumas Drift and Fort Langley Formation, see Lithologic Units and Environments of Deposition)*

Ca-e — *Raised marine, deltaic, and fluvial deposits:* Ca, *raised marine beach, spit, bar, and lag veneer, poorly sorted sand to gravel (except in bar deposits) normally less than 1 m thick but up to 8 m thick, mantling older sediments and containing fossil marine shell casts up to 175 m above sea level;* Cb, *raised beach medium to coarse sand 1 to 5 m thick containing fossil marine shell casts;* Cc, *raised deltaic and channel fill medium sand to cobble gravel up to 15 m thick deposited by proglacial streams and commonly underlain by silty to silty clay loam;* Cd, *marine and glaciomarine stony (including till-like deposits) to stoneless silt loam to clay loam with minor sand and silt normally less than 3 m thick but up to 30 m thick, containing marine shells. These deposits thicken from west to east.* Ce, *mainly marine silt loam to clay loam with minor sand, silt, and stony glacio-marine material (see* Cd), *up to 60+ m thick. In many of the upland areas sediments mapped as* Cc *and* Cd *are mantled by a thin veneer (less than 1 m) of* Ca

VASHON DRIFT AND CAPILANO SEDIMENTS

VC — *Glacial drift including: lodgment and minor flow till, lenses and interbeds of substratified glaciofluvial sand to gravel, and lenses and interbeds of glacio-lacustrine laminated stony silt; up to 25 m thick but in most places less than 8 m thick (correlates with* Va, b); *overlain by glaciomarine and marine deposits similar to* Cd *normally less than 3 m but in places up to 10 m thick. Marine derived lag gravel normally less than 1 m thick containing marine shell casts has been found mantling till and glaciomarine deposits up to 175 m above sea level; above 175 m till is mantled by bouldery gravel that may be in part ablation till, in part colluvium, and in part marine shore in origin*

VASHON DRIFT

Va,b — *Till, glaciofluvial, glaciolacustrine, and ice-contact deposits:* Va, *lodgment till (with sandy loam matrix) and minor flow till containing lenses and interbeds of glaciolacustrine laminated stony silt;* Vb, *glaciofluvial sandy gravel and gravelly sand outwash and ice-contact deposits*

PRE-VASHON DEPOSITS

PVa-h — *Glacial, nonglacial, and glaciomarine sediments:* PVa, *Quadra fluvial channel fill and floodplain deposits, crossbedded sand containing minor silt and gravel lenses and interbeds;* PVb, *Quadra(?) glaciofluvial deposits, deltaic, and crossbedded sand to gravel (may be in part* Vb*);* PVc, *Quadra marine interbedded fine sand to clayey silt believed to be off shore equivalents of* PVa; PVd, *Coquitlam till, glaciomarine (?); and glaciolacustrine deposits;* PVe, *Cowichan Head fluvial, organic colluvial, and bog and swamp sediments;* PVf, *Semiahmoo till, glacio-fluvial, glaciomarine, and glaciolacustrine deposits;* PVg, *Highbury fluvial and bog and swamp deposits;* PVh, *Westlynn glaciofluvial sandy gravel*

UNDIVIDED PRE-VASHON DEPOSITS

UPV — *Till, glaciofluvial, glaciolacustrine, fluvial, marine, and organic sediments*

TERTIARY

T — *Tertiary bedrock including sandstone, siltstone, shale, conglomerate, and minor volcanic rocks; where bedrock is not at the surface it is overlain by glacial deposits and colluvium*

PRE-TERTIARY

PT — *Mesozoic bedrock including granitic and associated rock types; where bedrock is not at the surface it is overlain by glacial deposits and colluvium*

Note: Except in areas mapped as PT *and* T, *the Quaternary deposits are normally more than 10 m thick and may be up to 300+ m thick. The materials at the surface are underlain by older deposits as illustrated in the legend and table of formations*

**Unit used only in cross-section*

Geological boundary, mainly gradational .....

Area of recorded landslides ..... RS

Area of recorded flooding (except the Fraser River floodplain) ..... RF

Geology by J.E. Armstrong 1949-1952, 1973-1975, W.L. Brown 1949-1950, S.R. Hicock 1974, 1976

Additional information from E.C. Halstead 1954-1975; Province of British Columbia Soils Survey 1956-1965

For bedrock geology see GSC Memoir 335 by J.A. Roddick

Compiled by J.E. Armstrong and S.R. Hicock 1976

Geological cartography by R.S. Hill, Geological Survey of Canada

Any revisions or additional geological information known to the user would be welcomed by the Geological Survey of Canada

Base-map assembled by the Geological Survey of Canada from maps published at the same scale by the Surveys and Mapping Branch in 1976, 1977

Copies of the topographical edition of these maps may be obtained from the Canada Map Office, Department of Energy, Mines and Resources, Ottawa

Approximate magnetic declination 1978, 22° 23′ East decreasing 4.2′ annually

Elevations in feet above mean sea level

Copies of this map may be obtained from the Geological Survey of Canada
601 Booth Street, Ottawa, Ontario K1A 0E8
3303 - 33rd Street, N.W., Calgary, Alberta T2L 2A7
100 West Pender Street, Vancouver, B.C. V6B 1R8

INDEX MAP

MAP 1484A
SURFICIAL GEOLOGY
NEW WESTMINSTER
WEST OF SIXTH MERIDIAN
BRITISH COLUMBIA

Scale 1:50,000

Kilometres 1 0 1 2 3 4 Kilometres
Miles 1 0 1 2 Miles

Universal Transverse Mercator Projection

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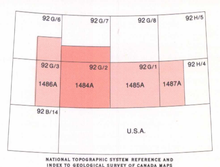

NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX TO GEOLOGICAL SURVEY OF CANADA MAPS

Printed by the Surveys and Mapping Branch, 1980

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MAP 1484A
NEW WESTMINSTER
BRITISH COLUMBIA

This map has been produced from a scanned version of the original map
Reproduction par numérisation d'une carte sur papier

1484A

APPENDIX M: Enkadrain 3615R Data Sheets

COLBOND

Enkadrain® 3615R*

Colbond Building Products — Drainage

Technical Data

Fabric Properties

Property	English Units	Metric Units	Test Method
Polymer	*Polypropylene*		
Fabric Color	*Black*		
Weight	*4.5 oz/yd ^{2}*	*152.6 g/m ^{2}*	*ASTM D 5261*
Grab Strength MD/CD	*120.0 lbs*	*0.54 kN*	*ASTM D 4632*
Grab Elongation	*50%*	*50%*	*ASTM D 4632*
Trapezoidal Tear	*50.0 lbs*	*0.22 kN*	*ASTM D 4533*
Puncture Strength	*70.0 lbs*	*0.31 kN*	*ASTM D 4833*
AOS (maximum average)	*70 US Sieve*	*0.212 mm*	*ASTM D 4751*
Flow Rate	*120.0 gal/min/ft ^{2}*	*4887 l/sec/m ^{2}*	*ASTM D 4491*
Permittivity	*1.8 sec^{-1}*	*1.8 sec^{-1}*	*ASTM D 4491*

Values are MARV Minimum Average Roll Value

Polymer Properties

Polypropylene has excellent resistance to organic solvents, degreasing agents, acids, and alkalines. It has tensile strength superior to high density polyethylene. It is has a low moisture absorption rate, is resistant to staining, and is very light weight.

Packaging

Property	English Units	Metric Units
Product ID	*3615-101-0001*	
Core Width	*39.0 in*	*99.1 cm*
Length	*100.0 ft*	*30.5 m*
Area	*36.0 yd ^{2}*	*30.1 m ^{2}*
Area	*324.0 ft ^{2}*	*30.1 m ^{2}*
Roll Diameter	*27.0 in*	*68.6 cm*
Gross Roll Weight	*77.0 lbs*	*34.9 kg*

Global Plastic Sheeting
1331 Specialty Drive
Vista, CA 92081
Telephone 866.597.9298
Fax 760.597.9574

wwwglobalplasticsheetingcom

**Replaces Enkadrain 9615 and 9120..*

To the best of our knowledge, the information contained herein is accurate. However, Colbond Inc. cannot assume any liability whatsoever for the accuracy or completeness thereof. Final determination of the suitability of any information or material for the use contemplated, of its manner of use and whether the suggested use infringes any patents is the sole responsibility of the user. These products may be covered by patents or patents pending.

COLBOND

Enkadrain® 3615R*

Colbond Building Products — Drainage

Description

Enkadrain 3615R is one of a new generation of environmentally conscious Enkadrain products. This drainage composite consists of a post-industrial recycled polypropylene drainage core of fused, entangled filaments and a geocomposite fabric bonded to one side. The entangled filaments are molded into a square waffle pattern that maintains the flexible design of other Enkadrain products. This product, because it exceeds 40% post-industrial recycled content, can help contribute up to 2 LEED points, when used in conjunction with other recycled content products. Enkadrain 3615R can contribute towards additional LEED points when used with a green roof by reducing stormwater runoff, heat islands and energy consumption.

Recommended Applications

- Foundation walls
- Green roofs
- Plaza decks
- Retaining walls
- Beneath slabs
- Earth sheltered homes
- Underground parking
- Exterior planters

Features and Benefits

- Excellent durability
- Protects waterproofing during and after backfill
- Conforms to irregular surfaces and corners
- Waffle design creates open flow path — even during backfill
- Continuous flow even under high loads
- Long rolls reduce installation costs by reducing butt seams and eliminating interlocking
- Recycled content polymer contributes towards LEED points
- Increased flow rates over same thickness nylon and HDPE drains
- Designed for higher load conditions
- 3” fabric overlap flap

Technical Data

Physical Properties

Property	English Units	Metric Units
Core Material	*Recycled Polypropylene*	
Thickness	*0.45 in*	*11.43 mm*
Total Weight	*28.5 oz/yd ^{2}*	*966.4 g/m ^{2}*
Core Weight	*24.0 oz/yd ^{2}*	*813.8 g/m ^{2}*
Colbond Compressive Load Test[1]	*>30,000 psf*	*kN/m ^{2} No failure**

[1]Colbond Test Method: ASTM 1621 D modified and ASTM D 4716
**Failure defined as reaching yield point or no continued measurable flow under stated load*

Flow Rates

Pressure	1.0 Gradient	0.5 Gradient	0.2 Gradient
250 psf	*21.0 gal/min/ft*	*14.5 gal/min/ft*	*9.6 gal/min/ft*
500 psf	*21.0 gal/min/ft*	*13.8 gal/min/ft*	*8.2 gal/min/ft*
1000 psf	*19.7 gal/min/ft*	*13.0 gal/min/ft*	*8.0 gal/min/ft*
2000 psf	*19.0 gal/min/ft*	*14.1 gal/min/ft*	*8.0 gal/min/ft*
3000 psf	*18.9 gal/min/ft*	*13.2 gal/min/ft*	*7.7 gal/min/ft*
3600 psf	*18.9 gal/min/ft*	*12.9 gal/min/ft*	*7.5 gal/min/ft*
5000 psf	*18.1 gal/min/ft*	*12.2 gal/min/ft*	*7.5 gal/min/ft*
8000 psf	*11.1 gal/min/ft*	*7.1 gal/min/ft*	*4.1 gal/min/ft*

Typical flow vs. pressure for vertical applications (ASTM D 4716) Sample Configuration: Plate/Enkadrain/Plate
Values are average of machine direction and cross machine direction test results

Global Plastic Sheeting
1331 Specialty Drive
Vista, CA 92081
Telephone 866.597.9298
Fax 760.597.9574

wwwglobalplasticsheetingcom

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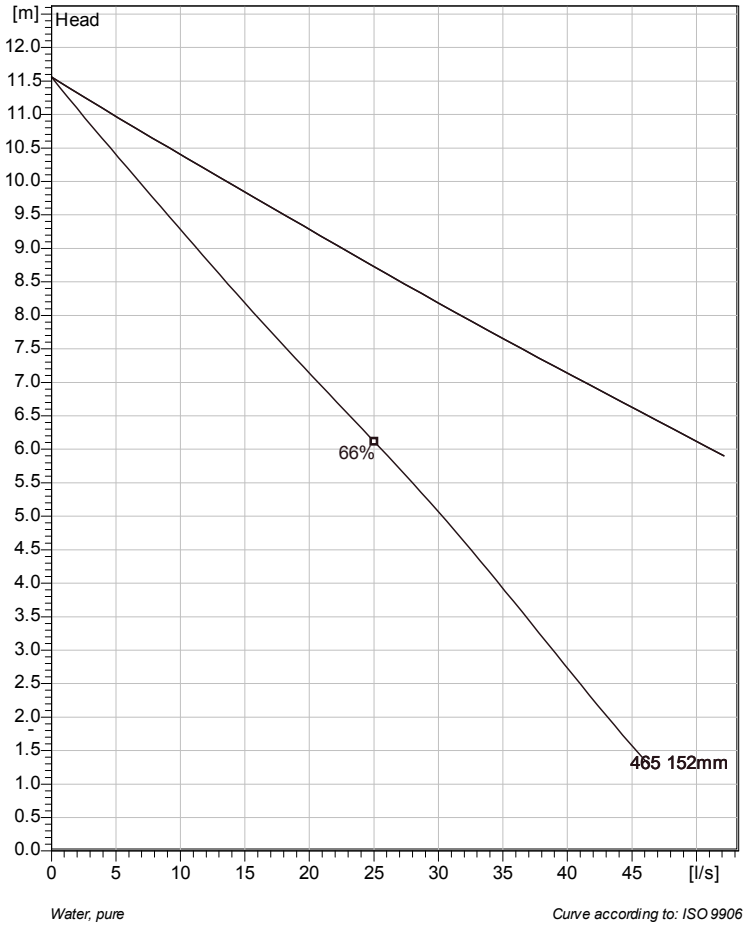
APPENDIX N: Pump Specifications

NP 3102 MT 3~ 465

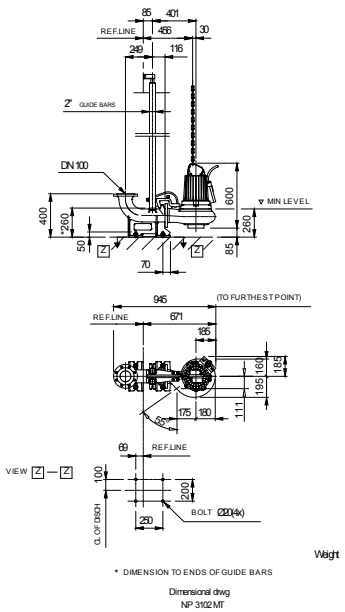
Technical specification



Water, pure *Curve according to: ISO 9906*

Note: Picture might not correspond to the current configuration.

Installation: P - Semi permanent, Wet



General

Patented self cleaning semi-open channel impeller, ideal for pumping in most waste water applications. Possible to be upgraded with Guide-pin® for even better clogging resistance. Modular based design with high adaptation grade.

Impeller

Impeller material	Grey cast iron
Discharge Flange Diameter	100 mm
Suction Flange Diameter	100 mm
Impeller diameter	152 mm
Number of blades	2

Motor

Motor #	N3102.181 18-11-4AL-W 5hp
Stator variant	68
Frequency	60 Hz
Rated voltage	400 V
Number of poles	4
Phases	3~
Rated power	3.73 kW
Rated current	7.4 A
Starting current	40 A
Rated speed	1735 1/min
Power factor	
1/1 Load	0.86
3/4 Load	0.82
1/2 Load	0.74
Efficiency	
1/1 Load	84.5 %
3/4 Load	85.5 %
1/2 Load	85.0 %

Configuration

Project	Project ID	Created by	Created on	Last update
			2015-02-25	

NP 3102 MT 3~ 465

Performance curve

Pump

Discharge Flange Diameter	100 mm
Suction Flange Diameter	100 mm
Impeller diameter	152 mm
Number of blades	2

Motor

Motor #	N3102.181 18-11-4AL-W 5hp
Stator variant	68
Frequency	60 Hz
Rated voltage	400 V
Number of poles	4
Phases	3~
Rated power	3.73 kW
Rated current	7.4 A
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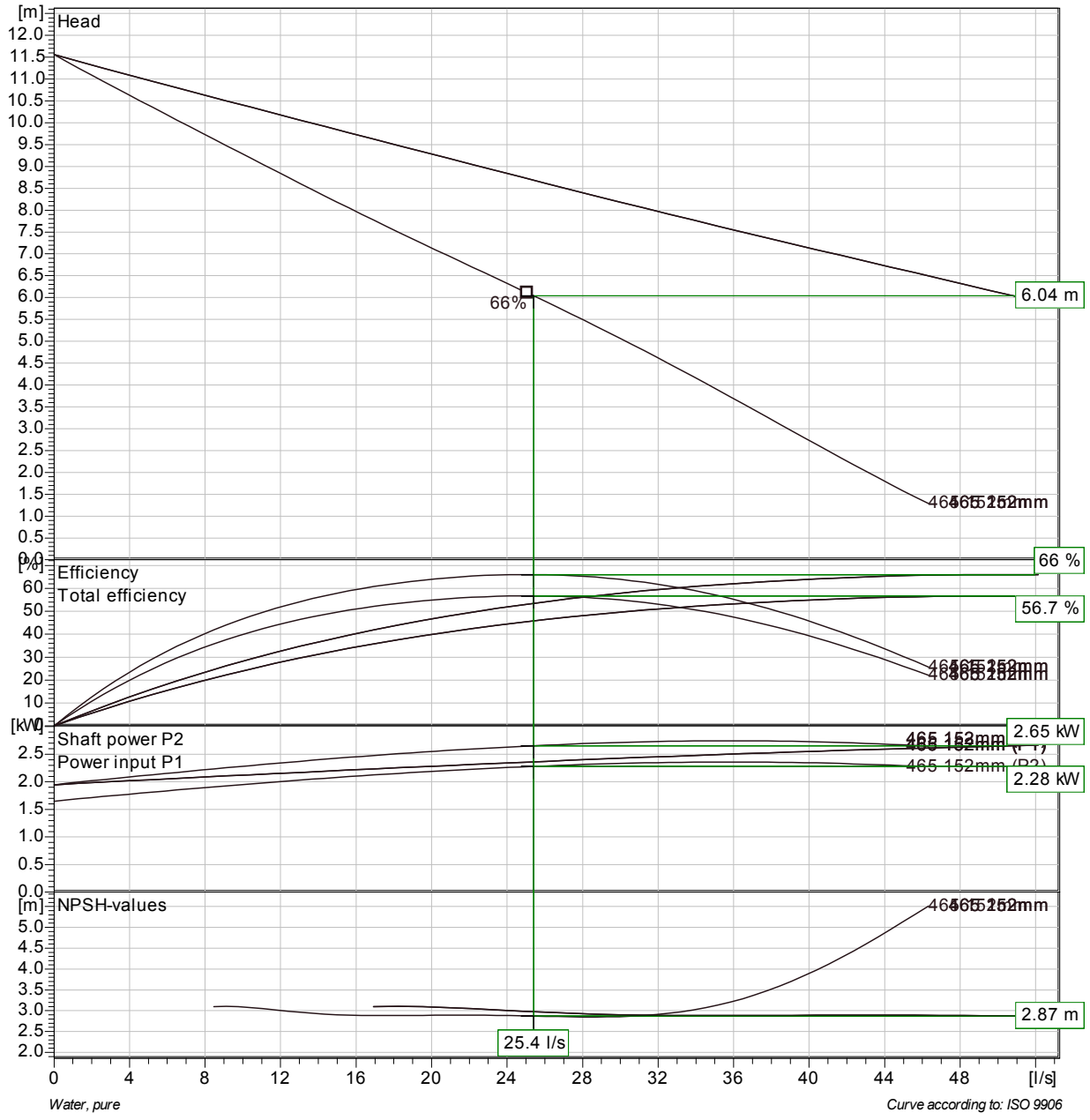
Rated speed	1735 1/min

Power factor	
1/1 Load	0.86
3/4 Load	0.82
1/2 Load	0.74

Efficiency	
1/1 Load	84.5 %
3/4 Load	85.5 %
1/2 Load	85.0 %



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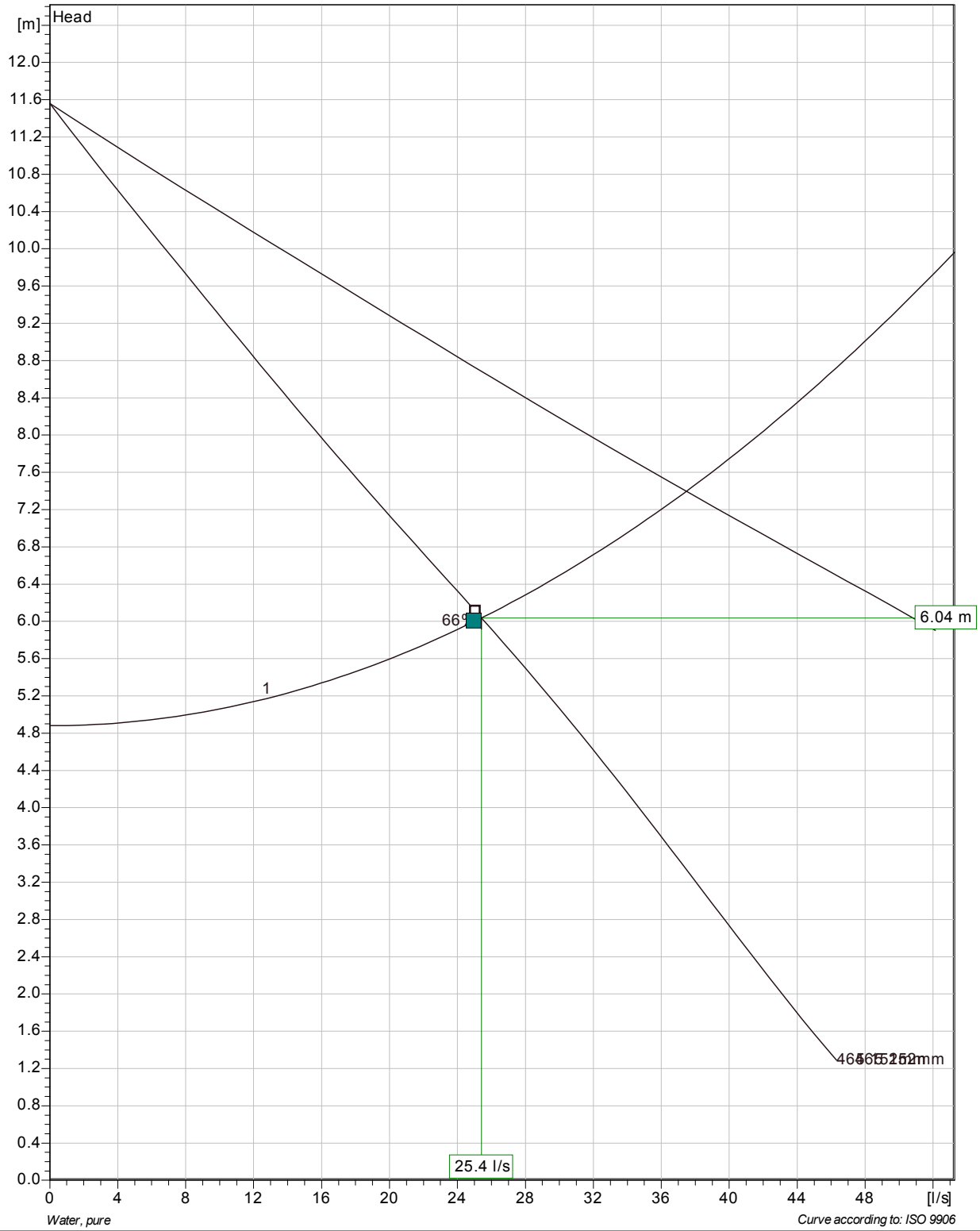
NP 3102 MT 3~ 465

Duty Analysis

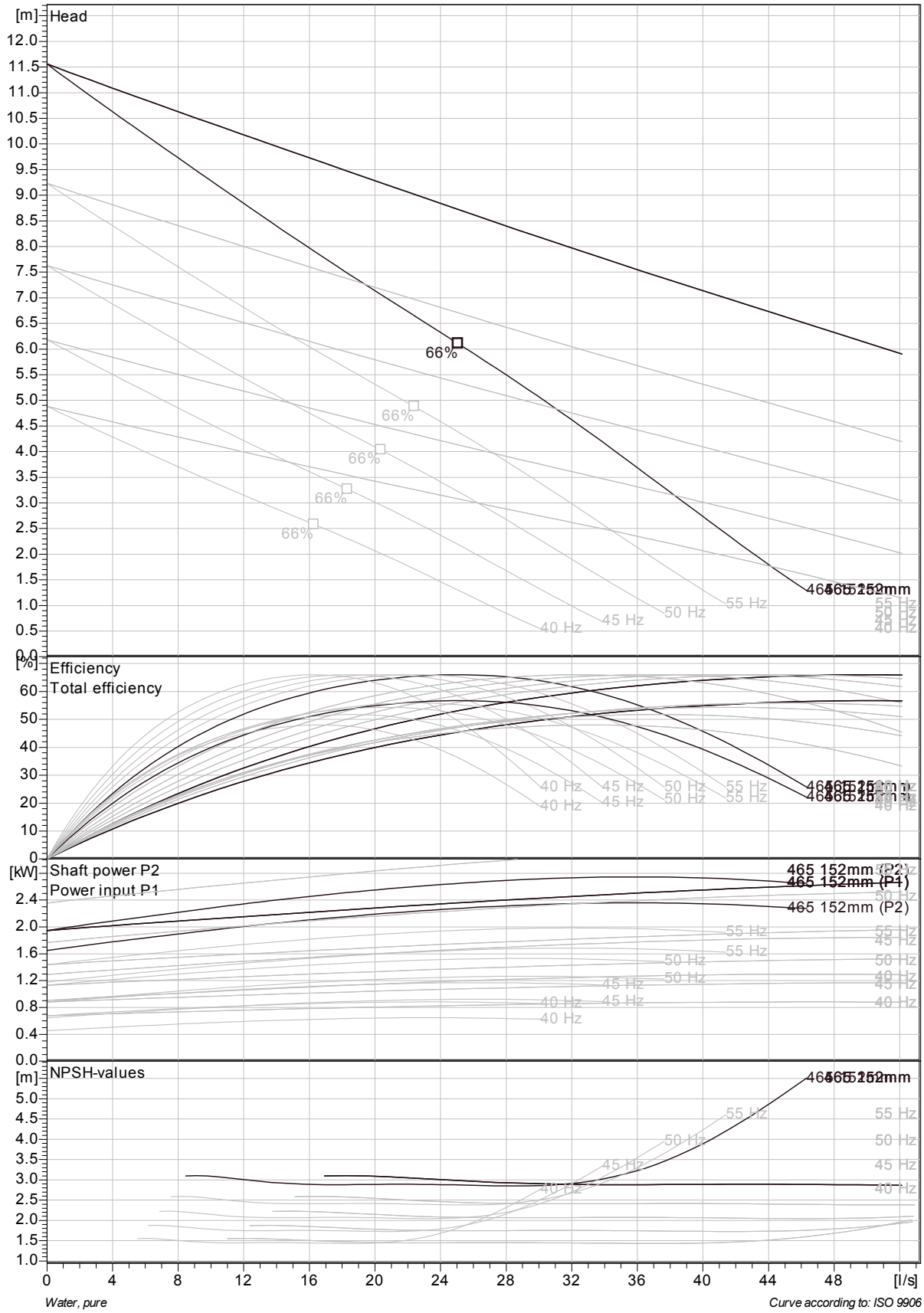


Pumps running /System	Individual pump			Total					
	Flow	Head	Shaft power	Flow	Head	Shaft power	Pump eff.	Specific energy	NPSHre
1	25.4 l/s	6.04 m	2.28 kW	25.4 l/s	6.04 m	2.28 kW	66 %	0.029 kWh/m³	2.87 m

Project	Project ID	Created by	Created on	Last update
			2015-02-25	

NP 3102 MT 3~ 465

VFD Curve



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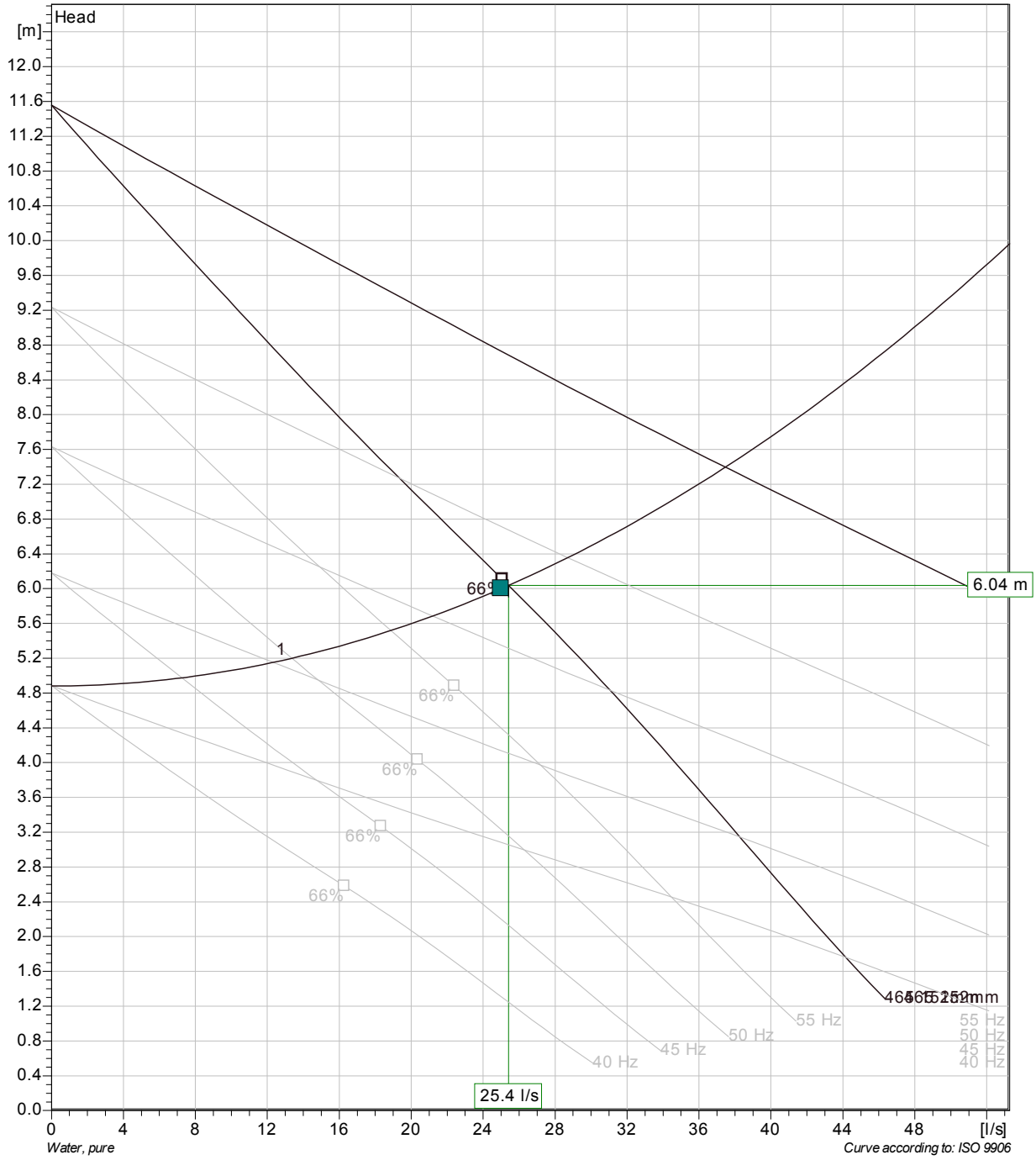
NP 3102 MT 3~ 465

VFD Analysis

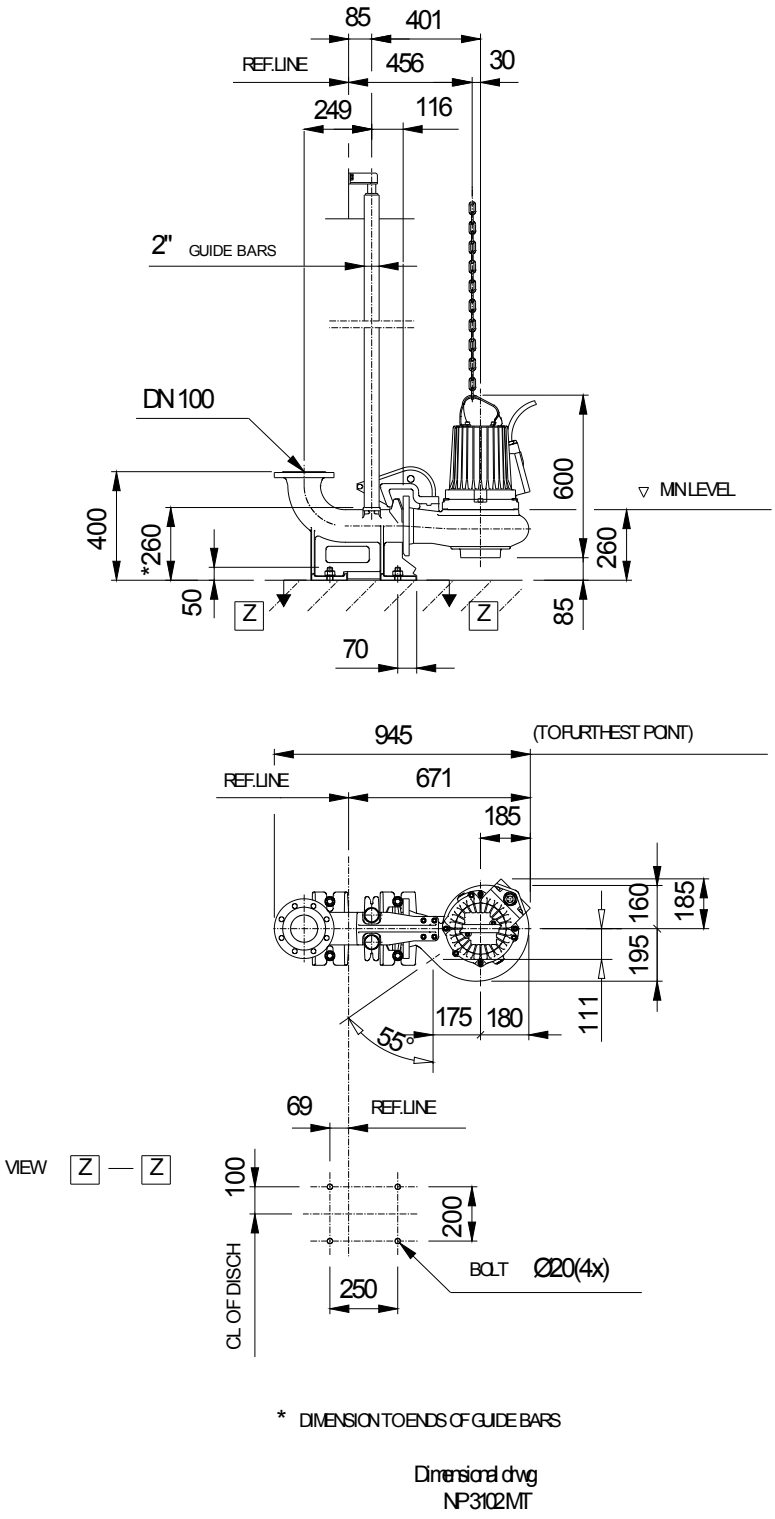


Pumps running /System	Individual pump Frequency	Flow	Head	Shaft power	Total Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
1	60 Hz	25.4 l/s	6.04 m	2.28 kW	25.4 l/s	6.04 m	2.28 kW	66 %	0.029 kWh/m³	2.87 m
1	55 Hz	18.9 l/s	5.52 m	1.58 kW	18.9 l/s	5.52 m	1.58 kW	64.8 %	0.0275 kWh/m³	2.42 m
1	50 Hz	13.4 l/s	5.2 m	1.13 kW	13.4 l/s	5.2 m	1.13 kW	60.1 %	0.0289 kWh/m³	2.07 m
1	45 Hz	7.25 l/s	4.97 m	0.762 kW	7.25 l/s	4.97 m	0.762 kW	46.4 %	0.0384 kWh/m³	1.87 m
1	40 Hz	0.0276 l/s	4.88 m	0.453 kW	0.0276 l/s	4.88 m	0.453 kW	0.291 %	6.83 kWh/m³	

Project	Project ID	Created by	Created on	Last update
			2015-02-25	

NP 3102 MT 3~ 465

Dimensional drawing



Weight

* DIMENSION TO ENDS OF GUIDE BARS

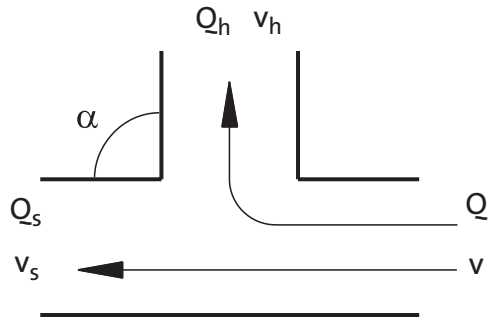
Dimensional dwg
NP3102MT

Project	Project ID	Created by	Created on	Last update
			2015-02-25	

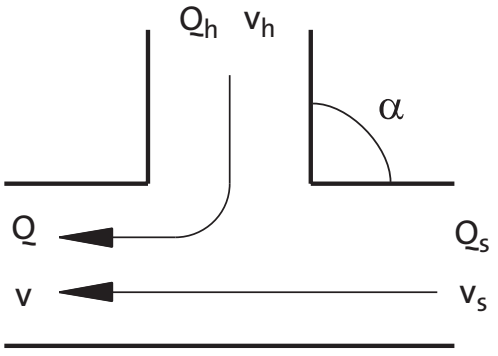
APPENDIX O: Pipe Loss Coefficients

Local Resistance Factors

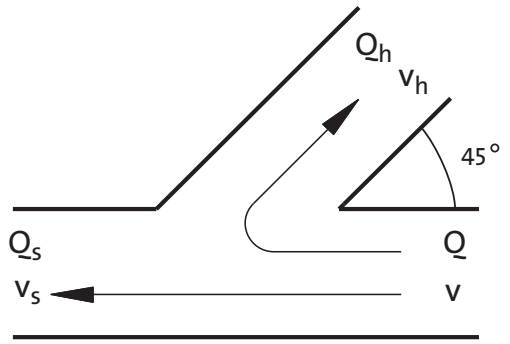
Branches



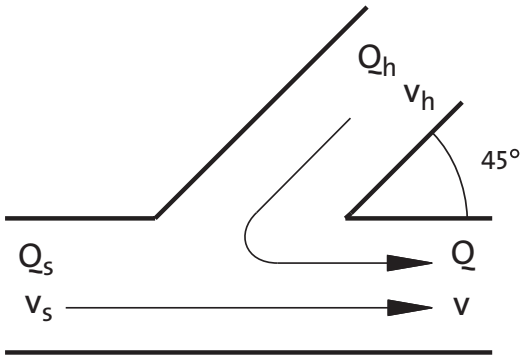
Q_h/Q	Diverging flows			
	α = 90°		α = 45°	
	ζ_h	ζ_s	ζ_h	ζ_s
0,0	0,95	0,04	0,90	0,04
0,2	0,88	-0,08	0,68	-0,06
0,4	0,89	-0,05	0,50	-0,04
0,6	0,95	0,07	0,38	0,07
0,8	1,10	0,21	0,35	0,20
1,0	1,28	0,35	0,48	0,33



Q_h/Q	Merging flows			
	α = 90°		α = 45°	
	ζ_h	ζ_s	ζ_h	ζ_s
0,0	-1,00	0,04	-0,90	0,04
0,2	-0,40	0,17	-0,38	0,17
0,4	0,08	0,30	0,00	0,19
0,6	0,47	0,41	0,22	0,09
0,8	0,72	0,51	0,37	-0,17
1,0	0,91	0,60	0,37	-0,54

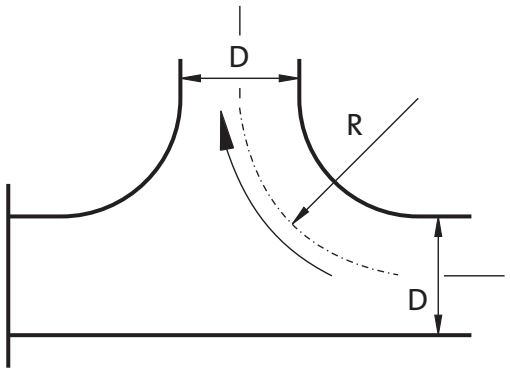


Q_h/Q	Merging flows	
	ζ_h	ζ_s
0,0	-0,82	0,06
0,2	-0,30	0,24
0,4	0,17	0,41
0,6	0,60	0,56
0,8	1,04	0,80
1,0	1,38	1,13

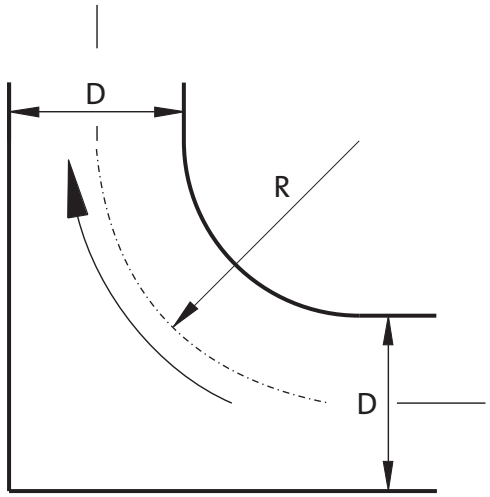


Q_h/Q	Diverging flows	
	ζ_h	ζ_s
0,0	0,92	0,06
0,2	0,97	-0,06
0,4	1,12	0,00
0,6	1,31	0,09
0,8	1,50	0,20
1,0		0,30

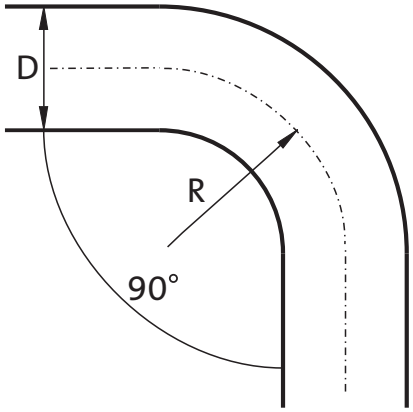
Bends



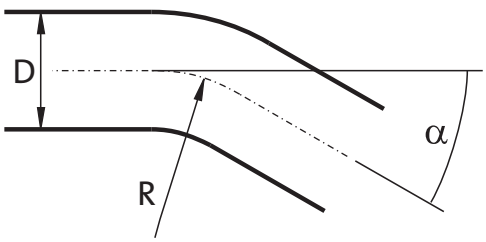
R/D = 1, 5;ζ = 0, 4



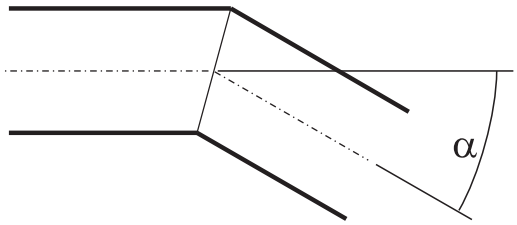
R/D = 1, 5;ζ = 0, 7



R/D	1	2	3	4	6
ζ	0,36	0,19	0,16	0,15	0,21
R/D	8	10	12	16	20
ζ	0,27	0,32	0,35	0,39	0,41

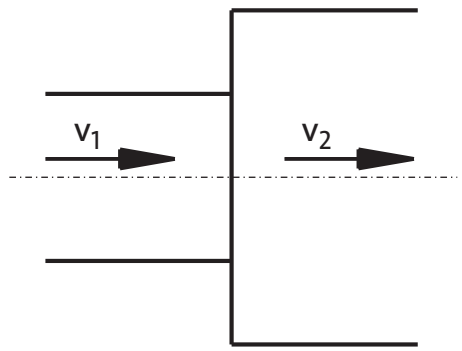


α	ζ		
	R/D		
	1	2	4
20°	0,07	0,03	0,03
40°	0,13	0,06	0,06
60°	0,20	0,10	0,09
80°	0,27	0,13	0,12
90°	0,32	0,15	0,13
120°	0,39	0,19	0,17
140°	0,46	0,23	0,20
160°	0,52	0,26	0,23
180°	0,60	0,30	0,26

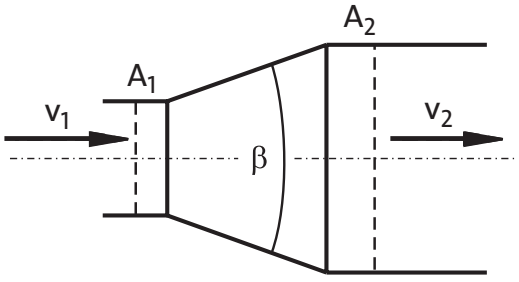


α	20°	40°	50°	70°	80°
ζ	0,03	0,12	0,24	0,54	0,74
α	90°	120°	140°	180°	
ζ	1,00	1,86	2,43	3,00	

Expansions and Contractions

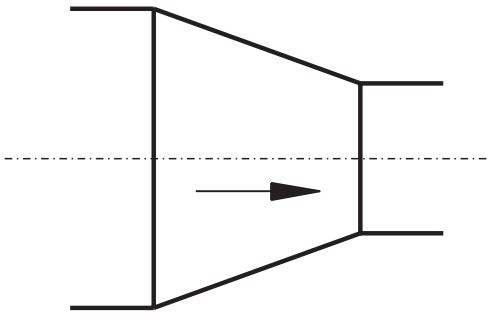


$$H_{Jn} = \frac{(v_1 - v_2)^2}{2g}$$



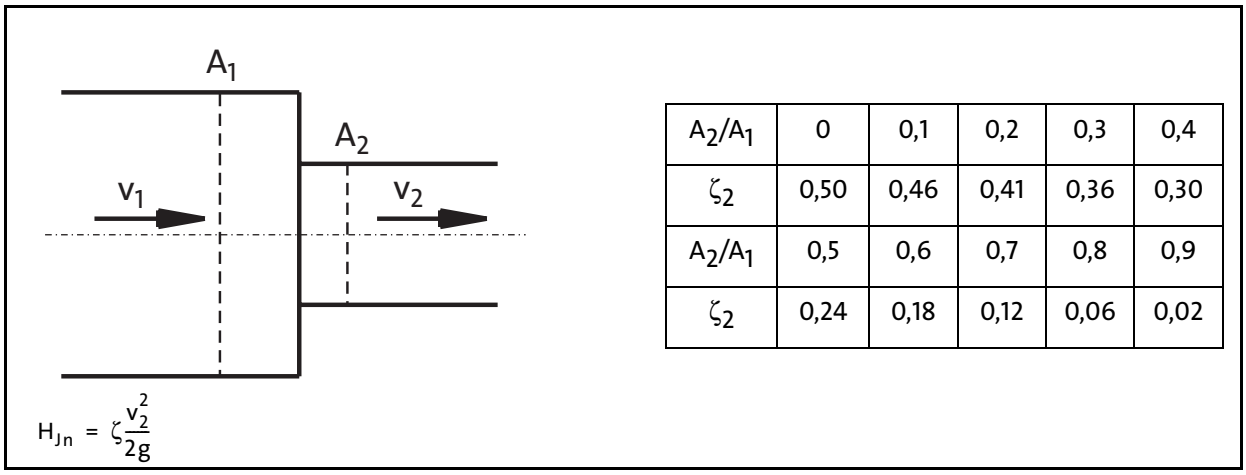
$$H_{Jn} = \zeta \frac{v_1^2}{2g} \qquad \zeta = k\left(1 - \frac{A_1}{A_2}\right)^2$$

β°	k	β°	k	β°	k
5	0,13	45	0,93	100	1,06
10	0,17	50	1,05	120	1,05
15	0,26	60	1,12	140	1,04
20	0,41	70	1,13	160	1,02
30	0,71	80	1,10		
40	0,90	90	1,07		

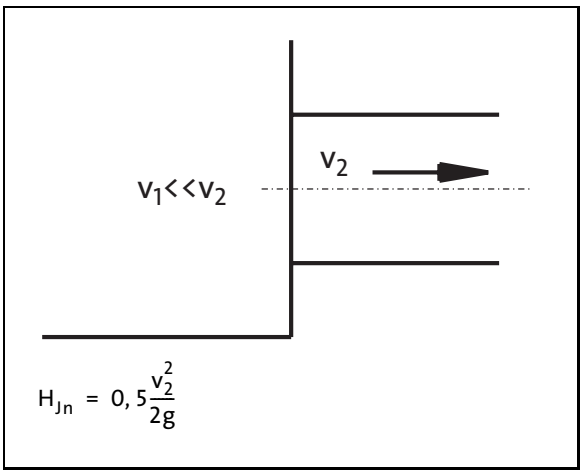


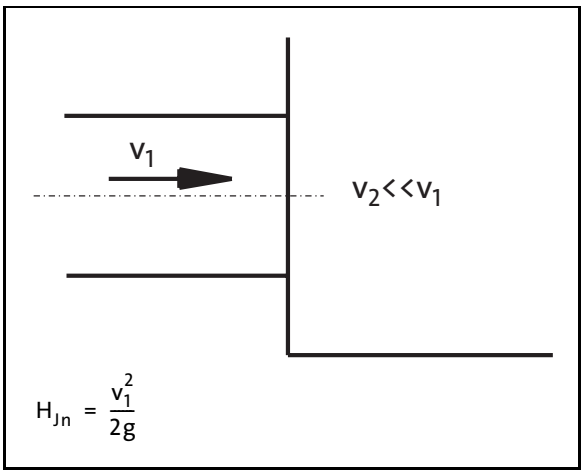
$H_{Jn} \approx 0$

Friction drag not included

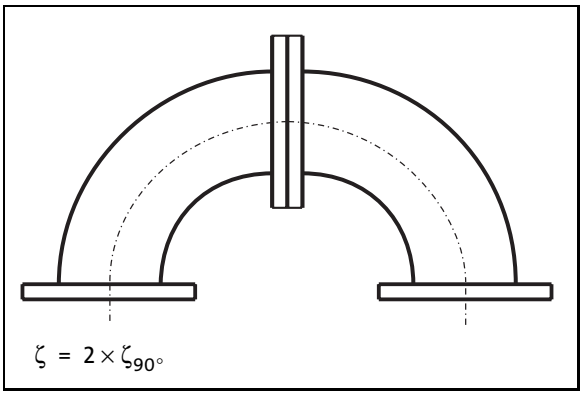


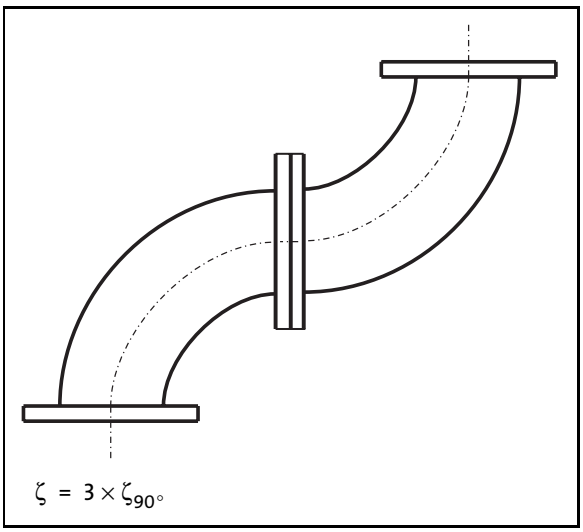
A_2/A_1	0	0,1	0,2	0,3	0,4
ζ_2	0,50	0,46	0,41	0,36	0,30
A_2/A_1	0,5	0,6	0,7	0,8	0,9
ζ_2	0,24	0,18	0,12	0,06	0,02

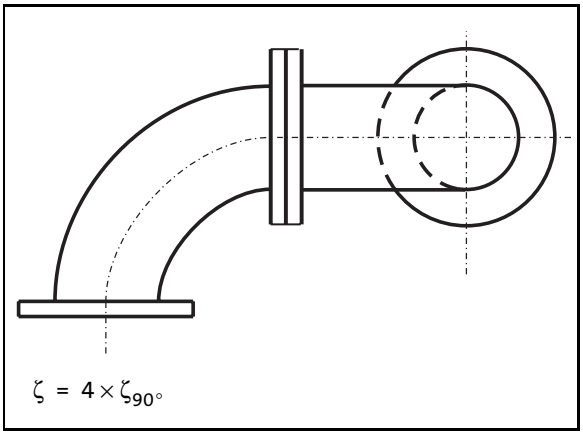




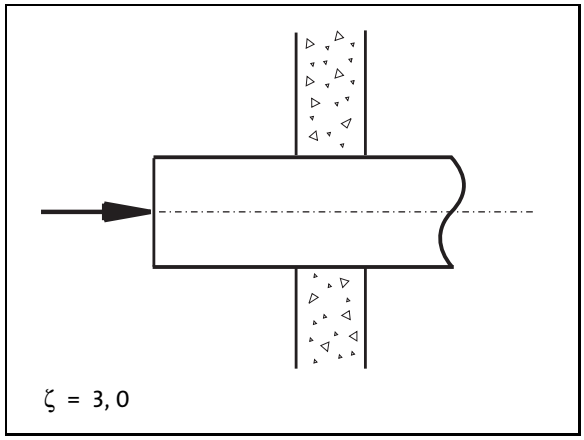
Bend Combinations

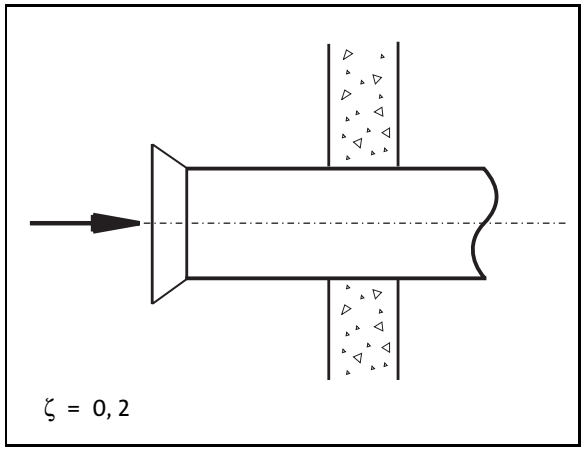


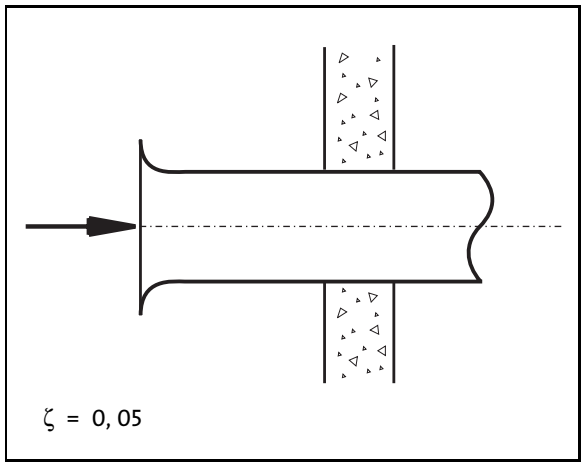




Suction Inlets







APPENDIX P: City of Richmond Sanitary Pump Station Design Criteria

RICHMOND ENGINEERING DEPARTMENT

SANITARY PUMP STATIONS DESIGN CRITERIA

DRAFT

March 6, 2003

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1. GENERAL

The purpose of this document is to serve as a general guideline for the design of sanitary pump stations within the City of Richmond. This document contains two parts: the design criteria and the typical drawing set. The design criteria pertain to all sanitary pump stations while the typical drawing set is primarily relevant to duplex pump stations with individual pump sizes less than 15 kW.

The criteria and typical drawings have been prepared for use by Professional Engineers (the Consultant) who are suitably qualified for the completion of this work. Specific site criteria and criteria not contained within this document or associated documents shall be in accordance with good engineering practice, as determined in consultation with the Manager of Engineering Design and Construction or assigned representative.

These standards are provided as a guide, the Consultant shall remain fully responsible for the design and construction of City infrastructure in accordance with good engineering practice to address the specific needs and site conditions of their project.

This document is to be used in conjunction with the Richmond Engineering Design Specifications, the City of Richmond Supplementary Specifications and Detailed Drawings, and the City of Richmond approved edition of the Master Municipal Construction Documents.

2. PROCESS

The process outlined below has been chosen to ensure that pump station design and construction works can be completed in a timely manner while optimizing the amount of involvement required of City staff.

Task	Explanation
1. Project Award	
2. Project Initiation Meeting	• Confirm Scope of Work • Confirm Site Location • Confirm catchment boundaries • Confirm land-use designations for OCP and proposed uses
3. Draft Pre-Design Report	• Submit as outlined in Section 3 for Review by City
4. Review by City	• Review of Draft Pre-Design Report
5. Final Pre-Design Report	
6. Draft Construction Documents	• Draft Detailed Design Drawings • Draft Supplementary General Conditions • Draft Construction Cost Estimate
7. Review by City	• Review of Construction Documents
8. Final Construction Documents	• Detailed Design Drawings • Supplementary General Conditions • Construction Cost Estimate
9. Tender by City	• Technical assistance to be provided by the Consultant to answer Tender questions
10. Shop Drawings	• To be reviewed and approved by Consultant with copy sent to City
11. Programming Provided by City	• City to provide programming for SCADA system
11. Shop Testing/Inspection	• Shop testing is required for the completed electrical kiosk • Shop inspection may be required, at the City's discretion for the fibreglass wet well
11. Construction	• Inspection services to be provided by the Consultant

Task	Explanation
12. Draft O&M Manuals	• Contractor to prepare and submit O&M Manuals to Consultant for completion and submission to the City (as outlined in Section 3)
13. Review by City	• Review of O&M Manuals
14. Commissioning	• Consultant to arrange for Commissioning with City in attendance • Commissioning procedure to be sent to City and Contractor in advance (as per Section 3)
15. Final O&M Manuals	• Revised O&M Manuals based on Review by City and Commissioning
16. Record Drawings	• Record drawings submission in accordance with Section 3

3. SUBMISSIONS

3.1 Pre-Design Report

The purpose of the Pre-Design Report is to provide the City with a review of the design alternatives and recommended configuration and equipment selection for the proposed station. Where appropriate at least two design alternatives shall be shown with a recommendation by the Consultant on which alternative to proceed with. Attached in Appendix A is a sample table of contents for the Predesign Report. The following is a description of the items that must be included in the report:

a) Flow Calculations
- A catchment map showing how the existing and future land parcels will be serviced
- A summary of the design flows based on present and future conditions

b) Force Main Design
- A review of force main sizing alternatives based on cleansing and headloss considerations
- A review of transient analysis requirements

c) Pump Selection
- System curve for existing and future design conditions
- Pump curves superimposed on system curve for all standard Richmond pumps that suite the design points

d) System Configuration
- A review of inlet pipe sizes and required wet-well storage
- An indication of the length of inlet pipe that will be operating submerged and the storage volume contained within the submerged portion
- A description of the general station configuration

e) Controls and Operation
- A description of the station instrumentation and control logic
- A description of the wet-well ventilation design
- A description of the radio communication path and issues to be resolved during detailed design

f) Seismic Design and Geotechnical Concerns
- A review of foundation requirements
- A review of dewatering and construction slope requirements
- A review of seismic design requirements

- A review of site preloading requirements

g) Pump Station Configuration and Equipment
- A table listing the major system components, manufacturer, and delivery

h) Site Design
- A review and recommendation of right of way and easement requirements
- An outline of access requirements, including integration into surrounding designs
- An outline of any landscaping issues and how there are to be addressed

i) Schedule
- Projected schedule through to completion of commissioning including an estimate for work by other agencies and developers (if appropriate)

j) Construction Cost Estimate
- Class B cost estimate (15% Contingency)

k) Site Plan
- A plan showing the sanitary pump station, surrounding area, inlet sewers, force main, right-of-way, construction easement, access, and other associated items.

l) Geotechnical Report

3.2 Construction Documents

The construction documents submission should include the following:

a) Supplementary General Conditions including:
- all site specific specifications
- supplementary technical specifications necessary (ie. Fibreglass wet-well and piping specification)
- O&M manual submission requirements
- testing and commissioning requirements

b) Construction Drawings to City of Richmond Drafting Standards

c) Construction Class A cost estimate (5% contingency)

3.3 Operations and Maintenance Manual

The manual should be laid out as follows:

a) Title Sheet labelled "Operating and Maintenance Manual, (Insert Name) Pump Station" and containing the date.

b) List of Contents

c) Section 1 – Introduction (information to be inserted by the Consultant)

d) Section 2 – Design Description (information to be inserted by the Consultant)

e) Section 3 – Commissioning
- Commissioning Procedure and Record Sheet (information to be inserted by the Consultant)

f) Section 3 – Mechanical
- Description of mechanical equipment and its operation
- Equipment manufacturer's data and service manuals

g) Section 4 – Electrical and Controls
- Description of electrical and controls equipment and the systems operation
- Level and Alarm Settings
- Test Certificates or Reports and Approval Certificates of Tests
- PLC Ladder Logic Printout and SCADA System Screen
- Equipment manufacturer's data and service manuals

h) Section 5 – Maintenance Program
- Listing of equipment with associated warranty schedule, recommended spare parts, nearest service centre

i) Appendix A – Construction Record Drawings (information to be inserted by the Consultant)

j) Appendix B – Approved Shop Drawings

3.4 Commissioning Procedure

A Commissioning Procedure is to prepared by the Consultant and submitted to the Contractor and the City at least two weeks in advance of the scheduled commissioning date. This procedure is to outline what tests will be conducted and what records will be recorded. At the completion of the commissioning the procedure and record sheet are to be included in the O&M Manuals.

3.5 Record Drawings

Record Drawings are to be submitted in accordance with the City Drafting Standards.

4. DESIGN REQUIREMENTS

The following section outlines the necessary design requirements that are to be addressed during the design of sanitary lift stations.

4.1 Flow Calculations

a) Catchment Areas

Sanitary sewer catchment areas are to be developed in consultation with the Manager of Engineering Design and Construction. Consideration should be given for any servicing plans that have been prepared for the respective area. The following issues need to be addressed in finalizing the catchment area:

- Minimize the number of pump stations
- Avoid double pumping of sewage where possible
- Keep the depth of the pump stations as shallow as possible (maximum depth of 4.5m)
- Ensure the grades of sanitary sewers can withstand settlement concerns

b) Land Use

Consideration must be given to existing, proposed and OCP land uses. The time frame for each should also be considered when determining if an initial smaller pump may be upsized in the future to accommodate future growth or if the ultimate pump should be installed at the onset.

c) Design Flows

Design flows shall be determined as outlined in the City of Richmond Design Specifications. Consideration should be given for existing and proposed uses to determine if sewage generation rates will be higher than the estimated flow based on land use.

4.2 Force Main Design

Force mains shall be designed in accordance with the City of Richmond Design Specifications. The Consultant shall consider and advise the City if a transient analysis is warranted to determine if transient conditions will affect elements of the pump station or force main design.

4.3 Pump Selection

For duplex stations, pumps shall meet maximum flow condition with one pump in failure mode. For multiple pumping stations, the largest capacity pumping unit shall have an equal standby unit – which can be operated in the alternating pump sequence.

The City standard pump station design includes rail mounted submersible pumps. The City maintains spare parts for a set of City standard pumps. Appendix B contains a list of the current City standard pumps. All pumps must adapt to standard discharge elbows and rails that conform to Flygt dimensions.

4.4 Pump Station Configuration and Design

There are two main categories that govern pump station configuration. The first category is the City standard that is reflected in the attached Typical Drawings consists of a duplex pumping arrangement with pumps upto 15 kW. The second category relates to stations that either include pumps larger than 15 kW or those that contain more than 2 pumps.

Category 1: Duplex Stations Up to 15 kW

The standard design for the City duplex pump stations consists of a customized fabricated wet-well with electrical and controls in an above ground kiosk. This design represents the majority of the existing City pump stations.

A key feature of these stations is the inlet pipe(s) that enter the wet-well tangentially submerged. Three key parameters must be met to ensure that these pipes are capable of delivering the flow rate demanded by the pump and to ensure that during pump draw down the pipe(s) receive sufficient scouring action:

1) The inlet pipe flow capacity at 50% depth must equal the maximum pumping rate (with one pump running) for the station.
2) The velocity in the inlet pipe(s) at 20% depth is at least 0.9 m/s.
3) The distance between the invert of the inlet pipe(s) and the pump off elevation must ensure sufficient volume exists to fully drain the inlet pipe(s) without cycling the pumps on and off. A minimum distance of 100mm is required.

The volume outlined in the third parameter is equal to the volume that remains in the inlet pipes at the depth when the pump rate exceeds the pipe conveyance capacity.

The minimum distance between pump starts and stops must be based on a maximum of 10 pump starts per hour per pump (total of 20 starts per hour for two alternating pumps) at an

inflow rate equal to half the pump discharge capacity. The submerged volume within the inlet pipes may be included in the operating volume.

Category 2: Other Stations

For stations that are not covered by Category 1 specific design requirements must be determined by the Consultant and approved by the Manager of Engineering Design and Construction.

4.5 Controls and Operation

Category 1: Duplex Stations Up to 15 kW

Category 1 pump stations are to operate as a duplex pumping station, alternating pumps with each cycle. Each station is to include a sonic level sensor that is the primary sensor for pump starts and stops, low level alarm, and continuous level monitoring. A high level float is required as a back-up control. In addition temperature sensors are to be provided on each pump to monitor overheating and a magnetic flow meter installed to provide continuous flow measurement.

In the event of a power failure each station is to be equipped with connectors that conform to requirements of the City portable generators.

Ventilation at each station is to be by forced air using a fixed speed fan that runs continuously. The minimum ventilation rate is to be 12 air changes per hour or higher if required for safety considerations. Ventilated air is to be exhausted through the hatch lids and into the gravity sewer during pump operation.

Communication between the City SCADA system and the pump station is via radio transmission. The Consultant shall verify and identify any radio path issues at the pre-design stage.

Category 2: Other Stations

The requirements for controls and operations of Category 2 stations should be developed by the Consultant and approved by the Manager of Engineering Design and Construction. In general the control logic should conform to the philosophy implemented at Category 1 stations. For pumps over 15 kW (20 HP) the Consultant shall give consideration to including soft start and stop controls.

4.6 Seismic and Settlement Design

A geotechnical investigation is required for each pump station. This investigation must include consideration for both engineering design and construction issues. Included in the investigation must be the assessment of liquefaction potential during seismic activities and long term settlement potential. Where preloading of the pump station site is required it shall extend sufficiently beyond the boundary of the site area so as to prevent movement of the pump station from future preloading of abutting properties.

To ensure the stations have a reasonable level of protection during long term settlement and seismic activities each station is to provide the following:

1) Force main and gravity sewer connections are to be designed to allow for up to 300mm of vertical ground movements.
2) Wet well and electrical kiosk foundations sized to prevent overturning.

4.7 Site Design

The site design of each pump station should give consideration for the local area. This must include right-of-way, construction easement, and long term maintenance access requirements. The site plan must indicate how the station grading ties into the adjacent sites. All site drainage must be directed away from the wet-well and kiosk. Landscaping of the site should suit the local area. Special requirements for landscaping, if applicable, will be provided by the Manager of Engineering Design and Construction. Protection in the form of bollards or other means must be provided where appropriate to ensure accidental damage risk is limited.

Sufficient space must be provided to:

1) Allow maintenance vehicles to park off of the travelled roadway.
2) Allow for safe movement of vehicles entering and exiting the site.
3) Allow lifting equipment to park sufficiently close to hatches to permit the removal of pumps.
4) Allow for sufficient access to deliver, connect, and operate the portable generator.

Site access must be provided from the public roadway unless otherwise approved by the Manager of Design and Construction.

A water service connection must be provided to each site in accordance with the typical drawings. Sufficient access must be provided to allow City crews room to connect a portable backflow preventor and washdown hose.

APPENDIX A

Pre-Design Report Sample Table of Contents

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Appendix A Geotechnical Report

Appendix B Calculations

APPENDIX B

Standard Pump List

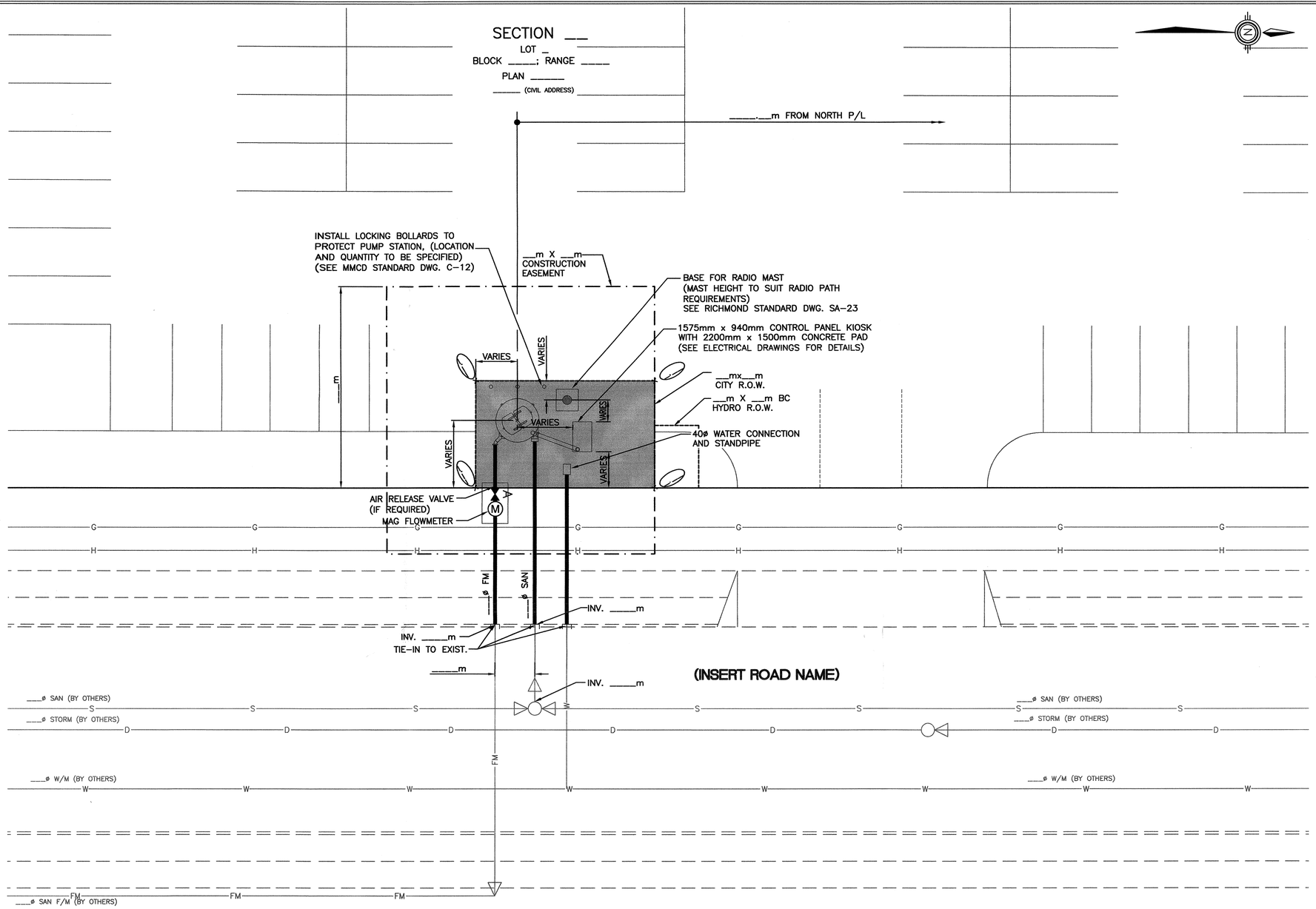
CITY OF RICHMOND STANDARD PUMPS

Flygt		KSB		Ingersoll Dresser	
Pump	Impeller	Pump	Impeller	Pump	Impeller
CP3102	432				
CP3127	432				
CP3152	432				
CP3201					

APPENDIX C

Typical Drawings

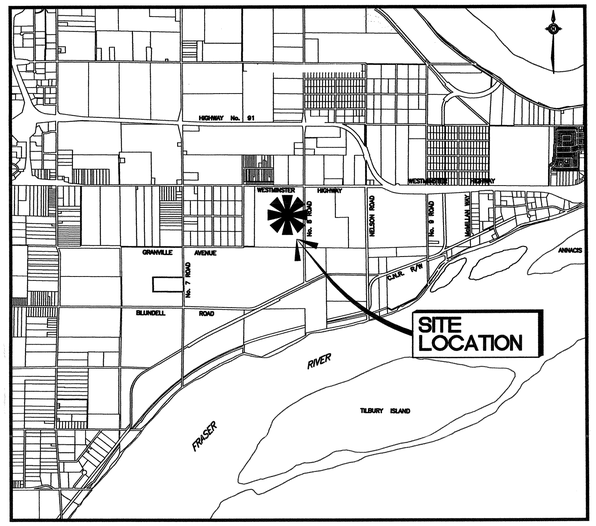
SECTION ___
LOT _
BLOCK _____; RANGE _____
PLAN _____
_____ (CIVIL ADDRESS)



SECTION ___
BLOCK _____; RANGE _____
LOT _
REM PCL _
REF PLAN ___
PLAN _____
_____ (CIVIL ADDRESS)

DETAIL "A"
SCALE 1:125

0 5 10
Meters



LOCATION PLAN

GENERAL NOTES:

1. ALL CONSTRUCTION MATERIALS TO BE IN ACCORDANCE WITH CITY OF RICHMOND SUPPLEMENTARY SPECIFICATIONS AND DETAIL DRAWINGS, AND WITH THE CURRENT CITY APPROVED EDITION OF THE MMCD STANDARDS AND SPECIFICATIONS UNLESS OTHERWISE NOTED.

2. CITY APPROVAL TO BE OBTAINED PRIOR TO CONNECTION TO EXISTING SYSTEM AND CONNECTION TO BE CARRIED OUT UNDER CITY INSPECTOR'S SUPERVISION.

3. REPORT ANY DISCREPANCIES TO THE ENGINEER PRIOR TO CONSTRUCTION.

4. MARK ALL CAPPED STUB ENDS WITH STAKES.

5. CONTRACTOR TO CONFIRM PUMP STATION PAD ELEVATIONS WITH CITY OF RICHMOND PRIOR TO CONSTRUCTION. PAD TO BE GRADED TO ENSURE DRAINAGE AWAY FROM WETWELL, KIOSK AND OTHER PHYSICAL STRUCTURES.

6. FOR TYPICAL TRENCH DETAIL, SEE MMCD STANDARD DWGS G4.

7. ALL EXISTING ROAD STRUCTURES AFFECTED BY THE WORKS SHALL BE REINSTATED BY CONTRACTOR TO THE SATISFACTION OF CITY OF RICHMOND.

8. CONTRACTOR SHALL PROVIDE 24 HOURS NOTICE TO ENGINEER PRIOR TO CONDUCTING LEAKAGE TESTING OF THE FORCEMAIN. TESTING TO CONFORM TO CITY OF RICHMOND REQUIREMENTS.

FOR APPROVAL
MAR 2 1 2003
URBAN SYSTEMS

B.C. GAS SERVICES

THE DEVELOPER OR CONTRACTOR SHALL BE RESPONSIBLE FOR DETERMINING EXISTING LOCATION OF GAS SERVICE LINES, AND WHERE NECESSARY ARRANGE FOR THEIR RELOCATION IN ORDER TO FACILITATE INSTALLATION OF THE WORKS SHOWN ON THESE PLANS. A LIST OF SERVICE LINE LOCATIONS MAY BE OBTAINED FROM:

B.C. GAS SERVICE RECORDS DEPARTMENT
TELEPHONE 293-8552

NOTE- B.C. GAS REQUIRES 10 DAYS NOTICE PRIOR TO THE COMMENCEMENT OF ANY WORK.

BENCHMARK

ALL ELEVATIONS ARE TO GEODETIC DATUM AND REFER TO RICHMOND BENCHMARK NUMBER:

ELEVATION _____ FIELD BOOK Nº _____

CITY WORK ORDER Nº _____ TENDER / PROJECT Nº _____

CONTRACTOR WORK ORDER Nº _____ ACCOUNT Nº _____

REFERENCE DRAWINGS

PROPERTY ACQUISITION	Aq
SURVEY PLAN & PROFILE	PP
ROAD CONSTRUCTION	Oc
STORM SEWER INSTALLATION	Lc
WATERMAIN INSTALLATION	Wc
ORNAMENTAL STREET LIGHTING	Tc
TRAFFIC SIGNALS	Ec
SANITARY SEWER INSTALLATION	
OTHER	

NOTE- PROVE LOCATION OF ALL UTILITIES / SERVICES BEFORE STARTING CONSTRUCTION.

Nº	DATE	BY	CH.	DESCRIPTION
H				
G				
F				
E				
D				
C				
B				
A	MAR. 21, 2003	S.B.	D.K.	CITY APPROVAL

REVISIONS

City of Richmond
6911 No. 3 ROAD RICHMOND B.C. V6Y 2C1

TITLE: RICHMOND SANITARY SEWERS
ALL AREAS
TYPICAL PUMP STATION (15 kw
INFLUENT SEWERS AND FORCEMAIN

DESIGN:	S. BRUBACHER	DWG. Nº: TYPICAL	
DRAWN:	D. Barry		
CHECKED:	D.KIRSOP	SCALE: AS NOTED	DATE: March, 2003
ENGINEER:	S. BRUBACHER	SEC. Nº: N/A	SHT. Nº: 1 OF 3

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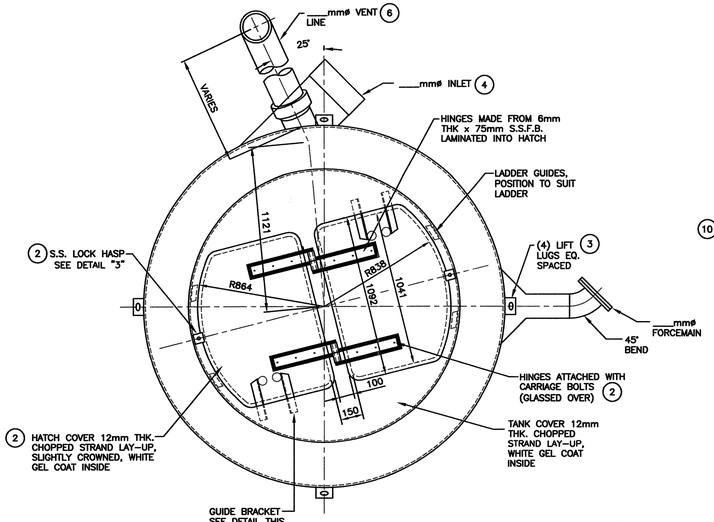
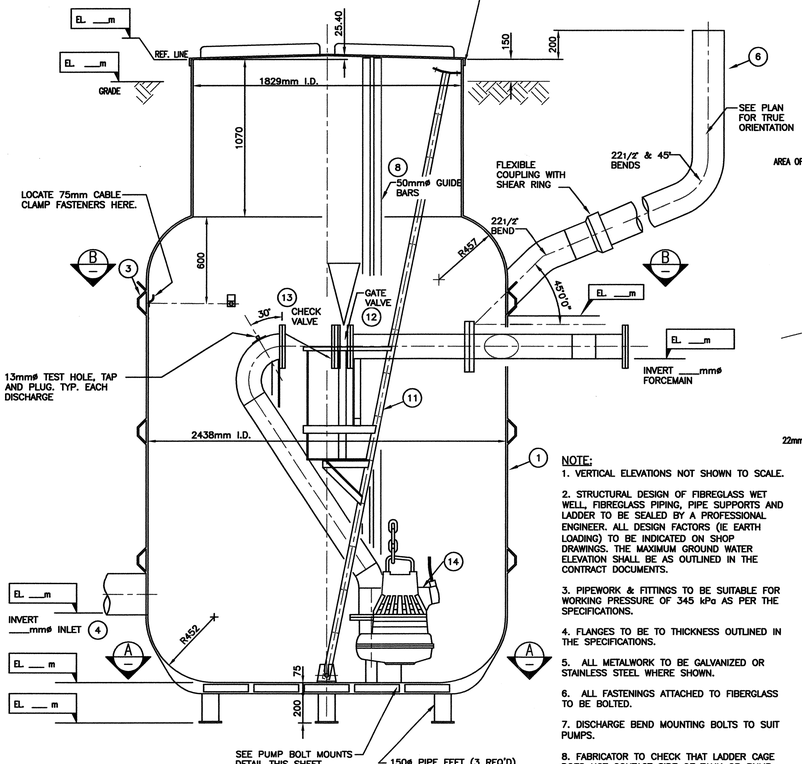


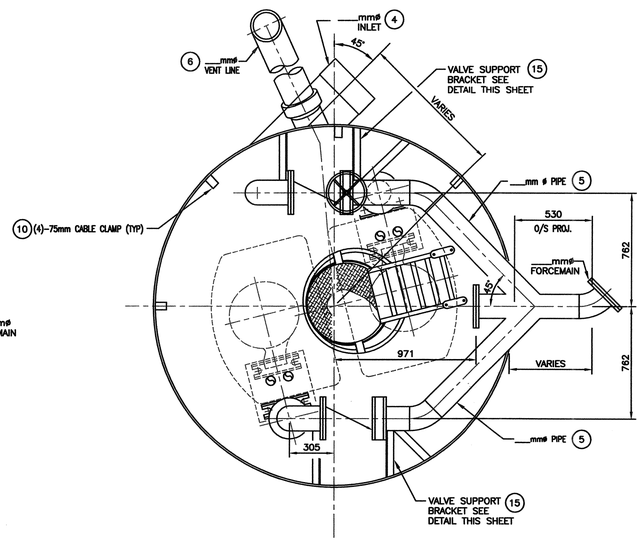
PLAN



ELEVATION

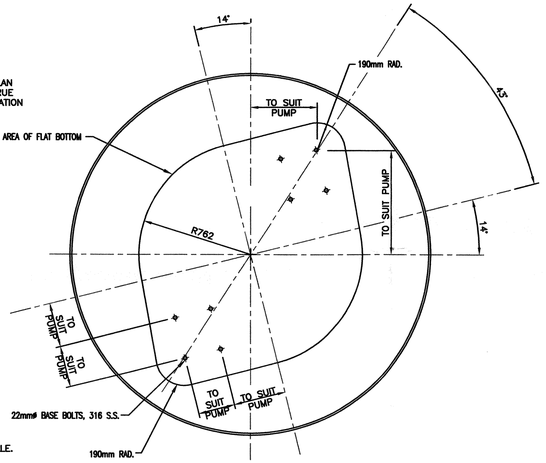
SCALE N.T.S.

NOTE: SEE PLAN VIEW FOR TRUE ORIENTATION



SECTION "B-B" – PUMPS LAYOUT

SCALE 1:20



SECTION "A-A" – BASE LAYOUT

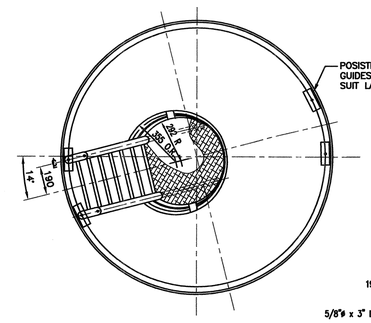
SCALE 1:20

NOTE:

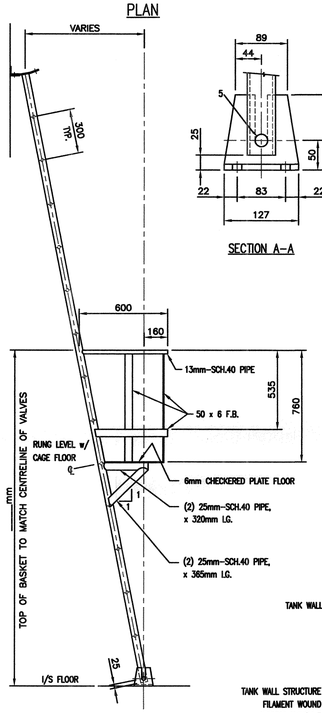
1. VERTICAL ELEVATIONS NOT SHOWN TO SCALE.
2. STRUCTURAL DESIGN OF FIBREGLASS WET WELL, FIBREGLASS PIPING, PIPE SUPPORTS AND LADDER TO BE SEALED BY A PROFESSIONAL ENGINEER. ALL DESIGN FACTORS (IE EARTH LOADING) TO BE INDICATED ON SHOP DRAWINGS. THE MAXIMUM GROUND WATER ELEVATION SHALL BE AS OUTLINED IN THE CONTRACT DOCUMENTS.
3. PIPEWORK & FITTINGS TO BE SUITABLE FOR WORKING PRESSURE OF 345 kPa AS PER THE SPECIFICATIONS.
4. FLANGES TO BE TO THICKNESS OUTLINED IN THE SPECIFICATIONS.
5. ALL METALWORK TO BE GALVANIZED OR STAINLESS STEEL WHERE SHOWN.
6. ALL FASTENINGS ATTACHED TO FIBERGLASS TO BE BOLTED.
7. DISCHARGE BEND MOUNTING BOLTS TO SUIT PUMPS.
8. FABRICATOR TO CHECK THAT LADDER CAGE DOES NOT CONTACT SIDE OF TANK OR PUMP GUIDE RAILS DURING SWINGING ACTION. ADJUST DIMENSIONS TO SUIT. LADDER TO SWING ALONG CENTRE LINE OF ACCESS HATCHES.
9. PUMP STATION FLOOR TO BE SUFFICIENTLY STIFF TO PREVENT BUCKLING UNDER HYDRO-STATIC UPLIFT FORCE.
10. PUMP STATION PIPE FEET AND ATTACHMENTS TO BE REINFORCED TO PREVENT EITHER TEAR OUT OR PUNCH THROUGH.

BILL OF MATERIALS

ITEM	QTY	DESCRIPTION
1	1	Fibreglass Wetwell (By Barski Industies, Chemposit or Approved Equal.
2	2	Fibreglass Hatches c/w 304 SS Double Hinges 4 Lock Hasps.
		Lock to be Supplied and Keyed to Richmond Standards.
3	4	Lifting Lugs, Galvanzied
4	1	___mmø Inlet, Machine to SDR-35 PVC Pipe
5	1	___mm x ___mm x ___mm WYE Discharge Pipe, FRP,
		c/w ___mm CleanoutT w/ Blind, FRP,
		and (2)-___mmø Riser Pipes, FL x FL, FRP
6	1	___mmø Vent, FRP c/w Flexible Coupling (Minimum 200ø)
7	4	___mmø Pump Base Mount
8	4	___mmø Pipe Guide Bars (Galvanized) c/w Upper Guide Bar Holder & Top Bracket
9	3	150mmø Pipe x 200mm LG. Feet Capped One End, FRP
10	4	75mm Cable Clamps
11	1	Ladder Assembly c/w Cage, Mounting Bracket & Top Bracket
12	2	150ø SS Knife Gate Valve
13	2	150ø Valmatic Swing FLEX Check Valve or Approved Equal
14	2	Pumps
15	4	Aluminum Valve Support Brackets.



PLAN

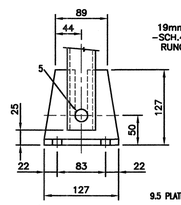


LADDER & CAGE ELEVATION

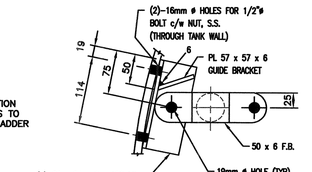
(1) REQ'D.

NOTE: ASSEMBLY TO BE GALVANIZED

SCALE – N.T.S.



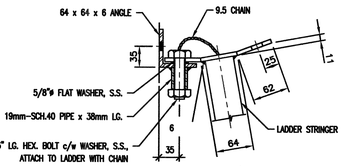
SECTION A-A

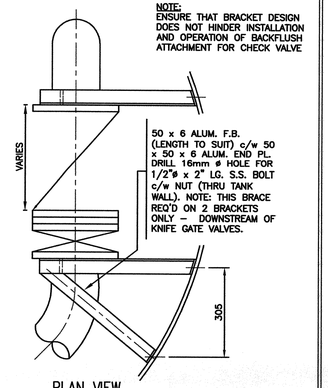


TOP BRACKET DETAIL

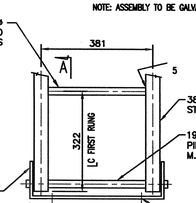
(2) REQ'D.

NOTE: ASSEMBLY TO BE GALVANIZED





PLAN VIEW

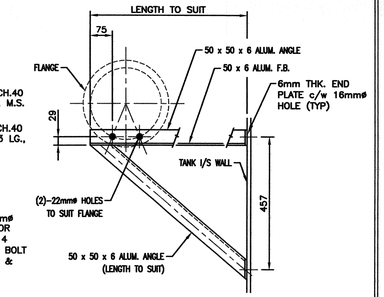


A

LADDER MOUNTING BRACKET

(1) REQ'D.

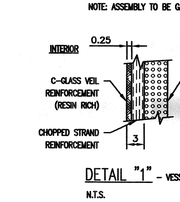
NOTE: ASSEMBLY TO BE GALVANIZED



VALVE SUPPORT BRACKETS – ELEVATION VIEW

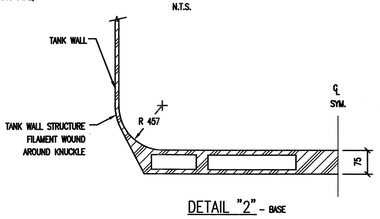
(4) REQ'D.

NTS



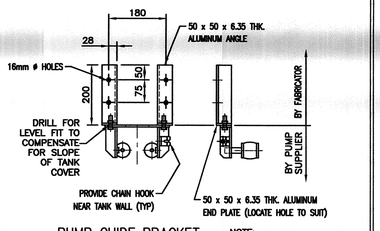
DETAIL "1" – VESSEL WALL

N.T.S.



DETAIL "2" – BASE

NTS

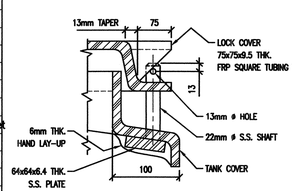


PUMP GUIDE BRACKET

(TO SUIT PUMP)

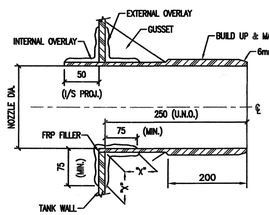
(2) REQ'D.

NOTE: UPPER GUIDE BAR HOLDERS TO BE INSTALLED AFTER DISCHARGE BEND IN POSITION AND GUIDE BARS PLUMBED



DETAIL "3" – LOCK HASP

N.T.S.

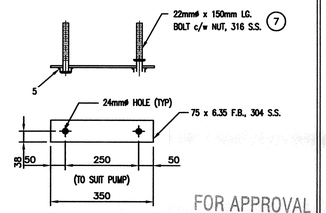


DETAIL "4" – TYPICAL NOZZLE, MACHINED OR FLANGED

N.T.S.

NOZZLE NOTES

A MINIMUM OF 2 LAYERS OF WOVEN ROVING IS REQUIRED FOR NOZZLE PORTION OF OVERLAY. TANK PORTION OF OVERLAY SHALL BE SAME THICKNESS AS TANK WALL. DIMENSION "X" SHALL BE GREATER THAN ONE HALF THE NOZZLE DIAMETER. INTERNAL OVERLAY TO HAVE A MINIMUM OF 2 LAYERS MATT. FRP REINFORCING MATERIAL TO BE CUT TO A SHAPE TO ENSURE A SMOOTH LAMINATE.



PUMP BOLT MOUNTS

(4) REQ'D.

FOR APPROVAL

MAR 21 2003

URBAN SYSTEMS

B.C. GAS SERVICES

THE DEVELOPER OR CONTRACTOR SHALL BE RESPONSIBLE FOR DETERMINING EXISTING LOCATION OF GAS SERVICE LINES, AND WHERE NECESSARY ARRANGE FOR THEIR RELOCATION IN ORDER TO FACILITATE INSTALLATION OF THE WORKS SHOWN ON THESE PLANS. A LIST OF SERVICE LINE LOCATIONS MAY BE OBTAINED FROM:

B.C. GAS SERVICE RECORDS DEPARTMENT

TELEPHONE 293-8552

NOTE– B.C. GAS REQUIRES 10 DAYS NOTICE PRIOR TO THE COMMENCEMENT OF ANY WORK.

BENCHMARK

ALL ELEVATIONS ARE TO GEODETIC DATUM AND REFER TO RICHMOND BENCHMARK NUMBER:

ELEVATION _____ FIELD BOOK Nº _____

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CONTRACTOR WORK ORDER Nº _____ ACCOUNT Nº _____

REFERENCE DRAWINGS

PROPERTY ACQUISITION	Aq
SURVEY PLAN & PROFILE	PP
ROAD CONSTRUCTION	Oc
STORM SEWER INSTALLATION	Lc
WATERMAIN INSTALLATION	Wc
ORNAMENTAL STREET LIGHTING	Tc
TRAFFIC SIGNALS	Ec
SANITARY SEWER INSTALLATION	
OTHER	

NOTE– PROVE LOCATION OF ALL UTILITIES / SERVICES BEFORE STARTING CONSTRUCTION.

Nº	DATE	BY	CH.	DESCRIPTION
H				
G				
F				
E				
D				
C				
B				
A	MAR. 21, 2003	S.B.	D.K.	CITY APPROVAL

REVISIONS

City of Richmond

6911 No. 3 ROAD RICHMOND B.C. V6Y 2C1

TITLE: RICHMOND SANITARY SEWERS
ALL AREAS
TYPICAL PUMP STATION < 15 kw
STRUCTURAL ARRANGEMENT

DESIGN:	S. BRUBACHER	DWG. Nº:	TYPICAL
DRAWN:	D. Barry		
CHECKED:	D.KIRSOP	SCALE: AS NOTED	DATE: March, 2003
ENGINEER:	S. BRUBACHER	SEC. Nº: N/A	SHT. Nº: 2 OF 3

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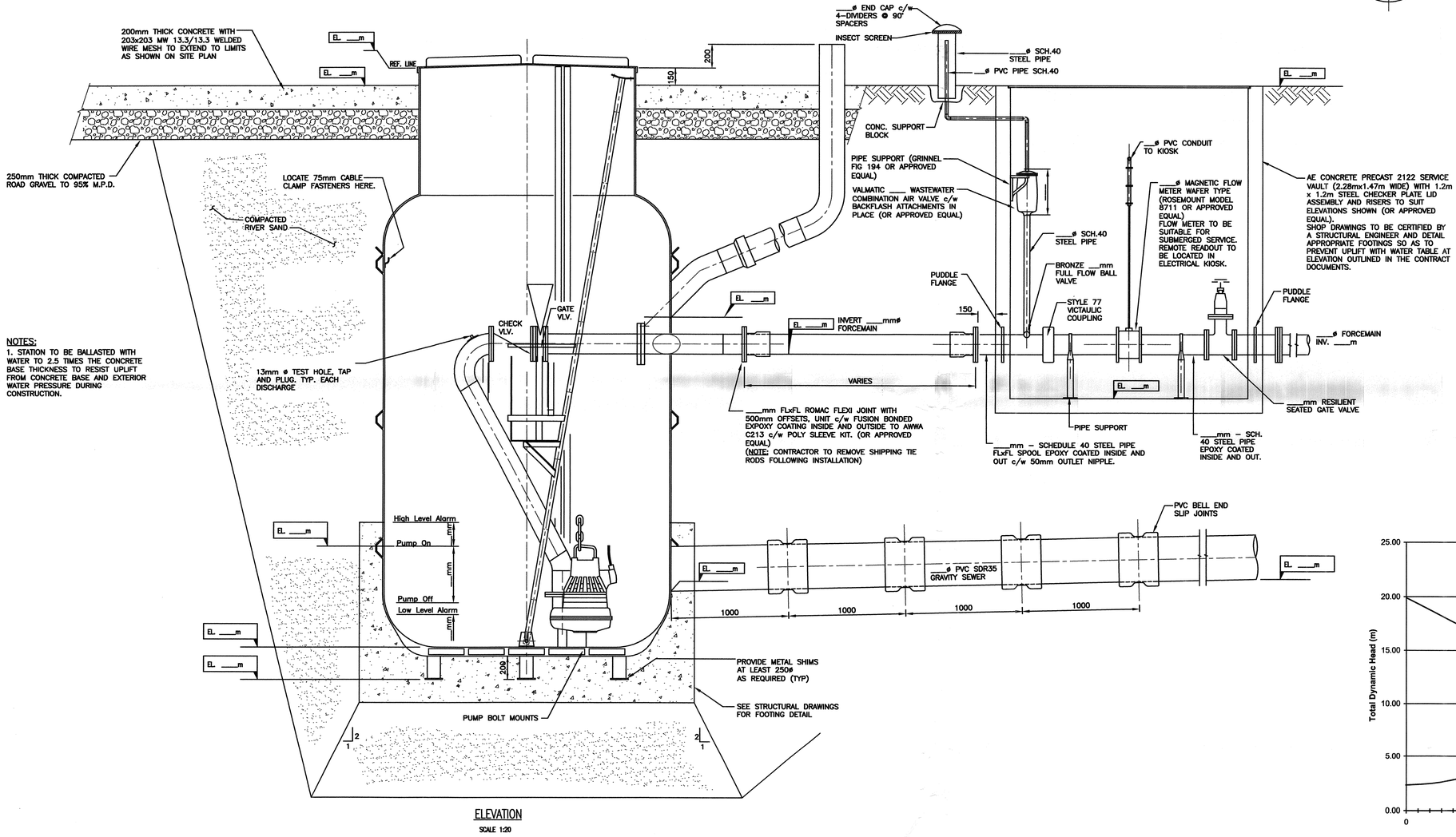
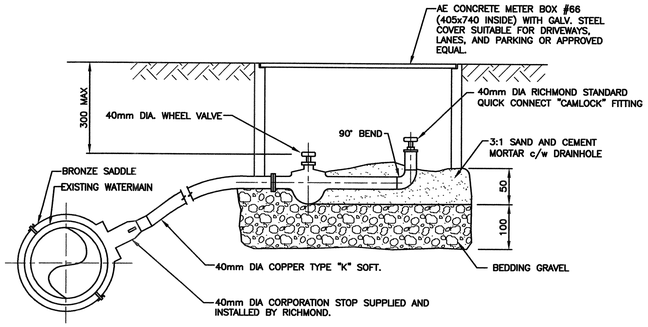


ELEVATION

SCALE 1:20

NOTES:

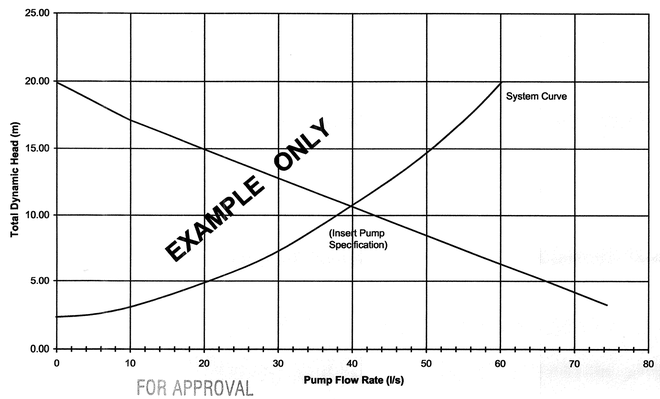
1. STATION TO BE BALLASTED WITH WATER TO 2.5 TIMES THE CONCRETE BASE THICKNESS TO RESIST UPLIFT FROM CONCRETE BASE AND EXTERIOR WATER PRESSURE DURING CONSTRUCTION.



STANDPIPE DETAIL

SCALE N.T.S.

THE REQUIREMENT FOR THE INSTALLATION OF A BACK FLOW PREVENTOR OR 300mm AIR GAP ABOVE MAXIMUM WATER LEVEL WITHIN THE CHAMBER MUST BE REVIEWED AND APPROVED BY THE MANAGER OF DESIGN AND CONSTRUCTION PRIOR TO FINALIZING THE DESIGN.



FOR APPROVAL

MAR 2 1 2003

URBANSYSTEMS

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TRAFFIC SIGNALS	Ec
SANITARY SEWER INSTALLATION	
OTHER	

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REVISIONS

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City of Richmond
6911 NO. 3 ROAD RICHMOND B.C. V6Y 2C1

TITLE: RICHMOND SANITARY SEWERS
ALL AREAS
TYPICAL PUMP STATION < 15 kw
INSTALLATION DETAILS

DESIGN:	S. BRUBACHER	DWG. Nº:	TYPICAL
DRAWN:	D. Barry		
CHECKED:	D.KIRSOP	SCALE: AS NOTED	DATE: March, 2003
ENGINEER:	S. BRUBACHER	SEC. Nº: N/A	SHT. Nº: 3 OF 3

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APPENDIX Q: City of Surrey Design Criteria Manual

CITY OF SURREY
Engineering Department

DESIGN CRITERIA MANUAL
MAY 2004

City of Surrey

Design Criteria

USERS REGISTRATION FORM

FAX BACK AT 604-591-8693

Document holders must complete this registration form and forward by fax to the City's Utilities Manager at (604) 591-8693 to receive updates and information pertaining to the document if any are issued. Please verify the City of Surrey web site before using this document to ensure you are using the most up-to-date version.

BUSINESS NAME: _____

_____

CONTACT: _____

BUSINESS ADDRESS: _____

_____

_____

TELEPHONE: _____

FAX: _____

INTERNET E-MAIL ADDRESS: _____

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SECTION 1

Introduction

1.0 INTRODUCTION

1.1 The Use of this Design Criteria Manual

This Design Criteria Manual has been updated and replaces all previous versions and revisions. Always verify that you are using the most recent version.

1.2 Intent of these Standards

This manual has been prepared for providing guidelines to the Engineering Designer and the development industry in the design of engineering servicing facilities and systems of the City of Surrey.

It is intended to provide the minimum design criteria and standards for proposed works. The onus is on the Engineering Designer to ensure that their designs meet accepted engineering principles and are adequate for the site conditions and their accepted use.

The City does not have the staffing resources to review design submission and expressly relies on the Engineering Designer for professional expertise and thorough review of their submission.

1.3 Application of these Design Criteria

The guidelines and performance standards defined in this manual shall apply to:

- the preparation of all engineering designs and drawings for;
- execution of,

projects in the City of Surrey.

These standards are set out as the minimum requirements and shall not be considered a rigid requirement where variations acceptable to the City will achieve better technical and economical solutions. Engineering Designers are encouraged to seek innovative and superior solutions where appropriate. A Design Engineer who wishes to adopt criteria not specifically included in or variant from those within this manual, shall justify the proposed change in a letter/report prepared, signed and sealed by a professional engineer. Submissions must demonstrate that the proposed change is equivalent to or better than these guidelines. The letter/report shall be submitted to the City Engineer (Engineer) for review and approval, prior to acceptance of the proposed change.

In spite of using these standards and specifications, the Developers and their Consulting Engineers remain fully responsible for the design and construction of municipal infrastructure utilities according to good engineering standards adequate to address the specific needs and site conditions of their project.

The Engineering Designer must be satisfied that the design criteria contained herein are applicable to the project at hand, and must apply more stringent criteria where appropriate. The Developers and Engineering Designers are fully responsible for designing to standards which exceed these standards when specific site conditions dictate that more stringent performance measures are required.

All design and construction details for City infrastructure services shall be in accordance with this Design Criteria Manual, and with the Standard Construction Documents (General Conditions, Supplementary Specifications and Supplementary Standard Drawings), and with the most recent Master Municipal Construction Documents - Volume II - Specifications and Standard Detail Drawings, as adopted by the City, all referred to in the Design & Construction Standards of the Surrey Subdivision and Development By-law.

Where conflicts or discrepancies may appear between 'similar' drawings and/or specifications prepared by the City of Surrey and those presented in the Master Municipal Construction Documents, the Designer shall review the conflict or discrepancy with the Engineer and shall obtain the Engineer's approval for the correct drawing and/or specification before proceeding.

1.4 Revisions to this Design Criteria Manual

The criteria and design parameters contained in the manual are subject to constant review and re-evaluation and the Engineer reserves the right to initiate revisions or additions to these criteria as and when he deems it is necessary to make such revisions.

The Engineer encourages submissions from Design Engineers at large wishing to amend the City's Design Criteria. Such submissions shall be in a report format, signed and sealed by a professional engineer, and shall include clear and succinct expressions of concern, suggestions for alternatives including their economic, engineering and environmental benefits, and, recommendations proposed to address improvements to the current Design Criteria.

The Engineer may, at his sole discretion, review, assess and accept or adopt in whole or in part, the submissions and/or the recommendations from a Design Engineer for inclusion within the Design Criteria Manual at a future date.

1.5 Interpretation of the Design Criteria

The City reserves the right to the final decision with regard to the interpretation of the intent of the Design Criteria and these standards, and with regard to the acceptability of changes from the standards, or of standards proposed by the Engineering Designer.

Final decisions, interpretations and approvals will be given by the Engineer.

1.6 Statutory Requirements for Approvals by Other Authorities and the City of Surrey

The Engineering Designer shall remain responsible for compliance with all the statutory requirements of other relevant authorities which are mandated to regulate and approve such works and shall arrange for and secure all approvals from the appropriate authorities.

Where this Design Criteria Manual refers to: by-laws, acts, regulations and standards, this shall mean the most recent edition or amendment of the referenced document.

Where due to amendment of statutory requirements, conflicts or inconsistencies with this Design Criteria Manual arise, the Engineering Designer is to be responsible for applying the more stringent requirement, and shall refer the issue to the Engineer.

1.7 Certifications

Design Engineers offering their services, directly to the City or through Developers, shall accept responsibility for their designs by completing and attaching the following statement to their design notes and design drawings:

> "I ..... Professional Engineer, in good standing in and for the Province of British Columbia, hereby certify that the works as herein set out on the attached drawings have been designed to good engineering standards and in accordance with the latest edition of the City of Surrey Design Criteria Manual, the Master Municipal Construction Documents (MMCD), and the City of Surrey Standard Construction Documents (General Conditions, Supplementary Specifications and Supplementary Standard Drawings), adopted by the City of Surrey.
>
> .....……
> (Signature)

SECTION 2

General

2.0 GENERAL

2.1 General Items

A. Glossary of Terms

The following terms found in the Design Criteria Manual shall have the meanings indicated herein:

"**City**" shall mean the City of Surrey as a corporate body, or the Engineering Department, as represented by the **Engineer**.

"**Engineer**" shall mean the professional Engineer authorized by the General Manager of the Engineering Department to **review and accept**, on behalf of the Engineering Department: proposals, reports, documents, design submissions, and detailed engineering drawings pertinent to infrastructure utilities to be incorporated in the City.

"**Consultant**", "**Engineering Consultant**", "**Consulting Engineer**", "**Design Engineer**", "**Engineering Designer**", "**Engineer of Record**", "**Designer**" and "**Contract Administrator**" shall mean the professional Engineers, singularly or jointly, responsible for the preparation of: proposals, reports, associated documents, design submissions and detailed engineering designs and drawings, and for the execution and the implementation of such designs for infrastructure utilities and services to be incorporated in the City.

"**Developer**" shall mean the proponent of a land development proposal, or the **Owner** as defined in a Servicing Agreement. Requirements of the Developer stated in this manual, or standards, may, where appropriate, apply to an Engineering Consultant or Contractor acting on the Developer's behalf.

"Specifications" shall mean the Master Municipal Construction Documents (MMCD, 2000) Volume II - Specifications, and the City of Surrey 'Standard Construction Documents – Supplementary Specifications', latest revision, including all amendments and appendices.

"Standard Drawings" shall mean the Master Municipal Construction Drawings (MMCD, 2000), Volume II - Specifications - Standard Detail Drawings, City of Surrey - Standard Drawings, and the City 'Standard Construction Documents – Supplementary Standard Drawings', latest revision, including all amendments.

"**Unique Designated Areas**" shall mean particular areas in the City which have been given a special designation due to their unique nature, community, geography or topography which require some 'particular design criteria' pertaining to municipal infrastructure utility services.

B. Existing Services

Existing service information is available from the City. These records are made available on the understanding that the City cannot, and does not, guarantee their accuracy. The Design Engineer or user of such information shall make appropriate verification to ensure the accuracy of critical details.

C. Expansion of the City's Infrastructure Systems and Extensions of Mains

Expansion of the City's infrastructure systems or extensions of mains from the existing systems shall be in strict compliance with the appropriate **Extension Regulation By-laws** applicable to the proposed extensions.

D. Approved Materials and Products

Materials and Products which are approved for use in the City are published in the City of Surrey, Supplementary Master Municipal Construction Documents. Some references to materials and products may be made in this Manual, the Supplementary Specifications, or on the Supplementary Standard Drawings. If the appropriate use of certain materials or products is in doubt, confirm the acceptance of the material or product with the Engineer prior to its incorporation into a design.

E. Units

The units for all design and construction shall be SI (International System of Units), and shall conform to the Canadian Metric Practice Guide, CSA CAN3-Z234.1.

F. Drawing Preparation

Engineering drawings, details sketches and digital files prepared for submission to the City must conform to the City of Surrey's Construction Drawing Standards and Digital Infrastructure Data Standards and are required to contain the following data:

- graphics of existing services;
- graphics and annotations of the proposed services;
- attributes of the proposed services;
- information pertaining to the description of the project and the consulting engineering company.

The data provided by the City will be based on NAD83 (NMIP93) with UTM grid coordinates. The proposed data must be based on the same projection and shown in its true geographic location.

2.2 Servicing Requirements Related to Zone

The minimum type of services required under various zones shall be in accordance with the following Table 1, Table 2 and Table 3, unless otherwise provided for in the Subdivision and Development By-law.

Table 2.1
Servicing Requirements

Land Use	*Zoning By-law 5942*	**Water**	**Sanitary Sewer**	**Drainage**	**Wiring**	**Highway Dedication, Pavement Width & Sidewalks**	**Street Lighting**
A-1, A-2	*A-1,A-2,A-3*	1 or 2	4	O	OH	Table 2	SL-IO
RA	*RS*	1 or 6	4	5	OH	Table 2	SL-IO
RA-G	*R-A(G)*	1	4	5	OH	Table 2	SL
RH, RH-G, RC, RF, RF-9, RF-12, RF-SS, RF-SD, RF-G, RM-D, RM-M, RM-10, RM-15, RM-19, RM-30, RM-45, RM-70, RM-135, RMC-135, RMC-150	*R-1,R-H(G),R-F, R-F(R), R-F(F), RF-SS, R-F(C), R-F(D), R-F(M), RT-1, RM-1, RM-2, RM-3, RM-4, RFR-SS*	1	3	5	UG	Table 2	SL
C-4,C-5,C-8,C-8A,C-8B, C-15, C-35, CHI, CG-1, CG-2,CTA	*C-L, C-S, C-R(1), C-R(2), C-R(3), C-R(4), C-C, C-H, C-G(1), C-G(2), C-T(1) C-T(2), C-G*	1	3	5	UG	Table 2	SL
IB	*I-1, I-P(2), I-G, I-C*	1	3	5	UG	Table 2	SL
IL,IH	*I-4, I-S, I-T, I-W, I-H*	1	3	5	U/O	Table 2	SL
IS	*I-L(S)*	1	4	5	OH	Table 2	SL
IA	*I-A*	1 or 2	3 or 4	5	U/O	Table 2	SL
PC, PA-1, PA-2, PI, CCR, CPR, CPG, CPM, RMS-1, RMS-1A, RMS-2	*P-C, P-A, P-P(1), P-P(2), P-R, P-D, P-P,*	To the standards of the surrounding Zone					
All zones in South Westminster and Bridgeview (as shown in the Standard Drawings)		1	3	FD	OH	Table 2	SL
All zones in West Panorama Ridge (as shown in the Standard Drawings)		1	3 or 4	7	UG	Table 2	SL - PR

Notes To Abbreviations In Table 2.1

O: Open ditch drainage system.

OH: Overhead wiring for electrical and telecommunications wiring.

UG: Underground wiring for electrical and telecommunications wiring.

For single family residential, all electrical and telecommunications wired service lines must be located underground except as hereinafter provided:

1. Subdivision is on the same side as a 'major existing overhead hydro plant' (3-phase primary).

   Overhead service connections will be permitted on those lots on the same side as an existing major overhead hydro plant.

2. Subdivision is on same side as existing overhead pole line.

   Overhead service connections will be permitted where a subdivision is

   (i) on the same side of the street as an existing overhead pole line, and

   (ii) more than two-thirds of the block length* of that side of the street is developed to OCP density and has overhead wiring.

   * A block length is 200 m minimum.

   The above exceptions are only applicable where the street has NOT been identified as an underground electrical beautification project area by the City.

U/O: Underground wiring for electrical and telecommunications wiring except for overhead primary power distribution.

SL: Street lighting to the criteria in the Design Criteria Manual.

SL-IO: Street lighting at intersections only.

SL-PR: Low profile street lighting at intersections of collector & arterial roads and in front of public buildings only.

FD: Modified French drain - ditch drainage system.

1: Water supply from the City distribution system to the criteria the Design Criteria Manual, proposes to achieve.

2: Each parcel shall have a proven source of water meeting the most recent Drinking Water Quality Standards of the Province of British Columbia, and of sufficient quantity to provide a continuous flow of 2300 litres per day, all as certified by a Hydrogeologist registered in and for the Province of British Columbia.

3: Sanitary sewage collection system connected to the City trunk sewage mains.

4: A sewage disposal system meeting the requirements of the Regional Health Board.

5: Drainage system as specified in the Design Criteria Manual.

6: Where a proposed subdivision in an RS or RA Zone does not involve the extension of a water main, but fronts an existing water main which is unable to provide the fire flow specified in the Design Criteria Manual, but is able to provide at least 30 litres per second in addition to peak day demand as determined by the Design Criteria Manual, subdivision may be permitted, provided that:

(a) the owner has provided to the General Manager, Engineering, a certificate from a Professional Engineer registered in the Province of British Columbia, specializing in fire protection engineering, stating that a structure or structures of particular area, shape, construction materials, and location can be constructed within the proposed subdivision, in conformance with the Fire Underwriters Survey's "Water Supply for Fire Protection - A Guide to Recommended Practice", current edition, and in conformance with the NFPA13D[1] specification, current edition.

[1] National Fire Protection Association

(b) the owner has registered a restrictive covenant in favour of the City of Surrey on the title of all lots created which provides:

In recognition that the City water main servicing this lot is unable to provide the fire flow required by the City's design criteria, the owner agrees:

(i) not to construct or use any dwellings or accessory structures on the lot that are not sprinklered in accordance with the NFPA13D* specification, current edition, and as approved by the engaged Professional Engineer.

(ii) not to construct or allow to be constructed any dwellings or accessory structures on the lot which will require a fire flow in excess of the available fire flow as determined by the Fire Underwriters Survey's "Water Supply for Public Fire Protection - A Guide to Recommended Practice", current edition.

(iii) that all building designs in support of applications for building permits shall be certified by a Professional Engineer specializing in fire protection engineering, attesting that each sprinkler system to be installed provides protection as set out in the NFPA13D* specification, current edition, and that the minimum fire flow calculated following the Fire Underwriters Survey's "Water Supply for Public Fire Protection - A Guide to Recommended Practice", current edition, is equal to or less than the fire flow available to the lot.

(iv) to indemnify and save harmless the City of Surrey, and its administrators, from any and all loss, damages or other expenses in any way arising from or caused by anything done hereunder.

* National Fire Protection Association

7: Open shallow swale drainage system with driveway culverts together with piped storm sewers where flow volumes (five year storm), velocities, existing storm systems or site conditions warrant. Detention pursuant to the Design Criteria Manual.

Table 2.2
Highway Dedication, Pavement Widths And Sidewalks

Land Use **(1)**	*Zoning By-law 5942*	**Road Classification** *Note 1*	**Dedication width (m)** *Note 1*	**Pavement width (m)** *Notes 1&2*	**Number of sidewalks** *Notes 1&3*	**Shoulders or curbs** *Notes 1,4 & 5*
A-1, A-2	*A-1, A-2, A-3*	Limited Local	16.5	6.0	0	shoulders
		Through Local	20.0	6.0	0	shoulders
		Through Collector	20.0	7.3	1	shoulders
		Major Collector	20.0	7.3	2	shoulders
		Undivided Arterial	24.0	7.3	2	shoulders
RA, RA-G, RH,RH-G RC, RF, RF-SS, RF-G, RM-D	*RS, R-A(G) , R-1,R-H(G), R-F,R-F(R), R-F(F), RF-SS, R-F(C), R-F(D), RFR-SS*	Limited Local	16.5	8.0	1	barrier curbs
		Through Local	20.0	8.5	2	barrier curbs
		Through Collector	22.0	12.2	2	barrier curbs
		Major Collector	22.0	12.2	2	barrier curbs
		Undivided Arterial	24.0	14.0	2	barrier curbs
		Divided Arterial	27.0	19.0	2	barrier curbs
RM-M. RM-10, RM-15, RF-12, RF-9, RF-SD, RM-19	*R-F(M),RT-1*	Limited Local	20.0	11.0	1	barrier curbs
		Through Local	20.0	11.0	2	barrier curbs
		Through Collector	22.0	12.2	2	barrier curbs
		Major Collector	22.0	12.2	2	barrier curbs
		Undivided Arterial	24.0	14.0	2	barrier curbs
		Divided Arterial l	27.0	19.0	2	barrier curbs
RM-30, RM-45, RM-70, RM-135, RMC-135, RMC-150	*RM-1.RM-2, RM-3,RM-4*	Limited Local	20.0	11.0	2	barrier curbs
		Through Local	20.0	11.0	2	barrier curbs
		Through Collector	22.0	12.2	2	barrier curbs
		Major Collector	22.0	12.2	2	barrier curbs
		Undivided Arterial	24.0	14.0	2	barrier curbs
		Divided Arterial	27.0	19.0	2	barrier curbs
C-4, C-5, C-8, C-8A, C-8B, C-15, C-35, CHI, CG-1, CG-2, CTA	*C-L, C-S, C-R(1), C-R(2) C-R(3), C-R(4), C-C, C-H C-G(1), C-G(2), C-T(1) C-T(2), C-G*	Limited Local	20.0	11.0	2	barrier curbs
		Through Local	20.0	11.0	2	barrier curbs
		Through Collector	22.0	12.2	2	barrier curbs
		Major Collector	22.0	12.2	2	barrier curbs
		Undivided Arterial	24.0	14.0	2	barrier curbs
		Divided Arterial	27.0	19.0	2	barrier curbs
IB, IL, IH, IS	*I-1,I-P(2), I-G,I-C I-4, I-S, I-T, I-W, I-H I-L(S)*	Limited Local	20.0	11.0	1	barrier curbs
		Through Local	20.0	11.0	1	barrier curbs
		Through Collector	22.0	12.2	1	barrier curbs
		Major Collector	22.0	12.2	2	barrier curbs
		Undivided Arterial	24.0	14.0	2	barrier curbs
		Divided Arterial	27.0	19.0	2	barrier curbs

Table 2.2, continued
Highway Dedication, Pavement Widths And Sidewalks

IA, All zones in South Westminster and Bridgeview (as shown in the Standard Drawings)	*I-A*	Limited Local Through Local Through Collector Major Collector Undivided Arterial	20.0 20.0 22.0 22.0 24.0	11.0 11.0 12.2 12.2 14.0	1 1 2 2 2	barrier curbs barrier curbs barrier curbs barrier curbs barrier curbs
All zones in West Panorama Ridge (as shown in the Standard Drawings)		Limited Local Through Local Through Collector	16.5 20.0 20.0	6.0 6.0 7.3	0 0 0	shoulders shoulders shoulders
All grid zones			20.0			

(1) CD Zones: Highway Dedication, Pavement Widths and Sidewalks shall conform to the applicable land use as per this Table.

Table 2.3
Highway Dedication, Pavement Widths And Sidewalks
Alternative Local Roads Standards
(Neo-Traditional Road Sections)

Land Use **(1)**	*Zoning By-law 5942*	**Road Classification** *Note 1*	**Dedication width (m)** *Note 1*	**Pavement width (m)** *Notes 1&2*	**Number of Sidewalks** *Notes 1&3*	**Shoulders or curbs** *Notes 1,4 & 5*
RA, RA-G, RH, RH-G, RC-type I, RF, RF-G,	*RS, R-A(G) R-1, R-H(G), R-F, R-F(R), R-F(F), R-F(C), RFR-SS*	Limited Local Through Local	15.5 18.0	6.6 8.5	1 2	barrier curbs barrier curbs
RM-M. RM-19 RF-SD RC-type II & III RF-SS, RF-9 RM-10, RF-12, RF-12C RM-15 RM-D	*R-F(M), RT-1*	Limited Local Through Local	17.0 18.0	8.0 8.5	1 2	barrier curbs barrier curbs
RM-30, RM-45	*RM-, RM-2*	Limited Local Through Local	18.0 20.0	8.5 10.5	2 2	barrier curbs barrier curbs
RM-70, RM-135, RMC-135, RMC-150	*RM-3, RM-4*	Limited Local Through Local	20.0 20.0	10.5 10.5	2 2	barrier curbs barrier curbs

(1) CD Zones: Alternative Local Roads Standards shall conform to the applicable land use as per this Table.

Table 2.2 & Table 2.3
Highway Dedication, Pavement Widths And Sidewalks

Notes To Tables 2 & 3

Note 1 These requirements are to be read in conjunction with Part V of the By-law.

(a) Highway dedications for collector and local roads are in accordance with Section 995 of the Local Government Act. Public utilities may not be accommodated in the location preferred by the Public Utility Companies except by additional or separate dedication or statutory right-of-way.

(b) Local Roads longer than 220m or servicing more than 100 self-contained dwellings units shall be classified as Through Local.

Note 2 Pavement Widths

(a) Where construction of half of the width of the pavement standard is required, and the other half does not exist, the minimum width of pavement for all zones will be 6 metres, and the minimum width of dedication will be 10 metres.

(b) Additional pavement width is needed at the intersection of lanes in order to provide turn radius, and may be needed at intersections with arterial roads in order to provide traffic turn lane channelization. Refer to Schedule "D" hereof, Arterial, Major Collector and Grid Road Plan Map R-91, the Supplementary Standard Drawings.

(c) Parking in cul-de-sac heads or in parking bays is permitted when the designated highway dedication to accommodate the parking arrangements together with sidewalks and street lights is insufficient, additional property for parking spaces shall be dedicated.

(d) If a highway dedication already exists or if topographic conditions are extreme, the road requirements shall conform to current Council policy for unopened roads.

Note 3 Sidewalks

Sidewalks are required in accordance with this table, and Part V of the By-law.

In land use zones: RF, RF-SS, RA, RA-G, RH, RH-G, RF, RF-G, RM-D, RM-M, RC, RF-SD, RF-9, RF-12, RM-10, RM-15 and RM-19:

- sidewalks are not required on limited local roads less than 50 metres in length;
- a sidewalk is required on one side only on limited local roads 50 metres to 220 metres in length;
- sidewalks are required on both sides of limited local roads over 220 meters in length.

Where sidewalks are provided on one side only, they shall be located on the side closest to an existing or future school, park or transit route.

Note 4 Shoulders

Shoulder details are shown in the Standard Drawings.

Note 5 Curbs

Where driveway locations can be determined prior to construction and no curb exists, barrier curb shall be installed in that block. Where rollover curb exists in a part block, rollover curb shall be installed to complete that block.

Rollover curbs may be used as an option on local roads in RA, RA-G, RH and RH-G zones. Barrier curbs are to be used on all corner lots.

For neo-traditional road sections, (where barrier curb is required), rollover curb may be utilized in cul-de-sac bulbs.

Use MMCD Standard Detail Drawing C4 for all curbs except on Arterial roads. For arterial roads, the curb will be MMCD Standard Detail Drawing C5 or as specified by the Engineering Designer.

2.3 Utility Rights-of-Way Widths

Where specifically approved by the Engineer to locate a City service within a utility right-of-way, the minimum widths of rights-of-way shall be:

(a) for a single service

R.O.W. width = twice the depth from surface to the crown of the pipe PLUS trench width
[3 metres minimum width]

(b) for two services within the same trench
R.O.W. width = twice the depth from surface to the crown of the deeper pipe PLUS trench width
[5 metres minimum width]

(c) for two or more services adjacent to one another but in the separate trenches
R.O.W. width = cumulative widths for single services PLUS any difference to provide the required separation
[6 metres minimum width]

(d) When the service is within a City road allowance but the distance from the property line to the centre of the main is less than one half of the width necessary for a single service, the difference shall be provided as right-of-way on the adjacent property.

In all cases the width of rights-of-way shall be sufficient to permit an open excavation with side slopes in accordance with the WCB regulations, without impacting on or endangering adjacent structures.

Where required, sanitary trunk and interceptor sewers shall have rights-of-way wide enough for future widening and/or twinning. The width of the right-of-way shall be the required separation between pipe centrelines plus 2 times the depth to the crown of the deeper sewer.

The Design Engineer shall provide cross sections on the design drawings, indicating the minimum safe distances to adjacent building footings based on a safe angle of repose from the limits of the excavation.

The maximum depth of sewers in a right-of-way shall be 3.5 metres from finished ground surface to the pipe crown unless approved by the Engineer.

2.4 Utility Separation: Sanitary Sewer or Storm Sewer vs. Water Mains

A. Horizontal Separation

At least three (3) metre horizontal separation is to be maintained between a water main and either a sanitary sewer or a storm sewer according to the requirements of the Regional Health Board.

In very special circumstances, specifically where the soils are determined to be impermeable, lesser separation than the required three (3) metres may be permitted by the Regional Health Board and accepted by the Engineer provided however that:

- the sewer main and water main are installed in separate trenches and the water main invert is at least 0.5 metres above the crown of the sanitary sewer or storm sewer and the joints are wrapped with heat shrink plastic or packed with compound and wrapped with petrolatum tape in accordance with the latest version of AWWA Standards C217, and C214 or C209; or ,

- they are installed in the same trench with the water main located at one side on a bench of undisturbed earth at least 0.5 metres above the crown of the sanitary sewer or the storm sewer and the joints of the water main are wrapped with heat shrink plastic or packed with compound and wrapped with petrolatum tape in accordance with the latest version of the AWWA Standards C217, and C214 or C209.

B. Vertical Separation

Where a sanitary sewer or storm sewer cross a water main, the sewer shall be below the water main with a minimum clearance of 0.5 metres and the joints of the water main, over a length extending 3 metres either side of the sewer main, are wrapped with heat shrink plastic or packed with compound and wrapped with petrolatum tape in accordance with the latest version of the AWWA Standards C217, and C214 or C209.

Where trench lines cross at different elevations, an adequate support for the upper pipe shall be provided to span the trench width, regardless of the order in which each pipe is installed.

C. Alternate Conditions

Subject to the approval of the Regional Health Board, when it is impossible to obtain proper vertical separation as stipulated above, the sanitary sewer shall be either constructed of PVC pipe and be pressure tested to assure water-tightness or wrapped with impermeable material. The impermeable wrapping material must be approved by the Engineer.

2.5 Utility Separation: Storm Sewers - Sanitary Sewers

A. Sewers in Common Trench

Storm and sanitary sewers may be installed in a common trench, provided that the design has taken into account:

- interference with service connections,
- stability of the benched portion of the trench,
- conflict with manholes and appurtenances.

In no case shall the horizontal clearance between sewer pipes be less than 1.0 m, or the horizontal clearance between manholes be less than 0.3 m, whichever is greater.

2.6 Design Populations by Zoning or Land Use Designation

Where required for calculation of utility services capacities, in various zones, the Gross Density, or Equivalent Population Factor, in Table 2.6 shall be used.

Table 2.6
Design Populations by Zoning or Land Use Designation
(Surrey Zoning By-Law 12000)

ZONE	LAND USE	GROSS DENSITY, or EQUIVALENT POPULATION FACTOR People per Hectare (PPha)
A-1	General Agriculture	11
A-2	Intensive Agriculture	11
C-15	Town Centre Commercial	90
C-35	Downtown Commercial	725
C-4	Local Commercial	60
C-5	Neighbourhood Commercial	60
C-8	Community Commercial	60
C-8A, C-8B	Community Commercial A	90
CCR	Child Care	50
CG-1	Self-Service Gasoline Station	50
CG-2	Combined Service Gasoline Station	50
CHI	Highway Commercial Industrial	60
CPG	Golf Course	50
CPM	Marina	50
CPR	Commercial Recreation	50
CTA	Tourist Accommodation	70
IA	Agro-Industrial	90
IB	Business Park	90
IH	High Impact Industrial	90
IL	Light Impact Industrial	90
IS	Salvage Industrial	90
NS	Not Specified	0
PA-1	Assembly Hall 1	50
PA-2	Assembly Hall 2	50
PC	Cemetery	0
PI	Institutional	50

...continued,

Table 2.6, continued

Design Populations by Zoning or Land Use Designation

(Surrey Zoning By-Law 12000)

ZONE	LAND USE	GROSS DENSITY, or EQUIVALENT POPULATION FACTOR People per Hectare (PPha)
RA	One-Acre Residential	11
RA-G	Acreage Residential Gross Density	11
RF	Single Family Residential	66
RF-G	Single Family Residential Gross Density	66
RF-12	Single Family Residential – 12m frontage	89
RF-12C	Single Family Residential – 12m frontage Secondary Suite	149
RF-SS	Single Family Residential Secondary Suite	118
RF-9	Single Family Residential – 9m frontage	128
RF-9C	Single Family Residential – 9m frontage Secondary Suite	216
RF-SD	Single Family Duplex - Semi-Detached	75
RH	Half-Acre Residential	22
RH-G	Half-Acre Residential Gross Density	22
RM-10	Cluster Housing	114
RM-135	Multiple Residential Development	566
RM-15	Multiple Residential Development	103
RM-19	Multiple Residential Development	131
RM-30	Multiple Residential Development	206
RM-45	Multiple Residential Development	266
RM-70	Multiple Residential Development	414
RM-D	Duplex Residential	114
RM-M	Manufactured Home Park	114
RMC-135	Multiple Residential Development	566
RMC-150	Multiple Residential Development	725
RMS-1, 1A	Special Care Housing 1	50
RMS-2	Special Care Housing 2	50

A. Population by Household Size

Where there is a known number of lots or units to be developed, the Designer should estimate service population based on average household size.

Area	Detached Units	Townhouse Units	Apartment Units
City Centre	2.8	2.9	1.8
Cloverdale	2.8	2.5	1.7
Fleetwood	3.4	2.5	2.9
Guildford	3.2	2.8	2.1
Newton	3.8	3.0	2.5
South Surrey	2.9	2.3	1.6
Whalley	3.5	3.0	2.8

B. Population Projections

The current Official Community Plan indicating future land use is complemented with a population projection map available in the Planning Department.

2.7 Special Pipe Installation Methods (Tunneling/Boring/Casing)

Where special methods for installation have to be used, (e.g., such as where the pipe(s) through fill sections, tunnelling, jacking, or boring) details of the placement methods and support for the pipe must be submitted with the overall design for the Engineer's approval.

A. Tunnelling

All tunnelling designs shall have design loadings, construction specifications, and methods defined based on geotechnical, hydrogeological, and other site specific conditions to the satisfaction of the Engineer. Liners are to be suitably reinforced where necessary to withstand design loadings. Where pipes are to be installed within tunnels lined with temporary support systems, the annular space between the pipe(s) and the tunnel lines shall be backfilled, and all void spaces are to be filled by pressure grouting.

B. Boring

When pipes are installed by cased or uncased boring methods, the annular spaces between the outside of the pipe and the inside of the casing or borehole shall be completely backfilled and/or all void spaces are to be filled by pressure grouting. This requirement should be considered in the selection of the casing size to ensure sufficient clearance is available to permit effective grouting of the annular space.

C. Pipe Casing

A permanent pipe casing shall only be backfilled by sand, and both ends of the casing pipe should be grouted to prevent the seepage of water. Proper spacers without backfill are also acceptable. This requirement should be considered in the selection of the casing size to ensure sufficient clearance is available to permit effective backfilling and grouting of the annular space.

SECTION 3

Water Distribution System

3.0 WATER DISTRIBUTION SYSTEM

3.1 General Water Distribution System Requirements

A. Glossary of Terms

Feeder Mains	are large diameter mains conveying water from the supply source and feeding to a large area primarily through a network of major grid mains. Only major grid mains may be tied to a feeder main; service connections or hydrants are not permitted on feeder mains unless approved by the Engineer.
Major Grid Mains	are mains generally 300 mm diameter and larger delivering water from a feeder main to local distribution mains as well as providing water to abutting properties. Service connections and hydrants are permitted on major grid mains.
Distribution Mains	are mains 250 mm diameter or less, distributing water locally through service connections. Hydrants are permitted on distribution mains capable of delivering fire flows sufficient for land uses in the adjacent areas.
Agriculture Water Distribution System	is a system comprising of 150mm and 100mm diameter water mains for distributing only domestic water to premises on farmlands within the Agricultural Zone areas in Surrey.
Per Capita Demand	Average Day Water Demand per Person '**a**' = 500 L/d [averaged over 365 days] Maximum Day Water Demand per Person '**d**' = 1,000 L/d [averaged over 100 days of summer] Peak Day Water Demand per Person '**h**' = 2,000 L/d [peak hour demand extrapolated to 24 hr.]

3.2 Water Distribution System

A. General

Determination of sufficiency and adequacy of the existing system may be proven using the analytical methods given in the following sections.

B. Methodology of Analysis

Existing Water Distribution System

For analysis of the existing system, the flow [$Q_{available}$] at the test point within local system network shall be determined using source nodes and assuming their input heads as described below. No other demand need be imposed at any other nodes. The residual head at the test point in the theoretical analysis, shall not be allowed to fall less than 14 metres hydraulic head.

New Water Distribution System

For analysis of the proposed expansion of the distribution system, the availability of the total demand [Q_{design}] shall be tested at the most critical location of the system expansion under consideration. Existing water mains may be utilized for theoretical network analysis, if they afford any advantage. However, the Designer must ensure that the system configuration is set up as it is supposed to operate under ultimate conditions including proper pressure zone separations.

(a) Formula to be used:

The analysis of the pipe network system shall be carried out using the Hazen-Williams equation.

(b) Hazen-Williams' 'C' Coefficient:

In all instances, the City's water distribution system shall have the following values of the Hazen-Williams' coefficient.

C = 125 for all water mains 250 mm diameter and larger
C = 100 for all water mains 200 mm diameter and smaller

(c) The Source Nodes:

The source node(s) to be used for analysis as starting point(s) of the network system analysis with the available head(s) is(are) as follows:

(i) For design of feeder mains, the pertinent pump station or PRV station shall be taken as the source node for analysis with the discharge head at the station as the starting input head.

(ii) For design of major grid mains and local distribution mains, the source node(s) for analysis may be assumed to be:

- for design flows not exceeding 120 L/s, the tie-in point(s) to the nearest 300 mm or larger diameter water main(s) continuously tied to the supply source,
- for design flows exceeding 120 L/s, the tie-in point to the nearest feeder main continuously tied to the supply source.

The input head(s) at the source node(s) shall be 70% of the (respective) static head (i.e., 70% of the difference between the hydraulic grade elevation of the pressure zone and the ground elevation of the source node.)

(d) Pressure Zones:

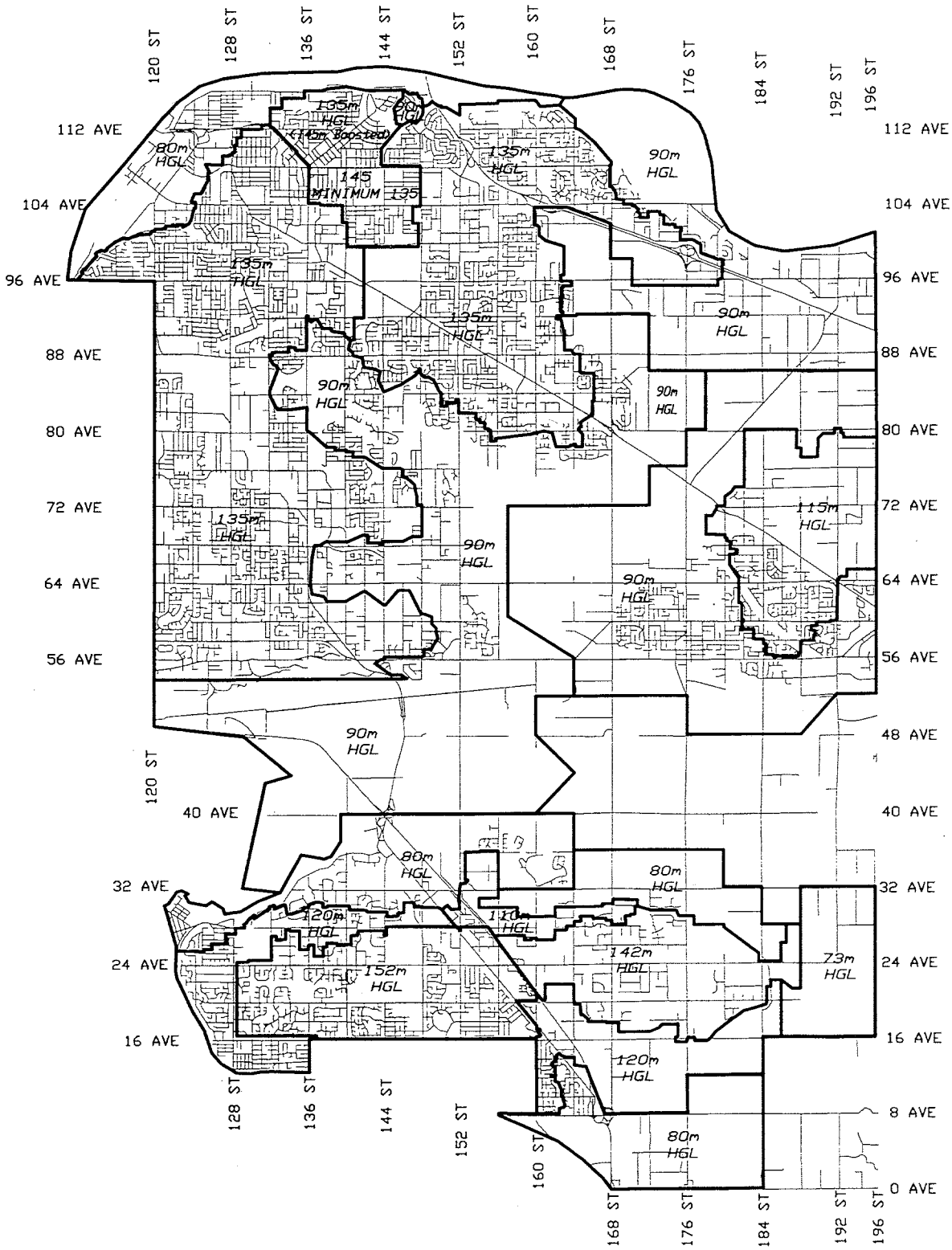
The ultimate hydraulic grade elevations of the various pressure zones in Surrey are shown on Figure 3.1. These ultimate hydraulic grade elevations shall be used in all analysis notwithstanding the fact that some of the ultimate zones may not yet be set. The Designer shall verify, with the Engineer, the accuracy of this information prior to commencing design or analysis.

(e) Pressure Heads at Nodes:

It is intended that the City's distribution system will provide an operating pressure head of 28 metres minimum at all nodes during peak hour demand conditions. When analyzing the system on the basis of peak hour, a minimum residual of 28 m hydraulic head must be maintained at all nodes.

The City intends to maintain a minimum of 14 m residual head at the exit side of fire hydrant at maximum day plus fire flow condition. In general, if the flow from the hydrant does not exceed 60 l/s, the hydraulic head required at the water main upstream of the hydrant remains the same as 14 m. If the design engineer requires the flow from a single hydrant to exceed 60 l/s, the hydraulic head required at the water main upstream of the fire hydrant will have to be greater to account for the head losses through the hydrant.

The minimum hydraulic head immediately upstream of the water main required for a single hydrant delivering fire flows is as follows:



3			
2			
1	MAY 2004		Title PRESSURE ZONE BOUNDARIES
	Revision Date	Approved	

SURREY
CITY OF PARKS

Approved		DRAWING NUMBER
Date	JANUARY 2002	FIGURE 3.1
Drawn By	Surrey Engineering	

Flow (l/s)	Minimum Hydraulic Head at Water Main/Nearest Node Required (m)
45	14.0
60	14.0
90	15.8
120	22.6
150	31.4

For flow rates not detailed above, and for situations where multiple hydrants are required to deliver the fire flow, the minimum hydraulic head can be calculated as the greater of 14m or 7m plus the head loss through the hydrant. However, regardless of the fire flow delivered, the minimum hydraulic head at the water main or the nearest node must be 14m.

Head loss through the hydrant(s) should be calculated as

$$hl = 1083Q^2$$

where: hl = head loss (m)
Q_{design} = flow (m^3/s)

The minimum hydraulic head can then be calculated as the greater of 14m or $7m + 1083Q_{design}^2$.

The minimum hydraulic head for all nodes within 400m of the test hydrants should be at least 14m.

The minimum hydraulic head for all nodes beyond 400m of the test hydrant should be at least 21m.

Difficulty achieving these should be reviewed with the Engineer.

(f) Demands and Flow:

The total demand [Q_{design}] shall be the greater of the following:

$Q_{design} = D + F$ Maximum Day Demand for the population or 'equivalent population' plus the fire flow requirement:

or,

$Q_{design} = H$ Peak Hour Demand for the population or 'equivalent population':

where:

'D' = 'Aggregate' Maximum Day Demand

= 1,000 L/capita/day x population or 'equivalent population' for the study area.

'H' = 'Extrapolated Aggregate' Peak Day Demand

= 2,000 L/capita/day x population or 'equivalent population' for the study area.

'F' = Fire Flow requirement for the study area.

(g) Equivalent Population to Determine Commercial & Industrial Demand:

Water demand for commercial and industrial areas shall be estimated using the Gross Density, or Equivalent Population Factor from Table 2.9, **Design Populations by Zoning or Land Use Designation**.

For a known water-user, a more accurate estimate of water demand shall be made using available information on similar projects elsewhere. Table 3.2(a), **Typical Range of Water Demands** provides flow ranges of water demand estimates for some categories of user, and is provided as a guide only.

Table 3.2(a)
Typical Range of Water Demands

User	Range of Demand L/(person or unit)/d
Assembly hall, per seat	6-10
Automobile service station: Per set of pumps	1800-2200
Per vehicle served	40-60
With car wash	16,000
Auto - car dealer/renter per hectare	30,000
Bowling alley, per alley	600-1000
Camp: Children's, central toilet and bath	160-200
Day, no meals	40-70
Luxury, private bath	300-400
Trailer with private toilet and bath, per unit (2-1/2 persons)	500-600
Cemetery per hectare	3,600
Country Club: Resident type	300-600
Transient type, serving meals	60-100
Curling club per lane	8,500
Fairground (based on daily attendance)	2-6
Golf Course per hectare	1,500
Green House per hectare	27,000
Hotel per patron	200-400
Ice Arena per rink	85,000
Institution: Average type	400-600
Hospital	700-1200
Lodging House and Tourist Home	120-200
Motel	400-600
Office	40-60
Picnic Park, with flush toilets	20-40
Restaurant (including toilet): Average type, per seat	120-180
Average type, 24 h. per seat	160-220
Tavern, per seat	60-100
School: Day, with cafeteria or lunchroom	40-60
Day, with cafeteria and showers	60-80
Boarding	200-400
Self-Service Laundry, per machine	1000-3000
Store: First 7.5m of frontage	1600-2000
Each additional 7.5m of frontage	1400-1600
Swimming Pool, toilet and shower	40-60
Theatre: Indoor, per seat, two showings per day	10-20
Outdoor, including food stand, per car (3-1/3 persons)	10-20

(h) Fire Protection Flow:

Table 3.2(b), **Fire Flow Design Requirements** lists the minimum fire protection requirements for land use in each of the zones. In all zones, land use will be subject to immediate availability and deliverability of maximum day demand plus relevant full fire protection 'F'.

Design of new extensions to the water system shall be based on immediate deliverability of maximum day demand plus full fire protection 'F' for the site under consideration.

Interim Fire Flow values may be used only if the full fire protection can be achieved through: any of the water system upgrades identified within the City's current 10-year Servicing Plan; or, system looping proposed by the Developer within his own development.

Table 3.2(b)
Fire Flow Design Requirements[1]

Zone	Zone Name/Description	Design Fire Flow	Interim Fire Flow
		L/s	L/s
A-1	General Agriculture		
A-2	Intensive Agriculture		
RA	One-Acre Residential	60	45
RA-G	Acreage Residential Gross Density	60	45
RH	Half-Acre Residential	60	45
RH-G	Half-acre Residential Gross Density	60	45
RF	Single Family Residential	60	45
RF-SS	Single Family Residential Secondary Suite	60	45
RF-G	Single Family Residential Gross Density	60	45
RF-12	Single Family Residential	60	45
RF-9	Single Family Residential	60	45
RF-SD	Single Family Duplex	90	70
RM-D	Duplex Residential	90	70
RM-M	Manufactured Home Residential	90	70
RC	Cluster Residential	120	90
RM-10	Multiple Residential 10	120	90
RM-15	Multiple Residential 15	120	90
RM-19	Multiple Residential 19	120	90
RM-30	Multiple Residential 30	120	90
RM-45	Multiple Residential 45	120	90
RM-70	Multiple Residential 70	200	150
RM-135	Multiple Residential 135	200	150
RMC-135	Multiple Residential Commercial 135	200	150
RMC-150	Multiple Residential Commercial 150	200	150
RMS-1, RMS-1A	Special Care Housing 1	90	65
RMS-2	Special Care housing 2	200	150
PC	Cemetery		
PA-1	Assembly Hall 1	90	65
PA-2	Assembly Hall 2	120	90
PI	Institutional	120	90

Table 3.2(b), continued
Fire Flow Design Requirements[1]

Zone	Zone Name/Description	Design Fire Flow	Interim Fire Flow
		L/s	L/s
C-4	Local Commercial	90	65
C-5	Neighbourhood Commercial	90	65
C-8	Community Commercial	120	90
C-8A	Community Commercial A	120	90
C-8B	Community Commercial B	120	90
C-15	Town Centre Commercial	200	150
C-35	Downtown Commercial	200	150
CHI	Highway Commercial Industrial	120	90
CG-1	Self-Service Gas Stations	90	65
CG-2	Combined Self-Service & Full Service Gas Stations	90	65
CTA	Tourist Accommodation	120	90
CCR	Child Care	90	65
CPR	Commercial Recreation	120	90
CPG	Golf Course	90	65
CPM	Marina	90	65
IB	Business Park	250	190
IL	Light Impact Industrial	250	190
IH	High Impact Industrial	250	190
IS	Salvage Industrial	250	190
IA	Agro-Industrial	250	190
CD	Comprehensive Development		

Note 1: These are considered minimum acceptable values. For a site development where specifics of the proposed building structure are known other more stringent criteria such as the Fire Underwriters Survey - "Water Supply for Public Fire Protection, A Guide to Recommended Practice (1991), Part II" may apply.

If the maximum fire flow available within the City's distribution system at the site is determined to be less than the flow required for the fire protection of the site, the Developer/Owner/Applicant is responsible to either upgrade the water supply system sufficiently to provide the higher fire protection necessary for the site, or, take whatever other measures necessary to reduce fire protection requirements of the proposed development to match the level of protection afforded by the City's distribution system.

(i) Hydraulic Grade and Maximum Velocities Within Pipes:

The flow characteristics of the selected pipe conveying the water design flow shall be as follows:

(i) the hydraulic grade in mains larger than 250 mm diameter shall not exceed 0.5%.

(ii) the velocity of flow shall not exceed 2 m/s for ultimate design flows, and where interim fire flow is permitted, the velocity of flow shall not exceed 3.25 m/s.

(j) Design Period and Population Projections:

Major elements of the Water Distribution System such as pumping stations, and pressure reducing valves, etc. shall be designed to serve the full saturation population anticipated in the City's most current Official Community Plan for the service area.

Section 2.9 lists parameters for Design Populations by Zoning or Land Use Designation. For all industrial areas, use 45 p.p.ha for the design population.

3.3 Agricultural Water Distribution System

A. Design Period and Population Projections

The Agricultural Water Distribution System shall be designed for servicing the saturation density of population expected:

(a) allowing for 4 people per lot for lot areas less than 4 ha.

(b) allowing for 8 people per lot for lot areas greater than 4 ha.

The designs are to allow for water demand for domestic consumption only with a minimum residual hydraulic head of 28 metres at the street level.

Design Flow shall be calculated as Q_{design} = 25 X 2,000 L/capita/day for the ultimate service population.

For an Agricultural Water Distribution System, the source node(s) for starting point(s) for analysis may be assumed to be at the nearest 200 mm or larger diameter water main.

3.4 Design of System Pumping Station and Pressure Reducing Valve Station Facilities

A. General

Design Guidelines and specific requirements for pumping station and pressure reducing valve station facilities under consideration shall be obtained from the Engineer prior to undertaking the designs.

Access and safety features of the facilities shall be in accordance with the Workers' Compensation Board of British Columbia Regulations.

The Design Engineer shall ensure that the location chosen for the specific facility is appropriate, safe and easily accessible for maintenance by the City Operations personnel.

The Design Engineer shall prepare and submit a pre-construction report, complete with all drawings, calculations, schematic diagrams of vital components in the facility, application forms such as those for providing electric power, telecommunication connection, water supply tie-ins for the facility, drain connection, indication of proposal to treat landscaping concerns where necessary, etc.

For pressure reducing valve station facilities, the Designer's pre-design report shall address the requirements given in this Design Criteria Manual and the City's *Guideline for the Design & Construction of Pressure Reducing Valve Stations.*

3.5 Design of Water Distribution System Components

A. General

Pipes and fittings should be designed so as to withstand all stresses, internal as well as external, whether caused by static pressures, dynamic pressures, transient pressures, thermal stresses, or stresses induced by vertical loads and impact of traffic.

B. Mains

(a) Size

Sizes for the water distribution network for all areas of Surrey including the water system network for Agricultural areas are to be reviewed with the Engineer.

The minimum size of a new water main shall be 200 mm diameter, except:

(i) in the City and Town Centres where the minimum size of a new water main shall be 250 mm diameter (see Figure 3.2);

and

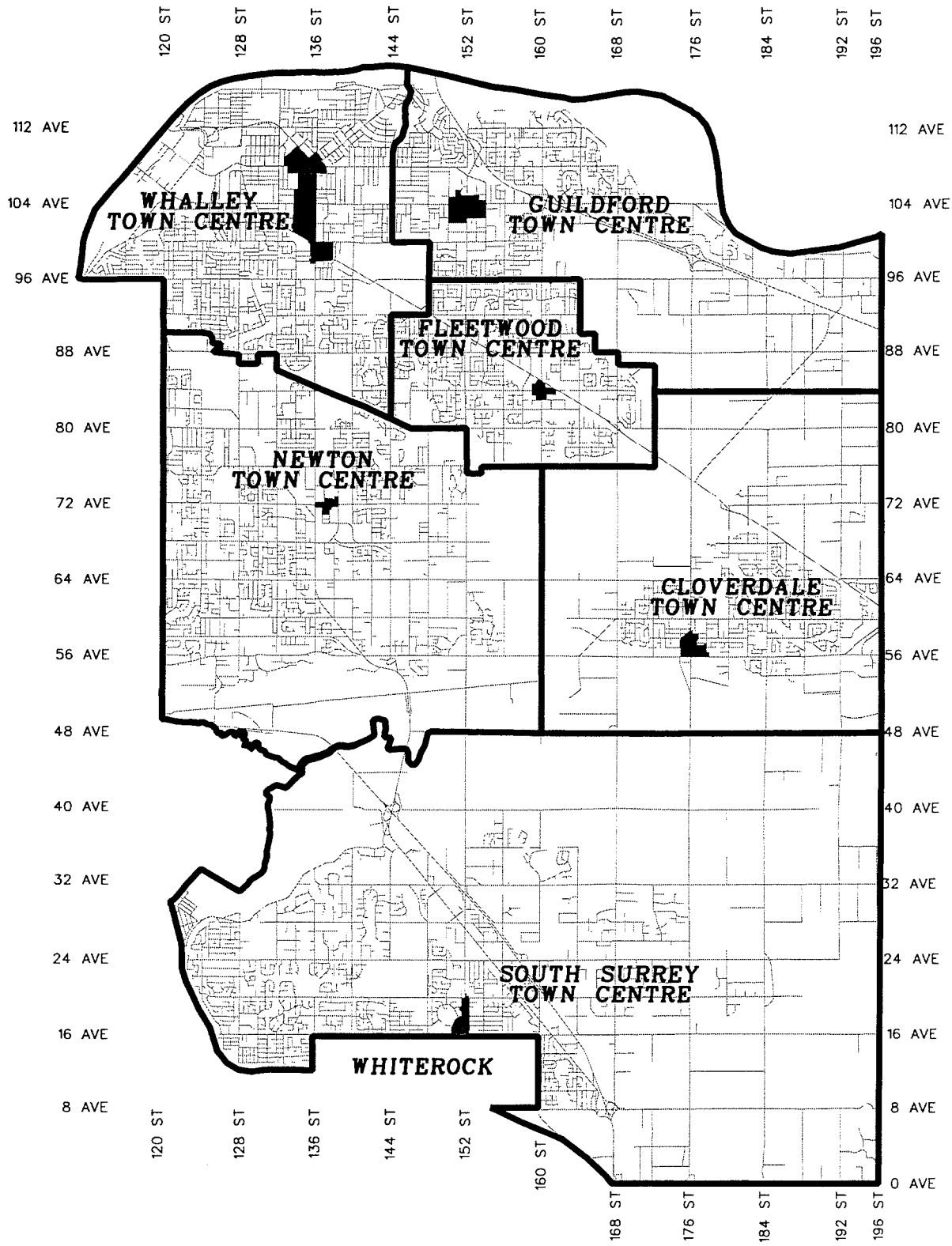
(ii) except in the agricultural area where the minimum size shall be 100 mm diameter.

On dead-end roads, where no further extension of the distribution system is possible, mains less than 200 mm diameter may be used for the last lengths not exceeding 100 metres.

(b) Location

Major Grid and Distribution mains should be located within the road right-of-way as shown on the pertinent Standard Drawings.

Where technically impractical, as determined by the Engineer, water mains in side yard and rear yard statutory or dedicated rights-of-way may be approved. The rights-of-way shall be a minimum of 3.0 metres wide and access, capable of supporting the intended maintenance vehicles in all weather conditions,



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	Revision Date	Approved

All Dimensions Shown In Millimetres, Unless Otherwise Noted

Title: TOWN CENTRES

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved: Mentchible.
Date: JANUARY 2002
Drawn By: Surrey Engineering

DRAWING NUMBER
FIGURE 3.2

must be provided to any valve chambers, meter chambers, or other water system appurtenances requiring access by personnel for service or maintenance, per Section 2.4. Where no such appurtenances are provided, no access road is required.

Where possible, water mains shall be looped through back-to-back cul-de-sacs to avoid dead-end mains.

To eliminate stagnant water conditions on dead end mains, water mains should be terminated at the last hydrant, and a small diameter service line should extend to houses being serviced beyond the hydrant, per Section 3.5 B(a).

When water mains cross railroads or Regional Major Road Network (MRN), including Provincial Highways, a steel carrier pipe shall be provided and must be designed to meet the applicable loading and the requirements of the authority having jurisdiction. The size of the casing pipe must be at least 25% larger than the outside diameter of the water main pipe bell. For the purpose of this Section, Regional Major Road Network includes the following roads:

Water mains shall be provided on both sides of Regional Major Road Network (MRN) roads and Provincial Highways, to minimize the number of service connections crossing the road.

Provincial Highways in Surrey are:

Highway No. 1
Highway No. 10
Highway No. 15
Highway No. 99

MRN roads in Surrey are:

120 Street (Scott Road) from Highway 10 to King George Highway
King George Highway from Pattullo Bridge to 8 Avenue
152 Street from 16 Avenue to Ferguson Diversion
108 Avenue from King George Highway to Ferguson Diversion
Ferguson Diversion from 108 Avenue to 152 Street
104 Avenue from King George Highway to 160 Street
96 Avenue from 120 Street to King George Highway
96 Avenue from Barnston Drive to 196 Street
Barnston Drive from 176 Street to 96 Avenue
64 Avenue from 120 Street to 196 Street
16 Avenue from 152 Street to 196 Street
Fraser Highway from King George Highway to 196 Street

Hydrants shall be provided at 200-metre spacing on both sides of the MRN.

(c) Depth

Minimum cover over any water main pipe shall be 1 metre to the finished grade. For roads that have yet to be constructed, the ultimate finished grade shall first be approximated through preliminary road design.

Minimum cover over water main pipes crossing under ditches shall be 0.5 metre.

Water mains shall not be installed at depths greater than 1.5 metres, unless there is justification for deepening the main and approval is given by the Engineer.

(d) Grade

Minimum slope on a water main shall be 0.1%.

When the slope of a water main equals or exceeds 10%, provision shall be made to anchor the pipe. When the slope of a water main pipe exceeds 10%, use ductile iron pipe.

(e) Corrosion Protection

Geotechnical soils analysis on the alignment of any proposed metallic pipeline shall be conducted to determine the corrosiveness of the native soils. If the soils are expected to be corrosive, then measures shall be taken in the design and construction of the pipeline to prevent the corrosion of the metal pipeline and appurtenances. Corrosion protection measures must be approved by the Engineer.

(f) Materials

The Design Engineer shall ensure that his choice of pipe material is appropriate for the purpose and the surroundings. Refer to Section 7.6 for material requirements in seismic areas.

Ductile iron pipe water mains shall be used in all areas with compressible soils (for example, areas in Bridgeview - South Westminster). The pipe joints of all sizes will require a suitable form of mechanical restraints.

Use ductile iron pressure class 350 pipe in seismic areas and on arterial roads.

(g) Tie Rod

The Design Engineer shall provide tie rods or restraint joints, as a minimum, to the following locations:

- hydrants
- road crossings
- blow-offs
- temporary caps
- fittings or pipes larger than 300mm
- carrier pipe in casings
- connections to valves outside PRVs

C. Gate Valves

(a) Size

The valves shall be the same diameter as the water main up to 300 mm diameter.

The main line valves on Feeder Mains 350 mm diameter and 400 mm diameter may be smaller by one (1) size.

The main line valves on Feeder Mains 450 mm diameter and larger may be smaller by two (2) sizes.

Geared operators, with risers and extension rods and a valved bypass for equalizing pressures shall be provided on main line gate valves 350 mm diameter and larger.

Explicit permission will be sought from the Engineer for the use of butterfly valves.

(b) Valve Spacing

Gate valves on Major Grid and Distribution Mains 250 mm diameter and 300 mm diameter shall not be spaced greater than 200 metres apart.

Gate valves on Feeder Mains (over 300 mm diameter) shall not be spaced greater than 800 metres apart.

Gate valves on agricultural distribution mains shall not be spaced greater than 400 metres apart or a limit of 20 services impacted by a shutdown.

(c) Location Configuration

Line valves at road intersections shall be installed at the projected lot lines.

Normally, 3 valves will be required at an "X" intersection of mains, and 2 valves at a "T" intersection of mains.

Tie in of a Major Grid or Distribution Mains to a Feeder Main and shall be valved.

D. Hydrants

(a) Hydrants – Off-Site

Hydrants shall not be spaced more than 200 metres apart. For streets having a longer block length, hydrant spacing up to 210 metres will be acceptable. Hydrants, if possible, should be located at road intersections, 1.0 metre from property line with pumper nozzle at right angles to the curb.

Hydrant locations will be dependent upon the need for fire protection. Where building locations have been determined, a sufficient number of hydrants shall be provided within 300 metres of the principal entrance of the building to deliver the total Design fire flow as required by Table 3.2(b), or the building use, whichever is greater.

Fire hydrants on major arterial roads and provincial highways shall be installed with standard spacing on either side of the road.

Existing 150 mm diameter water mains may be fitted with new fire hydrants if the hydrant will deliver fire flow ‘F’ for the land uses covered by the hydrant.

(b) Hydrants – On-Site

The first hydrant nearest the building is regulated by the British Columbia Building Code and is to be located not more than 45 metres, or 90 metres to the building, dependent on whether the building requires a fire hydrant (siamese) connection.

Where building locations have not been determined, the center of the front lot line is deemed to be the principal entrance, and the first hydrant shall be located not more than 45 metres from the center of the front lot line.

E. Air Valves

Air valves are generally not required on water mains 300 mm diameter and smaller, unless identified by the Engineer. The Design Engineer shall address any special need for air valves on mains smaller than 300 mm diameter with the Engineer. Water mains larger than 300 mm diameter require double acting air valves at all

summits in the main. The air valve orifice size shall be a minimum 0.125 mm diameter per mm diameter of main and designed by an Engineer.

The Design Engineer shall address the need for air valves on agricultural distribution mains to prevent potential floating as a result of air entrapment within a pipe. Air valves shall be appropriately designed.

F. Blowdowns and Blowoffs

On all mains greater than 350 mm diameter, install blowdowns at the lowest point in the pipeline profile between the line valves in accordance with the Standard Drawings.

Install 50 mm diameter or larger diameter blowoffs to achieve flushing of the pipe in accordance with the Standard Drawings.

G. Thrust Blocks

Provide thrust or reaction blocks on tees, bends, and caps. Unless site conditions indicate otherwise, calculate the size on the basis of undisturbed soil bearing strength of 70 kPa and a system operating pressure of 1380 kPa. Details in the Standard Drawings may be used as a guideline only. The Designer must design thrust blocks with due regard for pipeline pressure transients and expected test pressures. Thrust block design calculations and soil bearing pressures must be shown on design drawings.

Use a treated timber blocking system for thrust blocks on water main appurtenances in compressible soils. Treatment of the wood shall be in accordance with the Provincial Ministry of Environment, Lands and Parks requirements.

Mechanical joint restraint may be required where thrust blocks could be disturbed by future works. Reverse thrust block shall be used if the designer determines that the thrust block could be or would be removed for future connections or extensions. The reverse thrust block shall be fitted with tie rods as specified. The Designer must determine if future infrastructure may jeopardize the integrity of the proposed thrust restraint and modify the design accordingly.

H. Check Valves

Where a check valve is required on a main line, it shall be installed complete with an equal diameter bypass with a gate valve, riser and operator extension.

I. Service Connections

Service connections shall be sized appropriately for the designated land use and configured as shown on the Standard Drawings. Service connections will be terminated at the property line with a shut off valve.

The Designer shall ensure that the need of the property will be met both in terms of pressure and flow under the City's current, as well as future, operating mode of the system.

Where a water service is being installed in a trench common to other services, the depth of the water service at property line shall be in accordance to the B.C. Plumbing Code, and, shall not be deeper than 1.5 metres unless approved otherwise by the Engineer.

All connections 100 mm diameter and larger require a check valve at the property line.

J. Fire Lines

Fire line sizes shall be designed in accordance with Fire Underwriters Survey - "Water Supply for Public Fire Protection, A Guide to Recommended Practice, 1991".

The Designer shall ensure that the existing City water main has adequate ability to deliver the fire flow necessary at the point of connection.

K. Test Points and Chlorination

For the purpose of pressure testing and chlorination of all new mains, a minimum of one test point shall be installed beside a line valve on each section of a main, between two valves. These test points shall consist of a 20 mm corporation stop with a female outlet threaded for iron pipe. The corporation stop installed for the purpose of an air valve may be used as a test point or as a bleed point. Locations of the test points shall be optimized to ensure thorough sterilization of a newly installed water main.

L. Water Meter Installation

All water meter related installations must conform to all applicable specifications and designs contained in the most recent Engineering Department Water Meter Installation Specifications & Standards. This document is available for free on the City's web site in PDF format or can be purchased from the Engineering Front Counter for $20.

3.6 Water System Seismic Design Standards

A. Area

The areas where the seismic design standards apply are delineated on Figure 3.3. The following design criteria must be used in areas subject to permanent ground deformation due to liquefaction or landslide.

B. Materials

The following material will be used:

- Water mains and fittings shall be ductile iron. No PVC is allowed.
- Valve bodies and component will be ductile iron.
- Hydrants will be ductile iron.

C. Joint Restraint

All pipeline, fittings and appurtenance joints shall be restrained so that they will not pull out when subjected to extension forces. The joint restraint system will be strong enough to resist loading developed by 50 meters of buried pipe wrapped in polyethylene being pulled through the ground.

D. Pipe wrapping

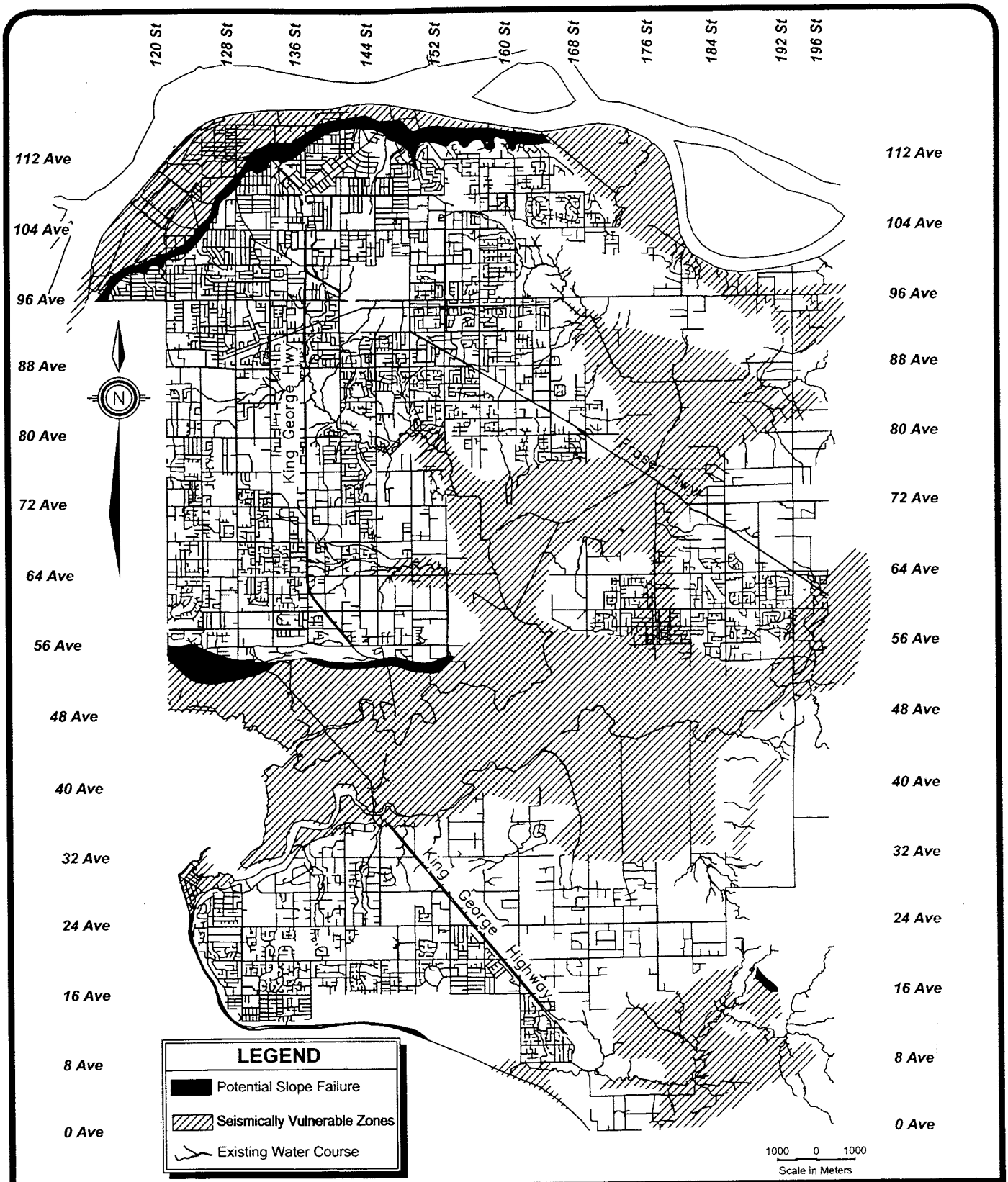
To minimize soil-pipe interaction, pipe shall be wrapped with polyethylene (baggy) such as is commonly used for corrosion protection. The intent of the wrapping is not to provide corrosion protection. Where required, corrosion protection is to be designed as outlined in Section 3.0.

E. Connections to structures

The designer shall calculate the expected differential movement between pipe and structure and provide a design that will accommodate the movement.

F. Service Connections

Provide an offset and or loop in the service connection to accommodate movement up to 0.5 meters of the pipeline through the soil.



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1	May 2004	V. L.
	Revision Date	Approved

SURREY
CITY OF PARKS

AREAS OF WATER SYSTEM THAT ARE VULNERABLE TO SEISMIC EVENTS

This map is solely for the purpose of displaying seismic impact on Surrey's sewer and water system.

Approved Matthews.
Date Sept. 1999
Drawn By kwl Kerr Wood Leidal Associates Ltd. CONSULTING ENGINEERS

DRAWING NUMBER
FIG 3.3

G:\Mapping\cad\standards2002\DesignCriteria\DesignCriteriaDWG\FIGURE 3.3.DWG

SECTION 4

Sanitary Sewer System

4.0 SANITARY SEWER SYSTEM

4.1 General Sanitary Sewer System Requirements

A. Glossary of Terms

A **sanitary sewer** is a conduit that is intended to carry waste water from residences, commercial buildings, industrial plants and institutions. Unavoidable storm water, surface drainage and groundwater infiltration may also be present in sanitary sewers.

In the sanitary sewer system:

Interceptor Sewers	are large diameter sewers which intercept and convey sewage flows from more than one trunk sewer.
Trunk Sewers	are sewers which convey 'peak wet weather flows' in excess of 40 litres per second from the total upstream service catchment area. Typically, a sewer that serves a population of approximately 3,000 people (upstream) is designated as a trunk sewer.
Local Sewers	are sewers upstream of a trunk sewer and have theoretical capacity for peak flow less than 40 litres per second including a nominal allowance for infiltration.
Terminal Sewers	are sewers at the most upstream sections of the sewer system network branches.
Service Connections	are the lateral sewer pipes, including an inspection chamber, from the sanitary sewer, in municipal rights-of-way, to the property line of a parcel of land.
Building Sewers	are small diameter sewers on-site, on a parcel of land, connecting a building to a service connection at the property line.
Natural Catchment Area	is the total upstream area which drains to a sewer by gravity.

Force Mains	are sewers, operating under pressure, which join the pump(s) discharge from a sewage pumping station to a point of gravity flow, or in some cases another force main.
Per Capita Sewage Flow	Average Day Dry Weather Flow per Person '**adwf**' = 350 L/d.

In some cases, the sewer may also service areas lower in elevation than the sewer. Where sewage, from outside the natural catchment area, is discharged into a catchment from a force main, the catchment area tributary to the force main will be included as part of the catchment area.

4.2 Sanitary Sewer System

A. System Capacity

The Designer shall discuss downstream system capacity requirements with the Engineer. If required, determination of sufficiency and adequacy of the existing system, downstream of the proposed catchment area, shall be done using the analytical methods given in the following sections.

B. Methodology of Analysis

Existing Sanitary Sewer Systems

For analysis of existing sanitary sewer systems, hydraulic calculations shall be made using peak flow rates determined using parameters, criteria and formulas given below, assuming steady state hydraulic flow conditions.

The hydraulic analysis of the **existing** system shall be based on:

Available Pipe Capacity of: $Q_{\text{pipe capacity}} = 0.7 \times Q_{\textbf{full capacity}, \text{theoretical}}$

Every legal lot within the subject catchment area of the system shall be assumed to have been provided a commitment to develop to the maximum potential of its current zoning regardless of whether or not the legal lot has an existing service connection or if the lot is not discharging the allowable sewage flow according to the zoning.

The analysis of the sanitary sewer system shall be determined from the most upstream point in the subject catchment area to the point downstream where the system connects to the Greater Vancouver Regional District (GVRD) sanitary interceptor sewer, where required by the Engineer.

The additional inflow and infiltration component of the sewage flows in the existing system shall be the actual flow determined in the catchment area. For analysis, the values shown in the Standard Drawings shall be used.

Any and all sections of the sanitary sewer system which have calculated peak sewage flows in excess of the $Q_{\text{pipe capacity}}$ shall be deemed to be insufficient and out of capacity to allow additional sewage flow to be discharged into the system.

New Sanitary Sewer Systems

For analysis of proposed new sanitary sewer system extensions, the extent and boundaries of the proposed catchment area shall be confirmed with the Engineer prior to analysis and design of further extensions to the City's sanitary sewer system.

(a) Peaking Factor to be used:

A 'peaking factor' is the ratio of peak dry weather flow to the average dry weather flow (adwf). The calculation of sewage flows shall have a 'peaking factor' applied to the Average Dry Weather Flow components of the sewage based on the population, or 'population equivalent', of the subject catchment area. The peaking factor shall be calculated using the Harman equation.

Peaking Factor $$PF_{\text{Harman}} = 1 + \frac{14}{4 + \sqrt{\frac{\text{Population}}{1000}}}$$

(b) Flow Formula to be used:

The hydraulic analysis of sewer pipes shall be carried out assuming steady state flow conditions and using the Manning equation.

Under the pipe flowing "FULL" condition, the Manning equation is:

$$\text{Flow Rate } Q = \frac{1}{n} \times A \times R^{0.66} \times S^{0.5}$$

where:
- Q = pipe flow in cubic metres per second
- A = cross sectional area of pipe in square metres
- R = hydraulic radius in metres, D/4
- D = diameter of pipe in metres
- S = slope of energy grade line in metres/metre
- n = Manning coefficient of roughness

(c) Manning's 'n' Coefficient:

In all instances, the City's sewer system shall have a value of Manning's coefficient of roughness n = 0.013 for all pipes.

(d) Groundwater Infiltration and System Inflow Component:

A groundwater infiltration and system inflow component of 11,200 litres per hectare per day should be used in the system analysis.

(e) Sewage Design Flow:

The total design sewage flow [Q_{design}] shall be based on the ultimate saturation population densities and land use designations, in accordance with the Official Community Plan, for the subject catchment area. Sanitary sewers shall be sized to convey the calculated sewage flows, including infiltration and inflow.

The total design sewage flow shall be the following:

Q_{design} = Peak Sewage Flow from all Sources + Infiltration Inflow

Equivalent Population Component:

Use Table 2.6 for 'equivalent population factors' according to zoning and land use designations in the subject catchment area.

For the following special uses, design flows shall be modified as follows:

(i) Hospitals use 900 litres per bed per day

(ii) Nursing and Rest Homes use 450 litres per bed per day

Peaking Factors are not applied in (a) & (b)

'ADWF' = adwf x 'aggregate' population (or, population equivalent)

Peak Wet Weather Flow:

'PWWF' = **ADWF x Peaking Factor + Infiltration Inflow**

'Q_{design}' = **'PWWF'**

(f) Velocities Within Sanitary Sewers:

All sanitary sewers shall be designed at grades which will ensure sewage flow at a self-cleansing velocity of 0.6 m/s at least once every twenty four hours, based on flow from the full development upstream, except where the maximum grade possible is limited. In such cases, upon approval by the Engineer, the required flow velocity may be reduced to a minimum of 0.45 m/s provided the depth of flow at the peak wet weather flow condition exceeds 25% of the diameter of the pipe.

Where the sanitary sewer pipe grade is such that the velocity of flow is in excess of 5 m/s, the system design shall include measures to prevent problems related to scour, erosion and pipe movement.

4.3 Design of Sanitary Sewer System Components

A. General

Sanitary sewers shall be designed as open channels with the depth of flow, under the maximum design flow condition, not to exceed 50% of the internal diameter of the sewer (i.e., d/D = 0.5).

For interceptor and trunk sanitary sewers, the depth of flow under the maximum design flow condition, shall not exceed 70% of the internal diameter of the sewer (i.e., d/D = 0.70).

B. Mains

(a) Size

Minimum sewer sizes are:

- 200 mm diameter - for residential lands
- 250 mm diameter - for industrial lands
- For new extensions, no reduction in pipe size shall be made for pipes downstream, irrespective of grade provided on the pipe, unless specifically approved, in writing, by the Engineer.

(b) Location

Sewers shall be located as shown on the Standard Drawings, in municipal road or open lane.

Where technically impractical, as determined by the Engineer, sewers in side yard and rear yard statutory rights-of-way may be approved. The rights-of-way shall be a minimum of 5.0 metres wide. No connections or manholes will be allowed and the sewer alignment must be linear.

(c) Depth

Unless approved by the Engineer, sewers shall be installed at a nominal depths between 2.0 metres and 3.5 metres, from finished ground surface to pipe invert. Pipe cover less than 1.5 metres but more than 1.0 metre above the outside crown of the pipe may be permitted if the location of the sanitary sewer is clearly outside the 'travelled' portion of road pavement.

Sewers shall not be designed with pipe cover less than 1.5 metres above the outside crown of the pipe nor with depths in excess of 3.5 metres, unless specifically approved by the Engineer on the basis of unusual servicing circumstances.

Sewer depth shall be sufficient to provide appropriate gravity service connections to all properties tributary to the sewer. Pumped connections may be approved by the Engineer as stipulated in Section 4.3.E.

Where a new sewer will service existing buildings, the crown of the sewer shall be at least 1.0 metre below the basement elevations of the lots to be serviced.

Where a new sewer will service existing vacant parcels of land, the sewer shall be at a depth to allow the service connection to meet the requirements of Section 4.3.E.

(d) Curvilinear Sewers

Curvilinear sewers are only permitted under special circumstances and must be approved by the Engineer prior to design and construction.

Pipes between two consecutive manholes may be installed on a defined curve, provided that the maximum joint deflection does not exceed 1/2 the deflection recommended by the pipe manufacturer. Only one vertical or one horizontal defined curve is permitted between any two manholes. Curvilinear sewer designs shall include proposed elevations at 5 metre stations for vertical curves and sufficient data for setting out of horizontal curves and detailing as-built construction record information.

PVC pipes shall not be bent (between the pipe joint ends) to form curves. Manufactured long bends or PVC high deflection stops coupling (e.g., Certain Teed, or approved equal) shall be used to achieve curves, if approved by the Engineer.

(e) Pipe Slopes

Pipes with slopes at 15 % or greater shall have an approved anchoring system.

Pipes with slopes at 15 % or greater shall be designed with special attention to scour velocities and potential damage to the pipe structure. Proposed pipe protection systems to prevent pipe invert damage shall be approved by the Engineer.

Sections of upstream sewers, or terminal sewers, may require steeper grades to ensure self-cleansing velocity under partial flow conditions. The following design alternatives are acceptable:

- The terminal section of sanitary sewer, servicing 6 or less house service connections, shall have a minimum grade of 1.0 %.
- A sanitary sewer, servicing the 7th to 12th house service connections, shall have a grade of 0.6 % or greater.
- A sanitary sewer, servicing the 13th house service connection (or more), shall have a grade of 0.5 % or greater.
- Pipe grades less than 0.5 % may only be used once the peak wet weather flow produces a flow velocity in excess of 0.6 m/s, accounting for dynamics of partial pipe flow.

(f) Connections to GVS&DD Trunks

Tie-ins to GVS&DD trunks must have some form of odour control. Odour control will be reviewed and approved by the GVRD and the Engineer.

C. Aerial Pipe Bridges and Inverted Siphons

Proposed exposed bridge-type crossings of sanitary sewers or inverted siphons must be reviewed with the Engineer, prior to design. The Design Engineer shall obtain written approval-in-principle, from the Engineer, for the proposed facility and, prior to proceeding with the design, obtain appropriate criteria and guidelines for the design.

D. Manhole Structures

(a) Location

Manholes are required at the following locations:

- every 150 metres of sewer main or, where mid-block clean-outs are provided, every 300 metres of sewer main.
- every change of pipe size.
- every change of line or grade that exceeds 1/2 the maximum joint deflection recommended by the manufacturer, or where the radius of an approved curvilinear sewer alignment is less than 30 metres.
- all sewer confluence's and junctions, (except those with interceptor sewers).
- at the top end of all terminal sewers.

Temporary cleanouts are permitted where an extension of the sewer, in the future, will provide a manhole at an appropriate spacing.

Clean-outs are not permitted at the terminal ends of the system. Mid-block clean-outs with the foot-bend pointing uphill are permitted between two manhole structures.

Offset manholes in the two systems may be considered under some circumstances. Approval by the Engineer will be required for offset manholes.

(b) Drop Manhole Structures

Drop manholes, designed in accordance with the Standard Drawings, shall only be used when a new incoming sewer cannot be steepened or where site conditions do not permit excavation to the base of an existing manhole.

Inside drop pipe structures may be permitted only under exceptional circumstances and when all other options have been ruled out. A new inside drop manhole shall be larger in diameter than the standard manhole and shall accommodate the incoming sewer and drop pipe, as well as ensuring sufficient access and working space for personnel and safety equipment within the manhole. Approval of the size of the drop manhole must be obtained from the Engineer, prior to design and construction.

(c) Through Manhole Structures

The crown elevations of sewers entering a manhole shall not be lower than the crown elevation of the outlet sewer. No drop in invert is required for a through manhole where the sewer mains are of the same size. A 30 mm drop in invert for alignment deflections up to 45 degrees and a 60 mm drop in invert for alignment deflections from 45 degrees to 90 degrees shall be provided.

A straight through ramp drop up to one (1) pipe diameter may be permitted under special circumstances if approved by the Engineer.

E. Service Connections

Each lot will have:

- a gravity connection to the frontage sewer; or
- a gravity connection to the sewer in an open lane, walkway or service corridor with an access road.

When not feasible and approved by the Engineer, each lot will have:

- a pumped connection to a frontage sewer, provided a restrictive covenant is registered on the lot and the system is engineered against pump failures; or

- a gravity connection through a private rear lot easement to a sewer, provided it does not traverse more than one lot, the easement is registered and a dedicated connection with an IC for the lot exist on the fronting storm sewer.

(a) Size

The size of a service connection shall be selected to accommodate the peak flow rate generated on the property being served.

Service connections for single family dwellings shall be a minimum 100 mm diameter in size.

For all other cases, the minimum size for service connections shall be 150 mm diameter, unless approved by the Engineer.

An independent service connection shall be provided to each legal lot abutting a City gravity sewer. If there is more than one building structure on a legal lot and there is a potential for future subdivision, each building unit shall require an independent service connection. The Designer is to review these circumstances with the Engineer.

Duplex residential premises will be provided with independent service connections for each unit.

(b) Location and Depth

For undeveloped lots, service connections shall be located as shown on the Standard Drawings with a depth to provide sufficient grade and depth to a building structure which could be located at a front-yard setback of 7.5 metres.

Where a building structure exists on a parcel of land, service connections shall be installed at the location acceptable to the property owner. The service connection shall be extended 2.0 metres into the property, if approved by the property owner.

(c) Tie-in

Tie-ins shall be in accordance with the Standard Drawings. A service connection to a manhole shall have its invert at the crown elevation of the highest sewer in the manhole. The connection shall discharge in the same direction as that of the sewer main.

(d) Slope

The slope or grade of the service connection, between the inspection chamber and the crown of the sewer main, shall be a minimum of 2 %, as shown on the Standard Drawings.

F. Inspection Chamber

The invert of the service connection inspection chamber (IC) must be a minimum 1.2 metres below the finished ground elevation at the inspection chamber.

For service connections to existing trunk or interceptor sewers, the invert of the service connection inspection chamber shall be a minimum of 1.0 metre above the crown of the trunk or interceptor sewer. If the hydraulic elevation of any potential surcharge in the trunk or interceptor sewer is known, the invert of the inspection chamber on the service connection must be above the surcharge elevation.

G. Special Connections

Direct connections to a Greater Vancouver Sewerage and Drainage District's (GVS&DD) trunk or interceptor sewers may be permitted by the GVS & DD, at their sole discretion. When so permitted, connections shall comply with the criteria and details stipulated by the GVS&DD. The Engineer's conditions of approval of the service connection and/or decision shall be final and shall override any lesser stipulations of the GVRD. Service connections to a GVS&DD trunk will require a p-trap or some other means to control odour into the service lateral.

Service connections to City's interceptor sewer will require a P-trap or some other means to control odor entering into the service connection.

4.4 Sewage Pumping Stations and Force Mains

The Design Criteria for this section is a general outline only. Detailed criteria and specific requirements should be obtained from, and reviewed with the Engineer, prior to design of the facilities. Good Engineering design practice shall be used in the design of sanitary sewage pumping stations and force mains. It is recommended that the Designer refer to the City of Surrey's - *Guideline for the Design & Construction of Sanitary Sewage Pumping Stations.*

Prior to commencing detailed design of a pumping station facility, the Designer shall confirm the design catchment areas, design flows and the proposed location of the pumping station facility with the Engineer. The Designer shall submit a pre-design report that addresses the requirements given in this Design Criteria Manual and the *Guideline for the Design & Construction of Sanitary Sewage Pumping Stations* for approval by the Engineer, prior to commencing detailed design.

The pumping station and/or force main facilities shall be designed for the defined tributary catchment area, with design flows calculated for : short term, intermediate future and long term future (ultimate approved saturation development) stages.

4.5 Low Pressure Sewerage System

Beyond the reaches of the gravity sewer system, the City may consider a low pressure sewer system comprising on-site pumping units to a common force main. Given the

complexity of these systems, the Engineering Designer must review the application with the Engineer and the Ministry of Health prior to approval. Design guidelines are available from the City for these systems.

A. General

The City may consider low pressure sanitary sewer systems for areas which are beyond the reaches of the City gravity sewer system and not large enough to provide economic justification for a community sewage pump station, or where soil conditions or topography are not suitable for a gravity sewer system. A low pressure sanitary sewer system consists of on-site privately-owned and operated sewage pumps with discharge pipes connected to a City-owned and operated low pressure sewage force main.

Systems in which private pump units discharge into a public gravity sewer or force main from a public community sewage pump station are not classified as low pressure sanitary sewer systems. Where specifically indicated herein, some of the items included in this guideline are applicable to such other pumped systems.

Pump chamber details design and all ancillary components design within the private property shall be certified by a professional engineer.

The intent of this manual is to provide guidelines to the Design Engineer as outlined in Section 1.0 of the *City of Surrey Engineering Department Design Criteria Manual*.

B. Restrictive Covenant

The land title for each property served by a private pump unit located on the property shall include a registrable covenant, filed by the property owner, requiring the property owner to undertake in perpetuity operation, maintenance and renewal when necessary of the pump unit and connection to the public sewer, including the section of connection pipe on public property or right-of-way. Excavation of the portion of connection pipe located on public property or right-of-way shall not be undertaken without a permit from the City. The required format of the restrictive covenant will be provided by the City at the **Preliminary Design** stage.

C. Codes And Standards

Low pressure sewer systems and the components thereof shall be designed and constructed in conformance with the following codes and standards:

- British Columbia Plumbing Code, Part 7, Plumbing Services
- British Columbia Electrical Code

- Surrey Plumbing By-law
- Surrey Electrical Inspection By-law
- British Columbia Health Act and Sewage Disposal Regulations
- Greater Vancouver Regional District Sewer Use Bylaw
- Workers Compensation Board Regulations
- Master Municipal Construction Documents and City of Surrey Supplementary Documents
- City of Surrey Engineering Department Design Criteria Manual

In case of conflict between these guidelines and specific items in the above design criteria manual and construction documents, these guidelines will take precedence.

D. System Layout

The preliminary layout of a proposed low pressure system should be approved by the Engineer before detailed design proceeds.

(a) Preliminary Design
(before Key Plan Circular Stage/Key Player Meeting/Project Scoping)

The following information is required for a preliminary design submission:

- Plan of the entire area to be served by the proposed system, including adjacent areas currently and potentially served by gravity sewers and community sewage pump stations
- Topographic plan
- Report on soil conditions
- Preliminary layout
- Area development sequence and timetable
- Pump unit power requirements

(b) Design Development
(at Key Plan Circular Stage or Project Detailing)

Basic data and design criteria for detailed system layout include the following:

- Location, elevation and design flow for each pump unit
- Location and direction of flow of each lateral, branch and main, plus details of the system discharge point. Lay out system to minimize length of runs, avoid abrupt changes in direction and avoid loops.
- Location and elevation of system high points. Adjust pipe profiles where possible to avoid high points.

Design documents for system approval shall include a plan showing the following information for each property served:

- Building site grade, minimum floor elevation and pump chamber inlet elevation
- Pump unit and service connection locations and elevations
- Pump unit configuration (Simplex or Duplex)
- Pump chamber diameter, depth and operating elevations
- Pump head and capacity requirements, plus recommended manufacturer and model, pump curve and power requirements.

Other documents to be submitted for system approval include the following:

- Qualifications of supplier of pump unit package as indicated under **PUMP UNIT GENERAL REQUIREMENTS**.
- Sample of Operation and Maintenance document to be provided to pump unit owners as indicated under **PUMP UNIT GENERAL REQUIREMENTS**.

E. System Hydraulic Design

System design shall include complete hydraulic data for each section of pipe including flows, heads, velocities and maximum retention times. Submission of this information shall include a table showing all of the data for each anticipated stage of the system development.

F. Design Flows

Design flows for sizing pressure sewers, including service connections and City force mains, shall be determined on the basis of the velocity and head criteria indicated under **HYDRAULIC CALCULATIONS** Sections and the pipe details indicated under **PIPE** Sections. The minimum design flow for a service connection is 0.7 l/s.

Calculate design flows in individual sections of City force main using one of the following procedures, depending upon the type of development.

(a) Single Family Residential Areas

Use the pump capacities , determined as indicated under **PUMP DETAILS**, and the number of pumps indicated in Table 4.5.1.

Table 4.5.1
Number of Single Family Residential
Pumps Operating Simultaneously

Number of Single Family Residential Pumps Connected	Number of Pumps Operating Simultaneously
1	1
2 to 3	2
4 to 9	3
10 to 18	4
19 to 30	5
31 to 50	6
51 to 80	7
81 to 113	8
114 to 149	9

(b) Multi-Family, Non-Residential and Mixed Areas

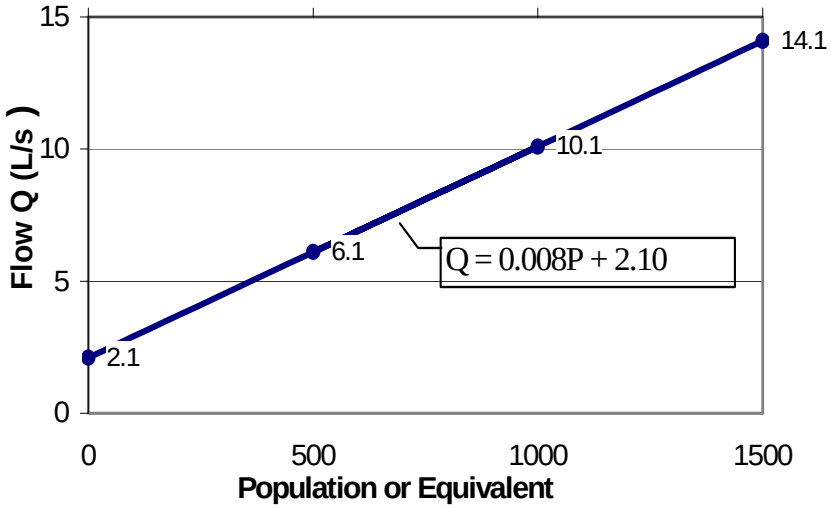
This procedure applies to any development in which pump capacities exceed those for single-family residences. For the upstream end of the system, where there are only one or two connections, assume the connected pumps are operating. Further downstream, use the following equation, the typical form of which is illustrated in Figure 4.5.1.

$$\mathbf{Q = CP + F}$$

Where:

Q = Design flow in L/s
C = Coefficient based on type of development and peaking factors; standard value: 0.008
P = Population or equivalent
F = Factor based on minimum flows, standard value: 2.10

Figure 4.5.1
Design Flows



G. Hydraulic Calculations

Criteria for Hydraulic design calculations include the following:

- Pipe flow formula: Hazen Williams, with friction coefficient C=130
- Minimum velocity: V = 0.6 m/s
- Maximum operating head (total dynamic head, TDH): compatible with pumps and not exceeding 35 m (343 kPA) unless otherwise approved by the City in advance.

System test pressures shall be 2.0 times the maximum operating head and not less than 700 kPA.

H. Pipe

Acceptable pipe materials include the following:

- High density polyethylene (HDPE) to AWWA C901 for pipes 75 mm diameter and smaller, and AWWA C906 for pipes 100 mm diameter and larger. Outside diameter (OD) to iron pipe size (IPS) dimensions. Pressure class and OD-based dimension ratio (DR): 130 and 13.5 respectively.
- Polyvinyl chloride (PVC) to CSA B137.3, Series 200 (SDR21)

Minimum pipe sizes are as follows:

- From grinder pump unit to City low pressure force main: 38 mm internal diameter (ID)

- From pump unit to public gravity sewer: 50 mm ID
- City low pressure sewage force main: 50 mm ID

Joints: Compatible with pipe material and fittings, and complete with appropriate thrust restraints in accordance with MMCD and supplementary specifications.

Installation Depths: Minimum 1.0 m on public right-of-way and 0.75 m on private property. Maximum depths without approval of City: 3.0 m.

Installation between pump unit and City force main and City force main shall include 150 mm wide green Detectable Identoline warning tape 150 mm below ground surface.

I. Cleanout Manholes

Cleanout manholes are required on low pressure force mains at ends, junctions, low points, changes of direction exceeding 22.5° and at maximum 100 m spacing. Details are shown on the standard drawings.

J. Air Valves

Sewage air release valves are required at system high points and major changes in grade (10% or greater). Details of air valve assemblies are shown on the standard drawings.

K. Discharge

Location and detail of system discharge will be subject to City approval at the Preliminary Design stage of a project. Discharge will be into a manhole and will include fittings to make the discharge submerged. Fittings will be removable to provide for flushing.

L. Service Connections

Service connections to the public sewer shall include integral wye fittings oriented in the direction of flow.

Each service connection shall include a chamber located on private property at the property line. Details of the chamber and valves and fittings to be included are shown on the standard drawings. Check valves shall be epoxy-coated cast iron, full-ported, wye body ball check valves.

M. Pump Unit General Requirements

General requirements include the following:

- Pump unit package design, including the service connection, shall be sealed by a professional engineer registered in the Province of B.C.

- All pump and control equipment shall be certified by CSA or an equivalent certification agency approved by the Engineer.

- Pump unit specifications are subject to approval by the Engineer at the preliminary design stage of a development.

- Permits:
  - Plumbing permit applications shall be in accordance with the Surrey Plumbing By-law and shall include design drawings, B.C. Building Code Schedules B-1 and B-2 and a copy of the pump unit operating and maintenance instructions. Building Code Schedule C-B shall be submitted after completion of the installation.
  - Electrical permit applications shall be in accordance with the Surrey Electrical Inspection By-law and shall include design drawings.

- Duplex (two pump) units are required for multi-family and most non-residential properties.

- Location: The pump chamber shall be installed outside of the building in a location convenient for maintenance. The control/alarm panel shall be located in close proximity to the chamber either outside or inside of the building.

- Detailed, concise operating and maintenance instructions shall be submitted to the owner of each pump unit package. A summary shall be taped to the inside of the control panel door.

- Suppliers Qualifications: Pump unit suppliers shall have documented experience and ability in design, supply and servicing of pump unit packages including pump(s), chamber, piping and controls.

N. Pump Details

Pumps for low pressure systems shall be submersible grinder pumps. Grinder assemblies shall consist of hardened stainless steel components designed to grind sewage solids into fine particles which pass easily through the pump (with typical 32 m diameter discharge) and piping.

Pump units shall be capable of discharging the design flow at the maximum operating head. Pump design flow shall be based on minimum flow velocity as indicated under **DESIGN FLOWS**, or the peak dry weather flow calculated as

indicated in the Sanitary Sewer System section of the *City of Surrey Design Criteria Manual.* The higher of the two design flows shall be used.

Grinder pumps shall be either centrifugal or semi-positive displacement pumps.

Pump curves shall be "steep" within the design operating range, i.e. where total head is below the maximum operating head, such that the reduction of capacity with increasing head does not exceed 0.03 L/s/m.

Pump units discharging through 100 mm diameter or larger service connections into 150 mm diameter or larger low pressure force mains may be solids-handling submersible centrifugal pumps.

For systems not classified as low pressure sewers where pumps discharge into gravity sewers or force mains from City-owned community pump stations, and where service connections are 100 mm diameter or larger, pumps may be solids handling submersible centrifugal pumps.

Pumps shall be manufactured using durable, non-corrosive metallic components, and shall be supplied with a warranty effective for at least two (2) years after startup. Approved pump manufacturers, subject to review at the Design Development stage, include the following:

- Barnes
- Environment One
- Hydramatic
- ITT Flygt
- Myers
- Zoeller

O. Pump Chamber Details

Criteria for pump chamber design include the following:

- Material and construction: Fibreglass reinforced polyester (FRP) or high density polyethylene (HDPE) with smooth interior, bottom shaped to avoid solids build-up, walls and bottom of sufficient thickness or with exterior corrugations to withstand soil pressure, and base to include flange for concrete collar to prevent flotation.
- Chamber lid and connections (inlet, discharge, ventilation and electrical) shall be factory-installed and watertight; lid shall be reinforced FRP or galvanized steel and provide access to full diameter of tank.
- Chamber diameter to provide for convenient operating and maintenance access and required storage volumes. Minimum diameter: 750 mm.

- Depth to accommodate inlet and discharge pipe elevations and to provide sufficient operating and storage volumes.
- Chamber volume between pump on and off levels to be based on pump cycle times between 5 and 30 minutes. A typical operating volume for a single family residential unit is 200 L.
- Chamber volume for emergency storage (above normal pump start level) shall be based on minimum 6 hours storage at average dry weather flow (adwf) calculated as indicated in the Sanitary Sewer System section of the *City of Surrey Design Criteria Manual*. Subject to approval by the Engineer, emergency storage may be provided in a separate chamber, or standby power may be provided in lieu of emergency storage.

P. Piping Details

Piping design criteria include the following:

- Pump chamber piping shall be designed to accommodate easy pump removal and replacement. Unless an approved equivalent system is provided, pump chambers with depth of 1.8 m or greater shall include a pump lift out coupling and slide rail system.
- Pump discharge piping shall include full ported check valve and ball valve. Where a slide rail system is not provided, a union shall be included between the two valves.
- An anti-siphon valve is required where a pump is located higher than any part of the low pressure system.

Q. Pump Chamber Ventilation

Each pump chamber shall include a minimum 50 mm diameter vent pipe installed in accordance with the BC Plumbing Code and the Surrey Plumbing Bylaw.

Unless otherwise approved by the plumbing inspector, the vent discharge shall be installed approximately 600 mm below ground level to the building wall and shall be connected to the building plumbing ventilation system.

If approved by the plumbing inspector, the vent discharge may be located either on the building exterior wall or attached to a post in a secure location if the pump chamber is greater than 25 m away from the building.

R. Electrical

All materials and installation shall comply with the B.C. Electrical Code Regulation and City of Surrey requirements, collectively referred to as “Code”.

Power supply shall be from the building served by the pump unit.

The following nominal service voltages will be acceptable:

.1 For residential installations: 120/208 V or 120/240 V, single-phase.
.2 For industrial/commercial installations: as above, or 120/208 V or 347/600 V, three-phase.

Wiring from the building to the pump chamber shall be underground.

Where a building electrical system includes emergency standby power, the pump unit power supply shall be connected to the emergency power.

S. Pump Chamber Classification

Pump chambers for single-family and duplex residential service are not considered to be "hazardous locations" for electrical code purposes.

Pump chambers for multi-family and non-residential service are considered as Hazardous, Class I locations. Material and installation requirements for these locations are further classified as either Zone 1 or Zone 2, depending upon the standard of ventilation, as follows:

- Zone 1: No mechanical (forced air) ventilation
  - Motors must be "explosion-proof"
  - Motors must have over-temperature protection
  - Float switches must have "intrinsic safe barriers"

- Zone 2: "Adequate" (forced air) ventilation:
  - 3-phase submersible motors must remain fully submerged
  - Single-phase submersible motors must remain fully submerged if they have no spark-producing devices. If they have spark-producing devices, these motors must be "explosion proof"
  - Float switches must have "intrinsic safe barriers"

T. Controls

Pump controls shall automatically start and stop the pump(s) and provide a high level alarm.

Level switches shall be either pressure switches, if approved at the preliminary design stage of the project, or float switches.

Unless otherwise approved at the preliminary design stage, power and control wiring shall be continuous from the pump unit and level switches to junction boxes

located above grade near the pump chamber or on the exterior of the building. Where the pump chamber is classified as hazardous, a conduit seal shall be provided between the junction box and the control panel.

Subject to prior approval by the building inspector, the control cabinet shall be installed in one of the following locations:

- On an exterior building wall close to the pump chamber;
- Inside the building near an outside door which is close to the pump chamber; or
- On a post adjacent to the pump chamber if the chamber is located 25 m or more away from the building.

If located outdoors, the control cabinet shall be lockable and weatherproof (EEMAC Type 3) and made from non-corrosive materials. Junction boxes shall be non-corrosive Type 4X.

The control panel shall be approved as specified under **PUMP UNIT GENERAL REQUIREMENTS** and shall include the following features:

- Control voltage limited to maximum 120 VAC
- White “power on” light
- Float switch indication lights
- Green “pump on” light
- Red “motor overload” light
- Red “over temperature” light, if required by Code
- Manual reset of fault conditions
- High level alarm light and buzzer
- Pump disconnect switch
- Motor starter
- Hand-Off-Auto (HOA) selector switch
- Control transformer, if required to suit control voltage
- Automatic alternator for multiple pump units
- Control Fuse
- Terminal Strip
- Form “C” (SPDT) alarm contact, rated minimum 3A, 120 VAC, wired to a set of isolated terminal blocks.

The alarm circuit shall include an alarm light buzzer and test /silence switch. If the control cabinet is mounted outside, the alarm signal shall be transmitted to an alarm box installed inside the building.

In non-residential, multi-family and other “high value” installations, a remote alarm using telephone auto-dialer or other suitable technology should be considered.

4.6 Sanitary Sewer Seismic Design Standards

A. Introduction

The following proposed design standards are intended to define the type of gravity and forcemain pipe systems that are acceptable within two different geotechnical conditions encountered in the City of Surrey. It is intended that the proposed design standards shall be applied in addition to all other relevant specifications.

B. Geotechnical

These design standards address each of the two following geotechnical conditions:

1. Where no permanent ground deformation is expected due to liquefaction or landslide.
2. Where permanent ground deformation is expected due to liquefaction or landslide.

Figure 3.3, in the Water Section – Proposed Location of Seismic Design Standards indicates the proposed locations for use of these standards.

If the Designer disagrees with the lateral displacement zones shown on the map, the Designer shall be responsible for conducting a detailed sight investigation to demonstrate, to the satisfaction of the Engineer, that the site is not subject to liquefaction or landslide.

C. Pipeline Design – No Permanent Ground Deformation

All pipeline materials and products currently allowed in the Surrey Municipal Design Criteria Manual and approved Standard Construction Documents shall be acceptable, except for the use of cast iron pipe fittings or valves in force mains.

D. Pipeline Design – Subject to Permanent Ground Deformation Due to Liquefaction or Landslide

(a) Gravity Sewer Design – Class 1

Failure Consequences and Intended Application

Class 1 design criteria apply in areas subject to permanent ground deformation due to liquefaction or landslide, where there may potentially be severe sewer failure consequences. The proposed Class 1 design standard should be applied within these areas where the gravity sewer is to be installed:

1. Above a potable water pipeline.
2. Parallel to a potable water pipeline with less than 3 metres of separation.
3. Within 100 metres of an environmentally sensitive water body.
4. Within the recharge area for a potable water well or spring supply.
5. In other locations where the failure consequences would be significant as required by the City Engineer.

Expected Performance

The sewer shall be designed so that the joints will not separate, and that the pipe will experience ductile deformation to accommodate permanent ground deformation during an earthquake. The design shall limit the flotation of the pipe.

Design

Pipe and Fittings

Use of ductile iron, steel, or high-density polyethylene pipe and fittings is required. Pipe, pipe fittings and pipe coatings shall comply with existing municipal standards. Use of concrete pipe (either reinforced or un-reinforced), PVC, and grey or cast iron pipe or fittings is not allowed.

Joint Restraint

All pipeline, fittings and appurtenance joints shall be restrained, so that they will not allow pullout when subjected to extension forces. The joint restraint system shall be strong enough to resist loading developed by 50 metres of buried pipe being pulled through the ground (wrapped in polyethylene). An appropriate design reference would be *Thrust Restraint Design for Ductile Iron Pipe* published by the Ductile Iron Pipe Research Association.

Pipe Wrapping

Pipe shall be wrapped with 8 mill thickness polyethylene (a baggy), such as is commonly used for corrosion protection, to minimize soil-pipe interaction. It is not the intent that this pipe wrapping will provide corrosion protection.

Pipe Flotation Control

If the pipeline is located within the liquefiable layer and is 500mm or greater in diameter, provision should be made to limit flotation, either by designing the pipe system for neutral buoyancy in liquefiable soils or positively holding down the pipe to keep it from floating under liquefaction conditions.

Typically, any required flotation control is achieved by encasing the pipe in concrete in order to achieve the specified neutral buoyancy. Under most circumstances, it is acceptable to assume that the pipe is half-full of sewage for the purposes of these calculations.

Manhole Flotation Control

Provision shall be made to limit flotation, either by designing the manhole for neutral buoyancy in liquefiable soils or positively holding down the manhole to keep it from floating for manholes with one or more pipes of 500mm or greater diameter entering the manhole.

Typically any required flotation control is achieved by thickening the concrete base slab order to achieve the specified neutral buoyancy.

Connections to Manholes and Structures

The designer shall calculate the expected differential movement between the pipe and structure, and provide a design that will accommodate the movement to the satisfaction of the Engineer for manholes with pipes of 500mm, or greater, diameter entering the chamber.

Typically this would be achieved by installing two mechanical couplings or flexible joints in the sewer pipe. One would be located close to the outside face of the manhole barrel and one would be located a short distance away, ideally at the edge of the manhole excavation.

(b) Gravity Sewer Design – Class 2

Failure Consequences and Intended Application

It is the intent to apply the Class 2 design criteria in locations where failure consequences, in areas subject to permanent ground deformation due to liquefaction or landslide, are not severe and thus where Class 1 design is not required.

Expected Performance

It is the intent that the sewer will be designed so that the pipe sections will not crack or break. Joint separation and flotation may occur during an earthquake.

Design

Material

All pipeline materials and products allowed in the Design Criteria Manual and Standard Construction Documents shall be acceptable, except for the use of unreinforced concrete pipe.

Connections to Manholes

The design shall provide flexibility at pipe connections to manholes to accommodate differential movement for manholes with pipes of 500mm, or greater, diameter entering the chamber.

Typically this would be achieved by installing two mechanical couplings or flexible joints in the sewer pipe. One would be located close to the outside face of the manhole barrel and one would be located a short distance away, ideally at the edge of the manhole excavation.

(c) Forcemain Design

The design of forcemains shall be the same as for Class I Gravity Sewer design, except that flotation control is not required. Forcemain design is consistent with the seismic resistant design of water pipelines in Section 3.0.

SECTION 5

Storm Drainage System

5.0 STORM DRAINAGE SYSTEM

5.1 General

Section 5.0 provides the guidelines to plan and design stormwater drainage facilities and systems in the City of Surrey. The policy framework guiding the City's drainage servicing practice is contained in Drainage Management Policy, H-45. The general framework of the intent of these guidelines is outlined in section 1 of this Design Criteria Manual.

All drainage servicing designs must conform to the applicable federal, provincial, and municipal statutes, bylaws, and guidelines. These include, amongst others, statutes such as The Local Government Act, Fisheries Act, Water Act, Navigable Waters Protection Act, Wildlife Act, Dyking Act, and guidelines such as Land Development Guidelines for the Protection of Aquatic Habitat and Stream Stewardship - A Guide for Planners and Developers.

A. Previous Design Guidelines

Surrey's drainage system has been constructed over many years using versions of the Municipality's design criteria that were in effect at the time. This current criteria is to be used when designing all new infrastructure and when assessing the adequacy of existing systems. Should an existing system not meet current criteria due to a change in the criteria, the design engineer will be responsible to judge whether a non-conformance to the criteria for the existing downstream may be acceptable. This non-conformance must be submitted for review and sign-off by both the design engineer and the City Engineer. Sign-off by the City will not relieve the design engineer of liability normally associated with the design of drainage infrastructure.

5.2 Drainage Servicing

A. Scope

Sub-Section 5.2 describes the drainage servicing process, objectives and general requirements.

B. Drainage Planning And Land Use Planning

The City of Surrey has adopted a multi-level land use planning approach beginning with the Official Community Plan (OCP), to a more detailed level of density planning through the Neighbourhood Concept Plans (NCP), to finally a review of re-zoning applications consistent with the OCP and the NCP.

In response to the OCP, the Engineering Department prepares Master Drainage Plans (MDP). The MDP provides a review of drainage opportunities and constraints on a watershed by watershed basis and presents an appropriate conceptual drainage servicing plan that meets the City's drainage standards/criteria. All development related servicing proposals should satisfy the servicing framework given in the appropriate MDP.

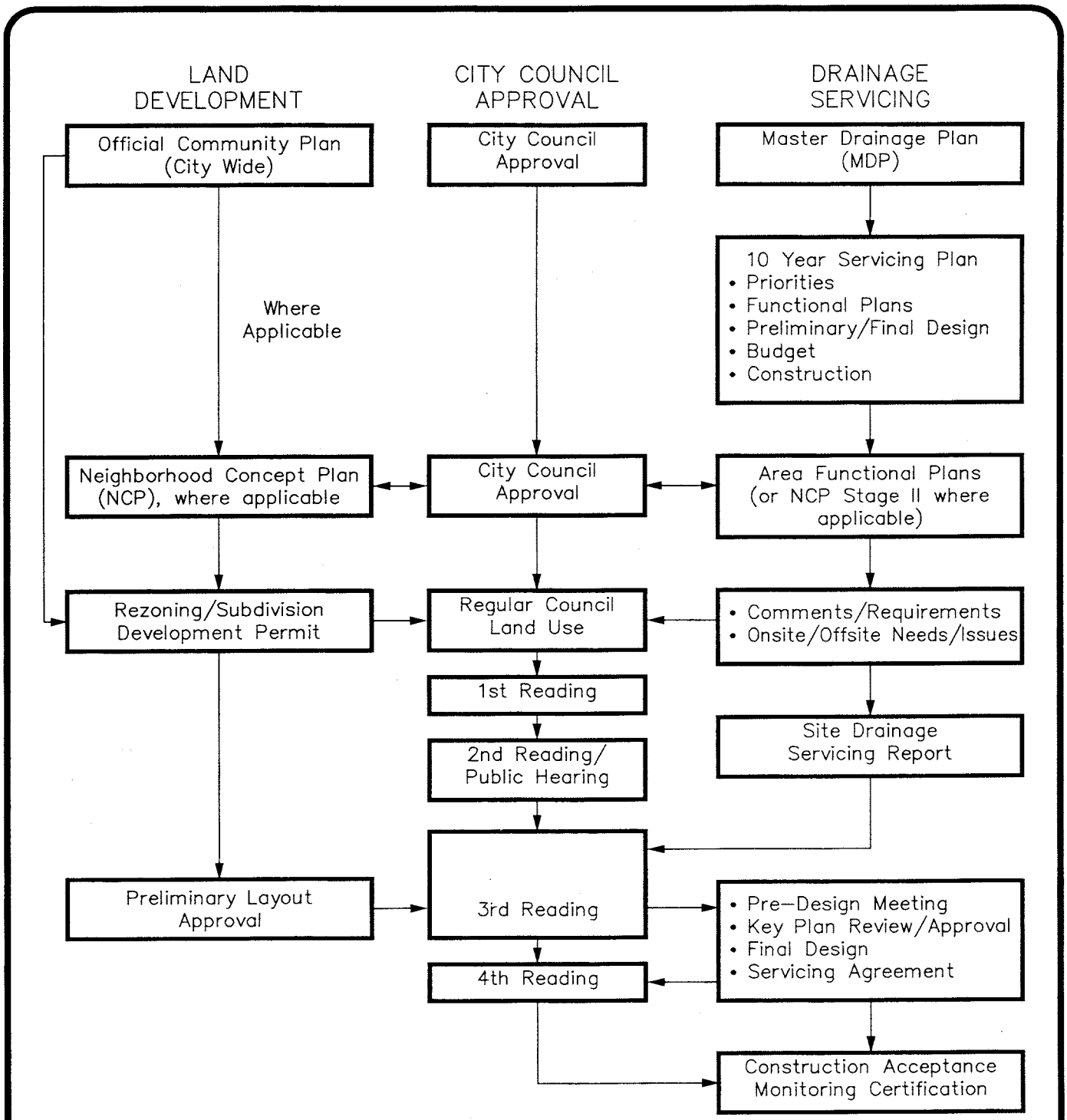
Figure 5.1 shows the inter-relationship between drainage planning and land use planning and the staged approval by City Council. Drawing Figure 5.2 shows the overall Master Drainage Plan (MDP) boundaries of the key watersheds within the City.

In situations where no MDP exists or where new development is proposed before the completion of the required works recommended in a MDP, the developer is required to complete those works necessary to service the specific development. Interim stormwater management measures may be considered providing that they can be practically achieved and protect the downstream drainage system from surcharge and erosion. Interim detention in NCP areas will only be considered if the land for the ultimate pond is secured in favour of the City.

C. Master Drainage Plan (MDP)

The Master Drainage Plan proposes an optimum drainage servicing strategy that meets the ultimate land use in the watershed. The proposed MDP must address all identified constraints and provide the following information:

- Conceptual schemes for storm drainage servicing including trunk storm sewers, catchment detention ponds, minor and major flow routes, and erosion protection.
- Department of Fisheries & Oceans and BCMWLAP review.
- Hydrological and hydraulic model of pre-development and ultimate development condition.
- Stakeholder and public input.
- Bio-inventory of creeks and watercourses.
- Hydrogeological Impact Assessment (in areas where DFO and BC Environment jointly require its consideration).
- Inventory of watercourses and trunk drainage facilities.
- Sizes and performance requirements of catchment detention ponds.
- Priority of MDP recommendations.



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2		
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	Revision Date	Approved

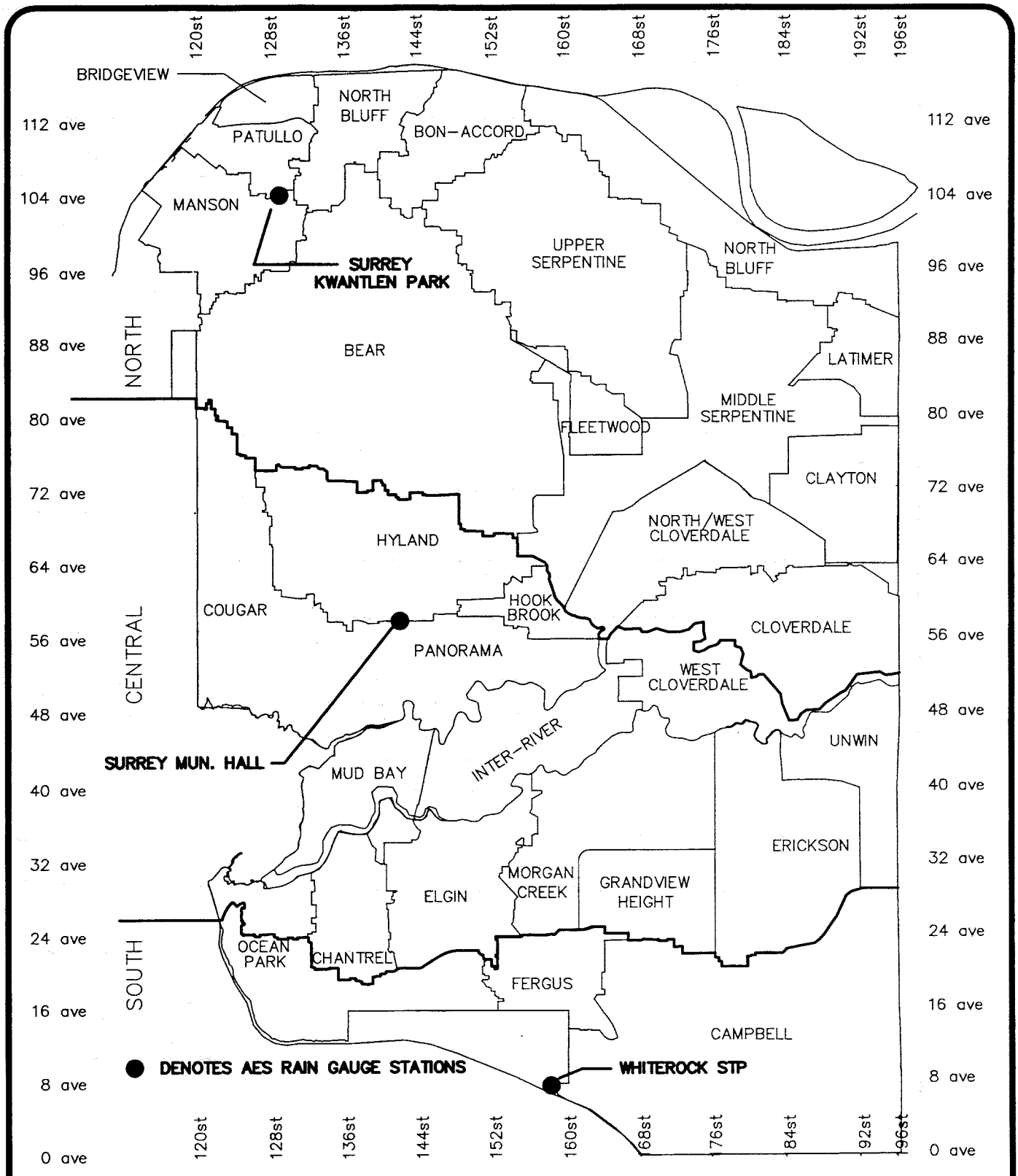
All Dimensions Shown In Millimetres, Unless Otherwise Noted

Title LAND DEVELOPMENT AND DRAINAGE SERVICING OVERALL APPROVAL PROCESS

SURREY
CITY OF PARKS

Approved	
Date	AUGUST 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
FIGURE 5.1



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	Revision Date	Approved

All Dimensions Shown In Millimetres, Unless Otherwise Noted

Title CITY OF SURREY MASTER DRAINAGE PLAN AND RAINFALL BOUNDARIES

SURREY
CITY OF PARKS

Approved	
Date	AUGUST 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
FIGURE 5.2

D. Servicing Objectives

The planning for drainage systems which meet the needs of growth must meet four basic criteria which form the fundamental aspects of the City's Drainage Policy:

(a) A minor system conveyance capacity up to the 1:5-year return period storm to minimize inconvenience of frequent surface runoff.
(b) A major system conveyance capacity up to the 1:100-year return period storm to provide safe conveyance of flows to minimize damage to life and property.
(c) Where erosion is a concern, to the more stringent of the two following criteria:
   - control the 5-year post-development flow to 50% of the 2-year post-development rate; or
   - control the 5-year post-development flow to 5-year pre-development flow rate.
(d) Maintenance of a flood control and drainage system in the lowlands that meets provincial guidelines for agriculture in floodplains (ARDSA).

The satisfactory resolution of the drainage servicing constraints is often the most significant aspect of the land development project viability and timing.

E. Typical Drainage Constraints to New Development

The following summary Table 5.2(a) provides an overview of typical drainage constraints in Surrey and their impacts and potential mitigative measures. These should be central to the development servicing strategies.

Emergence of groundwater (springs) can have an impact on potential development. Although this is frequently seen as a minor detail in the servicing strategy, the emergence of groundwater and related surface conveyance across road ways and sidewalks can have a very significant impact on safety as well as the infrastructure itself. Servicing strategies and infrastructure must be designed to account for this.

Table 5.2(a)
Typical Drainage Constraints

DRAINAGE CONSTRAINTS	IMPACTS	POTENTIAL MITIGATION OPTIONS
• Undersized or Missing Minor System	• Flooding or reduced service for existing development	• Detention • Replace or install appropriate drainage system.
• Safe conveyance of major flows.	• Flooding of properties. • Ponding on streets.	• Reduce flows by storage. • Provide conveyance capacity through continuous flow routing on surface or pipe systems with increased inlet capacity.
• Increased lowland flooding.	• Inconvenience and road safety concerns in urban lowlands (Fraser River). • Impacts to viable farming in agricultural lowlands.	• Reduce duration of flooding to provincial agricultural standards. • Increase pumping, conveyance, and storage capacity.
• High peak flow in creeks.	• Erosion and siltation. • Creek instability. • Impacts to fish habitat .	• Use storages to reduce flows. • Divert high flows. • Leave strips along creek banks. • Creek erosion protection.
• Water quality deterioration.	• Impact on fish/plants/ wildlife.	• On site management. • Best Management Practices (BMPs). • Infiltration facilities.
• Under utilization of existing ponds.	• High flows/velocities in creeks lead to increased erosion.	• Improve controls. • Enlarge storage capacity. • Abandon and replace with larger community ponds.
• Absence of dedicated leave strips and floodplain right-of-way (ROW) along creeks/waterways.	• Reduction in riparian area. • Loss in aesthetic and environmental value. • Maintenance access problems.	• Obtain leave strips along creeks under City ownership. • Protect floodplain by approving riparian protection Bylaw and right to flood ROWs. • Creek ROWs.

The City's objective is to encourage the development community to conduct progressive and early evaluation of the drainage servicing needs of their land development projects.

Table 5.2(b) summarizes the process to be followed by developers to meet City requirements for drainage servicing.

A Conceptual Servicing Plan is recommended for each development application prior to the Preliminary Layout Approval (PLA) at third reading.

Key player meetings between the Developer, the Land Development Project Consultant, and the Engineer are encouraged and may be requested by the proponent.

Table 5.2(b)
Drainage Review Process For Land Development Servicing

Development Stage	Requirements	Sign-off
Prior to Regular Council Land Use	At discretion of Engineer, a Conceptual Drainage Servicing Report	Engineering Planning
Preliminary Layout Approval (3rd reading)	• Conceptual Drainage Servicing Report • Watercourse top-of-bank and set back delineation	Engineering Planning
Pre-Design	• Stormwater Control Plan (Draft) • Pre-Design checklist • Sediment Control Plan (Draft)	Land Development
Key-Plan Circulation	• Final Stormwater Control Plan • Final Sediment Control Plan	Engineering Planning
Formal Drawing Presentation and Completed Servicing Agreement	• Final Design Drawings • Final Agency Approvals • Servicing Agreement and Financial Obligations • Ministry of Environment Approvals (if required)	Land Development

F. Development Design Requirements

All development proponents are required to submit the following plans for review and approval:

Stormwater Control Plan

Stormwater Control Plans describe in detail how the proposed development will impact the existing drainage system and how the proposed major and minor drainage infrastructure meets the City's drainage policies and design criteria.

The Stormwater Control Plan must be provided by all developments that alter the existing drainage characteristics.

The Stormwater Control Plan must be in the form of a written report and must include the following:

- Consideration of impact on the total watershed and recommendations in the MDP or NCP (if applicable).
- Tributary areas in the catchment including existing and ultimate land use.
- The development area within the drainage catchment including all features such as roads, natural watercourses, watercourse crossing structures, and low or poorly drained areas.
- Contour plan with 1.0 m elevation interval (1:2500 scale).
- Plan view of existing and proposed drainage systems.
- Major and minor conveyance capacity.
- Impervious or Runoff coefficient values for each catchment area based on future OCP land use.
- Hydrologic calculations summarized in table form and supporting parameters to a point 200 metre downstream of the discharge into an existing trunk storm sewer or as identified in the engineering comments. (Rational Method accepted for areas less than 20 hectares. The unit hydrograph technique to be applied for areas exceeding 20 hectares).
- 1:100-year flow routing internal and external to the development.
- Control of discharges to meet downstream conditions such as prevention of erosion and flooding.
- Outfall capacity constraints including storm sewers and natural watercourses.
- Location and sizes of detention facilities including summary of design flows, volumes, and control orifice sizing.
- Show the HGL in the detention facility and account for potential backwater effects in the design of sewers draining into it.
- Areas of major cut or fill (greater than 1.0 m).
- Sediment control plan.
- Hydraulic considerations - surcharged system impact, water flow on road surface. A profile of the 100-year HGL against MBEs is required.

- Recommendations for works required to address the above including any interim facility.

It is the Designer's responsibility to confirm the extent of the drainage catchments gain acceptance by the Engineering Department of the Stormwater Control Plan at the pre-design stage of the development acceptance process.

Groundwater

Control of groundwater emergence and protection of municipal and private infrastructure from the negative impacts of groundwater must become part of the overall servicing strategy for a development. As noted above, groundwater management must be accounted for in a site's infrastructure design. The use of cut-off drains or connecting servicing trenches to the storm sewer system are two possible solutions to this problem. Where groundwater emergence can reasonably be expected, the design engineer must ensure the issue is addressed to protect both public and private property.

Sediment Control Plan

Sediment Control Plan is a requirement of all development projects and must clearly outline the measures to be taken to reduce sediment discharges from the site during the full construction period (servicing and building construction). Sediment control ponds shall not be combined with stormwater detention ponds unless adequate measures are undertaken to prevent migration of silt during major storms and the retention volume is adequate for control of silt discharge. The designer must refer to the **"Land Development Guidelines for the Protection of Fish Habitat"** as a basis for sediment control design.

5.3 Stormwater Runoff Generation (Hydrology)

A. Scope

Subsection 5.3 describes the rationale, methodology and parameters for determining the hydrologic variables such as rate and amount of stormwater runoff in the design of storm drainage flow conveyance and storage facilities, in the City of Surrey.

Protection from flooding will be provided up to the 200-year level for areas in the floodplains of the Fraser, Serpentine, Nicomekl and Campbell Rivers. All other areas will be protected from 100-year flood flows.

B. Rainfall Data

Data from the Surrey Kwantlen Park, Surrey Municipal Hall and White Rock STP AES rainfall gauges will be used in designing drainage infrastructure in the City of Surrey. As shown in Figure 5.2, the three gauges are assigned to specific areas of the City from North to South to account for variation in rainfall distribution.

Rainfall Intensity Duration Frequency (IDF) curves for 5 minutes to 24-hour durations for each of the three stations are provided in Tables 5.3(a), (b), (c), as well as on Figures 5.3(a), (b), (c). Rainfall depths taken from these curves can be used with the Rational method.

Design storms that reflect historic conditions in Surrey will be used for Hydrograph Method computations. Tables 5.3(d) (i), (ii), (iii), (iv) provide design storm hyetographs for areas covered by the Kwantlen Park gauge (as delineated in Figure 5.2) for durations of 1, 2, 6, 12 and 24 hours. For areas covered by the other three gauges, IDF curve values for the appropriate gauges can be used to pro-rate the Kwantlen Park design hyetographs shown in Table 5.3(d).

Longer duration rainstorms which are typical for lower mainland last about three to five days. These events are critical for the effective functioning of the stormwater storage facilities. For example, in South Surrey, during the winter of 1996/97, the 39 hour event recorded from November 26 to November 28, 1996 had a rainfall depth of 71.4 mm, and had a return frequency of approximately 2 years and the January 29, 1997, 18 hour event with 61.3 mm of rain had a 25 year (maximum) return period. These events are presented in Table 5.3(f) and Figure 5.4. These historical events must be used for confirming storage facilities design performance during such events.

Long duration wet weather periods of up to one month containing 5 to 100-year level storms would be critical to the adequate functioning of storage facilities. All proposed stormwater control facilities must be tested at the design stage to confirm their safe operation for these critical wet weather periods.

Using the historical hourly rainfall data for these gauges, appropriate critical periods have been selected and are tabulated in Table 5.3(f). The related hourly data for long duration performance analysis is available from the City in digital form.

Rainfall data applicable for the design of lowland flood control related works is given on Table 5.3(g) i, ii, iii, iv (Storm Distribution for ARDSA Standard Evaluation of Lowland Flood Control).

Table 5.3 (a)

Rainfall IDF Data - Kwantlen Park

ATMOSPHERIC ENVIRONMENT SERVICE
RAINFALL INTENSITY - DURATION FREQUENCY VALUES
GUMBEL -METHOD OF MOMENTS – 1996

****

TABLE 2 SURREY KWANTLEN PARK, BC 1107873
LATITUDE 4912 LONGITUDE 12252 ELEVATION 93 M

****

RETURN PERIOD RAINFALL AMOUNTS (MM)

DURATION	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	# YEARS
5 MIN	3.1	4.3	5.1`	6.1	6.8	7.5	35
10 MIN	4.5	6.3	7.5	9.1	10.2	11.3	35
15 MIN	5.5	7.7	9.1	10.9	12.3	13.6	35
30 MIN	7.5	10.4	12.3	14.7	16.5	18.3	35
1 H	10.9	13.9	15.8	18.3	20.2	22.0	35
2 H	16.1	19.8	22.2	25.2	27.5	29.8	35
6 H	31.6	37.3	41.0	45.8	49.3	52.8	35
12 H	46.9	57.0	63.7	72.1	78.3	84.5	35
24 H	64.6	82.9	95.0	110.3	121.7	133.0	35

INTERPOLATION EQUATION **R = A * T ** B**
R = RAINFALL RATE (MM / HR)
T = TIME IN HOURS

STATISTICS	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
MEAN OF R	14.7	19.9	23.3	27.7	30.9	34.1
STD. DEV. R	11.9	16.8	20.1	24.2	27.3	30.4
STD ERROR	.8	1.1	1.5	2.0	2.4	2.8
COEFF. (A)	11.5	15.1	17.4	20.4	22.5	24.7
EXPONENT (B)	-.457	-.484	-.496	-.507	-.513	-.518
MEAN % ERROR	3.6	4.8	5.8	7.0	7.7	8.2

Table 5.3 (b)
Rainfall IDF Data - White Rock STP

ATMOSPHERIC ENVIRONMENT SERVICE
RAINFALL INTENSITY - DURATION FREQUENCY VALUES
GUMBEL -METHOD OF MOMENTS – 1996

TABLE 2 WHITE ROCK STP, BC 1108914
LATITUDE 4901 LONGITUDE 12246 ELEVATION 15 M

RETURN PERIOD RAINFALL AMOUNTS (MM)

DURATION	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	# YEARS
5 MIN	2.9	3.9	4.6`	5.4	6.0	6.7	27
10 MIN	4.3	6.0	7.1	8.5	9.5	10.6	27
15 MIN	5.3	7.8	9.5	11.6	13.2	14.7	27
30 MIN	8.0	12.7	15.9	19.9	22.8	25.7	27
1 H	11.4	18.3	22.9	28.7	33.0	37.2	33
2 H	16.2	24.0	29.1	35.7	40.5	45.3	33
6 H	28.6	36.1	41.1	47.4	52.1	56.7	33
12 H	36.9	45.6	51.4	58.7	64.1	69.4	33
24 H	50.6	62.5	70.5	80.4	87.9	95.2	33

INTERPOLATION EQUATION **R = A * T ** B**
R = RAINFALL RATE (MM / HR)
T = TIME IN HOURS

STATISTICS	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
MEAN OF R	14.1	20.2	24.2	29.4	33.2	36.9
STD. DEV. R	11.2	15.6	18.5	22.3	25.1	27.9
STD ERROR	.9	4.0	6.1	8.7	10.7	12.7
COEFF. (A)	10.8	15.2	18.1	21.7	24.3	27.0
EXPONENT (B)	-.493	-.522	-.534	-.545	-.551	-.557
MEAN % ERROR	4.4	10.2	12.8	15.2	16.6	17.6

Table 5.3 (c)
Rainfall IDF Data - Surrey Municipal Hall

ATMOSPHERIC ENVIRONMENT SERVICE
RAINFALL INTENSITY - DURATION FREQUENCY VALUES
GUMBEL -METHOD OF MOMENTS – 1996

TABLE 2 SURREY MUNICIPAL HALL, BC 1107876
LATITUDE 4906 LONGITUDE 12250 ELEVATION 76 M

RETURN PERIOD RAINFALL AMOUNTS (MM)

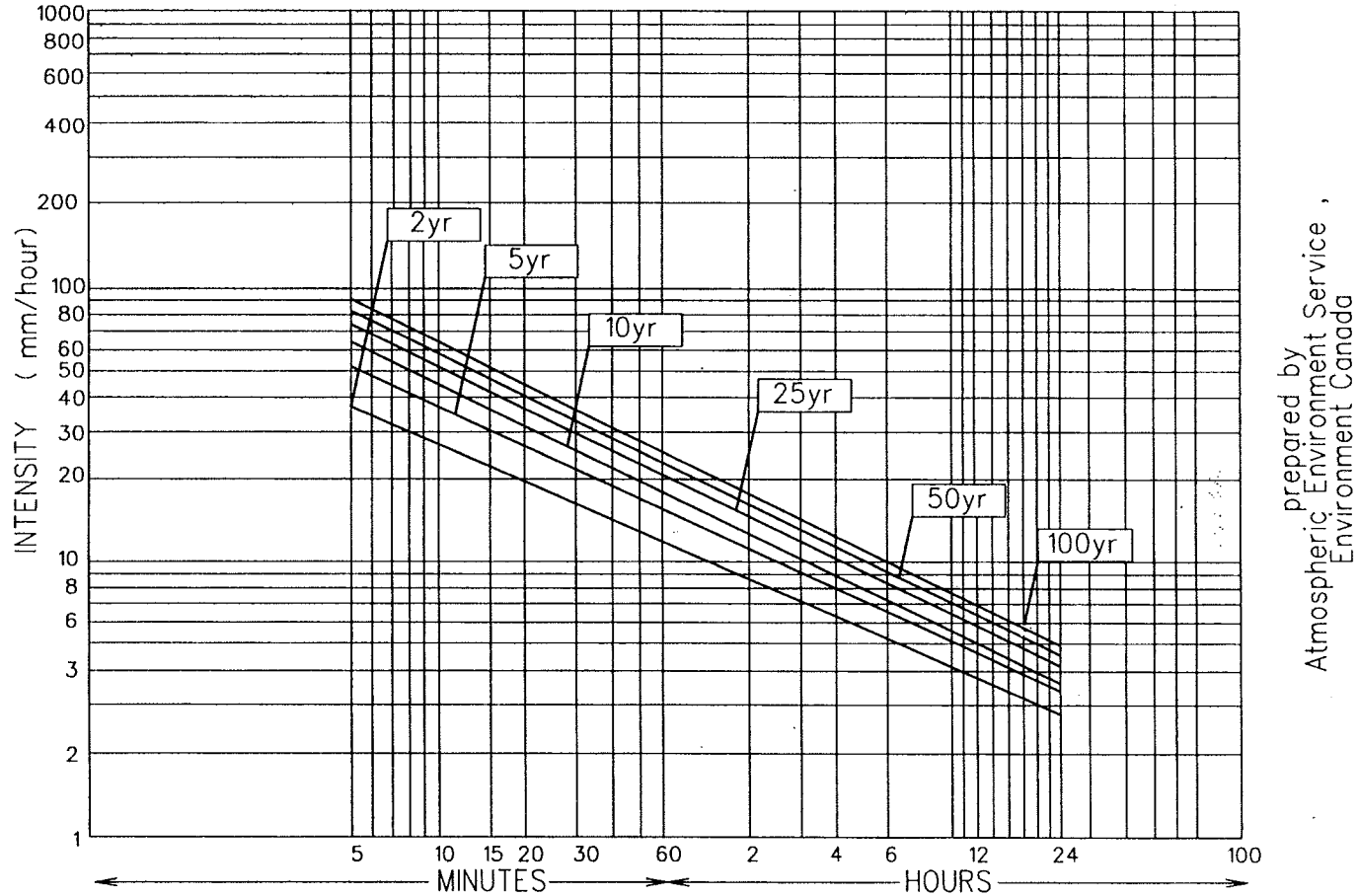
DURATION	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	# YEARS
5 MIN	2.9	5.4	7.1`	9.2	10.7	12.3	12
10 MIN	4.2	6.9	8.7	10.9	12.6	14.2	12
15 MIN	5.2	8.0	9.8	12.1	13.8	15.4	12
30 MIN	7.2	10.2	12.3	14.8	16.7	18.6	12
1 H	10.0	12.9	14.8	17.1	18.9	20.7	34
2 H	14.6	17.7	19.8	22.4	24.3	26.2	34
6 H	26.9	32.5	36.2	40.9	44.3	47.8	34
12 H	39.2	47.3	52.6	59.4	64.4	69.4	34
24 H	56.2	67.7	75.3	84.9	92.0	99.1	34

INTERPOLATION EQUATION **R = A * T ** B**
R = RAINFALL RATE (MM / HR)
T = TIME IN HOURS

STATISTICS	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
MEAN OF R	13.5	21.3	26.4	32.9	37.7	42.5
STD. DEV. R	11.1	20.9	27.5	35.8	41.9	48.1
STD ERROR	.3	2.8	4.5	6.7	8.3	9.9
COEFF. (A)	10.4	14.6	17.3	20.6	23.1	25.5
EXPONENT (B)	-.477	-.551	-.580	-.605	-.619	-.631
MEAN % ERROR	2.1	7.1	9.0	10.5	11.4	12.0

SHORT DURATION RAINFALL INTENSITY DURATION FREQENCY CURVE DATA FOR SURREY KWANTLEN PARK B.C.

GUMBEL METHOD OF MOMENTS BASED ON RECORDING RAIN GUAGE DATA FOR THE PERIOD 1962 - 1996 (35 YEARS)



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Atmospheric Environment Service ,
Environment Canada

All Dimensions Shown In Millimetres. Unless Otherwise Noted		
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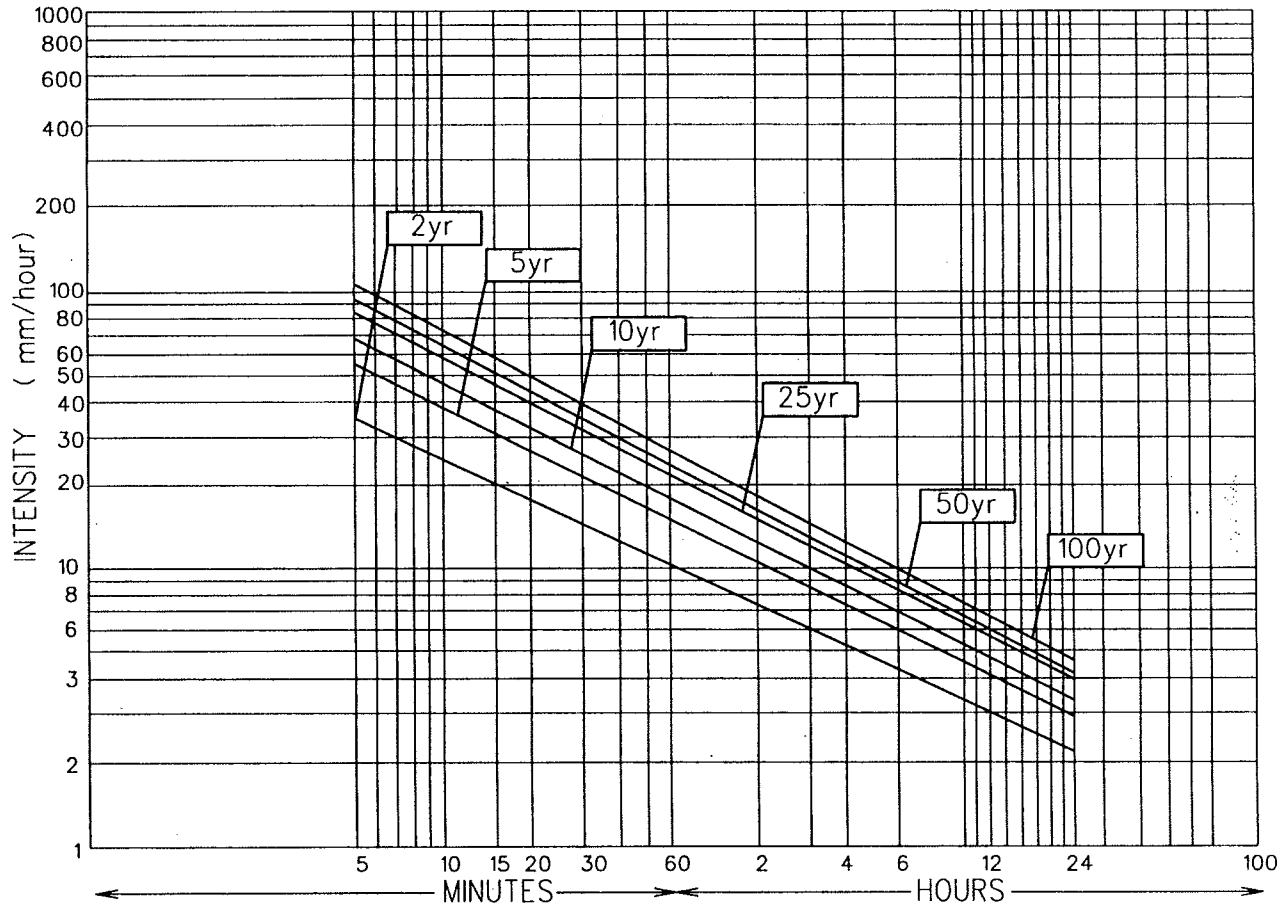
	Revision Date	Approved

SURREY
CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Title	RAINFALL IDF CURVES KWANTLEN PARK	
Approved		DRAWING NUMBER
Date		FIGURE 5.3A
Drawn By	Surrey Engineering	

SHORT DURATION RAINFALL INTENSITY DURATION FREQENCY CURVE DATA FOR WHITE ROCK STP, B.C.

GUMBEL METHOD OF MOMENTS BASED ON RECORDING RAIN GUAGE DATA FOR THE PERIOD 1964 - 1996 (33 YEARS)



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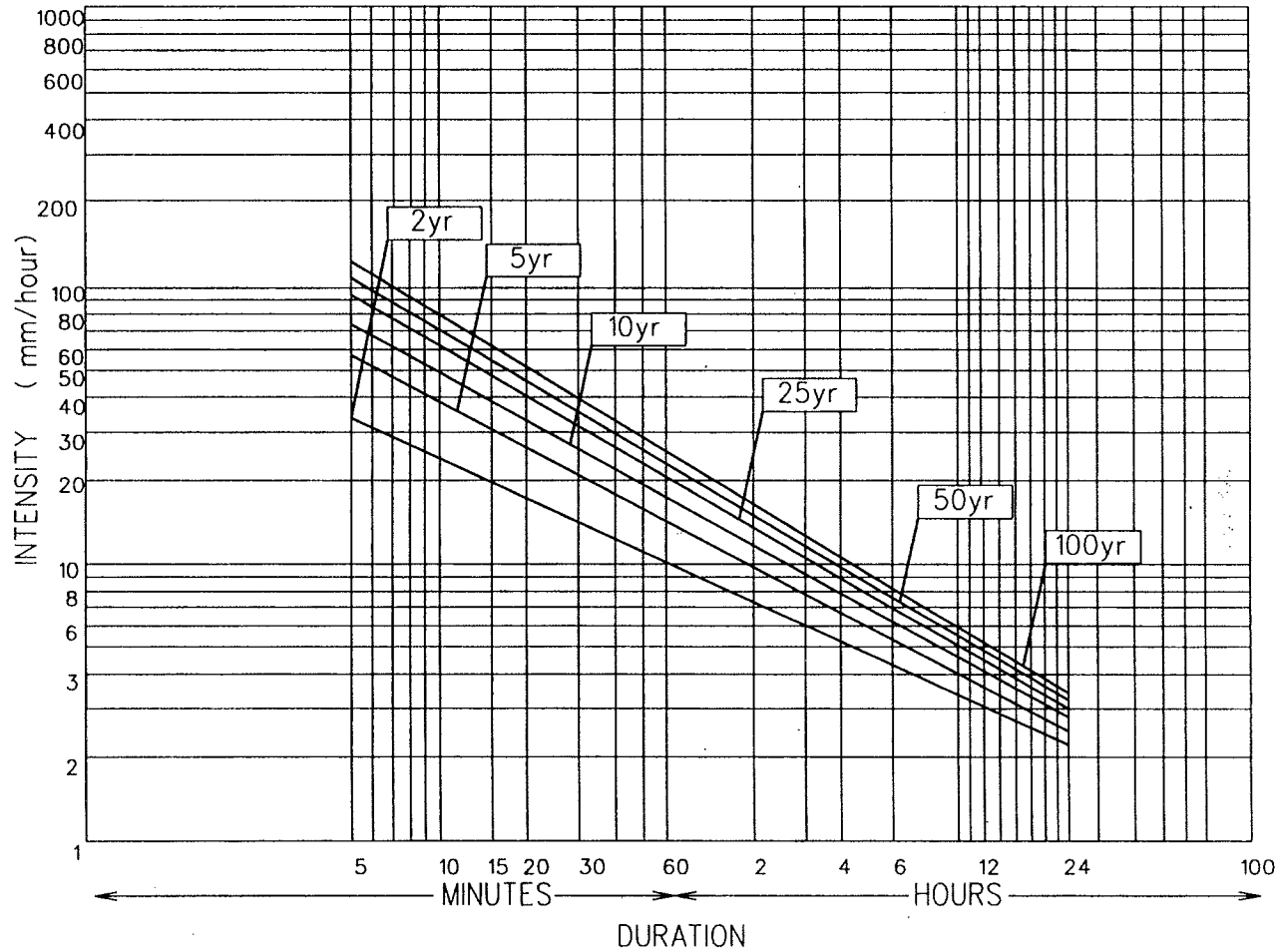
SURREY
CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Title	RAINFALL IDF CURVES WHITE ROCK STP	
Approved		DRAWING NUMBER
Date		FIGURE 5.3B
Drawn By	Surrey Engineering	

SHORT DURATION RAINFALL INTENSITY DURATION FREQENCY CURVE DATA FOR SURREY CITY HALL, B.C.

GUMBEL METHOD OF MOMENTS BASED ON RECORDING RAIN GUAGE DATA FOR THE PERIOD 1962 -1996 (35 YEARS)



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Atmospheric Environment Service ,
Environment Canada

All Dimensions Shown In Millimetres. Unless Otherwise Noted			
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SURREY
CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Title	RAINFALL IDF CURVES SURREY CITY HALL	
Approved		DRAWING NUMBER
Date		FIGURE 5.3C
Drawn By	Surrey Engineering	

Table 5.3 (d) (i)
1:2-Year Storm Intensity - Kwantlen Park

Time (Min)	1 Hour AES	2 Hour AES	Time (Min)	6 Hour AES	12 Hour SCS	Time (Min)	24 Hour SCS
0	0.00	0.00	0	0.00	0.00	0	0.00
5	6.54	4.83	10	3.80	1.18	20	1.26
10	7.85	4.83	20	3.80	1.18	20	1.29
15	11.77	5.80	30	3.80	1.18	40	1.29
20	11.77	5.80	40	4.43	2.36	60	1.62
25	13.08	8.69	50	4.43	2.36	80	1.62
30	14.39	8.69	60	4.43	2.36	100	1.62
35	18.31	8.69	70	5.69	2.84	120	1.94
40	14.39	8.69	80	5.69	2.84	140	1.94
45	10.46	9.68	90	5.69	2.84	160	1.94
50	9.16	9.68	100	5.06	3.31	180	2.26
55	7.85	10.63	110	5.03	3.31	200	2.26
60	5.23	10.63	120	5.06	3.31	220	2.26
65		13.52	130	5.06	4.25	240	2.90
70		13.52	140	5.03	4.25	260	2.90
75		10.63	150	5.06	4.25	280	2.90
80		10.63	160	7.59	5.67	300	3.88
85		7.73	170	7.59	5.67	320	3.88
90		7.73	180	7.59	5.67	340	3.88
95		6.76	190	5.69	8.04	360	5.49
100		6.76	200	5.69	8.04	380	5.49
105		5.80	210	5.69	8.04	400	5.49
110		5.80	220	5.69	9.93	420	6.79
115		3.86	230	5.69	9.93	440	6.79
120		3.86	240	5.69	9.93	460	6.79
125			250	5.69	7.56	480	5.17
130			260	5.69	7.56	500	5.17
135			270	5.69	7.56	520	5.17
140			280	5.06	6.14	540	4.20
145			290	5.05	6.14	560	4.20
150			300	5.06	6.14	580	4.20
155			310	5.06	5.67	600	3.88
160			320	5.03	5.67	620	3.88
165			330	5.06	5.67	640	3.88
170			340	4.43	4.73	660	3.23
175			350	4.43	4.73	680	3.23
180			360	4.43	4.73	700	3.23
185			370		3.78	720	2.59
			380		3.78	740	2.59
			390		3.78	760	2.59
			400		4.25	780	2.90
			410		4.25	800	2.90
			420		4.25	820	2.90
			430		2.84	840	1.94
			440		2.84	860	1.94
			450		2.84	880	1.94
			460		3.78	900	2.59
			470		3.78	920	2.59
			480		3.78	940	2.59
			490		2.84	960	1.94
			500		2.84	980	1.94
			510		2.84	1000	1.94
			520		2.36	1020	1.62
			530		2.36	1040	1.62
			540		2.36	1060	1.62
			550		1.89	1080	1.29
			560		1.89	1100	1.29
			570		1.89	1120	1.29
			580		2.36	1140	1.62
			590		2.36	1160	1.62
			600		2.36	1180	1.62
			610		1.89	1200	1.29
			620		1.89	1220	1.29
			630		1.89	1240	1.29
			640		1.89	1260	1.29
			650		1.89	1280	1.29
			660		1.89	1300	1.29
			670		2.36	1320	1.62
			680		2.36	1340	1.62
			690		2.36	1360	1.62
			700		1.89	1380	1.29
			710		1.89	1400	1.29
			720		1.89	1420	1.29
Rain (mm)	10.90	16.10		31.60	46.90		64.60

Table 5.3 (d) (ii)
1:5-Year Storm Intensity - Kwantlen Park

Time (Min)	1 Hour AES	2 Hour AES	Time (Min)	6 Hour AES	12 Hour SCS	Time (Min)	24 Hour SCS
0	0.00	0.00	0.00	0.00	0.00	0	0.00
5	8.34	5.94	10.00	4.47	2.28	20	1.66
10	10.01	5.94	20.00	4.47	2.28	40	1.66
15	15.01	7.13	30.00	4.47	2.28	60	1.66
20	15.01	7.13	40.00	5.21	2.85	80	2.07
25	16.68	10.69	50.00	5.23	2.85	100	2.07
30	18.35	10.69	60.00	5.21	2.85	120	2.07
35	23.35	10.69	70.00	6.72	3.42	140	2.49
40	18.35	10.69	80.00	6.72	3.42	160	2.49
45	13.34	11.88	90.00	6.72	3.42	180	2.49
50	11.68	11.88	100.00	5.97	3.99	200	2.90
55	10.01	13.07	110.00	5.96	3.99	220	2.90
60	6.67	13.07	120.00	5.97	3.99	240	2.90
65		16.63	130.00	5.97	5.13	260	3.73
70		16.63	140.00	5.96	5.13	280	3.73
75		13.07	150.00	5.97	5.13	300	3.73
80		13.07	160.00	8.95	6.84	320	4.97
85		9.51	170.00	8.95	6.84	340	4.97
90		9.51	180.00	8.95	6.84	360	4.97
95		8.30	190.00	6.72	9.69	380	7.05
100		8.30	200.00	6.72	9.69	400	7.05
105		7.13	210.00	6.72	9.69	420	7.05
110		7.13	220.00	6.72	11.97	440	8.70
115		4.75	230.00	6.72	11.97	460	8.70
120		4.75	240.00	6.72	11.97	480	8.70
125			250.00	6.72	9.12	500	6.63
130			260.00	6.72	9.12	520	6.63
135			270.00	6.72	9.12	540	6.63
140			280.00	5.97	7.40	560	5.39
145			290.00	5.96	7.40	580	5.39
150			300.00	5.97	7.40	600	5.39
155			310.00	5.97	6.84	620	4.97
160			320.00	5.96	6.84	640	4.97
165			330.00	5.97	6.84	660	4.97
170			340.00	5.21	5.70	680	4.15
175			350.00	5.23	5.70	700	4.15
180			360.00	5.21	5.70	720	4.15
185			370.00		4.56	740	3.32
			380.00		4.56	760	3.32
			390.00		4.56	780	3.32
			400.00		5.13	800	3.73
			410.00		5.13	820	3.73
			420.00		5.13	840	3.73
			430.00		3.42	860	2.49
			440.00		3.42	880	2.49
			450.00		3.42	900	2.49
			460.00		4.56	920	3.32
			470.00		4.56	940	3.32
			480.00		4.56	960	3.32
			490.00		3.42	980	2.49
			500.00		3.42	1000	2.49
			510.00		3.42	1020	2.49
			520.00		2.85	1040	2.07
			530.00		2.85	1060	2.07
			540.00		2.85	1080	2.07
			550.00		2.28	1100	1.66
			560.00		2.28	1120	1.66
			570.00		2.28	1140	1.66
			580.00		2.85	1160	2.07
			590.00		2.85	1180	2.07
			600.00		2.85	1200	2.07
			610.00		2.28	1220	1.66
			620.00		2.28	1240	1.66
			630.00		2.28	1260	1.66
			640.00		2.28	1280	1.66
			650.00		2.28	1300	1.66
			660.00		2.28	1320	1.66
			670.00		2.85	1340	2.07
			680.00		2.85	1360	2.07
			690.00		2.85	1380	2.07
			700.00		2.28	1400	1.66
			710.00		2.28	1420	1.66
			720.00		2.28	1440	1.66
	13.90	19.80		37.30	57.00		82.90

Table 5.3 (d) (iii)
1:10-Year Storm Intensity - Kwantlen Park

Time (Min)	1 Hour AES	2 Hour AES	Time (Min)	6 Hour AES	12 Hour SCS	Time (Min)	24 Hour SCS
0	0.00	0.00	0	0.00	0.00	0	0.00
5	9.48	6.66	10	4.92	2.54	20	1.90
10	11.37	6.66	20	4.92	2.54	40	1.90
15	17.06	7.98	30	4.92	2.54	60	1.90
20	17.06	7.98	40	5.73	3.19	80	2.38
25	19.04	11.99	50	5.76	3.19	100	2.38
30	20.83	11.99	60	5.73	3.19	120	2.38
35	26.54	11.99	70	7.38	3.83	140	2.85
40	20.83	11.99	80	7.38	3.83	160	2.85
45	15.16	13.32	90	7.38	3.83	180	2.85
50	13.27	13.32	100	6.57	4.46	200	3.33
55	11.37	14.65	110	6.54	4.46	220	3.33
60	7.58	14.65	120	6.57	4.46	240	3.33
65		18.65	130	6.57	5.73	260	4.27
70		18.65	140	6.54	5.73	280	4.27
75		14.65	150	6.57	5.73	300	4.27
80		14.65	160	9.84	7.64	320	5.69
85		10.66	170	9.84	7.64	340	5.69
90		10.66	180	9.84	7.64	360	5.69
95		9.33	190	7.38	10.83	380	8.08
100		9.33	200	7.38	10.83	400	8.08
105		7.99	210	7.38	10.83	420	8.08
110		7.99	220	7.38	13.37	440	9.98
115		5.33	230	7.38	13.37	460	9.98
120		5.33	240	7.38	13.37	480	9.98
125			250	7.38	10.19	500	7.60
130			260	7.38	10.19	520	7.60
135			270	7.38	10.19	540	7.60
140			280	6.57	8.28	560	6.18
145			290	6.54	8.28	580	6.18
150			300	6.57	8.28	600	6.18
155			310	6.57	7.64	620	5.69
160			320	6.54	7.64	640	5.69
165			330	6.57	7.64	660	5.69
170			340	5.73	6.37	680	4.75
175			350	5.76	6.37	700	4.75
180			360	5.73	6.37	720	4.75
185			370		5.10	740	3.80
			380		5.10	760	3.80
			390		5.10	780	3.80
			400		5.73	800	4.27
			410		5.73	820	4.27
			420		5.73	840	4.27
			430		3.83	860	2.85
			440		3.83	880	2.85
			450		3.83	900	2.85
			460		5.10	920	3.80
			470		5.10	940	3.80
			480		5.10	960	3.80
			490		3.83	980	2.85
			500		3.83	1000	2.85
			510		3.83	1020	2.85
			520		3.19	1040	2.38
			530		3.19	1060	2.38
			540		3.19	1080	2.38
			550		2.54	1100	1.90
			560		2.54	1120	1.90
			570		2.54	1140	1.90
			580		3.19	1160	2.38
			590		3.19	1180	2.38
			600		3.19	1200	2.38
			610		2.54	1220	1.90
			620		2.54	1240	1.90
			630		2.54	1260	1.90
			640		2.54	1280	1.90
			650		2.54	1300	1.90
			660		2.54	1320	1.90
			670		3.19	1340	2.38
			680		3.19	1360	2.38
			690		3.19	1380	2.38
			700		2.54	1400	1.90
			710		2.54	1420	1.90
			720		2.54	1440	1.90
Rain (mm)	15.80	22.20		41.00	63.70		95.00

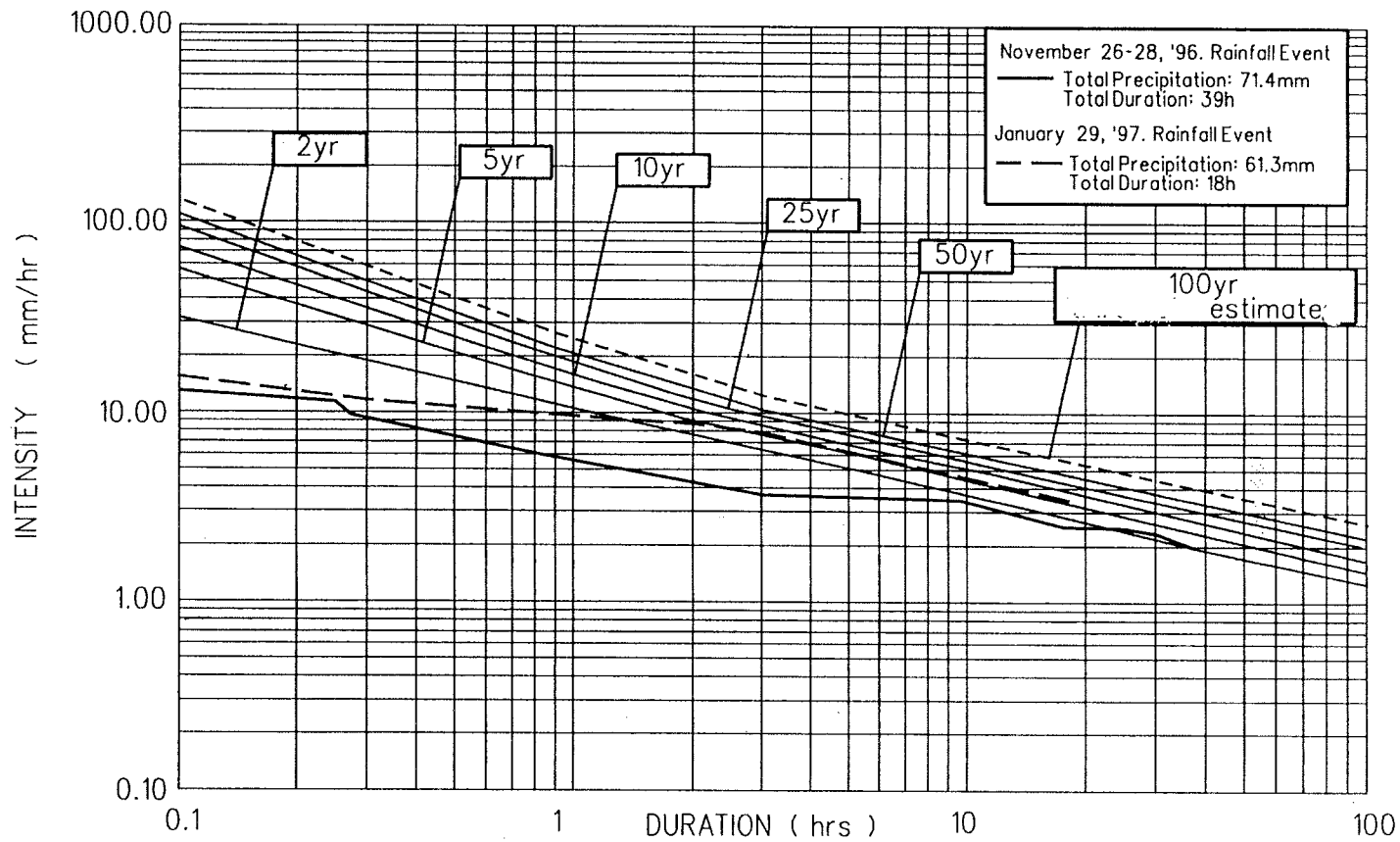
Table 5.3 (d) (iv)
1:100-Year Storm Intensity - Kwantlen Park

Time (Min)	1 Hour AES	2 Hour AES	Time (Min)	6 Hour AES	12 Hour SCS	Time (Min)	24 Hour SCS
0	0.00	0.00	0	0.00	0.00	0	0.00
5	13.11	8.94	10	6.34	3.38	20	2.66
10	15.81	8.94	20	6.34	3.38	40	2.66
15	23.60	10.73	30	6.34	3.38	20	2.66
20	23.60	10.73	40	7.38	4.23	40	3.33
25	26.23	16.09	50	7.42	4.23	60	3.33
30	28.85	16.09	60	7.38	4.23	80	3.33
35	36.72	16.09	70	9.50	5.07	100	3.99
40	28.85	16.09	80	9.50	5.07	120	3.99
45	22.57	17.88	90	9.50	5.07	140	3.99
50	18.36	17.88	100	8.46	5.92	160	4.66
55	15.81	19.67	110	8.42	5.92	180	4.66
60	10.49	19.67	120	8.46	5.92	200	4.66
65		25.02	130	8.46	7.61	220	5.99
70		25.02	140	8.42	7.61	240	5.99
75		19.67	150	8.46	7.61	260	5.99
80		19.67	160	12.67	10.14	280	7.98
85		14.31	170	12.67	10.14	300	7.98
90		14.31	180	12.67	10.14	320	7.98
95		12.52	190	9.50	14.36	340	11.31
100		12.52	200	9.50	14.36	360	11.31
105		10.73	210	9.50	14.36	380	11.31
110		10.73	220	9.50	17.74	400	13.96
115		7.15	230	9.50	17.74	420	13.96
120		7.15	240	9.50	17.74	440	13.96
125			250	9.50	13.52	460	10.64
130			260	9.50	13.52	480	10.64
135			270	9.50	13.52	500	10.64
140			280	8.46	10.98	520	8.65
145			290	8.42	10.98	540	8.65
150			300	8.46	10.98	560	8.65
155			310	8.46	10.14	580	7.98
160			320	8.42	10.14	600	7.98
165			330	8.46	10.14	620	7.98
170			340	7.38	8.45	640	6.65
175			350	7.42	8.45	660	6.65
180			360	7.38	8.45	680	6.65
185			370		6.76	700	5.32
			380		6.76	720	5.32
			390		6.76	740	5.32
			400		7.61	760	5.99
			410		7.61	480	5.99
			420		7.61	800	5.99
			430		5.07	820	3.99
			440		5.07	840	3.99
			450		5.07	860	3.99
			460		6.76	880	5.32
			470		6.76	900	5.32
			480		6.76	920	5.32
			490		5.07	940	3.99
			500		5.07	960	3.99
			510		5.07	980	3.99
			520		4.23	1000	3.33
			530		4.23	1020	3.33
			540		4.23	1040	3.33
			550		3.38	1060	2.66
			560		3.38	1080	2.66
			570		3.38	1100	2.66
			580		4.23	1120	3.33
			590		4.23	1140	3.33
			600		4.23	1160	3.33
			610		3.38	1180	2.66
			620		3.38	1200	2.66
			630		3.38	1220	2.66
			640		3.38	1240	2.66
			650		3.38	1260	2.66
			660		3.38	1280	2.66
			670		4.23	1300	3.33
			680		4.23	1320	3.33
			690		4.23	1340	3.33
			700		3.38	1360	2.66
			710		3.38	1380	2.66
			720		3.38	1400	2.66
Rain (mm)	22.00	29.80		52.80	84.50		133.00

Table 5.3 (e)
November 26-28, 1996 and January 29-30, 1997 Rainstorms in South Surrey

November 26 - 28, '96 Rainfall Event					January 29 - 30, '97 Rainfall Event			
Duration (hrs)	**Date**	**Time**	**Hourly Intensity (mm/hr)**	**Cumulative Rainfall (mm)**	**Date**	**Time**	**Hourly Intensity (mm/hr)**	**Cumulative Rainfall (mm)**
1	Nov-26	11:00	0.40	0.40	Jan-29	10:00	0.00	0.00
2	Nov-26	12:00	0.36	0.76	Jan-29	11:00	0.80	0.80
3	Nov-26	13:00	0.52	1.28	Jan-29	12:00	0.48	1.28
4	Nov-26	14:00	0.72	2.00	Jan-29	13:00	1.20	2.48
5	Nov-26	15:00	0.50	2.50	Jan-29	14:00	1.27	3.75
6	Nov-26	16:00	0.10	2.60	Jan-29	15:00	1.53	5.28
7	Nov-26	17:00	0.20	2.80	Jan-29	16:00	1.09	6.37
8	Nov-26	18:00	0.40	3.20	Jan-29	17:00	1.75	8.12
9	Nov-26	19:00	1.47	4.67	Jan-29	18:00	2.00	10.12
10	Nov-26	20:00	1.98	6.65	Jan-29	19:00	3.60	13.72
11	Nov-26	21:00	1.60	8.25	Jan-29	20:00	4.00	17.72
12	Nov-26	22:00	0.91	9.16	Jan-29	21:00	8.20	25.92
13	Nov-26	23:00	1.44	10.60	Jan-29	22:00	9.60	35.52
14	Nov-27	0:00	0.96	11.56	Jan-29	23:00	7.40	42.92
15	Nov-27	1:00	2.14	13.70	Jan-30	0:00	5.40	48.32
16	Nov-27	2:00	2.02	15.72	Jan-30	1:00	4.60	52.92
17	Nov-27	3:00	3.68	19.40	Jan-30	2:00	4.40	57.32
18	Nov-27	4:00	2.00	21.40	Jan-30	3:00	3.30	60.62
19	Nov-27	5:00	2.53	23.93	Jan-30	4:00	0.70	61.32
20	Nov-27	6:00	2.57	26.50	Jan-30	5:00	0.00	61.32
21	Nov-27	7:00	3.10	29.60				
22	Nov-27	8:00	1.80	31.40				
23	Nov-27	9:00	0.60	32.00				
24	Nov-27	10:00	0.92	32.92				
25	Nov-27	11:00	1.88	34.80				
26	Nov-27	12:00	1.20	36.00				
27	Nov-27	13:00	0.80	36.80				
28	Nov-27	14:00	0.96	37.76				
29	Nov-27	15:00	3.74	41.50				
30	Nov-27	16:00	2.22	43.72				
31	Nov-27	17:00	3.28	47.00				
32	Nov-27	18:00	5.20	52.20				
33	Nov-27	19:00	1.32	53.52				
34	Nov-27	20:00	3.08	56.60				
35	Nov-27	21:00	5.04	61.64				
36	Nov-27	22:00	3.06	64.70				
37	Nov-27	23:00	3.90	68.60				
38	Nov-28	0:00	2.00	70.60				
39	Nov-28	1:00	0.80	71.40				
40	Nov-28	2:00	0.00	71.40				
41	Nov-28	3:00	0.00	71.40				
42	Nov-28	4:00	1.80	73.20				
43	Nov-28	5:00	4.00	77.20				
44	Nov-28	6:00	0.28	77.48				

SURREY MUNICIPAL HALL RAIN GUAGE



	All Dimensions Shown In Millimetres, Unless Otherwise Noted
3	
2	
1	
	Revision Date Approved

SURREY
CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Title	NOVEMBER 28TH 1996 RAINFALL IN SOUTH SURREY
Approved	
Date	
Drawn By	Surrey Engineering

DRAWING NUMBER
FIGURE 5.4

Table 5.3 (f)
Selected Historical 30-Day Rainfall Events

(A) Kwantlen Park Historical 30-day Events

Depth (mm)	Rainfall in mm for Return Period (years)							
Event Date	2-Yr		5-Yr		10-Yr		25-Yr	
	Antecedent	30-day	Antecedent	30-day	Antecedent	30-day	Antecedent	30-day
11/10/87	10	303						
11/01/80			16	377				
10/16/75					47	423		
10/26/83							69	470

(B) Municipal Hall Historical 30-day Events

Depth (mm)	Rainfall in mm for Return Period (years)							
Event Date	2-Yr		5-Yr		10-Yr		25-Yr	
	Antecedent	30-day	Antecedent	30-day	Antecedent	30-day	Antecedent	30-day
11/10/87	7	256						
11/16/66			40	318				
10/16/75					36	352		
12/22/67							5	363

(C) White Rock Historical 30-day Events

Depth (mm)	Rainfall in mm for Return Period (years)							
Event Date	2-Yr		5-Yr		10-Yr		25-Yr	
	Antecedent	30-day	Antecedent	30-day	Antecedent	30-day	Antecedent	30-day
11/11/74	30	219						
10/16/75			23	258				
12/10/66					28	284		
11/04/95							0	319

Notes: 1. AES rainfall records from 1968 to 1996 were used.
Antecedent rainfall is the sum of the rainfall over the seven days preceding the 30-day event.
For long-term performance analysis, hourly data is available.

Table 5.3 (g) i.
Storm Distributions for ARDSA Standard Evaluations of Lowland Flood Control
Kwantlen Park Rainfall Gauge - Winter Season Hyetograph

hour	10-year winter season 5-day duration hourly precip (mm)
1	0.90
2	2.20
3	0.40
4	0.90
5	0.70
6	0.20
7	1.70
8	2.80
9	1.50
10	1.50
11	2.80
12	2.60
13	2.08
14	2.58
15	5.20
16	8.68
17	8.48
18	9.38
19	4.97
20	5.17
21	3.15
22	3.82
23	5.53
24	5.42
25	2.23
26	2.03
27	0.80
28	2.90
29	3.70
30	3.00
31	1.81
32	3.38
33	2.39
34	1.68
35	3.12
36	1.62
37	1.62
38	0.00
39	0.00
40	0.00
41	0.00
42	1.87
43	2.79
44	2.44
45	0.00
46	0.00
47	0.00
48	2.11
49	1.04
50	0.46
51	0.00
52	0.81
53	0.81
54	2.65
55	0.81
56	0.00
57	0.46
58	0.46
59	0.00
60	0.00

hour	10-year winter season 5-day duration hourly precip (mm)
61	0.00
62	0.00
63	0.00
64	2.08
65	1.50
66	0.00
67	0.23
68	0.00
69	0.00
70	0.00
71	0.00
72	0.46
73	0.69
74	0.00
75	0.00
76	0.00
77	2.31
78	11.31
79	5.65
80	1.04
81	0.46
82	0.23
83	0.00
84	0.00
85	0.00
86	0.00
87	0.23
88	0.00
89	0.00
90	0.00
91	0.00
92	0.00
93	0.00
94	0.00
95	0.00
96	0.23
97	0.81
98	1.27
99	0.00
100	0.58
101	0.00
102	0.23
103	0.81
104	0.00
105	0.00
106	0.58
107	1.27
108	1.62
109	0.00
110	0.00
111	0.00
112	0.00
113	0.00
114	0.00
115	0.00
116	1.62
117	2.19
118	2.54
119	1.62
120	1.15
TOTALS:	**172.33**

Table 5.3 (g) ii., continued

Storm Distributions for ARDSA Standard Evaluations of Lowland Flood Control

Pitt Meadows STP Rainfall Gauge - Growing and Winter Season Hyetographs

hour	10-year growing season 2-day duration hourly precip (mm)	10-year winter season 5-day duration hourly precip (mm)
1	1.07	0.88
2	0.83	0.20
3	1.24	0.39
4	0.41	0.88
5	0.66	0.68
6	1.07	0.20
7	1.24	1.66
8	0.44	2.74
9	0.66	1.47
10	1.24	1.47
11	0.41	2.74
12	1.07	2.54
13	1.90	2.04
14	3.39	2.53
15	6.38	5.08
16	12.02	8.48
17	3.38	8.29
18	2.97	9.17
19	2.39	4.86
20	2.69	5.05
21	3.52	3.07
22	3.11	3.74
23	2.69	5.40
24	2.03	5.30
25	3.35	2.18
26	1.43	1.98
27	2.85	0.78
28	2.22	2.83
29	1.82	3.62
30	1.03	2.93
31	1.19	1.76
32	1.98	3.31
33	1.98	2.33
34	0.79	1.65
35	1.59	3.05
36	1.19	1.59
37	0.31	1.59
38	0.58	0.00
39	0.58	0.00
40	1.16	0.00
41	0.97	0.00
42	0.58	2.65
43	0.58	3.96
44	0.31	3.47
45	0.00	0.00
46	0.00	0.00
47	0.36	0.00
48	0.36	2.98
49		1.47
50		0.65
51		0.00
52		1.14
53		1.14
54		3.76
55		1.14
56		0.00
57		0.65
58		0.65
59		0.00
60		0.00
61		0.00
62		0.00
63		0.00
64		2.94
65		2.12
66		0.00
67		0.33
68		0.00
69		0.00
70		0.00
71		0.00
72		0.65
73		0.98
74		0.00
75		0.00
76		0.00
77		3.27
78		16.01
79		8.00
80		1.47
81		0.65
82		0.33
83		0.00
84		0.00
85		0.00
86		0.00
87		0.33
88		0.00
89		0.00
90		0.00
91		0.00
92		0.00
93		0.00
94		0.00
95		0.00
96		0.33
97		1.17
98		1.84
99		0.00
100		0.84
101		0.00
102		0.33
103		1.17
104		0.00
105		0.00
106		0.84
107		1.84
108		2.34
109		0.00
110		0.00
111		0.00
112		0.00
113		0.00
114		0.00
115		0.00
116		2.34
117		3.18
118		3.68
119		2.34
120		1.67
TOTALS:	**84.02**	**193.11**

Table 5.3 (g) iii., continued

Storm Distributions for ARDSA Standard Evaluations of Lowland Flood Control

Surrey Municipal Hall Rainfall Gauge - Winter Season Hyetograph

hour	10-year winter season 5-day duration hourly precip (mm)
1	0.68
2	1.67
3	0.30
4	0.68
5	0.53
6	0.15
7	1.29
8	2.12
9	1.14
10	1.14
11	2.12
12	1.97
13	1.58
14	1.96
15	3.94
16	6.58
17	6.43
18	7.11
19	3.77
20	3.92
21	2.38
22	2.90
23	4.19
24	4.11
25	1.69
26	1.54
27	0.61
28	2.20
29	2.80
30	2.27
31	1.36
32	2.57
33	1.81
34	1.28
35	2.37
36	1.23
37	1.23
38	0.00
39	0.00
40	0.00
41	0.00
42	1.67
43	2.49
44	2.18
45	0.00
46	0.00
47	0.00
48	1.87
49	0.93
50	0.41
51	0.00
52	0.72
53	0.72
54	2.37
55	0.72
56	0.00
57	0.41
58	0.41
59	0.00
60	0.00

hour	10-year winter season 5-day duration hourly precip (mm)
61	0.00
62	0.00
63	0.00
64	1.85
65	1.34
66	0.00
67	0.21
68	0.00
69	0.00
70	0.00
71	0.00
72	0.41
73	0.62
74	0.00
75	0.00
76	0.00
77	2.06
78	10.08
79	5.04
80	0.93
81	0.41
82	0.21
83	0.00
84	0.00
85	0.00
86	0.00
87	0.27
88	0.00
89	0.00
90	0.00
91	0.00
92	0.00
93	0.00
94	0.00
95	0.00
96	0.27
97	0.95
98	1.49
99	0.00
100	0.68
101	0.00
102	0.27
103	0.95
104	0.00
105	0.00
106	0.68
107	1.49
108	1.90
109	0.00
110	0.00
111	0.00
112	0.00
113	0.00
114	0.00
115	0.00
116	1.90
117	2.58
118	2.99
119	1.90
120	1.36
TOTALS:	**143.36**

Table 5.3 (g) iv., continued

Storm Distributions for ARDSA Standard Evaluations of Lowland Flood Control

White Rock STP Rainfall Gauge - Winter Season Hyetograph

hour	10-year winter season 5-day duration hourly precept (mm)
1	0.60
2	1.47
3	0.27
4	0.60
5	0.47
6	0.13
7	1.13
8	1.87
9	1.00
10	1.00
11	1.87
12	1.73
13	1.39
14	1.72
15	3.47
16	5.79
17	5.66
18	6.26
19	3.31
20	3.45
21	2.10
22	2.55
23	3.68
24	3.62
25	1.49
26	1.35
27	0.53
28	1.93
29	2.47
30	2.00
31	1.20
32	2.26
33	1.59
34	1.13
35	2.08
36	1.08
37	1.08
38	0.00
39	0.00
40	0.00
41	0.00
42	1.11
43	1.66
44	1.45
45	0.00
46	0.00
47	0.00
48	1.25
49	0.62
50	0.27
51	0.00
52	0.48
53	0.48
54	1.58
55	0.48
56	0.00
57	0.27
58	0.27
59	0.00
60	0.00

hour	10-year winter season 5-day duration hourly precip (mm)
61	0.00
62	0.00
63	0.00
64	1.23
65	0.89
66	0.00
67	0.14
68	0.00
69	0.00
70	0.00
71	0.00
72	0.27
73	0.41
74	0.00
75	0.00
76	0.00
77	1.37
78	6.72
79	3.36
80	0.62
81	0.27
82	0.14
83	0.00
84	0.00
85	0.00
86	0.00
87	0.21
88	0.00
89	0.00
90	0.00
91	0.00
92	0.00
93	0.00
94	0.00
95	0.00
96	0.21
97	0.72
98	1.13
99	0.00
100	0.51
101	0.00
102	0.21
103	0.72
104	0.00
105	0.00
106	0.51
107	1.13
108	1.44
109	0.00
110	0.00
111	0.00
112	0.00
113	0.00
114	0.00
115	0.00
116	1.44
117	1.95
118	2.26
119	1.44
120	1.03
TOTALS:	**115.58**

Notes:

1) Winter Design Storm Event: 10-Year 5-day duration storm hyetographs are developed for the four rain gauges at

   Surrey Kwantlen Park
   Surrey Municipal Hall
   Pitt Meadows STP, and
   White Rock STP

   The application of the data for different watersheds and river reaches is to be determined in consultation with the City's Engineering Department.

2) Growing Seasons Design Storm Event: 10-year 2-day duration, storm hyetograph from Pitt Meadows STP gauge data is developed for the entire city. Analysis confirms that the southwest to northeast precipitation gradient which is strongly evident in winter is not present during the growing season. Pitt Meadows gauge record is considered to represent the total city while being lightly on the conservative side.

C. Rational Method

(a) Application

The use of the Rational Method for final design calculations is to be limited to the design of minor or major storm drainage system components proposed to accommodate flows from catchments with an area of approximately 20 Ha or smaller.

Computer simulation programs based on hydrograph techniques are required for such for catchments greater than 20 Ha.

(b) Formula

$$Q = RAIN$$

Where
Q = Flow in cubic metres per second
R = Runoff coefficient (see table 5.3 (h) below)
A = Drainage area in hectares
I = Rainfall intensity in mm/hr
N = 0.00278

Table 5.3 (h) Runoff Coefficients

Description of Area	% Imperviousness Ratio	Runoff * Coefficient	Runoff Coefficient (100 year Plans)
Commercial	90	0.80	0.95
Industrial	90	0.80	0.95
Residential			
RA, RA-G	50	0.45	0.54
RH, RH-G	55	0.50	0.60
RF, RF-SS, RM-D	65	0.60	0.72
RF-G, RM-M, RM-10, RM-15, RM-19, RM-30, RM-45, RM-70, RM-135, RMC-135	65	0.60	0.72
RMC-150, RF-9, RF-12, RF-SD	80	0.70	0.84
Parks, Playgrounds, Cemeteries; Agricultural Land	20	0.25**	0.30
Institution; School; Church	80	0.75	0.90

** Passive use parks may reduce coefficient to 0.13.

Note: This table assumes conventional site drainage of directing all surface drainage overland into streets and the CB's (i.e., no on-site BMP's). The runoff coefficients account for antecedent wet conditions .

(c) Time of Concentration (T_c)

Time of Concentration is defined as the time required for stormwater runoff to travel from the most remote point of drainage basin to the point of interest.

- Formula

  Time of concentration (T_c) is the cumulative sum of three flow times Overland (T_o), Channel (swale or stream), Culvert or Storm Drain.

Overland Flow (To):

SCS Handbook on Hydrology gives some approximate average velocities from which the time of concentration can be estimated for use with either the SCS Method or the Hydrology or the Rational Method for estimating peak discharge.

Several equations for overland flow have been developed, the kinematic wave equation below is one example.

Kinematic Wave Equation:

$$T_o = \frac{6.92\ L^{0.6} n^{0.6}}{i^{0.4}\ S^{0.3}}$$

Where:

T_o = Overland flow travel time in minutes
L = Length of overland flow path in meters
S = Slope of overland flow in m/m
n = Manning Coefficient
i = Design storm rainfall intensity in mm/hr

Channel Flow Time:

When the channel characteristics and geometry are known, the preferred method of estimating channel flow time is to divide the channel length by the cannel velocity obtained by using the Manning equation, assuming bank full conditions.

Culvert or Storm Drain Flow Time:

Flow velocities in a short culvert are generally higher than they would be in the same length of natural channel and comparable to those in a lined channel. In most cases, including short runs of culvert channel, flow time calculation

will not materially affect the overall time of concentration (T_c). When it is appropriate to separate flow time calculations, such as for urban storm drains, Manning's equation may be used to obtain flow velocities within pipes.

(d) Time of Concentration in Developed Basins

Time of concentration ranges are given to ensure uniformity in unit runoff and storage computations.

Development Area (m^2)	Minimum (minutes)	Maximum (minutes)
Less than 2000	10	15
2000 to 4000	15	20
4000 and over	15	30

In developments where substantial undeveloped areas are to remain, the contributing drainage area flows and corresponding time of concentration should be checked by trial and error to determine the maximum peak outflow rate.

(e) Drainage Area

The extent of the tributary drainage areas for the storm drainage system being designed shall be determined using the natural and/or the proposed contours of the land.

It is stressed that it is the Engineering Designer's responsibility to confirm the extent of the drainage areas with the City's Engineering Department prior to final design, and to incorporate the designs for the minor and major flows into an overall coordinated system.

(f) Rainfall Intensity

As discussed in Subsection 5.3.B, Figure 5.2 has been prepared showing rain gauge catchments for rainfall intensity distribution in the City and it shall be used in conjunction with Figures 5.3 A, 5.3 B and 5.3 C, intensity duration frequency curves, to interpolate the appropriate rainfall intensity in mm per hour for the desired catchment area.

(g) Presentation of Rational Method Computations

The designer shall tabulate the design calculations using Table 5.3 (j) (or similar) for submission with the Stormwater Control Plan.

Table 5.3 (i)
Rational Method Calculation Sheet

Consultant:	Storm Sewer Design Criteria	Sheet of
Project No.:	Rainfall Intensity (5-year storm)	File Name:
Project Description:	Rainfall Intensity (100-year storm)	Completed by:
	Q = RAIN	Date:
Location:	Q = C*I*A	Checked by:
	MANNINGS "n" =	Date:

Manhole		Drainage Area Description	Area (ha)	Runoff Coefficient	C *A	Total C *A	Time of Concentration	Total Time	Intensity		Flow		Sewer Design						Inc. Travel Time to Downstream Manhole	Ratio		Q(100) Slope	Comments
									I(10)	I(100)	Q(10)	Q(100)	Slope	Pipe Dia.	Mannings "n"	Q Cap.	V Cap.	Length		Q(5)/ Q Cap.	Q(100)/ Q Cap.		
From	To		A	C	(ha)	(ha)	(min)	(min)	(mm/hr)	(mm/hr)	(L/s)	(L/s)	%	(mm)		(L/s)	(m/s)	(m)	(min)	%	%	%	Major Flow Routes

D. Hydrograph Method

(a) Application

For all storage computations and the design of conveyance sewer systems servicing areas greater than 20 hectares, hydrologic computer programs using hydrograph generation methodology shall be applied.

(b) Selection of Hydrologic Computer Program

Selection of Computer Programs

Before commencing any computer modelling for purposes of Drainage Design Studies, the Developer or the Engineering Designer shall obtain acceptance from the Engineer on the selection of the proposed computer program. In view of the very limited site specific calibration data available, the selection and proper application of appropriate computer programs should include a comprehensive review of the program's historical usage/application in other urban/urbanizing watersheds. This is primarily the responsibility of the Engineering Designer. It is necessary to use computer models which have the capability to adequately represent the hydrologic characteristics of the watersheds, rainfall distributions, and generate hydrographs for a critical storm or series of storms. The computer model must also have the capacity to route these hydrographs through a network of conduits, surface channels, and storage facilities.

For planning level analysis (Master Drainage Planning) of rural and urban areas, the OTTHYMO programs (OTTHYMO '89 and Visual OTTHYMO) is appropriate, especially when backwater and surcharge effects are not significant. In the application of OTTHYMO, the "SCS/CN #" approach should be used only for the 'rural' or undeveloped conditions; if adequate calibration of flows based on monitored rainfall/runoff data has been done in developed areas, the use could be extended to 'urban' areas.

Infiltration methods such as Green Ampt or Horton's should be used for urban watersheds. However, these methods require careful selection of parameters that are specific to the soils of the area being considered.

For functional and detailed designs of sewer systems with no surcharge or backwater effects, programs such as MIDUSS and HYDSYS are appropriate. OTTHYMO can be used to generate design flows with pipe designs being designed using a manual method. When new systems are designed, the initial sizing of the system could be done using the Rational Method and then checked using an appropriate computer model.

For detailed evaluation of the operation of sewer networks and stormwater storage facilities, a program set such as the EPA SWMM RUNOFF and EXTRAN is appropriate.

For evaluating the performance of storage facilities over long winter wet weather periods which are typical to Lower Mainland, continuous modelling programs such as QUALHYMO, and SWMM TRANSPORT are appropriate.

Efforts should be made to calibrate/validate the results of these analyses, using observed rainfall/flow data even from other similar watersheds prior to detailed design. As a minimum, sensitivity of the model predictions to the variation in key parameters values should be tested and the findings used to develop realistic and conservative models of the system being evaluated.

The rates listed in table 5.3 (j) are maximums to be used for uncalibrated models of detention facilities.

Table 5.3 (j) 1:2 year Maximum Runoff rates

Existing Condition	Release Rate (l/s/Ha)
Wooded	5
Grassland	7
Rural Residential	10
Single Family	17
Town House	25
Apartment	29
Industrial / Commercial	37

- Modelling Procedures

  Post-development hydrographs are to be determined at key points of the trunk sewer and major systems for the 5- and 100-year design storms for storm durations of 2, 6, 12, and 24-hour events and for each development condition. This process will identify the most critical event to be used in sizing the design element. It should be noted that the storm durations which generate the critical peak flow rate is not necessarily the same duration that generates the critical storage volume for peak flow attenuation. Drainage systems which involve a number of interconnected ponds in series, or which have relatively restricted outlet flow capacity, may require analysis for sequential storm events or modelling with a continuous rainfall record.

  At the detailed levels of design (Functional Feasibility Report and beyond) the hydraulic grade lines (HGL) in the minor system, for the 1 in 5-year and 1 in 100-year design storms, are to be determined and plotted on profile plans of the minor conveyance system and compared with the

existing/proposed minimum building elevations (MBE) to ensure major flood protection.

- Watershed Data Preparation

  When modelling portions of the watershed which have been developed previously, data preparation shall be based upon existing conditions. Data preparation for planning areas shall be based upon the best available planning information as per the Official Community Plan (OCP), Local Area Plans (LAP), and/or the Neighbourhood Concept Plan (NCP).

  Typical imperviousness values and runoff coefficient values to be used are given in Subsection 5.3 C.

- Rainfall Data

  Tabulated rainfall data, as listed in Subsection 5.3 B as applicable, shall be used for all computer modelling studies.

- Presentation of Modelling Results

  To document the design rationale used to develop the hydrologic model and to standardize the presentation of model results, a design report will be submitted with the development plans and shall include an appropriate section which will indicate the following:

  – type and version of computer model used.
  – all parameters and specific simulation assumptions used.
  – design storms used, to be clearly documented and plotted.
  – summary of peak flows and inflow/outflow hydrographs of storage facilities.
  – volumetric runoff coefficient or total runoff obtained.
  – peak flow vs. area, plotted for each event studied.

  The report documentation should include:

  (1) A plan showing subcatchment areas, watershed boundary and the drainage system.

(2) For detention ponds, stage-area storage-discharge curves and the layout of pond control devices.

(3) The functional layout of the flow control/diversion structure and the tabular/graphical plots of inflow and outflow hydrographs.

(4) For locations where pre–development flows control the allowable outflow rates, both pre and post development hydrographs must be shown.

(5) Tables summarizing the above described performance related optional parameters.

5.4 Minor Conveyance System Hydraulic Design

A. Scope

Subsection 5.4 outlines the design criteria which apply to the preliminary and detailed design of storm drainage minor conveyance systems. The emphasis of this section is on those criteria which determine the size and grade profiles of storm sewers and certain elements of the system arrangements, such as inlet requirements. Major system design requirements are addressed in Subsection 5.5.

B. Level Of Service

The minor drainage system will be designed to convey the 5- year return period rainfall event runoff.

C. Storm Sewers

(a) Sizing Of Storm Sewers

- Methodology For Sizing Storm Sewers

  Storm sewers will be sized to provide the required capacity in free flow (not surcharged) conditions using Manning's formula.

- Manning's N

  Manning's n value of 0.013 will be used for standard smooth wall plastic and concrete pipe.

- Minimum Size For Storm Sewers

  The minimum storm sewer size will be 200 mm inside diameter. Where ditches discharge directly into a storm sewer, the minimum pipe diameter will be 375 mm.

(b) Trunk Sewers

Trunk sewers are sewer servicing an urban drainage basin in excess of 20 ha. In cases where the land is predominantly parkland, a comparison of peak flows should be used to designate the sewer as a trunk.

(c) Surcharged Sewers

Sewers must be designed to have free flow for the 5-year design flows. Surcharged sewers to convey the design flows are **permitted only as exceptions** under the following conditions:

(i) Where temporary discharge to an existing ditch with a submerged outlet is required to allow for a future extension of the sewer at an adequate depth.
(ii) Where flow will surcharge the outlet sewers into detention ponds during storm events and until the pond is drained down to the normal water level.

Surcharged sewers shall have the 5-year hydraulic grade line shown on the drawings. In addition, in cases where the CB inlets and the sewers are designed to carry the 100-year flows, the 100-year hydraulic grade line shall be shown.

In all such cases, it must be clearly demonstrated that the projected highest hydraulic grade line is safely below the minimum building elevations (MBE) of all of the serviced properties.

(d) Storm Sewer Slope Requirements

- Velocity Requirements

  All storm sewers shall be designed and constructed to give mean velocities, when flowing full, of greater than 0.60 m/s based on **Manning's formula**. Flow velocities of 0.90 to 1.0 m/s are recommended.

  Where design velocities are supercritical or in excess of 3.00 m/s, special provision shall be made to protect against displacement of sewers by erosion or shock. No upper limit to flow velocities in storm sewers is defined. However, when supercritical flow does occur, (where steep grades are utilized), the Designer shall provide appropriate analysis and justification and make provisions in the design to ensure that structural stability and durability concerns are addressed. Flow throttling or energy dissipation measures to prevent scour will be required to control the flow velocity or to accommodate the transition back to subcritical flow.

- Minimum Slopes

  The following listing shows the minimum slopes permitted for various sewer sizes:

Sewer Size	Minimum Slope
CB leads (200&250)	1.00%
300 mm	0.22 %
375 mm	0.15 %
450 mm	0.12 %
525 mm and larger	0.10 %

The minimum slope shall be 0.4% for the most upstream leg of any storm system (between the terminal manhole and the first manhole downstream there from) unless approved by the Engineer.

When pipe slopes less than 0.4% are used, the designer will confirm that the proposed system meets the minimum velocity requirements.

(e) Location

Storm sewers are to be located as shown on the Standard Drawings within a municipal road or open lane.

Where technically impractical, as determined by the Engineer, storm sewers in side yard and rear yard statutory rights-of-way may be approved. The rights-of-way shall be a minimum of 5.0 metres wide, preferably all on one lot. No connections or manholes will be allowed and the storm sewer alignment must be linear.

All weather, vehicular access must be provided to all manholes and inspection chambers and flow control structures.

(f) Depth

Where the catchment is on both sides of a road, storm sewers shall be installed at a depth, to be able to service properties on both sides of the roadway where economically feasible. Elevation of storm sewers at upstream tributary points must be of sufficient depth to service all of the tributary lands. Pipe installations that have less than 1 m cover, or deeper than allowable for Class III pipe, or have different bedding than specified in the Standard drawings, shall be specially designed for their specific conditions.

(g) Groundwater

Storm sewer connections to other utility trenches shall be provided where there is a possibility of groundwater concentration.

Seepage collars or clay plugs will be provided where groundwater may adversely affect steep sewers.

D. Manholes

Manholes are required every:

- 150 metres for pipes less than 900 mm diameter.
- 300 metres in pipes 900 mm diameter or larger.
- change of pipe size.
- change of line or grade that exceeds ½ the maximum joint deflection recommended by the manufacturer or where the radius of curvilinear alignment is less than 30 metres.
- sewer confluences.
- manhole spacing for storm sewer tunnels of 1350 mm diameter and larger will be evaluated on a site-specific basis.

The crown of pipes entering a manhole shall be set at or above the crown of the outlet pipe.

Hydraulic losses are to be calculated through manholes with significant change of grade or alignment, or at confluence of one or more sewer pipes entering a manhole. Drops are not required in manholes without change of grade or alignment. A minimum drop of 30 mm shall be provided where the inlet is not at 180 degrees to the outlet.

Maximum Spacing for Manhole Access

(a) Cleanouts will be provided midway between manholes when their spacing exceeds 150m.

E. Cleanout

Temporary clean-outs are permitted where an extension of the sewer, in the future, will provide a manhole at an appropriate spacing.

F. Catch Basin Spacing

Catch basins shall be provided at regular intervals along roadways, at upstream end of radius at intersections and at low points (sags). Where possible, low points are not to be located within curb returns at intersections. The Designer must ensure that sufficient inlet capacity is available to collect the entire minor flow, or major flow if required, into the underground pipe system.

The spacing of the catch basins shall be based on hydraulic requirements. In general, this is determined by the 5-year design storm peak flow capture needs. Additional CB's at closer intervals will be needed if the 100-year design flows are to be captured and drained by the sewer system.

The capacity of a single catchbasin can be calculated by the orifice equation:

$Q = 0.5\ CA\ (2gh)^{0.5}$

Where
- Q = inlet capacity (m^3/s)
- 0.5 = clogging factor
- C = orifice coefficient (0.8)
- A = open area (0.068 m^2 for Dobney B-23 grate in m^2)
- g = gravitational acceleration (9.81 m/s^2)
- h = depth of ponding (m)

The maximum spacing shall be established to permit each catch basin to drain a maximum area of 500 m^2 on road grades up to 3% and 350 m^2 on steeper grades. If the major flow is to be conveyed in the pipe system, additional catch basins are required.

Table 5.4(a), or other approaches which recognize the impact of roadway gradient and cross fall on the capture capacity of the catchbasin grates, can be used to check the flow intercepted by standard grates. Where non-standard conditions exist designs shall be based on RTAC Drainage Manual Volume III, Section 5.6 Pavement Drainage Design.

Lawn basins are to be located where significant surface seepage presents hazards for sidewalks, driveways and low properties.

Table 5.4(a)
Flow Interception By Curved Grate Catch Basin Inlets

Manning's Coefficient n = 0.016
m = 7
WIDTH OF FLOW = 1.83 m
DEPTH OF GUTTER DEPRESSION = 0'

FLOW INTERCEPTED BY CURVED GRATE INLETS - Q cms

Sx / Sy		Crossfall						
		2.0%	**3.0%**	**4.0%**	**5.0%**	**6.0%**	**7.0%**	**8.0%**
	0.5%	0.012	0.024	0.039	0.056	0.076	0.090	0.094
	1.0%	0.017	0.034	0.055	0.075	0.081	0.075	0.078
	2.0%	0.024	0.048	0.068	0.070	0.067	0.063	0.059
	3.0%	0.030	0.057	0.065	0.062	0.058	0.053	0.050
	4.0%	0.035	0.058	0.060	0.056	0.051	0.047	0.043
	5.0%	0.039	0.058	0.056	0.051	0.046	0.042	0.039
	6.0%	0.042	0.056	0.043	0.047	0.043	0.039	0.036
	7.0%	0.046	0.053	0.049	0.044	0.040	0.036	0.033
	8.0%	0.049	0.052	0.046	0.041	0.037	0.034	0.031
	9.0%	0.052	0.049	0.044	0.039	0.035	0.032	0.030
	10.0%	0.055	0.047	0.042	0.037	0.034	0.031	0.028

GUTTER FLOW - Q cms

Sx / Sy		Crossfall						
		2.0%	**3.0%**	**4.0%**	**5.0%**	**6.0%**	**7.0%**	**8.0%**
	0.5%	0.012	0.024	0.039	0.056	0.076	0.099	0.123
	1.0%	0.017	0.034	0.055	0.080	0.108	0.139	0.174
	2.0%	0.024	0.048	0.078	0.113	0.152	0.197	0.246
	3.0%	0.030	0.059	0.095	0.138	0.187	0.253	0.302
	4.0%	0.035	0.068	0.101	0.159	0.213	0.279	0.348
	5.0%	0.039	0.076	0.123	0.178	0.241	0.312	0.389
	6.0%	0.042	0.083	0.134	0.195	0.264	0.341	0.452
	7.0%	0.046	0.090	0.145	0.210	0.285	0.369	0.461
	8.0%	0.049	0.096	0.155	0.225	0.305	0.394	0.492
	9.0%	0.052	0.102	0.165	0.239	0.323	0.418	0.522
	10.0%	0.055	0.107	0.174	0.252	0.341	0.441	0.551

Sx - Hwy Crossfall
Sy - Hwy Gradient

G. Ditches

Note that no new ditches shall be created for servicing land development projects on Municipal rights-of-way, except in designated lowland areas where poor soil exists.

(a) Depth

Ditches adjacent to travelled roadways shall not exceed 1 m in depth in urban rights-of-way 27 m or less, unless adequate safe slope and barriers can be provided (RTAC).

(b) Shape

Ditches shall be designed for the 1:5-year flows with a minimum of 600 mm freeboard (lowland excepted). Ditches shall be trapezoidal in shape having maximum side slopes of 1½ H : 1 V and a minimum bottom width of 0.5 m, depending on the soil characteristics.

The minimum grade of a ditch shall be 0.5% (lowlands excepted). The maximum velocity in an unlined ditch shall be 1 m/s. Higher velocities may be permitted where soil conditions are suitable or where erosion protection has been provided. On steep slopes, grade control structures may be used to reduce velocities.

(c) Ditch Right-of-Way

Ditch right-of-way shall be sufficiently wide to provide a 3.6 m graded access road suitable for maintenance vehicles in addition to the width required for the ditch.

H. Culverts

(a) Minimum Diameter

The minimum culvert diameter shall be 300 mm for driveways and 600mm for roadway crossings.

Driveway culverts shall be designed to accommodate the minor flow unless otherwise indicated.

(b) Hydraulics

Culverts crossing all roads shall be designed to accommodate the major flows with either inlet or outlet control. (Twin systems are preferred to reduce constraints where the natural creek width exceeds the single pipe diameter.) Surcharging to optimize channel storage is preferred, provided the backwater profile does not encumber residential properties.

On collector and local roads, road overtopping will be permitted only when the replacement of existing facilities or the installation of a secondary relief culvert is not economically feasible and the back water profile does not negatively encumber residential property. Where road overtopping is anticipated, appropriate scour protection shall be provided. All roads shall be graded to provide the sag point at the watercourse culvert crossing to provide a fail-safe major system outlet with limited ponding on the road right-of-way.

I. Inlet and Outlet Structures

(a) General

The Standard Drawings shall be used as a guide for designing inlet and outlet structures for storm sewers and culverts. Outlets for culverts and storm sewers, having discharge velocities greater than 1.0 m/s require evaluation of the downstream channel and rip-rap or an approved energy dissipating structure may be required to control erosion.

(b) Structural Design

The structural requirements for inlet and outlet structures, given on Standard Drawings are the minimum requirements only. Generally, structures exceeding 1 m in height or 2 m in width should receive individual structural design.

(c) Safety Grillage and Trash Screens

A safety grillage, as detailed in Standard Drawings, is required at the entrance of every storm sewer or on culverts 450 mm diameter or greater which exceed 30 m in length.

Trash screen is required at:

- the entrance to every storm sewer or culvert of less than 450 mm diameter, over 30 m in length, when the inlet minor flow velocity exceeds 2 m/s;

- where there are long runs of natural watercourse, preferably at a road culvert;
- not closer than 1 metre from all openings in the culvert.

J. Flow Control Structures

For the design of flow control structures at stormwater storage facilities riparian diversions, and trunk sewer diversions, the orifice and weir equations may be used.

Orifice Equation

$q = Ca(2gh)^{0.5}$

Where
- q = Desired Release Rate (m^3/s)
- a = Area of Orifice (m^2)
- g = Acceleration due to Gravity (m/s^2)
- h = Net Head on the Orifice Plate (m)
- C = Coefficient of Discharge

For a sharp or square edged orifice, use a value of 0.62 for C.

Minimum orifice size shall be 100 mm in diameter. Where smaller orifices are required special provisions are required to prevent blockage. These special provisions will be clearly marked on the design drawings.

Weir Equation

$q = CLH^{1.5}$

Where
- q = Desired Release Rate (m^3/s)
- C = Coefficient of Discharge
- L = Effective Length of Crest (m)
- H = Total Head on Crest (m)

Flow control manholes shall be a minimum of 1,200 mm diameter to provide for access and maintenance. See sample layout in Drawing SSD-D.9. and Drawing SSD-D.10.

K. Pipe Joints And Recharge Issues

Generally storm sewers shall be designed to provide low flow exfiltration to the pipe bedding backfill and contribute to groundwater recharge.

(a) Joints

All concrete pipe joints shall be open except where the pipe is temporarily or permanently designed to act under head or when bedding material is river sand.

(b) Bedding Backfill

Pipe shall be laid on a bedding, in accordance with Specification that will give adequate support to the pipe under the design conditions.

Furthermore, where "Open Joints" are used, bedding shall be limited to 25 mm gravel, 19 mm crushed gravel or 32 mm crushed gravel, the gradation of which are as per Master Municipal Construction Documents (MMCD), designed to prevent piping conditions.

(c) Recharge Areas

Where groundwater recharge has been designated as desirable and existing surficial and pipe area soils are identified as suitable by a geotechnical engineer, additional site specific designed "soak away" systems shall be provided.

(d) Closed "Jacketed" Joints

Where conditions for unstable flow exist in steep piped systems, and area soils are not suitable, appropriately designed sealed systems are required.

(e) Sediment and Erosion Control during Construction

Temporary sediment basins and channels for erosion control at construction site shall be designed so that the minimum detention time is 10 minutes. See Drawing SSD-D.6 for a typical quality-control manhole and Drawing SSD-D.7 for typical silt control measures designed to protect the downstream system.

(f) Sediment Basins

Sediment basins shall be provided within any natural watercourse, channel or storm sewer where the silt load is detrimental to the hydraulics of the storm sewer facility. Construction of such facilities immediately upstream of the road culvert is desirable, to provide ready access for cleaning and maintenance. Drawing SSD-D.7 is an example that should be adapted to meet site specific control volumes and timings.

L. Storm Sewer Service Connections

(a) General Requirements for Storm Services to Properties

Storm sewer service connections are required to be provided for lots zoned for detached residential use for the purposes of draining the perimeter (foundation) drains. All service connections require an inspection chamber (IC).

Roof drains will discharge to splash pads.

(b) Commercial/Institutional, Industrial, and Multiple Residential Properties

Storm sewer service connections for the connection of on-site storm drainage systems and/or roof drains are to be provided to properties zoned or proposed to be zoned for commercial, institutional, industrial and multiple residential land use. When required service locations are known, storm service connections should be installed concurrently with the general area servicing. Otherwise, installation of such connections may be deferred until the specific property development is proposed.

(c) Storm Services From Easements

Storm sewer services to properties zoned for detached residential land use shall not be permitted, from sewer mains located in easements.

Service connections to industrial and commercial/institutional properties may be permitted from sewers located in easements, provided that the nature of the proposed development will permit access to the easement and excavation as may be necessary for purposes of repair or reconstruction of the service connection.

(d) Priority Listing for Storm Sewer Service Connections

Each lot will have:

- a gravity connection to the frontage storm sewer; or
- a gravity connection to the storm sewer in an open lane, walkway or service corridor with an access road.

When not feasible and approved by the Engineer, each lot will have:

- a pumped connection to a storm sewer, provided a restrictive covenant is registered on the lot, an overflow is installed when practical, and the system is engineered against pump failures; or

- a gravity connection through a private rear lot easement to a storm sewer, provided it does not traverse more than one lot, the easement is registered and a dedicated connection with an IC for the lot exist on the fronting storm sewer.

- Size and Grade

  Residential storm service connections will meet the following:

  - 100 mm minimum diameter
  - 2.0% minimum grade from property line to storm sewer
  - 300 mm clearance from the 100 year HGL to the MBE
  - 500 mm clearance above the obvert of the storm sewer to the MBE

  For commercial/industrial sites and multi-family sites, the storm service size and grade to be established by the engineer.

- Location

  (a) Development Lots
  Service connections for new lots shall be located as shown on the Standard Drawings. The connection shall be extended not less than 2.0 m into the property as shown on Standard Drawings.

  (b) *Existing Properties*
  All proposed storm sewers shall be designed within practical limits with adequate depth to properly service all existing properties which it passes. All existing lot drains shall be connected to the storm sewer provided that:

  – all habitable areas (i.e., MBE) are 0.3 m above major flow hydraulic grade line; or
  – private backwater valve and sump pump pressure systems are installed, subject to acceptance by the City.

(e) <u>Lot Grades, Drainage and Building Elevations</u>

When designing future lot grades and building elevations, the following points should be incorporated:

– grade lots to the nearest roadway.

– minimize the number of lots lower than adjacent roadways.

- avoid drainage across another lot where practical.
- if cross lot drainage is required, provide dedicated access for maintenance by registering an easement, right of way or dedication as approved by the City
- provide flood proofing at road low points.
- ensure the building is clear of major system hydraulic grade line, except where specific flood prevention measures have been applied, such as catch basin inlet control devices, or a foundation drainage (third pipe) system.

(f) Alternative Foundation Drainage Disposal System

An alternative to the normal practice of connecting the foundation (perimeter) drains to the minor system through the storm sewer service, is to use a separate sewer, which is connected only to the foundation drains, and has a free discharge, above the 100-year flood level (Third Pipe System). The third pipe system will be designed in the same manner as a normal minor system (5-year, 100-year flows and HGLs). The Designer is responsible to confirm that the hydraulic capacity of the foundation drain collecting system is sufficient for the sub-surface drainage conditions, lot grading, and type of connections to the system. The third pipe system must have separate manholes from the sanitary sewer system. Minimum diameter of the third pipe system shall be 200 mm.

Reverse graded driveways or basement level entries shall not be connected to the third pipe systems. Storm and sanitary services or roof leader drains shall also not be connected to these third pipe systems. A restrictive covenant is to be placed against all properties to comply with the above limitations.

M. Alignment of Sewers

(a) Location of Sewers within Road or Lane/Walkway

The alignment of storm sewers within road or open lane are to conform to the standard plans for Location of Utilities, as given in Section 2 of this Manual.

(b) General Alignment Requirements

Sewers shall generally be installed with straight alignment and uniform slope between manholes, and generally parallel with the centreline of the roadway .

(c) Spacing of Sewers

Except where installed in the same trench, sewers running parallel and within the same road right-of-way shall normally be horizontally separated by a minimum of 3.0 m, measured from centreline to centreline. When installed in a common trench, pipes shall be installed with a minimum separation of 0.25 m, measured horizontally between vertical lines tangent to the adjacent outside faces of the pipes. (For sewers in a common trench, refer to comments on the design basis, and to requirements for leakage testing of sanitary sewers.)

(d) Horizontal Separation

See Section 2.

(e) Sewers in Common Trench

See Section 2.

(f) Curvilinear Sewers

Pipes between two consecutive manholes may be installed on a defined curve, provided that the maximum joint deflection does not exceed 1/2 the maximum deflection recommended by the manufacturer. Only one vertical or one horizontal, defined curve is permitted between manholes. Curvilinear sewer designs shall include elevations at 5 metre stations for vertical curves and sufficient data for setting out of horizontal curves and providing as-built information. CCTV inspection of the curved sewers is required before acceptance by the City.

PVC pipes shall not be bent in curves; Manufactured long bends or PVC high deflection stops coupling (e.g., Certain Teed) shall be used to achieve curves.

The centreline alignment of sewers installed on a curve shall run parallel to curb or street centreline.

For tighter radii, where approved by the Engineer, bulk concrete shall be used on the outside of the joint of concrete pipe to increase the sheer strength, as per the American Concrete Pipe Association “Design Data Series, #21”, July 1969, or as updated.

The minimum slopes for curved sewers shall be 50% greater than the minimum slopes required for straight runs and ensure velocities are equal to or greater than 0.6 m/s.

(g) Utility Rights-of-Way for Drainage Facilities

See Section 2.

N. Manholes, Junctions and Bends

(a) General Manhole Requirements

Manholes shall be installed at the end of each sewer, at all changes in sewer size, grade, or alignment and at all junctions. All sewers shall have sufficient access manholes provided to suit maintenance purposes and to permit air venting. All manholes shall be 1050 mm minimum inside diameter or consistent with WCB requirements, and constructed to the City's standards. Safety steps are required for access down manholes.

(b) Location of Manholes

Manholes for sewers located within roadway right-of-ways shall be generally located within the travel lanes or centre median as appropriate, between the outside curb lines.

No standard manhole shall be located such that its centreline is closer than 1.5 m from a roadway curb face. Manhole tops, (frames and covers) shall not be located within a sidewalk unless approved by the engineer.

(c) Manhole Orientation - Safety Steps

Manholes are to be oriented so that safety steps are on the centreline perpendicular to the main flow channel.

(d) Flow Channels Through Manholes

The flow channel through manholes shall be made to conform in shape to that of the sewers from the invert up to the spring line (one-half the diameter above the invert) of the incoming sewer. Flow channels shall be shaped to provide a smooth transition of flow inlet to outlet sewers. For sewers 375 mm and larger (with reference to the outlet sewer), the channel sides shall be carried vertically up from the spring line to the three-fourths depth point. Benches beside the channel shall be sufficient slope toward the channel for drainage, to a maximum slope of 80 mm/m (to provide safe footing).

(e) Energy Loss Provisions at Manholes, Junctions and Bends

There is a loss of energy when flow passes through a bend in a sewer, a manhole on a sewer line, or a point where sewers meeting in a manhole or a specially designed junction chamber. These losses can be negligible as in the

case of a small diameter sewer flowing partially full at minimum velocities, or substantial as in the case of a large diameter storm sewer flowing full and turning 90 degrees in a manhole. It is the Designer's responsibility to ensure that he provides additional head energy in the sewer design to allow for the losses to be incurred. In cases where the head available is limited, the Designer will have to adjust the design to provide for a system which is hydraulically smoother.

- Major Junctions and Bends

  (a) Analysis Requirements

  For bends and junctions in 675mm diameter sewers or larger, or where flow velocities greater than 2 m/s are anticipated, or for complex or unusual sewer junctions, detailed analysis is required, and the Designer should consult appropriate references, for example, Sangster, Wood, Smerdon, and Bossy at the University of Missouri, and Bulletin No. 41 entitled "Pressure Changes at Storm Drain Junctions", and the ASCE Journal of the Hydraulics Division entitled, "Pressure Changes at Open Junctions in Conduits".

  (b) Guidelines for Large Bends and Junctions

  It is recommended that sudden, extreme changes of direction be avoided where large flows and high velocities are involved. Where changes of direction in the order of 90 degrees are necessary, the following guidelines are to be considered:

  - The ratio of the radius of the bend (R), measured to the pipe centreline to the pipe's inside diameter (D) should be greater than 2.
  - Where R/D is less than 2, the maximum bend deflection at one point should be 45 degrees (i.e., use two - 45 degree bends to turn 90 degrees).
  - Benching on the outside of bends in manholes should be carried upwards to provide super elevation to contain the flow in the channel.
  - Bends in large sewers should not be incorporated with junctions at the same location. Separate structures should be provided to serve each function. Large inflows from opposing directions are not to be combined at one structure.

- Manholes and structures at which flow direction changes occur must be designed with anchorage to resist thrust and impact forces generated by the flow.
- Special consideration must be given to the provisions for safe access to such structures, considering appropriate location of manholes.

- Minor Junctions and Bends

  To facilitate the rapid determination of head losses in manholes, simplified methods, as outlined below, are adequate for the majority of manholes involving small pipe sizes (600 mm and smaller) and low flow velocities.

  The Head loss (H_L) is computed by multiplication of the head loss coefficient (K_L) for the particular bend or junction in the manhole by the velocity head of the flow through the outlet sewer.

  i.e., $H_L = K_L (V_0^2/2g)$

  (a) Bends

  Head loss coefficients (K_L) may be determined as shown in the table below.

Deflection Flow Channel Characteristics

Deflection Angle	Deflection Flow Channel Characteristics	Head Loss Coefficient
90°	No benching or deflector, or where they are only up to the springline.	K_L=1.5
90°	Benching or deflector to crown of sewers.	K_L=1.0
Less then 90°	To determine the head loss coefficient, multiply the head loss coefficient for a 90° bend and the appropriate flow channel type by a head loss ratio factor from the curve in Drawing SSD-D.17.	

(b) Junctions with Side Outlets

For junctions with inlets at or near right angles to the outlet, the head loss coefficient applicable will vary depending on whether the incoming flow is deflected towards the outlet, or if incoming flows impinge with each other. The following values should be used:

K_L=1.5 impinging flow with no deflector between inlets,

K_L=1.0 when a deflector is provided between the inlets, (the deflector is required to be the full height and width of the incoming flows)

(c) Sump Manhole

Where ditches discharge into a storm sewer system, the initial connecting manhole shall be of a sump type as per Standard Drawings. Except under special conditions, ditches discharging into a storm sewer system of 600 mm diameter or larger do not require sump manholes. Where a manhole sump is used in lieu of catch basin sumps, the sump manhole shall serve no more than 5 upstream catch basins.

All non-sump manholes shall be channelled and benched. A special enlarged detail shall be provided for manholes of special design.

O. Catch Basin Inlets

(a) General Catch Basin Requirements

Details of the various approved catch basin structures and components are provided in the Master Municipal Construction Documents (MMCD). Catch basins shall be constructed using precast concrete barrels, shoulder and neck rings, and cast iron or ductile iron frames and covers.

Catch basins shall be of the grillage-sump or non-sump design as per Standard Drawings. Non-sump catch basins may be used only where sump manhole is used in lieu. A catch basin shall be located to intercept the water flowing in the gutter in advance of the wheelchair ramp.

(b) Catch Basins Using Special Frames and Covers

Side inlet catch basin frames and covers are required for new developments and where higher inlet capacity is required. These may be installed using 525 or 900 mm catch basin barrels as appropriate, or may be installed using 1200 mm catch basin manholes.

(c) Catch Basin Leads

The catch basin lead size and slope shall be based upon hydraulic capacity requirements. Leads shall be 200 mm in diameter (minimum) for single basins and 250 mm (minimum) in diameter for double basins. Double catch basins shall not be connected directly together but rather one basin will be “Y” ed into the lead of the other. Catch basin leads should be taken into manholes wherever possible. Maximum length of lead shall be 30 m.

Catch basin grates are to be set 30 mm below the gutter line. The gutter and blacktop are to be shaped to form a dish around the inlet.

P. Drop Manholes

Drop manholes are to be used to carry flow between sewers at higher and lower elevations. Generally, these shall be vertical drop shafts with inlet (upper) and outlet (lower) connection or chambers.

Where the invert elevation of a sewer entering a manhole is more than 1.0 m above the invert of the outlet sewer, then that manhole will be considered a Drop Manhole.

When the size of the inlet pipe to a drop manhole is large in comparison to the drop shaft diameter and where it is anticipated that the impingement of flow on the drop shaft wall opposite the inlet may create conditions which would not permit stable flow and air passage to and from the drop shaft, then the inlet shall be designed to provide a smooth transition of flow from the horizontal direction to the vertical.

When the rate of flow and the distance of the fall down the drop are of such magnitudes that there is potential for significant entertainment of air into the flow, then the drop shaft and lower connection shall be designed so as to provide for release of the entrained air and ventilation of the drop shaft.

(a) Drop Manhole Features not Permitted

Use of baffled vertical drop shafts is not permitted due to associated maintenance and access problems.

(b) Design Criteria for Drop Manholes

- Inlet Upper Connection

  Where an inlet connection shall provide for a smooth transition of flow from horizontal to vertical, it shall be designed so that at the design flow rate, the flow will not back-up in the inlet sewer line, and shall have a free outfall to the drop shaft, with critical depth control at the entrance to the drop shaft from the inlet sewer. To achieve this , the following conditions shall be met:

  - the inlet pipe (upstream of the inlet connection) shall be at a mild slope such that the design flow is subcritical, and the pipe shall be of sufficient size that it is not under surcharge.
  - the pipe bottom profile, from the springline down to the invert, shall form a smooth vertical curve between the inlet pipe and the drop shaft, with no sharp breaks in grade, projections or edges in the vertical curve portion of the channel. The radius of the vertical transition curve shall be such that the nappe of the flow will maintain contact with the inlet invert. The actual vertical curve radius used shall incorporate a minimum safety factor of three (i.e., actual invert radius = theoretical radius where cavitation begins to occur times the safety factor).

- Drop Shaft

  A drop shaft of a diameter approximately equal to or larger than that of the largest sewer inlet pipe shall be used. This will ensure that the drop shaft capacity exceeds the inlet sewer capacity with ample provision for air

flow and unforeseen conditions. For multiple large inlet pipes connecting to a single drop manhole, the enlargement of the drop shaft should be considered as necessary.

Provisions of air vents at intervals along the drop shaft is recommend. These vents should be interconnected by a vent pipe to a manhole above the inlet and to the outlet connection. The vent connection may be a pipe placed outside of the drop shaft, or a divider wall within the drop shaft located no more than one-fourth of the shaft diameter from the shaft wall opposite the inlet.

A standard manhole with restraining cover mechanism, designed to withstand the pressures resulting from possible air discharge and surcharge at the MH, is to be provided directly over the drop shaft, extending from the inlet connection upward to the ground surface.

- Outlet (Lower) Connection

  The outlet connection shall be designed to provide a hydraulic jump basin to dissipate energy, to convert the flow to subcritical velocity, and to allow for the release of entrained air before the flow enters the downstream connected sewer.

  The hydraulic jump may be of the free or forced typed depending on the available length of outlet pipe from the base of the shaft to the connection to the downstream sewer, and the anticipated operating tail water conditions.

  An air vent connection to the shaft vent system, is to be provided at the crown of the outlet pipe, or an air vent or manhole may be provided downstream of the drop structure to allow removal of air released at the lower connection. This vent or manhole is to be located upstream of the point where the flow surface profile is expected to reach the crown of the outlet pipe. (i.e., before the flow level reaches the second sequence depth of hydraulic jump), or upstream of the point where full flow of the outlet pipe is anticipated under design flow conditions.

Q. Storm Sewer Outfall Structures

(a) Requirements

At the end of an outfall sewer, energy dissipaters are often necessary to avoid downstream erosion and damage of creeks, ravine, or river banks from the high exit velocities. Outfall structures are required at locations where it is necessary to convert supercritical flow to subcritical flow, dissipate the

released flow energy, and establish suitably tranquil flow conditions downstream from the sewer outfall.

(b) Hydraulic Requirements

When sewer discharge is at subcritical flow, then smaller concrete structures with suitable baffles, aprons, and riprap will be acceptable. For all outfalls, it is required that a rigorous hydraulic analysis be completed to ensure that the exit velocities to natural watercourses will not produce scour and damage. The final exit velocities, where the flow passes from an apron or erosion control medium to the natural channel, shall not exceed the flow rates suitable to maintain creek morphology and shall be further limited as required based on site specific soil and flow conditions. Where high outlet tail water conditions or other downstream conditions may result in formation of a forced hydraulic jump within the sewer pipe upstream from the outfall, special consideration shall be given to the design of that sewer pipe with regard to bedding and structural requirements.

(c) Safety Provisions

All sewer outlets shall be constructed to prevent children or other unauthorized persons entering the connected sewers. Grating, with vertical bars spaced at no more than 150 mm shall be installed fixed in the form of a gate with adequate means for locking in a closed position. Provision for opening or removal of the grate for cleaning or replacing the bars is required. Gratings should be designed to break away under extreme hydraulic loads in the case of blockage.

Guard-rails or fences of corrosion resistant material shall be installed along concrete headwalls and wingwalls to provide protection against persons inadvertently falling over the wall.

(d) Outfall Aesthetics

Outfalls, which are often located in parks, ravines, or on river banks should be made as safe and attractive as is reasonably possible. The appearance of these structures is important and cosmetic treatment or concealment must be considered as part of the design. Concrete surface treatment such as bushhammered concrete or exposed aggregate are recommended to present a pleasing appearance and remove future markings by public, etc.

R. Rural Runoff Inlets and Outlet Structures

The required inlet capacity to accept rural runoff will be addressed in the hydraulic portions of the Drainage Master Plan, and Functional Design Studies. All designs

shall be detailed in the Stormwater Control Plan . Each inlet may be unique, and appropriate consideration must be given to provisions for grates, debris interception, sediment catchment and storage, maintenance and local constraints. Proper rights of way will be required to permit access to inlets by maintenance equipment and vehicles for maintenance purposes. Generally this will be required to be through a road right-of-way or utility right-of-way. Rural runoff inlets may be located within public lands controlled by authorities other than the City with relevant approvals; however, location of inlets in easements on privately owned property will be permitted only where warranted by special circumstances.

Standard Drawings shall be used as a guide for designing inlet and outlet structure for storm sewers and culverts.

The structural requirements for inlet structures, given on Standard Drawings are the minimum requirements only. Generally, structures exceeding 1m in height or 2 m in width should receive individual structural design.

Gratings installed over the ends of rural runoff inlets shall be sized with hydraulic capacity of 200% of the design flow rate to allow for the effects of blockage or fouling of the grates by debris carried by the flow.

Consideration of safety and aesthetics identified for sewer outfalls shall apply to the design of rural runoff inlets.

S. Subsurface Drains

Subsurface drains shall be used where supported by a soils report carried out by a qualified geotechnical engineer..

Subsurface drains located adjacent to roads shall be extended well below the road base. The material for subsurface drains shall be clear round drain rock in an envelope of approved filter material. A minimum 100 mm PVC perforated pipe shall be placed at the bottom of the trench. The drain shall be finished with 100 mm of open graded topsoil and covered with sod.

T. Swales

Swales shall be used in storm sewered City road allowances where there is no curb and gutter to direct the minor flow towards catch basins or the City storm sewer system. Swales shall be used in conjunction with proper lot grading to convey lot runoff, as well as to convey minor flows, and to direct major flows within rights-of-way.

5.5 Major System Hydraulic Design

A. Scope

Subsection 5.5 outlines the requirements and considerations which apply to the detailed design of the conveyance elements of the major drainage system, and of surface grading plans that generally apply to residential subdivisions. The continuation of these flows through downstream watercourses is discussed in Subsection 5.7.

B. Representation of the Major Conveyance System

The nature and detail of the Major Conveyance System is to be shown on the Stormwater Control Plan within the Detailed Engineering Drawings. Information shown is to include the direction of surface flows on roadways, other rights-of-way, and all surface flow routes, areas subject to ponding and depths of ponding, elevations of overflow points from local depressions, and details of channel cross sections. Where significant major system flows are expected to discharge or overflow to a watercourse, ravine, environmental reserve area, etc., the rate and projected frequency of such flows is to be noted on the Stormwater Control Plan.

C. Surface Drainage On Public Rights-Of-Way - Major System

(a) Level of Service

Rights-of-way for utilities, walkways, and other public purposes shall be graded to provide a continuous surface drainage system to accommodate flows from rainfall events up to the 1 in 100-year events and convey these flows to appropriate safe points of escape or storage.

The service level for the major system includes protection against surface flooding and property damage for the 1 in 100-year return frequency design storm. Roadway and other surface features along the major flow path shall provide a minimum of 350mm freeboard to the finished ground elevation of buildings on adjacent properties. Overflows will be provided from all sags or depressions such that there will be a minimum freeboard of 150 mm ground surface elevation at adjacent buildings, and such that the maximum depth of ponding is limited to 350 mm.

(b) Flow Capacity of Street

The theoretical street carrying capacity can be calculated using modified Manning's formula with an "n" value applicable to the actual boundary conditions encountered. Recommended values for n are:

- 0.018 for roadway
- 0.05 for grassed boulevards.

(c) Major Flow Routing

All overland flows shall have specifically designed flow routes, that are protected and preserved by registered easements, restrictive covenants or rights-of-way. The major flow routing shall normally be provided along roads and in natural watercourses. In some cases, the major flow may also be carried alongside the road in grassed swales, and between roads in rights-of-way.

– Where the road is used to accommodate major flow, it shall be formed, graded and sufficiently depressed below the surrounding property lines to provide adequate hydraulic capacity. On arterial roads, the 100-year flow depth shall not be higher than centreline of the pavement with the maximum flow depth not to exceed 300 mm. On collector and local roads, the entire roadway may be used as a major flood path with the maximum flow depth not to exceed 350 mm.

– Where roadways, used for major flows, intersect, care shall be taken to lower the intersection to allow flows to pass over the cross street. Where major flow routes turn at intersections similar care in the road grading design is required.

– Major flow routes on the surface are not be permitted between lot lines or on easements/rights-of-way where public access may be difficult unless approved by the Engineer.

– Major flow routing shall be shown on the stormwater control plans and sufficient design shall be carried out to provide assurance to the Engineer that no serious property damage or endangering of public safety will occur under major flow conditions. The discharge point from the development for the major flow route, shall be coordinated with the downstream routing to outfalls as determined by the City of Surrey. Where major flow outfalls to a receiving watercourse, an energy dissipater, or other such measure shall be provided to minimize erosion.

- The use of catch basin inlet control devices to separate major and minor hydraulic grade lines, may be allowed subject to the satisfaction of the Engineer regarding the suitability of such control devices. Where catchbasin inlet control devices are used, minimum building elevations may be controlled by the hydraulic grade line occurring in the minor system.

D. Piped – Major System

In special circumstances, or where lower building elevation are desired, the minor system, may be enlarged or supplemented to accommodate the major flow.

All habitable areas of buildings including crawl spaces and basements shall be above the major flow hydraulic grade line (HGL), except where specific flood proofing measures to eliminate backwater effects from the downstream HGL have been taken.

- A pipe system will be designed with adequate inlets to accommodate introduction of the major flow.
- The proportion of flow to be carried along the major routing shall be the total major flow less the flow carried in the minor system.
- In conjunction with the piped system, a surface overflow route will be provided from all potential surface ponding locations along the major flow route.
- Pipe systems to convey the major flows will follow the design guidelines used for the minor system.

5.6 Stormwater Storage Facility Design

A. Scope

Subsection 5.6 identifies the general design parameters and specific requirements that must be considered and addressed in the planning and design of stormwater storage facilities.

B. Basis For Planning And Design

(a) Level of Service

Stormwater management storage facilities shall be designed to satisfy the servicing objectives as stated in Subsection 5.2.D. The requirements for hydraulic performance for stormwater storage facilities including storage capacity, design water depths, outlet restrictions, bypass and drawdown rates, and other basic design parameters such as storage volume and discharge requirements may be defined and documented in the Master Drainage Plans (MDPs). More site specific design parameters such as pond shape, orientation, locations of various inlet/outlet structures, stage/discharge and characteristics and design water level elevations may be found in the Functional Feasibility Plans.

(b) Site Selection

In general, the site suitability is determined by the watershed topography and natural drainage conveyance and confluence locations. If feasible, these storage facilities may be sited in conjunction with other park and secondary school sports field facilities as part of common community facilities to enhance their visual and environmental benefits as well as to minimize costs through sharing the land requirements. The conjunctive location of stormwater storage facilities with parks and or school sports fields require close consultation with the public, Parks Board, School Board, etc.

(c) Capacity Requirements

The storage capacity requirement is determined by the need to control the post-development peak outflow from the contributing watershed. In Surrey this requirement is primarily for the 5-year level design storm flow to be controlled as detailed in Servicing Objectives 5.2.D. In addition to the computed storage requirement contained at a given design depth, each facility must have an additional freeboard depth, as defined in these standards.

It is strongly recommended that when computing the detention storage requirements for a given event, the lowest 0.2 m depth of the pond above the controlled outflow pipe's invert be excluded, as this depth is usually taken up by the stormwater runoff preceding a design storm event.

Depending on site and/or downstream constraints, these design parameters and the overall servicing scheme will need to be customized during final design.

(d) Geotechnical Considerations

Final designs for stormwater management ponds will include investigations to address groundwater table, soil permeability, composition and stability.

(e) Sediment Control

A Sediment Control Plan is required as part of the Design Report to define measures which must be taken for control of sediment. Details of sediment control measures are to be included in the Project's design drawings. In addition, effective protocol must be incorporated into the construction contracts to ensure that the construction related silt control needs are adequately met by the contractors.

(f) Staged Construction - Standards for Interim Facilities

The City's aim is to have these community detention facilities located in their ultimate locations from the start of the development, even if they are constructed on a staged basis.

When stormwater management storage facilities are to be implemented in stages, the standards applicable to the design and construction of the interim facilities are to be generally in accordance with the standards set out herein for permanent facilities of that type. (e.g., Where an interim dry pond facility is proposed as a preliminary stage in the implementation of a stormwater management pond system, it shall be designed and constructed in accordance with the criteria and standards applicable to a permanent pond). All interim facilities must continue to effectively function during further staged expansion related construction. Any proposal for application of alternative standards will require special approval from the Engineer.

C. Storage Alternatives

The review of stormwater management alternatives for application to a specific development area should consider the storage methods listed and described in this Subsection, and other methods of merit which the designer may determine. The

optimum number and location of stormwater management facilities must be determined, bearing in mind the major/minor system concept. A combination of the various types of facilities should be considered to determine the most economically feasible and effective drainage system.

(a) Wet Ponds

Wet ponds or extended detention ponds is the method wherein storm runoff is collected and stored for a significant period, and released after the storm runoff from the contributing area has ended. This type of storage is often associated with "wet reservoirs," more commonly referred to as "Stormwater Management Lakes" or "Wet Ponds". These may accommodate special recreational or aesthetic uses centred around a minimum permanent pool. As well, water quality related benefits should be achieved by extending the storage duration for the more frequent runoff from the watershed.

(b) Dry Ponds

Dry ponds are also one of the common types of storage utilized in urban drainage works. Generally, frequent low flows are not detained in dry ponds. When the inflow is large enough, the proper functioning of flow controls on the outlet from the system restricts the outflow to a rate much less than the inflow, and causes the excess to be temporarily detained in a storage element. This results in meeting the downstream receiving system constraints.

(c) Constructed Wetlands

Constructed wetlands are one of the most promising types of stormwater storage options particularly useful where, in addition to reducing peak outflows rates, improving water quality is an important consideration. Thus to improve the aquatic habitat needs both as a habitat as well as a biofiltration facility that improves water quality, these constructed wetlands would be very useful as part of Surrey's stormwater management options.

Some applicable technical documents are listed in the Bibliography/References to obtain more information about their characteristics, types, applicability for different climatic regions.

(d) Other Stormwater Control Measures

There are many other measures which can be implemented at individual lot levels, as part of the stormwater conveyance system, at end of pipe/conveyance system and as part of receiving watercourses. These include Best Management Practices (BMP's) such as reduced lot grading; infiltration of on-lot drainage including roof drainage; parking lot storages, grassed

swales, pervious pipe and catch basin systems; different types of infiltration facilities such as trenches, basins, strips; stream and valley corridor buffer strips etc. (See: Best Management Practices Guide for Stormwater, October 1999, GVRD).

Depending upon additional constraints such as the need to maintain watercourse base flows; reduce the risk to watercourse water quality; above measures should be pursued in addition to the community stormwater storage facilities sized to handle larger volumes and rates of flows.

(e) Storage Location Options

Depending on the watershed's topographical characteristics as well as the constraints imposed by the developments and the receiving watercourses, storage facilities can be located variously as outlined below.

- Off-Stream Storage

  A minor conveyance system may conduct low flows directly to an outlet, but have restricted outlet capacity or flow control elements which cause only storm hydrograph peaks to be routed to storage. This form of storage is usually termed "off-stream" or "off-line" storage. The storage may incorporate depressed open areas, reservoirs, and low lying recreation fields.

- Channel Storage (Blue-Green Storage)

  Slow-flow channels with wide bottoms provide channel storage as an inherent part of their hydraulic characteristics. As the channel fills to transport water, it is also storing water in a transient form.

- On-Stream Storage

  On-stream storage is achieved through the construction of an embankment across a channel so that a storage pond is formed. Spillway considerations are important to pass large floods exceeding the design runoff.

- Underground Storage

  Typically these are over-sized sewers or storage vaults which are configured to be on or off-line the flow sewer system. The outlets are controlled to meet the flow control requirements.

D. General Design Requirements

(a) Outflow Control Works

The outlet from a stormwater management storage system must incorporate appropriate means for control of outflow, to limit rate of discharges as prescribed in the MDP Report and/or the Functional Feasibility Plan Report (FFP). In addition, the outlet works must include provisions for operational flexibility; minimizing water level fluctuations below normal water level due to evaporation losses, etc.; access for maintenance; and to address unintentional blockage of the outlet and the possible need to either stop outflow or increase the rate of outflow. See Drawing SSD-D.9.

(b) Overflow Provisions

An overflow spillway is to be provided for each storage facility design and, such provisions are to be incorporated in the facility design. The Designer is to identify the probable frequency of operation of the overflow spillway. The functional requirements of the spillway should consider the possible consequences of blockage of the system outlet or overloading due to consecutive runoff events, such that the storage capacity of the facility may be partially or completely unavailable at the beginning of a runoff event.

Since the storages are generally designed to attenuate peak flows up to the 5-year level, if it is unfeasible to provide overflow spillways from the storage ponds during larger events, an alternate design must be provided for the safe routing of these excess flows to receiving watercourses.

(c) Maintenance and Service Manual

As part of the responsibility for design of a community stormwater management storage facility, the Design Engineer shall prepare and provide a Maintenance and Service Manual for the Facility along with as-built drawings following construction.

Six complete copies of the manual are to be provided to the Engineer prior to the time when the operation responsibility of the facility is transferred to the City, which will generally be at the time of approval of substantial completion. The manual shall include complete equipment manufacturer's operation, maintenance, service repair instructions, and complete parts lists for any mechanized or electrical equipment incorporated in the design.

The manual is to include, at minimum, the following information:

- A copy of the final Engineering Drawings relating to the Stormwater Storage Facility and appurtenances, updated to "As-Constructed".

- A completed Data Summary Form for the storage, area, elevation, and outlet control characteristics of the pond. See Table 5.6(a), as a sample.
- Schematic diagrams of the inlet and outlet arrangements, connecting to and arrangement of upstream and downstream systems, including all controls, shutoff valves, bypasses, overflows, and any other operation or control features.
- Location plans for all operating devices and controls, access points and routes, planned overflow routes, or likely point of overtopping in the case of exceedence of the design containment volume.
- Stage-Area-Storage, and Stage-Discharge Curves with clear relationships of the stages to surrounding features.
- Stage-discharge relationships for receiving storm sewers or channels downstream of the storage outlet, with indication of backwater effects which may restrict the outflow or which shall be considered in the operation of the facilities outlet controls.
- An outline of the normally expected operational requirements for the facility.
- An outline of emergency operating requirements under possible abnormal situations.
- Information/data sheets to document post-construction monitoring expectations and findings.

(d) Signage for Safety

The design for stormwater management facilities shall include adequate provisions for installation of standard signage to warn of anticipated water level fluctuations, with demarcation of the expected maximum water levels for design conditions. Warning signs for thin ice conditions, safety, etc. will be provided and installed by the Engineering Department, Operations.

(e) Engineering Drawing Requirements

The engineering drawings for any stormwater management facility are to include the following information, in addition to the physical dimensions.

- stage-volume, stage-area, and stage-discharge curves for 2, 5, and 100-year level storms.
- elevations at: Normal Water Level (NWL), 5-Year Level, Freeboard Level.

- volumes at: Normal Water Level (NWL), 5-Year Level, Freeboard Level.
- notation indicating the lowest allowable building opening elevation for lots abutting the pond.
- depth at: Normal Water Level (NWL), 5-Year Level, Freeboard Level.
- length of shoreline at Normal Water Level (NWL), 5-Year Level, Freeboard Level.
- pond area (ha) at Normal Water Level (NWL), 5-Year Level, Freeboard Level.
- contributing basin size (ha) and catchment plan.
- measurements to locate submerged inlets(s), outlet(s) and sediment traps referenced to identifiable, permanent features which are not submerged at Normal Water Level (NWL).

Table 5.6 (a)
Pond Data Summary

NAME: _____ ID NUMBER: _____
LOCATION: _____ TYPE: _____

CONSTRUCTION YEAR: _____ GIS ID#: _____

LEVEL LOCATION	SIZE (ha) (surf. area)	ELEVATION (m)	VOLUME (m^3)	DEPTH (m)	DISCHARGE (m^3/s)
BOTTOM					
NWL *					
1:2-YEAR					
1:5-YEAR					
1:100-YEAR					
HWL *					
EMBANKMENT TOP					

* Minimum information required for wet ponds - NWL / HWL
Minimum information for dry ponds - Bottom / 1:5 / 1:100 / HWL

CONTRIBUTING CATCHMENT: _____ (Ha)
NUMBER OF INLETS: _____

			INVERT
LOCATION(S):	_____	SIZE: _____	ELEV. _____
	_____	_____	_____
	_____	_____	_____

NUMBER OF OUTLETS: _____

			INVERT
LOCATION(S):	_____	SIZE: _____	ELEV. _____
	_____	_____	_____
	_____	_____	_____

ALLOWABLE 5-YEAR LEVEL OUTFLOW RATE: _____
CONTROLLED 5-YEAR LEVEL OUTFLOW RATE: _____
STATUS: _____
MISC. NOTES: (depths/special conditions, make up water needs, etc.)
_____
_____
_____
SUBMERGED INLET(S) & OUTLET(S) @ NWL: _____
_____
_____

E. Design Details for Wet Ponds

(a) Land Dedication and Easement Requirements

The requirement for dedication of land on which a stormwater management pond is to be situated will be in accordance with the policy established by the City, as may be revised from time to time. The area of land which would be covered by water when the pond level is at its highest water level (100-year) plus the edge treatment will be designated as a Statutory Right-of-Way. This designation will also apply to all rights-of-way for access to and protection of inlet and outlet sewers and flow control facilities, maintenance access routes to the pond, and to a certain proportion of the lands fronting on the pond, from the upper edge of the area containing the edge treatment to the limit of the waters edge when the water surface is at the design high water elevation.

A restrictive covenant and/or a limit for the Minimum Building Elevation (MBE) will be placed upon those lots abutting the pond to guide lot development that design requirements of the stormwater storage facility are not compromised and that an adequate free-board is maintained.

(b) Minimum Pond Size

The minimum catchment area of any pond shall be 20 ha. This discourages the proliferation of large numbers of small ponds, with the resultant higher maintenance cost and lower efficiency impact. The storage size is determined on the basis of outflow control requirements as presented in this manual under Subsections 5.2 and 5.6.

(c) Side Slopes

Side slopes requirements are to be as shown in Drawing SSD-D.8.

Areas covered by water, from the design high water level down to the normal water level shall have a maximum slope of 7 (horizontal) and 1 (vertical) and extend at a maximum slope of 7:1 (H:V), from normal water level to a depth of 0.4 m (i.e., a distance of 3 m horizontally into the pond for safety needs).

Steeper side slopes, up to 4(H): 1(V) may be considered for areas separated from the public by a log rail or are inaccessible due to vegetation and thus minimize safety risks.

A slope of 4:1 (H:V) shall be used from the 0.43 m depth point (below normal water level) to the pond bottom.

Proposals to amend the slope requirements will be reviewed and approved by the Engineer on a site specific basis.

(d) Minimum Depth

The minimum depth from normal water level to pond bottom (beyond the side slope area) shall be 1.5 m. Refer to Drawing SSD-D.8.

(e) Pond Bottom Material

For areas where the ground water table is below the Normal Water Level (NWL), the pond bottom and side slopes are to be composed of impervious material with a suitably low permeability (e.g. with a permeability coefficient in the order of 1 x 10-6 cm/s).

For areas where the groundwater table is expected to be near or above the NWL, the pond bottom may be of a pervious material as dictated by geotechnical considerations.

(f) Circulation Requirements

Narrow and/or dead bay areas where floating debris may accumulate are to be excluded at the design stage. Inlets and outlets should be located with consideration of the need to maximize detention time and circulation within the pond water body.

(g) Inlet and Outlet Requirements

- Submergence of Inlets and Outlets

  Inlet and outlet pipes and headwalls are to be 200 mm ± below NWL, with the crown of the pipe at least 1.0 m below normal water level. Inlet and outlet pipe inverts are to be a minimum 0.1 m above the pond bottom. Forebays are to be constructed on pond bottom to accommodate extra depth requirements for placing inlet/outlet structures, as required.

- Provision for Free Outfall from Inlets to Ponds

  Where feasible, the invert elevation at the first manhole upstream from the pond in a minor system or the connecting or interconnecting pipe system, shall be at or above the normal water level of the pond to avoid deposition of sediments in the inlet pipe. To avoid backwater effects on the upstream sewers leading to the pond, the obvert of the inlet sewer at the first manhole upstream from the pond shall be at or above the pond level for the 1 in 5-year storm. A drop structure upstream from the pond will

generally be required to achieve this. "Inlet" and "outlet" control calculations are required to verify the mode of operation of the pond inlets. In cases where grades set limits on the above, special maintenance needs, such as periodic flushing/cleaning must be identified.

- Provisions for Water Level Measurements

  To permit direct measurement of water level in the pond, a manhole is to be provided hydraulically connected to the pond such that the level of water in the manhole will mimic the pond water surface level.

- Provisions for Lowering the Pond Level

  The provision of the means to drain the pond completely by gravity drainage is desirable. Where a gravity drain is not feasible, provisions are to be made in association with the outlet works or otherwise, so that mobile pumping equipment may be installed and used to drain the pond.

(h) Sediment Removal Provisions

The pond design shall include an approved sedimentation removal process for control of heavy solids which may be washed to the pond during the construction period associated with the development of the contributing basin.

Sediment basins shall be provided at all inlet locations for continued use after completion of the subdivision development. Stormwater storage/detention ponds shall not take the place of a development's sediment control storage basin.

(i) Pond Edge Treatment

Edge treatment or shore protection is required and shall be compatible with the adjacent land use. The treatment used shall meet criteria for low maintenance, safety and habitat requirements.

The edge treatment is to cover ground surfaces exposed or covered by water during a pond level fluctuation to 0.3 m below or above the normal water elevation, refer to Drawing SSD-D.8, and shall be adequate to prevent erosion of the pond edge due to wave action. The typical acceptable edge treatment shall be, but is not limited to, a 250 mm deep layer of well graded washed rock with a 75 mm minimum size or alternatively appropriate edge vegetation.

The proposal of variations to the edge treatment minimum is encouraged. The final selection of edge treatment being subject to the acceptance of the Engineer.

(j) Maintenance Access Requirements

All-weather vehicle access must be provided to all pond outlet controls and works. A vehicle access route shall also be provided to the edge of all stormwater management ponds suitable to carry maintenance vehicles and for use as a boat launch point. This access shall also be suitable for all-weather use. The access surface shall be a minimum of 3.0 m wide, shall extend into the pond beyond the pond edge at normal water depth to a point where the normal water depth is 1.0 m, and shall be accessible from and extend to a public road right-of-way. Sharp bends in this access route are to be avoided.

(k) Landscaping Requirements

Landscaping plans for areas bounding the pond shall be submitted as part of the Engineering Drawings. Landscaping of all proposed public lands included for purposes of the pond and of all proposed easement areas on proposed private property, including all areas from the pond edge treatment to the limit of inundation when the pond is filled to the design high water level, is to be part of the pond construction requirement. The minimum requirement for landscaping shall be the establishment of grass cover. Refer to Drawing SSD-D.8.

F. Design Details For Dry Ponds

The design details should follow those given for wet ponds with specific modifications as outlined below.

(a) Land Dedication and Easement Requirements

Dry ponds to be operated by the City of Surrey are to be located within Statutory Rights-of-Way lots which are to encompass all lands subject to inundation at the 100-year design high water level.

Lands subject to inundation for larger storm events, to the limit of inundation for the design maximum event, are to be included within the Statutory Right-of-Way. If the slope integrity may be jeopardized by cutting or filling of priority lots, a restrictive covenant will be placed on lots abutting the dry pond to control lot development so as not to compromise design requirements at the HWL. This is to ensure an adequate freeboard is maintained.

(b) Frequency of Operation

All dry ponds shall be off-line storage areas designed to temporarily detain excess runoff and thereby reduce the peak outflow rates to the connected

downstream system. These facilities may be subject to prolonged inundation during winter due to the rainfall pattern in the lower mainland.

(c) Side Slopes

Side slopes subject to inundation upon filling of the dry pond shall have a maximum slope of 4 (horizontal) to 1 (vertical) within public property.

(d) Depth of Ponding

The maximum live storage limit in a dry pond is for 3.0 m for the 100-year event and 1.5 m for the 5-year event, as measured from the invert elevation of the outlet pipe.

(e) Bottom Grading and Drainage

The dry pond shall be graded to properly drain all areas after its operation. The dry pond bottom shall have a minimum slope of 0.5% and a slope of 0.7% or greater is recommended where feasible. Lateral slopes for the pond bottom shall be 0.5% or greater. French drains or similar means may be required where it is anticipated that these slopes will not properly drain the dry pond bottom, or where dictated by multiple use or other special considerations.

(f) Safety Provisions at Inlets and Outlets

All inlet and outlet structures associated with dry ponds shall have grates provided over their openings to restrict access and prevent entry into sewers by children or other persons. A maximum clear bar spacing of 0.150 m shall be used for gratings.

Grated outlet structures, are to be designed with a hydraulic capacity of at least twice the required capacity to allow for possible plugging. Further, the arrangement of the structures and the location of the grating shall be such that the velocity of the flow passing through the grating will not exceed 1.0 m/s. Appropriate fencing and guard-rails are to be provided to restrict access and reduce the hazard presented by structure head and wing walls.

(g) Landscaping

Landscaping plans shall be submitted as part of the Engineering Drawings for dry ponds, and the completion of landscaping will be considered part of the improvement construction. The minimum requirement for landscaping of dry ponds shall be the establishment of grass cover.

G. Post Construction Monitoring

In consultation with the City, where required, appropriate monitoring systems to collect data on the watershed development condition, rainfall in the watershed, storage depth, and the inflows/outflows from these storage facilities must be designed and constructed. The objective is to collect actual rainfall and storm flow data related to the operation of the as-constructed drainage system, compare with design objectives and carry out further improvements/adjustments, as required.

5.7 Watercourse Drainage Design

A. Scope

Surrey's storm drainage conveyance system consists of two main components: the closed conduits comprising the sewers, manholes and outfalls and the open conduits comprising the ditches, creeks, watercourses, culverts, bridges, and the rivers. The open conduits form a major part of the total system and are discussed in this section under the generic term "watercourses".

Watercourses have the dual function of safely conveying runoff for the total spectrum of frequent to infrequent storms as well as providing sustainable habitat for aquatic and terrestrial life native to the local environment. The ability of the watercourses to perform these functions in perpetuity must be protected by preventing land development, and roadway crossing related encroachments within its total right-of-way, including the floodplain for extreme runoff conditions such as the 100 to 200-year level storm related flows.

Subsection 5.7 outlines the issues, resource management factors and drainage conveyance design approach and procedures and required performance parameters for watercourses, including erosion protection and hydraulic structures. The management philosophy and the design approach is to provide a natural drainage system wherever feasible.

B. Watercourse Drainage Management Issues

(a) Overland Flow Path

The overland drainage system of each watershed comprises the natural streams and valleys and the man-made streets, swales, channels and ponds and is generally called the major drainage system. It is the keystone to safe and comprehensive urban drainage, as it accommodates the runoff from more intense and less frequent storms. Properly designed and constructed, the major system will "essentially eliminate" the risk of loss of life and property damage due to flooding. It is a fact that the major flow conveyance system will exist in

a watershed whether or not it has been planned or designed and whether or not development has been wisely situated with respect to it. Water will obey the law of gravity and flow downhill to seek its lowest level whether buildings or people are in its way or not, see Figure 5.5.

(b) Land Use, Floodplain, and Top-of-bank Setbacks

A watercourse is classified as either a flowing stream having a defined channel formed by a distinct bed and banks, or a definite overland flow path provided by natural gullies, ravines or depressions. The nature and characteristics of the watercourse depend greatly on the interaction of the flowing water, over time, with the bed and bank cover and underlying material.

The water flow in the watercourse may be perennial (year round) or ephemeral (seasonal), depending on the watershed and meteorological conditions prevalent to the area.

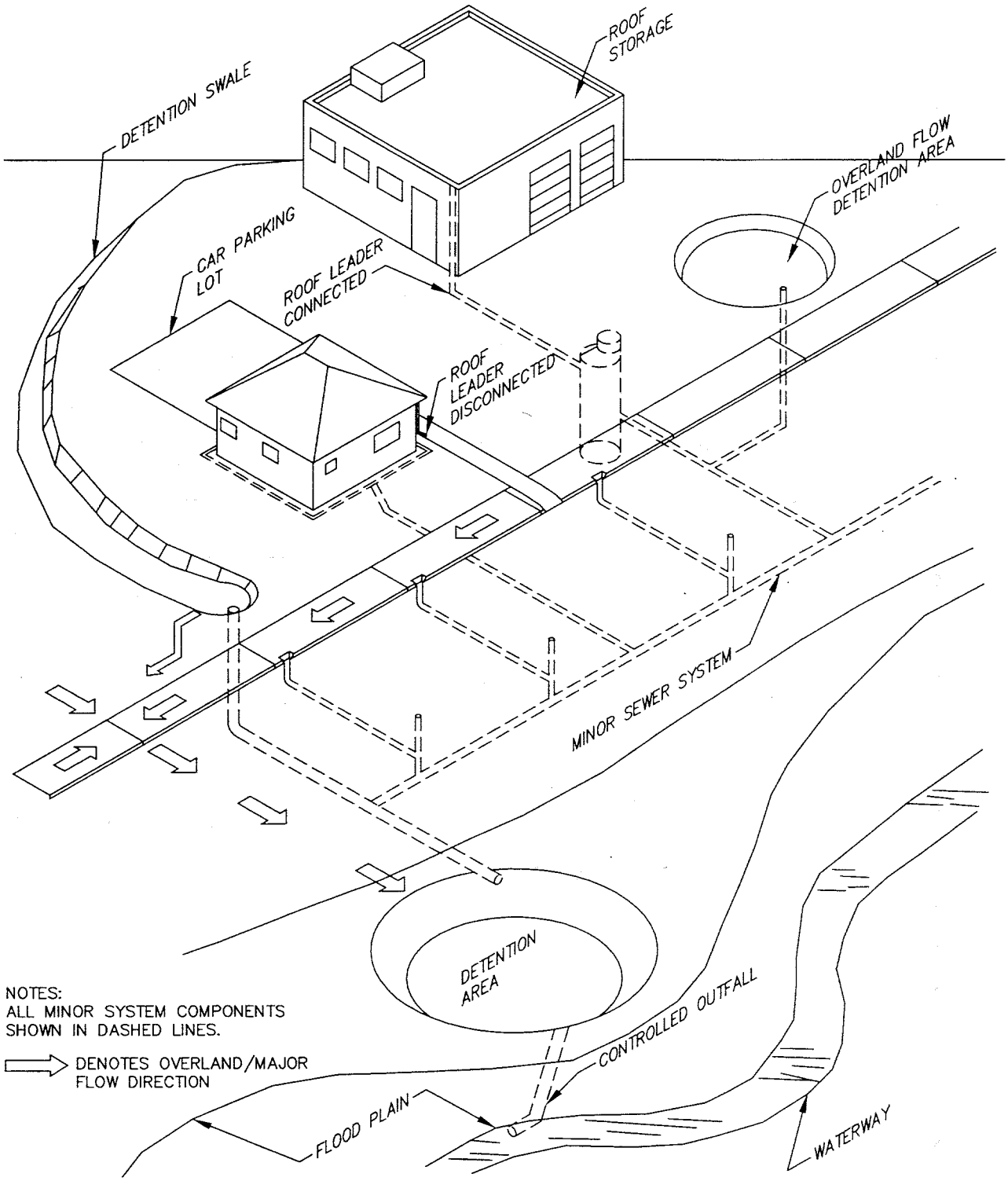
Land use designations must recognize that flow conveyance during dry weather as well as wet to extremely wet weather as one of the two primary functions of a *watercourse,* with the second primary function being the supporting of terrestrial and aquatic habitat natural to the area.

The area designated as the *floodplain, s*ee Figure 5.6 is needed to safely convey stormwater flows such that it provides a level of protection against surface flooding and property damage up to and including the 1:100-year return frequency design storm with an appropriate freeboard of up to 0.6 m. (In British Columbia, for large rivers, such as the Fraser, Nicomekl and Serpentine Rivers, the equivalent regulatory flood criteria is the 1:200-year flood). For watercourses, this requirement would be contained within the ravine section defined by the top of the banks on both sides of the watercourse and would cover the defined leave strip.

No watercourse shall be diverted, blocked or abandoned, or its floodplain be encroached without the prior approval of the Engineer, City Council, and the provincial and federal government agencies who administer the relevant Acts such as the Water Act, Municipal Government Act, and the Fisheries Act.

(c) Erosion and Sediment Impacts of Urbanization

It has long been recognized that urbanization of a basin tends to increase peak streamflows compared to those for the pre-development conditions. These increases in peak discharge resulting from urbanization, if not controlled, will tend to cause enlargement of the stream channel.



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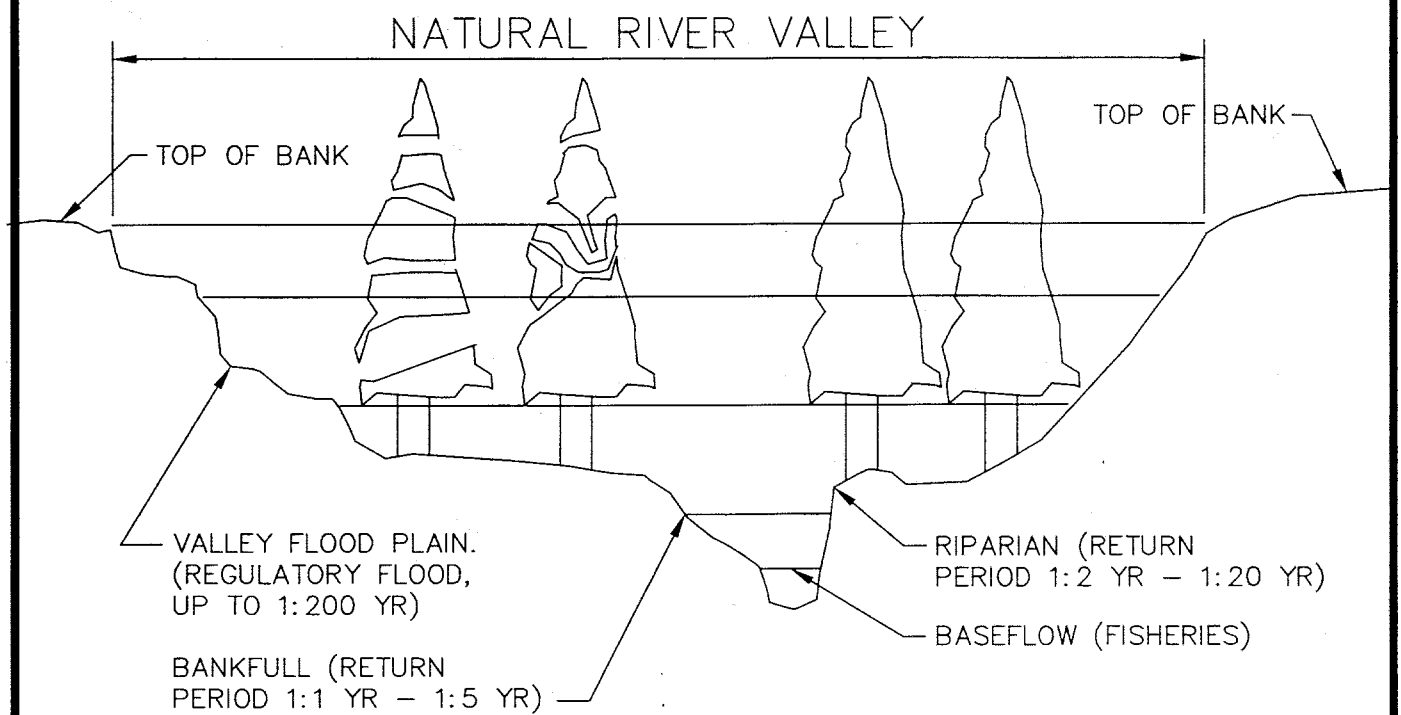
1		Title TYPICAL MAJOR/MINOR SYSTEM
	Revision Date Approved	

SURREY
CITY OF PARKS

Approved		DRAWING NUMBER
Date	AUGUST 1998	FIGURE 5.5
Drawn By	Surrey Engineering	



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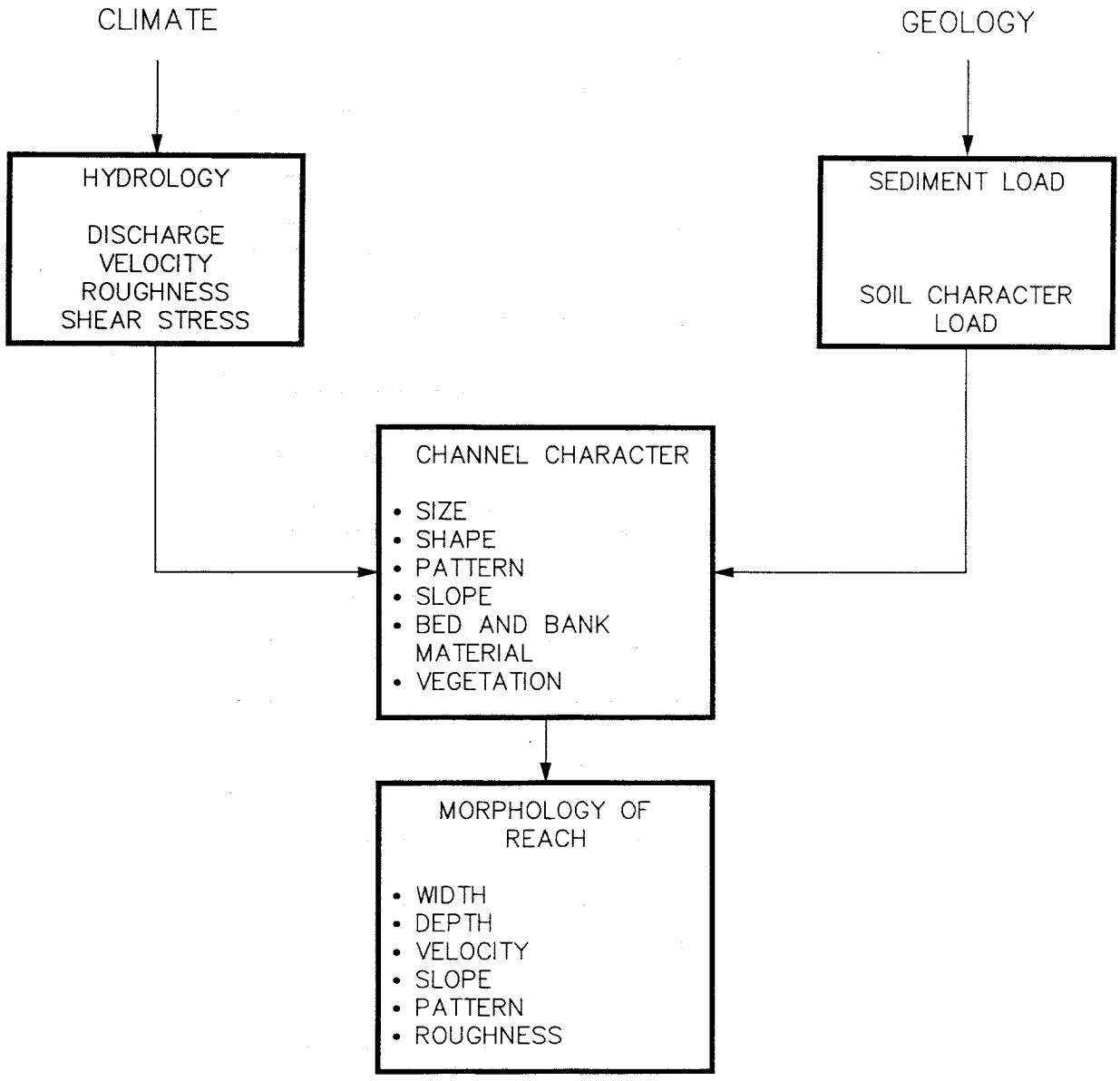
	Revision Date	Approved

Title: FOUR MAJOR DESIGN STAGES FOR NATURAL CHANNEL / VALLEY MANAGMENT

SURREY
CITY OF PARKS

Approved	
Date	AUGUST 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
FIGURE 5.6



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Title FACTORS CONTROLLING CHANNEL MORPHOLOGY

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CITY OF PARKS

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Date	AUGUST 1998
Drawn By	Surrey Engineering

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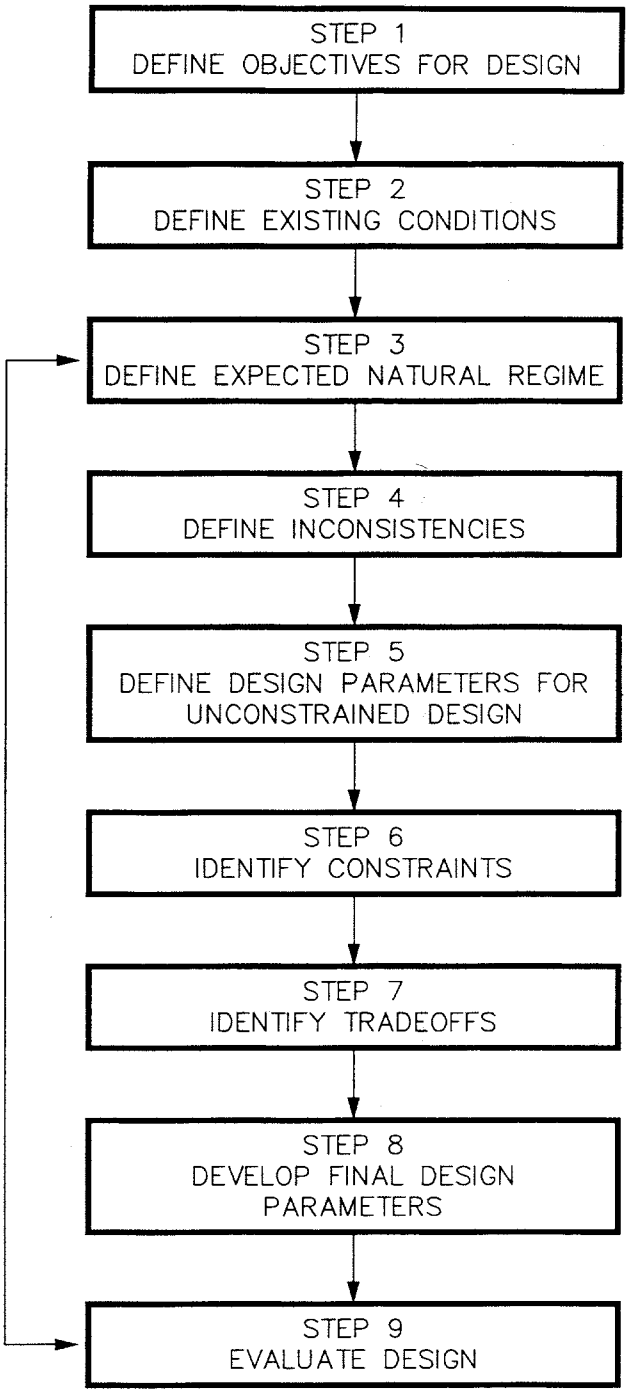
FIGURE 5.7



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1		Title NINE (9) DESIGN STEPS
	Revision Date Approved	

SURREY
CITY OF PARKS

Approved		DRAWING NUMBER
Date	AUGUST 1998	FIGURE 5.8
Drawn By	Surrey Engineering	

The control and reduction of peak flows through stormwater management within the development results in a more economical overall drainage servicing system by lessening the protection work needed to manage the downstream flooding, erosion, and sedimentation. This approach would have some benefit by managing the stream bank erosion rate at its natural geological level, and therefore, a significant benefit to water quality. However, in some cases, the increased duration of these controlled flows due to the increased volume of runoff generated after development may speed up the natural erosion regime. Where erosion appears to be a significant factor, further reduction of runoff rates through other on-site and off-site measures such as BMP's, diversions, storages, as well as protection of the critical erosion sites should be considered and incorporated into the overall drainage servicing scheme.

The development process results in initial increases in silt and gravel loading of creek flows. Contributions from construction sites and due to changes in flow, will initially increase this loading. However, with adequate care and protection, watercourses stabilize over a period of time as geometric changes in the channel adjust to accommodate the new flows.

The Designer must consider the impact of these changes and provide specific on-site/off-site measures to protect the watercourse and receiving waters during this transition period.

(d) Minimum Watercourse Protection Approach

The need for protection of watercourses should be minimized through the implementation of the stormwater management guidelines on a site specific and community basis within the developing watershed.

Where the Designer has identified the need to provide protection to a watercourse, the integrated requirements for fisheries and for drainage must be evaluated.

Provision of erosion protection at adequate locations can minimize additional impacts on watercourses which are caused by construction in the stream bed. Proposed erosion protection shall be evaluated by comparing the benefits and impacts on the watercourse. This evaluation is to be submitted to the Engineer and the Ministry of Environment for comment.

(e) Master Plans and Land Use Controls

Designs for watercourses must conform to the Planning Process framework in Subsection 5.2. Designs must conform with the findings and recommendations of the various design studies and reports, including the

applicable Neighbourhood Concept Plan (NCP), Master Drainage Plan (MDP), and the Environmental Impact Assessments (EIA). In all cases, including those for which specific background information as above is not available, the designer must initially confirm with the Engineer the design requirements and develop the design solutions to ensure that latest relevant data and information are used for the required analytical work.

(f) Government Agency Requirements

The following publications provide general guidelines to be applied to fisheries streams; but in all cases, the specific requirements of the Environmental Agency having jurisdiction under various federal and provincial statutes shall govern. This requires that the designer should consider the latest version of the applicable guidelines enacted as part of the Fisheries Act, Water Act, and other Federal/Provincial Statutes, as well as City's policies and bylaws.

For more information on silt/sediment control measures, refer to the current versions/updates of: The Land Development Guidelines for the Protection of Aquatic Habitat published by Ministry of Environment and the Department of Fisheries and Oceans Canada 1992; and, the June 1992 Urban Runoff Quality Control Guidelines for the Province of British Columbia; the September 1994 Stream Stewardship: A Guide for Planners and Developers; the 1996 Greenway Implementation Plan for B.C.

All designs of proposed works in natural watercourses shall be submitted by the Designer to the Water Rights Branch of the Ministry of Environment for approval. This agency will forward the application to other concerned agencies for comment prior to issuing approval. With time, this submission process/procedure may be revised and it is the Designer's responsibility to confirm to the current requirements.

(g) Stakeholder Stewardship

Designs must recognize the dual function of watercourses, and both protect the ecological resource values of the system while accommodating storm runoff. Development must recognize the multiple jurisdiction involved of Senior Government agencies, the property owners, as well as the municipality outlined in the September 1994 Stream Stewardship, A Guideline for Planners and Developers, (or its latest update).

(h) System Characteristics and Constraints

Detailed site specific surveys, investigations, analysis and design are required to fully and properly assess and evaluate watercourse constraints and

functional characteristics for a full range of issues such as flow conditions, top-of-bank definition, bed and bank protection, habitat protection, etc.

(i) Maintenance and Operation

Detailed watercourse designs must address, in addition to the hydraulic and structural demands for safe storm drainage conveyance, all requirements to maintain and operate the system to the required service levels.
These include provision for:

- Appropriate physical access.
- Maintenance and Monitoring.
- Public Safety.

C. Sustaining the Natural Resource

(a) Aquatic Habitat Protection

In addition to accommodating storm drainage minor and major system conveyance requirements, all watercourse designs shall meet the requirements of Department of Fisheries and Oceans (DFO) and Ministry of Environment, Lands and Parks (MOE,LP) for fish sensitive streams. See Subsection 5.7 B.

The City of Surrey's Engineering Department Map "Fisheries Watercourses Classification" provides known information which is to be verified by site specific studies where required by DFO.

(b) Greenways, Wetlands, Vegetation, and Wildlife

Communities are placing an increasingly higher value on parks and natural areas. Where site conditions allow, natural drainage systems should be used incorporating wetlands to support the trend toward sustainable communities. Existing natural watercourse systems must be integrated into communities to form part of a comprehensive and continuous regional open space system.

The level of environmental protection within a watercourse will be defined by the findings of the environmental studies coordinated by the City's Planning Department. These, as well as the requirements of government agencies for leave strips and setbacks should be integrated into the drainage designs as complementary components. The complete ravine system, including top-of-bank setbacks must be considered to be part of the natural stream's environmental reserve.

(c) Development Setbacks and Top-of-Bank Limits

Where the watercourses are relatively flat, the normal low flow channel meanders within a wider floodplain contained within the top-of-banks. The floodplain is an integral part of the watercourse, as it conveys large and infrequent floods.

Where watercourses traverse steep terrain, they often form well entrenched gullies or ravines. This downcutting is natural and continuous as the watercourse ravine is in a transitional state of dynamic change in response to the hydrologic cycle's seasonal impacts.

Development and building setbacks are required to all ravines to permit continuation of the natural erosion process as well as protect people/property from the impacts of such ongoing morphological adjustments between the top-of-banks. Therefore, no development-related encroachments to the top-of-banks should be permitted in view of the increased hazards and the breach of applicable statutes, as well as the potential interference with the ongoing geological changes natural to the watercourse within its top-of-bank limits and all along its length, see Figure 5.6.

D. Open Conduit Drainage Design Approach

Use of open conduits as part of the drainage system has significant advantages in regard to cost, capacity, multiple use for recreational and aesthetic purposes, and potential for transitory detention storage. Disadvantages include right-of-way needs and maintenance costs. Careful planning and design are needed to minimize the disadvantages and to increase the benefits.

The ideal open conduit is a natural channel carved by changing flow over a long period of time. The benefits of such a channel are that:

(a) Velocities are usually low, resulting in longer travel times and lower downstream peak flows.
(b) Channel storage tends to decrease peak flows.
(c) Maintenance needs are usually low because the channel is somewhat stabilized.
(d) The channel provides a desirable green belt and recreational area adding significant societal benefits.

The closer an artificial channel character can be made to that of a natural channel generally the better will be its long term value to the eco-system.

(a) Open Conduit Classification

Open conduit classification must recognize property ownership, the jurisdiction of government agencies as defined in the Fisheries Watercourse

Classification map, as well as the function and hierarchy within the Drainage System.

While the storm sewer system, which is a closed conduit system, is classified as a hierarchy of pipes from service connections, lateral sewers, collector sewers, trunk sewers (> 20 ha) to oversized trunk sewers, the open conduit system will extend from graded lots and swales on private property to roadways, man-made as well as natural ditches, canals, creeks, watercourses, and rivers, as classified below.

It is noted that **man-made** open conduit drainage works are those that have been historically constructed by the people to manage surface drainage using various open conduit and other special components. The terms **upland** and **lowland** are used in the context of the differentiation between land directly affected by the tidal conditions and the flood freshets; **lowlands** are directly affected and the **uplands** are not.

A. The **man-made** open drainage systems include the following three categories:
A.1 Roadways and Ditches
A.2 Canals
A.3 Culverts, Pumping Stations, and Special Structures

B. **Upland natural** open drainage includes the following hierarchical categories:
B.1 Natural drainage swales (servicing area ≤ 20 ha)
B.2 Natural drainage channels (intermittent flow drainage > 20 ha)
B.3 Creeks and streams with perennial flow including base flows

C. **Lowland natural** open drainage system includes the following categories:
C.1 Natural Ditches
C.2 Creeks and streams with base flows
C.3 Rivers (potentially navigable waters)

In general, the terminology “watercourse” and “stream” are used interchangeably.

The maintenance of conveyance related right-of-way requirements without significant changes to the operating depths must be recognized as a major criterion in the protection of open conduit flood paths, when designing all crossing and channelling structures.

In addition to the above general classification of open conduits in terms of their locations, functions, and hierarchy within the drainage system, it is also

important that they be classified in terms of their morphology to develop an understanding of their state of geological condition and the structural stability. Reference can be made to the Rosgen classification system or Stream Corridor Restoration Principles, Practices and Processes (http://www.usda.gov/stream_restoration).

(b) Overall Design Principles and Methodology

The table below summarizes the various analyses to be undertaken as part of the process of designing a natural channel.

Natural Channel Design Analysis

PURPOSE	ANALYSIS	CRITERIA	METHOD
Hydrology	Estimate flows	Regulatory Riparian Bank Full Low Flows (Base Flows)	Local data Regional data Model analysis
Stream hydraulics	Estimate velocities, forces, timing	Erosion, fish habitat	Estimate energy and water surface profile
Channel geometry	Relate channel and flow conditions	Width, depth, slope, substrate	Field data and hydraulic analysis
Fish habitat	Identify existing and future habitat conditions	Depth, velocity, sediment, water quality	Relate hydrology, hydraulic, and channel geometry with fish habitat requirement

E. Overview of Design Parameters

The geometric stability of a natural drainage channel is a complex issue as it depends on the magnitude of the fluvial hydraulic forces generated by a dynamic, interactive process involving a number of hydrologic, hydraulic and morphologic variables. Therefore, a natural channel must be carefully studied to determine what cost effective measures are needed so as to control future bottom scour and bank undercutting and preserve the natural appearance while functioning properly.

The choices of channels available to the designer are many, depending upon good hydraulic practice, environmental design, sociological impact, and basic project requirements. However, from a practical standpoint, the basic choice to be made initially is whether or not the channel is to be a lined one for higher velocities, a grassed channel, or a natural channel already existing.

The choice must be made upon a variety of multi-disciplinary factors and complex considerations which include:

Hydraulic

- watercourses slope, topography, and surface soils.
- right-of-way and capacity needed.
- ability to drain adjacent lands.
- basin sediment yield.

Structural

- creek geomorphology.
- costs.
- availability of materials.
- habitat requirements.

Environmental

- city policies.
- senior government agency requirements for habitat sustainability.
- neighbourhood character and aesthetic requirements.
- need for new green areas.

Sociological

- community social patterns.
- community children safety.
- land ownership.
- pedestrian traffic.

The Designer must consider all the various forces and hazards including:

- curvature impacts.
- changes in cross-sections (transition losses).
- hydrostatic forces.
- free board (0.6 m).
- backwater effects.
- hydraulic jumps.
- free-draining underdrains.
- roughness coefficients / finished surfaces etc., and any special local factors.

Uniform flow for a given channel condition of roughness, discharge and slope, there is only one possible depth for maintaining a uniform flow. This depth is the normal depth. When roughness, depth and slope are known at a channel section, there can be only one discharge for maintaining a uniform flow through the section. This discharge is the normal discharge.

The Manning Formula (metric) is used to compute the normal depth, under free flow (non-surcharged) conditions.

$$Q = \frac{A\ R^{2/3}\ S_o^{1/2}}{n}$$

Where	Q	=	discharge in m^3/s
	n	=	roughness coefficient (Table 5.7.2)
	A	=	area in square metres
	R	=	hydraulic radius, A/P
	P	=	wetted perimeter, m
	S_0	=	channel bottom slope of hydraulic grade line in m/m
			(normally it is the slope of channel bottom)

The investigation details necessary to ensure that the natural channel will be adequately protected from erosion and habitat degradation will be different for every watercourse; however, the Designer will generally find it necessary to prepare cross-sections of the channel for the major design runoff, to investigate the bed and bank material as to the particle size classification and to generally study the stability of the channel under future conditions to flow. It is called to the Designer's attention that supercritical flow often does exist in steep, natural channels (> ± 4.0%) and frequent checks should be made during the course of the backwater computations to identify if the computations do not reflect supercritical flow conditions.

If it is necessary to provide subcritical flow under design flows, it may be necessary to construct drops or erosion cut-off check structures at regular intervals. However, these channels should be left in as near a natural condition as possible, and for that reason extensive modifications should not be undertaken unless they are found to be necessary to avoid excessive erosion with subsequent deposition downstream.

The usual design criteria for artificial open channels do not apply to natural channels, but such criteria can be used to advantage in gauging the adequacy of a natural channel for projected future changes in runoff regime.

Utilization of natural channels requires that primary attention be given to both erosive tendencies and carrying capacity adequacy. The floodplain of the waterway must be defined so that adequate zoning can take place to protect the waterway from encroachment and maintain both its flow capacity for extreme hydrologic conditions and the storage potential in perpetuity. The use of natural channels is encouraged because of the low maintenance cost and social benefits available.

Design criteria and techniques which should be used as guidelines include the following points:

Channel and overbank capacity adequate for 100-year runoff, with an additional freeboard of 0.6 m.

Velocities in natural channels do not exceed critical velocity for a particular section (which is only rarely more than 2 m/s dependent upon watercourse geomorphology, channel bottom composition and vegetative cover).

Define water surface limits so that floodplain can be defined along with top-of-bank limits.

Filling of the flood fringe reduces valuable storage capacity and tends to increase downstream runoff peaks. Filling should be discouraged in all urban waterways where hydrographs tend to rise and fall sharply.

Use roughness factors (n) which are representative of unmaintained channel conditions (recognizing the varying seasonal conditions).

Construct drops or erosion cut-off check structures to control water surface profile slope, particularly for the initial storm runoff.

Prepare plans and profiles of floodplain. Make appropriate allowances for future bridges which will raise the water surface profile and cause the floodplain to be extended.

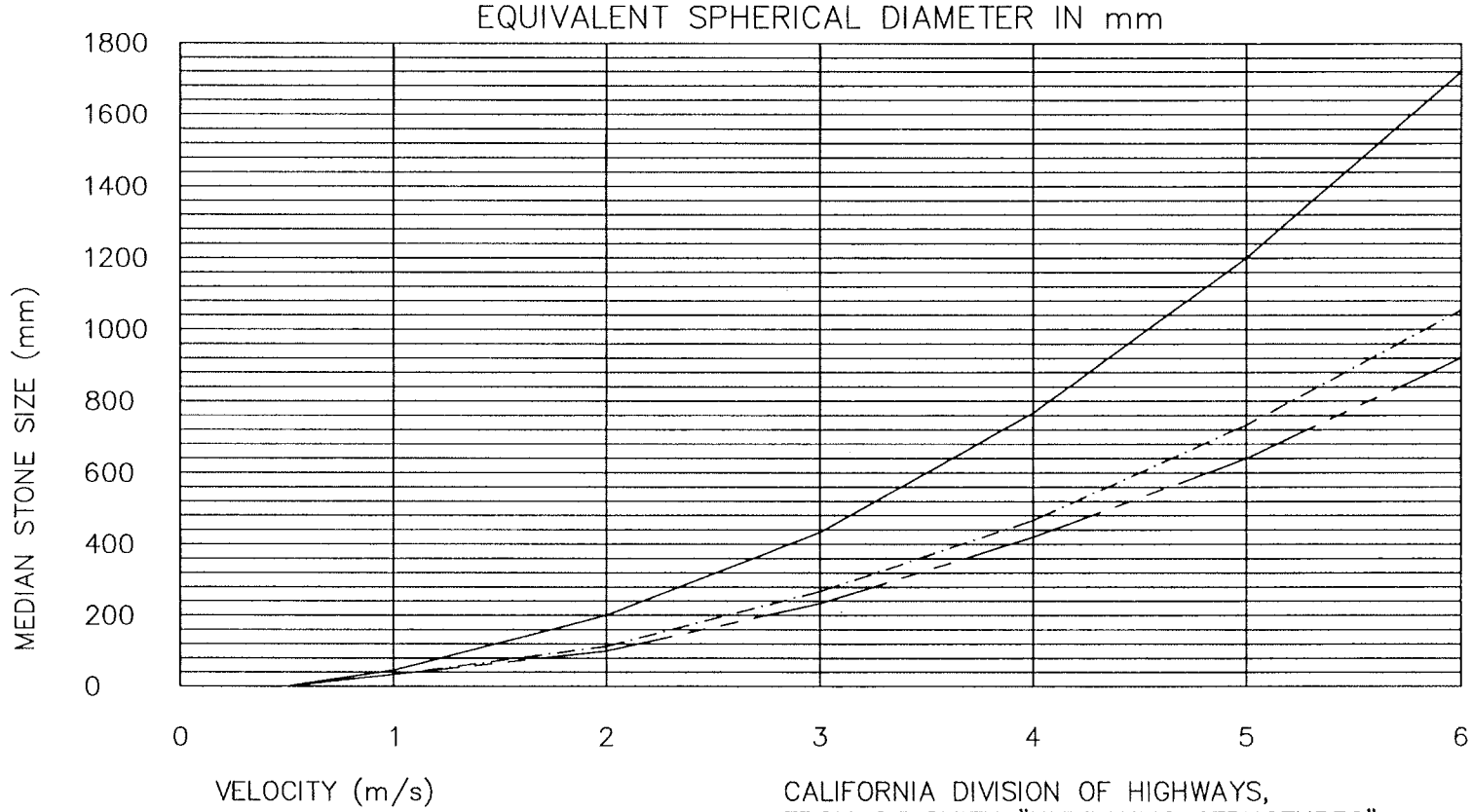
Where creek bed gravels are inadequately sized to provide watercourse bed and bank protection in areas of existing erosion use rock armouring to increase flow resistance in accordance with Figure 5.9. Depths and cross-sectional requirements to conform to MOE,LP standards.

Grade control structures may be allowed in the watercourse. The maximum rise permitted for the structure is 0.6 m with 0.3 m being the optimum. A lined pool, below the jump or rise, for a minimum length of 1.5 times the jump height must be provided.

The following is a list of key design parameters and brief descriptions:

(a) Preliminary Design Criteria

Particularly useful in preliminary design and layout work. Any final design which has parameters which vary significantly from those below should be carefully reviewed for adequacy.



CALIFORNIA DIVISION OF HIGHWAYS,
FROM C.D.SMITH "HYDRAULIC STRUCTURES"
UNIVERSITY OF SASKATCHEWAN 1985.

LEGEND:

——————— 1:1 SIDE SLOPE

-·-·-·-·-·-·- 1:2 SIDE SLOPE

—— – – —— 1:3 SIDE SLOPE

H:\PROJECTS\ PLOT SCALE \02A\

All Dimensions Shown In Millimetres, Unless Otherwise Noted		
3		
2		
1		
	Revision Date	Approved

SURREY
CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Title	MEDIAN STONE SIZE FOR BANK PROTECTION
Approved	
Date	FEBRUARY 2002
Drawn By	Surrey Engineering

DRAWING NUMBER
FIGURE 5.9

(b) Critical Flow

Critical Flow in an open channel or a covered conduit with a free water surface characterized by several conditions which are:

- The specific energy is a minimum for a given discharge.
- The discharge is a maximum for a given specific energy.
- The specific force is a minimum for a given discharge.
- The Froude number is equal to 1.0.

If the critical state of flow exists throughout an entire reach, the channel flow is critical flow and the channel slope is at critical slope (Sc). A slope less than Sc will cause subcritical flow. A slope greater than Sc will cause supercritical flow. A flow at or near the critical state is not stable. In the design, if the depth is found to be at or near critical, the shape or slope should be changed, if practical, to achieve greater hydraulic stability with uniform flow.

(c) Design Velocity

Maximum for major design storm runoff needs to recognize the scour potential of the soil-vegetative cover complex. Average velocities need to be determined using backwater calculations which accounts for drops, expansions, contractions, and other structural controls. Velocities need to be kept sufficiently low to prevent excessive erosion in the channel. The velocities of about 1.0 m/s are generally recommended as maximums for major storm runoff flow in natural channels with vegetative cover and 2.0 m/s with bed materials greater than 100 mm. Higher velocities (i.e., over 3.0 m/s) may require bank protection measures dependent on the creek bed composition.

(d) Design Depths

Maximums of flow should also recognize the scour potential of the soil-vegetative cover complex. Scouring power of water increases in proportion to a third to fifth power of depth and is also a function of the length of time flow is occurring. As preliminary criteria and design depth of flow for the major storm runoff flow should not exceed 1.5 metres in areas of the cross-section outside the low flow channel area.

(e) Design Slopes

Grass lined channels, to function well, normally have slopes of from 0.2 to 0.6 percent. Where the natural topography is steeper than desirable, (>3%) drops should be considered.

(f) Curvature

The less sharp curves, the better the channel functioning will be. In general, centerline curves should not have a radius of less than about twice the design flow top width, but not less than 30 metres.

(g) Design Discharge Freeboard

Bridge deck bottoms and sanitary sewers often control the freeboard along the channel banks in urban area. Where they do not, the allowance for freeboard should be based upon the conditions adjacent to the channel. For instance, localized overflow in certain area may be desirable because of ponding benefits. In general, a minimum freeboard of 600 mm should be allowed.

(h) Channel Cross Sections

The Channel shape may be almost any type suitable to the location and the environmental conditions. Often the shape can be chosen to suit open space and recreational needs to crease additional sociological benefits.

However, limitations within which design must fall for the major storm design flow include:

- Side Slopes: The flatter the side slope, the better. 4:1 is a normal maximum slope: however, local standards or conditions may require flatter side slopes. Under special conditions where development exists and right-of-way is a problem, the slopes may be as steep as 3:1 which is also the maximum limit for mowing equipment.
- Depth: The maximum normal design depth should not exceed 1.5 metres.
- Bottom Width: The bottom width should be designed to satisfy the hydraulic capacity of the cross-section recognizing the limitations on velocity and depth.
- Low Flow: Natural low flow channels or underdrain pipes are desirable on all urban grassed channels.

(i) Roughness Coefficients

The hydraulic roughness of man-made grass lined channels depends on the length of cutting, if any, and the type of grass, as well as the depth of flow. Care must be exercised in operation and maintenance in periods following completion of construction, and before the grass stand has matured. While a Manning's friction factor (n) of 0.070 might be chosen for lower flows, before the grass is up, the effective **'n'** may be as low as 0.025. A runoff during this period would have higher velocities and erosion will result.

(j) Low Flow Channels

The low flows, and sometimes base flows, from urban areas must be given specific attention. Waterways which are normally dry prior to urbanization will often have a continuous base flow after urbanization because of lawn irrigation return flow, both overland and from ground water in-flow. Continuous flow over grass will destroy a grass stand and may cause the channel profile to degrade.

Low flows must be carried in low flow channel or ditch. A low flow channel capacity should be approximately 0.5 to 1.0 percent of the major design flow. If an underdrain pipe is used it should be at least 600 mm in diameter, be provided with access manholes and be sloped so that a velocity of at least 1 metre per second is maintained at 1/2 full pipe depth.

A low flow channel is subject to erosion and must therefore be amply protected with appropriate erosion control devices. To prevent erosion, silting and excessive plant growth, concrete lined trickle channels are often preferred in urban areas.

(k) Erosion Control

Natural channels are erodable to some degree. Practice has shown that to design a grassed or natural channel completely protected from erosion is uneconomical and costly. It is far better to provide reasonable erosion-free design with plans in place to take additional erosion control measures and corrective steps after the first year of operation. However, the use of erosion control cut-off walls at regular intervals in a grassed or natural channel is desirable. Such cut-off walls will safeguard a channel from serious erosion in case of a large runoff prior to the vegetation developing a good root system. Such cut-off walls are also useful in defining and containing the low flow channel.

Erosion control cut-off walls are usually of precast concrete, approximately 200 mm inches thick and from 450 mm to 1 metre deep, extending across the entire bottom of the channel. They can be shaped to fit a slightly sloped bottom to help direct water to the low flow trickle channel or to an inlet.

In maintaining the appropriate channel slope, the Designer may find it necessary to use frequent drops. Erosion tends to occur at the edges and immediately upstream and downstream of a drop even though it may be only 150-450 mm high. Proper use of riprap and gabions at these drops is necessary.

(l) Water Surface Profile

A water surface profile must be computed for all channels and clearly shown on the final drawings. Computation of the water surface profile should utilize standard backwater methods, taking into consideration all losses due to changes in velocity, drops, bridged openings, and other obstructions. Computations begin at a known point and extend in an upstream direction for subcritical flow. It is for this reason that the channel should be designed from a downstream direction to an upstream direction. It is necessary to show the energy gradient on all preliminary drawings to help insure against errors.

This work can be conducted using a state-of-the-art computer programs such as HEC-2 or HEC-RAS, developed by the U.S. Army Corps of Engineers and are versatile programs widely used for backwater calculations. They are based on the Standard Step Method as outlined below.

The standard step method computes the change in water depth given a fixed change in position along the channel. This is necessary where channels are non-prismatic and thus defined by selections at fixed positions. The procedure involves the following general steps.

- For the given flow rate, compute the velocity head and friction slope at the section where the water surface profile is known.
- Estimate a water surface elevation at the next section along the channel and compute the friction slope and velocity head.
- Compute the energy loss through the reach and substitute the computed values in the energy equation.
- If the estimated value of upstream depth does not result in the energy equation being satisfied, a new trial depth is assumed and the process is repeated until the equation is satisfied.

This type of analysis is very tedious if it is carried out manually, particularly if the channel sections are irregular and defined by a large number of coordinates. Consequently, the calculations are most often carried out using computers.

In summary, these programs will compute subcritical or supercritical profiles using the standard step method. The input consists of flow rates, channel cross sections, Manning's roughness coefficients (which can vary with depth or distance across the floodplain) and distance between cross sections. Geometry describing culverts and bridges can also be entered so that head loss through these types of structures can be computed. Floodplains can be accounted for by subdividing the cross-section into a left floodplain, main flow channel and right floodplain each with a distinct Manning's roughness coefficient. The

effects of channel improvements and encroachments on the floodplain can also be quickly analyzed.

The use of this or other similar programs is recommended when extensive backwater calculations are required to analyze existing channel systems, or to perform checks or new designs. This program is available through commercial computer service centres, university computing centres and/or government agencies. Other programs for similar types of analyses may also be available from these sources.

F. Erosion Protection Measures

The implementation of stormwater management policies is expected to control the post-development flows to the level of the pre-development flow rates. The resulting flows will tend to be of longer duration than the pre-development flows but may still cause increased erosion due to the slope and geomorphological characteristics of the watercourse and the resulting flow durations and velocities.

Bank protection must be considered along existing and new watercourses to provide adequate erosion control. Sections with materials which are not able to withstand the erosive force of the design flows should be provided with additional protection. This protection can take the form of bank armouring, soil stabilization, flow deflection or other methods applicable to each project on a site specific basis. Some key optional measures are summarized below:

(a) Grass Lined and Natural Channels

These may be considered to be the most desirable artificial channels. The channel storage, the lower velocities, and the sociological benefits obtainable create significant advantages over other types. The design must give full consideration to aesthetics, to sediment deposit, and to scour, as well as hydraulics as natural channels are most suitable for flatter gradients of less than 2%.

(b) Concrete Lined Channels

Concrete lined channels should only be provided where there are topographic, hydraulic and right-of-way needs and no over-riding fisheries habitat and environmental requirements exist - i.e., for a special surplus flow bypass, which would exceed the use of a normal storm sewer conduit; and requires high velocity, supercritical flow.

(c) Riprap Slope Protection

The resistance to the flowing current in the vicinity of the banks is proportional to the flow velocity and is a fraction or multiple of the average velocity in the channel. Restrictions and bends can increase the localized velocities by 30% or more while along straight sections of the bank, velocities can be 2/3 to 3/4 of the mean velocity. Areas that will require special attention include the inside bank at the start of a bend, the outside bank at the end of a bend, and the nose of projections where the velocities can be increased.

The size of stone riprap required to stabilize an erodable bank depends on the adjacent velocity, the flow pattern and the steepness of the bank. Drawing SSD-D.16 shows the relation between the velocity of flow and the mean rock diameter as determined by the California Highways Department.

Drawing SSD-D.16 can be used as a guide for riprap selection but additional factors including stone density, grading, shape, and placement must also be considered. Smaller channels may require larger stone to protect from localized flow concentrations.

The design of stone riprap needs to consider the scour of underlying materials. The use of granular material or geotextiles shall provide a suitable barrier to prevent the migration of finer materials caused by either the flow in the main channel or by flows from the channel banks due to seepage.

Riprap thickness should be not less than 1.5 times the mean stone diameter. The selection of riprap or gabion structures may be affected by fisheries requirements and should be considered carefully prior to design, see Drawing SSD-D.16.

Alternate methods of bank protection will include solutions which provide increased soil cohesion such as bio-engineering, as discussed below.

(d) Bio-Engineering

Bio-engineering methods of bank protection should be considered for the protection and stabilization of watercourses as both economical and aesthetic solutions.

Bio-engineering solutions use live plants and vegetative matter to provide banks lining and cohesion of bank materials to resist scour. As demonstrated by the natural riparian vegetative cover in creeks and watercourses, live plant root system provide cohesion to soil particles as well as flexible erosion resistant material. Vegetative matter placed on the banks provide erosion control and fine material accumulation.

Vegetative matter will require anchoring to prevent the loss of material. The use of vegetative matter for bank protection should be designed to promote sedimentation for long term protection. Recommended references include the following:

Johnson, A.W. and J.M. Stipula, 1993, Guidelines for Bank Stabilization Project in the Riverine Environments of King County, King County, Washington, King County Surface Water Management Division, Seattle, WA.

Gray, D.H. and A.T. Leiser, 1982, Biotechnical Slope Protection and Erosion Control, Van Norstand Reinholt Company N.Y., N.Y.

Gray, D.H. and R.B. Sottir, 1996, Biotechnical and Bioengineering Slope Stabilization: A practical guide for erosion guide, John Wiley and Sons, N.Y.

Schiechtl, H.M. and R. Stern, 1997, Water Bioengineering Techniques for Water Course Bank and Shoreline Protection, Blackwell Science, Great Britain.

Coppin, N.J. and I.G. Richards, 1990, Use of Vegetation in Civil Engineering, Butterworths, London, England.

G. Bridges, Culverts And Other Hydraulic Structures

Hydraulic structures are used in storm runoff drainage works to control water. Flowing water does not readily change direction, accelerate, or slow down without help, and water will flow faster than it should if watercourse is too steep, causing uncontrolled erosion.

Hydraulic structures increase the cost of drainage facilities, and their use should be limited by careful and thorough hydraulic engineering practices to those location and functions justified by prudent planning.

On the other hand, use of hydraulic structures can reduce initial and future maintenance costs by changing the character of the flow to fit the project needs, and by reducing the size and cost of related facilities.

Hydraulic structures include energy dissipaters, channel drops or checks, bridges, culvert baffle chutes, and many other specific drainage works. Their shape, size and other features vary widely from job to job, depending upon the function to be served. Detailed hydraulic design procedures, and sometimes physical model testing must govern the final design of all hydraulic structures.

(a) Energy Dissipaters

Energy dissipaters are often necessary at the end of outfall sewers or channels. Stilling basins, a type of energy dissipater, are useful at locations where the Designer wants to convert super-critical flow to subcritical flow to permit placid water in a pool area downstream from a high velocity channel.

(b) Drops

The use of drops is a convenient and economical way to reduce the effective slope of a natural or artificial channel. In general, the vertical height of the drop should be kept minimal so as to reduce erosion and turbulence problems. With natural channels, the use of check dams is often preferable. Similar principles are involved as with drops. Drops must accommodate the fish passage requirements and if necessary provide fish ladders.

(c) Bridges

The use of bridges provides for the crossing of the channel with a roadway, as against a culvert, which permits a channel to cross under a roadway. Bridges should not unduly restrict or adversely affect the flow character of the channel. Adequate hydraulic opening area should be allowed.

(d) Acceleration Chutes

Acceleration chutes can be used to maximize the use of limited downstream right-of-way, and to reduce downstream channel and pipe costs. Chutes should, of course, be used only where good environmental design concepts permit the use of high velocity flow. Generally, in urban drainage design, open channels should have slow flow.

(e) Baffle Chutes

Baffle chutes can be utilized to lower the energy gradeline, as well as the energy gradient, in an orderly fashion. Baffle chutes are particularly useful where side channel ponding areas exist for temporary detention of storm runoff water. Baffle chutes are a form of energy dissipater.

(f) Drainage Pump Stations

Detailed criteria and specific requirements for drainage pump station facilities should be obtained from, and reviewed with the Engineer, prior to design of the facilities. Good Engineering design practice shall be used in the design of drainage pump stations. It is recommended that the Designer refer to the City of Surrey's - *Guideline for the Design & Construction of Drainage Pump Stations*.

Prior to commencing detailed design of a pump station facility, the Designer shall confirm the design catchment areas, design flows and the proposed location of the pump station facility with the Engineer. The Designer shall submit a pre-design report that addresses the requirements given in this Design Criteria Manual and the *Guideline for the Design & Construction of Drainage Pump Stations* for approval by the Engineer, prior to commencing detailed design.

H. Lowland Drainage

Flooding and poor drainage are the two main issues associated with the Serpentine-Nicomekl lowlands in Surrey. Flooding results from the conveyance and discharge limitations of the two rivers due to tidal impacts and runoff from the total contributing watersheds

The drainage objectives and level of service set for these areas are connected with the Agri-food Regional Development Subsidiary Agreement (ARDSA) program, set a few decades ago. On the basis of these and the latest engineering evaluation of the lowland drainage servicing needs, the following agricultural land flood control criteria (ARDSA criteria) is developed:

The ARDSA criteria are as follows:

In the growing season (March 1 to October 31), flooding should be restricted to a maximum of 2 days in duration in the 10-year, 2-day storm.

In the remainder of the year (November 1 to February 28), flooding should be restricted to a maximum of 5 days in duration in the 10 –year, 5-day storm.

Between storms, and in periods when drainage is required, the base flow level in ditches should be maintained at 1.2 m below ground level to provide a free outlet for drains.

The drainage improvement work will require the review and acceptance by the City's Engineer in relation to the implementation of the Serpentine-Nicomekl lowland flood control project.

In addition to the above agricultural land flood control criteria for the Serpentine-Nicomekl lowlands, the regulatory floodplain for the four river basins is delineated for the 200-year flood by the Ministry of Environment, Lands and Parks. Filling and/or development within the flood line are allowed only after review by the City and the Ministry.

Appendix

APPENDIX

A.1 Surrey Drainage Policy

A.1 SCOPE

This Appendix summarizes the drainage needs of the City, objectives of the drainage management effort and the currently approved drainage policy. The drainage criteria and standards that follow thereafter are the guidelines for developing and sizing the servicing infrastructure which will meet the intent of those objectives and the drainage policy.

A.2 SURREY'S STORMWATER DRAINAGE SYSTEM

Drawing No. SSD-D.2 shows the City's main drainage basins comprising the uplands and the lowlands. Generally the upland area is being urbanized while the lowland is within the designated Agricultural Land Reserve (ALR). These lands are drained out by four rivers: Serpentine, Nicomekl, Campbell, and Fraser, through a network of natural watercourses (i.e., rivers, creeks, and ditches) and storm sewers. These watercourses are not only the drainage routes but are the habitats supporting aquatic life such as various species of indigenous pacific salmon. The upland drainage system operates as a gravity controlled open channel system; however, the lowland drainage system operation is impacted by the diurnal tides and the extended wet weather during the winter season (October to April).

These diverse meteorological, hydrological, topographical and eco-system characteristics of the City's watershed and the watercourses have created a complex environment with divergent rainfall-runoff impact control needs. It poses many challenges to developing and managing a viable drainage servicing scheme for the City, as mandated by the Municipal Government Act.

A.3 OBJECTIVES

- Maintain performance capacity and condition integrity of the existing drainage system.
- Obtain public and stakeholder consultation and early feedback on related issues.
- Provide adequate servicing infrastructure to all newly developing areas and minimize downstream adverse impacts.
- Adopt a financially stable long-term capital, operation, and maintenance program for drainage needs.
- Protect the physical integrity of watercourse / creeks, their banks and floodplains.
- Control the sediment loadings and erosion potential resulting from clearing of land for development and other construction activity.
- Minimize detrimental impact on aquatic life and wildlife habitats along watercourses.

- Manage the low land area drainage by controlling flooding levels within reasonable economic limits and cost benefit.
- Minimize the potential for water quality impairment resulting from land development in the watersheds.

A.4 POLICY

A.4.1 Policy Summary

In order to address the City's drainage goals and objectives as well as the needs of environmental sustainability, the City has adopted the following policies:

Preservation and Protection of Watercourses

1. Surrey will utilize stormwater management methods to limit peak flow discharges to natural creeks. The methods of control are determined by the Master Drainage Plans.

   Surrey will work with the development community and environmental agencies to gain public ownership of creek lands as areas develop.

   Surrey will combine in-stream fish enhancement works with erosion control works to limit the impact of urban development where approved by the senior government environmental agencies.

   Surrey will carry out groundwater studies in conjunction with Master Drainage Plans where baseflows to streams is critical for fishery habitat.

2. Sediment Discharges from Construction Related Activities in Surrey's Watersheds.

   Surrey will enforce as much as possible, the silt discharge guidelines set by the Ministry of Environment, Lands and Parks and require Developers to meet those standards.

3. Water Quality of Stormwater Runoff

   This is an emerging issue still undergoing review in many jurisdictions. This issue will be reviewed to bring the City in line with the current state of practice appropriate for conditions prevalent in Surrey.

   Surrey will participate in the GVRD Liquid Waste Management Plan to set requirements for the quality of stormwater discharges to the environment.

4. Protection of Property

   Surrey will collect flow monitoring data to calibrate hydrology models to determine 'pre-development' flow rates in streams.

   Surrey will require habitable building levels to be above the estimated 100-year flood elevation except in floodplains regulated by the Ministry of Environment where the Ministry standards will apply.

5. Lowland Drainage and Flood Control

   A lowland flood control strategy will be developed based on evaluation of the current engineering studies, impacts on farming operations, and cost/benefit considerations.

6. Public and Stakeholder Consultation

   Surrey will obtain timely input from all stakeholders for planned drainage servicing schemes at the earliest stage possible.

7. Watershed Based Management Approach

   Surrey will use Master Drainage Plans to achieve a watershed stewardship approach to stormwater management with the goal of sustaining fish habitat while providing cost effective drainage services for its citizens.

8. Stormwater Management Financing

   Surrey will follow a stormwater management financing policy that is equitable and affordable.

A.4.2 Purpose

This policy is intended to achieve the following:

- Define the City's approach, as a community, towards managing drainage.
- Direct the planning of future infrastructure based on sound principles and proven technology and direct the updating of City's drainage servicing criteria and standards.
- Communicate the City's intent to all stakeholders including the public, developers, decision makers, farmers, environmental agencies, etc.

A.4.3 Goals Of Drainage Policies

Based on the legislated mandate of the City to carry out the storm drainage management function and with an appreciation of the changing public

expectations, the City recognizes that it's storm drainage related goals are as follows:

- To plan, design, construct, maintain, and operate the City of Surrey's storm drainage servicing system such that the services:

  - meet the needs of the people of Surrey.
  - will protect the natural resources within Surrey.
  - allow sustainable growth.
  - are within the financial capability of the municipality.
  - are within City's legislative authority.

A.4.4 Surrey's Key Drainage Issues And Policy Approaches

Over these past few years, the City has identified some key drainage issues in Surrey, In summary, these relate to the following general areas.

.1 Drainage Planning Process

To properly serve the drainage needs of the City, advanced planning of the drainage system and needed facilities is required. Such planning needs to be carried out on an overall watershed management basis. This will allow total overall watershed strategies to be prepared as opposed to dealing with development by development issues. The vehicle to achieve this are Master Drainage Plans, which are being prepared for the various watersheds within the City.

.2 Watercourse, Environmental, and Habitat Protection

The watercourses in Surrey have two major riparian functions, namely: carrying the stormwater drainage safely from upstream areas to the three major rivers (Serpentine, Nicomekl, and Campbell) and secondly supporting the life needs of wildlife and aquatic life dependent on these waterways.

Over the years, it is perceived that both these riparian functions are not being adequately met due to the many changes that have occurred upstream and along these watercourses, largely caused by land use changes from rural to urban, encroachment of the floodplain, the removal of riparian vegetation and the degradation of water quality.

Therefore, a creek management strategy comprising the following key components will be part of City's drainage policy.

(a) Quantity of Flow Entering Creeks

The City will adopt a flow control standard to limit peak flows from urbanizing areas entering creeks to a pre-development level for the 2-year and 5-year return period storms. This standard will be reviewed and validated on a site specific basis.

(b) Sediment Control from Construction

Developers will be required to design, implement, and maintain sediment control plans during the construction period of their projects.

(c) Stream Bank and Floodplain Protection

The City shall seek to obtain ownership of creek corridors through new developing areas, and that the means of achieving this ownership shall not be dependent on the 5% park land dedication allowance. In areas where creek ownership can not be practically achieved, the City will work to encourage public awareness of the need to care for natural watercourses.

(d) Quality of Storm Discharges

Maintaining the structural integrity of creeks and watercourses will remain the primary focus of the City's activities in drainage. Methods to address water quality will be implemented where appropriate through the use of non-structural methods, i.e., best management practices and structural methods such as wet ponds, wetlands, etc. The GVRD Liquid Waste Management Plan, when finalized, will serve as Surrey's guidelines for water quality management.

(e) Base Flow and Groundwater

Base flows are the flows entering creeks during dry weather periods. The source of base flows is the ground water table in the soil. There is concern that land use changes reduces the infiltration of rainfall to the groundwater and thus reduce the quantity of base flows entering creeks.

As part of land use plans, the City will review the degree of impact and sensitivity of creeks to changes in base flows with the Ministry of Environment, Lands and Parks and recommend appropriate management methods where they are required and where they can be effective. These management methods will then be implemented in conjunction with development.

.3 Lowland Drainage

The agricultural community along the Serpentine and Nicomekl river lowlands are impacted by flooding during heavy rains. The principal cause of this flooding is the low elevation of the land compared with the combined effect of storm runoff and the downstream water level created by the high tides.

Historically this issue had been managed on a localized basis through the construction of ditches and local pump stations. Some pump stations and ditch upgrading programs were cost shared through an agreement between the Federal, Provincial, and Municipal governments and the farmers.

The City is in the process of completing a comprehensive engineering and management evaluation of this issue with a view to define a strategy to deal with lowland flooding and drainage service needs for farmers in the entire floodplain.

.4 Public and Stakeholder Consultation

An extensive public consultation process was undertaken for the 'Future Surrey' vision statement that was approved by City Council on January 25, 1996. In addition, the City has adopted a proactive approach of consulting the public on issues impacting their quality of life on a daily or long term basis.

This stakeholder approach is being incorporated in the master drainage planning process to obtain early input and comments prior to the completion of the drainage plans. Local residents will be encouraged to review and comment on Master Drainage Plans prior to the completion of these plans and that this will be adopted as part of the Master Drainage Planning process. Public input will also be sought as projects move to detailed siting and design stages.

.5 Inter-Agency and Inter Departmental Coordination

The Federal Department of Fisheries and Oceans and the BC Ministry of Environment are involved with managing creeks and watercourses. The City will foster close interagency coordination from the earliest planning stages through to ongoing creek and floodplain stewardship programs.

A.2 Glossary of Terms

The following is a list of key terms used in this section and their definitions.

1	Detailed Engineering Drawings	The plans for construction of municipal improvements, required under the terms of a servicing agreement, which set out the detailed arrangement and specifications.
2	Detention Storage	The volume of stormwater runoff which can be stored by off-line super pipes or ponds for controlled release during or immediately following the storm.
3	Drainage Basin	A drainage basin is a geographic area with defined geographic limits which is defined by a common trunk sewer and outfall system.
4	Dry Pond	A surface drainage facility designed to temporarily detain excess rainfall runoff during significant rainstorms thereby reducing peak outflow rates. The stored runoff is then released at a rate equal to the capacity of the outfall pipe during or after the storm event. These facilities are normally dry between rainfall events and function as open spaces for other uses during dry periods.
5	Drainage Pump Station	A mechanical pumping facility designed to discharge storm drainage from one elevation to a higher elevation and/or from one geographic location to another by way of a force main or drainage spillway.
6	Exfiltration	The amount of water that leaks out from the storm drain system through poor joints, cracks, and walls of pipes and manholes.
7	Floodplain	The relatively flat or lowland area adjoining a river, stream, watercourse, lake, or other body of standing water which will be covered temporarily with flood water, on a periodic basis.

8	Force Main	A sewer pipe that operates under pressure to carry flow under a hydraulic head. Force mains are generally used downstream of pumping stations or from uplands to lowlands.
9	Interim	An adjective to describe the progressive steps or stages of development of a system or facility, which denotes the anticipated future modifications by degrees from one functional form to another, by enlargement or adjustment of capacity. The continued existence and usage of an interim facility is anticipated, and its total removal or abandonment is not proposed.
10	Lot Grading	The reshaping or sloping of the land surface, to be done in accordance with approved lot grading plan(s) which forms part of the approved Detailed Engineering Drawings. The purpose of lot grading is to provide proper drainage to the land and direct surface runoff away from buildings.
11	Master Drainage Plan (MDP)	A drainage servicing report to develop and evaluate all alternatives relating to storm servicing of a major sub-watershed to meet the site drainage requirements. Preferably this report should be submitted and approved by Engineering Department prior to the preparation of Neighbourhood Community Plan (NCP), approval.
12	Major Drainage System	The storm drainage system which operates when the capacity of the minor system is exceeded usually during storms more infrequent than a 1:5-year design event. This system is commonly composed of surface drainage routes in the form of streets, ditches and/or swales, detention ponds, and the total floodplain of watercourses
13	Manhole	Sewer appurtenances used as a means of access from the ground surface to sewers for inspection and cleaning and also to allow the free flow of air in and out of the sewer system.

14	Manning's Formula	A widely accepted formula for calculating and/or evaluating the hydraulic capacity of gravity (non-pressure) sewers and open channels, accounting for the bed or water surface slope, length, width and depth of flow, shape of the cross-section, and the internal surface roughness characteristics.
15	Minor Drainage System	Also called the Convenience System which is frequently used for collecting, transporting, and disposing of snow melt and storm runoff up to the design capacity of the system, usually based on a 1:5-year design storm. The system includes roadway curbs and gutters, catch basins, lawn basins, storm sewer pipes, detention ponds, and open drainage ditches and swales, as well as low flow channels in watercourses.
16	Overland Flow	Surface runoff resulting from precipitation on the surface of a drainage area during and immediately following a period of rain
17	Oversize	Portion of the capacity and/or depth of any storm or sanitary lateral sewer which exceeds the capacity and/or depth of the sewer which is required to serve the development area, and which is required to service an area outside of the development area.
18	Post-Development Flows	Refers to storm runoff on an area after its complete development.
19	Pre-Development Flows	Refers to storm runoff on an area in its natural or undeveloped state. In Surrey, for undeveloped areas, this condition is assigned to that which existed in 1978.
20	Staged or Interim Facility	A staged storm drainage system that is consistent with the concepts of the permanent or ultimate system including its location and connection and therefore provides the permanent level of service. The staged or interim facility may vary from the ultimate in that it may be necessary to reconstruct, add to, duplicate, or expand the facility to achieve the ultimate system.

21	Storm Events	Refer to the frequency or the time (in years) which a storm of certain intensity and duration may reoccur. Examples include 1 in 5-year, 2-hour duration storm commonly used in designing the minor storm drainage system.
22	Stormwater Management Facility	A man-made pond providing for storage of stormwater drainage during peak flows in order to control the rate of outflow or discharge. The discharge rate is usually equal to or less than the rate at which stormwater would have drained from the area prior to development (usually under agricultural conditions). This control ensures that upon development, the drainage systems (whether they are natural or man-made) do not have to accept a higher rate of runoff subsequent to development than prior to development. In areas where the existing agricultural runoff creates downstream problems, the rate of discharge would be controlled to a rate that is less than that encountered prior to development.
23	Sump Pump	A small pump in the sump pit with its discharge pipe extending to the outside of a building to discharge onto the lawn, or to a storm sewer service.
24	Super Pipes	Large-diameter pipes used as subsurface storage units to store excess storm runoff.
25	Surcharge	Term used to describe a situation where the actual flow in a pipe is greater than the free flow capacity of the pipe, thereby filling the sewer and manholes to above the crown of the affected incoming and outgoing pipes.
26	Temporary Connection	The connection of a facility or service in a location that differs from the ultimate or final plan or design. The temporary connection would be a facility or location that differs from the ultimate. For example, in the case of a roadway, a temporary connection may be made to an arterial road to provide for access and the connection will be ultimately planned or may even be to a drainage basin that is different from the drainage

		basin that is to ultimately receive the drainage from the development.
27	Temporary Facility	A sewer, water main, power roadway facility constructed to service a development on an interim basis for a specified time frame. The facility will be abandoned at a predetermined time or upon a predetermined event such as construction of a permanent facility.
28	Top-of-bank	The top of a steep bank which defines the upper limit of an escarpment or a ravine in ground formations such as watercourses.
29	Trunk Storm Sewer	A storm sewer servicing an area equal to or larger than 20 hectares.
30	Tunnels	Underground excavations and sewers installed by such means. Generally large diameter concrete pipes or cast-in-place sewers installed at depths where it is more economically and physically feasible to tunnel than to install the facilities by the widely used open excavation method.
31	Weeping Tile	A perforated plastic pipe placed beside the footing at the outside perimeter of the basement intended to lower the water table behind the basement wall, to be below the basement floor level.
32	Wet Pond	A man-made lake intended to provide partial or total short-term stormwater storage, generally with release during or after the storm event at a controlled discharge rate. Such facilities normally contain water to a minimum level at all times.

A.3 List of References

The reference resources applicable for the analytical and design activities relevant to storm servicing continually evolve as the state of practice undergoes modifications to meet the needs and expectations of the public, the regulatory agencies, and the development industry.

The following is a selected list of publications which provide relevant information.

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4. "Design Criteria Manual", City of Surrey Engineering Department; (January 1995).
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7. "Vulnerability of Natural Watercourses to Erosion", Ministry of Natural Resources, Ontario; (November 1982).
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11. "Sustainable Suburbs Study: Creating More Fiscally, Socially and Environmentally Sustainable Communities", City and Community Planning Division of the City of Calgary; (April 1995).
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13. "Concrete Pipe Design Manual", American Concrete Pipe Association; Viena Virginia, (1980).
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16. "Handbook of PVC Pipe - Design and Construction", Uni-Bell PVC Pipe Association; Dallas, Texas, (1982).
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20. "Open Channel Hydraulics", Ven Te Chow, Ph.D., Professor of Hydraulic Engineering, University of Illinois; New York, (1959).
21. "Stormwater Management Practices Planning and Design Manual", Ontario Ministry of Environment and Energy (1994).

22. "Guide to Bridge Hydraulics", Project Committee on Bridge Hydraulics, Roads and Transportation Association of Canada; (1973 - Reprinted in 1975).
23. "Controlling Urban Runoff: A Practical manual for Planning and Designing Urban BMPs" Thomas R. Schueler of the Department of Environmental Programs, Metropolitan Washington Council of Governments; (July 1987).
24. "Land Development Guidelines for the Protection of Aquatic Habitat", Department of Fisheries and Oceans Canada and the BC Ministry of Lands and Parks (1992).
25. "Urban Storm Drainage, Criteria Manual Volumes 1 & 2", Wright McLaughlin Engineers; Denver, Colorado, (March 1969).
26. "Preliminary Report on Erosion Control Measures for Several Streams in Surrey", New East Consulting Services Ltd., Surrey, BC; (August 1995).
27. "Drainage Manual, Volumes 1 and 2", Roads and Transportation Association of Canada - RTAC (1982).
28. "Surface Water Design Manual", King County Washington State, USA (1998 Draft).
29. "Stormwater Management Manual" for the Puget Sound, Washington State, USA (1992).

SECTION 6

Roadworks System

6.0 ROADWORKS SYSTEM

6.1 General Roadworks System Requirements

Section 6.0 - Roadworks System, provides design criteria for the following aspects of road design within the City:

Roads
Sidewalk and Curb Requirements,
Street Lighting; and
Traffic Control

A. Non-Improved Road Frontage Grading

Wherever development projects do not include improvements to fronting road works, the development must grade the full frontage of the property to an elevation that shall not vary by more than 300mm from the ultimate road centreline elevation.

6.2 Roads

A. General Road Requirements

(a) Glossary of Terms

(i) Arterial Road - means a highway whose primary function is to carry through traffic from one area to another with as little interference as possible from adjacent land uses, but which may provide direct access to property as a secondary function when alternate access is not available.

(ii) Collector Road - means a highway whose primary function is to distribute traffic between arterial, other collector, and local roads within an area, but which also usually provides full direct access to properties.

(iii) Local Road - means a highway whose primary function is to serve vehicle trip ends by providing direct access to properties, and which usually connects to other local roads or to collector roads.

The Designer may use these definitions as a guideline and should refer to the "Surrey Subdivision and Development By-law", for clarification or classification and variation.

(b) Road Classification

As defined in the "Surrey Subdivision and Development By-law", arterial roads and major collector roads are set out in Drawing R-91, entitled "City of Surrey Arterial, Major Collector and Grid Roads Plan Map."

(c) Traffic Impact Studies

Traffic Impact Studies are required for new developments which are expected to generate approximately 150 trips during the peak hour of the generator. The threshold size of developments required to initiate a traffic impact study are generally as follows:

1)	Single Family Zones	-	200 units
2)	Townhouse Zones	-	250 units
3)	Apartment Zones	-	300 units
4)	Commercial Zones	-	50,000 sq. ft. GLA (4,645 sq. m)
5)	Office Zones	-	110,000 sq. ft. GFA (10,000 sq. m)
6)	Industrial Zones	-	200,000 sq. ft. GFA (18,000 sq. m)
7)	School Zones	-	500 students
8)	Other Zones	-	200 v.p.h. or at the discretion of the Engineer
9)	Special Circumstances	-	where development may impact on an already congested area, a high accident location or where site access or other safety issues are of concern

Note: GFA refers to Gross Floor Area

GFL refers to Gross Leasable Area

(d) Standard Cross-Sections

Required highway dedication, pavement widths and sidewalks are tabled the "Surrey Subdivision and Development By-law" and Section 2.0 of this Design Criteria Manual.

The general arrangement of the road cross-section features and the utilities to be constructed within the road right-of-way are to be in accord with the Standard Drawings. When existing utilities are already in place and not conforming to these standard arrangements this requirement is waived and a special design is required.

For subdivision servicing designs, appropriate arrangements must be made with other utilities to ensure for servicing of the site in the event that City

required dedication widths do not accommodate the specific requirements of other utilities.

(e) Design Requirements

The design parameters for internal and peripheral roads will differ according to the land use adjacent to the proposed road. These parameters are given in Table 6.2 following, for any given land use, within or peripheral to the subdivision. The parameters apply to geometrics, street lighting, and pavement design. Actual traffic counts should be used when available.

Storm water control plans shall be provided to the Engineer for approval for all roads and sidewalk projects in advance of final design.

(f) Maximum Road Lengths

Maximum road lengths for cul-de-sacs, P-loops, and future through roads shall be as follows. These maximum lengths may be relaxed in special circumstances but may require:

- Fire sprinklers of standard acceptable to the City with restrictive covenant for their ongoing necessity for those properties fronting the overall length of the road;
- an alternate emergency access route.

(i) Cul-de-sacs

The length of the cul-de-sac shall be measured along the centreline from the edge of the intersecting highway having more than one access to the centre of the cul-de-sac bulb.

a. In RM-30 and higher density zones, and industrial and commercial zone, roads shall not exceed 110 metres in length as measured from the intersecting highway, having more than one access, to the furthest limit of the road or to the centre of the turnaround.

b. In all other zones except Agricultural zones, two accesses are required when the road, as measured in Sub-Section (i) above, exceeds 220 metres in length.

c. In Agricultural zones, roads shall not exceed 400 metres in length, as measured in Subsection (i) above, and under no circumstances shall the road structure including the shoulders be less than 9.0 metres in width.

(ii) P-Loops

a. P-loops shall have a maximum total length of 500 metres. The entrance leg shall not exceed 220 metres in length and shall be a minimum of 6 metres wide.

b. The total street length of a P-loop may be increased in R-S, R-A(G), R-1, R-H(G), RA, RA-G, RH and RH-G zones as follows:

i. in R-S, R-A(G), RA and RA-G zones P-loops shall provide frontage to not more than 30 lots.

ii. in R-1, R-H(G), RH and RH-G zones P-loops shall provide frontage to not more than 40 lots.

(iii) Future Through Roads

"Future Through Road" shall mean a highway having or planned to have, two independent means of access to its length, as shown on the Planning & Development Department's Concept Plans.

a. The maximum length of the constructed portion of a future through road shall not exceed 400 metres, where it can reasonably be expected that the future extension will occur in a five year period.

b. There is no maximum length of the constructed portion of a future through road in the Agricultural zones.

Table 6.2
Roadway Design Standards

Land Use	Road Classification		Street Light (Lux)[3]	Design Speed (km/h)	IDT	% T[1]	Max. Block Length (m)
A-1, A-2, [2]	Local:	Limited	4	30	1000	2	120
RA,		Through	4	30	1000	5	250
RH, RA-G	Collector:	Major	6	50	3000	5-8	[4]
	Arterial:	Undivided	6	70	5000	10	[4]
RH-G	Local:	Limited	4	30	1000	2	120
		Through	4	30	1000	5	250
	Collector:	Major	6	50	3000	5-8	[4]
	Arterial:	Undivided	6	60	5000	10	[4]
RF	Local:	Limited	4	30	1000	2	120
		Through	4	30	1000	2	250
	Collector:	Major	6	50	1000	3	[4]
	Arterial:	Undivided	10	60	5000	10	[4]
		Divided	10	70	5000	10	[4]
RF-G, RM-M	Local:	Limited	6	30	1000	2	120
RM-15, RM-30		Through	6	30	1000	2	300
RF-12, RF-9	Collector:	Major	9	50	5000	3	[4]
RF-SD, RM-19	Arterial:	Undivided	14	60	5000	10	[4]
		Divided	14	70	5000	10	[4]
RM-45, RM-70	Local:	Limited	6	30	1000	2	120
RMC-150		Through	6	40	1000	2	300
	Collector:	Major	9	50	5000	3	[4]
	Arterial:	Undivided	14	60	5000	10	[4]
		Divided	14	70	5000	10	[4]
C-15, C-8, C-8A,	Local:	Through	9	40	1000	3-6	N/A
CHI, C-35, C-8B	Collector:	Major	12	50	5000	8	[4]
CG-1, C-4	Arterial:	Undivided	20	70	5000	10	[4]
CTA							

Table 6.2, continued
Roadway Design Standards

Land Use	Road Classification		Street Light (Lux)[3]	Design Speed (km/h)	IDT	% T[1]	Max. Block Length (m)
IL, IH IB, IS	Local:		4	50	1000	10	N/A
	Collector:	Major	6	60	3000	15	[4]
	Arterial:	Undivided	10	60	5000	15	[4]
		Divided	10	70	5000	15	[4]
IA, All Zones in South Westminster & Bridgeview Except RF	Local		4	50	1000	10	N/A
	Collector:	Major	6	60	3000	15	[4]
	Arterial:		10	60	5000	15	[4]

NOTES TO TABLE 6.2

(1) Initial daily average heavy trucks on design lane. This truck volume should be adjusted for an annual growth factor of 1% over the design life for local and collector roads. Arterials should be adjusted for an annual growth factor in the order of 3% or on the basis of a traffic study.

(2) For Zone A-1, A-2, RA, and RA-G, street lights required at intersections only.

(3) Illumination uniformity on Residential Local roadways shall be 6:1 (Avg:Min). All other road classifications require 3:1 (Avg:Min) illumination uniformity.

(4) Block lengths for collector and arterial roads as per the R-91 Map (City of Surrey Arterial, Major Collector, and Grid Roads Plan Map.

Abbreviations IDT- Initial Daily Traffic - The initial average daily number of all vehicles, in two directions, estimated for the first year of service.

% T - Percentage of Heavy Trucks (3 axles or more)

B. Road Design Components

(a) Geometric Road Design

- General

Pavement widths, shoulders or curb type, and right-of-way width, are to conform with the "Surrey Subdivision and Development By-law". The design speed, as shown in Table 6.2, governs horizontal and vertical geometrics. All road classifications shall be designed in accordance with the "TAC Geometric Design for Canadian Roads, 1999" except:

(i) Vertical and horizontal curve design should reflect the parameters of this section.

(ii) When a new road or an improvement to a road is being designed, all intersections with other existing roads are to be designed to meet the ultimate standard for the existing road. All tie-ins with existing roads shall be part of the adjoining existing road milled or sawcut and paved. The dimensions of this milling shall be determined by the Engineer.

(iii) The road profile and the curb and sidewalk grades are all governed by the final pavement, curb and sidewalk cross-section of the road and not the existing road unless the existing road is already completed to its final standard.

- Grades

Maximum longitudinal grades shall be:

Local Residential Roads	12%
Cul-de-sac bulbs	8%
Collector Roads, Local Industrial, and Local Commercial Roads	8%
Arterial Roads	7%

Minimum longitudinal grade shall generally be 0.5%, exception is accepted in totally flat areas where a minimum grade of 0.4% along the edge of pavement shall be provided, with the centerline grade remaining flat. Sufficient drainage must, in any event, be provided.

- Cross Slopes

  Standard cross slopes on streets shall be 2.5% with the crown point to the centre of the pavement. Where extreme topography applies, limited local roads may be designed with cross slopes from 1% to 4% and with one way cross falls. When existing streets, arterial or other classes, are being widened and existing driveways and private property levels dictate, crossfalls on the widening may be varied to 4% maximum, 1% minimum to effect economy and minimize adverse effects to existing properties.

- Drainage Considerations

  Where roadways cross watercourses or creeks, capacity must be provided to convey the 100 year flow without impacting the upstream flood levels.

  Conveyance of flows under roads shall be designed to meet the following levels of service:

Local Roads	1:10 year
Collector Roads	1:25 year
Arterial Roads	1:100 year

  1:100 year flood path routing shall be designed so that all flows are conveyed within the road allowance and flooding of adjacent properties is avoided.

  Sufficient drainage inlets shall be provided so that all flows from the 5-year minor storm events enter the storm sewer.

- Vertical and Horizontal Curves

  Special consideration must be given to provide adequate site distance and transition distance when combining horizontal and vertical curves.

  Vertical curves may be omitted where the algebraic difference in grades does not exceed 2% for local roads and 1% for other streets.

  The minimum centerline radius for curvature on through local roadways is 25 metres, subject to adequate sight lines and other design constraints. The curve should have a minimum 20 metre tangent between any road intersection and the curve and 'S' curves must have 20 metre tangent separating the two curves and shall be signed (curve ahead, 30 km/h).

  Right angle intersections shall be permitted for local roadways provided the inside curb return radius is not less than 9.0 metres.

  The minimum allowable radius horizontal curve for any design speed depends on the maximum rate of superelevation and on the side friction that can be developed between the tires and the pavement. The formula for calculating the radius is:

$$R_{min} = \frac{V^2}{127 \times (e + f)}$$

Where

R_{min} = radius of circular curve in metres
V = vehicle speed in kilometres per hour
e = roadway superelevation in metres per metre. This varies from site to site, but may not exceed 4%
f = side friction factor. The values below should be used for relevant speeds.

Minimum Centerline Radius*

Road Classification	Design Speed	*f*	*e* **	Radius
Low Speed Urban Design				
Limited Local	30 kph	0.31	-0.025	25 m
Through Local	30 kph	0.31	-0.025	25 m
Through Local	40 kph	0.25	-0.025	60 m
Major Collector	50 kph	0.21	-0.025	110 m
High Speed Urban Design				
Undivided Arterial	60 kph	0.15	-0.025	230 m
Undivided Arterial	70 kph	0.15	-0.025	310 m
Divided Arterial	70 kph	0.15	-0.025	310 m

** Centerline radius will vary depending on the cross slope used.
* This table shows minimum values only and does not apply to all circumstances.

(i) **Simple curves** may be used for road design on local roads and on major collector roads where the tangent angle is less than 30 degrees.

The minimum allowable radius for a simple curve without super elevation can be calculated using the above formula. A value of -0.025 should be used for “e” to represent normal crossfall from crown of road.

- Intersections

(i) Curb Treatment

Curb treatments shall be as follows:

Intersection Type			Curb Treatment
Road Class		**Road Class**	
4 or 6-lane Arterials	To	4 or 6-lane Arterials	11m Radius Curb Return
All other Arterials	To	All other Arterials	2-centred Compound Radius[1]
All Lanes	Fr/To	Arterials / Major Collectors	7m Radius Curb Return
Commercial / Industrial Lanes	Fr/To	All Other Roads	7m Radius Curb Return
Residential Lanes	Fr/To	All Other Roads	Curb Letdown
All Other Roads	Fr/To	All Other Roads	9m Radius Curb Return[2]

[1] Based on TST vehicle
[2] Under interim conditions curb return to accommodate SU-9 vehicle (TST vehicle for industrial roads)

Where intersecting an interim road cross-section, Type "B" concrete curb and gutter shall tie directly into the cross street existing pavement edge.

(ii) Corner Cuts

In all circumstances, the corner cut shall be sufficient to accommodate the required curb return radius. Typically, the corner cuts shall be as specified below:

Intersection Type	Corner Cut
R-91 to R-91	5m x 5m
All other roadway intersections	3m x 3m
Lane to Lane	5.5m x 5.5m
Lane to Arterial/Major Collector	3m x 3m
Residential Lane to all other roads	Not required
Commercial/Industrial lane to any road	3m x 3m

Wherever the City anticipates installing a traffic signal, a minimum 5.0-metre X 5.0-metre corner cut is required.

(iii) Crossing Sight Distance

Particular attention shall be given to the minimum 'Crossing Sight Distance' requirements and the maximum allowable approach grades and grade transitions on minor roads at intersections.

Crossing Sight Distance, required to provide a vehicle sufficient time to cross the major road before the arrival of an approaching vehicle, shall be calculated by the formula given in the TAC Geometric Design Manual (Section 2.3.3).

(iv) Grade and Cross Slope

For a 50 km/h design speed, the maximum allowable grade of a minor road at an intersection is 3.5%.

Cross slopes on through streets may be reduced to a minimum of 0.5% within the intersection.

See TAC Section 2.3.2.3.

(v) Location

Intersections shall be at right angles, with a maximum variation of 15 degrees for extraordinary circumstances.

Intersections proposed on curves or near the crest of hills are to be avoided. These proposed intersections are subject to sight line analysis in accordance with TAC.

(vi) Spacing

It is desirable to keep the number of intersections on arterial streets to a minimum. Nevertheless, too few intersections results in overloading of the turning movements and serious congestion. A minimum of one major intersection to the arterial system should be provided when 800 dwelling units share a single access to the arterial road. Special requirements should be reviewed with the Engineer.

Notwithstanding the above, the minimum spacing between intersections should provide for a minimum 40 m of left turn storage (at both intersections), 35 m of transition between storage lanes, and an allowance for the design vehicle left turning movement onto the arterial road.

Where T-intersections are staggered along any roadway, the minimum spacing between them shall be 60 metres as measured between near property lines of the staggered intersecting streets.

- Left Turn Channelization

(i) Ultimate Design

A 30:1 left turn taper should be used for 50 km/h and 60 km/h design speed and a 40:1 taper should be used for higher speeds. The 20:1 left turn taper is a minimum and unless there are definite limiting factors a more gentle taper is desired to make driving more comfortable. Standard Drawings show a range of channelization dimensions. Successive turn bays should be a minimum 150 metres apart from end of taper.

The minimum length of storage for left turning vehicles is 30 metres, and should be calculated by the formula:

$$SL = 2 \times (V_c \times V_L), \text{ where}$$

$$V_c = \frac{vph}{cph} \text{ and}$$

SL = segment length (metres)
V_c = vehicles per cycle
vph = vehicles per hour
cph = cycles per hour
V_L = design vehicle length (use 7.0 metres)

If successive intersections calling for left lane tapers are less than 400 metres apart, the jog in and back out results in undesirable alignment and the curb should be carried straight through unless property damage, etc., is so severe as to warrant minimum treatment.

Alignment shifts to avoid features to be preserved or for other design reasons must be treated carefully. When deflection angles are small such shifts result in abrupt “kinks” in driving alignment unless the shift is effectively limited to 1 to 100 range. Long curves to approximate the 1 to 100 shift must still be used to avoid “apparent” kinks visible only to a driver’s line of sight.

The Engineer should be consulted regarding any proposals to deviate from the above design ranges.

(ii) Interim Design

The above notes refer to consideration of ultimate curb lines and design. Many required designs are on interim stage for two lanes plus left turn, four lanes tapering to two, or even four lanes plus

left tapering to two lanes. The same considerations apply to these interim designs, and the Designer is referred to the Standard Drawings.

- Driveways

Driveway crossings shall conform to the Standard Drawings.

All driveways shall be at right angles to the roadway. Exceptions to this shall be gas stations located on or near R-91 roads, or right in/right out only configurations (45 degrees or 60 degrees).

All existing driveways not being used by a proposed development shall be removed and the boulevard reinstated with the appropriate treatment.

Developments generating more than 200 trips in any hour shall provide a minimum 2 m, maximum 4 m, wide median in the driveway to separate opposing traffic and provide pedestrian refuge.

All driveways shall be designed to incorporate a landing area. Landing area is defined as a 6 metre length of driveway, at a maximum grade of 5%, from property line into the site.

The maximum grade on the remainder of the driveway should be 15% along local streets and 10% along collector and arterials unless approved by the Engineer. Driveway grade changes are to be designed so that vehicles will not “hang up” or “bottom out.”

All driveways on arterial roadways within 120 m of the near side property line of an intersection shall be restricted to right in/right out turning movements only. A restrictive covenant shall be provided by the Developer.

Unless otherwise provided, the elevation of the driveway at property line shall not vary by more than 300 mm from the elevation of the centerline of the road.

The minimum spacing between the near side of a driveway and the property line of the intersecting street or the near side of another driveway shall be as follows:

Fronting Street	***Spacing***
Arterial	50 m
Collector	25 m
Local/Lane	9 m[1]

[1] may be less for paired single family residential driveways (as per SSD-R.42.1).

If a driveway cannot meet these requirements, the driveway must be located as far away from the intersection as possible along the minor street, or a joint access may be required if land use is compatible. Alignment and/or spacing from existing driveways on the opposite side of a roadway is required to avoid conflicting turning movements unless an existing raised median divides the roadway.

In zones CG-1 and CG-2, only one driveway shall be permitted to each arterial road to which the site fronts. These driveways shall be located as far removed from an intersection as possible. A second driveway may be permitted when one of the following conditions exist:

1) where the subject site fronts entirely to one arterial road; or

2) where, at the discretion of the Engineer, a second driveway may be required for on-site circulation of the design vehicle.

Major driveway crossings (accommodating more than 100 vehicles per hour) should be by curb return rather than driveway let down. Firehalls may have curb returns in lieu of a driveway let down.

Queuing storage, as measured from the ultimate property line, is the projection of the driveway into the site with no parking stalls or cross aisles directly accessible to it. This storage must be clear of all obstructions including speed bumps, gates, and fences.

Queuing storage shall conform to the following table[1]:

Parking Stalls	Length
0-100	6 m
101-150	12 m
151-200	18 m
>200	24 m

[1] Additional queuing length may be required by the Engineer and/or as determined by a traffic impact study.

Asphalt pavement driveways shall be 65 mm minimum asphalt pavement thickness on minimum 100 mm thick base material (typical for residential zoning).

Concrete pavement driveways shall have concrete pavement thickness of 120 mm minimum for residential and 200 mm minimum for commercial

and industrial, on minimum 100 mm thickness of granular base material and 200 mm granular sub-base material.

All driveways shall be located on the design drawings. Driveway between curb and sidewalk must be constructed in conjunction with the servicing works for all residential zones.

All lots having less than 18.0 m frontage shall have paired driveways to accommodate on-street parking.

Water, sanitary sewer and storm sewer services shall not be located under the driveway.

Driveway crossings onto arterial roads shall not be permitted when other means of access is available.

Driveway crossing profiles shall match the existing elevations with ultimate sidewalk requirements as specified in the Surrey Subdivision and Development By-law, and the Standard Drawings.

If driveway grades cannot meet the requirements the alternate design in grade change and storm water control must be approved by the Engineer.

All above ground utilities must be located a minimum of 1 metre from the near edge of a driveway. If the height of the utility is greater than 0.6 metres, the utility shall be located outside of the sight triangle as determined by stopping sight distance (TAC Geometric Design Manual).

- Cul-de-sacs

  Maximum road lengths for cul-de-sacs are specified in Section 6.2.1.6 (1). Permanent cul-de-sacs and emergency access shall conform to the Standard Drawings. Industrial cul-de-sacs may be of the bulb type with a 14 metre radius pavement, or alternatively, they may be of the hammerhead type.

- Temporary Dead Ends

  Temporary turnarounds shall be designed for roadways longer than 100 m which are to be extended in the future. Temporary turnarounds shall be paved at an 11 metre radius, unless otherwise required by the Engineer. A hammer head turnaround is also acceptable.

- Temporary Alternate Access

Where alternate access is required on temporary dead end roads, it shall have a minimum width of 6.0 metres and have structural capability to support 9.1 tonne axle loading.

- Lanes

  Lanes shall conform to the Standard Drawings. Lanes provide a means of keeping direct access off arterial streets.

  Where lanes must be provided they should run through from street to street without change of alignment. When corners or T-intersections are unavoidable, a supplementary 5.5 metre x 5.5 metre triangle right-of-way shall be dedicated for visibility and the return curb. This triangle must be paved.

  When a future through lane is temporarily constructed in excess of 100 m a hammerhead turnaround shall be provided. A hammerhead turnaround is required for all lanes in excess of 100 m with only one entrance.

  Lanes connecting from an arterial road to a local road should be avoided wherever possible to minimize cut-through traffic on the lane.

  Speed humps must be included with lane construction for all lanes with an ultimate length of 100m or more to reduce speeds and discourage shortcutting.

- Engineering Walkways

  Engineering walkways can be accommodated on a 4.0 metre right-of-way.

  The walkway should be of a hard paved surface for the entire width for maintenance reasons. The walkway should include differing pavement colouring and/or texturing within the front yard setback and along the edges of the walkway to delineate the ends of the walkway and to define a pedestrian corridor centred within the right-of-way.

  Chain link fencing should be used on each side for the length of the walkway. Decorative post and chain fence should be used within the front yard setback in place of chain link fencing for aesthetic reasons. Baffle gates are to be located at the front yard setback. See Standard Drawings for details.

- Multi-use Pathways

Multi-use pathways can be accommodated on a 6.0 metre wide (minimum) right-of-way. The pathway shall be 4.0 metres in width. The pathway may be of a paved or compacted granular surface. See Standard Drawings for details.

Pathways can use locking posts for vehicular access restriction in place of baffle gates depending on suitability for cycling, emergency or utility vehicle access.

- Railway Crossings

  Whenever road improvements are being made to arterials, collectors, or roadways with designated bicycle routes, pre-cast concrete railway crossing shall be used at the railway crossing.

(b) Residential Frontage Road Design Criteria

- Concept of Frontage Roads

  Frontage roads can be used to provide access to residences fronting arterial roadways, where they have either been identified on the Concept Plan for the area, or have been specifically approved by the Approving Officer. At the conceptual stage, the ultimate frontage road layout must be established, as per the Standard Drawings, including the number and location of access points to the frontage road. It is preferred that all frontage road accesses link to internal roads within the development, however, access to collector roads external to the development are permitted. Ultimate access to an arterial is not permitted.

- Development Staging of Local Frontage Roads

  When the proposed frontage road does not have direct access to a local or collector road, access can be temporarily permitted along an arterial roadway. Once the frontage road is developed to its ultimate configuration, all temporary access to the arterial road will be removed and access will be from collectors or other local roads. The developer who installs a temporary arterial access will be required to deposit sufficient funds with the City to cover future removal costs of the access.

- Frontage Road Design Elements

  i) Road Geometrics - Temporary Access to Arterial

  - The frontage road will temporarily function as a one-way street.

- The design shall generally conform to the Standard Drawings.

ii) Road Geometrics - Ultimate Development

- Temporary frontage road access along the arterial will be removed.
- Access between the frontage road and a collector will be to the criteria shown in the Standard Drawings.
- Turn-arounds shall be provided at the end of all frontage roads, either with a cul-de-sac, or a hammerhead turn-around as per the Standard Drawings.

iii) Pavement Widths for Frontage Roads

A 6.0 metre pavement width shall be provided on a frontage road, except where the frontage road is providing access to more than 50 lots or units, or is servicing commercial/industrial properties in which case the pavement width shall increase to 8.5 metres.

Where an existing frontage road is being extended, the pavement width shall correspond to the existing standard.

iv) Curbs

Barrier curbs shall be used for frontage roads. Where an existing frontage road is being extended, the curbs shall correspond to the existing standard.

v) Sidewalk

A 1.5 metre wide sidewalk shall be provided on one side of the frontage road. The location of the sidewalk (i.e., development side or arterial side) will be determined on a case by case basis by the Engineer, but shall generally be located on the arterial road side of the frontage road.

vi) Street Lighting

Double luminaires shall be provided to illuminate both the frontage road and the arterial. Lamp wattage and pole spacing shall conform to Section 6.4 – Street Lighting.

vii) Water Mains

The preferred location for water mains is under the sidewalk, approximately 1.0 metres from the curb.

viii) Storm Sewer

The preferred location for storm sewer is under the frontage road pavement, at a minimum offset of 1.5 metres from the curb. An alternate location for storm sewers is in the arterial roadway.

ix) Sanitary Sewer

The preferred location for sanitary sewer is at an offset no less than 1.0 metre from the storm sewer (common trench).

x) Electrical and Telecommunications Services

Electrical and telecommunications services shall be designed to meet the requirements of the respective utility company.

xi) Gas

Gas shall be designed to meet the requirements of BC Gas.

xii) Landscaping

The frontage road/arterial median shall be landscaped in accordance with the following guidelines to the satisfaction of the Approving Officer in consultation with the Parks and Recreation Department Administrator.

Landscaping shall:

- provide an effective screen for headlights in opposite directions and promote traffic safety;
- be capable of low maintenance; and
- Where mature trees exist, consideration be given to preserve them as part of the landscape boulevard.

All median designs must be reviewed and accepted by the City's Parks, Recreation & Culture Department.

(c) Pavement Structural Design

- General Intersections

  The following criteria shall be followed for structural design of Surrey roads.

  Asphalt Pavement Design - accepted references

  a) "A Guide to the Design of Flexible and Rigid Pavements in Canada - TAC"

  b) Asphalt Overlays and Pavement Rehabilitation
  The Asphalt Institute MS - 17

  c) Asphalt Institute "Superpave Level 1 Minimum Designs" SP-2

  d) AASHTO Guide for Design of Pavement Structures

  Concrete Pavement Design - accepted references

  a) "Design of Concrete Pavements for City Streets - Portland Cement Association"

  b) "Thickness Design for Concrete Pavements – Portland Cement Association"

- Road Life

  The structural design of the road pavement shall be adequate for a 20 year life under the expected traffic conditions as shown in Table 6.2 for each class of road.

  However, when future paving, widening or other servicing in the paved area is planned under Surrey's long term programs, the top 35 mm of asphalt may be deferred for later construction in accordance with City policy.

- Asphalt Pavement Design

  (i) Requirement

  Regardless of the method of design used, the maximum Benkelman Beam deflection (corrected for seasonal variation) on the finished pavement when tested for final acceptance by the City shall be not greater than 1.8 mm for **local** roads. The maximum

deflections on other road classes will be in accord with the Traffic Design Number as determined from Table 6.2 information for a 20 year life design.

The minimum total flexible pavement structure thickness for any local road shall be in accord with the Standard Drawings, regardless of the structural design requirements determined by the Benkelman Beam or CBR method of design.

Other than for isolated shoulder widening, whenever a pavement is being widened, a minimum overlay of 35 mm of asphalt for blending and levelling purposes shall be required over the full pavement width to the centerline of the pavement.

Deep strength and Superpave asphalt designs are acceptable provided the minimum thickness for the pavement structure as shown in the Standard Drawings is met.

(ii) Method

Road reconstruction and asphalt overlay design shall be based on the analysis of the results of Benkelman Beam tests and test holes carried out on the existing road which is to be upgraded, **or** by the CBR asphalt pavement design method.

The design for new roads shall be based on the analysis of the results of Benkelman Beam tests and test holes carried out on adjacent roads having similar subgrade soil conditions as the proposed road **or** by the CBR asphalt pavement design method. The results shall be supplemented by analysis of material taken from test holes dug on the proposed road site at intervals of approximately 80 metres, including soils classification, carried out by a qualified soils testing company.

Benkelman Beam tests shall be carried out in accordance with the procedures outlined in the **Roads and Transportation Association of Canada "Technical Publication No. 12."**

- Concrete Pavement Design

(i) Requirement

The minimum thickness of concrete pavement will be in accordance with the Supplementary Standard Drawing SSD-R.29 regardless of the structural design requirement determined, except that on limited local roads a concrete thickness of 120 mm will be

acceptable when good subgrade conditions and extremely low heavy truck volumes can be proven.

A qualified soils testing firm should be used to determine if the in-situ material is non-frost susceptible and, imported subbase material is not required. In general terms, however, the following soils characteristics will be deemed frost susceptible.

Frost-Susceptible Soils
(from lowest to highest susceptibility)

Group	Description
F1	Gravely soils containing between 3 and 20 percent finer than 0.02 mm by weight
F2	Sands containing between 3 and 15 percent finer than 0.02 mm by weight
F3	(a) Gravely soils containing more than 20 percent finer than 0.02 mm by weight, and sands, except fine silty sands, containing more than 15 percent finer than 0.02 mm by weight. (b) Clays with plasticity indices of more than 12, except (c) Varved clays existing with uniform conditions.
F4	(a) All silts including sandy silts. (b) Fine silty sands containing more than 15 percent finer than 0.02 mm by weight. (c) Lean clays with plasticity indices of less than 12. (d) Varved clays with non-uniform subgrade.

(ii) Method

The design for concrete pavements shall be based on the CBR values or plate bearing “k” value (Modules of Subgrade Reaction) of the Sub-grade, to be determined by a qualified soils testing company. This is to be supplemented by analysis of material taken from test holes on the proposed road at intervals of approximately 80 metres.

The thickness of concrete pavement required can then be determined by using design criteria published by the Portland Cement Association or by standard computation methods of rigid pavement design.

The expected traffic flows and volume of heavy trucks are determined from Table 6.2 for the class of road and using a 20 year life design. The concrete flexural strength for roadways will be 4 MPa, at 28 day strength.

- Special Designs

Whenever compressible soils are present **or** when maximum probable spring rebound values greater than 12 mm, or CBR values less than 2% are identified, standard design procedures for flexible and rigid pavements cannot be applied.

A special design, usually involving preloading, is indicated and the special design proposed shall be supported by detailed soils testing and evaluation by a professional Engineer. The general principle for such special design is:

i) Lightweight Fill

Use light weight fill (such as hog fuel with liner) to help achieve a desired road elevation while minimizing settlement due to load. (Hog fuel shall only be used with permission from the Ministry of Environment, Lands and Parks.) If hog fuel is used, special design shall be used to prevent leakage to fish habitat.

ii) Polystyrene

Use polystyrene fill to help achieve a desired road elevation while minimizing settlement due to load.

iii) River Sand

Use river sand or granular subgrade fill to preload. The material may then used to help achieve the required minimum overall depth of pavement structure.

iv) Settlement Monitoring

Monitor settlement and consolidation over a period of time usually a minimum of 3 months. When the primary settlement stage is

complete the preload is removed and the finished pavement structure completed.

v) Foamed Concrete

Foamed concrete subgrade may be used as an alternate to preloading if supported by detailed soils testing and evaluation by a professional Engineer. The general principle of using foamed concrete is to remove an amount of existing material equal to the weight of the new road structure consisting of foamed concrete, which has a density less than that of water, subbase and base gravels and asphaltic concrete.

- Shoulders

When called for, gravel shoulders shall be load carrying shoulders . They will have a minimum base thickness of 100 mm.

6.3 Sidewalk and Curb

A. General Sidewalk and Curb Requirements

(a) Sidewalk

For the requirements for sidewalks refer to the Surrey Subdivision and Development By-law.

(b) Curbs

Barrier curbs are to be constructed except where rollover curb is used to match existing conditions, within the block on the side of road fronting the subject development, and subject to the approval of the Engineer.

(c) Wheelchair Ramps

Wheelchair ramps, from elevated sidewalk areas to crosswalks shall be provided at all curb returns and intersections. Ramps shall also be provided for access to walkways.

(d) Design Parameters

- Alignment

Sidewalks shall be contained within the City road allowance. The sidewalk should be parallel to the curb. The dimension, between the near edge of the curb face should be as defined in the Standard Drawings.

Modifications to alignment using 3.5m radius back-to-back curbs are allowed to preserve features such as ornamental trees and street furniture, or to avoid obstacles such as hydrants and poles. A minimum 0.3m offset to obstructions is required. Any modification to alignment must be approved by the Engineer.

If the sidewalk alters the existing drainage pattern then sufficient works must be provided to maintain the existing pattern.

- Clear Width

  The clear width of the sidewalk should be 1.5 metres as shown in Standard Drawings. In exceptional circumstances a clear width of 1.2 metres is allowed around permanent features, subject to the approval of the Engineer.

- Setback

  The sidewalk shall be separated and set back a minimum of 2.0 metres from the face of curb by the boulevard strip unless matching existing conditions. Under exceptional circumstances, this standard shall be modified to accommodate other constraints.

  In land use zones C-35 and C-15 and where the boulevard width is less than 2.0 metres, the sidewalk shall cover the entire area between the curb and property line.

- Crossfall

  The sidewalk crossfall should be 2% sloping from the property line toward the curb.

  Crossfall may be permitted to vary up to $\pm$5% relative to the adjacent curb top to suit property elevations. Where the sidewalk grade slopes toward the property line, adequate drainage to the City storm drainage system shall be provided.

  If the back edge of sidewalk ends in a sharp drop to adjacent property, a 0.15 m curb along the back edge of sidewalk and/or 1.2 metre high handrail shall be constructed to provide drainage control and pedestrian safety.

- Planting Pockets

  In order to visually break up large expanses of concrete, planting pockets of shrubbery, trees and ground cover may be used adjacent to the curb.

  The plants selected for these areas shall be a species that will not; grow to restrict sight lines at driveways and intersections, encroach into traffic lanes, obscure street signs and signals, have roots that damage pavement. Trees shall not be placed under BC Hydro lines.

- Exposed Aggregate and Paving Stones

  Designs calling for finish of the sidewalk other than that shown in the Standard Drawings; using exposed aggregate, mechanical treatment of the concrete surface, or paving stones, must be examined and approved by the Engineer.

  The use of stamped concrete instead of concrete sidewalk and boulevard strip is encouraged around commercial areas as a means of enhancing the appearance of the sidewalk.

6.4 Street Lighting

A. General Street Lighting Requirements

(a) Continuity and Conformity

For street lighting requirements refer to Table 6.2, and the Surrey Subdivision By-law. The maintained horizontal illumination levels and the uniformity ratios shall comply with that specified in the most current edition of the *ANSI/ IES RP-8 National Standard Practice for Roadway Lighting* unless otherwise noted in Table 6.2.

For projects which are specific in providing night-time lighting for walkways and bikeways, the illuminance shall be in compliance with the recommended levels in the IES DG-5-94 Recommended Lighting for Walkways and Class 1 Bikeways.

Installation of street lighting components shall be in accordance with the MMCD, Supplemental Specifications for street lighting and the Standard Drawings.

(b) Light Source

The light source for luminaires shall high pressure sodium (HPS). Light sources may differ in designated areas such as Surrey City Centre, but any deviation from HPS must be approved by the Engineer.

(c) Illuminance Levels and Uniformity

Illuminance levels defined in Table 6.2 are the minimum maintained average horizontal illuminance values.

These levels should be met or exceeded in all cases. The maintained levels shall include a light loss factor (LLF) as outlined in Table 6.4.

The average to minimum uniformity ratios shall not exceed 3:1 with the exception of local residential roadways where the uniformity shall not exceed 6:1.

(d) Layout and Spacing

Street light poles shall have a staggered or opposite layout on roadways exceeding 8.5 m in width, one sided layout for roadways 8.5 m wide or less.

Street light poles shall be located in favour of intersections, property corners and pedestrian walkways.

Spacing shall be governed by roadway width, road configuration and intersecting property lines.

(e) Interconnection Conduit

1-75 mm RPVC traffic signal interconnection conduit design shall be provided in conjunction with street lighting designs of Arterial and Collector classified roadways.

The conduit shall be common trenched with the street lighting system conduit.

Type 66 concrete pull boxes will be required at maximum 100 m intervals.

The conduits shall have a 6 mm nylon pull string installed and capped ends.

The Designer shall coordinate the design with the Traffic Operations Manager to ensure the conduit system will be integral from intersection to intersection.

(f) Decorative Street Lighting

The City has designated Unique Designated Areas in which Decorative Street Lighting is utilized to enhance the streetscape. Areas such as Surrey City Center, Fleetwood, Panorama Ridge, Morgan Creek and others have decorative lighting specific to these neighbourhoods.

The City shall provide the Developer with generic details of the decorative lighting requirements and a list of approved suppliers for use in producing design drawings.

The Developer will be required to submit the following as part of the decorative lighting design:

(i) Shop drawings of the street light poles proposed complete with pole design criteria, sealed by a Professional Engineer registered in BC.
(ii) Detailed information and specifications of the luminaires proposed.
(iii) Detailed information on pole accessories (banner arms, receptacles, etc.).
(iv) 8 ½ x 11 AutoCADD drawings detailing assembled pole and luminaire units.
(v) Full size design drawings detailing the complete site installation.

B. Materials

(a) Street Light Poles

Unless special decorative lighting is required, street light poles shall be standard davit or post top type.

Davit type poles shall be 7.5 m, 9.0 m, 11.0 m or 13.5 m in height.

Post top poles shall be 6.0 m or 7.5 m in height.

Post top type poles may be used on roadways of 11.0 m width or less only, unless approved by the Engineer.

When an existing street lighting system is being expanded, the existing system standard will take precedence over the above captioned criteria, if the roadway classification and land use are identical.

(b) Luminaires

Luminaire ballasts shall be CWI or Mag Reg type.

Davit Type

Davit type luminaires shall be IES Type 2, 3 or 4 Medium Semi-cutoff distribution.

Refractors shall be glass for mounting heights of 9.0 m or greater. Polycarbonate refractors shall be used for lower mounting heights.

Post Top Type

Post top type luminaires shall be IES Type 2, 3 or 5 Medium Semi-cutoff distribution. Refractors shall be polycarbonate. Internal house side cut-off shields shall be provided with all post top luminaires.

C. Design Calculations

(a) Lighting Calculations

Lighting calculations shall be based on the illuminance methods described in ANS1/1ESNA RP-8.

When performing lighting calculations, Designers shall refer to the most current edition of the IES publications.

Computer lighting calculation shall be performed using the grid spacing shown in Figure 6.4.

Grid spacing for walkways or bikeways shall be maximum 1.0 m.

Lighting calculations shall be prepared using initial rated lamp lumens and the total light loss factor (LLF) outlined in Table 6.4.

Table 6.4
Light Loss Factors – High-Pressure Sodium[4]

Lamp Lumen Depreciation (LLD)[(1)]	Lamp Dirt Depreciation (LDD)[(1)]	Luminaire Component Depreciation (LCD)[(2)]	Equipment Factor (EF)[(3)]	Total Light Loss Factor (LLF)
0.82	0.94	0.98	0.95	0.72

Notes
(1) Based on a 5 year maintenance cycle
(2) Degradation of the reflector and refractor (glass)
(3) Effect of ambient temperature on the lamp including the ballast and lamp factors

LLF = LLD x LDD x LCD x EF

(4) For metal halide lamps, refer to manufacturer's specifications.

(b) Voltage Drop

Upon request from the City, the Designer shall submit voltage drop and load calculations for the street lighting system.

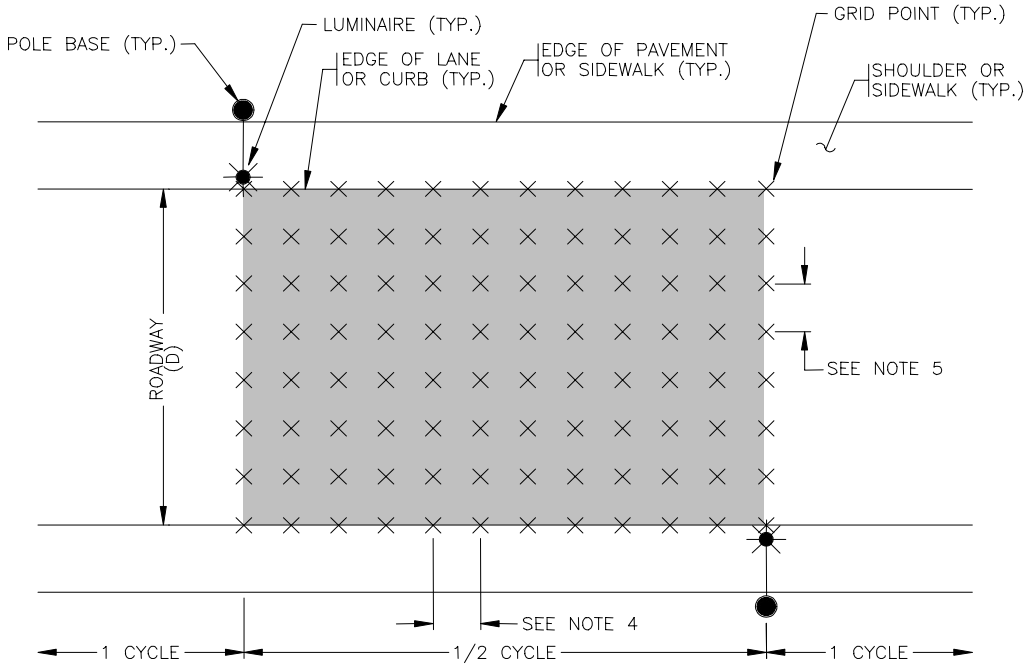

Figure 6.4
Grid Spacing for Calculating Average Horizontal Illuminance
and Average to Minimum Uniformity Ratio

Notes

1. One luminaire cycle is defined as the distance between two consecutive luminaires which are located along the same side of the roadway.
2. Calculation area is defined as the area bound by the grid points contained within a ½ cycle. (Shaded Area).
3. Calculations shall take into account 1 luminaire cycle on each side of the calculation area. (This would be a total of 6 luminaires).
4. Longitudinal grid spacing shall equal the luminaire spacing 1/2 cycle divided by 10 and shall not exceed 5 metres.
5. To obtain grid points across the roadway, divide the distance “D” by the next whole number greater than “D”. (IE. If “D” = 10.8 m then the grid spacing = 10.8/11 = 0.98 m).

6.5 Traffic Control

A. General

Traffic control devices, installed during and following the construction of a road, should support public safety, protect property, provide public convenience, and manage traffic flow.

The Designer, when designing works for a new road or altering the function or physical characteristics of an existing road, should adhere to the requirements of Design Criteria, Section 6.0, and the "TAC Geometric Design Guide for Canadian Roads, 1999". Traffic control devices must be approved by the Engineer.

B. Design Components

(a) General

The Standard Construction documents shall be used in conjunction with the *B.C. Motor Vehicle Act Regulation* Division (23) Traffic Control Devices,

and

the *B.C. Motor Vehicle Act* R.S.B.C. 1996, Chapter 318, Clauses 130-140.

It is assumed that the reader has a sound knowledge of traffic signal design. Refer to Part B, Traffic Signals, of the most current edition of the *Manual of Uniform Traffic Control Devices for Canada* (MUTCD) for information on traffic signal concepts and terminology.

SECTION 7

Unique Designated Areas

7.0 UNIQUE DESIGNATED AREAS

7.1 General Supplementary Requirements for "Unique Designated Areas"

A. General

The City of Surrey has designated several areas of the municipality as special unique areas that warrant special infrastructure services or non-standard levels of service. Prior to undertaking land development or the design of services in these areas the Developer and/or Consultant shall meet with and confirm with the Planning Department and Engineering Department all requirements and levels of services expected.

These areas have particular criteria included in this Section of the Design Criteria Manual and in Section U of the Supplementary Standard Drawings.

7.2 Bridgeview - South Westminster Requirements

A. Area

The area for Bridgeview - South Westminster is delineated on the Standard Drawings SSD-U.1.

B. Sanitary Sewers

Due to unique peat soil conditions, the Bridgeview - South Westminster area of Surrey has been serviced, in the past, by a sanitary vacuum sewer system. This system is not to be extended and will be replaced over time by a "steep grade sanitary sewer system".

Properties fronting on an existing vacuum sewer main will be permitted to connect to the vacuum sewer system within the allowable flow criteria. Proposed service connections to the vacuum sewer system must be given approval by the Engineer.

(a) Steep Grade Sanitary Sewer System - Design and Construction Criteria

Common

(i) Pipe bedding material

(a) in travelled and untravelled areas, in granular material, to be 19mm gravel or 13 mm sand to 300 mm above the pipe crown

(b) in travelled areas and peat to be 19 mm gravel up to pipe spring line
(c) in untravelled areas and peat to be 19 mm gravel up to pipe spring line

(ii) Backfill

(a) in travelled and untravelled areas, in granular material, to be granular
(b) in travelled areas and peat to be compacted native peat or imported peat
(c) in untravelled areas and peat to be compacted peat

(iii) The directional drilling method of construction may be permitted, if approved by the Engineer.

Collector Sewers

(i) Pipe diameter to be 200 mm

(ii) Minimum depth

(a) in travelled areas to be 1.0 metre
(b) in untravelled areas to be 1.0 metre

(iii) Minimum pipe grade

(a) upstream section to be 1.0%
(b) downstream section, where applicable, to be 0.8%

(iv) Maximum spacing between manholes to be 100 metres

(v) Pipe material to be PVC DR 18 with concrete filled sandbags to compensate for buoyancy

(vi) Pipe joints to be Bell and Spigot

Manholes

(i) Barrel material to be fibreglass reinforced plastic (FRP)
(ii) Base material to be concrete designed to compensate for buoyancy
(iii) Manhole stubs to be FRP or PVC integral with the barrel
(iv) Manhole cover to be cast iron

Service Connections

(i) Pipe material

(a) between collector sewer and the inspection chamber (IC) to be PVC DR 18 with concrete filled sandbags to compensate for buoyancy

(b) upstream of the inspection chamber to be PVC DR 18 with concrete filled sandbags to compensate for buoyancy

ii. Minimum pipe grade to be 2.0%
iii. Maximum drop connection pipe grade to be 100%

Pump Stations

(i) Materials

(a) Wet well to be fibreglass reinforced plastic (FRP)
(b) Ballast to be concrete designed to compensate for buoyancy

(ii) Pipe stubs to be FRP or PVC integral with the wet well
(iii) Pumps to be duplex submersible sewage pumps to pass 75 mm solids
(iv) Internal pipeline to be ductile iron or steel (corrosion protection method to be approved by the Engineer
(v) Internal fittings to be cast iron or ductile iron
(vi) Check valves to be cast iron with outside lever and weight
(vii) Valves to be eccentric plug valves
(viii) Miscellaneous metals to be stainless steel or aluminum
(ix) Bolts to be stainless steel
(x) Electrical equipment to be housed in a kiosk with a fan
(xi) Wash down to be local hydrant or stand pipes
(xii) Level control switches to be Milltronics Multi-Ranger Plus with additional low-level intrinsically safe float switches

Force Main

(i) Material to be polyethylene pipe with fused joints and concrete filled sandbags to compensate for buoyancy

Design Features

The system design shall have pumped units located within collector road and arterial road network cells to minimize road crossings.

The pumping stations are to be located in the areas of deepest peat.

The sewers are to grade from deep peats to shallower peats.

Utilize the existing vacuum system force mains where possible.

Paved vehicular access shall be provided to the pumping stations.

(b) Vacuum Sewers

- Design Flow

  Surrey's vacuum sewer system is designed to accept a sewage discharge of 2,500 litres per hectare of commercial/industrial property per day, or 1,000 litres per single family dwelling unit per day with instantaneous rate of discharge not exceeding 7.5 litres per property over any 15 second interval.

  No allowance shall be made for groundwater infiltration into the system.

- Building Sewer

  The gravity pipe must be leak-tight and must have a minimum of 1% fall towards the interface unit comprising of the vacuum valve with integral actuator. This is shown in the Standard Drawings SSD-U.1.1.

- Vacuum Service Connection

  The vacuum service connection joins the interface unit to the vacuum sewer. Normally, the gravity connection is below the vacuum sewer and the lift is taken in the valve chamber and/or service connection to compensate for the difference in elevation as well as for providing slope towards the main.

  There shall be a maximum 1.5 metres from the invert of the valve chamber to the valve outlet.

  Pipe in the service connection shall be at least one size smaller than the main and must be laid with at least 1% fall towards the sewer main.

C. Road Sections

Typical road sections are shown on the Standard Drawings SSD-U.1.3. Typical driveway crossings are shown in Standard Drawings SSD-U.1.4 and SSD-U.1.5.

7.3 West Panorama Ridge Requirements

A. Area

The area for West Panorama Ridge is delineated on the Standard Drawings SSD-U.2.

B. Ditch Crossings

Specific ditch crossing details for West Panorama Ridge are shown on the Standard Drawings SSD-U.2.1.

C. Road Sections

Typical road sections are shown on the Standard Drawings SSD-U.2.2.

West Panorama Ridge Area: 70 Watt post top street lights required only at intersections of arterial and collector roads. No streetlights shall be installed in other locations unless authorized by the Engineer. (See Table 6.2)

7.4 Surrey City Center Requirements

A. Area

The area for Surrey City Center is delineated on the Standard Drawings SSD-U.3.

B. Roadworks System

Specific roadworks system details for Surrey City Center are shown on the Standard Drawings SSD-U.3.1.

C. Interim Standards

A five year moratorium (expiring July 28, 2003) has been instituted for the following development requirements:

- undergrounding of existing overhead wiring;
- installation of special City Centre street lights.

All other design criteria apply.

7.5 Central Semiahmoo Requirements

A. Area

The area for Central Semiahmoo is delineated on the Standard Drawings SSD-U.4.

B. Roadworks System

Specific roadworks system details for Central Semiahmoo are shown on the Standard Drawings SSD-U.4.2 to SSD-U.4.4.

Street lighting shall be Post top style to the RH-G standard.

APPENDIX R: City of Surrey Supplementary MMCD

SURREY
CITY OF PARKS

CITY OF SURREY
Engineering Department

SUPPLEMENTARY MASTER MUNICIPAL CONSTRUCTION DOCUMENTS

SUPPLEMENTARY GENERAL CONDITIONS

SUPPLEMENTARY SPECIFICATIONS

SUPPLEMENTARY STANDARD DRAWINGS

May 2004

SURREY
CITY OF PARKS

City of Surrey

Supplementary Master Municipal Construction Documents

USERS REGISTRATION FORM

FAX BACK AT 604-591-8693

Document holders must complete this registration form and forward by fax to the City's Utilities Manager at (604) 591-8693 to receive updates and information pertaining to the document if any are issued. Please verify the City of Surrey web site before using this document to ensure you are using the most up-to-date version.

BUSINESS NAME: _____

_____

CONTACT: _____

BUSINESS ADDRESS: _____

_____

_____

TELEPHONE: _____

FAX: _____

INTERNET E-MAIL ADDRESS: _____

SURREY
CITY OF PARKS

CITY OF SURREY
Engineering Department

STANDARD CONSTRUCTION DOCUMENTS

SUPPLEMENTARY GENERAL CONDITIONS

May 2004

SUPPLEMENTARY GENERAL CONDITIONS

The following conditions form part of the *Contract* and are supplementary to the MMCD General Conditions and Specifications. In the event of a direct conflict between the MMCD General Conditions and these Supplementary *GC*s, the Supplementary *GC*s take precedence. Notwithstanding this order of precedence, in the event of a conflict between or within any of the *Contract Documents*, the more stringent provisions shall apply with the intent that those which produce the highest quality with the highest level of safety, operational reliability, durability and performance, shall govern.

DEFINITIONS **1**

1.4 Delete *GC* 1.14 and substitute the following:

1.14 "***Contract Administrator***" means the person, firm or corporation appointed by the *Owner* in writing to the *Contractor*. The *Contract Administrator* may be the *Owner's* Engineer, other employee or officer, or may be an outside consultant. Pursuant to the Builders Lien Act, the *Contract Administrator* shall be the Payment Certifier.

1.6 To *GC* 1 DEFINITIONS add the following:

1.61 ***"Archaeological Artifacts"*** means any fossils, artifacts, coins, articles of value or antiquity, remains, and other things of geological, archaeological or historical interest or value discovered at the *Place of the Work*.

1.62 ***"City of Surrey Certificate of Insurance"*** means that certain document form entitled *"City of Surrey Certificate of Insurance"* completed by the *Owner* and the Owner's insurer, a copy of which is available on request through the *Contract Administrator*.

1.63 ***"Commencement Date"*** has the meaning set out in paragraph 5.12 of the Form of Tender.

1.64 ***"Highway"*** includes a street, road, lane, bridge, thoroughfare, sidewalk, boulevard, viaduct and any other way open to public use.

1.65 ***"Public Art"*** means publicly accessible original art that the *Owner* separately contracts and that is funded through the capital cost of the *Work* and is created and/or installed at or near the *Work*.

1.66 ***"Utilities"*** is used broadly and includes but is not limited to any and all lines, poles, structures, facilities, utilities for power, cable TV, telephone, telecommunications, all sanitary and storm sewers, all water, oil, gas and electric services, all steam pipes and services, all survey monuments, all street lights, traffic lights, traffic detector loops embedded in pavement, culverts, rail tracks, whether located above or below ground, whether visible or invisible, whether man-made or natural.

DOCUMENTS **2** Delete GC 2.2.4 a) and substitute the following:

2.2.4 a) the *Contract Documents* shall govern and take precedence in the following order with the Agreement taking precedence over all other *Contract Documents*:

i) Agreement

ii) Addenda

iii) Supplementary General Conditions (Project), if any

iv) Supplementary General Conditions

v) General Conditions

vi) Supplementary Specifications (Project)

vii) Supplementary Specifications

viii) Specifications

ix) Drawings list in Schedule 2 to the Agreement

x) Supplementary Detail Drawings

xi) Standard Detail Drawings

xii) Executed Form of Tender

xiii) Instructions to Tenderers

xiv) All other *Contract Documents*

CONTRACT ADMINISTRATOR **3** No Change

CONTRACTOR **4**

Control of the *Work* 4.1 To *GC* 4.1 add the following:

4.1.3 If the *Contractor* fails to clean up the *Site* when so ordered by the *Contact Administrator*, the *Owner* may proceed to do whatever is necessary to restore the *Site* to as tidy a condition as before the commencement of the *Work* and charge the cost thereof against the *Contractor* and set-off the costs thereof against the *Contract Price*.

Protection of *Work*, Property and the Public

4.3 Delete *GC* 4.3.1 and substitute the following:

4.3.1 In performing the *Work* the *Contractor* shall protect the *Work*, the *Owner*'s property and other person's property from damage. The *Contractor* shall at the *Contractor*'s own expense, make good any such damage and indemnify the *Owner* from any loss or expense which arises as a result of the *Contractor*'s operations.

4.3 Delete *GC*s 4.3.4, 4.3.5 and 4.3.6.

To *GC* 4.3 add the following:

4.3.4 The *Owner* does not possess complete or accurate information with respect to the occurrence or the location of existing *Utilities* that will or may be encountered by the *Contractor* during the performance of the *Work*. Any plans, surveys, maps or descriptions of *Utilities* given to the *Contractor*, verbal or otherwise, are intended only as an aid to assist the *Contractor* in locating these construction obstacles. However, the *Contractor* is solely responsible to take all steps necessary to investigate, locate, verify and protect all *Utilities*.

4.3.5 The *Contractor* hereby saves the *Owner*, its elected and appointed officials, employees and agents harmless from and against all liability, actions, causes of action, claims damages, expenses, costs, debts, demands or losses suffered or incurred by them or any of them, including consequential damages and damages to third parties, whether known or unknown, foreseeable or not, for which the *Owner* or any of them might be liable arising from the provision of or failure to provide information regarding *Utilities*.

4.3.6 In performing *Work* on or near *Utilities*, or where it is necessary to cut, move or alter any *Utilities*, the *Contractor* shall communicate and make arrangements with the proper authorities and perform the *Work* in compliance with any direction or instruction received from that authority. Any damage to *Utilities* by the *Contractor* shall be repaired at the *Contractor*'s expense. Where *Utilities* are serving the public while construction is in progress, it shall be the responsibility of the *Contractor* to plan and execute the *Work* such that the disruption of service provided by such *Utilities* is held to a minimum.

The Contractor shall give Terasen Gas three weeks notice and shall allow additional two weeks for them to carry out any relocation work when crossing a Terasen line.

4.3.7 Where any part of the *Work* is to be performed on private property, it is the responsibility of the *Owner* to arrange for and acquire required rights-of-way. However, the *Contractor* shall ensure that its *Work* on private property is co-ordinated with the *Contract Administrator*. The *Contractor* shall not attend on any private property until the *Contract Administrator* has confirmed to the *Contractor* in writing that the *Work* thereon may proceed.

4.3.8 While it is anticipated that the *Owner* will be able to arrange required access to private property in a timely fashion, the *Contractor* will be flexible in accommodating delays or *Changes* in the sequence or schedule of the *Construction Schedule*, without additional compensation.

4.3.9 On completion of *Work* in or rights-of-way, the *Contractor* shall deliver to the *Contract Administrator*, a formal release in writing, in a form provided by the *Owner*, signed by each owner of private property on which the *Work* was performed, verifying that the *Contractor* has cleaned up the private property to that owner's satisfaction and that the owner has no claim upon the *Contractor* or the *Owner* as a result of the *Work*.

4.3.10 The *Contractor* shall keep all portions of the *Work* well, properly and efficiently drained during construction and until *Total Performance*. The *Contractor* shall be responsible for locating and connecting all functional service connections of adjacent properties. The *Contractor* shall be liable for all loss, damage and expense resulting from the *Contractor*'s failure to comply strictly with this obligation.

Inspections

4.12 Delete *GC* 4.12.1 and substitute the following:

4.12 4.12.1 The *Contractor* is solely responsible for ensuring that the *Work* is performed in accordance with the requirements of the *Contract Documents*. The *Contractor* shall perform or cause to be performed all tests, inspections and approvals of the *Work* as required by the *Contract Documents* or as required by the *Contract Administrator*. Any reference in the specifications to inspection and testing shall mean that the *Work* described in the specification must be inspected and tested in a manner approved by the *Contract Administrator*. The *Contractor* shall only employ or engage as agent or consultant for testing, a person approved by the *Owner*. Where the specification indicates that the *Contract Administrator* will arrange for testing, the *Contractor* continues to be solely responsible for testing of the *Work*. Upon immediate completion of each test, certified copies of each test shall be submitted by the testing laboratory directly to the Contract Administrator.

4.12 To *GC* 4.12 add the following:

4.12.6 Neither the performance of tests or inspections by the *Owner* or the *Contract Administrator*, nor the arranging for performance of tests or inspections by the *Owner* or by the *Contract Administrator* nor the acceptance of the *Work* by the *Owner* or *Contract Administrator* shall relieve the *Contractor* of its responsibility for the proper performance of the *Work* or make the *Owner* or the *Contract Administrator* liable for inspections or testing or for the *Work* if it is subsequently determined that the *Work* as performed does not comply with the requirements of the *Contract*.

SHOP DRAWINGS **5** No Change

OTHER CONTRACTORS **6** No Change

CHANGES **7**

7.1 To *GC* 7.1 add the following:

7.1.5 All *Change Orders* shall be approved by the *Owner* before proceeding with the *Work*.

EXTRA WORK **8** No Change

VALUATION OF CHANGES AND EXTRA WORK **9** No Change

FORCE ACCOUNT **10** No Change

CONCEALED OR UNKNOWN CONDITIONS **11**

Definition 11.1 Delete *GC* 11.1.1 and substitute the following:

11.1 11.1.1 A "*Concealed or Unknown Condition*" means either *Hazardous Materials* or *Archaeological Artifacts* not disclosed in the *Contract Documents* or observable in the *Contractor's* inspection of the *Place of the Work*.

11.1 To *GC* 11.1 add the following:

11.1.2 The risk of, responsibility and liability for *Utilities* and subsurface soil conditions, known or unknown, rests solely with the *Contractor*. The *Contractor* acknowledges and agrees that it has not relied on the accuracy or completeness of any data or information provided by or on behalf the *Owner* in assessing these risks. The *Contractor* acknowledges and agrees that it has conducted its own independent investigations and has taken into account the risks of unknown or concealed conditions, other than those defined in *GC* 11.1.1 hereof and the *Contract Price* for the *Work* includes for these risks.

HAZARDOUS MATERIALS **12** No Change

DELAYS **13** No Change

ACCELERATION **14** No Change

OWNER'S RIGHTS ON CONTRACTOR'S DEFAULT **15**

Notice of Default 15.2 Delete *GC* 15.2.1 and substitute the following:

15.2 15.2.1 On the occurrence of any one or more of the following events:

a) it is discovered that any representation or warranty made by the *Contractor* herein was false or materially misleading when made;

b) the *Contractor* fails to procure or maintain any bonds or required insurance coverage's;

c) the *Contractor* fails to comply with the requirements or obligations of the Workers Compensation Act;

d) the *Contractor* fails to commence the *Work* in the time required;

e) the *Contractor* fails to diligently proceed with and prosecute the *Work*;

f) the *Contractor* fails to execute the *Work* in strict accordance with any of the terms of the *Contract*;

g) the *Contractor* fails to pay any *Subcontractor* for *Work* done; or

h) the *Contractor* fails to comply strictly with any requirements of the *Contract.*

the *Owner* may notify the *Contractor* in writing that the *Contractor* is in default of the *Contractor*'s contractual obligations and instruct the *Contractor* to correct the default in the five (5) *Days* immediately following the receipt of such notice.

CONTRACTOR'S RIGHTS ON OWNER'S DEFAULT **16**

***Work* Stoppage** 16.2 Delete *GC* 16.2.2 and substitute the following:

16.2.2 The *Owner* may, at its discretion, stop all or part of the *Work*, in which event, subject to GC 16.2.3, the provisions of GC 13 (Delays) shall apply. If the *Work* stoppage required under this GC 16.2.2 continues for 60 calendar *Days*, and provided the *Work* stoppage is not required or requested to accommodate seasonal *Work*, the *Contractor* may, by giving notice to the *Owner* in writing, terminate the *Contract.*

16.2 To *GC* 16.2 add the following:

16.2.3 The *Owner* may stop all or part of the *Work* if the *Contractor* is performing the *Work* in a manner that is not consistent with the requirements of the *Contract.* Such *Work* stoppage shall not give rise to entitlement to extension of *Contract Time* pursuant to *GC* 13.

Termination 16.4 Delete *GC* 16.4 and substitute the following:

16.4 16.4.1 If the *Contractor* terminates the *Contract* GC 16.2.2, the *Owner* shall pay the *Contractor*:

a) for *Work* done under the *Contract*, pursuant to the terms of the *Contract*; plus

b) reimbursement of expenditures, such as for products, materials, services, *Subcontractors* and equipment, which the *Contractor* incurred to the date of termination on account of the remaining *Work.*

16.4.2 The amounts recoverable by the *Contractor* pursuant to *GC* 16.4.1 shall be the *Contractor's* sole remedy for costs, damages and expenses resulting from the events giving rise to the termination by the *Contractor.* In no event shall the *Contractor* be entitled to claim or recover against the *Owner* any costs, damages or expenses, whether for breach of *Contract* by the *Owner* or pursuant to the *Contract*, for loss of anticipated profits, consequential damages, impact costs, loss of contribution to overhead or any amount, other than those amounts recoverable pursuant to *GC* 16.4.1.

DISPUTES **17** No Change

PAYMENT **18**

Payment 18.5 Delete *GC* 18.5.1 and substitute the following:

18.5 18.5.1 The net amount shown for payment on a *Payment Certificate* shall be due and payable to the *Contractor* on or before the thirtieth (30th) calendar day from receipt of the *Payment Certificate* by the *Owner.*

TAXES, DUTIES AND GST **19** No Change

LAWS, NOTICES, PERMITS AND FEES **20** To *GC* 20.3 add the following:

20.2.3 In addition to the requirements of *GC* 20.2.2, the City will apply for permit from Ministry of Transportation for work performed on Provincial highways and including their rights-of-way. The Contractor shall obtain a copy of the permit from the City and shall comply with all conditions of the permit.

WORKERS' COMPENSATION REGULATIONS **21**

Compliance with Workers' Compensation Requirements 21.3 To *GC* 21.3 add the following:

21.3.3 The *Contractor* acknowledges and agrees that for purposes of the Occupational Health & Safety Regulation of the Province of British Columbia, B.C. Regulation 296/97, including but not limited to Section 3.3(2) of Core Requirements, Parts 1-4 and Sections 20.1, 20.2 and 20.3 of Industry/Activity Specific Requirements Parts 20-33, and any amendments or successors thereto, the *Contractor* shall be the "prime contractor" for the Project and shall comply with all requirements of the aforesaid regulation.

INDEMNIFICATION **22** No Change

DAMAGES AND MUTUAL RESPONSIBILITY **23** No Change

INSURANCE **24**

Required Insurance 24.1 Delete *GC* 24.1.1 b) and substitute the following:

24.1.1

b) Wrap Up Comprehensive General Liability Insurance covering bodily injury, death and property damage with occurrence and aggregate limit to $5,000,000.00.

The policy will be endorsed to include the *Owner*, the *Contract Administrator* and all *Subcontractors* as named additional insureds. Contractual liability coverage will be of sufficient scope to include the liability assumed by the *Contractor* under the terms of this *Contract* and the on-site creation and installation of any Public Art undertaken in conjunction with the *Work*. The insurance shall include:

- Premises and Operations
- Broad Form Products and Completed Operations;
- *Owner*'s and *Contractor*'s Protective Liability;
- *Contractor*'s Contingent Liability;
- Blanket Written Contractual;
- Contingent Employer's Liability;
- Non-Owned Automobile;
- Cross Liability/Severability of Interests;
- Employees as Additional Insureds;
- Personal Injury;
- Broad Form Property Damage;
- Broad Form Loss of Use.

and where such further risk exists:

- Shoring, Blasting, Excavating, Underpinning, Demolition, Removal, Pile-driving and Caisson Work, Work Below Ground Surface, Tunnelling and Grading, as applicable;
- Elevator and Hoist Liability;
- Operation of Attached Machinery;

Any deductible shall be for the account of the *Contractor* and shall not exceed $2,500.00 for any one occurrence.

24.1 To *GC* 24.1.1 c) add the following:

24.1.1

c) Any deductible shall be for the account of the *Contractor*. The policy will include coverage for flood and earthquake, and shall extend to cover any Public Art undertaken in conjunction with the *Work*, and property at any other location, while in transit and during erection, installation and testing. Coverage shall extend to protect the interest of the *Owner*, and to the extent that the *Owner* has an insurable interest, the policy will have the *Owner* as first loss payee. The insurance shall include:

- a Breach of Conditions clause, "Notwithstanding anything contained elsewhere in this policy, any breach of a condition of the policy, whether by commission or omission, by one of the parties hereby insured shall not prevent recovery by any other party or all parties hereby insured who are innocent of any such act or breach.", and
- coverage of resultant damage from error in design that are carried out by the Contractor; and
- coverage of resultant damage from faulty workmanship; and
- coverage of resultant damage from faulty materials.

MAINTENANCE PERIOD **25** No Change

EARLY USE OF THE WORK **26** No Change

Add the following *GC* 27, 28, 29, 30, 31, 32, 33, 34 and 35:

MAINTENANCE OF HIGHWAYS **27**

Highway Maintenance 27.1

27.1.1 The *Contractor* is responsible for the maintenance and repair of any *Highway* affected by the *Work*.

27.1.2 *Work* on a *Highway* shall be carried out in such a manner that will not prevent traffic on any *Highway* or prevent access to property fronting on the *Highway* without first having obtained permission to do so from the authorities having jurisdiction. In that regard, the *Contractor* shall perform its *Work* in strict compliance with the requirements, rules, regulations and by-laws of any Federal, Provincial or municipal authority having jurisdiction.

TRAFFIC CONTROL **28**

Traffic Control 28.1

28.1 In addition to all other obligations contained in the *Contract Documents* or any of them, the *Contractor* shall, at its own expense:

a) apply for and obtain all permits required including any City Road & Right of Way Permit and Traffic Obstruction Permit;

b) submit a traffic control plan to the *Owner*'s Traffic Operations Manager for review and approval;

c) where it is necessary to dig a trench across a *Highway*, provide, install and maintain suitable temporary crossings to control traffic. The *Contractor* shall be liable for all loss, damage or expense to person or property arising out of the provisions, installation and maintenance of such crossings;

d) unless expressly referred to in the *Contract Documents*, under ordinary conditions, temporary road closures will not be permitted. The *Contractor* should organize and schedule the *Work* so as to minimize the need for temporary road closures and detours;

e) where temporary road closures are permitted by the *Owner*, advise the *Contract Administrator*:

i) at least five (5) *Days* prior to the date of any desired partial closure, and

ii) at least ten (10) *Days* prior to the date of a any desired full closure,

so that the *Owner* may assess traffic control priorities and coordinate with *Other Contractors* working in the area. If there are conflicts with *Other Work*, the *Contractor* will be advised of alternate periods during which he may affect the requested traffic control measure;

f) notify police, fire, BC Hydro and BC Transit before affecting the traffic control measure;

g) comply fully with the following:

i) detours permitted between the hours of 9:00 a.m. and 3:30 p.m. only,

ii) one lane traffic must be maintained and kept open at all times for buses and emergency vehicles,

iii) local traffic must be accommodated through the construction zone without hazard and with the least possible delay,

h) prior to commencement of the *Work*, prepare and deliver a list of all signs, such as traffic control signs, school signs and playground signs. Maintain these signs at all times during the construction. When the permanent signs are removed during construction, the *Contractor* shall keep and maintain temporary signs of equal quality in place at all times until permanent replacement signs are reinstated;

i) protect mailboxes at all times during construction. If mailboxes cannot be maintained, the *Contractor* shall make suitable arrangement for the delivery of mail to the residents affected.

PUBLIC CONVENIENCE, ACCESS, CLEAN-UP **29**

Public Convenience 29.1

29.1.1 In addition to all other obligations contained in the *Contract Documents* or any of them, the *Contractor* shall, at its own expense:

a) carry out the *Work* so as to minimize the inconvenience to the public;

b) deliver to businesses and residents copies of letters provided to the *Contractor* by the *Owner*, advising these persons of intended construction activities. The *Contractor* shall deliver these letters no sooner than ten (10) *Days* and no later than five (5) *Days* before the start of construction in the affected area;

c) not obstruct any *Highway* longer or to any greater extent than is absolutely necessary;

d) provide full, proper and safe access to, from and past buildings and properties, both for vehicles and pedestrians, and for this purpose construct and maintain, in good order and serviceable condition, suitable and convenient platforms, approaches, structures, bridges, crossings or similar works;

e) ensure that closed sidewalks are:

i) closed by signs and barricades at the first acceptable intervening street or avenue, and at the location where the sidewalk is discontinuous, and

ii) provided with an alternative temporary walkway approved by the *Contract Administrator*,

f) not deposit any material upon any *Highway* without first obtaining the approval of the *Contract Administrator* to the location, manner of placement, nature of the material to be deposited and length of placement of the material;

g) as the *Work* proceeds or as directed by the *Contract Administrator*, remove and dispose of all rubbish and other deleterious material, remove false-work, forms, temporary structures, all equipment and machinery, and leave the *Work* in a clean, tidy and fully-restored condition. All curbing, sidewalks, drainage ditches and

culverts, shrubs, fences and other surface properties that have been removed, damaged or disturbed in the performance of the *Work* shall be restored or replaced to a condition equivalent to that which existed before the *Work* began.

PATENTS AND COPYRIGHTS **30**

Patent and Copyright Compliance 30.1

30.1.1 The *Contractor* shall pay all royalties, patents and license fees applicable to any portion of the *Contract Work.* The *Contractor* is obligated to ensure that the *Work* as performed does not breach any copyright, patent or license agreement.

Indemnification 30.2

30.2.1 The *Contractor* hereby releases, indemnifies and saves harmless the *Owner,* its elected and appointed officials, employees and agents from and against any and all liability, actions, causes of action, claims damages, expenses, costs, debts, demands or losses suffered or incurred by the City, (including but not limited to, solicitor and own client costs) for or on account of or incurred by reasons of any actual or alleged breach by the *Contractor* of any patent, license or copyright.

HOURS OF WORK **31**

Regulation of *Work* Hours 31.1

31.1.1 In scheduling and performing its *Work* the *Contractor* shall comply with any ordinance, by-law or regulation affecting or limiting the hours of *Work.*

31.1.2 Unless the *Contract Administrator* otherwise agrees, the *Contractor* shall not perform *Work* beyond the standard eight (8) hour *Day.*

31.1.3 Unless the *Contract Administrator* otherwise agrees, the *Contractor* shall not perform *Work* on a Saturday, Sunday or holiday.

31.1.4 Where *Work* is performed on a Saturday, Sunday, holid*ay* or on an overtime basis, the *Contractor* agrees to pay the *Owner* for all costs of any required employees, agents, consultants and inspectors. The *Owner* may deduct and set-off these costs from any amount due to the *Contractor.*

TERMINATION **32**

32.1 32.1.1 The *Owner* may at any time and without reasonable cause, terminate the *Contract*, in whole or in part, by giving fifteen (15) calendar *Days* written notice of termination to the *Contractor*.

32.1.2 After receipt of a written notice of termination, and except as otherwise directed by the *Contract Administrator*, the *Contractor* shall:

a) stop *Work* under the *Contract* on the date and to the extent specified in the notice of termination;

b) place no further orders or subcontracts except as may be necessary for completion of such portion of the *Work* as is not terminated;

c) as directed by the *Contract Administrator*, terminate all orders and subcontracts to the extent that they relate to the performance of *Work* terminated by the notice of termination and/or assign, transfer and deliver to the *Owner* in the manner, at the times, and to the extent directed by the *Contract Administrator*, all of the right, title and interest of the *Contractor* under the subcontracts;

d) transfer title and deliver to the *Owner* in the manner, at the times and to the extent, if any, directed by the *Contract Administrator*, the fabricated or unfabricated parts of *Work* in process, completed *Work* produced as part of, or acquired in connection with the performance of, the *Work* terminated by the notice of termination and in the *Contractor*'s possession or reasonable control;

e) complete performance of such part of the *Work* as shall not have been terminated by notice of termination; and

f) mitigate the costs for which the *Owner* may be liable.

32.1.3 Upon termination of the *Work* for convenience, the *Contractor* shall be entitled to be paid:

a) for *Work* done under *Contract*, pursuant to the terms of the *Contract*; plus

b) the reasonable and necessary expenses paid or incurred by the *Contractor* in connection with such termination.

33.1.4 If the *Owner* terminates the *Contract* pursuant to *GC* 15.3 and it is subsequently determined that the termination was wrongful for any reason, then the termination pursuant to *GC* 15.3 shall be

deemed to be and have been a termination for convenience pursuant to *SGC* 33 and the *Contractor's* entitlement to compensation or damages for termination shall be limited to those costs recoverable under *GC* 33.1.3.

ARCHAEOLOGICAL ARTIFACTS 33

Archaeological Artifacts 33.1

33.1.1 Any *Archaeological Artifacts* discovered by the *Contractor* shall, as between the *Owner* and the *Contractor*, be deemed to be the absolute property of the *Owner*.

33.1.2 The *Contractor* shall immediately advise the *Contract Administrator* of the discovery by the *Contractor* of any *Archaeological Artifacts* and take all reasonable precautions to protect and preserve same.

NON-RESIDENTS 34

Non-Residents 34.1

34.1.1 If the *Contractor* is a non-resident of British Columbia, it shall:

a) obtain all necessary approvals, consents, permits, licenses, certificates, registrations and other authorizations required to comply with all applicable laws, regulations, by-laws or Codes in the performance of the *Work*; and

b) obtain from the Retail Sales Tax Office, a certificate confirming that the *Contractor* has duly registered, and provide proof of same to the *Contract Administrator*, prior to commencement of the *Work*.

34.1.2 The *Contractor* shall ensure that all *Subcontractors* who are non-resident in British Columbia have obtained all necessary approvals, consents, permits, licenses, certificates, registrations and other authorizations required to comply with all applicable laws, regulations, by-laws or Codes in the performance of the *Work*, and have registered with the Retail Sales Tax Office, has a Goods and Service Tax registration number, a provincial Retail Sales Tax registration number and a Workers Compensation Office registration number.

34.1.3 The *Contractor* is responsible to ensure that all applicable taxes or remittances are made by itself and its *Subcontractors* and in relation to non-resident *Subcontractors*, any applicable retentions or withholdings are made.

SURREY
CITY OF PARKS

CITY OF SURREY
Engineering Department

STANDARD CONSTRUCTION DOCUMENTS

SUPPLEMENTARY SPECIFICATIONS

May 2004

The City of Surrey "Supplementary Specifications" are supplemental specifications to the **Master Municipal Construction Document (Printed 2000) (MMCD),** and take precedence over the MMCD Specifications.

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GENERAL REQUIREMENTS (MMCD Specifications Division 1)

SS 1.1 Utilities

.1 The Contractor shall inform the respective utility agencies with sufficient notice in regard to the affected utility covers. The Contractor shall loosen the utility covers for adjustment by others and to have the adjustment completed at least one day prior to paving.

.2 All waterworks valve box covers that are not Nelson type shall be replaced with circular Nelson type service box covers. These circular Nelson type service box covers will be supplied by the City. All box covers that are removed and not reused shall be delivered to the City's Works Yard at 6645 - 148 Street, Surrey. For all waterworks valve covers, Contractor shall make the adjustment as instructed.

.3 No separate payment will be made for this work. Payment for this work is deemed to be included in the respective items tendered.

.4 No payment shall be made for any delays resulting from this work not being completed prior to paving as required.

SS 1.2 Weigh Ticket Control

.1 For items that are measured by weight, the Contractor shall:

.1 co-ordinate his work so that no more than two Engineer's representatives are required to collect and check the weigh tickets at any one time.

.2 arrange weigh tickets to be collected and verified at specific locations on the site as agreed by the Engineer.

.2 The Engineer can refuse approval of tickets received after the day of placement. Payment is only for the material completely incorporated into the works as witnessed by the Engineer's representative.

.3 If the Contractor fails to meet any of these conditions, the Engineer has the right to refuse approval of any weigh tickets presented.

SS 1.3 Payment

.1 Payment for services, activities and works under Division 1 - General Requirements and General Conditions shall deem to be included in the prices tendered as shown in the Schedule of Quantities and Prices.

.2 No separate payment will be made for haulage. The payment for this work is deemed to be included in the respective unit prices tendered.

SS 1.4 Traffic Regulation
(MMCD Section 01570)

.1 Signs shall be reflectorized to a minimum 3M Engineering Grade Standard.

.2 Symbolic messages shall be used where a symbolic message exists (as per B.C. Traffic Control for Work on Roadways Manual).

.3 Signs that are not conforming to standards will be removed and replaced with suitable signing at Contractor's cost.

.4 Obtain prior approval from the Engineer on all construction speed limit changes before placement of the signs.

.5 With exception of stop signs and street markers all regulatory signage should not be installed until the one year maintenance period has expired.

.6 Where it is necessary to temporarily disrupt on-street parking for construction:

- .1 Distribute 48-hour advance notices to residents.
- .2 Supply and erect temporary no-parking signs.
- .3 Do not impound parked vehicles unless instructed to do so by RCMP.
- .4 Vehicles may be towed at Contractor's risk and expense to a nearby location. Inform registered owner as soon as possible where vehicle has been relocated. Do not charge vehicle recovery or towing fees to vehicle owner.

SITE WORK (MMCD Specifications Division 2)

SS 2.1 Mass Excavation

1.0 GENERAL

.1 Section SS 2.1 refers to those portions of work required for the removal and disposal off-site of all above ground and underground structures including pipes, asphalt, concrete, reinforced concrete, granular materials, concrete slabs and obstacles, specifically designated on the Drawings and/or as specified.

1.1 Related Work

		MMCD
.1	Clearing and Grubbing	Section 02111
.2	Site Grading	Section 02210
.3	Excavating, Trenching and Backfilling	Section 02223
.4	Roadway Excavation, Embankment and Compaction	Section 02224
.5	Reshaping Granular Roadbed	Section 02231
.6	Reshaping Existing Subgrade	Section 02235
.7	Hot-Mix Asphalt Concrete Paving	Section 02512
.8	Concrete Walks, Curbs and Gutters	Section 02523
.9	Cold Milling	Section 02574
.10	Full Depth Reclamation	Section 02575

1.2 Protection

.1 Protect in accordance with MMCD Section 02223 - Excavating, Trenching and Backfilling.

.2 Protect existing items designated to remain and materials designated for salvage. In event of damage to such items, immediately replace or make repairs to approval of Engineer.

1.3 Measurement for Payment

.1 Payment will be made in Lump Sum. Clearing and Grubbing in MMCD Section 02111 will be included in this payment. This price shall also include rough grading, loading, shaping, hauling and disposal of spoil, pavement cutting and removal, sod cutting and storage or removal. This payment covers all mass excavation carried out under roadways, sidewalks, curbs, driveways, drainage, water and sanitary works, street lights, traffic lights and structural works of the Contract.

3.0 EXECUTION

3.1 Preparation

.1 Inspect site and verify with Engineer those items designated for removal and items to remain.

3.2 Removal

.1 Remove items as indicated and/or as specified.

.2 Do not disturb adjacent items designated to remain in place.

.3 In removal of pavements, curbs and gutters:

.1 Square up adjacent asphalt surfaces to remain in place by saw cutting only.

.2 Protect adjacent joints and load transfer devices.

.3 Protect underlying granular materials.

.4 When removing reclaimed asphalt pavement (RAP) for subsequent incorporation into hot mix asphalt concrete paving, prevent contamination with base coarse aggregates.

.5 When removing pipes under existing or future pavement area, excavate at least 300 mm below pipe invert.

3.3 Salvage

.1 Carefully dismantle items containing materials for salvage and stockpile salvaged materials at locations as indicated by Engineer.

3.4 Sealing

.1 Seal pipe ends and walls of manholes or catch basins as indicated or as directed. Secure plug to form watertight seal.

3.5 Disposal of Material

.1 Dispose of materials not designated for salvage or re-use in work.

3.6 Backfill

.1 Backfill in accordance with MMCD Section 02223 - Excavating, Trenching and Backfilling.

3.7 Restoration

.1 Upon completion of work, remove debris, trim surfaces and leave work site clean.

.2 Reinstate areas and existing works both within and outside areas of mass excavation to conditions that existed prior to commencement of work.

SS 2.2 Clearing and Grubbing
(MMCD Section 02111)

1.0 GENERAL

1.1 Measurement for Payment

.1 No separate payment will be made under this Section. Payment for the work under this Section will be made under Mass Excavation Section.

2.0 PRODUCTS

3.0 EXECUTION

SS 2.3 Site Grading
(MMCD Section 02210)

1.0 GENERAL

.1 This section is a "LANDSCAPING SECTION" and refers to those portions of the work that are unique to preparation of subgrade, by rough grading and filling, to provide a base that will allow placing of growing medium (topsoil) to specified depths. This Section does not apply to grading of driveways, sidewalks, road shoulders, roadways and any other structures. This section must be referenced to and interpreted simultaneously with all other sections pertinent to the works described herein.

1.1 Measurement for Payment

.1 No separate payment will be made for topsoil stripping. Payment for this work shall be included in the payment for Common Excavation.

.2 Common excavation and its redistribution to design elevations and grades will be measured in cubic metres based on before and after cross sections measured at a maximum of every 20 metre interval as determined.

.3 Supply and placement of each type of fill specific or as shown will be measured: in tonnes based on weigh tickets.

.4 No payment will be made for work carried out on soft spots that are caused by the method of construction or due to the Contractor's negligence.

2.0 PRODUCTS

3.0 EXECUTION

3.1 Excavation Compaction

.1 Refer to 3.5.4 in MMCD Section 02223 for compaction requirement for boulevard, easement, roadway, driveways and sidewalks.

SS 2.4 Excavating, Trenching and Backfilling for Trenches
(MMCD Section 02223)

1.0 GENERAL

1.1 Measurement for Payment

.1 Separate payment will be made for excess excavation as approved at the unit price per cubic metre. The unit price shall also include excavation, shoring, drainage, dewatering and disposal of surplus spoil.

.2 Separate payment will be made for extra backfill placed at the unit price per tonne. Extra backfill is defined as backfill for over-excavated trench and filling of ditches. This item shall only be placed when and where directed by the Engineer.

2.0 PRODUCTS

2.1 Extra Backfill

.1 Extra backfill shall be pit run gravel (imported material).

.2 Trench backfill on arterial road shall be crushed granular sub-base as specified in MMCD Section 02226, 2.9.

3.0 EXECUTION

3.1 Backfill and Compaction

.1 Works shall be carried out in accordance with MMCD Section 02223,3.5, except for boulevard and easement along Provincial highways and driveways where the compaction shall be 95% Modified Proctor density.

.2 Frequency of density tests shall be one test per 50 lineal metres of trench per metre of depth of backfill.

3.2 Temporary Pavement Patching

.1 In accordance with MMCD Section 02223, 3.6.6 only when directed by the Contract Administrator.

3.3 Permanent Pavement Restoration

.1 In accordance with MMCD Section 02223, 3.6.7 except:

.1 Pavement restoration shall be placed to match the existing asphalt thickness as shown in SSD-G.3. If the existing asphalt is less than 100mm, then place pavement to 100mm. If the existing asphalt is greater than 150mm, then place to 150mm.

SS 2.5 Roadway Excavation, Embankment and Compaction
(MMCD Section 02224)

1.0 GENERAL

1.1 Definition

.1 In addition to the rock excavation and common excavation specified in MMCD Section 02224, mass excavation will also be recognized. See Supplementary Specification Section SS 2.1 for Mass Excavation.

1.1 Measurement for Payment

.1 Subgrade preparation shall be measured in square metre of surface area of the roadways and driveways. The unit price shall include shaping, compacting, adding water or drying the subgrade material to obtain the required subgrade cross section, density, and moisture content.

.2 Payment for subgrade preparation under sidewalks and boulevard strips shall be included in their respective sections.

2.0 PRODUCTS

3.0 EXECUTION

3.1 Proof Rolling

.1 The Contractor is responsible for proof rolling as outlined in MMCD Section 02233, 3.5, of base course grade prior to the placement of concrete curb and gutter, roadway paving, sidewalk and walkway paving.

.2 If the Contractor disagrees with the Engineer's determination of soft areas, density tests, Benklemen beam testing or other mutually acceptable testing shall be carried out and be the determining criteria.

.3 The frequency of density tests shall be one test per 500m^2 per 150mm lift.

SS 2.6 Unit Paving
(MMCD Section 02515)

1.0 GENERAL

.1 Section SS 2.6 refers to those portions of work that are required to install interlocking pavers.

1.1 References

.1 Concrete pavers shall conform to ASTM C939 to C982, specifications for solid concrete interlocking paving units.

1.2 Measurement for Payment

.1 Payment for unit paving will be measured in square metres for each thickness of unit paver shown in the Form of Tender. The price shall include the supply and installation of all materials, including pavers of varying colour, size and type, edging bedding sand, joint sand, 75 mm thick base gravel, screening of sand, cutting of all edges to fit, compaction, adjusting, levelling, cleaning surface of excess sand and soil, and supply and application of protective sealant.

2.0 PRODUCTS

2.1 Materials

.1 Paver type, size and colour, shall be as indicated on the Contract Drawings.

.2 Pigmentation of concrete pavers shall be a solid colour throughout the unit.

.3 Normal weight aggregate shall be used for the concrete mix.

.4 Bedding sand shall conform to the following gradation limits:

Sieve Size	% Passing
9.52 mm	100
4.75 mm	95 - 100
2.35 mm	80 - 100
1.18 mm	50 - 85
600 micro-metre	25 - 60
300 micro-metre	10 - 30
150 micro-metre	5-15
75 micro-metre	0-10

.5 Jointing sand shall consist of at least 30% of 1 mm sand particles and shall otherwise meet the requirements for bedding sand.

.6 All concrete pavers shall be sealed with "Uniseal", "Webseal 100", or a proven equivalent.

3.0 EXECUTION

.1 Concrete pavers shall be delivered and stored on-site in metal strapping or shrink wrapped PVC.

.2 Sand, when stock piled on site, shall be protected against the rain.

.3 Prior to installation of concrete pavers all street signs shall be installed.

.4 Paver thickness shall vary. All pavers used in driveways shall be a minimum 80 mm thick. All pavers used for boulevard or sidewalk areas shall be a minimum 60 mm thick.

.5 Sand bedding shall have a moisture content not less than 6% and not more than 8% prior to compaction.

.6 All pavers shall be sealed with a clear protective sealant after installation.

.7 Sand bedding shall be spread evenly over an area not greater than required to receive concrete pavers in one day and shall be protected against accidental pre-compaction and rain.

.1 This bedding shall have a minimum compacted thickness of 20 mm and a maximum compacted thickness of 40 mm, and shall be graded to meet crossfalls in boulevards, sidewalks and driveways.

.8 Concrete pavers shall be laid in a pattern as indicated on the Contract Drawings.

.1 Joints between units shall not exceed 3 mm.

.2 Full units shall be installed first and edge pieces fitted subsequently.

.9 Edge restraint shall be as indicated on the Contract Drawings.

.10 Gaps at junctions between concrete pavers and edge restraints shall be filled with purpose made or cut edge pieces. Paver shall be cut to fit other conditions.

.1 All pavers shall be cut with an approved paver guillotine or masonry cut-off saw to neatly, and accurately fit without damaged edges.

.11 Pavers shall be vibrated to their final level by having not less than 3 passes of a vibrating plate compactor.

.1 The compactor shall be a high frequency, low amplitude unit with plate size sufficient to cover a minimum 12 pavers.

.12 After placement, jointing sand shall be spread over the paver surface and vibrated to completely fill all joints.

.1 Jointing sand shall be reinstalled after the first heavy rainstorm.

3.1 Acceptance

.1 All pavers must drain freely with no ponding of water.

.2 Defective, chipped or poorly cut pavers shall be replaced.

.3 The paver surface shall be true to elevation and free from deviations in excess of 6 mm, tested with a 3 m long straight edge placed at any location on the surface.

.4 Surfaces shall abut flush with adjacent materials.

SS 2.7 Cold Milling
(MMCD Section 02574)

1.0 GENERAL

.1 Section SS 2.7 refers to those portions of work that are required for the milling of existing asphalt pavement.

1.1 Related Work

		MMCD
.1	Roadway Excavation, Embankment and Compaction	Section 02224
.2	Hot-Mix Asphalt Concrete Paving	Section 02512
.3	Full Depth Reclamation	Section 02575

1.2 Measurement for Payment

.1 Payment for surface milling and full depth milling will be made separately at the unit rate per square metre of area milled and as determined.

.2 These unit prices shall include milling, spreading, shaping, grading and compacting milled material to form a suitable base for the placement of asphaltic concrete pavement.

.3 These unit prices shall also include shaping, compacting, adding water, loading, hauling, and disposal of any milled material which is classified unsuitable or useable on another site in or in another area of the same street as determined or a site provided by the Contract.

3.0 EXECUTION

3.1 Surface Milling

.1 Surface milling shall apply where existing asphaltic pavement is milled up to 75 mm in depth.

3.2 Full Depth Milling

.1 Full milling shall apply where the full thickness of the asphalt mat is to be milled.

3.3 Sample Section

.1 Prior to the start of the milling work, the Contractor shall provide a sample section of 15 metre long, to demonstrate the effectiveness of the proposed milling operation.

3.4 Milling Operation

.1 Where directed, the existing asphalt concrete shall be milled by equipment suitable to produce a well-graded material with the largest aggregate size not exceeding 25 mm in maximum dimension.

.2 Subject to prior approval of the Engineer, the milled material shall be used on site for road base and subbase construction as directed. The Engineer will determine the mixture ratio between the milled material and the imported base and sub-base material and the method of placing. Any surplus to requirement shall be disposed of to an approved site.

.3 Should additional granular material be required, it shall be spread on the surface of the milled material in such a way that it kneads with the milled material. The material shall be bladed to proper grade and cross section as directed.

.4 Unless otherwise specified in writing by the Engineer, the milling of the existing asphalt shall be followed by repaving within five (5) working days of the commencing of the milling. The milled asphalt surface shall be graded, monitored, signed and maintained until paved (final) at no additional cost to the City.

.5 All manhole rims, valve covers, and utility cover lids must have an asphalt slope from the top of the lid to milled surface of sufficient length to prevent damage to vehicular traffic. These slopes are to be completely removed immediately prior to final paving. These utilities must be monitored until final paving.

.6 Grader mounted grinders are not acceptable for this work.

SS 2.8 Pavement Patching

1.0 GENERAL

.1 Section SS 2.8 refers to those portions of work that are required patching of existing asphalt pavement that involves repair of the existing asphalt concrete beyond 1 metre from the edge of the existing pavement unless otherwise shown.

.2 Work required in Section SS 2.8 shall be accordance with the City of Surrey Pavement Cut Policy.

1.1 Related Work

		MMCD
.1	Traffic Regulation	Section 01570
.2	Excavating, Trenching and Backfilling	Section 02223
.3	Roadway Excavation, Embankment and Compaction	Section 02224
.4	Aggregates and Granular Materials	Section 02226
.5	Dust Control	Section 02242
.6	Granular Base	Section 02233
.7	Granular Subbase	Section 02234
.8	Hot-Mix Asphalt Concrete Paving	Section 02512
.9	Asphalt Prime	Section 02546
.10	Asphalt Track Coat	Section 02547

1.2 Measurement for Payment

.1 Pavement patching will be measured and paid on the basis of square metre. Separate unit price will be made for pavement patching with area less than 5 square metres, and pavement patching with area equal to or greater than 5 square metres.

.2 These unit prices also include tack coat, prime coat, sawcutting, excavating, loading, hauling, and disposing of excavated material.

.3 Payment for patching work and the removal of broken asphalt at the pavement edge within 1 metre of the existing road will be paid for separately under sawcutting, common excavation and subgrade preparation.

.4 No payment shall be made for pavement reinstatement for trenches under the installation and repair of all water mains, storm and sanitary sewers, appurtenances and connections that are carried out under this Contract. Payment for these works is deemed to be included in their respective items.

.5 Separate payment will be made for granular base and subgrade preparation under MMCD Section 02233, 1.4, and MMCD Section 02234, 1.4.

2.0 PRODUCTS

2.1 Asphalt Concrete

.1 Asphalt concrete shall be in accordance with MMCD Section 02512.

2.2 Base and Subbase

.1 Aggregate for subbase and base shall be in accordance with MMCD Sections 02234, 02233 and 02226.

3.0 EXECUTION

3.1 Pavement Patching

.1 Pavement patching shall be required where shown or as directed.

.2 Sawcut the perimeter of "patch" as marked out in square or rectangular shapes, as detailed on MMCD Standard Detail Drawings G5 and Supplementary Standard Drawing G3.

.3 Excavate and dispose the asphalt in the marked areas to the top of gravel base.

.4 Remove and replace gravel base and subbase as and when directed.

.5 Subgrade preparation in accordance with MMCD Section 02235, as and when directed.

.6 Compact the existing/replacement gravel base to 95% Modified Proctor Density.

.7 Apply tack coat or prime coats where applicable or as directed.

.8 Supply, place, shape and compact hot mix asphalt concrete to produce a tight surface conforming with adjacent area. The minimum thickness and the type of mix for the asphalt concrete shall be as shown.

SS 2.9 Superpave Asphalt Mix and Paving (Item 4.10)

1.0 GENERAL

Add new clause 1.0.2:

.2 This Section applies to mix Superpave designs for "design traffic load of 3 to less than 30 million ESAL". If a higher design traffic is specified, the publication "*Superpave Level 1 Mix Design – Superpave Series No. 2 (SP-2)*" must be used.

1.2 References

Add new clause 1.2.2**:**

.2 "*Superpave Level 1 Mix Design – Superpave Series No. 2 (SP-2)*" and C-SHRP Technical brief # 17.

2.0 Products

Replace Section 2.0 with:

2.1 Materials

.1 Mineral Aggregates as described in Chapter 3 of "*Superpave Level 1 Mix Design – Superpave Series No. 2 (SP-2)*"

.2 Asphalt cement to meet or exceed Performance Grade PG 58-22. Submit test results confirming conformance with the PG specification.

2.2 Mix Design

.1 Design of mix to follow Level 1 procedures as published in the current edition of Asphalt Institute Manual SP -2, Superpave Level 1 Mix Design. All procedures of Chapter 5 of the above mentioned publication are required, including *Moisture Sensitivity*.

.2 Provide gradation curve based on the results of at least five (5) samples for each aggregate type (or stockpile).

.3 Superpave Design Gyratory Compactive effort to be based on following criteria , unless modified by the Engineer:

Number of Gyrations	
Initial	8
Design	100
Maximum	160

3.0 Execution

3.1 Plant and Mixing Requirements

3.4 Mixing Tolerances

Replace Clause 3.3.4 with:

.1 During plant production, the gradation of the asphalt mix aggregate shall be tested. Samples shall be obtained at the plant both prior to and after the addition of asphalt cement. Test results shall be made available within three (3) hours of sampling.

.2 During plant production, the mixture properties shall be within the following tolerances of the design :

Mixture Property	*Tolerance*
Asphalt Content	± 0.3 %
Air Voids	± 1.0 %
Voids filled with asphalt, %	65 - 75
Dust Proportion	0.6 - 1.2

.3 The *Owner* will conduct Quality Assurance testing. Quality Assurance testing may be conducted at the hot mix plant. The Contractor shall provide 100 amp single phase 250 volt power outlet receptacle and space within 15 meters of the receptacle for mobile test equipment.

3.1.11 Production Quality Control Plan

Add new Clause 3.1.11:

.1 A Production Quality Control Plan (PQCP) shall be submitted to the Engineer at least 7 days prior to paving. No paving will be permitted until the PQCP has been approved. As a minimum the PQCP shall include:

(a) monitoring procedures for stockpiles plant aggregate gradation and consistency
(b) asphalt cement content
(c) tests required and frequency for Quality Control
(d) time frame for test results during paving

.2 The Contractor shall employ qualified personnel, including at least one certified technician to implement and oversee the PQCP.

3.6 Compaction

Replace Clause 3.6.1 with:

.1 Roll asphalt continuously to density between 91.0% and 96.0% of the maximum theoretical density. Ninety percent (90%) of a minimum five (5) samples shall meet this criteria. In addition, no individual test can be less than 89.0%.

.2 The *Contractor* is responsible for Quality Control. A Construction Quality Control Plan (CQCP) shall be submitted to the Engineer 7 days prior to paving.

As a minimum, the CQCP shall include full details of:

(a) the paving equipment
(b) number of trucks
(c) rate of placement
(d) contemplated rolling patterns
(e) testing for control of density

3.7 Joints

Add New Clause 3.7.1.4:

.4 Feather joints are not permitted. Construct butt joints at all locations where meeting existing pavement. Surface milling for preparing butt joints will be paid separately under item 4.16 b). Butt joint locations are not shown on the Contract drawings. The location of all butt joints shall be determined by the Contractor.

SS 2.10 Hot-Mix Asphalt Concrete Paving
(MMCD Section 02512)

1.0 GENERAL

2.0 PRODUCTS

2.1 Mix Design

.1 Conduct stripping test to AASHTO T283: Moisture Susceptibility of Design Asphalt Content and Design Aggregate.

.2 Compact six (6) specimens at 7% Air Voids. Test three (3) dry and three (3) wet. Add anti-stripping agent if required.

3.0 EXECUTION

3.1 Paving - General

.1 The asphalt mix shall be placed at a temperature between 135° C and 163° C measured in the mat immediately behind the paver.

.2 Following the placement of asphalt, the Contractor shall in the presence of the Engineer, open all manholes, catch basins, valve chambers and valve boxes, clean all debris from the inside of the frame, clean covers, and then replace the covers.

3.2 Paving – Overlay

.1 When placing asphalt concrete pavement for overlay of existing roads, tie-in points are to be milled butt joints. Feathering to existing surfaces will not be permitted.

.2 Minimum milling: Depth – 35mm
Width – 1.0 metre

3.3 Core Testing and Acceptance

.1 For conventional asphalt, the frequency of Marshall tests shall be one test for each asphalt type, minimum one per day. For Superpave asphalt, the frequency of Marshall tests shall be one test per 500 tonnes, minimum one per day.

.2 For street paving, core locations will be selected for each pass of the paving machine as follows:

.1 Across the width, core locations will be selected randomly from one-sixth increments.

.2 Along the length, core locations will have a randomly selected start with cores at a spacing of approximately, but not to exceed 200 metres.

.3 For other paving operations, a minimum of one core for every 700 square metres of asphalt mix placed.

.4 A section of pavement is deemed to have met the specification for compaction if 5 consecutive cores average 97% or more of the 75 blow Marshall density obtained in an approved hot mix laboratory test conducted on an actual field sample with no individual core less than 95%. The temperature of the mix shall approximate the temperature of the paver. For this purpose, a section of pavement is defined as an area the width of one pass of a paving machine by the length required to obtain 5 consecutive cores.

.5 A section of pavement is deemed to have met the specification for thickness if 5 consecutive cores average the design thickness $\pm$ 5mm with no individual core greater than 10mm less than the design thickness.

.6 Asphalt pavement areas less than 3500 square metres are deemed to have met the specification if results from all cores comply with the above criteria.

.7 The asphalt pavement areas less than 700 square metres, core testing will be at the discretion of the Engineer. acceptance will be based on an appropriate combination of cores, visual, and hot-mix test results.

.8 Core holes shall be reinstated to the satisfaction of the Contract Administrator.

SS 2.11 Asphalt Sidewalks, Driveways and Curbs

1.0 GENERAL

.1 Section SS 2.11 refers to those portions of the work that are unique to the construction of asphalt sidewalks, driveways and curbs. This section must be referenced to and interpreted simultaneously with all other Sections pertinent to the works described herein.

1.1 Related Work

		MMCD
.1	Roadway Excavation, Embankment and Compaction	Section 02224
.2	Granular Base	Section 02233
.3	Granular Subbase	Section 02234
.4	Hot-Mix Asphalt Concrete Paving	Section 02512
.5	Asphalt Prime	Section 02546
.6	Asphalt Tack Coat	Section 02547

1.2 Measurement for Payment

.1 Excavation, embankment fill (subgrade fill) and subgrade preparation will be measured in accordance with Section SS 2.5 - Roadway Excavation, Embankment and Compaction.

.2 Granular subbase and base material will be measured in tonnes in accordance with MMCD Section 02234 and MMCD Section 02233 respectively.

.3 Asphalt sidewalks and driveways will be measured in tonnes of asphalt concrete in place. This unit price shall also include polyethylene sheet for asphalt sidewalk.

.4 Asphalt curbs will be measured in linear metres of asphalt curb in place. Hand-formed curbing shall be considered incidental to the asphalt curbs paving and no separate payment shall be made for hand-formed asphalt curb.

.5 No additional payment will be made for sawcutting at the driveways, sidewalks or curbs to meet lines and tie-ins. Payment for this work is deemed to be included in the unit prices.

2.0 PRODUCTS

.1 Asphalt concrete for asphalt curbs: to MMCD Section 02512, Hot-Mix Asphalt Concrete Paving except the grade shall be 60-70.

3.0 EXECUTION

3.1 Asphalt Sidewalks and Driveways

.1 Refer to SS 2.11, Section 1.1, for Related Works.

.2 Sidewalks and driveways shall not be opened to pedestrians or vehicles until the mix has cooled sufficiently to prevent deformation.

3.2 Asphalt Curbs

.1 Curbs shall be machine extruded. The weight of the placing machine shall be such that compaction is obtained without the machine riding above the bed on which the curb is constructed. The machine shall form curbing that is uniform in texture, shape and density.

.2 The curbs shall be placed to an accurate alignment and shall have high density free of honeycomb. The curbs shall be protected from traffic by barricades or other suitable method until the curb has hardened.

3.3 Tolerances

.1 Maximum horizontal deviation

= 20 mm (for sidewalks and driveways)
= 6 mm (for curbs)

.2 Maximum vertical deviation

= 12 mm (for sidewalks & driveways)
= 6 mm (for driveways & curbs)

.3 Maximum deviation measured with a 3 metre straight edge

= 6 mm

SS 2.12 Concrete Walks, Curbs and Gutters
(MMCD Section 02523)

1.0 GENERAL

1.1 Measurement for Payment

.1 Payments under MMCD Section 02523 shall also include jointings and surface finishing. Curb within the area ramp or driveway crossing is considered regular curb for the purpose of payment.

.2 Concrete driveway will be measured in place and paid by area in square metres for different types of finishes.

2.0 PRODUCTS

2.1 Curbs & Gutters

.1 Use narrow base type as shown in MMCD Standard Detail Drawings, Drawing No. C4.

3.0 EXECUTION

SS 2.13 Painted Pavement Markings
(MMCD Section 02580)

1.0 GENERAL

1.1 Measurement for Payment

.1 Payment for temporary road markings will be measured and paid on a linear metre basis. This unit price shall include supply, installation and removal of the temporary markings.

2.0 PRODUCTS

3.0 EXECUTION

3.1 Temporary Road Markings

.1 Temporary traffic lines and stop bars shall be placed immediately following laying of the asphalt pavement.

.2 The traffic line shall be a 100 mm x 300 mm strip of prefabricated reflective yellow tape having an adhesive backing and shall be placed at 10 metre intervals along the centre of pavement.

.3 The stop bar shall be 2 - 100 mm continuous strips of prefabricated reflective white tape having an adhesive backing and placed across the travel lanes at traffic control intersections.

.4 Remove the tape when instructed.

SS 2.14 Waterworks
(MMCD Section 02666)

1.0 GENERAL

1.1 Measurement for Payment

.1 Payment will be made in accordance with MMCD Section 02666 and shall also include pavement sawcutting, undercrossings, anchor thrust blocks, pre-testing, wrapping of joints, surface restoration, connections to existing house connection and to the main line, co-ordination with the City's Water Operations Manager in regards to the tie-in with existing main and surface restoration at tie-in locations.

.2 Concrete bedding and encasement of pipe will be measured and paid separately in linear metres.

.3 Payment for pipe casing will be made in lump sum. This price shall allow for the method of construction by tunnelling, augering, jacking or open cut trench procedure that is to be approved prior to construction. This price shall also include any annular fill.

.4 Supply and installation of all pipe crosses, tees, bends, caps, flanges and all related fittings and valves shall be measured in units installed.

.5 Service connections will be measured and paid for on a lineal metre basis.

2.0 PRODUCTS

.1 Products shall be as listed in Appendix, Section SS A1.1, or as approved by the Engineer.

.2 No cast iron valves on fittings.

.3 Tie Rods:

MMCD Specification Section 02666, 2.2.10.1, replaced as follows:

Water mains are typically restrained by thrust blocks. Alternatives are Flanged joints, Joint Restraint Devices, Tie Rods, or a combination of them. Reverse thrust blocks shall be used for temporary restraints whether for testing or for fittings that would allow connections or extensions. The reverse thrust blocks shall be fitted with tie rods of size and number as indicated below.

Tie rods to be continuous threaded steel to ASTM A307 Grade A, Zinc plated to ASTM B633 or cadmium plated to ASTM B766. Tie rod sizes and number of rods to be as indicated in the table below:

Nominal Pipe Size (mm)	Water Testing Pressure (Kpa)	Minimum Number of Tie Rods	Tie Rod Diameter
150	1380	2	20mm
200	1380	2	20mm
250	1380	2	20mm
300	1380	4	20mm
350	1380	4	20mm
400	1380	6	20mm
450	1380	8	20mm

Each manufacturer produces fittings with varying numbers and sizes of tie rod lugs. A Professional Engineer shall confirm any lesser variation from the table above in writing. The tie rods shall be designed for the pressure specified in the water works testing procedure indicated in MMCD Section 02666, 3.19.2, with a resistance factor of 0.67 (CSA-S16.1-94) and a minimum factor of safety of 2.0.

Tie rods must be the correct size for the lug opening provided. All lugs provided must be used.

Where tie rods are used temporarily for testing of the main, they shall be completely removed after testing of the main. Alternatively, if they are left in place, they must be in accordance with this specification.

Nuts, internally threaded couplings and washers to be in accordance with MMCD Section 02666, 2.2.10.2. Nuts on A 307 rods shall be tightened to an amount corresponding to the full effort of a person using a spud wrench. When so specified, nuts shall be prevented from working loose by the use of lock washers, lock nuts, thread bearing, welding, or other methods approved by the City.

2.1 Hydrants

.1 Colour:
Finish paint above ground shall be lime-yellow monamel marine (Reid paint (General) #10-549, DuPont paint #7744 or CIL paint #2329-3486).

.2 Hydrant lead pipe material shall be ductile iron pipe.

2.2	**Concrete**	.1	Concrete shall be 25 MPa.

3.0 EXECUTION

3.1	**Ductile Iron Pipe**	.1	Place ductile iron water main pipe in granular bedding as shown in MMCD Standard Detail Drawing No. G4.
3.2	**Testing and Disinfection**	.1	All testing and disinfection to be carried out by the City, or other testing agency as approved by the Engineer. Testing by the City will be carried out only upon successful pre-testing by the Contractor.
3.3	**Testing**	.1	The Contractor shall be in attendance during the hydrostatic testing.
3.4	**Pipe Casing**	.1	Maintain line and grade of the water main inside the pipe casing by using wooden skid as shown or approved pipe spacers manufactured for this purpose.
		.2	Seal both ends of the casing with joint filler of sand bags.
		.3	Ensure the pipe does not float.
		.4	Only ductile iron pipe with joint restraint device shall be used.
3.5	**Pipe Protection**	.1	All water pipes shall be protected at both ends with either a bag or cap, provided at the factory to ensure the interior integrity of the pipe.

3.5 Tie-Ins

.1 Tie-ins to the existing water mains will be performed by the City's forces. The Contractor shall cooperate fully with the City's forces and provide them with suitable working areas and conditions to allow their work to proceed efficiently. At least 3 weeks notification shall be given to the City's Water Operations Manager before any testings and tie-ins including reconnections of services.

.2 After installation and prior to testing of the water main, the City's Water Operations Manager or his designate shall again be alerted of the anticipated tie-in. Upon completion of testing, the City forces will, within three weeks, tie the main into the existing waterworks system.

.3 The Contractor shall temporarily reinstate and maintain the surface to the satisfaction of the Engineer, and shall provide and maintain traffic control, barriers, lights and signs until the City's forces have completed the tie-in. After completion of the tie-in, the Contractor shall complete the permanent surface restoration.

.4 Pipes and fittings for the tie-ins shall be supplied by the Contractor.

.5 Payment for providing and maintaining all temporary surface restoration, traffic control, carriers, lights and signs shall be included in the unit prices tendered for supply and installation of water mains.

SS 2.15 Storm Sewers
(MMCD Section 02721)

1.0 GENERAL

1.1 Measurement for Payment

.1 Payment will be made in accordance with MMCD Section 02721 and shall include pavement sawcuttings, connection with the existing service connection and with the main line.

.2 Concrete bedding and encasement of pipe will be measured and paid separately in linear metres.

.3 Ditch cleaning and regrading prior to storm sewer installation or excavation for roadworks shall be measured and paid under MMCD Section 02224.

.4 Boulevard swale not exceeding 300 mm in depth shall be measured and paid on a linear metre basis.

.5 French drains will be measured and paid on a linear metre basis. This unit price shall include supply and laying the 100 mm diameter perforated pipe, aggregate stone and the filter fabric.

.6 Payment for pipe casing will be made in lump sum. This price shall allow for the method of construction by tunnelling, augering, jacking or open cut trench procedure that is to be approved prior to construction. This price shall also include any annular fill and /or end capping.

2.0 PRODUCTS

.1 Products shall be as listed in Appendix, Section SS A1.1, or as approved by the Engineer.

2.1 Inspection Chamber

.1 The lid for the storm sewer service inspection chamber shall be PVC pigmented green.

2.2 Inserta-Tee's

.1 Inserta Tee's will only be permitted for connections to existing systems and to new storm sewer construction larger than 300 mm diameter. Manufactured wyes shall be used on all other new storm sewer systems.

3.0 EXECUTION

3.1 Cleansing and Flushing

.1 Clean existing culverts that form part of existing storm sewer.

3.2 Ditch Cleaning and Regrading

.1 Where storm sewer is not constructed within the limit of existing ditch, ditches shall be cleaned to remove silt, clay, grass, weeds or the like materials and regraded as shown or as directed, prior to storm sewer installation.

3.3 Boulevard Swale

.1 Construct boulevard swale not exceeding 300 mm in depth where directed or as shown. This swale shall be formed in native material and shall be graded to suit local conditions and to provide proper drainage.

3.4 French Drains

.1 French drains shall be installed as shown in the Standard Drawings, unless approved by the Engineer. The pipe shall be 100 mm minimum diameter PVC SDR35 perforated pipe or approved equivalent.

3.5 Pipe Installation

.1 Reverse grade shall not be accepted.

.2 Bending the PVC pipe shall not be accepted unless with prior approval from the Engineer.

3.6 Service Connection

.1 All existing service connections presently emptying into a drain or culvert system shall be located and marked. The invert elevations of the service connections shall be recorded at the property line for existing service connections and at the end of the service lead inside the property line for future service connections. All new and existing service connections are to have inspection chambers installed 300 mm from the property line.

.2 All functional service connections shall be connected to the new storm sewer and the Contractor shall be held liable for any damage resulting from service connections left unconnected.

.3 Where a service connection is suspected of septic conditions, such service connection shall be corrected and reported to the Engineer on the suspicion.

.4 Payment for locating all service connections at appropriate adjacent properties shall be deemed to be included in the Unit Price tendered in the Schedule of Quantities and Prices.

.5 Service terminus and marker stakes shall be located to a length of 2.0 m past the property line or to a length equal to the depth of the service at the property line, whichever is greatest.

3.7 Video Inspection - Super VHS Format

.1 ***New Storm Sewer Mains:*** Carry out a video inspection test of **all main lines**, up to and including 450 mm diameter within the entire scope of work of the project. The video inspections shall be done following the **completion of construction.**

.2 ***Storm Sewer Service Connections:*** Carry out video inspections of **all service connection** leads within the entire scope of the project. The video inspections shall be done following the **completion of construction.**

.3 ***Existing Storm Sewer Mains***: Where there are 3 or more services connections required between manholes of an existing main, the system is to be video inspected. Less than 3 connections will require the Consultant or City representative to inspect the direct connection work at the main and certify as correct. Where this has not been done, the requirement for video inspection of the existing main at the connection point will be necessary.

.4 Video inspection reports are to be in a format acceptable to the Engineer. Video equipment and testing procedures are to be conducted in a manner acceptable to the Engineer. The Consultant shall submit the final video's and reports certifying the work and requesting acceptance of the system by the City.

.5 The entire system must be flushed immediately prior to carrying out a video inspection test in order to identify ponding areas.

.6 The City reserves the right to request that the storm sewers and/or the connections be video inspected at the eleventh month if problems are encountered during the maintenance period.

.7 The system shall be flushed and cleaned to remove any debris entering into the system during construction.

3.8 Tolerance Specification

.1 Ponding in storm sewer main lines and connections shall not exceed a depth of:

20 mm maximum, measured over a 3 metre length of pipeline, for pipe 100 mm to 150 mm diameter inclusive.

and

30 mm maximum, measured over a 3 meter length of pipeline, for pipe 200 mm to 450 mm diameter inclusive.

.2 For all material other than concrete pipes, visible cracks of any size as identified by video or visual inspection shall be cause for rejection.

Concrete pipe shall not have cracks exceeding ASTM C76M-03 specifications for reinforced pipe and ASTM C14M-03 for non-reinforced pipe.

SS 2.16 Channel Excavation - Cleaning and Deepening

1.0 GENERAL

.1 Section SS 2.9 refers to those portions of work that are unique to constructing, cleaning, deepening, widening and relocating water channels.

1.1 Related Work

			MMCD
.1	Environmental Protection		Section 01561
.2	Rock Removal		Section 02221
.3	Mass Excavation	Section SS 2.1	-
.4	Clearing and Grubbing		Section 02111
.5	Riprap		Section 02271
.6	Gabions		Section 02272
.7	Storm Sewers		Section 02721
.8	Pipe Culverts		Section 02723
.9	Topsoil and Finish Grading		Section 02921

1.2 Measurement for Payment

.1 Channel excavation for new channels will be measured in cubic metres in their original location by method of average end areas.

.1 Channel (common) excavation - cross sections will be taken after clearing and grubbing and prior to stripping of topsoil.

.2 Cleaning and deepening of existing channels will be measured in metres of channel.

3.0 EXECUTION

3.1 Excavation

.1 Excavate new channels to design lines, grades and cross sections as shown.

.2 Deepen existing channels to design lines, grades and cross sections as shown and clean channel bottom of debris and roots.

.3 Do not place excavated materials adjacent to channel in the side of the channels in a manner that will impede flow of surface water from adjacent land or endanger the stability of the side of the channel.

SS 2.17 Manholes and Catch Basins
(MMCD Section 02725)

1.0 GENERAL

1.1 Measurement for Payment

.1 Measurement for manhole rings shall be made vertically from the lowest invert to the bottom of the concrete cover slab. Payment for manhole rings shall be made at the unit price per vertical metre for the various manhole diameter classifications. The unit price shall include the supply and installation of standard concrete manhole rings complete with ladder rungs and safety platforms all as specified.

.2 Supply and installation of service connections, catch basin leads and lawn basin connection will be measured in metres horizontally from the outside wall of the sewer main to the outside wall of the catch basin for each lead pipe size installed for all depth range.

.3 Adjustment of the frame and cover will be measured in units adjusted.

.4 Removal and relocation of existing units will be measured in units removed and relocated.

.5 For catch basin with asphalt surround and channelling flume; the unit price shall also include the asphalt surround and channelling flume including preparation of the base.

.6 Grill screen and trash screen will be measured in units installed.

.7 If, in the Engineer's opinion, the Contractor is negligent and caused damage to the existing castings and adjacent installations that are in good condition, the Contractor shall bear the expenses of replacing the damaged parts without compensation.

.8 Cleanouts will only be permitted as a temporary measure in storm sewer construction.

.9 These unit prices also shall include excavation, disposal of surplus excavated material, supply of all units, cast-in-place concrete, pipes, fittings, and related materials, bedding, backfill, clearing, testing where applicable, surface restoration, benching and channelling, brickworks, riser rings, grouting, adjustment of frame to final grade, replacement of any damaged units and all other work and material necessary to complete the installation as shown and specified herein.

2.0 PRODUCTS

2.1 Materials

.1 Concrete shall be 30 MPa minimum strength unless otherwise stated.

.2 Precast manhole sections: ASTM C478 complete with ladder rung, ASTM C928 and to the safety regulations of the Workers' Compensation Board of B.C.

.3 The minimum thickness for precast concrete base section shall be 150 mm, measured from the underside of the base to the lowest part in concrete channeling.

.4 Ductile iron frames and cover on Arterial/R91 roads.

.5 All manhole barrels are to be fitted with approved gaskets and the joints made watertight using cement mortar inside and outside the barrel.

SS 2.18 Sanitary Sewers
(MMCD Section 02731)

1.0 GENERAL

1.1 Measurement for Payment

.1 Regrading and relaying of the sanitary service connections will be measured in linear metres. This unit price shall also include cost of coupling to existing service.

.2 Sanitary service connections will be measured and paid for by the lineal metre. The price shall include excavation, connections, reinstatement, and disposal of excess soil.

.3 Payment for pipe casing will be made in lump sum. This price shall allow for the method of construction by tunnelling, augering, jacking or open cut trench procedure that is to be approved prior to construction. This price shall also include any annular fill and/or end capping.

2.0 PRODUCTS

.1 Products shall be as listed in Appendix, Section SS A1.1, or as approved by the Engineer.

2.1 Inspection Chamber

.1 The lid for the sanitary sewer service inspection chamber shall be PVC pigmented red.

.2 Plug for temporary blocking of the inlet of inspection chamber shall be removed upon the completion of the work.

2.2 Inserta-Tee's

.1 Inserta-Tee's will only be permitted for connection to existing systems. Manufactured wyes shall be used on all new sanitary sewer systems.

3.0 EXECUTION

3.1 Pipe Installation

.1 Bending the PVC pipe shall not be accepted unless with prior approval from the Engineer.

.2 Service connection terminus and marker stakes shall be located to a length of 2.0 m past the property line or to a length equal the depth of the service at the property line, whichever is greatest.

3.2 Infiltration Test

.1 For concrete sewer pipes having a diameter smaller than 675 mm:

.1 Infiltration test to include testing of sewer main, service connections and manholes in each section or sections.

.2 Test section to be sealed at highest point with removable watertight plug. Leakage to be measured by means of an approved weir or meter. Duration of test to be determined by Engineer.

.3 Allowable leakage to be same as that calculated for exfiltration less 10% if external head is 600 mm or less. Above infiltration limits to constitute maximum total allowable infiltration for section.

.4 If test section has infiltration amount in excess of allowable, Contractor to replace or repair section of sewer. Such sections to be re-tested until they meet allowable leakage limits.

.2 For concrete sewer pipes having a diameter of 675 mm and larger, the pipes shall be tested as follows:

.1 Where the groundwater is above the crown of the pipe in a given tested section:

.1 infiltration test in compliance with ASTM C969.

.2 all joints to be tested in compliance with ASTM C1103.

.2 Where the groundwater is lower than the crown of the pipe in a given tested section:

.1 only joints test in compliance with ASTM C1103 shall be required.

3.3 Light Test

.1 Where requested by the Engineer, a light test shall be performed. Gravity mains, other than service connections, shall be lamped from manhole to manhole to check alignment and grade. Lamping shall be carried out using strong light or mirrors by an approved lamping testing firm.

.2 Where light tested, all pipe sections shall have a minimum 75% pipe diameter exposed when measured horizontally and a minimum 100% pipe diameter exposed when measured vertically when lamped.

.3 The Contractor shall facilitate and provide all the necessary safety equipment for the Engineer to inspect and witness the testing.

3.4 Video Inspection - Super VHS Format

.1 ***Sanitary Sewer Service Connections:*** Carry out a video inspection test of **all service connection** leads within the entire scope of the project. The video inspection shall be done following the **completion of construction**.

.2 ***New Sanitary Sewer Mains:*** Carry out a video inspection test of **all main lines** within the entire scope of the project. The video inspection shall be performed at the completion of construction of all surface works.

.3 ***Existing Sanitary Sewer Mains:*** Where there are 3 or more services connections required between manholes of an existing main, the system is to be video inspected. Less than 3 connections will require the Consultant or City representative to inspect the direct connection work at the main and certify as correct. Where this has not been done, the requirement for video inspection of the existing main at the connection point will be necessary.

.4 Video inspection reports are to be in a format acceptable to the Engineer. Video equipment and testing procedures are to be conducted in a manner acceptable to the Engineer. The Consultant shall submit the final video's and reports certifying the work and requesting acceptance of the system by the City.

.5 The entire system must be flushed immediately prior to carrying out a video inspection test in order to identify ponding areas.

.6 The City reserves the right to request that the sanitary sewers and/or connections be video inspected at the eleventh month if problems are encountered during the maintenance period.

.7 The system shall be flushed and cleaned to remove any debris entering the system during construction.

3.5 Tolerance Specification

.1 Ponding in sanitary sewer main lines and connections shall not exceed a depth of:

10 mm maximum, measured over a 3 metre length of pipeline, for pipe 100 mm to 250 mm diameter inclusive.
and
15 mm maximum, measured over a 3 meter length of pipeline, for pipe 300 mm and larger diameter.

3.6 Testing Requirements

.1 Upon completion of cleaning and flushing of each section carry out an infiltration or exfiltration test in addition to lamping.

.2 When cleaning and flushing sanitary lines the debris shall be removed or pumped out of the sewer system.

.3 Flushing procedures shall be approved by the Engineer, and the City Operations Department when working in the vicinity of a pump station.

SS 2.19 Sewage Force Mains
(MMCD Section 02732)

1.0 GENERAL

2.0 PRODUCTS

.1 Products shall be as listed in Appendix, Section SS A1.1, or as approved by the Engineer.

3.0 EXECUTION

3.1 Force Main Identification

.1 Red PVC marker tape to be placed at top of the pipe zone. Marker tape shall be continuous, 75 mm wide and lettered permanently with "SEWAGE FORCE MAIN" at 1.0 m intervals along tape.

3.2 Testing

.1 Test pressure applied to the sewage force main, during testing, shall be 1.5 times the maximum design peak transient pressure condition.

SS 2.20 Planting of Trees, Shrubs and Ground Covers
(MMCD Section 02950)

1.0 GENERAL

1.1 Measurement for Payment

.1 Supply and installation of tree grates will be measured and paid on a units installed basis.

.2 Tree planter pocket will be measured and paid on a unit excavated basis. This unit price shall include excavation and disposal of waste material and topsoil.

.3 Bark mulch will be measured and paid on the basis of square metre. This unit price shall include the supply and placing of the polyethylene sheets.

1.2 Inspection

.1 All planted medians to be inspected by City's Parks, Recreation & Culture Department. Contract Administration to arrange for inspection.

2.0 PRODUCTS

3.0 EXECUTION

3.1 Planting

.1 1.5 metre square by 1.0 metre deep planter pockets shall be excavated as directed or as shown.

.2 Supply and planting of trees will be undertaken by the City's Parks and Recreation Department forces.

.3 Fill planter pockets with topsoil.

3.2 Tree Grates

.1 Place a set of tree grates for each planter pocket flush with surrounding sidewalk and boulevard strip.

3.3 Mulching

.1 Bark mulch shall be supplied and placed with a complete layer of 4 mm thick black polyethylene underneath.

SS 2.21 Street Lighting
(MMCD Division 16 - Section 16550)

1.0	**GENERAL**	.1 No change.	
2.0	**PRODUCTS**		
2.6	**Poles and Related Equipment**	.1 No change.	
2.10	**Fuses and Fuse Holders**	.1 Alter 2.10	Fuse Holders shall be Ferraz Shawmut feb11-11-Sureholder and Ferraz Shawmut FSB1Boot
2.11	**Service Panel**	.1 No change.	
2.12	**Ground Equipment**	.1 No change.	
2.21	**Street Light and Sign Luminaires**	.1 Replace 2.21	Davit Luminaires shall be: ▪ 100Watt (Thomas&Betts 114G 671 28) ▪ 150Watt (Thomas&Betts 114G 676 28) ▪ 250Watt (Thomas&Betts 114G 673 3) ▪ 100Watt (Thomas&Betts 114G 671 28) ▪ or approved alternate Post Top Luminaires shall be: ▪ 100Watt (Thomas&Betts TW L15S 3Y5A) ▪ 150Watt (Thomas&Betts TW L10S 3Y5A) ▪ or approved alternate Ballast shall be CWI type. Luminaires mounted on 13.0m davit poles or taller shall have glass refractors. Luminaires mounted on 9.0m or shorter davit poles shall have polycarbonate refractors.
2.28	**Paint**	.1 No change.	

3.0 EXECUTION

3.3 Concrete Bases .1 No change.

3.6 Poles and Related Equipment .1 No change.

3.13 Wiring .1 No change.

3.21 Paint .1 No change.

3.22 .1 The detail drawings (available in the City of Surrey "Standard Construction Documents - Supplementary Standard Drawings" are to form part of this Street Lighting Supplementary Specification and are herein referred to as Standard Drawings.

3.9 Wiring (in Poles) .1 from Traffic Signals Section 3.9, SS Page 63, ver. 2000.

Add 3.9.4 Looping of feeder conductors with "T" taps shall not be permitted

SS 2.22 Cast-In-Place Concrete
(MMCD Section 03300)

1.0 GENERAL

2.0 PRODUCTS

3.0 EXECUTION

3.1 Field Quality Control

Field quality control for concrete curb, gutter and sidewalk shall include the following:

.1 Concrete shall develop a minimum compressive strength of 32 MPa at 28 days based on standard cylinder test, performed in accordance with CSA A23.2-9C.

.2 The Engineer may determine necessary corrective action if required due to results of a 7 day test.

.3 In the event that the cylinders, tested at 28 days, fail to achieve the specified 32 MPa, the contractor shall, upon notification, obtain cores for further testing. The cores are to be drilled from the portions of the structure in question and tested prior to the 38th day.

.4 The core test shall be performed in accordance with CSA 23.2-14C. The compressive strength of the concrete, based on core tests, shall be interpreted from CSA A23.1-94, Clause 17.5.8.2.

.5 Concrete not meeting the minimum compressive strength criteria shall be rejected and must be removed and replaced.

.6 One strength test (3 specimen cylinders) shall be made for each 150 lineal metres of work constructed. In no case, however, shall there be less than one strength test for concrete placed in one day. One cylinder shall be tested at 7 days, 2 cylinders shall be tested at 28 days.

.7 Cores are to be tested following moisture conditioning in accordance with CSA procedures.

SS 2.23 Traffic Signals

1.0 GENERAL

1.0.2 .1 The Surrey Supplementary Master Municipal Construction Documents outline the requirements for the installation or modification of traffic signals as required by these Supplementary Specifications and associated Contract Drawings.

1.4 Electrical Energy Supply .1 Add: 1.4.4 The Contractor shall coil and tape conductors out of weatherhead. Utility company shall complete electrical service connections.

2.0 PRODUCTS

2.1 General

.1 Delete 2.1.2 and substitute the following:

All products supplied to be new, in accordance with Contract Documents. All Products are to meet Canadian Electrical Code requirements and meet CSA, (c)UL, or ITS (Warnock Hersey) standards.

.2 Delete 2.1.3 and add the following:

2.1.6 Materials supplied by the City will be available at the Surrey Works Yard (6645 148 Street, Surrey, B.C.). The Contractor shall examine all materials and equipment for quantity and defects, and shall sign a statement of materials acceptance specifically listing the materials and quantities thereof, and noting all defective material. In so accepting these materials, the Contractor shall assume responsibility for their protection and for their quality except for latent defects not reasonably noticeable at the time of examination. All costs of receiving, loading, transporting material from the Surrey Works Yard to the job site, handling, storing, inspecting, testing and installing shall be included in the Contractor's lump sum prices. The Contractor shall verify that the materials provided by the City are available and shall arrange work schedules accordingly. The Contractor shall give the Contract Administrator a minimum of 14 days written notice prior to the time the materials supplied by the city are required.

3.3 Concrete Bases

.1 Add the following:

3.3.7 All excavated material for base installation shall be removed and disposed of off-site and replaced with 19mm crushed gravel granular base import backfill material, compacted to 95% modified proctor density.

3.3.8 Traffic signal bases shall be pre-cast as per MMCD standard drawings E1.13 for both "Type-S shaft" and "Type-L shaft" signal poles.

3.4 Junction Boxes and Vaults

Add the following:

3.4.5 All junction box and vault lids to be galvanized steel.

3.4.6 Junction boxes at the intersection corner closest to the traffic signal cabinet shall be a large concrete junction box (as per MMCD standard drawing E3.3 and E3.4) or a concrete vault (as per MMCD standard drawing E3.5 and E3.6), depending on intersection configuration.

3.4.7 All galvanized steel junction box lids shall be bonded

3.4.8 Junction boxes for loop cable conductors, and median (protected left turn) signals shall be type 37 concrete junction boxes as per Surrey supplementary standard drawing SSD-R.E.11.

3.4.9 Junction boxes for primary signal poles and secondary signal poles (intersection corners) shall be type 66 concrete junction boxes as per Surrey supplementary standard drawing SSD-R.E.12.

3.4.10 Conductors shall be grouped and labelled in junction boxes as per Surrey supplementary standard drawing SSD-R.E.12.

3.4.11 Conduit shall enter the junction box or concrete vault from the sides of the junction box or vault as per MMCD standard drawing E3.6.

3.5 Underground Conduit

Add the following:

3.5.6 R. PVC conduits shall be rigid polyvinyl chloride to CSA Standard C22.2 No. 211.2. Couplings, adapters, bends, and fittings shall be R. PVC and shall conform to CSA Standard C22.2 No.85. R.PVC conduit shall be installed in strict accordance with manufacturer's recommendations using CSA certified cement. The conduit shall not be bent in the field. Factory bends will be accepted.

3.5.7 Rigid steel conduit shall be hot-dipped galvanized steel pipe conforming to CSA C22.2 No. 45. All rigid conduit ends shall be reamed and all necessary bushings, locknuts, elbow and bends shall be provided. All joints shall be made with threaded couplers.

3.5.8 Clamps shall be hot dip galvanized malleable iron.

3.5.9 Before pulling conductor cable/wire into a run of conduit, the conduit shall be blown out with compressed air, then swabbed out, so as to remove all debris materials. The conductors shall be pulled in slowly by hand or hand winch, in order to keep close control on pulling tension and prevent cutting the conduit at bends.

3.5.10 Underground conduit placed in paved areas requires removal and disposal of all excavated material to an off-site location and replaced with 19mm crushed gravel granular base import backfill material (as per MMCD section 2223), compacted to 95% modified proctor density.

3.6 Poles and Related Equipment

Add the following:

3.6.13 Traffic signal poles shall be "Type-S shaft" signal poles as per MMCD standard drawings E5.11 to E5.13. Traffic signal poles with required arm length greater than 10.5 metres shall be "Type-L shaft" signal poles as per MMCD standard drawings E5.14 to E5.16. Traffic signal pole specifications in Surrey City Centre are unique and specifications are available from the City of Surrey Traffic Operations section. Bike pushbutton poles are required on bicycle routes and are detailed in Surrey supplementary standard drawing SSD-R.E.25.

3.6.14 Poles shall be erected plumb, using the shims supplied if required. No more than 4 shims shall be used for any one pole.

3.6.15 After traffic signal poles are installed, there shall be at least one thread of the anchor bolts exposed on top of all nuts. The nut covers shall not be installed until exposed anchor bolt threads have been inspected by the contract administrator or designate.

3.6.16 Poles are to be painted. Prime coat shall be General Paint META Prime (vinyl wash). Finish coat shall be Non-Alkyds colour base paint (aluminum colour in most areas, Lumec GN4 Blue Green colour in Surrey City Centre).

3.6.17 Pole refinishing: Contractor must clean and wire brush galvanized surfaces, touch up scratches and abrasions with prime coat (General Paint META Prime (vinyl wash)), and apply finish coat of non-alkyds colour base paint.

3.6.18 Pole Painting: Poles must be free from moisture (rain, dew, frost, fog). No pole painting will commence if frost is predicted within 24 hours of the proposed painting.

3.6.19 Paint prime coats shall be a maximum thickness of 0.5 mil. Finish coats shall be 2 coats of paint within 12 hours of the prime coat application.

3.7 Traffic and Pedestrian Signal Head Mounting

Add the following:

3.7.5 Traffic signal heads shall be aluminum, have acrylic lenses, and conform to the latest TAC and ITE Standards and Specifications. Each primary signal head section shall be 300 mm in diameter and have a cowl visor. Each secondary signal head section shall be 300 mm in diameter and shall have a 300 mm long tunnel visor. All primary signal heads shall have yellow aluminum backboards with 75mm border of yellow prismatic retro-reflective sheeting (3M™ Scotchlite™ Diamond Grade™ VIP Reflective Sheeting Series 3990 or approved alternate).

3.7.6 Primary traffic signal heads shall be mounted to pole arms as per MMCD standard drawing E6.9. Primary traffic signal heads shall be safety cabled to the pole arm using 3/32" galvanized steel aircraft cable looped through the traffic signal backboard and fastened with a rope clip (VAN-RC18 or approved alternate).

3.7.7 Fire signal heads shall have special yellow backboards as detailed on Surrey supplementary standard drawing SSD-R.E.23. All fire signal backboards shall have a 75mm border of yellow prismatic retro-reflective sheeting (3M™ Scotchlite™ Diamond Grade™ VIP Reflective Sheeting Series 3990 or approved alternate).

3.7.8 Pedestrian signal heads shall be IDC (U.S. Traffic), Model 7090 (Canadian Standard Symbols), complete with Z-Crate Visor or approved alternate.

3.7.9 Signal head housings shall be powder coated 'Traffic Signal Green' in colour.

3.7.10 Post top secondary signal head mounting is not acceptable.

3.7.11 Secondary traffic signal head and pedestrian head mounting brackets and hardware shall be installed as per MMCD standard drawing E6.2. Traffic signal poles shall be drilled such that all wiring shall be located within the poles and traffic signal brackets.

3.7.12 Mounting hardware shall be powder coated 'Traffic Signal Green' in colour.

3.7.13 Traffic signal lamp type to be supplied as follows:

.1 300mm red, amber and green signal head – 300mm LED display (see approved products list)

.2 Pedestrian signal head – LED display (see approved products list)

3.7.14 Each lane of through traffic requires one primary traffic signal head. Traffic signal heads shall be located and oriented as shown on the contract drawings. Secondary traffic signal heads shall be oriented to point at the road centreline approximately 30 metres from the corresponding signal stop line.

3.7.15 Primary traffic signal heads shall be minimum 4.75 metres and maximum 6.0 metres from the bottom of the primary traffic signal head backboard to the finished road grade below.

3.7.16 Secondary traffic signal heads and pedestrian traffic signal heads shall be 2.5 metres from finished grade to the bottom of the signal head. Pedestrian push buttons shall be located 1.0 metre above finished grade.

3.7.17 Traffic signal heads and pedestrian signal heads shall be completely obscured with burlap from the time of installation until the system is in operation. Traffic signal head lenses and pedestrian signal head lenses and reflectors shall be cleaned prior to signal start-up.

3.7.18 Signal heads and brackets shall receive Traffic Signal Green touch-up paint at any spots where the original finish is scratched.

3.9 Pedestrian Pushbuttons

Add the following:

3.9.4 All pushbutton plates to be Globe Foundry Ltd. G53 or approved alternate c/w white background and black raised characters. Button mechanism is to be raised style with mounting fully external to the pole (recessed button will not be accepted).

3.9.5 Bike pushbutton plates are required on City of Surrey bicycle routes and are detailed in Surrey supplementary standard drawing SSD-R.E.25. All bicycle pushbutton plates to be Greenlite GEL240 or approved alternate c/w white background and black raised characters. Button mechanism is to be raised style with mounting fully external to the pole (recessed button will not be accepted).

3.10 Luminaires and Photocells

Add the following:

3.10.4 Luminaires shall be securely fastened to the poles, levelled and cleaned after pole erection and plumbing is complete.

3.10.5 Photocells shall be oriented towards the north and directed away from adjacent light sources.

3.12 Electrical Service and Demarcation Panels

Add the following:

3.12.3 Electrical service panels shall meet all Canadian Electrical Code requirements.

3.12.4 Electrical service panel shall be installed on streetlight poles or utility poles minimum 2.5 metres away from the traffic signal cabinet. The electrical service panel may be installed in a service base if no streetlight poles or utility poles are located nearby (as per MMCD standard drawing E8.4).

3.13 Wiring

Add the following:

3.13.14 All traffic signal conductors shall be No. 14 AWG stranded copper with type RW90 insulation.

3.13.15 Traffic signal conductor cable shall be 19 conductor cable and shall conform to CSA Standard 22.2 No. 239-97.

3.13.16 All traffic signal conductors shall be connected in the pole handholes. Splicing in the junction boxes is not allowed.

3.13.17 All field wiring terminations shall be installed using a Thomas & Betts Sta-Kon Comfort Crimp™ Terminal Tool or approved alternate.

3.15 Traffic Signal Cabinet

NOTE: All references to "Traffic Controller" in the MMCD Volume II (Year 2000) shall be replaced with "Traffic Signal Cabinet"

Add the following:

3.15.9 Pole mounted traffic signal cabinets shall be used only when specified on the Contract Drawings.

3.15.10 Traffic signal cabinet shall be located as shown on the contract drawings. The traffic signal cabinet shall be oriented such that the doors, when open, are parallel to adjacent property line. The front of the traffic signal controller and associated rack mounted equipment shall face away from the intersection.

3.15.11 Traffic signal cabinet shall be mounted on a concrete base as per MMCD standard detail drawing E2.3. Two (2) concrete bollards (as per Surrey supplemental standard drawing SSD-R.E.10) shall be installed to protect the traffic signal cabinet. Concrete working pads shall be installed as per MMCD standard drawing E2.5.

3.15.12 Silicone sealant shall be used between the traffic signal cabinet and concrete base to ensure a weather tight seal.

3.15.13 Duct-seal shall be placed over/in all underground conduits entering traffic signal cabinet. All unused conduits shall be capped with a glued R.PVC cap.

3.15.14 Surrey will supply two (2) traffic signal cabinet padlocks and one (1) electrical service panel padlock.

3.15.15 Traffic signal cabinet interior must be kept dry during inclement weather.

3.16 Detector Loops

Add the following:

3.16.3 Shielded cables for detector loops shall be single two conductor No. 16 AWG stranded copper conductors twisted and shielded within a cable envelope.

3.16.4 Detector loops shall be 1.8 metre diameter round loops at the stop bar and 2 metre x 4 metre rectangular dipole loops in the left turn lane as per Surrey supplemental standard drawing SSD-R.E.33.

3.16.5 Detector loop shall be installed in the base lift of asphalt when possible.

3.16.6 Loops in adjacent lanes shall be wound in opposite directions, i.e.; clockwise, counter clockwise, clockwise, etc.

3.16.7 Each shielded cable shall run continuously with no splices from the traffic signal cabinet to the junction box. Splices between the detector loop and the shielded cable shall be connected with solderless type connectors and dipped in 3M ScotchKote™.

3.18 Advance Warning Signs

Add the following:

3.18.2 Advance warning signs shall have sign luminaire omitted.

3.18.3 All advance warning sign displays shall be LED.

3.18.4 Advance warning signs shall have illustration details in yellow prismatic retro-reflective sheeting (3M™ Scotchlite™ Diamond Grade™ VIP Reflective Sheeting Series 3990 or approved alternate).

3.18.5 Advance warning signs shall be completely covered with burlap sacking from the time they are installed until the system is turned on for full operation. Plastic garbage bags are not acceptable.

3.19 Ground and Bonding

Add the following:

3.19.5 Grounding electrodes shall be 21 mm diameter x 3 m long copperweld, as per Canadian Electrical Code requirements.

3.19.6 Ground plate shall be as per Canadian Electrical Code requirements.

3.19.7 No grounding rod or plate electrodes shall be installed inside the traffic signal cabinet base.

3.23 Emergency Vehicle Pre-Emption System (Opticom)

3.23.1 The Contractor shall install, as required by the contract drawings, emergency vehicle pre-emption (Opticom) receiver units on signal pole arms as per manufacturer's instructions and as directed by the Contract Administrator. The Contractor shall also provide all required aiming and testing of this equipment required for correct operation.

3.23.2 Shielded cables for emergency vehicle pre-emption system shall be "3M Opticom Cable, model 138", no alternates.

3.23.3 Opticom receiver units to be supplied by the City of Surrey.

3.24 Overhead Street Name Signs

3.24.1 The Contractor shall install all overhead street name signs. Street name signs shall be supplied by the City of Surrey. Street name signs shall be mounted using a single mid-span spring cushion sign hanger supplied by the contractor (Greenlite Traffic GEL 337 or approved alternate). Street name signs shall be safety cabled to the pole arm using 3/32" galvanized steel aircraft cable looped through the street name sign and fastened with a rope clip (VAN-RC18 or approved alternate).

3.26

The detail drawings (available in the City of Surrey "Standard Construction Documents – Supplementary Standard Drawings" are to form part of this Traffic Signals Supplementary Specification and are herein referred to as Standard Drawings.

SS 2.24 Agricultural Land Waterworks

(Supplementary to SS 2.14, and MMCD Section 02666)

1.0 GENERAL

1.1 Measurement for Payment

.1 Payment will be made in accordance with MMCD Section 02666 and City of Surrey Supplementary Specifications SS 2.14.

2.0 PRODUCTS

2.1 Polyethylene Pipes, Joints and Fittings

.1 This supplementary specification is intended to supplement SS 2.14 and applies to distribution mains and service connection products for domestic water systems in the agricultural lands.

.2 High Density Polyethylene Pipe:

.1 Pipe:

.1 To AWWA C906 pressure class DR-9.

.2 Iron pipe size equivalent outside diameter.

.3 To be compatible with specified mechanical joint fittings and valves without special adapters.

.3 Fittings:

.1 Fabricated HDPE mitred fittings to AWWA C906 suitable for pressure rating equivalent to DR-9 pipe rating.

.2 Moulded HDPE fittings to ASTM 3261 suitable for pressure rating specified and fusion to main pipe, dimensions as specified in Contract Documents.

.3 Flanged joints to AWWA C906 flat faced stub end and loose hot-dip galvanized ductile iron (ATM A536) backup ring drilling to ANSI B16.1, ANSI B16.5, or AWWA C207, class suitable for pressure rating equivalent to DR-9 pipe rating.

.4 Nuts and bolts as specified for "Fittings" in MMCD 02666.

3.0 EXECUTION

3.1 General

.1 This supplementary specification is intended to supplement SS 2.14 and applies to distribution mains and service connection installations for supplying domestic water to the agricultural lands.

3.2 Polyethylene Pipe Installation

.1 Handle pipe in accordance with pipe manufacturer's recommendations. Do not use chains or cables passed through pipe bore so that weight of pipe bears upon pipe ends. Do not drag lengths of polyethylene pipe over broken rock or objects which will score pipe.

.2 Lay and join pipes to manufacturer's instructions and specifications except as noted for C151, high density polyethylene pipe to ASTM D2774 and D2321.

Pipe bedding details to be as shown on Contract drawings, including MMCD Standard Detail Drawing G-4. Other installation procedures shall be as per manufacturer's instructions.

.3 For HDPE pipe, pipe cold bending allowed to a minimum radius of 50 times nominal pipe size without special fitting.

.4 Cut pipes as required, as recommended by pipe manufacturer, without damaging pipe or its coating and leave smooth end at right angles to axis of pipe.

.5 Joints:

.1 Maintain pipe joints free from mud, silt, gravel and other foreign material.

.2 Butt-fuse high density polyethylene in strict accordance with manufacturer's instructions and to be completed by personnel trained by the manufacturer.

.3 Ensure flanged joints at ambient temperature of surrounding soil at time they are bolted together. Re-tighten flange bolts 24 hours after initial flange bolt tightening.

.4 Ensure all polyethylene pipe at temperature of surrounding soil when it is backfilled and compacted.

.6 Anchor weights to be included where the pipe is susceptible to floatation caused by native, organic soil conditions and high groundwater tables. Anchors to be incorporated as per the manufacturer's recommendations and as specified in the Contract Documents.

.7 Ensure completed joints are restrained by compacting bedding material alongside and over installed pipes or as specified otherwise.

.8 When any stoppage of work occurs, restrain pipes in an approved manner to prevent "creep" during down time.

.9 Polyethylene pipes with different wall thickness shall be joined by means of a flange assembly.

.10 Recheck components assembled above ground after placing in trench to ensure that no movement of joints has taken place.

.11 Test and/or bleed points consisting of Corporation cocks, sized to achieve minimum flushing velocities of 0.8 m/s in accordance with AWWA C651, to be provided where shown on Contract Drawings or as required by Contractor for pressure testing and flushing.

3.3 Service Connection Installation

.1 Install service connections to 3.2 and as shown on the Standard Drawings.

.2 Service connection to be completed in accordance with manufacturer's recommendations and specifications.

.3 Service connections shall be connected by methods of thermal butt-fusion as outlined in ASTM-D265. Butt-fusion tees or couplings shall be used for all service connections. Wet tapping of polyethylene pipe will not be accepted.

3.4 Thrust Blocks

.1 Anchor weights to be placed on all branches of valves, tees, wyes, bends, changes in pipe diameter, reducers and fittings. Anchors to be placed on undisturbed ground, anchor bearing areas, and location as specified on Contract Drawings.

.2 Place 6 mil polyethylene between interface of concrete and the fitting.

.3 Thrust blocks not required for HDPE systems at reducers and fittings where jointing system is pullout resistant. Bolted, sleeve type coupling or connection to other materials lacking equivalent pullout resistance to employ thrust block to prevent HDPE pipe movement.

.4 Do concrete work in accordance with MMCD Section 03300 - Cast-in-Place Concrete.

.5 Keep joints and couplings free of concrete.

3.5 Pipe Surround

.1 Water main identification : yellow PVC marker tape to be placed at top of pipe zone. Marker tape to be continuous, 75 mm wide and lettered permanently with "Water Main" at 1.0 m intervals along tape.

SS 2.25 Asphalt Tack Coat

1.0 GENERAL

1.1 Measurement for Payment

.1 Asphalt tack coat will be measured in litres of undiluted product.

.2 All related work specified in this Section as incidental to application of tack coat is deemed to be included in applicable unit price for tack coat.

2.0 PRODUCTS

2.1 Materials

.1 High Float Emulsified Asphalt Grade HF-150S.

.2 Emulsion shall conform to the following requirements:

Requirement	Min.	Max.
Residue by Distillation % by mass	62	--
Oil Distillate % by volume	0.5	4
Saybolt Viscosity Furol Seconds at 50 C	35	150
Sieve Test % retained on 1.0mm si	--	0.1
Coating Test %	90	--
Float Test on residue at 60 C, S	1200	--
Penetration Test on residue at 25C, 100g, 5 s	150	250

3.0 EXECUTION

3.1 Application

.1 Do not dilute unless authorized by the engineer.

.2 Apply undiluted tack coat at 0.15 litres per square metre.

SS 2.26 Aggregates & Granular Materials (MMCD Section 02226)

1.0 GENERAL

2.0 PRODUCTS

2.1 Materials - Testing

.1 Sieve analysis and proctors are required for each type of material to be used prior to the commencement of work and every 2,000 tonnes during the work.

SS 2.27 Topsoil & Finish Grading

1.0 GENERAL

2.0 PRODUCTS

2.1 Materials - Testing .1 Contractor to provide an analysis of each type of material to be used prior to commencement of the work and analysis of a minimum of 2 random samples of growing medium taken just before planting.

SS 2.28 List of Approved Materials and Products

1.0 Approval

.1 This List of Approved Materials and Products was revised, and approved by the Engineer, to supersede all previous oral and written approvals and all lists of an earlier date.

.2 Subject to the restrictions contained herein, materials and products named in this List are approved for use in the City of Surrey.

.3 In the context of this Section, a product is approved when the vendor obtains a letter from the Engineer stating that such product is approved for use in the City of Surrey, and that the name of the product is entered into the List of Approved Materials and Products.

.4 Where brand names are specified for a product, any proposal for an alternate product requires the approval of the Engineer.

.5 A product is acceptable when it meets all the requirements stipulated in the Master Municipal Construction Documents (MMCD), and the City of Surrey Supplementary Specifications. It refers to a generic product which may be incorporated into the works without specific approval. Names of generic products are not entered into the List of Approved Materials and Products.

2.0 Specifications

.1 Specifications which an approved or an acceptable product shall meet are stipulated in the Master Municipal Construction Documents (MMCD). Some additional specifications or standards are listed in the Design Criteria Manual.

3.0 Exclusions

.1 This List may contain products which are specifically excluded by the Engineer for use in the City of Surrey, even though such products may be listed as approved in the Master Municipal Construction Documents (MMCD).

.2 Prior to the design of: Water Distribution System Pressure Reducing Valve Stations, Sanitary Sewer System Sewage Pumping Stations and Force Mains, and Storm Drainage System Drainage Pump Stations, approved materials and products shall be reviewed with the City of Surrey Engineering Department, regardless of being approved in the Master Municipal Construction Documents (MMCD).

4.0 Revisions

.1 The Engineer may revise this list at any time without prior notice by adding or removing listed products or by making any other changes to the specifications or restrictions.

5.0 List of Approved Materials and Products

"Generic" = Acceptable products meeting specifications but are not specifically approved by name.

Alternates to the items in this list require the approval of the Engineer.

	Product	*Approved Material / Type*	*Approved Product*	*Restrictions/Additional Specifications*
5.1	***Water Main***	• Ductile Iron • PVC (Polyvinyl Chloride) (except in seismic design areas - see Design Criteria)	"Generic"	Ductile Iron pipe shall be AWWA C151 Pressure Class with standard cement mortar lining to AWWA C104. PVC pipe to AWWA C900 shall be minimum 200 mm diameter (for New Pipe) and maximum 300 mm diameter. Pipe DR shall be 18. All PVC water mains shall be pigmented **blue**. HDPE pipe is not permitted, **except** for water supply to Agricultural Lands for size equal to or less than 150 mm diameter.
5.2	***Water Main Fitting***	• Ductile Iron • Compact Ductile Iron	• Terminal City Iron Works • Norwood • Sigma	No PVC fittings for mainline water mains. Deflection coupling by Certain Teed. PVC 0R18, C800, Class 150, 5° bend fitting is acceptable. - 300mm and below (China and India foundry); - Larger than 300mm (Mexico foundry only)
5.3	***Water Service Connection***	• Copper • Polyethylene	"Generic"	Polybutylene pipe is not permitted.
5.4	***Gate Valve***		• Terminal City Iron Works • Canada Valve • Mueller • Clow	All direct bury mainline valves shall be gate valves. No cast iron valves permitted.
5.5	***Butterfly Valve***			Butterfly valves not permitted unless approved by the Engineer for specific installations only. No cast iron valves permitted
5.6	***Blowoff Valve***		"Generic"	Restrictions, to be approved by the Engineer.
5.7	***Air Valve***		• Apco • Val-Matic	Combination air valves only.

	Product	*Approved Material / Type*	*Approved Product*	*Restrictions/Additional Specifications*
5.8	***Hydrant***		• Terminal City C71P • Canada Valve "Century" B-50-B • Clow M93 Brigadier High Flow	City Centre fire hydrants shall be high flow capacity hydrants. Ductile iron body in seismic areas.
5.9	***Corporation Stop***		• Cambridge • Ford • Mueller • Hayes • MacDonald	Up to 50 mm only. Use mainline gate valve for larger sizes.
5.10	***Curb Stop***		• Cambridge • Ford • Mueller • Hayes • MacDonald	Up to 50 mm only. Use mainline gate valve for larger sizes. No cylinder type.
5.11	***Coupling***	Plain End	• Dresser Style 38 or Style 162 • Robar • Smith-Blair • Romac • Canpac	Repair clamps are not permitted.
		Flanged Adapter	• Dresser Style 128 • Robar • Smith Blair	
5.12	***Joint Restraint***		Uni-Flange Series 1300, 1350, 1390, 1300C, 1390C, 1400 & 1450 Star Pipe Series 3000 and 3100P, Stargrip wedge-type	No set screw type for PVC pipes. Approval required from the Engineer for specific installations only. Mechanical joint fittings and uniflange series 1400 and 1450 are acceptable. All joint restraints shall have a minimum 250 psi pressure rating.
		Uniflange series 1400 and 1450	Star pipe, Series 3000 Stargrip and Series 3100P ductile iron pipe restraint	
5.13	***Joint Protection***		• Trenton Tec Tape • PVC Shrink Sleeve • Denso Petroleum Tape	To be used when minimum clearance with a sewer cannot be achieved.
5.14	***Saddle***		• Canpac SC-2 • Robar 2506DS • Robar 2706DS • Smith Blair 313 for D.I. pipe	
5.15	***Water Valve Box***		• Terminal City • Dobney D-5 • Trojan	Cover marked "WATER". Nelson Type, rectangular boxes only

	Product	*Approved Material / Type*	*Approved Product*	*Restrictions/Additional Specifications*
5.16	***Curb Stop Box***		• Terminal City • Dobney D-10 • Mueller A-726 • Mueller A-728 • Trojan	Service box, extendable style.Cover marked "WATER".
5.17	***Bolt and Nut***	Zinc plated Cadmium plated Stainless Steel	Yield and Tensile Strengths to be approved by the Engineer.	
5.18	***Tie Rod***	Zinc plated Cadmium plated Stainless Steel	Yield and Tensile Strengths to be approved by the Engineer.	
5.19	***Storm Drain***	PVC	"Generic"	
		Non-reinforced Concrete Reinforced Concrete		Size restrictions, size to be approved by the Engineer.
		Ribbed PVC	• Ultra Rib • LOC PVC • Korflo PVC	Concentric ribbed pipe only is permitted, No spiral ribbed pipe. Size restrictions (Max. 675 mm diameter), size to be approved by the Engineer.
		Ribbed HDPE	• Boss 2000	Certified to CSA B182.8-02 allowed in lowland applications only.
5.20	***Storm Culvert***	Concrete Galvanized Corrugated Metal Ribbed HDPE	"Generic"	Minimum diameter 300 mm. PVC, Ribbed PVC and HDPE or corrugated steel pipe requires prior approval from the Engineer for specific installations only. Ribbed HDPE, certified to CSA B182.8-02, permitted in lowland applications only where risk of exposure to hydrocarbons is low.
5.21	***Storm Service Connection***	PVC	"Generic"	New PVC main: use manufactured wyes. New concrete main: use PVC stub with bell, pre-cemented with epoxy resin. New or existing ribbed PVC main: use Inserta-Tee. Other mains: use strap saddles.
5.22	***Sanitary Sewer***	Pipes same as for storm applications	"Generic"	HDPE or ribbed PVC pipe, and ductile iron pipe is not permitted.
5.23	***Sanitary Force Main***	Pipes, fittings, mainline valves, boxes, couplings, bolts and nuts, and tie-rods same as for water applications	"Generic"	HDPE Pipe allowed in low-pressure system. Valve box cover marked "SANITARY SEWER". Air valves shall be specially designed for sewage applications. RED PVC Marker Tape labelled "SEWAGE FORCE MAIN" is required. Maximum size of PVC pipe shall be 300 mm diameter. Mechanical pipe joints are not permitted.

	Product	*Approved Material / Type*	*Approved Product*	*Restrictions/Additional Specifications*
5.24	***Sanitary Service Connection***	Pipes same as for storm service connection	"Generic"	Size restrictions, size to be approved by the Engineer.
		Inspection Chamber	Royal 70A 4x8 WLP-1 Galaxy Plastic	
5.25	***Manhole Frame and Cover***		• Dobney • K Casting • Westview Sales Ltd. • Sierra Distributors Ltd. • Turner Riser Rings	Refer to Supplementary Standard Drawings for required lettering on Manhole Covers for sanitary and storm sewers, including in fish habitat areas. Shall be compatible and interchangeable with existing City of Surrey castings.
5.26	***Catch Basin and Other Castings***	CB Frame	• Dobney • K Casting • Westview Sales Ltd. • Sierra Distributors Ltd.	Refer to Supplementary Standard Drawings for required lettering on Manhole Covers for sanitary and storm sewers, including in fish habitat areas. Shall be compatible and interchangeable with existing City of Surrey castings.
		CB Grate	• Dobney • K Casting • Westview Sales Ltd. • Sierra Distributors Ltd.	Refer to Supplementary Standard Drawings for required lettering on CB Grates, including in fish habitat areas.
		Lawn Basin Grate	• Dobney • K Casting • Westview Sales Ltd. • Sierra Distributors Ltd.	
		Valve Chamber Frame and Cover	• Dobney • K Casting • Westview Sales Ltd. • Sierra Distributors Ltd.	Cover marked "CITY of SURREY".

Plantings Recommended for: 5.0 Metre Walkway

	Product	*Approved Material / Type*	*Approved Product*	*Restrictions/Additional Specifications*
5.27	***Plantings recommended for walkways***		• Arctostaphylos uva ursi - varities • Cornus sercia 'Kelseyi' • Cotoneaster adpressa praecox • Cotoneaster dammeri • Cotoneaster microphylla • Cotoneaster microphyllus • Eunomyous fortunei - varities • Gaultheria shallon • Genista pilosa 'Vancouver Gold' • Ilex crenata 'Convexa' • Ilex crenata 'Green Thumb' • Ilex crenata 'Hetzi' • Ilex crenata 'Golden Gem' • Mahonia aquifolium 'Compacta' • Pinus mugo 'Pumilio' • Potentilla arbuscula • Potentilla fruiticosa - varities • Prunus laurocerasus 'Otto Luyken' • Spriea x bumalda - varities • Taxus cuspidata 'Nana' • Viburnum opulus 'Nanum'	Alternatives must be approved by the Engineer prior to installation.

SURREY
CITY OF PARKS

CITY OF SURREY

Engineering Department

SUPPLEMENTARY MASTER MUNICIPAL CONSTRUCTION DOCUMENTS

SUPPLEMENTARY STANDARD DRAWINGS

May 2004

Table of Contents - Major Sections

Section	Drawing Description
G	General
W	Water Distribution System
S	Sanitary Sewer System
D	Storm Drainage System
R	Roadworks System
U	Unique Designated Areas

Note: These City of Surrey 'Supplementary Standard Drawings' (SSD) are to be used in conjunction with the Master Municipal Construction Documents (MMCD, 2000) Volume II - Standard Detail Drawings.

Where there are conflicts or discrepancies between these City of Surrey 'Supplementary Standard Drawings' and the Master Municipal Construction Documents 'Standard Detail Drawings' - the City of Surrey 'Supplementary Standard Drawings' shall take precedence.

Any deviations from the City of Surrey 'Supplementary Standard Drawings' and/or the MMCD 'Standard Detail Drawings' proposed by a Design Engineer, for services to be provided in the City of Surrey, must be approved by the Engineer prior to design of the proposed services.

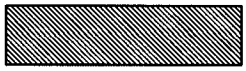
CITY OF SURREY

Engineering Department

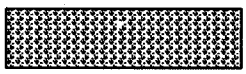
Supplementary Standard Drawings

Drawing Table of Contents - General

Drawing Number	Drawing Title
SSD-G.1	Legend for Materials
SSD-G.2	Lot Service Connections
SSD-G.3	Temporary Pavement Patching and Common Trench Installation
SSD-G.4	Pavement Cutting
SSD-G.4.1	Pavement Cutting
SSD-G.5	Manhole Benching Details
SSD-G.6	Manhole Frames and Cover
SSD-G.7	Surface Ring
SSD-G.8	Riser Ring

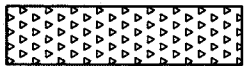


PROPOSED A.C. PAVEMENT



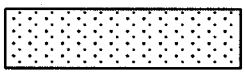
EXISTING PAVEMENT

GRANULAR BASE

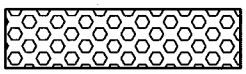


GRANULAR SUBBASE

UNDISTURBED EXISTING GROUND

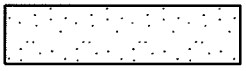


GRANULAR PIPE BEDDING

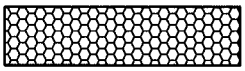


IMPORTED GRANULAR BACKFILL

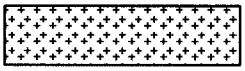
APPROVED NATIVE BACKFILL



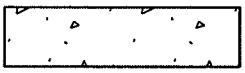
PIT RUN SAND



DRAIN ROCK



IMPORTED TOP SOIL



CONCRETE

3		
2		
1	MARCH 2002	
	Revision Date	Approved

All Dimensions Shown In Millimetres, Unless Otherwise Noted

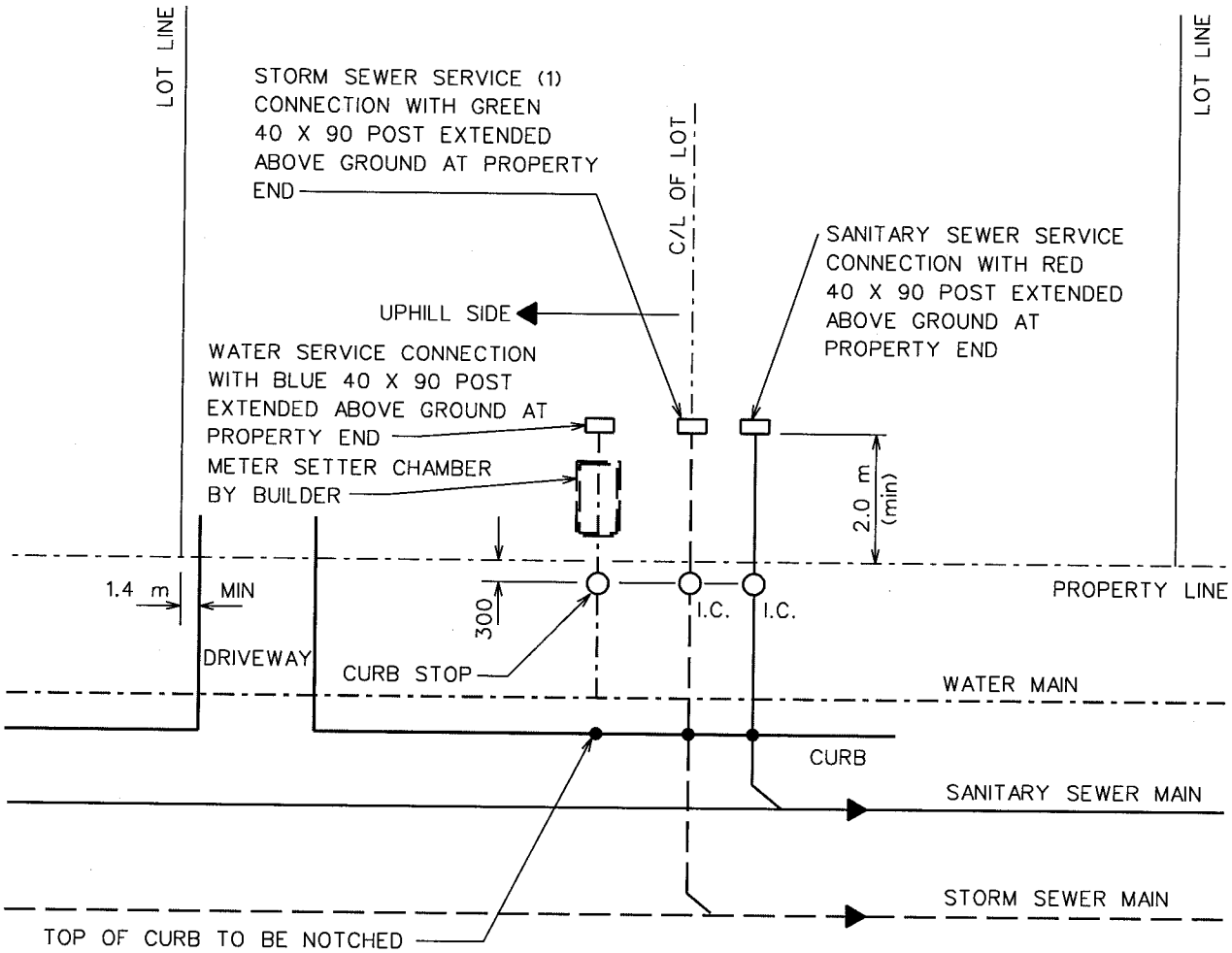
Title: LEGEND FOR MATERIALS

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-G.1

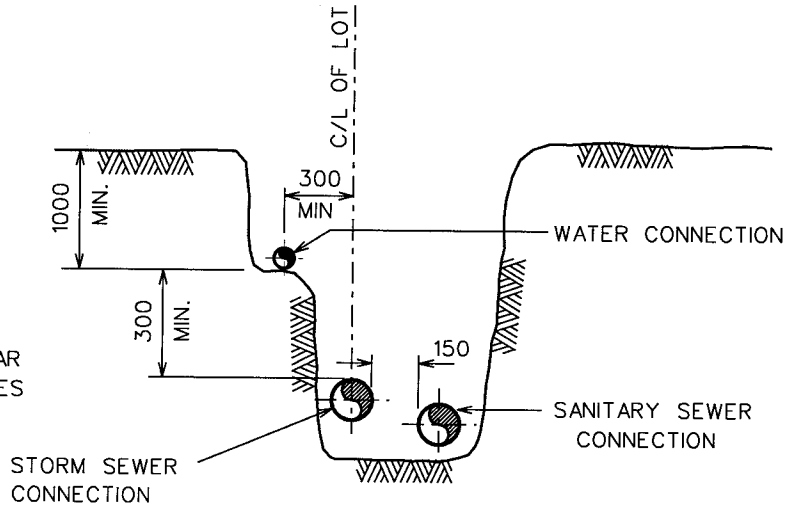
G:Mapping\Cad\Standards2002\General\General Dgn\SSD-G1.dgn



NOTES:

(1) STORM SEWER SERVICE CONNECTION MAY ALTERNATIVELY BE 300 FROM THE SIDE PROPERTY LINE ON THE LOWER END OF THE GENERAL GRADE OF THE AREA.

(2) ALL CONNECTIONS SHALL BE LOCATED CLEAR FROM THE DRIVEWAY AND THE SERVICE LINES FOR THE HYDRO POWER LINE, B.C. TEL AND OTHER UTILITIES. EXEMPTION MAY BE ALLOWED IN CUL-DE-SACS SUBJECT TO THE APPROVAL OF THE ENGINEER.



SECTION

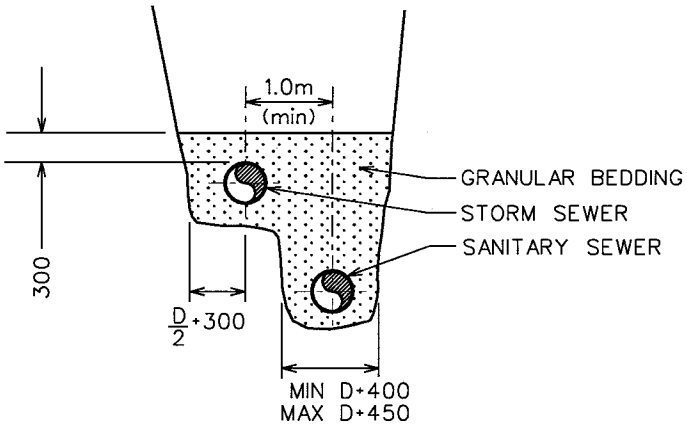
3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1	MARCH 2002	Title: LOT SERVICE CONNECTIONS
	Revision Date / Approved	

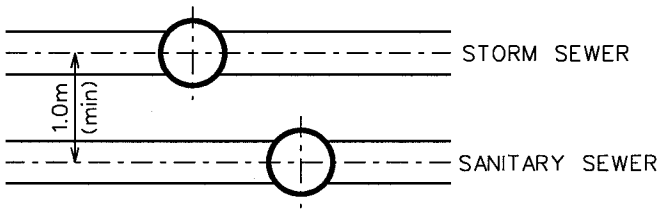
SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

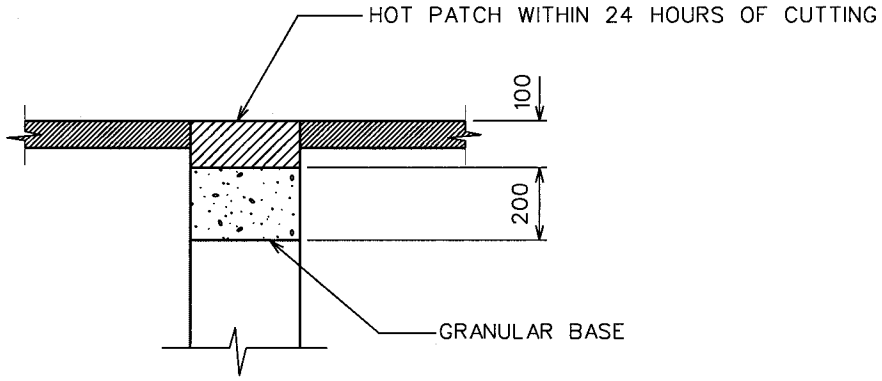
DRAWING NUMBER: SSD-G.2

G:Mapping\Cad\Standards2002\General\General Dgn\SSD-G2.dgn





COMMON TRENCH INSTALLATION



TEMPORARY PAVEMENT PATCHING (ROAD CUT PATCH)(1)

NOTES: (1) ONLY WITH APPROVAL OF CONTRACT ADMINISTRATOR.
(2) THE MINIMUM CLEARANCE BETWEEN MANHOLES IS 300.

3		
2	MARCH 2002	
1	NOVEMBER 1999	
	Revision Date	Approved

All Dimensions Shown In Millimetres, Unless Otherwise Noted

Title: TEMPORARY PAVEMENT PATCHING AND COMMON TRENCH INSTALLATION

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

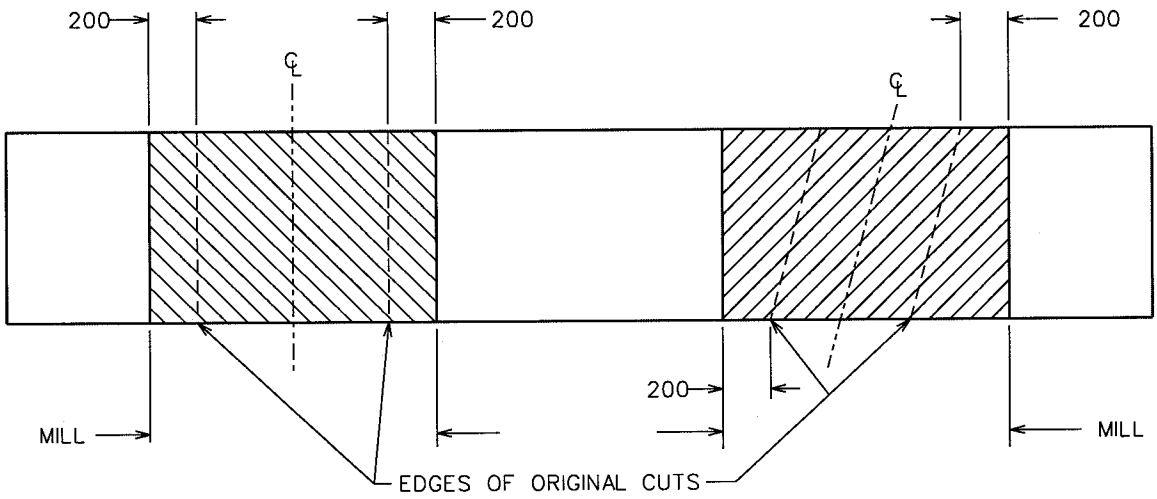
Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-G.3

G:Mapping\Cad\Standards2002\General\General Dgn\SSD-G3.dgn

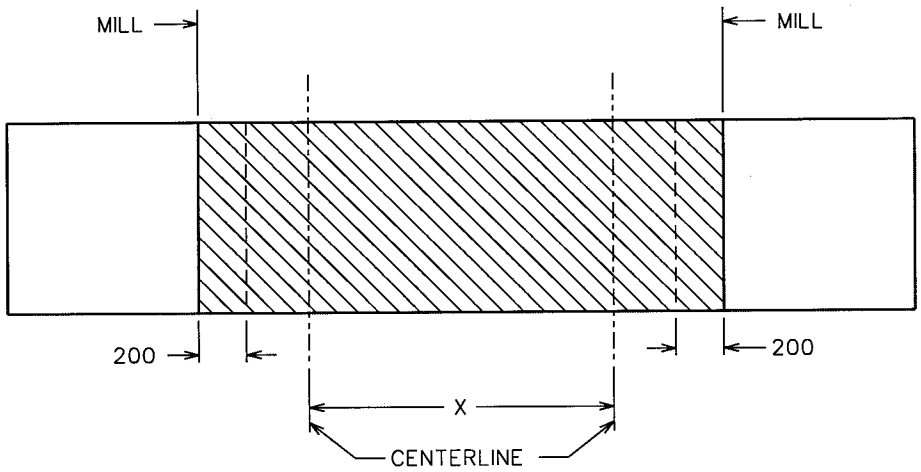
A. ARTERIAL AND MAJOR COLLECTOR ROADS

X-CUT



B. DIAGONAL CUT

C. MULTI-SERVICE CUTS



ROAD WIDTH OR TRAVELLED LANES CUT.
X-5 m OR LESS

3		
2		
1	MARCH 2002	
	Revision Date	Approved

All Dimensions Shown In Millimetres, Unless Otherwise Noted

Title: PAVEMENT CUTTING

SURREY CITY OF PARKS SUPPLEMENTARY STANDARD DRAWINGS

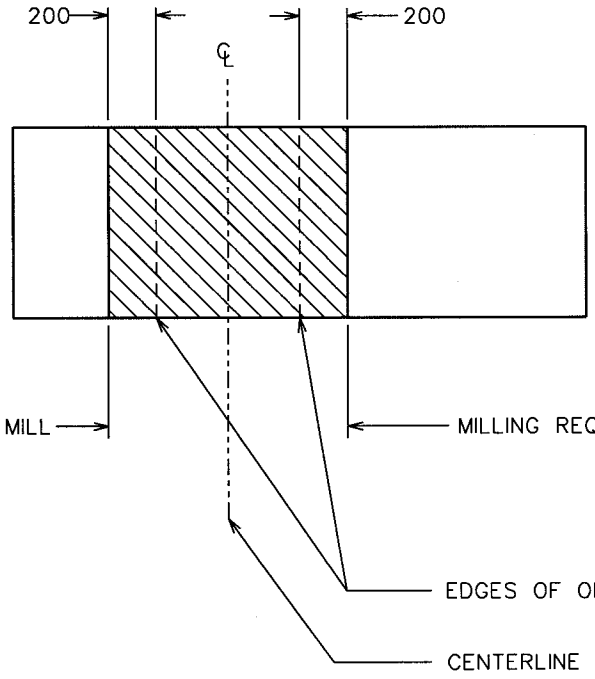
Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER SSD-G.4

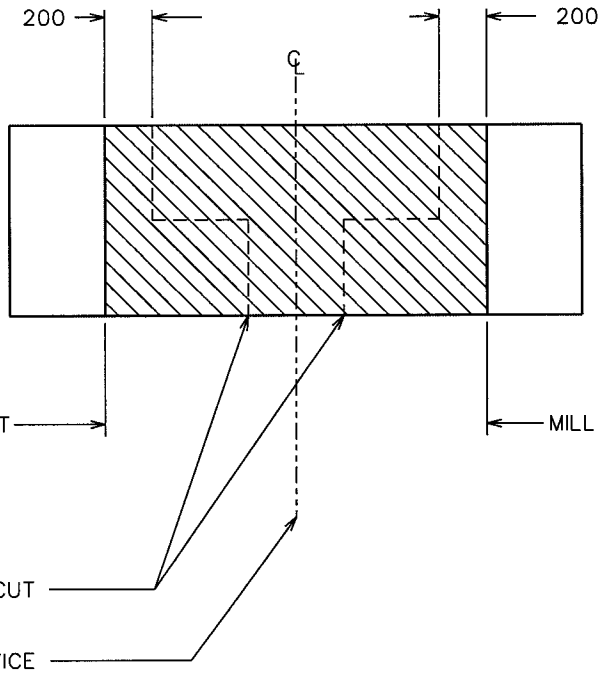
G:Mapping\Cad\Standards2002\General\General Dgn\SSD-G4.dgn

D. LOCAL ROADS

X-CUT

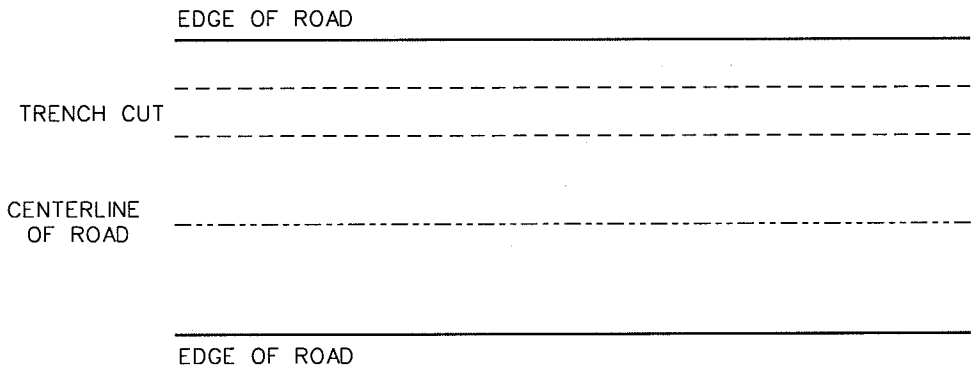


E. IRREGULAR CUT



ALL ROAD CLASSIFICATIONS

F. LONGITUDINAL CUTS



NOTE: (1) 50 mm TEMPORARY OR 100 mm PATCH RESTORATION DURING CONSTRUCTION. EDGE TRIMMING & FULL 100 mm PATCH AT END OF MAINTENANCE PERIOD IF 50 mm WAS INITIALLY USED.

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1	MARCH 2002	Title: PAVEMENT CUTTING
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER SSD-G.4.1

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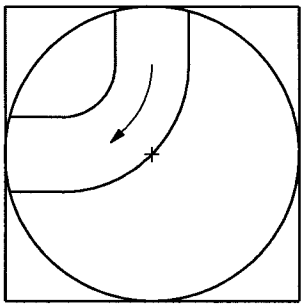
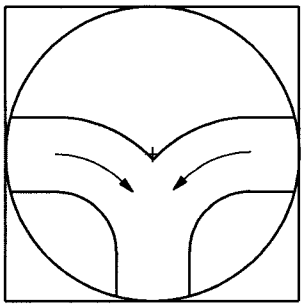
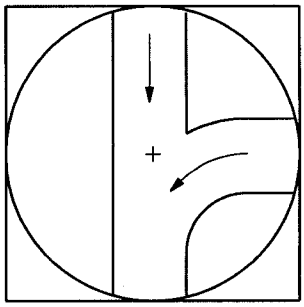


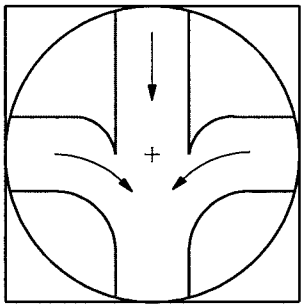
1. RIGHT ANGLE BEND



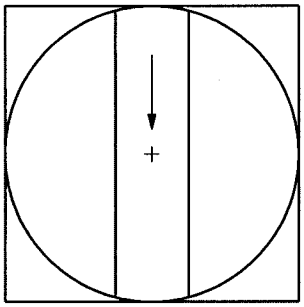
2. TEE CONNECTION



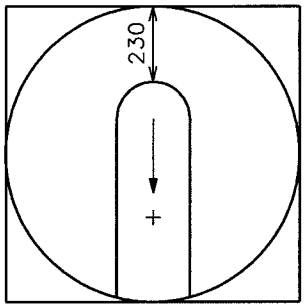
3. THREE WAY JUNCTION



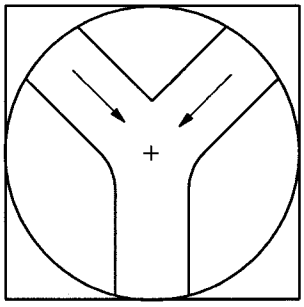
4. FOUR WAY JUNCTION



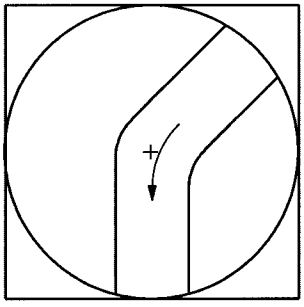
5. STRAIGHT THROUGH



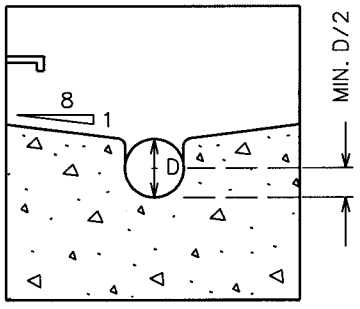
6. DEAD END



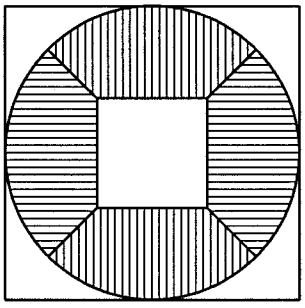
7. WYE CONNECTION



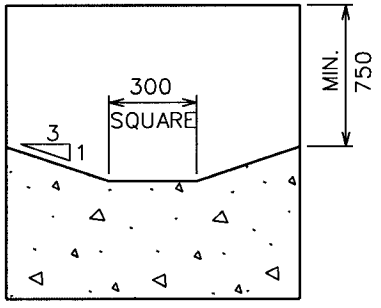
8. 45° BEND



SECTION



SUMP



SECTION

SUMP DETAIL

NOTE: (1) BENCHING DETAILS ARE CONCEPTUAL ONLY.
BENCHING CONFIGURATION AND INVERTS SHALL BE CHECKED FOR HYDRAULIC ADEQUACY.

3		
2		
1	MARCH 2002	
	Revision Date	Approved

All Dimensions Shown In Millimetres, Unless Otherwise Noted

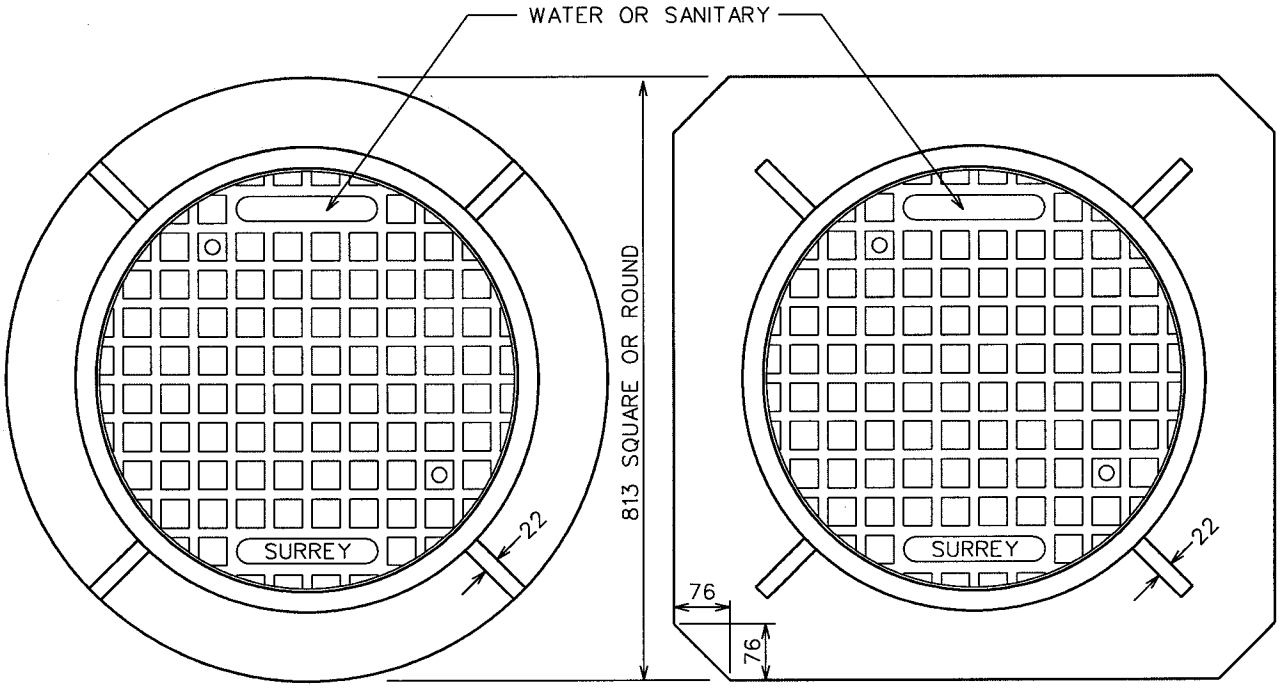
Title: MANHOLE BENCHING DETAILS

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

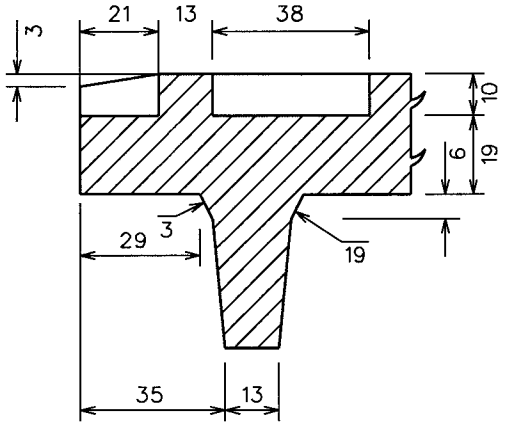
DRAWING NUMBER
SSD-G.5

G:Mapping\Cad\Standards2002\General\General Dgn\SSD-G5.dgn



ROUND FRAME & COVER

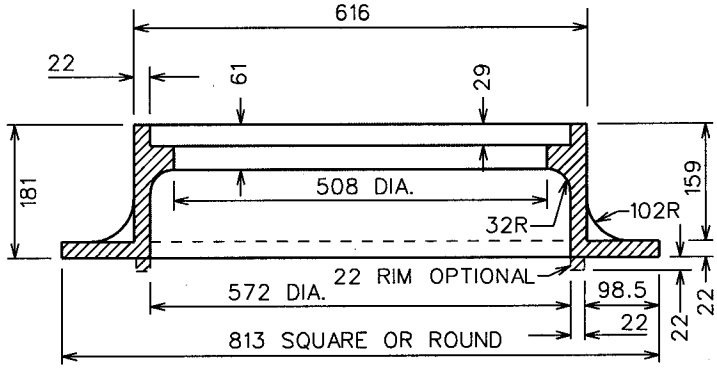
SQUARE FRAME & COVER



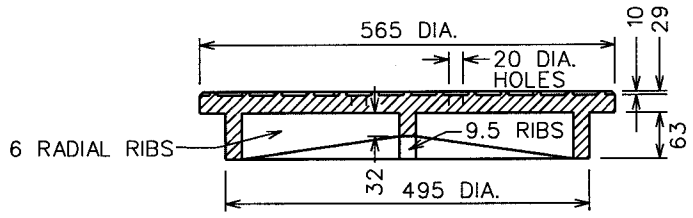
DETAIL OF RIM

N.T.S.

MATERIAL : CAST IRON



SECTION THRU FRAME



SECTION THRU COVER

NOTE: (1) FOR STORM MANHOLE COVER OR GRATE DETAIL, SEE SSD-D.25
(2) USE DUCTILE IRON FRAME AND COVER ON ARTERIAL ROADS.

3		
2	MARCH 2002	
1	NOVEMBER 1999	
	Revision Date	Approved

All Dimensions Shown In Millimetres, Unless Otherwise Noted

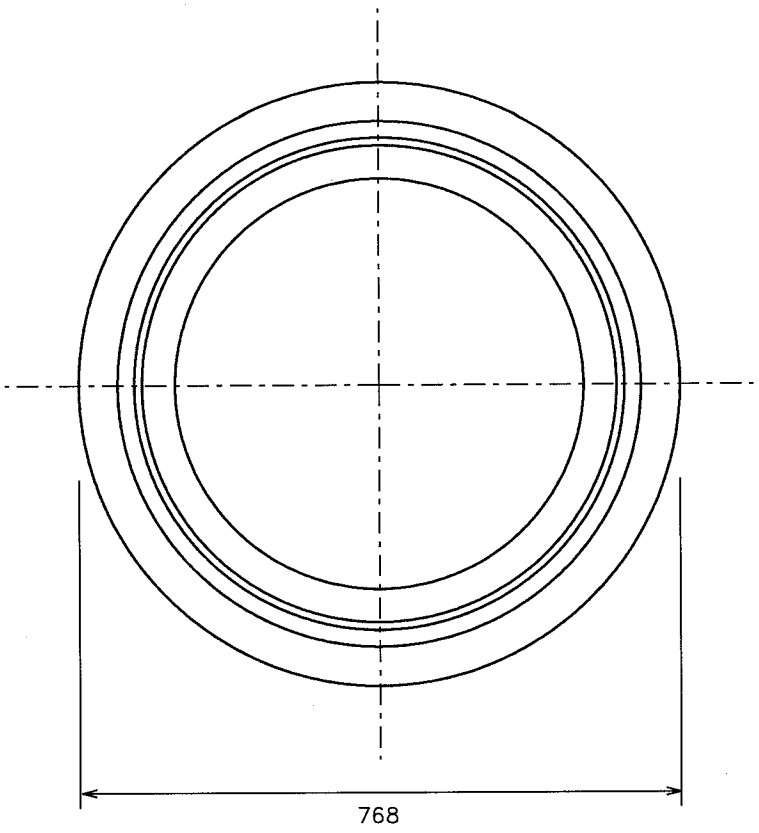
Title: MANHOLE FRAMES AND COVER

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

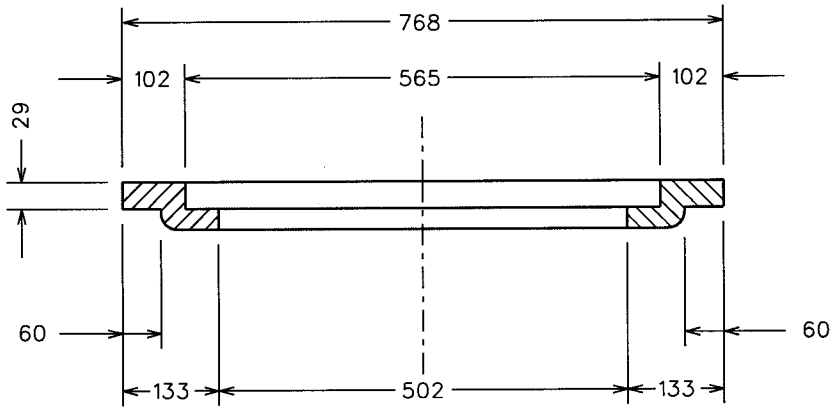
Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-G.6

G:Mapping\Cad\Standards2002\General\General Dgn\SSD-G6.dgn



SURFACE RING



SECTION THRU COVER

3		
2		
1	MARCH 2002	
	Revision Date	Approved

All Dimensions Shown In Millimetres, Unless Otherwise Noted

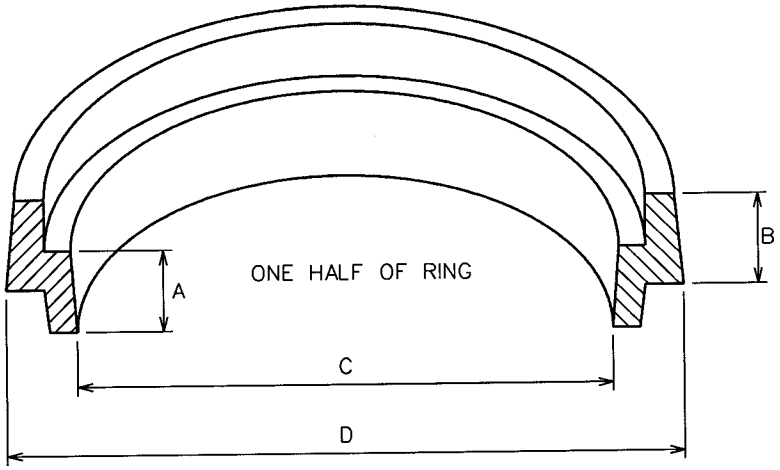
Title: SURFACE RING

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-G.7

G:Mapping\Cad\Standards2002\General\General Dgn\SSD-G7.dgn



MANHOLE EXTENSION RING

MANHOLE EXTENSION RING DETAILS			
DIMENSIONS			
A	B	C	D
38	38	508	616
51	38	508	616
63	38	508	616
76	38	508	616
101	38	508	616
127	38	508	616

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1	MARCH 2002	Title: RISER RING
	Revision Date Approved	

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-G.8
Drawn By	Surrey Engineering	

G:Mapping\Cad\Standards2002\General\GeneralDgn\SSD-G8.dgn

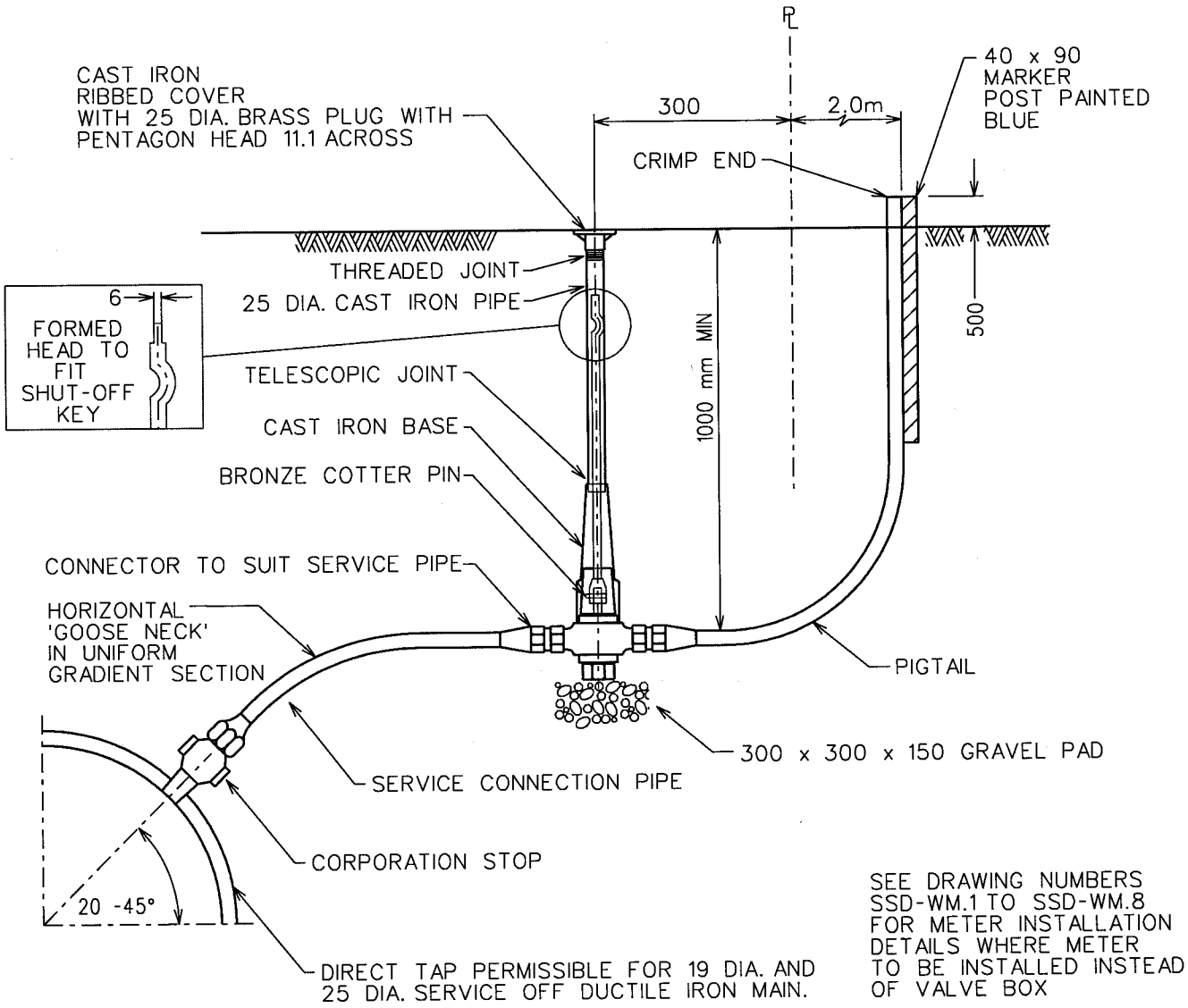
CITY OF SURREY

Engineering Department

Supplementary Standard Drawings

Drawing Table of Contents - Water Distribution System

Drawing Number	Drawing Title
SSD-W.1	Water Service Connection – Valve Box
SSD-W.2	Unassigned
SSD-W.3	Thrust Block Dimensions for Water Mains
SSD-W.4	PRV Station Chlorinated Water Control
SSD-W.5	PRV Station Chlorinated Water Control
SSD-W.6	Unassigned
SSD-W.7	Unassigned
SSD-W.8	Blowoff Chamber
SSD-WM1	General Layout
SSD-WM2	Meter Chamber Installation for Meters 25mm Diameter and Smaller



SEE DRAWING NUMBERS SSD-WM.1 TO SSD-WM.8 FOR METER INSTALLATION DETAILS WHERE METER TO BE INSTALLED INSTEAD OF VALVE BOX

DOUBLE STRAP SADDLE REQUIRED FOR SERVICES OFF DUCTILE IRON MAIN GREATER THAN 25 DIA.

NOTES:
(1) THIS DETAIL FOR SERVICES 19mm TO 50mm ONLY.
(2) PVC SADDLES TO MMCD SECTION 02666.
(3) INSTALL SERVICE PIPE WITH 'GOOSE NECK' IN HORIZONTAL POSITION.
(4) WHEN CURB STOP INSTALLED IN DRIVEWAY PLACE COVER IN CHAMBER. MARK 'WATER' SEE MMCD DRAWING S9 FOR TYPICAL DETAIL.
(5) REFER TO CONTRACT DRAWINGS AND MMCD SECTION 02666 FOR DETAILED SPECIFICATIONS.
(6) OPERATING ROD DIAMETERS - 14mm FOR 25mm OR SMALLER CURB STOPS
- 19mm FOR 32mm TO 50mm CURB STOPS

3	DECEMBER 2003	
2	OCTOBER 2002	LISA OLIVIER
1	JULY 2002	
	Revision Date	Approved

All Dimensions Shown In Millimetres, Unless Otherwise Noted

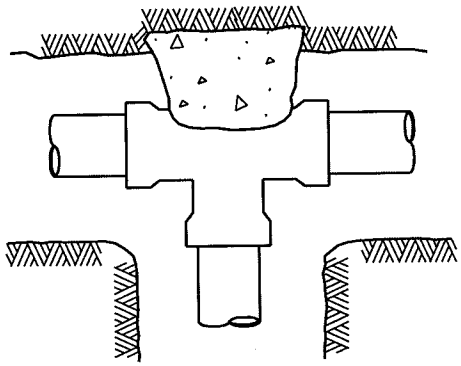
Title: WATER SERVICE CONNECTION

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

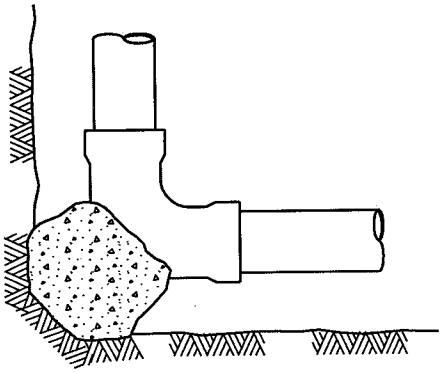
Approved	
Date	FEBRUARY 2002
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-W.1

G:Mapping\Cad\Standards2003\Water Distribution\Water Dgn\SSD-WM1.dgn



CAPS AND TEES



BENDS

BEARING AREA OF THRUST BLOCKS		
FITTING	PIPE DIA.	BEARING AREA
CAPS AND TEES	150	0.4m²
	200	0.6m²
	250	1.0m²
	300	1.4m²
	350	1.9m²
	400	2.5m²
90° BENDS	150	0.5m²
	200	0.9m²
	250	1.4m²
	300	2.0m²
	350	2.7m²
	400	3.5m²
45° BENDS	150	0.3m²
	200	0.5m²
	250	0.7m²
	300	1.1m²
	350	1.5m²
	400	1.9m²
22½° & 11¼° BENDS	150	0.2m²
	200	0.3m²
	250	0.4m²
	300	0.5m²
	350	0.7m²
	400	1.0m²

THE ABOVE TABLE IS BASED ON A SOIL BEARING STRENGTH OF 70 kPa AT 1380 kPa WORKING

NOTES: (1) THRUST BLOCKS OF 20 MPa CONCRETE TO BE PLACED AGAINST UNDISTURBED GROUND

(2) CONCRETE SHALL NOT COVER FITTINGS, BELLS OR FLANGES

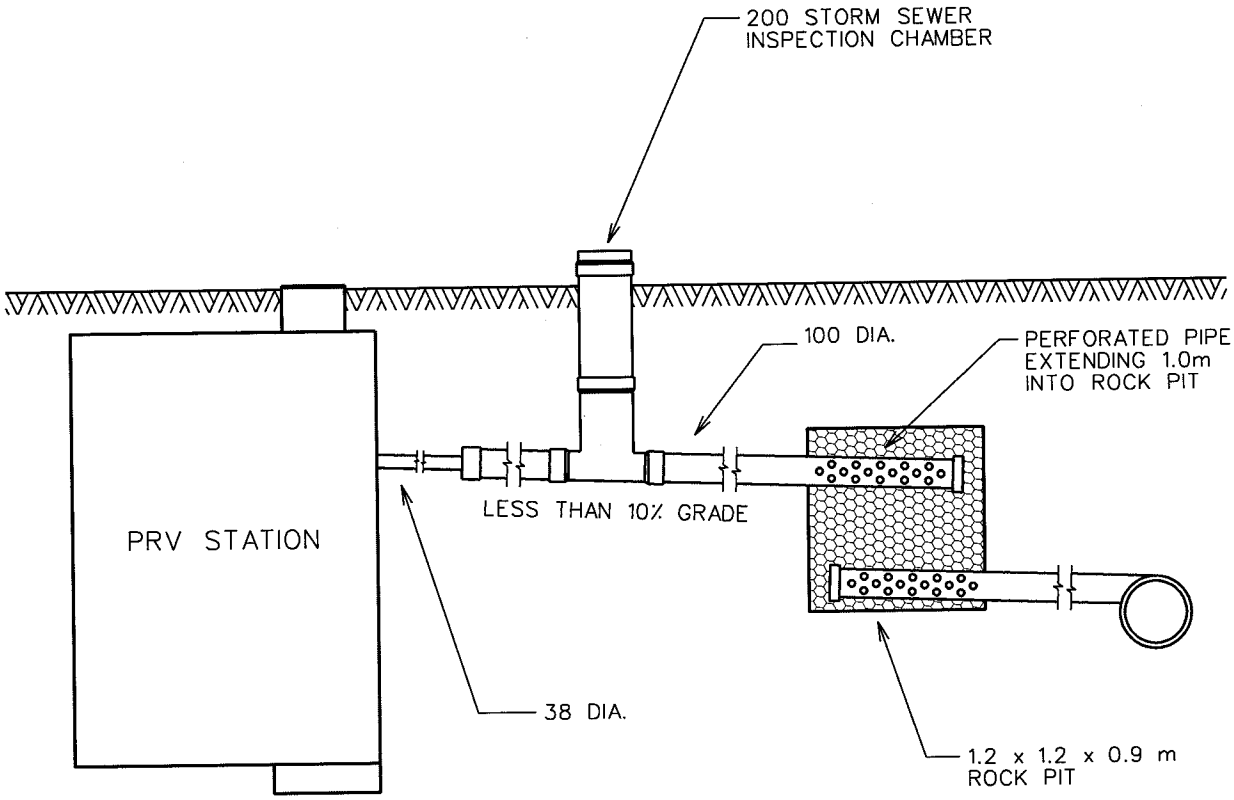
3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1	March 2002	Title: THRUST BLOCK DIMENSIONS FOR WATER MAINS
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER SSD-W.3

G:Mapping\Cad\Standards2002\Water Distribution\Water Dgn\SSD-W3.dgn



SYPHON INSTALLATION

3		
2		
1	March 2002	
	Revision Date	Approved

All Dimensions Shown In Millimetres,
Unless Otherwise Noted

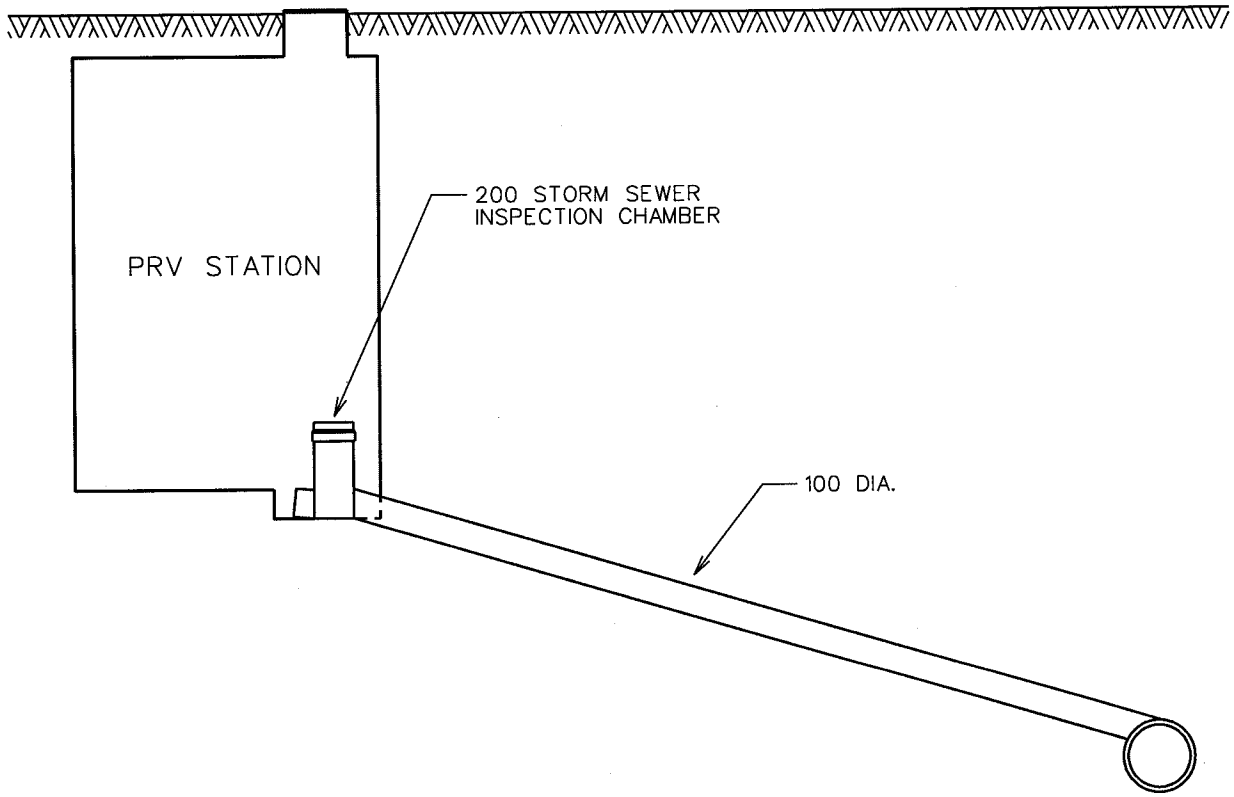
Title
PRV STATION CHLORINATED WATER CONTROL

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	November 1999
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-W.4

G:Mapping\Cad\Standards2002\Water Distribution\Water Dgn\SSD-W4.dgn



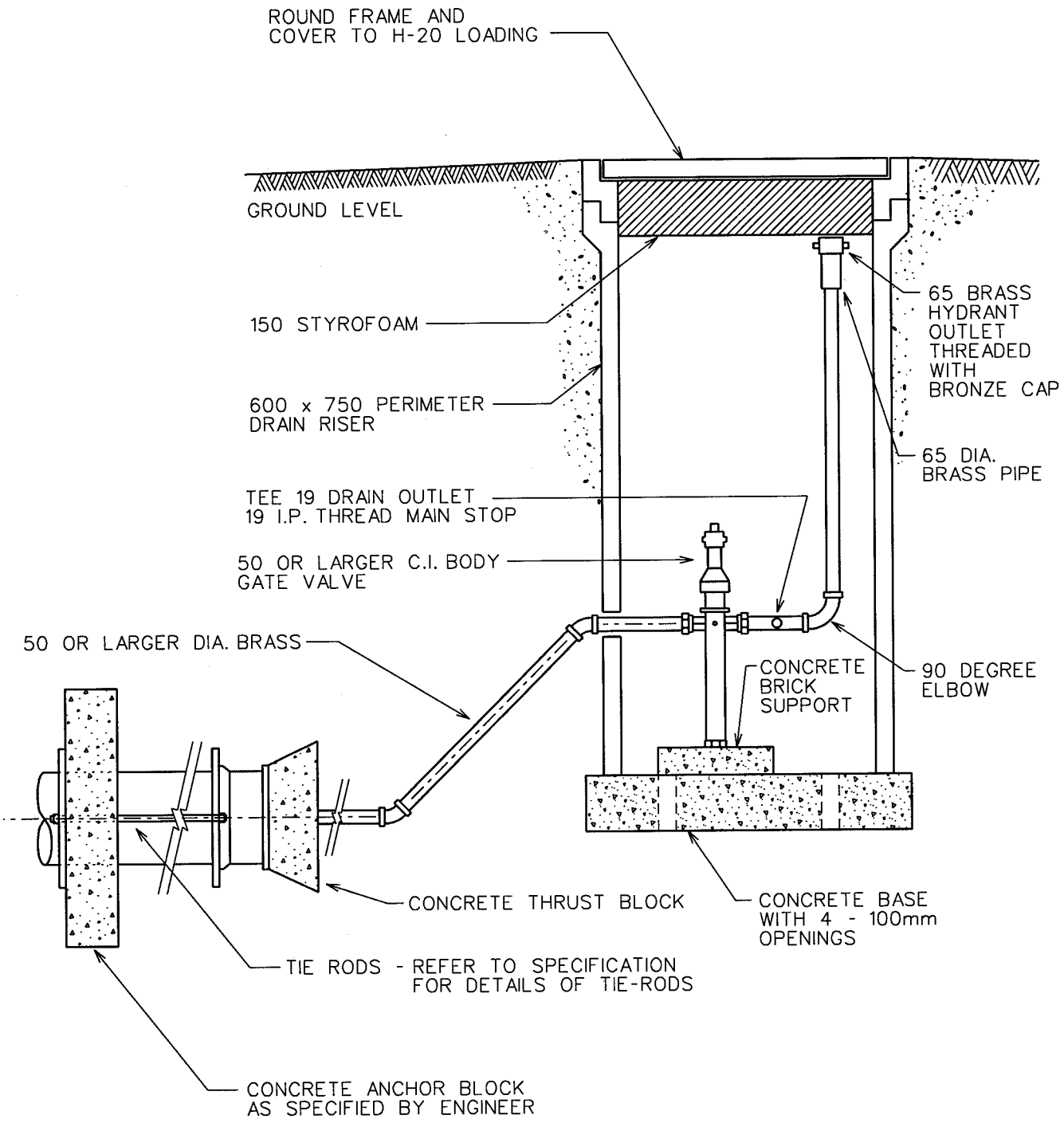
GRAVITY INSTALLATION

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1	March 2002	Title PRV STATION CHLORINATED WATER CONTROL
	Revision Date Approved	

SURREY CITY OF PARKS SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER SSD-W.5
Date	November 1999	
Drawn By	Surrey Engineering	

G:Mapping\Cad\Standards2002\Water Distribution\Water Dgn\SSD-W5.dgn



NOTE: 1) TF500 HYDRANT OR EQUIVALENT COMPLETE WITH SS SHAFT.

3	March 2004	Kok Kuen Li
2	December 2003	Kok Kuen Li
1	January 2002	
	Revision Date	Approved

All Dimensions Shown In Millimetres,
Unless Otherwise Noted

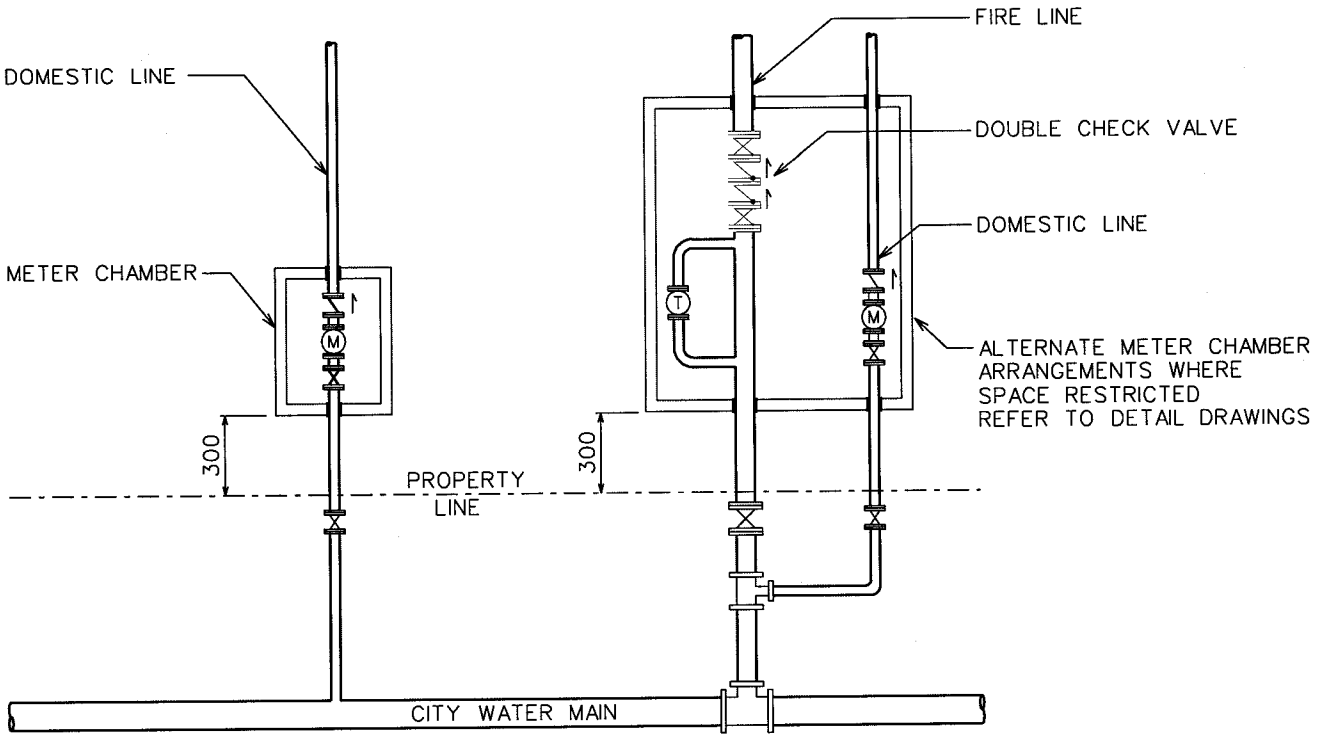
Title: BLOWOFF CHAMBER

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-W.8

G:Mapping\Cad\Standards2003\Water Distribution\Water Dgn\SSD-W8.dgn



SINGLE SERVICE CONNECTION

SEE SSD-WM2, SSD-WM3, SSD-WM4, SSD-WM4.1

FIRE SERVICE

SEE SSD-WM5, SSD-WM5.1

FLANGE JOINT OVER 50 DIA.

CURB STOP - UP TO 50 DIA.
OR GATE VALVE - OVER 50 DIA.

BRASS SCREW TYPE CHECK VALVE - UP TO 50 DIA.
OR SWING TYPE CHECK VALVE - OVER 50 DIA.

(M) METER

(T) TATTLE TALE METER

NOTES:

1. THIS DRAWING SHOULD BE REVIEWED IN CONJUNCTION WITH THE DOCUMENT , "WATER METER INSTALLATION STANDARDS AND SPECIFICATIONS."
2. FOR SUPPLY OF METERS REFER TO TABLE 1 OF THE "WATER METER INSTALLATION STANDARDS AND SPECIFICATIONS."
3. CONNECTIONS GREATER THAN 50 SHALL BE RESTRAINED TO THE CITY WATER MAIN.
4. ALL FITTINGS OVER 50 DIAMETER SHALL HAVE FLANGE OR HUB JOINTS.
5. CHAMBERS AND VAULTS SIZED AS SPECIFIED IN TABLE 3 OF "WATER METER INSTALLATION STANDARDS AND SPECIFICATIONS."
6. COMBINED SERVICE AND INSIDE APPLICATIONS SEE SSD-WM6, SSD-WM7, AND SSD-WM8.
7. 75mm SERVICE LINES ARE NOT ALLOWED.

3		
2	December 2003	J. Pillai
1	February 2002	
	Revision Date	Approved

All Dimensions Shown In millimetres, Unless Otherwise Noted

Title: GENERAL LAYOUT

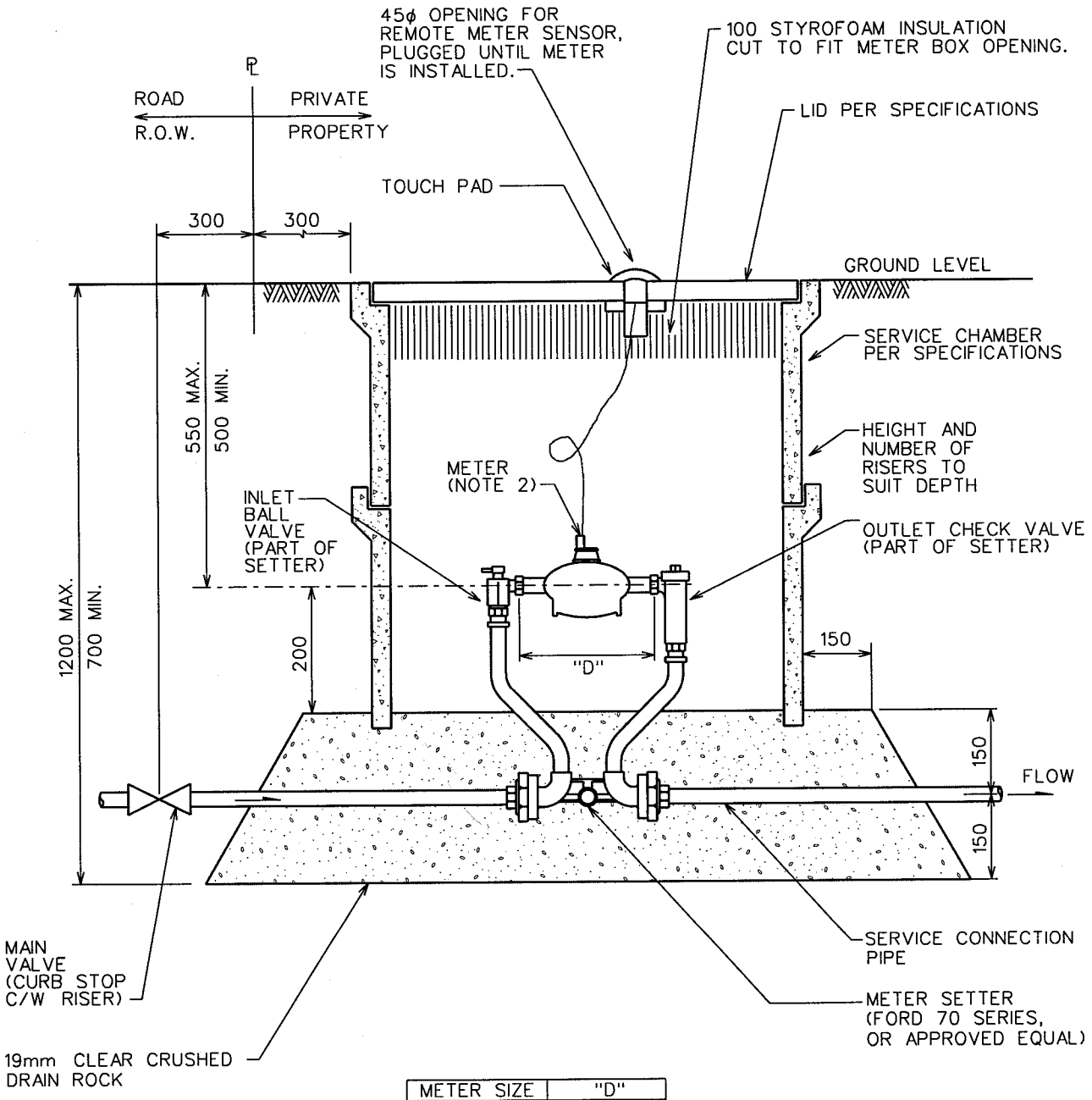
SURREY CITY OF PARKS

WATER METER INSTALLATION STANDARDS

Approved	
Date	December 1999
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-WM1

G:\MAPPING\CAD\STANDARDS2003\WATER METER\WATER METER DGN\WM1.DGN



METER SIZE	"D"
16x19	191
19	229
25	273

NOTES:

1. THIS DRAWING SHOULD BE REVIEWED IN CONJUNCTION WITH THE DOCUMENT, "WATER METER INSTALLATION STANDARDS AND SPECIFICATIONS" BY CITY OF SURREY.
2. FOR SUPPLY OF METERS REFER TO TABLE 1 OF THE "WATER METER INSTALLATION STANDARDS AND SPECIFICATIONS."

3	May 2004	V. Lalonde
2	December 2003	J. Pillai
1	March 2002	
	Revision Date	Approved

All Dimensions Shown In millimetres, Unless Otherwise Noted

Title: METER CHAMBER INSTALLATION FOR METERS 25mm DIAMETER AND SMALLER

SURREY CITY OF PARKS

WATER METER INSTALLATION STANDARDS

Approved	
Date	December 1999
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-WM2

G:\MAPPING\CAD\STANDARDS2003\WATER METER\WATER METER DGN\SSD-WM2.dgn

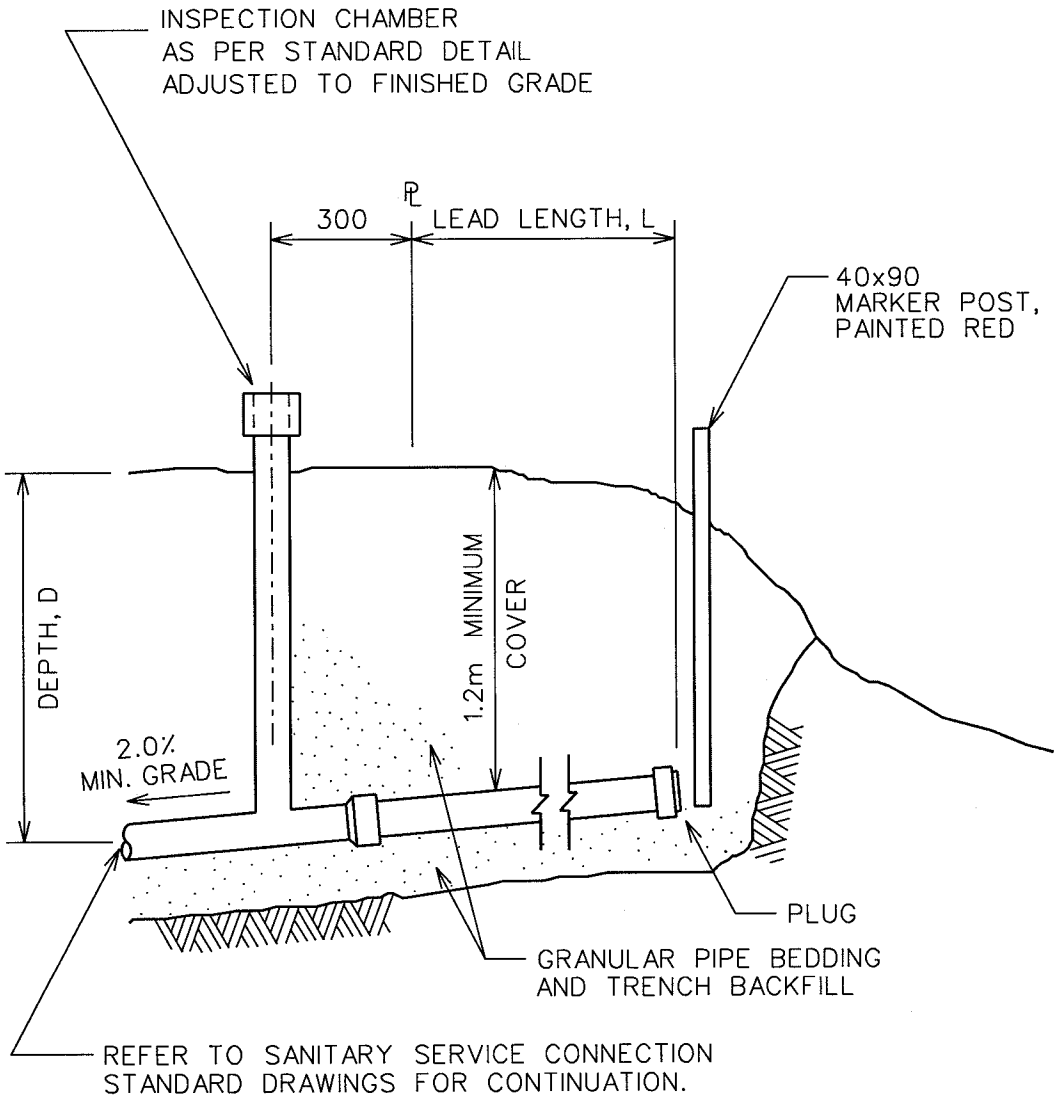
CITY OF SURREY

Engineering Department

Supplementary Standard Drawings

Drawing Table of Contents - Sanitary Sewer System

Drawing Number	Drawing Title
SSD-S.1	Sanitary Sewer Service Lead at Property
SSD-S.2	Typical Low Pressure Sewer Connection
SSD-S.3	Clean Out Manhole for Low Pressure Sewers
SSD-S.4	Air Valve Assembly for Low Pressure Sewers



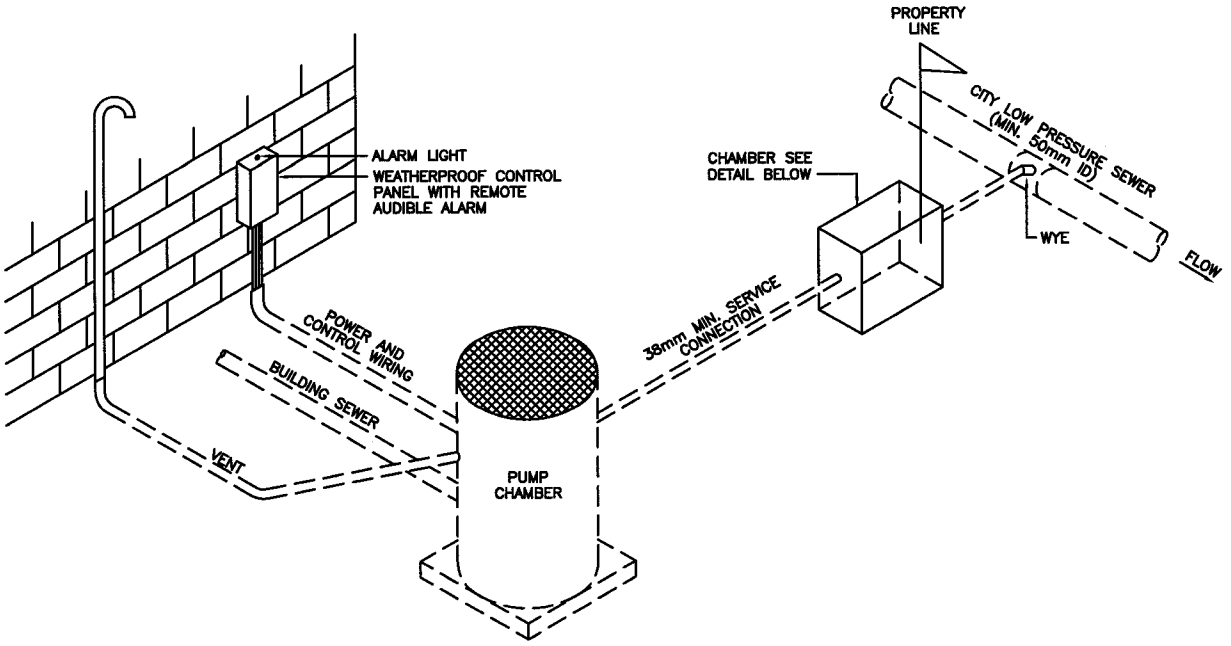
NOTES: (1) LEAD LENGTH, L = DEPTH, D OR 2.0m WHICH EVER IS GREATER.
(2) SERVICE LEADS TO BE 100mm DIA. DR28 (WHITE) OR AS SPECIFIED ON CONTRACT DRAWINGS.

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1	FEBRUARY 2002	Title: SANITARY SEWER SERVICE LEAD AT PROPERTY
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

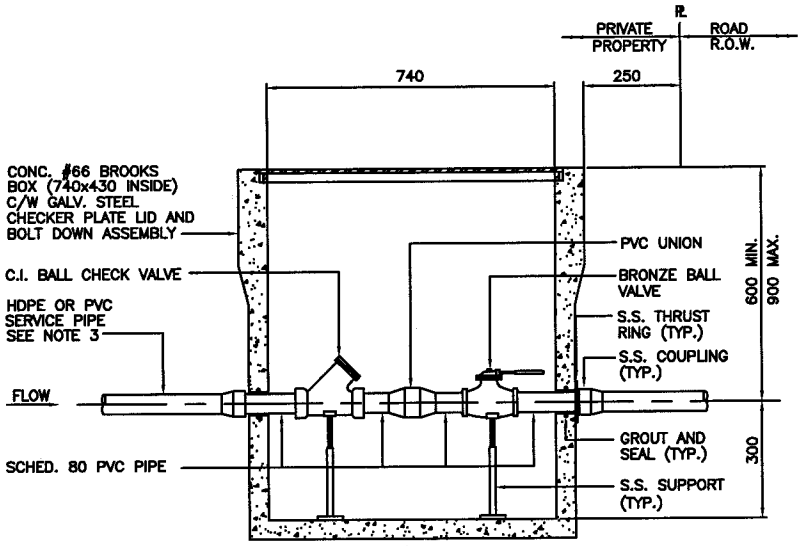
Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-S.1
Drawn By	Surrey Engineering	

G:Mapping\Cad\Standards2002\SanitarySewer\SanitaryDGN\SSD-S1.dgn



TYPICAL LOW PRESSURE SEWER CONNECTION

N.T.S.



CHAMBER DETAIL

N.T.S.

NOTES:

1. CONTROL PANEL MAY BE LOCATED INSIDE BUILDING OR ON POST ADJACENT TO PUMP CHAMBER IF APPROVED BY CITY.
2. VENT MAY BE CONNECTED TO BUILDING VENT SYSTEM OR LOCATED ADJACENT TO PUMP CHAMBER IF APPROVED BY CITY.
3. ALL PIPE SIZES REFER TO INSIDE DIAMETER (I.D.).
4. SERVICE PIPE MIN. I.D.: 38mm
5. PROPERTY OWNER IS RESPONSIBLE FOR MAINTENANCE OF ALL SEWER CONNECTION COMPONENTS INCLUDING PIPE BETWEEN PROPERTY LINE AND THE CITY SEWER.
6. CHAMBER ACCESS IS TO BE UNOBSTRUCTED.
7. CITY STAFF OR AGENTS ARE ALLOWED UNRESTRICTED ACCESS TO CHAMBER.
8. CHAMBER AND PUMP CHAMBER ARE IN THE PRIVATE PROPERTY.

Revision Date	Approved

All Dimensions Shown In Millimetres, Unless Otherwise Noted

Title: TYPICAL LOW PRESSURE SEWER CONNECTION

SURREY CITY OF PARKS

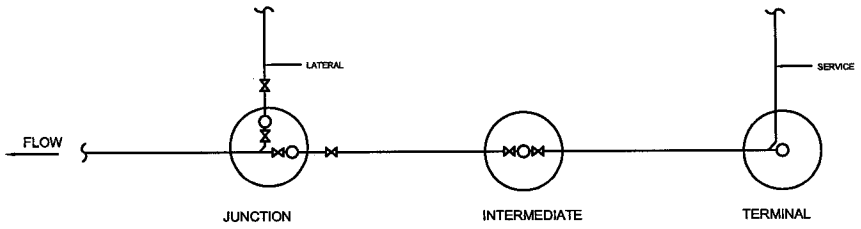
Approved: Vincent Lalonde.

Date: May 2004

Drawn By: Associated Engineering (BC) Ltd

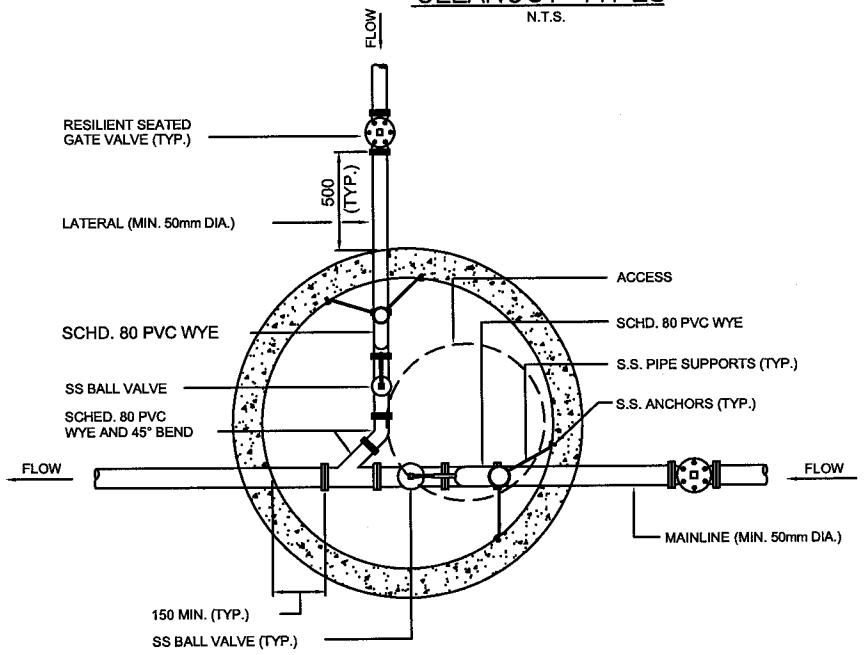
DRAWING NUMBER: SSD-S.2

FILE:Q:\032459\SKETCH\032459SK001.DWG



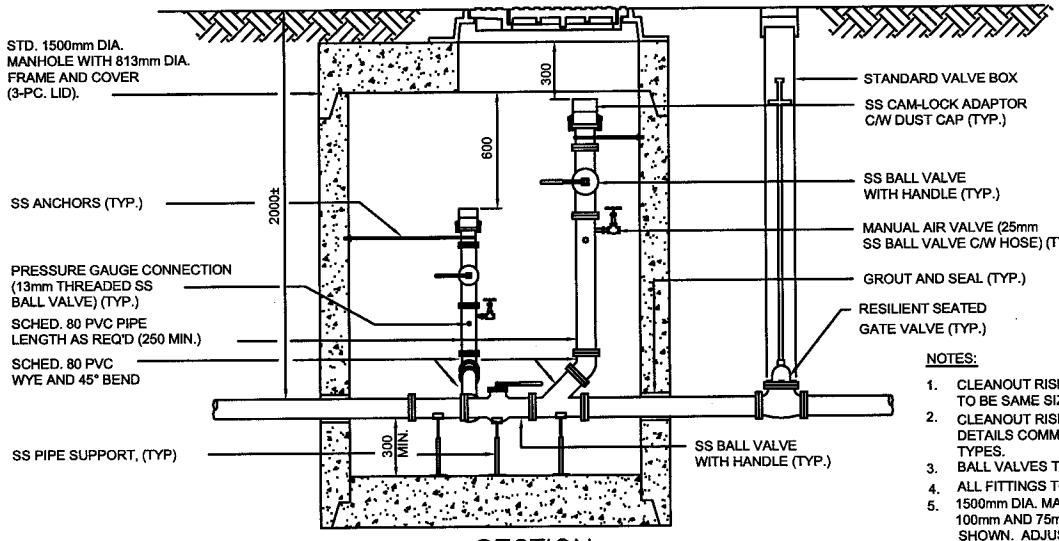
CLEANOUT TYPES

N.T.S.



TYPICAL CLEANOUT AT JUNCTION

1:40



SECTION

1:40

NOTES:

1. CLEANOUT RISER, VALVE AND CAM-LOCK TO BE SAME SIZE AS DOWNSTREAM PIPE.
2. CLEANOUT RISER, FITTING AND VALVE DETAILS COMMON FOR ALL CLEANOUT TYPES.
3. BALL VALVES TO BE FULL PORTED.
4. ALL FITTINGS TO BE FLANGED.
5. 1500mm DIA. MANHOLE REQUIRED FOR 100mm AND 75mm FORCEMAINS AS SHOWN. ADJUST AS REQUIRED FOR DIFFERENT SIZES.
6. SEE MMCD STANDARD MANHOLE DRAWING FOR RUNGS AND OTHER DETAILS.

Revision Date	Approved

All Dimensions Shown In Millimetres, Unless Otherwise Noted

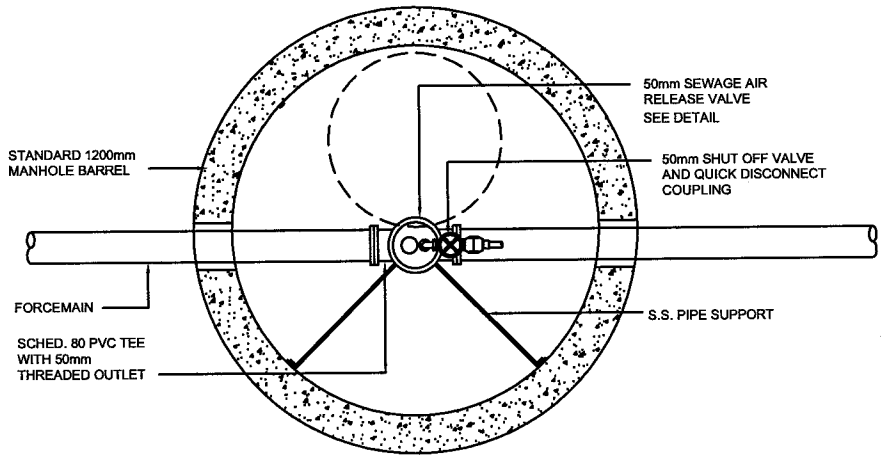
Title: CLEANOUT MANHOLE FOR LOW PRESSURE SEWERS

SURREY CITY OF PARKS

Approved	
Date	May 2004
Drawn By	Associated Engineering (BC) Ltd

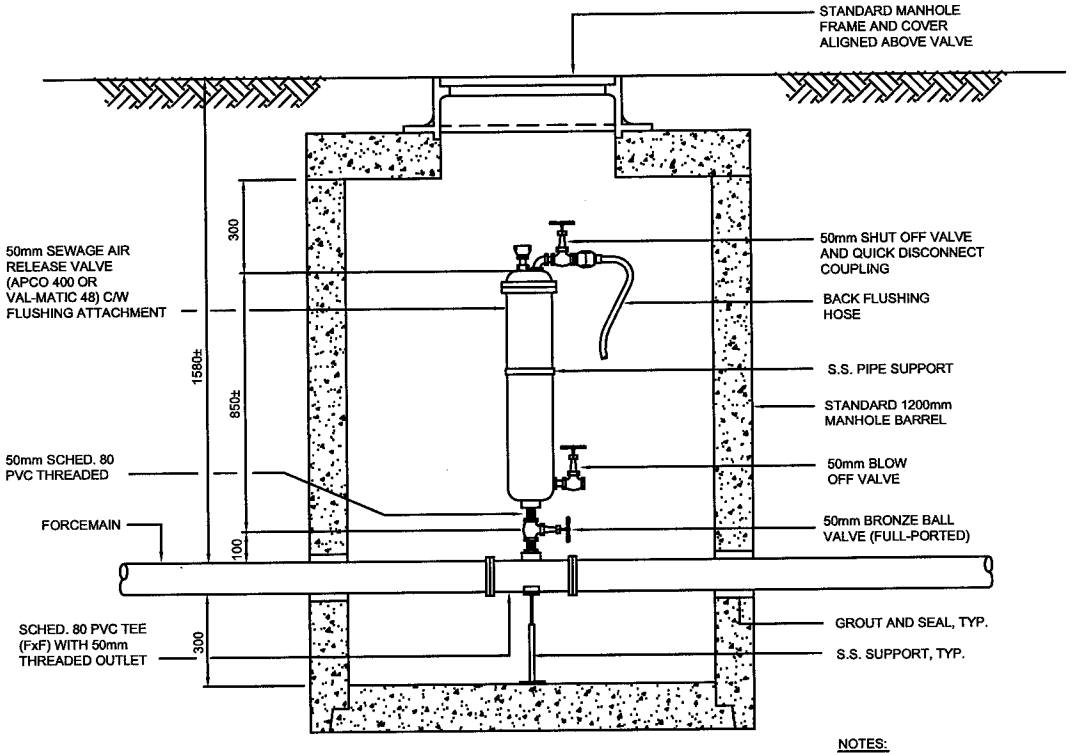
DRAWING NUMBER: SSD-S.3

FILE:Q:\032459\SKETCH\032459SK003.DWG



AIR VALVE CHAMBER –PLAN

1:25



AIR VALVE CHAMBER – DETAIL

1:25

NOTES:

1. 100mm DIA. FORCEMAIN SHOWN. ADJUST AS REQUIRED FOR DIFFERENT SIZES.
2. SEE MMCD STANDARD MANHOLE DRAWING FOR RUNGS AND OTHER DETAILS.

All Dimensions Shown In Millimetres, Unless Otherwise Noted

Title: AIR VALVE ASSEMBLY FOR LOW PRESSURE SEWERS

Revision Date	Approved

SURREY CITY OF PARKS

Approved	
Date	May 2004
Drawn By	Associated Engineering (BC) Ltd

DRAWING NUMBER: SSD-S.4

FILE:Q:\032459\SKETCH\032459SK002.DWG

CITY OF SURREY

Engineering Department

Supplementary Standard Drawings

Drawing Table of Contents - Storm Drainage System

Drawing Number	Drawing Title
SSD-D.1	Unassigned
SSD-D.2	Unassigned
SSD-D.3	Unassigned
SSD-D.4	Unassigned
SSD-D.5	Typical Water Quality / Sediment Control Inlet Chamber
SSD-D.6	Sediment Control Concept Schematic
SSD-D.7	Typical Sediment Control Pond Schematic
SSD-D.8	Recommended Side Slopes for Detention Ponds
SSD-D.9	Typical Control Manhole (Community Detention Pond)
SSD-D.10	Flow Control Manhole
SSD-D.11	Unassigned
SSD-D.12	Unassigned
SSD-D.13	Unassigned
SSD-D.14	Unassigned
SSD-D.15	Unassigned
SSD-D.16	Unassigned
SSD-D.17	Head Loss Ratio Factor – Bends
SSD-D.18	Unassigned
SSD-D.19	Unassigned
SSD-D.20	Unassigned
SSD-D.21	Unassigned
SSD-D.22	Sampling Manhole
SSD-D.23	Storm Sewer Service Lead at Property
SSD-D.24	Temporary Storm Sewer Cleanout
SSD-D.25	Storm Manhole Covers and Grate
SSD-D.26	Top Inlet Catch Basin
SSD-D.27	Drainage Grate and Frame
SSD-D.28	Boulevard Basin Grate
SSD-D.29	Asphalt Aprons for Catch Basins
SSD-D.30	Commercial Driveway Sump

Continued – next page

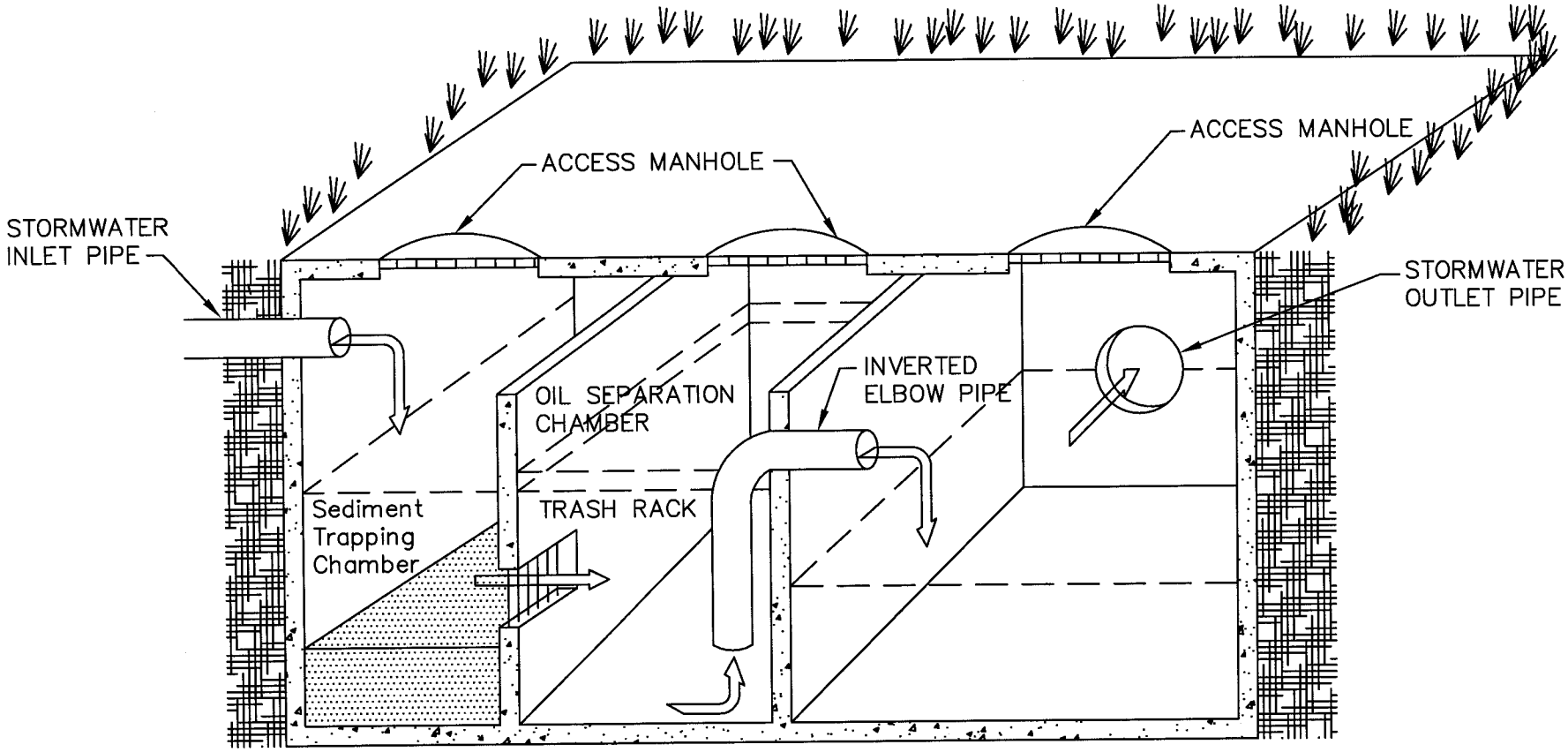
CITY OF SURREY

Engineering Department

Supplementary Standard Drawings

Drawing Table of Contents - Storm Drainage System

Drawing Number	Drawing Title
SSD-D.31	Road Drainage for Roads Without Curbs
SSD-D.32	Timber Headwall Detail for Use Only in Lowlands
SSD-D.33	Subdrain
SSD-D.34	Detention Basin Plan View
SSD-D.35	Unassigned
SSD-D.36	Gate Details for Detention Ponds
SSD-D.37	Siltation / Sediment Erosion Control Check Feature Detail



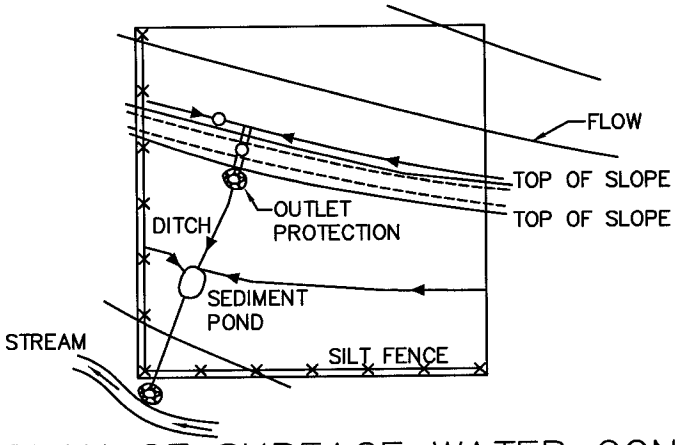
All Dimensions Shown In Millimetres, Unless Otherwise Noted		
3		
2		
1		
	Revision Date	Approved

SURREY
CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

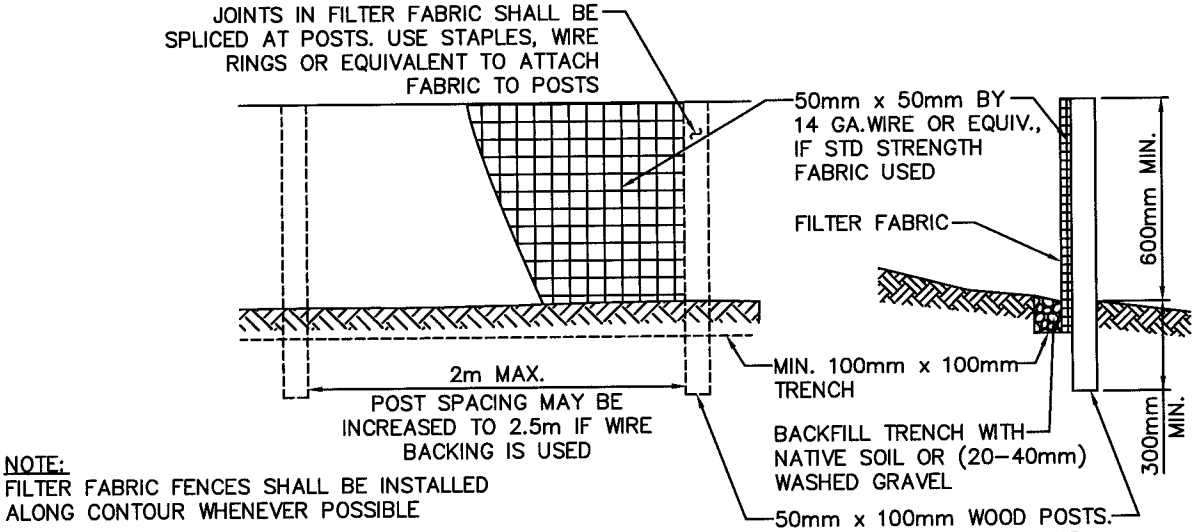
Title TYPICAL WATER QUALITY / SEDIMENT CONTROL INLET CHAMBER

Approved		DRAWING NUMBER
Date	FEBRUARY 2002	SSD-D.5
Drawn By	Surrey Engineering	

H:\PROJECTS\ PLOT SCALE \02A\

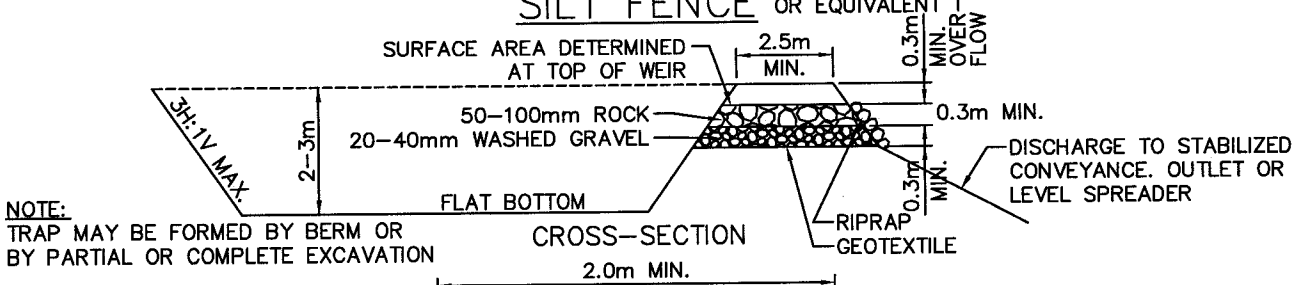


SKETCH PLAN OF SURFACE WATER CONTROLS



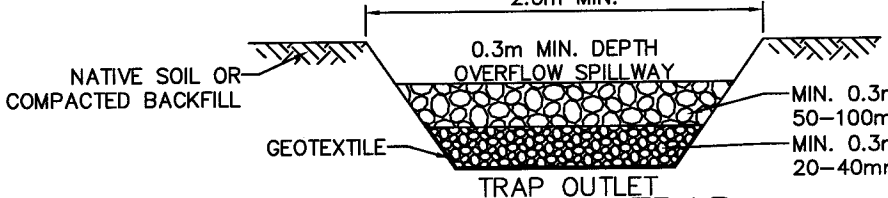
NOTE:
FILTER FABRIC FENCES SHALL BE INSTALLED ALONG CONTOUR WHENEVER POSSIBLE

SILT FENCE



NOTE:
TRAP MAY BE FORMED BY BERM OR BY PARTIAL OR COMPLETE EXCAVATION

CROSS–SECTION



TRAP OUTLET

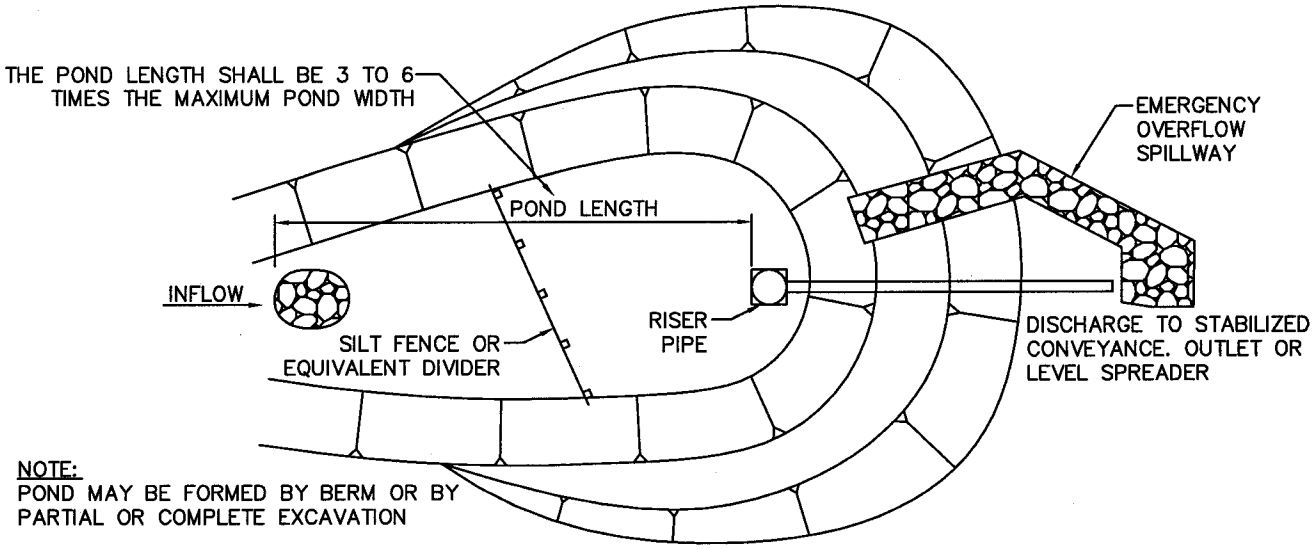
SEDIMENT TRAP

NOTE: (1) REFER TO CONTRACT DRAWINGS AND THE SUPPLEMENTARY SPECIFICATIONS, SECTION FOR 'TRAFFIC SIGNALS'

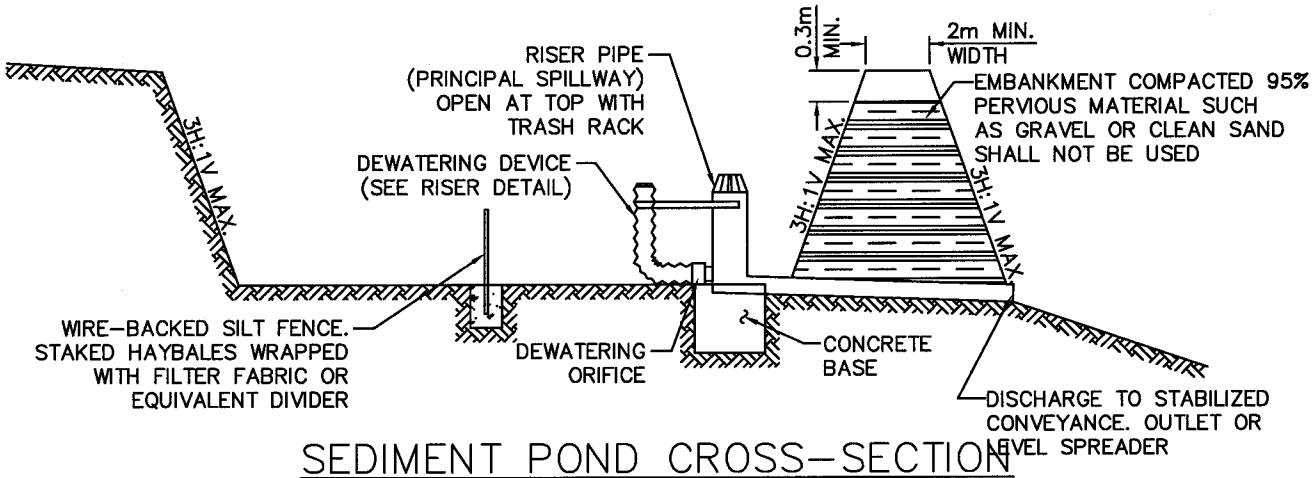
3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title SEDIMENT CONTROL CONCEPT SCHEMATIC
	Revision Date Approved	

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

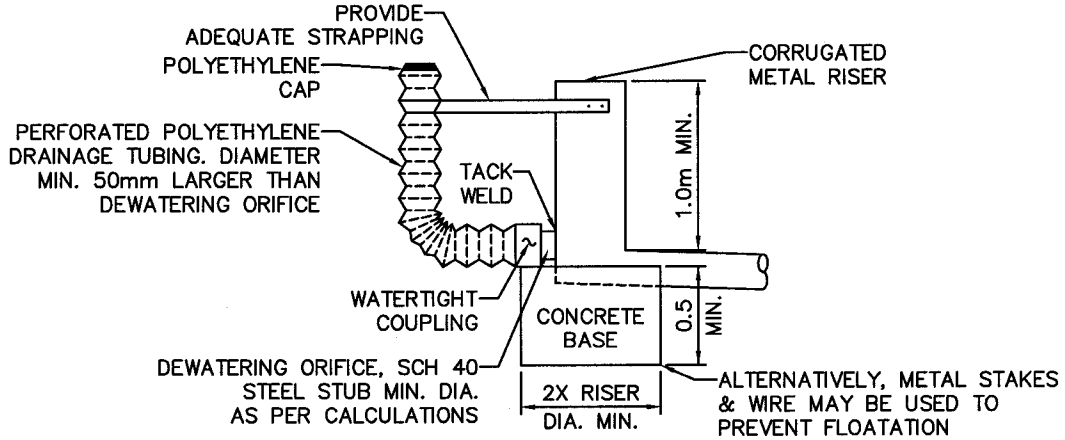
Approved		DRAWING NUMBER
Date	FEBRUARY 2002	SSD–D.6
Drawn By	Surrey Engineering	



SEDIMENT POND PLAN VIEW



SEDIMENT POND CROSS-SECTION



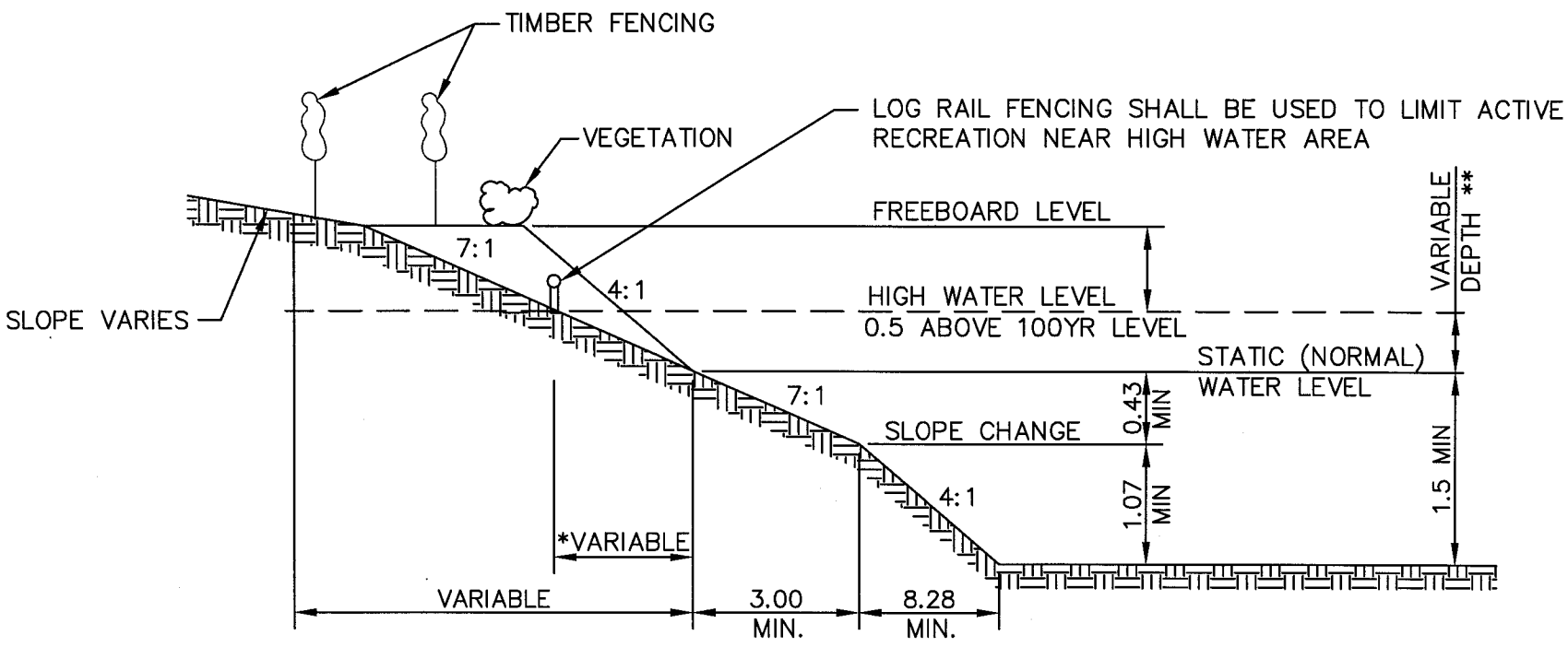
SEDIMENT POND RISER DETAIL

NOTE: (1) REFER TO CONTRACT DRAWINGS AND THE SUPPLEMENTARY SPECIFICATIONS, SECTION FOR 'TRAFFIC SIGNALS'

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title TYPICAL SEDIMENT CONTROL POND SCHEMATIC
	Revision Date Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	AUGUST 1998	SSD-D.7
Drawn By	Surrey Engineering	



NOTES:

1. *MAXIMUM SIDE SLOPE OF 4:1 (H:V) MAY BE USED PROVIDED ADEQUATE VEGETATION IS USED TO PREVENT ACCESS.
2. ** MAX 2.0 m. FOR <=5 YEAR LEVEL AND 3.0 M FOR THE 100 YEAR LEVEL
3. ALL DIMENSIONS ARE IN METRES

H:\PROJECTS\02A\PLOT SCALE WHAT IS THE PLOT SCALE ?

All Dimensions Shown In Millimetres, Unless Otherwise Noted

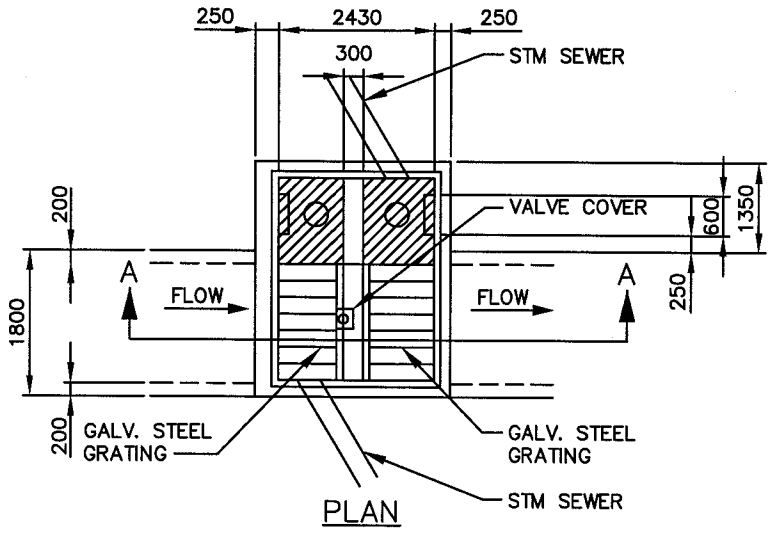
3		
2		
1		
	Revision Date	Approved

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

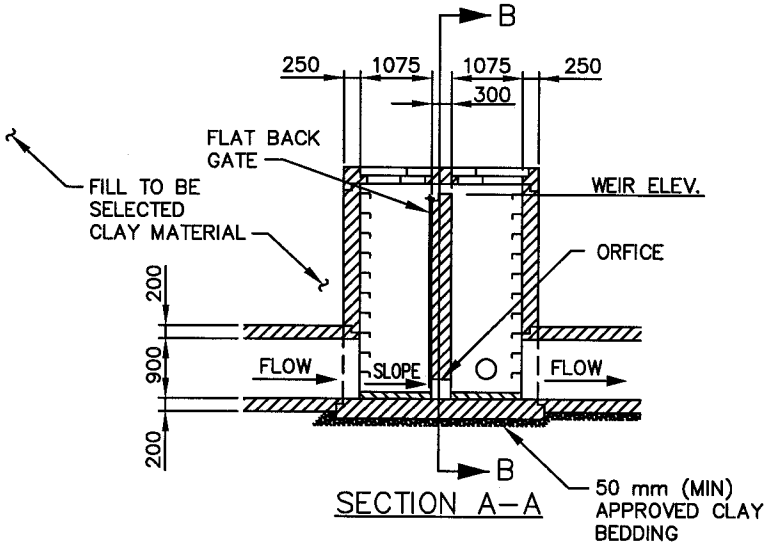
Title RECOMMENDED SIDE SLOPES FOR DETENTION PONDS

Approved	
Date	08/01/98
Drawn By	Surrey Engineering

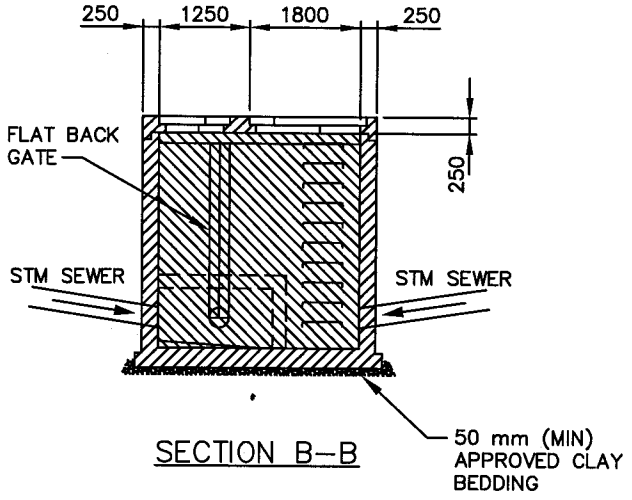
DRAWING NUMBER
SSD-D.8



PLAN



SECTION A–A



SECTION B–B

All Dimensions Shown In Millimetres, Unless Otherwise Noted		
3		
2		
1		
	Revision Date	Approved

SURREY CITY OF PARKS

SUPPLEMENTARY STANDARD DRAWINGS

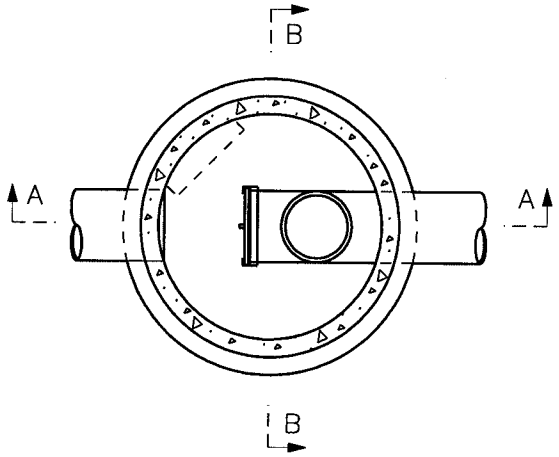
Title TYPICAL CONTROL MANHOLE (COMMUNITY DETENTION POND)

Approved	
Date	08/01/98
Drawn By	Surrey Engineering

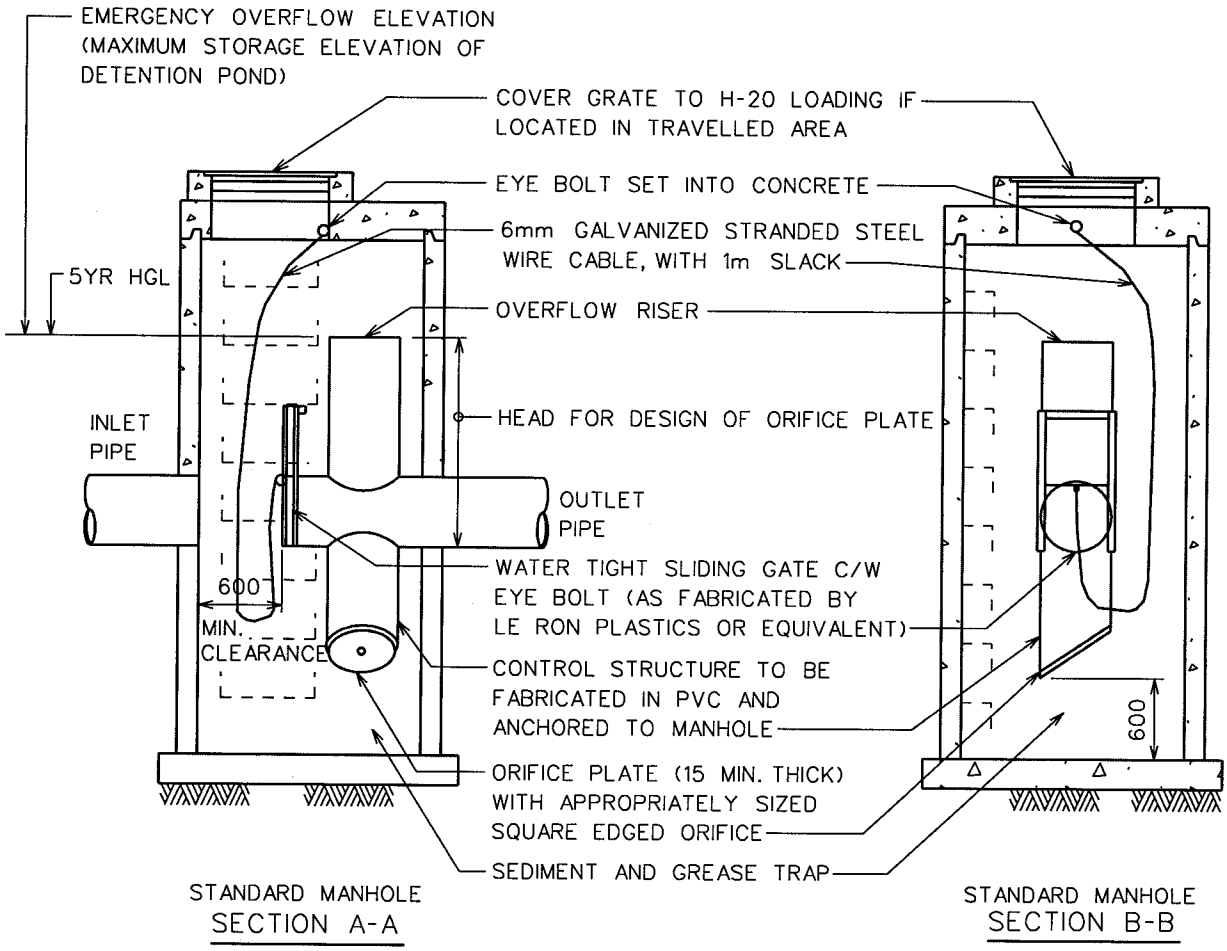
DRAWING NUMBER

SSD–D.9

H:\PROJECTS\02A\
PLOT SCALE



PLAN



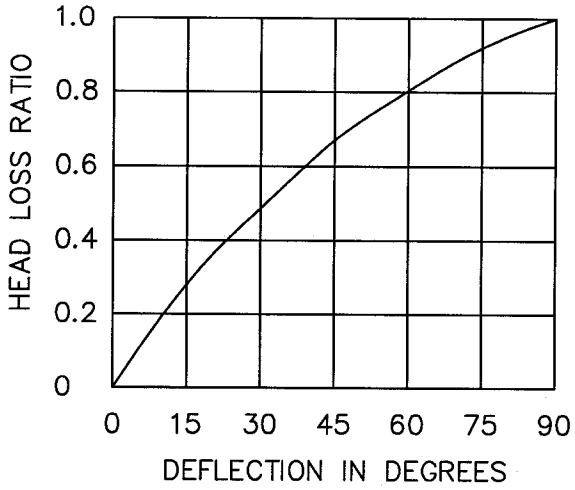
STANDARD MANHOLE
SECTION A-A

STANDARD MANHOLE
SECTION B-B

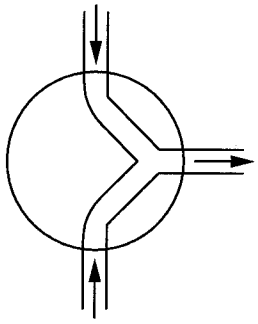
3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1	MARCH 2002	Title: FLOW CONTROL MANHOLE
	Revision Date Approved	

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

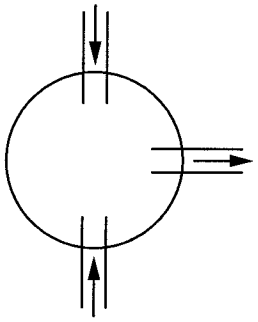
Approved		DRAWING NUMBER
Date	JUNE 1998	SSD-D.10
Drawn By	Surrey Engineering	



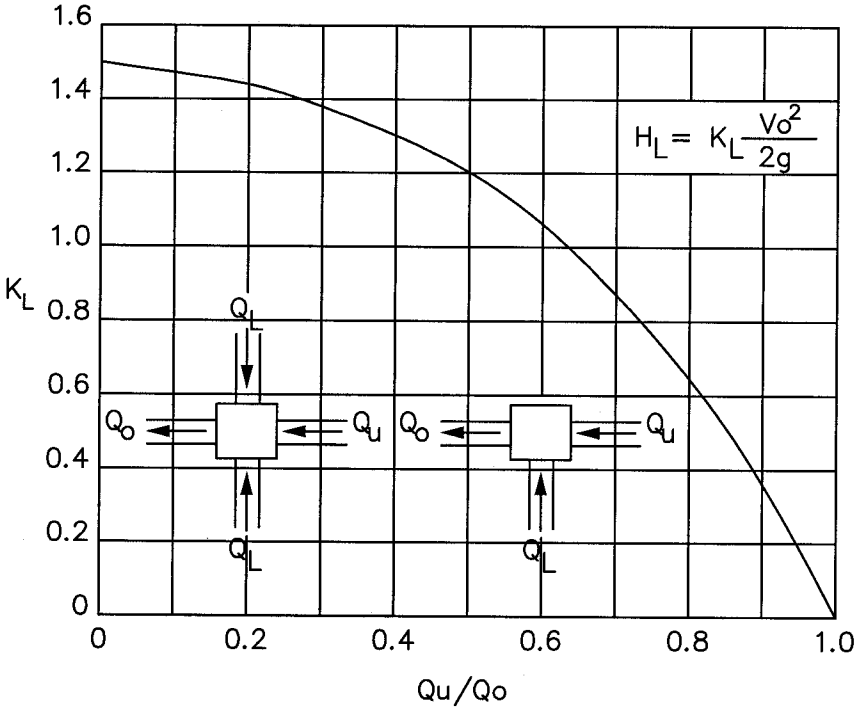
HEAD LOSS RATIO FACTOR



WITH DEFLECTOR



WITHOUT DEFLECTOR



HEAD LOSS COEFFICENT – JUNCTIONS

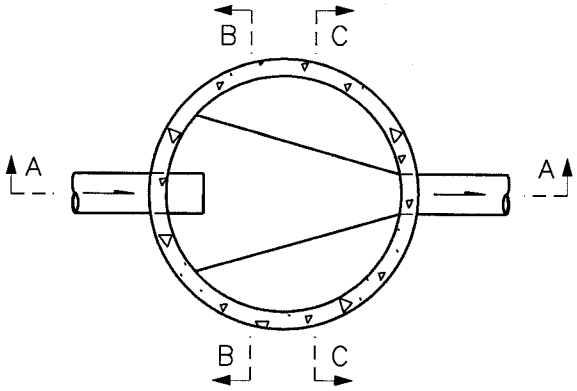
NOTE: (1) REFER TO CONTRACT DRAWINGS AND THE SUPPLEMENTARY SPECIFICATIONS, SECTION FOR 'TRAFFIC SIGNALS'

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title HEAD LOSS RATIO FACTOR - BENDS
	Revision Date Approved	

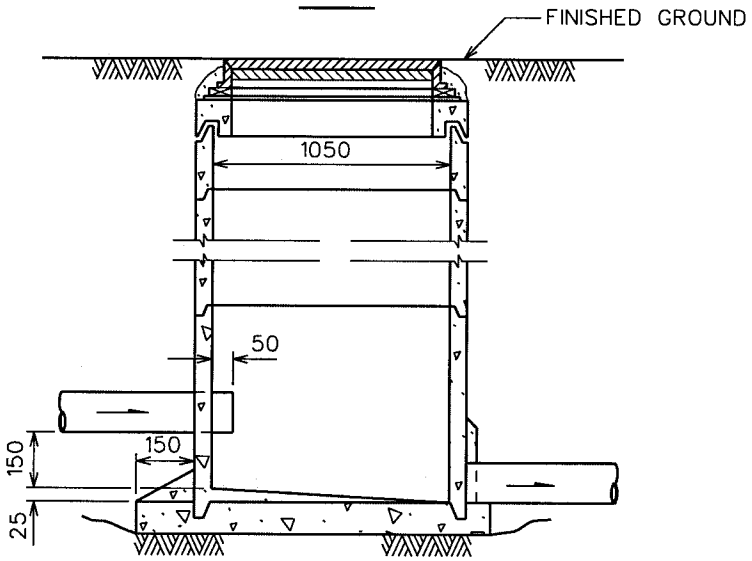
SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	AUGUST 1998
Drawn By	Surrey Engineering

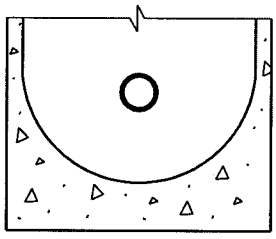
DRAWING NUMBER
SSD-D.17



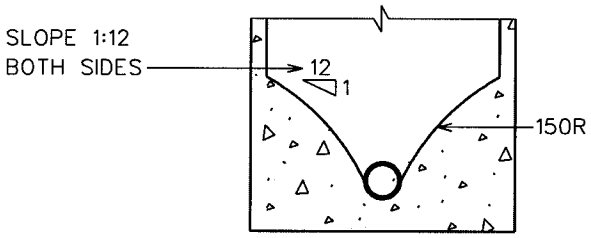
PLAN



SECTION A-A



SECTION B-B



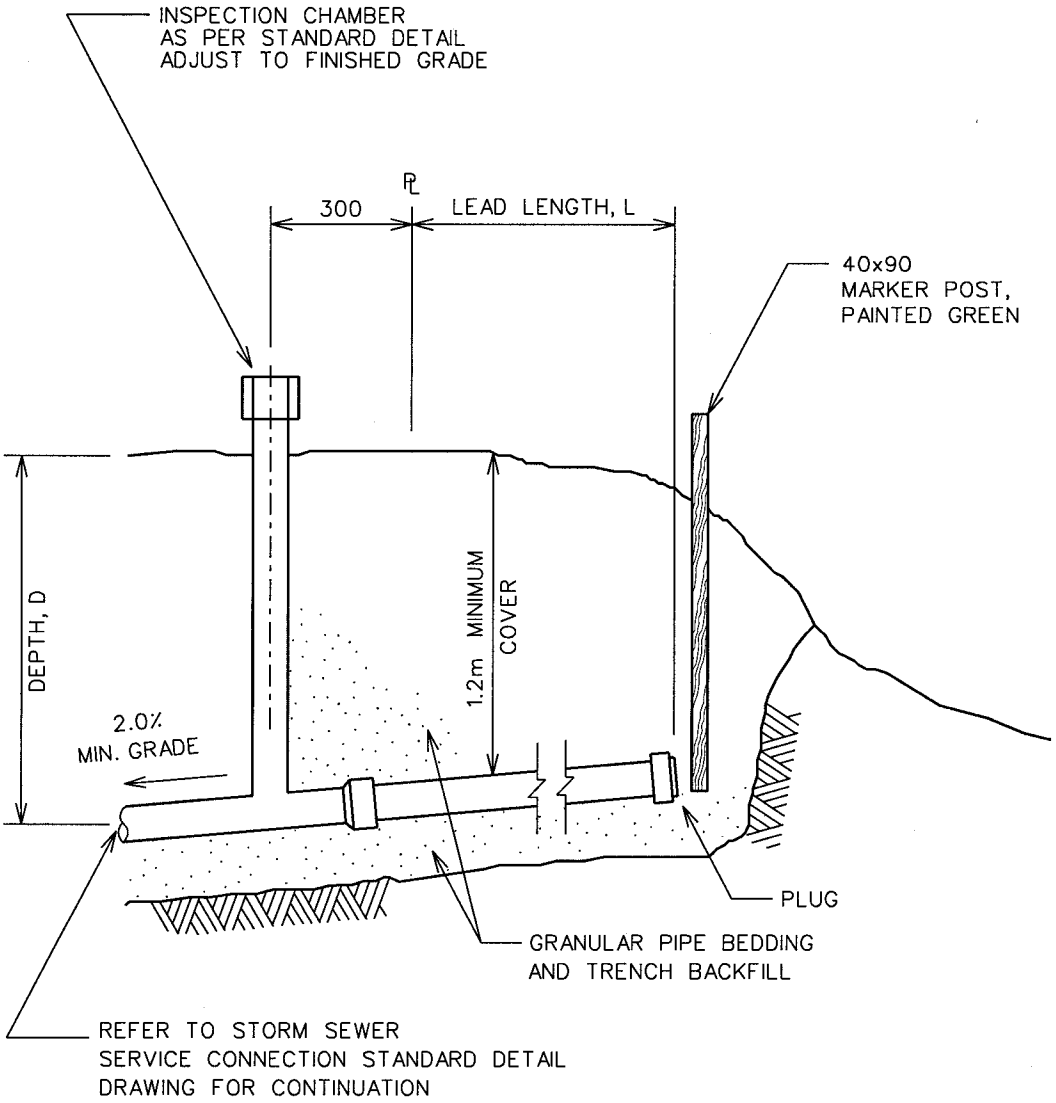
SECTION C-C

NOTE: (1) INLET AND OUTLET SIZE AS APPROVED BY THE ENGINEER FOR SIZE OF CONNECTION.

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: SAMPLING MANHOLE
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	JUNE 1998	SSD-D.22
Drawn By	Surrey Engineering	



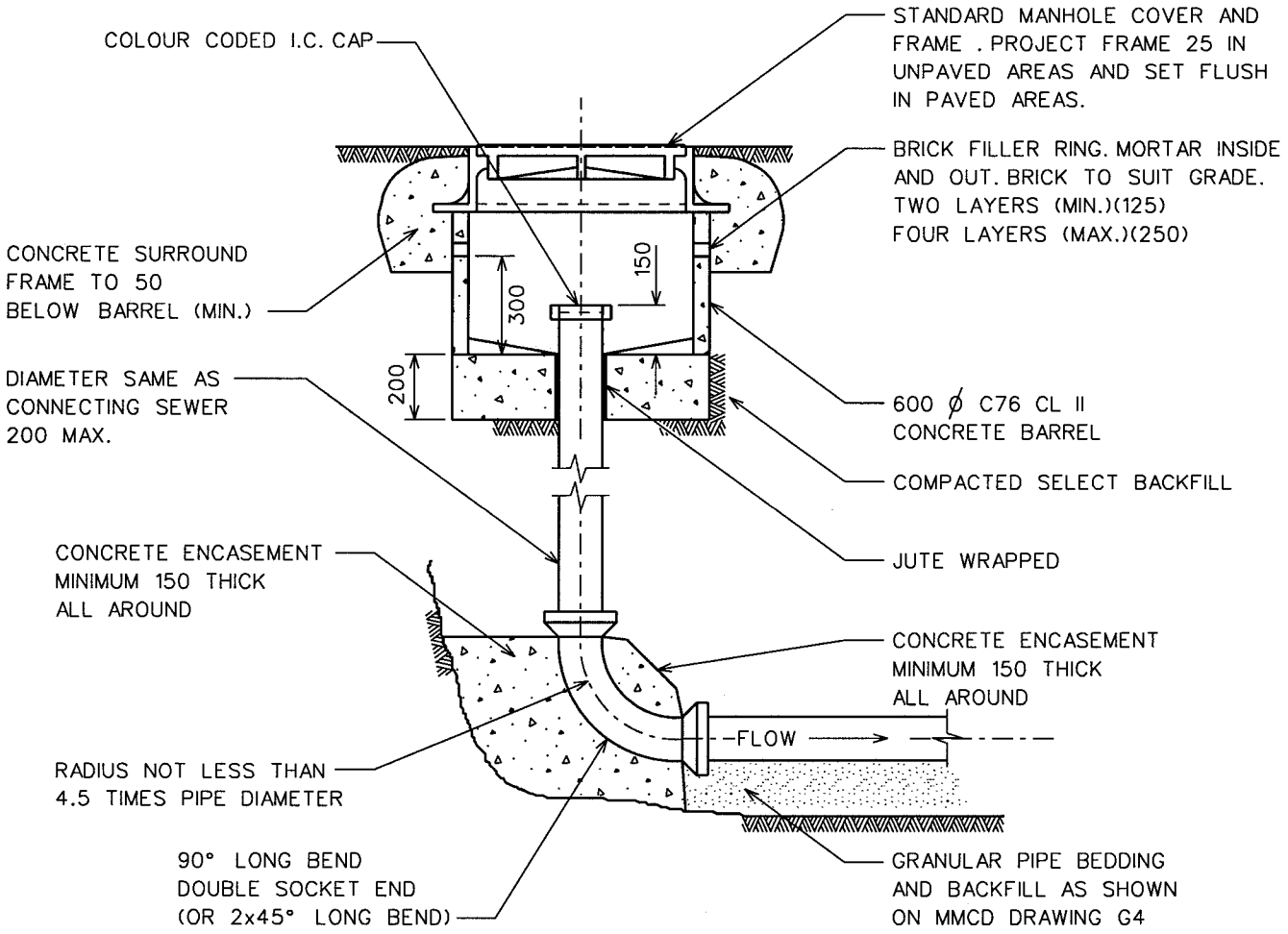
NOTES: (1) LEAD LENGTH, L = DEPTH, D OR 2.0m WHICH EVER IS GREATER.

(2) SERVICE LEADS TO BE 100mm DIA. DR28 (WHITE) OR AS SPECIFIED ON CONTRACT DRAWINGS.

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1	FEBRUARY 2002	Title: STORM SEWER SERVICE LEAD AT PROPERTY
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	JUNE 1998	SSD-D.23
Drawn By	Surrey Engineering	

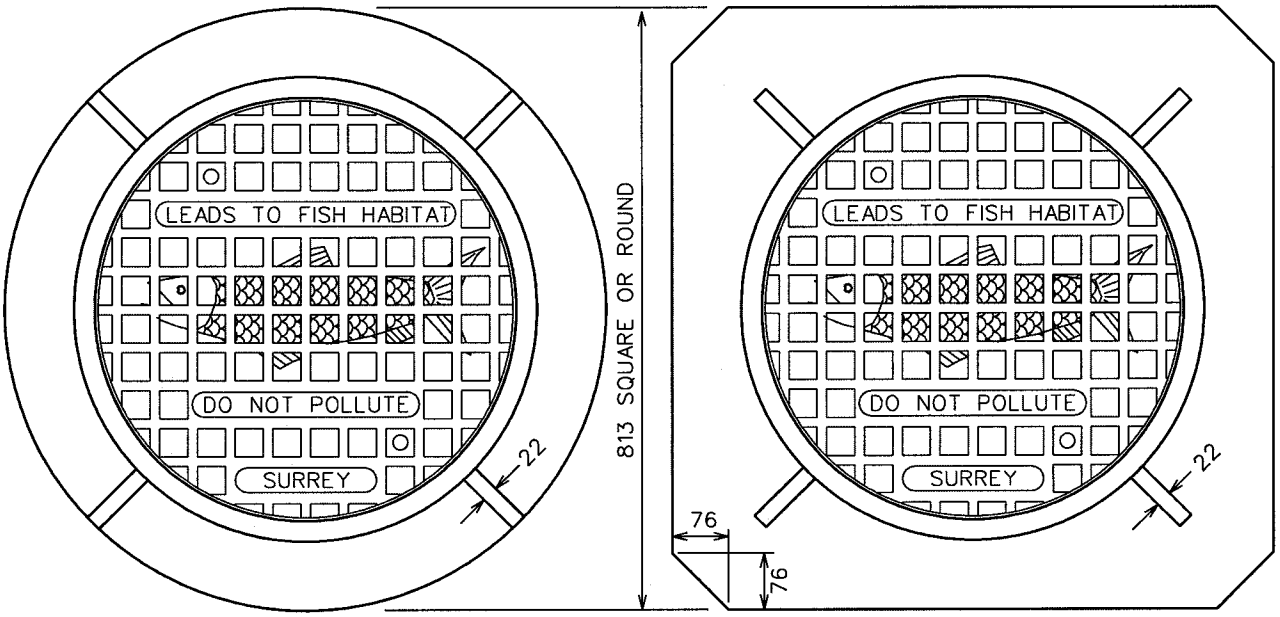


NOTE: (1) ALL PIPE FITTINGS PVC DR28 c/w GASKETS

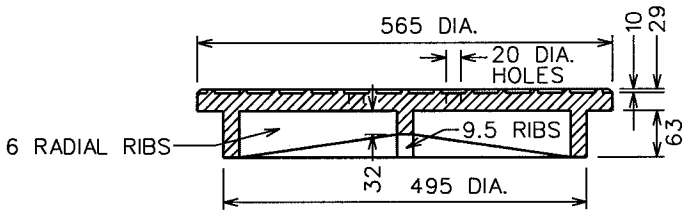
3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: TEMPORARY STORM SEWER CLEANOUT
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

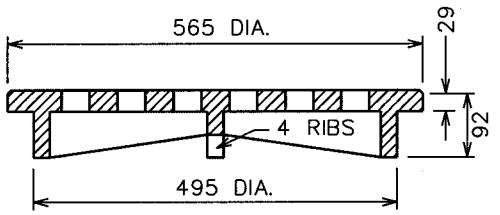
Approved		DRAWING NUMBER
Date	JUNE 1998	SSD-D.24
Drawn By	Surrey Engineering	



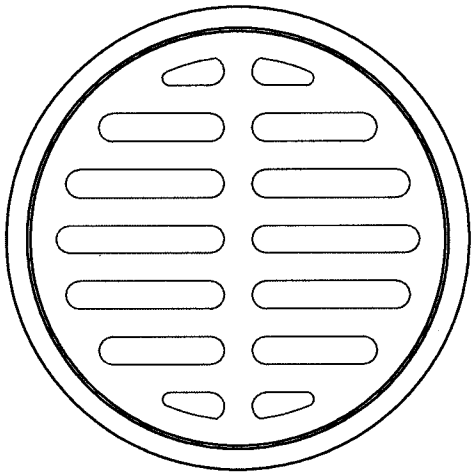
ROUND or SQUARE FRAME & COVER



SECTION THRU COVER



SECTION THRU GRATE



BLANK GRATE

GRATE FOR USE
IN NON-TRAFFIC AREAS

NOTE:

(1) SYMBOL OF FISH TO BE RAISED ON TOP OF COVER BY 8mm.

(2) USE DUCTILE IRON FRAME AND COVER ON ARTERIAL ROADS.

3		
2		
1		
	Revision Date	Approved

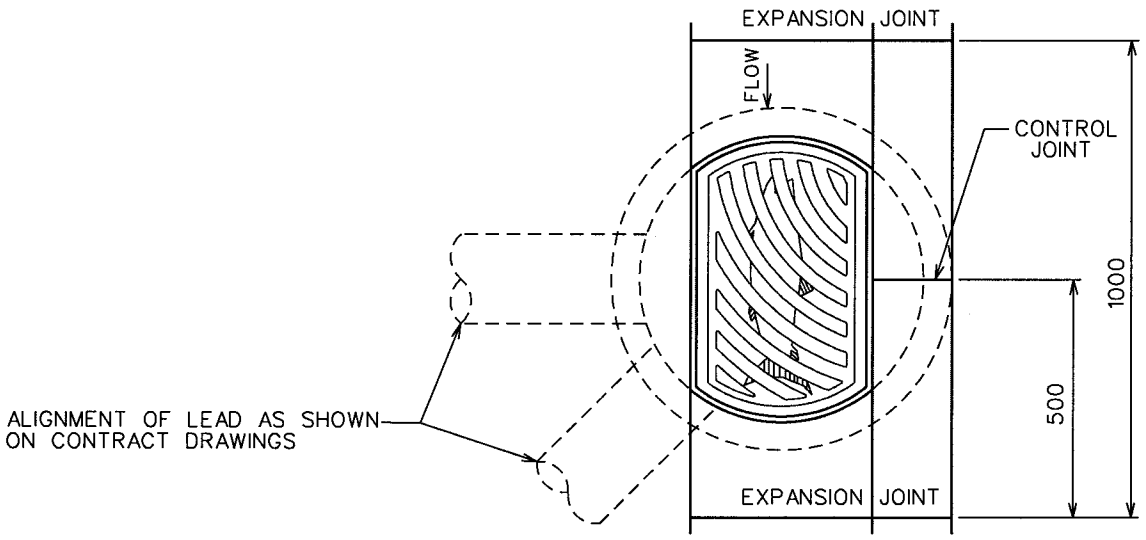
All Dimensions Shown In Millimetres,
Unless Otherwise Noted

Title: STORM MANHOLE COVERS AND GRATE

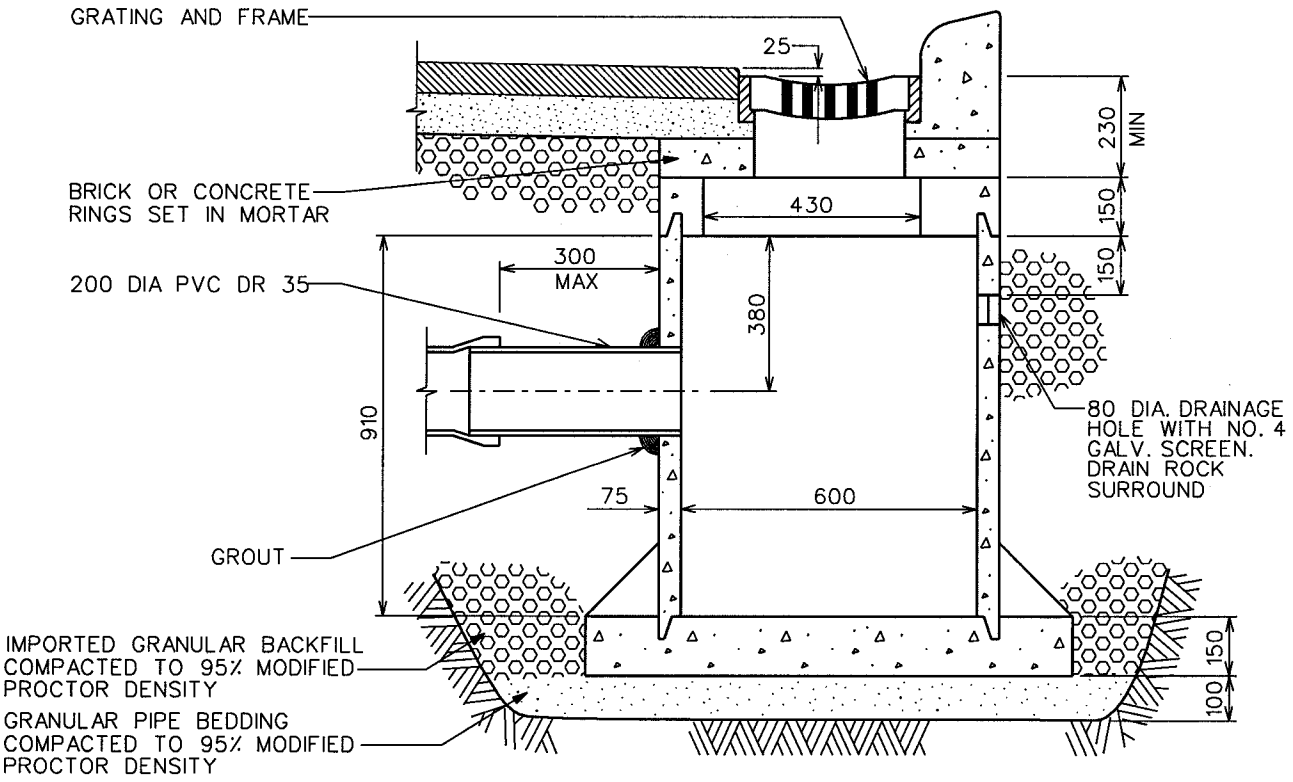
SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	JUNE 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-D.25



FRAME AND COVER DETAILS



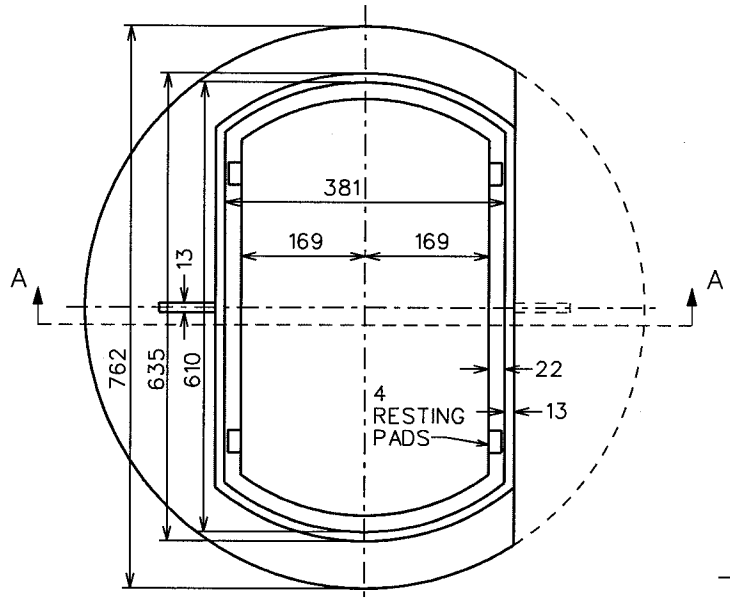
STANDARD CATCH BASIN

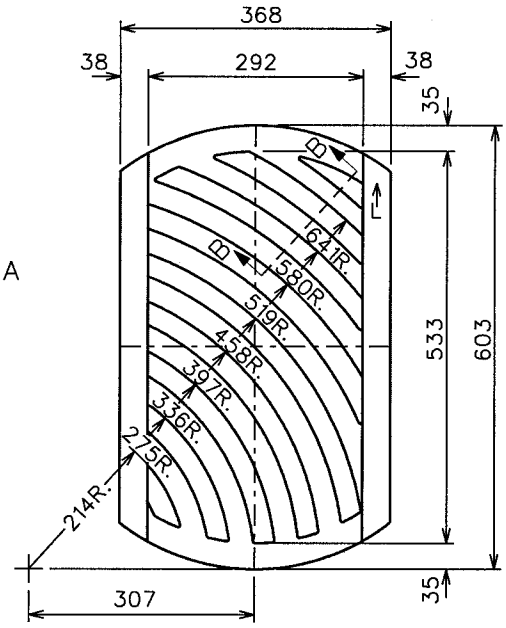
NOTES: (1) DETAILS ARE DRAWN FOR PRECAST RISERS ON CAST-IN-PLACE BASES.
(2) PRECAST UNITS c/w BASE, APPROVED BY ENGINEER, ARE ACCEPTABLE.

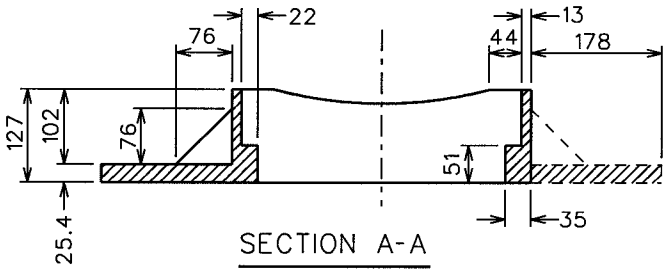
3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: TOP INLET CATCH BASIN
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

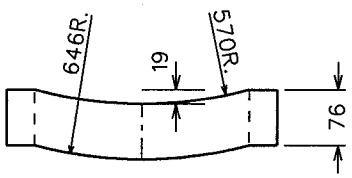
Approved		DRAWING NUMBER
Date	JUNE 1998	SSD-D.26
Drawn By	Surrey Engineering	



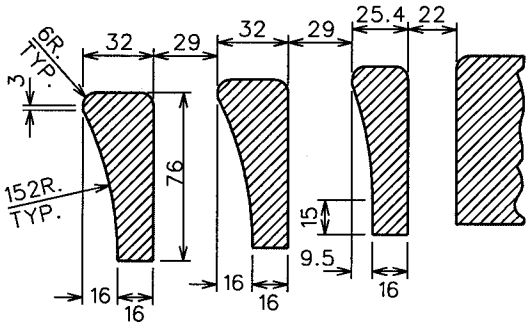




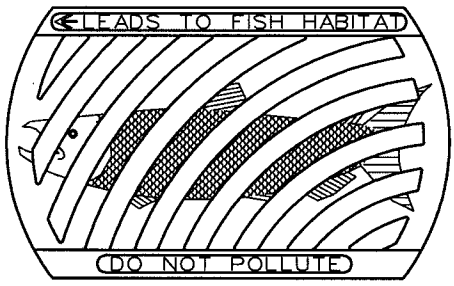
SECTION A-A



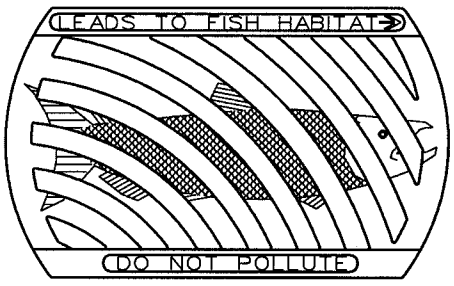
GRATE ELEVATION



SECTION B-B



LEFT HAND GRATE



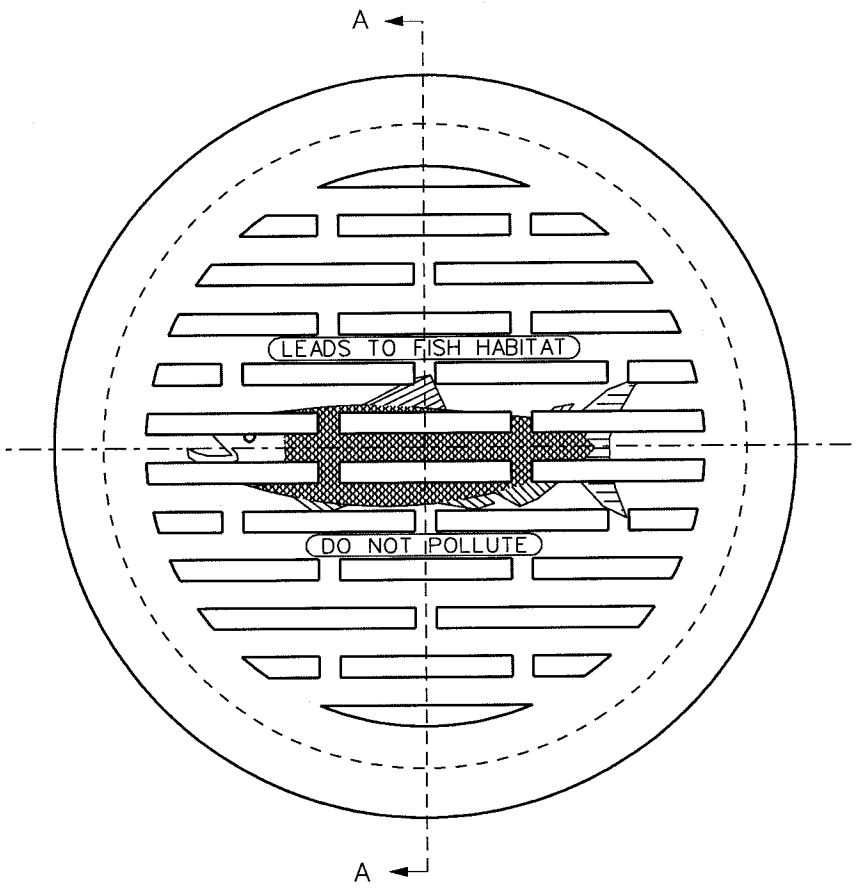
RIGHT HAND GRATE

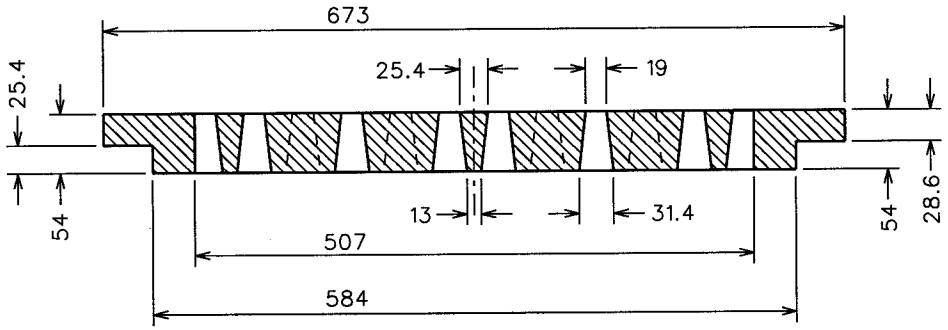
NOTE: (1) SYMBOL OF FISH TO BE INDENTED ON TOP OF GRATE BY 3mm.

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: DRAINAGE GRATE AND FRAME
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	JUNE 1998	SSD-D.27
Drawn By	Surrey Engineering	





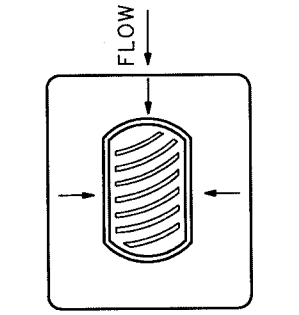
SECTION A-A

NOTES: (1) SYMBOL OF FISH TO BE INDENTED ON TOP OF GRATE BY 3mm.
(2) FOR INTENDED USE WITHIN CITY R/W's
(3) USE DUCTILE IRON FRAME AND GRATE ON ARTERIAL ROADS.

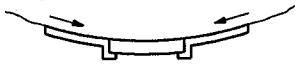
3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: BOULEVARD BASIN GRATE
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	JUNE 1998	SSD-D.28
Drawn By	Surrey Engineering	

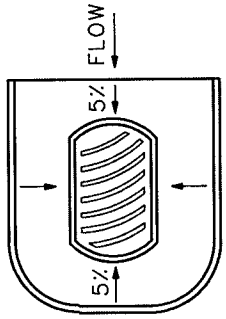


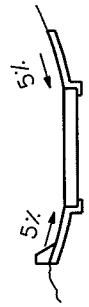
GRADE TO MATCH
SWALE BOTH SIDES



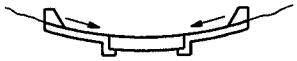
SWALE TYPE APRON

FOR GRADE UP TO 3%





GRADE TO MATCH
SWALE BOTH SIDES



CURB TYPE APRON

FOR GRADES FROM 3-5%

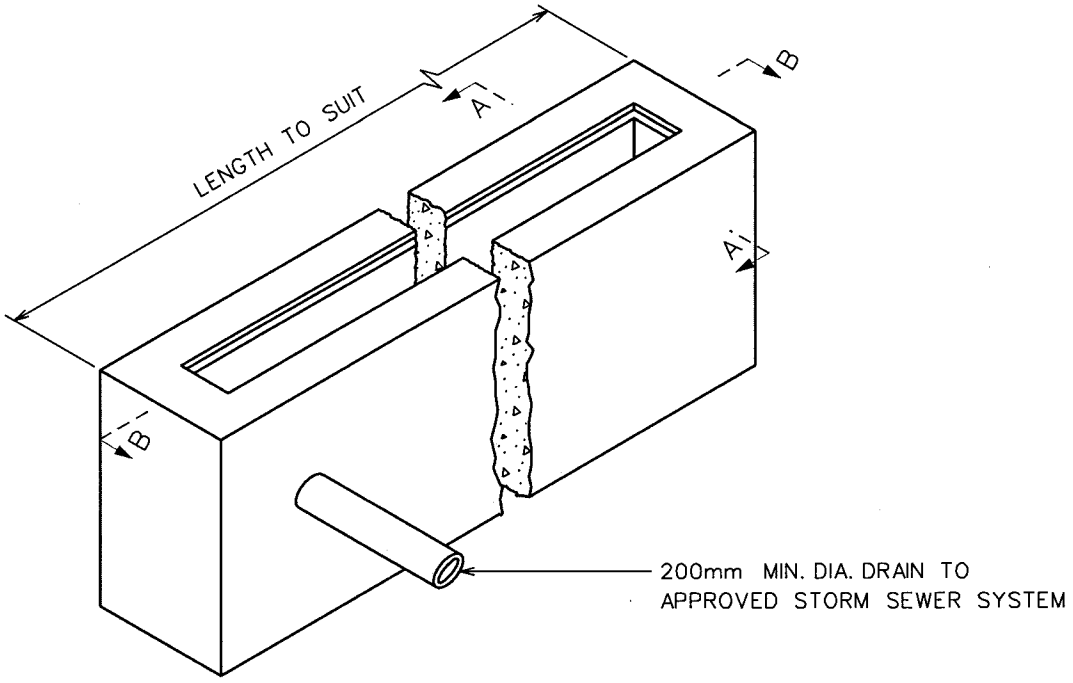
NOTES: (1) ALL ASPHALT TO BE 19mm CLASS B.
(2) APRON THICKNESS 50mm.
(3) MINIMUM WIDTH OF ASPHALT SURROUND IS 0.5m
(4) ALL APRON CURB 75 x 255
EXTRUDED OR FORMED CURB

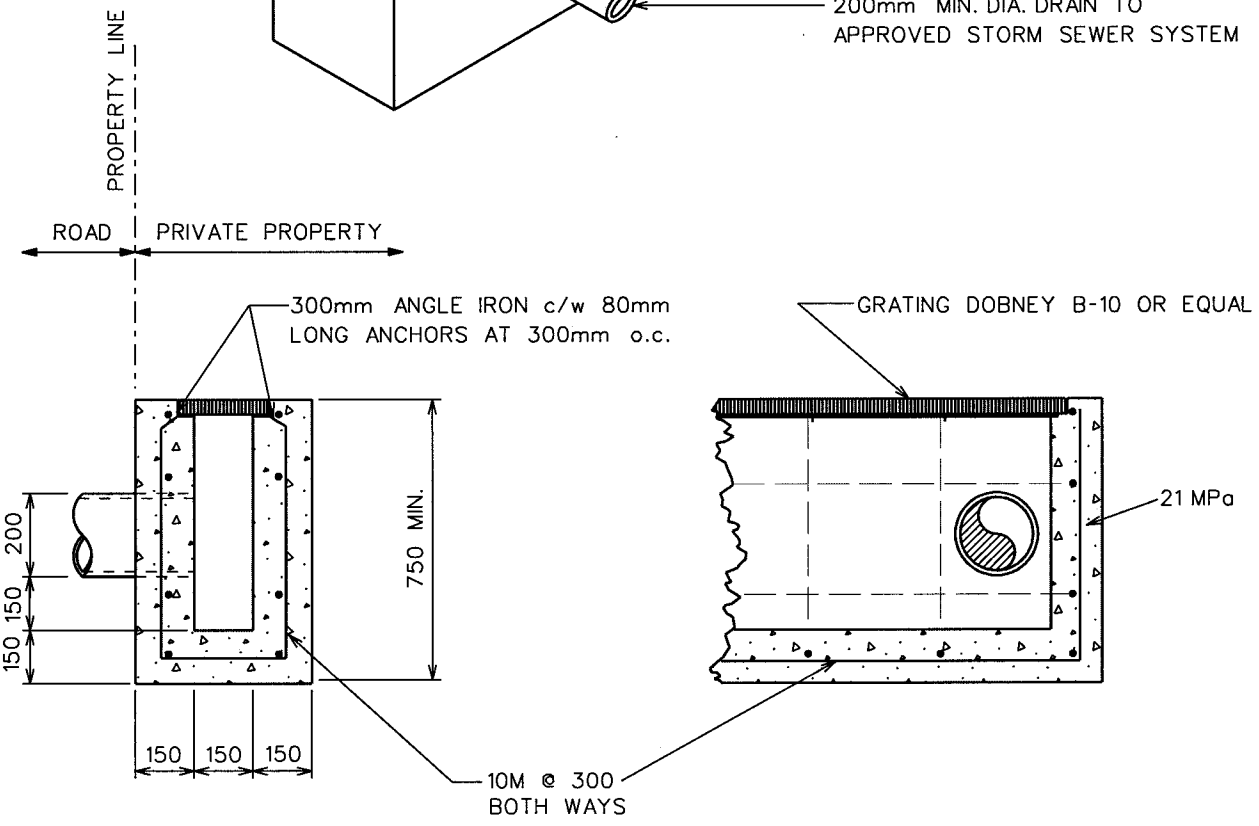
3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: ASPHALT APRONS FOR CATCH BASINS
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	JUNE 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-D.29





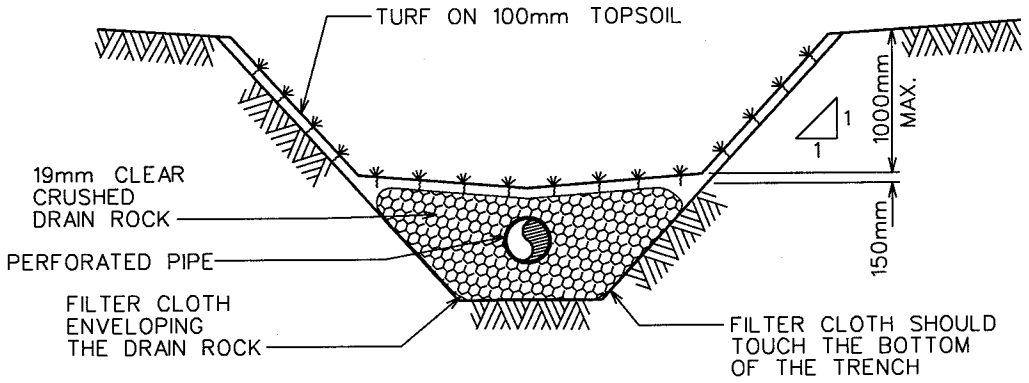
SECTION A-A

SECTION B-B

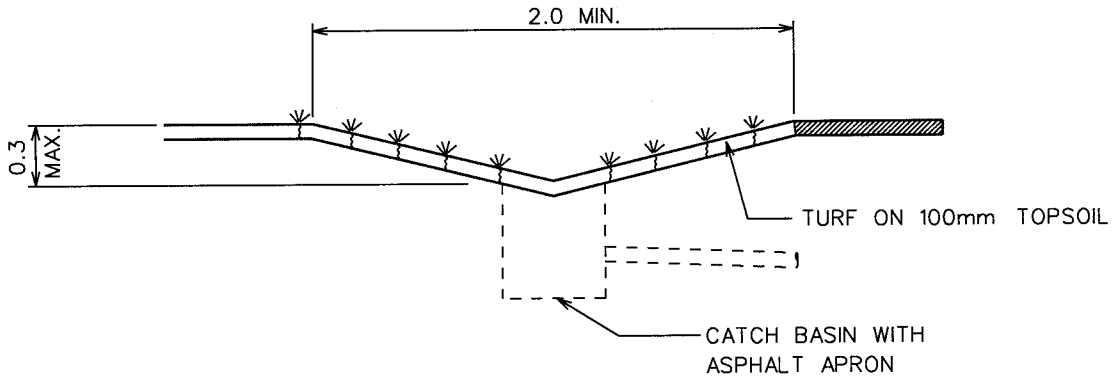
3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: COMMERCIAL DRIVEWAY SUMP
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

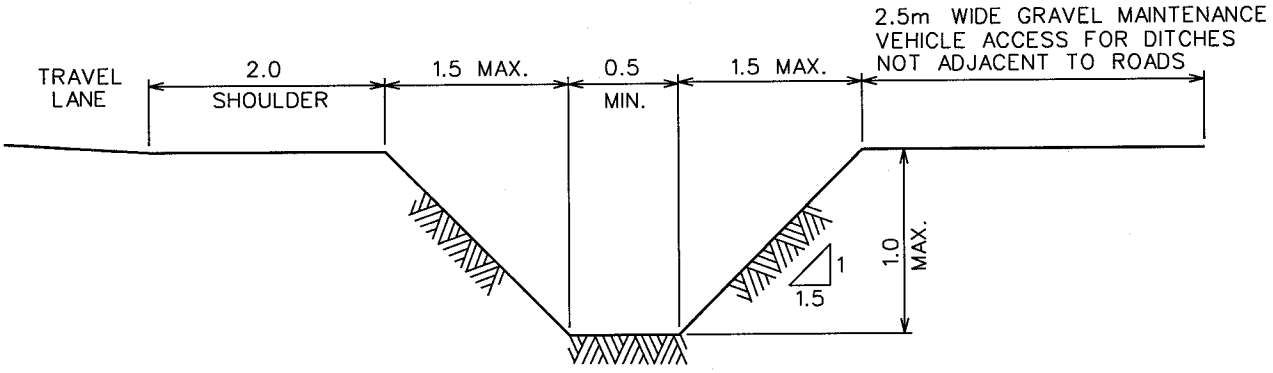
Approved		DRAWING NUMBER
Date	JUNE 1998	SSD-D.30
Drawn By	Surrey Engineering	



SOUTH WESTMINSTER-BRIDGEVIEW



SODDED SWALE



DITCH

3		
2		
1		
	Revision Date	Approved

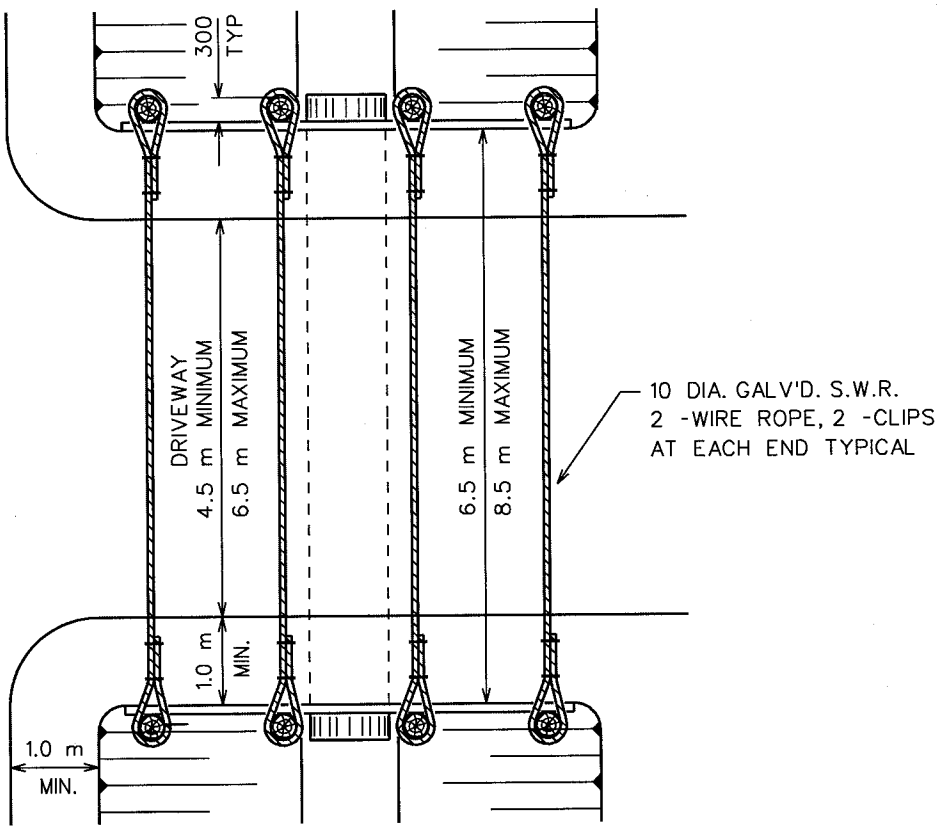
All Dimensions Shown In Millimetres, Unless Otherwise Noted

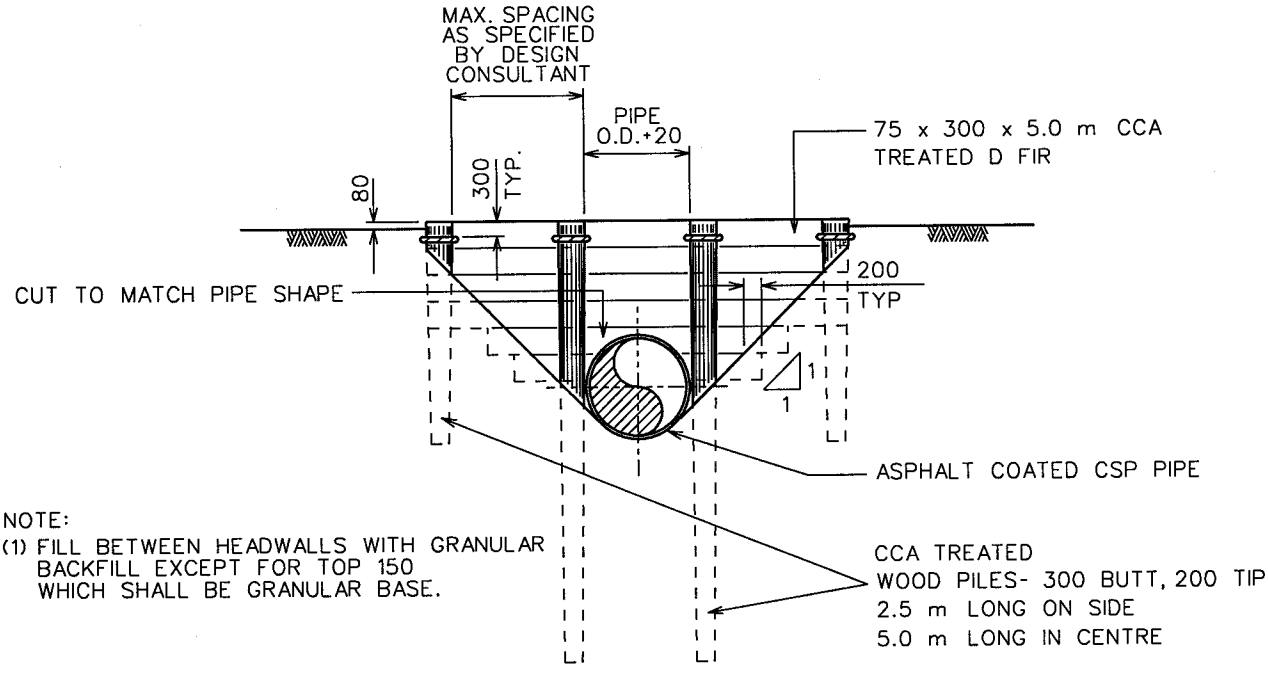
Title
ROAD DRAINAGE FOR ROADS WITHOUT CURBS

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	JUNE 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-D.31





NOTE:
(1) FILL BETWEEN HEADWALLS WITH GRANULAR BACKFILL EXCEPT FOR TOP 150 WHICH SHALL BE GRANULAR BASE.

3		
2		
1		
	Revision Date	Approved

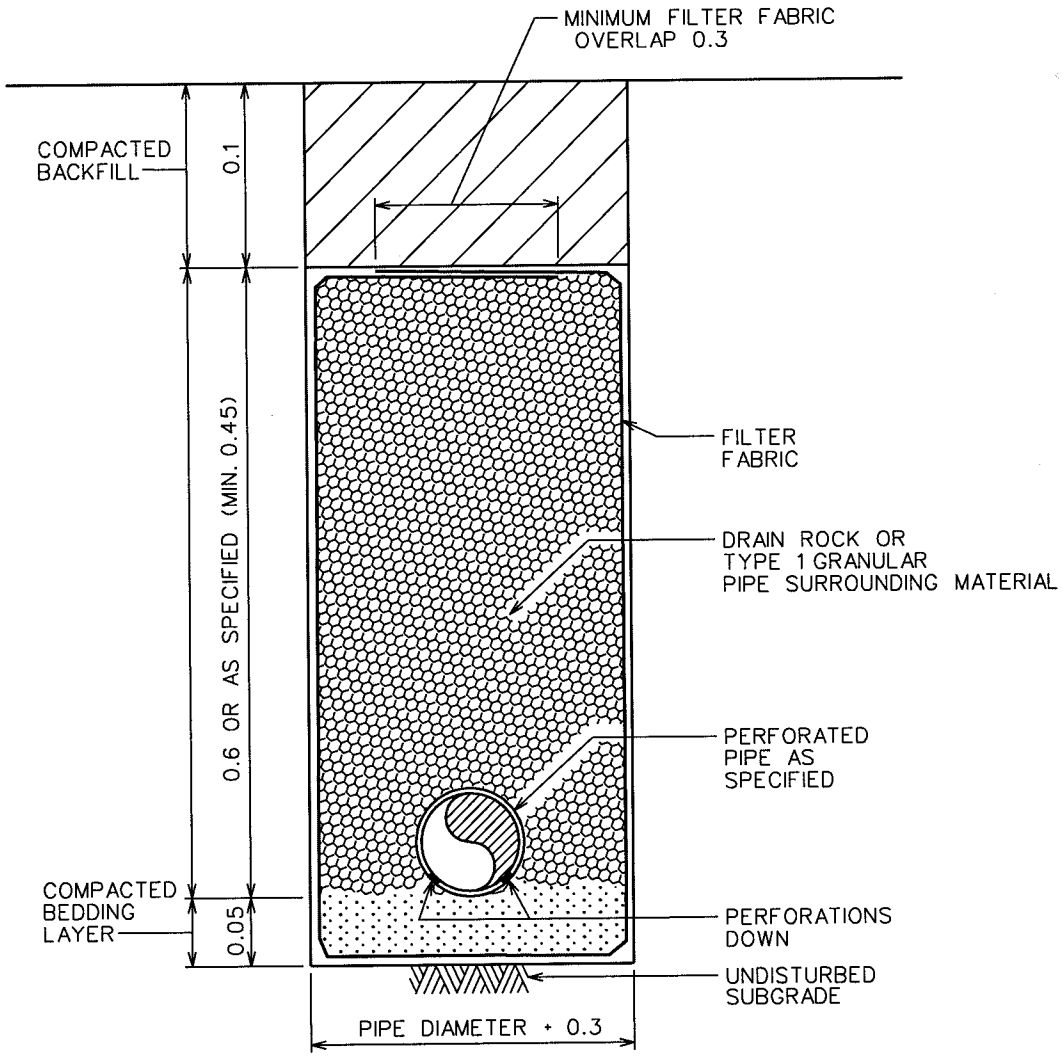
All Dimensions Shown In Millimetres, Unless Otherwise Noted

Title: TIMBER HEADWALL DETAIL FOR USE ONLY IN LOWLANDS

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	JUNE 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-D.32



FILTER FABRIC MIN. SPECIFICATIONS:

(A) BREAKING LOAD MIN. 0.33 kN

(B) BURSTING STRENGTH MIN. 0.86 MPa

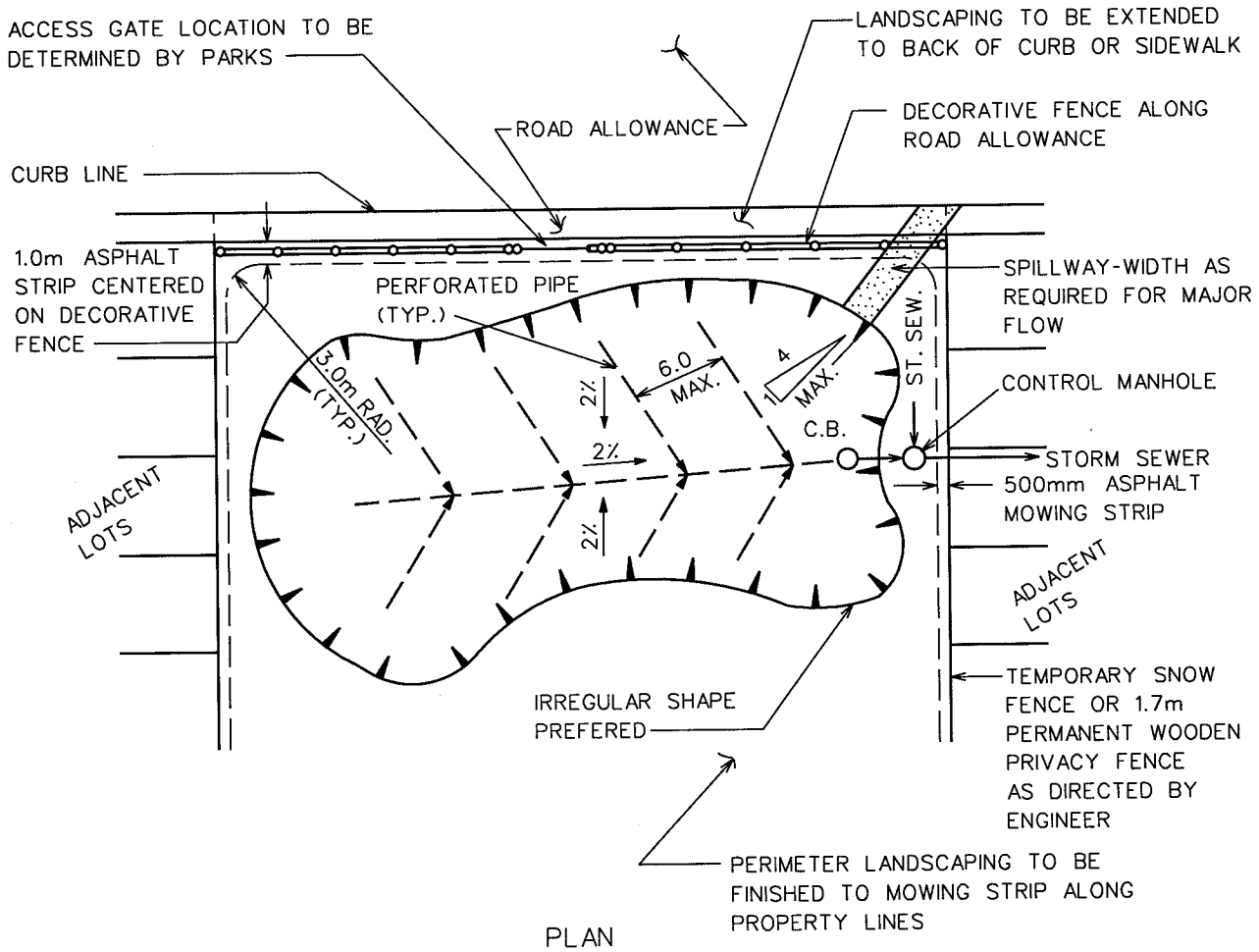
(C) PERMEABILITY MIN. 5 TIMES PERMEABILITY OF SOIL RETAINED

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: SUBDRAIN
	Revision Date / Approved	

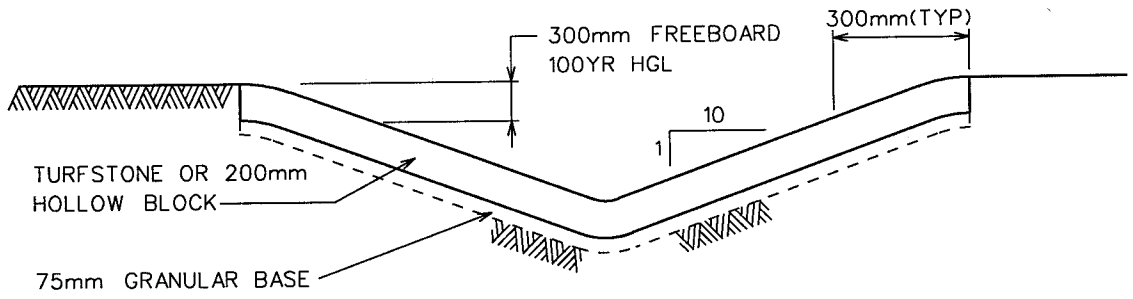
SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	JUNE 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-D.33



PLAN



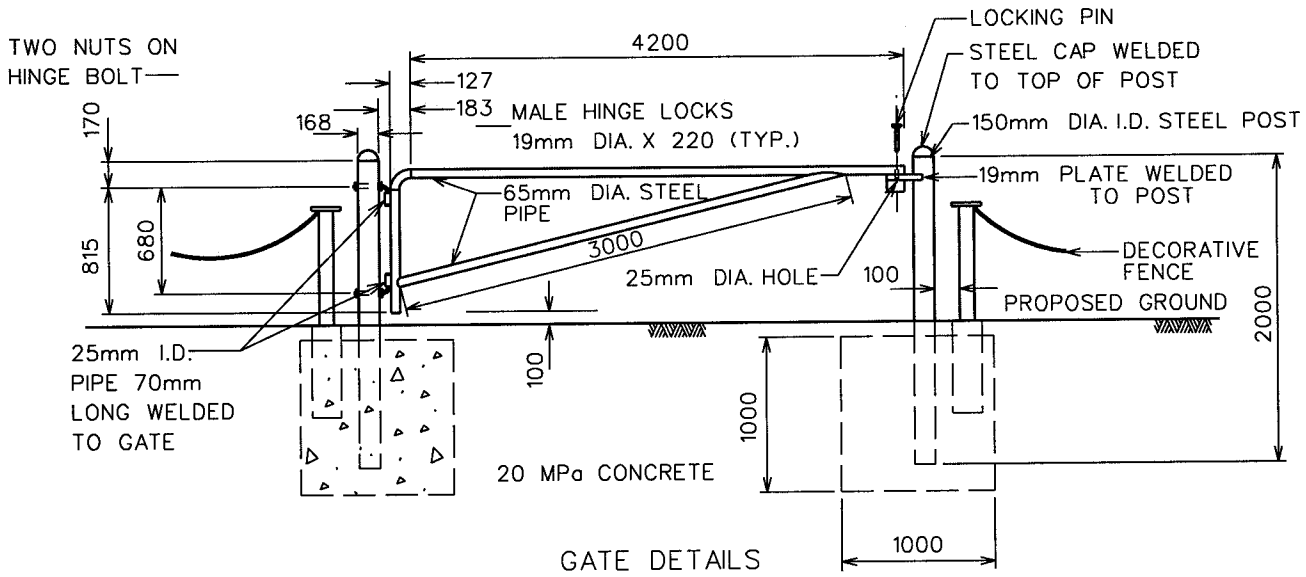
SPILLWAY SECTION

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: DETENTION BASIN PLAN VIEW
	Revision Date / Approved	

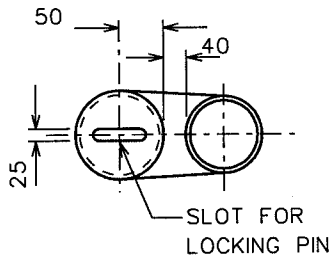
SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	JUNE 1998
Drawn By	Surrey Engineering

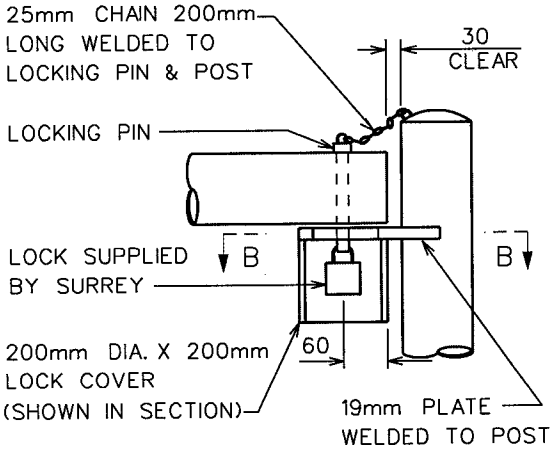
DRAWING NUMBER: SSD-D.34

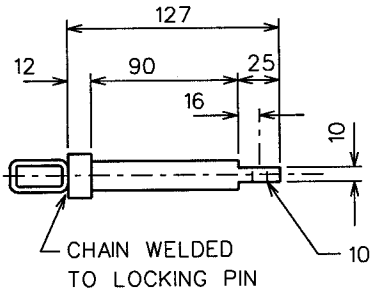


GATE DETAILS

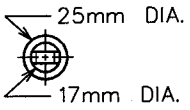


SECTION B-B





SIDE VIEW



END VIEW

GATE LOCKING PIN DETAIL

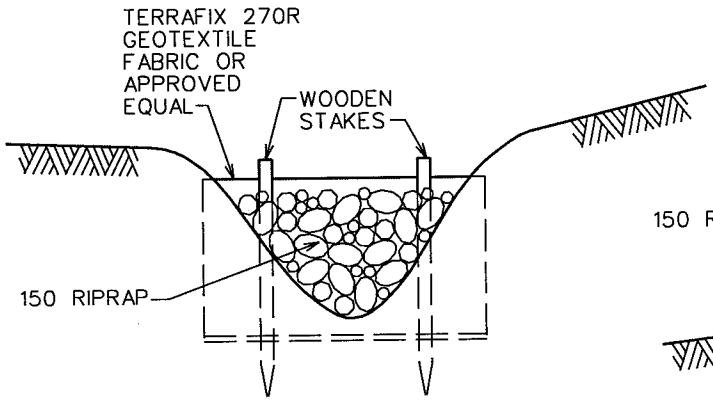
NOTE: (1) ALL GATE COMPONENTS TO HAVE PRIME COAT AND TWO COATS OF WHITE ENAMEL PAINT. ALL STEEL TO BE A MINIMUM OF A36 GRADE.

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1	November 16, 1999	Title: GATE DETAILS FOR DETENTION PONDS
	Revision Date Approved	

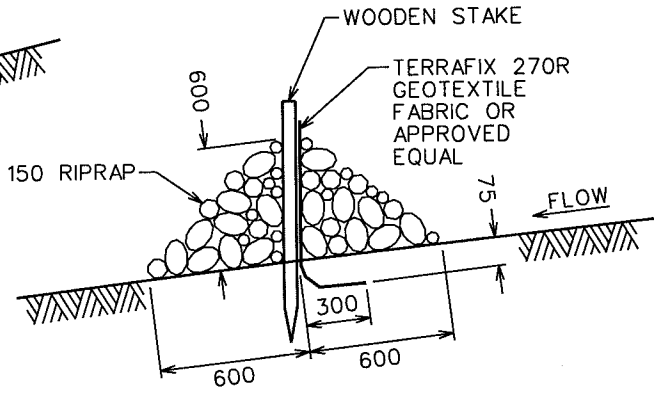
SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	JUNE 1998
Drawn By	Surrey Engineering

DRAWING NUMBER SSD-D.36

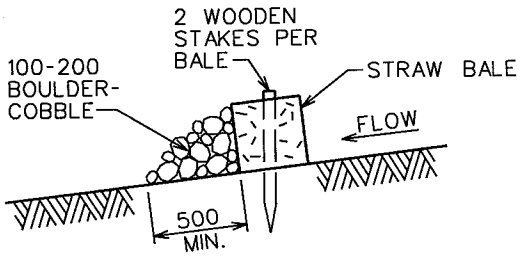


END VIEW

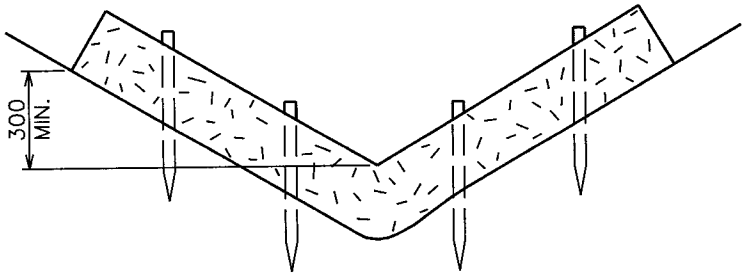


SIDE VIEW

TYPE 'A'



SIDE SECTION



CROSS SECTION

TYPE 'B'

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title SILTATION / SEDIMENT EROSION CONTROL CHECK FEATURE DETAIL
	Revision Date Approved	

SURREY CITY OF PARKS SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	JUNE 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-D.37

CITY OF SURREY

Engineering Department

Supplementary Standard Drawings

Drawing Table of Contents - Roadworks System

Drawing Number	Drawing Title
SSD-R.1	Road Classification Sketch
SSD-R.2	Unassigned
SSD-R.3	Road Sections where matching existing curbed roads
SSD-R.4	Urban Forest Road Sections - 2.0 Metre Wide Boulevard
SSD-R.4.1	Alternative (Neo-Traditional) - Limited Local Road Sections – RA to RM-19
SSD-R.4.2	Alternative (Neo-Traditional) Limited Local Road Sections – RM-30 to RMC-150
SSD-R.4.3	Alternative (Neo-Traditional) Through Local Road Sections
SSD-R.4.4	Alternative (Neo-Traditional) Parking Pocket Road Sections
SSD-R.4.5	Unassigned
SSD-R.5	Typical Road Sections - Divided Arterial Roads
SSD-R.6	Typical Road Sections - King George Hwy - 8 Ave to Hwy 99
SSD-R.6.1	Typical Road Sections - King George Hwy - 108 Ave to EWRR
SSD-R.6.2	Typical Road Sections - King George Hwy – EWRR to 128 St
SSD-R.7	Unassigned
SSD-R.8	Typical Road Sections – Roads without curbs
SSD-R.9	Typical Road Sections – Half-road sections
SSD-R.9.1	Alternative (Neo-Traditional) Half Road Sections
SSD-R.10	Typical Half Road Section - Without Curbs
SSD-R.11	Frontage Road Concepts
SSD-R.11.1	Typical Frontage Road / Collector Road Access
SSD-R.11.2	Typical Temporary Frontage Road Entry / Exit
SSD-R.11.3	Typical Frontage Road Section
SSD-R.12	Typical Lane Section
SSD-R.12.1	Typical Lane Section - Alternate
SSD-R.13	Cul-de-Sac
SSD-R.14	Residential Cul-de-Sac With Island
SSD-R.15	Temporary Turnaround
SSD-R.16	Temporary Turnaround and Cul-De-Sac
SSD-R.17	Channelized Intersection - Interim Design for 2 Thru Lanes & Left Turn Lane

Continued – next page

Drawing Table of Contents - Roadworks System

Drawing Number	Drawing Title
SSD-R.18	Channelized Intersection - 12.2 m Pavement
SSD-R.19	Channelized Intersection - 14 m Pavement
SSD-R.20	Channelized Intersection - 19 m Pavement
SSD-R.21	Raised Median – 4.4 m Wide Standard
SSD-R.21.1	Raised Median - Bicycle Friendly
SSD-R.22	Median Planting Section
SSD-R.23	Transition from 4 Lanes to 2 Lanes
SSD-R.24	Typical On-Street Parking Bay
SSD-R.25	Bus Shelter Location and Pad Detail
SSD-R.26	Typical Bus Pull-Off and Landing For Collector Roads
SSD-R.27	Typical Bus Bay Stop
SSD-R.28	Asphalt Road Construction with Minimum Pavement Sections
SSD-R.29	Typical Concrete Road Construction with Minimum Pavement Section
SSD-R.30	Control Joints for Concrete Pavement
SSD-R.31	Intersection Joint Layout for Concrete Pavement
SSD-R.32	Isolation Joints for Concrete Pavement
SSD-R.33	Interim Curb Installation
SSD-R.34	Unassigned
SSD-R.35	Unassigned
SSD-R.36	Unassigned
SSD-R.37	Unassigned
SSD-R.38	Guide Rail
SSD-R.39	Guide Rail - Assembly and Mounting
SSD-R.40	4.0 Metre Multi-Use Pathway
SSD-R.40.1	Typical Engineering Walkway or Emergency Access R.O.W.
SSD-R.40.2	Baffle Gate
SSD-R.40.3	Locking Post
SSD-R.40.4	Median Style Bicycle Crossing
SSD-R.40.5	"Next to Road" Pathway
SSD-R.41	Driveway Crossing Locations
SSD-R.42	Commercial/Industrial Letdown Driveway

Continued – next page

CITY OF SURREY

Engineering Department

Supplementary Standard Drawings

Drawing Table of Contents - Roadworks System

Drawing Number	Drawing Title
SSD-R.42.1	Residential Letdown Driveway
SSD-R.42.2	Curb Return Driveway Crossing
SSD-R.43	Driveway Crossing for Barrier Curbs - Dimension Details
SSD-R.44	Driveway Crossing for Rollover Curbs
SSD-R.45	Unassigned
SSD-R.46	Unassigned
SSD-R.47	Unassigned
SSD-R.48	Vacuum Sewer and Water Driveway Crossing
SSD-R.49	Concrete Sidewalk and Barrier Curb with 1.1 m Wide Concrete Infill
SSD-R.50	Concrete Sidewalk and Rollover Curb
SSD-R.51	Concrete Sidewalk and Barrier / Rollover Curb With 2.0 m / 3.0 m Wide Grass Boulevard
SSD-R.52	Unassigned
SSD-R.53	Typical Traveled Access in R.O.W.
SSD-R.54	Asphalt Sidewalks
SSD-R.55	Masonry Walk and Crosswalk Details
SSD-R.56	Concrete Steps Without Footing - With Bicycle Ramp
SSD-R.57	Security Chain-Link Fence - Gates
SSD-R.58	Security Fence - Barbed Wire
SSD-R.59	Decorative Fence
SSD-R.60	Bull Nose Median End
SSD-R.E.1	Unassigned
SSD-R.E.2	Type D2 Concrete Base for 13.5 m Davit Pole Precast
SSD-R.E.3	Precast Type D2 Concrete Base for 13.5 m Davit Pole
SSD-R.E.4	Type 2 Shaft Installation Details for 13.5 m Davit Pole
SSD-R.E.5	Type 2 Shaft Installation Details for 13.5 m Davit Pole
SSD-R.E.6	Wiring Diagram for 60A Service Base
SSD-R.E.7	Unassigned
SSD-R.E.8	Unassigned
SSD-R.E.9	Unassigned
SSD-R.E.10	Model 170 Traffic Signal Cabinet Installation

Continued – next page

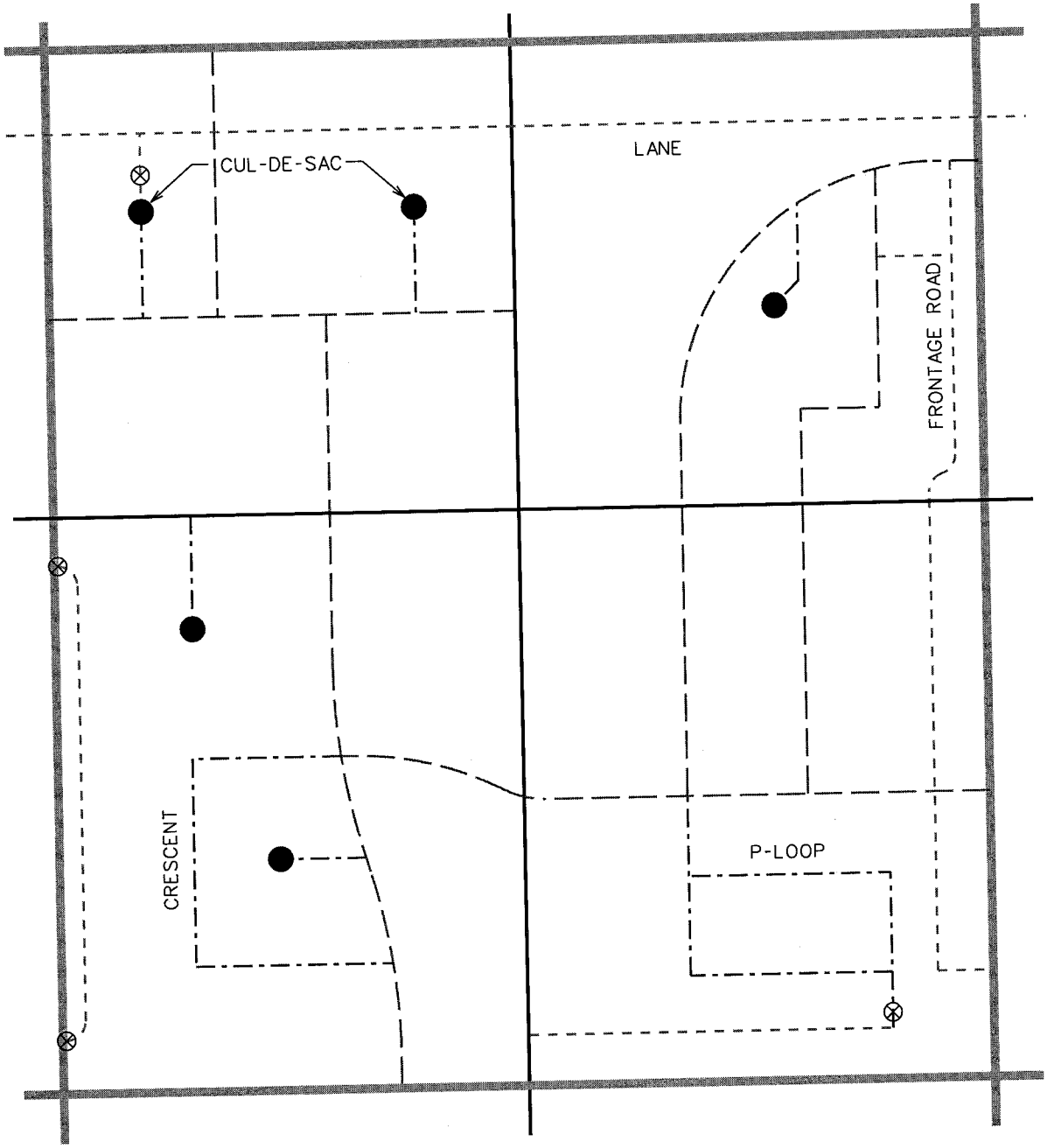
CITY OF SURREY

Engineering Department

Supplementary Standard Drawings

Drawing Table of Contents - Roadworks System

Drawing Number	Drawing Title
SSD-R.E.11	Type 37 Junction Box Details (Concrete)
SSD-R.E.12	Type 66 Junction Box Details (Concrete)
SSD-R.E.13	Unassigned
SSD-R.E.14	Unassigned
SSD-R.E.15	Unassigned
SSD-R.E.16	Unassigned
SSD-R.E.17	Unassigned
SSD-R.E.18	Unassigned
SSD-R.E.19	Unassigned
SSD-R.E.20	Street Name Sign Mounting Details
SSD-R.E.21	Unassigned
SSD-R.E.22	Unassigned
SSD-R.E.23	Fire Signal Signs
SSD-R.E.24	Unassigned
SSD-R.E.25	Bicycle Pushbutton Post
SSD-R.E.26	Unassigned
SSD-R.E.27	Unassigned
SSD-R.E.28	100A Traffic Signal Service Panel Wiring Schematic
SSD-R.E.29	Unassigned
SSD-R.E.30	Unassigned
SSD-R.E.31	Phasing Diagram for 8-Phase Controller
SSD-R.E.32	Controller Cabinet Loop, Pre-Emption and Pedestrian Assignments
SSD-R.E.33	Detector Loop Locations
SSD-R.E.34	Unassigned
SSD-R.E.35	Unassigned
SSD-R.E.36	Unassigned



LANES/FRONTAGE ROAD
LIMITED LOCAL
THROUGH LOCAL
COLLECTOR
ARTERIAL
⊗ POOR DESIGN CONCEPT

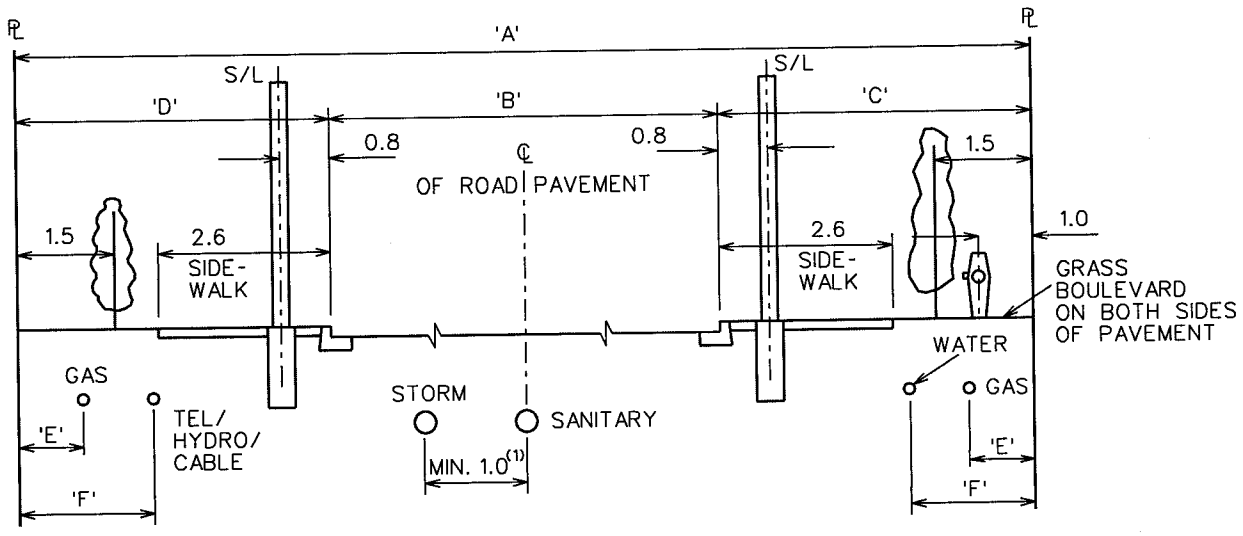
NOTES: (1) THIS SKETCH IS A GUIDE ONLY.
THE ROAD CLASSIFICATION SHALL BE AS DETERMINED BY THE ENGINEER.

3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1		Title: ROAD CLASSIFICATION SKETCH
	Revision Date / Approved	

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

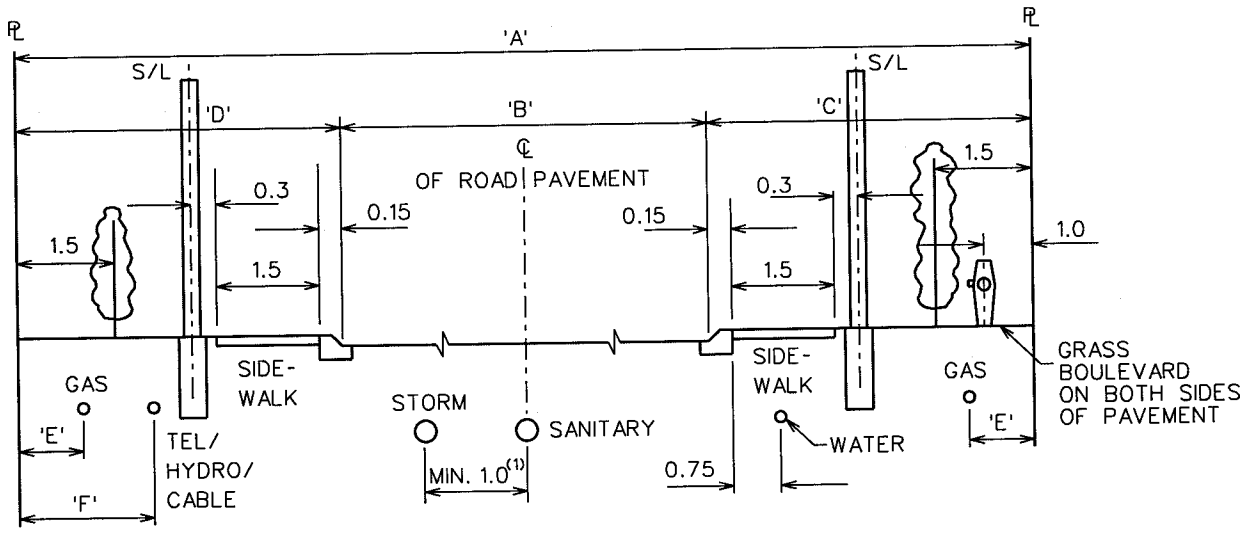
Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-R.1



ROADS WITH BARRIER CURB

A	B	No. OF S/WALK	C	D	E	F
20	8.5	2	5.75	5.75	0.8	2
20	11	2	4.5	4.5	0.6	2
22	12.2	2	4.9	4.9	0.8	2
24	14	2	5	5	0.8	2



ROADS WITH ROLLOVER CURB

A	B	No. OF S/WALK	C	D	E	F
16.5	8	1	4.25	4.25	0.8	2
20	8.5	2	5.75	5.75	0.8	2
20	11	2	4.5	4.5	0.6	1.8
22	12.2	2	4.9	4.9	0.8	2

NOTES: (1) REFER TO MINIMUM SPACING BETWEEN SEWERS IN THE COMMON TRENCH DRAWING.

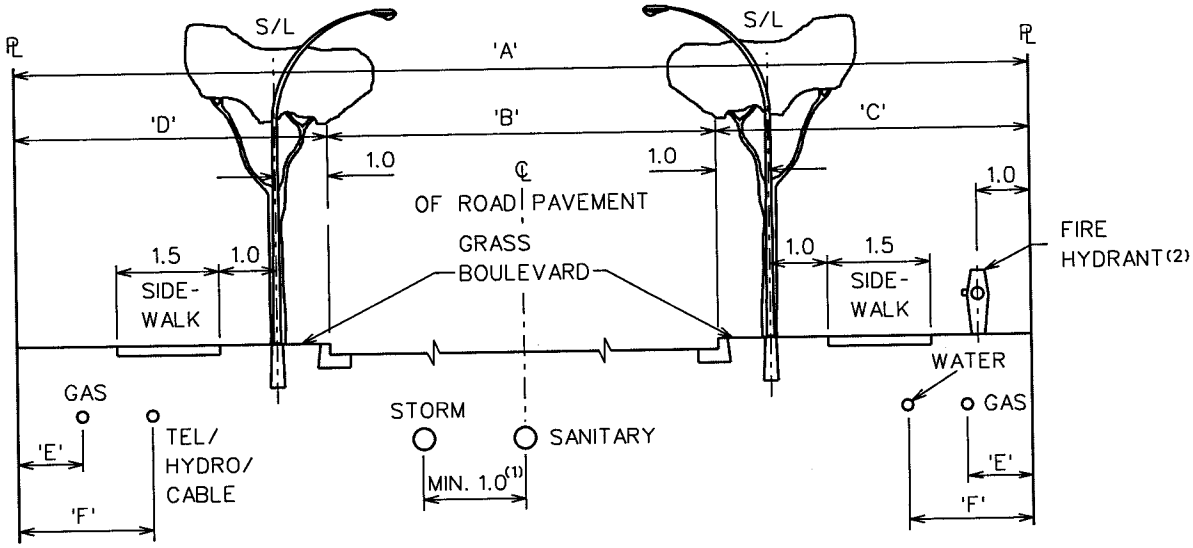
(2) THESE SECTIONS CAN ONLY BE USED TO MATCH EXISTING CONDITIONS AND ARE SUBJECT TO THE APPROVAL OF THE ENGINEER.

3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1	MARCH 2002	Title: ROAD SECTIONS WHERE MATCHING EXISTING CURBED ROADS
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.3



A	B	No. OF S/WALK	C	D	E	F
16.5	8	1	4.25	4.25	0.8	2
20	8.5	2	5.75	5.75	0.8	2
20	11	2	4.5	4.5	0.6	2
22	12.2	2	4.9	4.9	0.8	2
24	14	2	5	5	0.8	2

NOTES : (1) REFER TO MINIMUM SPACING BETWEEN SEWERS IN THE COMMON TRENCH DRAWING.

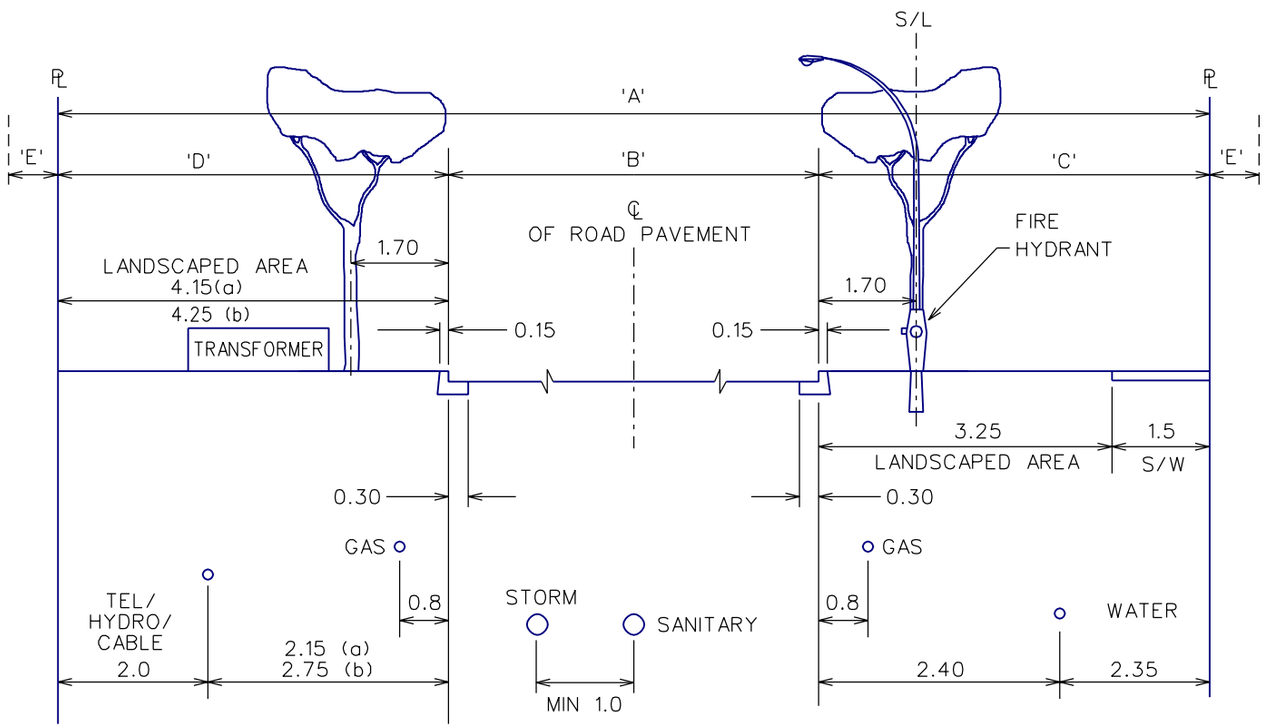
(2) WHERE THE FIRE HYDRANT IS IN THE WAY OF THE SIDEWALK, THE LOCATION SHALL BE SHIFTED TO THE SAME ALIGNMENT AS THE STREET LIGHT.

3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1	MARCH 2002	Title TYPICAL (URBAN FOREST) ROAD SECTIONS - 2.0 m WIDE BOULEVARD
	Revision Date Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-R.4



ROADS WITHOUT PARKING POCKETS

ZONING	LENGTH (m)	TYPE OF TRAFFIC FLOW	A	B	C	D	E(5)
RA to RC-I(a)	< 220	QUEUING(4)	15.5	6.6	4.75	4.15	min. 0.5
RC-I to RM-19 (b)	< 220	QUEUING	17.0	8.0	4.75	4.25	min. 0.5

(a) INCLUDES RA, RA-G, RH, RH-G, RF, RF-G, RC-TYPE I
(b) INCLUDES RC-TYPE II AND III, RF-SS, RF-SD, RF-12, RF-12C, RF-9, RM-D, RM-M, RM-10, RM-15, RM-19

NOTES:
(1) STREET LIGHTS AND SIDEWALK ONE SIDE ONLY - OPPOSITE HYDRO/TEL/CABLE.
(2) NO SIDEWALK REQUIRED IF ROAD LENGTH < 50 METRES.
(3) BARRIER CURB ONLY EXCEPT RA, RA-G, RH AND RH-G ZONES WHICH CAN USE ROLLOVER CURB.
(4) PARKING PERMITTED ONE SIDE ONLY. (NO PARKING SIGNAGE REQUIRED ON OTHER SIDE.)
(5) MINIMUM 0.5 METRE STATUTORY R.O.W. REQUIRED WHERE SIDEWALK IS REQUIRED.
(6) TRANSFORMER MUST BE 6.1m FROM ANY COMBUSTIBLE SURFACE OR CONCRETE FENCE IS REQUIRED.
(7) SPEED REDUCTION MEASURES SHOULD BE CONSIDERED FOR UNINTERRUPTED BLOCK LENGTHS > 100m.
(8) MEDIUM TO LARGE STREET TREES ONLY.
(9) NO TREES TO BE PLANTED WITHIN 3.0 METRES OF A COMMON SIDEYARD PROPERTY LINE.

3	JULY 2004	JAIMIE BOAN
2	MARCH 2004	KOK KUEN LI
1	DECEMBER 2003	KOK KUEN LI
	Revision Date	Approved

All Dimensions Shown In Metres,
Unless Otherwise Noted

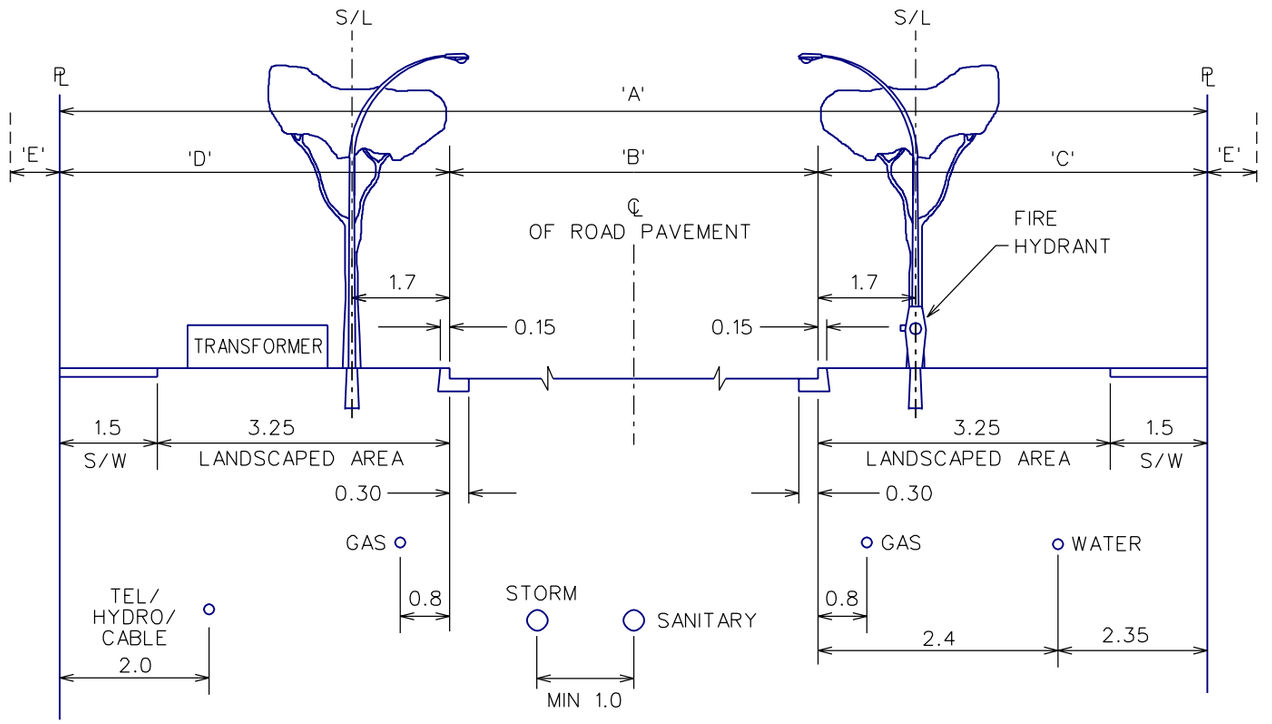
Title: ALTERNATIVE (NEO-TRADITIONAL)
LIMITED LOCAL ROAD SECTONS RA to RM-19

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	FEBRUARY 2002
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-R.4.1

.../Roads Dgn/SSD-R_04_001.dgn 04/07/27 09:04:41 AM



ROADS WITHOUT PARKING BAYS

ZONING	LENGTH (m)	TYPE OF TRAFFIC FLOW	A	B	C	D	E(5)
RM-30 to RM-45 (a)	< 220	TWO-WAY OR QUEUING (6)	18.0	8.5	4.75	4.75	min. 0.5
RM-70 to RMC-150 (b)	< 220	TWO-WAY	20.0	10.5	4.75	4.75	min. 0.5

(a) INCLUDES RM-30, RM-45
(b) INCLUDES RM-70, RM-135, RMC-135, RMC-150

NOTES: (1) SIDEWALK REQUIRED BOTH SIDES.
(2) BARRIER CURB ONLY.
(3) STREET LIGHTS ONE SIDE ONLY WITH 8.5m PAVEMENT WIDTH - OPPOSITE HYDRO/TEL/CABLE.
(4) STREETLIGHTS STAGGERED ON BOTH SIDES WITH 10.5 PAVEMENT WIDTH.
PRIMARY STREETLIGHT DUCTING TO BE OPPOSITE HYDRO/TEL/CABLE.
(5) MINIMUM 0.5 METRE STATUTORY R.O.W. REQUIRED EACH SIDE.
(6) AS DIRECTED BY CITY TRANSPORTATION ENGINEER.
(7) TRANSFORMER MUST BE 6.1m FROM ANY COMBUSTIBLE SURFACE OR CONCRETE FENCE IS REQUIRED.
(8) SPEED REDUCTION MEASURES SHOULD BE CONSIDERED FOR UNINTERRUPTED BLOCK LENGTHS > 100m.
(9) MEDIUM TO LARGE STREET TREES ONLY.
(10) NO TREES TO BE PLANTED WITHIN 3.0 METRES OF A COMMON SIDEYARD PROPERTY LINE.

3	JULY 2004	JAIMIE BOAN
2	MARCH 2004	KOK KUEN LI
1	DECEMBER 2003	KOK KUEN LI
	Revision Date	Approved

All Dimensions Shown In Metres,
Unless Otherwise Noted

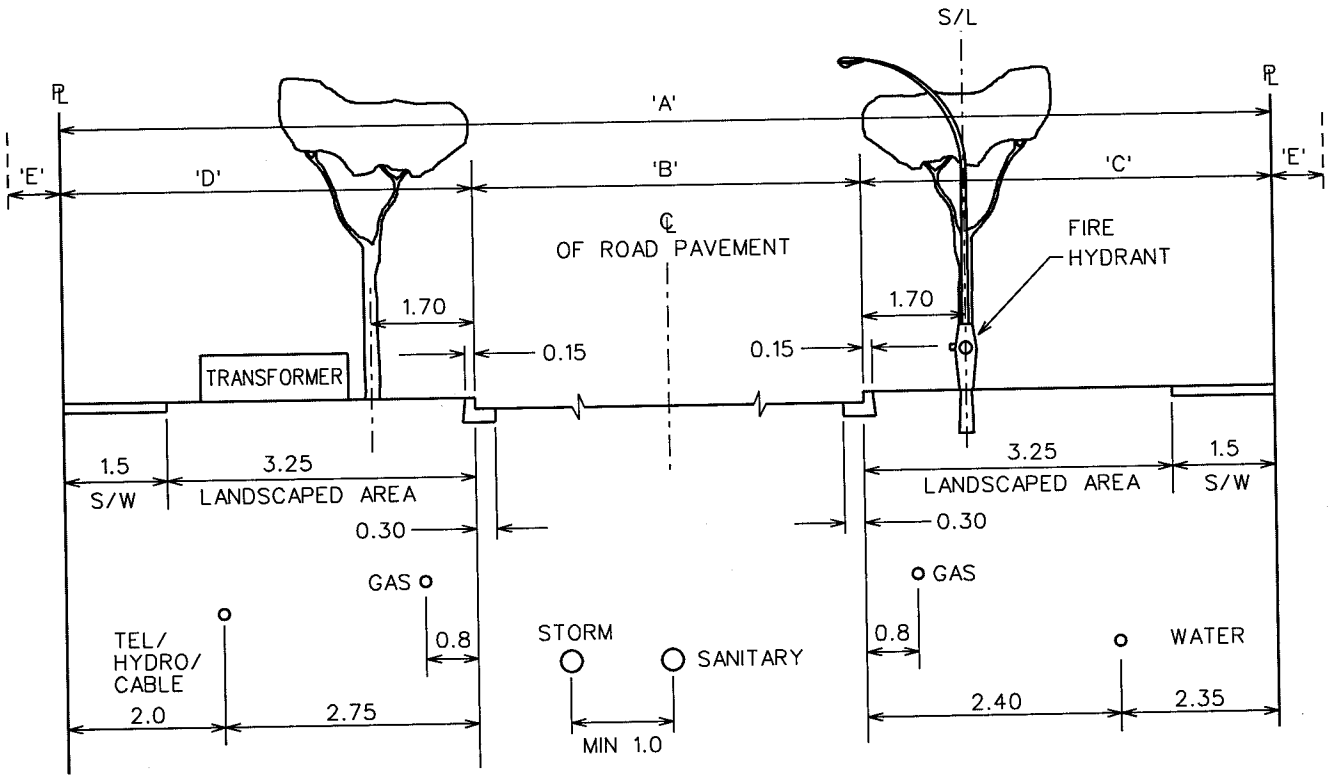
Title: ALTERNATIVE (NEO-TRADITIONAL) LIMITED LOCAL ROAD SECTIONS RM-30 to RMC-150

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	September 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-R.4.2

.../Roads Dgn/SSD-R_04_002.dgn 04/07/27 09:02:32 AM



ROADS WITHOUT PARKING POCKETS

ZONING	LENGTH (m)	TYPE OF TRAFFIC FLOW	A	B	C	D	E(5)
RA to RM-19 (a)	N/A	TWO WAY OR QUEUING(6)	18.0	8.5	4.75	4.75	min. 0.5
RM-30 to RMC-150 (b)	N/A	TWO WAY	20.0	10.5	4.75	4.75	min. 0.5

(a) INCLUDES RA, RA-G, RH, RH-G, RF, RF-G, RC-TYPE I, II, III, RF-SS, RF-SD, RF-12, RF-12C, RF-9, RM-D,RM-M, RM-10, RM-15, RM-19

(b) INCLUDES RM-30, RM-45, RM-70, RM-135, RMC-135, RMC-150

NOTES: (1) SIDEWALK REQUIRED BOTH SIDES.
(2) BARRIER CURB ONLY EXCEPT RA, RA-G, RH AND RH-G ZONES WHICH CAN USE ROLLOVER CURB.
(3) STREET LIGHTS ONE SIDE ONLY WITH 8.5m PAVEMENT WIDTH - OPPOSITE HYDRO/TEL/CABLE.
(4) STREETLIGHTS STAGGERED ON BOTH SIDES WITH 10.5 PAVEMENT WIDTH.
PRIMARY STREETLIGHT DUCTING TO BE OPPOSITE HYDRO/TEL/CABLE.
(5) MINIMUM 0.5 METRE STATUTORY R.O.W. REQUIRED EACH SIDE.
(6) AS DIRECTED BY CITY TRANSPORTATION ENGINEER.
(7) TRANSFORMER MUST BE 6.1m FROM ANY COMBUSTIBLE SURFACE OR CONCRETE FENCE IS REQUIRED.
(8) SPEED REDUCTION MEASURES SHOULD BE CONSIDERED FOR UNINTERRUPTED BLOCK LENGTHS > 100m.
(9) MEDIUM TO LARGE STREET TREES ONLY.
(10) NO TREES TO BE PLANTED WITHIN 3.0 METRES OF A COMMON SIDEYARD PROPERTY LINE.

3		
2		
1	DECEMBER 2003	KOK KUEN LI
	Revision Date	Approved

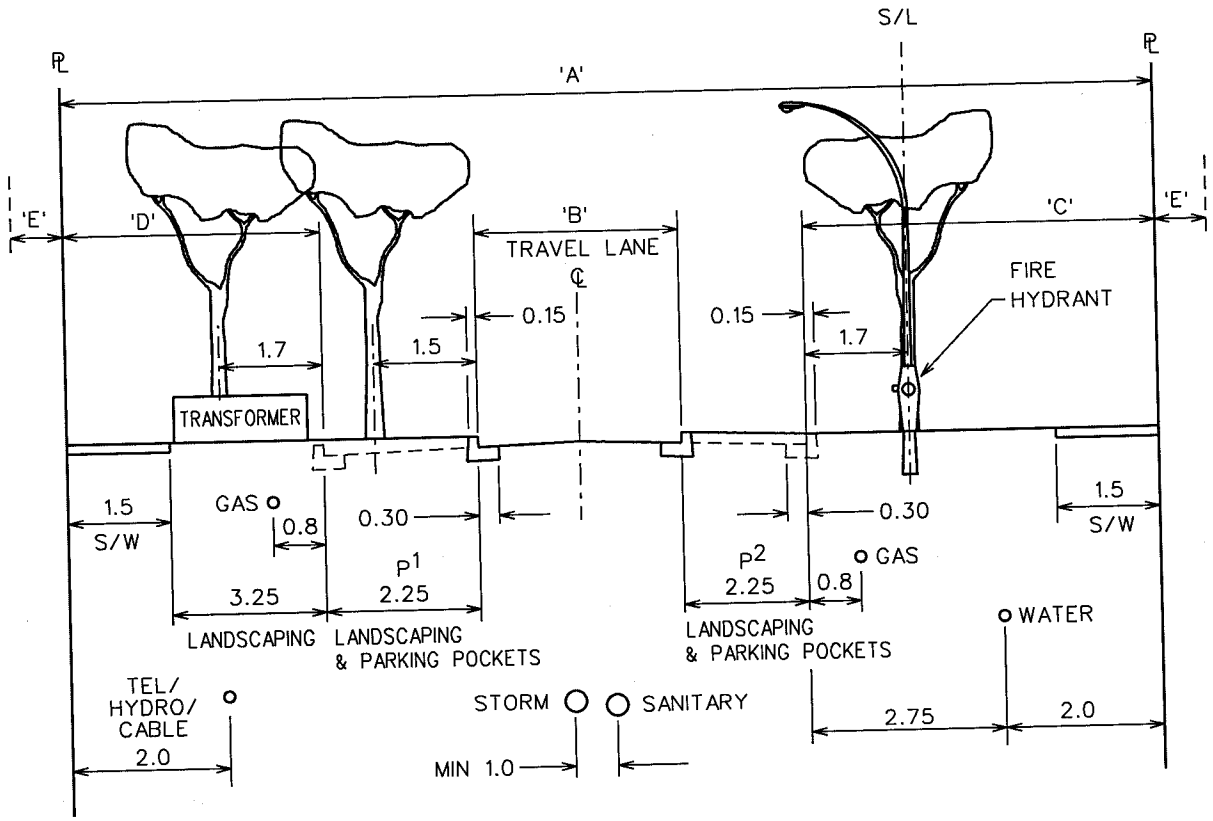
All Dimensions Shown In Metres, Unless Otherwise Noted

Title: ALTERNATIVE (NEO-TRADITIONAL) THROUGH LOCAL ROAD SECTIONS

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	September 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.4.3



ROADS WITH PARKING POCKETS

CLASSIFICATION	LENGTH (m)	TYPE OF TRAFFIC FLOW	A	B(5)	C	D	E(6)	P^1	P^2	B + P
THROUGH LOCAL	N/A	QUEUING (a)	18.0	4.0	4.75	4.75	min. 0.5	2.25	2.25	8.5
		TWO-WAY (b)	18.0	6.0	4.75	4.75	min. 0.5	2.50	0	8.5
		TWO-WAY (a)	20.0	6.0	4.75	4.75	min. 0.5	2.25	2.25	10.5

(a) BOTH SIDES PARKING
(b) ONE SIDE PARKING

NOTES:
(1) SIDEWALK REQUIRED BOTH SIDES.
(2) BARRIER CURB ONLY EXCEPT RA, RA-G, RH AND RH-G ZONES WHICH CAN USE ROLLOVER CURB.
(3) STREET LIGHTS ONE SIDE ONLY WITH 8.5m PAVEMENT WIDTH - OPPOSITE HYDRO/TEL/CABLE.
(4) STREETLIGHTS STAGGERED ON BOTH SIDES WITH 10.5 PAVEMENT WIDTH.
PRIMARY STREETLIGHT DUCTING TO BE OPPOSITE HYDRO/TEL/CABLE.
(5) MINIMUM 6.0m PAVED TRAVEL WAY WIDTH REQUIRED FOR 25m FROM FACE OF CROSS STREET CURB.
(6) MINIMUM 0.5 METER STATUTORY R.O.W. REQUIRED.
(7) TRANSFORMER MUST BE 6.1m FROM ANY COMBUSTIBLE SURFACE OR CONCRETE FENCE IS REQUIRED.
(8) SPEED REDUCTION MEASURES SHOULD BE CONSIDERED FOR UNINTERRUPTED BLOCK LENGTHS > 100m.
(9) MEDIUM TO LARGE STREET TREES ONLY.
(10) NO STREET TREES TO BE PLANTED WITHIN 3.0 METRES OF A COMMON SIDEYARD PROPERTY LINE.

3		
2	DECEMBER 2003	KOK KUEN LI
1	MARCH 2002	
	Revision Date	Approved

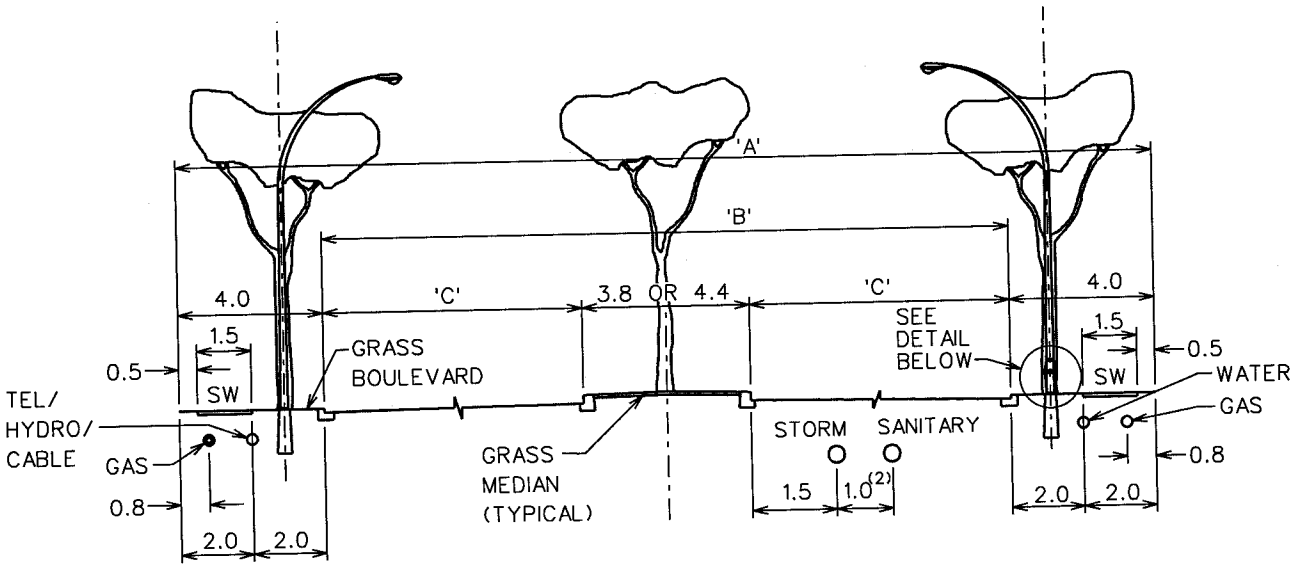
All Dimensions Shown In Metres,
Unless Otherwise Noted

Title: ALTERNATIVE (NEO-TRADITIONAL) PARKING POCKET ROAD SECTIONS

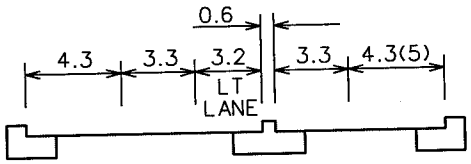
SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	September 1998
Drawn By	Surrey Engineering

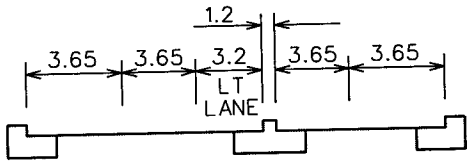
DRAWING NUMBER
SSD-R.4.4



DIVIDED ARTERIAL

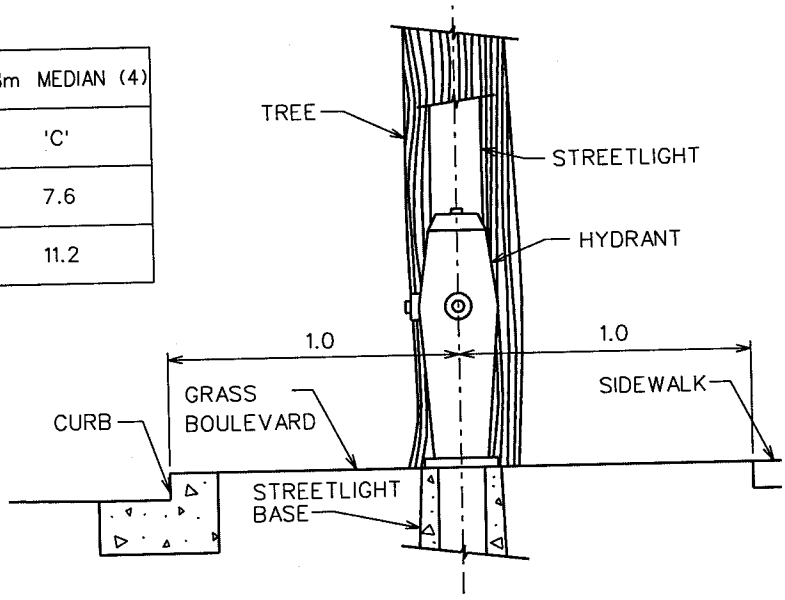


DETAIL 'C' - 4 LANE 3.6m MEDIAN



DETAIL 'C' - 4 LANE 4.4m MEDIAN

			4.4m MEDIAN (3)	3.8m MEDIAN (4)
	'A'	'B'	'C'	'C'
4 LANE	27	19	7.3	7.6
6 LANE	34	26	10.8	11.2



DETAIL

NOTES: (1) DIMENSIONS SHOWN ARE FOR NEW ROAD CONSTRUCTION . SPECIAL DESIGN CONSIDERATION IS REQUIRED WHEN WIDENING AN EXISTING ARTERIAL ROAD.
(2) REFER TO MINIMUM SPACING BETWEEN SEWERS IN COMMON TRENCH DRAWING.
(3) 4.4m MEDIAN IS SET FOR 1.2m MEDIAN / 3.2m LEFT TURN LANE AT INTERSECTION.
(4) BICYLCE FRIENDLY 3.8m MEDIAN IS SET FOR 0.6m MEDIAN / 3.2m LEFT TURN LANE AT INTERSECTION.
(5) SIDE INLET CATCHBASINS REQUIRED.

3		
2		
1	January 2004	Kok Kuen Li
	Revision Date	Approved

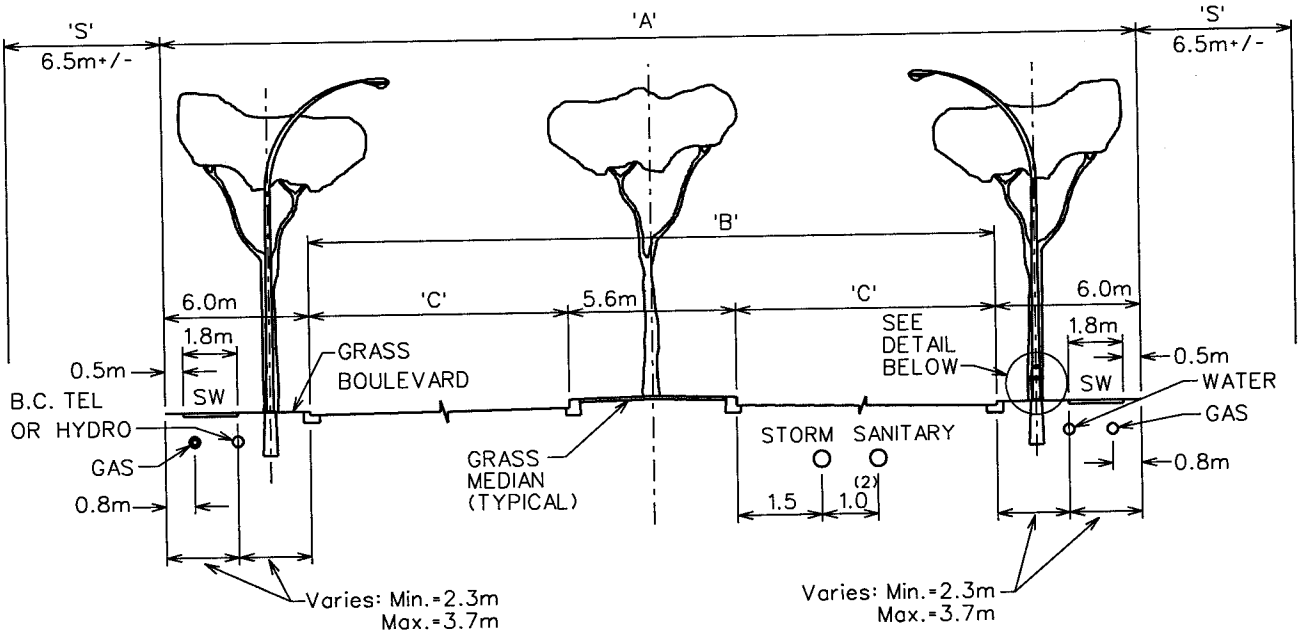
All Dimensions Shown In Millimetres, Unless Otherwise Noted

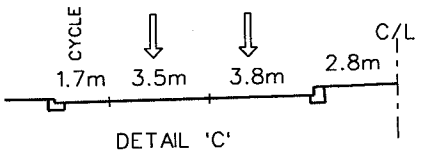
Title: TYPICAL ROAD SECTIONS- DIVIDED ARTERIAL ROADS

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

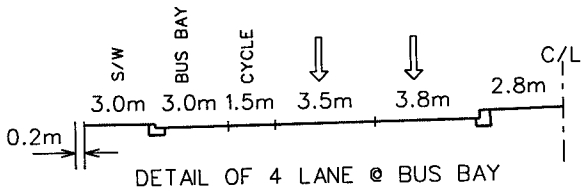
Approved	
Date	FEBRUARY 2002
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.5

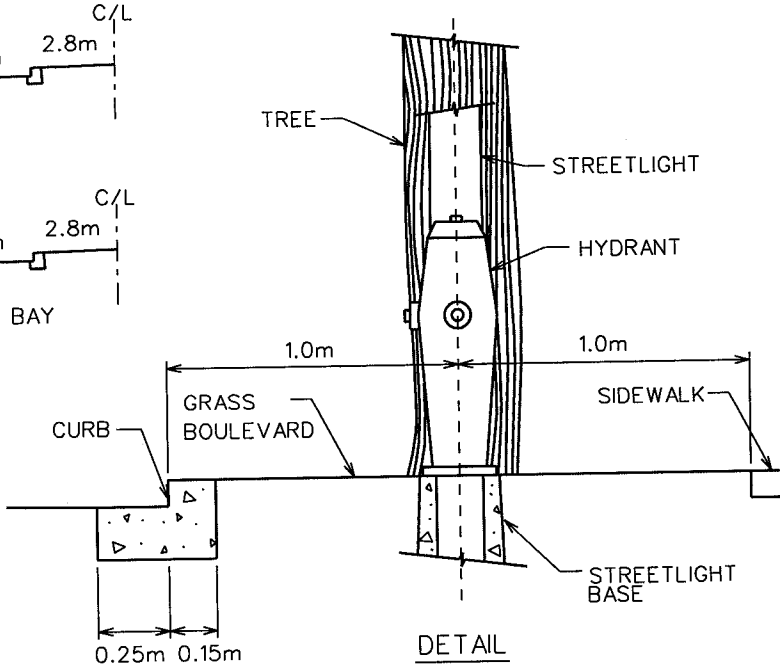




DETAIL 'C'



DETAIL OF 4 LANE @ BUS BAY



DETAIL

	'A'	'B'	'C'	'S'
2 LANE 8th to 16th Ave	29.6	17.6	6.0	9.5
4 LANE 16th to 34th Ave	35.6	23.6	9.0	6.5
6 LANE 34th Ave to Hwy #99	42.6	30.6	12.5	3.0

NOTE: (1) SIDEWALKS ARE TO MEANDER AT HERITAGE TREES ETC..
(2) INCREASE R/W ('A') FROM SURPLUS R/W ('S') AT HERITAGE TREES AND BUS SHELTERS.
(3) SPECIES OF TREE TO BE APPROVED BY PARKS AND RECREATION.
(4) LANE WIDTHS / THRU - 3.5 / TURN - 3.3 / CYCLE - 1.5 / CURB CLEARANCE 0.2 / 0.3

3		
2	March 2000	
1	November 1999	
	Revision Date	Approved

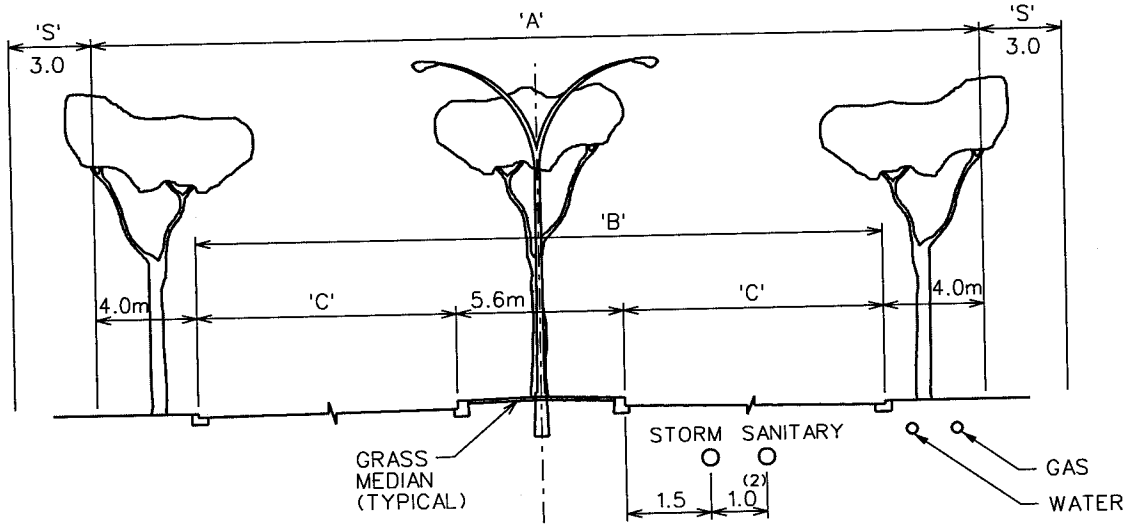
All Dimensions Shown In Millimetres, Unless Otherwise Noted

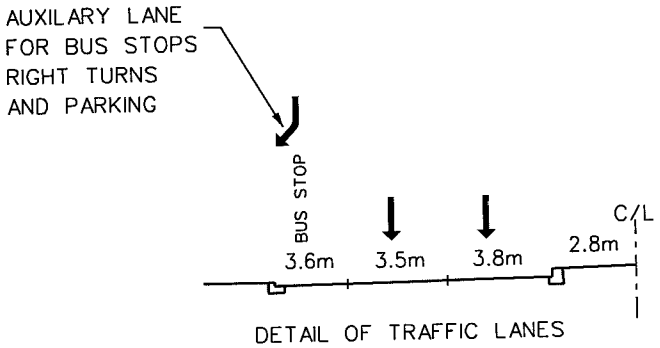
Title: TYPICAL ROAD SECTIONS- KING GEORGE HWY - 8 AVE to HWY 99

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.6





DETAIL OF TRAFFIC LANES

	'A'	'B'	'C'	'S'
6 LANE	35.4	27.4	10.9	3.0

NOTE: (1) SIDEWALK AND STREETLIGHTS TO CITY CENTER STANDARD (SSD-U.3.1)
(2) INCREASE R/W ('A') BY STAT. R/W ('S') AT ULTIMATE BUILDING STAGE.
(3) SPECIES OF TREE TO BE APPROVED BY PARKS AND RECREATION.
(4) LANE WIDTHS / THRU - 3.5 / TURN - 3.3 / CURB CLEARANCE 0.2 / 0.3

3		
2		
1		
	Revision Date	Approved

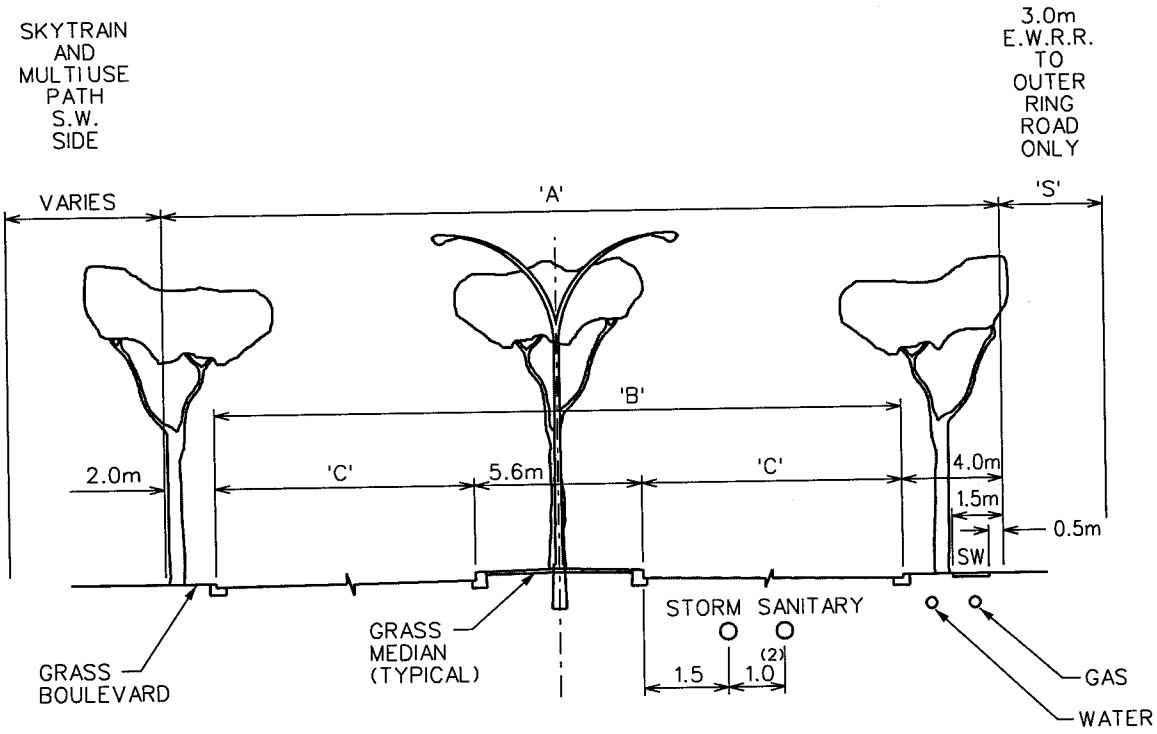
All Dimensions Shown In Millimetres,
Unless Otherwise Noted

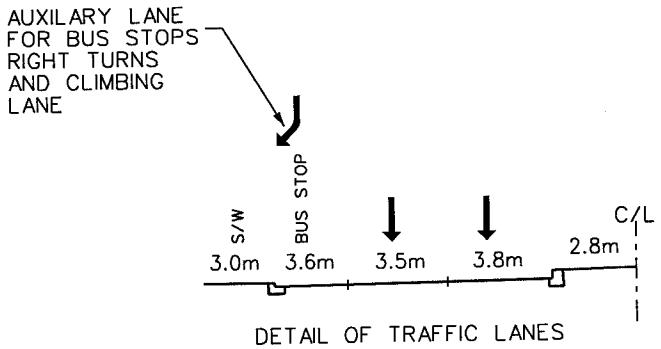
Title: TYPICAL ROAD SECTIONS-
KING GEORGE HWY - 108 AVE to E.W.R.R

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 2000
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-R.6.1





DETAIL OF TRAFFIC LANES

	'A'	'B'	'C'	'S'
6 LANE	33.4	27.4	10.9	3.0

NOTE: (1) EAST SIDEWALK TO CITY CENTER STANDARD (SSD-U.3.1) EWRR TO OUTER RING ROAD.
(2) INCREASE R/W ('A') BY STAT. R/W ('S') AT ULTIMATE BUILDING STAGE.
(3) SPECIES OF TREE TO BE APPROVED BY PARKS AND RECREATION.
(4) LANE WIDTHS / THRU - 3.5 / TURN - 3.3 / CURB CLEARANCE 0.2 / 0.3

3		
2		
1		
	Revision Date	Approved

All Dimensions Shown In Millimetres, Unless Otherwise Noted

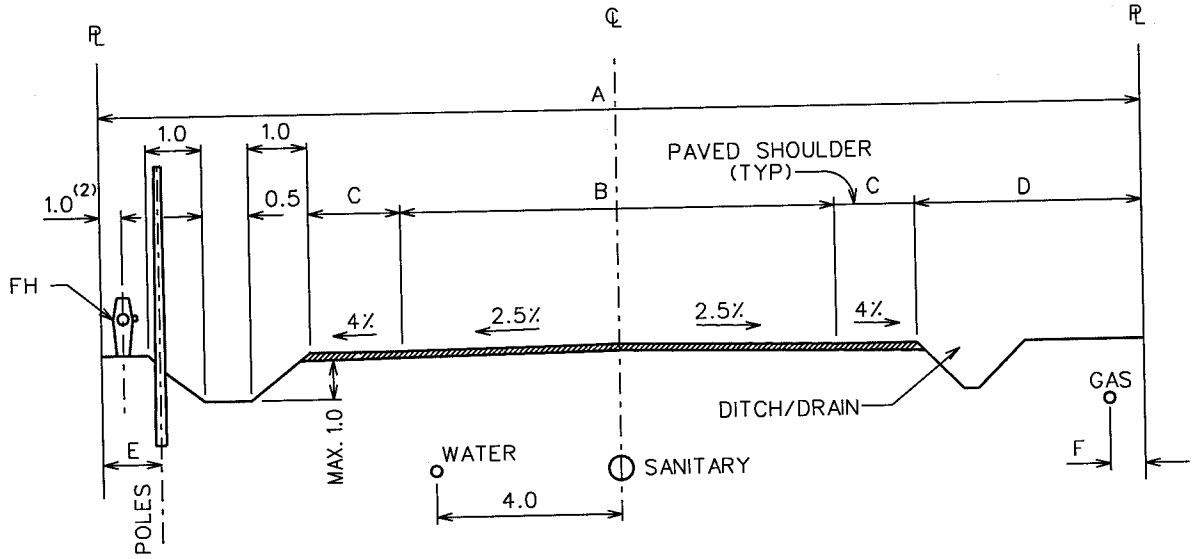
Title: TYPICAL ROAD SECTIONS- KING GEORGE HWY - E.W.R.R. to 128 STREET

SURREY CITY OF PARKS

SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 2000
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.6.2



RURAL ROADS

A	B	C	D	E	F
16.5	6.7	1.5	3.4	2.0	0.8
20	6.7	1.5	5.15	2.0	0.8

NOTES: (1) THE LOCATION OF THE FIRE HYDRANT FROM THE PROPERTY LINE IS TYPICAL (1.0), AND CAN BE LESS IF SPACE DOES NOT PERMIT. VEHICHLE ACCESS SHOULD BE PROVIDED IF THE DITCH DEPTH EXCEEDS 0.7 m.

3		
2		
1		
	Revision Date	Approved

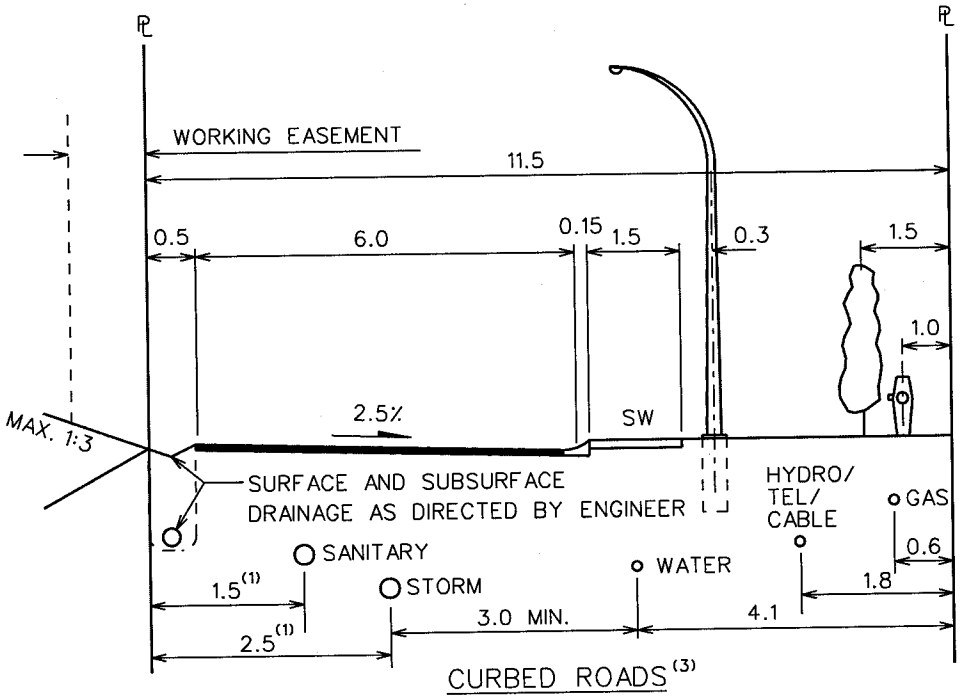
All Dimensions Shown In Metres, Unless Otherwise Noted

Title: TYPICAL ROAD SECTIONS- ROADS WITHOUT CURBS

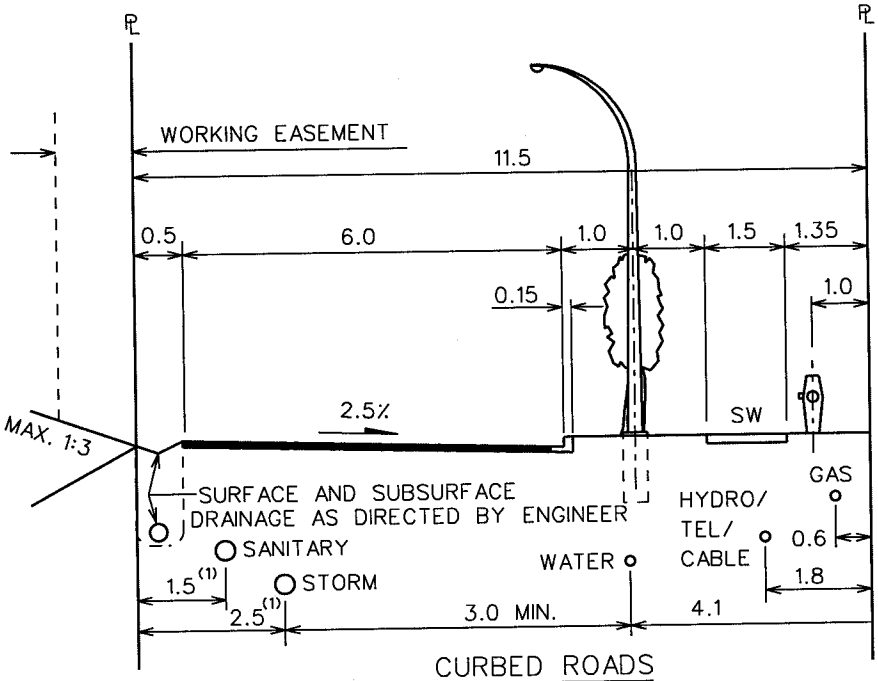
SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.8



CURBED ROADS (3)



CURBED ROADS

NOTES: (1) REFERS TO MINIMUM SPACING BETWEEN SEWERS IN COMMON TRENCH DRAWING.

(2) HALF ROAD WITH CURBS SHALL REFLECT THE ULTIMATE ROAD CROSS SECTION AS SHOWN IN R.3 & R.4

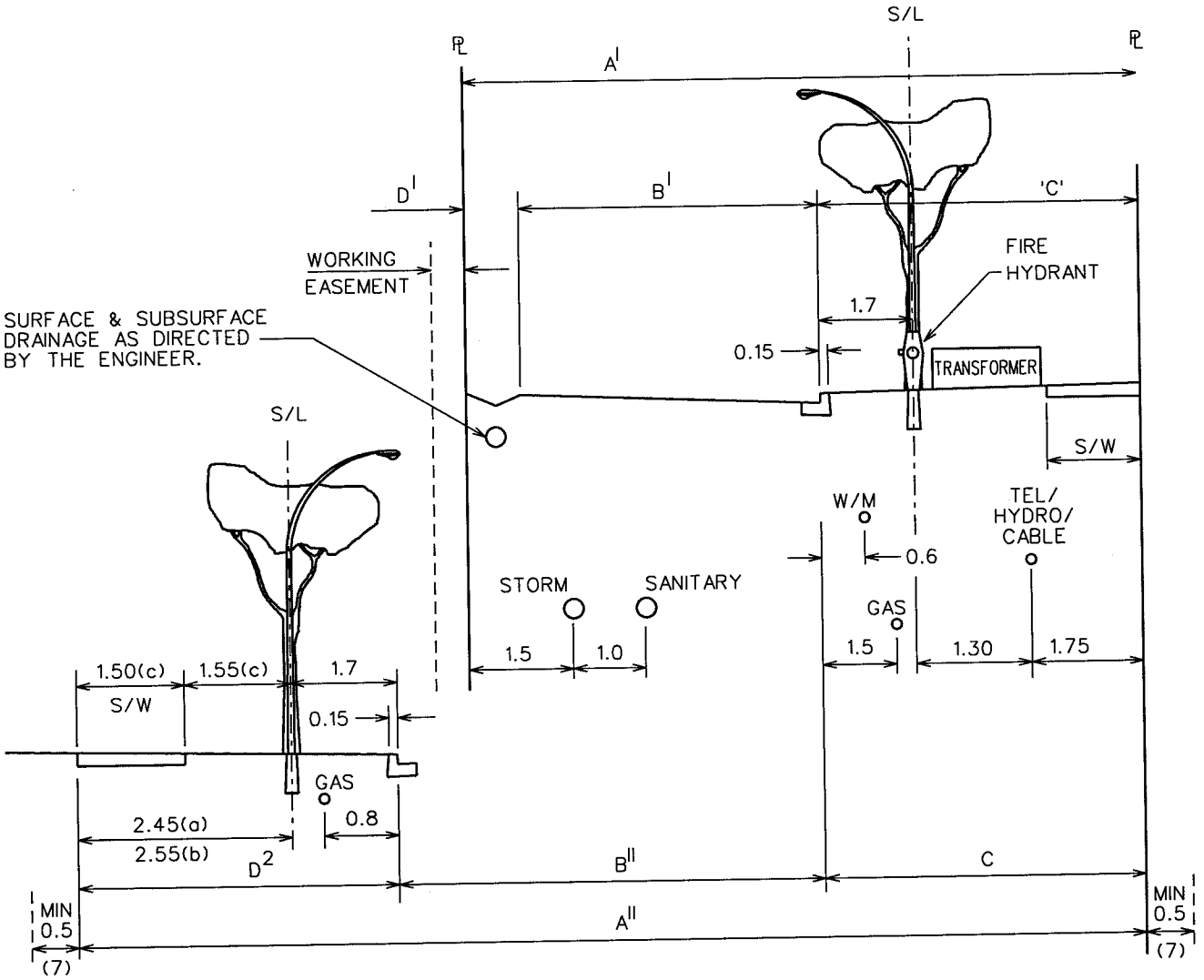
(3) THIS ALTERNATIVE TYPICAL HALF ROAD SECTIONS WITH CURB CAN ONLY BE USED SUBJECT TO THE APPROVAL OF THE ENGINEER.

3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1	FEBRUARY 2002	Title: TYPICAL ROAD SECTIONS- HALF ROAD SECTIONS
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-R.9



CLASSIFICATION	LENGTH (m)	TYPE OF TRAFFIC FLOW	HALF ROAD (I) SIDEWALKS	A	B	C	D	ULTIMATE ROAD (II) SIDEWALKS	A	B	C	D
LIMITED LOCAL	≤220	QUEUING (a)	0	11.5	6.0	4.75	0.75	1	15.5	6.6	4.75	4.15
		QUEUING (b)	0	11.5	6.0	4.75	0.75	1	17.0	8.0	4.75	4.25
THROUGH LOCAL	N/A(c)	QUEUING / TWO WAY	1	11.5	6.0	4.75	0.75	2	18.0	8.5	4.75	4.75
		TWO-WAY	1	11.5	6.0	4.75	0.75	2	20.0	10.5	4.75	4.75

NOTES: (1) NO SIDEWALK REQUIRED ON ROAD LENGTHS < 50 METRES.
(2) BARRIER CURB ONLY EXCEPT RA, RA-G, RH AND RH-G WHICH CAN USE ROLLOVER CURB.
(3) STREET LIGHTING TO BE INSTALLED ON THE PROPOSED SIDE OF THE ROAD.
(4) MEDIUM TO LARGE STREET TREES, ONLY.
(5) TRANSFORMER MUST BE 6.1m FROM ANY COMBUSTIBLE SURFACE OR CONCRETE FENCE IS REQUIRED.
(6) B.C. GAS TO SWEEP MAIN AROUND STREET LIGHT BASES.
(7) MINIMUM 0.5m STATUTORY R.O.W. REQUIRED WHERE SIDEWALK IS REQUIRED.

3		
2	January 2004	Kok Kuen Li
1	MARCH 2002	
	Revision Date	Approved

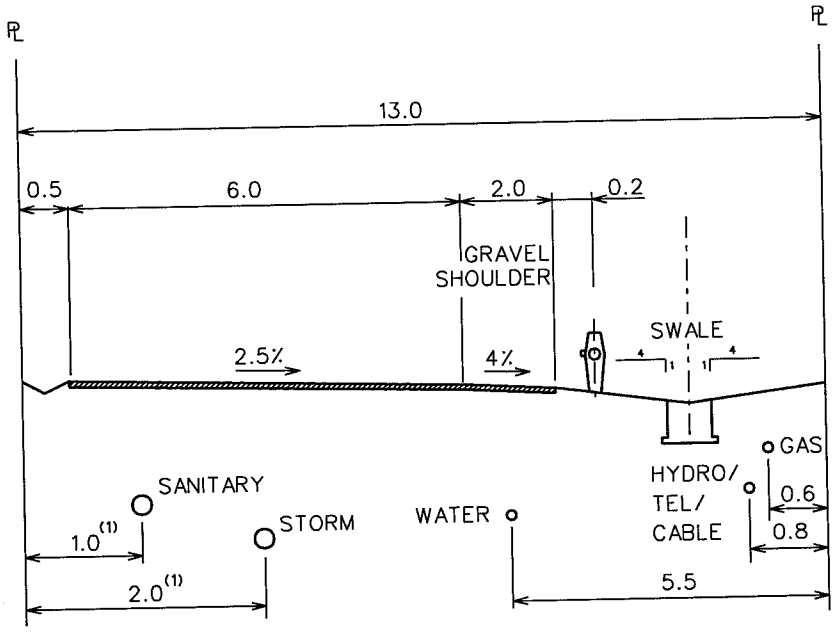
All Dimensions Shown In Metres,
Unless Otherwise Noted

Title: ALTERNATIVE (NEO-TRADITIONAL) HALF ROAD SECTIONS

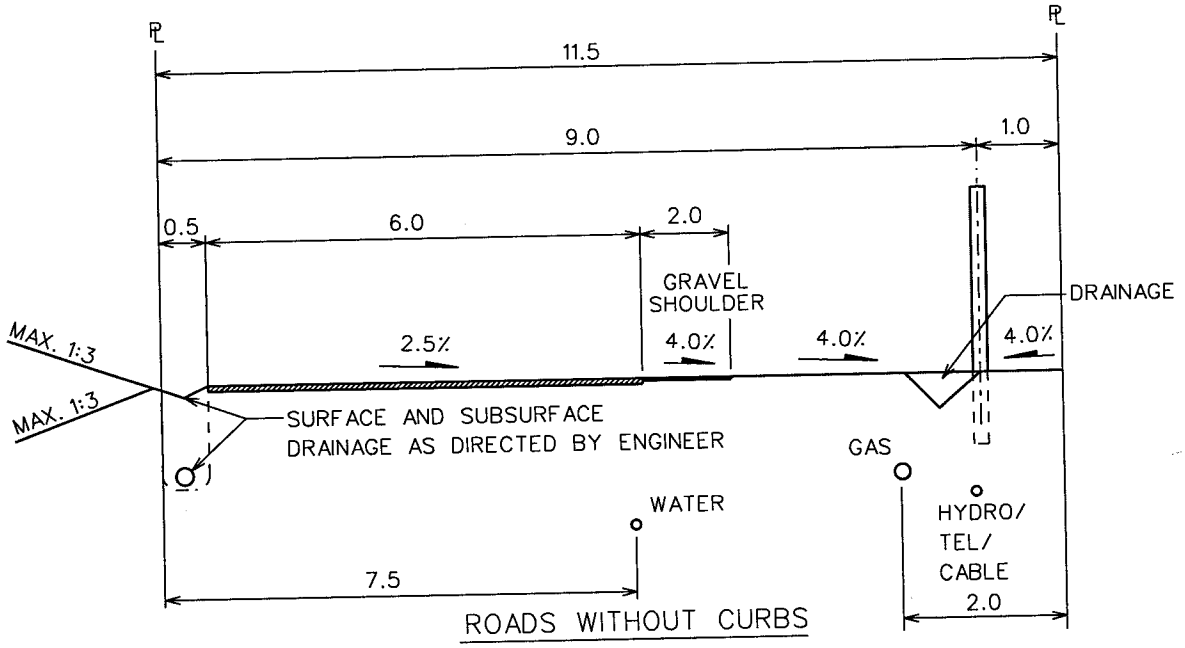
SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-R.9.1



WEST PANORAMA RIDGE



ROADS WITHOUT CURBS

NOTES: (1) REFER TO MINIMUM SPACING BETWEEN SEWERS IN COMMON TRENCH DRAWINGS.

3		
2		
1		
	Revision Date	Approved

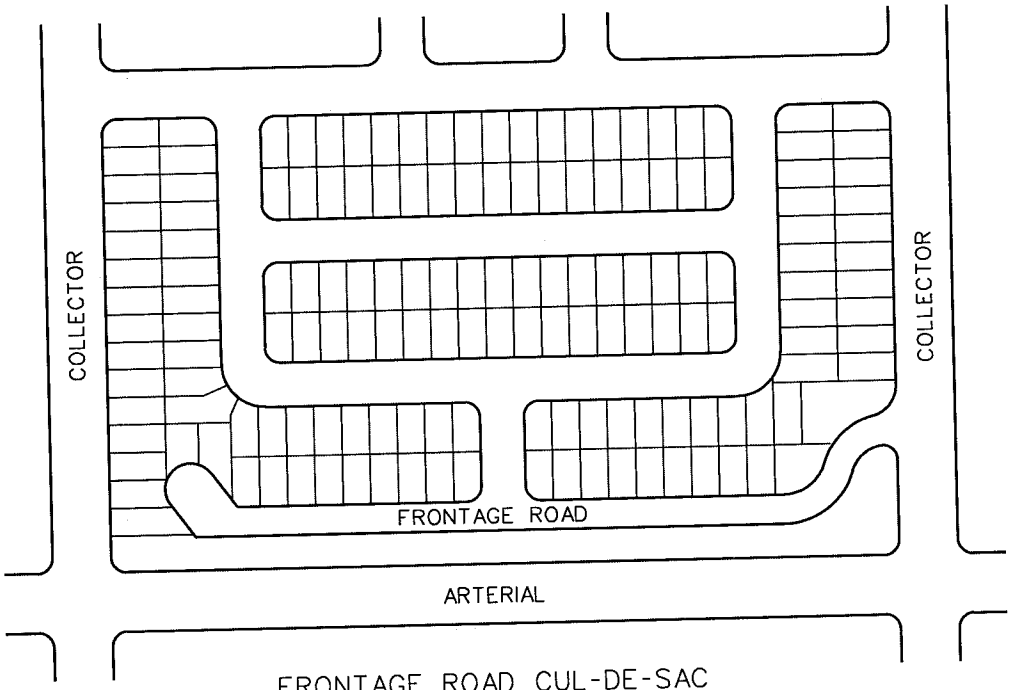
All Dimensions Shown In Metres, Unless Otherwise Noted

Title: TYPICAL HALF ROAD SECTION - WITHOUT CURBS

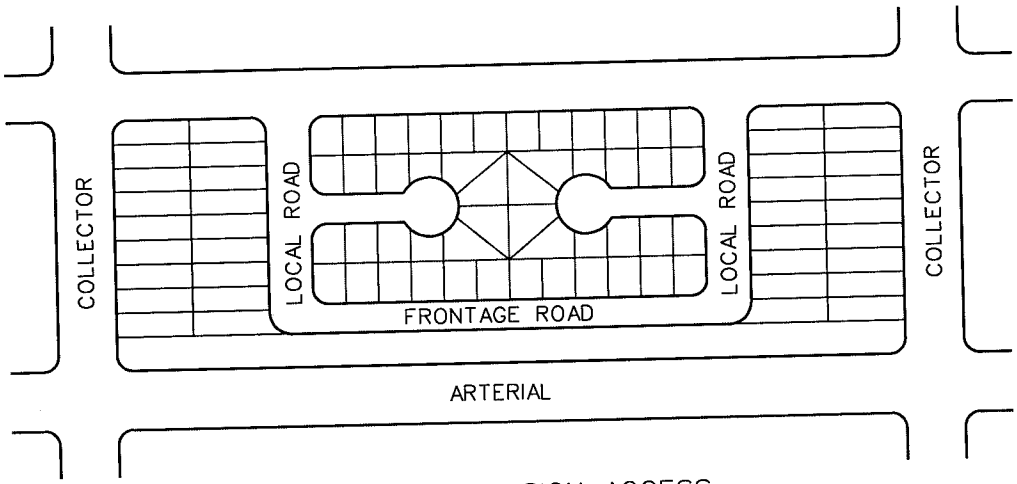
SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.10



FRONTAGE ROAD CUL-DE-SAC
AND FRONTAGE ROAD / COLLECTOR ROAD ACCESS
(SEE SSD-R.11.1)



INTERNAL SUBDIVISION ACCESS

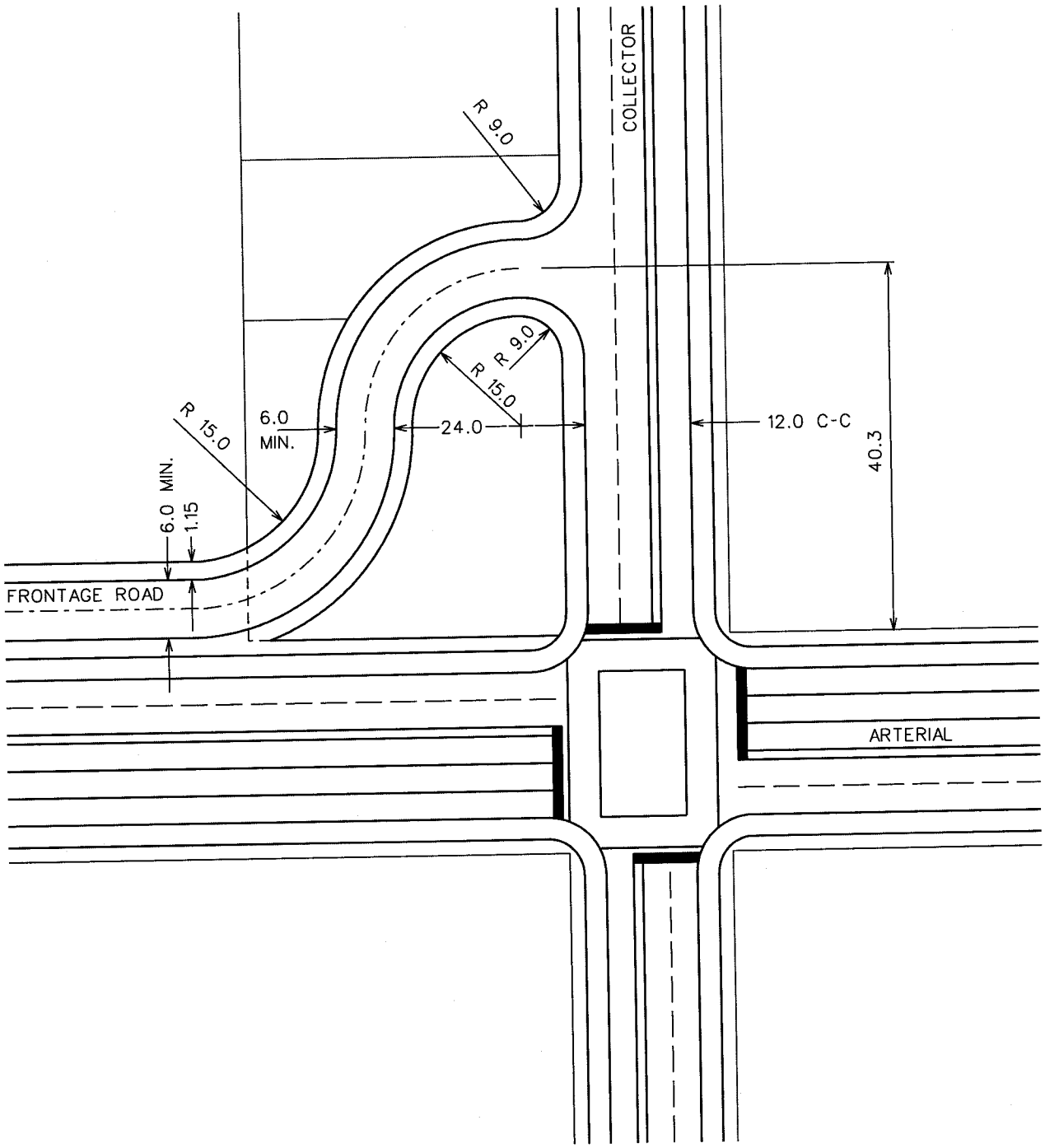
NOTES: (1) TEMPORARY FRONTAGE ROAD ACCESS OR OTHER CONCEPTS AS APPROVED BY THE ENGINEER AND APPROVING OFFICER.

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: FRONTAGE ROAD CONCEPTS
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-R.11

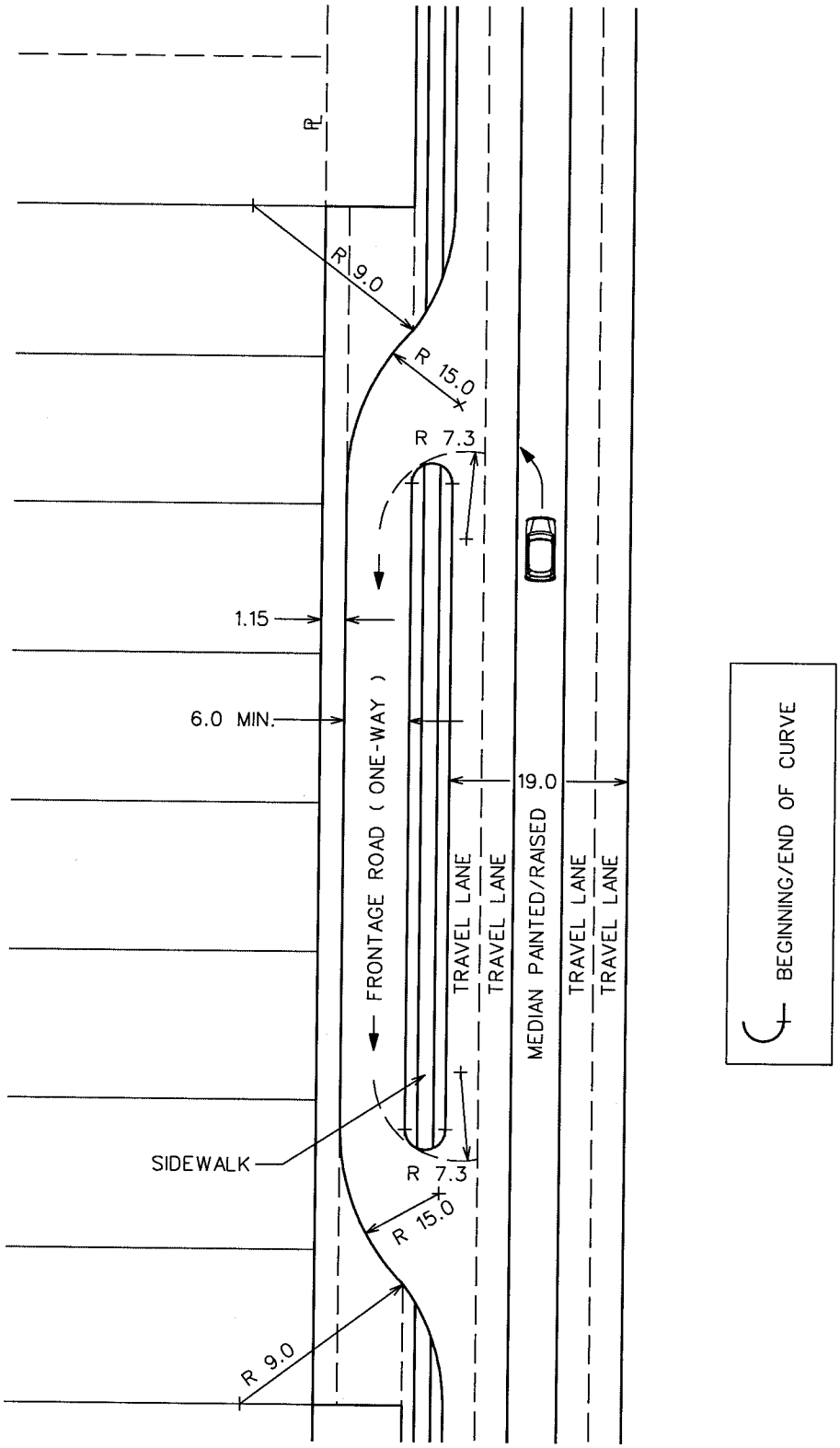


3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1		Title: TYPICAL FRONTAGE ROAD/ COLLECTOR ROAD ACCESS
	Revision Date Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.11.1



3		
2		
1		
	Revision Date	Approved

All Dimensions Shown In Metres, Unless Otherwise Noted

Title: TYPICAL TEMPORARY FRONTAGE ROAD ENTRY/EXIT

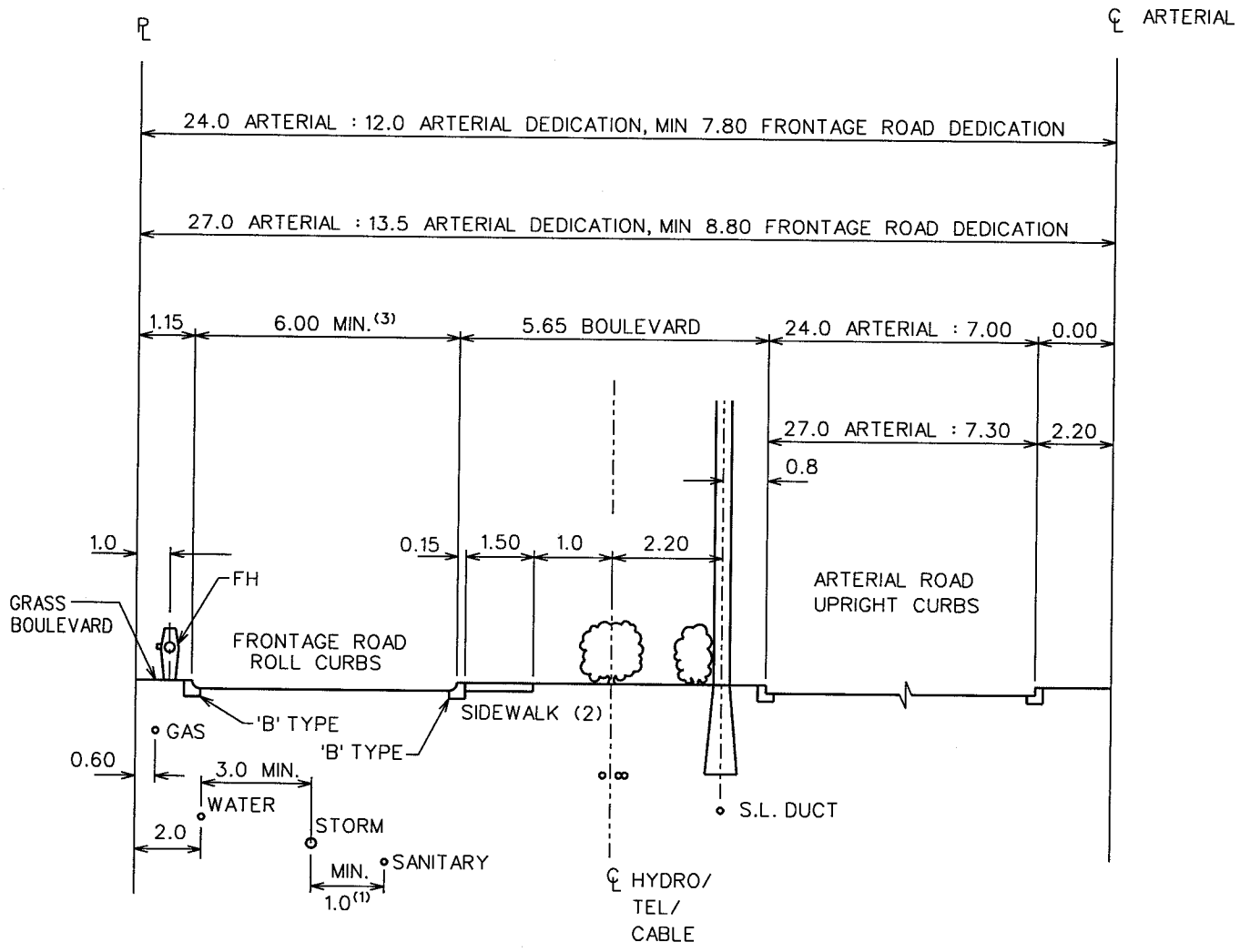
SURREY CITY OF PARKS

SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER

SSD-R.11.2



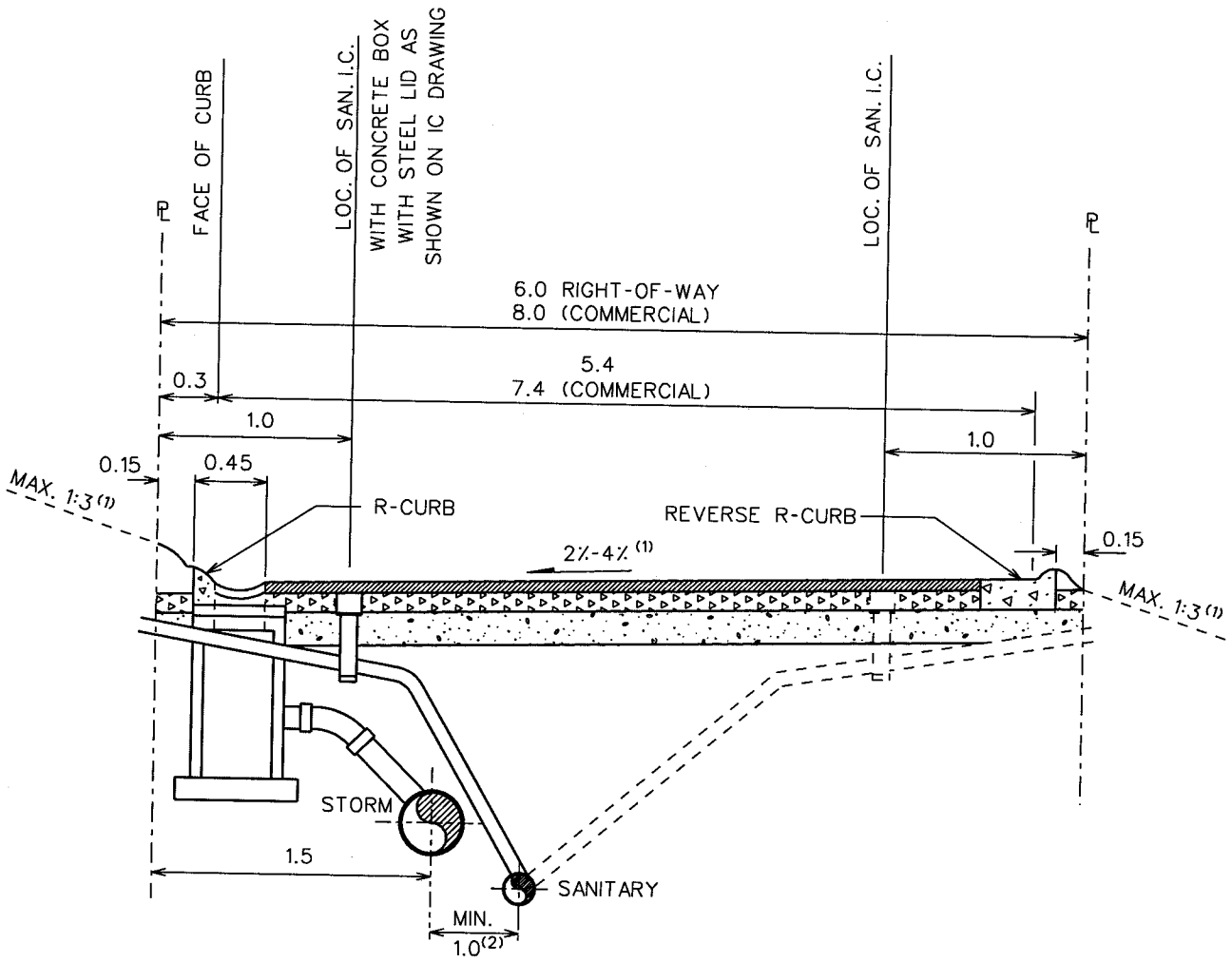
NOTES:
(1) REFER MINIMUM SPACING BETWEEN SEWERS IN COMMON TRENCH DRAWING.
(2) SIDEWALK LOCATION TO BE DETERMINED BY PLANNING DEPARTMENT.
(3) PROVIDE MORE ROAD RIGHT-OF-WAY IF PAVEMENT IS MORE THAN 6.0m.
(4) TREATMENT OF THE BOULEVARD SUBJECT TO THE APPROVAL OF THE ENGINEER.
(5) FRONTAGE ROADS SERVICING MORE THAN 50 LOTS OR UNITS, OR COMMERCIAL / INDUSTRIAL PROPERTIES SHALL HAVE A PAVEMENT WIFTH OF 8.5m.

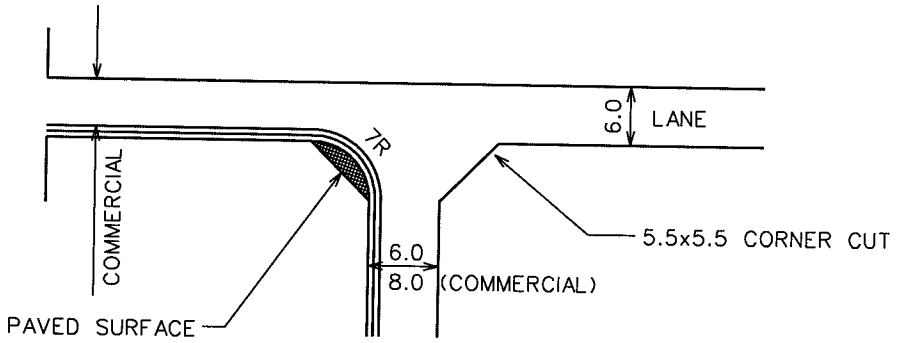
3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1		Title: TYPICAL FRONTAGE ROAD SECTION
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.11.3





LANE INTERSECTION

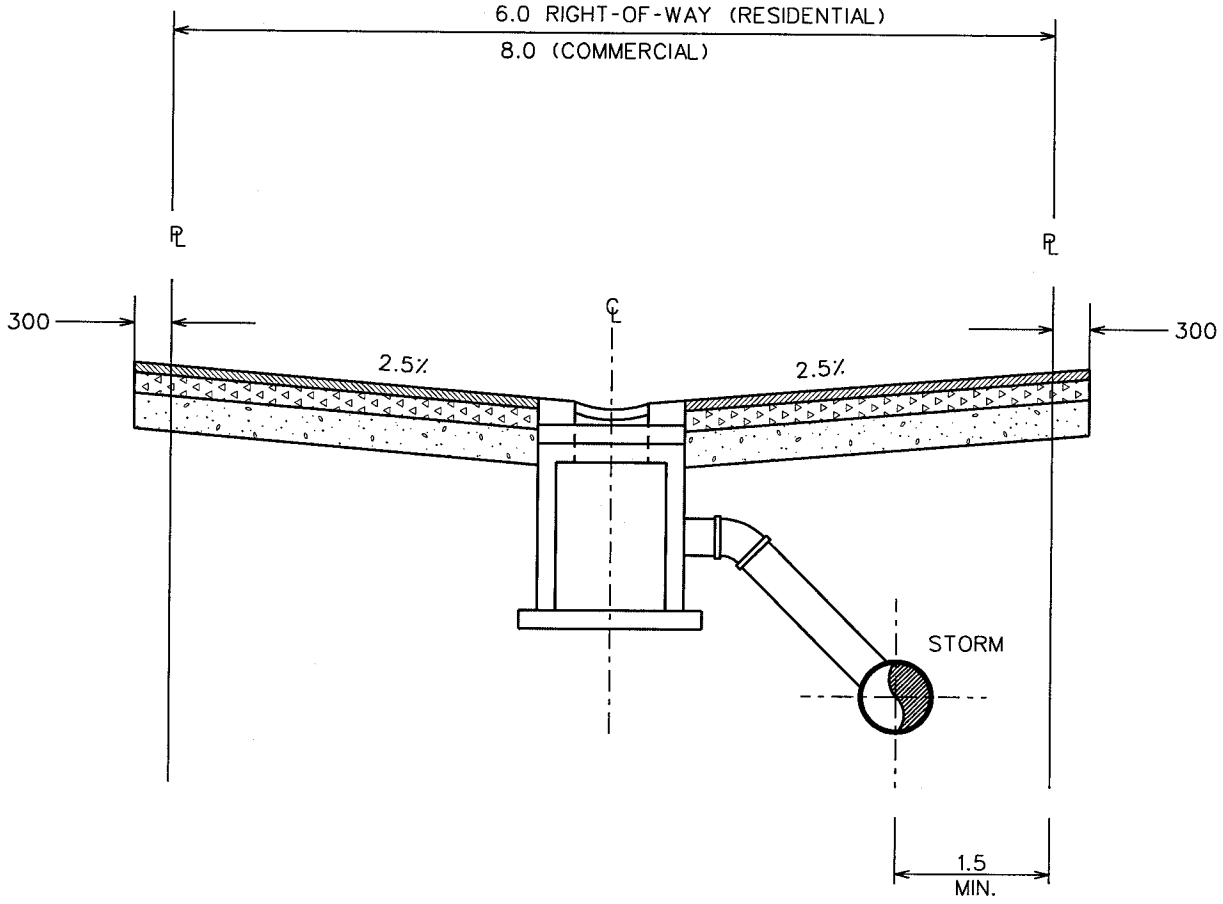
NOTES: (1) CROSSFALL SHALL BE AGAINST THE TOPOGRAPHY SLOPE OF THE ADJACENT AREA.
(2) REFER TO MINIMUM SPACING BETWEEN SEWERS IN COMMON TRENCH DRAWING.

3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1		Title: TYPICAL LANE SECTION
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.12



LANE INTERSECTION DETAILS

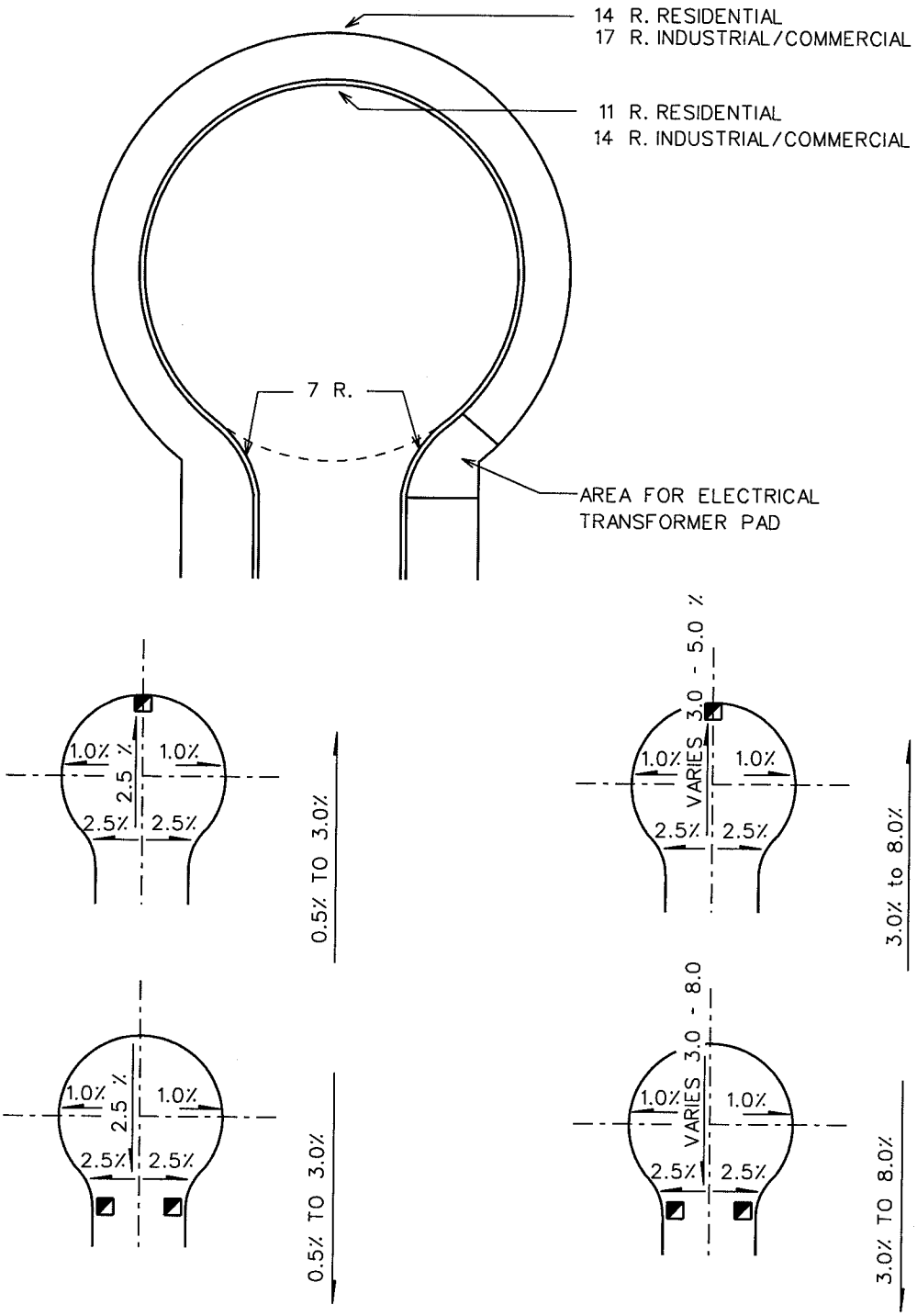
NOTE: (1) IF UTILITIES ARE GREATER THAN 3.0 METERS DEEP, ADDITIONAL ROAD ALLOWANCE MAY BE NEEDED.

3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1		Title: TYPICAL LANE SECTION - ALTERNATE
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	September 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-R.12.1



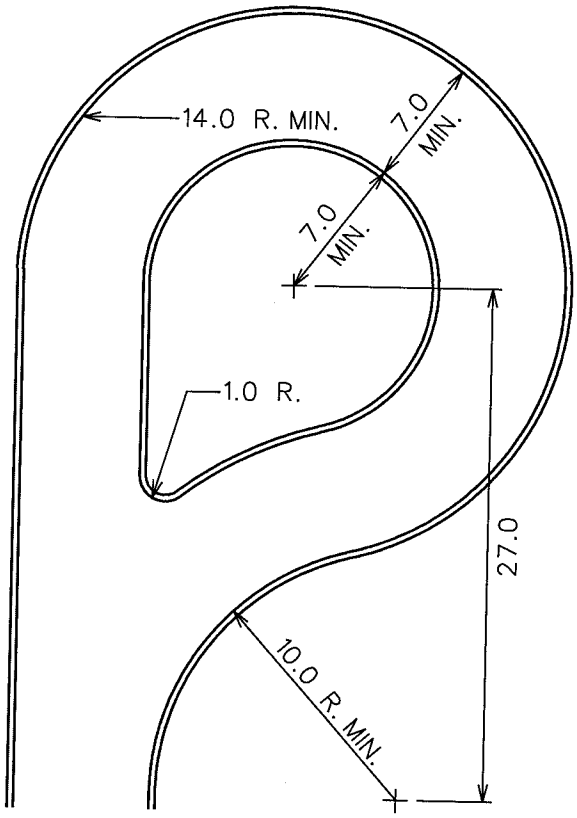
CUL-DE-SAC GRADING DETAILS

LIMITED LOCAL ROADS

3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1	November 1999	Title: CUL-DE-SAC
	Revision Date Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER SSD-R.13
Date	APRIL 1998	
Drawn By	Surrey Engineering	



TURNAROUND WITH ISLAND

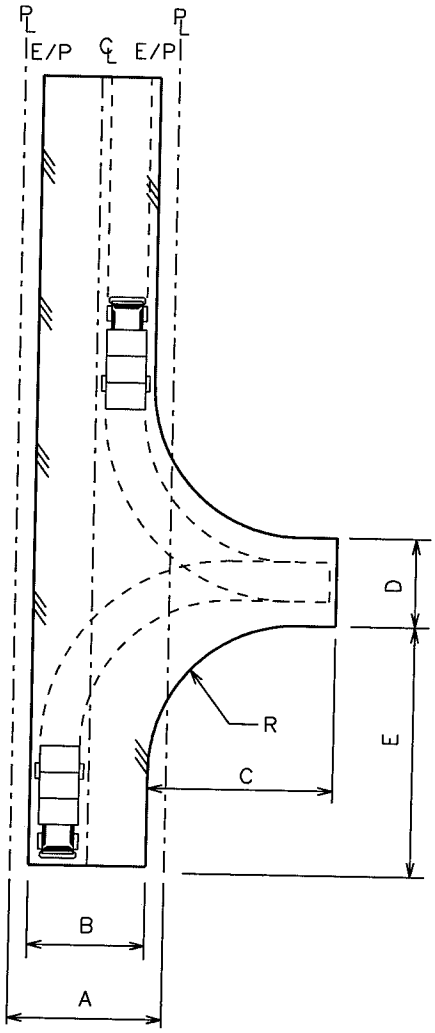
NOTES: (1) NO PARKING SHALL BE POSTED AT THE CURBSIDE.
2) ISLAND TREATMENT SUBJECT TO THE ENGINEERS APPROVAL.

3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1		Title: RESIDENTIAL CUL-DE-SAC WITH ISLAND
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.14



DESIGN VEHICLE	A	B	C	D	E	R
SU-9	6.0	5.4	15.0	5.0	16.0	7.0
P	6.0	5.4	7.0	3.5	9.0	3.0

NOTES: (1) DESIGN VEHICLE AS DIRECTED BY THE ENGINEER.

3		
2		
1		
	Revision Date	Approved

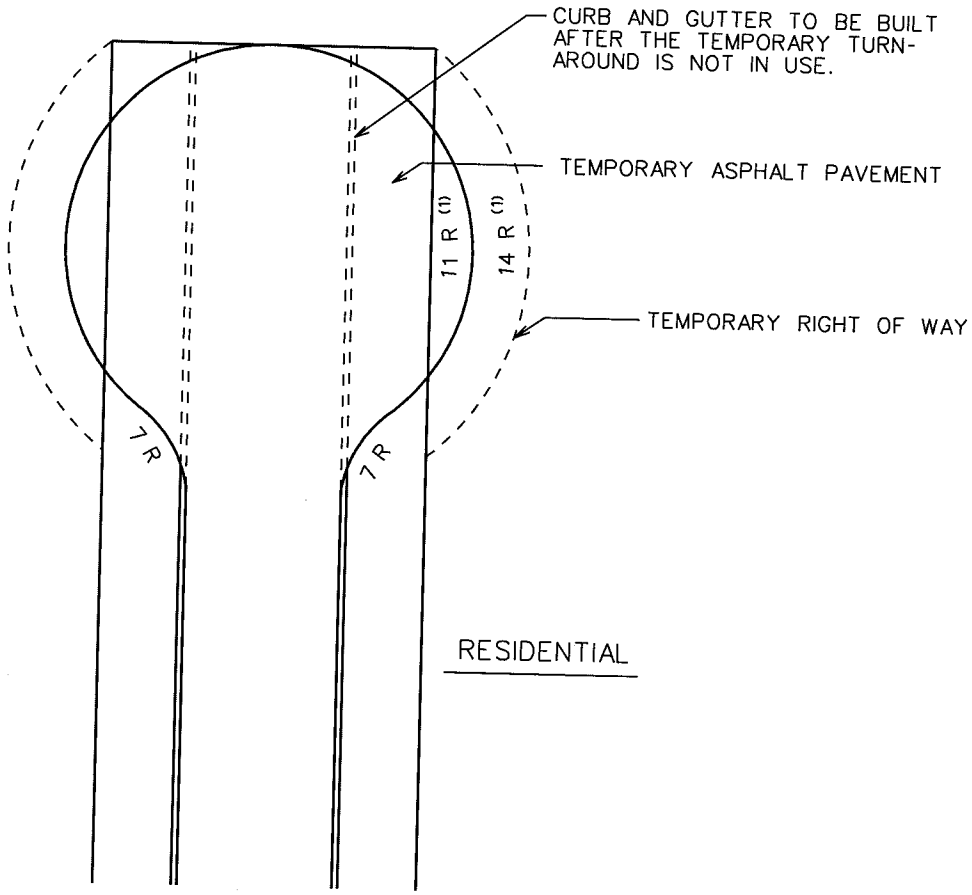
All Dimensions Shown In Metres, Unless Otherwise Noted

Title: TEMPORARY TURNAROUND

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.15



RESIDENTIAL

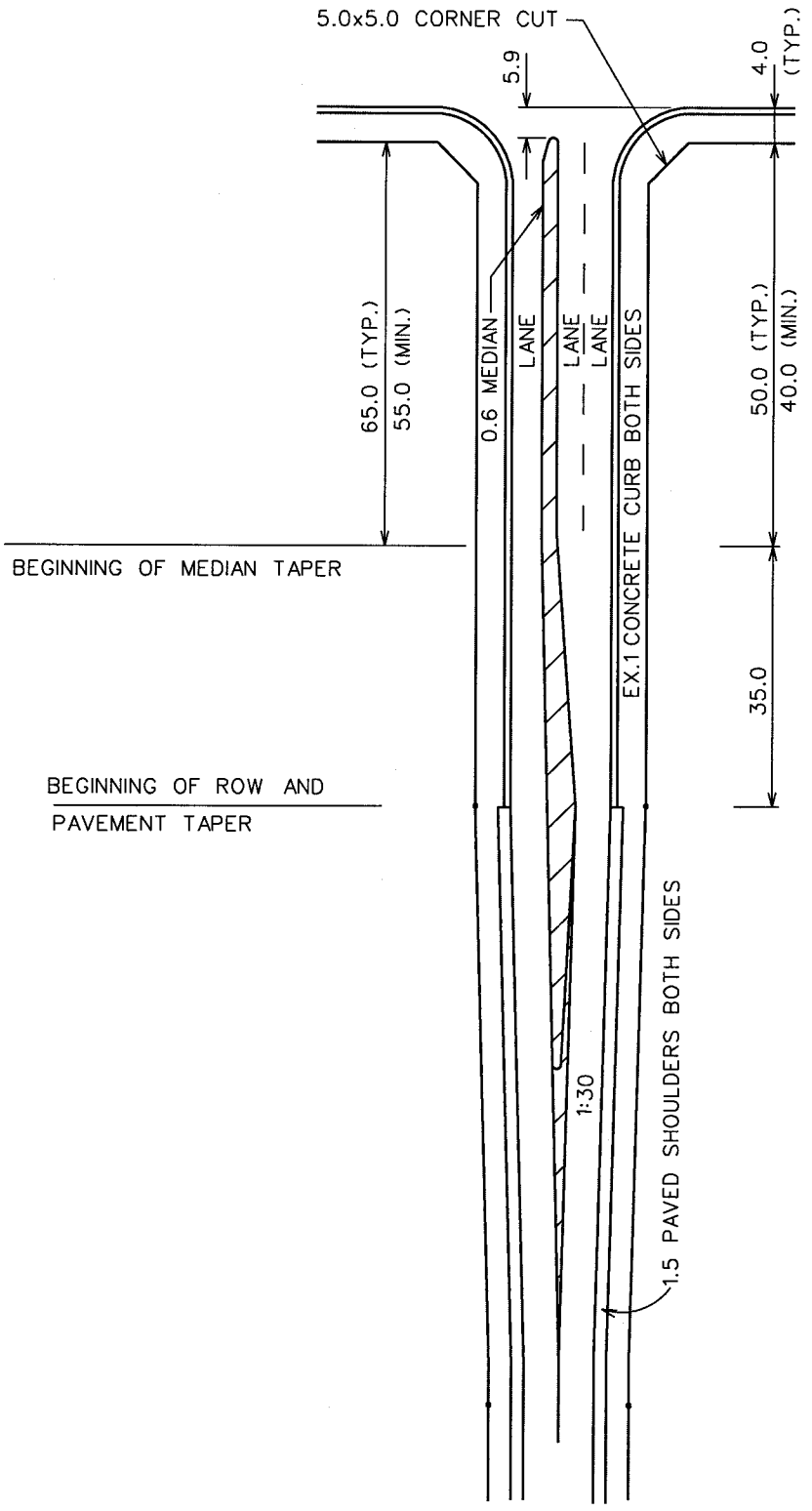
NOTES: (1) THE RADII WILL BE 14 R AND 17 R RESPECTIVELY FOR COMMERCIAL AND INDUSTRIAL ZONES.

3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1		Title: TEMPORARY TURNAROUND & CUL-DE-SAC
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.16



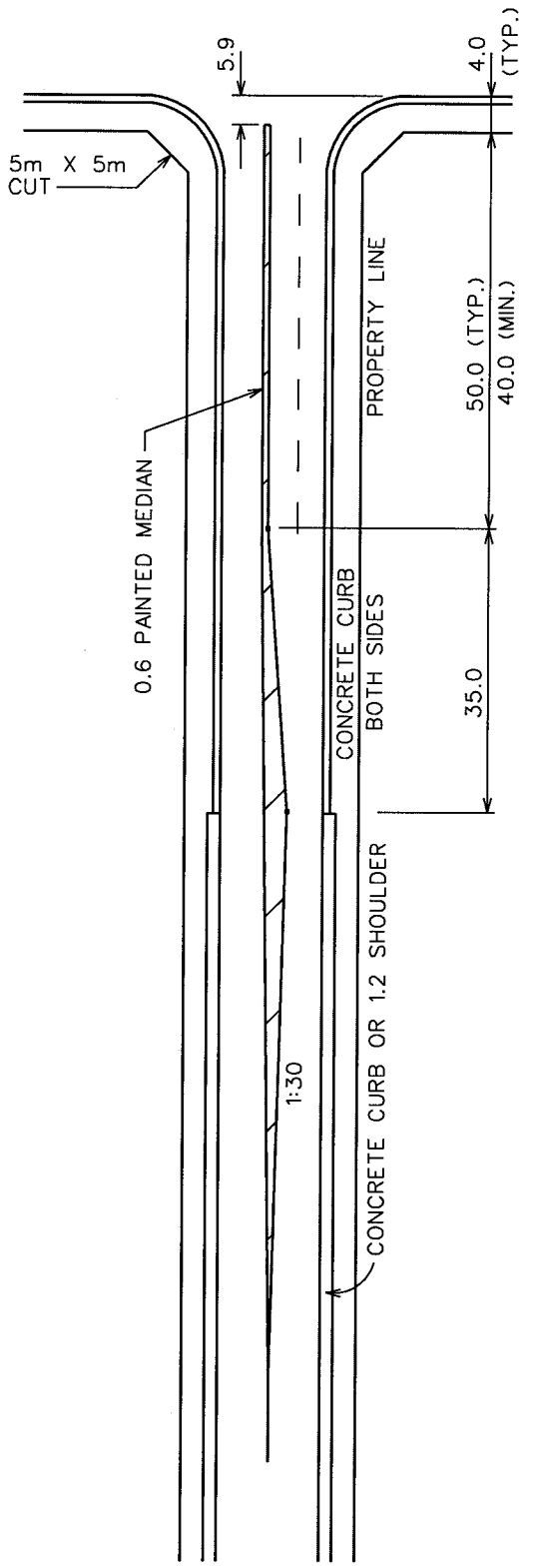
NOTES: (1) REFER TO THE PAVEMENT MARKING MANUAL FOR ROAD MARKING.
(2) PAINTED MEDIAN ONLY AS DIRECTED BY THE ENGINEER.

3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1		Title: CHANNELIZED INTERSECTION - INTERIM DESIGN FOR 2 THRU LANES & LEFT TURN LANE
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.17



NOTE: (1) REFER TO THE PAVEMENT MARKING MANUAL FOR ROAD MARKING.

3		
2		
1		
	Revision Date	Approved

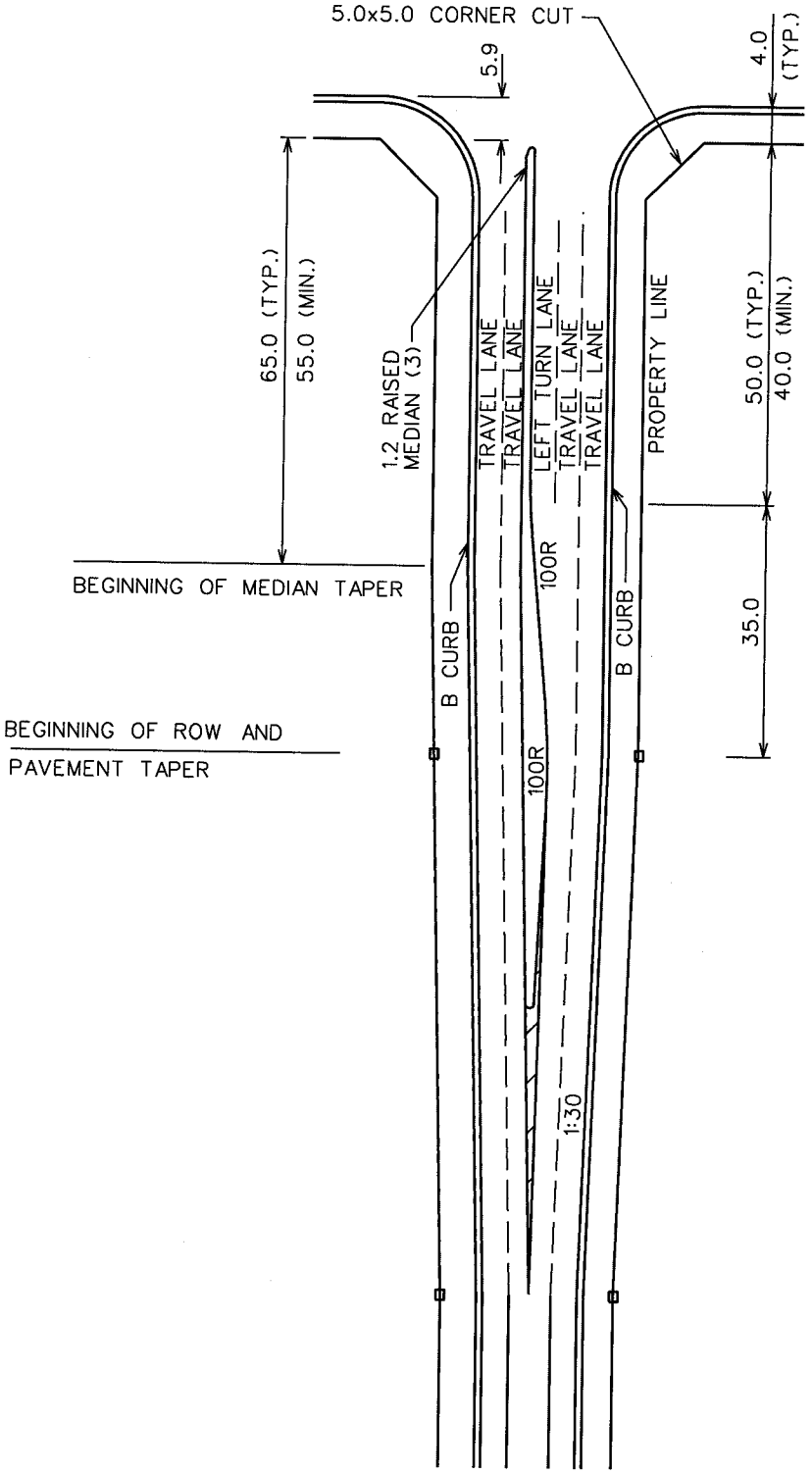
All Dimensions Shown In Metres, Unless Otherwise Noted

Title: CHANNELIZED INTERSECTION - 12.2m PAVEMENT

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-R.18



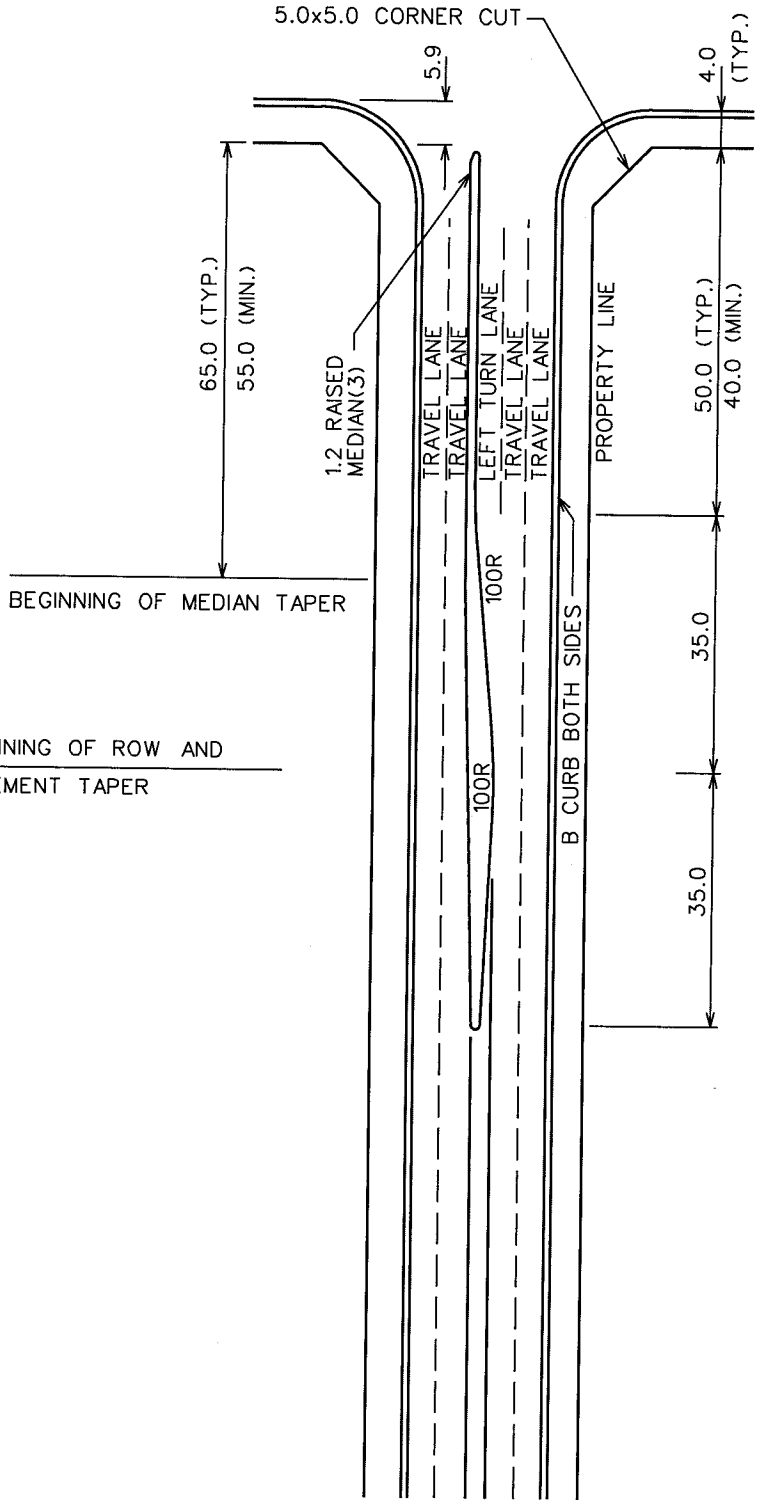
NOTES: (1) REFER TO THE PAVEMENT MARKING MANUAL FOR ROAD MARKING.
(2) RAISED MEDIAN ONLY AS DIRECTED BY THE ENGINEER.
(3) FOR BICYCLE FRIENDLY DESIGN, MEDIAN TO BE 0.6m WIDE.

3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1		Title: CHANNELIZED INTERSECTION - 14.0 m PAVEMENT
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.19

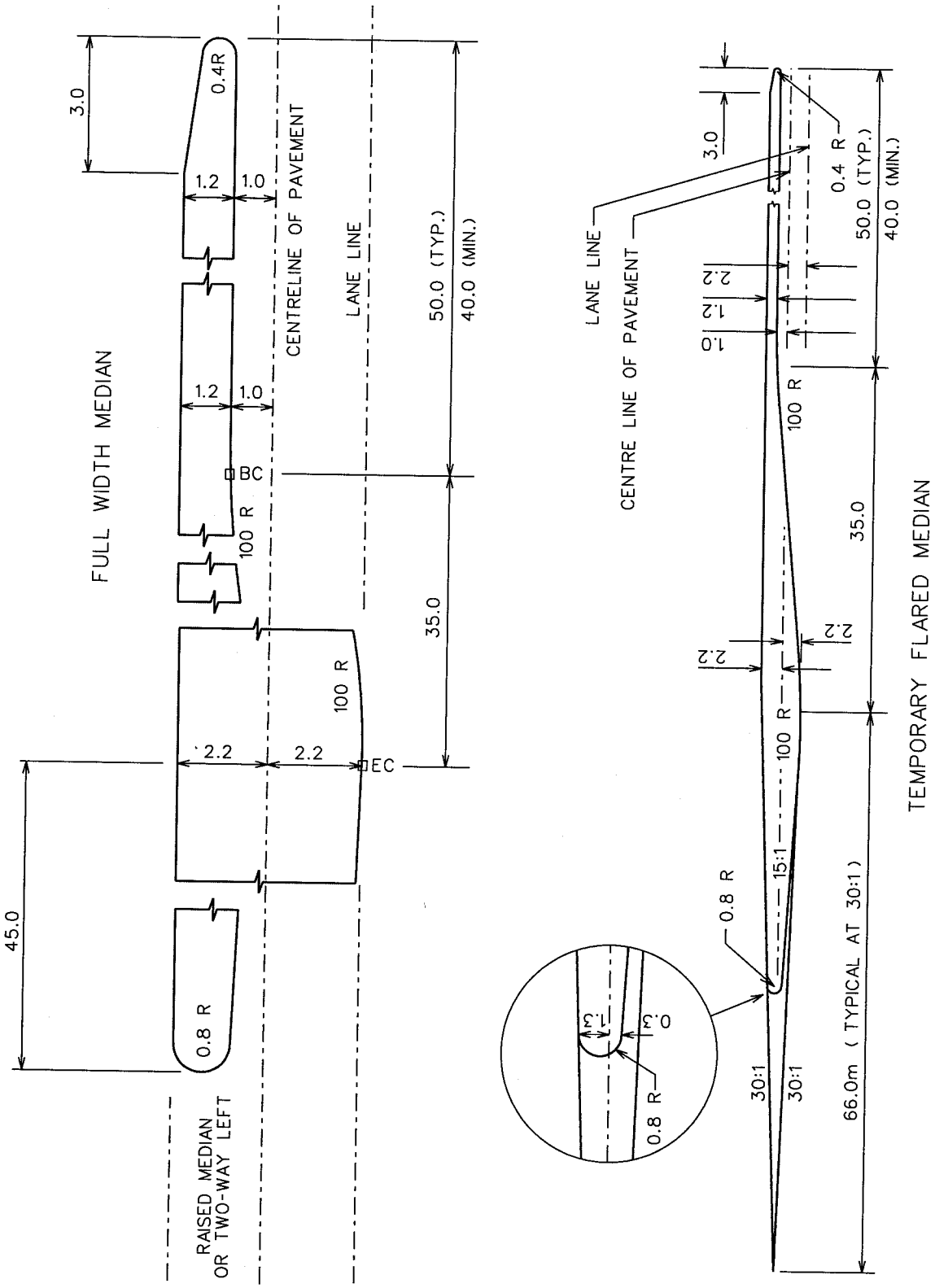


NOTES: (1) REFER TO THE PAVEMENT MARKING MANUAL FOR ROAD MARKING.
(2) RAISED MEDIAN ONLY AS DIRECTED BY THE ENGINEER.
(3) FOR BYCYCLE FRIENDLY DESIGN, MEDIAN TO BE 0.6m.

3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1		Title: CHANNELIZED INTERSECTION - 19.0 m PAVEMENT
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-R.20
Drawn By	Surrey Engineering	

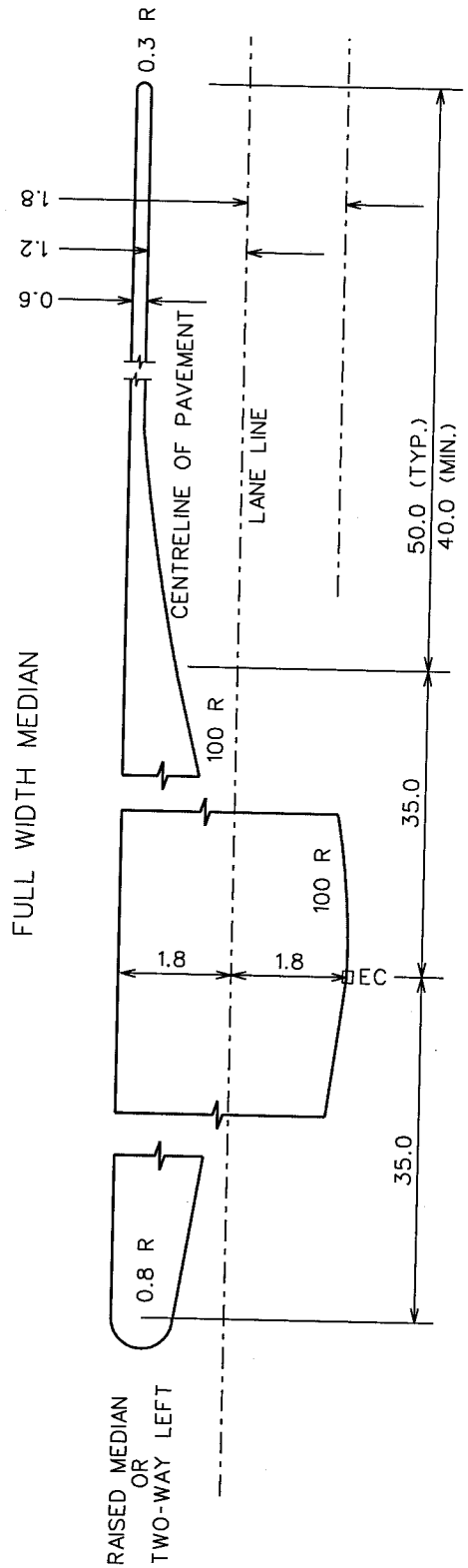


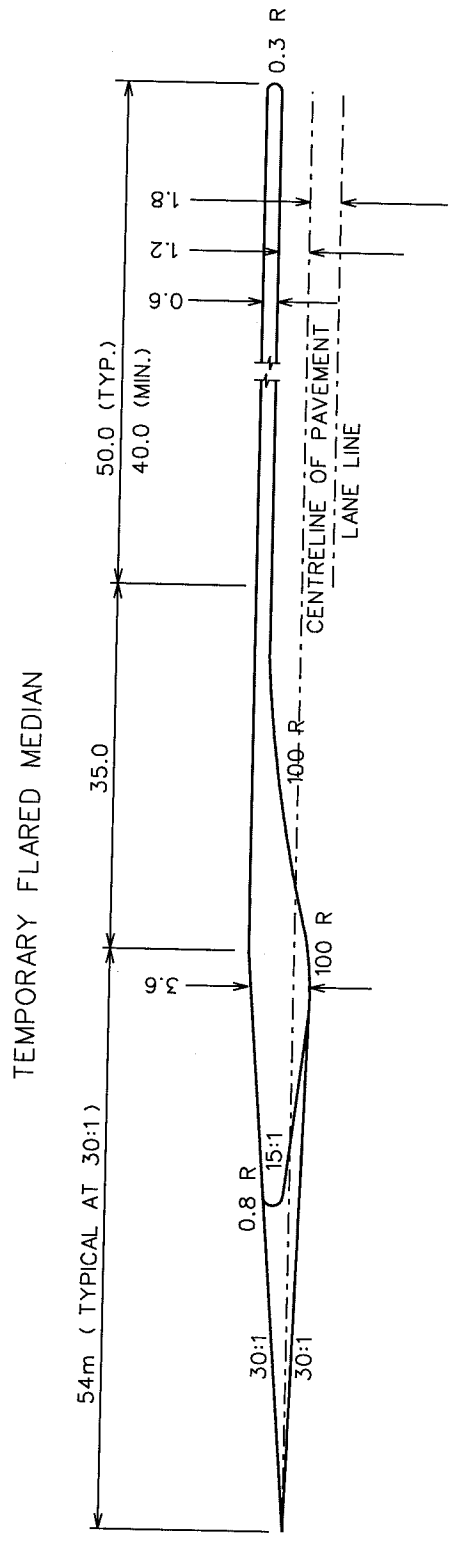
3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1		Title: RAISED MEDIAN 4.4m WIDE STANDARD
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	FEBRUARY 2002
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.21





3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1	FEBRUARY 2002	Title: RAISED MEDIAN - BICYCLE FRIENDLY
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.21.1

NOTE:

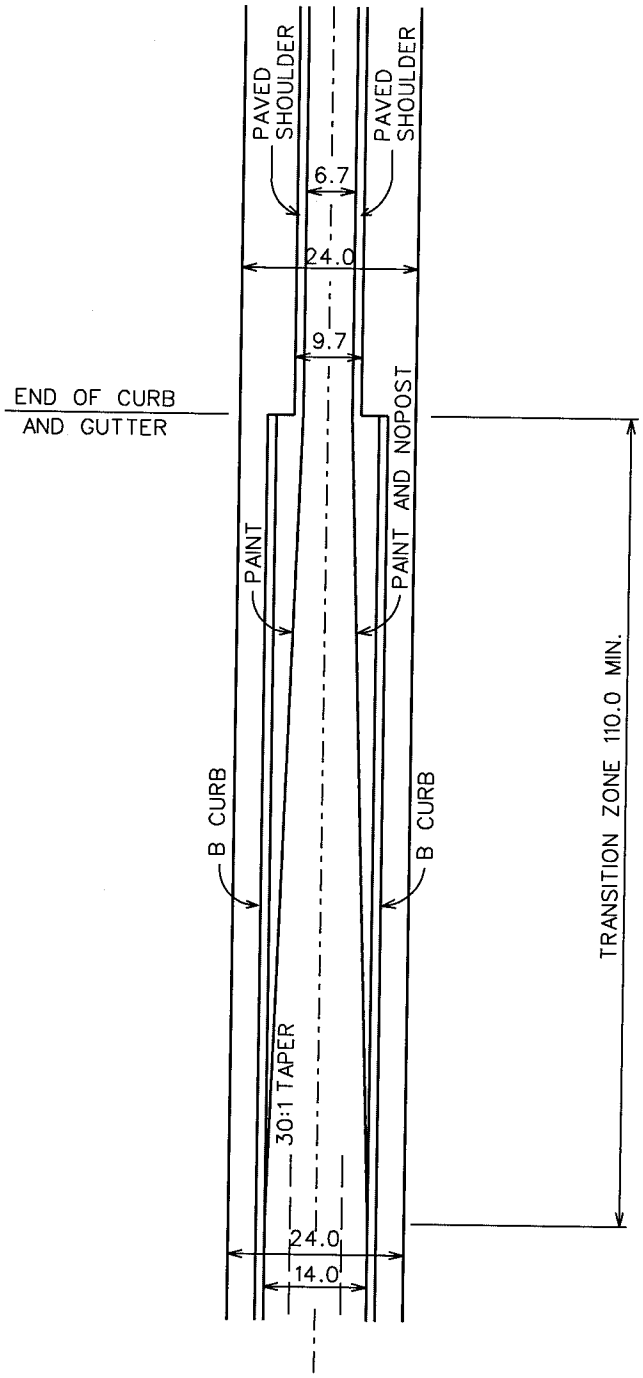
1) CONCRETE MAINTENANCE STRIP, SOIL DEPTH, AND SOIL QUALITY APPLY TO ALL LANDSCAPE MEDIANS INCLUDING GRASS MEDIANS.
2) PLANT MATERIAL TO BE SELECTED FROM LIST OF ACCEPTABLE PLANT MATERIAL CITY OF SURREY PARKS DIVISION STANDARD CONSTRUCTION DOCUMENTS
3) PROTECT PLANT MATERIAL FROM DAMAGE DURING TRANSPORTATION AND PLANTING
4) LOCATE AND FLAG ALL BURIED UTILITIES IN PLANTING BEDS PRIOR TO DIGGING ENSURE THAT UTILITIES ARE PROTECTED DURING CONSTRUCTION
5) DO NOT EXPOSE PLANTS TO DIRECT SUN OR FROST
6) PRUNE ONLY IN ACCORDANCE WITH STANDARD CONSTRUCTION DOCUMENTS

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		
	Revision Date Approved	Title: MEDIAN PLANTING SECTION

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	FEBRUARY 2002
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.22



NOTES: (1) TRANSITION FROM 14.0 m PAVEMENT TO 7.3 m PAVEMENT SHOWN: OTHER TRANSITIONS SIMILAR MAINTAINING THE 30:1 TAPER.

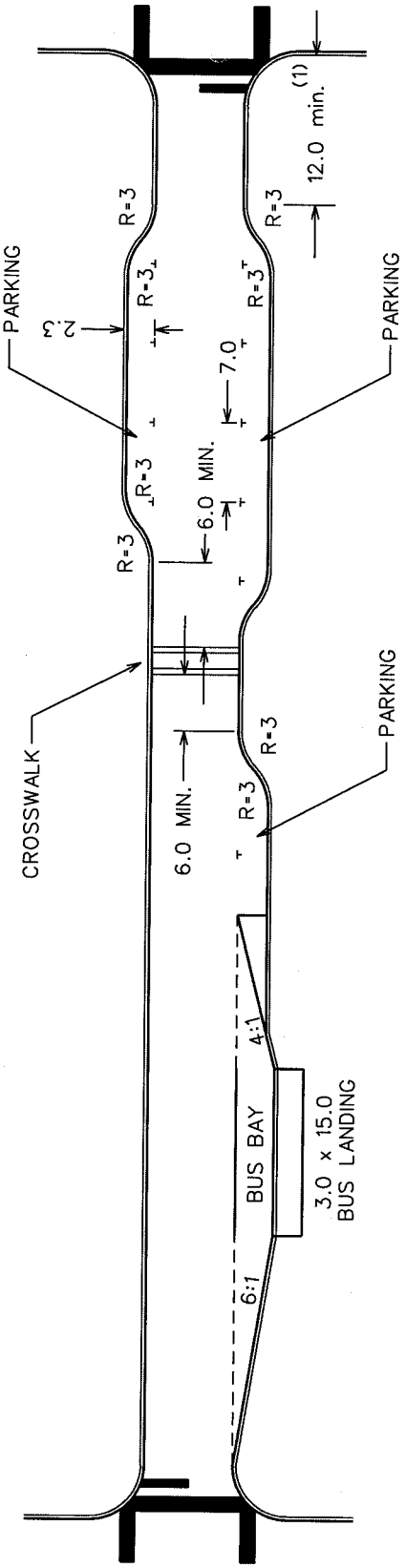
(2) REFER TO PAVEMENT MARKING MANUAL FOR ROAD MARKINGS.

3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1		Title: TRANSITION FROM 4 LANES TO 2 LANES
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.23



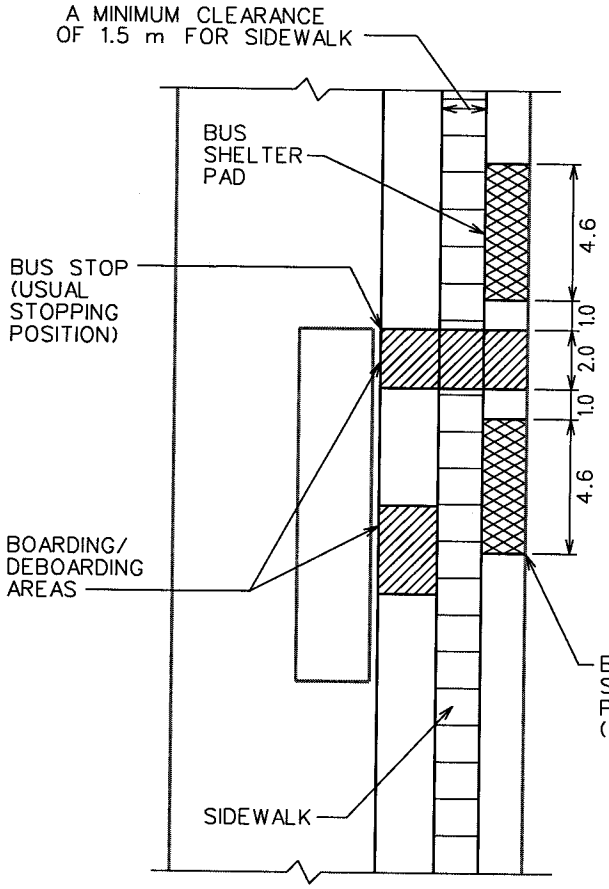
NOTE: (1) VARY AS REQUIRED TO MEET STOPPING SIGHT DISTANCE.

3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1		Title: TYPICAL ON-STREET PARKING BAY
	Revision Date / Approved	

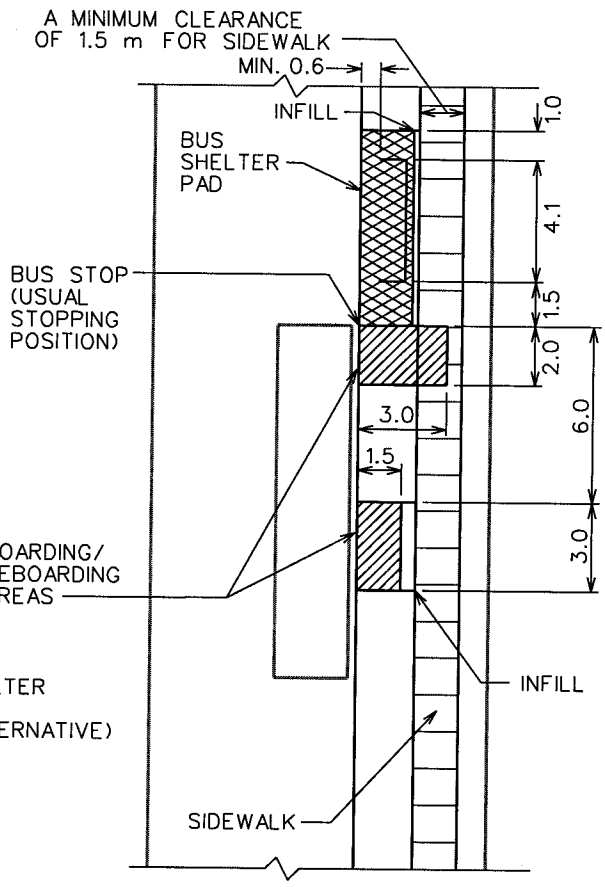
SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

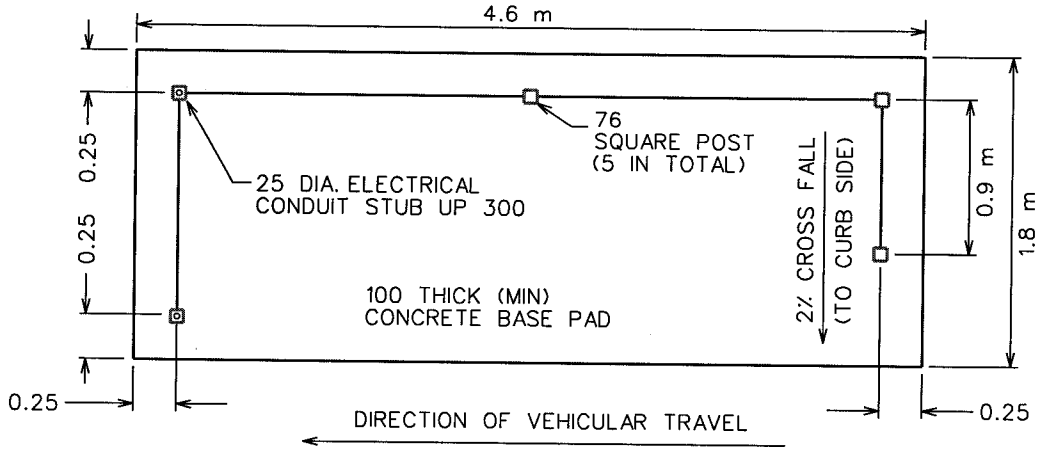
DRAWING NUMBER: SSD-R.24



BUS SHELTER LOCATION
BEHIND SIDEWALK



BUS SHELTER LOCATION
IN FRONT OF SIDEWALK



BUS SHELTER PAD DETAIL

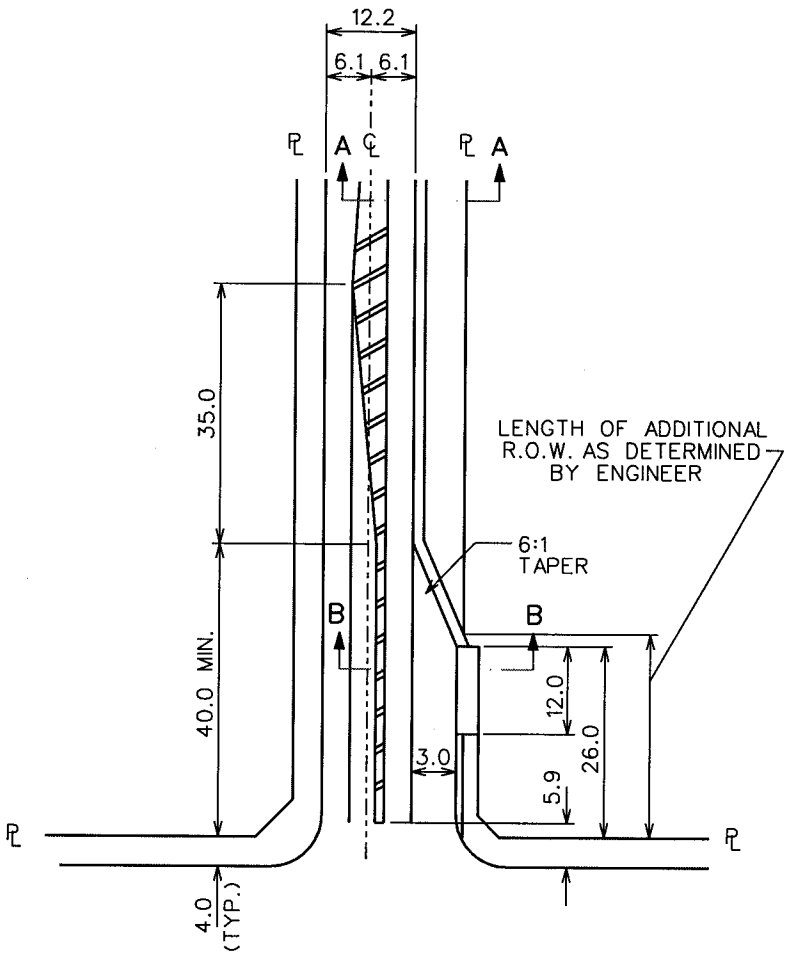
NOTE: (1) BUS SHELTER SHALL BE LOCATED SUCH THAT: NOT TO ENCROACH UPON THE BOARDING/DEBOARDING AREAS: HINDERING VISIBILITY FOR TRAFFIC FROM NEARBY DRIVEWAYS, LANES, OR ROADS: BLOCKING DOORWAYS OR WINDOWS OF ADJACENT BUILDINGS.
(2) BUS SHELTER PAD SHALL BE EXTENDED TO INCLUDE FRONT DOOR BOARDING AREA AS SPECIFIED BY THE ENGINEER.

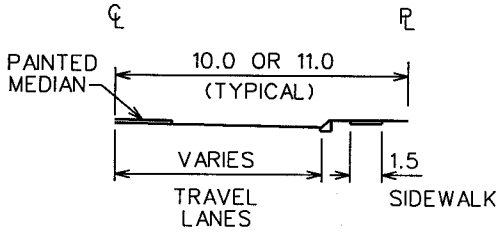
3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1		Title: BUS SHELTER LOCATION AND PAD DETAIL
	Revision Date / Approved	

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

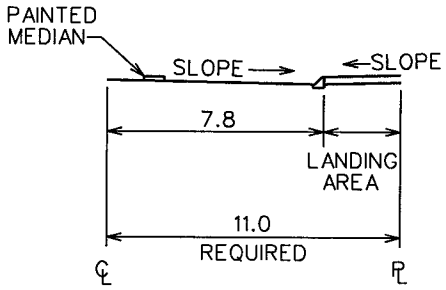
Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-R.25





SECTION A-A



SECTION B-B

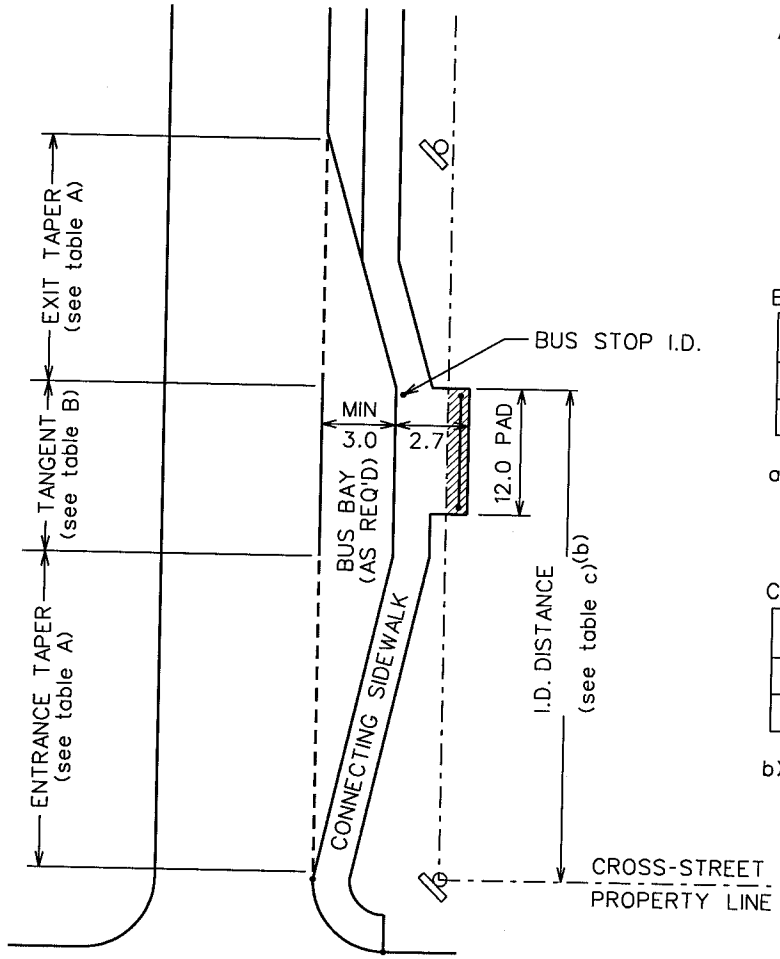
NOTES: (1) REFER TO PAVEMENT MARKING MANUAL FOR ROAD MARKINGS.
(2) REFER TO B.C. TRANSIT TO DETERMINE NEED FOR ENTRANCE TAPER.

3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1		Title: TYPICAL BUS PULL-OFF AND LANDING FOR COLLECTOR ROADS
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-R.26



A) BUS BAY TAPER RATIO

SPEED	ENTRY	EXIT
50 km/h	6:1	4:1
> 50 km/h	8:1	8:1

B) BUS BAY TANGENT

BUS TYPE	LENGTH
STANDARD	15m (a)
ARTICULATED	21m (a)

a) ADD 8m BETWEEN BUSES IF INDEPENDANT DEPARTURE REQUIRED

C) I.D. DISTANCE

BUS MOVEMENT	LENGTH
STRAIGHT THRU	18m
FOLLOWING TURN	26m

b) I.D. DISTANCE APPLIES ONLY IF ENTRY TAPER IS REQUIRED (3)

STATUTORY ROW REQUIRED IF WIDTH EXCEEDS TYPICAL ROAD DEDICATION

NOTES:
1) BUS BAY REQUIRED ON ALL ROADS WITH WITH POSTED SPEED > = 60 km/h
2) BUS BAY REQUIRED ON ALL ROADS WITH 1 LANE PER DIRECTION
3) COAST MOUNTAIN BUS COMPANY TO DETERMINE NEED FOR ENTRANCE TAPER.
4) ADDITIONAL 0.3m LANDING PAD WIDTH REQUIRED IF OBSTRUCTION AT BACK OF PAD.
5) BUS BAY MAY ENCROAH ADJACENT LANE (3.0m MIN. LANE WIDTH) TO MINIMIZE PROPERTY IMPACTS.
6) BUS BAY SEPARATE FROM BIKE LANE PREFERRED WHERE PROPERTY ALLOWS.
7) RB-58B IN CLOSEST PROXIMITY TO INTERSECTING SHOULD BE INSTALLED ON PROPERTY LINE. RB-58R-51L TO BE PLACED AT END OF EXIT TAPER.

3		
2	January 2004	Kok Kuen Li
1	March 2003	B. Fisher
	Revision Date	Approved

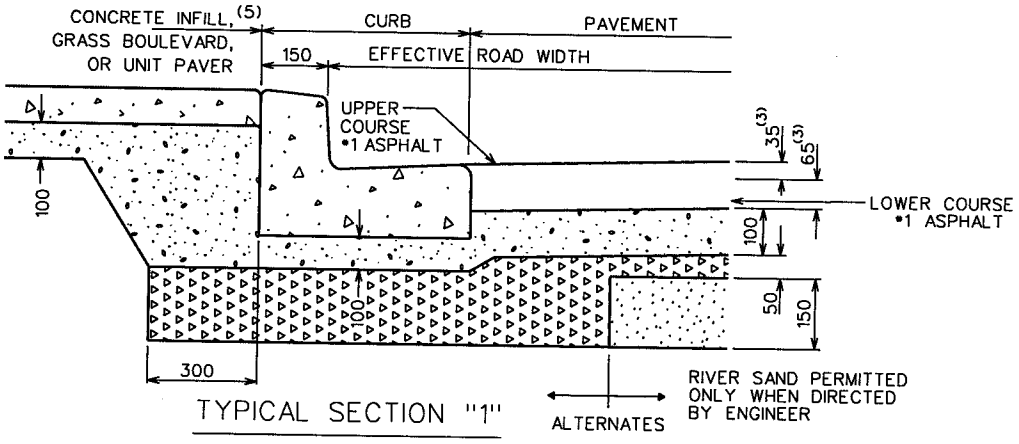
All Dimensions Shown In Metres, Unless Otherwise Noted

Title: TYPICAL BUS BAY STOP

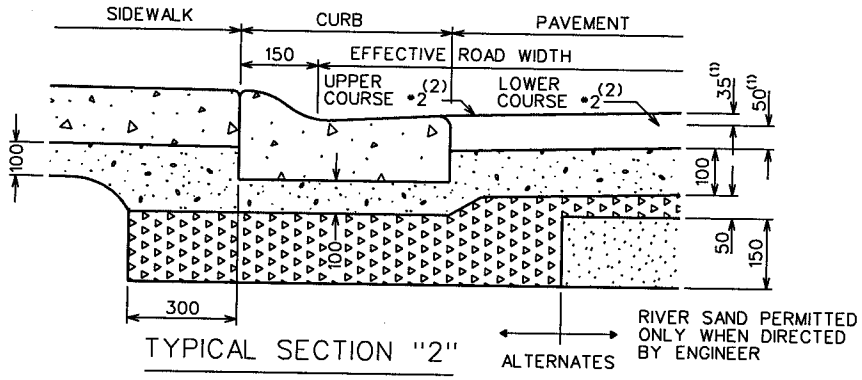
SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

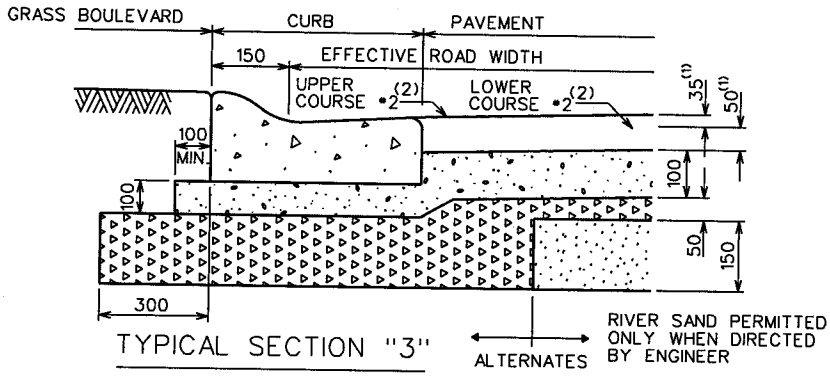
DRAWING NUMBER: SSD-R.27



TYPICAL SECTION "1"



TYPICAL SECTION "2"



TYPICAL SECTION "3"

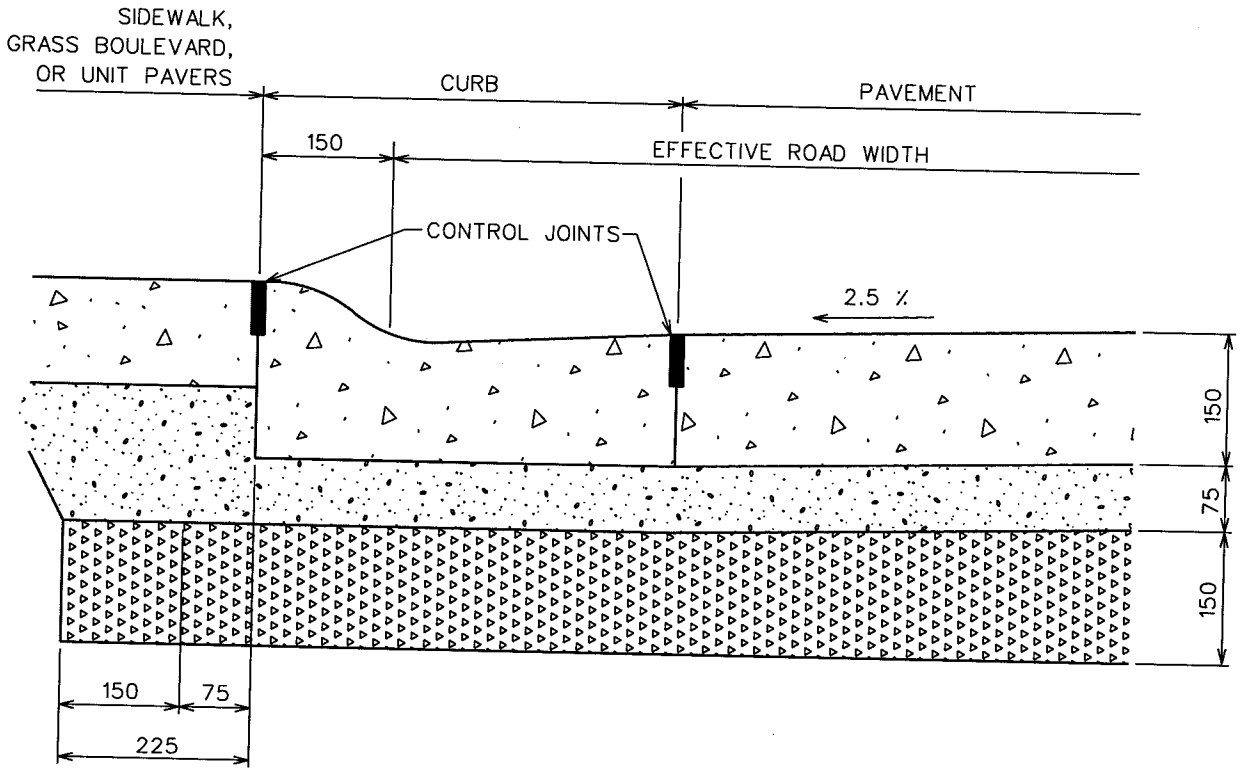
NOTES:
(1) FOR THROUGH AND MAJOR COLLECTOR ROADS THE MINIMUM ASPHALT THICKNESS SHALL BE 35 AND 65 FOR SURFACE AND BASE LAYERS RESPECTIVELY
(2) FOR THROUGH AND MAJOR COLLECTOR ROADS USE LOWER COURSE No.1 AND UPPER COURSE No.1 RESPECTIVELY
(3) FOR LOCAL ROADS IN MULTI-FAMILY ZONE, THE MINIMUM ASPHALT THICKNESS SHALL BE 35 AND 50 FOR SURFACE AND BASE LAYERS RESPECTIVELY
(4) ROADS WITHOUT CURB AND GUTTER SHALL HAVE A MINIMUM PAVEMENT SECTION:
- 100 THICKNESS GRANULAR BASE
- 200 THICKNESS GRANULAR SUBBASE AND
(a) LOCAL AND LIMITED COLLECTOR ROADS: 85 THICKNESS ASPHALT
(b) MAJOR AND THROUGH COLLECTOR AND ARTERIAL ROADS: 100 THICKNESS ASPHALT.
(5) FOR GRASS BOULEVARD, THE CROSS SECTIONS FOR THE BASE AND SUBBASE SHALL BE SIMILAR TO SECTION "3"

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: ASPHALT ROAD CONSTRUCTION WITH MINIMUM PAVEMENT SECTIONS
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.28



3		
2		
1		
	Revision Date	Approved

All Dimensions Shown In Millimetres,
Unless Otherwise Noted

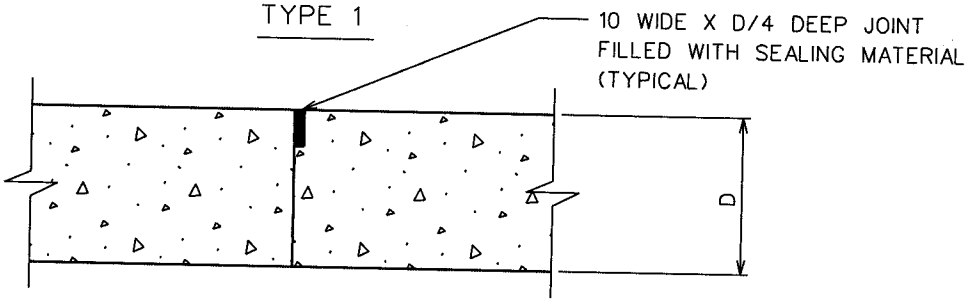
Title TYPICAL CONCRETE ROAD CONSTRUCTION WITH MINIMUM PAVEMENT SECTION

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

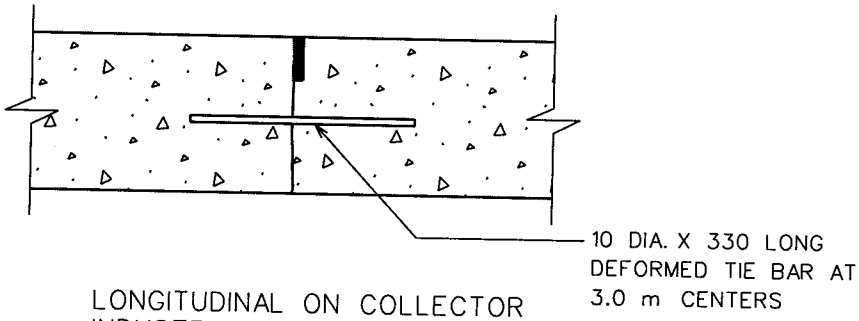
DRAWING NUMBER
SSD-R.29

TYPE 1



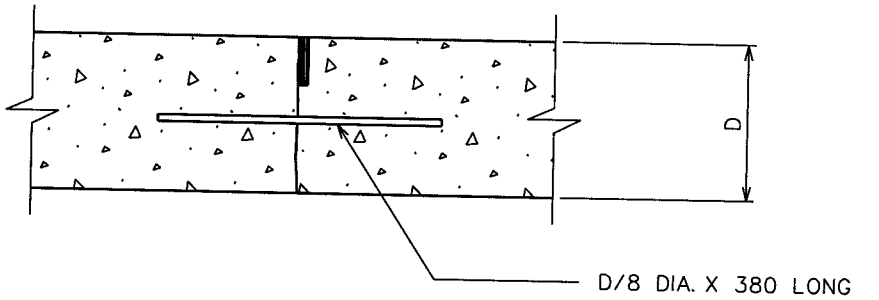
TRANSVERSE AND LONGITUDINAL ON
RESIDENTIAL LOCAL STREETS

TYPE 2



LONGITUDINAL ON COLLECTOR
INDUSTRIAL OR ARTERIAL STREETS

TYPE 3



TRANSVERSE ON COLLECTOR
INDUSTRIAL OR ARTERIAL STREET
AND FOR CONSTRUCTION JOINTS

3		
2		
1		
	Revision Date	Approved

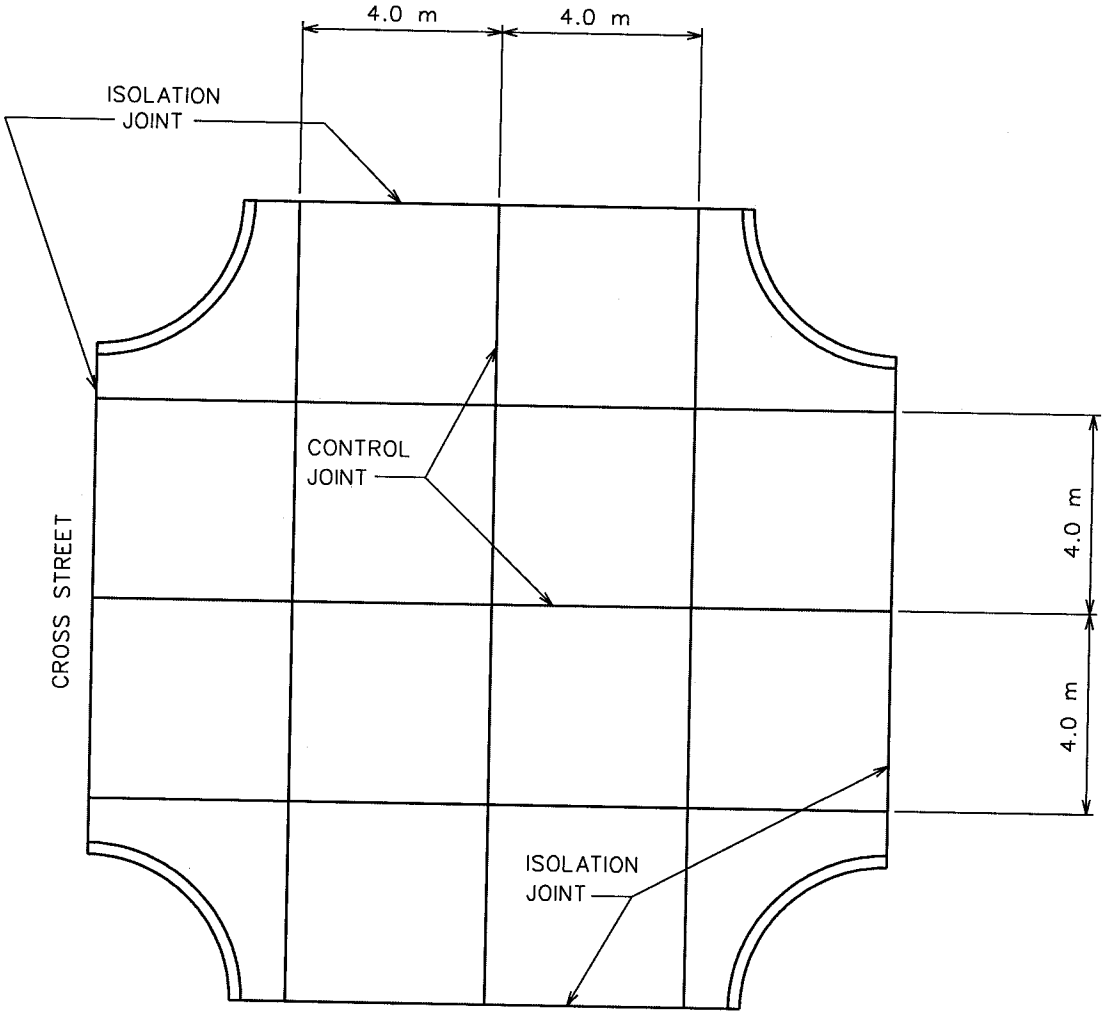
All Dimensions Shown In Millimetres,
Unless Otherwise Noted

Title
CONTROL JOINTS FOR CONCRETE PAVEMENT

SURREY
CITY OF PARKS
SUPPLEMENTARY
STANDARD
DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

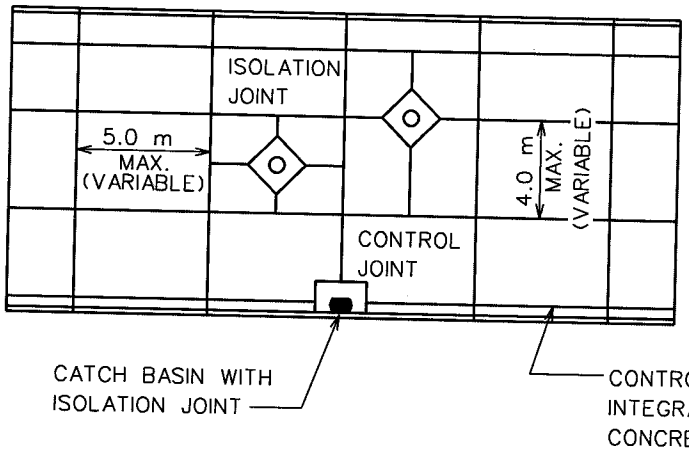
DRAWING NUMBER
SSD-R.30

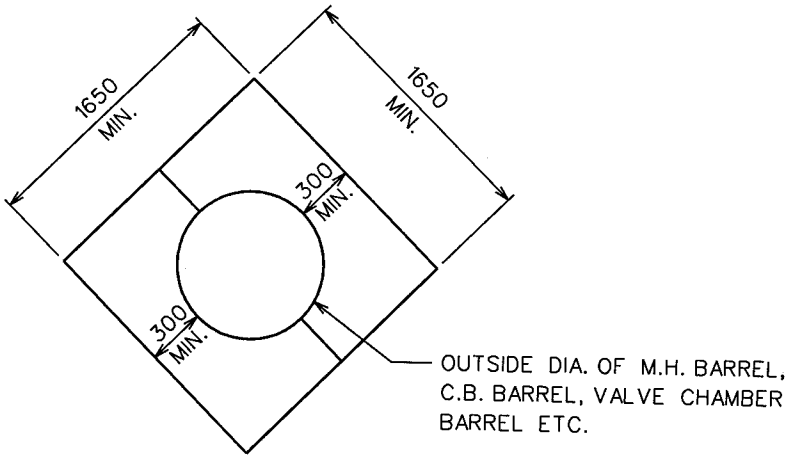


3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1		Title: INTERSECTION JOINT LAYOUT FOR CONCRETE PAVEMENT
	Revision Date / Approved	

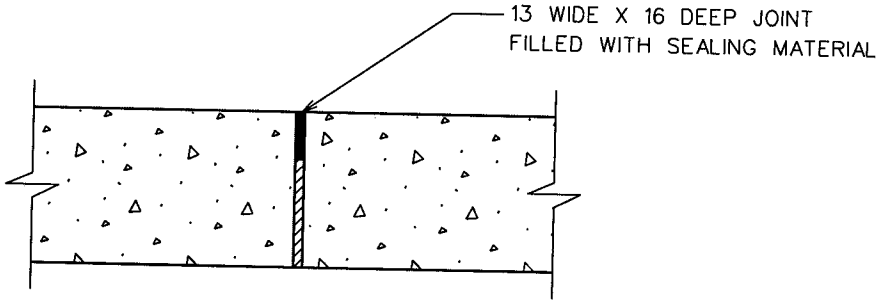
SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-R.31
Drawn By	Surrey Engineering	





STANDARD ISOLATION DETAIL



ISOLATION JOINT
TYPE 1

3		
2		
1		
	Revision Date	Approved

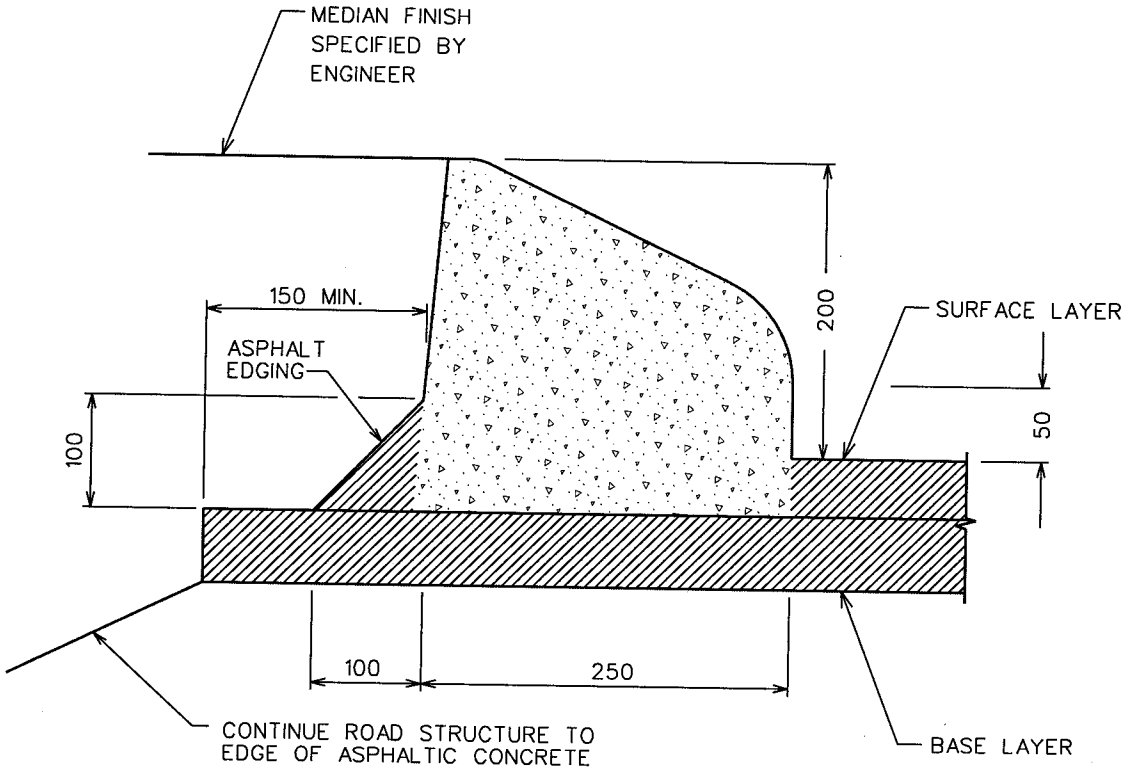
All Dimensions Shown In Millimetres, Unless Otherwise Noted

Title
ISOLATION JOINTS FOR CONCRETE PAVEMENT

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-R.32



NOTE: (1) THIS IS AN ALTERNATIVE TO THE INTERIM CURB SHOWN IN MMCD STANDARD DETAIL DRAWING C6.

3	March 2004	Vince Lalonde
2	January 2004	Kok Kuen Li
1	March 2003	J. Boan
	Revision Date	Approved

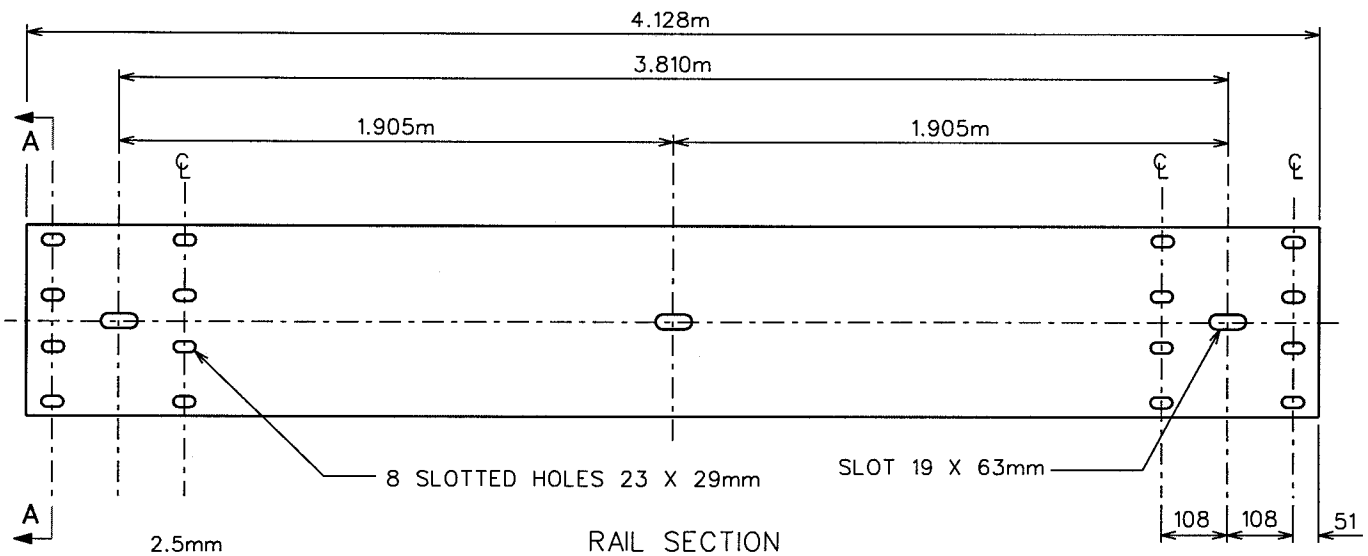
All Dimensions Shown In Millimetres, Unless Otherwise Noted

Title: INTERIM CURB INSTALLATION

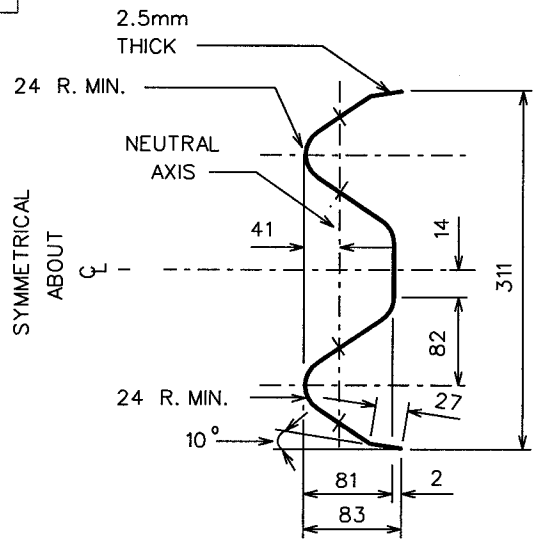
SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

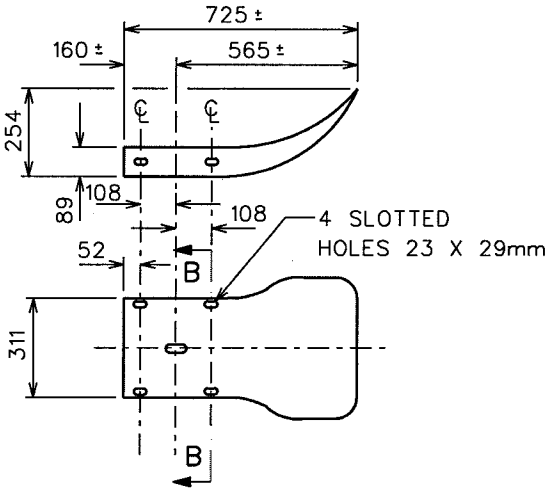
DRAWING NUMBER
SSD-R.33



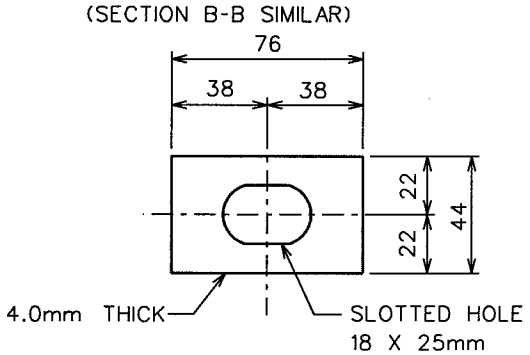
RAIL SECTION



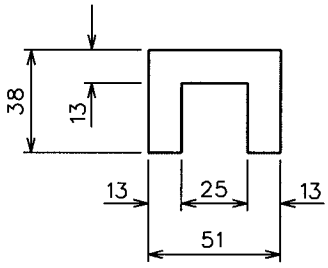
ENLARGED SECTION A-A



TERMINAL SECTION



RECTANGULAR WASHER



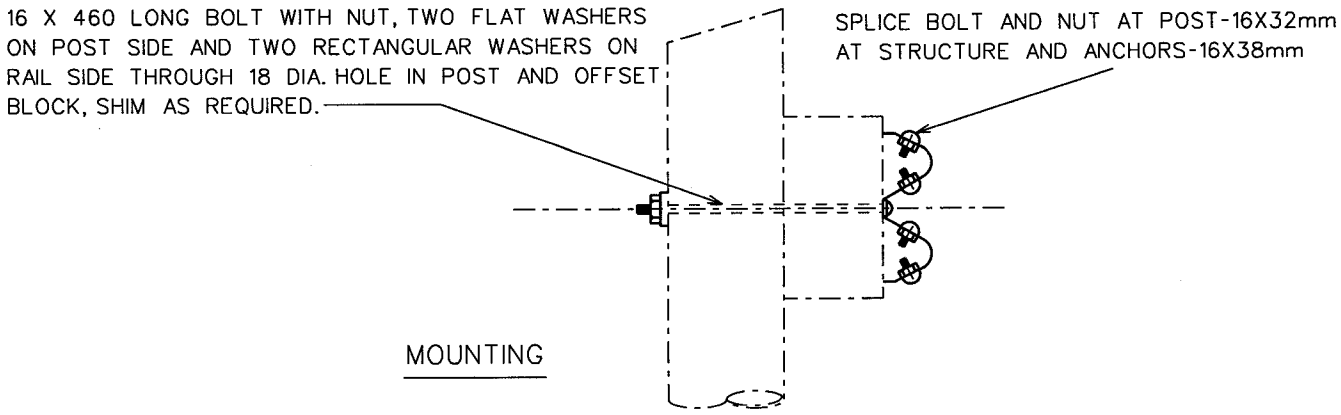
SHIM

NOTE: (1) ALL METAL TO BE GALVANIZED FINISH

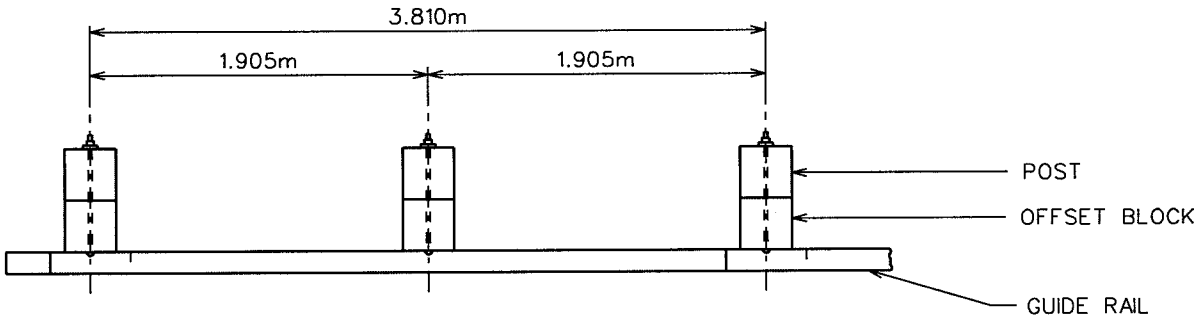
3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: GUIDE RAIL
	Revision Date / Approved	

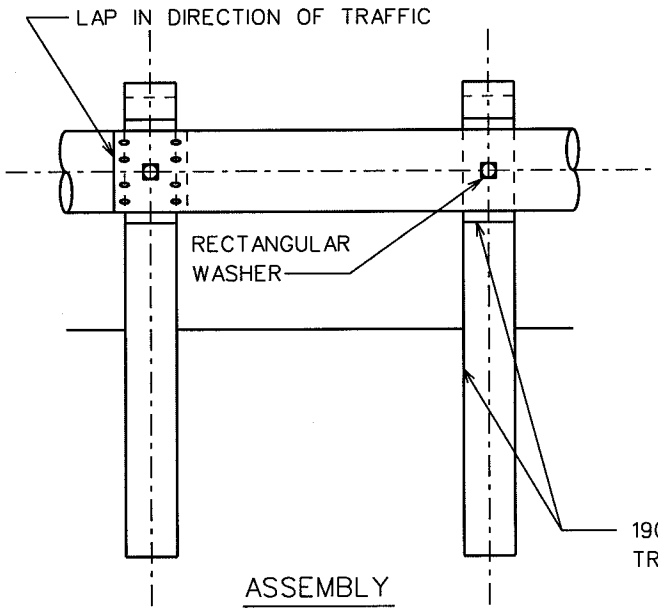
SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-R.38
Drawn By	Surrey Engineering	

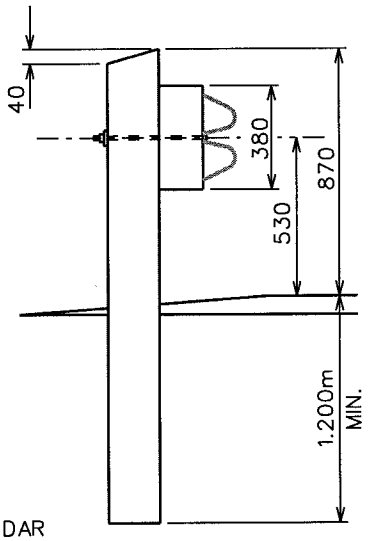


MOUNTING





ASSEMBLY



NOTE: (1) ALL METAL TO BE GALVANIZED FINISH

3		
2		
1		
	Revision Date	Approved

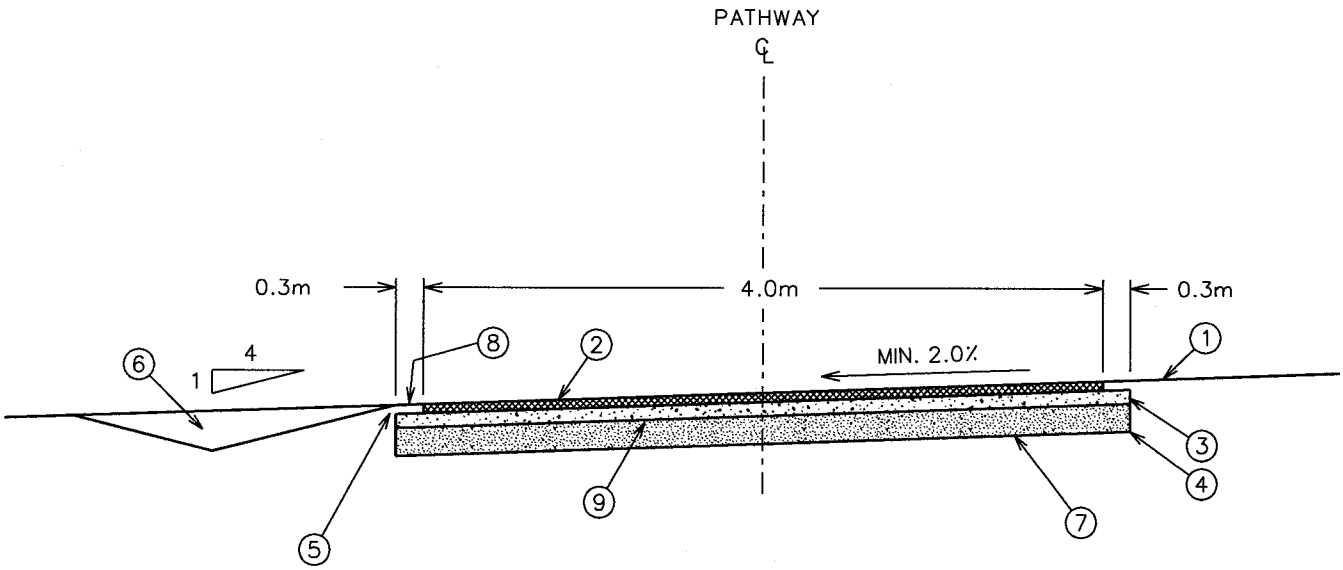
All Dimensions Shown In Millimetres, Unless Otherwise Noted

Title: GUIDE RAIL - ASSEMBLY & MOUNTING

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-R.39

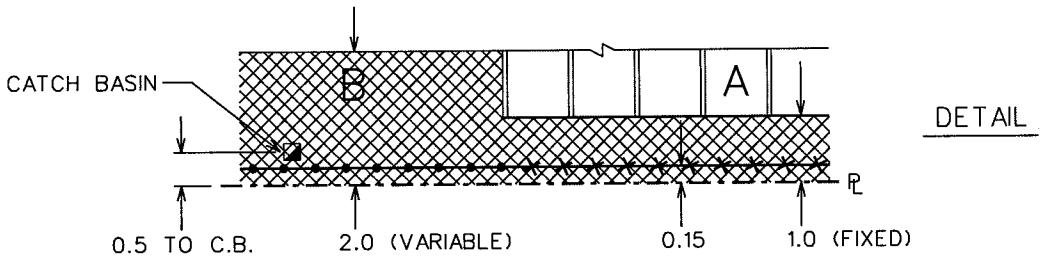


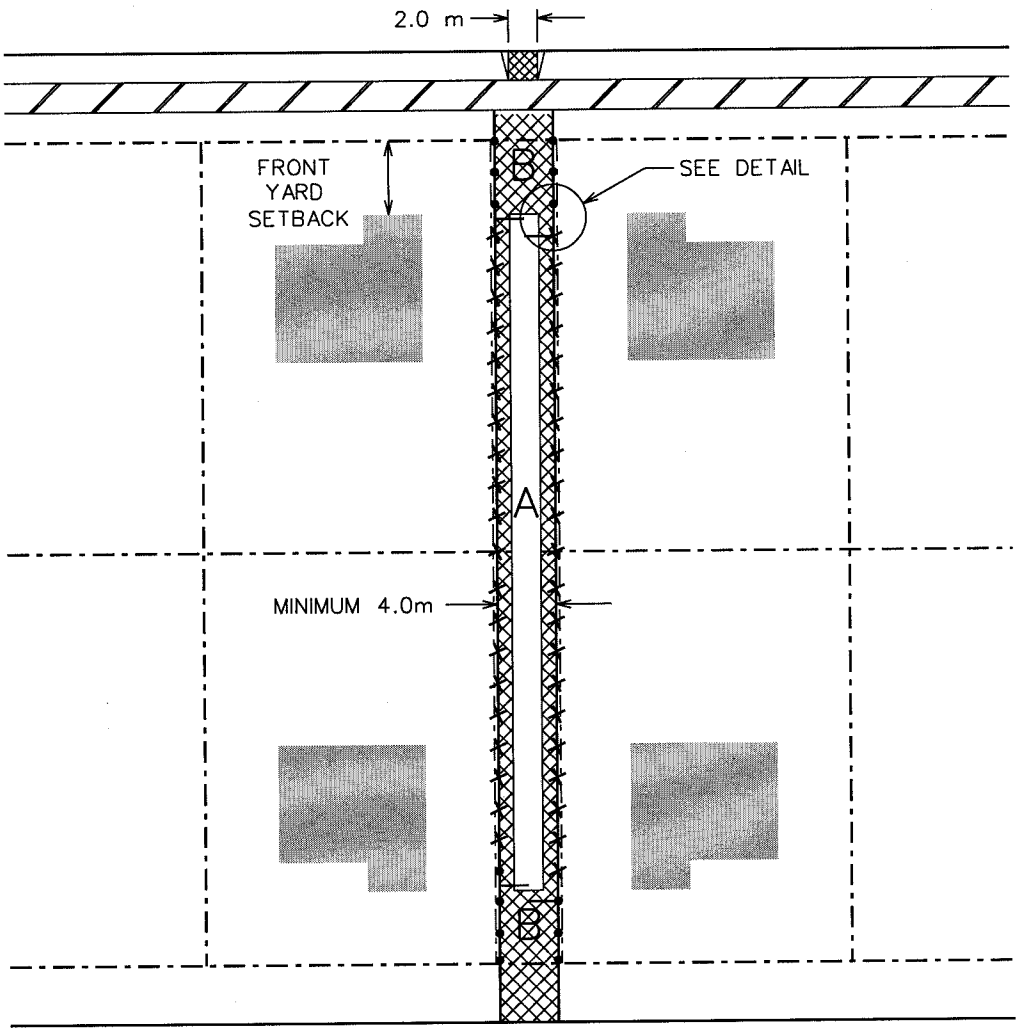
1. EXISTING GROUND.
2. 50mm ASPHALT.
3. 75mm GRANULAR BASE (19mm MINUS) UNDER PROPOSED ASPHALT COMPACTED TO 95% MODIFIED PROCTOR DENSITY.
4. STRIPPING ZONE - STRIPPING DEPTH TO BE VARIABLE AND BASED ON ENGINEER'S RECOMMENDATIONS ON SITE. REPLACE WITH SELECT GRANULAR SUBBASE (75mm MINUS) COMPACTED TO 95% MODIFIED PROCTOR DENSITY.
5. APPROVED SUB-GRADE COMPACTED TO 95% MODIFIED PROCTOR DENSITY.
6. DITCH (0.25m MIN. DEPTH TYP.) EXISTING TOPSOIL TO BE HYDROSEEDED.
7. GEOTEXTILE (NILEX No. C-14 OR EQUIVALENT) (SEE STRIPPING NOTES ON PROFILE).
8. SHOULDERS TO CONSIST OF PREVIOUSLY STRIPPED TOPSOIL (HYDROSEEDED).
9. 4 mil BLACK POLYETHYLENE.

3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1		Title: 4.0 m MULTI-USE PATHWAY
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-R.40
Drawn By	Surrey Engineering	





×-×-×-×-×	1.2 m HIGH CHAIN LINK FENCE (SSD-R.57)
●-●-●-●-●	POST AND CHAIN FENCE (SSD-R.59)
A	TYPICAL SIDEWALK
B	STAMPED / COLORIZED SIDEWALK
|	BAFFLE GATE (SSD-R.40.2)
—·—·—	PROPERTY LINE

NOTE: (1) ASPHALT OR CONCRETE FOR A AND B AS SPECIFIED BY THE PLANNER.
(2) REFER TO SSD-R.51 FOR CONCRETE SIDEWALK SECTION.
(3) REFER TO SSD-R.54 FOR ASPHALT SIDEWALK SECTION.

3		
2	March 2004	Kok Kuen Li
1	January 2004	Kok Kuen Li
	Revision Date	Approved

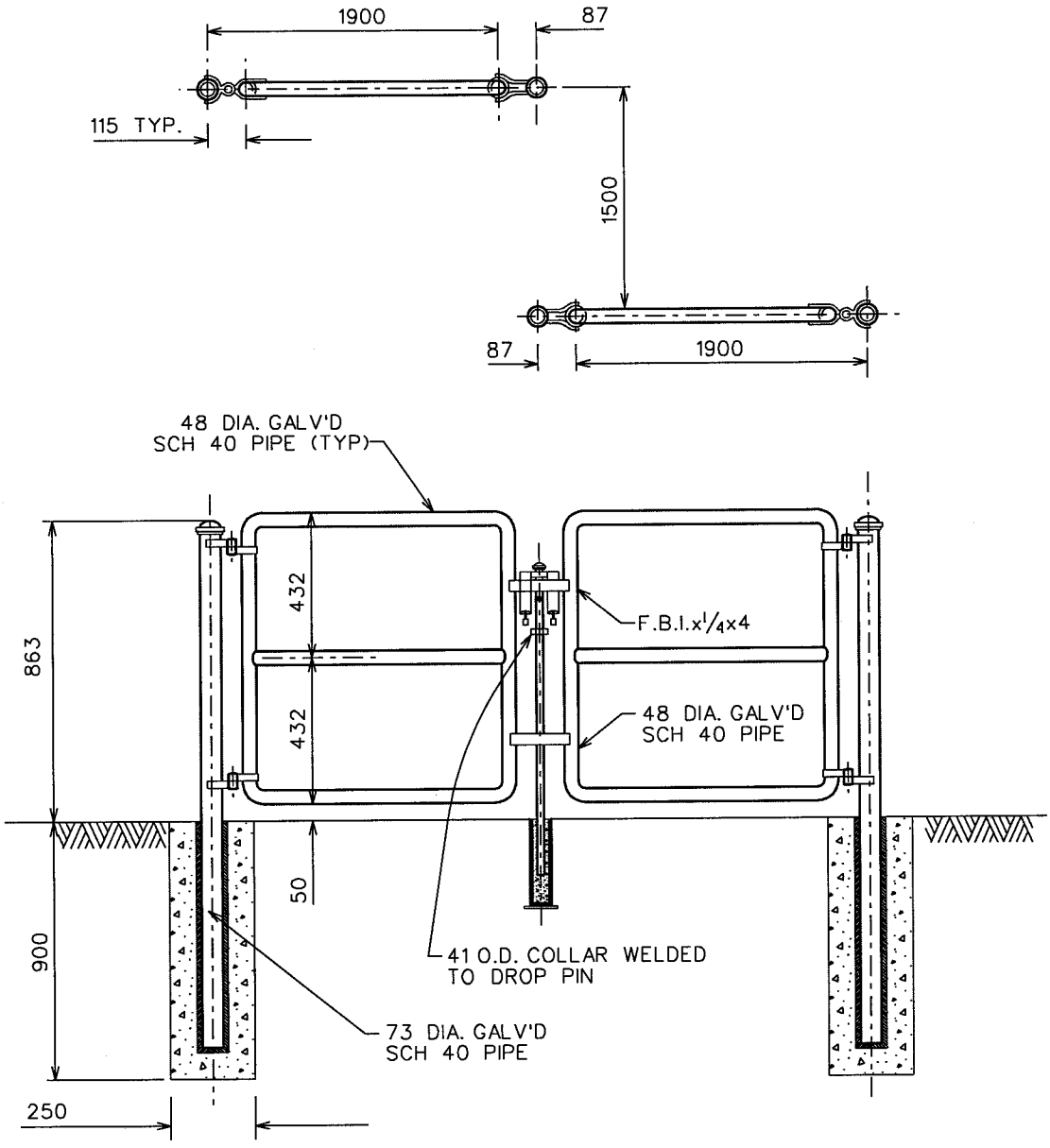
All Dimensions Shown In Metres, Unless Otherwise Noted

Title: TYPICAL ENGINEERING WALKWAY OR EMERGENCY ACCESS R.O.W.

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.40.1



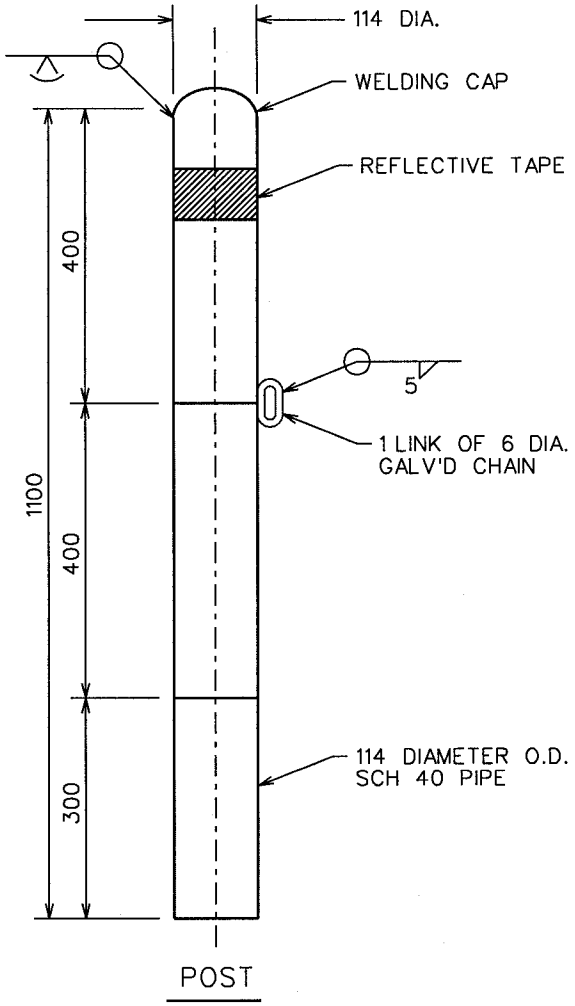
NOTE: (1) ALL JOINTS SEAL-WELDED AND PAINTED WITH ZINC RICH PAINT.

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: BAFFLE GATE
	Revision Date Approved	

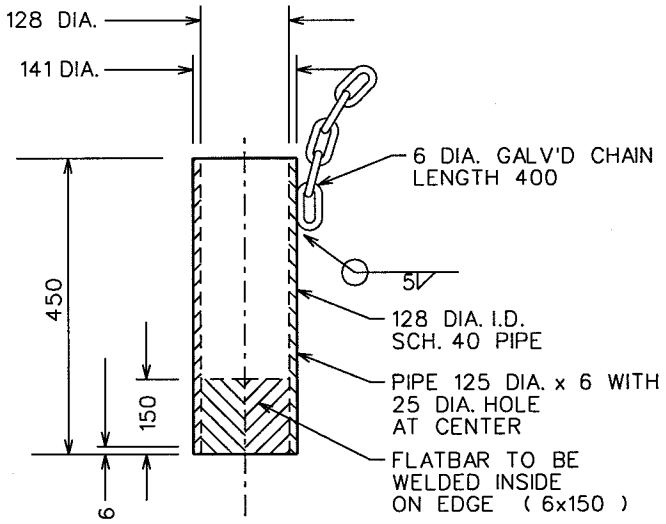
SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

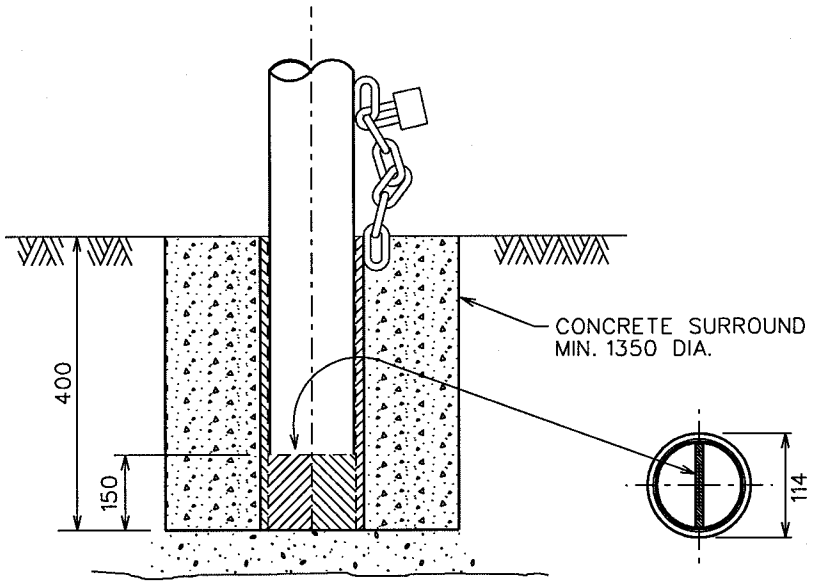
DRAWING NUMBER: SSD-R.40.2



POST



SLEEVE



ASSEMBLY

NOTE: (1) FINISH POWDER COATED WHITE.

3		
2		
1		
	Revision Date	Approved

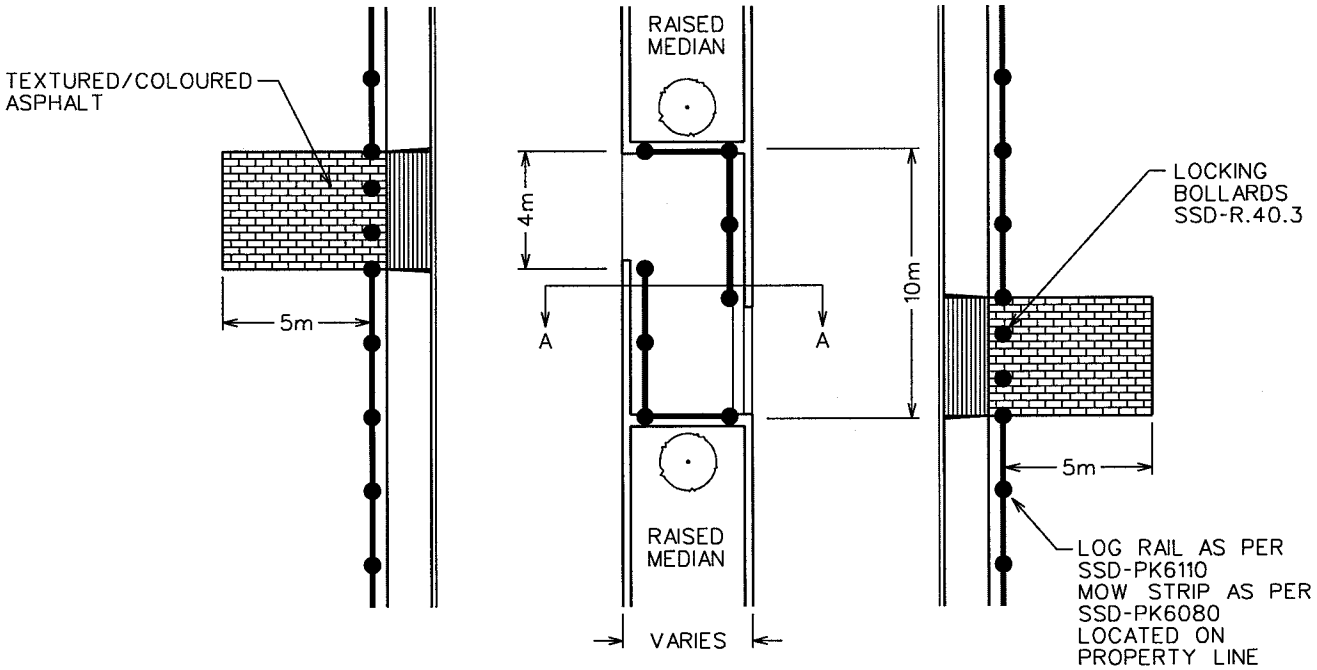
All Dimensions Shown In Millimetres,
Unless Otherwise Noted

Title: LOCKING POST

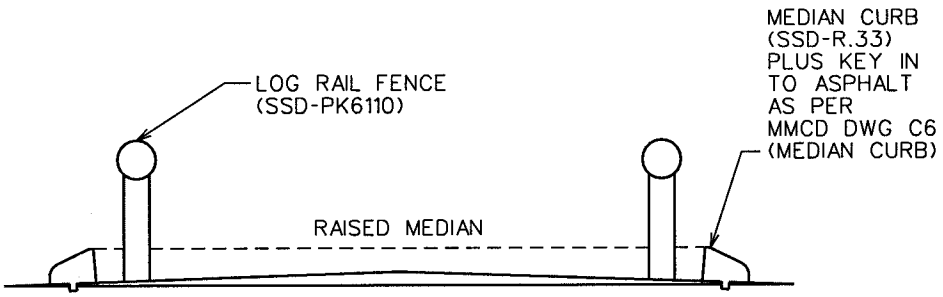
SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

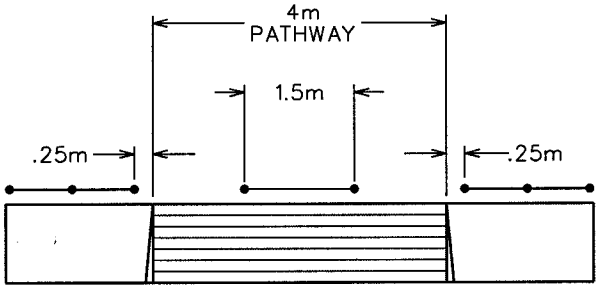
DRAWING NUMBER
SSD-R.40.3



MEDIAN CROSSING
CROSS SECTION A-A



MEDIAN CROSSING
CROSS SECTION A-A



BOLLARD LOCATION DETAIL

NOTE: 1. DRAINAGE FEATURES IN THE MEDIAN AS REQUIRED.

3	March 2004	Kok Kuen Li
2	January 2004	Kok Kuen Li
1	March 2003	B. Fisher
	Revision Date	Approved

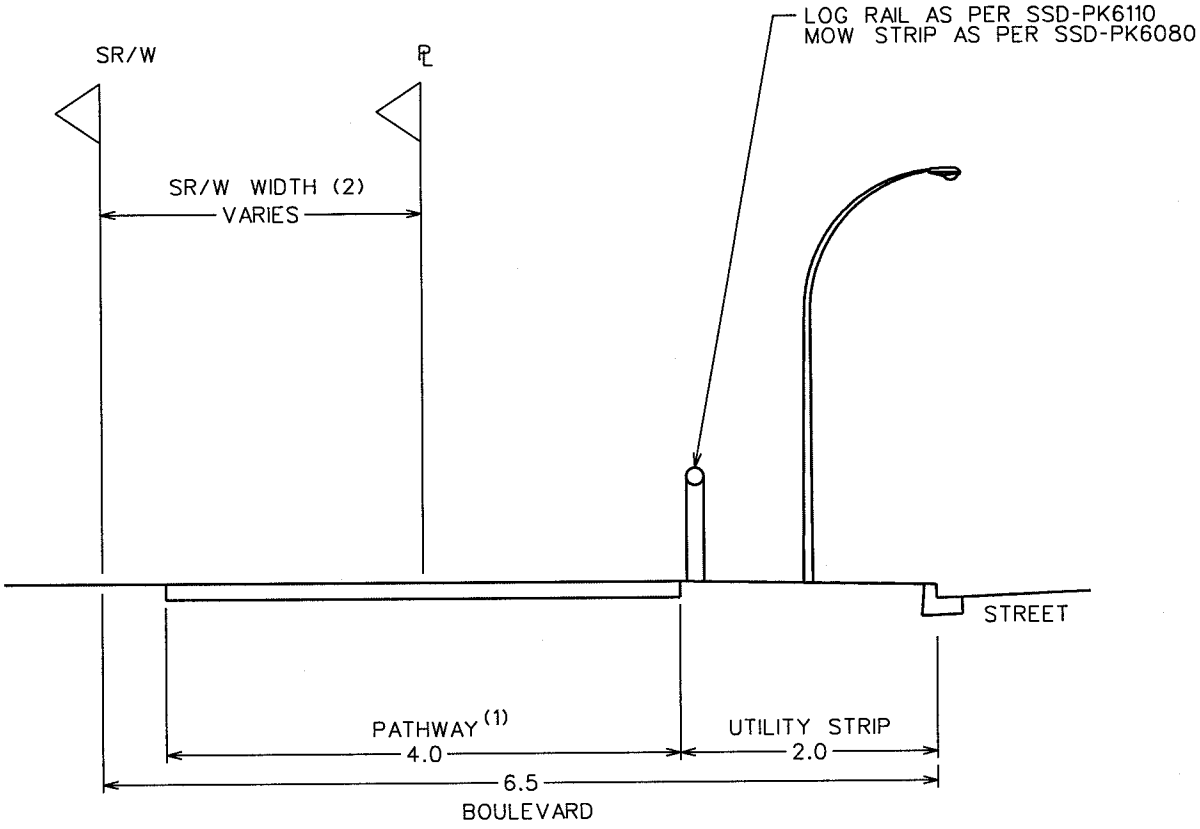
All Dimensions Shown In Millimetres, Unless Otherwise Noted

Title: MEDIAN STYLE BICYLE CROSSING

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	March 2003
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-R.40.4



NOTES:

(1) PATHWAY MAY CONSIST OF 4.0m ASHPALT PATHWAY (SSD-R.40) OR 1.5m CONCRETE SIDEWALK PLUS 2.5m ASPHALT PATHWAY AS SPECIFIED BY THE ENGINEER.

(2) STATUTORY RIGHT-OF-WAY (SR/W) REQUIRED IF BOULEVARD WIDTH EXCEEDS TYPICAL ROAD DEDICATION AS SPECIFIED BY THE ENGINEER / APPROVING OFFICER.

(3) ADDITIONAL SR/W WIDTH MAY BE REQUIRED AS SPECIFIED WITHIN NCP DOCUMENTS.

(4) LOCKING BOLLARDS AS PER SSD-R.40.3 REQUIRED AT INTERSECTIONS / DRIVEWAYS.

3		
2	January 2004	Kok Kuen Li
1	March 2003	B. Fisher
	Revision Date	Approved

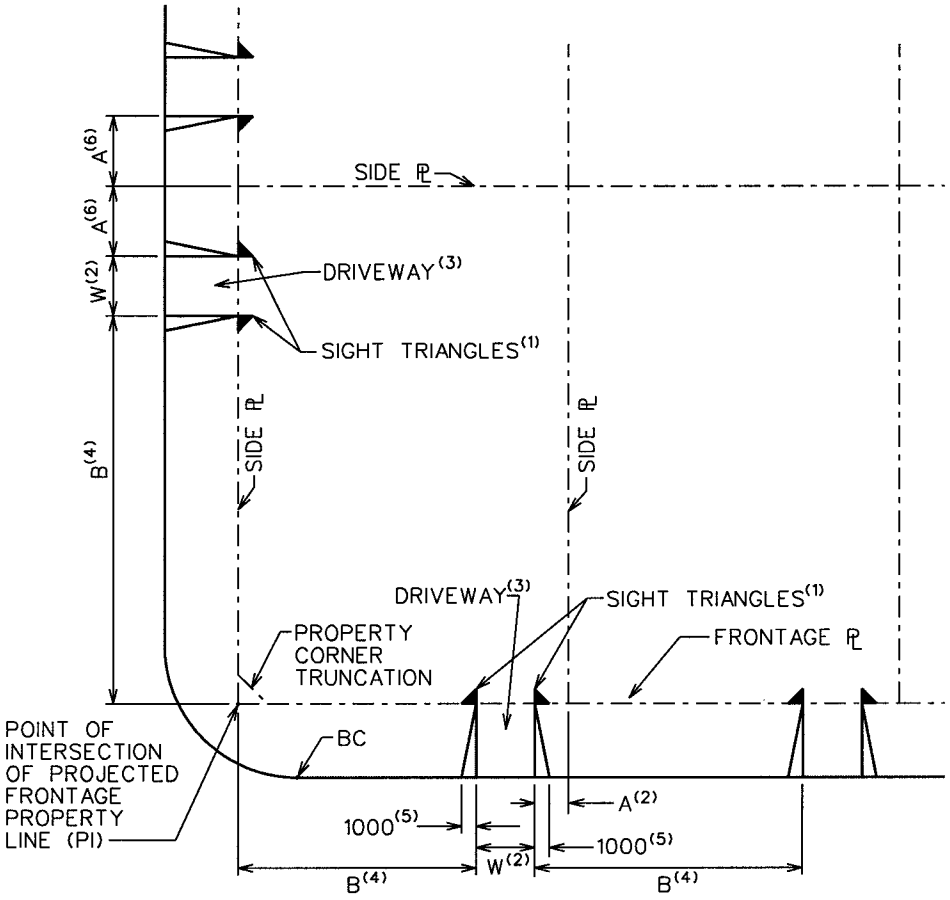
All Dimensions Shown In Metres,
Unless Otherwise Noted

Title: "NEXT TO ROAD " PATHWAY

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-R.40.5



NOTES: (1) SIGHT TRIANGLE: - 1.0 m X 1.0 m FOR SINGLE RESIDENTIAL ZONES
- USE TAC GEOMETRIC DESIGN DESIGN GUIDE FOR CANADIAN ROADS, 1999 EDITION, SECTION 2.3.3 FOR OTHERS.
- OBSTRUCTION TO SIGHT (EG. LANDSCAPE, FENCES, SIGNS, ETC.) SHALL NOT BE HIGHER THAN 0.5m WITHIN THE SIGHT TRIANGLE.

(2) FOR DIMENSION OF 'W' AND 'A', SEE TABLE ON SSD-R.42

(3) FOR CORNER LOTS IN SINGLE FAMILY ZONE, DRIVEWAYS SHALL BE LOCATED NEAR SIDE PROPERTY LINE AND AWAY FROM INTERSECTION.

(4) 'B' SHALL BE MIN. 9.0 m FOR LOCAL ROADS, 25.0m FOR COLLECTOR ROADS AND 50.0m FOR ARTERIAL ROADS.

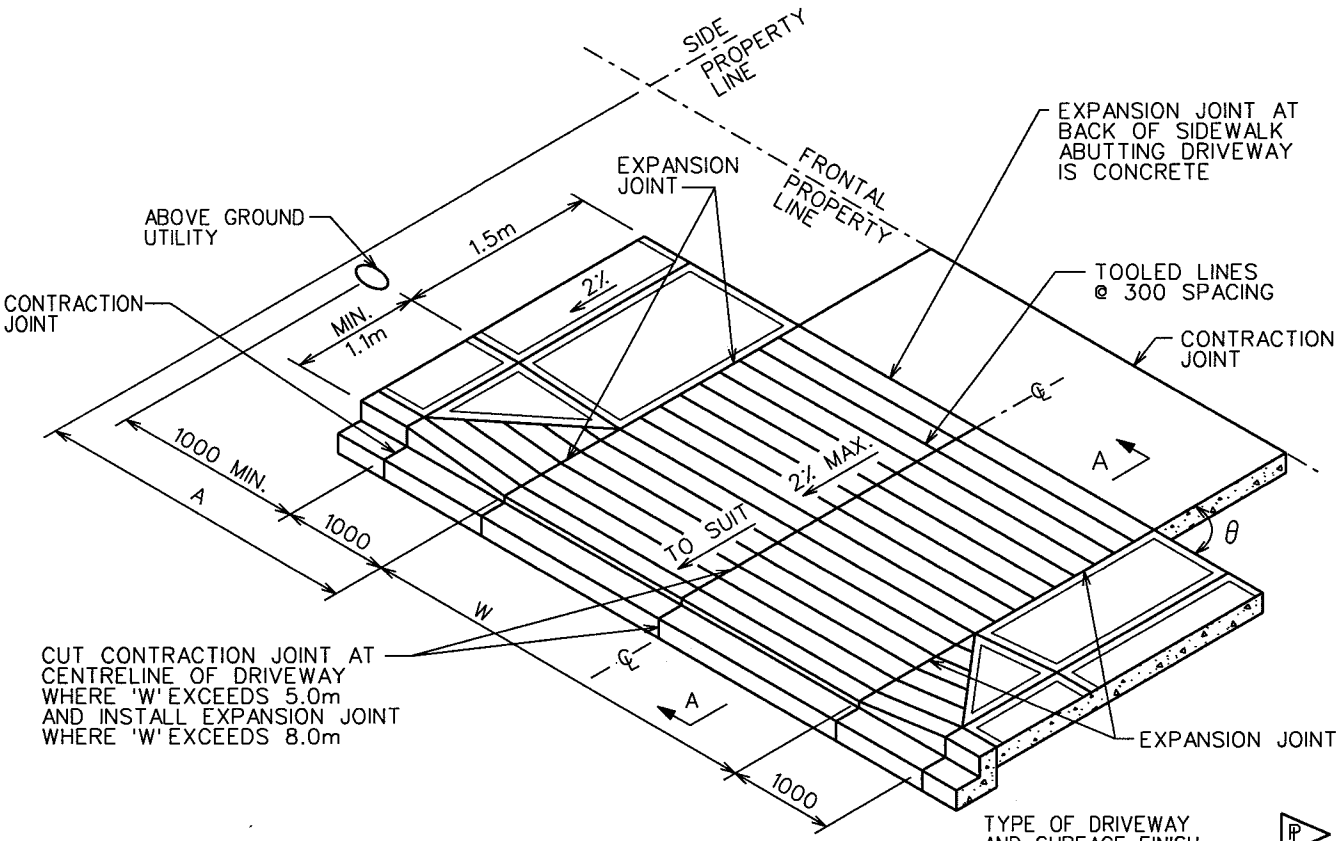
(5) THE FLARE IS NOT REQUIRED FOR ROLLOVER CURBS. FLARE IS NOT REQUIRED WHERE GRASS / LANDSCAPING ABUTS A RESIDENTIAL DRIVEWAY. FLARE NOT PERMITTED WITH PAIRED RESIDENTIAL DRIVEWAYS EXCEPT WHERE SIDEWALK ABUTS THE CURB TO MATCH EXISTING STANDARD.

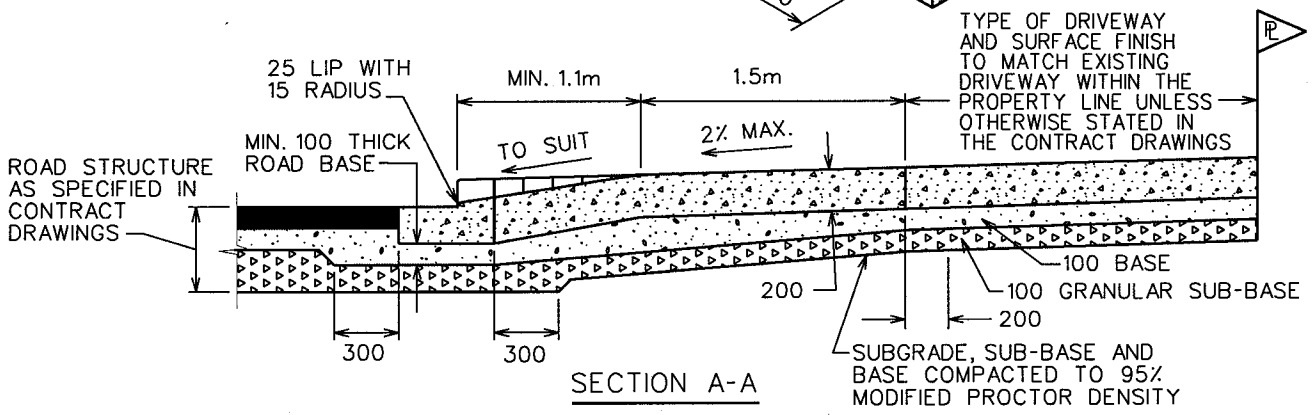
(6) FOR SINGLE RESIDENTIAL ZONE DRIVEWAYS THE SPACING SHALL BE MIN. 'A' ON EACH SIDE OF THE PROPERTY LINE BETWEEN DRIVEWAYS, FOR ALL OTHER ZONES, SPACING BETWEEN SUCCESSIVE DRIVEWAYS SHALL BE 'B'.

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1	MARCH 2002	Title: DRIVEWAY CROSSING LOCATIONS
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-R.41
Drawn By	Surrey Engineering	





SECTION A-A

ZONE	DRIVEWAY TYPE	W		A	θ-MIN. ANGLE BTWN. THE FRONTAGE PROP. LINE AND THE EDGE OF DRIVEWAY (DEG.)
		MIN. (m)	MAX. (m)	MIN. DISTANCE FROM SIDE PROPERTY LINE (m)	
COMMERCIAL	TWO WAY	7.3	9.0 (EXCLUDING MEDIAN)	2.0	90
	ONE WAY	4.0	6.0	2.0	45
INDUSTRIAL	TWO WAY	7.3	11.0 (EXCLUDING MEDIAN)	2.0	90
	ONE WAY	4.0	7.3	2.0	30

NOTE: (1) DRIVEWAYS SHOWN ORIENTED AT 90 °TO CURB UNLESS SPECIFIED OTHERWISE ON CONTRACT DRAWINGS.

3	March 2004	Kok Kuen Li
2	January 2004	Kok Kuen Li
1	March 2002	
	Revision Date	Approved

All Dimensions Shown In Millimetres, Unless Otherwise Noted

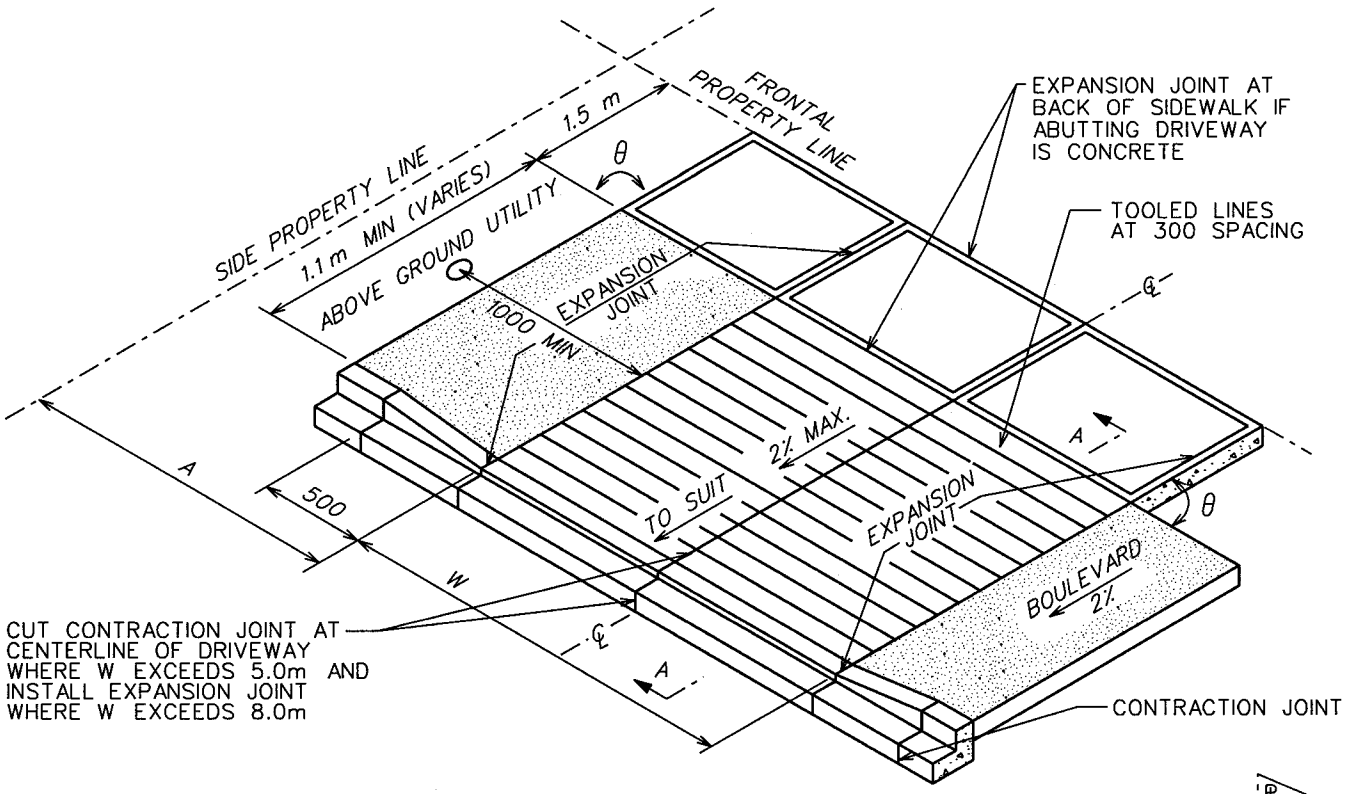
Title: COMMERCIAL/INDUSTRIAL LETDOWN DRIVEWAY

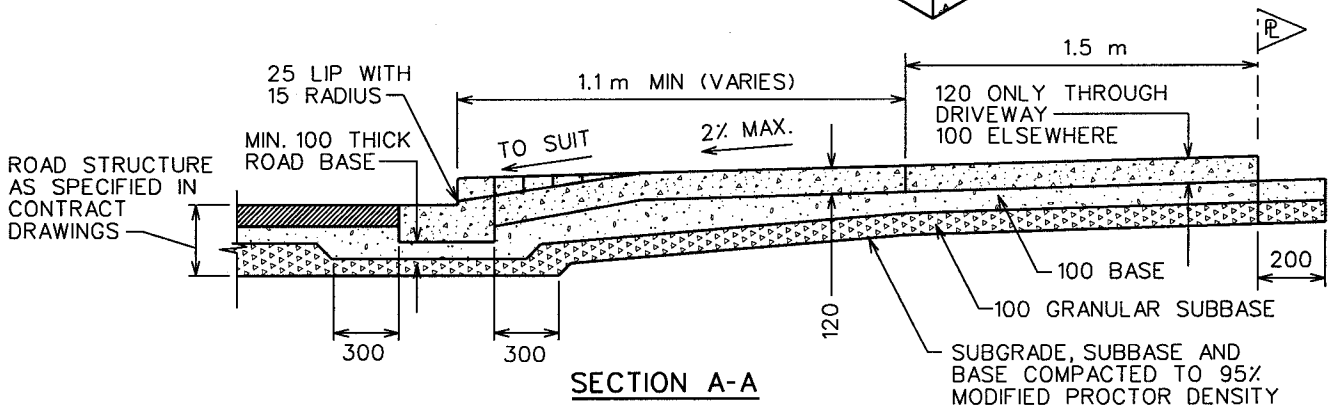
SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	FEBRUARY 2002
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.42

G:\MAPPING\CAD\STANDARDS2003\ROAD_WORKS\Roads DGN\R.42.0.DGN





SECTION A-A

ZONE	DRIVEWAY TYPE	W		A	θ-ANGLE OF INTERSECTION
		MIN. (m)	MAX. (m)	MIN. DISTANCE FROM SIDE PROPERTY LINE (m)	
SINGLE (4) FAMILY RESIDENTIAL	RF12 TYPE 1	3.5	4.5	0	90
	RF12 TYPE 2	4.5	5.5	1.2	90
	OTHER	4.5	6.0(2)	1.2(3)	90
MULTI-FAMILY RESIDENTIAL	TWO WAY	6.0	9.0 (EXCLUDING MEDIAN)	2.0	90
	ONE WAY	4.0	6.0	2.0	45

NOTES:
1. DRIVEWAYS SHOWN ORIENTED AT 90° TO CURB UNLESS SPECIFIED OTHERWISE ON CONTRACT DRAWINGS.
2. DRIVEWAY WIDTH MAY BE INCREASED TO 8.0m MAX. FOR LOTS WITH THREE CAR GARAGES PROVIDED NOT MORE THAN 33% OF THE FRONT YARD SETBACK IS PAVED.
3. DRIVEWAY OFFSET MUST NOT BE LESS THAN THE SIDEYARD SETBACK FOR THE LOT.
4. ALL NEW SINGLE FAMILY RESIDENTIAL DEVELOPMENTS WITH BARRIER CURB SHALL CONSTRUCT LETDOWNS TO THE MAXIMUM WIDTH.

	Revision Date	Approved
3	March 2004	Kok Kuen Li
2	January 2004	Kok Kuen Li
1	February 2002	

All Dimensions Shown In Millimetres, Unless Otherwise Noted

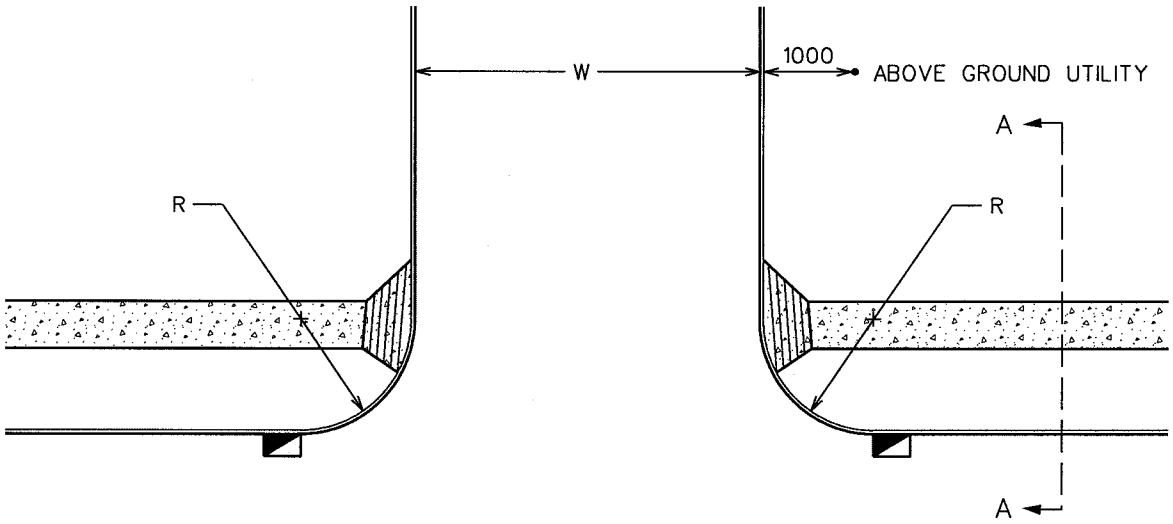
Title: RESIDENTIAL LETDOWN DRIVEWAY

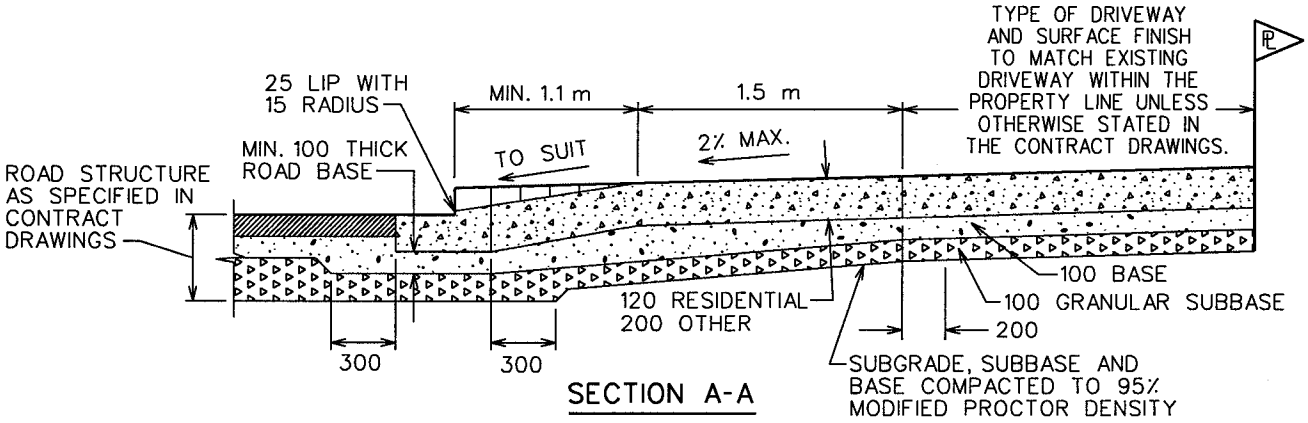
SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	September 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.42.1

G:\MAPPING\CAD\STANDARDS2003\ROAD WORKS\Roads DGN\R.42.1.DGN





SECTION A-A

ZONE	DRIVEWAY TYPE	W		A	θ-MIN. ANGLE BTWN. THE FRONTAGE PROP. LINE AND THE EDGE OF DRIVEWAY (DEG.)	R	
		MIN. (m)	MAX. (m)	MIN. DISTANCE FROM SIDE PROPERTY LINE (m)		MIN.	MAX.
MULTI-RESIDENTIAL, MOBILE HOME RESIDENTIAL, 'P' ZONE AND COMMERCIAL ZONES	TWO WAY	6.0(2)	9.0 (EXCLUDING MEDIAN)	2.0	90	7.0	9.0
	ONE WAY	4.0	6.0		45		
INDUSTRIAL ZONE	TWO WAY	7.3	11.0 (EXCLUDING MEDIAN)	2.0	90	7.0	12.0
	ONE WAY	4.0	7.3		30		

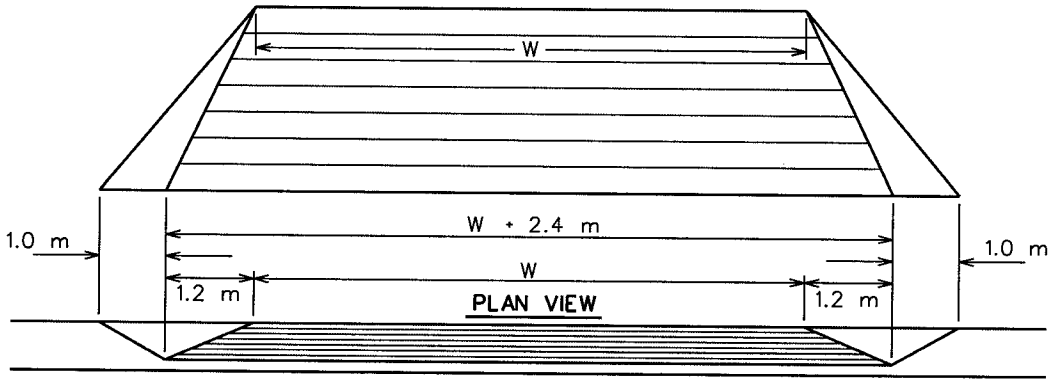
NOTE: (1) DRIVEWAYS SHOWN ORIENTED AT 90° TO CURB UNLESS SPECIFIED OTHERWISE ON CONTRACT DRAWINGS.

(2) MINIMUM 7.3m FOR COMMERCIAL DRIVEWAY.

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1	MARCH 2002	Title: CURB RETURN DRIVEWAY CROSSING
	Revision Date / Approved	

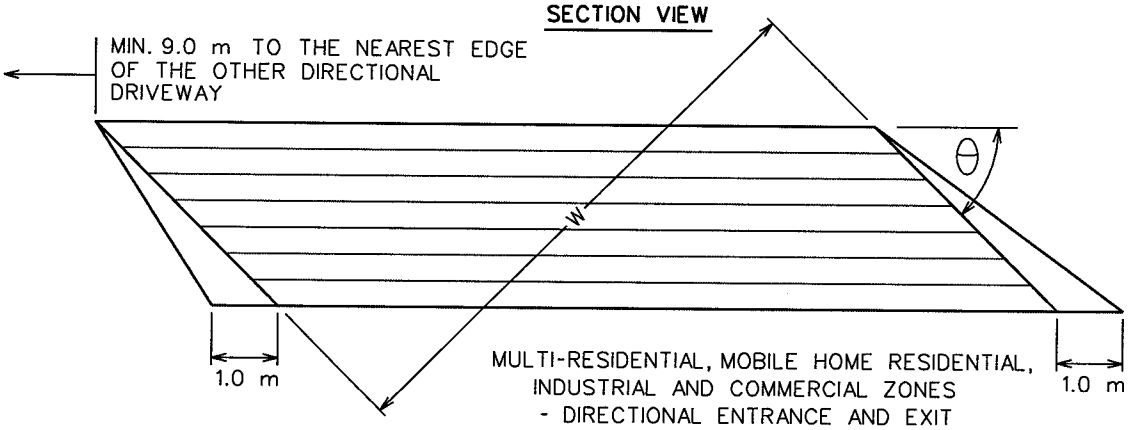
SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	September 1998	SSD-R.42.2
Drawn By	Surrey Engineering	

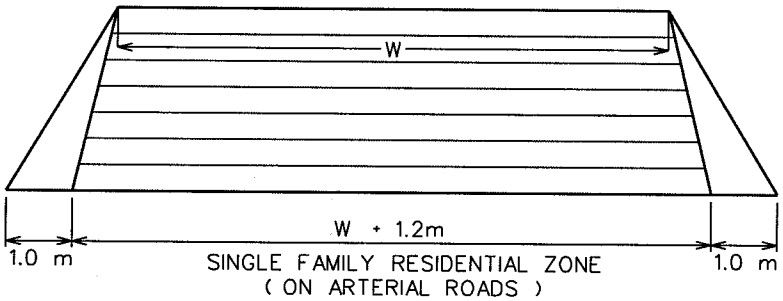


MULTI-RESIDENTIAL, MOBILE HOME RESIDENTIAL,
INDUSTRIAL AND COMMERCIAL ZONES

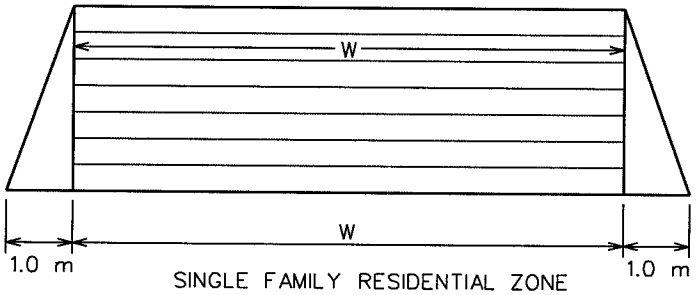
SECTION VIEW



MULTI-RESIDENTIAL, MOBILE HOME RESIDENTIAL,
INDUSTRIAL AND COMMERCIAL ZONES
- DIRECTIONAL ENTRANCE AND EXIT



SINGLE FAMILY RESIDENTIAL ZONE
(ON ARTERIAL ROADS)



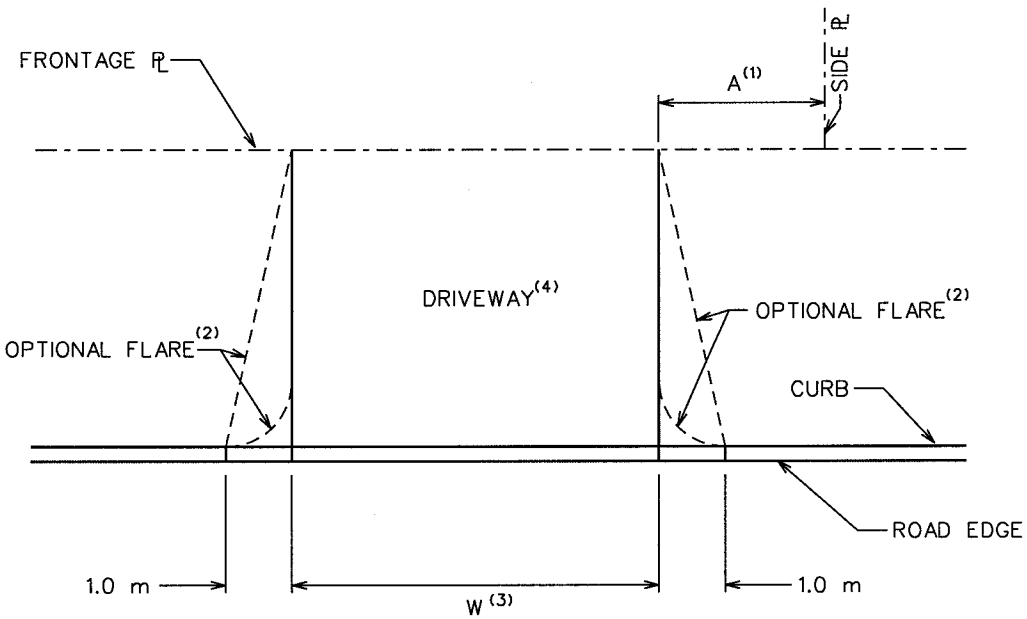
SINGLE FAMILY RESIDENTIAL ZONE
(ON LOCAL AND COLLECTOR ROADS)

NOTE: (1) DRIVEWAYS SHOWN ORIENTED AT 90° TO CURB UNLESS SPECIFIED OTHERWISE.
(2) NO DRIVEWAY FLARES WITH PAIRED DRIVEWAYS.

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1	FEBRUARY 2002	Title: DRIVEWAY CROSSING FOR BARRIER CURBS - DIMENSION DETAILS
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-R.43
Drawn By	Surrey Engineering	



NOTES:

(1) SEE TABLE ON SSD-R.42 DRIVEWAY CROSSING FOR BARRIER CURBS FOR MINIMUM DISTANCE FROM SIDE PROPERTY LINE.

(2) FLARE IS OPTIONAL. THIS FLARE IS NOT ALLOWED FOR SINGLE FAMILY ZONES ON LOCAL OR COLLECTOR ROADS.

(3) SEE TABLE ON SSD-R.42 DRIVEWAY CROSSING FOR BARRIER CURBS FOR WIDTH OF DRIVEWAY.

(4) NO LETDOWN FOR DRIVEWAY.

3		
2		
1		
	Revision Date	Approved

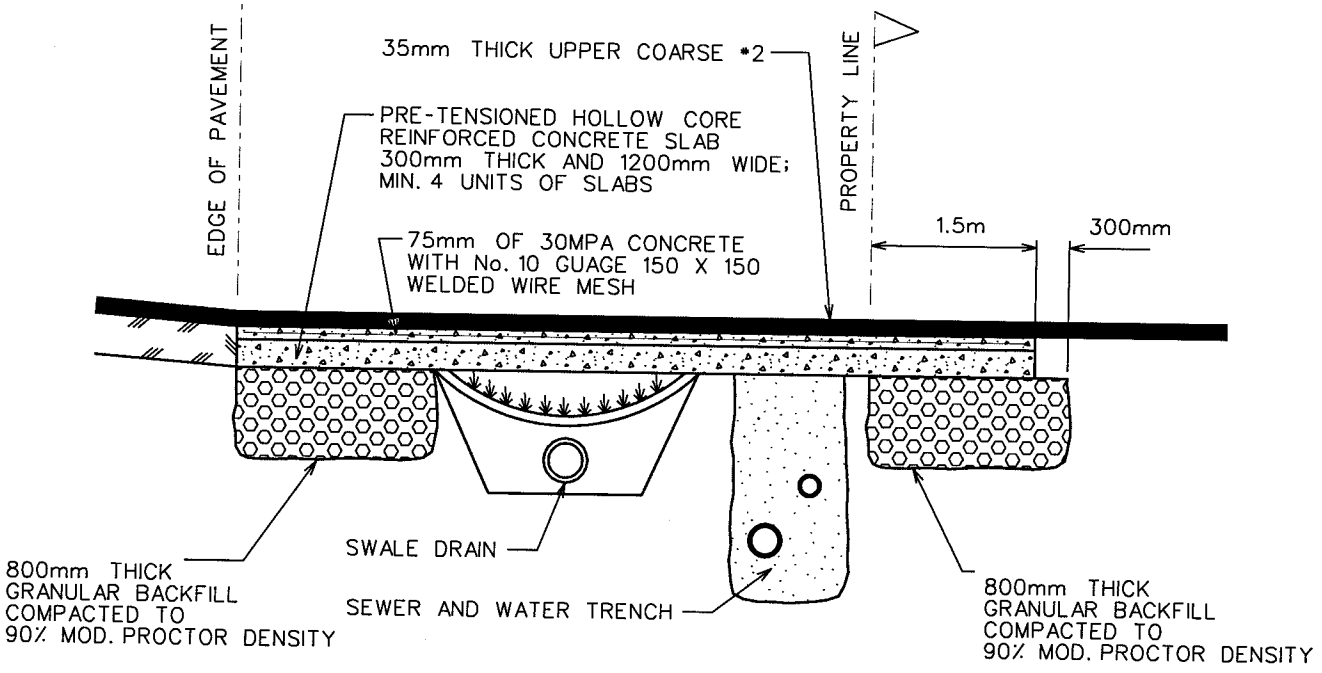
All Dimensions Shown In Millimetres, Unless Otherwise Noted

Title
DRIVEWAY CROSSING FOR ROLLOVER CURBS

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-R.44



3		
2	January 2004	Kok Kuen Li
1	December 2003	J. Pillai
	Revision Date	Approved

All Dimensions Shown In millimetres,
Unless Otherwise Noted

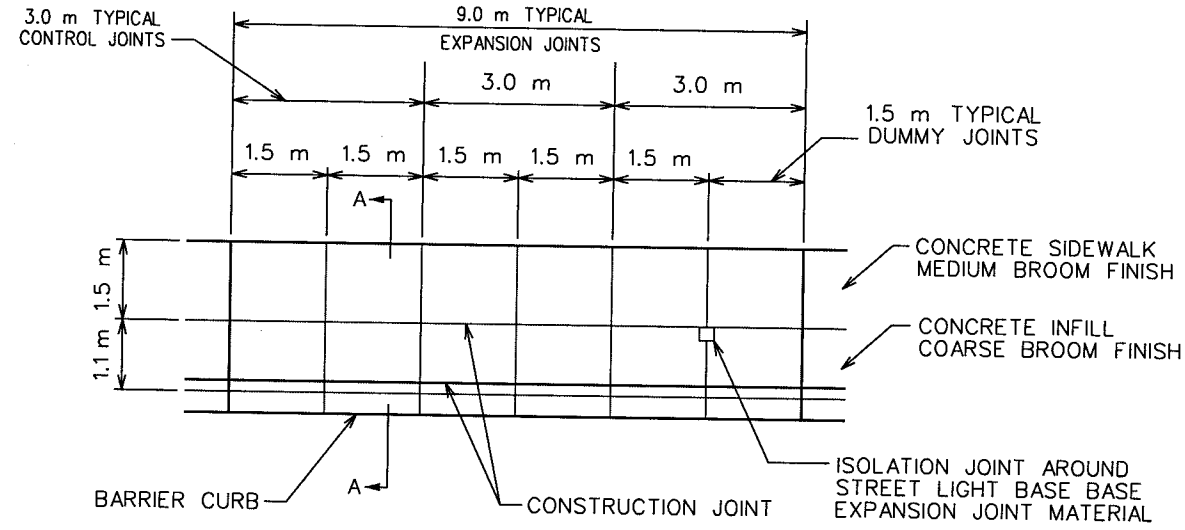
Title
VACUUM SEWER AND WATER DRIVEWAY CROSSING

SURREY
CITY OF PARKS

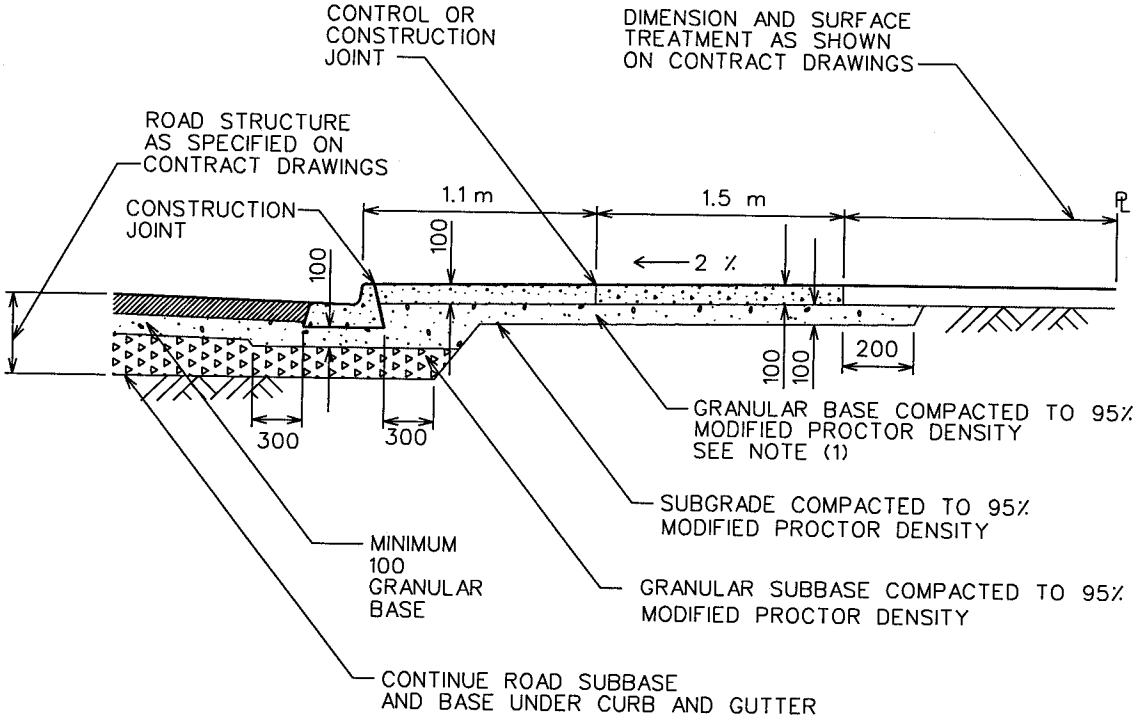
WATER METER
STANDARDS
FOR EXISTING
INSTALLATION

Approved	J. Pillai
Date	December 1999
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-R.48



PLAN



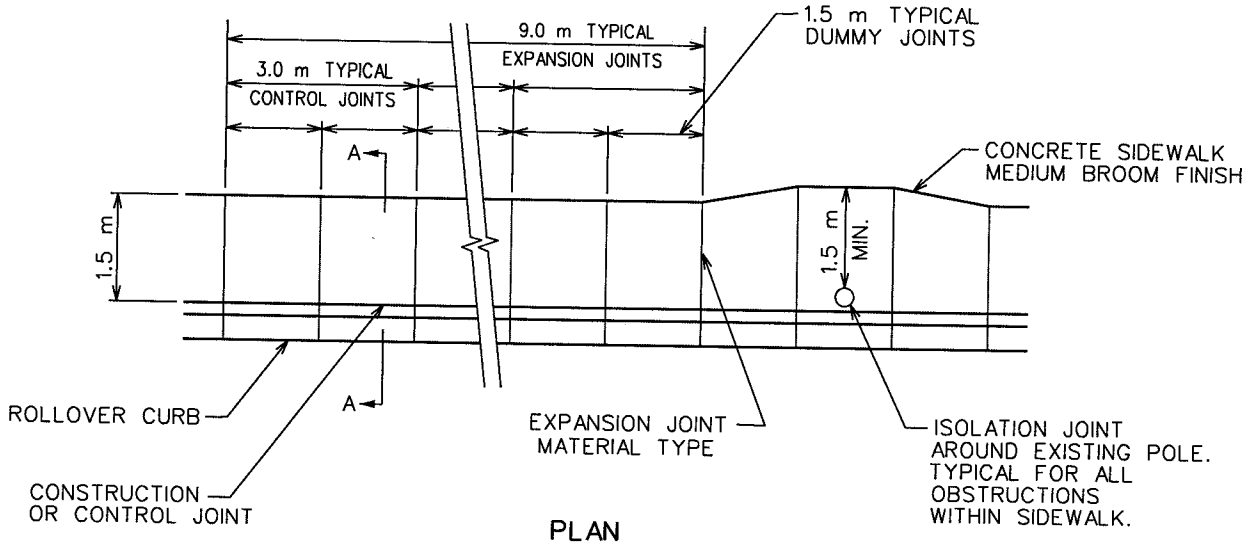
SECTION A-A

NOTE: (1) 120 THICKNESS AT RESIDENTIAL DRIVEWAY CROSSINGS.

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: CONCRETE SIDEWALK AND BARRIER CURB WITH 1.1 m WIDE CONCRETE INFILL
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	September 1998	SSD-R.49
Drawn By	Surrey Engineering	



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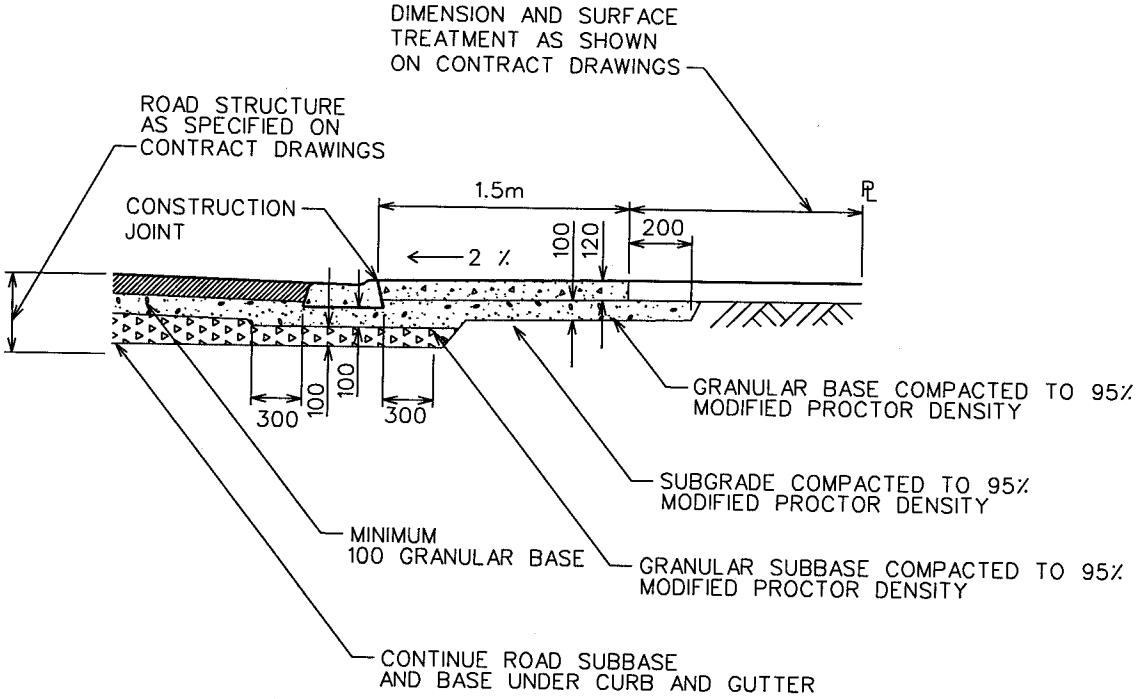
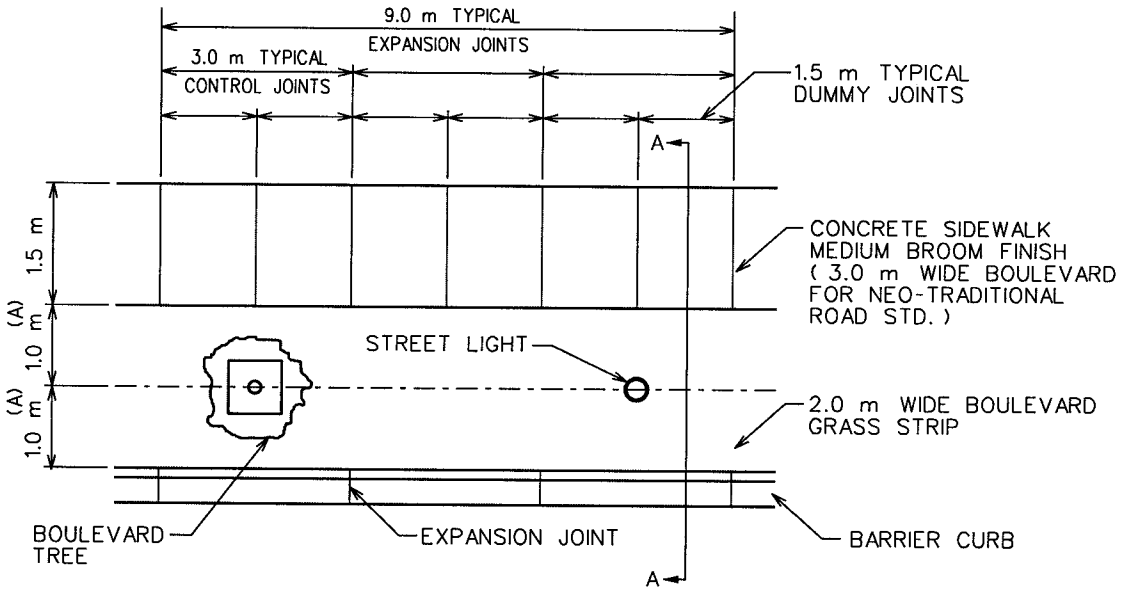


SECTION A-A

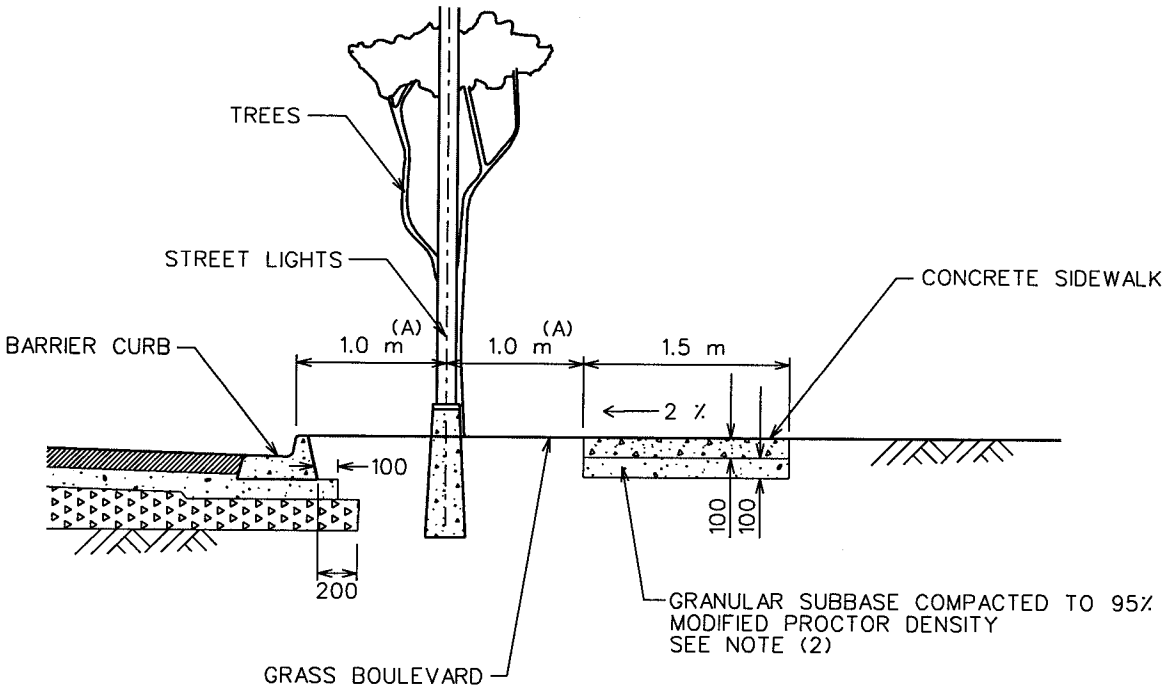
3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: CONCRETE SIDEWALK AND ROLLOVER CURB
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-R.50
Drawn By	Surrey Engineering	



PLAN



SECTION A-A

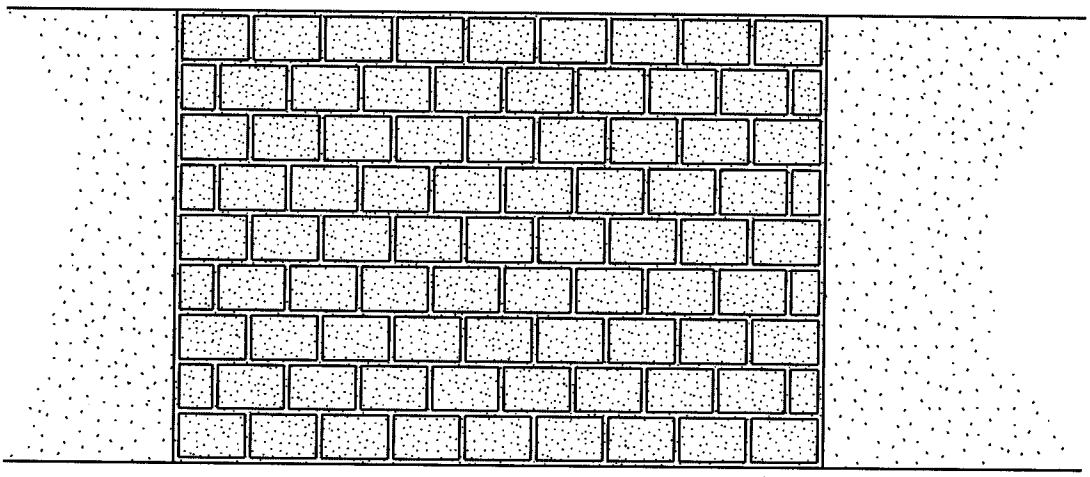
NOTES: (1) 1.5 m FOR NEO-TRADITIONAL ROAD STANDARDS.
(2) 120 THICKNESS AT RESIDENTIAL DRIVEWAY CROSSINGS.

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: CONCRETE SIDEWALK AND BARRIER / ROLLOVER CURB WITH 2.0 m / 3.0 m WIDE GRASS BOULEVARD
	Revision Date / Approved	

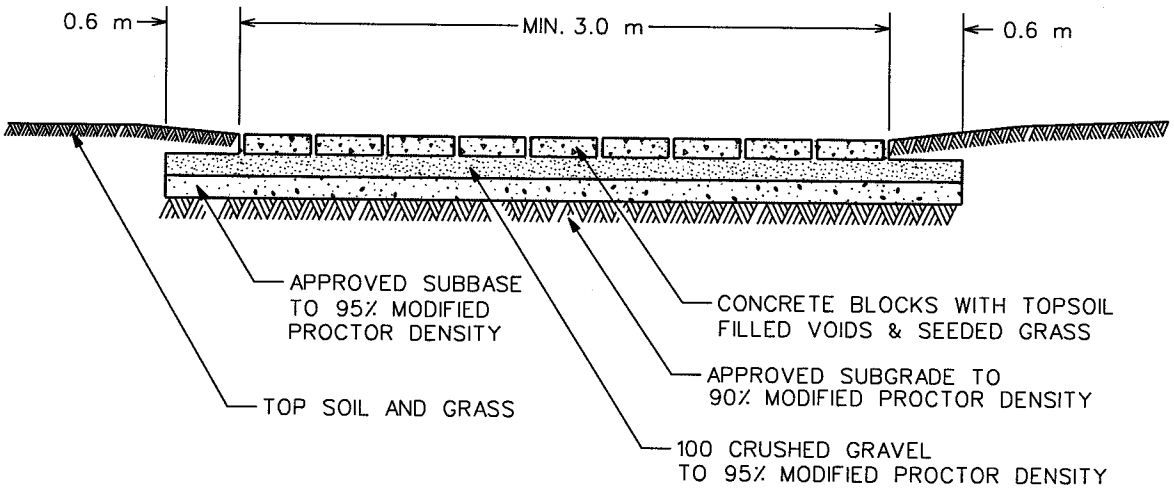
SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	September 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.51



PLAN VIEW

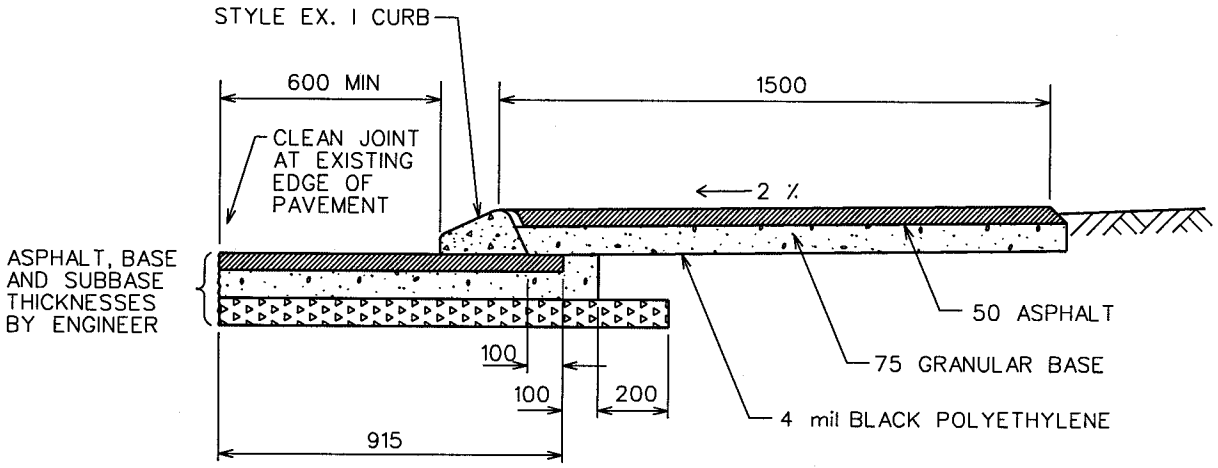


SECTION

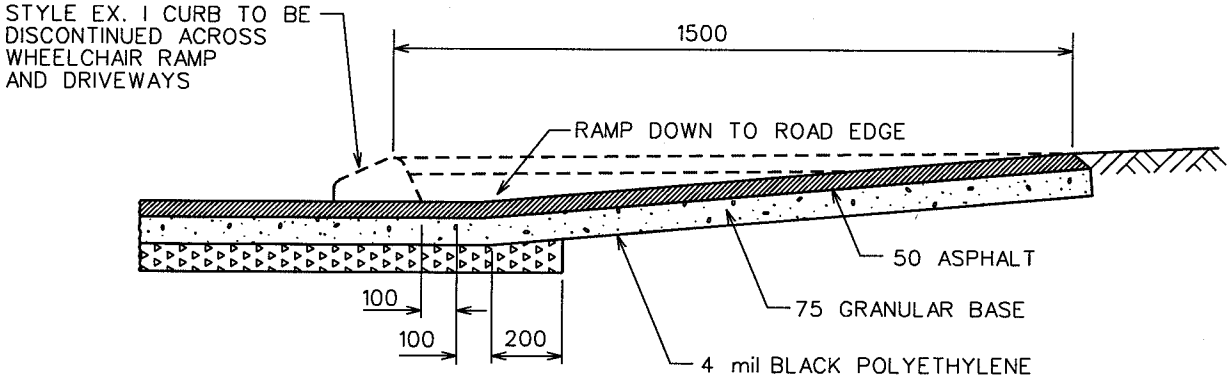
3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: TYPICAL TRAVELLED ACCESS IN R.O.W.
	Revision Date / Approved	

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-R.53
Drawn By	Surrey Engineering	



ASPHALT SIDEWALK ADJACENT TO EXISTING PAVEMENT



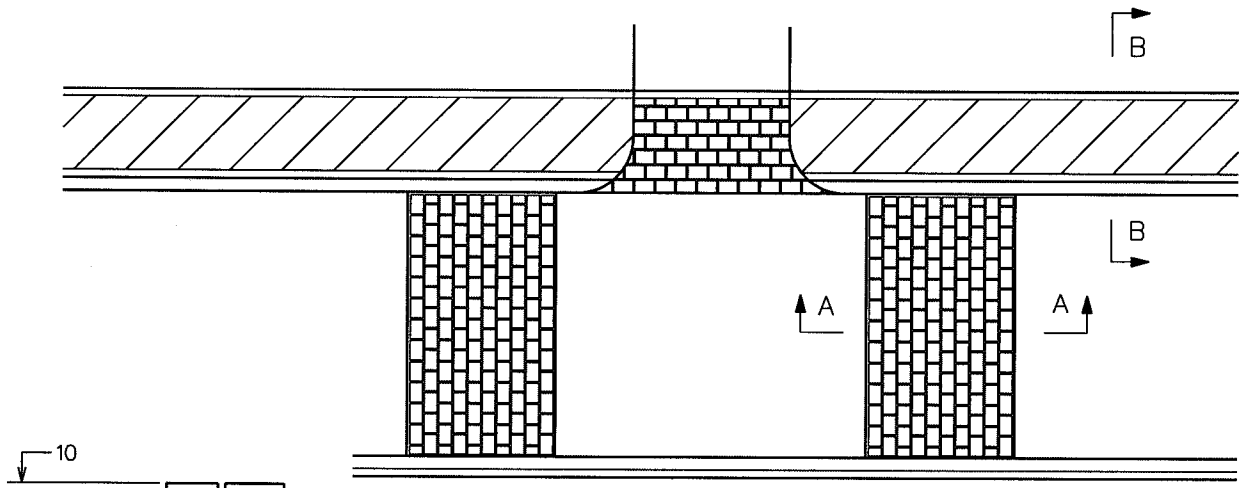
ASPHALT SIDEWALK AT WHEELCHAIR RAMP

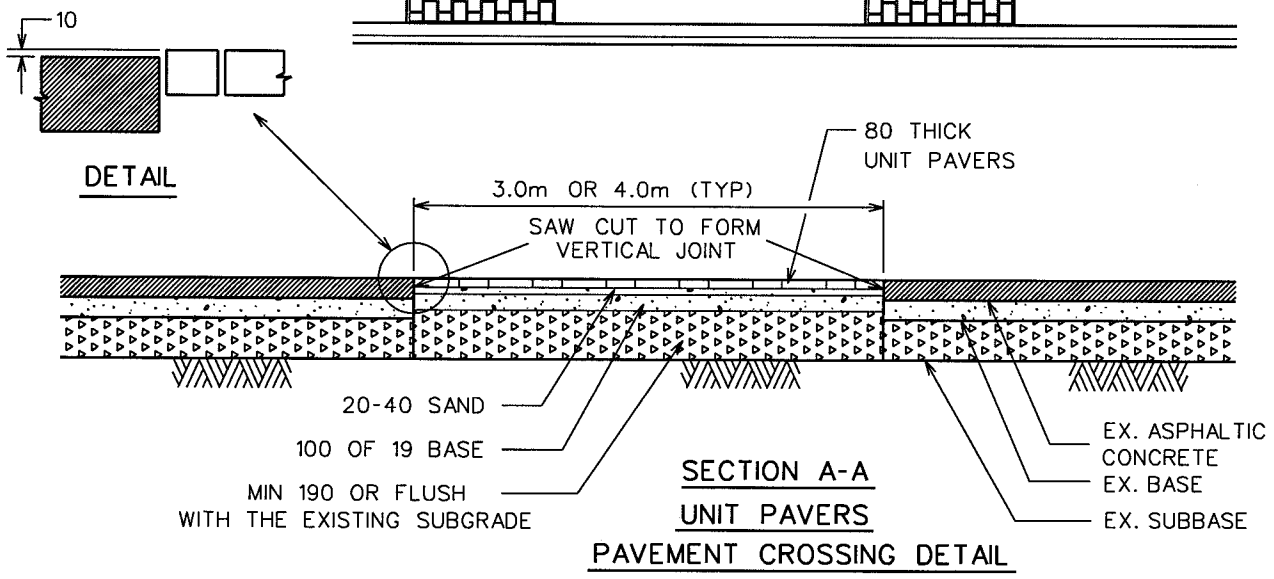
NOTE: (1) SEE SSD-R.45 FOR PAVEMENT STRUCTURE FOR DRIVEWAYS.

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: ASPHALT SIDEWALKS
	Revision Date / Approved	

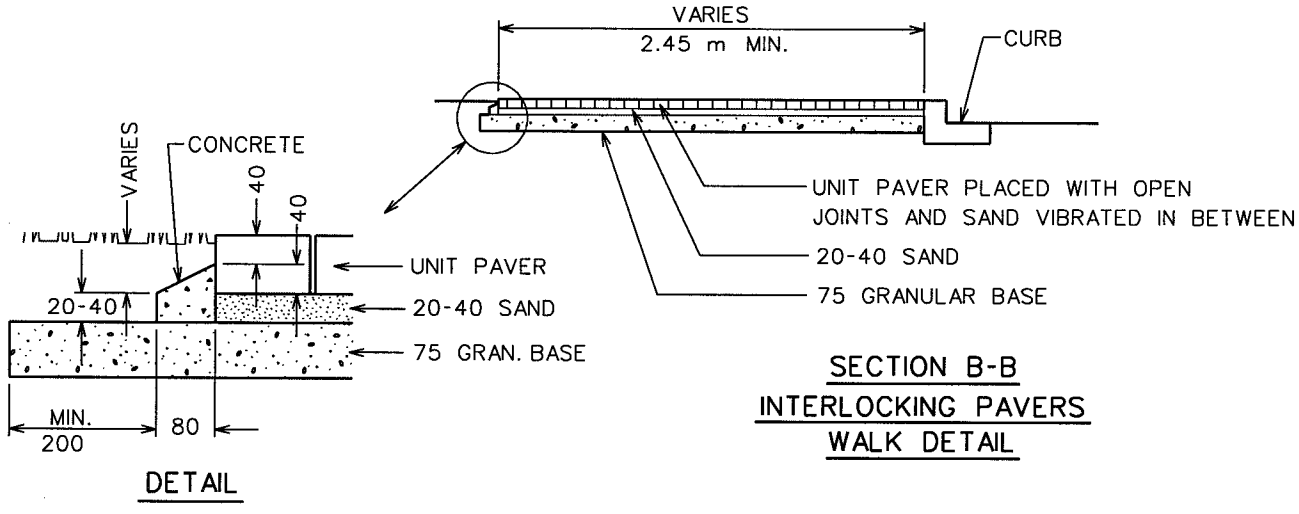
SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-R.54
Drawn By	Surrey Engineering	





SECTION A-A
UNIT PAVERS
PAVEMENT CROSSING DETAIL



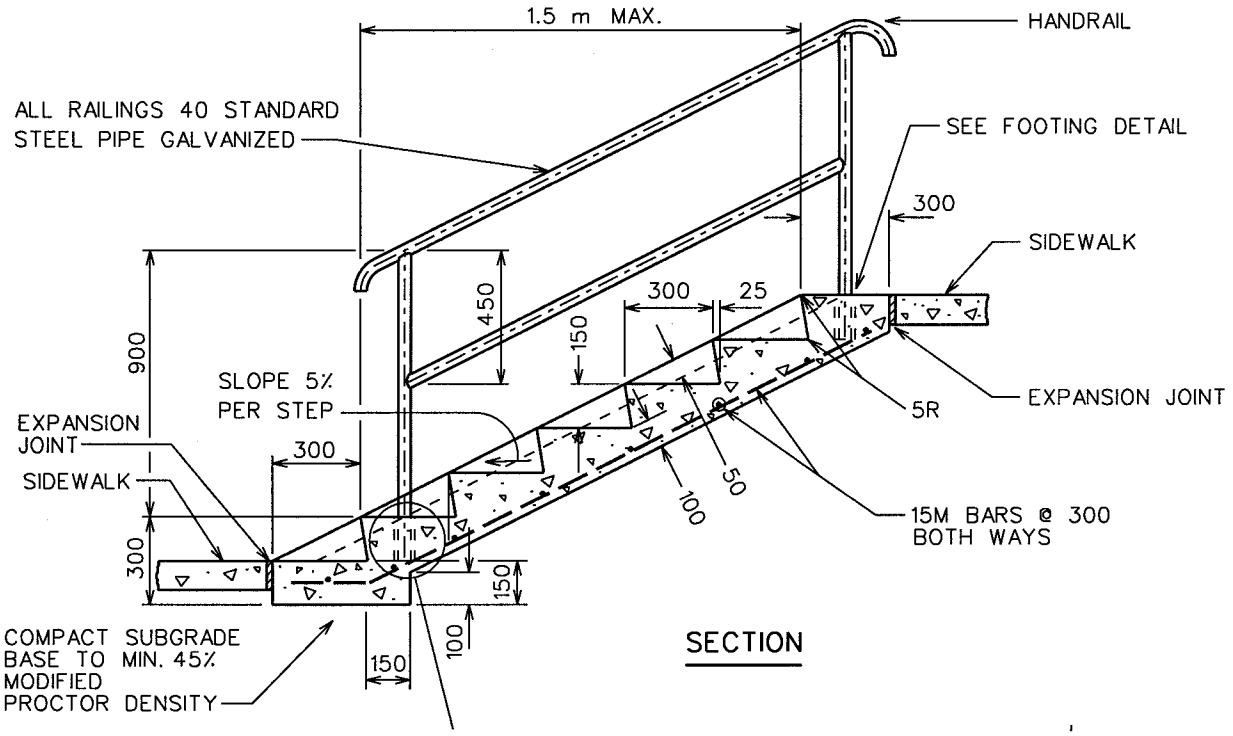
SECTION B-B
INTERLOCKING PAVERS
WALK DETAIL

NOTE: (1) TYPE OF PAVERS AS DIRECTED BY ENGINEER

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: MASONRY WALK AND CROSSWALK DETAILS
	Revision Date / Approved	

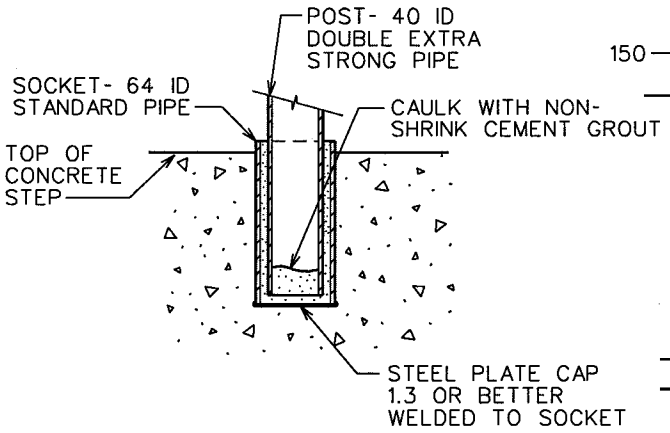
SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-R.55
Drawn By	Surrey Engineering	

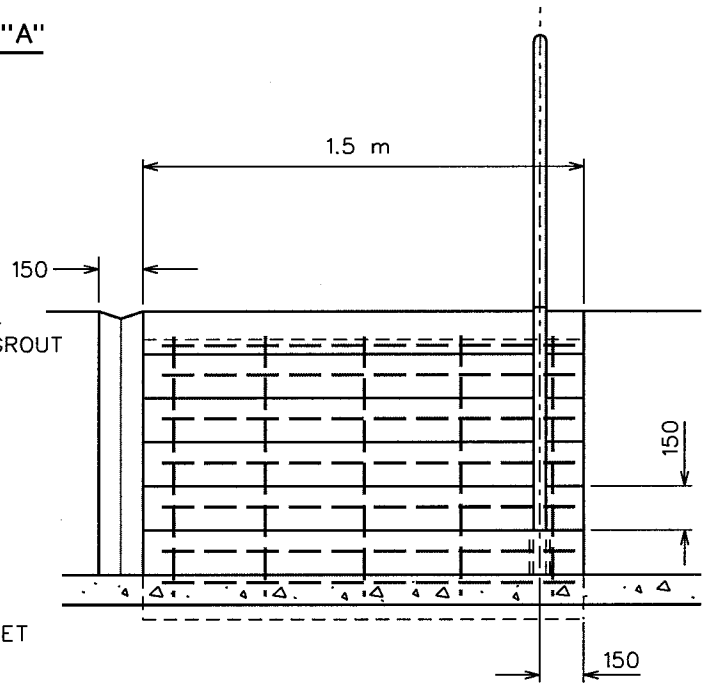


SECTION

DETAIL "A"



DETAIL "A"



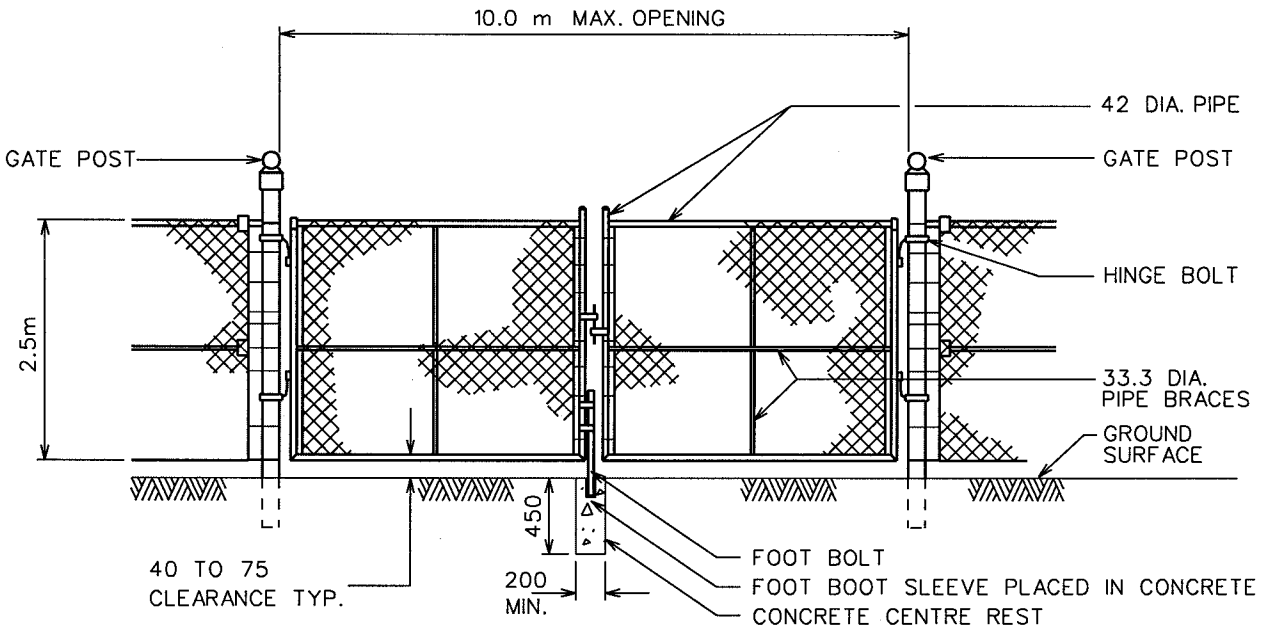
FRONT ELEVATION

NOTE: (1) LARGER STAIRS TO BE DESIGNED BY AN ENGINEER.

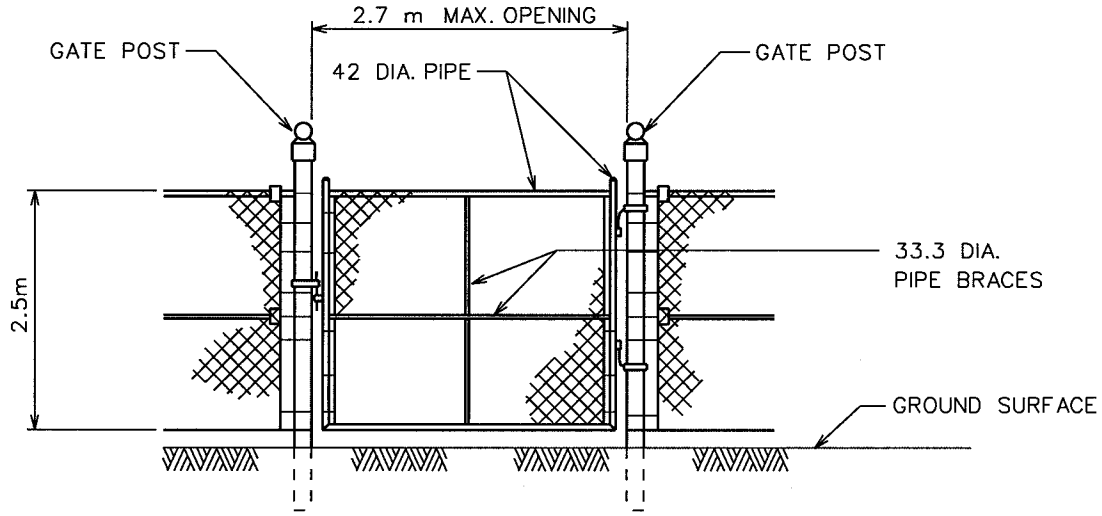
3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1	FEBRUARY 2002	Title CONCRETE STEPS WITHOUT FOOTING - WITH BICYCLE RAMP
	Revision Date Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-R.56
Drawn By	Surrey Engineering	



SECURITY DOUBLE GATE



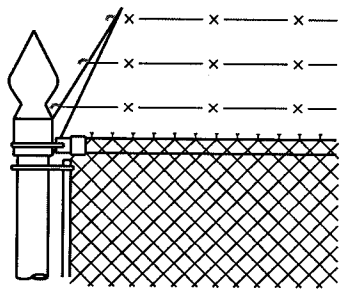
SECURITY SINGLE GATE

NOTES: (1) GATE LEAVES UP TO 1.8 m WIDE REQUIRE HORIZONTAL BRACE ONLY.
(2) GATE LEAVES OVER 1.8 m WIDE REQUIRE HORIZONTAL AND VERTICAL BRACES.

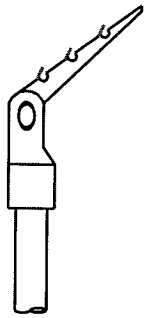
3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: SECURITY CHAIN-LINK FENCE - GATES
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

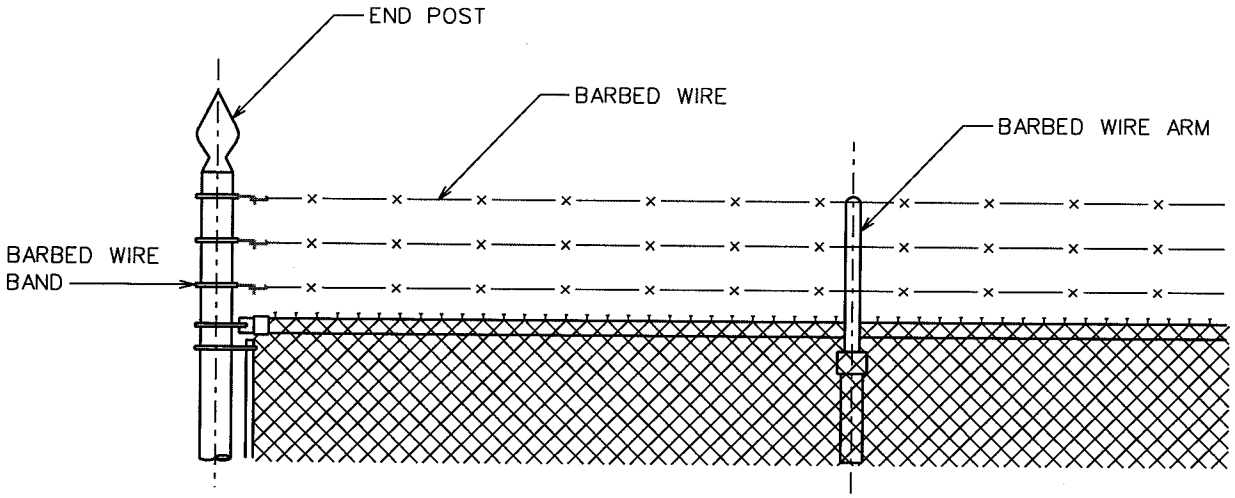
Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-R.57
Drawn By	Surrey Engineering	



CORNER POST
WITH BARBED WIRE ARM



BARBED WIRE ARM



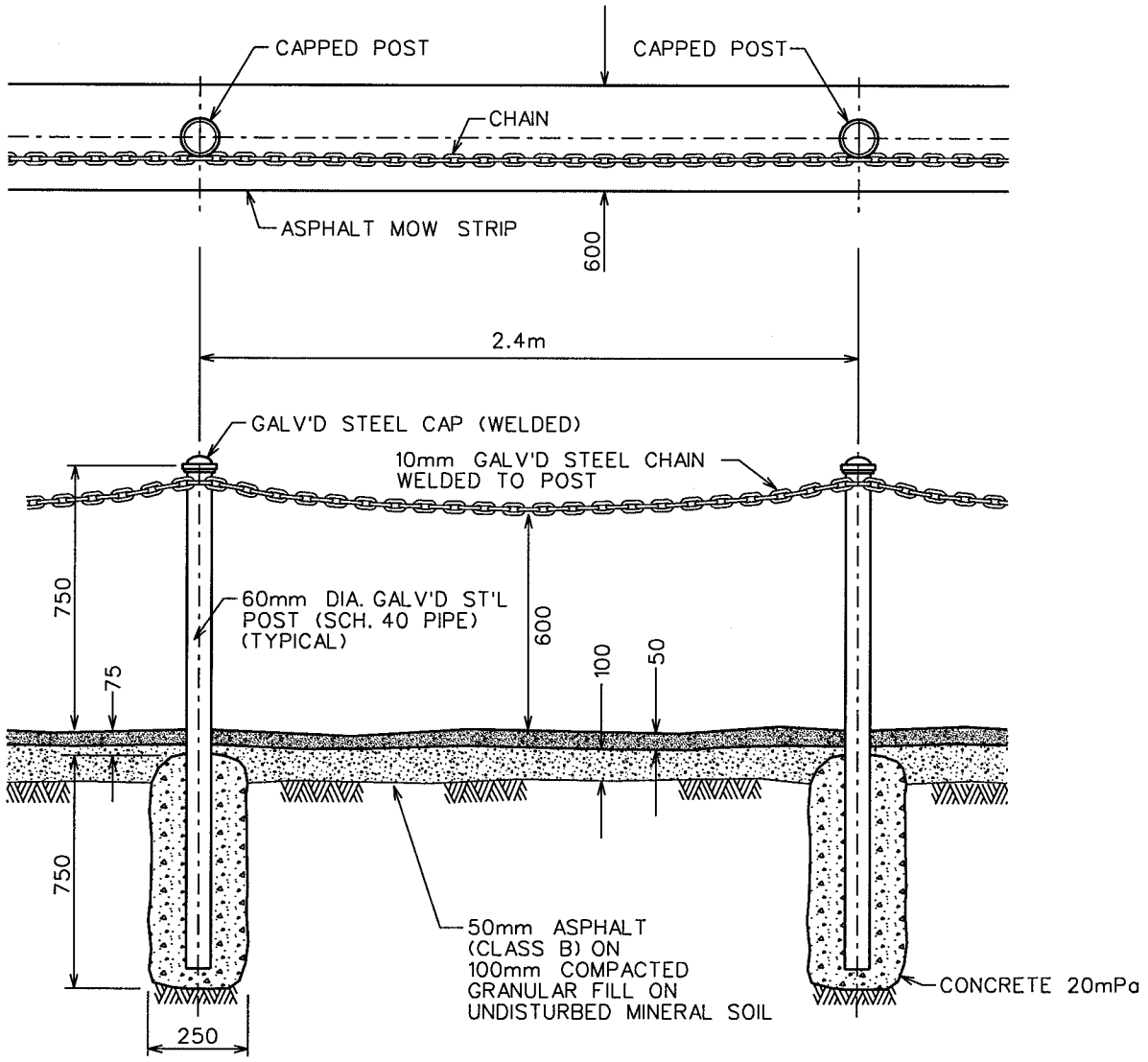
BARBED WIRE DETAILS

NOTE: (1) USE ONLY WHEN DIRECTED BY AN ENGINEER

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: SECURITY FENCE - BARBED WIRE
	Revision Date / Approved	

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-R.58
Drawn By	Surrey Engineering	

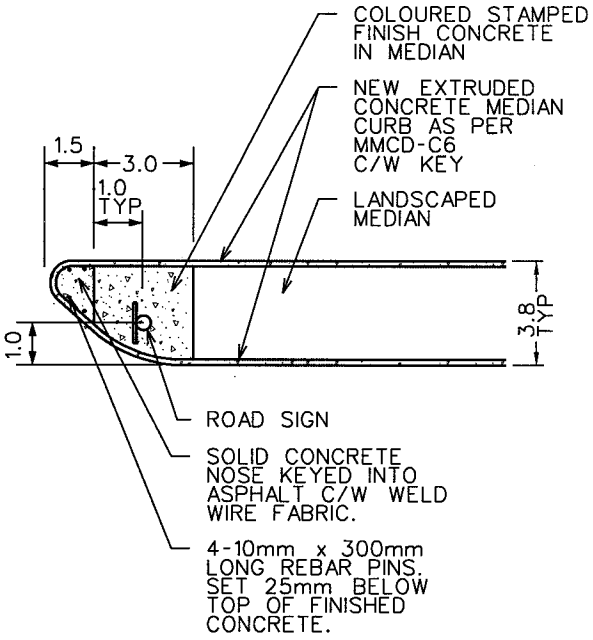


NOTES: (1) WELDS TO BE PAINTED WITH ZINC-RICH PAINT.
(2) PARKING LOTS- PEDESTRIAN OPENINGS MUST BE PROVIDED EVERY 15.25m AND MUST BE 1.0m IN WIDTH

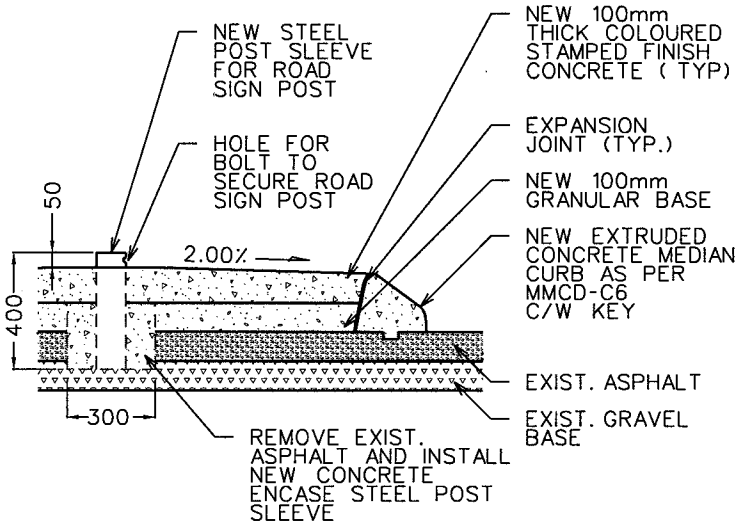
3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: DECORATIVE FENCE
	Revision Date / Approved	

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

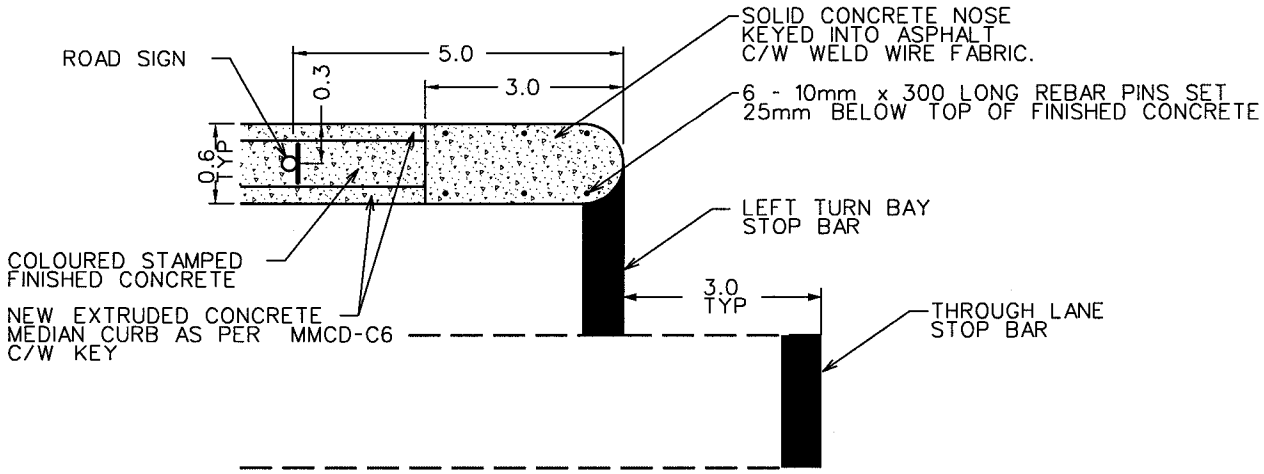
Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-R.59
Drawn By	Surrey Engineering	



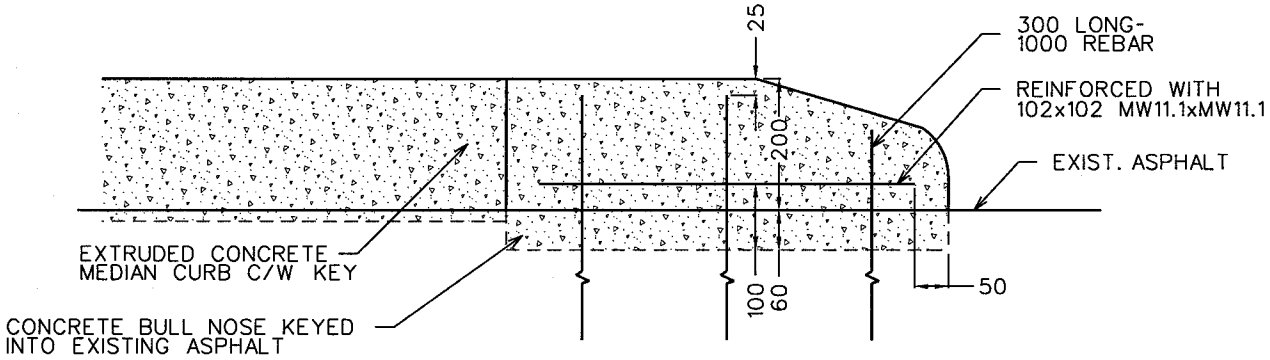
BULL NOSE MEDIAN END



COLOUR BROOM FINISH CONCRETE IN MEDIAN



BULL NOSE MEDIAN END AT LEFT TURN BAY

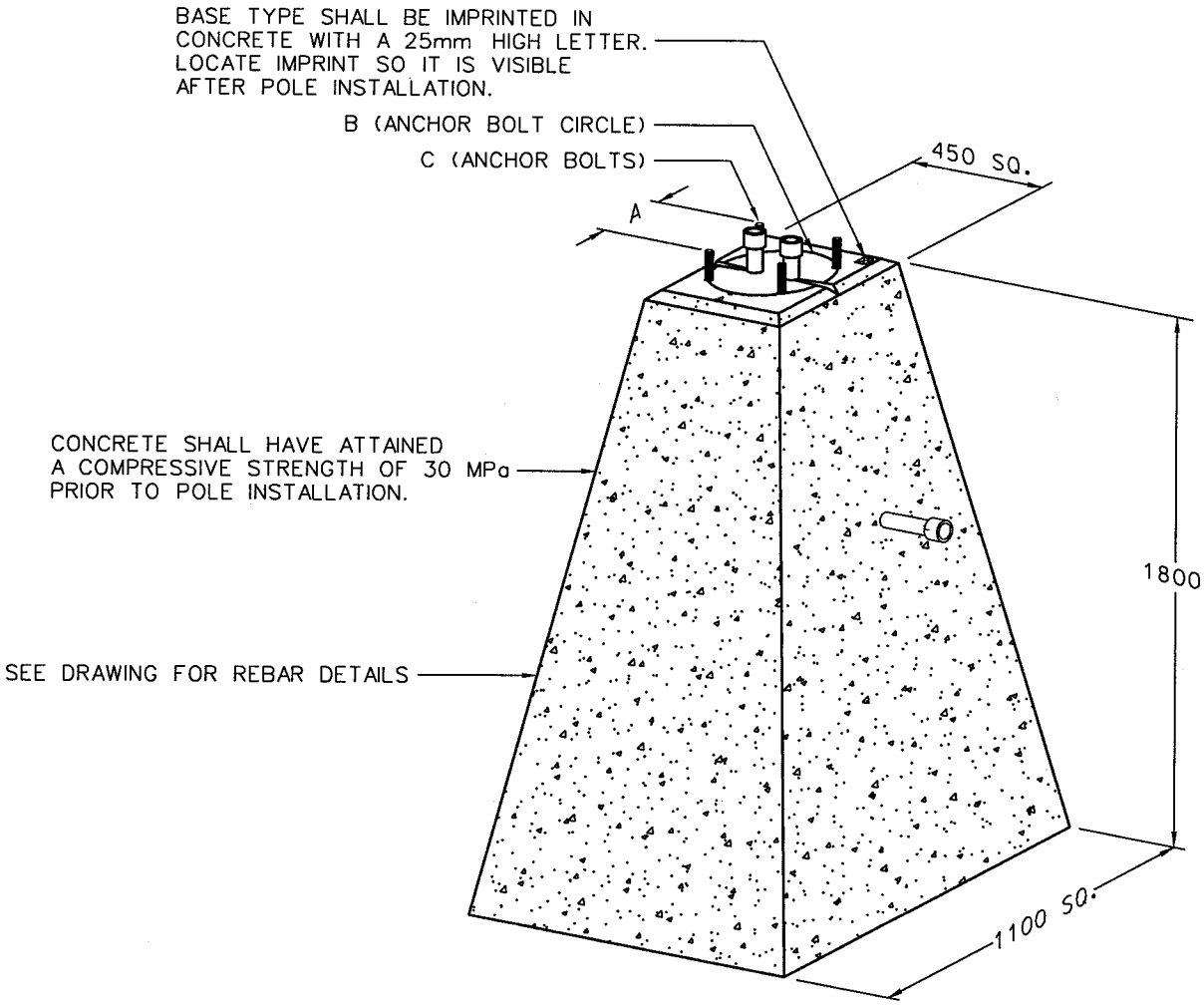


SOLID CONCRETE BULL NOSE

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: BULL NOSE MEDIAN END
	Revision Date / Approved	

SURREY CITY OF PARKS — STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	JUNE 2002	SSD-R.60
Drawn By	Surrey Engineering	



PRECAST CONCRETE BASES

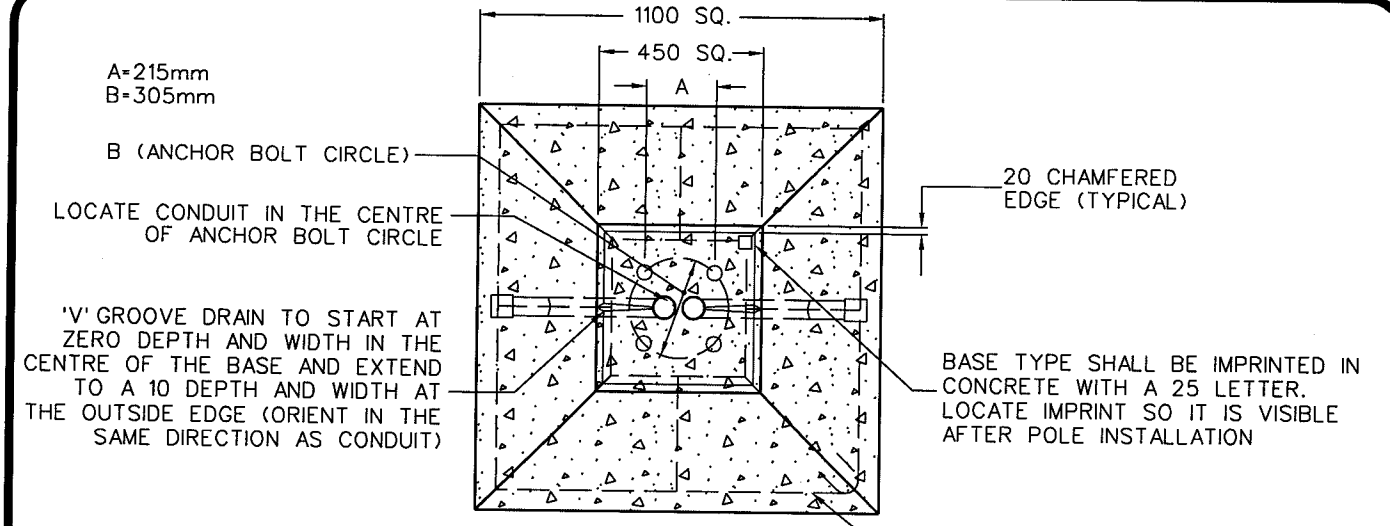
NOTES: (1) REFER TO CONTRACT DRAWINGS AND THE SURREY SUPPLEMENTARY MASTER MUNICIPAL SPECIFICATIONS, SECTION 2.21 FOR "STREET LIGHTING"

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1	MARCH 2002	Title: TYPE D2 CONCRETE BASE FOR 13.5 m DAVIT POLE PRECAST
	Revision Date / Approved	

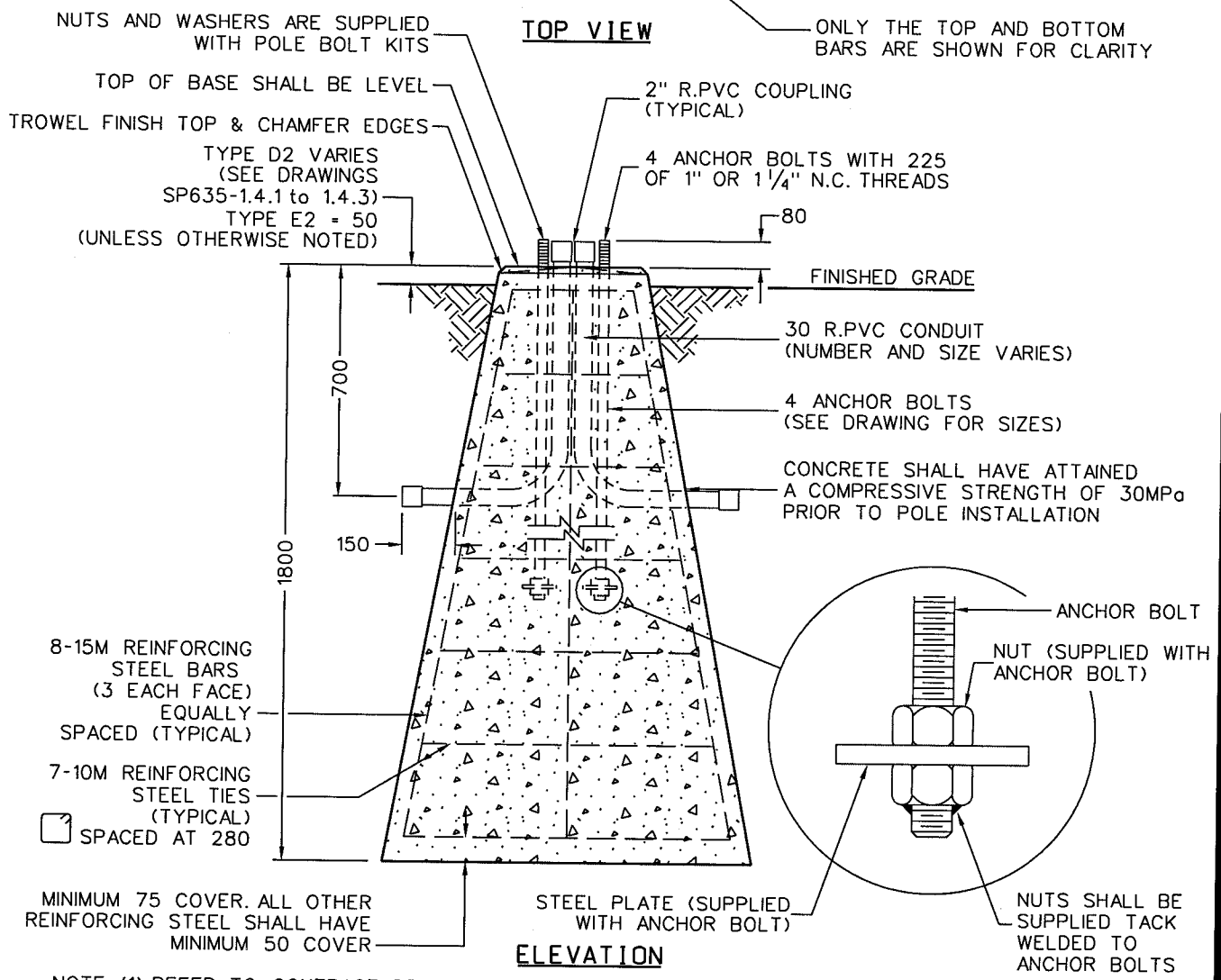
SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.E.2



TOP VIEW



ELEVATION

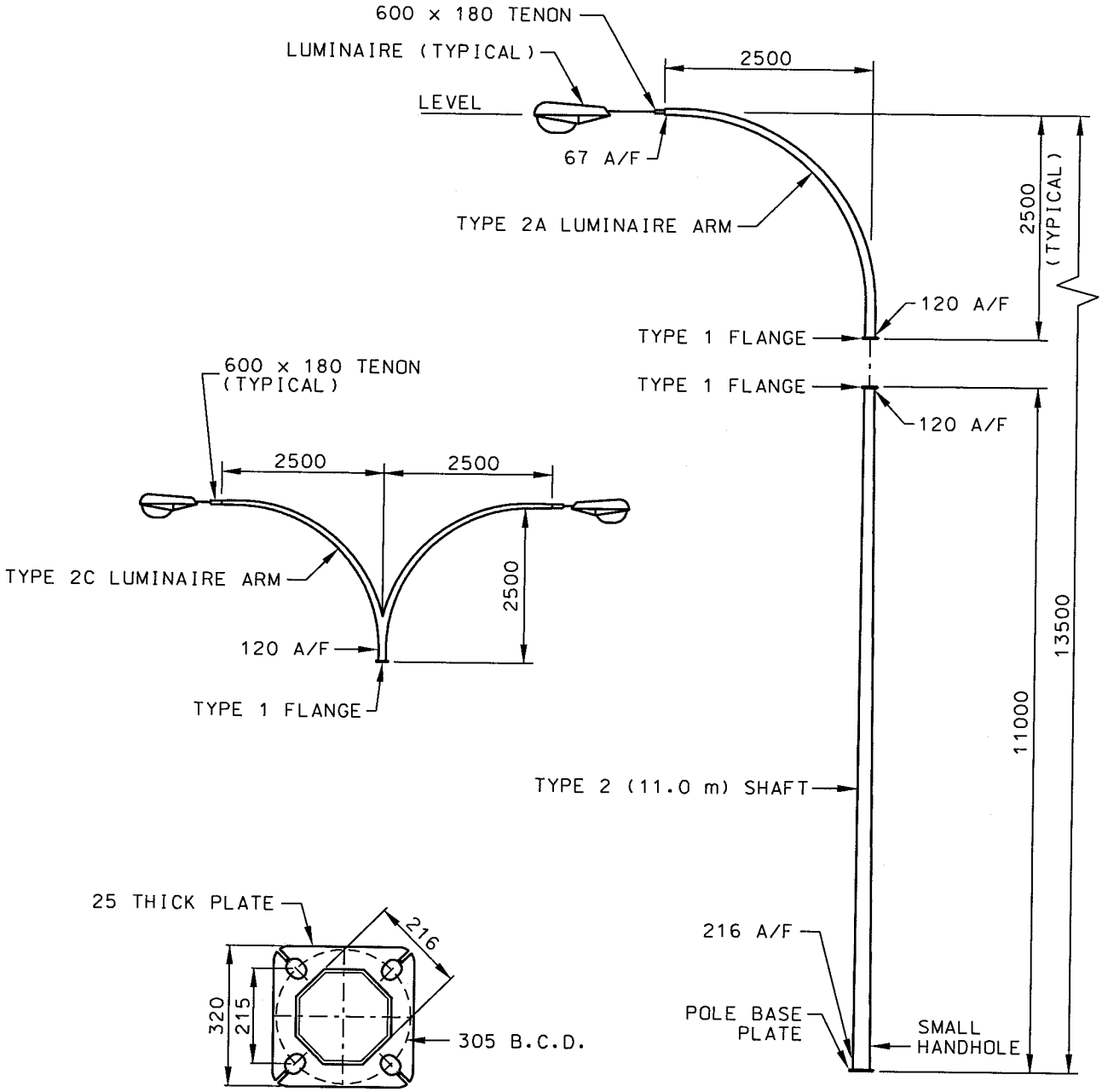
NOTE: (1) REFER TO CONTRACT DRAWINGS AND THE SURREY SUPPLEMENTARY MASTER MUNICIPAL SPECIFICATIONS, SECTION 2.21 FOR "STREET LIGHTING"

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1	MARCH 2002	Title: PRECAST TYPE D2 CONCRETE BASE FOR 13.5 m DAVIT POLE
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.E.3



POLE BASE PLATE

ELEVATION

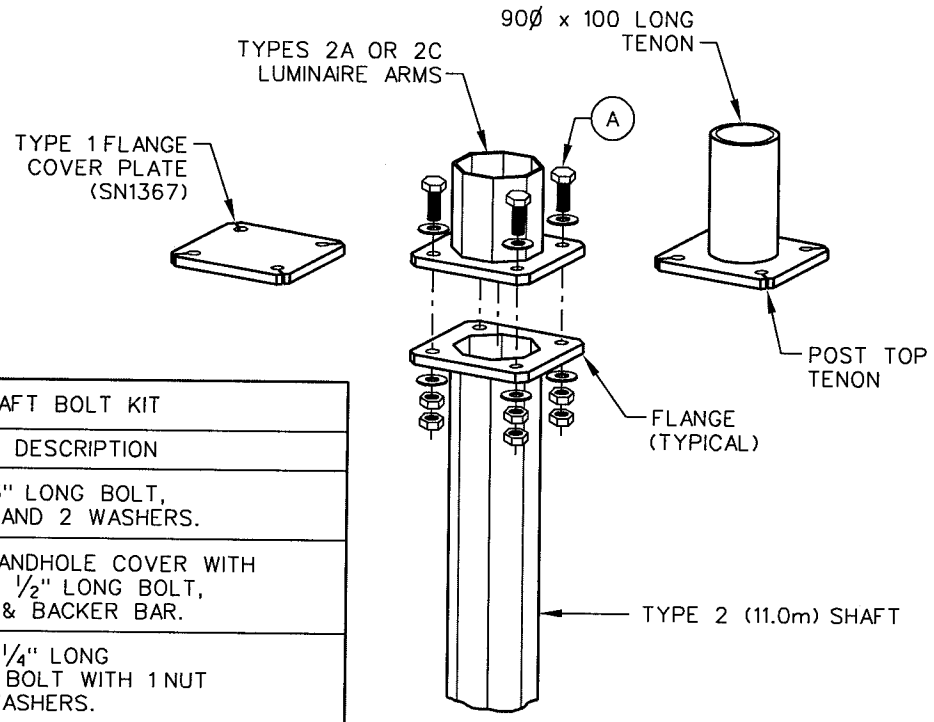
NOTE: (1) REFER TO CONTRACT DRAWINGS AND THE SURREY SUPPLEMENTARY MASTER MUNICIPAL SPECIFICATIONS, SECTION 2.21 FOR "STREET LIGHTING"

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1	MARCH 2002	Title: TYPE 2 SHAFT INSTALLATION DETAILS FOR 13.5 m DAVIT POLE
	Revision Date / Approved	

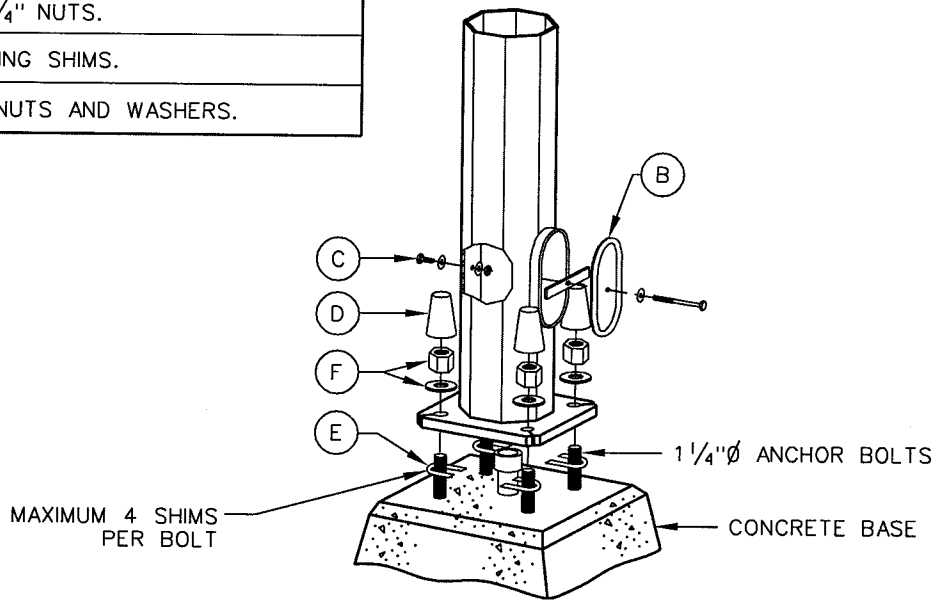
SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.E.4



TYPE 2 (11.0m) SHAFT BOLT KIT		
ITEM	QUANTITY	DESCRIPTION
A	4	5/8"Ø x 3" LONG BOLT, 2 NUTS AND 2 WASHERS.
B	1	SMALL HANDHOLE COVER WITH 3/8"Ø x 3 1/2" LONG BOLT, WASHER & BACKER BAR.
C	1	3/8"Ø x 1 1/4" LONG BONDING BOLT WITH 1 NUT AND 2 WASHERS.
D	4	PLASTIC NUT COVERS FOR 1 1/4" NUTS.
E	4	LEVELLING SHIMS.
F	4	1 1/4"Ø NUTS AND WASHERS.



POLE ASSEMBLY DETAIL

NOTE: (1) REFER TO CONTRACT DRAWINGS AND THE SURREY SUPPLEMENTARY MASTER MUNICIPAL SPECIFICATIONS, SECTION 2.21 FOR "STREET LIGHTING"

3		
2		
1	MARCH 2002	
	Revision Date	Approved

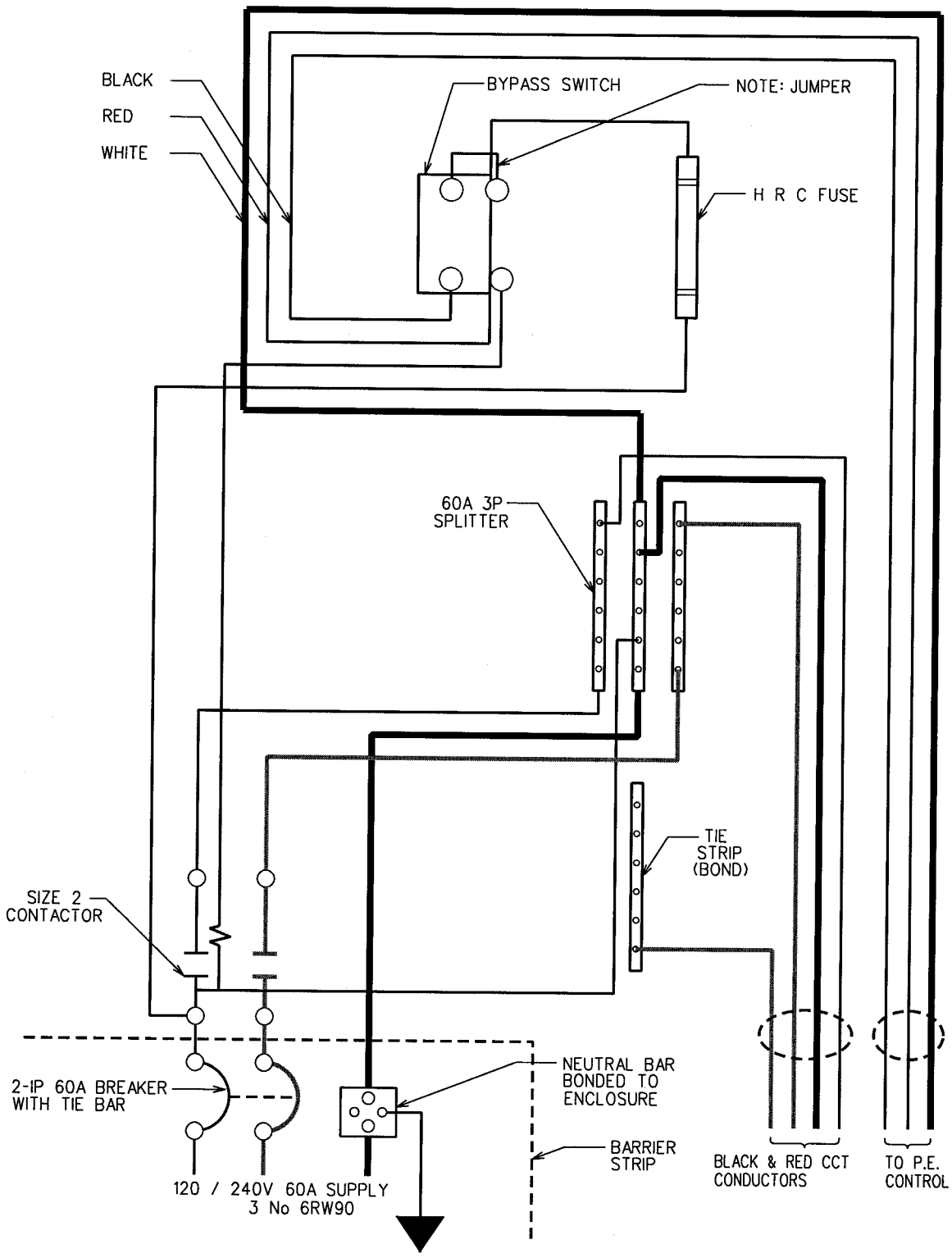
All Dimensions Shown In Millimetres, Unless Otherwise Noted

Title: TYPE 2 SHAFT INSTALLATION DETAILS FOR 13.5 m DAVIT POLE

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.E.5



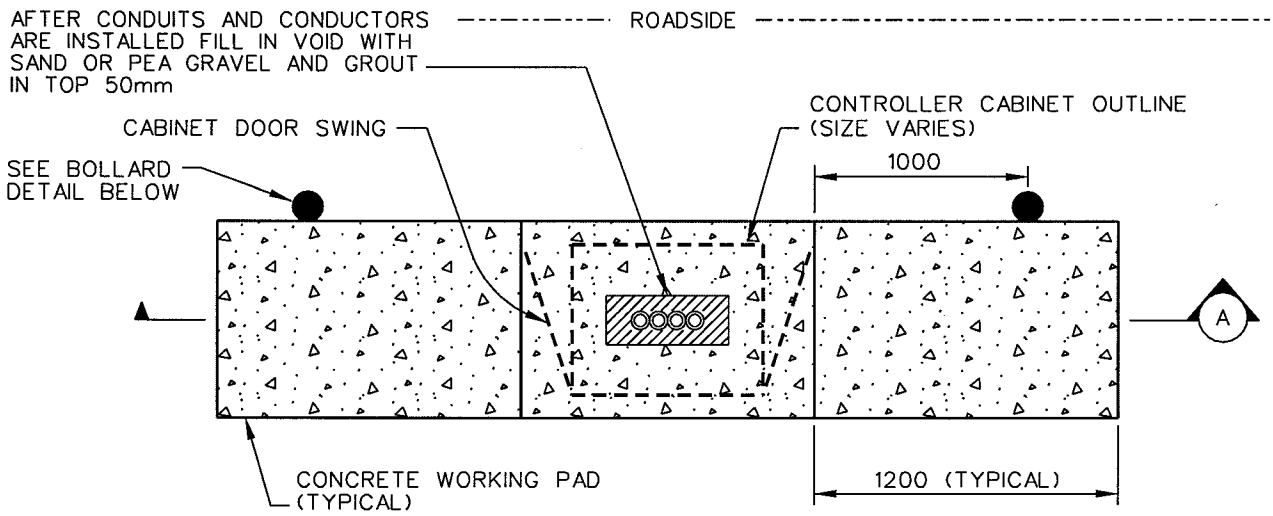
NOTE: (1) REFER TO CONTRACT DRAWINGS AND THE SUPPLEMENTARY SPECIFICATIONS, SECTION FOR 'TRAFFIC SIGNALS'

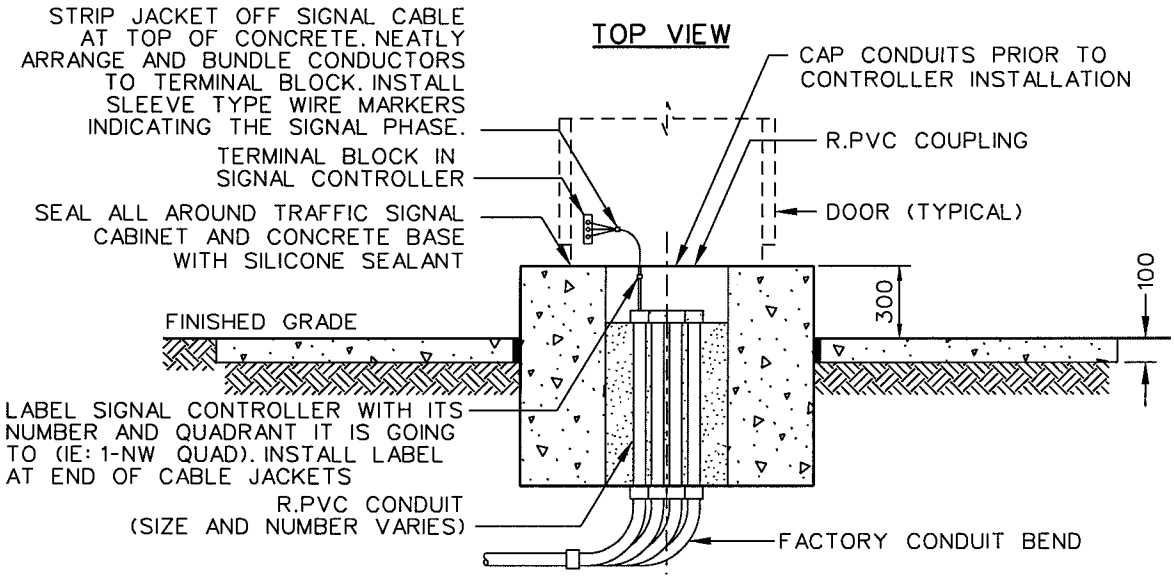
3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1	MARCH 2002	Title WIRING DIAGRAM FOR 60 A SERVICE BASE
	Revision Date Approved	

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

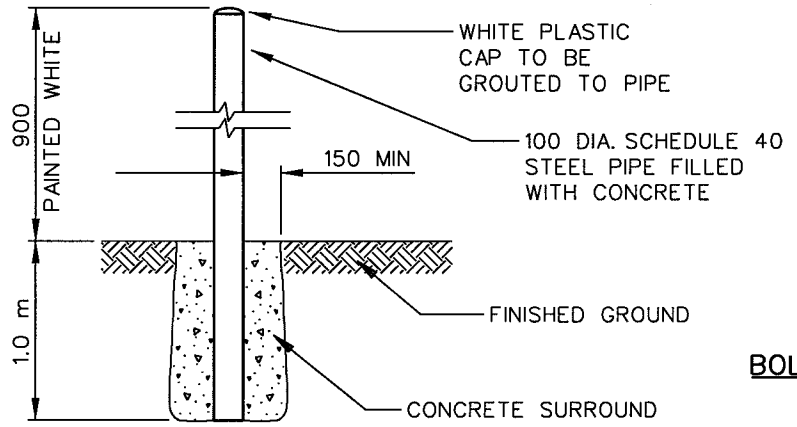
Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-R.E.6





SECTION (A)



BOLLARD DETAIL

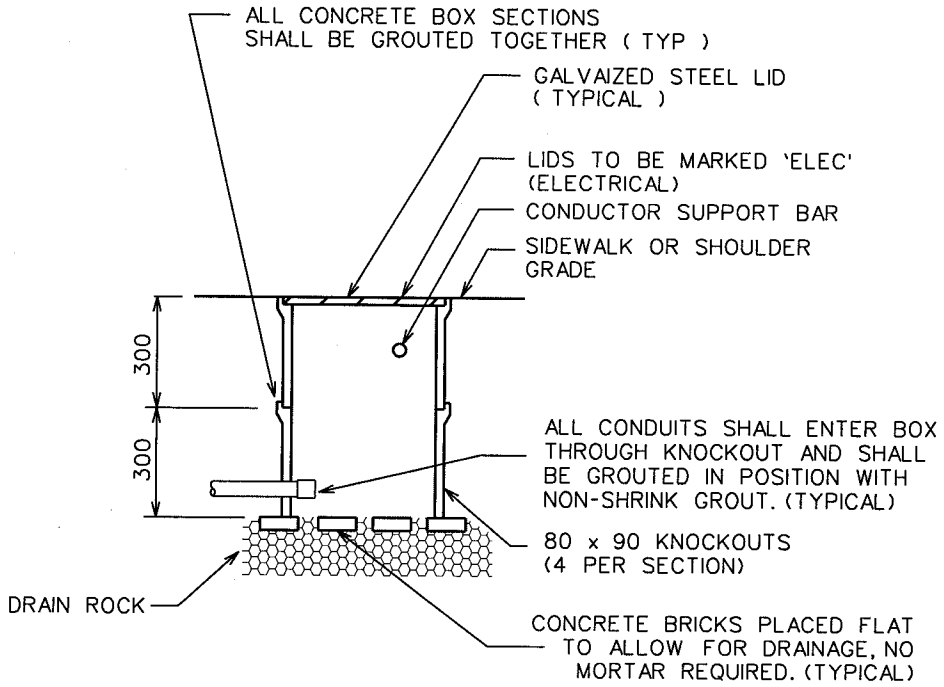
NOTE: (1) REFER TO CONTRACT DRAWINGS AND THE SUPPLEMENTARY SPECIFICATIONS, SECTION FOR 'TRAFFIC SIGNALS'

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1	MARCH 2002	Title: MODEL 170 TRAFFIC SIGNAL CABINET INSTALLATION
	Revision Date Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

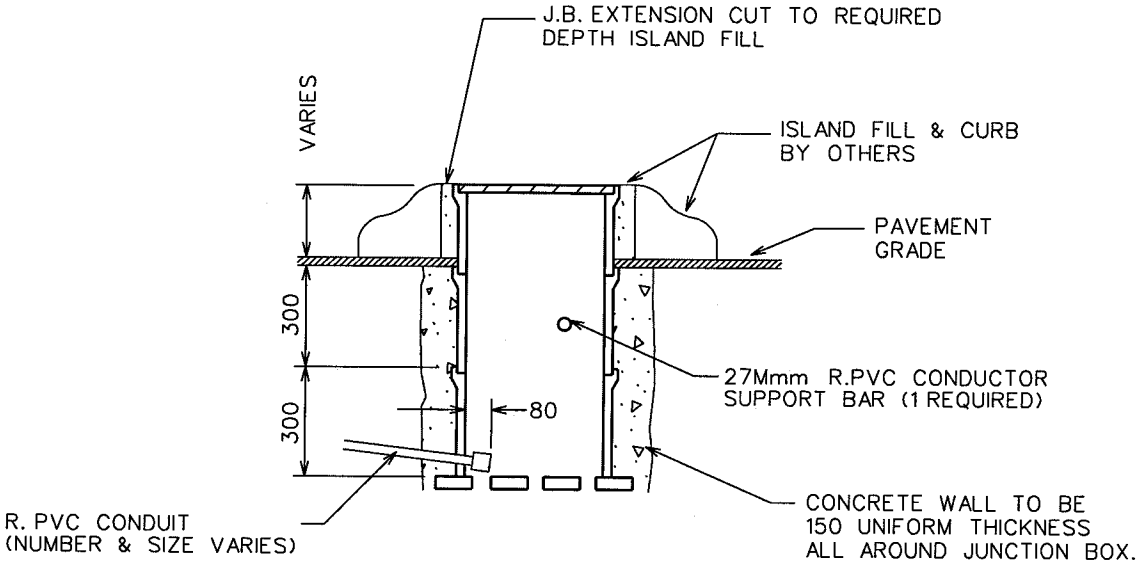
Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.E.10



TYPE 37 J.B. IN SIDEWALK OR ROAD SHOULDER

(305 x 510 I.D.)



TYPE 37 JUNCTION BOX IN MEDIAN / BESIDE CURB

(305 x 510 I.D.)

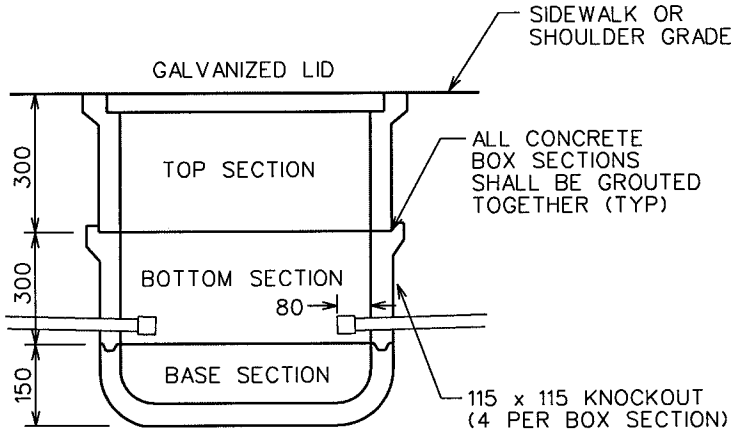
NOTES: (1) REFER TO CONTRACT DRAWINGS AND THE SURREY SUPPLEMENTARY MASTER MUNICIPAL SPECIFICATIONS, SECTION 2.23 'TRAFFIC SIGNALS'

(2) ALL CONDUITS TO DRAIN TO JUNCTION BOX.

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1	MARCH 2002	Title: TYPE 37 JUNCTION BOX DETAILS (CONCRETE)
	Revision Date / Approved	

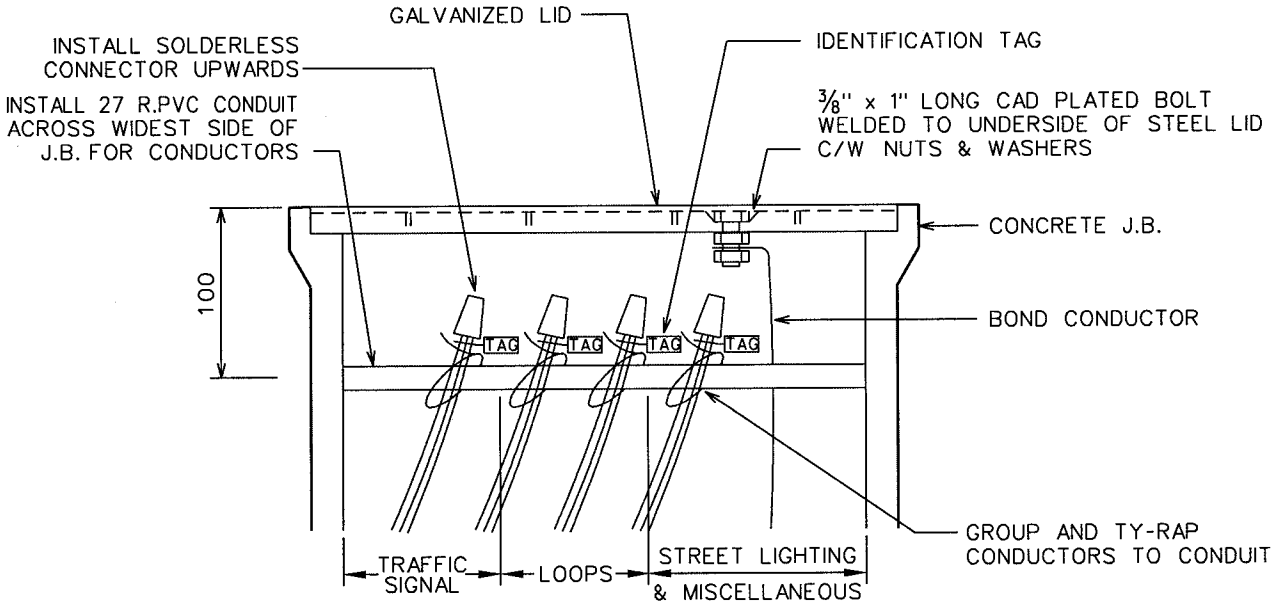
SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-R.E.11
Drawn By	Surrey Engineering	



TYPE 66 JUNCTION BOX

(430 x 760 I.D.)



CONDUCTORS IN J.B.'S

NOTES: (1) REFER TO CONTRACT DRAWINGS AND THE SUPPLEMENTARY SPECIFICATIONS, SECTION FOR 'TRAFFIC SIGNALS' FOR 'TRAFFIC SIGNALS'.
(2) LEAVE 1.0 m OF SLACK FOR ALL CONDUCTORS IN JUNCTION BOX.
(3) GROUP AND BUNDLE ALL CONDUCTORS SEPARATELY AS FOLLOWS:
- DETECTORS LOOP CABLES
- SIGNAL CONDUCTORS
- LIGHTING AND MISCELLANEOUS CONDUCTORS
(4) IDENTIFICATION TAGS SHALL BE NEATLY MARKED WITH A BLACK INDELIBLE PEN.
(5) OFFSET R.PVC CONDUIT BAR 100 FROM SIDE OF JUNCTION BOX.

3		
2		
1	MARCH 2002	
	Revision Date	Approved

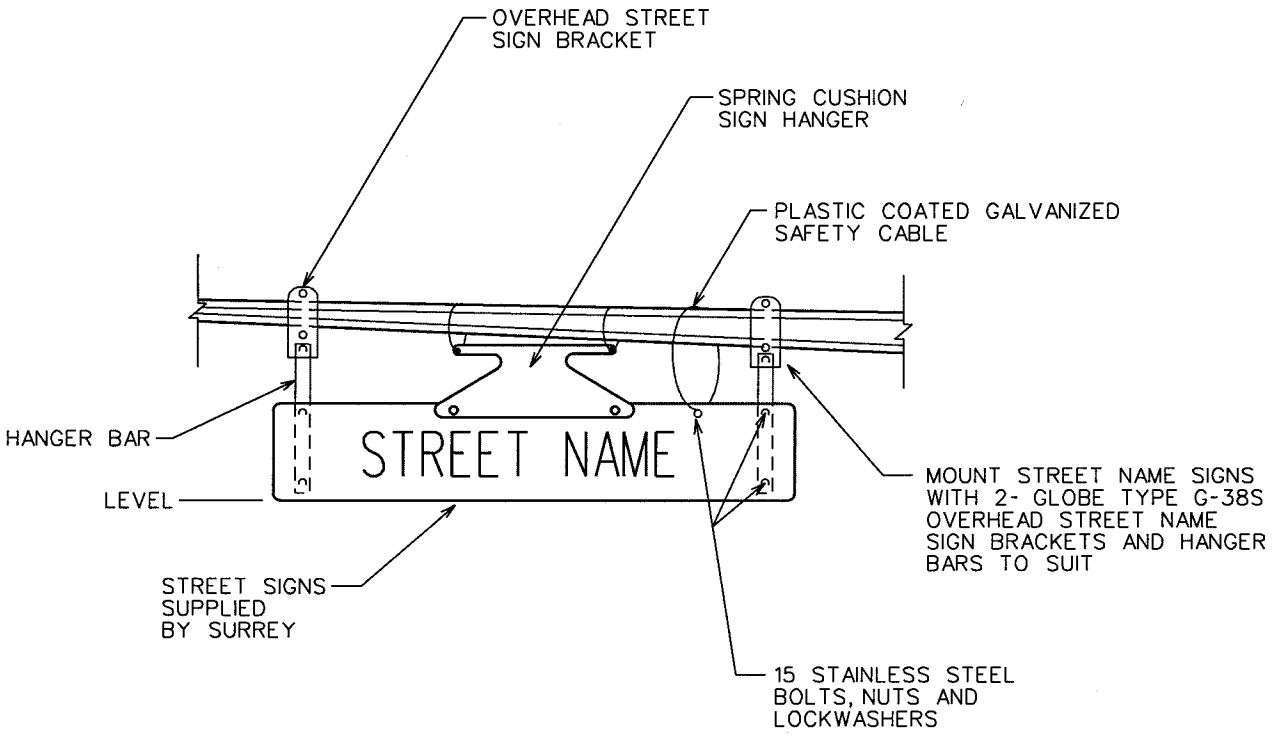
All Dimensions Shown In Millimetres, Unless Otherwise Noted

Title: TYPE 66 JUNTION BOX DETAILS (CONCRETE)

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.E.12



STREET NAME SIGN MOUNTING DETAIL

NOTE: (1) REFER TO CONTRACT DRAWINGS AND THE SUPPLEMENTARY SPECIFICATIONS, SECTION FOR 'TRAFFIC SIGNALS'

3		
2		
1	MARCH 2002	
	Revision Date	Approved

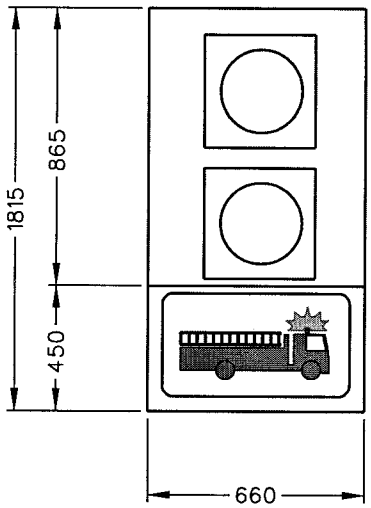
All Dimensions Shown In Millimetres, Unless Otherwise Noted

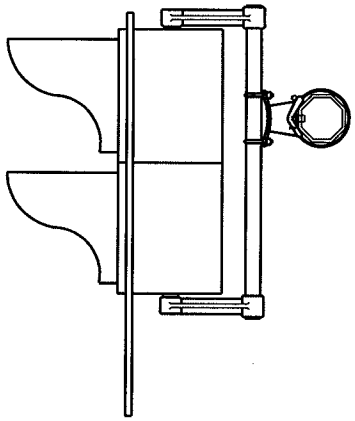
Title: STREET NAME SIGN MOUNTING DETAILS

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

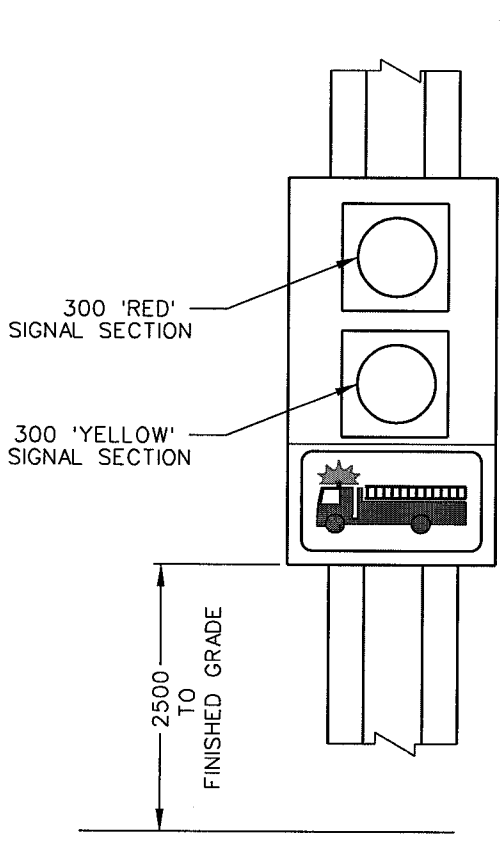
Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

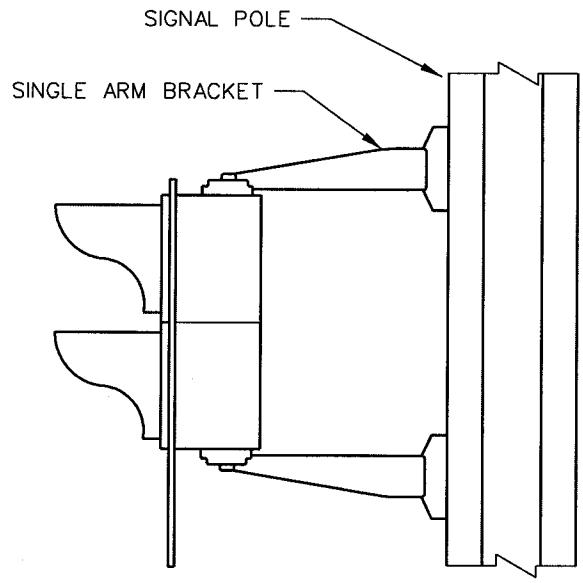
DRAWING NUMBER: SSD-R.E.20





PRIMARY FIRE SIGNAL HEAD MOUNTING





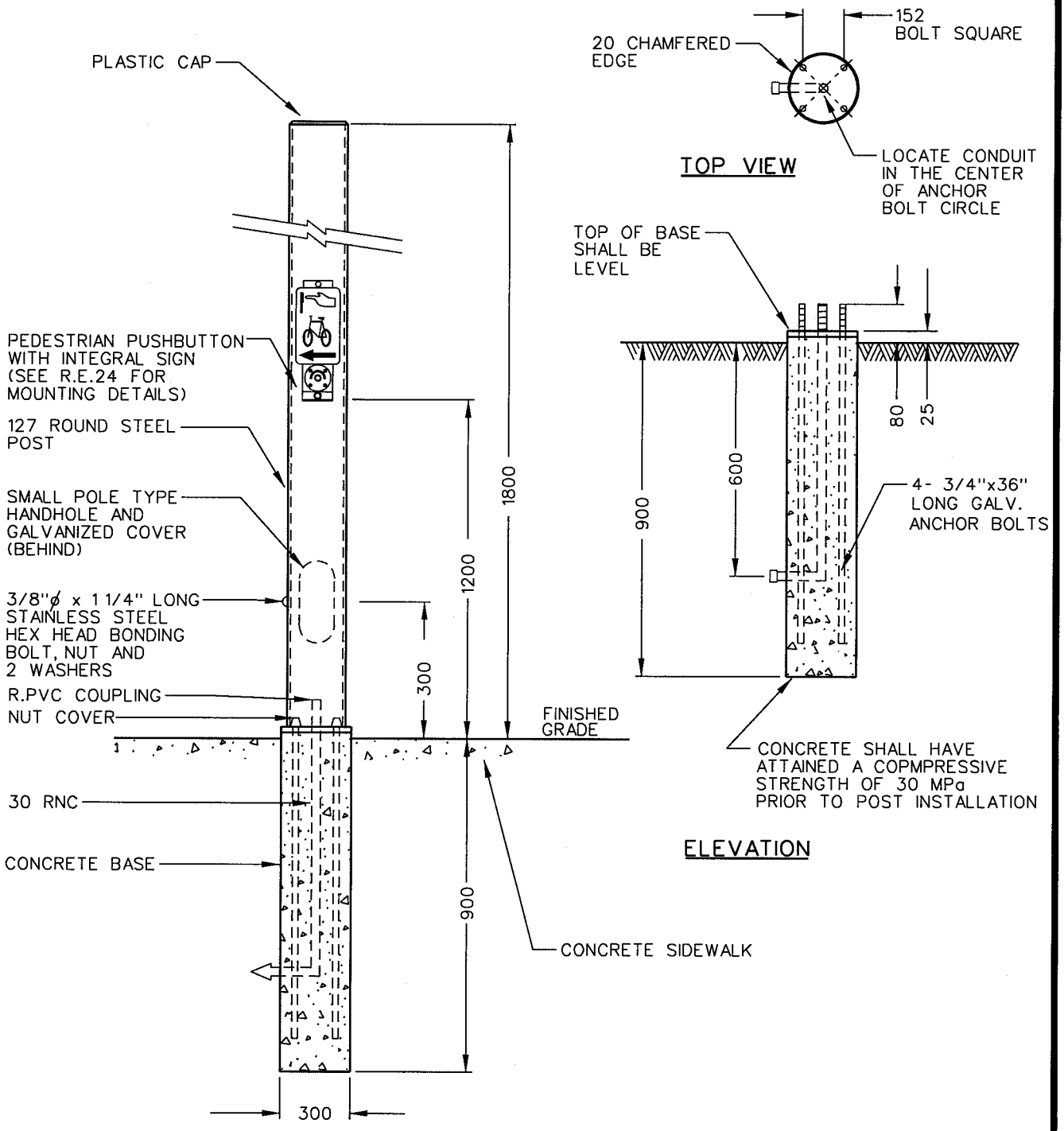
SECONDARY FILE SIGNAL HEAD MOUNTING

NOTE: (1) REFER TO CONTRACT DRAWINGS AND THE SUPPLEMENTARY SPECIFICATIONS, SECTION FOR 'TRAFFIC SIGNALS'

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1	MARCH 2002	Title: FIRE SIGNAL SIGNS
	Revision Date Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-R.E.23
Drawn By	Surrey Engineering	



NOTE: (1) REFER TO CONTRACT DRAWINGS AND THE SUPPLEMENTARY SPECIFICATIONS, SECTION FOR 'TRAFFIC SIGNALS'

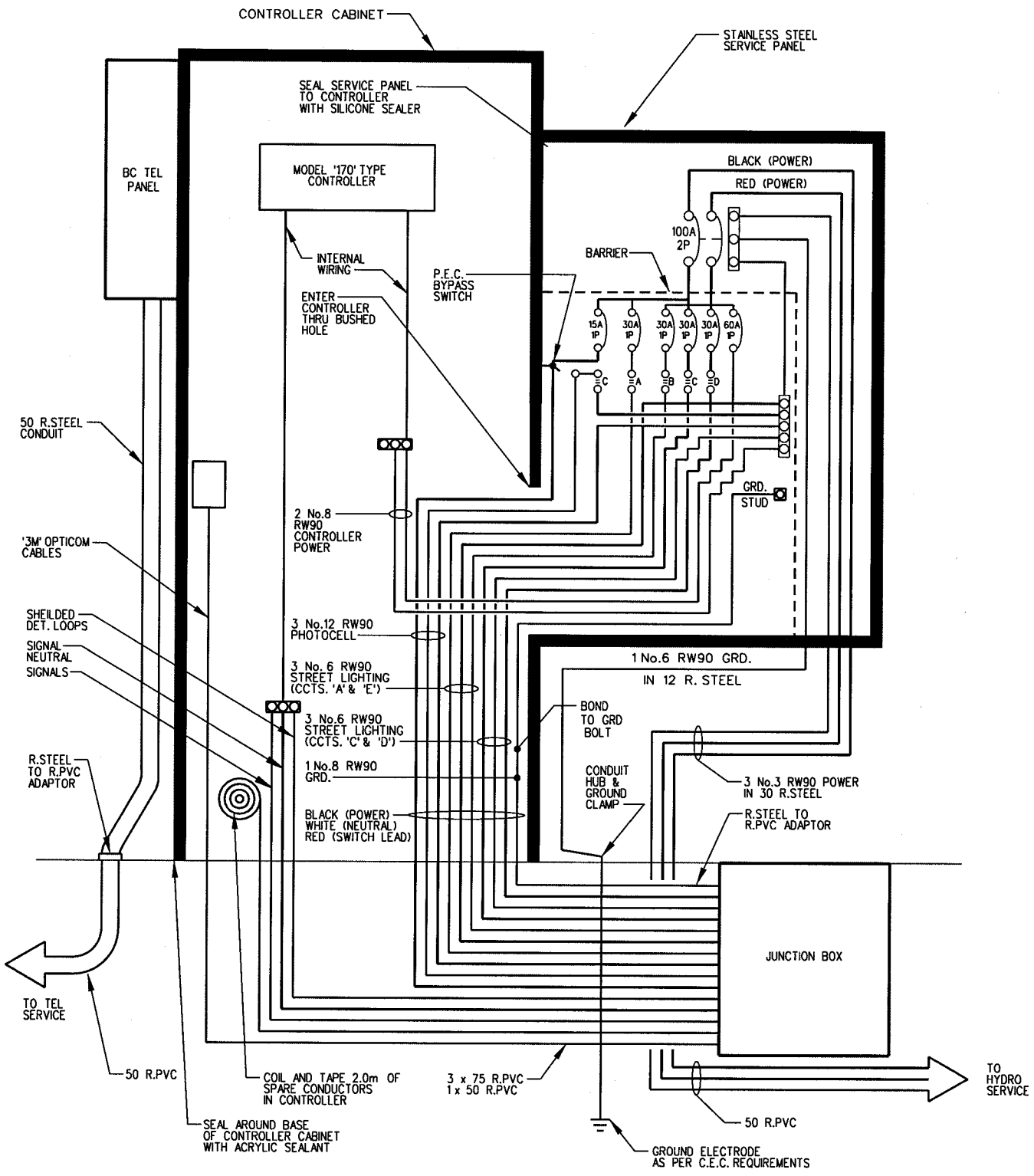
(2) POST TO BE HOT DIP GALVANIZED AFTER FABRICATION.

(3) POST FABRICATION TO MEET REQUIREMENTS OF MINISTRY OF TRANSPORTATION AND HIGHWAYS MATERIAL STANDARDS SECTION 301 - TRAFFIC SIGNAL LUMINAIRES AND SIGN POLES.

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: BICYCLE PUSHBUTTON POST
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-R.E.25
Drawn By	Surrey Engineering	

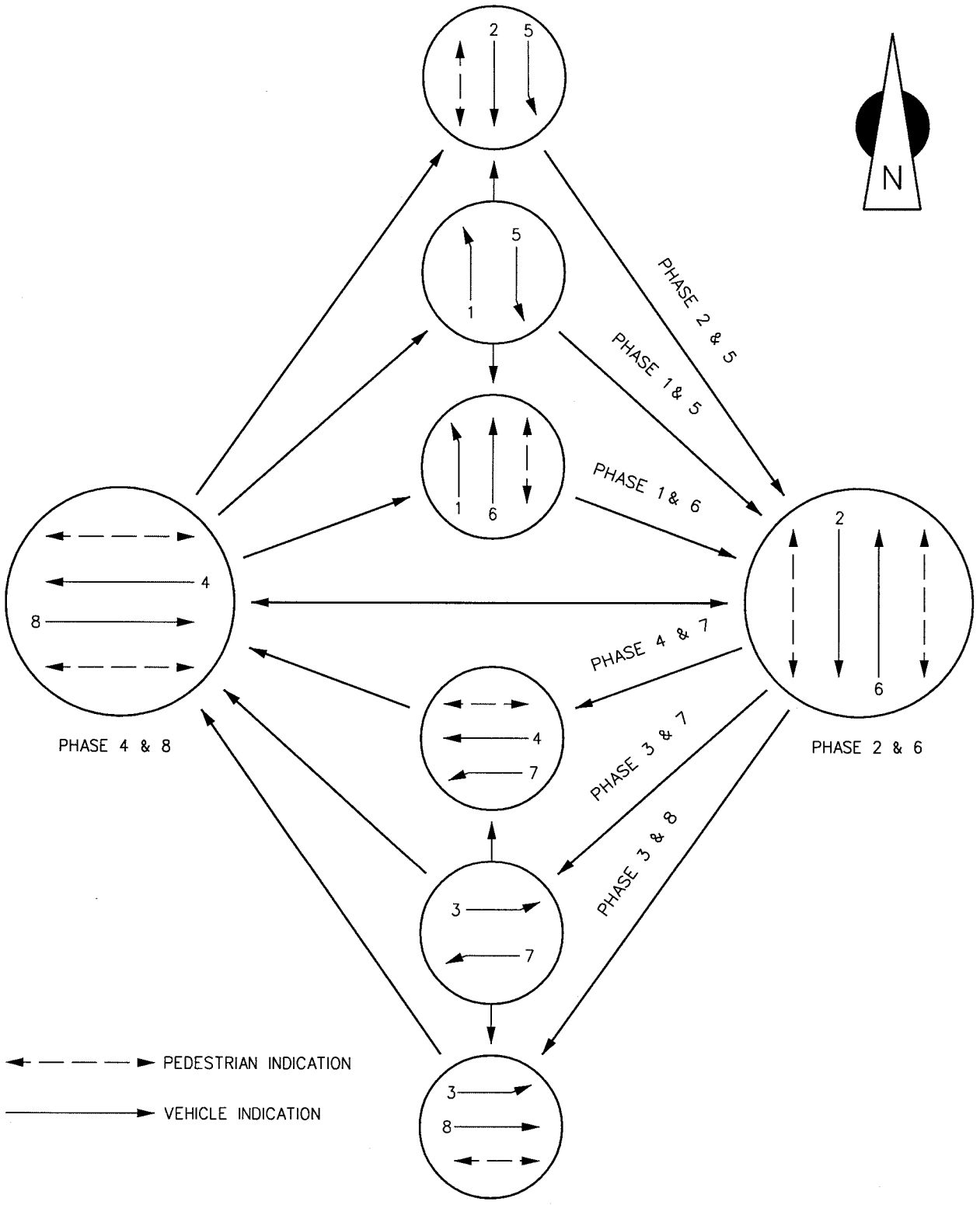


NOTE: (1) REFER TO CONTRACT DRAWINGS AND THE SUPPLEMENTARY SPECIFICATIONS, SECTION FOR 'TRAFFIC SIGNALS'

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: 100A TRAFFIC SIGNAL SERVICE PANEL WIRING SCHEMATIC
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-R.E.28
Drawn By	Surrey Engineering	



NOTE: (1) REFER TO CONTRACT DRAWINGS AND THE SUPPLEMENTARY SPECIFICATIONS, SECTION FOR 'TRAFFIC SIGNALS'

3		
2		
1		
	Revision Date	Approved

All Dimensions Shown In Millimetres, Unless Otherwise Noted

Title
PHASING DIAGRAM FOR 8-PHASE CONTROLLER

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-R.E.31

LOWER	1	Phase 5 E.CT	UPPER
	2	CENTER LANE NORTH BOUND PHASE 6 E.CT TB3 (7,8)	LEFT TURN LANE NORTH BOUND PHASE 6 E.CT TB3 (5,6)
	3	PHASE 6 E	CURB LANE NORTH BOUND PHASE 6 E.CT TB3 (9,10)
	4	PHASE 6 CALL	
	5	PHASE 7 E.CT	
	6	CENTER LANE EAST BOUND PHASE 8 E.CT TB5 (11,12)	LEFT TURN LANE EAST BOUND PHASE 8 E.CT TB5 (9,10)
	7	PHASE 8 E	CURB LANE EAST BOUND PHASE 8 E.CT TB7 (1,2)
	8	PHASE 8 CALL	
	9	WB LEFT TURN PHASE 7 E.CT TB7 (11,12)	SB LEFT TURN PHASE 5 E.CT TB7 (9,10)
	10	NOT ASSIGNED	NOT ASSIGNED
	11	SPARE 3	SPARE 2
	12	EV B	EV A
	13	EV D	EV C
LOWER	14	RR 2	RR 1 UPPER

INPUT FILE 'J' FRONT VIEW

LOWER	1	Phase 1 E.CT	UPPER
	2	CENTER LANE SOUTH BOUND PHASE 2 E.CT TB2 (7,8)	LEFT TURN LANE SOUTH BOUND PHASE 2 E.CT TB2 (5,6)
	3	PHASE 2 E	CURB LANE SOUTH BOUND PHASE 2 E.CT TB2 (9,10)
	4	PHASE 2 CALL	
	5	PHASE 3 E.CT	
	6	CENTER LANE WEST BOUND PHASE 4 E.CT TB4 (11,12)	LEFT TURN LANE WEST BOUND PHASE 4 E.CT TB4 (9,10)
	7	PHASE 4 E	CURB LANE WEST BOUND PHASE 4 E.CT TB6 (1,2)
	8	PHASE 4 CALL	
	9	EB LEFT TURN PHASE 3 E.CT TB6 (11,12)	NB LEFT TURN PHASE 1 E.CT TB6 (9,10)
	10	NOT ASSIGNED	NOT ASSIGNED
	11	SPARE 1	ADVANCE FUTURE
	12	PED PHASE 4 TB8 (5,6)	PED PHASE 2 TB8 (4,6)
	13	PED PHASE 8 TB9 (8,9)	PED PHASE 6 TB9 (7,9)
LOWER	14	STOP TIME	FLASH SENSOR UPPER

INPUT FILE 'I' FRONT VIEW

LEGEND

EV	EMERGENCY VEHICHLE
CT	COUNT
E	EXTENSION
PED	PEDESTRIAN PUSH BUTTON
RR	RAILROAD PRE-EMPTION

THIS SIDE UP →

NOTE: (1) REFER TO CONTRACT DRAWINGS AND THE SUPPLEMENTARY SPECIFICATIONS, SECTION FOR 'TRAFFIC SIGNALS'

3		
2		
1		
	Revision Date	Approved

All Dimensions Shown In Millimetres, Unless Otherwise Noted

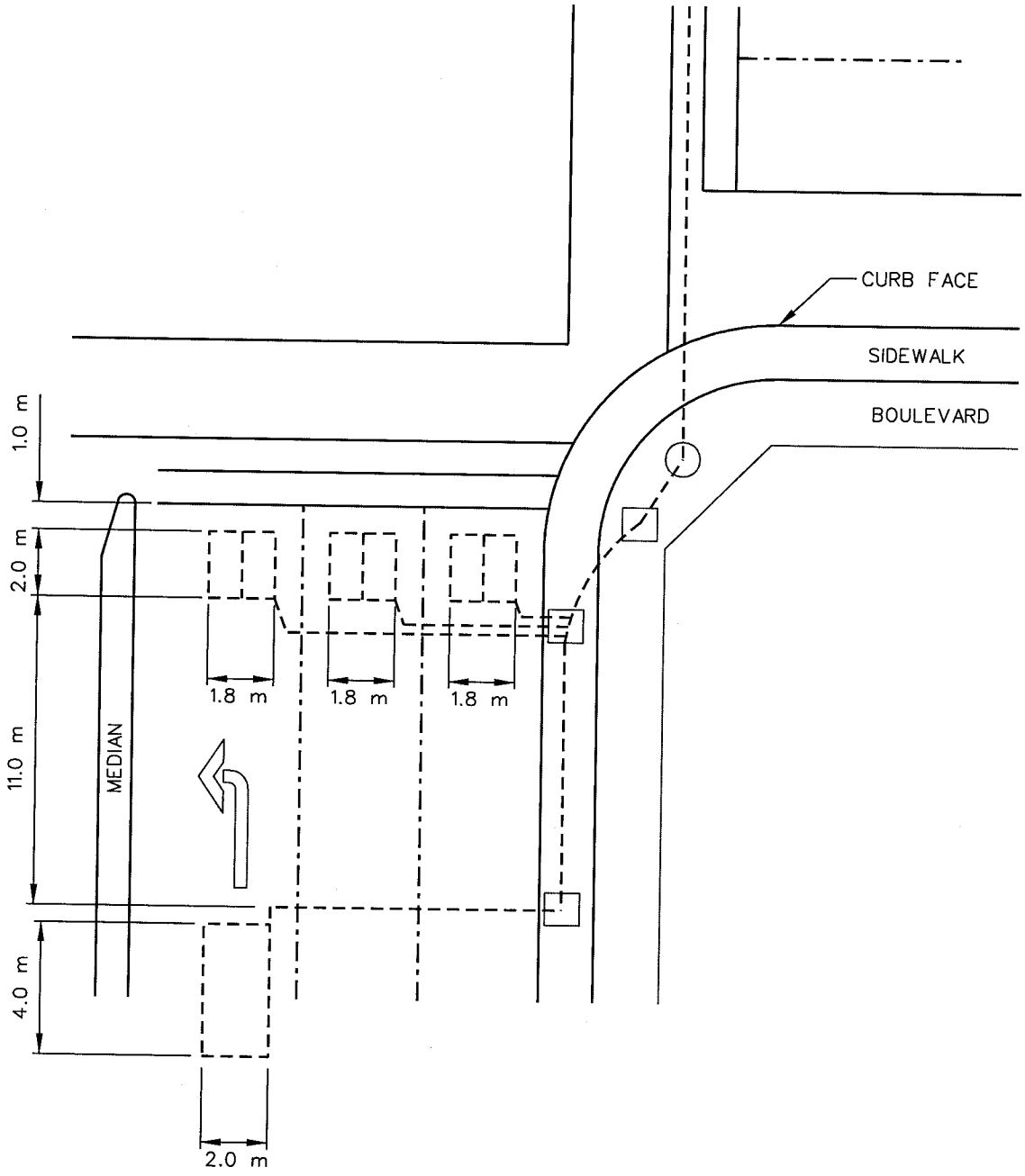
Title: CONTROLLER CABINET LOOP, PRE-EMPTION AND PEDESTRIAN ASSIGNMENTS

SURREY CITY OF PARKS

SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.E.32



NOTE: (1) REFER TO CONTRACT DRAWINGS AND THE SUPPLEMENTARY SPECIFICATIONS, SECTION FOR 'TRAFFIC SIGNALS'

(2) LOOPS SHALL BE LOCATED IN THE CENTRE OF EACH LANE UNLESS OTHERWISE NOTED ON CONTRACT DRAWINGS.

3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1	MARCH 2002	Title: DETECTOR LOOP LOCATIONS
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-R.E.33

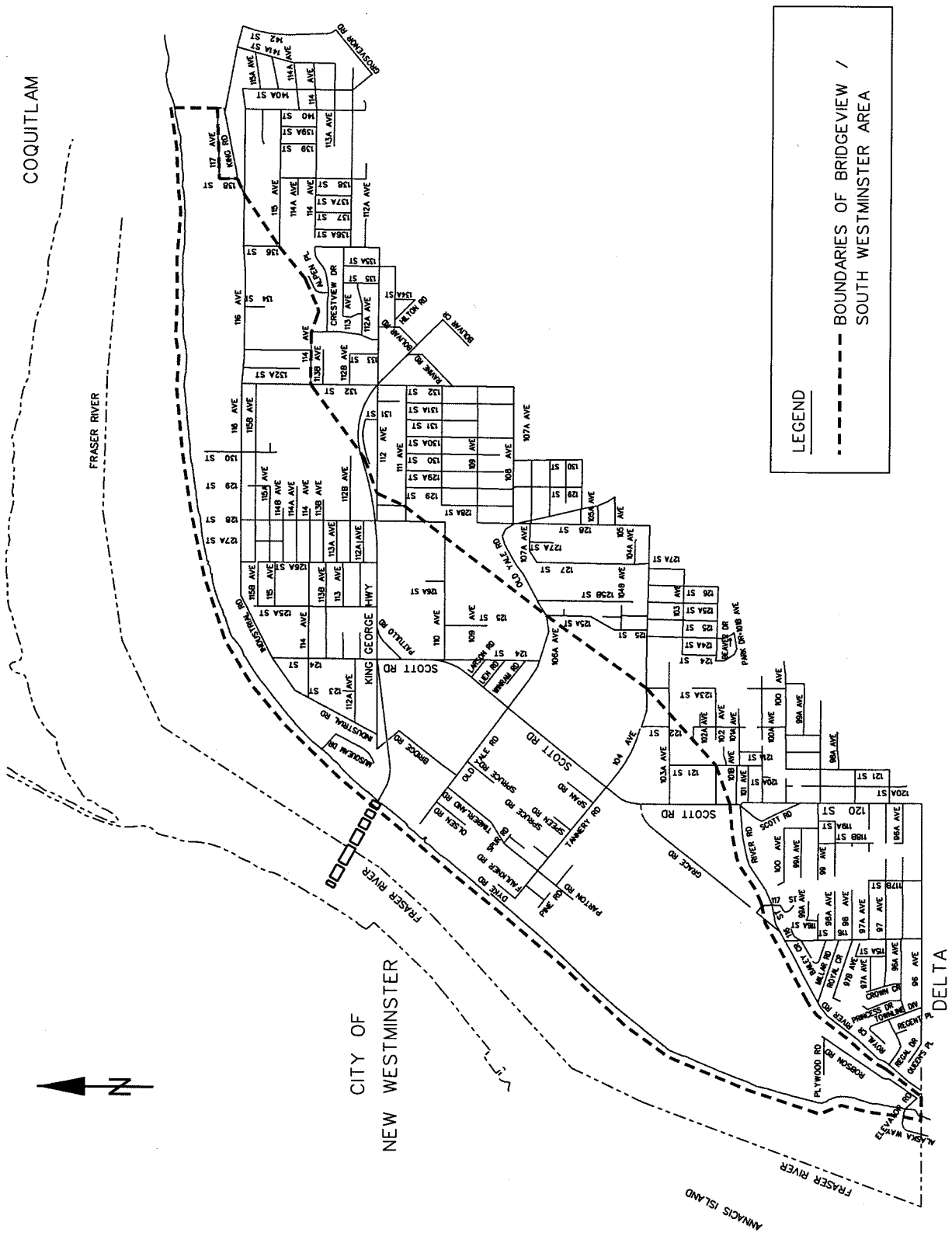
CITY OF SURREY

Engineering Department

Supplementary Standard Drawings

Drawing Table of Contents - Unique Designated Areas

Drawing Number	Drawing Title
SSD-U.1	Bridgeview / South Westminster - Area Delineation
SSD-U.1.1	Unassigned
SSD-U.1.2	Unassigned
SSD-U.1.3	Typical Road Sections - Roads Without Curbs
SSD-U.1.4	Residential Driveway Crossing Bridgeview & South Westminster
SSD-U.1.5	Driveway for roads without curbs and swale Bridgeview & South Westminster
SSD-U.2	West Panorama Ridge - Area Delineation
SSD-U.2.1	Ditch Crossings - West Panorama Ridge
SSD-U.2.2	Typical Road Sections - West Panorama Ridge
SSD-U.3	Surrey City Center - Area Delineation
SSD-U.3.1	Unassigned
SSD-U.4	Central Semiahmoo - Area Delineation
SSD-U.4.2	Typical Road Sections - Limited Local
SSD-U.4.3	Typical Road Sections - Through Local
SSD-U.4.4	Typical Road Sections - Limited or Through Collector

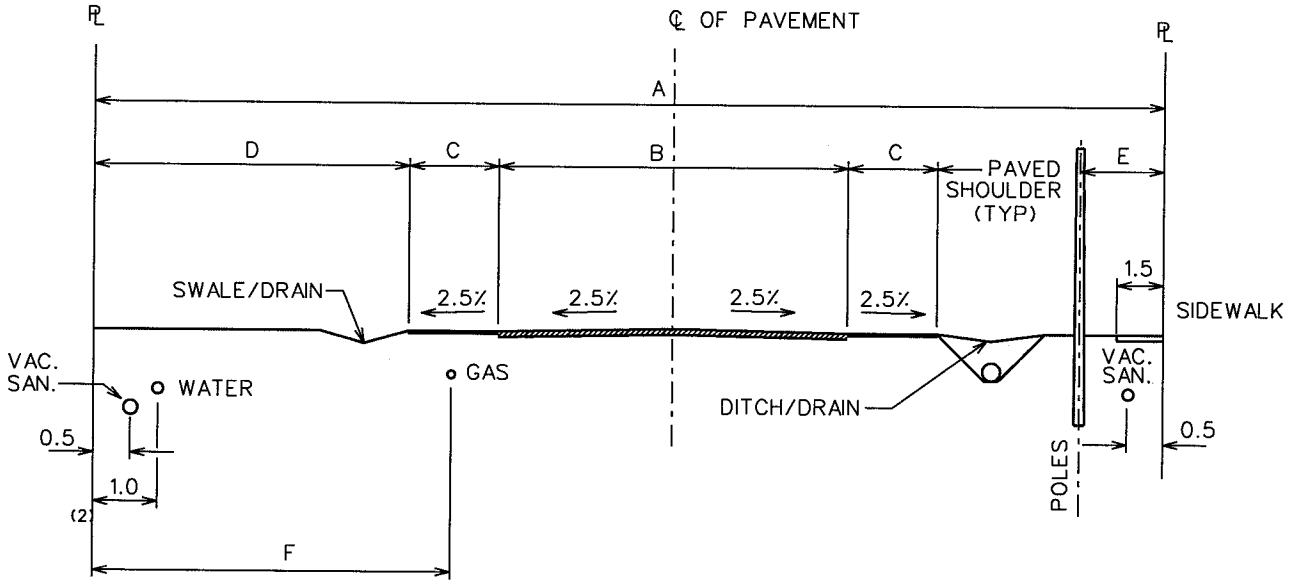


3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: BRIDGEVIEW / SOUTH WESTMINSTER AREA DELINEATION
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-U.1



A	B	C	D	E	F
20	11.0	2.0	1.75	1.8	2.75
20	12.2	2.0	1.2	1.8	2.2
24	14.0	2.0	3.0	1.8	4.0

BRIDGEVIEW-SOUTH WESTMINSTER[1]
EXCEPT RF (F) ROADS

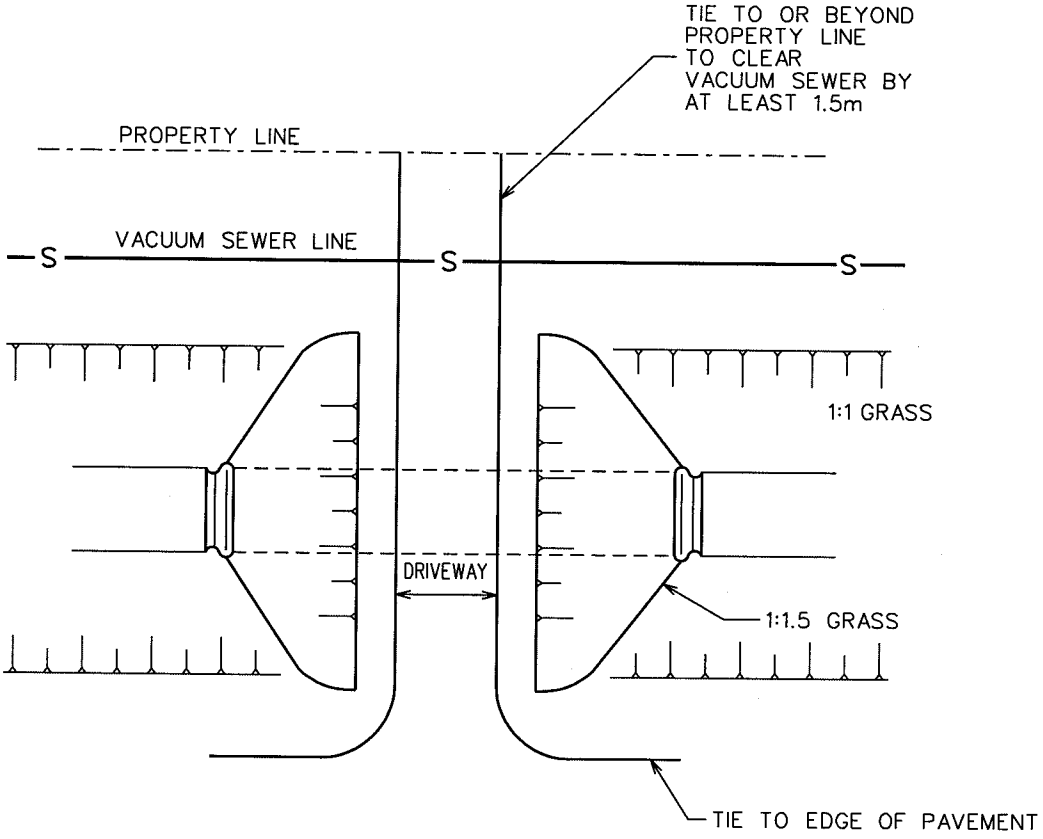
NOTE: (1) INTERIM STANDARD FOR ROADS NOT PRELOADED IN BRIDGEVIEW AND SOUTH WESTMINSTER; BUILT SUBJECT TO THE APPROVAL OF THE ENGINEER.

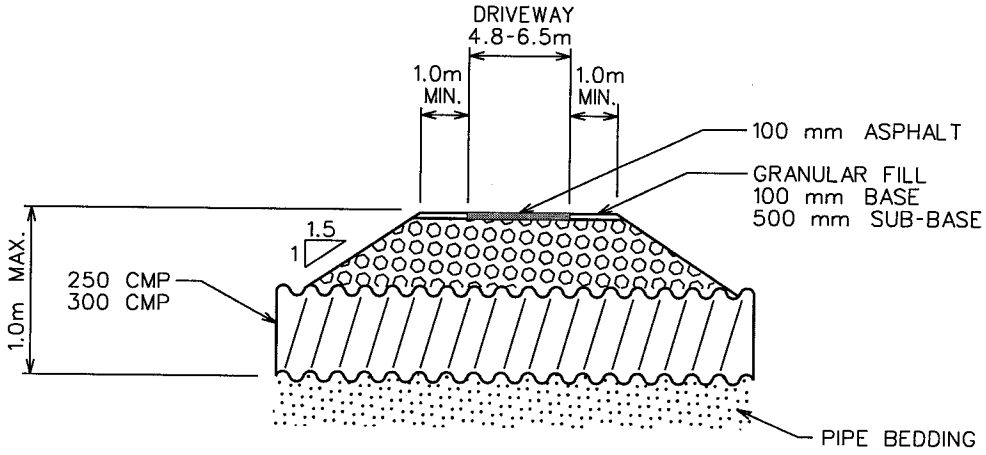
3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1		Title: TYPICAL ROAD SECTIONS- ROADS WITHOUT CURBS
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-U.1.3





DRIVEWAY CROSSING

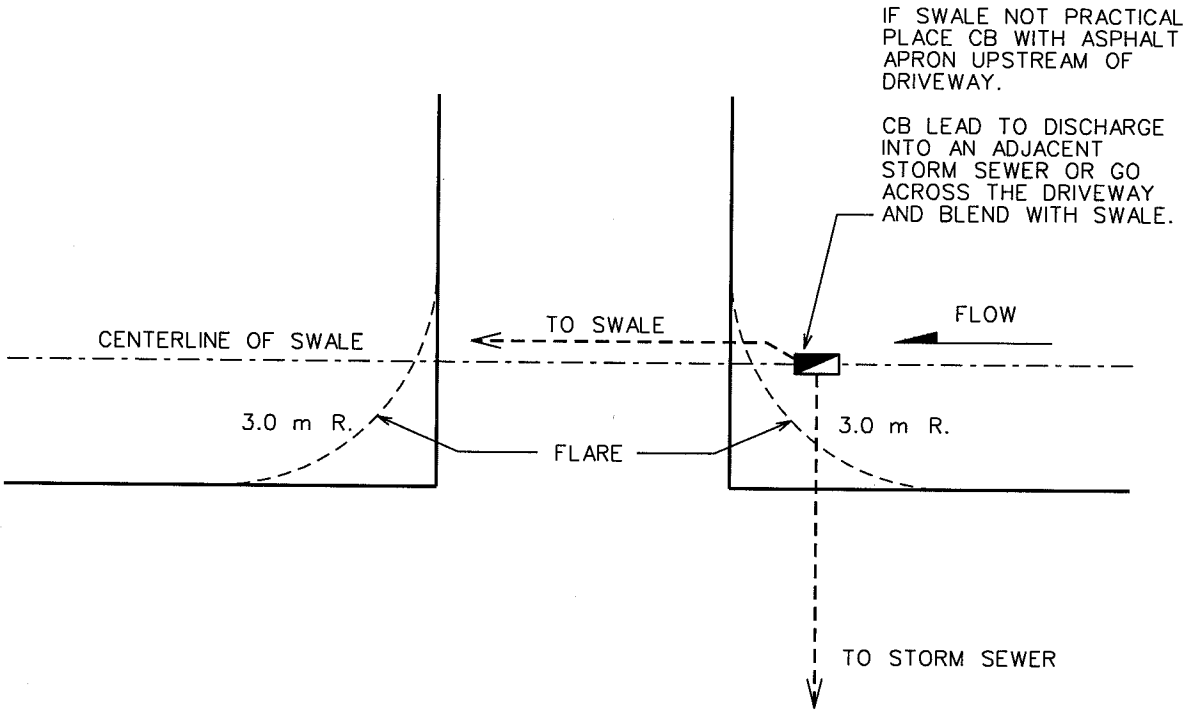
3			All Dimensions Shown In Millimetres, Unless Otherwise Noted
2			
1			Title: RESIDENTIAL DRIVEWAY CROSSING BRIDGEVIEW & SOUTH WESTMINSTER
	Revision Date	Approved	

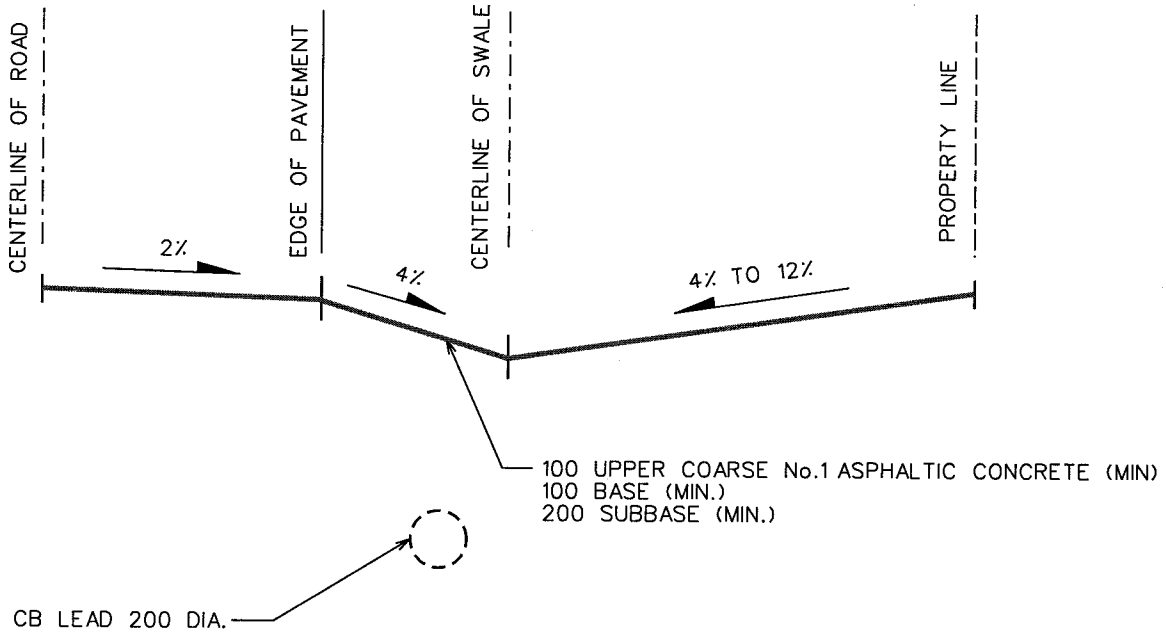
SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	September 1999
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-U.1.4

G:\Mapping\Cad\Standards1999\UniqueDesignation\ssdunique.dgn





SECTION THROUGH DRIVEWAY

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title DRIVEWAY FOR ROADS WITHOUT CURBS & SWALE BRIDGEVIEW & SOUTH WESTMINSTER
	Revision Date Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	September 1999	SSD-U.1.5
Drawn By	Surrey Engineering	

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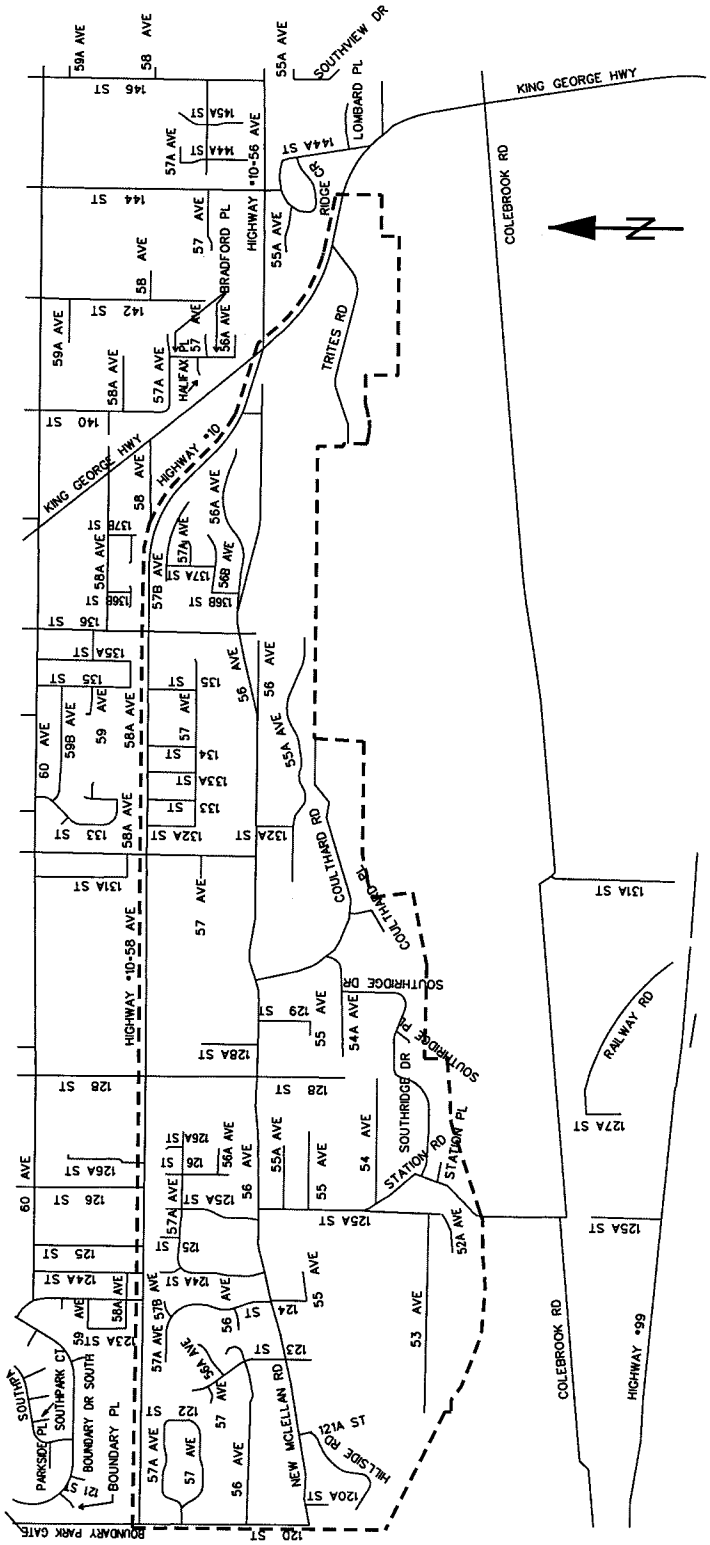


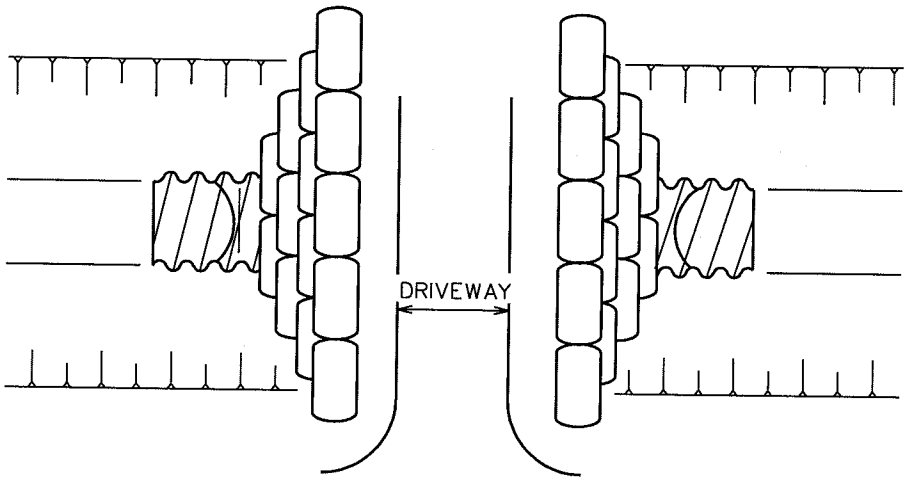
LEGEND

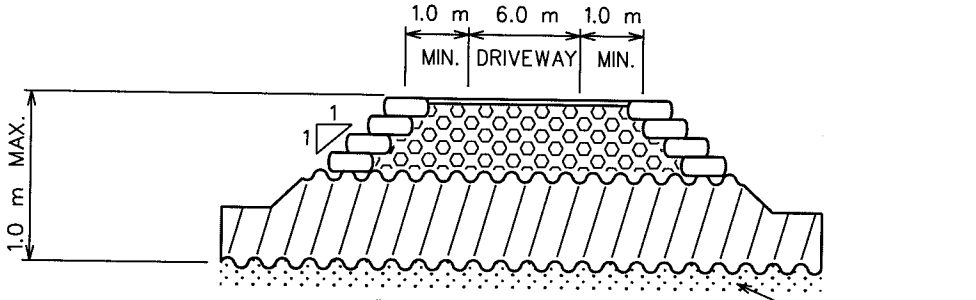
---------- BOUNDARIES OF WEST PANORAMA RIDGE

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		Title: WEST PANORAMA RIDGE AREA DELINEATION
	Revision Date / Approved	

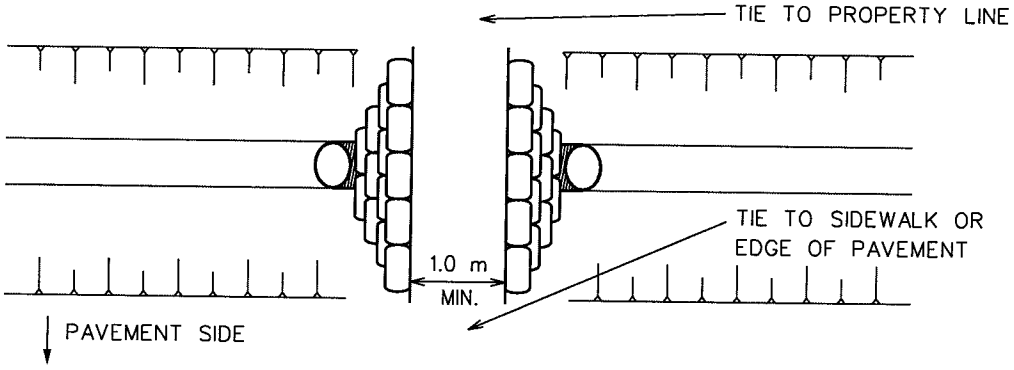
SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

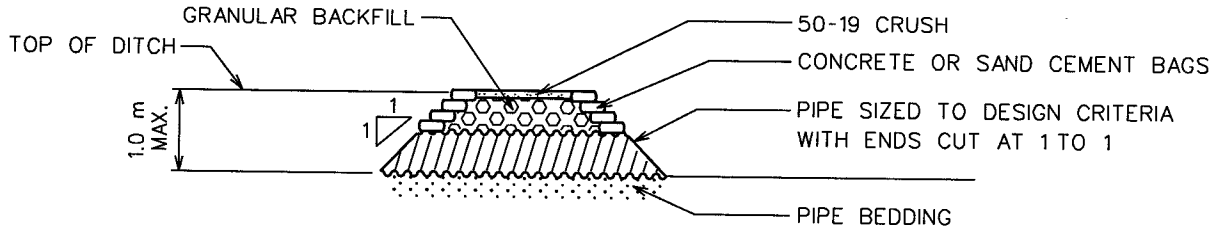
Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-U.2
Drawn By	Surrey Engineering	





DRIVEWAY CROSSING





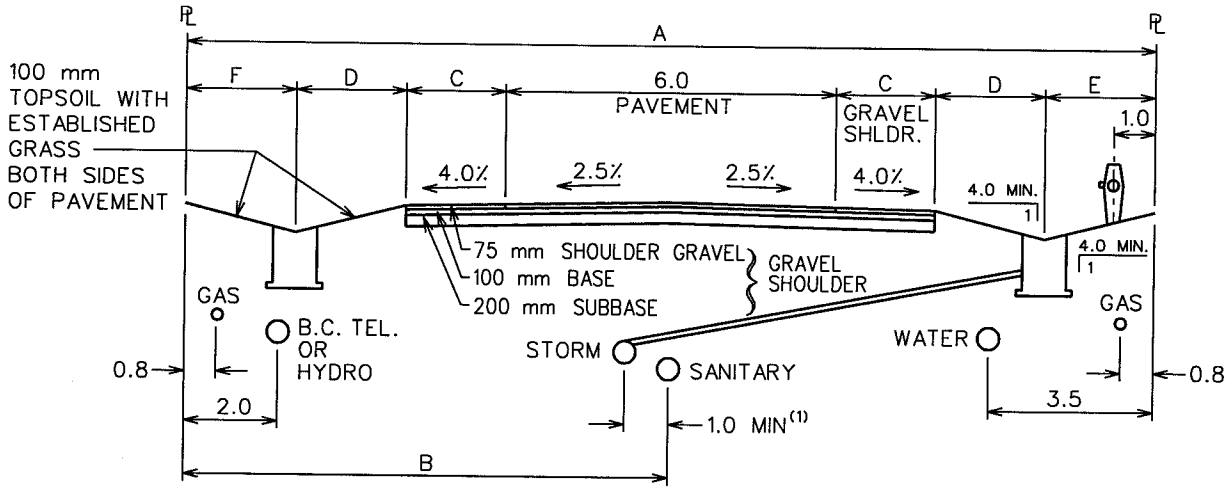
PEDESTRIAN DITCH CROSSING

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		
	Revision Date Approved	Title: DITCH CROSSINGS WEST PANORAMA RIDGE

SURREY CITY OF PARKS
SUPPLEMENTARY STANDARD DRAWINGS

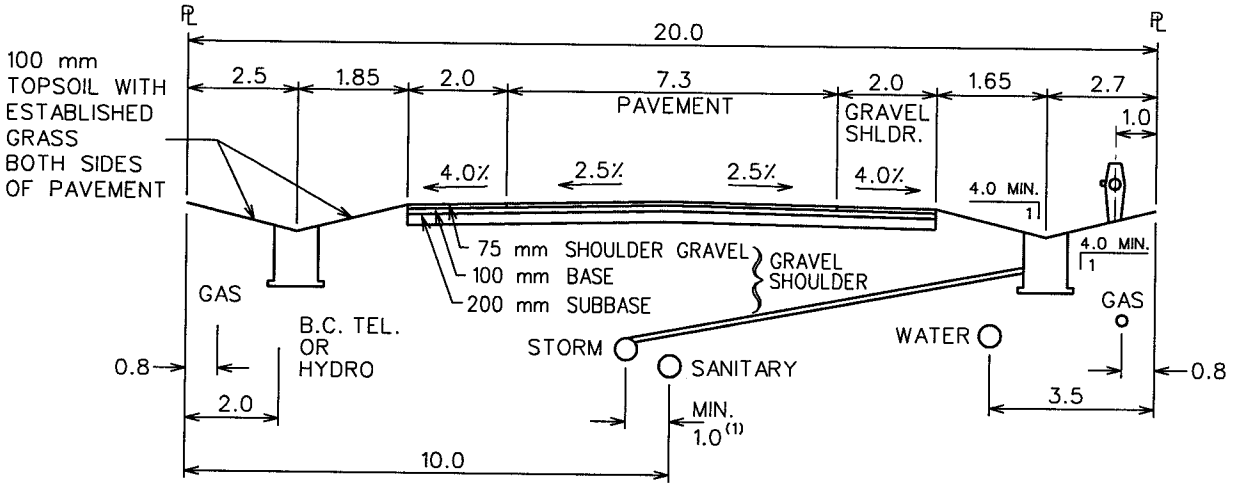
Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-U.2.1



LOCAL

A	B	C	D	E	F
16.5	8.25	2.0	1.5	1.8	1.7
20.0	10.0	2.0	2.4	2.7	2.5



COLLECTOR

NOTES : (1) REFER TO MINIMUM SPACING BETWEEN SEWERS IN COMMON TRENCH DRAWING.

3		
2		
1		
	Revision Date	Approved

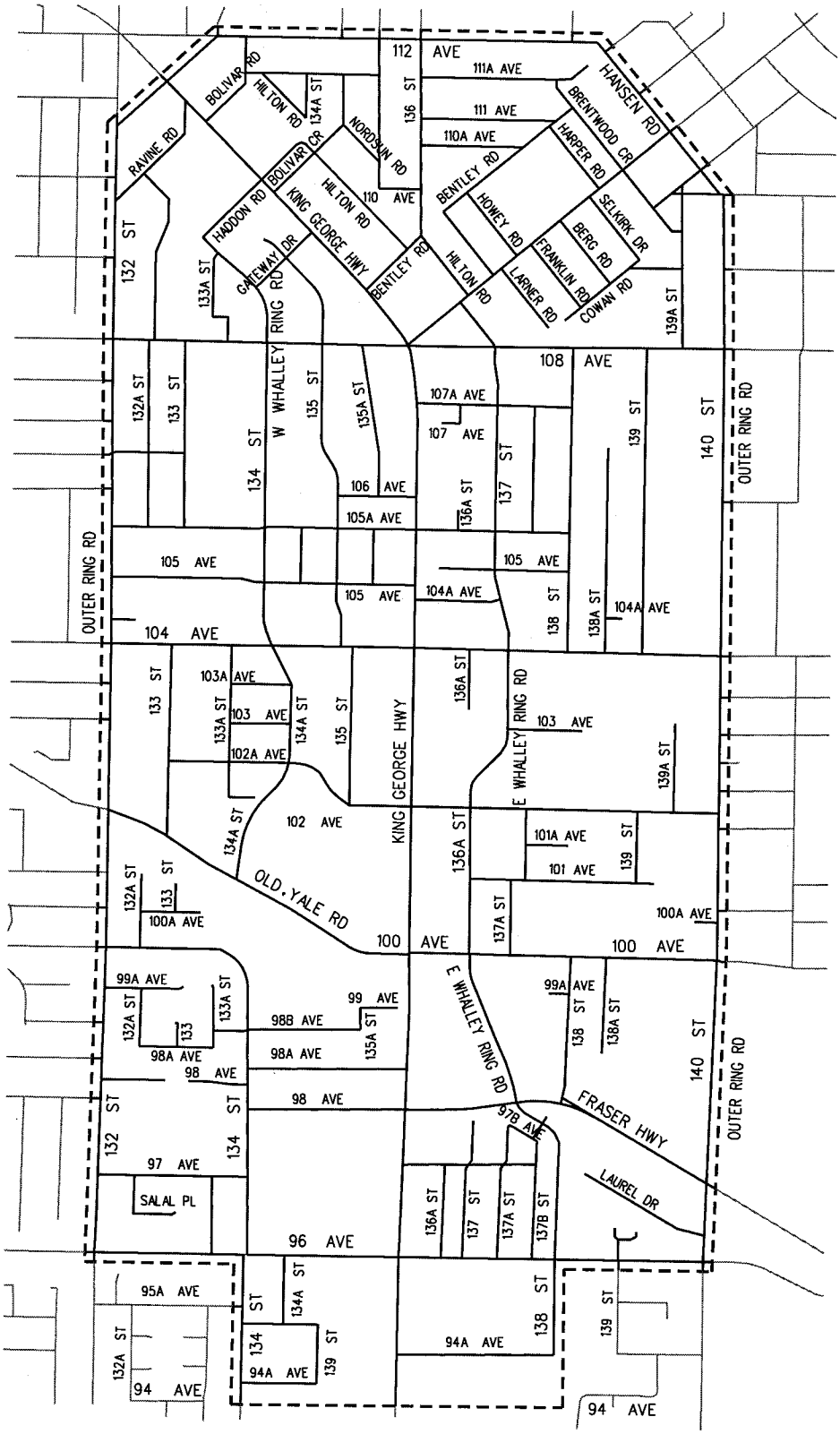
All Dimensions Shown In Metres,
Unless Otherwise Noted

Title: TYPICAL ROAD SECTIONS-
WEST PANORAMA RIDGE

SURREY
CITY OF PARKS
SUPPLEMENTARY
STANDARD
DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-U.2.2



3		
2	October 2002	G. Gahr
1	August 2002	G. Gahr
	Revision Date	Approved

All Dimensions Shown In Millimetres, Unless Otherwise Noted

Title: SURREY CITY CENTRE AREA DELINEATION

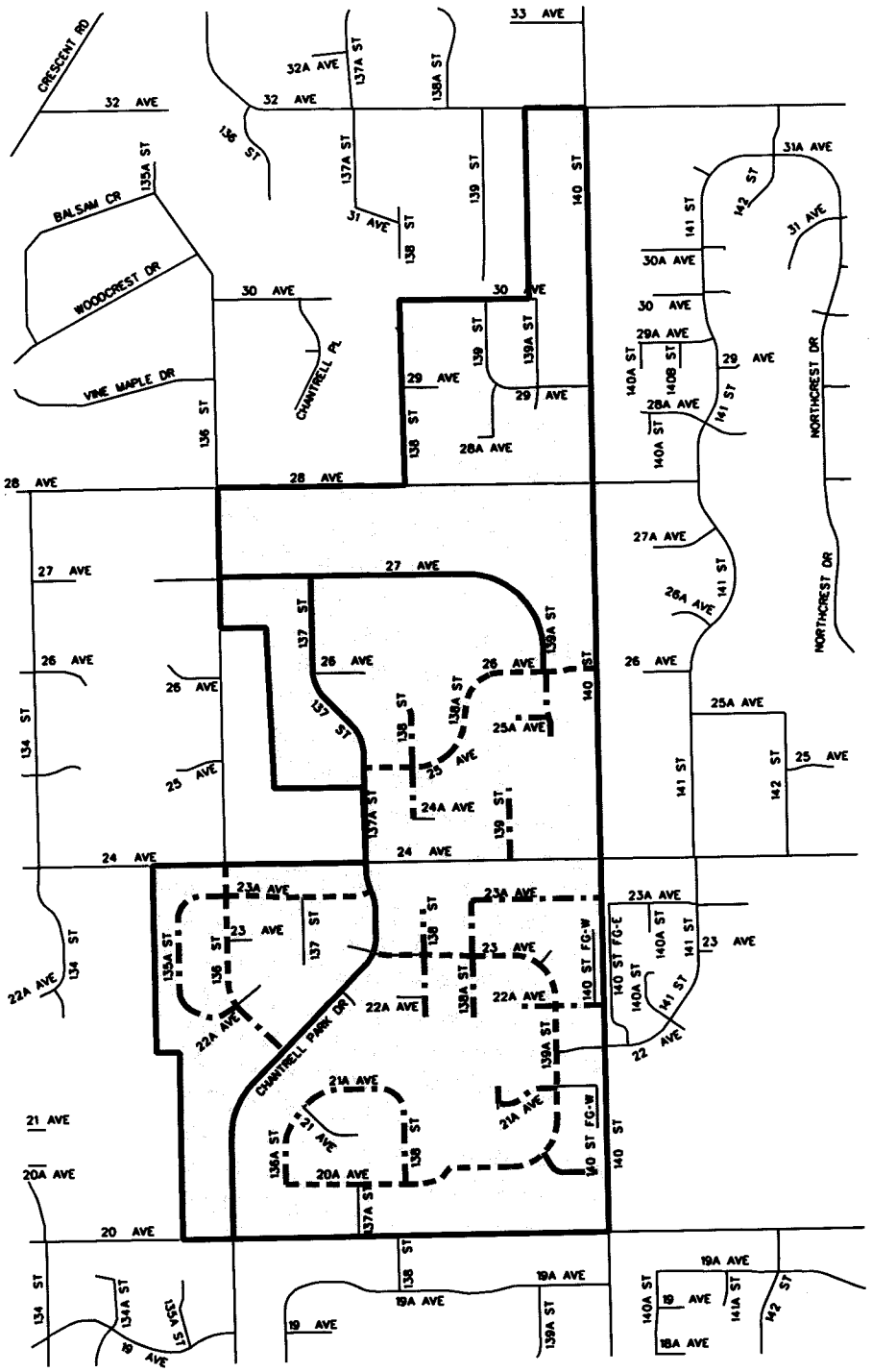
SURREY CITY OF PARKS

SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER

SSD-U.3.0



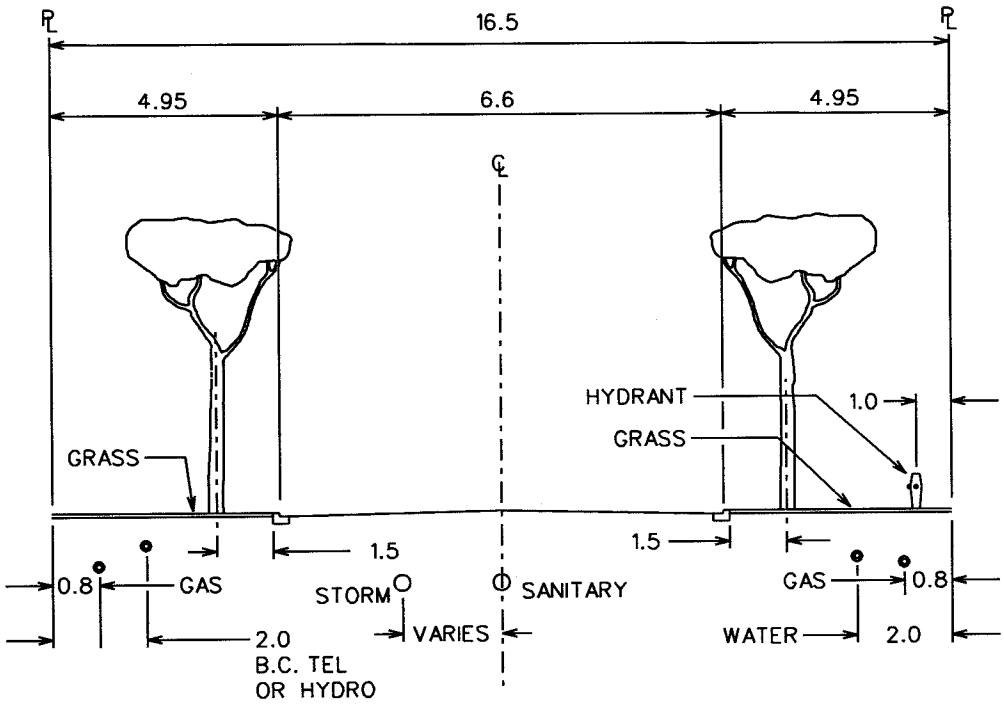
LEGEND

- BOUNDARIES OF CENTRAL SEMIAHMOO
- LIMITED or THROUGH COLLECTOR
- THROUGH LOCAL
- LIMITED LOCAL

3		All Dimensions Shown In Millimetres, Unless Otherwise Noted
2		
1		
	Revision Date Approved	Title: CENTRAL SEMIAHMOO AREA DELINEATION

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-U.4
Drawn By	Surrey Engineering	



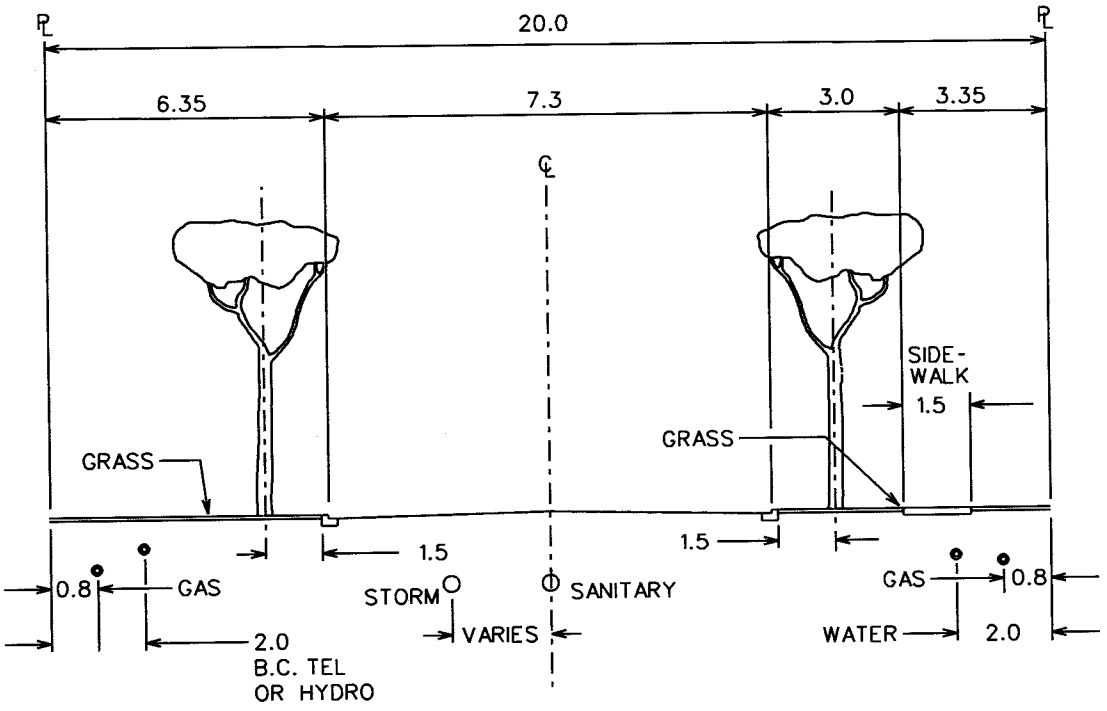
STREET LIGHTS LOCATED 0.8 m BACK FROM FACE OF CURB

PROPOSED

3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1		Title: TYPICAL ROAD SECTIONS LIMITED LOCAL
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved		DRAWING NUMBER
Date	APRIL 1998	SSD-U.4.2
Drawn By	Surrey Engineering	



STREET LIGHTS LOCATED 0.8 m BACK FROM FACE OF CURB

HYDRANTS LOCATED 1.0 m INTO BOULEVARD FROM EDGE OF SIDEWALK

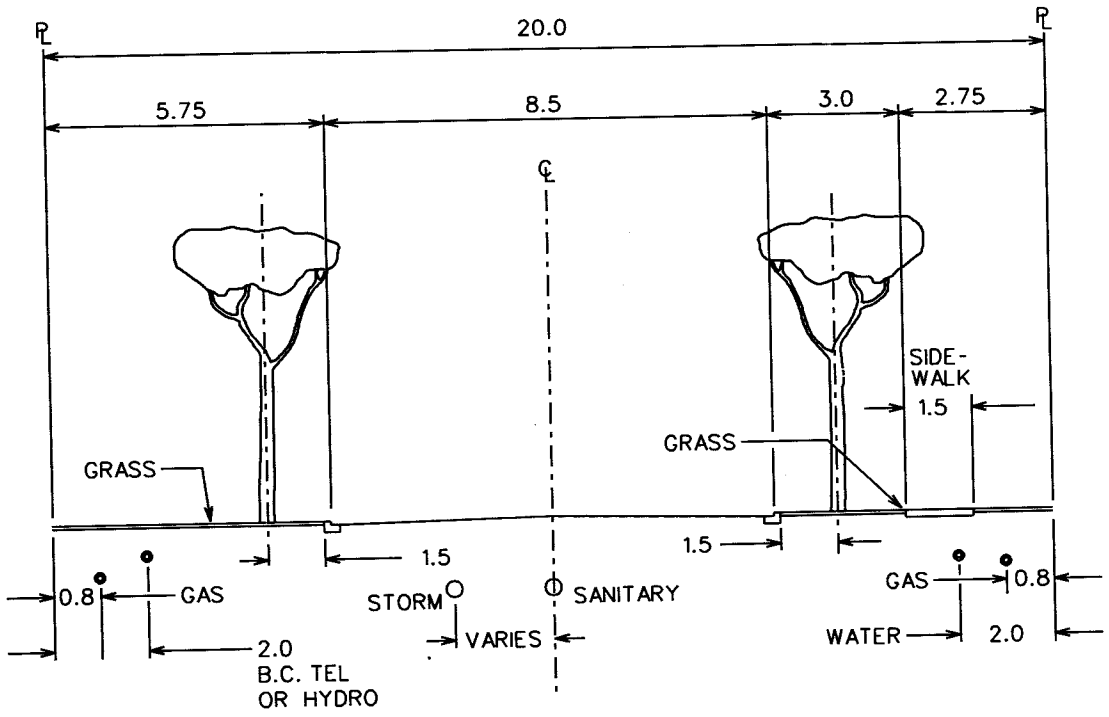
PROPOSED

3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1		Title: TYPICAL ROAD SECTIONS THROUGH LOCAL
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER
SSD-U.4.3



STREET LIGHTS LOCATED 0.8 m BACK FROM FACE OF CURB

HYDRANTS LOCATED 1.0 m INTO BOULEVARD FROM EDGE OF SIDEWALK

PROPOSED

3		All Dimensions Shown In Metres, Unless Otherwise Noted
2		
1		Title: TYPICAL ROAD SECTIONS LIMITED OR THROUGH COLLECTOR
	Revision Date / Approved	

SURREY CITY OF PARKS — SUPPLEMENTARY STANDARD DRAWINGS

Approved	
Date	APRIL 1998
Drawn By	Surrey Engineering

DRAWING NUMBER: SSD-U.4.4