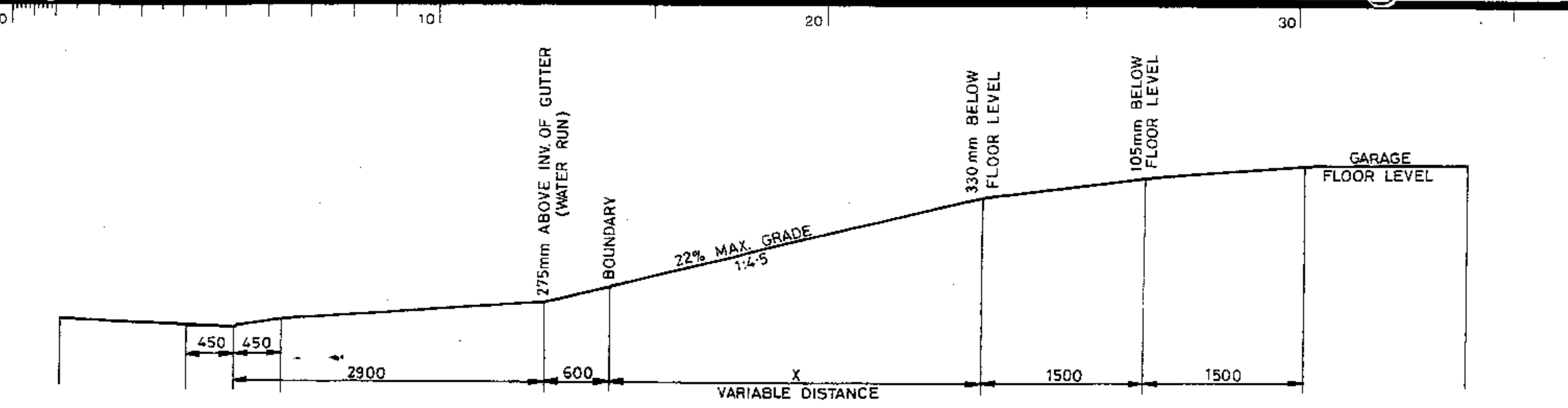
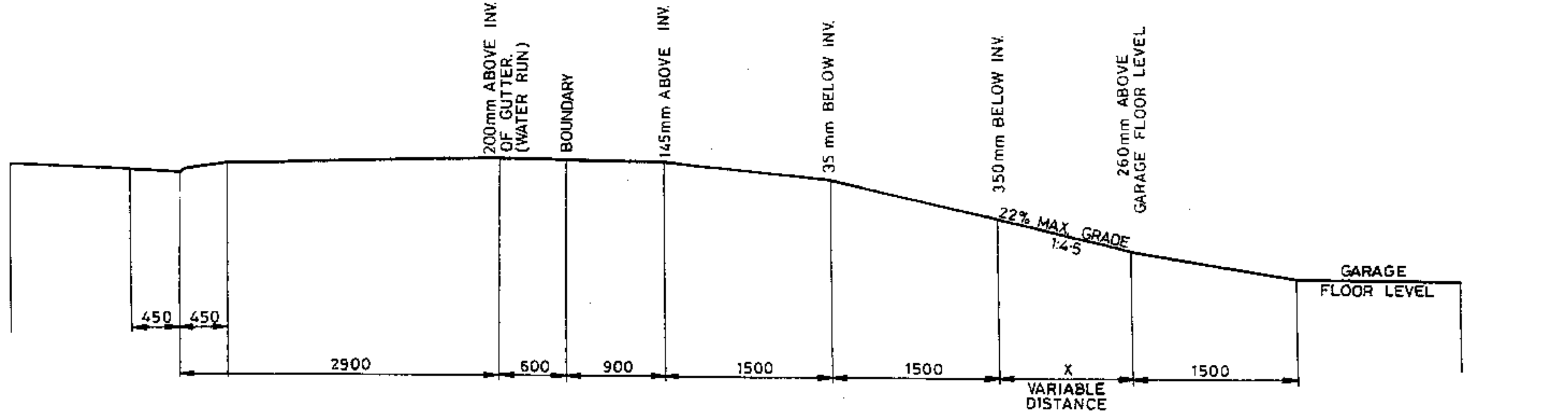
APPENDIX

A





BAULKHAM HILLS SHIRE COUNCIL

MAXIMUM ALLOWABLE GRADES FOR DRIVEWAYS WITH 3.5m FOOTPATH.

DRAWN BY GB	DATUM
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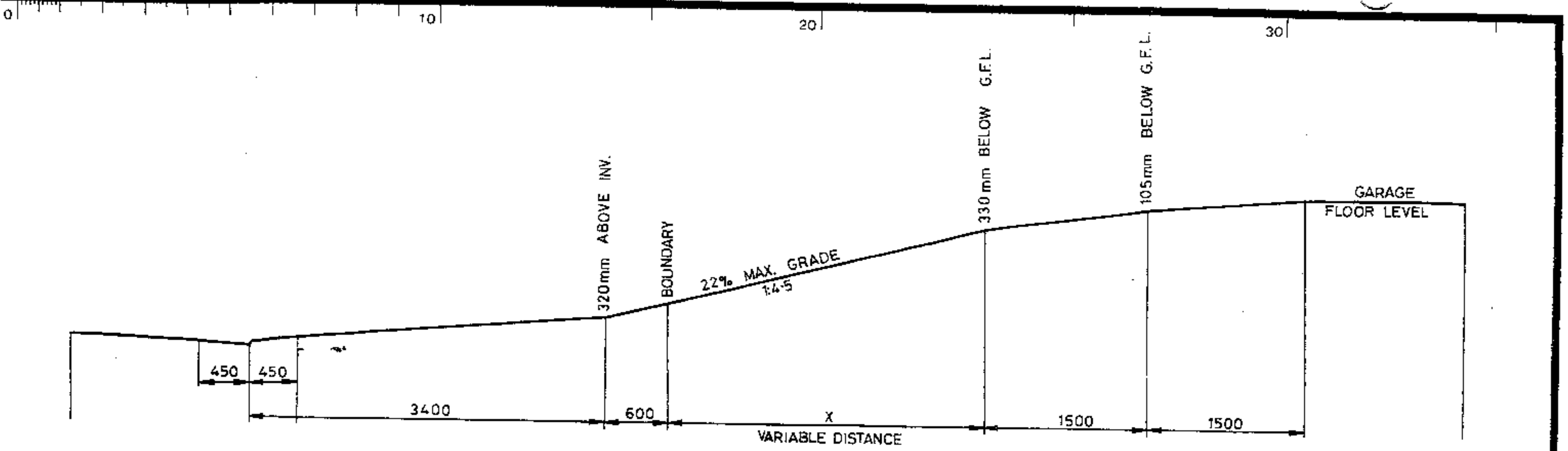
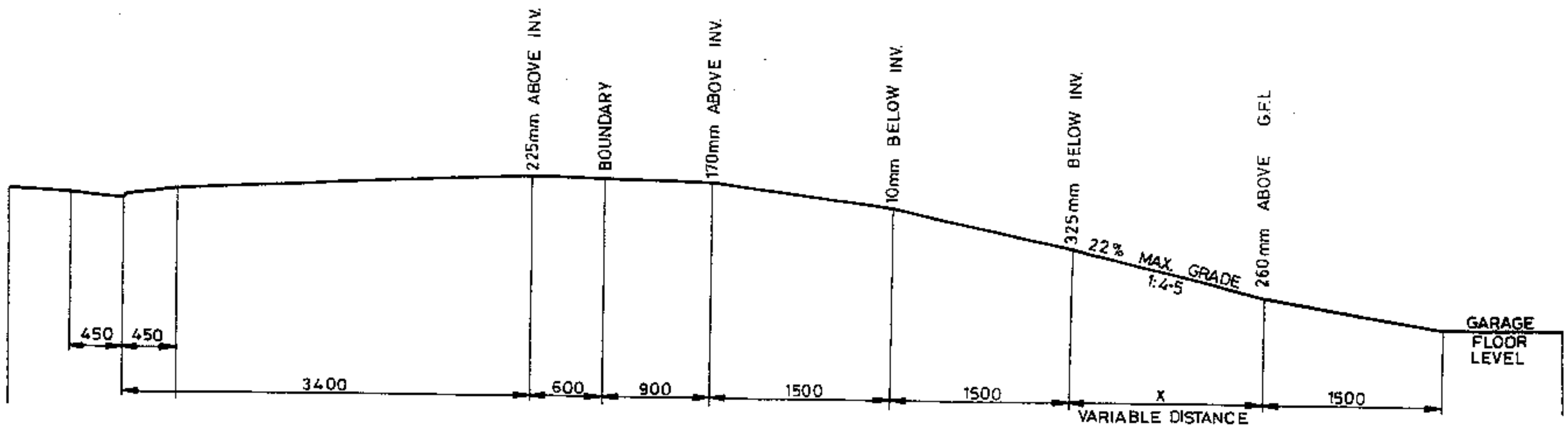
FILE	PLAN REF. No. SD 101
SHEET 1 OF 5	





BAULKHAM HILLS SHIRE COUNCIL

MAXIMUM ALLOWABLE GRADES FOR DRIVEWAYS WITH 4m FOOTPATH.

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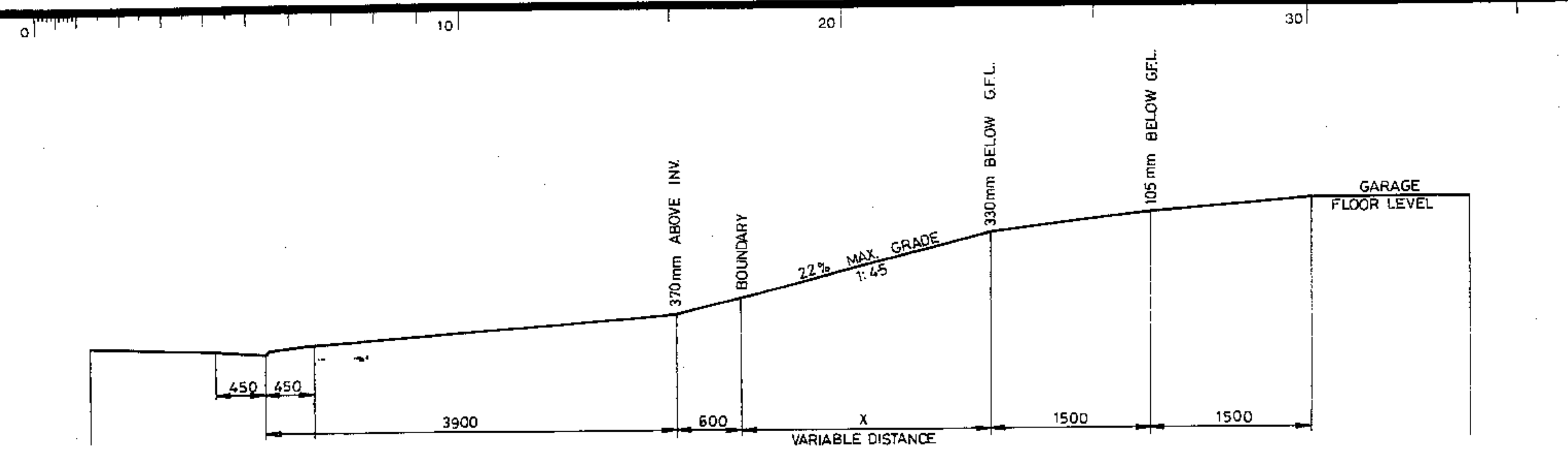
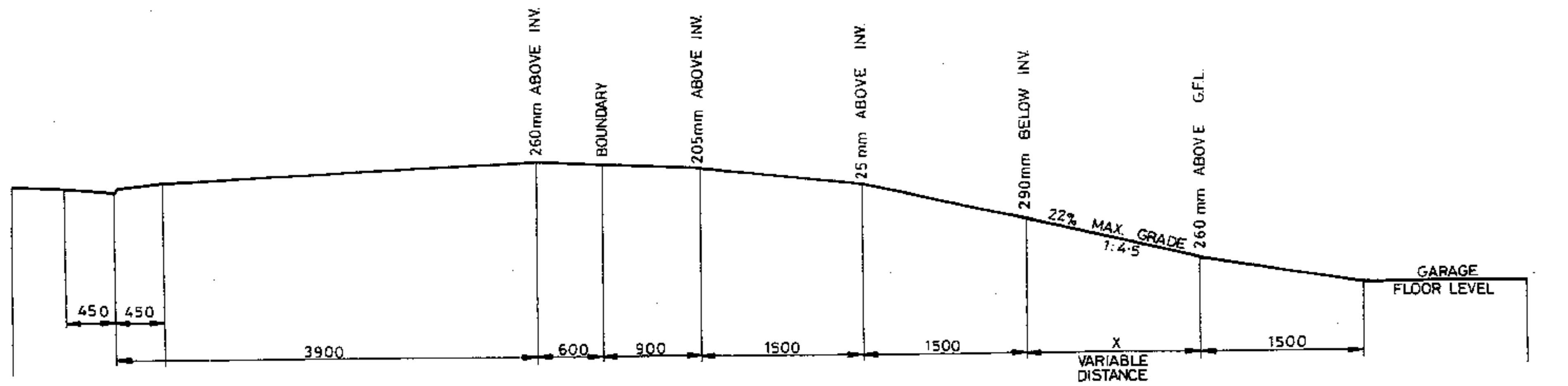
FILE		PLAN REF. No.	SD 101
SHEET 2 OF 5			





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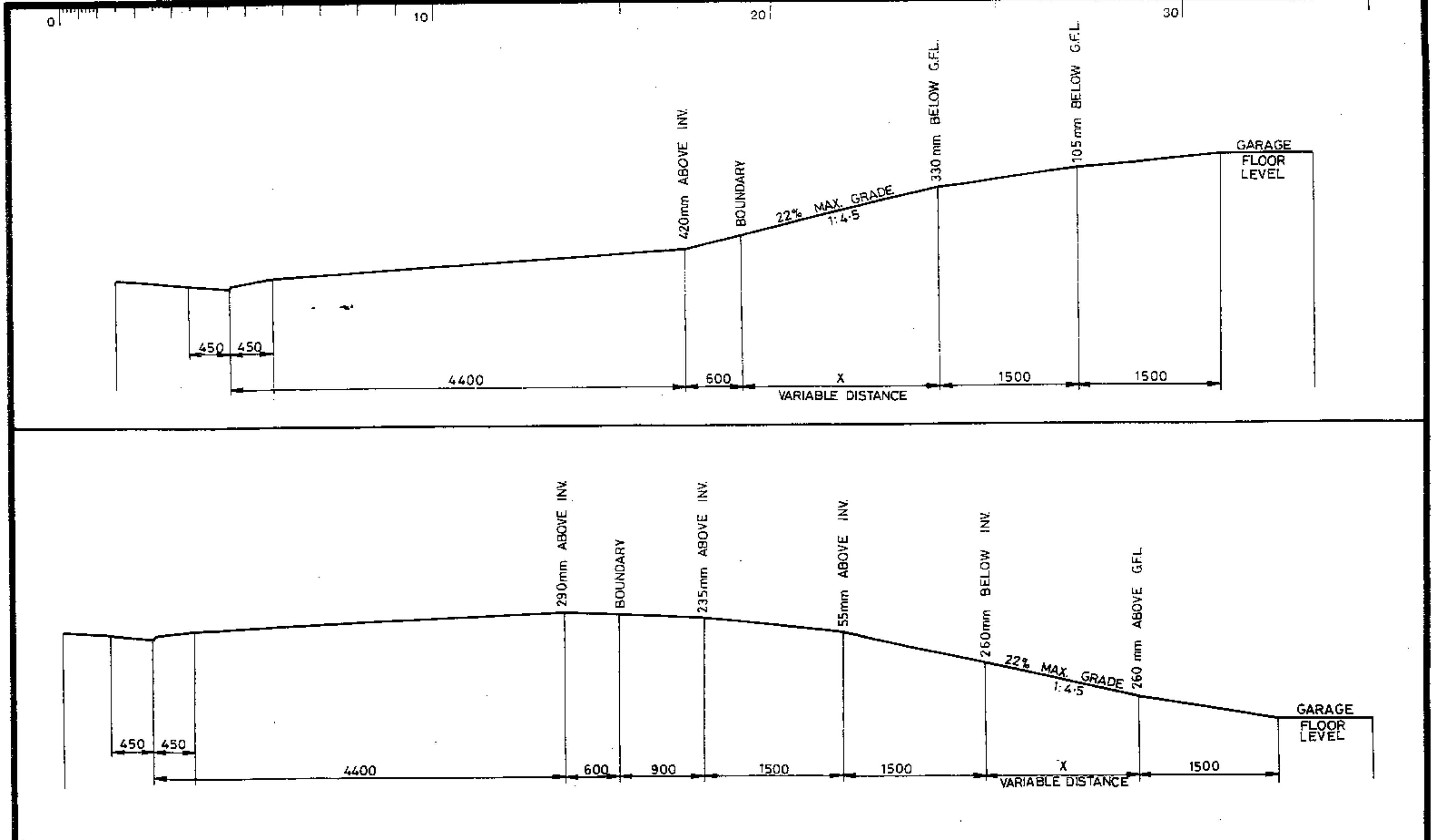
		FILE	PLAN REF. No. SD 101
		SHEET 3 OF 5	



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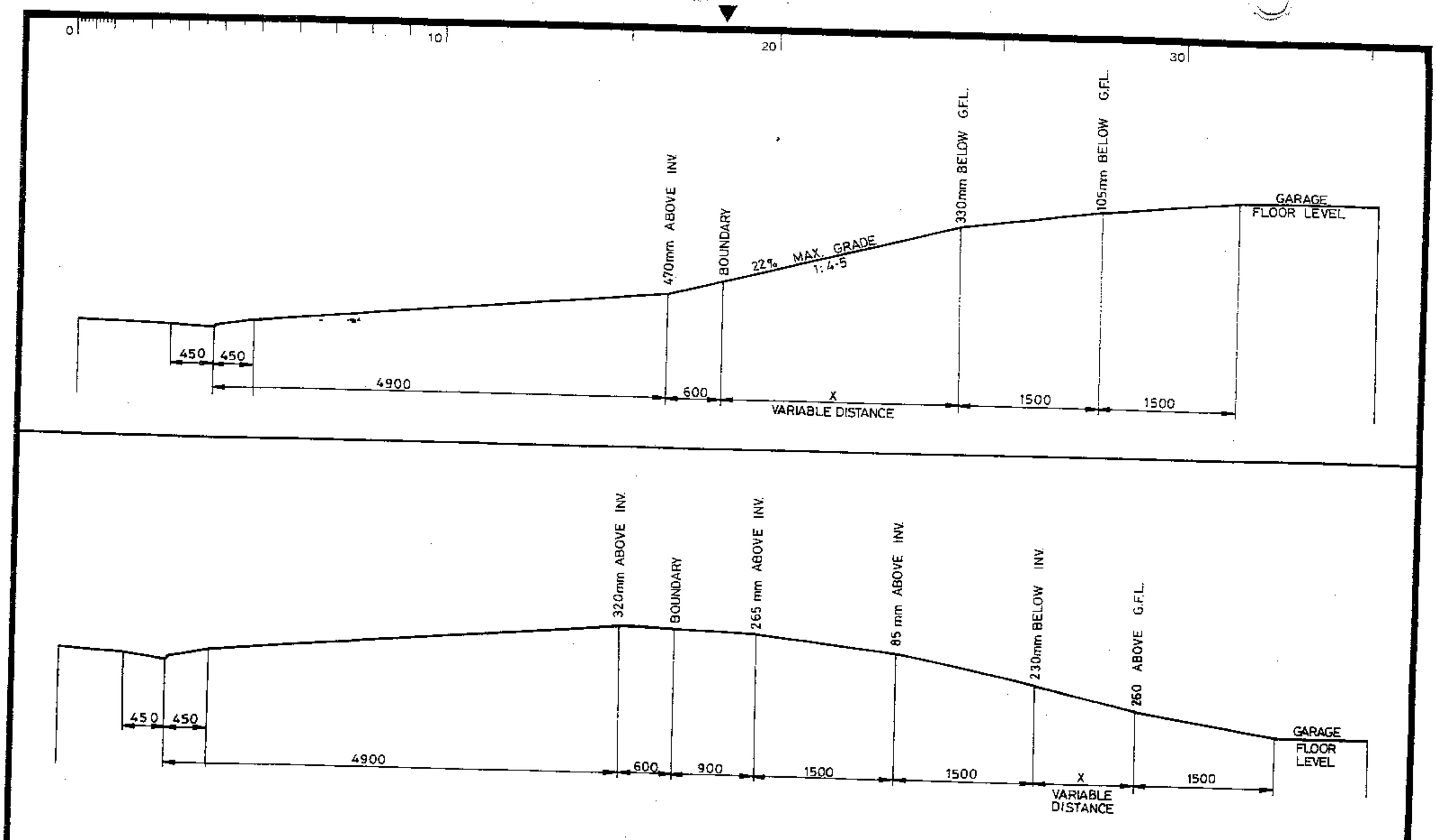
		DATE JUNE 97	RATIO N.T.S.
		FILE	PLAN REF. No. SD 101
		SHEET 4 OF 5	



BAULKHAM HILLS SHIRE COUNCIL	MAXIMUM ALLOWABLE GRADES FOR DRIVEWAYS WITH 5.5m FOOTPATH.	DRAWN BY GB	DATUM
		DATE JUNE 97	RATIO N.T.S.
		FILE	PLAN REF. No. SD 101
		SHEET 5 OF 5	

APPENDIX

B

Baulkham Hills Shire Council

EASEMENT FLOOD STUDY

June 1997

Baulkham Hills Shire Council

Easement Flood Study

CONTENTS

1. INTRODUCTION

1.1 Purpose of Form

Council requires flood information when assessing applications for development near easements and water courses.

A comprehensive flood study is required where:

- The site is in a known flood area
- The development involves a large investment
- A watercourse is involved.

In many situations a comprehensive, and expensive, flood study is not warranted. For example Council needs flood information for easements when assessing applications for adjacent buildings. A simple flood study will often provide sufficient information for this purpose.

The purpose of this form is to:

- Provide a simple standardised procedure for estimating flood information in situations where a comprehensive flood study is not warranted.
- Reduce costs to applicants by eliminating the time a consultant would spend developing a flood study procedure.
- Assist consultants by giving a clear indication of what is required by Council.
- Help consultants prepare informed quotes by enabling them to assess the work required before the job commences.
- Enable rapid checking of submissions by eliminating the need to check the method before checking the results.

1.2 Appropriate Use of Procedure

The procedure in this form is intended for calculation of small scale flood information in urban drainage easements. It is not intended for calculation of flood information in watercourses, channels or major overland flow paths. Flood information will be rejected if this simple procedure is used when a more comprehensive flood study should be used.

1.3 How To Use The Form

The basis for the procedure is explained in detail below.

The procedure is summarised as calculation sheets in Appendix A. The sheets may be detached and used as the submission to Council when complete.

1.4 Flood Standard

The procedure shown in this form calculates flood information for the 100 year Average Recurrence Interval flood standard.

Pipelines are assumed to have a maximum design capacity of 20 year Average Recurrence Interval. This maximum has been adopted because it is difficult to get sufficient inlet capacity to fill pipelines of larger design capacity.

1.5 Flood Related Building Standards

Floors must be 300 millimetres above the ground level against the walls.

Floors must be 300 millimetres above the top of floodwaters flowing along Council drainage easements in a 100 year Average Recurrence Interval design flood.

In river flood areas the floors must be 500 millimetres above the level of a 100 year Average Recurrence Interval design flood.

Pool coping must be 150 millimetres above the level of a 100 year Average Recurrence Interval design flood.

Development approval conditions show specific flood related requirements to be met by a development.

2. ESTIMATION OF FLOOD FLOW

2.1 Method Of Flood Estimation

The procedure shown in this form is based on the Rational Method of flood estimation.

The catchment is considered as a whole rather than being divided into sub-catchments.

The steps to estimating peak flow from the catchment are:

STEP 1 Define catchment on a catchment plan. Measure area of catchment.

STEP 2 Derive the Time of Concentration.

STEP 3 Adopt a design storm duration equal to the Time of Concentration. Determine Average Rainfall Intensity for adopted storm duration.

STEP 4 Adopt Coefficient of Runoff for catchment.

STEP 5 Combine these values in the Rational Method formula to calculate peak flow from the catchment.

2.2 Catchment Plan

A catchment plan must be submitted with calculations. Information to be shown on the catchment plan is detailed on the calculation sheets in Appendix A.

2.3 Time Of Concentration

Time of Concentration is taken to be the time taken by storm runoff to flow from the most remote part of the catchment to the outlet. The Rational Method assumes that storms which produce peak outflows from a catchment have duration equal to the catchment time of concentration.

Time of Concentration is derived using the chart shown in Appendix A (Country Roads Board, 1982; Argue, 1986; Queensland Water Resources Commission, 1992).

Since the catchment is being considered as a single unit it follows that more complex methods for estimating time of concentration are not justified. A comprehensive flood study which divides the catchment into sub-catchments is required if a consultant wishes to uses more complex methods for estimating Time of Concentration.

2.4 Rainfall Intensity

The Rainfall Intensity to be adopted for this procedure is for a storm which has a duration equal to the catchment Time of Concentration.

Appendix A includes rainfall intensities which are representative of the two major catchments within Baulkham Hills Shire. The Parramatta River catchment is represented by intensity data for the Cumberland State Forest at West Pennant Hills. Data for the Castlebrook Cemetery at Kellyville is representative of the intensity values for the Hawkesbury River catchment.

Representative intensity values have been used because there is only a small variation in intensity values across each of the catchments. Within the Baulkham Hills Shire the rainfall intensity in a 100 year Average Recurrence Interval Design storm varies by approximately 10 millimetres/hour across the Parramatta River catchment and 3 millimetres/hour across the Hawkesbury River catchment.

2.5 Coefficient of Runoff

Coefficient of Runoff values are shown in Appendix A.

Fraction impervious values were adopted from unpublished research by the Upper Parramatta River Catchment Trust.

Coefficient of runoff values were derived using the procedure shown in Australian Rainfall and Runoff 1987 (Institution of Engineers Australia, 1987) as follows:

STEP 1 Adopt a fraction impervious value f_i for the catchment. The following values were adopted (Upper Parramatta River Catchment Trust):

Urban areas	$f_i = 0.80$
Non urban areas	$f_i = 0.05$

STEP 2 Determine the 1 hour rainfall intensity $^1I_{10}$ for the 10 year Average Recurrence Interval for the catchment. The following values were adopted:

Parramatta River Catchment	$^1I_{10} = 49.7$
Hawkesbury River Catchment	$^1I_{10} = 45.0$

STEP 3 Using the fraction impervious values adopted in step 1 read the 10 year C value from Figure 14.13 in Australian Rainfall and Runoff 1987.

Parramatta River Catchment	Urban	$C_{10} = 0.80$
	Non Urban	$C_{10} = 0.46$
Hawkesbury River Catchment	Urban	$C_{10} = 0.79$
	Non Urban	$C_{10} = 0.40$

STEP 4 Multiply the C_{10} value by the 100 year Frequency Factor, 1.20, to determine the Coefficient of Runoff for the design storm.

Parramatta River Catchment	Urban	$C_{100} = 0.96$
	Non Urban	$C_{100} = 0.55$
Hawkesbury River Catchment	Urban	$C_{100} = 0.95$
	Non Urban	$C_{100} = 0.48$

2.6 Peak Flow From Catchment

Calculate peak flow from the catchment using the Rational Method:

$$Q_{100} = 0.00278 C_{100} \, {}^{t}I_{100} A$$

Expanded:

$$Q_{100}=0.00278(C_{U,100}A_U+C_{NU,100}A_{NU})^tI_{100}$$

Where:

Q_{100}	=	Peak flow rate from design storm with an Average Recurrence Interval of 100 years (cubic metres/second)
0.00278	=	Coefficient enabling use of metric units in the Rational Method formula
$C_{U,100}$	=	Coefficient of Runoff for urban sub-catchment, Average Recurrence Interval of 100 years
$C_{NU,100}$	=	Coefficient of Runoff for non urban sub-catchment, Average Recurrence Interval of 100 years
$^tI_{100}$	=	Average Rainfall Intensity for a design storm duration of t hours and an Average Recurrence Interval of 100 years (millimetres/hour)
A_U	=	Area of urban catchment (hectares)
A_{NU}	=	Area of non urban catchment (hectares)

3. ESTIMATION OF FLOOD LEVEL

3.1 Method Of Flood Level Estimation

The steps to estimating flood levels are:

STEP 1 Adopt peak flow calculated for catchment.

STEP 2 Determine capacity of pipe system through the site (if any).

STEP 3 Derive overland flow rate by subtracting pipe flow from peak flow for catchment.

STEP 4 Determine the overland flow path capacity by survey.

STEP 5 Adopt a trial flood level. Use Manning's Equation to compare overland flow against the capacity of the overland flow path at the trial flood level. Repeat with different trial flood levels until overland flow rate matches the capacity of the overland flow path at the chosen trial flood level.

STEP 6 Plot the calculated flood levels on cross sections and longitudinal section of the overland flow path.

3.2 Flow Through Pipe

The chart in Appendix A provides an estimate of pipe capacity using the Colebrook-White formula. This method provides an estimate of pipe capacity flowing full but not under pressure.

The maximum capacity of pipes is assumed to be the 20 year Average Recurrence Internal flow.

Given that flow estimation errors of up to 20% are inherent in drainage design (Argue, 1986) the pipe capacity estimation given by Figure 3 should be sufficient. A comprehensive flood study including a hydraulic grade line analysis is required if a consultant wishes to uses more complex methods for estimating pipe flow.

Use of the Colebrook-White formula with k = 0.3mm is recommended by Australian Rainfall and Runoff 1987 (Institution of Engineers, Australia, 1987) Technical Note 8.

3.3 Surface Flow

Surface flow is taken as the peak flow from the catchment less the flow in pipe.

$$Q_{s,100}=Q_{100}-Q_{p,100}$$

Where:

$Q_{s,100}$ = Surface flow from design storm with an Average Recurrence Interval of 100 years
(cubic metres/second)

Q_{100} = Catchment flow from design storm with an Average Recurrence Interval of 100 years
(cubic metres/second)

Q_p = Pipe flow (maximum is 20 year Average Recurrence Interval flow off catchment)
(cubic metres/second)

3.4 Capacity Of Overland Flow Path

Determine overland flow path capacity by survey. Survey requirements are detailed in Appendix A.

3.5 Flood Level

Choose a trial flood level and determine Hydraulic Radius of overland flow path at the chosen flood level.

$$R = \frac{A_w}{P}$$

Where:

R = Hydraulic radius of overland flow path at trial flood level (metres)

A_w = Area of waterway of overland flow path at trial flood level (square metres)

P = Wetted perimeter of overland flow path at trial flood level (metres)

Use Manning's equation to calculate capacity of overland flow path at trial flood level (Institution of Engineers, Australia 1987).

$$Q_C = \frac{AR^{\frac{2}{3}} S_{fp}^{\frac{1}{2}}}{n}$$

Where:

Q_c = Capacity of overland flow path at trial flood level and 100 year Average Recurrence Interval (cubic metres/second)

A_w = Area of waterway at trial flood level (square metres)

R = Hydraulic radius at trial flood level (metres)

S_{fp} = Slope of overland flow path (metres/metre)

n = Manning's roughness parameter from Appendix A
(Road Construction Authority, 1982; Argue 1986)

Compare capacity of overland flow path to the calculated surface flow. Reiterate the calculations using a different trial flood level until the overland flow path capacity equals the surface flow rate.

The 100 year Average Recurrence Interval flood level is adopted as the flood level at which the overland flow path capacity is equal to the surface flow rate.

4. ESTIMATION OF FLOOD HAZARD

4.1 Method Of Hazard Estimation

The hazard to pedestrians presented by floodwater flowing across the overland flow path is estimated in the following steps:

STEP 1 Adopt the maximum depth of flow derived from estimation of the flood level.

STEP 2 Calculate the velocity of flow using Manning's formula.

STEP 3 Calculate the product of depth x velocity.

4.2 Safety Criteria

To ensure pedestrian safety the product of depth and velocity should not exceed 0.4 (Institution of Engineers, Australia 1987).

4.3 Calculation of Hazard

Use Manning's equation to calculate surface flow velocity (Queensland Water Resources Commission, 1992).

$$V = \frac{AR^{\frac{2}{3}} S_{fp}^{\frac{1}{2}}}{n}$$

Where:

V = Velocity of overland flow path at trial flood level and 100 year Average Recurrence Interval
(metres/second)

R = Hydraulic radius at trial flood level
(metres)

S_{fp} = Slope of overland flow path (metres/metre)

n = Manning's roughness parameter from Appendix A (Road Construction Authority, 1982; Argue 1986)

5. REFERENCES

1. Argue J. R. 1986, *Storm Drainage Design in Small Urban Catchments: A Handbook for Australian Practice*, Special Report No. 34, Australian Road Research Board, Vermont South, Vic.

2. Institution of Engineers, Australia 1987, *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Barton, A.C.T.

3. Queensland Water Resources Commission 1992, *Queensland Urban Drainage Manual*, Brisbane, Qld.

4. Road Construction Authority 1982, *Road Design Manual*, Melbourne, Vic.

5. Standards Association of Australia, 1978, *Australian Standard 2200-1978 Design Charts for Water Supply and Sewerage*, North Sydney, N.S.W.

6. Upper Parramatta River Catchment Trust (Unpublished), *Fraction Impervious*, Parramatta, N.S.W.

APPENDIX A

EASEMENT FLOOD STUDY

CALCULATION SHEETS

EASEMENT FLOOD STUDY

1. BACKGROUND

1.1 Site Identification

File Numbers : Council __________ Applicant __________

Site Address : ____ ______________________
______________________ ______

Real Property Description : Lot _____ DP _________

1.2 Designer Details

Calculations By : ______________________________

Organisation and Address : ______________________________
____
____ ______________________
______________________ ______

1.3 Information to be Submitted

Calculations

These calculation sheets should be completed and submitted to Council.

Catchment Plan

Attach a 1:4000 scale catchment plan. Council has contour maps available for sale.

Catchment plan shall show:

- Location of site
- Catchment boundary (lowest site boundary to be shown as catchment outlet)
- Major contours at 10 metre intervals
- Intermediate contours at 2 metre intervals
- Longest flow path used in calculation of Time of Concentration of catchment.

Levels and contours shall be on Australian Height Datum.

Survey

Attach survey plans of the overland flow path. Survey details shall include:

- Longitudinal section of overland flow path at 1:200 natural scale.
- Cross sections of overland flow path at 1:200 natural scale.
- Site plan showing the location of longitudinal section and cross sections.

Cross sections should meet the following criteria:

- Sections shall be drawn looking upstream.
- Cross sections to be located where the site boundary crosses the overland flow path and at intermediate locations.
- A cross section should be shown at the narrowest part of the overland flow path.
- Cross sections shall be perpendicular to the overland flow path. Skew cross sections shall not be used.
- Levels shall be on Australian Height Datum.

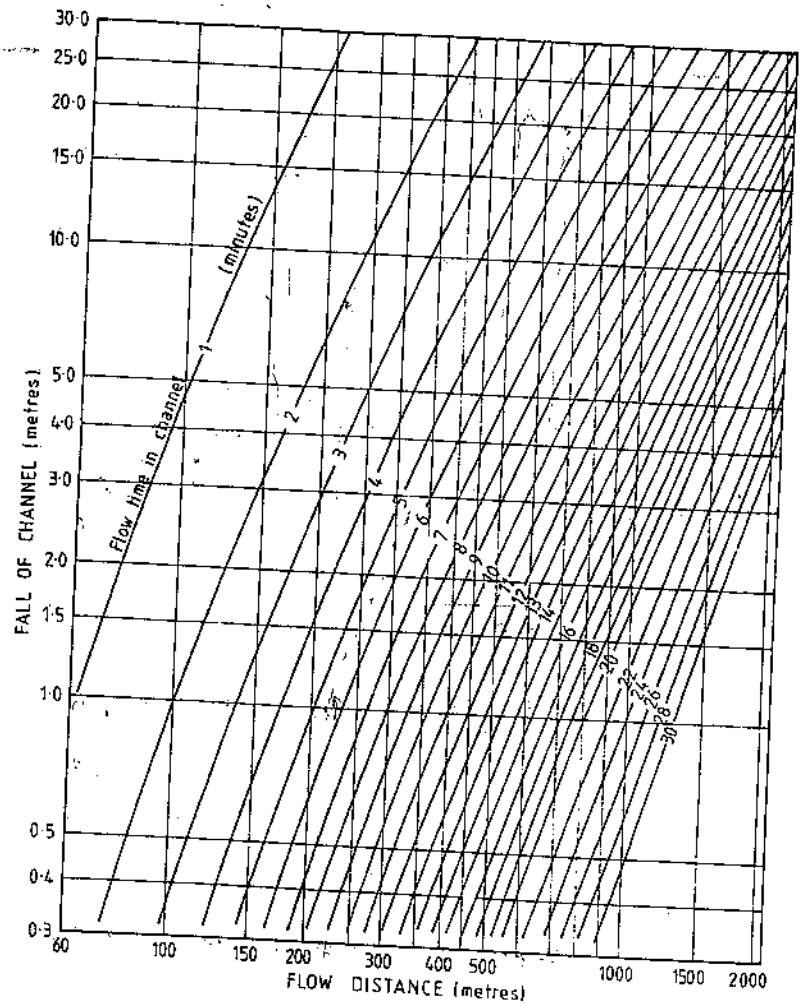
2. ESTIMATION OF FLOOD FLOWS

2.1 Time Of Concentration

Use Figure 2.1 to determine the time required for stormwater runoff to flow from the most remote part of the catchment to the outlet.

Figure 2.1

TIME OF CONCENTRATION



Flow travel time can be obtained directly from the chart or by applying a multiplier as follows:

- Kerb and gutter channels — x 1 (direct from chart)
- Underground pipes and culverts — x 1 (direct from chart)
- Blade cut channels — x 2
- Natural channels — x 3
- Grassed swales — x 4

Divide the flow path into sections if the fall of channel or flow distance exceed the maximum shown on Figure 2.1.

Section Show on catchment plan	Difference in level between top and bottom of flow path metres	Length of flow path metres	Time of Flow from chart minutes	Multiplier	Time of flow minutes
From ____ to ____	____	____	____	____	____
From ____ to ____	____	____	____	____	____
From ____ to ____	____	____	____	____	____
From ____ to ____	____	____	____	____	____
				Total	____ minutes

Time of Concentration

t_c = ____ **minutes** .... (A)

2.2 Rainfall Intensity

Adopt a design storm duration equal to the Time of Concentration of the catchment (A).

Adopted Storm Duration = ____ minutes

Use Figure 2.2 to identify the major river catchment in which the site is located.
Use Table 2.1 to determine rainfall intensity for adopted storm duration.

Rainfall Intensity (100 year Average Recurrence Interval)

$^{t}I_{100}$ = _____ mm/h . . . . (B)

Figure 2.2

MAJOR RIVER CATCHMENTS

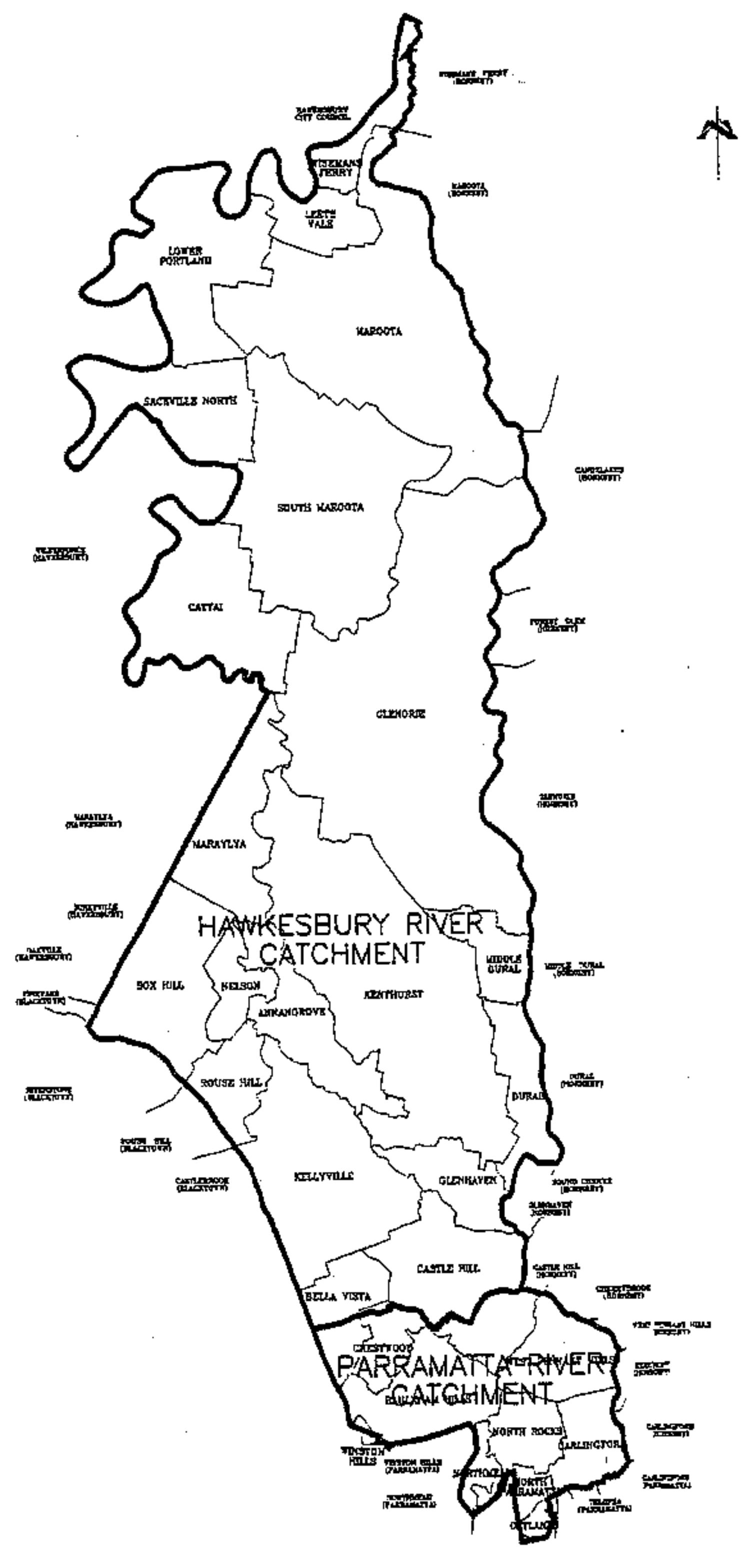


Table 2.1

RAINFALL INTENSITY

Storm Duration (minutes)	PARRAMATTA RIVER CATCHMENT 100 year Average Recurrence Interval Intensity (millimetres / hour)	HAWKESBURY RIVER CATCHMENT 100 year Average Recurrence Interval Intensity (millimetres / hour)
5	235	219
6	221	205
7	209	196
8	199	186
9	190	177
10	182	167
11	175	161
12	169	155
13	163	150
14	158	145
15	153	140
16	149	136
17	145	132
18	141	128
20	134	121
25	120	110
30	110	98
35	102	92
40	95	85
45	89	79
50	84	75
55	80	71
60	76	67
75	67	60
90	61	53
120	52	45

2.3 Coefficient Of Runoff

Adopt Coefficient of Runoff from Table 2.2

Table 2.2

COEFFICIENT OF RUNOFF

PARRAMATTA RIVER CATCHMENT		HAWKESBURY RIVER CATCHMENT	
Urban Coefficient of Runoff	Non Urban Coefficient of Runoff	Urban Coefficient of Runoff	Non Urban Coefficient of Runoff
0.96	0.55	0.96	0.48

Coefficient of Runoff (100 year Average Recurrence Interval)

$C_{U,100}$ = _____ **Urban** .... (C)
$C_{NU,100}$ = _____ **Non Urban** .... (D)

2.4 CATCHMENT FLOW

Calculate peak flow from catchment in 100 year Average Recurrence Interval design storm.

$^tI_{100}$ = _____ *(B)*
$C_{U,100}$ = _____ *(C)*
$C_{NU,100}$ = _____ *(D)*
A_U = _____ Catchment Plan
A_{NU} = _____ Catchment Plan

Q_{100} = 0.00278 (____ x ____ + ____ x ____) ____

Peak Flow from Catchment (100 year Average Recurrence Interval)

Q_{100} = ____ **cum/sec** .... (E)

3. ESTIMATION OF FLOOD LEVEL

3.1 Pipe Capacity

Estimate capacity of pipe flowing full but not under pressure from Figure 3.1.

D = _____ mm
S = _____ %

Q_p = $\frac{\_\_\_\_\_}{1000}$ Figure 3.1

Pipe capacity

Q_p = _____ cum/sec .... (F)

3.2 Surface Flow

$$Q_s = Q_{100} - Q_p$$

Q_{100} = _____ cum/sec (E)
Q_p = _____ cum/sec (F)

$Q_{s,100}$ = _____ - _____ (E) - (F)

Surface flow (100 year Average Recurrence Interval)

$Q_{s,100}$ = _____ cum/sec .... (G)

Figure 3.1

CAPACITY OF PIPES FLOWING FULL BUT NOT UNDER PRESSURE

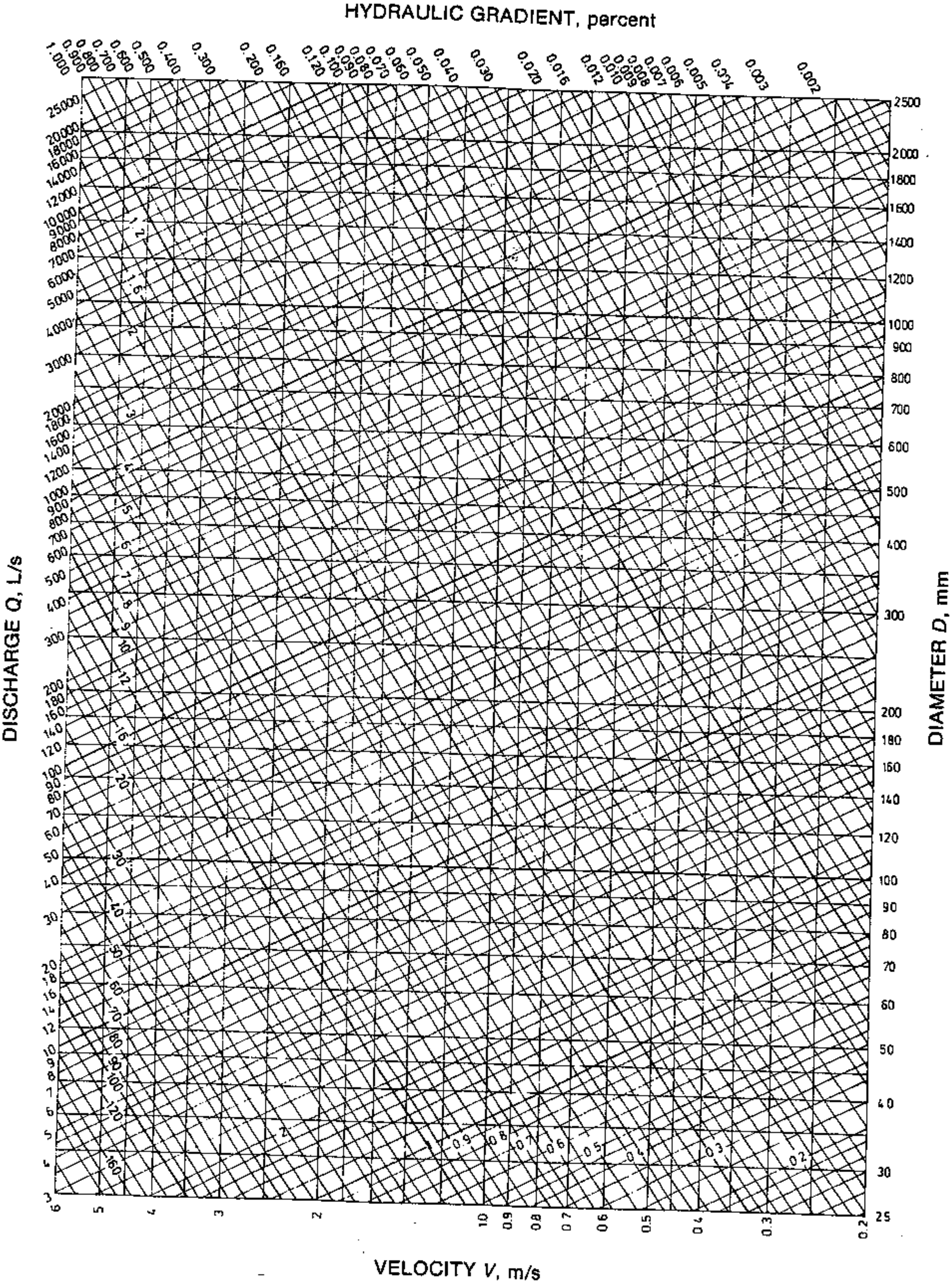


Table 3.1

MANNING ROUGHNESS COEFFICIENT *n*

Surface Type	Roughness Coefficient *n*
Concrete	0.013
Asphalt - highway standard	0.013
Asphalt - residential standard	0.014
Flush seal	0.018
Rough texture surfaces - pavers	0.020
Gravelled Surface	0.022
Bare Clay-Loam earth	0.025
Bare Clay-Loam earth - eroded	0.035
Lawns	0.050
Short Grass	0.060
Long Grass	0.100
Natural channel with medium vegetation, earth bed	0.040
Natural channel with medium vegetation, rock bed	0.045
Natural channel with medium vegetation, coarse gravel bed	0.050

3.3 Capacity Of Overland Flow Path

Obtain survey information of the overland flow path in accordance with survey requirements.

Adopt a trial flood level. Use Manning's Equation to compare overland flow against the capacity of the overland flow path at the trial flood level. Repeat with different trial flood levels until overland flow rate matches the capacity of the overland flow path at the chosen trial flood level.

Cross Section 1 (downstream boundary of site)

Trial flood level RL _______ AHD .... (H)

$$R=\frac{A_w}{P}$$

A_w	=	_____ sqm	Cross Section	....	(I)
P	=	_____ m	Cross Section	....	(J)
R	=	_____	(I)		
		_____	(J)		
	=	_____ m		....	(K)

$$Q_C=\frac{AR^{\frac{2}{3}}S_{fp}^{\frac{1}{2}}}{n}$$

Where:

A_w	=	_____ sqm	(I)
R	=	_____ m	(K)
S_{fp}	=	_____ m/m	Survey
n	=	_____	Table 3.1

Q_c = $\frac{\_\_\_\_ \times \_\_\_\_^{2/3} \times \_\_\_\_^{1/2}}{\_\_\_\_}$ $\qquad \frac{(I) \times (K)^{2/3} \times S_{fp}^{1/2}}{n}$

= _____ cum/sec .... (L)

Compare overland flow path capacity (L) to surface flow (G).

(L) = _____ cum/sec
(G) = _____ cum/sec
If (L) is not very close to (G) select a new trial flood level (H) and reiterate calculations.

Cross Section 2

Trial flood level RL ______ AHD .... (H)

$$R = \frac{A_w}{P}$$

A_w	=	_____	sqm	Cross Section	.... (I)
P	=	_____	m	Cross Section	.... (J)
R	=	_____ / _____		(I) / (J)	
	=	_____	m		.... (K)

$$Q_C = \frac{AR^{\frac{2}{3}} S_{fp}^{\frac{1}{2}}}{n}$$

Where:

A_w	=	_____	sqm	(I)
R	=	_____	m	(K)
S_{fp}	=	_____	m/m	Survey
n	=	_____		Table 3.1

Q_c = $\frac{\_\_\_ \times \_\_\_^{2/3} \times \_\_\_^{1/2}}{\_\_\_}$ $\qquad \frac{(I) \times (K)^{2/3} \times S_{fp}^{1/2}}{n}$

= _____ cum/sec .... (L)

Compare overland flow path capacity (L) to surface flow (G).

(L) = _____ cum/sec

(G) = _____ cum/sec

If (L) is not very close to (G) select a new trial flood level (H) and reiterate calculations.

Cross Section 3

Trial flood level RL ______ AHD .... (H)

$$R=\frac{A_w}{P}$$

A_w	=	____ sqm	Cross Section	....	(I)
P	=	____ m	Cross Section	....	(J)
R	=	____ / ____	(I) / (J)		
	=	____ m		....	(K)

$$Q_C=\frac{AR^{\frac{2}{3}}S_{fp}^{\frac{1}{2}}}{n}$$

Where:

A_w	=	____	sqm	(I)
R	=	____	m	(K)
S_{fp}	=	____	m/m	Survey
n	=	____		Table 3.1

Q_c = $\frac{\_\_\_\_ \times \_\_\_\_^{2/3} \times \_\_\_\_^{1/2}}{\_\_\_\_}$ $\qquad \frac{(I) \times (K)^{2/3} \times S_{fp}^{1/2}}{n}$

= ____ cum/sec .... (L)

Compare overland flow path capacity (L) to surface flow (G).

(L) = ____ cum/sec

(G) = ____ cum/sec

If (L) is not very close to (G) select a new trial flood level (H) and reiterate calculations.

Cross Section 4

Trial flood level RL ______ AHD .... (H)

$$R = \frac{A_w}{P}$$

A_w	=	_____ sqm	Cross Section	....	(I)
P	=	_____ m	Cross Section	....	(J)
R	=	_____	(I)		
		_____	(J)		

= _____ m .... (K)

$$Q_C = \frac{AR^{\frac{2}{3}} S_{fp}^{\frac{1}{2}}}{n}$$

Where:

A_w	=	_____ sqm	(I)
R	=	_____ m	(K)
S_{fp}	=	_____ m/m	Survey
n	=	_____	Table 3.1

Q_c = $\frac{\_\_\_\_ \times \_\_\_\_^{2/3} \times \_\_\_\_^{½}}{\_\_\_\_}$ $\qquad \frac{(I) \times (K)^{2/3} \times S_{fp}^{1/2}}{n}$

= _____ cum/sec .... (L)

Compare overland flow path capacity (L) to surface flow (G).

(L)	=	_____ cum/sec
(G)	=	_____ cum/sec

If (L) is not very close to (G) select a new trial flood level (H) and reiterate calculations.

Adopted flood levels

Cross Section 1 - RL __________ AHD
Cross Section 2 - RL __________ AHD
Cross Section 3 - RL __________ AHD
Cross Section 4 - RL __________ AHD

4. ESTIMATION OF FLOOD HAZARD

Calculate hazard at the cross section which has the largest depth of flow.

4.1 Calculation Of Hazard

$$V = \frac{AR^{\frac{2}{3}} S_{fp}^{\frac{1}{2}}}{n}$$

Where:

R	=	_____	m	(K)
S_{fp}	=	_____	m/m	Survey
n	=	_____		Table 3.1

V = $\underline{\quad\quad ^{2/3} x \quad\quad ^{1/2}}$ $\quad\quad$ $\frac{(K)^{2/3} x\, S_{fp}^{1/2}}{n}$

_____

_____ m/sec

APPENDIX

C

STORMWATER DRAINAGE

HYDRAULIC CHECKING SHEET

Job ....

[1] Pipe	[2] Length L (m)	[3] Design Flow-rate Q (L/s)	[4] Pipe Diameter (m)	[5] Full Pipe Velocity V (m/s)	[6] $\frac{V^2}{2g}$ (m)	[7] D/S HGL Level (m) AHD	[8] Pipe Friction Loss $S_f . L$ (m)	[9] HGL just below U/S Pit (m) [7]+[8]	[10] Obvert Level at Upper End of Pipe (m)	[11] Pit Pressure Change Coeffs. k_w (or k_u)	[12] $k \cdot \frac{V^2}{2g}$ (m) [11]×[6]	[13] Adopted U/S Pit Water (or HGL) Level* (m)	[14] U/S Surface Level (m) AHD

* (higher of [9] and [10]) + [12]

PIPED URBAN STORMWATER DRAINAGE **HYDROLOGICAL**

Job ....

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
		FLOW TIMES										
Pit	Land-Use Type	Flow Length (m)	Slope (m/m)	"n"	Time (min)	Total Time (min)	Intensity **I** (mm/h)	Runoff Coeff. **C**	Area **A** (ha)	**C.A** (ha) [9]×[10]	**ΣC.A** (ha)	Q = **C.I.A** (L/s) [8]×[1… /0.3…

PIPED URBAN STORMWATER DRAINAGE

HYDROLOGICAL DESIGN SHEET 2

Job .... Ref. ....

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
	FULL AREA				PARTIAL AREA					
Pipe	Time t_c (min)	Intensity I (mm/h)	Σ C.A (ha)	Q = C.I.A. (L/s) [3]x[4]	Time t_c (min)	Intensity I (mm/h)	Σ C.A (ha)	Q = C.I.A. (L/s) [7]x[8]	Adopted Flow rate (L/s) Greater of [5]&[9]	Remarks

Designer .... Date .... Checked ....

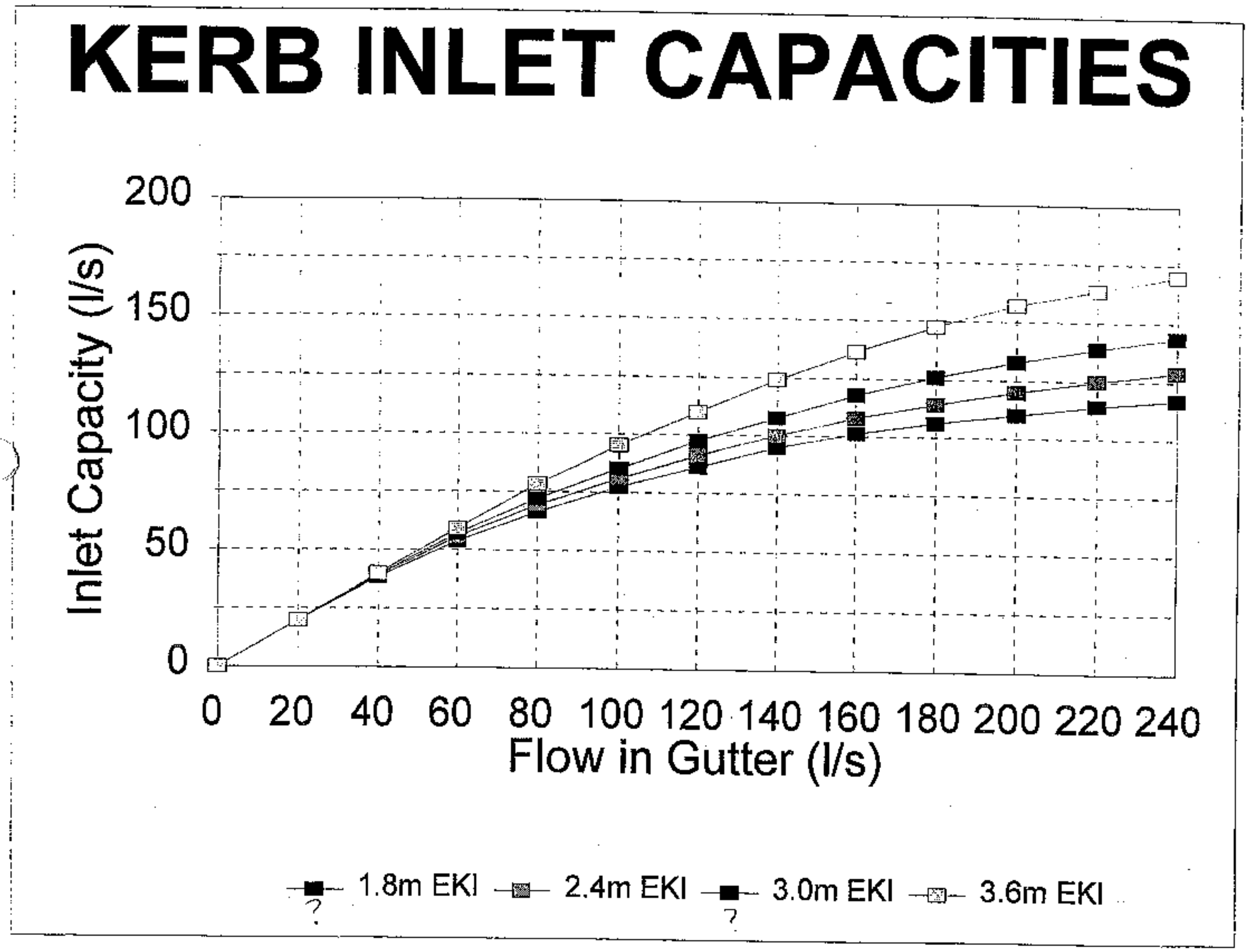
PIPED URBAN STORMWATER DRAINAGE **HYDROLOGICA**

Job ....

[1] Location	[2] Land-Use Type	[3] FLOW TIMES: Flow Length (m)	[4] Slope (m/m)	[5] "n"	[6] Time (min)	[7] Total Time (min)	[8] Intensity I (mm/h)	[9] Runoff Coeff. C	[10] Area A (ha)	[11] C.A (ha) [9]×[10]	[12] ΣC.A (ha)	C C ([8

APPENDIX

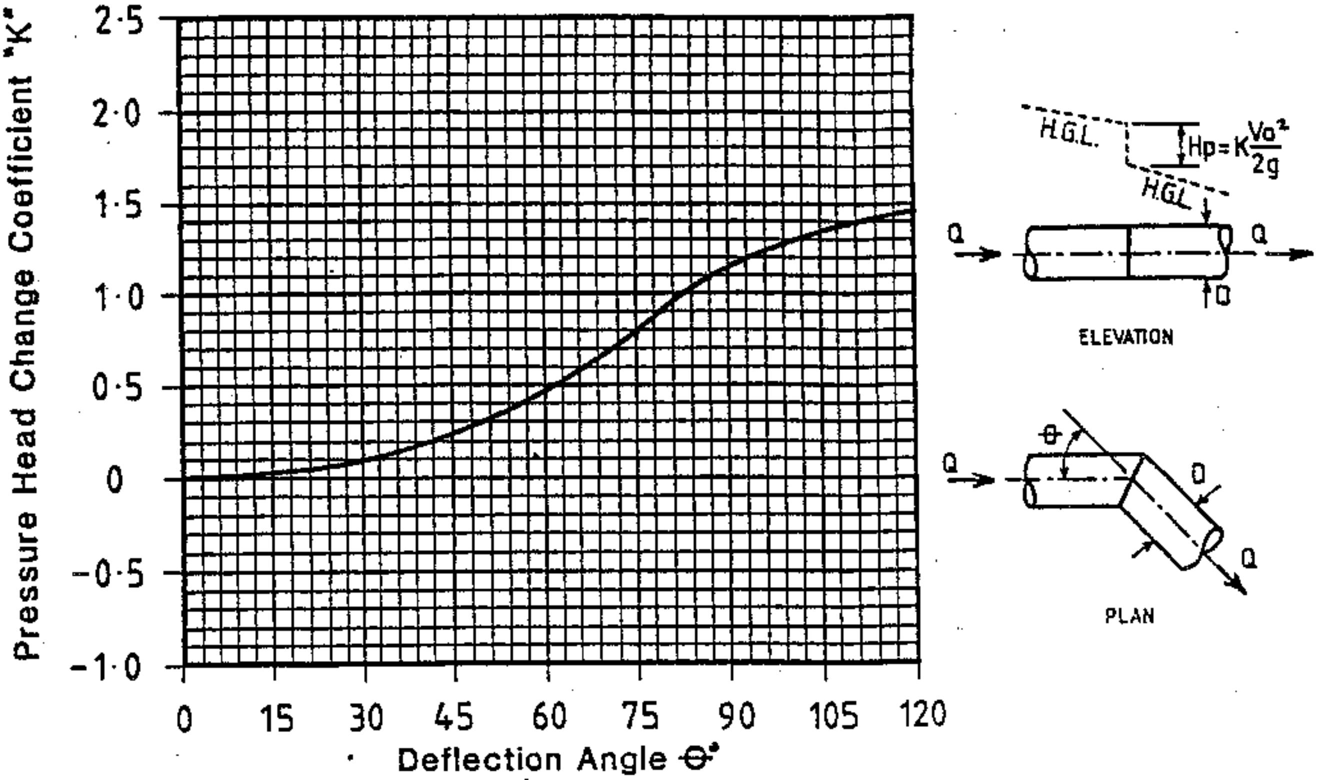
D



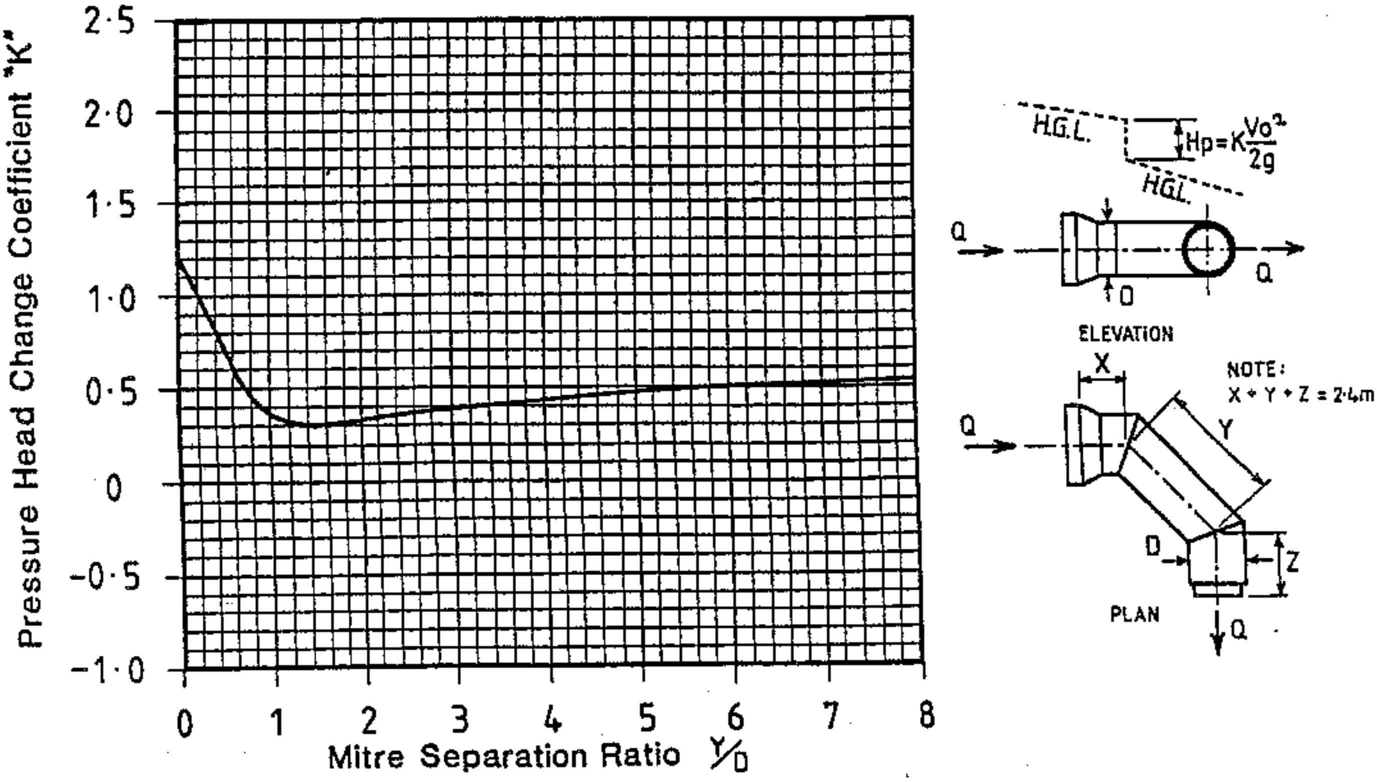
KERB INLET CAPACITIES
Inlet Capacity (l/s)
200
150
100
50
0
0
20
40
60
80
100
120
140
160
180
200
220
240
Flow in Gutter (l/s)
1.8m EKI
2.4m EKI
3.0m EKI
3.6m EKI

APPENDIX

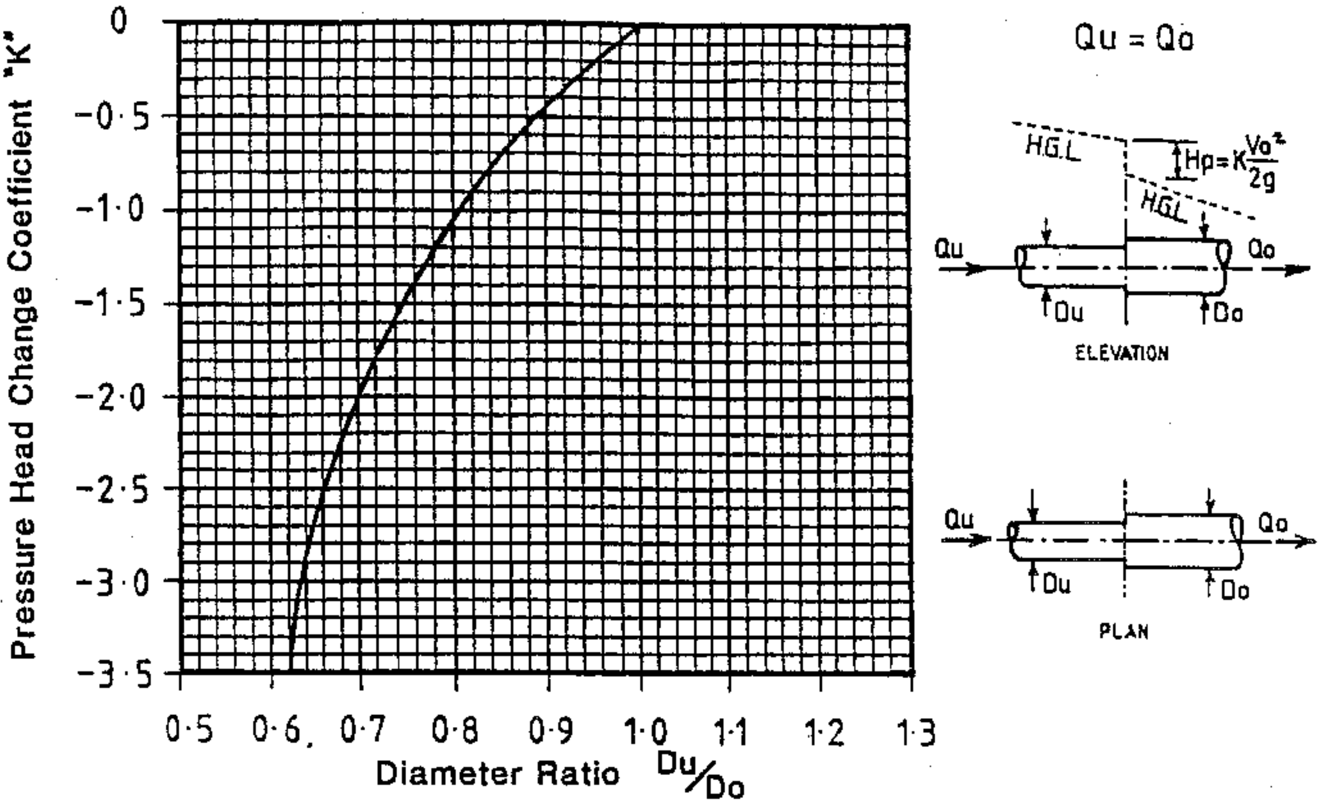
E



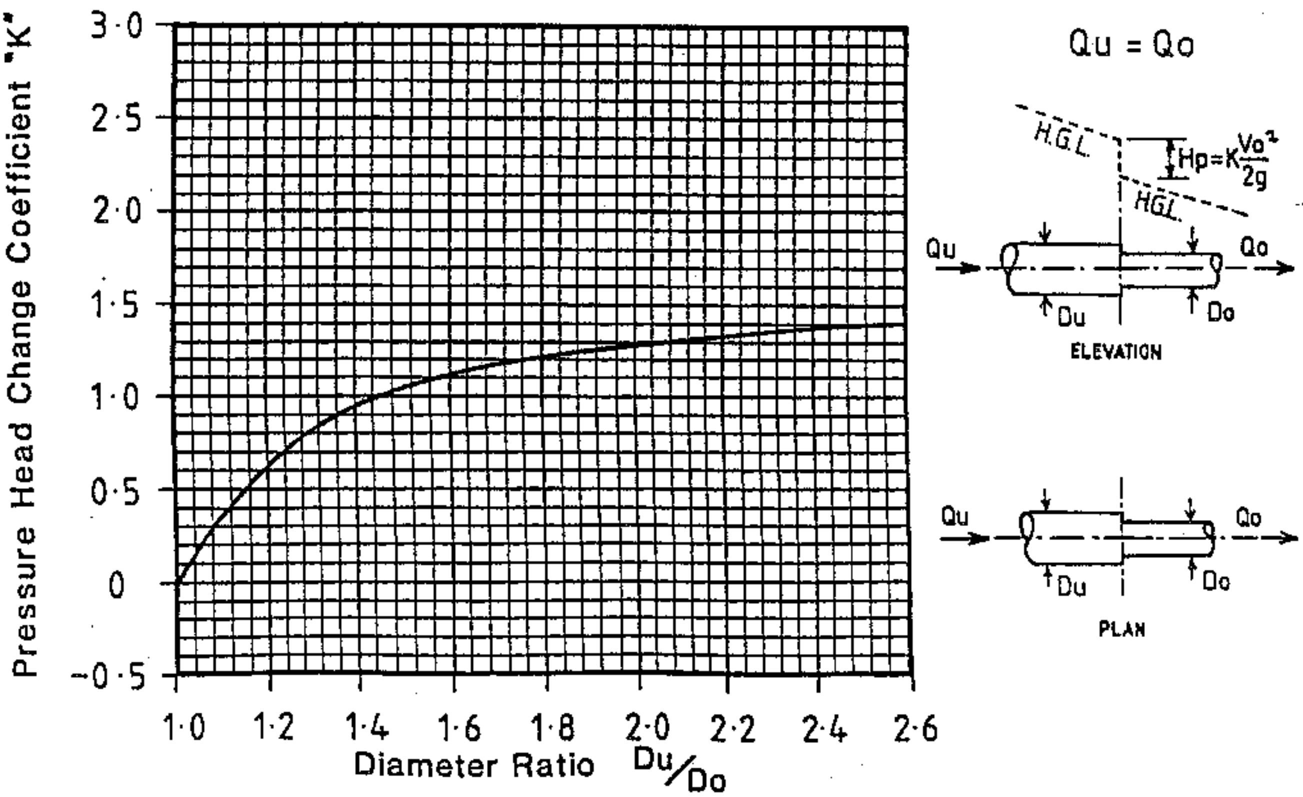
PRESSURE HEAD CHANGE COEFFICIENTS
FOR MITRE BENDS



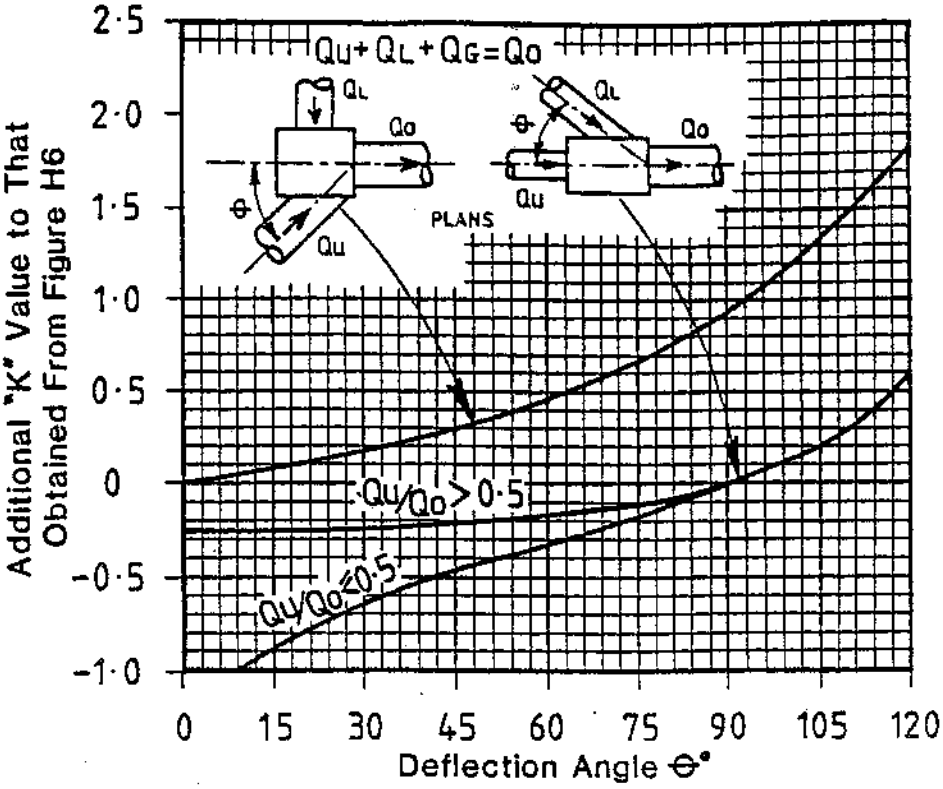
PRESSURE HEAD CHANGE COEFFICIENTS
FOR 90°COMPOUND BENDS (LOBSTERBACK)



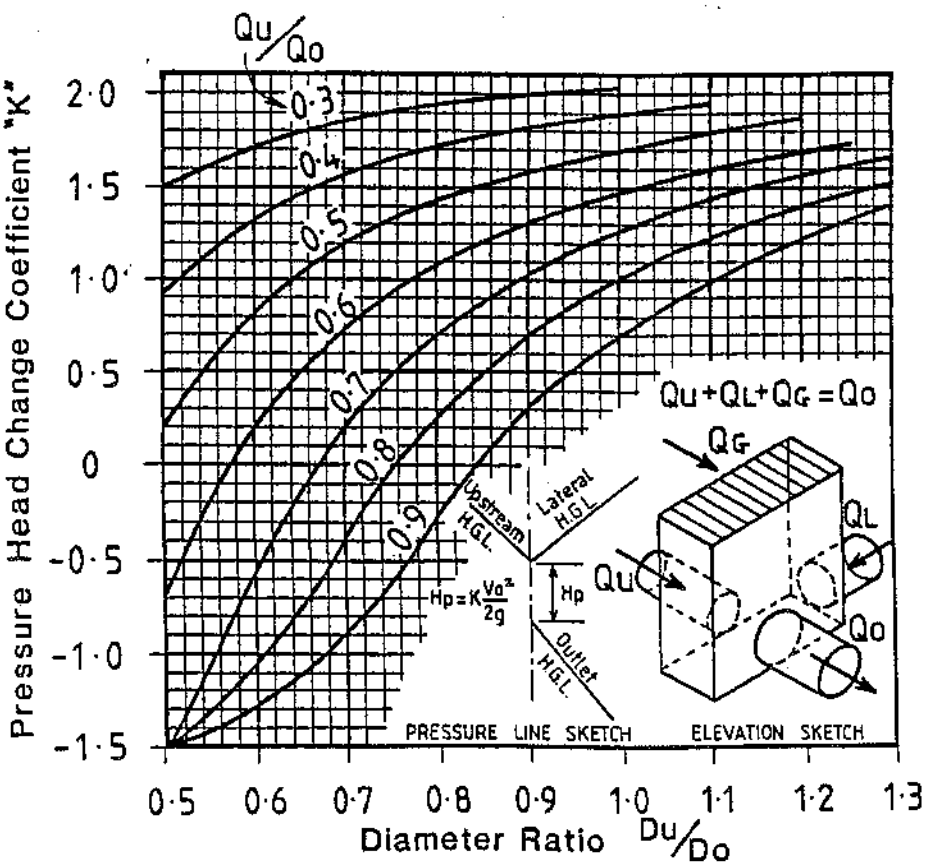
PRESSURE HEAD CHANGE COEFFICIENTS
FOR SUDDEN EXPANSIONS



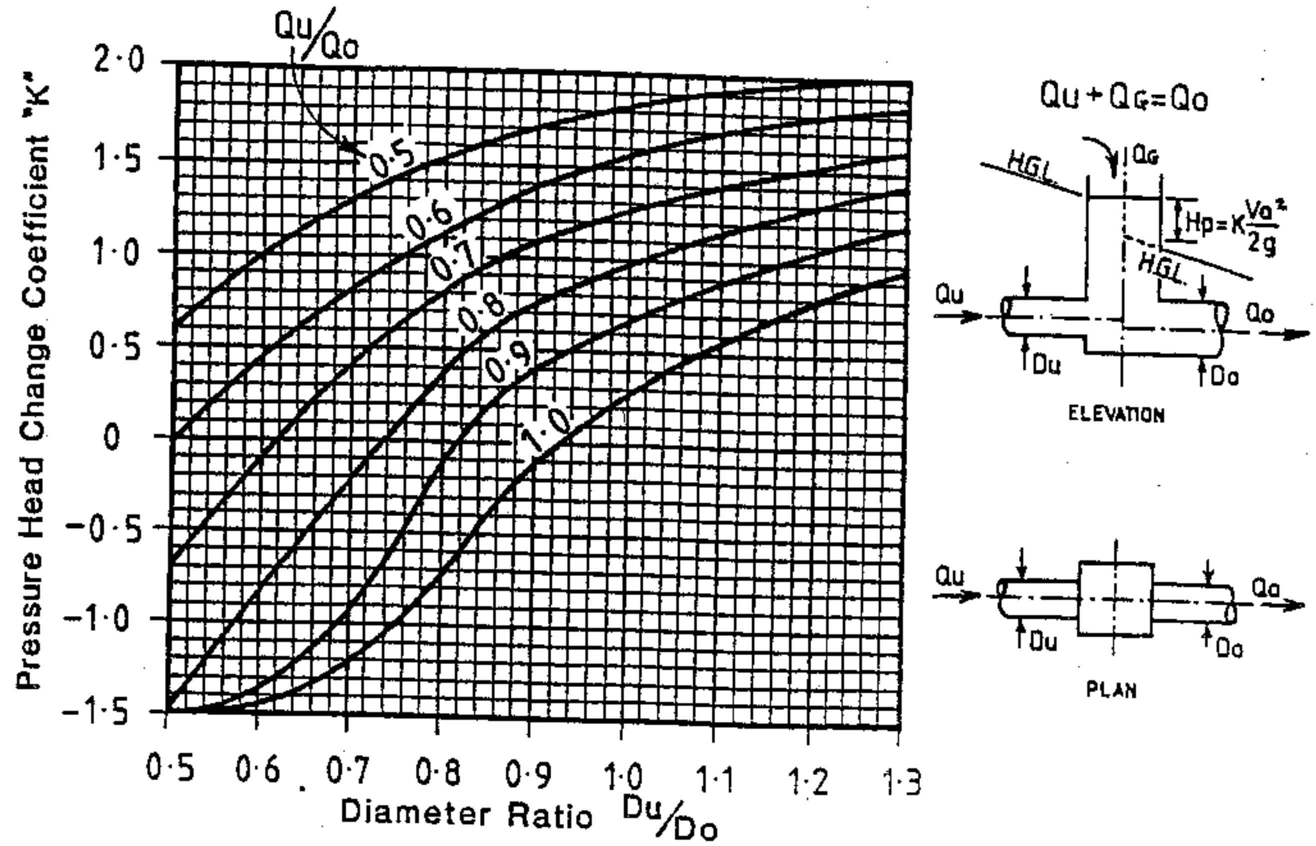
PRESSURE HEAD CHANGE COEFFICIENTS
FOR SUDDEN CONTRACTIONS OR REDUCERS



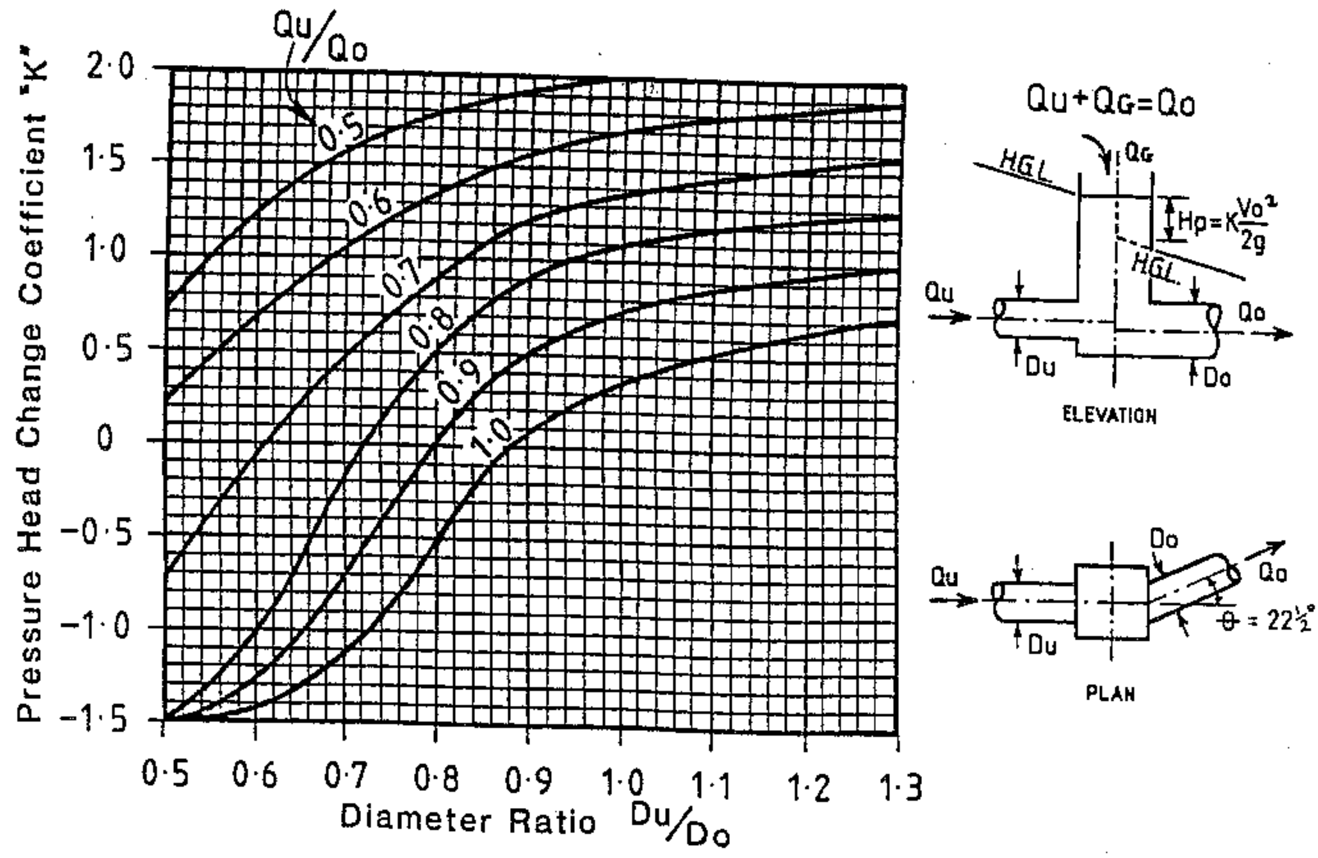
MODIFICATION OF PRESSURE HEAD CHANGE COEFFICIENTS FOR THE ANGLED JUNCTION OF THREE PIPELINES AT PITS



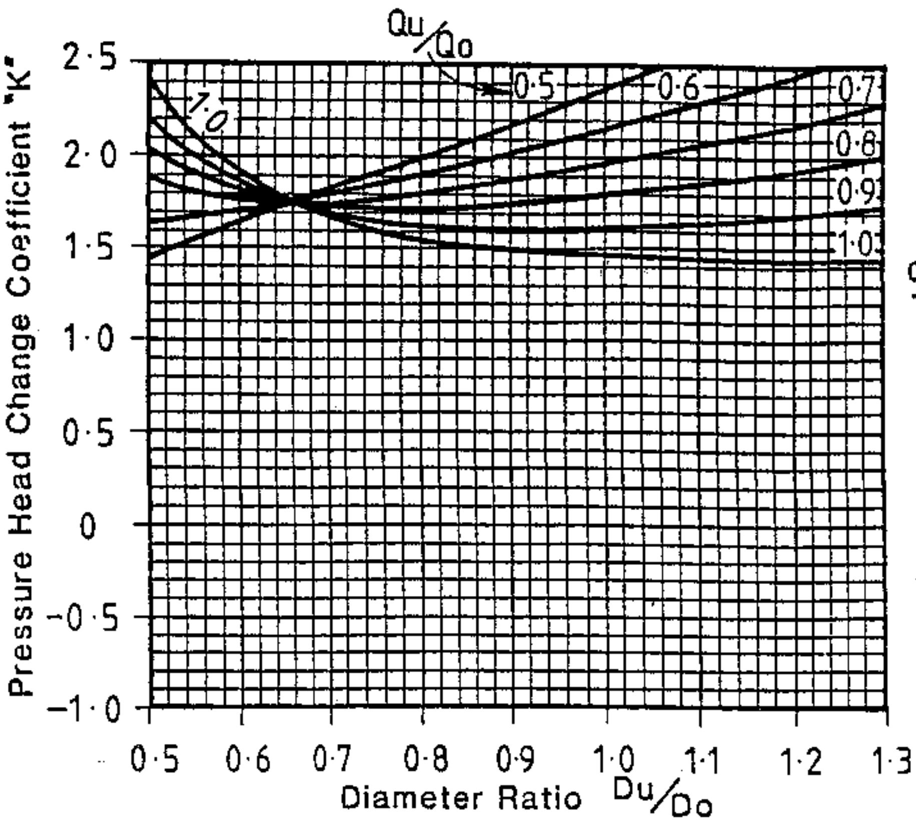
PRESSURE HEAD CHANGE COEFFICIENTS FOR THROUGH PIPELINE JUNCTION PIT WITH PERPENDICULAR LATERAL

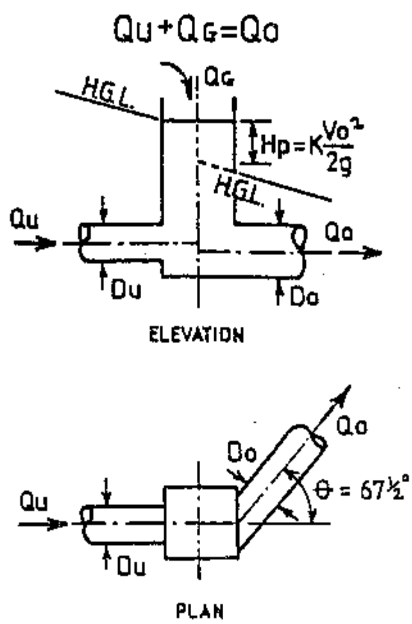


PRESSURE HEAD CHANGE COEFFICIENTS
FOR STRAIGHT THROUGH PIPELINES AT PITS

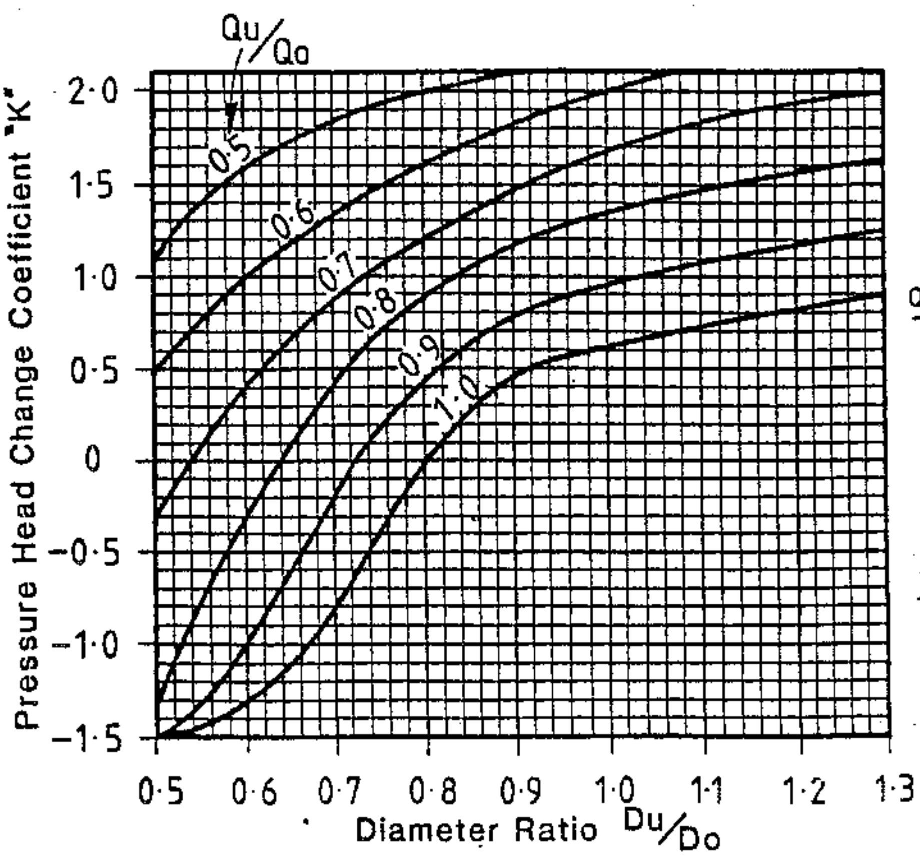


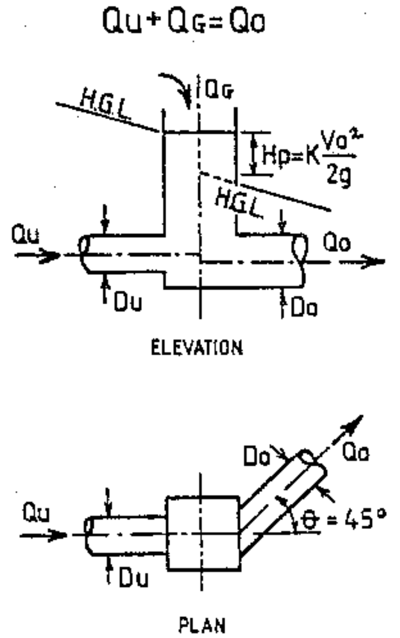
PRESSURE HEAD CHANGE COEFFICENTS
FOR 22½° BENDS AT PITS



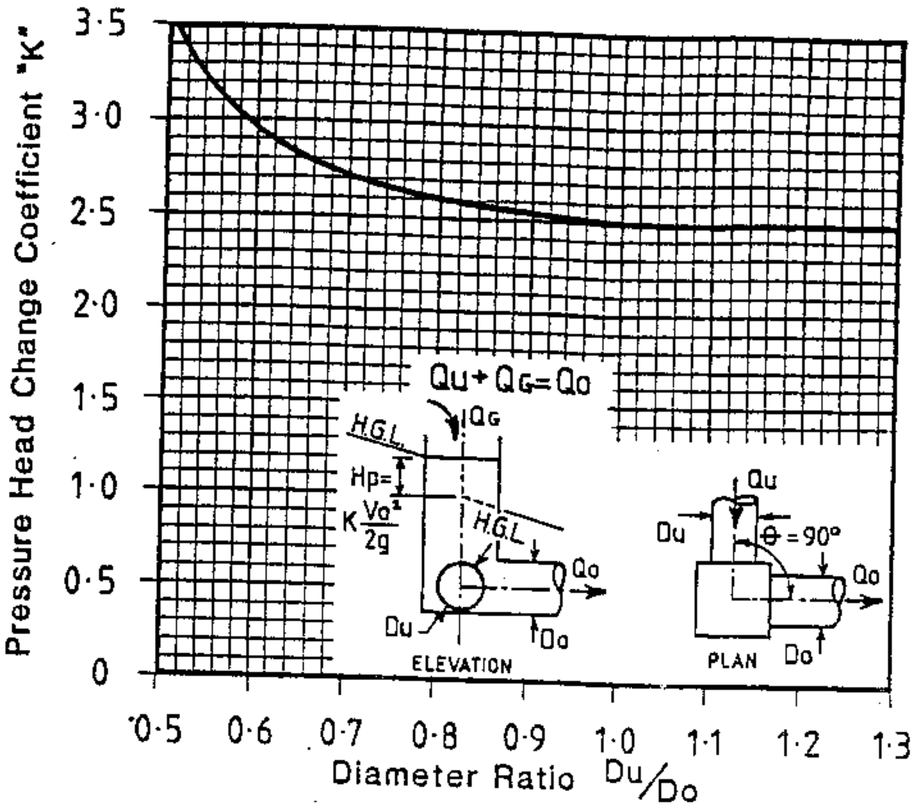


PRESSURE HEAD CHANGE COEFFICIENTS
FOR 67½° BENDS AT PITS

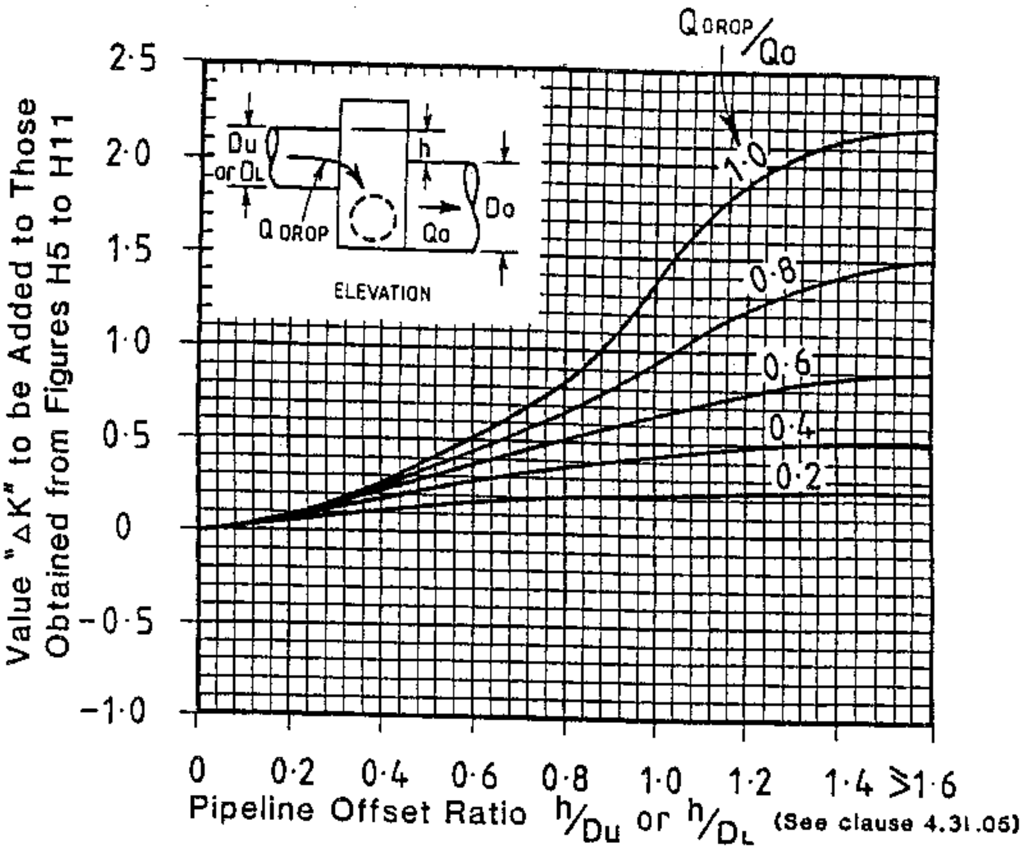




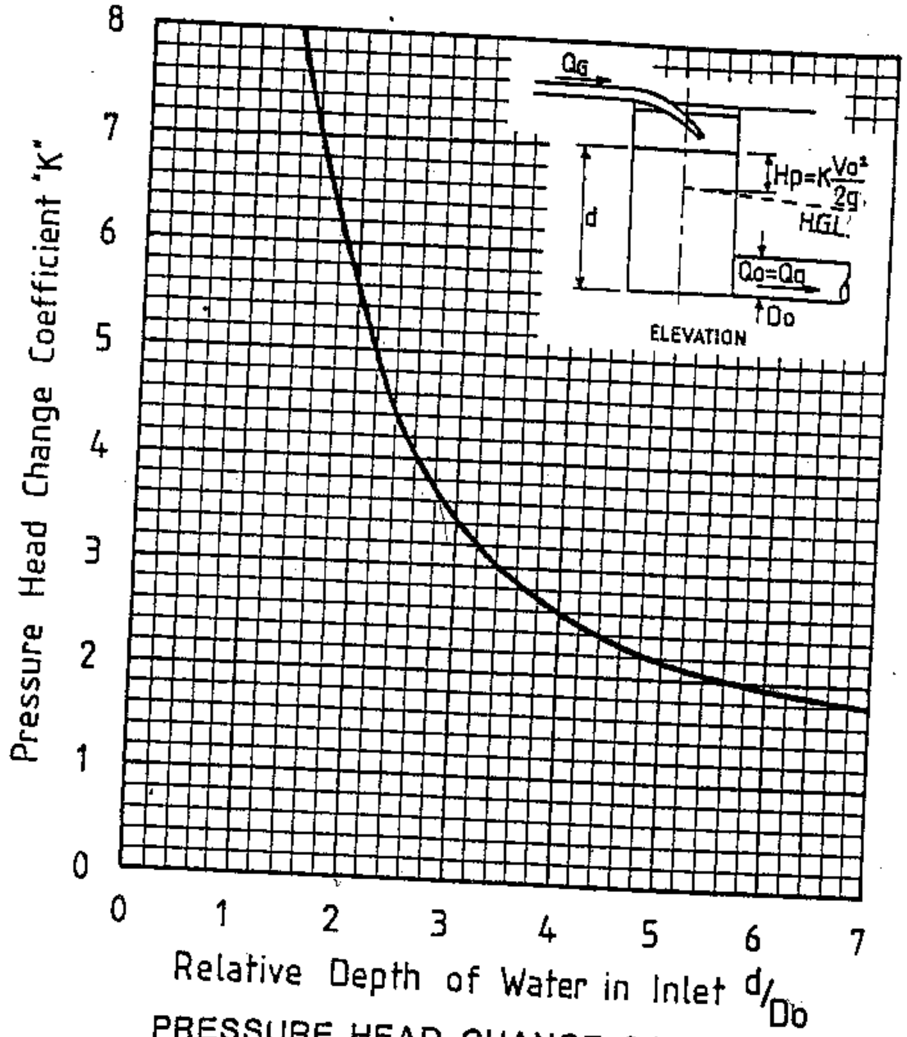
PRESSURE HEAD CHANGE COEFFICIENTS
FOR 45° BENDS AT PITS



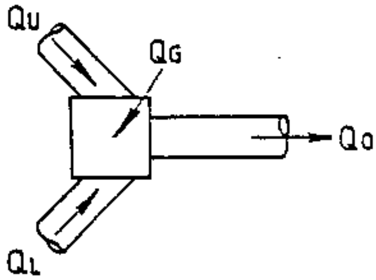
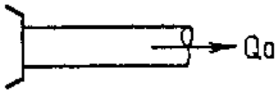
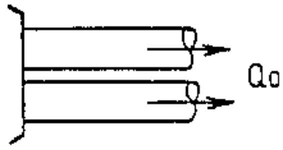
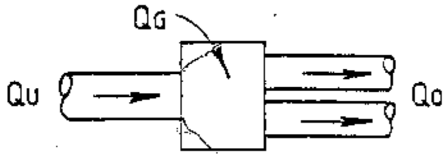
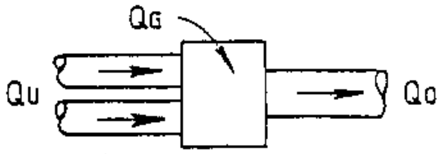
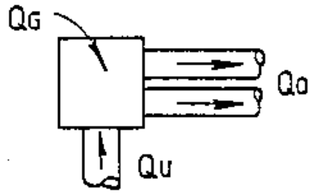
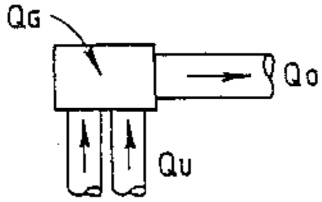
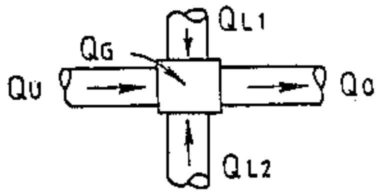
PRESSURE HEAD CHANGE COEFFICIENTS
FOR 90° BENDS AT PITS



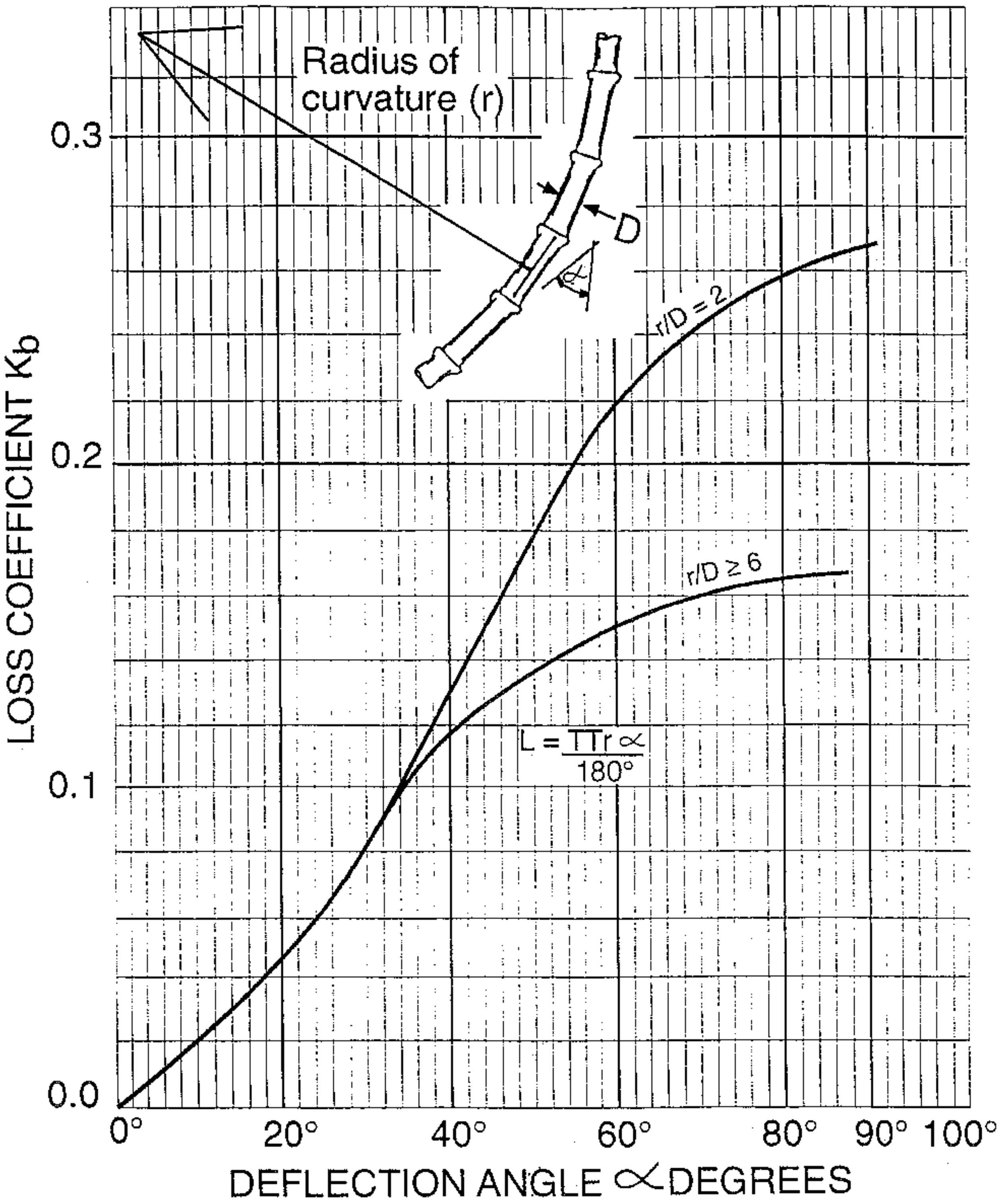
ADDITIONAL PRESSURE HEAD CHANGE
COEFFICIENTS FOR OFFSET PIPELINES AT PITS



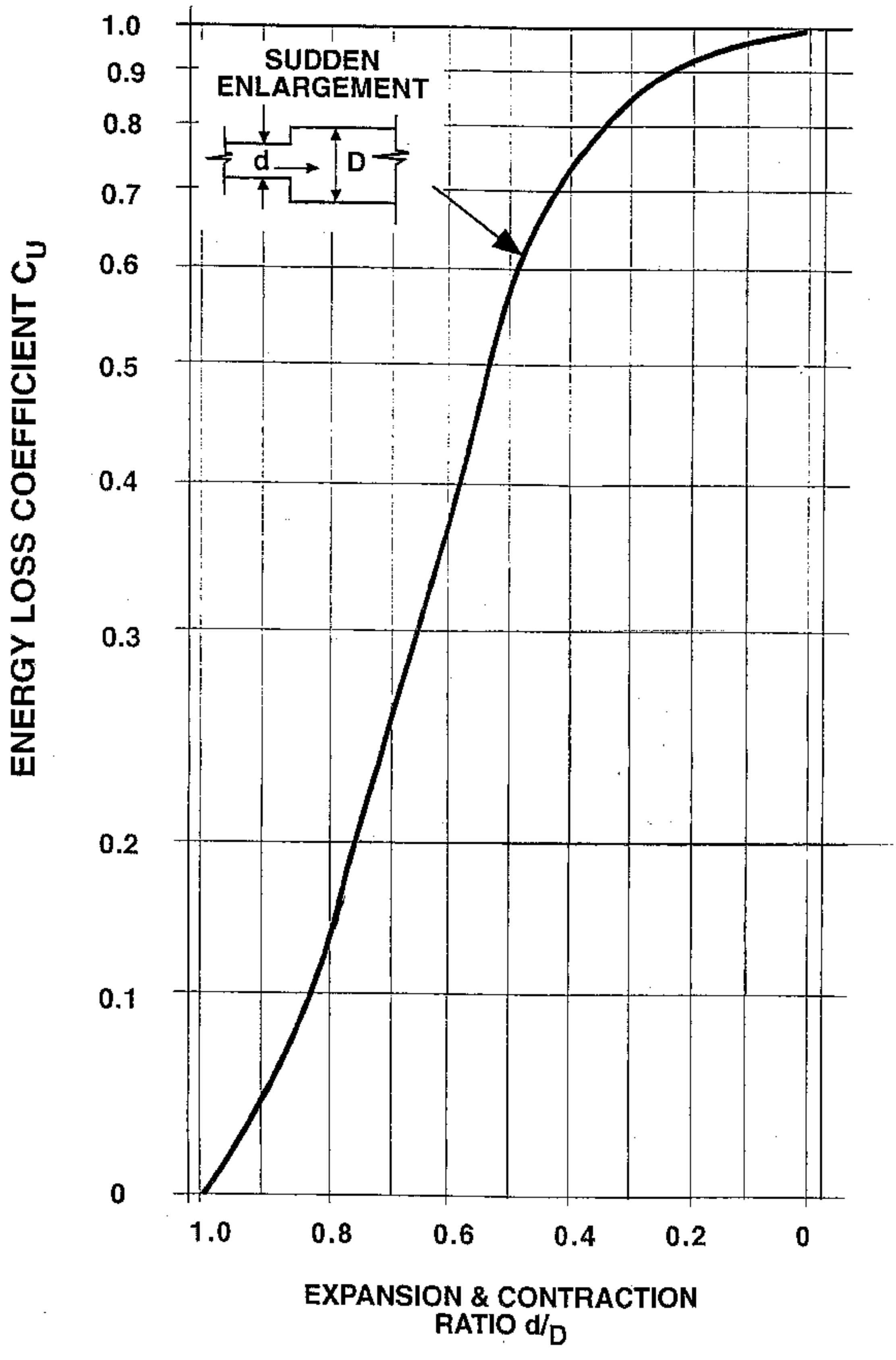
PRESSURE HEAD CHANGE COEFFICIENT
FOR GRATE INFLOW ONLY

PLAN VIEW OF STRUCTURE	"K" VALUE (No Significant Drop Through Pit)
	1·5 – 2·0
	1·5 2·0 (with trash rack)
	1·5 2·0 (with trash rack)
	1·5 – 2·0
	1·4 – 2·0
	2·5 – 3·0
	2·5 – 3·0
	1·6 – 2·5

PRESSURE HEAD CHANGE COEFFICIENTS
FOR VARIOUS PIT GEOMETRIES



Bend Loss Coefficient
Source: D.O.T. (1992)



Source: A.S. 2200 –1978

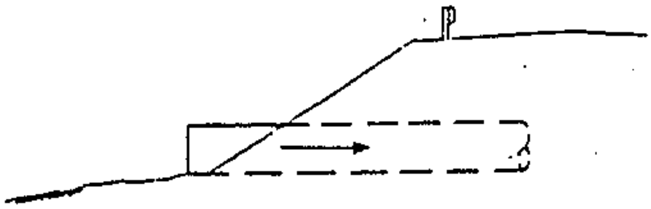
Entrance Loss Coefficients

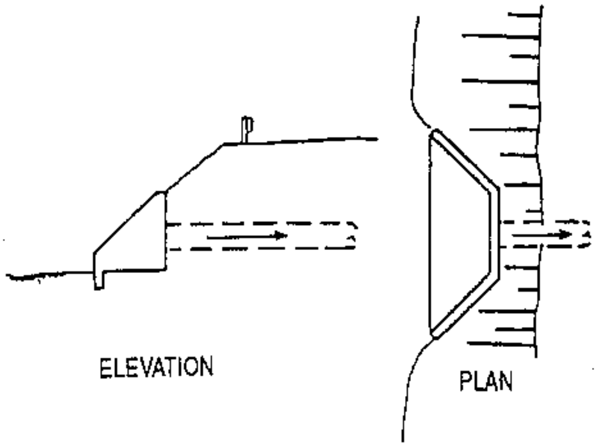
Type of Structure and Design of Entrance	Coefficient K_e
Concrete Pipe	
Projecting from fill, socket end (groove end)	0.2
Projecting from fill, square cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove end)	0.2
Square edge	0.5
Rounded (radius = D/12)	0.2
Mitred to conform to fill slope	0.7
End section conforming to fill slope	0.5
Hooded inlet projecting from headwall	See note
Corrugated Metal Pipe	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square edge	0.5
Mitred to conform to fill slope	0.7
End section conforming to fill slope	0.5
Reinforced Concrete Box	
Headwall parallel to embankment (no wingwalls)	
Square edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension	0.2
Wingwalls at 30° to 75° to barrel	
Square edged at crown	0.4
Crown edge rounded to radius 1/12 barrel dimension	0.2
Wingwalls at 10° to 25° to barrel	
Square edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square edged at crown	0.7

Note: Refer Argue (1960) and O'Loughlin (1960).

Adapted from Hee (1969)

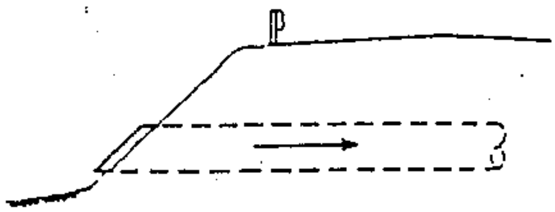
Projecting from Fill

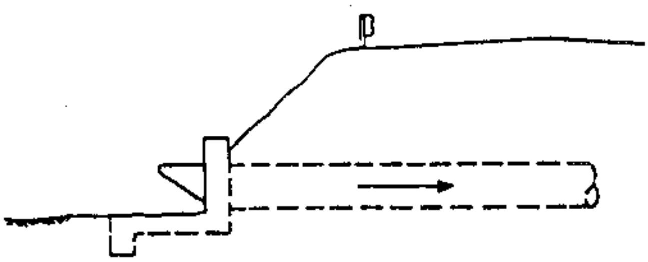




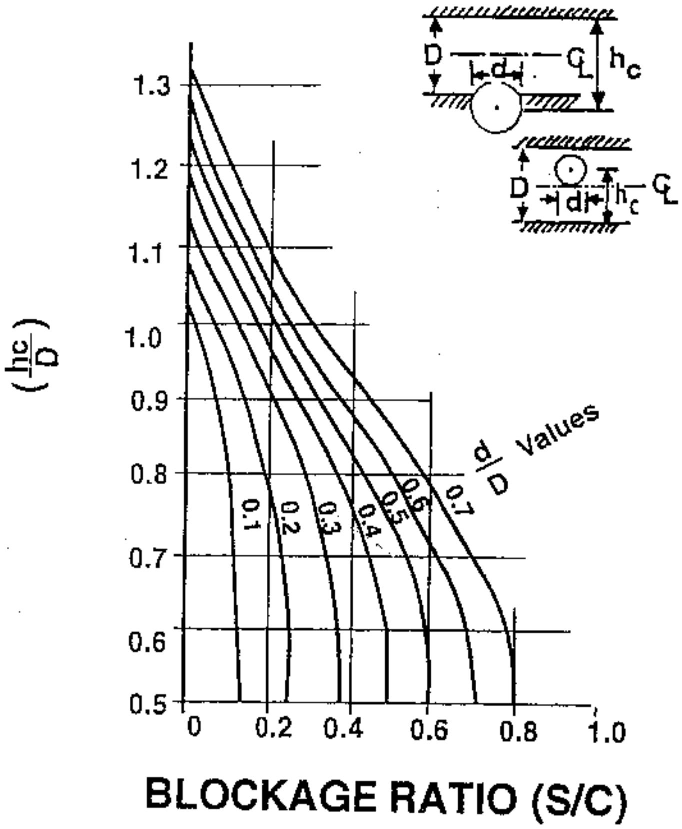
Headwall with Wingwalls

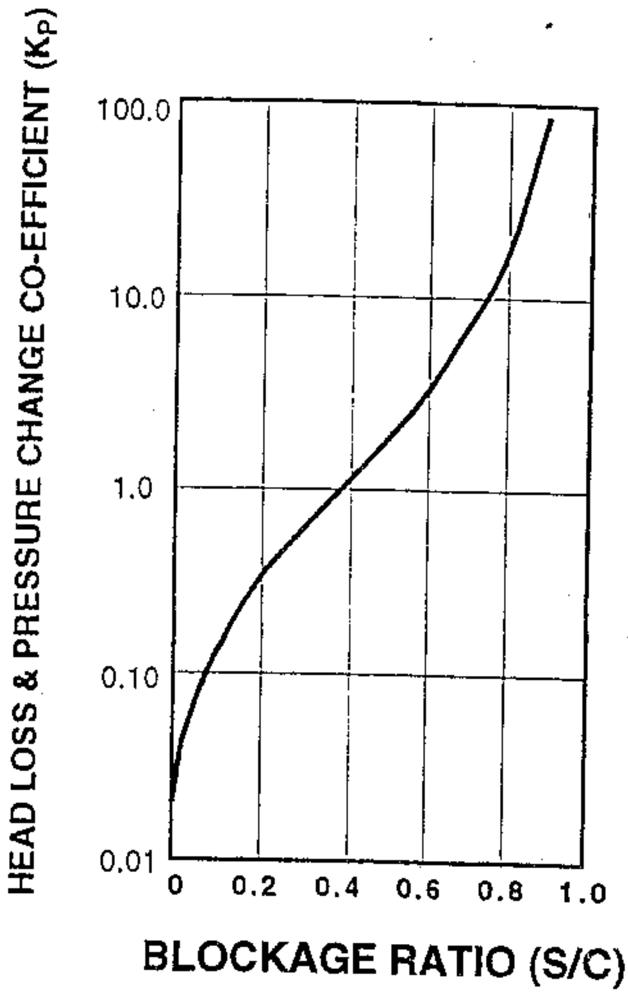
Mitred to Conform to Fill Slope
Types of Entrances





Hooded Entrance





Pressure Changes Caused by Obstructions
Source: Black (1987b)