THE CORPORATION OF THE CITY OF WHITE ROCK

BY-LAW NO. 777

A By-law to Regulate The Subdivision of Land in the City of White Rock

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The Municipal Council of the City of White Rock, in open meeting assembled, ENACTS AS FOLLOWS:-

1. In this By-law,

"Corporation" means the Corporation of the City of White Rock;

"Highway" means and includes a street, road, lane, bridge, viaduct, and any other way open to the use of the public, but does not include a private right-of-way on private property;

"Parcel" means any lot, block, or other area in which land is held or into which it is subdivided, but does not include a highway or portion thereof;

unless otherwise defined herein all words and expressions used in this By-law shall have the same meaning assigned to them as like words or expressions contained in the "Land Title Act", Chapter 219, R.S.B.C. 1979.

2. No land shall be subdivided within the Corporation unless and until the subdivision thereof has received the approval of the Approving Officer pursuant to the provisions of the "Land Title Act", Chapter 219, R.S.B.C. 1979, as amended, and no application for subdivision of land shall be approved by the Approving Officer unless such proposed subdivision:

(a) Is suited to the configuration of the land being subdivided;

(b) Is suited to the use to which it is intended; and

(c) Shall not make impractical the future subdivision of the land within the proposed subdivision or of any adjacent land.

3. No subdivision of land shall be approved unless the parcels to be created by such proposed subdivision shall be suited to the use to which they are intended, and the owner of the lands proposed to be subdivided shall state in writing such intended use when application is made for approval of such proposed subdivision.

4. The Approving Officer may refuse to approve a subdivision plan if he considers that the subdivision does not conform to:

(a) All applicable provisions of the "Land Title Act",

(b) All applicable provisions of the "Municipal Act",

(c) The respective Municipal By-laws regulating the subdivision of land and zoning, and

(d) The Official Community Plan adopted pursuant to the "Municipal Act".

5. All highways within or required in connection with a proposed subdivision shall be dedicated and cleared to the full width as set out in Schedule "A" hereto, which said Schedule is hereby incorporated with and made part of this by-law, and all such highways shall be graded, drained, surfaced and otherwise constructed in accordance with the standards contained in Schedule "B" hereto, which said Schedule is hereby incorporated with and made part of this by-law.

6. The owner of any lands which are proposed to be subdivided shall provide sidewalks, boulevards, transit bays, street lighting and underground wiring along all highways in the proposed subdivision in accordance with the standards contained in Schedule "B" hereto.

7. The owner of any lands which are proposed to be subdivided shall provide each parcel of land within the proposed subdivision with a water distribution system including the standard service connection thereto, and the said water distribution system shall be connected by trunk water mains to the existing community water system.

8. The owner of any lands which are proposed to be subdivided shall provide each parcel of land within the proposed subdivision with a sanitary sewage collection and disposal system including the standard service connection thereto, constructed in accordance with the standards contained in Schedule "B" hereto, and the said sewage system shall be connected by trunk sewer mains to the existing sanitary sewage system of the Corporation.

9. The owner of any lands which are proposed to be subdivided shall provide each parcel of land within the proposed subdivision with a drainage collection system including the standard service connection thereto, constructed in accordance with the standards contained in Schedule "B" hereto, and the said drainage system shall be connected by trunk drainage mains to the existing drainage system of the Corporation.

10. The Approving Officer may refuse to approve a subdivision plan if he is of the opinion that the cost to the Municipality of providing public utilities or other municipal works or service would be excessive.

11. All works and services to be provided to serve any proposed subdivision of land pursuant to this section shall be provided, constructed and installed to the standards prescribed by Schedule "B" to this by-law by and at the expense of the owner of the lands proposed to be subdivided prior to the approval of such subdivision, unless:

(a) The owner of the land deposits with the Corporation, a bond in the form and for an amount satisfactory to the Approving Officer having regard to the cost of installing and paying for all works and services required to this by-law; and

(b) The owner of the land enters into an Agreement with the Corporation to construct and install the prescribed works and services by a specified date or forfeit the amount secured by the bond to the Corporation.

12. Where an owner of land proposed to be subdivided constructs and installs the works and services necessary to serve the proposed subdivision without entering into the Agreement with the Corporation referred to in Section (11) hereof, the owner shall not connect such works and services to any of the Corporation's works, utilities or services and the Corporation shall not accept the works and services constructed and installed by the owner or any part thereof until:

(a) The works have been certified by a Professional Engineer to the best of his knowledge and belief as complete and constructed in accordance with the specifications and standards and requirements of this by-law.

(b) The owner has deposited with the Corporation one set of paper prints and one set of transparencies of the drawings showing the works as actually constructed, certified as correct by a Professional Engineer.

(c) The owner has completed the service connection record cards supplied by the Corporation to show the location of the sanitary sewers, storm sewer and water service connection to each parcel of land within the subdivision.

(d) The City Engineer has inspected the said works and notified the owner in writing of their completion to his satisfaction in accordance with the plans, specifications and standards and requirements of this by-law.

(e) The layout of the proposed subdivision of the land has been approved by the Approving Officer.

(f) The owner has entered into an agreement with the Corporation in which he covenants and agrees to:

(i) Maintain all of the said works and services in complete repair for a period of two years.

(ii) Remedy any defect appearing within two years from the date of acceptance of the said works and services by the Corporation, and to pay to the Corporation for any damage to other works or property resulting therefrom, save and except for defects caused by reasonable wear and tear, negligence of the Corporation, its servants or agents.

(iii) Deposit with the Corporation for a period of two years from the acceptance of the said works and services a sum equal to five percent of the cost of completion of the said works as calculated by the Municipal Engineer, and should the owner fail to maintain the said

works remedy any defect or pay for any damage arising therefrom the Corporation may deduct the cost of so doing from the said deposit.

(iv) Pay to the Corporation all inspection fees, administration fees, engineering fees and legal costs incurred by the Corporation in accepting and taking over such works and services and the cost of connecting all utilities and services required to serve the subdivision of the land.

13. The minimum area, width and depth of every parcel created by subdivision in each particular zone as established by the Municipal "Zoning By-law" as currently and thereafter from time to time, in effect, shall be as follows:

Zone		Minimum Area	Minimum Width	Minimum Depth
RS-1	One Family Residential Zone	5,000 sq. ft.	45 ft.	90 ft.
RS-2	One Family Residential Zone	3,900 sq. ft.	33 ft.	90 ft.
RS-3	One Family Residential Zone	3,000 sq. ft.	30 ft.	90 ft.
RS-4	One Family Residential Zone	1.5 acres	100 ft.	-
RT-1	Two Family Residential Zone	8,000 sq. ft.	60 ft.	100 ft.
RM-1	Low Density Multiple Family Residential Zone	8,000 sq. ft.	60 ft.	100 ft.
RM-2	Medium Density Apartment Residential Zone	8,000 sq. ft.	60 ft.	100 ft.
RM-3	High Density Apartment Residential Zone	8,000 sq. ft.	60 ft.	100 ft.
C-1	Local Commercial Zone	5,000 sq. ft.	50 ft.	100 ft.
C-2	Neighbourhood Commercial Zone	15,000 sq. ft.	165 ft.	Maximum 2 times width
C-3	Town Centre Commercial Zone	15,000 sq. ft.	165 ft.	Maximum 2 times width
CS-1	Service Commercial	15,000 sq. ft.	165 ft.	Maximum 2 times width
CS-2	Service Station Commercial Use	12,000 sq. ft.	165 ft.	Maximum 2 times width
CS-3	Tourist Commercial	15,000 sq. ft.	60 ft.	Maximum 2 times width
P-1	Civil Institutional Zone	8,000 sq. ft.	60 ft.	100 ft.
P-2	Special Institutional Zone	8,000 sq. ft.	60 ft.	100 ft.

No parcel created by subdivision shall have less than one-tenth (1/10) of its perimeter fronting on the highway.

(2) For the purpose of this Section, the width of a parcel shall be measured along a line running parallel to and 7.62 metres back from the lateral boundary of the highway upon which the said parcel fronts, and where the parcel fronts along more than one highway the distance shall be measured from the highway, other than a lane, having the shortest frontage and the depth shall be the measurement perpendicular to the width.

(3) Parcels created within the RS-1, RS-2 and RS-3 Zones shall be shaped and have dimensions which comply with the following requirements:

(a) In the RS-1 Zone, no lot shall have a boundary line of a length equal to or in excess of 3 times the length of any other boundary line;

(b) In the RS-2 Zone, no lot shall have a boundary line of a length equal to or in excess of 3.75 times the length of any other boundary line;

(c) In the RS-3 Zone, no lot shall have a boundary line of a length equal to or in excess of 4.25 times the length of any other boundary line.

14. Every applicant for approval of a subdivision shall pay all school taxes and all Municipal taxes, rates and charges assessed and levied against the lands to be subdivided, and where such taxes, rates and charges for the then current year have not been assessed, levied and imposed on the said lands at the date on which the approval of the subdivision is given by the Approving Officer, deposit with the Corporation the amount estimated by the Municipal Collector to be the total of the school taxes, Municipal taxes, rates and charges to be assessed, levied and imposed on the said lands for the then current year, and in

addition to the examination fee preseribed by the "Land Titles Act", shall pay an application fee of $25,00 for the first parcel to be created by the subdivision and $10.00 for each additional parcel.

Every deposit made pursuant to this section shall be deemed to be monies to be applied at a future date in payment of taxes pursuant to Section 439 of the "Municipal Act", and every such payment and deposit shall be accepted by the collector of the Corporation subject to the provisions of Section 440 of the "Municipal Act".

15. "White Rock Subdivision By-law 1966 No. 245" and amendments thereto is hereby repealed.

16. This By-law may be cited for all purposes as the "White Rock Subdivision By-law 1980 No. 777".

RECEIVED FIRST READING	the	day of	1980.
RECEIVED SECOND READING	the	day of	1980.
RECEIVED THIRD READING	the	day of	1980.
RECONSIDERED AND FINALLY ADOPTED	the	day of	1980.

_____
MAYOR

_____
CLERK/ADMINISTRATOR

"WHITE ROCK SUBDIVISION BY-LAW 1980 NO. 777"

SCHEDULE "A"

1. The minimum width of every highway allowance within a subdivision shall be 20 metres and the minimum width of every highway allowance that borders and is within a subdivision shall be 10 metres; provided however, that where any such highway has been designed by the Corporation as an arterial street the minimum width of such highway allowance with a subdivision shall be 27 metres and the minimum width of every such half highway allowance within a subdivision shall be 13.5 metres and the provisions of Section 732 of the "Municipal Act" c.290, R.S.B.C. 1979, as amended shall apply to such additional width of highway allowance.

2. Lanes shall only be required in subdivisions within the RS-1 Zone, and in subdivisions which abut on any arterial street or highway. The minimum width of every such lane allowance within a subdivision shall be 6 metres and the same shall be paved over the full width thereof and complete with curbs and gutters on each thereof and storm sewers.

3. All new highways within the subdivision, including widening strips of existing highways, cul-de-sacs, and lanes, if any, shall be cleared to their full width and shall be graded, drained and surfaced in accordance with the following minimum requirements for different zones and all construction and works shall be carried out in accordance with the standards prescribed and set out in Scedule "B" of this By-law.

SCHEDULE 'B'

SUBDIVISION BY - LAW # 777

ENGINEERING STANDARDS

CITY OF WHITE ROCK

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ROADS

1 CLASSIFICATIONS

1.1 ARTERIAL

A street usually providing a continuous route primarily for through traffic with land access a secondary consideration.

1.2 COLLECTOR

A street performing the dual function of land access and distribution of traffic between local and arterial streets.

1.3 LOCAL

A street providing land access with little or no provision for through traffic. Direct access is allowed to all abutting properties.

2 ROADWAY AND RIGHT-OF-WAY WIDTHS

2.1 DENSITY DEFINITION

Low density: less than 16 dwelling units per hectare
Medium density: between 16 and 30 dwelling units per hectare.
High density: greater than 30 dwelling units per hectare.

2.2 MINIMUM WIDTHS

A Roadways with Curbs

Classification	Density	R/W Width	Roadway Width
Collector	low	20 m	11.0 m
	med & high	20 m	13.0 m
*Local	low	18 m	8.5 m**
	med	18 m	9.5 m
	high	20 m	11.0 m

*for local roads in hillside locations (land slope exceeding 15% average) minimum R/W width shall be 20 m.
**where special provision for parking is made a roadway width of 6.0 m is acceptable on short culs-de-sac (5-6 residences)

B Roadways Without Curbs

Classification	Density	R/W Width	Roadway Width	Shoulder Width* (each side)
Collector	low	20 m	8 m	1.4 m
	med & high	20 m	8 m	2.5 m
**Local	low	18 m	6 m	0.6 m
	med	18 m	7 m	1.0 m
	high	20 m	8 m	1.0 m
Lanes	N/A	6 m	6 m	-

*if parking required a 2.5 m shoulder width required.
**for local roads in hillside locations (land slope exceeding 15% average) minimum R/W width shall be 20 m.

3 ROADWAY DESIGN CRITERIA

3.1 ALIGNMENTS

A General

Classification	Density	Design Speed Km/h	Max grade Desir %	Max grade Absol %	Min Stopping m	Max Superelev %	Min* Radius m
Collector	low	50	9	12	65	0.06	90
	med & high	60	8	10	85	0.06	130
Local	low	40	12	18	45	0.02	50
	med & high	50	12	15	65	0.02	90

* where grades exceed maximum desirable the minimum radius for horizontal curves must be increased.

B Grade

Minimum gutter grade shall be 0.50% with absolute minimum being 0.30%

Maximum grade for downhill culs-de-sac shall not exceed 8%

Absolute maximum grade may only be used where:

i) desirable grade cannot be obtained due to topographical constraints
ii) the geometric design of intersections can be improved by increasing grade on minor street to avoid compromising design of major street.

C Vertical Curvature

Classification	Density	Design Speed Km/h	K Values			
			Crest Curves		Sag Curves	
			Min	Desir	Min	Desir
Collector	low	50	7	10	6	11
	med & high	60	15	20	10	20
Local	low	40	4	5	4	7
	med & high	50	7	10	6	11

Use of K values below desirable may only be used where justified by topographical constraints.

Vertical curve length is calculated by the equation L = KA
L - Length in metres
A - Algebraic difference in grades percent
K - Given in above table.

D Cross-Slopes

Roadways shall generally be constructed using a centreline crown.

Under adverse topographic conditions, offset crown or cross fall may be used.

Minimum cross-slopes shall be 2%, with a maximum 4%.

Location of offset crowns shall be 2.5 m from high side curb or pavement edge.

Centreline valley may be used for lanes and local roads in mobile home subdivisions or in other similar developments.

3.2 INTERSECTIONS

A General

Intersections shall be as near as possible to right angles. The minimum angle of intersection shall be 70° and the maximum angle 110°.

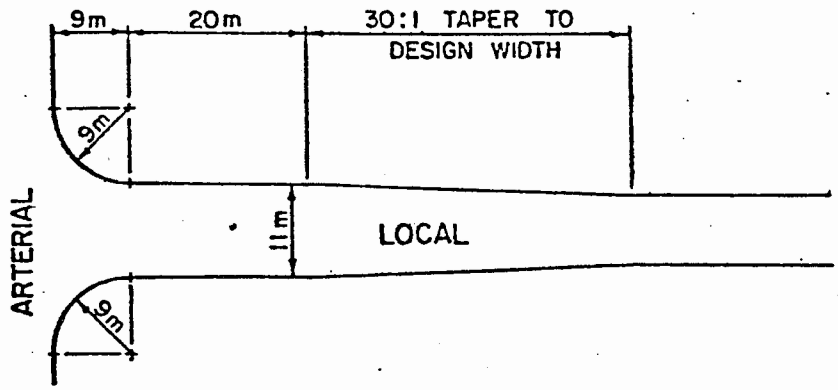
The minimum spacing between tee intersections along a street shall be 60 m.

B Curb-return Radii at Intersections

Street	Intersecting Street	Minimum Radius
Collector	Arterial	9.0 m
	Collector	7.5 m
Local	Arterial	9.0 m
	Collector	7.5 m
	Local	6.0 m

C Local Streets Intersecting with Arterials

Intersecting local streets shall have a minimum width of 11 m for a distance of 20 m from the major street curb return.



D Vertical Curvature at Intersections

Providing the minor intersecting street is marked as a STOP, the following K values may be used for the minor street:

	K Values			
	Crest Curves		Sag Curves	
Classification	Min	Pref	Min	Pref
Collector	4	6	4	6
Local	2	4	2	4

Minimum K Values for sag curves may be used where street lighting is provided.

E Cross-slope at Intersections

At intersections the cross fall of the minor street shall be varied to suit the cross fall of the major street.

The maximum rate for changing cross fall at intersections shall be as follows:

Collector	4% in 30 m
Local	6% in 30 m

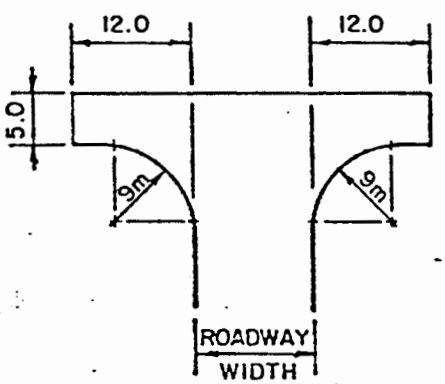
3.3 CULS-DE-SAC

Circular or Circular Offset

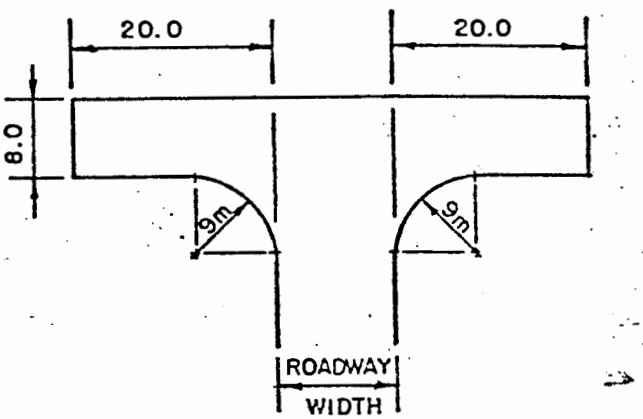
Classification	Density	R/W Width m	Radius m	Lane Width m
Local with centre island	low	28	11.0	6.75
	med & high	32	13.0	7.5
Local without island	low & med	25	10.0	-
	high	28	11.5	-

Tee or Hammerhead type may be used, lane width shall be as follows:

Low Density



Med and High Density



4 CLEARANCES

4.1 CLEARANCE AT BRIDGES

Horizontal clearance in metres from edge of travel lane:

Classification	Density	Overpass Lane Edge to Rail or Parapet		Underpass Lane Edge to Abutment or Wall	
		Sidewalk*	No Walk	Sidewalk*	No Walk
Collector	low	2.25	1.0	2.5	1.5
	med & high	2.5	1.0	2.5	1.75
Local	low	2.25	1.0	2.5	1.25
	med & high	2.25	1.0	2.5	1.25

*Sidewalk - minimum 1.5 m wide and minimum 150 mm above roadway grade

Minimum vertical clearance from finished road grade to bottom of underpass 4.90 m

4.2 AERIAL UTILITIES

Type	Vertical Clearance
Communications and guy wires	4.6 m
Hydro conductors 0 - 750 V	4.6 m
Hydro conductors 750 - 22000 V	5.0 m
Hydro conductors 22000 - 90000 V	5.5 m

For greater voltages check local hydro authority.

4.3 SIGNS AND POLES

Horizontal clearance from edge of travel lane to edge of pole or sign:

- Roadways without curbs 2.0 m
- Roadways with curbs 0.3 m min. 1.0 m preferable except where sidewalk is adjacent to curb in which case 1.6 m is preferable

Use of minimum clearance to be justified by safety appurtenances such as poles with break-away or frangible bases or sign poles of light weight fabrication.

Horizontal clearance between lighting pole and hydro pole shall be 2.5 m.

Vertical clearance between lighting pole and hydro lines of 750-22000 V shall be 2.5 m

4.4 TREES

Horizontal clearance from edge of travel lane to tree trunk shall be 2.0 m.

Horizontal clearance from edge of driveway, curb return or above ground utility to tree trunk shall be 2.5 m.

5 SIDEWALKS AND WALKWAYS

5.1 DESIGN CRITERIA

Where walkways are not an intergral part of a roadway the following shall apply:

		Maximum grade		Cross Slope		
					Maximum	
R/W	Width	Desir	Absol	Min	Desir	Absol
3 m	1.5 m	7%	9%	2%	4%	6%

Absolute grade and cross slope may be used only where desirable values cannot be obtained due to topographical constraints.

For pedestrian bridges or underpasses the minimum width shall be 2.5 m.

Where walkways are included in the road right-of-way, the following shall apply:

Location	Width	Cross Slope
Adjacent curb	1.6 m	2% except
Independent	1.2 m	at driveways

Generally sidewalk alignment constraints shall be identical to those of the adjacent roadway.

Cross slope shall be towards the gutter or ditch on the roadway.

5.2 REQUIREMENT WARRANTS

Classification	Density	Location*
Collector	all	both sides
Local	low	none
	med & high	one side

* Sidewalks should also be provided to suit a planned system of school collector walks

5.3 WHEELCHAIR RAMPS

Wheelchair ramps shall be formed at all intersections where curbs separate sidewalks or walkways from roadways. Wheelchair ramps shall be located at the mid point of the curb return.

5.4 SIDEWALK CROSSINGS

Density	Width
low & medium	4.5 m
high (one lane)	4.5 m
high (two lane)	9.0 m

For areas of high density, single driveways into a multi-dwelling unit may be treated as an intersection and curb-returns used.

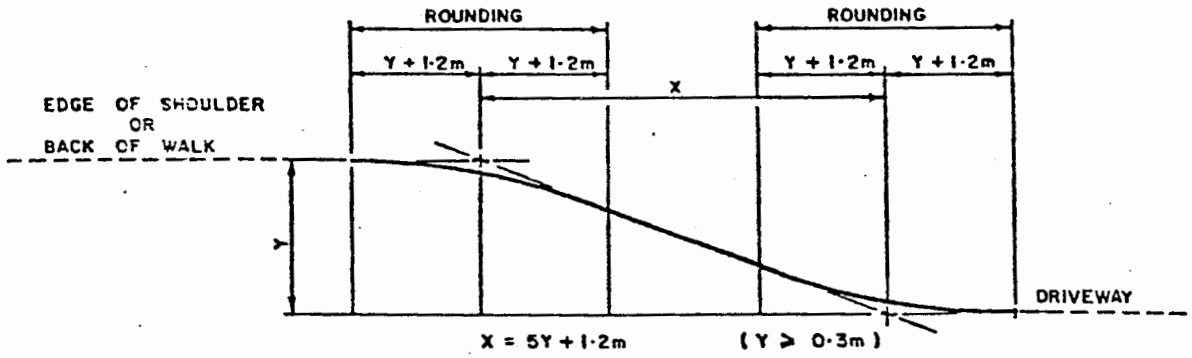
6 DRIVEWAYS

6.1 DESIGN CRITERIA

Density	Min Width
low & medium	3.0 m
high (one lane)	3.5 m
high (two lane)	6.0 m

6.4 DRIVEWAY PROFILE

Where driveways involve an elevation difference in excess of 0.3 m, the following profile can be used to define the maximum grade and vertical curvature. (Note that grades shall not exceed 20% in any case).



DRIVEWAY PROFILE

Note: Profile may be used for both positive or negative grades by reversing driveway road location.

7 PAVEMENT STRUCTURES

7.1 GENERAL

Pavement design shall be based on one of the following methods:

1) Past history of successful pavements in adjacent similar areas.
2) Any design method covered in Part 5 "Structural Design" of the RTAC Pavement Management Guide. Pavement design shall include consideration of the subgrade soil type, frost susceptibility, moisture conditions and subgrade drainage provisions.

7.2 DESIGN CRITERIA

Design life for all classifications of roads shall be minimum 20 years.

Where the Benkelman Beam design method is used, the design deflections (mean plus two standard deviations) shall be as follows:

local 1.5 mm
collector 1.3 mm

Where existing pavements are to be overlaid, the minimum thickness of asphaltic concrete pavement overlay shall be at least two times the maximum aggregate size, but in no case to be less than 25 mm.

7.3 PAVEMENT STRUCTURE

Regardless of the method used for pavement structure design, pavement structures shall be at least equal to or greater than the minimum pavement structures shown below.

Minimum pavement structures shown below are based on the in-situ soil classification as defined in the Unified Soil Classification System. (See Fig. 3.2.A).

Soils at the subgrade level having classifications of MH, CH, OH and Pt require special treatment or removal and replacement with soil having a higher classification.

7.4 MINIMUM PAVEMENT STRUCTURE USING ASPHALTIC CONCRETE PAVEMENT

Classif.	Minimum thickness with subgrade soil Classif SC & better	Minimum thickness with subgrade soil Classif ML/CL/OL
Local	50 mm asphaltic concrete 75 mm base course 150 mm sub base	50 mm asphaltic concrete 75 mm base course 300 mm sub base
Collector	75 mm asphaltic concrete 75 mm base course 180 mm sub base	75 mm asphaltic concrete 75 mm base course 330 mm sub base

7.5 MINIMUM PAVEMENT STRUCTURE USING PORTLAND CEMENT CONCRETE

Classif	Minimum thickness with subgrade soil Classif SC & better	Minimum thickness with subgrade soil Classif ML/CL/OL
Local	125 mm portland cement concrete 75 mm base course	125 mm portland cement concrete 75 mm base course 150 mm sub base
Collector	150 mm portland cement concrete 75 mm base course	150 mm portland cement concrete 75 mm base course 150 mm sub base

7.6 FROST SUSCEPTIBLE AREAS

For areas of frost susceptibility where the subgrade soils are classification GM/GC/SM/SC/ML/CL/OL, the roadbed shall consist of granular material to the minimum depth as defined below:

Classification	Minimum Frost Protection Depth as % of Frost Penetration
Local	20%
Collector	35%

Where the minimum frost protection depth exceeds the minimum pavement structure depth, granular material having a fines content of less than 12% shall be placed below the pavement structure to make up the difference.

7.7 MINIMUM STRUCTURES FOR SIDEWALK, WALKWAYS AND DRIVEWAYS

A Using Asphaltic Concrete

Item	Structure
Sidewalk, Walkways and Driveways	50 mm asphaltic concrete 75 mm base course

B Using Portland Cement Concrete

Item	Structure
Sidewalk, Walkways and Driveways	100 mm portland cement concrete 50 mm base course
Sidewalk Crossings	150 mm portland cement concrete 50 mm base course

8 LIGHTING

8.1 PHOTOMETRIC DESIGN CRITERIA

Classification	Density	cd/m^2	lx	Uniformity ratio average : minimum
Collector	all	0.80	12	5:1
Local	low	0.27	4	6:1
	med & high	0.40	6	6:1
Sidewalks*	--	0.13	2	6:1
Walkways	--	0.33	5	6:1

*for sidewalks adjacent to roadways

Illumination for bridges and overpasses shall be 50% higher than the approach intensity.

8.3 GRADE CROSSING

Illumination for unsignalized railway grade crossings shall be a minimum 1.0 cd/m^2.

For roadways with continuous lighting, the illumination level shall be increased to 200% of the normal level for a distance of 35 m in each direction from the crossing.

Illumination shall be from a minimum of two luminaires staggered on each side of the crossing.

8.4 BREAK-AWAY SUPPORTS

Where break-away supports are required, either frangible bases (coupling), slip-bases or progressive shear bases may be used.

It shall be shown that the design of the break-away support is suitable for the service load it is intended to carry.

9 BRIDGES

All bridge design shall be in accordance with National Standard of Canada, CSA Standard CAN 3-S6-M78.

Roadway bridges shall be designed to a minimum loading of MS 200.

10 MATERIALS

3.2.10.1 SELECT AGGREGATE

Select aggregate shall be used for sub base materials.

Select aggregate shall be a pit run gravel screened if necessary, uniform in quality and free from soft or disintegrated particles, clay and silt balls. It shall conform to the following gradation limits when tested in accordance with ASTM C136.

Standard Sieve Size	Gradation Limits (Percent by Weight Passing)
75.0 mm	100
26.5 mm	85 - 50
0.15 mm	16 - 0
0.075 mm	8 - 0

River sand or pitrum sand may also be used for subbase material, provided that it has less than 8% passing the 0.075 mm sieve, that it can be adequately compacted to attain the required stability, and that the effect of using sand has been taken into account in the pavement design.

10.2 CRUSHED AGGREGATE

Crushed aggregate shall be screened, crushed, durable gravel, uniform in quality and free from soft or disintegrated particles, clay or silt balls or an excess of flat or elongated pieces. It shall be capable of withstanding the effects of handling, spreading and compaction without excessive degradation or production of deleterious fines.

In the absence of satisfactory performance records for a particular source of aggregate, its soundness shall be tested according to ASTM Designation C88 using Magnesium Sulphate. Aggregate so tested shall be considered unsatisfactory if the loss after five cycles exceeds 20% for coarse aggregate or 25% for fine aggregate.

Crushed aggregate shall conform to the following gradation limits when tested in accordance with ASTM C136.

Type	Standard Sieve Size	Gradation Limits (Percent by Weight Passing) 12 mm mix	19 mm mix
Class A	19.0 mm	-	100
	13.2 mm	100	100 - 70
	9.5 mm	100 - 80	90 - 55
	4.75 mm	85 - 45	70 - 35
	2.36 mm	64 - 32	57 - 25
	1.18 mm	51 - 24	45 - 18
	0.60 mm	40 - 17	34 - 13
	0.30 mm	29 - 13	26 - 8
	0.15 mm	18 - 7	17 - 5
	0.075 mm	10 - 3	8 - 2
Class B	19.0 mm		100
	9.5 mm		100 - 60
	4.75 mm		80 - 40
	2.36 mm		60 - 30
	1.18 mm		45 - 20
	0.30 mm		20 - 8
	0.075 mm		8 - 2

Class A crushed aggregate shall be used for asphaltic concrete pavement. 12 mm mix shall be used for surface course pavements and 19 mm mix used for lower course pavements.

Class B crushed aggregate shall be used for base course material, shouldering and driveways. Class B crushed aggregate may also be used for bedding materials in water and sewer construction.

10.3 ASPHALT CEMENT

Asphalt cement shall conform to the following grades when tested in accordance with ASTM D5.

Climatic Zone	Grade
Temperate Coastal	85 - 100 penetration
Extreme Temperature Ranges (all other areas)	120 - 150 penetration

10.4 ASPHALTIC CONCRETE MIXES

Asphaltic concrete mixes shall conform to the following requirements based on the Marshall method of design:

Classification	Design Criteria	Climate Zone: Temperate	Climate Zone: Extreme
Local	Number of blows each face of test specimen	75	75
	Minimum % voids in mineral aggregate	14	14
	Percent air voids in compacted mixture	3-5	3-5
	Minimum modified Marshall stability, N @ 60°C	3600	3000
	Flow index, units of mm	2-4.5	2-4.5
	Minimum index of retained stability after immersion in water @ 60°C for 24 hours	75%	75%
Collector	Number of blows each face of test specimen	75	75
	Minimum % voids in mineral aggregate	14	14
	Percent air voids in compacted mixture	3-5	3-5
	Minimum modified Marshall stability, N @ 60°C	4600	4000
	Flow index, units of mm	2-4.0	2-4.0
	Minimum index of retained stability after immersion in water @ 60°C for 24 hours	85%	85%

10.5 PORTLAND CEMENT CONCRETE MIXES

Cement shall be normal Portland cement (Symbol 10) conforming to CAN 3-A5.

Concrete aggregate shall conform to CAN 3-A23.1. Concrete aggregate shall be a clean crushed stone or gravel and a clean well graded sand.

The minimum 28-day compressive strength shall be 30 MPa and the flexural strength shall be 4 MPa.

11 TYPICAL DETAILS

11.1 CONCRETE CURBS

Curb details shall conform to the following:

(a)	Curb with gutter	
	i) barrier	Fig. 3.2.B
	ii) mountable	Fig. 3.2.C
(b)	Curb without gutter	
	i) barrier	Fig. 3.2.D
	ii) mountable	
(c)	Curb on pavement	
	i) barrier	Fig. 3.2.E
	ii) mountable	

Classification	Density	Curb Type (in order of preference)
Collector	all	Curb with gutter, barrier
Local	low & med	Curb with gutter, barrier and mountable Curb without gutter, barrier and mountable
	high	Curb with gutter, barrier and mountable

Curb on Pavement shall be used only for islands or medians where fill materials are placed directly behind the curb.

Reverse gutter sections shall be used where the road cross-slope falls away from the curb.

Concrete curb may be cast monolithically with sidewalks where they are adjacent.

Sidewalk crossing details shall conform to the following:

(a)	adjacent barrier type curb	Fig. 3.2.F
(b)	adjacent mountable type curb	Fig. 3.2.G
(c)	separate from curb	Fig. 3.2.H

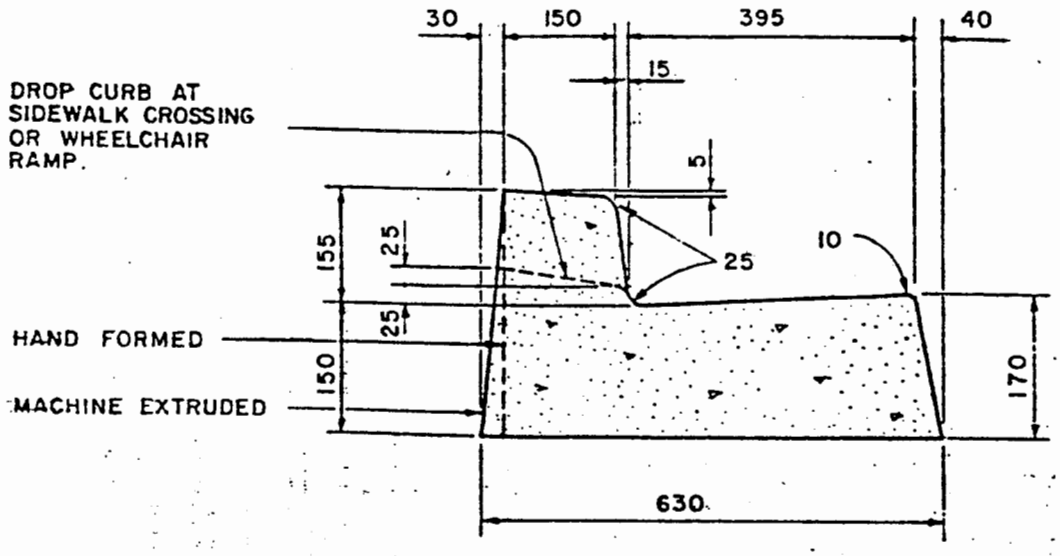
11.3 WHEELCHAIR RAMPS

Wheelchair ramp details shall be as shown on Fig. 3.2.I.

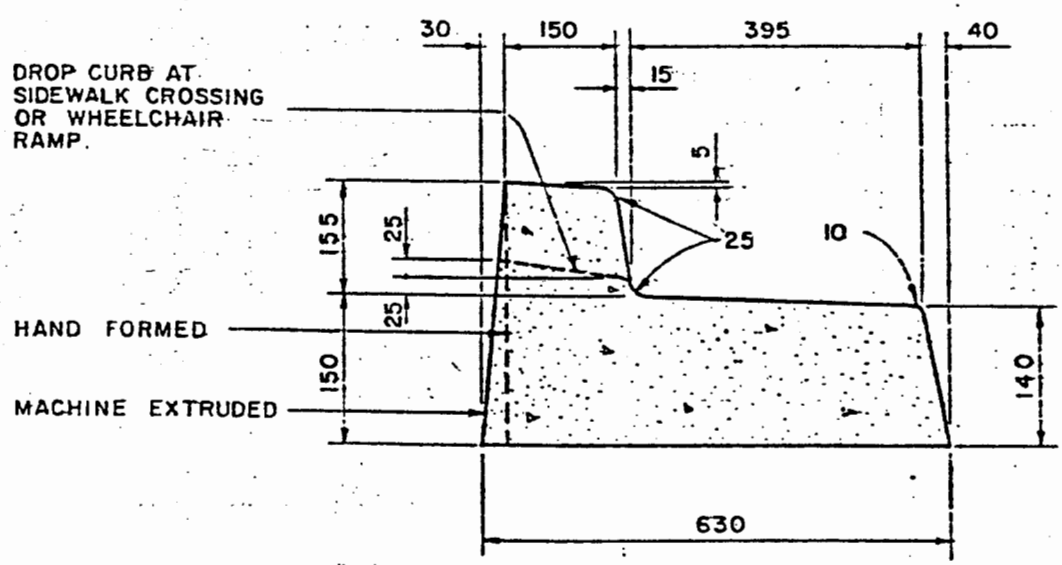
11.4 ROAD CONSTRUCTION DETAILS

Road construction details shall conform to the following:

(a)	Roadways with curbs	
	i) cut detail	Fig. 3.2.J
	ii) fill detail	Fig. 3.2.K
(b)	Roadways without curbs	
	i) cut detail	Fig. 3.2.L
	ii) fill detail	Fig. 3.2.M



STANDARD GUTTER



REVERSE GUTTER

NOTE.
ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.

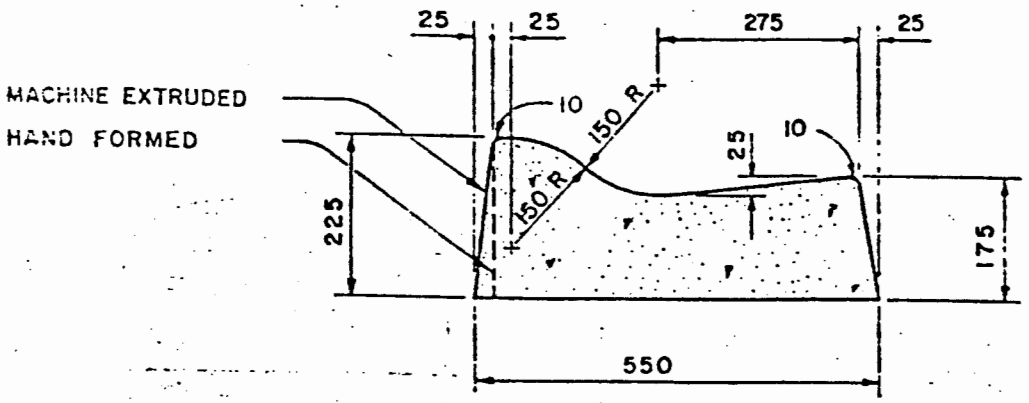
CURB WITH GUTTER
BARRIER TYPE

FIG. 3.2.B

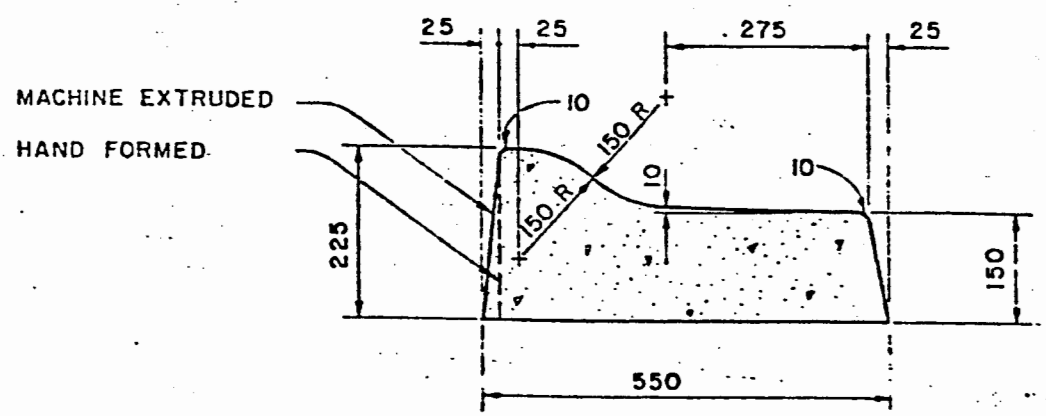
MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA
COARSE-GRAINED SOILS (MORE THAN 50 PERCENT BY WEIGHT LARGER THAN 0.075 mm SIEVE)	GRAVELS MORE THAN HALF COURSE GRAINS LARGER THAN 4.75 mm SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL GRADED GRAVELS, LITTLE OR NO FINES	CONTENT OF FINES LESS THAN 5 PERCENT
			GP	POORLY GRADED GRAVELS, AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	
		DIRTY GRAVELS (WITH SOME FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEED 12 PERCENT
			GC	CLAYEY GRAVELS, GRAVEL-SAND-(SILT) CLAY MIXTURES	
	SANDS MORE THAN HALF FINE GRAINS SMALLER THAN 4.75 mm SIEVE	CLEAN SANDS (LITTLE OR NO FINES)	SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	CONTENT OF FINES LESS THAN 5 PERCENT
			SP	POORLY GRADES SANDS, LITTLE OR NO FINES	
		DIRTY SANDS (WITH SOME FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12 PERCENT
			SC	CLAYEY SANDS, SAND-(SILT) CLAY MIXTURES	
FINE-GRAINED SOILS (MORE THAN 50 PERCENT BY WEIGHT PASSING 0.075 mm SIEVE)	SILTS LOW COMPRESSIBILITY	$W_L < 50\%$	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART
		$W_L > 50\%$	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS	
	CLAYS HIGH COMPRESSIBILITY	$W_L < 30\%$	CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS	
		$30\% < W_L < 50\%$	CI	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS	
		$W_L > 50\%$	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	
	ORGANIC SILTS AND CLAYS	$W_L < 50\%$	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	
		$W_L > 50\%$	OH	ORGANIC CLAYS OF HIGH PLASTICITY	
	HIGHLY ORGANIC SOILS		PT	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOR, AND OFTEN FIBROUS TEXTURE

UNIFIED CLASSIFICATION SYSTEM FOR SOILS

FIG. 3.2.A



STANDARD GUTTER

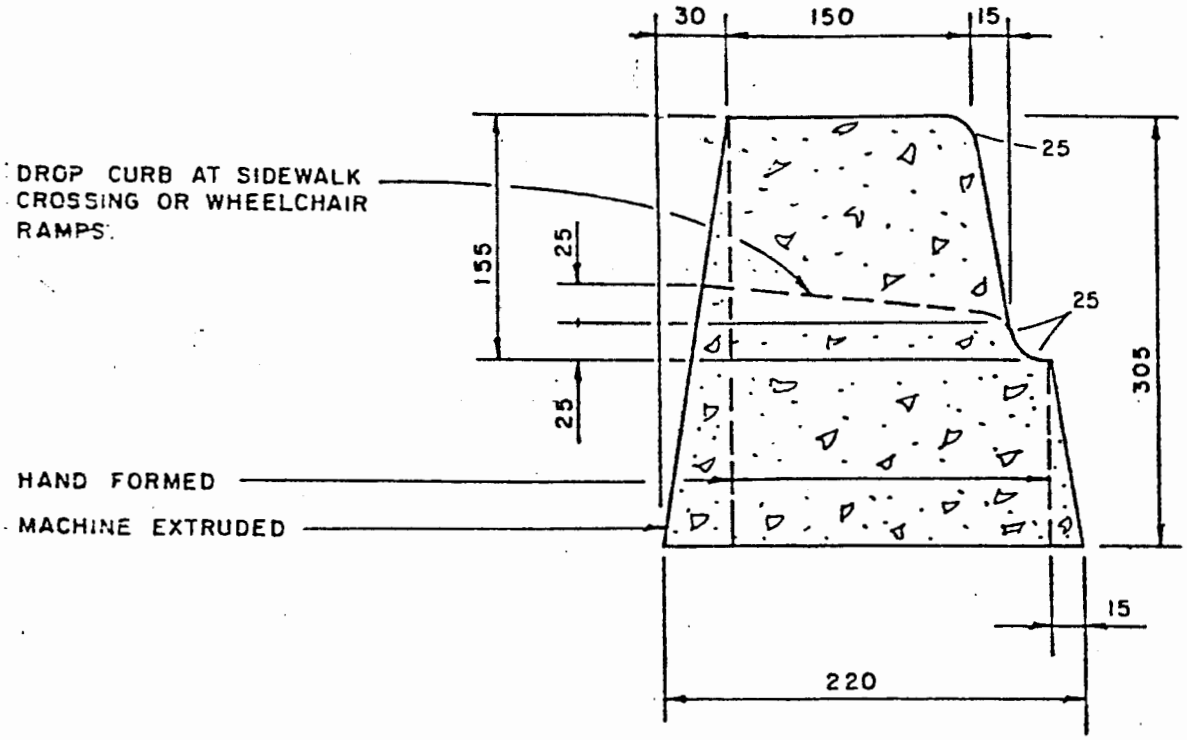


REVERSE GUTTER

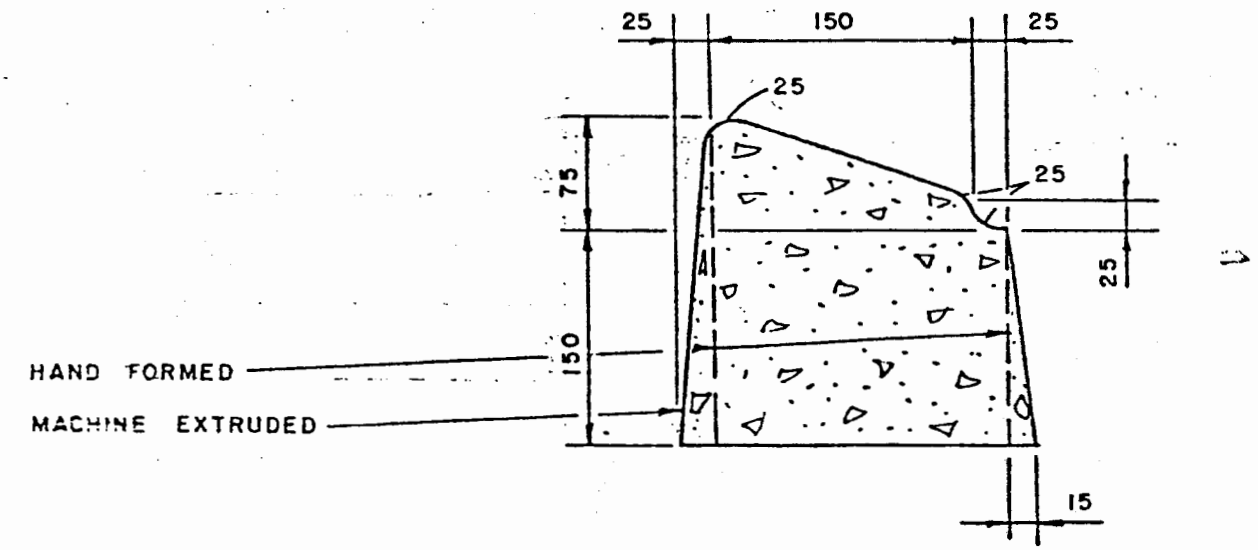
NOTE.
ALL DIMENSIONS IN MILLIMETRES
UNLESS OTHERWISE SPECIFIED.

CURB WITH GUTTER

FIG. 3.2.C



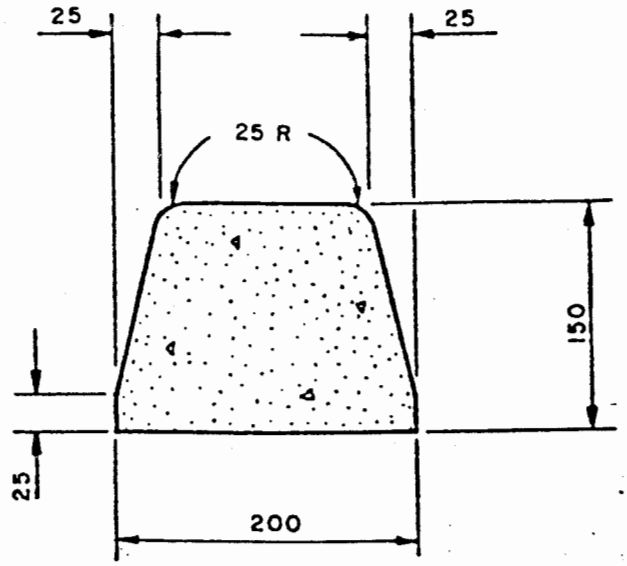
BARRIER TYPE



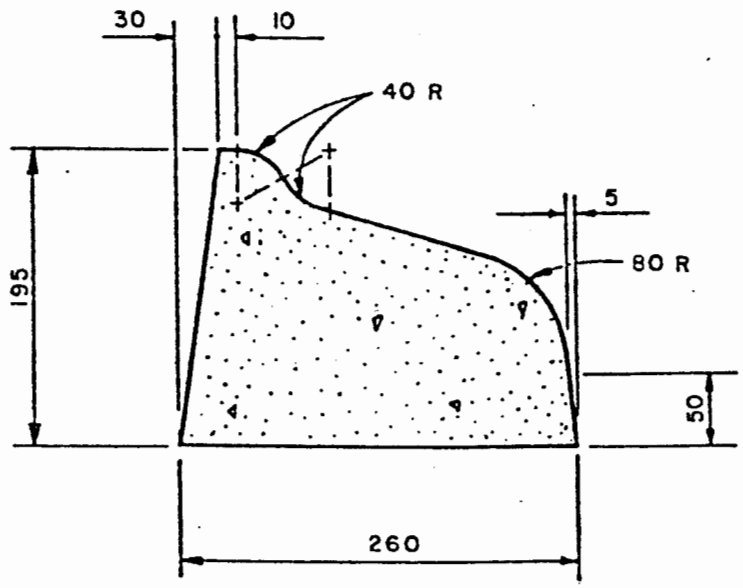
MOUNTABLE TYPE

NOTE.
ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.

CURB WITHOUT GUTTER FIG. 3.2.D



BARRIER TYPE

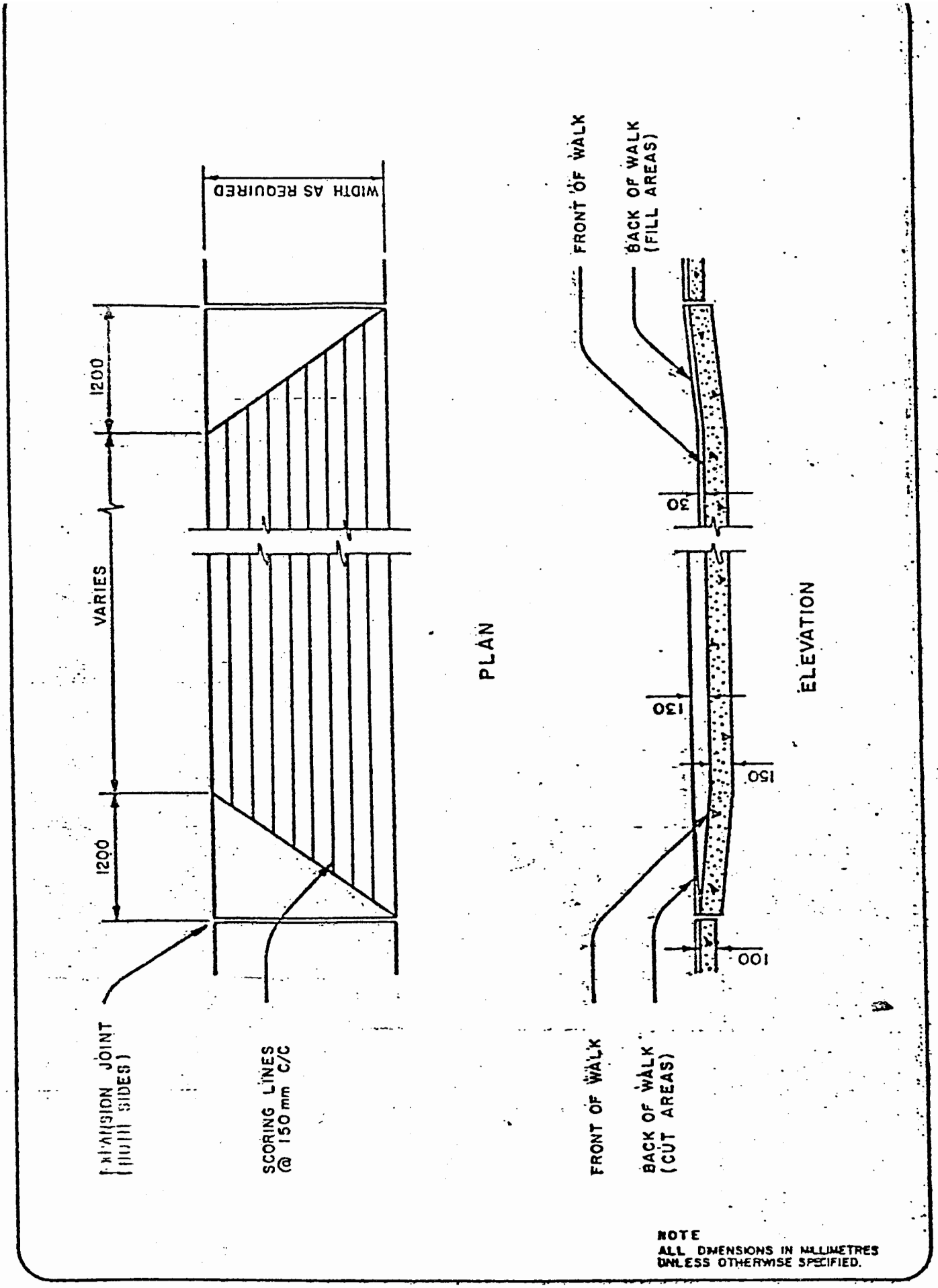


MOUNTABLE TYPE

NOTE
ALL DIMENSIONS IN MILLIMETRES
UNLESS OTHERWISE SPECIFIED.

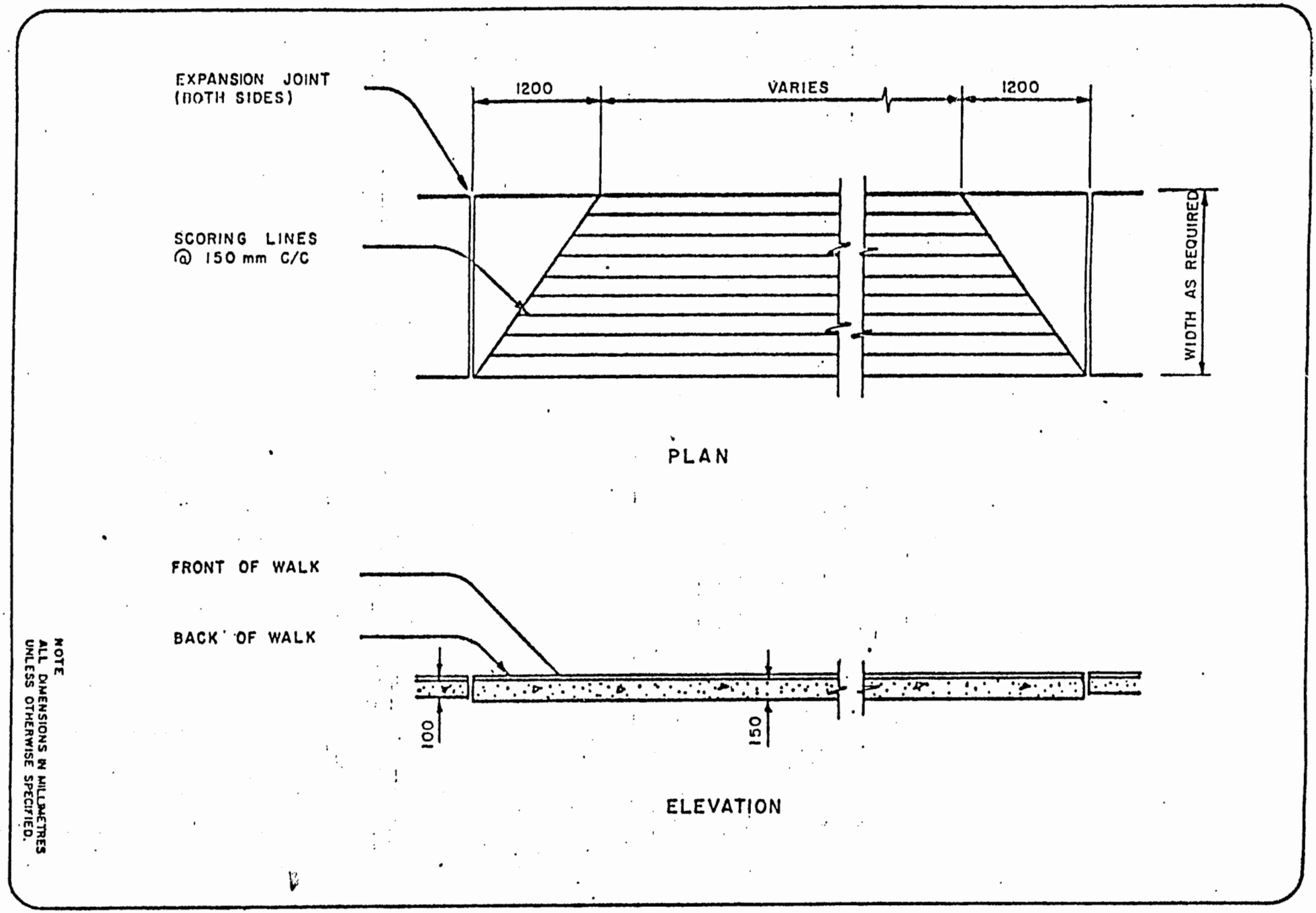
CURB ON PAVEMENT

FIG. 3.2.E



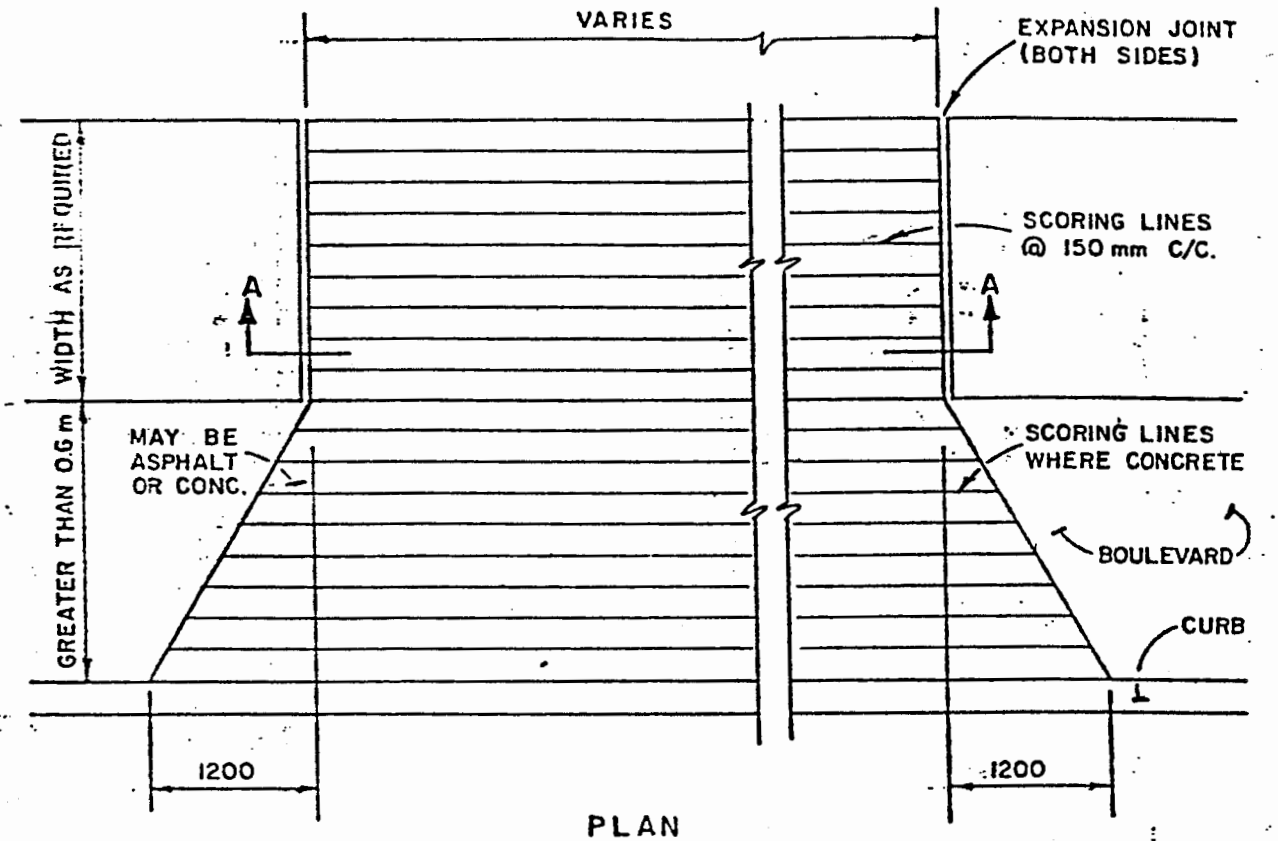
SIDEWALK CROSSING ADJACENT BARRIER TYPE CURB

FIG. 3.2.F

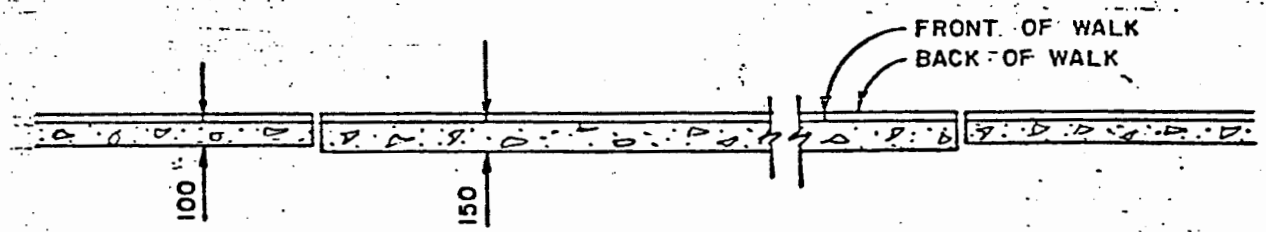


SIDEWALK CROSSING ADJACENT

FIG. 3.2.G



PLAN

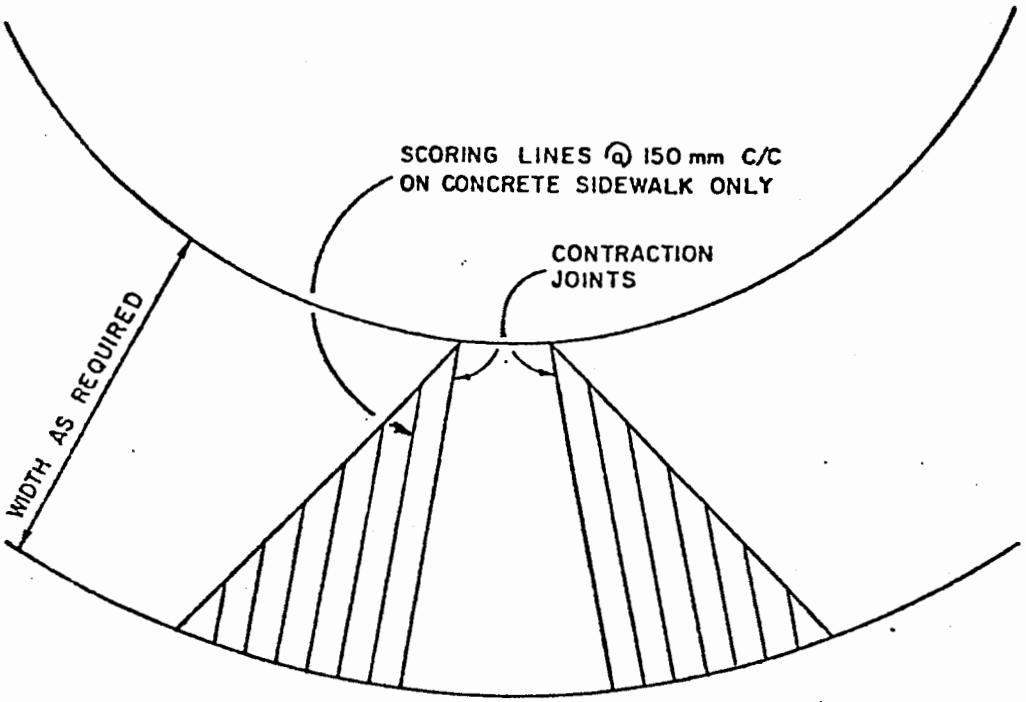


SECTION A-A

NOTE
ALL DIMENSIONS IN MILLIMETRES
UNLESS OTHERWISE SPECIFIED.

SIDEWALK CROSSING FOR
SIDEWALK SEPARATE FROM CURB

FIG. 3.2.H



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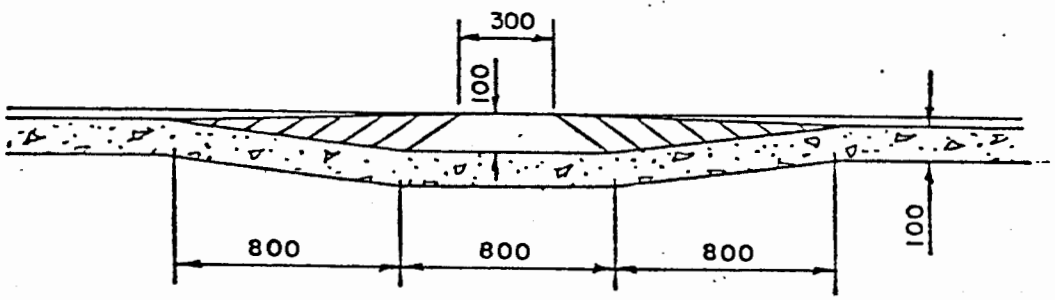
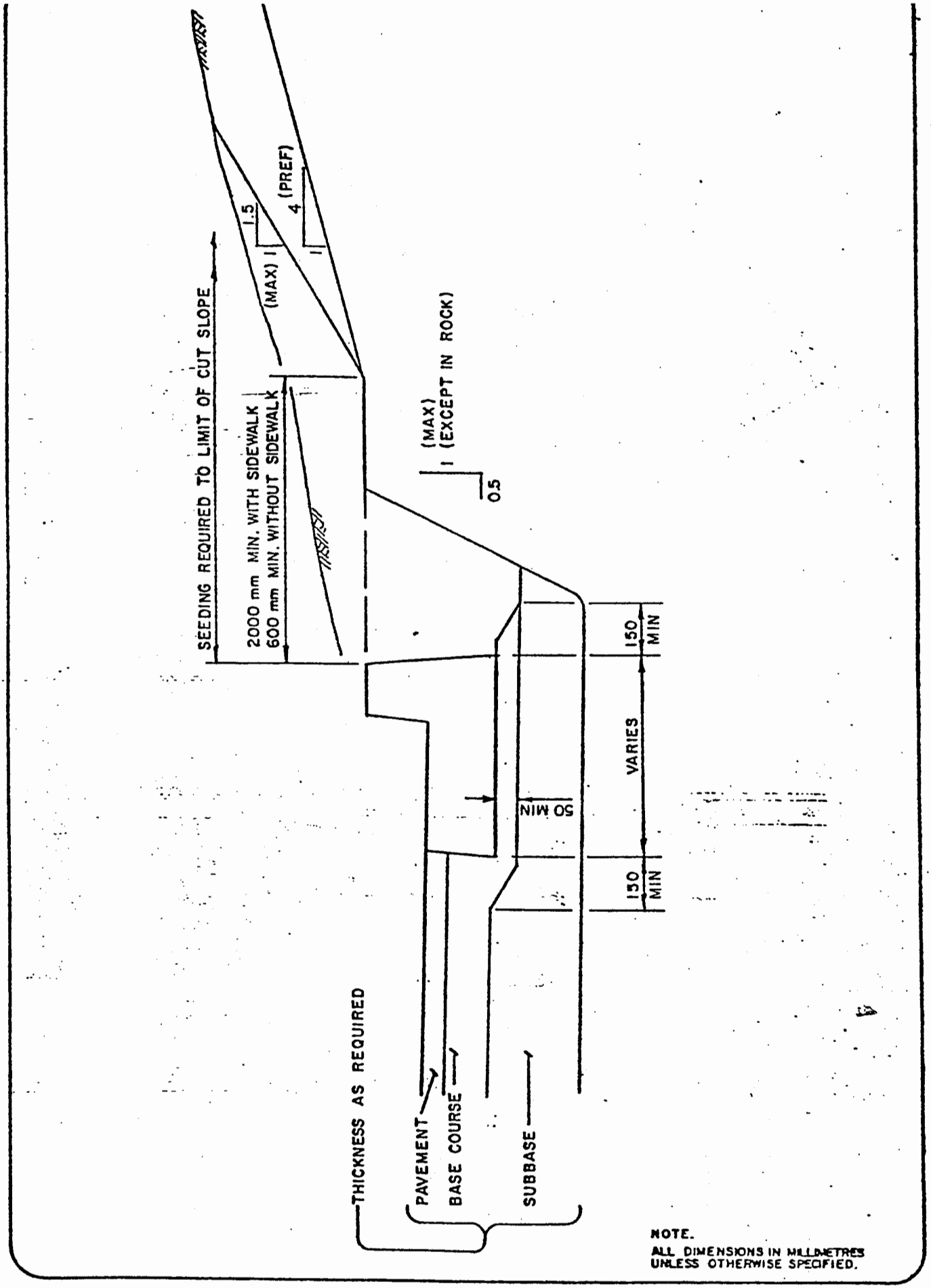


ELEVATION

NOTE
ALL DIMENSIONS IN MILLIMETRES
UNLESS OTHERWISE SPECIFIED.

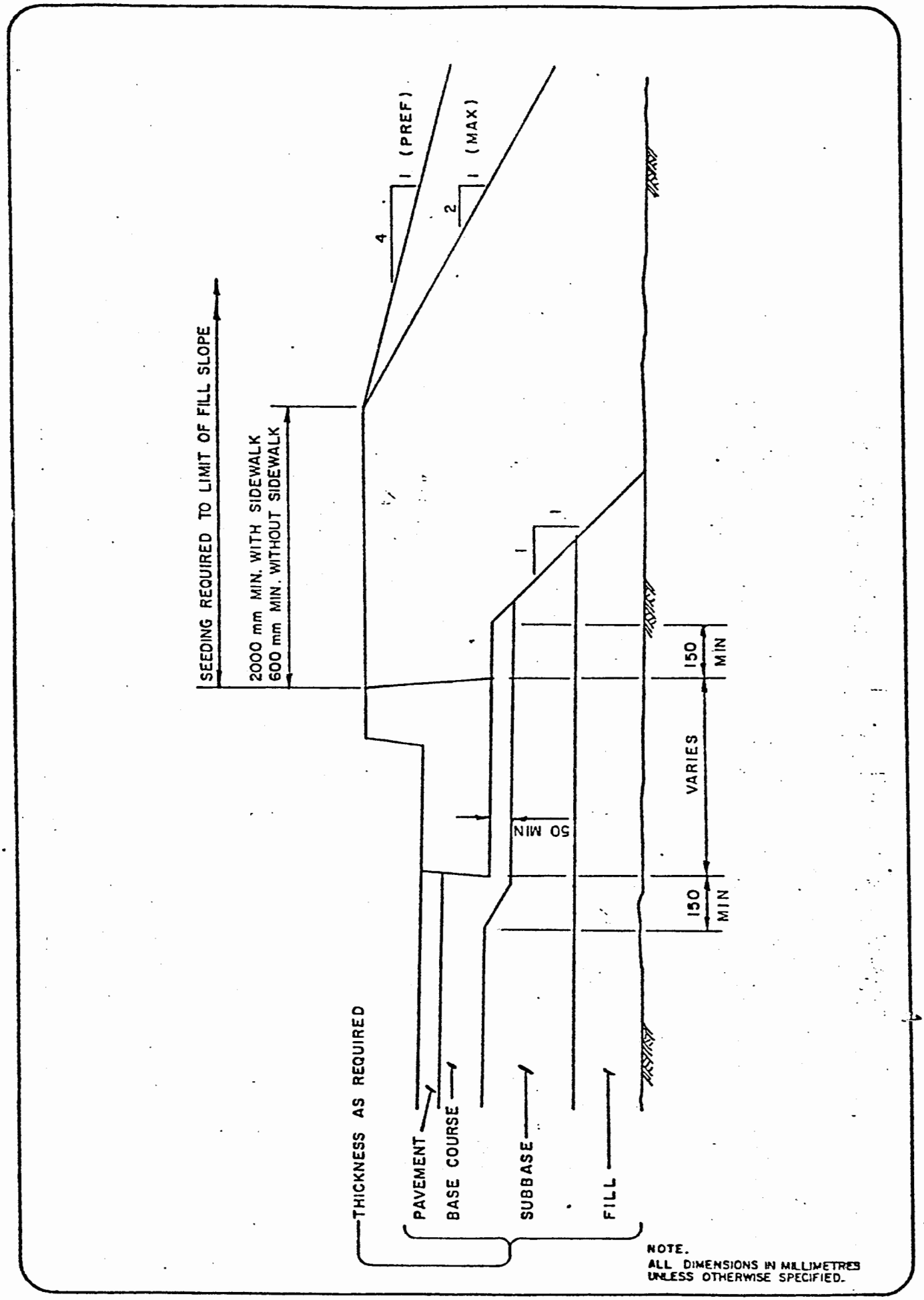
WHEEL CHAIR RAMP

FIG. 3.2.1

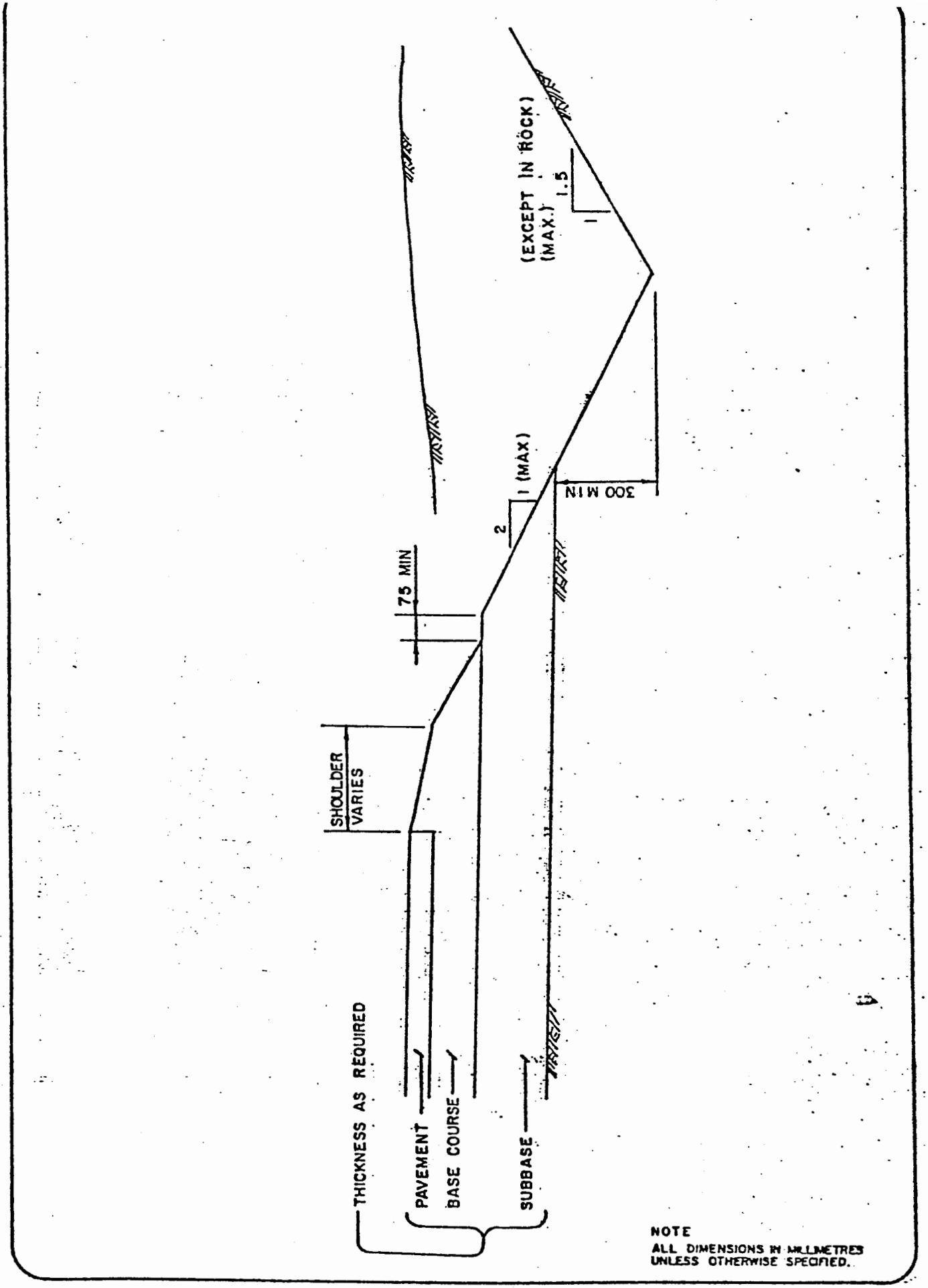


ROADWAYS WITH CURBS
CUT DETAIL

FIG. 3.2.J

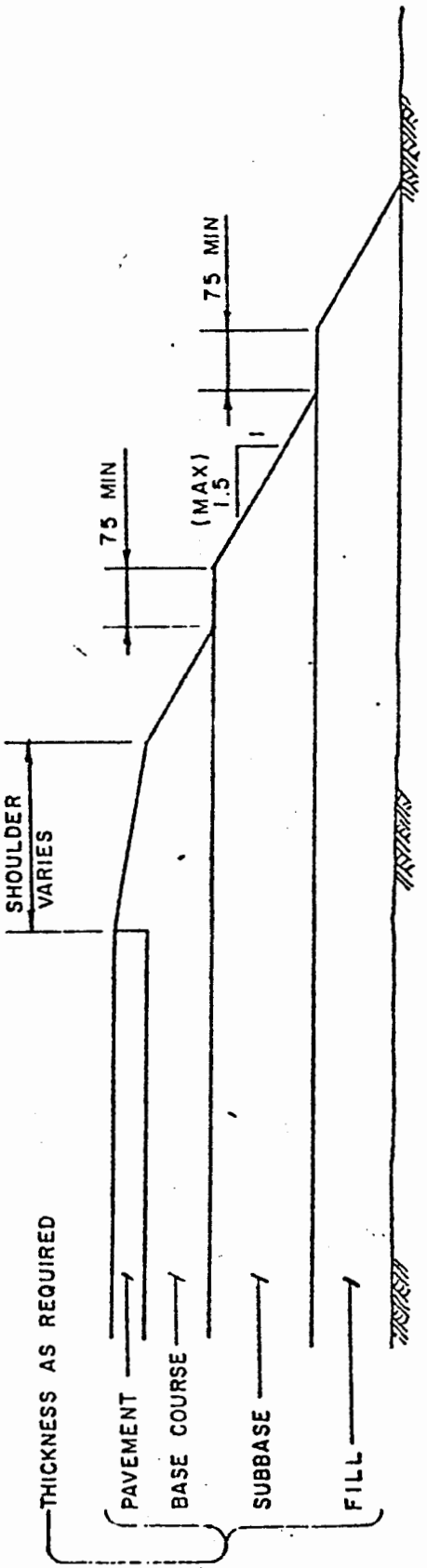


ROADWAYS WITH CURBS FIG. 3.2.K



ROADWAYS WITHOUT CURBS
CUT DETAIL

FIG. 3.2. L



NOTE
ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.

ROADWAYS WITHOUT CURBS FIG. 3.2 M

STORM DRAINAGE

1 DESIGN METHODS

Storm drainage systems shall be designed using either the conventional method or the storm water management concept as follows:

1.1 CONVENTIONAL

(a) Design shall be based on the Rational Formula.

(b) The method may be used for conventional developments if approved by the local authority.

1.2 STORM WATER MANAGEMENT

(a) The method involves the provision of facilities for detention, surface infiltration and sub-surface disposal to limit the peak runoff after development to that which occurred before development.

(b) The method ideally shall be used for all comprehensive developments and may be required by the local authority for conventional developments.

2 MINOR AND MAJOR SYSTEMS

Each drainage system shall consist of the following components:

(a) the Minor System shall consist of pipes, open channels and water courses which convey flows of a 5-year or 10-year return frequency. The system shall include driveway culverts.

(b) The Major System shall consist of surface flood paths, roadways and water courses which convey flows of a 100-year return frequency. The system shall include culverts crossing roadways.

3 DESIGN FLOWS

Design flows shall be computed using one or more of the following methods:

3.1 RATIONAL FORMULA

$$Q = \frac{AIR}{360}$$

where Q = Design flow in m^3/s
A = Drainage area in ha
I = Rainfall intensity in mm/hr
R = Runoff coefficient

See Storm Sewer Design Sheet, Fig. 3.3.A

The Rational Formula is applicable to small watersheds (approximately 8 ha or less) with drainage systems not including detention facilities.

3.2 HYDROGRAPH METHODS

Hydrograph methods are required for larger areas and for any drainage system including detention facilities. Available calculation methods include the following:

(a) Manual Methods

i) Modified Rational Method
ii) Ven Te Chow Method
iii) Colorado Urban Hydrograph Procedure

The above methods are described in American Public Works Association Special Report No. 43 entitled "Practices in Detention of Urban Storm Water Runoff".

iv) U.S. Soil Conservation Service (SCS) Method as described in SCS Technical Release No. 55 entitled "Urban Hydrology for Small Watersheds".

(b) Computer Modelling

i) Stormwater Management Model (SWMM). Details are available from the U.S. Environmental Protection Agency.
ii) Illinois Urban Drainage Area Simulator (ILLUDAS). Details are available from the Illinois State Water Survey.

4 RAINFALL INTENSITY/DURATION/FREQUENCY (IDF) CURVES

IDF curves shall be obtained from the local authority. If no curves have been prepared or adopted by the local authority, curves shall be obtained from the Atmospheric Environment Service of Environment Canada.

5 RAINFALL RETURN FREQUENCY

The following return frequencies shall be used for design:

(a) Minor Systems i) Conventional Design – 10-year return
ii) Storm Water Management – 5-year return

(b) Major Systems – 100-year return

6 TIME OF CONCENTRATION

Use the following formula:

$$T_C = T_I + T_F$$

where: T_C = Time of concentration for use as duration on IDF curve to get rainfall intensity.
T_I = Inlet time. See Fig. 3.2.B.
Minimum : 10 minutes
Maximum for most developments : 20 minutes
T_F = Flow time in channels and pipes. See item 3.3.12.

7 RUNOFF COEFFICIENTS (For Rational Formula)

Type of Area	Coefficient		
	Low	High	Standard
Low density housing	0.45	0.55	0.50
Medium density housing	0.55	0.65	0.60
High density housing	0.60	0.80	0.70
Park or golf course	0.15	0.25	0.20
Churches or schools	0.60	0.85	0.75
Roofs or pavements	0.90	1.00	0.95
Grassland	0.15	0.30	0.20
Cultivated	0.30	0.50	0.40
Woodland	0.10	0.40	0.25

Low values are applicable to areas with high soil permeability and gentle slopes (5% or less).

High values are applicable to areas with low soil permeability and steeper slopes (greater than 5%).

Standard values are for general application.

Higher values are possbily applicable in those areas which experience rainfall during the winter when the ground is frozen. These values might reach 0.80 to 0.95.

8 SITE AND LOT GRADING

The following criteria shall be used:

(a) Each lot should be graded to drain to the municipal storm drainage system, independently of adjacent lots where possible.

(b) Areas around buildings shall be graded away from the foundations to prevent flooding.

(c) Lots lower than adjacent roadways should be avoided where possible.

(d) Buildings should be above the Major System hydraulic grade line (see item 3.3.2).
Note: Stream gauging and flood level information is available for some streams from the following agencies:
i) Hydrology Division, B.C. Ministry of Environment.
ii) Planning and Survey Division, B.C. Ministry of Environment.
iii) Water Survey of Canada Branch, Inland Waters Directorate, Environmental Management Service, Environment Canada.

9 FOUNDATION DRAINS

A gravity connection to the municipal storm drainage system may be made only where the habitable portion of a dwelling is above the Major System hydraulic grade line. Otherwise, only a pumped connection will be permitted.

10 ROOF DRAINAGE

(a) Provided that a site is graded away from the building and such that surface water does not flow to adjacent lots, roof drainage shall be discharged to the ground and dispersed via splash pads at the downspouts.

(b) If site grading in accordance with (a) above is not possible, roof drainage shall be discharged into the municipal drainage system.

(c) On flat roofs, controlled-flow roof drain devices shall be installed to provide temporary storage and retard the discharge to the ground or storm sewer system.

11 DETENTION

Detention facilities shall be provided with adequate volume and restricted outlets designed to limit the discharge to the 5-year pre-development flow. Spillways shall be included to provide for emergency release and flows greater than the 5-year flow.

Typical detention facilities include the following:

(a) Roof storage - See item 3.3.10.
(b) Parking lot ponding - Flow control devices may include weirs or orifices in outlet catch basins or manholes.
(c) Gravel-filled trenches with perforated pipes.

(d) Rock-filled pits.
(e) Underground storage - Tanks, pipes or culverts.
(f) "Blue-Green" detention - Storage in channels and water courses.
(g) Detention basins.
(h) Retention ponds - Storage in lakes or ponds with an established permanent water level. Detention can be incorporated by providing storage capacity above the permanent water level.

12 FLOW CAPACITIES

12.1 STORM SEWERS AND OPEN CHANNELS

Use Manning's Formula $Q = \frac{AR^{0.667}S^{0.5}}{n}$ (See Fig. 3.3.C)

where Q = Design flow in m^3/s
A = Cross sectional area in m^2
R = Hydraulic radius in m
S = Slope of hydraulic grade line in m/m
n = Roughness coefficient
= 0.013 for asbestos cement, clay and concrete pipe
= 0.024 for corrugated steel pipe (unpaved).
= 0.02 for gravel lined channels
= 0.013 for concrete or asphalt lined channels
= 0.05 for natural streams and grassed channels

12.2 CULVERTS

Use the inlet control and outlet control methods referred to in:
(a) Handbook of Steel Drainage and Highway Construction Products, by American Iron and Steel Institute.
(b) Handbook of Concrete Culvert Pipe Hydraulics, by Portland Cement Association.

13 SEWER LOCATION

(a) See Fig. 3.6.A for typical location within road right-of-way.
(b) Service connections should be located adjacent to sanitary service connection at property line and shall be as shown on Fig. 3.5.C.
(c) Minimum separation from water mains and services:
i) 3.0 m horizontally.
ii) 0.5 m vertically below water pipe and in separate trench if 3.0 m horizontal separation is not possible.

14 MINIMUM DEPTH OF COVER

The minimum depth of cover shall be as follows:

(a) Storm sewers in roads: minimum 1.0 m
(b) Culverts across roads and driveways: minimum 0.3 m

15 MINIMUM PIPE DIAMETER

(a)	Storm Sewers		250 mm
(b)	Culverts	i) crossing roads	450 mm
		ii) crossing driveways	300 mm
(c)	Catch Basin Leads		200 mm
(d)	Leads to	i) foundation drains only	100 mm
		ii) roof drains and foundation	150 mm

16 MINIMUM VELOCITY AND GRADE

The minimum velocity for pipes flowing full or half full shall be 0.75 m/s. The corresponding minimum grades are as follows; steeper grades are desireable:

Pipe Size, mm	Mimimum Grade, m/100m	
	n = 0.013	n = 0.024
100 (4")	1.50	
150 (6")	1.00	
200 (8")	0.60	
250 (10")	0.40	
300 (12")	0.32	1.03
350 (14")	0.28	
375 (15")	0.23	0.77
400 (16")	0.20	
450 (18")	0.18	0.60
525 (21")	0.15	0.49
600 (24")	0.12	0.41
675 (27")	0.10	
750 (30")	0.09	0.31
900 (36")	0.07	0.24
1050 (42")	0.06	0.19
1200 (48")	0.05	0.16
1350 (54")	0.04	0.14

17 MINIMUM RADIUS OF CURVATURE

Minimum radius = 60 m for pipes up to 600 mm diameter.
22-1/2° mitres may be used for larger pipes.

Maximum joint deflection shall be as recommended by the pipe manufacturer.

18 HYDRAULIC LOSSES IN MANHOLES

The following criteria shall be used:

(a) Generally the crown of the downstream pipe shall not be higher than that of the upstream pipe. However, the 0.8 depth point of both pipes may be placed at the same elevation.

(b) Minimum drop in invert levels across manholes:
  i) straight run - no drop required
  ii) deflections up to 45° - 20 mm drop
  iii) Deflection 45° to 90° - 30 mm drop.

19 MANHOLE SPACING

The maximum distance between manholes shall be as follows:

Pipe Size (mm diameter)	Maximum Distance (m)
375 and smaller	125
450 to 750	155
900 and larger	185

20 CATCH BASIN SPACING

Catch basins shall be provided at regular intervals along roadways, at intersections, and at low points.

Catch basins shall be spaced to drain a maximum area of 500 m^2 on road grades up to 5% and 400 m^2 on steeper grades.

21 PIPE MATERIALS AND SPECIFICATIONS

21.1 PIPE MATERIALS

Pipe shall comply with the following specifications:

Material	Range (mm)	Specification
Reinforced Concrete	300 and up	ASTM C76 Class III and up
Non-reinforced Conrete	150 to 525	ASTM C14 Class 3
Corrugated Steel	150 and up	AASHO M-36
Asbestos Cement (AC)	100 and up	ASTM C428 Class 2400 and up
Polyvinyl Chloride (PVC)	100 to 150	ASTM D3034, SDR 28
	200 to 300	ASTM D3034, SDR 35

Pipe shall be jointed with rubber gaskets or gasketed fittings or couplings.

21.2 BEDDING MATERIAL

(a) Granular material for bedding of AC and PVC pipes shall be Class B crushed aggregate conforming to the gradation specified under item 3.2.10.2.

(b) Bedding material for other pipes shall be clean gravel or crushed rock, evenly graded from coarse to fine, with a maximum size of 25 mm and 90% retained on a 0.075 mm screen.

21.3 TRENCH SECTION

See Fig. 3.3.J for trenching and bedding details.

22 MANHOLE DETAILS

22.1 SIZE

Minimum inside barrel diameter = 1050 mm

22.2 SPECIFICATIONS

Precast manhole barrels and cover slabs shall conform to ASTM C478.

22.3 CONSTRUCTION

(a) Standard Precast type

i) For sewers 375 mm dia. or less. see Fig. 3.3.D
ii) For sewers 400 mm to 900 mm dia see Fig. 3.3.E
iii) For sewers 1050 mm dia and over see Fig. 3.3.F

(b) Drop Manhole Details..... see Fig. 3.3.G

(c) Manhole Cover and Frame..... see Fig. 3.3.H

23 CATCH BASIN DETAILS

Catch basin details and orientation of gratings shall be as shown on Fig. 3.3.I.

24 INLET AND OUTLET STRUCTURES

24.1 APPLICATION/SIZE

	Structure	Application	Size	Materials (see 3.3.24.2)
(a)	endwall	retain embankment fill over pipe	min height = 0.3 m above pipe min. width = 2 x height above invert	(i) to (vii) inclusive
(b)	wingwalls	transition outlet to channel shape	typical angle = 30° and 45° min. length = 2 x pipe I.D.	(ii), (iii), (v) and (vi)
(c)	apron	prevent bottom erosion	min. length = 2 x pipe I.D.	(iv), (vi) and (vii)
(d)	spillway	transition drop between pipe and channel bottom	special design required	(iv), (vi) and (vii)
(e)	energy dissipators	reduce discharge velocity	special design required	(vi) and (vii)

24.2 MATERIALS

i) concrete-filled sandbags
ii) concrete blocks
iii) prefabricated end sections
iv) gabions
v) binwalls (concrete or steel)
vi) reinforced concrete
vii) rock rip-rap (grouted or ungrouted)

24.3 GRATINGS

Gratings shall be installed at inlets and outlets of all sewer pipes over 450 mm in diameter.

25 TESTING

Testing of installed pipe shall consist of the following:

(a) Lamping or visual checking between manholes to ensure proper alignment and grade of pipe,
(b) manual joint gauging where access is possible,
(c) visual checking for joint leaks where access is possible,
(d) visual checking for pipe cracks where access is possible.

STORM SEWER DESIGN SHEET

PROJECT ______________________

DESIGNED BY ______________

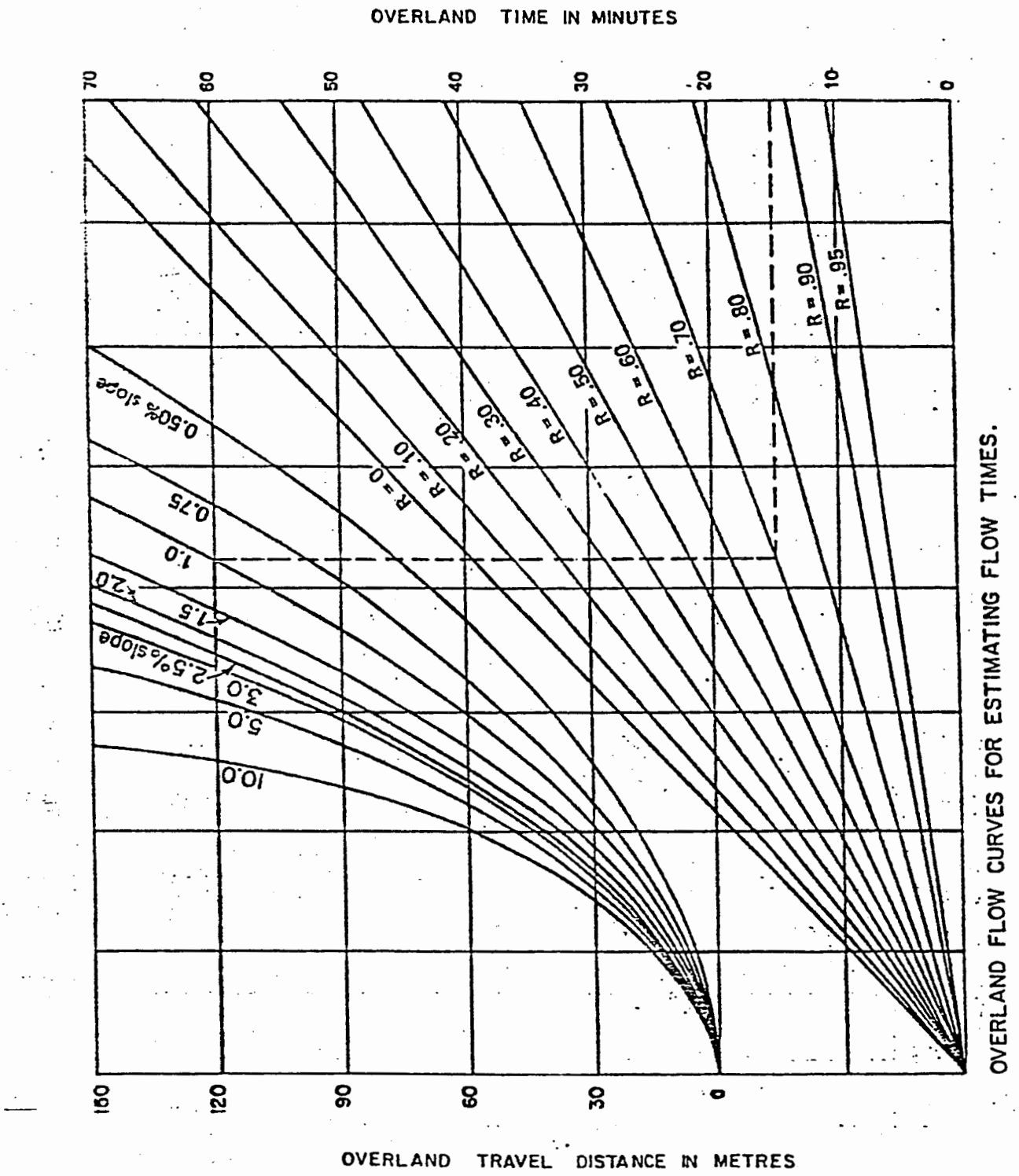
CHECKED BY ______________

SHEET ______ OF ______

JOB No. ______________

DATE ______________

LOCATION				AREA		FLOW $Q = 0.00278 \times A \times I \times R$							PIPE DATA						DROP			ELEVATIONS			
							EFFECTIVE AREA $\Sigma A \times R$		TIME OF CONCENTRATION (minutes)													UPSTREAM		DOWNSTREAM	
DWG. NO.	STREET OR LINE	FROM	TO	A	ΣA	RUNOFF COEF. R	INCR.	TOTAL	INCR.	TOTAL	RAINFALL INTENSITY I	DESIGN FLOW Q	CAPACITY	n	SLOPE	SIZE	VELOCITY	PIPE LENGTH	SLOPE	OTHER	TOTAL DROP	GROUND	INV.	GROUND	INV.


OVERLAND TIME IN MINUTES
70
60
50
40
30
20
10
0
R = .95
R = .90
R = .80
R = .70
R = .60
R = .50
R = .40
R = .30
R = .20
R = .10
R = 0
0.50% slope
0.75
1.0
2.0
1.5
2.5% slope
3.0
5.0
10.0
150
120
90
60
30
0
OVERLAND TRAVEL DISTANCE IN METRES
OVERLAND FLOW CURVES FOR ESTIMATING FLOW TIMES.

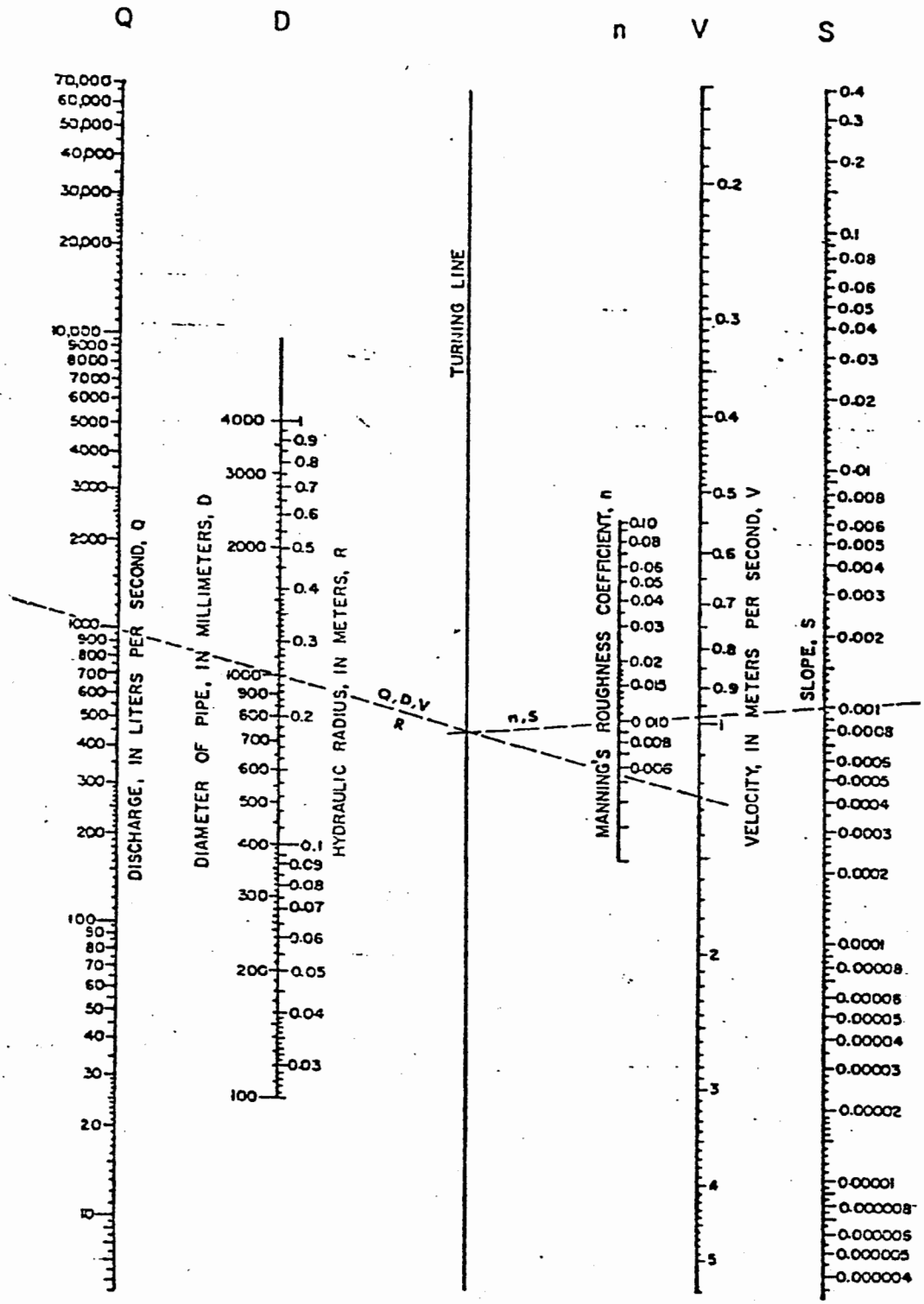
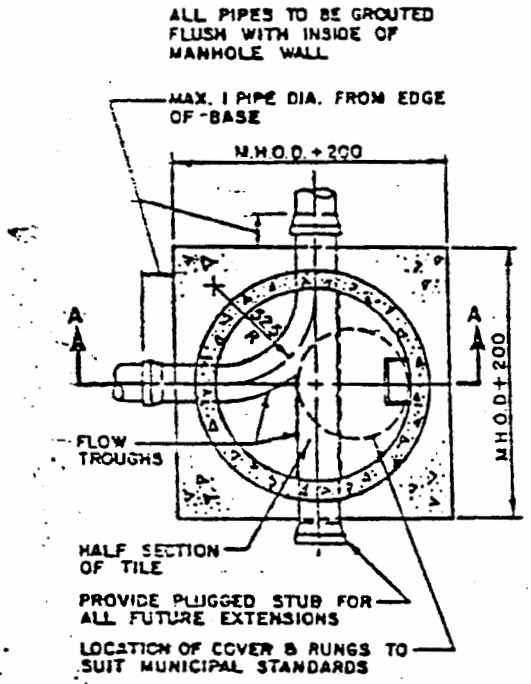
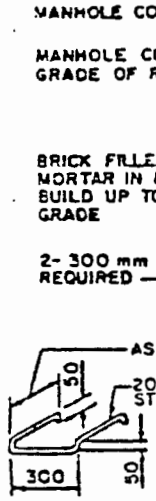


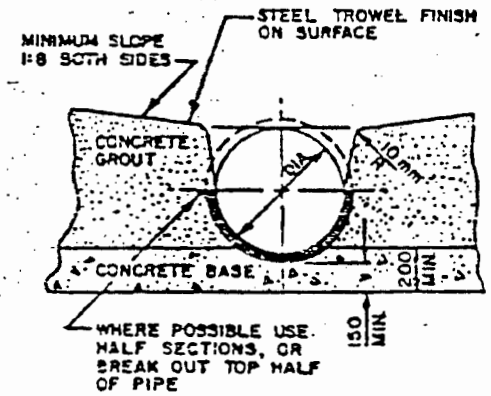
CHART BASED ON MANNING'S FORMULA



PLAN



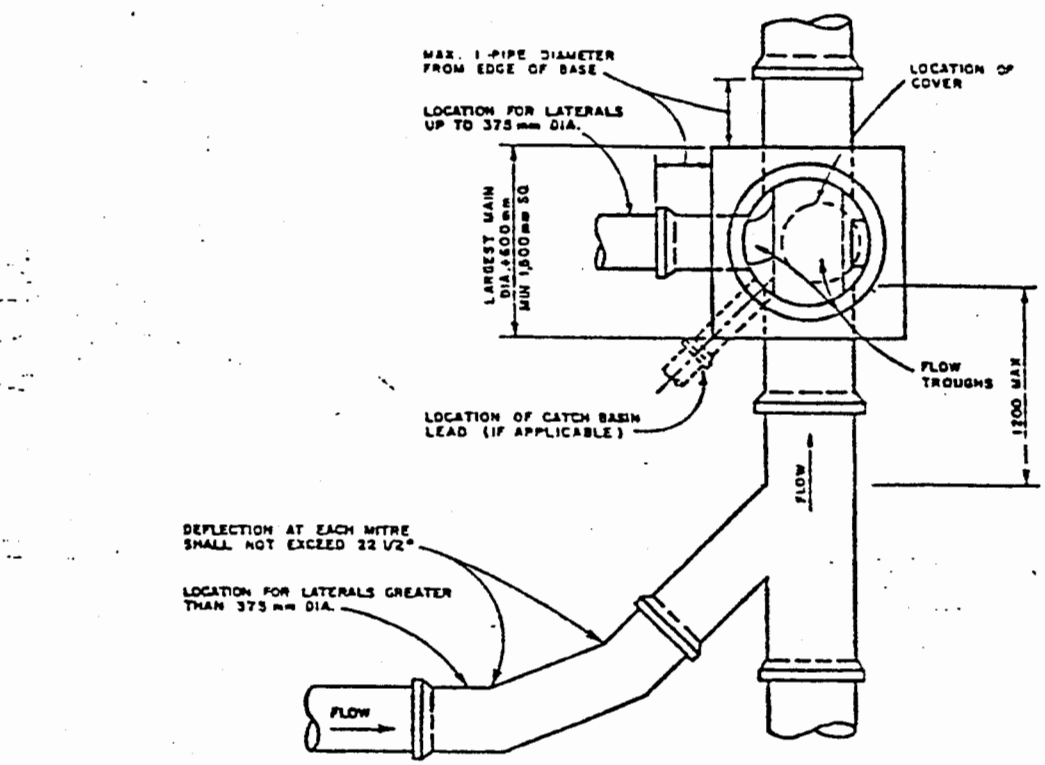
RUNG DETAIL
GALVANIZE AFTER FABRICATION

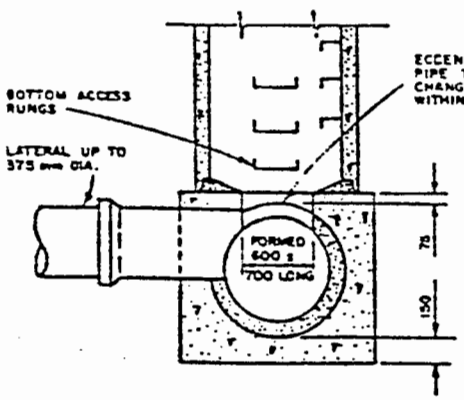


INVERT CHANNELLING IN MANHOLE

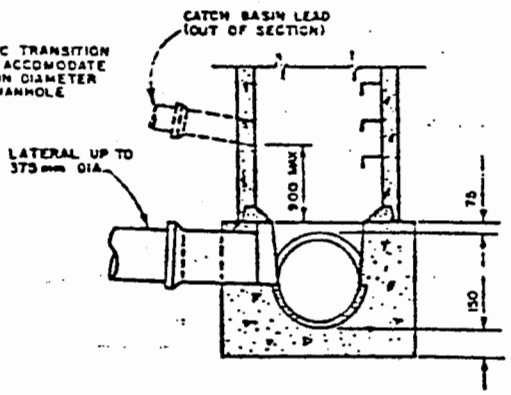
SECTION A-A
TYPICAL MANHOLE
PRECAST REINFORCED CONCRETE BARREL

NOTE.
ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.





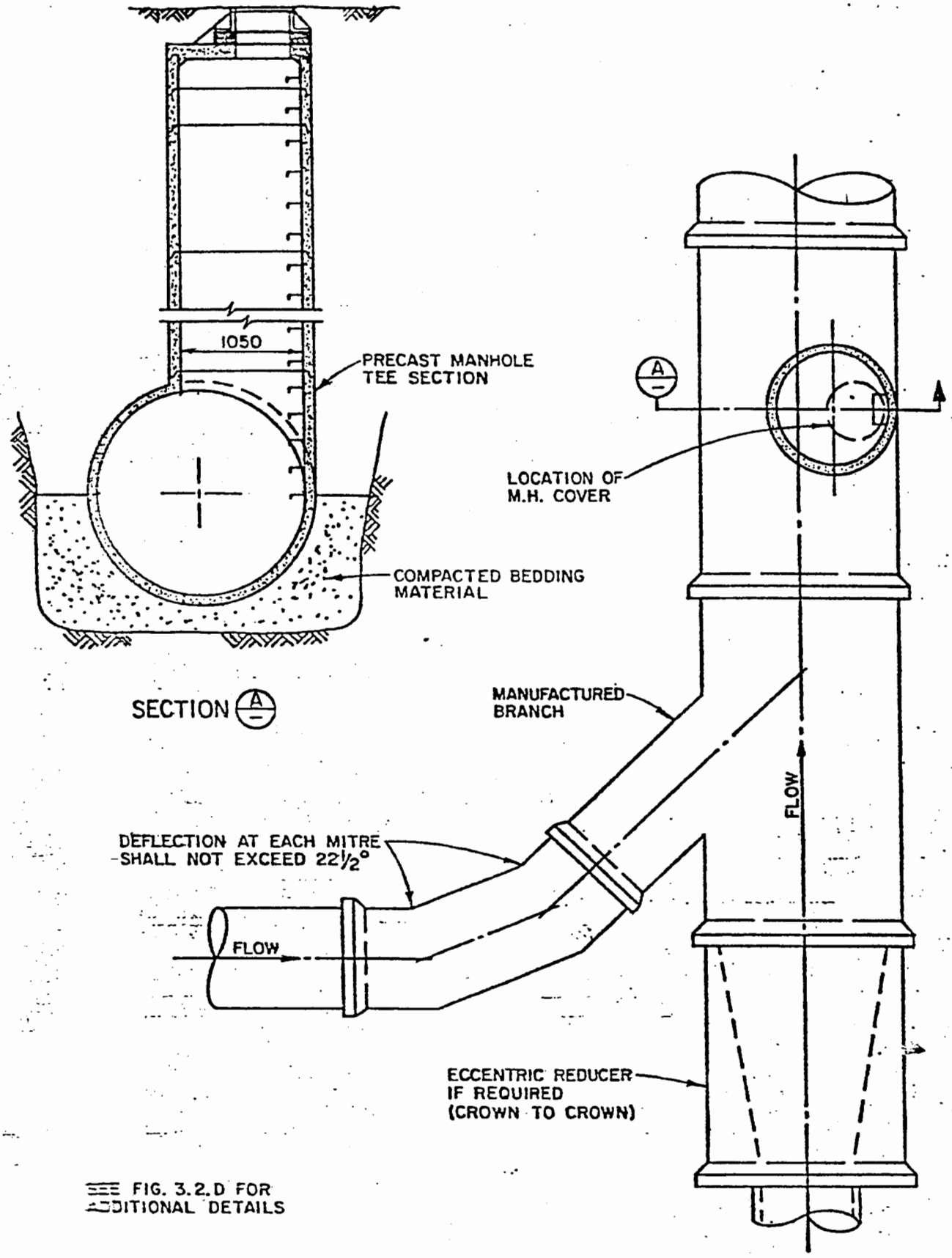
BASE SECTION THRU MANHOLES FOR PIPE 600mm DIA. TO 900mm DIA.



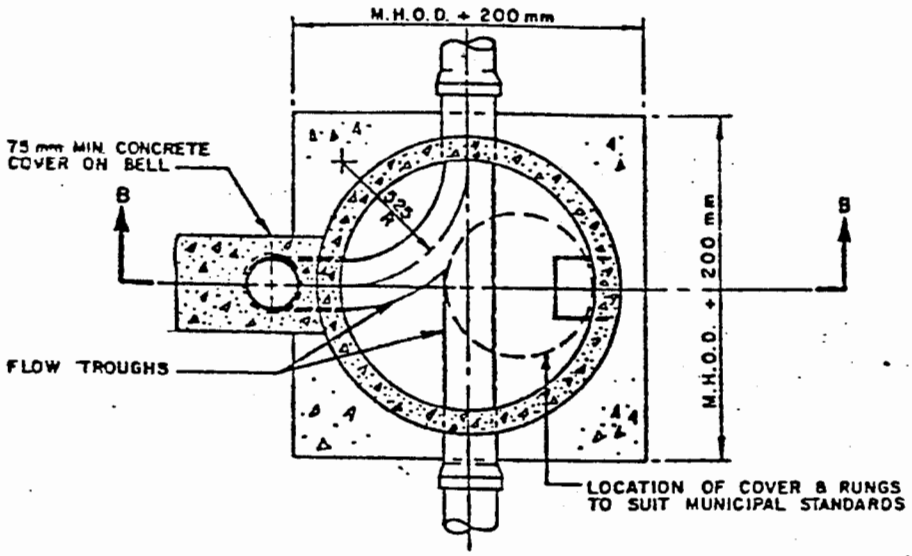
BASE SECTION THRU MANHOLES FOR PIPE UP TO 600mm DIA. INCLUSIVE

SEE FIG. 3.2.D FOR ADDITIONAL DETAILS

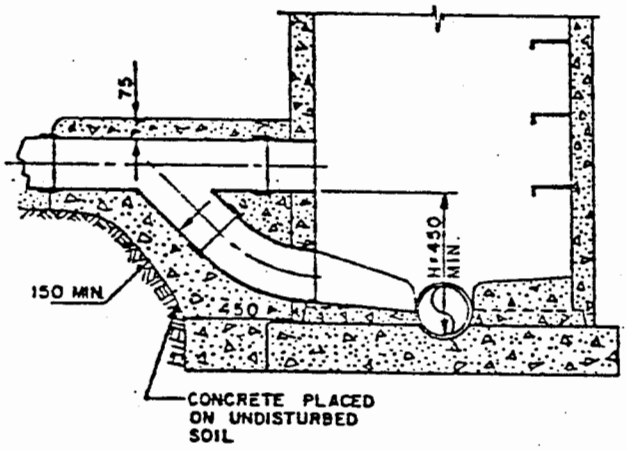
NOTE.
ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.



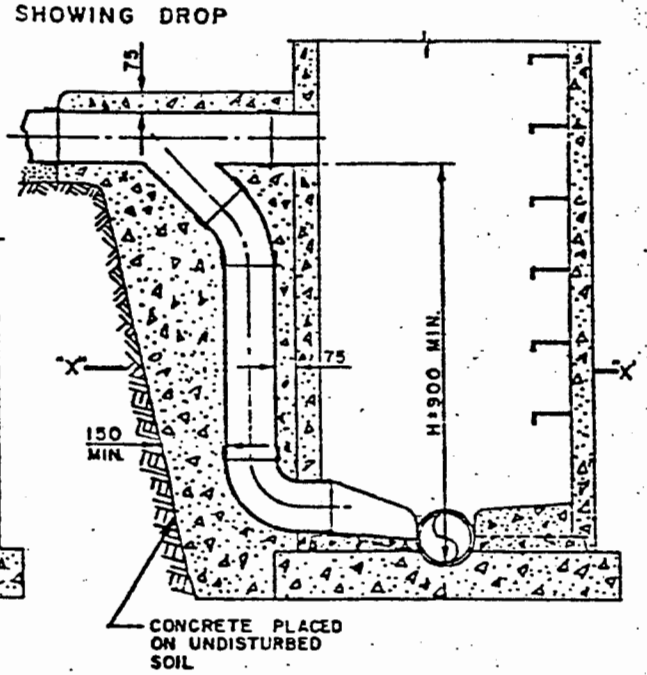
MANHOLE DETAILS FOR SEWERS -46- FIG. 3.3.F



PLAN AT "X-X" SHOWING DROP



SECTION B-B
DROP MANHOLE TYPE II

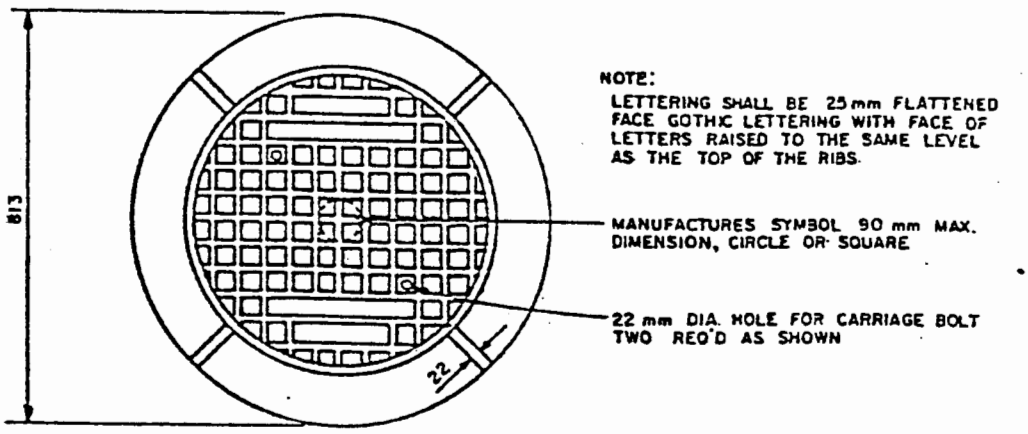


SECTION B-B
DROP MANHOLE TYPE I

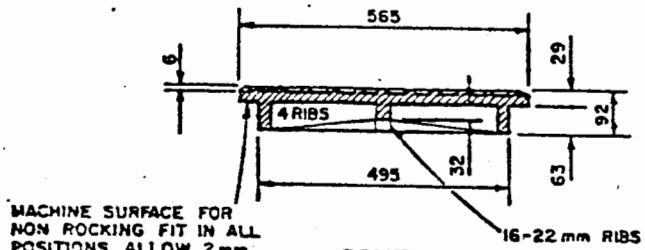
SEE FIG. 3.2.D FOR ADDITIONAL DETAILS

NOTE
ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.

DROP MANHOLE DETAILS FOR . . FIG. 3.3.G

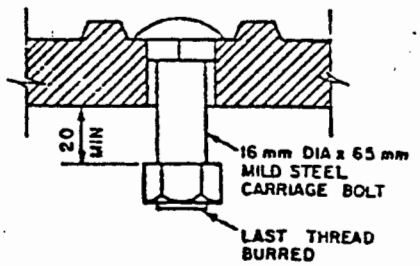


PLAN

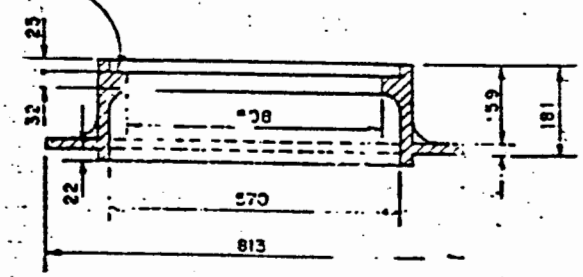


MACHINE SURFACE FOR NON ROCKING FIT IN ALL POSITIONS. ALLOW 2 mm RAISED FACE IN CASTING FOR MACHINING

COVER



CARRIAGE BOLT DETAIL



FRAME

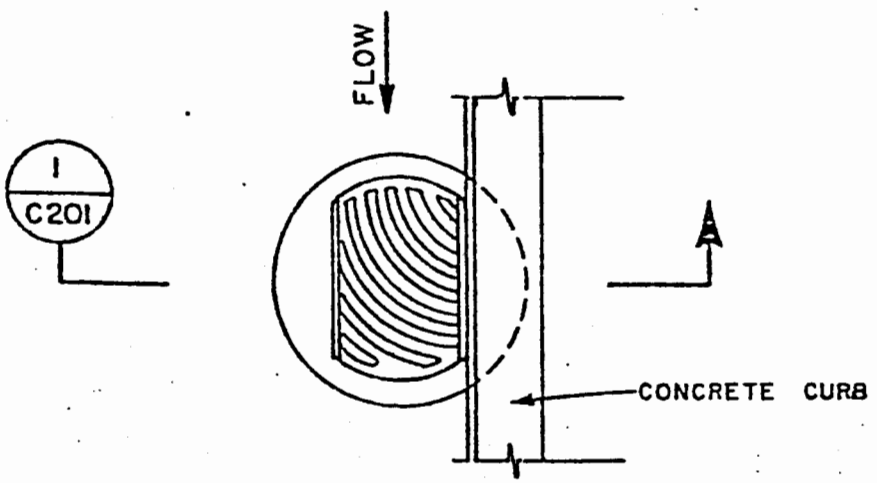
APPROXIMATE WEIGHTS

COVER – 60-66 kg
FRAME – 102-108 kg

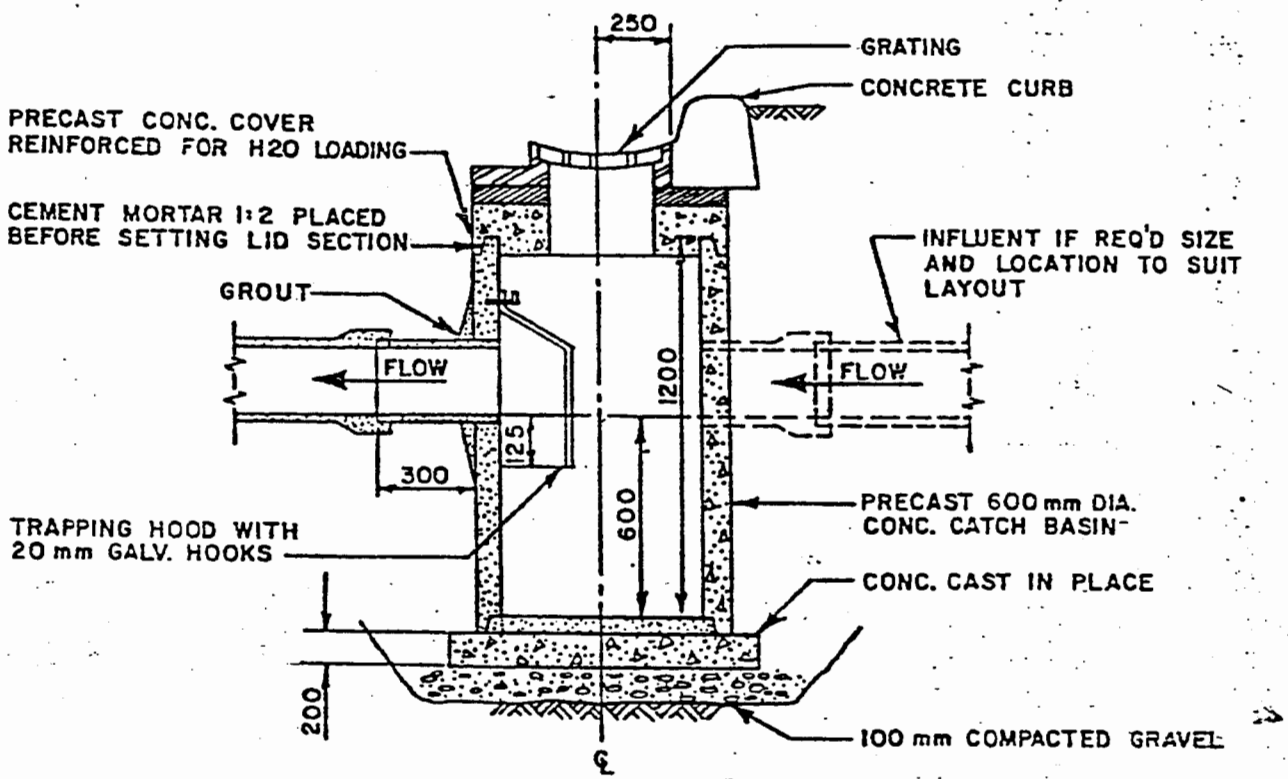
NOTE:
COVER & FRAME TO BE CAST IRON APPROVED FOR H-20 LOADING.

NOTE.
ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.

MANHOLE COVER AND FRAME -48- FIG. 3.3.H

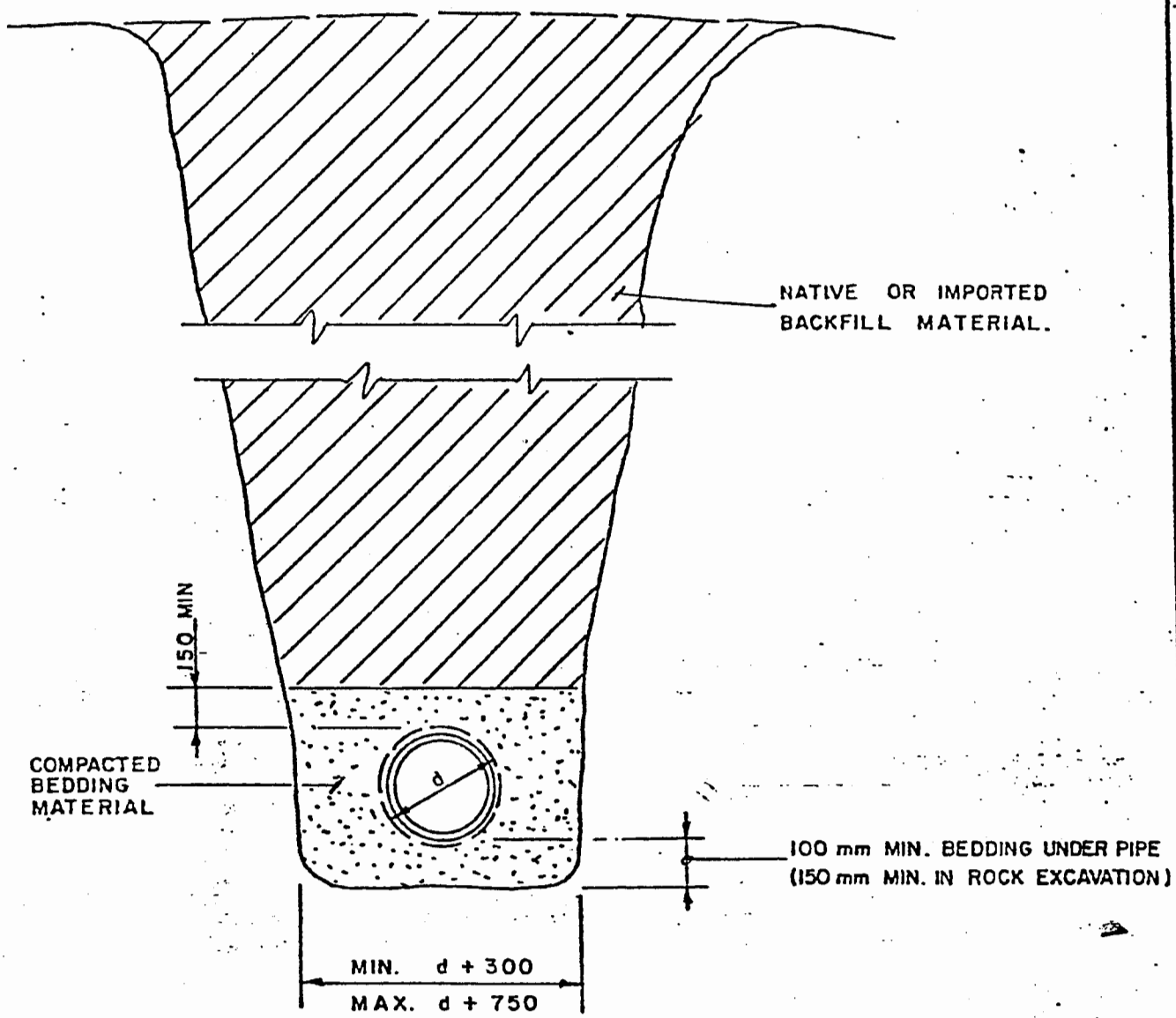


PLAN



SECTION 1/C201

NOTE.
ALL DIMENSIONS IN MILLIMETRES
UNLESS OTHERWISE SPECIFIED.



NOTES

d = OUTSIDE DIAMETER OF PIPE AT ITS LARGEST SECTION.

VERTICAL TRENCH TO EXTEND AT LEAST 100 mm ABOVE PIPE.

NOTE.
ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.

TRENCH SECTION

FIG. 3.3.J

SANITARY SEWER

1 PER CAPITA FLOW

New systems shall be designed on the basis of an average daily per capita flow of not less than 360 litres/day. For existing systems, an additional per capita allowance shall be made where the average annual flow exceeds this value and immediate remedial measures are not proposed.

2 PEAKING FACTOR

Use the Harman formula: $H = \frac{18+ P}{4+ P}$ (See Fig. 3.5.A)

Where: H = peaking factor
P = population in thousands

3 INFILTRATION

Average infiltration rate = 0.06 L/s/ha.
An additional allowance should be made where conditions are unfavourable.

4 DESIGN FLOW

Design flow Q = population x per capita flow x peaking factor + infiltration. See Fig. 3.5.B for Sanitary Sewer Design Sheet.

5 PIPE FLOW FORMULA

5.1 GRAVITY SEWERS

Use Manning's formula $Q = \frac{AR^{0.667}S^{0.5}}{n}$ (see Fig.3.3.C)

Where Q = Design flow in m^3/s
A = Cross sectional area in m^2
R = Hydraulic radius (area/wetted perimeter) in m
S = Slope of hydraulic grade line in m/m
n = Roughness coefficient
= 0.013 for all pipe except CSP.

5.2 SEWAGE FORCE MAINS

Use Hazen-Williams formula:

$$Q = \frac{CD^{2.63}S^{0.54}}{278\ 780}$$ (See Fig. 3.4.A)

where: Q = Rate of flow in L/s
D = Internal pipe diameter in m
S = Slope of hydraulic grade line in m/m
C = Friction coefficient
= 120 for all pipe

6 MINIMUM VELOCITY

Gravity sewers V = 0.61 m/s
Force mains V = 0.76 m/s

7 MINIMUM PIPE DIAMETER

Collector sewers D = 200 mm
Service connections D = 100 mm

8 MINIMUM PIPE GRADE

The following are minimum pipe grades. Steeper grades are desirable. Under special conditions, if detailed justifiable reasons are given, slopes slightly less than the following may be permitted, by special permission from the Ministry of Environment, but in no case will velocities below 0.46 m/s be permitted. It must be recognized that decreased slopes may cause additional sewer maintenance expense.

Pipe Diameter, mm	Minimum Grade, m/100m n=0.013
100 (4")	1.25
150 (6")	0.60
200 (8")	0.40
250 (10")	0.28
300 (12")	0.22
350 (14")	0.17
375 (15")	0.15
400 (16")	0.14
450 (18")	0.12

9 MINIMUM DEPTH OF COVER

Sewers shall be of sufficient depth to:

(a) Permit service connections to basements
(b) Prevent freezing
(c) Clear other underground utilities
(d) Prevent damage from surface loading.
Minimum cover without adequate concrete protection:
Travelled areas = 1.5 m
Elsewhere = 1.0 m

10 DISTANCE BETWEEN MANHOLES

Pipe Size, mm	Maximum Distance, m
375 and smaller	125
450 to 750	155
900 and larger	185

11 MINIMUM RADIUS OF CURVATURE

Minimum radius = 60 m
Maximum joint deflection shall be as recommended by pipe manufacturer.

12 HYDRAULIC LOSSES ACROSS MANHOLES

The following criteria shall be used:

(a) Generally the crown of the downstream pipe shall not be higher than that of the upstream pipe. However, the 0.8 depth point of both pipes may be placed at the same elevation.
(b) Minimum drop in invert levels across manholes:
i) Straight run - no drop required
ii) Deflections up to 45° - 20 mm drop
iii) Deflections 45° to 90° - 30 mm drop
(c) A drop pipe shall be installed when the drop between inverts exceeds 0.6 m. (See Fig. 3.3.G)

13 SEWER LOCATION

(a) Service connections: at centre of lot or 4.0 m from low side of lot boundary if slopes make centre location impractical.

(b) Separation from water mains:
i) minimum 3.0 m horizontally
ii) minimum 0.5 m vertical clearance below water mains and in separate trench if 3.0 m horizontal clearance is not possible.

14 MANHOLE DETAILS

(a) For sewers 375 mm dia. or less ..... see Fig. 3.3.D
(b) For sewers 400 mm to 900 mm dia. ..... see Fig. 3.3.E
(c) For sewers 1050 mm dia. and over ..... see Fig. 3.3.F
(d) Drop manhole details ..... see Fig. 3.3.G
(e) Manhole cover and frame ..... see Fig. 3.3.H

15 CONNECTIONS

Service connections shall be as shown on Fig. 3.5.C

16 PIPE MATERIALS AND SPECIFICATIONS

Pipe materials shall be selected from the following:

16.1 GRAVITY SEWERS

Material	General Size Range (mm)	Specification
Polyvinyl Chloride (PVC)	100 and 150	ASTM D3034, SDR 28
	200 to 300	ASTM D3034, SDR 35
Asbestos Cement (AC)	100	ASTM C644, Type II, Class 1500 minimum
	150 & larger	ASTM C428, Type II, Class 2400 minimum
Non-reinforced Concrete	150 to 450	ASTM C14, Class 3 minimum
Reinforced Concrete	525 & larger	ASTM C76, Class III minimum

16.2 FORCE MAINS

Material	General Size Range (mm)	Specification
Polyvinyl Chloride (PVC)	100 & larger	AWWA C900, SDR 18, or ASTM D2241, DR 17 & less Bell & spigot joints.
Asbestos Cement (AC)	100 & larger	AWWA C400, Type II, Class 150 minimum
Ductile Iron (DI)	100 & larger	AWWA C151, Class 50 minimum Cement lined (AWWA C104)
Polyethylene (PE)	75 & larger	CGSB 41-GP-25M, Series 45 to 140 as required Thermal fusionbuilt joints.

16.3 PIPE BEDDING MATERIALS

(a) Granular material for bedding of PVC, AC and PE pipes shall be Class B crushed aggregate conforming to the gradation specified under item 3.2.10.2

(b) For other pipe materials, bedding shall be clean gravel or crushed rock, evenly graded from coarse to fine, with a maximum size of 25 mm and 90% retained on a 0.075 mm screen.

16.4 TRENCH SECTION

See Fig. 3.3.J for trenching and bedding details.

17 TESTING

Testing of installed pipes shall depend on the height of existing ground water and shall consist of one of the following tests:

17.1 INFILTRATION TEST

(a) shall be performed when existing ground water level is 1.0 m or more above pipe,
(b) quantity of infiltration shall be measured by means of a weir or meter placed at the low end,
(c) duration of test need not exceed 8 hours.

17.2 EXFILTRATION TEST

(a) shall be performed when existing ground water level is less than 1.0 m above top of pipe,
(b) pipe shall be filled with water such that at least 0.6 m hydrostatic head is attained at the upper extremity. Pressures in excess of 3.0 m water head are not recommended,
(c) duration of test shall be not less than one hour and need not exceed 8 hours.

17.3 ALLOWABLE LEAKAGE FOR GRAVITY SEWERS

Leakage shall not exceed that calculated by the following formula:

$$\text{Allowable Leakage (litres)} = \frac{HDL}{850}$$

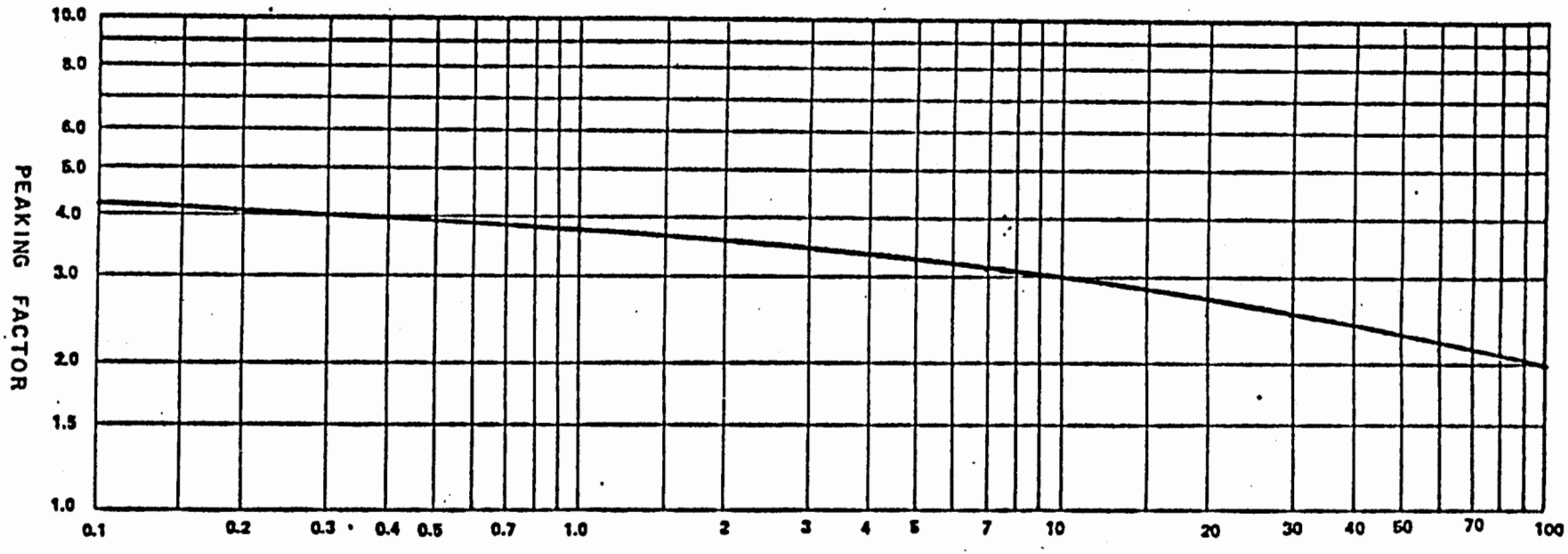
where: H = duration of test in hours
D = inside diameter in mm
L = length of test section in m

17.4 AIR TESTING

Low pressure air testing shall conform to the test procedure described in ASTM C-828, entitled "Tentative Recommended Practice for Low-Pressure Air Test of Vitrified Clay Pipe Lines".

17.5 TESTING OF FORÇE MAINS

Force mains shall be tested as described in item 3.4.19.



HARMAN FORMULA:

$$H = \frac{18 + \sqrt{P}}{4 + \sqrt{P}}$$

H = PEAKING FACTOR

P = POPULATION IN THOUSANDS

SANITARY SEWER DESIGN SHEET

PROJECT ____________________

AVG. PER CAPITA FLOW ____________________

DESIGNED BY ____________________

CHECKED BY ____________________

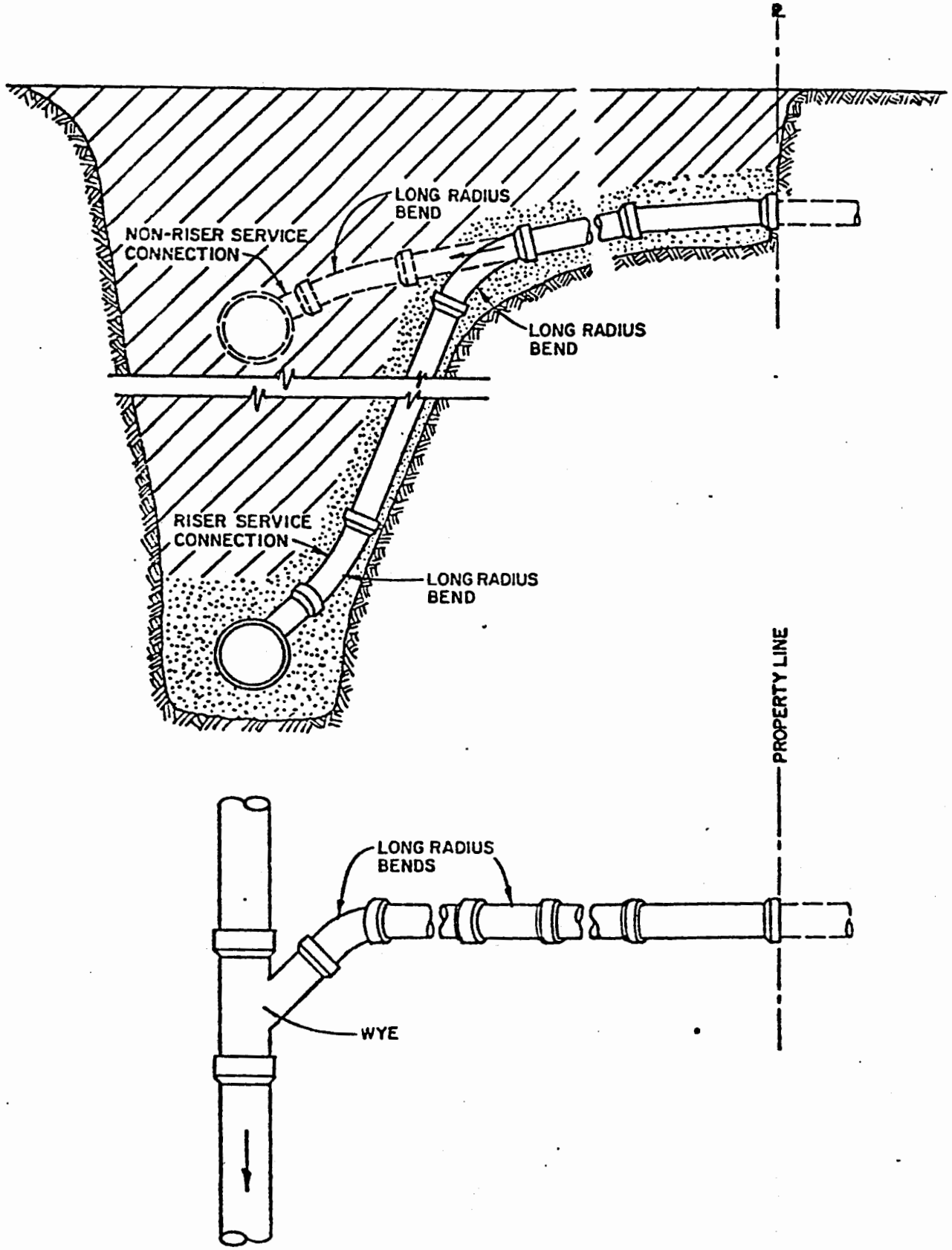
SHEET ________ OF ________

JOB No. ____________________

DATE ____________________

LOCATION				AREA		POPULATION			FLOW $Q = \Sigma P \times$ UNIT FLOW $\times H$ + INFILTRATION					PIPE DATA						DROP			ELEVATIONS			
																							UPSTREAM		DOWNSTREAM	
DWG. NO.	STREET OR LINE	FROM	TO	A	ΣA	DENSITY PERSONS PER HECTARE	P	ΣP	AVERAGE DAILY FLOW	PEAK FACTOR H	AVG. FLOW x H	INFIL-TRATION	DESIGN FLOW Q	CAPACITY	n	SLOPE	SIZE	VELOCITY	PIPE LENGTH	SLOPE	OTHER	TOTAL DROP	GROUND	INV.	GROUND	INV.

FIG. 3.5.B



NOTE
ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.

FIG. 3.5.C

UTILITIES

General guidelines for location of utilities:

(a) Keep manhole covers out of wheel paths on roadways.

(b) Keep manholes and valve boxes out of curbs.

(c) Keep light poles, power poles, telephone poles and hydrants out of sidewalks.

(d) Minimum clearance from face of curbs for any object: 0.3 m.

(e) On roadways without curbs, minimum clearance from pavement edge to any object: 2.0 m (rural).

(f) Keep all underground utilities from under curb lines.

(g) See Fig. 3.6.A for typical utility locations.

Utility installation should be in accordance with the following standard specifications:

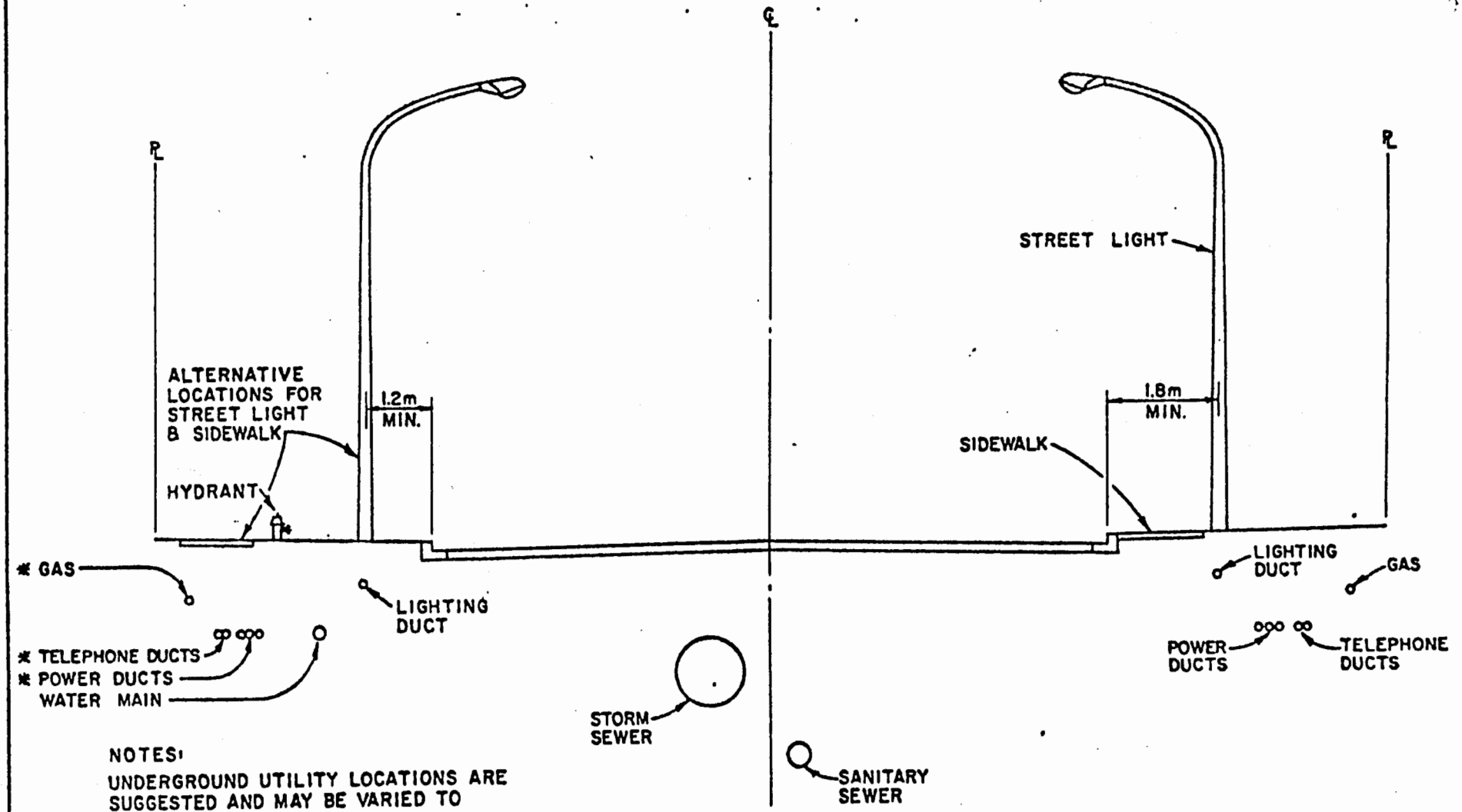
(a) British Columbia Hydro and Power Authority
Class of Work Specification
Construction of Underground Electrical Distribution Structures
Specification No. 1322 (current issue)

(b) British Columbia Hydro and Power Authority
Class of Work
Builder Installed Underground Structures for Residential Electric Distribution System
Specification No. 1323 (current issue)

(c) British Columbia Telephone Company
Buried Services Subdivisions
Specification No. 6020 (current issue)

(d) British Columbia Telephone Company
Underground Conduit Systems - Construction
Specification No. 6003 (current issue)

(e) Natural Gas installations by Gas Utility.



NOTES:

UNDERGROUND UTILITY LOCATIONS ARE SUGGESTED AND MAY BE VARIED TO SUIT LOCAL CONDITIONS.

TYPICAL SECTION FOR:
8.5m TO 9.5m PAVEMENT ON 18.0m R/W OR
11.0m TO13.0m PAVEMENT ON 20.0m R/W

* ALTERNATIVE LOCATION (WHEN CORRIDOR AVAILABLE)