CHAPTER 5 -
UTILITY SERVICES
STORMWATER AND LAND DRAINAGE

5.1 EXTRACTS FROM THE DISTRICT PLAN

Refer Appendix 15 Subdivision and Development Standards –
Utility Services: Stormwater and Land Drainage

5.2 GENERAL

Unless approved otherwise, all urban lots shall be provided with a connection to a stormwater drainage system. The stormwater system shall provide for the collection and control of all stormwater within the land being developed together with the drainage from the entire catchment upstream of the proposed system. The design of the stormwater system must also take into account the effects of the proposed subdivision or development on downstream systems.

For on-site disposal specific design and disposal details are required to ensure that satisfactory collection and disposal is possible.

The objective of a land drainage system is to regulate natural runoff to the extent that the effect of stormwater on the environment, property and people is contained within acceptable limits. This Code of Practice stipulates the frequency of floods to be used for design purposes. However, careful design of surface flow paths will reduce the potential for damage in flood conditions and in circumstances where the design capacity of main drainage is exceeded. Design must also include consideration of the location of dwelings so that adequate freeboard is provided for their floor levels. Secondary flow paths should be designed so that they will not include erosion (where topography allows) and debris traps should be constructed where necessary.

The Council has prepared Stormwater Management Plans for certain major catchments within the Rotorua urban area. The design of land drainage systems within subdivisions or developments is to take account of the drainage system catchment management plans where they exist.

Where pipes, drains or other structure forming part of the catchment plan have yet to be constructed and lie within or down-stream of the subdivision or development, the developer may be required to contribute towards the cost of these works.

5.3 RESOURCE CONSENTS

Within the Rotorua Central Business District there is no requirement for developers to obtain consents from the Regional Council for the discharge of stormwater.

This situation arises because the Rotorua District Council has applied for and obtained consents to discharge all stormwater from the Rotorua Central Business District to Lake Rotorua, whether directly or via streams entering the lake.

However, the responsibility for satisfying stringent discharge consent conditions may be transferred on to the developer by the District Council.

In all other cases consent from the relevant Regional Council will be required for the following work:

- The diversion of natural water during construction work.

- The permanent diversion of natural water as a consequence of the development.
- The discharge of stormwater

In the case of diversion of natural water during construction, the necessary consent shall be applied for by the subdividing owner and is to be exercised in the name of the subdividing owner.

The consent, in respect of the permanent diversion of natural water, will be exercised in the name of the Rotorua District Council, if not immediately, as once the subdivision has been accepted as complete by the Rotorua District Council. It will be a matter of negotiation between the subdividing owner and the Rotorua District Council on who will make the application and what form it should take in the first instance.

The consent covering the discharge of stormwater like that for the permanent diversion of natural water will be exercised in the name of the Rotorua District Council and again it will be a matter of negotiation between the subdividing owner and the Rotorua District Council on who will make the application and what form it should take.

5.4 DESIGN REQUIREMENTS

5.4.1 GENERAL

The land drainage system shall be capable of serving the entire catchment upstream of the subdivision and with due regard to the effect it may have on down-stream waterways and adjoining areas and shall be designed within the terms of the catchment management plan for the relevant catchment, if available. There should be early consultation with the relevant regional council. Where, due to increased run-off, the existing downstream system is inadequate, the subdivider may be required to either limit outflow from the subdivision or upgrade the downstream system.

If catchment management plans have been prepared for the catchment within which the subdivision or development lies, the above factors will have been accounted for in the design of the pipes, structures and other works provided for in the management plan. The design of further drainage works required for the subdivision or development will then need only allow for the drainage of the subdivision or development itself.

Where open watercourses are to form part of the land drainage system, this shall be determined at scheme plan approval stage and where no catchment management plan exists for the relevant catchment, the subdividing owner shall submit sufficient engineering design to enable Council to evaluate the proposals.

Each stormwater connection shall be capable of serving the whole of the building area of the lot, except where this requirement seems unreasonable and it can be shown to the satisfaction of the Engineer that the proposed connection is adequate for a predetermined building location and floor plan.

The stormwater connection shall be to a piped stormwater system preferably to manhole or adjacent cesspits. Where the topography is unsuitable, the stormwater from a limited number of houses may be piped to the road channel subject to approval by the Engineer.

Where further subdivision upstream of the one under consideration is provided for in the District Plan or applicable Regional Plan, the Engineer will require stormwater pipelines to be constructed to the upper limits of the subdivision.

Where the proposed subdivision or development brings about the need for additional works to be undertaken downstream of the subdivision or development, the developer will be required to contribute in proportion to the catchment area of his subdivision or development to the costs of the additional works.

5.4.2 PROTECTION FROM FLOODING

Compliance with the performance standards may be verified by evaluating the potential flooding risk and providing the necessary surface water control measures to satisfy the requirements.

Flood Risk Assessment shall take account of the characteristics of the total catchment. A search shall also be undertaken to find any relevant historical information on flooding. This could include reviewing records held be relevant bodies, discussions with the local inhabitants or appropriate field tests. **<u>Refer also to clause 3.8 “Protection of Property from Inundation”)</u>**

The assessment shall address the following:

a) The proximity and nature of any river, stream or watercourse and associated flood plains.

b) The capacity of culverts or watercourses downstream of the site and likelihood of upstream ponding resulting from under capacity or from blockage by debris or slips.

c) The upstream culvert and watercourse conditions and the location of the secondary flow path for flood water in the event of blockage or under capacity.

Calculations based on professional judgement taking account of the overall site conditions, details of the drainage system and the probable impediments to free flow (both upstream and downstream) shall determine the expected runoff ‘Q’ and show that the design flood levels at the site satisfy the Performance Standards.

Council may consider land is adequately protected from inundation if subject to drainage easements or restrictive covenants (building line and level) covering the inundated and ‘at risk’ areas.

New subdivisions adjacent to major water courses i.e; Utuhina Stream, Koutu Drain, Managakakahi Stream, Ohau Channel, Puarenga Stream, Waiteti Stream, Ngongotaha Stream, Waiwhero Stream and the Waingaehe Stream shall be specifically designed to have a floor level at not less than 0.3 metres above the predicted 1% annual expected probability (100 year) flood level.

Secondary flow paths shall be identified and where appropriate, catered for by specific design taking account of:

a) The capacity of the downstream surface water system and the risk of blockage as its intake.

b) The necessity for a secondary intake structure and the relative flow distribution between primary and secondary intakes for the likely degree of blockage.

5.4.3 ESTIMATION OF SURFACE WATER RUN-OFF

Surface water run-off for catchments up to 500ha may be calculated using the Rational Method. For catchment areas greater than 500ha the Modified Rational Method is used.

A permissible alternative to the Modified Rational Method for catchments larger than 500ha is the method described in "Flood Frequency in New Zealand".

5.4.4 RATIONAL METHOD

The formula to be used for catchments less than 500ha is:

$$Q = \frac{C\,I\,A}{360}$$

where

Q = run-off in cubic metres per second, m^3/s
C = run-off co-efficient (see Table 5)
I = rainfall intensity in mm/hr
A = area of catchment above the point being considered in hectares.

Design rainfall intensity curves for Rotorua for use with the "Rational Method" are found on Standard Stormwater Drainage Drawing No. 01.

5.4.5 MODIFIED RATIONAL METHOD

Where the catchment area is greater than 500 ha the Modified Rational Formula shall be used. This formula is:

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

where:
Q, C, I, A are as defined above, and
S = the shape factor (dimensionless)
= $0.4253 + 1.266K - 0.3952\,k^2$
k = $\frac{A}{100L^2}$
L = straight line length to catchment head in km

And

F = the area factor (dimensionless)

$$= 0.6 + 0.4\,e^{x}$$

$$x = \frac{-A}{7700}$$

S and F cab be determined from Table 5.1.

Table 5.1: Shape and Area Factors

K	S	A(ha)	F
0.33	.80	500	0.975
0.35	.82	800	0.96
0.40	.87	1000	0.95
0.45	.91	1500	0.93
0.50	.96	2000	0.91
0.60	1.04	3000	0.87
0.80	1.19	5000	0.81
1.00	1.30	7000	0.76
1.20	1.38	10000	0.71
1.40	1.42		
1.60	1.44		

Note: A modification for the Reporoa area has been developed by the Waikato Regional Council (Formerly Waikato Valley Authority)

5.4.6 RUN-OFF CO-EFFICIENT

Values of run-off co-efficient for various land use types can be obtained from Table 5.2. Where an area comprises different land use types, and average run-off co-efficient shall be determined based on the areas and run-off co-efficients of the component land use type.

Table 5.2: Run-off Co-Efficient

Description of Surface	C
Natural surface types	
Bare impermeable clay with no interception channels or run-off control	0.70
Bare uncultivated soil of medium soakage	0.60
Heavy clay soil types: - pasture and grass cover - bush and scrub cover - cultivated	 0.40 0.35 0.30
Medium soakage soil types - pasture and grass cover - bush and scrub cover - cultivated	 0.30 0.25 0.20
High soakage gravel, sandy and volcanic soil types - pasture and grass cover - bush and scrub cover - cultivated	 0.20 0.15 0.10
Parks, playgrounds and reserves: - mainly grassed - predominantly bush	 0.30 0.25
Gardens, lawns etc	0.25
Developed surface types	
Steel and non-absorbent roof surfaces	0.90
Asphalt and concrete paved surfaces	0.85
Near flat and slightly absorbent roof surfaces	0.80
Stone, brick and precast concrete paving panels: - with sealed joints - with open joints	 0.80 0.60
Unsealed roads	0.50
Railway and unsealed yards and similar surfaces	0.35
Land Use Types	
Fully roofed and/or sealed developments	0.90
Industrial, commercial, shopping areas and town house developments	0.65
Residential areas in which impervious area exceeds 35% of gross area. (This includes most modern subdivisions)	0.45

Note: The run-off co-efficient C is the variable in the rational formula least able to be precisely determined and has a direct result on the estimation of the discharge. Thus care is required in selecting a value for the co-efficient.

The co-efficient represents the integrated effects of infiltration, storage, evaporation, natural retention, interception etc, which all affect the time distribution and peak rate of run-off. The factors required to determine a value for C are surface type, characteristics topography and land use.

5.4.7 SLOPE CORRECTION

The values in Table 5.2 assume an average sloping terrain of 5-10% (ie: gently rolling) however, if the terrain is flatter or steeper this will have the effect of slowing down or speeding up overland flow and the value of C shall be reduced or increased according to Table 5.3.

Table 5.3: Slope Correction

Ground Slope	Adjustment factor for C
0-5%	-0.05
5-19%	0
10-20%	+0.05
20% or steeper	+0.010

The run-off co-efficients given in Table 5.2 are for ground considered as already wet from previous rain and shall be used in the calculation of surface water run-off.

5.4.8 FUTURE DEVELOPMENT

The chosen run-off co-efficient shall be based realistically on the conditions likely to exist after the full catchment development allowable by the operative plan under the Resource Management Act 1991.

5.4.9 RAINFALL INTENSITY

The rainfall intensity shall be that for a storm having duration equal to the time of concentration and a probability of occurrence as appropriate. Either local rainfall intensity curves or rainfall frequency duration tables may be used.

Note: The rainfall intensity curves for most areas are available from the territorial authority. These have been developed from meteorological data. Rainfall frequency duration tables for each of the official rain gauges throughout New Zealand are available from the NZ Meteorological Service.

5.4.10 TIME OF CONCENTRATION

The time of concentration and hence the critical storm duration of a catchment is the time taken for surface water run-off to reach the design point from the furthest point (in time) of the catchment, so that the whole catchment is contributing to the maximum discharge at the design point for any given probability of occurrence.

The time of concentration t_c (minutes) is calculated from the formula:

$t_c = t_e + t_f$

where

t_e = Time for run-off to travel overland from roofs, downpipes, carriageways, road channels, etc, to the point of entry at either a pipe or channel inlet (minutes).

t_f = Time for network flow comprising time of flow in pipes and/or open channels to design point (minutes)

Note: In some catchments, due to shape, surface water network and varying permeabilities within the catchment, part of the catchment under consideration may produce a higher peak flow than the whole of the catchment. Although the area for the part catchment is smaller, this may be more than offset by the higher intensity storm associated with a shorter time of concentration and storm duration. This situation will generally arise where the lower reaches of a catchment are densely developed and should be checked by calculation where appropriate.

The velocity of the surface water flow throughout the duration of a storm will vary as the depth of flow varies. Discharge characteristics normally give velocity somewhere between the mean velocity and the peak flow velocity. Unless better information is available, the velocity can be assumed to be 0.85 of the peak velocity.

Due allowance shall be made for the surface water disposal characteristics when analysing both the time of concentration and the run-off characteristics from the catchment area.

Note:
1. In some areas the run-off from roofs and streets may be directly piped whereas, the run-off over paved and unpaved surfaces may have a component of overland flow before entering the system.
2. It should be noted that administrative decisions can change the basis of evaluation. For example, the use of soakholes may be discontinued as a matter of policy, as those areas become increasingly urbanised. If an imprudent allowance for detention storage in soakholes has been made, an administrative change might then make all downstream surface water systems undersized.

Where the catchment area has a well defined and regularly repeated pattern for directing the surface water to the drain, the time of entry may be taken as:

t_e = 5 minutes for commercial or industrial areas where the majority of the surface of the catchment area feeding the drain consists of asphalt, concrete, paved or metalled surfaces.

T_e = 7-10 minutes for residential areas.

T_e = 10 minutes for low density residential areas.

In other areas and in cases where the catchment is longer than 1.0km, separate estimates of time of overland flow and time of road channel flow shall be calculated using the following approach:

a) The time of overland flow is to be calculated by the formula:

$$t = \frac{100nL^{0.33}}{S^{0.2}}$$

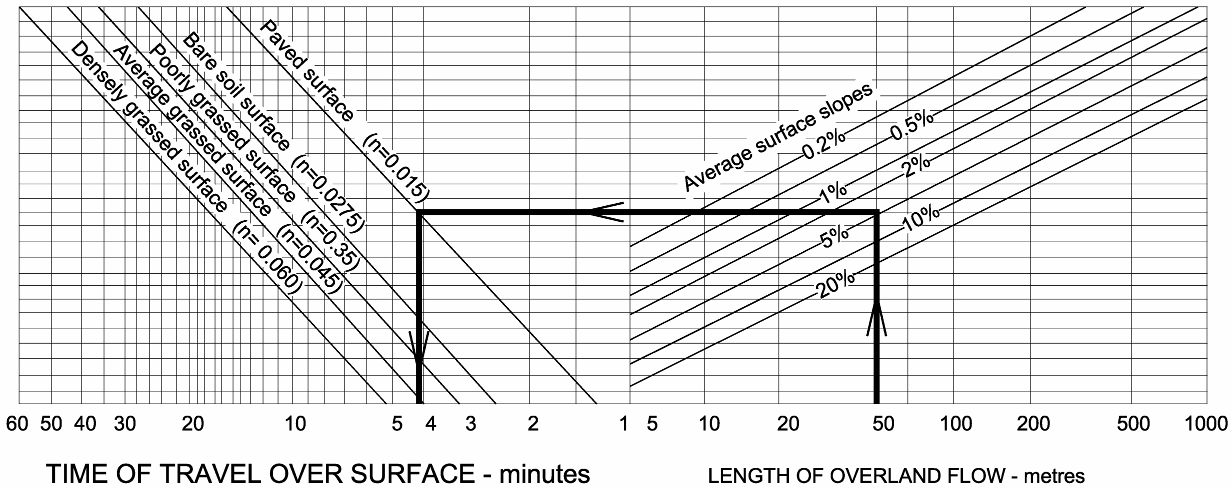
where

t is the time in minutes
L is length of overland flow in metres
S is slope in percent
n is the value for surface roughness

The results from this formula, for normal surface types, are shown in Figure 5.1.

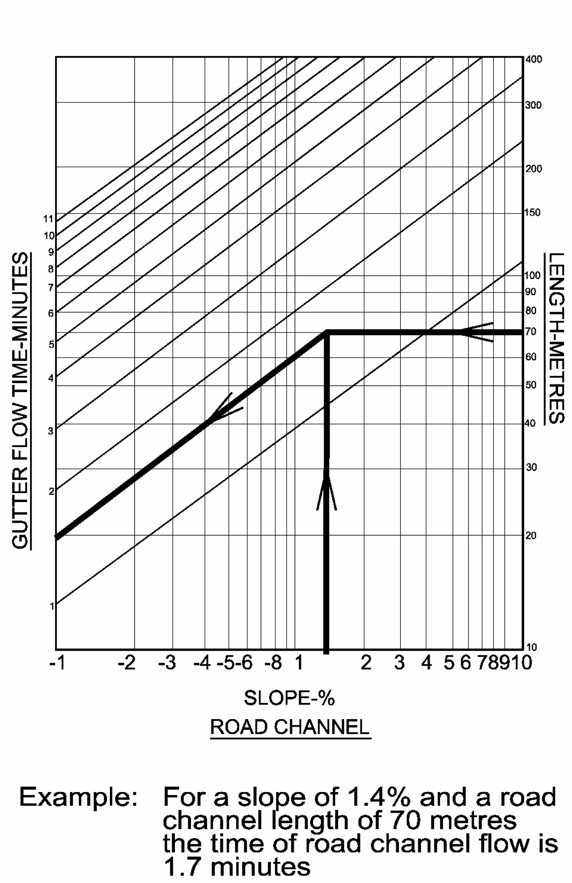
b) The time of road channel flow is the time taken for water to flow from the point of entering the road channel to the point of discharge to a sump, catchpit, drain or other outlet. Figure 5.2 may be used to obtain the time of flow.

Figure 5.1: Times for Overland Flow



Example: for surface water flowing 50m over a paved surface at a slope of 5%, the time of travel is 4.1 minutes

Figure 5.2: Road Channel Flow Times



Time of Pipe Flow

The time of pipe flow can be calculated from Figure 3 which is based on Manning's formula with n = 0.013. To follow this procedure, longitudinal sections are required of the piped systems, giving internal pipe diameters, lengths and gradients.

For preliminary calculations, if there is little detail of the final pipe systems, average pipe flow velocities of 3m/s for moderate to steep gradients and 1.5m/s for low gradients may be used.

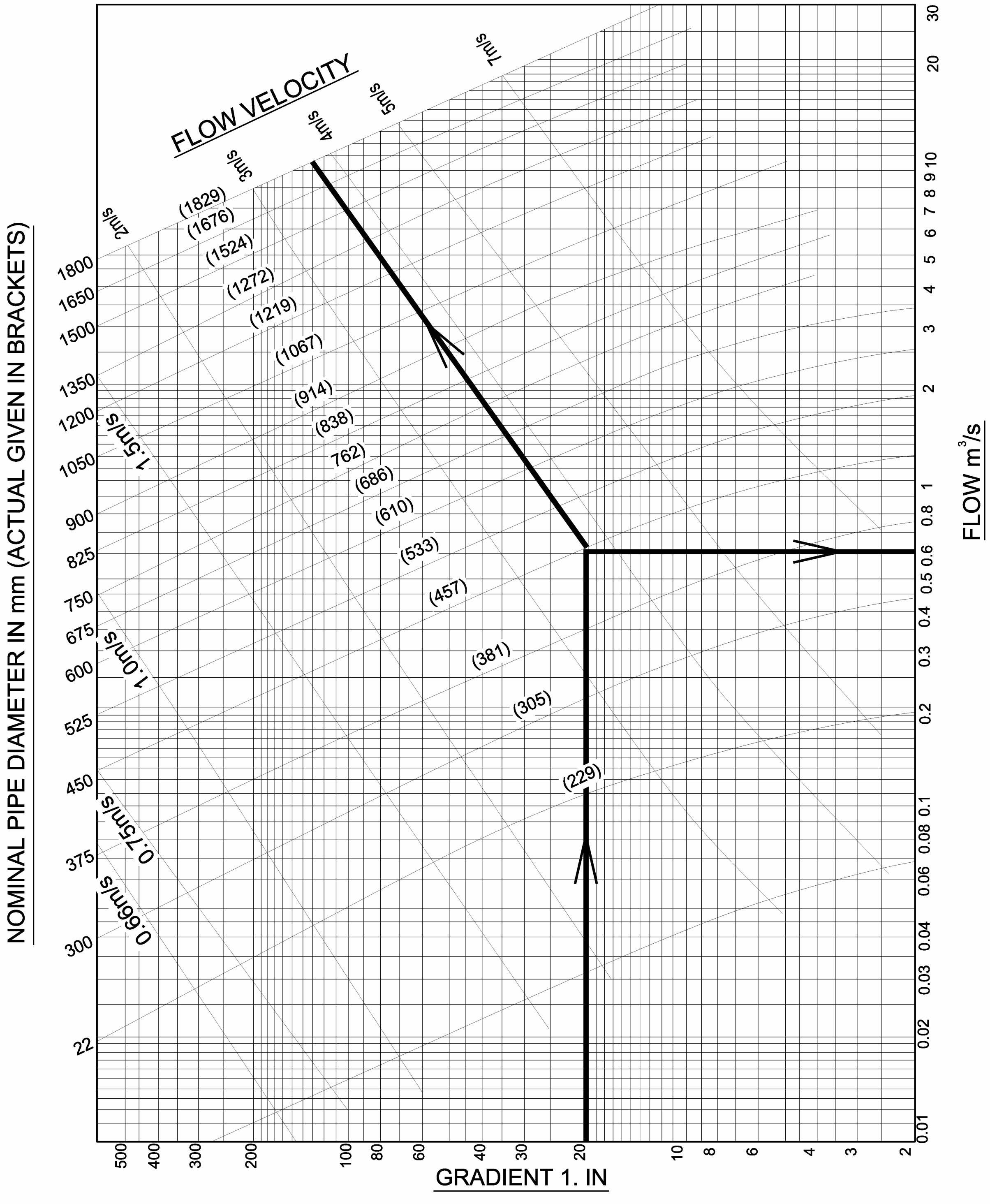
5.4.10.1 Time of Open Channel Flow

The time of flow in open channels (either watercourses or line channels) is calculated by means of Manning's formula.

If there is insufficient data to calculate the time of open channel flow, the approximate natural stream velocities as given in Table 5.4 are recommended for channels that are not severely restricted by meanders or fallen and tangled trees and other vegetation.

Figure 5.3: Pipe flow relationships for different combinations of internal diameter velocity and gradient.

Based on Mannings formula using n = 0.013 with an allowance for air entrainment)



Example: A 450 internal diameter pipe of a gradient of 1 in 20 would have a flow velocity of 3.75 m/s and a flow of 0.63m³/s

Table 5.4: Approximate Natural Stream Velocities

Catchment	Average slope %	Velocity m/s
Relatively flat	1 – 4	0.3 – 1.0
Undulating	2 – 8	0.6 – 2.0
Hilly	6 – 15	1.5 – 3.0

5.4.10.2 Alternative procedure

An alternative procedure uses the Ramser-Kirpich formula which is particularly suitable for rural areas and enables the calculation of time of concentration from:

$$t_c = 0.0195\left[\frac{L^3}{H}\right]^{0.385}$$

Where

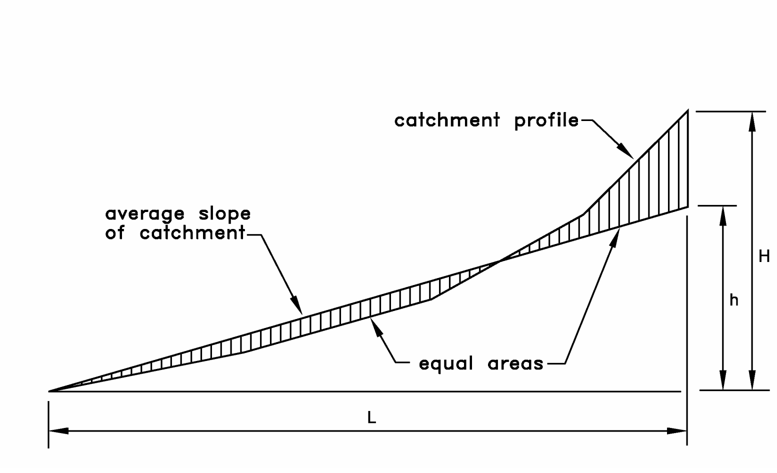
t_c = time of concentration in minutes

L = length of catchment in metres measured along the flow path

H = rise from bottom to top of catchment in metres

If the actual catchment slope varies significantly from the value H/L (eg: with a sudden steepening in the upper reached) the average slope and height h shall be determined from the equal areas method shown in Figure 5.4. Height h shall be substituted for H in the formula.

Figure 5.4: Equal Areas Method



5.4.10.3 Minimum Time of Concentration

Regardless of calculated results, 10 minutes shall be used as the minimum time of concentration for surface water run-off.

5.4.11 SIZING OF SURFACE WATER SYSTEM

This section deals with the sizing of surface water drains and relates only to drains which are "barrel controlled" for flow capacity. For drains which are controlled by either "inlet" or "outlet" flow conditions, flow capacity shall be calculated in a manner which incorporates the effects of the restriction. This limitation would normally only relate to larger diameter pipes designed to control a significant quantity of water originating "off-site".

5.4.12 MINIMUM SIZE OF DRAINS

To avoid blockages, public surface water drains shall have an internal diameter of no less than:

300mmØ for main pipes.
225mmØ for cesspit leads
300mmØ for cesspit leads for double sumps
110mmØ for property connections.

The internal diameter of a drain shall not decrease in size in the direction of flow.

5.4.13 HYDRAULIC DESIGN

Pipes shall be sized with the use of Manning's formula given below:

$$V = R^{2/3} S^{1/2} n^{-1}$$

Where

V = velocity in metres per second

R = hydraulic radius in metres = $\frac{A}{P}$

Where

A = cross-sectional area of flow

P = perimeter of the cross section of the flow

S = slope = $\frac{\text{vertical rise}}{\text{Horizontal rise}}$

N = roughness co-efficient. For circular pipes flowing full, n is to be taken as:

0.011 for HDPE and uPVC

0.013 for ceramic and concrete pipes

0.015 for cast-in-situ concrete culverts and drains and drains with velocity less than 1 m/s

0.03 – 0.035 for open ditches

Where a pipe gradient exceeds 1 in 10, an allowance for the bulking of the flow due to air entrainment should be made. This allowance is made by increasing the area of the pipe for the additional volume of air in the flow. The air to water ratio may be calculated from the formula:

$$\frac{Air}{Water} = \frac{kv^2}{gR}$$

Where

k	=	co-efficient of entrainment (dimensionless)
	=	0.004 for smooth concrete pipes or
		0.008 for cast-in-situ concrete culverts
v	=	velocity m/s
R	=	hydraulic radius m
G	=	acceleration due to gravity m/s²

Where air entrainment is likely, facilities to dissipate the excess energy and to allow the free escape of the excess air to the atmosphere are to be provided.

5.4.14 ENERGY LOSS THROUGH STRUCTURES

Hydraulic design shall make the appropriate allowance for energy losses at structures. These losses are generally associated with a change in direction of the flow or an increase or decrease in pipe size. As an access chamber is normally required at such changes, an additional fall can be provided through the access chamber to allow for the losses. This fall H_L is in addition to the fall produced by the gradient of the pipeline and can be calculated by:

$$H_L = \frac{Kv^2}{2g}$$

where

K = loss co-efficient for change in direction and can be determined from Figure 5.5.

Where there is an increase in pipe size at the access chamber, the hydraulic design shall ensure gravity flow with no surcharging for a storm having a 10% probability of occurring annually.

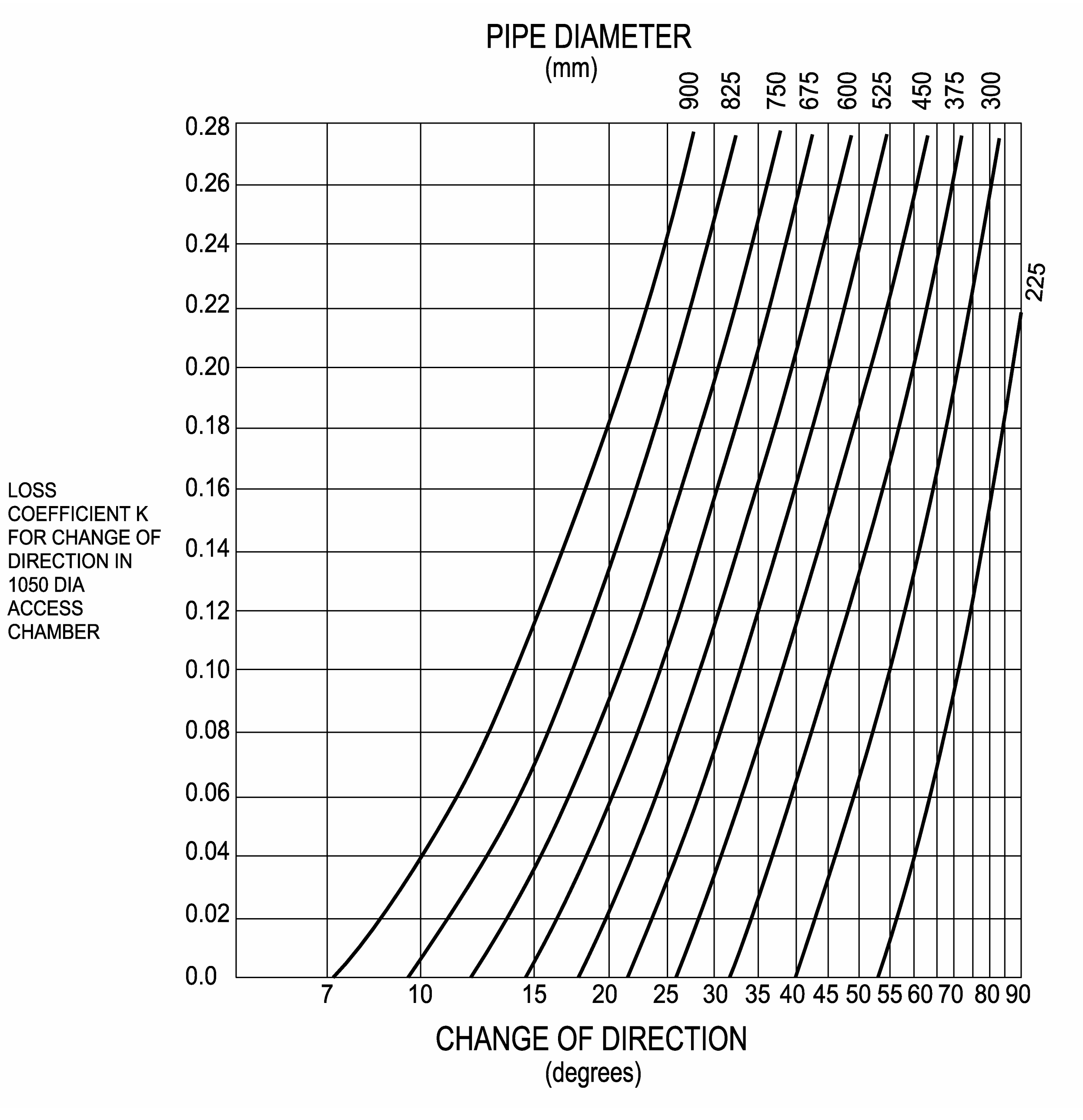
Note: This is normally achieved by maintaining the same soffit level for both drains at the access chamber.

In cases where a reduction in drain size is justified by a large increase in gradient, an additional head loss of $0.5v_e{}^2/2g$ is to be allowed for (v_e = exit velocity). Such reductions in size are only permissible where the exit pipe has an internal diameter of 300mm or greater.

5.4.15 ENERGY DISSIPATION STRUCTURES

Where the hydraulic analysis demonstrates that a significant turbulence or energy dissipation will occur, control structures shall be provided for energy dissipation to prevent damage to the drainage system, its outfall and the surrounding environment.

Figure 5.5: Energy Loss Coefficient



5.4.16 MINIMUM AND MAXIMUM VELOCITY

A drain flowing full shall have a minimum velocity of 0.7m/second.

No limitation on maximum velocity is practical, however, pipes must be laid within the limitations set by their manufacturers.

5.4.17 DISPOSAL TO SOAK PIT

Where the collected surface water is to be discharged to a soak pit, the suitability of the natural ground to receive the water shall be determined. This evaluation may involve field testing of ground soakage and discussion or direction from suitably qualified soils or geotechnical engineers.

Field testing of soakage may be carried out as follows:

a) Bore test holes of 100mm to 150mm diameter to the depth of the proposed soakhole. Record the ground profile as excavation proceeds. Located the ground water level if possible and assess the likely change in this during winter conditions and/or wet weather.

b) Fill the hole with water and maintain full for at least 4 hours (unless the soakage is so great that the hole completely drains in a short time).

c) Fill the hole with water to within 750mm of ground level and record the drop in water level against time until the hole is almost empty or over 4 hours, whichever is the shortest.

d) Plot the drop in water level against time on a graph and the soakage rate in mm/hr is determined from the minimum slope of the curve. If there is a marked decrease in soakage rate at the hole becomes nearly empty, the lower rates may be discarded and the value closer to the average can be adopted.

There is no established acceptable relationship between soakage rates from test results and sizing of soak holes. However, a general guide is to calculate the size of the soak pit taking both storage and outflow into account. If the test results show the soakage rate to be well above 500mm/hr, there will be less need for storage. If it is significantly less than 500mm/hr, very little surface water being discharged by the drainage system will percolate into the ground during a relatively short duration rainfall event. In this case, greater reliance will be placed on storage of surface water during peak discharge.

Where storage is an important element of the design philosophy, use of an access chamber structure or similar is preferred to the practice of placing large rocks in the hole.

5.5 OPEN WATERCOURSES

All watercourses are to be piped. However the Engineer may approve concrete line channels or unlined drains where flows exceed the capacity of a 1200mm diameter pipe.

Where the use of an open watercourse is permitted, the extent of improvement work shall be agreed with the Engineer in order to achieve a satisfactory compromise between the retention of the natural topography and vegetation and maintenance, hydraulic and safety considerations, including the downstream effects of the work.

Open watercourses, where permitted, shall generally be located in a drainage reserve or easement vested in Council to enable maintenance to be carried out. The cross section and erosion protection for the open watercourse shall be specifically designed and to the approval of the Engineer.

5.6 LOCATION OF PIPELINES

Stormwater drainage pipelines shall generally be aligned parallel with the street network, however their alignment may deviate from the standard parallel alignment provided there is no interference with other services and the pipes are located in the road reserve. Alternatively, stormwater drainage pipelines may be located in areas which will not reduce the building area available on the lot (that is, within the front, side or rear yard areas) or where it can be shown that a satisfactory house siting is available clear of the drainage lines. Stormwater pipelines shall be located not closer than 1.5m from any building.

Manhole structures shall be located at least 1.0 metres clear of all boundary lines.

Where a stormwater drain or structure is laid within private property, it shall be protected by an easement in favour of Council and of sufficient width to allow practical access for maintenance, and shall not be less than 3.0m wide.

5.7 PIPE

The following pipes may be used for stormwater drainage work, provided they comply with the relevant Standards, and subject to the following conditions.

Table 5.5: Acceptable Pipe Materials

Concrete	NZS 3107:1978
Ceramic	NZS 3302: 1983
Vitrified Clay	AS 1714: 1991
Steel	NZS 4442: 1988
UPVC	NZS 7649: 1988
HDPE	NZS 7604: 1981
A.B.S	NZS 7609: 1990

a) uPVC pipes may not be used where ground temperatures exceed 30°C.

b) HDPE pipes may not be used where ground temperatures exceed 50°C.

Other pipe may be permitted subject to the specific approval of the Engineer.

5.8 JOINT REQUIREMENTS

All joints in drains shall be watertight and prevent the infiltration of groundwater and the intrusion of tree roots.

Table 5.6: Acceptable Jointing Methods

Pipe Material	Jointing Method	Standard
Concrete	Rubber ring	BS 2494: 1976
Ceramic	Rubber ring or rubber sleeve	BS 2494, NZS 3302: 1983
Vitrified Clay	Rubber ring or rubber sleeve	BS 2494, NZS 3302: 1983
Steel	Rubber ring, welded or flanged	BS 2494, NZS 4442: 1988, BS 1560
UPVC	Rubber ring	BS2494, NZS 7643: 1979
HDPE	Heat welded or flanged	AS 2033: 1980
ABS	Solvent welded or flanged	NZS 7609: 1990

Acceptable jointing methods and the relevant standards are given in Table 5.6. Jointing of drains shall be subject to the tests called for. In case of HDPE pipes with rubber-ring joints, the procedure for jointing, along with the relevant standard for rubber-ring jointing, must be submitted for Engineer's approval, prior to construction.

Unless specified by the Engineer, solvent cemented pipes shall not be used for the construction.

Where a drain consists of unreinforced concrete, asbestos cement, ceramic, vitrified clay or rubber ring jointed steel, uPVC or HDPE, two flexible joints shall be installed. The first flexible joint shall be located not more than 300mm from the manholes outer wall. An additional flexible joint shall be located not more than 800mm from the wall of the manhole.

If the pipe is reinforced concrete and is for stormwater only, one flexible joint on each line at approximately half the pipe length is acceptable for 375mm diameter pipes or less. 450mm diameter pipes and larger do not require a flexible joint.

Note: This allows for differential settlement between the access chamber and the pipeline while minimising damage to the pipeline.

Refer also to 5.9 and 5.12.9

5.9 STRUCTURAL STRENGTH OF PIPES AND BEDDING

The pipe bedding shall be selected to meet the requirements of the class of pipe to be used and the design loading conditions. However, Type A bedding (concrete), may not be used in thermal environments.

The type of bedding and class of pipes adopted shall be in accordance with the pipe laying tables and bedding diagrams in NZS/AS 3725: 1989.

Under normal ground conditions pipes except uPVC, may be laid in accordance with the Type C bedding procedure as set out in NZS 4452: 1986.

The requirements for uPVC shall be set out in the SAA CA 68 and NZS 7643: 1979.

Where a pipeline is to be constructed through soft ground in unsuitable foundations such material shall be removed and replaced with other approved material or alternatively, other methods of construction shall be carried out to the approval of the Engineer to provide an adequate foundation for the pipeline.

The minimum cover for pipelines to become public assets shall be 0.5m in private properties or 0.75m in road reserve. Where this cover cannot be provided additional protection shall be provided. Alternatively the Engineer may allow the cover to be provided according to the manufacturer's specifications.

5.9.1 TRENCH SLOPE

Where the slope of the trench is 1 in 8 or greater, and the subsoil texture cannot be classified as "sandy loam" or "sandy" in accordance with clause 3.0 of Appendix C2 of ARC Technical Publication No 58, anti-scour blocks shall be provided. These anti-scour blocks shall be:

a) Constructed from 150mm thick concrete (17.5 Mpa) up to pipe diameters of 300mm and 300mm thick concrete (17.5 Mpa) for diameters greater than 300mm.

b) Keyed into the sides and floor of the trench by 150mm.

c) Extended to 300mm above the drain or to ground level where the drain cover is less than 300mm, and

d) Spaced at:

   (i) 7.5m centres for trench slopes between 1 in 8 and 1 in 5, or
   (ii) 5.0m centres for trench slopes greater than 1 in 5.

Note: The anti-scour blocks partition off the trench and prevent ground or surface water running along the trench and causing scouring.

5.10 PIPELINE CONSTRUCTION

The construction of pipelines shall be carried out in accordance with the requirements of NZS 4452: 1986 and NZS 7643: 1979, as appropriate.

5.11 BACKFILL REQUIREMENTS

Backfill above the specified pipe bedding and surround in grassed surfaces shall consist of excavated material machine compacted in layers not exceeding 300mm compacted depth. The surface shall be reinstated with a minimum depth of 100mm of topsoil, and grassed.

Backfill material and compaction procedures for pipes laid in existing carriageways shall be in accordance with Stormwater and Land Drainage Drawing SD-17. Note that the sand bedding and surround shown in the drawing will be replaced with the specified pipe bedding and surround.

Where pipes are to be laid under a proposed roadway, the backfilling must be in accordance with the following:

a) 300mm above pipe to be selected, compacted granular material to act as a cushion.

b) Remainder of trench to within 400mm of surface to be backfilled with compacted hardfill placed in 200mm layers.

c) The backfilling of the final 400m should be carried out in conjunction with formation work of the proposed road.

All trenches within existing formed carriageways shall be reinstated as per the requirements of the Rotorua District Council Street Opening Specification booklet. In particular the finished reinstatement level must match the existing level.

1. Hotmix must be joint sealed to hotmix with an approved sealer.
2. Hotmix must overlap chipseal by 100mm.
3. First coat chipseal to butt to edge of existing seal. Second coat chipseal must overlap existing chipseal by 100mm.

5.12 MANHOLES

5.12.1 GENERAL

In general manholes shall normally be provided at each change of direction or gradient, and at each branching line and at a spacing of not more than 100m. Manholes may be either cast in situ or of precast concrete, except that in thermal areas, manholes manufactured in HDPE or other corrosion resistant materials will be required.

A chamber can only be used at the end of a lateral just inside the boundary on private property if the depth from the invert on the outlet pipe to the ground level will not exceed one metre. Or at the end of a public drain if the depth of the invert on the outlet pipe will not exceed one metre from the ground surface, or to the satisfaction of the Engineer.

5.12.2 STANDARD MANHOLES

These are to be circular manholes with a minimum internal diameter of 1050mm and may be used in situations where the largest inlet pipe does not exceed 600mm in diameter. However, in a situation where there are multiple entries into a manhole with an inlet pipe of 600mm diameter or greater, a larger diameter manhole may be required.

Outlet pipes from manholes shall be of not less a diameter than the largest size pipe leading into the manhole. The Engineer may however give dispensation from this requirement in certain cases.

In environments where the Engineer considers that loose detritus is likely to find its way into stormwater systems, silt traps and/or special purpose screens may be required to be installed at intervals within the systems.

Cast in situ manholes shall be constructed using ordinary grade concrete (17.5 Mpa) vibrated to give maximum density and watertight construction.

Precast manholes shall consist of centrifugally spun 1050mm diameter concrete pipes to Class S standard. They shall have holes cast in the side for step irons.

The method of joining the precast sections shall be strictly in accordance with the recommendations of the precaster, and when using a proprietary jointing compound or *adhesive, in conformity with the manufacturers instructions to provide a watertight structure to the satisfaction of the Engineer.*

5.12.3 DEEP MANHOLES

Where manholes are more than 5.0m deep they shall be specifically designed and shall incorporate intermediate landing platforms or grills in order to prevent a free-fall of more than 5.0m.

5.12.4 SHALLOW MANHOLES

Where the depth to invert of a manhole is less than 1.0m, a shallow manhole may be constructed with a minimum diameter of 600mm, or a minimum width in the case of rectangular shallow manhole of 450mm. In all cases, shallow manholes shall be of sufficient diameter to allow full benching.

5.12.5 STORMWATER MANHOLES ON LARGER PIPELINES

Manholes on stormwater pipelines more than 600mm diameter and on smaller pipelines where the use of standard manholes is not suitable, should be specifically designed, and will require the Engineer's approval.

5.12.6 MANHOLE REQUIREMENTS

All holes established in manholes are to be cut or drilled to allow pipes to enter and exit the manhole. The use of sledgehammers or such like is prohibited. The internal walls of the manhole shall be made smooth in a manner free from joint gaps, to the satisfaction of the Engineer. The pipes entering and exiting the manholes are required to have the ends sealed using expoxy or approved sealant to the satisfaction of the Engineer.

All joints that will allow grout to take hold, shall be filled and made smooth. In particular, between risers, manholes top collar (lid-rings) and frame, and manhole top and risers.

In addition all internal, rough or protruding material, left over from the casting process shall be removed by suitable means and made smooth to the satisfaction of the Engineer.

5.12.7 STEP IRONS, STEPS AND LADDERS

All manholes other than shallow manholes shall be provided with galvanised steel step irons, steps or ladders approved by the Engineer in order to give reasonable access. Step irons shall be of the "dropper" or "safety" type such that a foot will not slide off them. All fittings used shall be hot-dip galvanised after fabrication. Where the smallest pipe entering a manhole is 600mm or greater, recessed steps shall be provided in the haunching within the manhole such that a person standing in the invert of the manhole may easily reach the lowest rung of the manhole steps or ladder. In thermal areas, where approved by the Engineer, ladders or step irons do not need to be provided.

5.12.8 DROP CONNECTIONS

Drop connections on stormwater manholes may be avoided by allowing pipes up to and including 300mm diameter to have an open "cascade" inside the manhole, provided the steps are clear of any cascade.

5.12.9 MANHOLES IN SOFT GROUND

Where the manhole is to be constructed in soft ground, the area under the manhole shall be undercut, backfilled and compacted with suitable hardfill to provide an adequate foundation for the manhole base.

5.12.10 TESTING OF MANHOLES

Manholes may be tested for water tightness by filling for 30 minutes. The allowable loss shall not exceed 1 litre per metre of depth. Care must be taken that undue pressure is not put on any of the downstream system while this test is taking place.

5.13 CONNECTIONS

The connection provided for each residential lot shall be of a type capable of taking the spigot end of an approved drainpipe of 100mm internal diameter unless the Engineer requires a larger size connection to be provided. The connection for each industrial/commercial lot shall be a normal 150mm diameter or larger and capable of servicing the lot.

Where the stormwater pipeline is outside the lot to be served, a 110mm diameter connection shall be extended to the boundary of the lot.

If the above conditions cannot be met, then the connection shall be a 220mm diameter line branching from a manhole in the main line. An extended 220mm diameter connection may be terminated without a manhole provided it is not more than 40m long and also that it does not serve more than two houses, otherwise a manhole shall be provided.

Where the design data is available, connections for commercial and industrial lots shall be designed to take the fill design flow from the area served by the connection.

Each connection shall be marked by a 50mm x 50mm timber stake (treated pine or better) extending to 300mm above ground level with the top painted blue. This marker post shall be placed alongside a timber marker installed at the time of pipelaying and extending from the connection to 150mm below finished ground level. The lower end of the marker post shall be adjacent to, but not touching the connection. Connections shall be accurately indicated on “As-Built” plans.

All connections whether to reticulation lines or to manholes shall be sealed either by a factory sealed stopper or a plug fixed with a rubber ring and held with stainless steel wire or factory made PVC cap solvent welded on.

5.14 RAMPED RISERS

Where an extended connection is to be taken from a pipeline to the boundary of another lot a ramped riser need not be used, and the extended connection may be sloped up at a continuous gradient from the pipeline, to terminate just inside the lot to be served at sufficient depth to drain the building site.

5.15 CONNECTION TO DEEP LINES

Where an existing or proposed stormwater pipeline is more than 5m deep, measured to the top of the pipe, connections shall not be made directly to it, but a new, shallower branch pipeline shall be laid from a manhole on the deep stormwater line and connections provided to the lots to be served.

5.16 INLET AND OUTLET STRUCTURES

Approved structures shall be constructed at the inlets and outlets of pipelines. An acceptable type of concrete is shown on Stormwater and Land Drainage Drawing SD-15. Provision must be made for energy dissipation unless it is demonstrated that the outlet velocities and soil conditions are such as to make this unnecessary. The design shall ensure non-scouring velocities at the point of discharge.

5.17 INSPECTION AND TESTING

All stormwater structures shall be inspected for compliance with the contract specification, the RCEIS and any other specified standard or specification.

General Compliance
Compliance checks will entail visual inspection of the materials used and workmanship of completed works. This shall include lamping of stormwater lines, checking the alignment, level and grade structures, checking structural integrity, (eg for cracks, exposed reinforcing, chipped concrete work, scoured channels, slumping etc).

Pressure Testing of Stormwater Lines
All projects, which include the construction of stormwater lines, shall have pressure tests carried out, either from manhole to manhole or manhole to inlet/outlet. The testing shall be carried out on lines picked at random by the Council Representative. At least one line in 5 shall be tested, eg a system of 1 to 5 lines shall have one test, 6 to 10 lines shall have 2 tests etc. If any one line fails a test of all remaining line shall be tested. Provision should be made for the payment of the random testing to be included in the cost of the works. The cost of further testing required because of the failure of a random test shall be borne by the contractor undertaking the work. The stormwater lines shall be capable of passing one of the following tests.

- Water Test
- Low Pressure Test
- High Pressure Test

5.17.1 WATER TEST

a) Fill pipe with water, ensuring all air is expelled.

b) If pipe materials absorb water, leave for 24 hours.

c) Top up water to test head levels. The minimum head shall be 1.5m above the top of the pipe or ground water level, whichever is the higher. The maximum head at the lower end of the pipeline should not exceed 6.0m.

d) Leave for 30 minutes then measure water loss.

e) The pipeline is acceptable if water loss does not exceed 2 ml per hour, per mm of internal diameter, per m of pipeline length.

Note: Care should be taken when conducting water testing of pipes on steep gradients, to ensure that excessive hydraulic pressures are not applied.

5.17.2 LOW PRESSURE AIR TEST

a) Introduce air to the pipeline till a pressure of 300mm of water is reached. (This may be measured by a monometer such as a 'U' tube, connected to the system).

b) Wait until the air temperature is uniform. (Indicated by the pressure remaining steady).

c) Disconnect the air supply.

d) Measure pressure drop after 5 minutes.

e) The pipeline is acceptable if the pressure drop does not exceed 50mm.

Note:

1. The low pressure air test is highly susceptible to temperature fluctuations during the test period. A 1°C change during the 5 minute test period will cause a pressure change of 30mm water gauge or 60% of the permitted change.

2. Failure to soak ceramic and concrete pipes can cause highly variable results. +

5.17.3 HIGH PRESSURE AIR TEST

a) Pressurise pipeline to 25 kPa.

b) Wait at least 2 minutes to ensure temperature stabilisation.

c) Disconnect air supply.

d) Measure the time taken (minutes) for the pressure to drop to 17 kPa.

e) The pipeline is acceptable of the time does not exceed that given for the appropriate pipe size in Table 8.

Table 5.7: Time for Pressure Drop Versus Internal Pipe Diameter

Internal Pipe diameter (mm)	Time for permissible Pressure Drop (minutes)
90	3
100	3
150	4
225	6