PART 3

ROADS

PART 3: ROADS

301 GENERAL DESIGN CONSIDERATIONS

301.1 Introduction

301.1.1 The road design principles set out in this Code focus on a number of considerations which are regarded as significant in meeting design objectives. The emphasis on this part of the Code is on urban design. For roading in rural areas reference should also be made to Part 7 of this Code.

301.1.2 Road design objectives are:

(i) To provide functional, durable and cost effective road design for both urban and rural areas.

(ii) To provide variety in the urban roadscape.

(iii) To promote conservation of land and construction materials consistent with utility, safety and user convenience.

(iv) To achieve residential roads that contribute to a good living environment.

(v) To encourage the separation of pedestrians and shopper parking from through roads in commercial centres.

(vi) To ensure reasonable compatibility between service lanes, on site service access and the roading requirements of the locality.

301.2 The Road Plan

301.2.1 General Principles

301.2.1.1 In urban areas the design of the road system shall provide for safe and convenient movement of motor vehicles, bicycles and pedestrians between private property and the various areas of activity within and beyond a community recognizing that -

(i) In those roads which provide direct access to residential buildings, environmental considerations, convenience of access and pedestrian safety will increasingly outweigh factors relating to traffic flow as the importance of the road as a traffic carried diminishes.

(ii) In those roads which provide primarily for the movement of traffic, property access will be increasingly limited as the importance of the road as a traffic carrier increases.

(iii) Absolute convenience and total safety are unobtainable at any cost. Some inconvenience and minor hazards are inherent even in the best practical design and important economic savings may be accomplished with only minor concessions to normal standards.

301.2.1.2 To improve the living environment, local residential roads providing property access should as far as possible be cul-de-sacs or loops of limited length, which do not offer through-routes for extraneous traffic and which through their form of construction, inhibit unsafe vehicle speeds.

301.2.1.3 The road network should be designed to form a hierarchy according to access and traffic functions, generally with roads intersecting only with roads in the same class or those immediately above or below in the hierarchy.

301.2.1.4 In the establishment of a road network specific provision should be made for the extension of future public transport services on to primary and collector roads. Where practicable stopping bays should be provided as indicated by the transport authority, and road geometry generally should be appropriate to public transport vehicles.

301.2.1.5 T-junctions are to be preferred to cross intersections particularly for minor roads. Acute-angle, Y-junctions and multi-leg intersections are to be avoided.

301.2.1.6 The number of road intersections should be minimized. Intersections on curves, particularly on the inside of curves, should be avoided.

301.2.1.7 Collector roads should not provide continuous through-routes for traffic between primary roads.

301.2.1.8 Wherever possible pedestrians and vehicular traffic should be separated. (The surest way to improve pedestrian safety is to remove automobiles from areas of potential conflict with pedestrian traffic.)

301.2.1.9 In industrial areas "no exit" roads should be avoided except where constrictions of topography or land use zoning support their use. Through roads provide flexibility of movement and property access and the means of linking public services without the attendant disadvantages which apply in residential areas.

301.2.2 Road Classification

301.2.2.1 The desirable carriageway characteristics of an urban road system are dictated by the traffic function served by each road in the system. There are two principal forms of urban roads:

(i) Primary roads - in which the traffic function is dominant.

(ii) Secondary roads - in which the access function dominates.

301.2.2.2 These two categories may be further subdivided to form a hierarchy of roads in accordance with the degree of access that each road offers to adjacent land and the proportion of through traffic it carried. Table 1 suggests a relationship of road function to geometric structural design and is included as an indication of the type and range of roads and private roads that could be provided for in the proposed subdivision.

301.2.2.3 Traffic function is a determining factor in road design. Predicted traffic volume will give a useful indication of traffic behaviour on the more heavily used road, but tends towards over-design of roads carrying less traffic, particularly at the collector road level, at which the access function should dominate.

In properly designed residential neighbourhoods without through-traffic, travel distances from residence to collector roads are short, actual traffic speeds are low, lane capacity is not a controlling design factor, and inconvenience or minor delay or need to decrease speed, so resented by the highway or arterial road user and the cause of many high-speed accidents, is expected by and is acceptable to residential traffic. In this

case, it is customary for the individual to drive protectively to avoid children and pets.

Momentary yielding to resolve minor residential traffic conflicts is practical at residential area speeds. Residential traffic yields to the driver backing from his driveway, or the backing drive yields, and no one is duly delayed. When residential traffic is impeded by parked vehicles, approaching vehicles often both yield, and then proceed with caution.

Average Daily Traffic (ADT) therefore is not considered the only index for minor residential road design because the traffic density and consequences of highway and arterial road speeds are not present and residential driving attitudes and habits are different.

301.2.2.4 The term "local road" is used to include all minor access roads, with a recommended carriageway width of 5.5m to 6.0m. Narrower widths will be appropriate under special conditions. Design of narrow roads should be based on actual vehicle and turning dimensions.

301.2.2.5 Recommended carriageway widths are for acceptable practice. Where topography or other considerations make these dimensions technically difficult and uneconomical, they may be reduced.

301.3 Parking

301.3.1 General

The vehicle parking requirements are outlined in Sections 18.4.2.4 and 18.4.2.5 of the District Plan.

Visitor's cars, trade vehicles and other transient traffic have no option but to park on the roadway long-term or short-term and it is necessary therefore to make provisions for the parking of some vehicles on all residential and industrial roads.

Provision of restrictive parking zones may be a legitimate device towards better balancing of moving vehicles and parking space needs in certain circumstances.

301.3.2 Carriageway Parking

301.3.2.1 As the traffic function of a road becomes more important, so too is it necessary to provide more specifically for vehicle parking in order that moving traffic is not impeded:

Arterial Roads - traffic function dominant and either a parking prohibition applies on the arterial with parking on adjacent service roads or parking lanes are provided on both sides of the traffic lanes.

Principal Roads - traffic function dominant. Parking lanes 3m wide on both sides of the traffic lanes.

Collector And Subcollector Roads - although primarily to provide property access, traffic requirements are sufficient to justify 2.5m wide parking lanes on each side of the traffic lane or lanes.

Local Roads - in residential areas because of the low traffic volume and traffic speed, the inconvenience of lane sharing by parked and moving traffic is sufficiently low to be acceptable. To enable moving vehicles to pass parked vehicles, a two lane width is provided but parking lanes are

not specifically provided. Such lanes need not be continuous but broken into parking bays separated by planted trees and shrubs.

In local industrial roads, because of the mixing of light vehicles with long less manoeuvrable heavy vehicles, parking width should be provided on each side of the carriageway to leave a clear lane for moving traffic only.

301.3.3 Off-carriageway Parking

301.3.3.1 In local residential roads, a considerable improvement in appearance can be obtained by limiting the carriageway width to that necessary to pass two vehicles, that is, two 2.5 to 3.0m wide lanes and by parking vehicles on paved parking bays spaced on alternate sides of in the centre of cul-de-sac heads. The additional width of berm thus obtained enables trees of a reasonable size to be introduced.

301.3.3.2 Where berm parking is approved by the Council, flush or mountable kerbing may be installed, and paths, if any and depending on the reserve width, moved towards the boundary line.

301.3.3.3 Berm damage by the wheels of vehicles can be reduced to an acceptable degree by sowing the tougher species of grass on material less susceptible to moisture than black loam, for example, pumice or pit metal, or by surfacing with other suitable material such as bricks or masonry blocks.

301.3.3.4 Where a Council requires a separate off-road parking area to be provided for each site, and topography prevents this being done, the Council may require the developer or subdivider to make a financial contribution towards providing neighbourhood parking areas as a condition of Council to the Resource Consent.

301.4 Carriageway, Reserve, and Formation Widths

301.4.1 Carriageway Width

301.4.1.1 Two lanes for moving traffic should be provided in all roads except for short local and sub-collector roads without through traffic where the traffic volume is insufficient to justify two lanes. This could apply to industrial roads as well as residential roads.

301.4.1.2 The recommended basic lane width for moving traffic is 3.0m, although this may be increased to 3.5m where the traffic function is dominant. Where there is significant bicycle traffic the lane width may be increased to 4m in primary roads.

301.4.1.3 In residential areas, the carriageway may be split into separate one-way lanes to preserve natural features such as trees or to minimize property access problems on steep terrain.

301.4.1.4 Urban Carriageway width will depend primarily on the function of the road, and is therefore the total of the widths of lanes required for parked and moving traffic as outlined in the previous sections and summarized in Table 3.1, NZS 4404:2004.

301.4.2 Road Reserve Width

301.4.2.1 Generally road reserve widths should be adequate to provide for pavement, footpaths (as required) utilities, drainage, landscaping and road furniture. Reserve widths may be reduced where services are placed

outside road reserves. Recommended minimum widths are scheduled in Tables 3.1 & 3.2, NZS 4404:2004.

301.4.2.2 Preservation of or capitalization on some unusual natural feature of a landscape or existing specimen trees may dictate an irregular shaped reserve.

301.4.3 Formation Width

301.4.3.1 Formation width shall be adequate to contain the services described in 301.4.2.1. Where topography permits, the formed width should extend beyond the road reserve boundary by 500mm, with batters providing a smooth transition to the adjacent lots. Alternative design may provide a lesser formation width with batters inside the road reserve where necessitated by steep slopes.

301.5 Carriageway Geometrics

301.5.1 Road Alignment

301.5.1.1 The Planner should be sensitive to subdivision construction, operation and maintenance costs which can often be minimised by properly relating road layout to natural topography.

301.5.1.2 Horizontal alignment of residential roads, should be based on terrain, designed roadway speed, or designed speed restriction as applicable, depending on road function.

301.5.1.3 Vertical alignment of residential roads should assure that inclines can be negotiated during all weather conditions and sight distances are adequate for safety. The ideal gradient should be deliberately considered as a planning factor when selecting locations for shopping centres, service centres, walks or footpaths.

301.5.1.4 Generally secondary roads should not require super-elevation or transition curves. Where considered necessary, these should be applied with restraint.

301.5.2 Intersection Design

301.5.2.1 Desired vehicle sight distances at intersections need to be related to road function and vehicular travel speeds. Unnecessary subordination optimum land use and tree planting to the requirements of vehicle sight distances can often be avoided by the provision of intersection control.

301.5.2.2 Hilltop and slightly below hilltop intersections should be avoided if possible. The radius of vertical curvature affects the intersection position for optimum visibility.

301.5.3 Gradients

301.5.3.1 A minimum gradient on all kerbed roads is necessary to prevent ponding of water. Also included in the design should be a camber to move water off the carriageway.

The amount of heavy traffic and public transport will influence the choice of maximum grades.

See 302.1.1.1.

301.5.4 Turning Requirements

301.5.4.1 Every cul-de-sac should be provided with a place where light vehicles may turn without reversing.

301.5.4.2 Provision should also be made, near the end of a cul-de-sac of such length as to preclude "backing up" of larger vehicles, for three-point or two-point turning utilising insets in the kerb line or kerb crossings. For an example, see fig. 3.5 NZS 4404:2004. Such kerb crossings should be specifically designed.

See 302.8.2.3.

Turning in a cul-de-sac is a manoeuvre faced by all vehicles. Because of the infrequency of calls upon large vehicles, their turning requirements should not be the determining factor in the selection of the road turning radius, because short-turning emergency vehicles can be acquired and less critical vehicles can manoeuvre during turns. Furniture vans are not emergency vehicles and have time to negotiate turns - they are likely to use driveways to facilitate loading and unloading. Regardless of turning space dimensions, parked vehicles will reduce available turning space. For typical cul-de-sac options, see Residential Roads and Footpaths - listed in Related Documents.

301.6 Pedestrian and Bicycle Traffic

301.6.1 General Principles

301.6.1.1 Pedestrian Traffic. Pedestrian access to schools, shopping and public transportation load points should connect destinations and be convenient. The advantages by way of public convenience, safety, cost and optimised land use of providing for pedestrian traffic outside of road reserves should be explored. Provision of road-wide footpaths should be in response to need rather than arbitrary policy. Footpaths should be eliminated where they are made unnecessary by an alternative pedestrian system with low traffic hazards. Access ways should connect destinations.

301.6.1.2 Bicycle Traffic

301.6.1.2.1 Commuter bicycle traffic is generally best catered for by providing suitable conditions on vehicle carriageways, such as adequate widths and riding surfaces.

301.6.1.2.2 Where the volume of traffic mix is such that bicycles and motor vehicles are in a lane-sharing situation additional width may be required to accommodate bicycles on primary roads.

301.6.1.2.3 Segregation of bicycles from motorised traffic within the same road reserve should generally be avoided because of the accident potential for cyclists at intersections, due to the increased conflict points generated by turning traffic.

301.6.1.2.4 Separate bicycle tracks not forming part of a roadway may be provided where these are designed to eliminate motor vehicle/bicycle points of conflict and where the advantages by way of shorter distances and easier grades, or both, make the bicycle path the preferred choice, or where the facility is intended for limited recreational use. Generally, any cycle track must provide a shorter route between home and destination than the road or cyclists will tend to use the roadway.

Provision for the declaration of paths as cycle tracks is contained in Section 332 of the Local Government Act 1974.

301.6.1.2.5 Paths intended for use by both cyclists and pedestrians should generally be avoided because of the danger to pedestrians from bicycles at speeds greater than 8km/h. Cyclists should be required to yield right of way to all pedestrians where they are permitted to share such facilities.

Where combined use of a path designated as a cycle track is proposed, some form of regulation will be required.

301.6.2 Pedestrian Circulation

301.6.2.1 In general some separation from vehicular circulation is desirable. To achieve such separation, a pedestrian system may contain three different types of footpaths or accessways:

(i) Paths usually about 0.6m to 1.0m wide connecting individual dwelling units with off-road parking, parking lots.

(ii) Local footpaths or accessways usually 1.1m wide connecting neighbouring dwelling units.

(iii) Paths connecting groups of dwellings with commercial centres and other community facilities. Width selection is dependent on pedestrian traffic requirements and whether the facility is to be designated for bicycle traffic.

301.6.2.2 All pedestrian paths will require a hard surface.

301.6.2.3 Footpaths and Accessway

301.6.2.3.1 Footpaths within a road reserve normally should be 1.1m wide, excluding drainage channels, kerb and pole width. In shopping areas, footpath widths require specific design but a width of 3.5m is desirable. Footpaths within a short cul-de-sac or court may be of sufficient benefit to justify the cost except where they form part of a pedestrian network.

301.6.2.3.2 Only small amounts of surface drainage should flow across walks or paths, and privateways into residential lots should be designed to minimise such flow.

301.6.2.3.3 A minimum cross slope of 2% towards the road when the path is in the road reserve is essential to provide surface drainage. The transverse slope should not exceed 5%.

301.6.2.3.4 The longitudinal profile of footpaths should not be depressed by vehicular crossings because of the hazards to pedestrians of the uneven surface. Footpath gradients should not exceed 16.7%. Where the ruling gradient is steeper, steps and combinations of steps and graded path may be necessary, but grades suitable for use of prams, shopping trundlers, and wheelchairs should be preferred to steps. Where paths are constructed steeper than 12.5%, a permanent non-skid surface and a handrail should be provided. (See 302.8.1 for pram and wheelchair crossings.)

301.6.3 Pedestrian/Vehicle Separation

301.6.3.1 Where considered desirable for pedestrian safety, regard should be had to the provision of separate systems for pedestrian, bicycle and motor vehicle use.

301.6.4 *Bicycle Traffic*

301.6.4.1 In roads with higher design speed and traffic volume, (that is, collector and primary roads) consideration should be given to the provision of manoeuvring width for bicycles where these are expected to be used to an appreciable extent. In designing for bicycle traffic, it is recommended that a bicycle profile width of 1.0m be adopted and provision made for lateral clearances from fixed or moving objects. Where volume of opposing traffic will prevent vehicles from crossing the centreline, lane width for lane sharing should be increased by 0.5m, giving a minimum combined parking and traffic lane width of 6m.

A useful design guide to bicycle traffic may be found in the Geelong Bikeplan.

301.7 Road Lighting

301.7.1 Road lighting in residential areas should be designed to provide safety, security and convenience primarily for pedestrians. Accessways in public areas or other locations away from roads should be illuminated and amalgamated with the detailed area plan or layout, enabling visual surveillance of the accessway from the road.

301.7.2 Road and path lighting should be selected to have a high illuminating efficiency and to provide no more illumination than is necessary for security or safety. Road lighting and bicycle or pedestrian path lighting should be located or mounted to minimize light shining upon residential windows, or into the eyes of drivers, pedestrians or cyclists.

301.7.3 Road lighting standards should preferably be constructed of light break-away material and positioned on the side of the footpath more distant from the carriageway.

301.8 Drainage

301.8.1 The road system will both contribute to the storm-water run-off for which drainage is required, and act as a secondary flowpath. While this will aid economy in primary flowpath design, consideration must also be given to public safety and access. In some circumstances roads may be designed as flood retention areas.

301.8.2 Disposal of surface water by natural percolation into the ground may have a significant effect on discharge into the drainage system, using economy in design capacity and reduction of downstream flooding. Where topography permits and the soil type is suitable, the Council may allow substitution of normal kerbing with flush edge strips, enabling water to be shed across berms to previous ground.

301.9 Landscaping

301.9.1 Landscaping seeks to realise character and impart identity to land subdivision for urban use, without sacrificing convenience and amenity so that residents can feel at home and have pride in their area.

The landscaping of roads will best be carried out as part of the overall landscaping of the subdivision where attention will have already been paid to the preservation of the landform and existing vegetation where this is

characteristic of the area, topsoil and features of geological, historical or ecological interest as appropriate.

301.9.2 Specific design relevant to road landscaping may include:

(i) Alignment to focus views and provide shelter from prevailing winds.

(ii) Tree Planting

The provision of large sized trees is probably the best single method of improving the appearance of urban subdivision - particularly residential areas. Apart from breaking up what is often an endless vista of houses, trees increase privacy, provide shade and wind shelter and reduce ambient noise levels.

While local authority or developer incentive schemes can achieve results for tree planting on private property, effort needs to be directed towards establishing tree plantings on road reserves and recreation areas.

In a road reserve of constant width, the necessary additional width for tree planting can be obtained by varying the carriageway and footpath positions within the reserve or deleting footpaths, where appropriate, provided adequate consideration is given to placement of services.

The location of trees and choice of species should have regard to any adverse shading of properties and any likely interference of the root systems with underground services.

Positive and worthwhile results can be obtained by providing localised widening of the road reserve specifically for the purpose of tree planting.

Provision should be made for adequate maintenance of plantings until properly established.

(iii) Earthshaping. Providing noise abatement, visual screening and relief.

(iv) Contrasting Pavement Surface Textures. These can assist in the differentiation of function and hierarchy of roads.

Subdivisional proposals should include a written statement of landscaping intent, together with a landscape plan and tree planting schedule.

302 ENGINEERING DESIGN

302.1 Road Geometry

The following guidelines for road geometry are suggested as an engineering ideal, but they will often need to be varied to allow flexible overall design in sympathy with the landscape.

Note: For rural roads reference should also be made to Part 7 of this Code

302.1.1 Longitudinal Gradients

302.1.1.1 The choice of a longitudinal gradient will depend principally on the type of terrain. The volume and extent of earthworks in new subdivisions is

influenced by the maximum and minimum gradients adopted. The minimum acceptable gradient will normally be 0.5%, but in exceptional conditions, a flatter minimum gradient may be necessary. Residential roads gradients should not be steeper than 12.5%. On all routes likely to carry significant volumes of public transport or heavy vehicles, the maximum gradient should not be above 8%.

302.1.1.2 Where gradients steeper than those recommended above are unavoidable, they should be restricted to those sections of the road where the alignment is straight, and should be kept as short as possible.

302.1.2 Vertical Curves

302.1.2.1 Vertical curves should generally comply with the minimum requirements of clause 3.7 of NRB Code of Practice - Design for urban streets (but note the NRB S/2 reference is withdrawn), except that shortening of under-vertical (sag) curve may be necessary to ensure that the gradient in the channel is not less than 0.5% Shortening of the vertical curve on a branch road adjacent to intersections may be required where the gradient of the branch road is more than 5%. Change of grade in flat land should have vertical curves of 60m minimum length where drainage permits.

302.1.3 Superelevation

302.1.3.1 Normal camber should be used in 50km/hr zones, or in areas that, in the opinion of the Engineer, are likely to become 50km/hr zones, except where superelevation is required by the Engineer. In the future, certain main routes may have increased speed limits, and if this development is a possibility, the Engineer may require superelevation to be constructed to a speed value nominated at the time of the request. Any superelevation shall comply with clause 3.6 of the NRB Code of Practice Design for urban streets.

302.1.3.2 Theoretical superelevation requirements may require adjustment to ensure flowing kerb profiles. Generally the best results are obtained from a graphical plot of each kerb profile, using a horizontal/vertical scale ratio of the order of 10 to 1.

302.1.3.3 The ruling profile gradient should be developed along the shortest or inside kerb. Where applicable, superelevation is added to the inside profile to obtain the profile of the outside kerb.

302.1.3.4 Reverse curves are to be separated by sufficient length of straight to allow for a satisfactory rate of superelevation reversal, consistent with the design standards.

302.1.4 Horizontal Curves

302.1.4.1 Horizontal curves in 50km/hr zones may be circular, with a minimum centreline radius of 80m for all industrial roads and for residential, sub-collector, collector and primary roads. For local roads the radius may be reduced progressively to a minimum of 15m as the traffic volume decreases.

302.1.4.2 In roads which may have a higher speed limit in the future, the Engineer may require transition curves with a specified speed value. Transition curves shall be calculated in accordance with clause 3.5 of the NRB Code

of Practice - Design for urban streets. Transition curves will not normally otherwise be required in secondary roads.

302.1.5 Extra Widening

302.1.5.1 Extra widening on curves is not normally required where the centreline radius exceeds 60m.

302.1.5.2 Where curves of less than 60 m are necessary for topographical or other reasons, extra widening of up to 1.5m may be applied according to the width of carriageway normally available to moving traffic, the radius of curvature and to the traffic function of the road. Should it be necessary to preserve a minimum berm width, extra widening is applied to the road reserve also.

302.1.6 Carriageway Crossfall

302.1.6.1 The normal crossfall should be 4% in both directions at right angles to the carriageway centreline, with a short vertical curve at the crown.

302.1.6.2 Where a differential level between kerblines is adopted to suit the existing topography of adjoining private property, crossfalls varying from 2% to 4% from the crown may be permitted, coupled with a lateral shift in crown position of up to one quarter of the carriageway width. Where a uniform crossfall is adopted from kerb to kerb this should not exceed 6% unless on a curve where superelevation would otherwise be permitted. Single crossfalls greater than 3% contra to normal superelevation will not be permitted.

302.1.7 Intersection Design

302.1.7.1 The kerbline radius at intersections should be kept as short as possible consistent with likely vehicle and pedestrian usage, but in any case shall not be less than 4m. Major intersections such as the junction of area roads with principal roads or greater, should be specifically designed to provide for bus and heavy vehicle usage.

302.1.7.2 The preferred angle of intersection is 90°, the minimum angle of carriageway intersection should be 80° for non-arterial roads. Carriageway alignment may be offset from the road reserve alignment to improve the intersection angle. Two roads intersecting the same road (T-intersections) should be offset at least 40m where practicable.

302.1.7.3 Wherever practicable the gradient within 30m of intersections on local roads should not exceed 10% and should preferably be less than 3%. Intersection gradients on all other roads should be less than 2% and preferably less than 1%.

302.1.8 Cul-de-sac Heads

The cul-de-sac head is an important feature and in its simple form should incorporate minimum 9 metre outside radius turning circle.

Turning areas using T, L or Y shaped heads which require a reversing movement of the turning vehicle will not be approved unless it can be shown there is no better alternative.

To maintain kerb gradients, the crossfall on paved areas within a cul-de-sac head may be reduced to not less than 2%.

302.1.9 Crossfall on Grass Berms

302.1.9.1 The shape, slope and vegetation of berms should be such as to allow satisfactorily for storm-water run-off, maintenance, location of services and vehicle crossings to properties (unless acceptable alternative parking is provided). To achieve satisfactory drainage, crossfall should be at least 5%.

302.1.9.2 Grassed areas for tree planting which are additional to the minimum berm width should be specifically designed, and in these areas steeper gradients may be permitted to a maximum of 20% providing the area can be mown or otherwise maintained by Council. Where a berm crossfall greater than 8% is proposed, it will be necessary to produce a cross-section along the individual property accesses to show that the sag or summit curves at crossings can be satisfactorily negotiated by a private 90 percentile car. Refer to NZS 4404:2004, Section 3.3.19 and fig 3.9.

302.2 Road Pavement

Types of Pavement

(i) Rigid Pavement. At present this alternative is rarely used but if required a design method is available in the NRB S4 pavement design system.

(ii) Pavement Units. With adequate support solid masonry paving units are of value in normal roadway situations and may also be a suitable alternative in light duty areas such as shopping malls and courtyards, where surface appearance is a consideration. At the same time these units should provide easier maintenance to underground services.

For design information refer to the manufacturers.

(iii) Flexible Pavement. Most pavements in urban subdivisions are built as flexible pavements. Generally, design and investigation costs of flexible pavements should be balanced against consequent savings in construction.

Heavily loaded pavements, therefore, can usually justify the more costly detailed engineering design tailored for each individual case. In the case of the more lightly loaded roads, and a significant proportion of subdivisions will fall into this category, sophisticated investigation and design can hardly be justified and a simpler less costly approach is appropriate.

In the case of the former, design method (1) as described in 302.2.1.1 should be applied where prescribed in Table 1. In the latter case where loading is light the empirical method (2) using standard structural sections may be used.

302.2.1 Flexible Pavement Design

302.2.1.1 Method (1): Use of CBR design as in NRB S/4.

All flexible pavements designed in accordance with the CBR method of design should be in accordance with NZS 4404:2004 Section 3.3.3 but using the design chart in the Appendix, figure 4. The minimum design period should be 20 years. The minimum pavement depth for all roads should be 200mm, and for privateways should be 130mm.

Subdividers and developers may submit alternative local materials for approval by the Council in pavement construction which may not comply in all respects with the standard NRB specifications. Each case will be considered on its merit based on the performance history and relevant

test documentation of the material along with the specific details of its proposed use in the pavement.
On completion of metalling, the Subdivider or developer should arrange for Benkelman Beam test to be taken by the subdivider on the carriageway to confirm consistency in pavement construction.

When the subgrade is up to the CBR strength of 7 and accepted by the control authority, the pavement layers as shown in Table 1 should be constructed.

Where the subgrade does not achieve this strength, some method of subgrade improvement is necessary.

See 302.2.3.

Where the subgrade has a strength greater than that represented by a soaked CBR value of 7, the thickness of the metal layers may be reduced by agreement with the Engineer.

Determination of the acceptability of the subgrade shall be by agreement with the Engineer based on site inspection.

302.2.2 *CBR Tests*

302.2.2.1 CBR values shall be determined in the laboratory according to test 18 of NZS 4402: Part 2P. For subgrade material that is sensitive to remoulding but which will not be disturbed during construction undisturbed samples should be used for CBR testing. Otherwise samples should be manufactured in the laboratory to a dry density equal to that in the field. The CBR values used in the pavement design shall be soaked values unless otherwise approved by the Engineer. Other values may be submitted for approval with sufficient evidence with reference to equilibrium moisture content to show that the value chosen should be the minimum strength value likely to be achieved by the subgrade material over the life of the pavement.

302.2.2.2 The CBR value used in the design shall be the 10-percentile value of the CBR tests taken on the subgrade material. The subgrade is the top one metre of material, either occurring naturally on the site or imported, on which the pavement is constructed.

To obtain the 10-percentile value, collate CBR test results from samples taken at the same level relative to the subgrade.

Where CBR values are required for aggregates these shall be based on laboratory tests prepared on the fraction passing the 19mm sieve.

302.2.3 Subgrade Improvement. The following are some methods of subgrade improvement that are acceptable:

(i) Compaction of Subgrade. This is likely to require drying to near optimum moisture content and compaction by plan suited to the material, such as sheepsfoot or similar roller for cohesive type materials.

(ii) Lime or cement stabilisation of the subgrade.

(iii) Removing soft material, including peat, and replacing with suitable material such as clay, sand, scoria, crushed sandstone, crushed rock, crushed building rubble, river gravels.

Where deep peat is encountered, excavation should not need to extend beyond 1 to 2m. At such depths a sufficiently sold foundation may be achieved by various methods of rafting such as the use of fascines and filter fabrics or large boulders.

In some cases filter fabrics can provide the necessary restraint on the subgrade to allow compaction of the improvement material. In others they can function to prevent subgrade penetration.

(iv) Subgrade Drainage:

302.2.4 Aggregate Specifications. Two basecourse qualities are recognised:

Quality	Size	Code
TNZ	All passing 40mm	AP40
General Quality	All passing 40mm	GAP 40

302.2.4.1 NRB AP 40. This is the code name for the material described in the National Road Board M/4 Basecourse specification, or in the approved local alternative NRB M/5 Basecourse specification. It is a high quality, high cost material developed for main highway use, manufactured to narrow tolerance under close control.

It is recommended that this specification be adopted in total where prescribed for use in Table 1 (p. 40).

302.2.4.2 GAP 40. This is a general quality basecourse specification suitable for use in lightly loaded pavements where economies can be achieved by the adoption of lower but sufficient quality materials and where the use of NRB M/4 would be wasted.

It is recommended that this specification be adopted where prescribed for use in Table 3.1 (NZS 4404:2004).

The specification limits recommended are:
Grading: Upper grading limits as for M/4.

Lower grading limits 5% below the M/4 levels

Crushing resistance (10% fines): Not less than 11 tonne

Weathering resistance: C.B. or better

Sand equivalent: Not less than 25

Local variants of the above parameters may be approved by the Engineer.

302.2.5 Sub-Base. Sub-base can be a lower strength durable material but must be capable of carrying the imposed loads without significant change. It shall be free of organic matter.

Grading: Within broad limits the grading in the sub-base layer is not important:

(i) The top size should not be larger than 60% of the depth of the layer. This will allow placing of the layer with grader and roller to a reasonably smooth surface. (A bulldozer and scraper may be more suitable for spreading coarse graded sub-base.)

(ii) The material should be sufficiently free draining so as not to be susceptible to undue weakening at highest in service moisture

content. That is, fines should be limited to avoid adverse pore pressure effects.

There are a large number of useful roading materials that are at present excluded by some over-restrictive roading specifications. Many of these materials can be taken directly from the quarry or pit without processing.

For close grading control, a material must usually be processed through a crushing and screening plant and the resultant cost is then similar to that of a fully processed basecourse.

A stabilised grading may not be necessary in the lower levels in a pavement structure because the overlying layers dissipate the wheel loadings and provide a confining pressure.

If the sub-base is used as a subgrade improvement, that is, below the nominal subgrade level, it only requires the properties of a good clay, so that grading, particle strength, and pore pressure considerations are not important.

It is important that breakdown of aggregate, under rolling, during the road building process does not produce an unsatisfactory structure. An example of this would be a soft brown greywacke which in the presence of excess water and rolling would break down to a soft clay and be unstable. Sand can form a very effective sub-base layer if it is placed with an excess of water, graded and lightly rolled.

302.2.6 Pavement Construction. Construction of metal courses should be to Transit New Zealand B/2. The minimum thickness of a metal course for flexible pavements should be 70mm.

Surfacing to flexible pavements should be either with a 20mm minimum depth of asphaltic concrete or a first coat chip seal to be followed (at a time agreed by the Council) by a second coat final surfacing which should be either a second chip seal or 20mm nominal thickness of asphaltic concrete.

Where asphaltic concrete is used without a first coat chip seal, a seal coat should be applied first to the prepared basecourse to provide a waterproofing layer.

First coat sealing with an asphaltic cutback should be to Transit New Zealand specifications P/3, M/1, and M/6.

Sealing with asphaltic concrete should be to Transit New Zealand specifications M/10 and P/9.

302.3 Subgrade Drainage

302.3.1 Underground Drainage

Where subsoils are not free draining, subsoil drains may be required under road channels. The under channel drains should consist of an approved filter drainpipe 50 to 100mm diameter in a trench backfilled with an approved free-draining material. The trench should be 300mm wide, the pipe invert 375mm below subgrade level, and the trench bottom 50mm below pipe invert.

302.3.2 *Additional Subgrade Drainage*

Any permanent wet spot in the subgrade should be drained to the underchannel drainage system. Where the wet area is below the level of the underchannel drain, it should be drained using approved filter drainpipes connected to the nearest storm-water system.

302.4 Kerbing and Channelling

302.4.1 All kerb and channel should be machine extruded. The subgrade under kerbing and channelling should be compacted and rolled to the same standard as the carriageway subgrade. After the kerb is poured suitable filling should be placed and compacted along the back face of the kerb before any metal is placed to the carriageway. Compaction should not be done until the concrete has attained sufficient strength to accept the compactive efforts without damage.

Contraction joints should be cut by guillotine and spaced at not more than 4m centres. Cold joints in concrete more than 2 hours old should be cut with a saw to a square surface to provide a proper face on which to restart the extrusion. All joints should be sealed.

Care should be exercised when rolling or grading adjacent to the kerb and channel to avoid damage.

302.4.2 Where kerbs and channels, or equivalent approved concrete, ceramic or stone edging, are to be provided on carriageways, they should comply with fig. 3.12 NZS 4404:2004. Mountable kerbs or their slip-formed equivalent may be approved for road islands and lightly trafficked precincts. Cast in situ concrete shall be to NZS 1900 : Chapter 9.3 with 28 day strength of 17.5 MPa, in 302.4.2.

302.4.3 Where crossfall is such that storm-water control is required on one side only of the carriageway, the channel may be eliminated on the higher side. Special provision for roof water drainage may be required.

302.5 Sumps

302.5.1 Sumps shall be spaced to provide for local rainfall intensities and the channel slope. Suggested typical spacings are:

(i) In channels draining one lane, in such a position that the run of water in any channel is 90 to 125m, and for channels draining two lanes, 60 to 90m.

(ii) Where required at intersections, at the kerbline tangent points.

(iii) At changes of gradient or direction in the channel where there may be a tendency for water to leave the channel.

(iv) A double sump is recommended -

a. At the lowest point in a sag vertical curve;

b. At ends of a cul-de-sac where water falls to the end;

c. On all channels where the gradient is steeper than 5%.

302.5.2 Sumps should normally be connected to a manhole on the storm-water drainage system by 225mm diameter pipes, except that if the trunk

storm-water drain is of a greater diameter than 600mm and a manhole is not conveniently located the sump lead may be saddled direct to that drain. A typical sump design is shown in fig. 3.13 to 3.19 NZS 4404:2004.

302.5.3 On footpath and accessways, sumps, if not required to take a design flow of more than 15 L/s may be 450mm x 450mm internal dimensions. An outlet of 150mm diameter will be permitted providing it is adequate for the designed flow.

302.6 Dished Channels

302.6.1 Dished channels in carriageways and parking bays.

302.6.1.1 Where possible these shall be avoided by providing for the parking bay camber to be a continuation of the road crossfall. Where no alternative is practical, a 600mm wide dished channel should be constructed and should be a mirror image of the standard channel as set out in fig 3.12 NZS 4404:2004.

302.6.2 Dished channels with footpaths or accessways

302.6.2.1 Where the contour of the finished ground level is such that a low level footpath is necessary, a channel should be constructed. This should follow the same gradient as the footpath and 450mm x 450mm sumps constructed to collect the surface water.

302.6.2.2 Where a significant amount of surface water will be concentrated by the footpath in a pedestrian accessway, it should be collected by a dished channel and disposed of through 450mm x 450mm sump.

302.6.2.3 The construction of these dished channels should be as shown in fig. 3.12 NZS 4404:2004.

302.7 Footpaths

302.7.1 Construction of Footpaths

302.7.1.1 Concrete footpaths should be constructed of concrete to NZS 1900: Chapter 9.3 with a 28 day strength of 17.5 MPa. The minimum depth should be 70mm concrete on 30mm compacted depth of fine granular material. The width should normally be 1.1m where the path is separate from the kerb, or 1.5m from kerb face to far edge of path when the concrete footpath is set adjacent to the kerb. Paths with asphaltic concrete surface should have a minimum thickness of 10mm of asphaltic concrete complying with NRB Specification MS/10k, June 1975, laid on 75mm of compacted basecourse on suitably compacted subgrade. Solid masonry paving units provide an alternative to cast in situ paving and may be lifted and replaced readily for servicing.

302.7.1.2 Commercial Areas

Footpaths in commercial areas should be the full width of the berm. When constructed with asphaltic concrete they should have a minimum thickness of 25mm of asphaltic concrete laid on 100mm of compacted basecourse.

302.7.1.3 Cul de Sacs

There shall be one footpath only in short cul de Sacs under 500m in length

302.7.2 *Timing of Footpath Construction*

302.7.2.1 Where most of the houses in a subdivision or road are likely to be built by the one agency and in other cases where satisfactory arrangements can be made, Council may agree to the construction of footpaths being postponed until the majority of the houses have been completed.

Care must be exercised to see that all driveways constructed before the footpaths are at the correct level. In industrial areas, the Council may defer footpath construction until it is warranted by the development.

Note: It is advised that footpaths and vehicular crossings should not be constructed until utility services have been installed.

302.8 Crossings

302.8.1 *Pram and Wheelchair Crossings*

Kerb Ramps. Kerb ramps should be located so that users have an unobstructed view of traffic approaching from any direction, and should be provided at pedestrian crossings, accessway, and where footpaths cross a kerbline at road intersections.

Ramps should be constructed to the standards (Clause 205) contained in NZS 4121:1985 "Code of Practice for Design and Access and Use of Buildings and Facilities for Disabled Persons".

302.8.2 *Vehicle Crossings*

302.8.2.1 A vehicle crossing should be provided between the kerbline and back of the footpath at the entrance to all entrance strips to rear lots, accessways and service lanes, and at any other place where the location of the future driveway to a section can be determined with reasonable certainty. Details of recommended forms of crossing are indicated in fig. 3.10 of NZS 4404:2004 except that the basecourse is not required

The crossings should normally be constructed of unreinforced concrete to NZS 1900: Chapter 9.3 with a 28 day strength of 17.5 MPa. The minimum depth of concrete should be 100mm on 30 mm compacted depth of fine granular material.

302.8.2.2 Where a footpath exists in permanent material and good condition, it may be incorporated into the crossing, providing resultant gradient is not more than 1 in 8.

302.8.2.3 Where crossings may be expected to carry heavy traffic, these should be specifically designed and the depth increased or reinforcing provided, or both, to the Engineer's requirement.

302.9 Berms

302.9.1 The minimum width of berm should be 4.5m measured from the kerb face. Alternative design may provide for a lesser width provided that adequate space is allowed for location of services within or outside the road reserve.

302.9.2 On completion of all other works including all other network utility services, the berms should be spread with first quality topsoil and compacted to a depth of 75mm. The topsoil shall be graded to kerb top and footpath edge and finished 15mm high to allow for settlement except

on the low side of the footpath where the topsoil should be finished flush to prevent water ponding.

After topsoiling, the berms should be sown with a seed mixture containing equal parts by weight of perennial rye grass and white clover or other approved mixture.

The mixture should be sown at a rate of 1kg to 100 sq metres. Grassed areas should be maintained free of excessive weed growth and kept mown throughout the maintenance period.

302.10 Service Lanes, Parking Bays, Privateways and Accessways

302.10.1 Commercial Service Lanes

302.10.1.1 Where commercial development is to be provided with access by means of a service lane it should consist of a minimum 5.0m carriageway with kerb and channel on the lower side and a concrete edging strip flush with the surface on the other side. Provision should be made for the disposal of storm-water. The pavement construction and surfacing should be in accordance with 302.2.

302.10.2 Industrial Service Lanes

302.10.2.1 Industrial service lanes should be constructed to the same pavement standards as industrial roads.

302.10.2.2 Where an industrial service lane serves properties on one side only, the surface may have a single crossfall with kerb and channel on the lower side and a concrete edging strip flush with the surface on the high side.

302.10.3 Parking Bays

302.10.3.1 Parking bays should be constructed to the same design standards as the road of which they are a part.

302.10.4 Pedestrian Accessways

302.10.4.1 Pedestrian accessways should be paved as a concrete path, 1,100mm wide centred on a minimum 2.5m accessway. Protection devices should be installed on each accessway to reduce vehicle, and motorcycle movements and provide total mobility access.

302.10.4.2 Where storm-water is likely to flow along the length of the accessway, provision should be made for the collection and disposal of storm-water.

302.10.4.3 Both sides of a pedestrian accessway should be bounded by a fence to a standard not less than as shown on fig. 8 of the Code.

302.10.5 Accessways

302.10.5.1 The minimum widths between boundaries should be as in the District Plan, and should include a grassed strip on either side to provide for the construction of underground services.

302.10.5.2 Accessways are to be constructed in accordance with details set out in fig. 8 of the Code.

302.10.5.3 Pavement should be constructed to a minimum width of 2.5m and a minimum pavement thickness of 150 GAP 40 where required by the Engineer, pavement should be surfaced with 2 coat seal or 25mm

asphaltic concrete, and provision made for the collection and disposal of storm-water to the road channel or other approved outlet.

Adequate turning area and passing space should be provided where length of the private way requires. Gradient should not exceed 16.7%. Minimum transverse slope should be 3%, and minimum inside radius of curve should be 9m.

302.10.5.4 For accessways serving up to 3 lots, vehicular access may be provided by two concrete strips 900mm wide by 100mm thick with a 800mm space between them. Concrete strips should be constructed of concrete with a 28 day strength of 17.5 MPa. Where the subgrade has a CBR less than 7, the concrete strips should be reinforced with 665 mesh.

302.10.6 Bicycle Tracks

302.10.6.1 Tracks for bicycle use should be constructed to standards as specified for footpaths. Where used by both pedestrian and cyclist a minimum paved width should be 2.5m assuming no side obstructions or walls. Where these are present, additional clearances should be provided. Storm-water disposal, fencing, handrails, and lighting should be provided as appropriate to the specific situation.

Note: It is advised that network utility services should be installed where required before the completion of development.

302.11 Lighting

302.11.1 Lighting of roads, service lanes, pedestrian accessways and amenity tracks should be to the standard of illumination recommended in AS/NZS 1158:2005. Primary roads should be illuminated to main route standard, and secondary roads to side road standard.

Road lights in minor roads shall be 70W HP Sodium and in major roads should be 150W HP Sodium.

The position of road lights will be to AS/NZS 1158:2005 subject to the approval of the Engineer.

A road light should be provided at each entrance to pedestrian accessways.