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LEETON
SHIRE COUNCIL

ENGINEERING GUIDELINES

FOR SUBDIVISIONS & DEVELOPMENT STANDARDS
2022/23

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GENERAL REQUIREMENTS

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GENERAL REQUIREMENTS
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1. INTRODUCTION

These general requirements for Subdivision and Development outline Council's procedures and practices for subdivision and development of land within the local government municipality.

These standards have been developed though previous involvement of Narrandera, Federation, Leeton, Albury, Wodonga and Griffith Councils and North East Regional Water Authority. Whilst encouraging a consistent regional approach the unique requirements of each Council are detailed. Where Council's standards differ, the specific Council standard is referenced.

Reviewing the existing guidelines of each Council has developed these updated engineering guidelines. It is intended that the guidelines be updated on a regular basis to reflect changing development requirements.

Council has determined that where a developer is required to carry out civil engineering works in connection with a subdivision or development and that upon completion by the developer the works become the responsibility of Council, then the works are to be constructed in accordance with these Guidelines.

These guidelines are to be read in conjunction with the planning instruments and development control plans applying to the site. Applicants are advised to ensure that all conditions of the Development Consent are addressed within the Engineering Drawings as a Subdivision Certificate or Completion of Works Certificate cannot be issued until the Development Consent conditions have been met in full.

The Subdivision and Development Guidelines comprise the following:

Part 1 General Requirement
Part 2 Design of Roads
Part 3 Stormwater Drainage Design
Part 4 Water Reticulation Design
Part 5 Sewerage Reticulation Design
Part 6 Landscaping, and Measures for Erosion, Sedimentation and Pollution Control
Part 7 Testing

Consultations with Council

Council encourages prospective applicants and their design consultant to meet with engineering staff prior to commencing the design process. This is to allow Council to discuss with the designers what is proposed and seek common ground before a significant start is made by consultants in commencing detailed plans. Applicants will be required to prepare a Traffic Engineering Report to assist in assessing the impact of the development on surrounding areas. The results of the report are to be incorporated into the detailed design.

2. GENERAL

National Standards for Subdivision and Land Development are rapidly changing in response to changing community expectations that have an increased emphasis on:

- Community facilities, public open space areas, landscaping and urban design outcomes that are associated with New Urbanism concepts
- Water sensitive urban design, water conservation and water quality
- Energy efficiency, sustainability
- Community safety and public open space areas

To assist in achieving these outcomes, approval will be merits based and consider the overall impact of the development on the community and not solely on compliance with minimum engineering standards.

To encourage the submission of innovative design solutions, staff are available for initial consultation to discuss and facilitate outcomes. In this context these guidelines may be subject to variation with approval from Council where outcomes are linked to environmental and community benefits. There are benefits in following traditional methods of design and standards, but users should question these and embrace new and improved procedures. Council strongly supports this approach, adopting the following hierarchical consideration of planning strategies:

- The Planning Scheme
- Land-Use Strategies
- Precinct Strategies
- Overall Subdivision Master Plan
- Specific Subdivision Stage Plans

An important part of the Engineering approval process will be the preparation of an overall Master Plan that provides for the integrated provision of urban landscaping, roads, stormwater drainage, water, sewer, gas, lighting, telecommunications and electrical services.

To facilitate approval of Engineering Drawings and release of Approved Plan for Subdivisions for subdivisions and developments, the following approach is encouraged:

- Prior to commencement of design meet with Council to discuss engineering development issues
- Integrate subdivision work with infrastructure, urban design and community master planning. Submit a Master Plan of the overall subdivision development for inclusion in Councils mapping system
- Demonstrate the application of Quality Assurance procedures when submitting designs and documents to Council for review with independent documented review by experienced staff prior to submission
- Council review will then focus on general compliance with strategy and these guidelines

3. ENGINEERING PLANS AND SPECIFICATIONS

3.1. DEFINITIONS, QUALIFICATIONS AND EXPERIENCE

Council means Leeton Shire Council. Representation of Council will be by "a designated officer of Council" with delegated authority. The respective Consultant/Engineer or Surveyor engaged by the Developer shall sign all Engineering Drawings.

All references to an Engineer shall be interpreted as a person acceptable for Chartered Membership of Engineers Australia or a person with equivalent qualifications and or experience.

All references to a Registered Surveyor shall be interpreted as a person registered under the Surveyors Act, 1929 as amended.

Council requires that design drawings be prepared to Council's standards by a person, either holding qualifications acceptable for Chartered Membership of Engineers, Australia, accreditation by the Institution of Surveyors under the Survey Practice Accreditation Scheme for Subdivisional Civil Works 1996 (SPAS 1996), or approved by Council and/or who has demonstrated experience in the preparation of drawings and specifications for land development.

3.2. SUBMISSION OF ENGINEERING DRAWINGS

Initially submit one preliminary set of Engineering Drawings, catchment plans, stormwater calculations, specifications and any other relevant documents for comment.

Three sets of Engineering Drawings are to be submitted with a covering letter for signature. One set of approved drawings will be returned to the applicant.

For uniformity of plan presentation, all plan sizes, lettering, line work and symbols are to conform to AS 1100 - Technical Drawing Standards.

All Engineering Drawings are to include a north arrow, a bar scale and a legend summarising line types and symbols.

The Engineering Plan set is to include sheets detailing the following:

- A cover sheet with a locality plan and sheet list
- Roads, kerb and gutter
- Stormwater drainage
- Stormwater catchments
- Water supply
- Sewerage
- Landscaping plan
- Dust, erosion and sediment control plan
- Telecommunications and fibre optic
- Electricity
- Traffic management plan
- Bulk Earthworks

3.3. SUBMISSION OF CONSTRUCTION SPECIFICATION

Preparation of a Construction Specification is the responsibility of the applicant The Construction Specification is to reference the requirements contained within Council's Engineering Guidelines, together with the appropriate standard specifications selected from other sources.

Specifications must be supplied with the Engineering Drawings to allow site assessment of works.

3.4. APPROVAL OF ENGINEERING DRAWINGS AND SPECIFICATION

Council will review the Engineering Drawings and Construction Specification for compliance with the following guidelines:

- Council's Subdivision Guidelines
- Relevant Australian Standards
- Relevant Local, State and Federal Government Legislation
- Council's Development Consent for the Subdivision

It is the entire responsibility of the person(s) or company submitting the documents, to ensure that the designs and specification are technically correct and comply with the above guidelines.

Council's approval is conditional on the above basis, and does not relieve the developer from rectifying any errors or omissions which become evident during construction. The approval is current for two years. If substantial works have not commenced inside the development consents period of currency, Council may require the submission of revised Engineering Drawings and Construction

Specification be submitted for approval with a new development application. In this case, the developer must comply with Council's current Engineering Guidelines.

3.5. COMMENCEMENT OF WORKS

Upon Councils approval of the Engineering Drawings and Construction Specification, the developer will be issued a construction certificate. Once a construction certificate is issued, the developer must provide Council at least 2 days notice prior to commencement of work (section 6.12(2)(c) of the EP&A Act).

3.6. DEVELOPERS RESPONSIBILITY

When Consent of a subdivision or other development includes conditions of construction which are embodied in the approved drawings and specification, the onus is primarily on the applicant to whom the approval is given to ensure that the work is completed in accordance with drawings and specifications and is to the satisfaction of the Council. The approved plan of subdivision will generally not be released until all engineering works (including works as executed drawings) are completed and all other conditions of the development consent are satisfied (section 6.15(2) of the EP&A Act).

The contractor carrying out subdivisional works is the responsibility of the developer, not Council, for constructing and maintaining the works to the approved standards and satisfaction of Council.

4. INSPECTION OF WORKS

4.1. INSPECTION AND UNINTERRUPTED ACCESS

All construction works which the developer is required to carry out in association with a subdivision or development will be inspected under the direction of Council.

All works are to be carried out to the entire satisfaction of Council. Council is to have uninterrupted access the development site at all time for the purpose of examination of facilities, works and materials.

4.2. PUBLIC SAFETY

The developer will be held responsible for the safety of the public to the extent that the works being undertaken influence or impact on the safe and efficient passage of the public through and/or around the works. The developer shall not obstruct the free passage of the public unless public safety is at risk and no other means of ameliorating that risk is readily available. The developer shall provide all watchmen, lights, barriers, signs and fences necessary to prevent any accidents to the public or private damage or loss. The developer shall provide, erect and maintain all necessary temporary roads, bridges, footways, drains and supports and protection in order to ensure the above.

4.3. DAMAGE TO SERVICES

The development must enquire as to the location of all services with 'Dial before you Dig' and any relevant service authorities. Existing services that have the potential to conflict with proposed works are to be physically located on site and documented on drawings.

In the event of any services being damaged or interrupted, the developer shall forthwith notify the responsible authority and take all necessary steps to provide for the safety of the public and to have the damage repaired as quickly as possible. The cost of all resulting repairs are to be borne by the developer.

4.4. TRAFFIC CONTROL

Signs, barricades, barriers, warning lights, etc. shall be placed where works are in progress and in accordance with AS 1742 - "Manual of Uniform Traffic Control Devices". Traffic Control must comply with RMS "Traffic Control at Work Sites".

The developer should ensure safe, continuous movement of traffic with a minimum of disturbance, in public roads. Prepare and implement an approved traffic management plan. Traffic control devices are to comply with RMS requirements. Signs, barricades, barriers, warning lights, etc., should be in accordance with AS 1742 Part 3 - "Manual of Uniform Traffic Control Devices".

4.5. FIRE FIGHTING PROVISION

The developer shall provide and maintain adequate fire fighting equipment and take adequate fire protection measures during the works and shall take action to prevent damage to, or destruction by fire of bushland trees, shrubs or grasses.

4.6. WORK WITHIN RAILWAY PROPERTY

Before starting any work across a railway line or railway property, the developer shall obtain from the Divisional Engineer, State Rail Authority, and approval in writing to commence such work. The developer shall comply with all requirements of the Rail Authority and complete such work to the Rail Authorities satisfaction.

4.7. NOTIFICATION

The developer shall provide the name, address and telephone number of the contractor at least seven days prior to the proposed date of commencement of any construction;

The developer shall provide 24 hours prior notice in respect of the following:

- Completion of formwork/stringlines for kerb and gutter
- Opening of trenches ready for pipe laying
- Placing of pipes in trenches prior to backfilling
- Placing and pouring of concrete
- Testing of water and sewer mains
- Completion of subgrade preparation before placing of pavement
- Completion of each pavement layer ready for testing
- Sealing of roadworks

The developer shall, if required by Council, submit dockets from the supplier of ready-mixed concrete in order that the quality of the concrete supplied may be checked.

The developer shall, within seven days of the sealing of any pavement, supply to Council all supply dockets and spraying records in respect of such work.

Council shall inspect the works to ensure that the works are constructed in accordance with Council requirements and the approved drawings.

Council does not carry out the functions of "Superintendent" as defined in the General Conditions of Contract - AS 2124 or AS 4000. The developer is required to appoint a suitably qualified consultant to carry out this function.

5. FEES AND CONTRIBUTIONS

5.1. SUBDIVISION/DEVELOPMENT INSPECTION FEES

Fees for Council examination of Engineering Drawings and inspection of subdivision works are to be paid prior to the release of the Approved Plan of Subdivision. These fees and charges are published annually in Councils revenue policy.

5.2. SERVICES/FACILITIES AND HEADWORKS CONTRIBUTIONS

The services provided by Council for which developer contributions may be currently obtained include:

- Roads & Traffic Management Facilities
- Open Space and Recreational Facilities
- Community Facilities
- Commercial Centre Car Parks
- Stormwater Drainage
- Sewerage
- Water Supply

These contributions are payable prior to the release of the "Approved Plan of Subdivision" and are based on the current Section 94 Contribution Plan under the Environmental Planning and Assessment Act 1979 and Section 64 of the Local Government Act 1993. Works associated with the Section 94 and Section 64 developer contribution plans are as described in detail in those documents.

5.3. TESTING OF WORKS

Testing for compliance of works with the Approved Plan of Subdivision and Construction Specifications shall be undertaken by the Contractor as part of a Quality Assurance Program as approved by Council. Council may prescribe additional tests to determine that acceptable standards of workmanship have been achieved in relation to its interests in the subdivision but otherwise the full cost of Quality Assurance testing will fall onto the Contractor and/or Developer. Where additional tests show that acceptable standards of workmanship are not being achieved all additional testing costs will be at the developers cost.

6. BONDS AND GUARANTEES FOR PERFORMANCE

The Works as Executed Drawings will not be signed and released by Council until certification is provided that all engineering works have been completed. A maintenance bond is required from the developer prior to the signature and release of the Works as Executed Drawings to the value of 5% of the contract price of the subdivision or $500 whichever is greater. The developer is to submit a copy of the successful Tenderers' bid for the construction of the subdivision works to allow this bond to be determined. To this end the Developer is to submit a copy of the successful Tenderers' bid for the construction of the subdivision works to allow the bond to be determined. This bond will be held by Council to cover any defects or omissions, which may arise or become apparent in the Maintenance Period.

Bank guarantees must not have an expiry dates.

The acceptance of Bonds and Guarantees for performance are at the discretion of Council.

6.1. DEFERRED WORKS

Subject to mutual agreement between the Developer and Council, where Council determines that it is not practical to physically construct works and that the deferment of works will result in improved community outcomes through co-ordination with other works, Council may consider a payment equivalent to the full cost of construction of the works. Deferred works typically relate to minor road widening that includes kerb and gutter extensions, footpaths and driveways.

7. WORKS-AS-EXECUTED (WAE) DRAWINGS

Following the completion of engineering works in a subdivision or development, Works-as- Executed (WAE) drawings are to be prepared and signed off by a registered surveyor/professional engineer and forwarded to the Council prior to the release of the final plan of subdivision.

WAE drawings shall show only the current stage of works that has been constructed or altered (existing or future stages of subdivisions must not be included in the WAE drawings).

The following certificate is to be appended to each page of the drawings and signed by the supervising Surveyor or Engineer

'I hereby certify that engineering works shown on the plan are Works-As-Executed and have been constructed in accordance with the drawings and specifications approved by the Council.'

Name: _____

Signature: _____

Capacity: _____

Date: _____

Council relies upon the professional skill and experience of the person responsible for the supervision of the works and ensuring the works are undertaken in accordance with the approved drawings and specifications together with these guidelines and any other appropriate standards.

Developers should be aware that Council inspections of the site are not a substitute for proper works supervision and Council relies on the skill, experience and diligence of the person accepting professional responsibility for this work to ensure it is constructed in a proper manner.

7.1. GENERAL REQUIREMENTS

General requirements regardless of the format Works-As-Executed drawings are submitted include;

- All sheets in an approved set of drawings (the "Complete Drawing Set") must be submitted
- All drawings should substantially be in black and white or greyscale
- There must be a clear delineation of the extent of works, including clear notation of any work that has been constructed in a previous stage or is proposed to be constructed in a future state
- The lot layout on the WAE drawings should be the same as the layout to be included on the plan of subdivision
- The revision detail for each sheet (regardless of whether the sheet contains WAE mark-up or not) shall be noted as follows:
    - Initial Submission must be marked as Revision "W1" with the notation "Works as Executed for Council Approval" and dated
    - Subsequent Revisions must be marked as "W#" (where # relates to the number of resubmissions) and dated
    - Final Revision must contain the notation "Approved Works as Executed" and dated
- The location of all Council infrastructure constructed should be included on the drawings;
    - WAE location of sewer maintenance holes, sewer junctions, stop valves, hydrants, inter-allotment drainage inlet points, drainage pits, kerbs, pump stations etc.
    - WAE levels of road centrelines, kerb inverts and swales, drainage and sewer longitudinal sections showing the constructed invert levels at each pit/manhole
    - Conduits, subsoil lines, stub mains and inter-allotment drainage lines should be shown on drawings
    - Location (including footprint) of any site fill, the natural surface levels, finished surface levels and compaction achieved
    - The location of temporary turning heads should be noted
- All changes from the approved design are marked-up in red including:
    - Items constructed (denoted by a tick)
    - Any additional items constructed
    - Any items not constructed (denoted by a strikethrough line and an "X" or cross)
    - Confirmation of any changes to existing infrastructure
- CCTV is to be used in accordance with current applicable standards to locate all sewer junctions and confirm the integrity of the installation. A video record is to be provided to Council in an agreeable file format as part of the conditions of compliance for the works

8. ELECTRONIC FILE REQUIREMENTS

With each hard-copy WAE submission, both a .pdf and .dwg format version are also to be submitted as below.

Adobe .pdf

- All sheets in an approved set of drawings (the "Complete Drawings Set") must be submitted in a single file, in page order
- Each drawing must be same as approved size (A3)
- Each drawing must be an electronic rendition of the submitted hard copy
- Each drawing must be legible, particularly if a scanned document, Council staff will determine acceptability of legible drawings on a case by case basis

AutoCAD .dwg

- Must be submitted with each set of the PDF files for Council review
- Drawing must be an acceptable DWG file version
    - Council can accept up to and including the latest DWG file version
    - Council must be advised where the DWG has been created in a non-Autodesk product, like Microstation or 12D
- Drawing must be on MGA (Zone 55) co-ordinates, with AHD datum
- Drawing must only contain:
    - Final Lot Layout
    - New and Altered Infrastructure Locations
    - Location of any existing infrastructure where newly installed infrastructure interfaces
    - Labelling (where appropriate)
    - Layering by Asset Type (Water, Sewer, Stormwater, Roads etc.)
- Each asset must be represented by a single feature (Nodes/Pits can be a block, pipes must be single line. Line types can be used where appropriate)
    - Where pipes connect they must share a common vertex (and where appropriate share that vertex with a node/pit)

9. CERTIFICATION OF COMPLETION OF WORKS

9.1. NOTIFICATION OF COMPLETION

When the Developer (or his Consultant) is of the opinion that Works of Subdivision have been completed, the Developer shall, in writing, request Council to issue a Certificate of Completion of Works.

Within 14 days of the receipt of the request, Council shall inspect the works and shall issue a Certificate of Completion of Works or shall give the Developer, in writing, the reasons for not issuing the above. The Developer or his Contractor shall be present for the inspection and assist Council with the checking of levels and opening of manholes, etc as required.

9.2. MAINTENANCE OF WORKS

The Maintenance Period will be 12 months and will commence on the date of the issue of the signature and release of Works As Executed Drawings. A maintenance bond shall apply during the period.

At any time during the Maintenance Period, Council may direct the Developer to rectify any omission or defect in the work, which exists at Certified Completion or becomes apparent prior to the expiration of the Maintenance Period. If defects or omissions are not rectified to Councils satisfaction, Council will be at liberty to rectify these and apply the maintenance bond for payment of the cost thereof.

The nature of some defects, eg water main breaks, sewer main connections etc., may necessitate Council's immediate repair. The maintenance bond may be used for the costs unless the Developer elects to pay Council separately.

Council requires Ten (10) working days' notice to allow checking of Works As Executed Drawings from the time of submission to the time of release.

10. SURVEY AND SETTING OUT REQUIREMENTS

10.1. CENTRELINE MARKING

The setting out of construction projects is generally project and experience driven and will be Surveyor specific. Individuals may follow in-house setout procedures with agreement from Council.

The suggestions in the following 2 sub-sections 10.1.1 and 10.1.2 can be viewed as recommendations only, in lieu of individuals accepted procedures.

10.1.1. Urban

The Centreline of the proposed road shall be pegged at a maximum spacing of 20 metres. Recovery pegs shall be placed on both sides of the road (off-set approximately 15 metres) at each curve tangent point (T.P.) and at spacing's of no more than 100 metres on straights.

10.1.2. Rural/Rural Residential

The centreline pegging shall be as required for urban roads except that the spacing shall be 40 metres and the provisions of RMS Standards shall apply in respect to the pegging of curve transitions. Comply with longitudinal and cross-sectional intervals in Part 2 of the Guidelines for the Design of Roads.

10.2. DATUM AND CO-ORDINATES

The survey shall be undertaken on Australian Height Datum and current MGA co-ordinates. The Datum used must be stated on all submitted plans.

10.3. BENCH MARKS

Bench Marks shall be established within the works area at intervals not exceeding 100 metres and in accordance with sound surveying practice.

10.4. SURVEY CONTROL MARKS

The survey control marks shall be placed in accordance with the "Survey Practice Regulation, 1990 " and Surveyor-General's Directions.

10.5. LOT BOUNDARIES

Lot boundaries shall be established to the standard required by" Survey Practice Regulation, 1990" and Surveyor-General's Directions prior to the final inspection of works.

11. MISCELLANEOUS

11.1. PUBLIC LIABILITY INSURANCE

Contractors engaged on Development or Subdivision Works shall take out Public Liability Insurance to the value of **$20** million. The policy shall specifically indemnify Council from all claims arising from the execution of the works.

Council will check annually on each Contractor's public liability insurance.

11.2. COMPLIANCE WITH ACTS AND LEGISLATIVE REQUIREMENTS

It is the responsibility of the Developer or his Contractor to ensure that all works are undertaken in a safe and efficient manner. The Contractor shall ensure compliance with the Workplace Health and Safety Act and any other relevant Acts, Ordinances and Regulations in New South Wales.

11.3. LOCATION OF PROPOSED SERVICES

The location and offset of proposed services shall be as per Council's Standard Drawing for service locations.

All services shall generally run parallel to the road centreline and shall cross the road centreline as close as possible to perpendicular to it unless otherwise approved by Council.

12. REFERENCES AND STANDARDS

The format of the guidelines has been simplified by making reference to both National and State Standards where applicable. Where these standards vary from the referenced standards the variations are highlighted and cross-referenced. The current version of the referenced standard will apply. The references below were current at time of publication of this standard. If any of the references are updated refer to the equivalent clause in the updated versions. These guidelines shall take preference over the referenced standards. In addition to the criteria outlined in this manual, any relevant acts, regulations and Australian Standards will apply.

Referenced standards include the following:

PART 2 DESIGN OF ROADS

- The RMS Road Design Guidelines
- The AUSTROADS Road Design Guides
- The Australian Model Code For Residential Development (1995)
- Building Regulations 2006 Part 4
- Guide to Residential Streets and Paths, Cement Concrete and Aggregates Australia
- AS 1742 Manual of Uniform Traffic Control Devices
- AS 1428 – "Design for Access and Mobility
- AS 2890; "Parking Facilities"
- AS 3798 "Guidelines on Earthworks for Commercial and Residential Development
- AS 1743; "Road signs – Specifications"
- Clear zone (refer to RMS Standard Drawings
- Australian Rainfall and Runoff (AR&R)

PART 3 STORMWATER DRAINAGE DESIGN

- Australian Rainfall and Runoff (AR&R)
- RMS Water Sensitive Urban Design Guidelines

PART 4 WATER RETICULATION DESIGN

- Water Services Association of Australia (WSAA) "Water Supply Code of Australia (WSA 03)
- AS 2280; Ductile Iron Pipes and Fittings
- AS 1477; PVC Pipes and Fittings for Pressure Applications
- AS 1432; Copper tubes for Plumbing, Gas Fitting and Drainage Applications
- AS 2544; Grey Iron Pressure Fittings
- AS 4799; Installation of Underground Utility Services and Pipelines with Railway Boundaries
- BCA
- AS/NZS 4765; Modified PVC (PVC-M) pipes for pressure applications
- AS/NZS 4441; Oriented PVC (PVC-O) pipes for pressure applications
- AS/NZS 3680; Polyethylene sleeving for ductile iron piping
- AS/NZS 4130; Polyethylene (PE) pipes for pressure applications

PART 5 SEWERAGE RETICULATION DESIGN

- Water Services Association of Australia (WSAA) "Sewerage Code of Australia" (WSA02)
- Water Services Association of Australia (WSAA) "Sewage Pumping Station Code Of Australia" (WSA04)
- Section 88b of the Conveyancing Act 1919
- AS 1260 Non-Pressure PVC Pipes and Fittings

PART 6 LANDSCAPING AND MEASURES FOR EROSION, SEDIMENTATION AND POLLUTION CONTROL

- Section 13 of the Bush Fires Act
- Section 41 of the Bush Fires Act
- Water Management Act 2000 (Part 3 management plans)
- Protection of the environment and operations Act 1997 (covers water, air, noise, pollution and waste)
- Local Land Services Act 2013
- Biodiversity Conservation Act 2016
- Fisheries Management Act 1994 (protects fisheries and habitat)
- Biosecurity Act 2015 (control of noxious weeds)
- The Local Government Act 1993
- Water Management Act 2000
- Environmental Planning and Assessment Act
- State Environmental Planning Policy (Coastal Management) 2018
- Soil conservation Act 1938
- State Environmental Planning Policies (Murray River SEPP 44, 55)

PART 7 TESTING

- AS 3798, Guidelines on Earthworks for Commercial and Residential Developments
- Sewerage Code of Australia (WSA02) Part 3 Construction; Third Edition Version 3.1
- Water Supply Code of Australia (WSA03) Part 3 Construction; Third Edition Version 3.1
- The RMS Road Design Guidelines
- AS 1012 Methods of Testing Concrete

PART 2
DESIGN OF ROADS

PART 2
DESIGN OF ROADS
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1. INTRODUCTION

This section of the Engineering Guidelines for Subdivisions and Developments outlines Council's recommended practice for the design of rural and urban roads. It is in no way a comprehensive 'Design Manual' and it is to be read in conjunction with and as a supplement to referenced standards.

The Subdivision and Development Guidelines comprise the following:

Part 1 General Requirement
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Part 7 Testing

2. URBAN ROADS

The following section applies to the provision of roads in urban areas, the classification of these roads as urban will be a determination of the Council.

2.1. DRAWINGS

A3 Engineering Drawings should be drawn at a 1:500 scale and include the following:

- Cover sheet with locality plan and drawing list
- Lot boundaries and numbers
- Road centreline chainages, radii, tangent points and deflection angles
- The location and reduced level of the bench marks (at 100m spacing), control points and recovery pegs used in the survey works. Summary table to be included
- Street names and north point
- Bar scales
- Proposed fill areas
- Locality sketch
- Trees
- Public utilities
- Existing surface levels, features services and structures
- Proposed service crossings
- Road reserve and carriage width
- Australian Height Datum
- A legend summarising linetypes and symbols
- Radii on kerb returns and kerb lines
- Vehicular crossings
- Contours and finished surface levels on lot corners
- Details of abutting roads and streets necessary to ensure matching in of levels and grades
- Existing and proposed drainage structures, overland floor paths (depth and width) plus drainage calculations
- Infrastructure service design is not to be undertaken in isolation rather as an integrated approach that anticipates conflict. For complex intersections where there is potential for service conflict, show service levels in section.

2.2. CENTRELINE LONGITUDINAL SECTIONS

The centreline longitudinal section should be drawn at 1:500 horizontal and 1:100 vertical scales and include the following:

- Reduced levels and linework of existing surface and of design level of road, left and right kerbs (if required), where variations in crossfall occur and building lines
- Chainages
- Length of vertical curves
- Design grades
- Length of vertical curves
- Existing and proposed services
- Drainage culvert drainage information
- Extent of roadworks

Longitudinal levels at:

- 20 metre intervals on straight grades
- 5 metre intervals in vertical curves
- At all intermediate changes of grade and horizontal direction

Longitudinal sections and cross sections should be taken along existing intersecting roads (approx. 50 metres) to enable kerb returns, dish crossings and stormwater drainage design.

2.3. CROSS SECTIONS

Cross sections are to be viewed from the direction of increasing chainage, provided at 20 metre intervals, should be drawn at 1:500 horizontal and 1:100 vertical scales and include the following:

- Chainage label
- Reduced levels and linework of existing surface
- Design levels and grades

Typical cross section details shall provide information as follows:

- Type of kerb & gutter
- Batters of cuttings and embankments are to be shown beyond the property alignment
- Depth and type of material in each layer of pavement
- Type of surfacing
- Subsoil drainage (where required)
- Pavement and nature strip crossfalls
- Footpath offset
- Service corridors
- Landscaping
- Road width between inverts
- Centreline
- Road crown

2.4. KERB RETURNS

Kerb profiles should be shown for all kerb returns, cul-de-sac bulbs and turning tees.

A scale of 1: 200 horizontally and 1:20 vertically is suggested. Levels at ¼ points. Kerb return radius shall be 7.5 metres in residential streets and 12 metres for industrial areas. Where bus routes are provided vehicle-turning paths shall be provided for at intersections.

2.5. STANDARD ROAD CLASSIFICATIONS AND ASSOCIATED WIDTHS

The guidelines below are **not** to be considered as inflexible development standards. The principles detailed in the Australian Model Code for Residential Development (1995) (http://www.creationcorporation.com.au/AMCORD/AMCORD/AMCORD.PDF) are generally supported. Accordingly, developers/subdividers are advised that Council will consider and, to some degree, encourage departures from the below guidelines where it can be clearly established such departures:

- Improve environmental and water quality outcomes
- Landscaping and urban design outcomes
- Are regarded as contributing to the amenity of the area

Changes to road width standards, should be considered in the context of an integrated approach:

- New Urbanism Principles
- Land-Use Strategies
- Master Plan's for Precincts
- Subdivisional Master Plans
- For road widths narrower than six metres Council reserves the right to consider these on a case-by- case basis

The road hierarchy comprises; Local distributor; Collector; Local access; Cul-de-sac and minor access.

TABLE 2.1 - ROAD STANDARDS, URBAN STREET NETWORK

Classification of Road	Local Distributor	Collector	Local Access	Local Access (Minor)	Cul-De-Sac & Minor Access
Maximum traffic Volume (vehicles/day)	5000-7000	3000	1000	500	150
Number of dwellings	500-750	300	100	50	15
Carriageway Width (m)	13	11	8	7	6
Footway Width (m)	2 x 5.5	2 x 5.5	2 x 5.5	2 x 4.0	2 x 3.5
Road Reserve (m)	24	22	19	15	13
Lane Provision	2 Moving Parking	2 Moving Intermittent Parking	2 Moving Intermittent Parking	2 Moving Intermittent Parking	2 Moving Intermittent Parking
Maximum desirable speed (km/h)	40-60	30-50	20-30	20-30	15-25
Maximum design speed (km/h) (for sight distance calculations)	60	50	40	40	30
Footpath	Both sides / shared with Cycleway	Both sides	One side	Not required	Not required
Cycle Way	2.5m wide shared cycleway	Marked	On road shared	On road shared	On road shared
Kerb and Gutter	150 mm high integral barrier	150 mm high integral barrier	Integral barrier or semi mountable	Integral barrier or semi mountable	Semi mountable

Verge: the distance between the property boundary and kerb invert.

Roads used as bus routes are usually designed to local distributor standards, i.e. 13 metre carriageway width or provision for two moving and two parking lanes. Where bus routes are provided in low traffic environments then consideration may be given to a reduction in width and or the provision of indented bus bays, however such approval will only be considered on a case- by-case basis.

Standard road widths are measured between kerb inverts as shown In the Engineering Drawings.

2.6. KERB AND GUTTER

All urban streets are to have sealed pavement with kerb and gutter.

Alternative kerb and gutter treatments that achieve water sensitive urban design outcomes are encouraged subject to prior approval as part of concept development.

The design of kerb and gutter shall comply with drainage requirements of Australian Rainfall and Runoff.

Kerb types are as shown on Council's Standard Drawings. Variations are subject to Council approval.

2.7. ROAD SURFACING

All new roads should be prime and spray seals 14mm, 7mm, double double with the following exceptions:

- Widening of existing roads - Seal to match the existing
- Laneways – Concrete
- Classified roads - to be determined in consultation with the RMS. Apply a prime coat prior to surfacing within the subdivision

2.8. ACCESS DRIVEWAY

Vehicle-crossovers are to be provided into each allotment and are to be in accordance with Council Standard Drawings and are to be within the following width ranges. Vehicle crossovers for subdivisions are to be provided at the time of house construction.

TABLE 2.2 VEHICULAR CROSSINGS

	Minimum Width (m)	Maximum Width (m)
Residential Crossing	3	6
Light Industrial Crossing	3.6	9
Heavy Industrial	5	12

Note: Widths are at the property boundary and do not include splays.

Where kerb and gutter is provided:

- Access driveways are to be a minimum of 1000 mm clear of all drainage structures on the kerb and gutter and are not to interfere with the existing public utility infrastructure, including Council drainage structures. Where driveway impacts on these structures it is to be located clear of the driveway
- Where kerb and gutter is not required by Council, allotment access is to incorporate a minimum 375 mm diameter stormwater pipe with concrete headwalls at each end. Where it is impractical to construct a minimum 375 mm pipe, a reduced pipe size or concrete dish crossing may be considered subject to approval on a case-by-case basis
- Property access is to be provided for forward entry and exit for other than single residential development
- Access to adjacent properties may be fully combined if single only or alternatively separated by a minimum distance of two metres
- Access to residential corner allotments shall be at least six metres from the road intersection property boundary
- The portion of the crossing that passes through the footpath is to be designed to AS 1428 'Design for Access and Mobility'

- Where driveway access slopes are in excess of 1:10 then a design car template should be used to check access
- On steeper sites that includes battle axe blocks the design and construction of the driveway is to account for stormwater
- Bridge type gutter crossings are not permitted
- Multiple driveways to each lot are discouraged and require specific approval
- Road access to cuttings is to be clear of services located in the embankment
- On corner allotments road access is to be off the secondary road

2.9. STAGED ROAD CONSTRUCTION

Where roads are constructed in stages as part of staged subdivision development, a permanent type barricade is to be constructed at the end of each stage to warn motorists of the dead-end and prevent their passage beyond and provide temporary between turn around at the end of each stage. Such barricades are to be removed when it is safe for through traffic to use this road and approval from Council has been received in writing.

The barricade should be made from a D4-2-1 Chevron or similar (refer AS 1743).

Turning Heads shall be constructed at dead ends with a minimum radius of 9.5 m. The extension of the road to be constructed utilising the appropriate pavement design standard for the road width and is to incorporate a two-coat seal.

2.10. ROAD CROSSINGS

All conduit trenches should be at a grade of not less than 1% and should be clearly located on relevant drawings. Trench backfill is to be 5% cement stabilised sand to Subgrade level.

2.11. TRAFFIC GENERATION

A local area traffic management plan shall be provided for the subdivision as part of the agreed Master Plan. This plan shall detail average annual daily traffic volumes (AADT), within the subdivision, assess the impacts of traffic on the surrounding street network. Where adverse impacts are identified traffic mitigation measures shall be implemented.

Qualified traffic consultants shall determine projected traffic volumes that account for existing traffic patterns, predicted future development and associated traffic generation.

In the absence of sophisticated traffic modelling, an assessment of trip traffic generation shall be based on 10 vehicle trips per allotment per day.

2.12. PAVEMENT DESIGN

2.12.1. Flexible Pavements

Road pavement design shall be based on the provision of flexible road pavements as follows:

- Australian Road Research Board 'Pavement Design for Light Traffic: a supplement to the AUSTROADS pavement design guide'
- Classified Road and Industrial road pavements are to be designed in accordance with 'a guide to Pavement Technology Part 2: Pavement Structural Design' and 'a guide to Asset Management Part 5: Pavement Performance' AUSTROADS

Pavement material shall be supplied in accordance with requirements of an approved pavement design that considers subgrade, subbase, and base course as an integral structure. Pavement design must be undertaken by a Council approved geotechnical consultant in accordance with the specific geotechnical site assessments. If works are on a state authority road pavement design must comply with the road authority requirements.

A minimum design life of 20 years should be used to determine the pavement thickness. Designers are to submit traffic loading calculations based on Australian Road Research Board

'Pavement Design for Light Traffic: a supplement to the AUSTROADS pavement design guide'.

Design Subgrade CBR values should be determined by either Geotechnical Engineering Consultants and/or agents of an NATA. registered laboratory. The investigation will include 'logging' of test holes to a depth not less than 1 metre below design Subgrade levels (unless rock is encountered). Soil samples should be taken at the design depth and CBR tests undertaken after soaking the samples for four days.

The frequency of test holes should be in accordance with Australian Road Research Board 'Pavement Design for Light Traffic: a supplement to the AUSTROADS pavement design guide'.

A copy of the site investigation report including test results should be submitted with the pavement design and the Engineering Drawings.

The minimum pavement thickness shall be 300 mm for roads and 150 mm for carparks.

2.12.2. Rigid Pavement Design

Requires approval in principle prior to the commencement of design. Concrete pavements are to be designed in accordance with Cement Concrete and Aggregates Australia's "Guide to Residential Streets and Paths".

2.13. SUBSOIL DRAINAGE

Subsoil drainage is to be provided as required by the Council Standard Drawings and is to be drained to an appropriate stormwater pit. Flushing points are to be provided at all upstream ends. The minimum grade for subsoil drainage is 1:250 with an absolute minimum grade of 1:300.

Subsoil drainage must be provided to drain all boxed out pavement that are not otherwise draining.

Subsoil drainage shall be provided on the topside of the road in the absence of stormwater drainage.

2.14. GEOMETRIC STANDARDS

The geometric design of arterial roads is to be based on the current AUSTROADS design standards for urban roads for an 80 km/hour travel speed.

The design of all other urban roads is to provide smooth, safe trafficable horizontal and vertical alignments, adequate sight distance with consideration being given to the road classification requirements, pedestrian access to each allotment, provision for utilities and drainage.

The design speed to be used for a particular road is as per Table 1 –Road Standards for the Urban Street Network.

For design speeds up to 60 km/hour, the use of transition curves is not considered necessary. The minimum radius of horizontal curves is: -

TABLE 2.3 MINIMUM RADIUS OF HORIZONTAL CURVES

Minimum Deflection Angle	Minimum Radius (m)
75°	20
60°	33
40°	65
30°	75
20°	100

Where the deflection angle is 90° and travel speed is not an issue, the size of the horizontal curve is to be related to the turning requirements of vehicles such as single unit trucks (removalist vans and garbage trucks). Details on the relationship between speed, radius and tangent lengths are referred to in AMCORD.

2.15. VERTICAL ALIGNMENT

The maximum permissible grade on an arterial road is to be 8%, with a minimum grade of 0.5%. The maximum permissible grade on all other roads is to be 16% for a maximum distance of 50m and 12% where the length of straight grade exceeds 50m. The minimum grade is 0.25%.

A maximum permissible grade of 10% (1 to 10) should be used adjacent to street intersection, locations of poor visibility, horizontal curves of radius 15 metres or less and at cul-de-sacs. Turning circles in cul-de-sacs on steep grades should have grades less than 5%.

Council's drainage requirements on steep grades may involve special structures and extensive piping through easements. Refer also to AR&R limitations on velocities.

Kerb and gutter is to have a desirable minimum grade of 0.33% (1 in 300) with an absolute minimum of 0.25% (1 in 400). Saw tooth shaped profiles that are reliant upon pipe drainage are discouraged. Special consideration is required for directing of the major flow path of water to designed flow paths.

Roads are to be designed to provide accessibility to the adjacent footpaths in accordance with AS 1428.2 Design for Access and Mobility.

Grades through intersections are not to exceed 4% to provide for stationery vehicles queued at intersections.

2.16. VERTICAL CURVES

Vertical curves are to be provided at all changes of grade and where practical should coincide with the horizontal curvature. The values given in Guide to the AUSTROADS Guide to Road Design Part 3: Geometric Design are applicable to urban conditions in the relevant ranges.

Eccentric vertical curves will only be accepted in difficult design situations with prior written approval.

2.17. PAVEMENT CROSSFALLS

The normal crossfall on bituminous pavements should be 3%.

The maximum crossfall permitted is 6% and will occur in super-elevated curves sideling land and road intersections.

Super-elevation of horizontal curves is to be based on the current AUSTROADS design policy for urban roads. The relative change in grade of kerb line and centreline is not to exceed 0.5%.

2.18. OFFSET CROWN

The crown may be shifted towards the higher side of the road. The crown should be not closer to the kerb line than 2.0 metres to ensure that the kerb retains capacity to transport stormwater flows. The designer is to assess the storm water capacity of the system.

2.19. SPLIT LEVEL CARRIAGEWAYS

Use of split-level carriageways is strongly discouraged. Consideration of any split level carriage way will require significant consultation and approvals through Council.

2.20. BATTERS

All roads should be cleared full width and 0.5 metres inside the lot boundaries, or to a sufficient width to include cut and fill batters.

Footpaths reserves should be formed so as to extend 0.3 metres past the road alignment into the adjacent allotments to enable fences to be constructed at road level. Road batters should lie wholly within the adjacent allotments commencing 0.3 metres beyond road boundaries.

- Such batters should be 1 vertical to 6 horizontal to allow for safe maintenance. Steeper batter slopes of 1 vertical to 4 horizontal are a minimum requirement
- Where the developer provides special treatments to these batter slopes that reduce maintenance and workplace health and safety issues, then steeper slopes may be tolerated subject to Council approval

2.21. BATTER ENCROACHMENT

Where any cutting or filling undertaken by a developer, whether shown on the drawing or not, encroaches on any private or crown property, is retained by an existing structure, or could possibly undermine or remove the support of any existing structure, the developer should either:

a. Take out an easement of support over such batter in favour of Council and pay such compensation as may be satisfactorily arranged with the owner or decided by a judicial body

OR

b. Construct an engineer designed retaining wall.

2.22. ROAD EMBANKMENTS

Road embankments should be checked for safety and protection provided in accordance with AUSTROADS Guide to Road Safety Part 9: Road Hazard Management. Safety barriers should not be used on road boundaries adjacent to residential allotments.

2.23. ROAD RESERVE BOUNDARIES

Road boundaries may be curved, but where they are to be fenced as chords, these should be not less than six metres. Where a number of such chords occur adjacent to each other, they should, as far as possible, be practically equal.

2.24. CUL-DE-SACS, Y-HEADS AND T-HEADS

The following requirements apply to cul-de-sacs, Y-heads and T-heads

- Demonstrate compliance with the turning path requirements for service vehicles
- The kerb line radius of a cul-de-sac should not be less than 9.5 metres
- Special provision should be made to take drainage from downhill cul-de-sacs through easements or drainage reserves that accommodate extreme flood events via underground drainage or via overland flow paths. The capacity of the major drainage system should be the 1% AEP event. As there is potential for upstream stormwater pits to block allow for overland flow paths of water through public owned land and reserves rather than private property
- Safety in design principles require street lighting to be located to improve the safety and the illumination of any pathways or reserves
- Y-heads & T-heads are to be a minimum length of 13 metres from the centreline intersection to end, or suitable distance to allow manoeuvring of Service Vehicle, whichever is greater.
- Design intersections that provide for solar orientation of blocks

2.25. PATHWAYS, LANES AND FOOTPATHS

2.25.1. Definitions

A Lane is a public road of width greater than three metres but not greater than 6 metres and is to be used primarily for access to the rear of premises.

A Pathway is a public road of width three metres or less. The maximum width to be adopted for pathways is three metres and is primarily for the use of pedestrians and/or cyclists.

A Footpath Reserve is that part of a public road exclusive of the carriageway and in the case of residential roads may not be less than 3.5 metres in width. Residential roads are public roads used primarily for access to residences.

2.25.2. Lanes

Lanes dedicated to the public as access from or between roads, or as access to public gardens and recreation space should be cleared, formed, graded, sealed, kerbed, guttered and drained and be suitable for vehicular access. In general, the maximum permissible grade to be used in lanes should be 15%.

2.25.3. Pathways

Pathways dedicated to the public as access from or between roads, or as access to public garden and recreation space should be designed in accordance with NSW Police 'Safer by Design Principles'. These pathways should be clear and provide uninterrupted lines of site with lighting located at the ends of the pathway. In general, the maximum permissible grade to be used in pathways should be 15%.

The maximum permissible grade to be used in pathways providing access to public gardens and reserves shall be 8%.

Although drawings will not generally be required, the developer should grade and provide drainage for pathways.

2.25.4. Footpaths

Pedestrian Access and Mobility

Footpaths are required as part of all subdivision developments. Footpaths are to be consistent with the requirements of Council's footpath Master Plan which may include reference to a pedestrian access and mobility plan.

TABLE 2.4 FOOTPATH REQUIREMENTS SPECIFIC TO LEETON SHIRE

Footpath Width	1.5 metres
Shared footpaths and cycle ways	2.5 metres
The construction of the footpath	At the developers cost after the building works are completed.
Footpath materials	Reinforced concrete SL72 125mm thick
Location of the footpath	600 mm from the property boundary
Requirement for footpath	Refer to Road Standards for the Urban Street Network and Master Plan.

Design is to be in accordance with AUSTROADS 'Guide to Road Design, Guide to Road Design Part 4: Intersections and crossings', 'Guide to Road Design Part 6A: Pedestrians and Cyclist Paths' and 'Guide to Traffic Management'.

Perambulator ramps should be provided at all kerb crossings and comply with pedestrian access and mobility requirements.

The requirement for footpaths is dependent on road classification and Council's footpath Master Plan.

Design is to be in accordance with Australian Standard AS 1428 – 'Design for Access and Mobility'.

Footpath Crossfalls

In areas where the footpath reservation is to be totally paved from the top of the kerb to the adjacent boundary, the crossfall is to be 1 in 50 towards the kerb (2%).

In areas where the footpath is unpaved or partially paved, crossfall from kerb to the adjacent boundaries is to be 1 in 33 towards the kerb (3%). Alternative treatments that achieve water sensitive urban design outcomes are encouraged subject to prior approval as part of the concept design development. The design of footpath crossfalls shall comply with the drainage requirements in Australian Rainfall and Runoff. 1% AEP flows shall be contained within the road reserve, public reserves or piped.

Vehicle accesses which cross footpaths are to be checked using standard vehicle templates.

2.26. CYCLEWAYS

Cycleways are to be provided in accordance with Council's cycleway plan that encourages alternative forms of transport. Cycleways shall be designed in accordance with AUSTROADS 'Guide to Road Design, Guide to Road Design Part 4: Intersections and crossings', 'Guide to Road Design Part 6A: Pedestrians and Cyclist Paths' and 'Guide to Traffic Management'.

2.27. STREET SIGNS

Street signs are to be erected at all street intersections and are to be in accordance with Councils Standard Drawings and relevant Australian Standards.

2.28. HALF WIDTH CONSTRUCTION

Where proposed subdivisions or developments front an existing sealed road and the existing pavement is of adequate strength and the vertical alignment is satisfactory, the existing pavement may be retained. The remainder of the half width construction is to be carried out to the equivalent standard of full width construction.

Should Council determine the existing pavement to be unsatisfactory, then the pavement construction is to be extended to the existing road centreline.

In all cases, the new seal should extend to the road centreline to avoid irregularities.

Any unsealed road must be sealed for the full width as per this manual for the entire length of the development.

2.29. INTERSECTIONS

- Intersection design should be based on the AUSTROADS publications 'Guide to Road Design Part 4: Intersections and Crossings' and 'Guide to Road Design Part 4A: 'Unsignalised and Signalised Intersections'
- 'T' junctions should be adopted in preference to four-way intersections. Where staggered 'T' junctions are to be provided, the intersecting roads should be located a minimum distance of two times stopping distance for the travel speed along the through-road (1.5 second reaction time)
- Roads should intersect at not less than 70°
- The minimum centreline spacing between intersections is 50 metres in urban areas
- Four-way intersections or cross intersections shall be designed with roundabouts
- Where intersections are in a configuration likely to cause traffic problems, the construction of traffic islands, or such traffic facilities is required to provide traffic control and safety

2.30. TURNING MOVEMENTS FOR DESIGN VEHICLES

Turning movements shall be provided for the design vehicle. Prior to commencement of design process consultation is required with Council to determine the design vehicles for the different street classifications. The fire emergency services vehicle is frequently the design vehicle. Vehicle turning movements must allow for left turn from the left lane without crossing lanes for design vehicles. Where requested, traffic movement paths shall be presented using such packages as 'Autoturn' or similar. Clearance of 500 mm shall be provided to the total swept path.

2.31. LOCAL AREA TRAFFIC MANAGEMENT

Traffic Management devices are to be designed in accordance with AUSTROADS publication "Guide to Traffic Management Part 8: Local Area Traffic Management". Local Area Traffic Management Devices may be required as a condition of Development Consent. Alternatively, developers may elect to install these devices where appropriate. The use and installation of the devices should be in accordance with Australian Standard 1742 (Part 13) - Local Area Traffic Management.

2.32. GUIDE POSTS

Guideposts and protection fencing are to be provided where required in accordance AS 1742, AUSTROADS and RMS guidelines.

2.33. SIGNPOSTING AND PAVEMENT MARKINGS

Signposting and pavement markings are to be provided where required in accordance with AS1742 "Manual of Uniform Traffic control Devices" and RMS road design guidelines.

2.34. CAR PARKING

Car parking is to be provided in accordance with

- DCP and LEP
- AUSTROADS 'Guide to Traffic Management Part 11 – Parking'
- AS 2890 Parking Facilities

Indented parking will only be considered as part of an integrated solution that enhances environmental and aesthetic outcomes such as for water sensitive urban design and entry features.

The developer is responsible for providing parking associated with the development onsite. Parking on the street is regarded as being additional to development generated parking and is for general public parking.

All car parking and manoeuvring surfaces are to be bitumen sealed or equivalent.

2.35. FLOODING

The design of the road system must account for the major flow paths associated with flood events as the piped stormwater drainage networks typically account for flow paths of water during minor events, the flow path of water during major events frequently involves the road network. In particular intersections shall be designed to direct the major flow path of water in accordance with an approved subdivision master plan.

Road longitudinal section sag points must direct flows to major open channels or intersections. Sag points mid-block are discouraged and will only be approved if consistent with an agreed drainage master plan. Direction of water to cul-de-sacs, Y-heads and T-heads is discouraged.

2.36. EARTHWORKS

In all new development areas lot filling is to ensure that finished surface levels are 300 mm above the 1% ARI flood levels. Where infill development occurs, consultation with Council regarding local requirements and Council flood policies is required.

Fire trails are to be graded to divert stormwater away from residential properties to either drainage reserves or road reserves.

Filling of depressions requires consent, as there is potential to redirect the major flow path of water and for subsequent land settlement. Earthworks are to be in accordance with AS 3798 'Guidelines on Earthworks for Commercial and Residential Development'.

2.36.1. Fill Plans

A plan showing filling, where any part of a subdivision has had the surface level raised by the placement of any fill, other than nominal topsoiling, is to be provided showing a minimum of that area of the subdivision that has been filled plus a reasonable surrounding area to enable the filled section to be located and should include the following:

- Road numbers and road names,
- Road reserve boundaries,
- Allotment layout, including easements and lots numbered in accordance
- with the final plan of subdivision,
- Extent of fill (using maximum intervals of 0.5m),
- Fill area hatched, and hatching shown in a legend as filled area,
- Stripped and finished levels,
- Contours, and
- Certification of the plan by a Registered Surveyor or Engineer

Council will require the imposition of a "Restriction on Use of Land" as part of the 88B instrument, identifying filled lots within the subdivision.

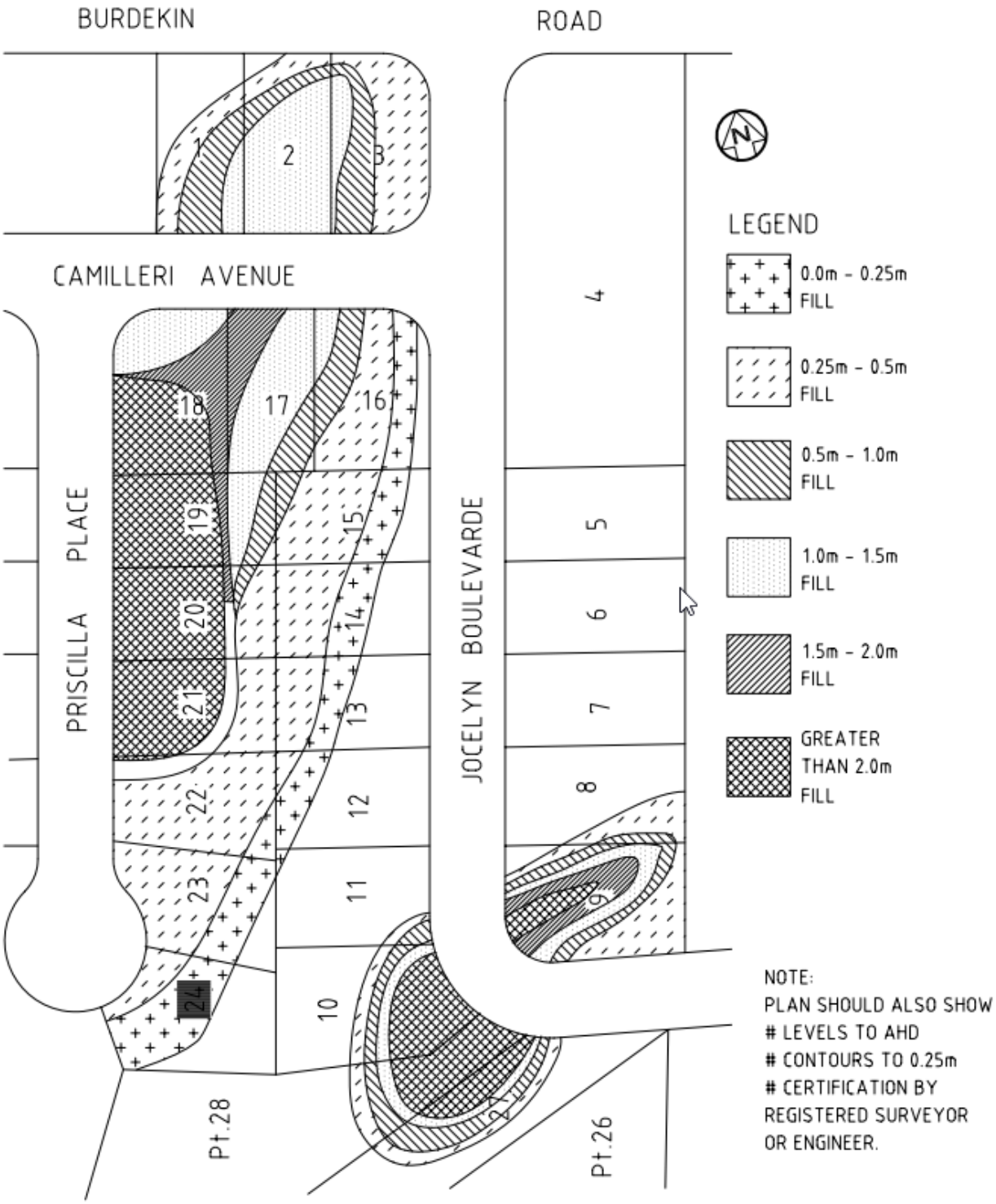


Figure 2.36 - Example of Lot Fill Plan

2.37. TESTING OF ROADS

All pavement courses, surfacing and Subgrade are to be tested in accordance with an approved testing regime and are to demonstrate that the pavement meets the requirement of the specification. Refer to part 7 Guidelines for Testing.

2.38. STREET LIGHTING

Street lighting is to comply with the current Australian Standard AS 1158 to provide for pedestrian and vehicular movements.

Lighting designs are to be prepared by suitably approved consultants and submitted for approval by the energy authority and Council.

2.39. ROAD SAFETY AUDITS

A road safety audit is to be undertaken of the road design to provide documentary evidence that the road design has taken risks and safety issues into account.

3. RURAL AND RURAL RESIDENTIAL ROADS

In addition to the preceding section relating to urban road design, this section applies to the provision of roads and access to rural and rural residential areas. Council is responsible for making the determination of areas where rural residential design standards apply.

New road widths require discussion with Council and should generally be in accordance with the following:

TABLE 3.1 RURAL/RURAL RESIDENTIAL

AADT	ROAD RESERVE	CARRIAGEWAY	SHOULDER	SEAL	FORMATION
<0-500	23	6.0	1.0	7.0	8.0
500-1000	23	6.5	1.0	7.5	8.5
1000-2000	23	6.5	2.0	8.5	10.5
>2000 (and all B double routes)	30	7.0	2.0	9.0	11.0

Note:

- In all cases AADT is that predicted at the end of the design period (usually 20 years)
- The designed pavement thickness is to extend for the full formation
- The road reserve width is nominal only and consideration is to be given to the extent of cut and fill batters, catch drains, intersection layout requirements, and provision for public utilities adjacent to the road reserve boundary. A minimum allowance of 3 metres from the batter point to the boundary is to be provided

3.1. DRAWINGS

A3 Engineering Drawings should be drawn at a 1:1000 scale and include the following:

- Cover sheet with locality plan and drawing list
- Lot boundaries and numbers
- Road centreline chainages, radii, tangent points and deflection angles
- The location and reduced level of the bench marks (at 100m spacing), control points and recovery pegs used in the survey works. Summary table to be included
- Street names and north point
- Bar scales
- Proposed fill areas
- Locality sketch
- Trees
- Public utilities
- Existing surface levels, features services and structures
- Proposed service crossings
- Road reserve and carriage width
- Australian Height Datum
- A legend summarising linetypes and symbols
- Radii on kerb returns and kerb lines
- Vehicular access and entrances
- Contours and finished surface levels on lot corners

- Details of abutting roads and streets necessary to ensure matching in of levels and grades
- Existing and proposed drainage structures, overland floor paths (depth and width) plus drainage calculations

Infrastructure service design is not to be undertaken in isolation rather as an integrated approach that anticipates conflict. For complex intersections where there is potential for service conflict, show service levels in section.

3.2. CENTRELINE LONGITUDINAL SECTIONS

The centreline longitudinal section should be drawn at 1:1000 horizontal and 1:100 vertical scales and include the following:

- Reduced levels and linework of existing surface and of design level of road, left and right kerbs (if required), where variations in crossfall occur and building lines
- Chainages
- Length of vertical curves
- Design grades
- Length of vertical curves
- Existing and proposed services
- Drainage culvert drainage information
- Extent of roadworks

Longitudinal levels at:

- 40 metre intervals on straight grades and horizontal curves exceeding R1000m
- 20 m intervals for horizontal curves between R 150 m and R 1000 m
- 10 m intervals for horizontal curves less than R 150 m
- At all intermediate changes of grade

Longitudinal sections and cross sections should be taken along existing intersecting roads for a sufficient distance to enable design requirements to be satisfied.

3.3. CROSS SECTIONS

Cross sections are to be viewed from the direction of increasing chainage, should be drawn at 1:500 horizontal and 1:1000 vertical scales and to be at:

- 40 m intervals along straight alignments and horizontal curves exceeding R1000 m
- 20 m intervals for horizontal curves R1000 and less
- All culvert sites
- The SS, TS, TP and SC of each horizontal curve. The scale should be 1:100 natural

Cross sections should not be terminated at the property alignment but should be levelled sufficiently beyond the road boundaries to enable batters of cut and fill to be shown.

Cross sections should show:

- Chainage Label
- Reduced levels and linework of existing surface
- Design levels on the road centreline
- Cross falls
- Centreline offsets
- Lateral dimensions if pavement and formation widths vary
- Batter slopes that vary from those shown on the typical cross section

Typical cross sections shall show:

- Pavement details
- Typical dimensions
- Subsoil drainage
- Road surfacing
- Kerb detail

3.4. PAVEMENT DESIGN

Road pavements are to be designed in accordance with the Australian Road Research Board Publications:

- AUSTROADS Guide to Pavement Technology Part 5. Pavement Evaluation and Treatment Design (2011). Refer Also to Section 4.10 Pavement Composition and Material Quality
- Rural Sealed Local Roads Manual

Prior to commencing pavement design meet with Council and undertake road design in accordance with a broad precinct based strategy that optimises pavement design and pavement life based on available quarry materials, subgrade conditions ground water moisture and economic considerations. A minimum design life of 20 years should be used to determine the pavement thickness. Designers are to submit traffic loading calculations.

Design subgrade CBR values should be determined by either Geotechnical Engineering Consultants and/or agents of a NATA registered laboratory. The investigation will include "logging" of test holes to a depth not less than one metre below design subgrade levels (unless rock is encountered). Soil samples should be taken at the design depth and CBR tests undertaken after soaking the samples for four days.

The frequency of test holes should be in accordance with 'Pavement Design for Light Traffic: a supplement to the AUSTROADS Pavement Design Guide'. The testing frequency of pavement material is to be specific and determined on a case by case basis depending on the condition of the road

A copy of the site investigation report including test results should be submitted with the pavement design and the Engineering Drawings.

3.5. GEOMETRIC STANDARDS

The Geometric design and design speed of rural roads is to be based on AUSTROADS Guide to Road Design Part 3: Geometric Design.

3.6. SIGHT DISTANCE

Adequate horizontal and vertical sight distance should be provided for the design speed in accordance with AUSTROADS Guide to Road Design Part 3: Geometric Design.

Vehicular access to properties is not permitted where the stopping sight distance is inadequate. Where practical, the horizontal and vertical curves should coincide.

3.7. VERTICAL ALIGNMENT

The maximum permissible grade on an arterial road is to be 8% with a minimum grade of 0.33%.

The maximum permissible grade on all other roads is to be 16% for a maximum distance of 150 metres on straight alignment with a minimum grade of 0.5%.

The maximum permissible grade of 10% (1 in 10) should be used adjacent to street intersections, locations of poor visibility, horizontal curves of radius 15 metres or less and at cul-de-sacs. Turning circles in cul-de-sacs on steep grades should have grades less than 5%

3.8. PAVEMENT CROSSFALLS

The normal crossfall on bituminous pavements should be 3% and the normal crossfall on unsealed shoulders should be 4%.

The maximum crossfall permitted is 6% and will occur on super-elevation curves and road intersections.

3.9. CLEARING AND GRUBBING

All road reserves should be cleared approximately 0.5 metres beyond the extent of roadworks. All trees to be removed must be clearly marked on the drawing with a diameter of the canopy and the trunk represented diagrammatically on the drawing. Native and threatened species impacts are to be identified and are subject to approval.

3.10. DRIVEWAY ACCESS

Roads should be located and designed so that vehicles can readily and safely access every lot of a subdivision. Where the natural surface slopes steeply to or from the road, the access to each lot should be given special consideration. Vehicle access to individual properties from arterial roads is not permitted. Where a rural subdivision adjoins a classified road or arterial road, property access shall be off internal or service roads with appropriate intersection treatments.

Driveway access to rural properties shall provide safe ingress and egress, having regard to sight distance and fire risk.

The driveway access is to be all-weather construction of a minimum depth of 200 mm compacted road gravel.

Where the driveway access connects to a sealed road the access way is to be bitumen seal or equivalent hard surface between the property boundary and the road carriageway.

All vehicle access requiring pipes shall utilise 4.88 metres minimum length culverts, setback for clear zone requirements and sized to ensure that table drain flows do not encroach onto the carriageway.

Driveway access pipe structures must cater to the 20% AEP storm. Minimum single diameter pipe culvert in the table drain is 375 mm.

Headwalls are to be trafficable if located within the roads clear zone (refer to RMS Standard Drawings)

Culvert or dish crossing invert levels are to be suitably designed for vehicle access, and provided to Council prior to construction.

Guide posts with delineators are to be provided at either side of the access point in accordance with the Australian Standard.

Site specific drawings must be submitted for approval.

For flows in excess of the pipe capacity the flow path must be checked to ensure that risk to the public and physical assets is minimised or eliminated. Major flow paths of water are to be clear of the edge of the gravel and sealed roads.

3.11. BUS ROUTES

Where there is a potential for future access by school bus services turning provision is required.

3.12. GUIDE POSTS

Guideposts and protection fencing are to be provided in accordance AS 1742, AUSTROADS and RMS guidelines.

3.13. ROAD NAME SIGNS

Road name signs are to be manufactured to accord with Council's Standard and should be erected at all intersections. The road name and colour of signs are to be in accordance with an approved sign location drawing.

3.14. INTERSECTIONS

'T' junctions should be adopted in preference to four-way intersections. Where staggered 'T' junctions are to be provided Intersection design should be based on AUSTROADS publication Guide to Road Design Part 4, 4A & 4B.

Roads should intersect at not less than 70°.

Where intersections are in a configuration likely to cause traffic problems, the construction of traffic islands, or such traffic facilities as required providing traffic control and safety.

3.15. PUBLIC UTILITIES

All public utilities in subdivisions should be provided underground. An early approach is to be made to those authorities for their requirements regarding conduits, contributions, layout drawings and other relevant details.

The location of proposed conduits beneath the road carriageway is to be shown on the drawings. Service location markers are to be attached to the kerb during construction.

3.16. STEEP GRADES

Where grades exceed 6%, a one-coat bitumen seal is to be provided on the road shoulders. Where shoulders are sealed, edge line marking is to be provided.

Where the grade of the table drain exceeds 6% and scouring is likely, a concrete lined drain is required.

Where the terrain permits, batters in the region of 4 horizontal to 1 vertical are desirable. Proposed batters of greater slope than 4 horizontal to 1 vertical require separate approval.

3.17. SIGNPOSTING AND PAVEMENT MARKINGS

Signposting and pavement markings in accordance with Australian Standard AS 1742 - Manual of Uniform Traffic Control Devices", are to be provided where required.

3.18. FIRE TRAILS

Fire trails are to be provided where required as part of an integrated network that improves community safety from the risk of fire.

Fire trails are to have a desirable maximum grade of 1 in 200. In localised sections steeper grades will be permitted with these sections requiring erosion treatment of gutters and drains.

3.19. ROAD SURFACING

The carriageway of Rural/Rural Residential roads should be sealed to a minimum standard of two coat spray bitumen seal.

The carriageway is to be marked with a 150 mm wide edge line for roads with AADT greater than 1,000 vehicles per day.

The shoulder adjacent to a barrier centreline is to be widened to 3.0 metres. A prime coat will be required prior to application of two coat seal.

Application rates of aggregates and binder, and the Average Least Dimension of aggregates, shall be submitted for approval prior to commencement of sealing on-site.

3.20. DUST SUPPRESSION

Consideration is on a case-by-case basis having regard to

- Existing impacts on buildings within 100 metres
- Potential future impacts
- Provide sealed surface 75 metres each side of access to building
- Where less than 30 vehicles per day provide 4.5 metre seal
- Where greater than 30 vehicles per day provide 6.2 metre seal

3.21. CAUSEWAYS AND FLOODING

Rural roads that include causeway crossings require calculation of flows and recurrence interval of events. Direction from Council will be required on the design criteria and risk assessment approach required.

3.22. EROSION PROTECTION

Erosion protection is required to minimise erosion potential where water concentrates, such as at piped culvert inlet and outlet systems.

3.23. SPLAYS AT INTERSECTIONS

Splays are to be provided at intersections.

Residential Roads – Min 4m x 4m Splay Corners with Min 9m Kerb Return Radii (Invert)

Industrial Roads – Min 6m x 6m splay Corners with Min 12m kerb return Radii (Invert)

3.24. RURAL ROAD DESIGN PHILOSOPHY

Rural road pavements are typically elevated in comparison to urban pavements, which are depressed to provide for the major flow path of surface water. Elevated rural road design is to include table drains that prevent water from ponding against and saturating into the subgrade. Table drains are to be designed to effectively transfer water away from the pavements gravel base and subgrade materials. Gravel base and subgrade materials are not to be boxed and should extend to a free draining surface. Where roads run adjacent to irrigation channels, an impermeable clay interface is to be constructed to prevent transfer of moisture.

3.25. GUARDRAILS

Provide in accordance with AUSTROADS standards.

3.26. BATTER AND DRAIN MAINTENANCE

The road reserve area shall be constructed with batter and drain slopes that permit routine access for mowing. This requires desirable minimum batter slopes of 4 horizontal to 1 vertical.

3.27. STANDARD DRAWINGS

All work is to be in accordance to approved Council Standard Drawings.

PART 3
STORMWATER DRAINAGE DESIGN
APRIL 2018

PART 3
STORMWATER DRAINAGE DESIGN
TABLE OF CONTENTS

1. INTRODUCTION

This section of the Engineering Guidelines for Subdivisions and Development Standards outlines Council's recommended practice for the design of stormwater drainage systems. It is in no way a comprehensive 'Design Manual' and it is to be read in conjunction with and as a supplement to referenced standards, notably the current version of Australian Rainfall and Runoff.

The Subdivision and Development Guidelines comprise the following:

Part 1 General Requirement
Part 2 Design of Roads
Part 3 Stormwater Drainage Design
Part 4 Water Reticulation Design
Part 5 Sewerage Reticulation Design
Part 6 Landscaping and Measures for Erosion, Sedimentation and Pollution Control
Part 7 Testing

2. GENERAL

Stormwater drainage design is to be based on the current version of Australian Rainfall and Runoff. At the date of preparation of this standard the current version of AR&R is 2016. This document is being continually updated.

The urban stormwater drainage system should:

- Convey stormwater runoff to the receiving water such that there is minimal nuisance flooding or flood damage
- Limit stormwater pollutants entering receiving water
- Assist with water conservation
- Allow for the integration of large-scale stormwater infrastructure with the use of the sites for multiple other uses (e.g. recreation, transportation etc)

The following four fundamental guiding principles remain relevant:

1. Analysis of stormwater drainage systems should where data permits be based on measured or observed real system behaviour
2. Stormwater drainage infrastructure must be viewed in relation to the total urban environment
3. Stormwater drainage systems should be designed and operated to maximise benefits to the community
4. Designers should be influenced by professional considerations such as ethics, standardisation and innovation

The objectives and guiding principles are important considerations that must be taken into account when determining stormwater drainage strategies and plans for subdivisional development. This signals a change in emphasis from the original approach where "*the main purpose of the urban stormwater drainage system was to collect and convey stormwater to receiving waters, with minimal nuisance, danger or damage*". *Council* strongly supports this approach, based on a hierarchical consideration of planning strategies as follows.

- The Planning Scheme
- Land-Use Strategies
- Precinct Strategies
- Stormwater Management Plan For City (Water Quality)
- Stormwater Strategy (Citywide Master Plan)
- Stormwater Catchment Plans
- Stormwater Studies And Investigations
- Overall Subdivision Drainage Master Plan
- Specific Subdivision Stage Drainage Plans

As infrastructure planning for Councils is evolving, Councils will have the strategies developed to varying extents. In the absence of a detailed strategy, the intention is that Council will work with a developer to encourage subdivision and development works that are consistent with an holistic approach to stormwater drainage conveyance, water quality and water sensitive urban design principles.

Infrastructure planning and design for new developments needs to consider riverine flooding conditions (i.e. flooding from natural waterways). Floodplain risk management plans which have been prepared for towns will define the existing flooding conditions on detailed inundation maps. Flood based planning controls will apply to the defined flood affected area (Flood Planning Area) generally by way of specific flood based controls which have been incorporated into Council's LEP and DCP.

Where floodplain risk management plans have not been prepared, hydrologic and hydraulic investigations will need to be completed for any waterways which may be impacting on the development area.

3. WATER SENSITIVE URBAN DESIGN (WSUD)

Stormwater drainage design is to include the principles of Water Sensitive Urban Design in subdivisional works. Include as part of the inception meeting with Council officers, discussion and agreement on Water Sensitive Urban Design and the extent to which these principles can be incorporated into the subdivision master planning and urban landscaping. Integrate the management of the urban water cycle with urban planning and design. Urban stormwater is to be managed as both a resource and for the protection of receiving waters. Encourage outcomes that promote the retention of stormwater runoff on site.

3.1. WSUD

-
- The sustainable management of the Water Cycle
- Principles of water consumption
- Water recycling
- Waste minimisation
- Environmental protection

3.2. THE ENVIRONMENTAL BENEFITS

- Improving the urban landscape
- Reduction of the export of pollution from the site
- Retardation of storm flows
- Reduced irrigation requirements

3.3. CONTEXT

Council's consideration of water sensitive urban design elements into subdivision design will consider the following:

- Lifecycle cost implications on the maintenance of the infrastructure
- The maintenance period and the success of the initial establishment
- Community safety and the safety of maintenance staff
- The provision of consistent citywide themes that recognise individuality of each locality

Water Sensitive Urban Design is to be undertaken in accordance with the general principals outlined in Australian Rainfall and Runoff. Information in Book 9, Chapter 4 is provided for the design of detention basins, on-site detention, constructed wetlands or ponds, bioretention basins, rainwater harvesting storages and infiltration systems.

4. STORMWATER DRAINAGE CALCULATIONS

All drainage design calculations shall be undertaken in accordance with the current version of Australian Rainfall and Runoff. The most appropriate method of calculation should be selected, having regard to the magnitude of flows and the potential for flooding. Book 9 of the current version of Australian Rainfall and Runoff includes guidelines for the management of stormwater volume (Chapter 4) and stormwater conveyance (Chapter 5).

Methods for design flow estimation include flood frequency analysis and regional flood frequency analysis (refer to Australian Rainfall and Runoff – Book 3) and the Rational method for estimating peak design flows only, and hydrologic modelling techniques for estimating design event hydrographs (refer to Australian Rainfall and Runoff – Book 5).

The rational method is highlighted here as it is suited to small subdivisional design where larger magnitude flows are not anticipated.

Q = CIA/360

Q is design flow rate cubic metres per second

I is rainfall intensity mm/hr

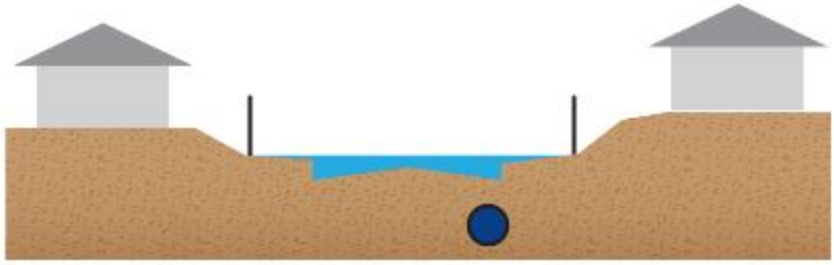
A is area in ha

C is coefficient of runoff

Rational method assumptions are based on statistical analysis of data to produce a "standard" design flow rate or discharge for stormwater drainage systems

4.1. MAJOR / MINOR SYSTEM DESIGN APPROACH

Council has adopted a major/minor drainage network philosophy for street drainage in accordance with Australian Rainfall and Runoff.



Example of major / minor system (extract from AR&R) – underground pipe minor system, roadway major system

It is critical that provision for managing design flows up to the 1% AEP event is incorporated into development designs. The road network can be designed to function as the major system flow carrier up to a point (i.e. until flows start impacting on adjoining allotments and / or exceeding vehicle and pedestrian stability limits). Once this occurs, dedicated overland flow paths are required which should generally coincide with natural flow paths. Building over natural flow paths instead of reserving these areas for conveying major system flows can lead to serious flooding impacts and also hinder future development in the same catchment.

4.2. CATCHMENT DISCHARGE

Developments shall be designed such that the rate of discharge will not increase as a result of development, unless otherwise approved by Council in accordance with an integrated catchment wide drainage strategy. This shall consider events that include the 1% AEP event.

This is particularly important where development is occurring within catchments where there are known existing flooding problems downstream(e.g. in older urban areas where development has occurred over overland flow paths leading to flooding impacts once the minor drainage system capacity is exceeded). New development upstream of known existing flooding problems will need to incorporate stormwater drainage measures which as a minimum do not exacerbate the downstream flooding problems. The options for achieving this are largely limited to detention and / or flow diversions.

4.3. STANDARDS OF PERFORMANCE

The design discharge capacity of the pipe drainage network (minor system) is given in Table 4.1. The design standard for the major system is the 1% AEP event (100 year ARI).

Table 4.1 Stormwater Pipe Network – Design Capacity Standards

Type of Development	Design Discharge Capacity
Residential Areas	10% AEP (9.5 year ARI)
Industrial and Commercial Areas	5% AEP (20 year ARI)

4.4. PROPERTY DRAINAGE

- Roof drainage systems are to be sized by rules based on a simplified Rational Method applied to roof surfaces
- Provide minimum 450 mm concrete pit with metal grate connected to Council pipe system with 100 mm connection. Approved precast pits are acceptable
- Provide easements in rear of block drainage that are in favour of Council
- Individual properties may drain to the kerb and gutter or alternatively to a piped underground drainage system where provided
- Identify and protect overland flow path with easements and the provision of unimpeded flow

4.5. PIPE SYSTEM DRAINAGE

The minor system is the gutter and pipe network capable of carrying runoff from minor storms. Pipes are sized to carry frequent flows, which in residential areas is up to a 10% AEP event to prevent nuisance flooding of streets. In rarer events, overflows are conveyed within the street network and drainage reserves (major system). Hydraulic capacities of overland flow paths are to be checked for their adequacy to convey the 1% AEP design flow. Designers need to determine the route for conveying overland flows whilst ensuring that hazardous situations do not arise on streets and footpaths, and that buildings are protected from flooding in a 1% AEP design event.

4.6. STORMWATER DRAINAGE – EASEMENT WIDTHS

Where easements are required, the following minimum width apply:

- Residential inter-allotment drainage:
  - Pipes up to 300mm – 1.5m
  - Pipes 300mm to 450mm – 2.0m
- Industrial/Commercial inter-allotment drainage, and Council drainage pipes:
  - Pipes up to 300mm – 2.5m
  - Pipes 300mm to 825mm – 3.0m
  - Pipes 825mm to 1350mm – 3.5m

Minimum 0.5m clearance to each side of the installed pipes is required for all easements. Easement width for other pipe sizes and multiple pipes shall be discussed and determined by Council.

All drainage structures must be contained within the relevant easements. Easements may be widened around these structures to ensure this occurs.

4.7. STORMWATER DRAINAGE PITS - LOCATION

- Provide stormwater drainage pits at intervals to limit gutter flow spread to 2 to 2.5 metres on any section of road other than a kerb return where the width is limited to 1 metre
- The maximum spacing between pits is approximately 90 metres subject to hydraulic calculations demonstrating acceptable flow widths and stormwater velocity
- Provide extended double grated gully pits at sag points
- Check inlet capacity of stormwater drainage pits match or exceed the design pipe capacity

4.8. STORMWATER DRAINAGE PITS - DESIGN

- Standard pits should be provided in drainage lines at all changes in grade, level or direction and at all pipe junctions
- The minimum clearance from the top of the manhole to the design water level in the pit should be 150 mm

- Pipe junctions where the deflection angle of the major flow exceeds 90° should be avoided
- Pipe grading across pits should be designed on the following basis
- No change in direction or diameter – minimum 50 mm drop
- No change in diameter but direction change – minimum 70 mm drop
- Changes in diameter shall be graded obvert to obvert
- Every endeavour is to be made to maintain flow velocities through pits and excessive drops will not generally be permitted
- Precast pits are acceptable subject to Council approval
- Minimum size drainage pits that require physical access are to be 1050 mm

4.9. STORMWATER DETENTION BASINS - DESIGN

4.9.1. Type & Location

Detention basins may be typically "wet" or "dry". Wet basins may include an artificial wetland facility, usually incorporating a deep water zone.

Dry basins drain to empty but may include a bio-retention treatment and/or a localised silt trap at pipe inlets. Within a "dry" detention basin, trickle flow channel or pipe drainage, together with a grid of subsoil drainage shall be provided across the basin floor. The minimum slope of a dry basin floor should be 2%.

Basins should be located where they are readily accessible for inspection and for maintenance vehicles from a public road, and should be contained within the a Public reserve or Drainage Reserve.

Where a basin is located in a flood plain the design should achieve its maximum elevation (RL) to limit inundation by flood waters. The lowest desirable level of the spillway should aim to be higher than the 20 year ARI event in the flood plain.

4.9.2. Capacity & Discharge

Detention basins retaining stormwater runoff shall be designed so that peak discharges from new development are not increased beyond that of the pre-developed environment for nominally the critical 1, 10 and 100 year ARI storm events. Basin design should result in a flowrate which fills the basin to the greatest extent, or possibly the longest time. Where a drainage system is complex, it is likely that storms of different durations will be critical for various parts of the system.

To satisfy this requirement it is possible that a multi-staged outlet may be necessary to control the outflow, ensuring adequate flow-rate control for the more frequent storm events. A drainage report and calculations shall accompany the detailed design proposal.

Where basins discharge into a drainage channel either by gravity or by pump that is under the control of Murrumbidgee Irrigation, then specific conditions must be sought from Murrumbidgee irrigation, and their approval and concurrence with the design must be provided.

4.9.3. Overflow

The overflow weir, or high-level outlet for any basin shall be set at a level and have the capacity to maintain the 100-year ARI flood event for the pre-developed catchment.

The overflow weir (and spillway) should be designed in accordance with weir design principles. The weir crest shall be constructed in concrete, keyed into the embankment,

and be designed to avoid possible failure in extreme storm events (greater than the 100yr event). The spillway down the embankment wall and at its toe should be protected from erosion with, as a minimum treatment, an approved robust stabilised (reinforced) earth/turf treatment including protection against turbulence/erosion at the embankment toe.

4.9.4. Freeboard

The top of basin embankment is to be minimum 300mm above the 100-year ARI flood event.

4.9.5. Water Depth

Temporary water depth calculated for the 100-year ARI event, in either a wet or a dry Basin, shall be limited to a maximum of 1.6m.

Where justified by reason of restrictive access, available area or other reasons, a greater depth may be considered

4.9.6. Embankment

Permanently inundated side slopes shall be no steeper than 6H:1V (excluding deep water zones). Maximum embankment slopes for mowing purposes shall be 5:1 (4:1 may be considered where available area or topography is restrictive).

The embankment shall be designed, and supervised in construction, by an engineer. The embankments shall be founded on and bonded to sound natural clay material incorporating a keyway and be compacted to (density and moisture) specifications prepared by a geotechnical engineer. Full details shall be shown on the plans.

The embankment, batters and basin floor shall be fully turfed or seeded with Kikuyu Grass and have an automatic sprinkler system installed in approval with Councils Open Spaces Manager.

4.10. SURFACE RUNOFF AND TRAVEL TIMES

4.10.1. Kinematic Wave Equation

Stormwater design shall account for overland flow prior to discharge to the pipe network.

The recommended formula to determine time of overland flow is the "Kinematic Wave" equation. There are restrictions on the use of this formula as this expression applies to planar or sheet

flow of water. The maximum length applicable should not exceed 60 metres. Consider a supposedly flat playing field, where water would concentrate into rivulets. A surface roughness or retardance coefficient "n*" is used which is not to be confused with Manning's "n".

$$t = 6.94 (L.n^*)^{0.6} / I^{0.4} . S^{0.30}$$ (14.2 AR&R 1987)

where:

t	is overland flow time (minutes)
L	is flow path length (m)
n*	is a surface roughness or retardance coefficient,
I	is rainfall intensity (mm/h)
S	is slope (m/m)

Note:
The lower the value of n*, the more conservative or the greater the flows. n* is normally taken as varying for 0.15 to 0.20 for residential overland flow.

TABLE 4.2 SURFACE ROUGHNESS OR RETARDANCE FACTORS

Surface Roughness or Retardance Factors	
Surface Type	Roughness Coefficient n*
Concrete or Asphalt	0.010 - 0.013
Bare Sand	0.010 - 0.016
Gravelled Surface	0.012 - 0.030
Bare clay-Loam Soil (eroded)	0.012 - 0.033
Sparse Vegetation	0.053 - 0.130
Short Grass Prairie	0.100 - 0.200
Lawns	0.170 – 0.048

Where overland flow is concentrated, naturally or by design, into an earth or grass lined channel, Manning's Formula for open channel flow can be used to estimate velocities and subsequently flow times:

Q = Q A.V = $AR^{2/3} S^{1/2}/n$

where A is flowrate (m^3/s), is the cross-sectional area of flow (m^2),
V is velocity (m/s),
P is the wetted perimeter of flow (m),
R is hydraulic radius (m), equal to A divided by P,
S is longitudinal slope (m/m), and
n is Mannings roughness coefficient

Alternatively gutter flow times can be estimated from design aids. Estimates of overland flow times are not highly accurate and gutter flow times added to these flow times need not be calculated precisely.

In applying the Rational Method note that the minimum duration for which rainfall intensity data applies is five minutes. The approximate travel for a typical residential block with a 2% fall from the rear to the front calculated via the Kinematic Wave equation will be approximately 15 minutes.

TABLE 4.3 MANNING'S ROUGHNESS COEFFICIENTS

Manning's Roughness Coefficients "n" for Open Channels	
Surface Type	Suggested n Values
Concrete Pipes or Box Sections	0.011 - 0.012
Concrete (trowel finish)	0.012 - 0.015
Concrete (formed, without finishing)	0.013 - 0.018
Sprayed Concrete (gunite)	0.016 - 0.020
Bricks	0.014 - 0.016
Pitchers or Dressed Stone in Mortar	0.015 - 0.017
Random Stones in Mortar or Rubble	0.020 - 0.035
Masonry	0.025 - 0.030
Rock Lining or Rip-Rap	0.020 - 0.033
Corrugated Metal (depending on size)	0.018 - 0.025
Earth (clear)	0.025 - 0.035
Earth (with weeds or gravel)	0.035 - 0.040
Short grass	0.030 - 0.035
Long grass	0.035 – 0.05

4.11. DIMENSION OF FLOW

- Limit flow width to 2 to 2.5 metres, along kerb and gutter and 1 metre around kerb returns for a 10% AEP storm
- Gutter flows are not to overtop the kerb
- Provide 300 mm of freeboard above the 1% AEP flood level for floor levels of habitable rooms
- Product of depth and velocity in a 1% AEP event 0.4m^2/s for safety of pedestrians or 0.6 to 0.7 m^2/s for the stability of parked vehicles
- Bypass flows shall not exceed 15% of total pit approach flow

4.12. PIT ENTRY CAPACITIES

Hydraulic design calculations must demonstrate adequate capacity of the stormwater drainage network to accept the design flows.

4.13. ESTIMATION OF FLOW RATES BY THE RATIONAL METHOD

A peak flowrate for a particular time of concentration is calculated. While this is adequate for design, the model is unsuitable for the simulation of drainage system behaviour in actual storms.

4.14. PARTIAL AREA EFFECTS

The time of concentration most commonly used is the full area time, which is the travel time for runoff from the longest flow path. Partial area calculations may be approximated by obvious partial catchment areas and for partial areas based on the concentration times of impervious zones directly connected to the pipe system.

4.15. RUNOFF COEFFICIENTS 'C'

The probabilistic interpretation covers the whole range of events involving different combinations of rainfalls and antecedent conditions using the equation below, which determines a runoff coefficient for the catchment for any ARI based on the 10-year ARI runoff coefficient for the entire catchment (C_{10}) and a conversion factor known as a 'frequency factor' (F) for that ARI.

$$C_y = F_y \times C_{10}$$

Where:

C_y	=	y – year ARI runoff coefficient for the entire catchment
F_y	=	y – year ARI frequency factor (see Table 4.4 for value
C_{10}	=	10 – year ARI runoff coefficient for the entire catchment

TABLE 4.4 URBAN FREQUENCY FACTORS

AEP (%)	ARI (years)	Frequency Factor(Fy)
63	1	0.8
50	1.4	0.85
20	4.5	0.95
10	9.5	1.0
5	20	1.05
2	50	1.15
1	100	1.2

Given this, in order to determine the runoff coefficient for the entire catchment it is necessary to use the following equations to determine the 10-year ARI runoff coefficient (C_{10}). This value is determined by combining the runoff coefficient of the pervious and impervious areas of the catchment, and is as such largely dependent on the fraction impervious (*f*).

$$C_{10} = (0.9 \times f) + [C_{10} \times (1 - f)]$$

$$C^1_{10} = 0.1 + [\, 0.0133 \times ({}^{10}I_1 - 25\,)]$$

Where:

C_{10} = 10 - year ARI runoff coefficient for the entire catchment

f = Impervious fraction of the catchment (value must be between 0.0 and 1.0)

C^1_{10} = 10 - year ARI pervious area runoff coefficient

${}^{10}I_1$ = 10 - year ARI, 1-hour rainfall intensity for the location (from locations IFD data)

4.16. FRACTION IMPERVIOUS

Typical fractions for impervious areas are:

Open Space/Parkland	0.1
Residential Lots - < 1000m2	0.60
Residential Lots - > 1000m2	0.45
Industrial Areas	0.9
Business Areas	1.0
Road Reserve Including Roads and Footpath	0.85

In situations where more accurate estimates of impervious area fractions can be determined the accurate estimates should be used in preference to the typical fractions given above.

4.17. DESIGN RAINFALL DATA

Design rainfall information is documented in Book 2, Chapter 3 of AR&R.

Design intensity – frequency – duration (IFD) for a particular site or catchment can be obtained from the following Bureau of Meteorology (BOM) web site:

http://www.bom.gov.au/water/designRainfalls/ifd/

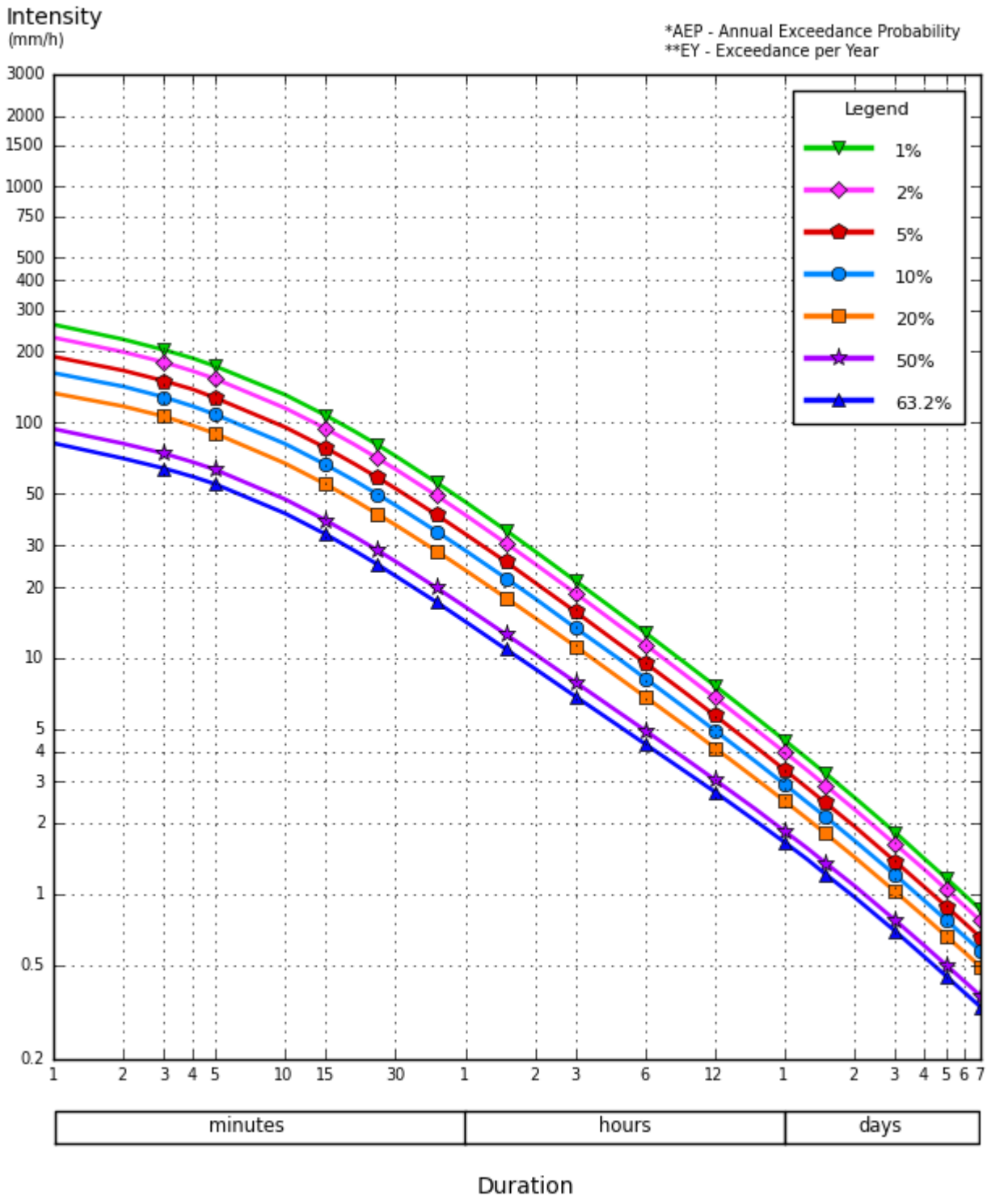
To generate an IFD table for a subject catchment, the approximate centroid coordinates of the catchment should be specified. Using the township of Leeton as an example (indicative Easting 445000, indicative Northing 6177000, Zone 55), the following 2016 AR&R IFD table is generated by accessing the above BOM web site:

LEETON TOWNSHIP – 2016 IFD DATA TABLE (RAINFALLS ARE IN MM/HR)

	Annual Exceedance Probability (AEP)						
Duration	**63.2%**	**50%#**	**20%***	**10%**	**5%**	**2%**	**1%**
1 min	81.6	93.8	133	162	190	229	260
2 min	70.3	81.3	117	142	166	199	225
3 min	63.8	73.8	106	128	150	180	203
4 min	58.8	67.8	96.8	117	138	165	187
5 min	54.7	63.0	89.7	108	127	153	173
10 min	41.1	47.2	67.0	81.1	95.4	115	131
15 min	33.5	38.4	54.6	66.1	77.9	94.1	107
20 min	28.5	32.7	46.6	56.5	66.5	80.4	91.5
25 min	25.0	28.7	40.9	49.6	58.5	70.6	80.4
30 min	22.3	25.7	36.7	44.5	52.4	63.3	72.0
45 min	17.3	19.9	28.5	34.5	40.6	49.0	55.6
1 hour	14.3	16.5	23.6	28.6	33.6	40.5	46.0
1.5 hour	10.9	12.6	18.0	21.8	25.6	30.7	34.8
2 hour	9.01	10.4	14.8	17.9	20.9	25.1	28.4
3 hour	6.86	7.88	11.2	13.4	15.7	18.8	21.2
4.5 hour	5.23	5.98	8.39	10.1	11.7	14.0	15.8
6 hour	4.31	4.92	6.84	8.19	9.53	11.4	12.8
9 hour	3.28	3.72	5.12	6.09	7.07	8.41	9.46
12 hour	2.70	3.04	4.15	4.92	5.70	6.78	7.62
18 hour	2.03	2.28	3.07	3.63	4.19	4.97	5.59
24 hour	1.65	1.84	2.47	2.91	3.35	3.98	4.47
30 hour	1.40	1.56	2.08	2.44	2.81	3.34	3.75
36 hour	1.21	1.35	1.80	2.12	2.43	2.88	3.24
48 hour	0.968	1.08	1.43	1.68	1.93	2.28	2.56
72 hour	0.693	0.771	1.02	1.20	1.37	1.62	1.82
96 hour	0.541	0.603	0.800	0.936	1.07	1.27	1.41
120 hour	0.445	0.496	0.659	0.771	0.881	1.04	1.16
144 hour	0.379	0.423	0.562	0.656	0.749	0.882	0.985
168 hour	0.331	0.369	0.490	0.572	0.652	0.767	0.856

Note:
The 50% AEP IFD **does not** correspond to the 2 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 1.44 ARI.
* The 20% AEP IFD **does not** correspond to the 5 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 4.48 ARI.

LEETON TOWNSHIP – 2016 IFD DATA CHART (RAINFALLS ARE IN MM/HR)



4.18. PIPE SYSTEM HYDRAULICS

Hydraulic grade line calculations should be used for the design of pipe systems.

4.18.1. Limiting Velocities

The minimum allowable velocity for design is normally taken as 1 m/s.

The absolute minimum allowable velocity is 0.6 m/s to provide self-cleansing velocities.

This minimum velocity requirement is different to the minimum grade requirement. The basis of the minimum grade approach relates to construction problems and tolerances. Minimum grades of 1/300 are acceptable for normal pipeline design.

4.18.2. Calculation of Pipe Friction

The Colebrook-White Equation is recognised as the best relationship for the full range of turbulent pipe flows. It follows the curved lines shown on the Moody Diagram. Manning's formula is valid in the completely turbulent section only; but prone to error in the transition zone. Subject to approval by Council, Manning's calculations may be accepted.

The Colebrook-White Equation:

$$V = -0.87\sqrt{(2g.D.S)}\ log_e\ [{}^{k}/_{3.7\ D} + {}^{2.51v}/_{D\sqrt{(2g.D.S)}}]$$

Where g is gravitational acceleration (m/s^2),

D is diameter (m),

S is energy line slope (m/m),

k v is pipe wall roughness (m), sometimes given as e, and is the kinematic viscosity (m^2/s). normally 1.0×10^{-6}

TABLE 4.5 COLEBROOK-WHITE EQUATION PIPE FRICTION

Pipe Material	Hydraulics Research Recommendations 'k' value (mm) for pipe conditions:			SAA Recommendations 'k' value (mm) for pipes concentrically
	Good	Normal	Poor	Jointed and clean
Concrete				
Spun precast, 'O' Ring Joints	0.06	0.15	0.3	0.03 to 0.15
Monolithic construction against rough forms	0.06	1.5	-	
Asbestos cement	0.06	0.03	-	0.015 to 0.06
uPVC				
With Chemically Cemented Joints	-	0.03		
with Spigot and Socket Joints	-	0.06		0.003 to 0.015

The design wall roughness value adopted should reflect conditions well into the service life of the pipe. Thus for concrete pipes a value of K = 0.3 mm is suitable, i.e. somewhere between "good" and "poor".

4.19. PIPE CONSTRUCTION

- Pipes are to be reinforced concrete pipe (RCP) rubber ring jointed with a minimum diameter of 300 mm
- Twin – walled corrugated polypropylene pipes may be used on Council's approval. All fittings and repairs to manufacturers details only. Cover on pipe to be supplied as per manufacturer's specifications or designed by a qualified engineer
- The minimum cover under road pavements is 300 mm below subgrade level or 600 mm below pavement surface level whichever is greatest
- The minimum diameter of inter-allotment drainage pipes is 225 mm with the exception of one lot where 150 mm pipes may be provided. Inter-allotment drainage pipe materials may be other than concrete but are subject to Council approval
- The minimum cover over inter-allotment drainage is 300 mm
- No reduction in pipe diameter is allowed for pipe reaches progressing downstream. Council will consider other materials on a case by case basis
- Backfilling must be in accordance with Australian Standards

PART 4

WATER RETICULATION DESIGN

APRIL 2018

PART 4
WATER RETICULATION DESIGN
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1. INTRODUCTION

This Part of Council's "Engineering Guidelines for Subdivisions and Developments" is related to water reticulation. Reference to Council will include reference to Council as the Water Authority.

References below are to WSA03-2011-3.1 which was current at the time of publication of this standard. These WSA updates incorporate references to duel water supply. If the WSA standard is updated refer to the equivalent clause. The design of water reticulation shall generally be in accordance with the latest version of the Water Services Association of Australia (WSAA) "Water Supply Code of Australia (WSA 03). **This part of Council's "Engineering Guidelines" take precedence over WSA 03** (ie. these are Council's requirements which may be different to WSA 03).

The other parts of the "Engineering Guidelines for Subdivisions and Developments" are as follows:

Part 1 General Requirement
Part 2 Design of Roads
Part 3 Stormwater Drainage Design
Part 4 Water Reticulation Design
Part 5 Sewerage Reticulation Design
Part 6 Landscaping, and Measures for Erosion, Sedimentation and Pollution Control
Part 7 Testing

This part of the "Engineering Guidelines" is set out in the same order as WSA 03 for ease of cross-referencing.

2. GENERAL

Council (as the Water Agency) will not provide a "Concept Plan" for the localised water supply system. This is the responsibility of the "Designer" and particularly so if the proposed development is going to be staged (ie. developed in stages). Council will, however provide details of items (a) to (j) inclusive as specified in Clause 1.2.5.1 of WSA 03 where available.

If such a staged development is proposed the "Designer" shall provide an indicative overall concept plan of the development at the time of submitting the first stage to Council for approval. This concept plan shall not be binding with respect to the proposed layout/staging; however, the final number of tenements cannot differ by more than 20% between the original concept plan and the ultimate constructed development.

All development in bush fire prone areas is to comply with the RFS NSW planning for bushfire protection.

3. SYSTEM PLANNING

3.1. SYSTEM PLANNING PROCESS

Extending/upgrading an existing water supply system (Refer WSA 2.2.2) In lieu of (a) and (b) of this Clause of WSA 03, the "Planner/Designer" shall:

a. Take into account points (i), (ii) and (iii) which will be provided by Council in designing the extension/upgrade of an existing water supply system to ensure that it adequately services any existing and any future customers on that system

b. Provide details of the proposed extension/upgrade in the preliminary/early phases of the design in particular existing and future customers, to Council to allow it to be "trialled/modelled" in Council's network analysis if available and determine its impact on the existing water reticulation system

c. The outcome of this trialling may lead to Council placing additional requirements on the proposed extension/upgrade and/or the developer to augment the existing system to meet the demands of the proposed extension/upgrade

3.2. DEMANDS (REFER WSA 2.3.1)

Demand rates shall be in accordance with Table 2.1 (Melbourne/Geelong) of WSA03-2002-2.3 unless the demand of the proposed development is known and exceeds those values in Table 2.1 in which case the "known" demand shall be used. Refer to extract Table 2.1 below.

TABLE 2.1 TYPICAL PEAK HOUR DEMAND RATES

Demand type[A]	Demand rate units	Adelaide	Ballarat/Bendigo	Brisbane	Canberra[B]	Darwin	Gold Coast	Melbourne/Geelong	Newcastle	Perth	Sydney	Gippsland
Residential												
High density	L/s/100 units	4.25	3	6	3[C]	9.8[D]	7.75	3	1.6	9.7	3	E
1000 m^2 lots	L/s/100 lots	9	9	15	15	15.6[D]	7.75	10	2.9	18.7	12	F
500 m^2 lots	L/s/100 lots	6.35	6	10	7.5	15.6[D]	5.81	8	2.9	14	6.5	F
Commercial	L/s/ha	1.20	0.5	0.4	0.6 – 1.1	1.1	1.21	0.6	0.5	0.7	0.9	E
Industrial												
General heavy	≥200 ha L/s/ha			0.25			G	0.8	E	0.7	E	E
	≥40 ha L/s/ha			0.4			G	1.0	E	0.7	1.3	E
Light	L/s/ha	0.65	0.5	0.25	0.54	1.1	1.21	0.4	0.26	0.7	1.3	E
Designated high usage	L/s/ha		2	E			G	2.5	E	E	E	E
Public utilities												
Schools	L/s/ha L/s/school	0.25	0.25	2	1.1	1.7	G	0.23	0.3		4 High 2 Primary	E
General public purposes	L/s/ha	0.25	0.1	1.0	0.75		G	0.2			0.1	E
Hospitals	L/bed/day L/s/ha	0.25	4000	1000	1.7		1870	900	1675	938	1500	E
Reserves												
Parks	L/s/ha		0.1	0	1.5	3.5	G	0.2			0.1	E
Golf courses	L/s/ha		0.1	0	1.5		G	0.05	0.04		0.1	E
Market gardens	L/s/ha			0			G	0.2			0.25	E
Pastures	L/s/ha			0			G	0.01			E	E
Gardens	L/s/ha			0	1.5		G	0.32			0.25	E
Other												
Fire demand	L/s/hydrant			H	J							

NOTES:

A *It is important to note that for small supply systems i.e. <2000 population the peak demand rates listed in Table 2.1 may be too low.*

B *Canberra's figures include an allowance for irrigation.*

C *High density residential figure based on each residential unit being 200 m2.*

D *Assume peak day factor (PDF) of 3.5.*

E *Assessed individually using an appropriate demand adjustment factor.*

F *Peak Hourly Demand typically in the range of 5 to 6 L/s/100 tenements (Moe–5, Sale–5.1, Morwell–5.7, Traralgon–5.9)*

G *Average day demand rate.*

H *15 L/s from one hydrant, 25 L/s from two adjacent hydrants with a minimum pressure of 100 KPa. Commercial areas shall have an additional requirement of 45 L/s from 3 adjacent hydrants. Fire flows are applied concurrently with a flow of 2/3 Peak Hourly Demand.*

J *25 L/s to 200 L/s dependent on fire risk category.*

3.3. SYSTEM HYDRAULICS

3.3.1. Minimum service pressure (Refer 2.5.3.3 and Table 2.3)

The minimum allowable service pressure shall be 300 kPa (30 m head) throughout the reticulation system when meeting a peak instantaneous demand of 0.15 litres/second/tenement. These minimum pressures are to be achieved with the relevant supplying water storage reservoir two thirds full.

Where the pressure does not meet the Council requirement this may be registered on the title as determined by Council.

In outlying areas Council may permit the minimum service pressure to be reduced to 100 kPa (10 m head), however in these instances the relevant property will be required to install a storage tank (1500 litres minimum capacity) and an on-property system capable of providing a minimum pressure of 300 kPa (30 m head).

3.3.2. Pressure variation analysis (Refer WSA 2.5.4)

Where distribution and reticulation systems are designed to control diurnal pressure variations, the diurnal demand factors are to be used for each customer category. Consult with Council prior to undertaking any analysis to determine requirements.

3.3.3. Determining supply zones (Refer WSA 2.5.5)

Council has no issue with different supply zones. The creation of **different pressure zones is not preferred** and "Planners/Designers" should discuss this issue with Council in the early stages of the design phase in an attempt to eliminate such zones. Pressure zones shall be consistent with Council's existing system.

3.4. PUMPING STATIONS (REFER WSA 2.8.3 (C))

A standby pump of the same capacity as the duty pump is required. Provision shall be made in the design and ultimate operation for the standby and duty pumps to be alternated.

The design of any water pump station **must be** undertaken in consultation with Council's' Water and Wastewater Mechanical and Electrical Group.

3.5. SERVICE RESERVOIRS (REFER WSA 2.9)

The minimum capacity for any service reservoir shall be on one day supply at peak demand. The reservoir should be located at an elevation such that the water level when the reservoir is

2/3 full provides not less than the minimum allowable service pressures at the customer's services under peak demand conditions (Table 2.3 of WSA –03 modified as per 3.3.1 above). Reservoirs are to be designed as part of an overall system and are to be located at elevations consistent with other reservoirs within the same pressure zone.

4. HYDRAULIC DESIGN

4.1. SIZING OF MAINS

4.1.1. Minimum pipe sizes (Refer WSA 3.1.2)

The minimum acceptable pipe size is 100 mm diameter for "residential" areas and 150 mm diameter for commercial and industrial areas.

The minimum pipe size for the bowls of courts, cul-de-sacs shall be 50 mm copper (65 mm nominal diameter if polyethylene (PE) pipe is being used), however fire hydrants must have a minimum main diameter of 100 mm on the supply side.

4.1.2. Fire flows (Refer WSA 3.1.5)

The following applies in addition to Clause 3.1.5 of WSA 03:

A minimum supply head of 28 metres is to be achieved at any fire hydrant within the reticulation system when drawing 11 litres/second from the individual hydrant and meeting a peak instantaneous demand of 0.10 litres/second/tenement throughout the system. A tenement is deemed to be the demand relating to a typical residential lot. Where the demand differs from that of a standard tenement the anticipated water supply demand for each development shall be used in undertaking the above calculations.

4.2. DESIGN PRESSURES

4.2.1. Maximum design pressure (denoted on design drawings)

The maximum design pressures are not required to be recorded on the 'design drawings'. However they should be shown on an overall concept plan at strategic locations that shall be included with the design computations provided to Council when the design is submitted for approval.

4.2.2. Empirical Sizing of Reticulation Mains (notes) (Refer WSA 3.1.3)

Minimum Class 16

4.3. PIPE AND FITTINGS PRESSURE CLASS

4.3.1. Pressure Class of system components (Refer WSA 3.3)

The minimum pipe and fittings pressure class for reticulation mains shall be PN 35 where ductile iron cement lined (DICL) pipes are used and Class 16 DIOD where uPVC rubber ring jointed pipe are used.

4.4. PRODUCTS AND MATERIALS (REFER WSA 4)

The following pipeline materials are currently approved for use however other materials may be considered but will require Council approval on a case-by-case basis.

4.4.1. Property Service Connections

PN 35 ductile iron cement lined (DICL) spigot and socket, rubber ring jointed pipe manufactured in accordance with AS 2280. If DICL flanged pipe is to be used the class shall be flange class pipe.

Type 'A'; copper pipe manufactured in accordance with AS 1432.

NOTE: Copper is only permitted for the bowl sections of courts and cul-de-sacs and property services. Pipeline fittings for joining Copper pipe to be silver soldered.

Class 16 PE is only permitted for the bowl sections of courts and cul-de-sacs and property services. However if the property service has to cross a road PE can only be used if it is inserted into a sleeve pipe of minimum Class 16. Sleeved pipes shall be installed so that water hammer and pressure fluctuations do not cause pipe movement with the conduit.

Pipeline fittings for joining PE to be only those approved by Council; and Pipeline fittings for joining DICL and/or PVC pipes shall be cast or ductile iron, cement lined and conforming to AS 2544 and AS 2280 respectively. If gibault joints are used they shall be the elongated type.

Copper tube Type A and Polyethylene (PE) pipe with trace wire is approved for use in property service connections. Copper tube is not approved for water reticulation use other than Courts and Cul-de-sacs. However if the property service has to cross a road, copper tube and Polyethylene (PE) pipe with trace wire is to be inserted into a sleeve pipe of minimum Class 16. Sleeved pipes shall be installed so that water hammer and pressure fluctuations do not cause pipe movement within the conduit.

4.4.2. Watermains DN100 to DN360

Between DN100 and DN250 water mains shall be constructed in:

PVC-M (AS/NZS 4765), Series 1 Blue Brut or 2 minimum PN 16 rubber ring joint. PVC must be lilac coloured where used in reuse or raw water systems;

PVC-O (AS/NZS 4441).

DICL (AS/NZS 2280), PN 35 rubber ring joint, polyethylene wrapped AS 3680; if DICL flanged pipe is to be used the class shall be flange class pipe;

Polyethylene (AS/NZS 4130) minimum PN 16, blue striped for potable systems, lilac striped for reuse or raw water systems. All jointing to be electro-fusion or butt-welded.

Place tracing wire marking tape in all PVC and Polyethylene trenches.

4.4.3. Watermains DN375 and larger

DN300 and over water mains shall be constructed in:

DICL AS/NZS 2280, PN 35, rubber ring joint, polyethylene wrapped AS 3680; Series 2 PVC Rubber Ring Joint minimum PN 16.

4.4.4. Fittings

Pipeline fittings for joining DICL, DIOD and/or uPVC pipes shall be conform to AS 2544 and AS 2280 respectively. If gibault joints are used they shall be the elongated type or vari-gib type.

5. GENERAL DESIGN

5.1. GENERAL REQUIREMENTS

5.1.1. Design tolerances (Refer WSA 5.1.1)

The following shall apply in lieu of Clause 5.1.1(a) and (b) (ii):

"The alignments shall be calculated to the nearest 5 mm and expressed/shown on the drawings to two decimal places with the rounding application being 0.4 mm rounded down to the second decimal place and rounded up to the second decimal place of a metre.

The horizontal alignment shall be referenced to GMA.

5.1.2. Levels (Refer WSA 5.1.2)

In addition to the requirements of Clause 5.1.2; where a longitudinal elevation forms part of the design drawings levels shall be specified at:

- Every 15 metre interval
- Horizontal changes if alignment where a bend(s) is used
- Vertical changes if alignment where a bend(s) is used

5.2. LOCATION OF WATERMAINS

5.2.1. General (Refer WSA 5.3.1a)

Additional to clause 5.3.1a watermains are to be located on the nature strip with the pipe alignment to be in accordance with Council Standard Drawings. Alternative alignments are subject to approval from Council.

5.2.2. Watermains near trees (Refer WSA 5.4.7)

In lieu of Clause 5.4.7 of WSA 03 the 'specialist advice' shall be sought from Council's Parks and Recreation Section. Further, the Parks and Recreation Section may require portions of the main to be underbored – this shall be specified on the Design Drawings. Particular attention is required in relation to the impact on the tree route system from the cumulative impact of the construction of all services and works. Pipes under trees are to be ductile.

5.2.3. Railway reserves (Refer WSA 5.2.3)

In addition to watermains being laid within railway reserves (either along or across them) being authorised by the Railway owner and complying with AS 4799, the design and ultimate construction shall comply with the requirements of the Railway owner.

5.2.4. Crossing Creeks or Drainage Reserves (Refer WSA 5.4.11)

Stabilisation or directional bore as approved by Council. Pipes under existing crossing creeks or drainage reserves are to be encased or directionally bored as approved by Council.

5.3. CONNECTION OF NEW MAINS TO EXISTING MAINS (REFER WSA 5.9)

Where it is necessary to connect to, tap into, or relocate an existing water supply main, Council Staff should carry out this work at the developer's expense.

The developer should lodge payment for the work in advance and give 14 days notice of when connection is required.

Council will provide all pipes and fittings required to complete the connection or tapping at the developer's expense.

5.4. PROPERTY SERVICES (REFER WSA 5.11)

A common property service, which is then further divided to service additional properties, is not permitted.

Property services shall be located such that the point where the meter assembly is located is within 300 mm of the property side boundary or in the middle of the property. Coordinate service design with other services.

5.5. OBSTRUCTION AND CLEARANCES (REFER WSA 5.12)

The maximum individual joint deflection for DICL in either the horizontal or vertical plane or a multiple joint (i.e. where there is deflection in both planes) shall be not more than 75% of the manufacturer's recommendation.

Pipe deflection for DIOD PVC shall be to Manufacturers Specifications (ie. No deflection in joints, deflection bends at midpoint of pipe).

4.1 STRUCTURAL DESIGN

5.6. PIPE ANCHORAGE

5.6.1. Anchor Blocks (Refer WSA 7.9.3)

Rapid set concrete anchor blocks are not allowed.

5.6.2. Restrained Elastomeric Seal Joint Water Mains (Refer WSA 7.9.5)

Not accepted.

4.2 APPURTENANCES

5.7. STOP VALVES

All stop valves shall be clockwise closing.

5.7.1. Gate valves (Refer WSA 8.2.2.2)

5.7.2. Stop valves for transfer/distribution mains (Refer WSA 8.2.3)

5.8. AIR VALVES

5.8.1. Installation design criteria

Air Valve Types to be only those approved by Council.

5.8.2. Air valve types (Refer WSA 8.4.3)

Air Valve Types to be only those approved by Council.

5.9. SWABBING JOINTS (REFER WSA 6.7)

Not required.

5.10. HYDRANTS

5.10.1. Hydrant types (Refer WSA 8.8.4)

Only spring type hydrants accepted.

5.10.2. Hydrant Spacing (Refer WSA 8.8.8)

Fire hydrants are to be provided in the main at maximum spacing of 60 metres and flushing hydrants are to be installed at all dead ends, including temporary dead ends for the purpose of flushing the main in addition to fire fighting. In addition provide hydrants / fire protection in accordance with BCA and fire authority requirements.

TABLE 7.1 AVERAGE DAY DEMANDS FOR NEW DOMESTIC PROPERTIES

Class of Building	Fire Fighting Flow (L/s)
1. Properties that are zoned for commercial (3) or industrial (4) purposes in the relevant LEP.	20
2. Any property not included in Category 1.	10

5.10.3. Hydrant Locations (Refer WSA 8.8.9)

Always in Road Reserve in accordance with Fire Authority requirements. Reticulation mains are not to be located within the road unless approved by exception. For battle-axe lots with access's exceeding 60m in length, a water main extension with a fire hydrant at the extremity is top be constructed along the handle to service the lots and provide fire protection.

5.11. FIRE FIGHTING FLOWS

Comply with fire authority requirements.

When checking a property for fire fighting adequacy, the fire flow should be taken from the closest hydrant to the property.

In commercial and industrial areas or in areas of high rise buildings a minimum of 150 mm diameter pipes should be used. Special fire fighting requirements exist for some large industries or in cases where fire could be especially severe.

The water systems are not designed, nor intended, to fight bush fires where flows in excess of the design allowances nominated here are attempted to be drawn from the system.

5.12. UNACCOUNTED WATER

An allowance equivalent to 15% of the average demand is to be made for unaccounted water resulting from leakage in the water distribution system and meter inaccuracies. Peaking factors are not to be applied to unaccounted water.

5.13. DISINFECTION OF WATERMAINS

All new watermains are to be disinfected prior to connection to Council's system. Disinfection must be carried out by approved contractor or Council.

6. DESIGN REVIEW AND DRAWINGS

6.1. DESIGN REVIEW (REFER WSA 9.1)

Submit a water supply check list.

6.2. DESIGN DRAWINGS (REFER WSA 9.2)

Provide longitudinal sections for trunk mains in accordance with WSA.

7. STANDARD DRAWINGS

Council Standard Drawings take precedence over WSA

PART 5

SEWERAGE RETICULATION DESIGN

APRIL 2018

PART 5
SEWERAGE RETICULATION DESIGN
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1. INTRODUCTION

This Part of Council's "Engineering Guidelines for Subdivisions and Developments" is related to sewerage reticulation. Reference to Council will include reference to the Council as the Sewerage Authority.

References below are to WSA02-2014-3.1 which was current at time of publication of this standard if the WSA standard is updated refer to the equivalent clause. The Design and Construction of sewerage reticulation shall generally be in accordance with the latest version of the Water Services Association of Australia (WSAA) "Sewerage Code of Australia (WSA02**)".**

However this part of Council's "Engineering Guidelines" takes precedence over the WSAA Standards. (ie. these are Council's requirements which may be different to WSA 02).

The other Parts of the Engineering Guidelines for Subdivisions and Development are as follows:

Part 1 General Requirement
Part 2 Design of Roads
Part 3 Stormwater Drainage Design
Part 4 Water Reticulation Design
Part 5 Sewerage Reticulation Design
Part 6 Landscaping, and Measures for Erosion, Sedimentation and Pollution Control
Part 7 Testing

This part of the "Engineering Guidelines" is set out in the same order as WSA 02 for ease of cross-referencing.

2. GENERAL

2.1. SCOPE (REFER WSA 1.1)

The design of sewage pumping stations (SPSs) is addressed in WSA 04 2005 Sewage Pumping Station Code of Australia. Council has an objective of minimising the number of pump stations to reduce ongoing maintenance costs and liabilities. Pump station and rising main shall be in accordance with Council Standards. These standards encourage a consistent approach to telemetry, electrical, pumps and maintenance issues throughout the system.

3. SYSTEM PLANNING

3.1. ASSESSMENT OF FUTURE CATCHMENT LOADS (REFER WSA 2.4.2)

4. FLOW ESTIMATION (REFER WSA 3)

4.1. DESIGN FLOW ESTIMATION METHOD (REFER WSA 3.3)

Flow estimation assumptions shall be given in the concept plan.

4.1.1. Traditional Design Flow Estimation Method (Refer WSA 3.3.2)

The method for determination the design flow shall be in accordance with the methodology specified by the water agency as follows.

5. DETAIL DESIGN

5.1. DETAIL DESIGN CONSIDERATIONS (REFER WSA 5.2)

5.1.1. Catchment Design (Refer WSA 5.2.1)

Where future development has the potential to occur beyond the estate, estate sewer reticulation is to be consistent with a catchment master plan. In the absence of a master plan prepared by Council a master plan must be prepared by the developer to an extent necessary to determine sewerage component sizing and location within the estate so that orderly development can occur.

Estate sewerage reticulation shall be extended through the estate to service future upstream catchments. Sewer extension to service the upstream catchment shall be subject to Authority approval at the cost of Council. Easements shall be created as part of an approved estate master plan to enable sewer construction that is not dependent and restricted by estate staging and lot release. Construction may be either directed by Council or alternatively constructed by the Council or its representatives.

5.1.2. Design Accuracy (refer WSA 5.2.2)

Location in plan shall be referenced to MGA coordinates.

5.1.3. Easements (Refer WSA 4.2.5)

Where Community or Shared Title occurs, Council's sewer responsibility ends at the property connection point (typically where the property vertical is located as visible on site outside of easement/MH inside the boundary line of the property). There will be one connection to service the combined community lots. Council may require an easement to be created over part or the entire infrastructure. The minimum width of an easement is to be 3 m

5.2. HORIZONTAL ALIGNMENT OF SEWERS (REFER WSA 5.3)

Road Crossings are perpendicular to the road centreline unless otherwise approved.

5.2.1. Easements (Refer WSA 5.2.8)

Sewers located in property other than owned by Council are to have an easement in favour of Council. The Developer is responsible for obtaining this easement; the release of the Deposited Plan of Subdivision is subject to the creation of this easement. The Developer is to transfer to Council sewer easements provided in the subdivision and execute a transfer and grant of easement in favour of Council pursuant to Section 88b of the Conveyancing Act 1919, as amended. The minimum width of sewer easement should be 3.0 metres.

Development that requires the submission of a development application to Council for approval will require the provision of an easement over existing sewer infrastructure.

5.2.2. All changes in direction using MH (Refer WSA 5.2.6)

An internal MH through drop between inlet pipe and outlet pipe is required as follows:

Deflection Angle	Drop (mm)
0° to 45°	30
46° to 90°	50

Deflections between 91° to 120° are by approval only. Deflections greater than 120° through Maintenance Holes are not permitted.

5.2.3. Horizontal Curves in Sewers (Refer WSA 5.3.8)

Typically not accepted but the corporation may approve curved sewers on a case-by-case basis.

5.3. OBSTRUCTIONS AND CLEARANCES (REFER WSA 5.4)

Sewer mains located within lots adjacent to stormwater drainage lines shall be a minimum of 750 mm clear of the stormwater pipe.

Council has a preference that buildings not be located over sewer mains. Where this is unavoidable subject to approval of Council, buildings may be constructed over sewer reticulation mains provided they are constructed so that no load from the structure is transmitted to the sewer main and the portion of the main under the building (and for a distance outside of the building shall be 2 metres minimum) is laid in cement lined, sulphate resistant, or ductile iron pipe equivalent to Class PN 35. Refer to Standard Drawing Class 18 uPvc DIOD (ductile iron outside diameter compatible). This concession is made primarily for buildings in established areas and will not be extended to new subdivisions unless special circumstances prevail.

5.4. PIPE SIZING AND GRADING (REFER WSA 5.5)

5.4.1. General (refer WSA 5.5.1)

Sewers shall be designed for PWWF capacity. The maximum and minimum allowable loadings for various pipe diameters are as shown in Appendix A – Sewer Capacity Grading Table of these standards.

5.4.2. Minimum pipe sizes for maintenance purposes (Refer WSA 5.5.4)

The minimum sewer main diameter is 150 mm.

5.4.3. Minimum grades for sewers (Refer WSA 5.5.7)

At the ends of lines the minimum grade is 1 in 80.

5.4.4. Minimum grades for self-cleansing (Refer WSA 5.5.7)

The maximum grade of reticulation sewer is limited to 1 in 10.

The minimum grades are shown in a table attached in Appendix A.

The values of Colebrook White roughness to be used in the design of gravity sewers are:

TABLE 5.1 VALUES OF COLEBROOK WHITE ROUGHNESS

Nominal Pipe Size (mm)	Full Flow - for estimation of Peak Hydraulic Capacity	Partial Flow - for estimation of Self-Cleansing Flows
150-300	k = 0.6 mm	k = 1.5 normal k = 3.0 for control lines
375-600	k = 0.6 mm	k = 3.0 mm
Above 600	k = 1.5 mm	k = 6.0 mm

Note: Control Lines are those lines that affect the overall depth of the system. The minimum grade for property sewers is 1 in 60.

5.4.5. Minimum cover over sewers (Refer WSA 5.6.3)

In accordance with WSA.

5.4.6. Minimum Depth of Sewer Connection Point (Refer WSA 5.6.5)

The depth of the junction is to be such that any location within the lot can be drained to it via a pipe with a minimum 300 mm of cover laid at a grade of 1 in 60. The pipe is to be located parallel to boundaries and account for raft slab construction.

5.4.7. Depth of Connection Point (refer WSA 5.6.5.4)

TABLE 5.2 PROPERTY SEWERS

Maximum depth to invert	2.0 metres spacing WAE to include MGA Co-ordinates marked with tape and marker post.
Termination of sewers that provide for future connection	Include MGA Co-ordinates, Mark with tape and marker post

5.4.8. Vertical Curves in Sewers (refer WSA 5.6.7)

Not accepted.

5.4.9. Compound Curves (refer WSA 5.6.8)

Not accepted

6. PROPERTY CONNECTION (REFER WSA 6)

6.1. LIMITATION OF CONNECTION TO SEWERS (REFER WSA 6.2)

Written approval is required from Council for connection to the existing Authority sewerage system. All work is to be carried out by Authority approved contractors at the developers' expense. Seven days prior notice is required. All materials are to be supplied by the Developer.

All work conducted on live sewers is to be in accordance with the relevant Workplace Health and Safety Regulations, and Confined Spaces Regulations.

6.2. METHODS OF PROPERTY CONNECTION (REFER WSA 6.3)

TABLE 6.1 METHODS OF PROPERTY CONNECTION

WSA 6.3.3 Buried interface method (type A)	Approved.
WSA 6.3.2 IO interface method	Not approved
Reference	WSA Standard Drawing WAT 1107

6.3. LOCATION OF PROPERTY CONNECTION POINTS (REFER WSA 6.5)

Where an unsewered dwelling is located on land that is being developed, the Developer shall connect the dwelling to the sewerage reticulation at his cost as part of the subdivision work. The Developer shall be responsible for the removal of any septic tanks and backfilling of the excavation to the satisfaction of Council. All new sewer mains and MHs must be tested prior to the dwelling being connected.

6.4. PROPERTY CONNECTION SEWERS (REFER WSA 6.6)

Not accepted.

7. MAINTENANCE STRUCTURES (REFER WSA 7)

7.1. TYPES OF MAINTENANCE STRUCTURES (REFER WSA 7.1)

a. Maintenance Holes	accepted.
b. Maintenance Shafts	not accepted
c. Termination	subject to authority approval on a case

7.2. SPACING OF MAINTENANCE STRUCTURES (REFER WSA 7.3)

MH maximum spacing is 80 metres.

7.3. MAINTENANCE HOLES (REFER WSA 7.6)

All maintenance structures shall be maintenance holes (MH) unless otherwise approved by Council.

Maintenance holes are required at all dead ends exceeding 30 metres in length. Sewer mains (referred to as junction and lead) that exceed 10 metres in length are sidelines that require a MH with a 150 mm connection where they enter the main at the downstream end. MHs are not to be located in road carriageways without specific approval of Council.

Where the development is utilising existing sewer mains or junctions, the mains, MHs or junctions must be upgraded to meet the current guideline requirements.

7.3.1. Types of MH Construction (refer WSA 7.6.2)

Cast insitu or precast units are to be as approved by Council. Tapers (cones) are not permitted on maintenance holes unless approved by Council.

PE and other plastics are not accepted.

MH is to be constructed as fully cast insitu or fully precast assemblies.

7.3.2. Ladders, Step irons and Landings. (REFER WSA 7.6.9)

Not required.

7.4. MAINTENANCE SHAFTS (MS) / MAINTENANCE CHAMBERS (MCS). (REFER WSA 7.7)

MS not accepted, TMS accepted.

8. ANCILLARY STRUCTURES (REFER WSA 8)

8.1. WATER SEALS, BOUNDARY TRAPS, WATER SEALED MH'S AND GAS CHECKS (REFER WSA 8.2)

Not required

8.2. INVERTED SYPHONS (REFER WSA 8.6)

Not accepted

9. STRUCTURAL DESIGN (REFER WSA 9)

9.1. PRODUCTS AND MATERIALS (REFER WSA 9.2)

Reticulation Pipes and Fittings must be in accordance with the manufacturers and relevant Standards. The following materials are approved for use:

TABLE 9.1 APPROVED MATERIALS FOR USE

Gravity sewer reticulation pipelines may be constructed from PVC non pressure pipe and fittings (AS 1260) minimum class SN8.
Ductile Iron, PN35, lining type to be confirmed with Council. NOTE: Portland cement concrete lining is not acceptable.
DIOD PVC.

Other materials may be considered however these materials will require approval on a case-by- case basis.

All pipes should be rubber ring jointed.

10. STANDARD DRAWINGS

All work is to be in accordance to approved Council Standard Drawings.

APPENDIX A
SEWER CAPACITY GRADING TABLE

	Pipe size 150			Pipe size 225			Pipe size 300			Pipe size 375		Pipe size 450		Pipe size 525		Pipe size 600		
	Tenements			Tenements			Tenements			Tenements		Tenements		Tenements		Tenements		
Grade	Min K (in mm)		Max	Min K (in mm)		Max	Min K (in mm)		Max	Min K (in mm)	Max	Min K (in mm)	Max	Min K (in mm)	Max	Min K (in mm)	Max	Grade
	1.5	3.0	0.6	1.5	3.0	0.6	1.5	3.0	0.6	3.0	0.6	3.0	0.6	3.0	0.6	3.0	0.6	
80	1	1	221															80
90	3	2	208															90
100	6	4	196	11	8	609												100
110	9	7	186	15	11	580												110
120	13	10	178	20	15	553	28	22	1225									120
130	18	14	170	25	20	530	33	27	1175									130
140	23	18	164	31	25	510	38	32	1129	39	2081							140
150	30	24	158	36	30	492	43	36	1089	44	2007							150
160	35	30	152	14	35	475	49	41	1053	49	1941	58	3188					160
180	48	41	143	52	45	446	61	52	989	61	1825	71	300					180
200	65	56	135	66	57	422	76	65	936	75	1727	86	2839	98	4313			200
220				83	71	401	92	79	890	90	1642	103	2703	116	4104			250
250				113	97	374	120	105	832	117	1536	131	2527	146	3840	163	5511	300
300	204	176	119	186	161	339	184	159	755	172	1395	188	2296	207	3492	227	5013	350
350				324	283	312	269	234	695	242	1287	259	2118	281	3222	305	4627	400
400							389	340	648	332	1199	347	1975	370	3006	396	4316	450
450							577	507	608	448	1120	454	1855	475	2826	504	1060	500
500							1175	1039	575	602	1066	585	1757	600	2674	628	3843	550
550										809	1013	747	1670	748	2544	773	3656	600
600										1191	967	953	1596	926	2430	940	3494	650
650												1126	1531	1138	2331	1134	3351	700
700												1630	1471	1400	2242	1362	3222	750
750												2829	1420	1732	2162	1628	3109	800
800														2185	2089	1948	3006	850
850														2925	2024	2341	2926	900
900																2850	2825	1000
1000																5668	2673	

PART 6

LANDSCAPING AND MEASURES FOR EROSION, SEDIMENTATION AND POLLUTION CONTROL

APRIL 2018

PART 6
LANDSCAPING AND MEASURES FOR EROSION SEDIMENTATION AND POLLUTION CONTROL
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1. INTRODUCTION

This section of the Engineering Guidelines for Subdivisions and Developments outlines Council's recommended practice for the **Landscaping and Measures for Erosion, Sedimentation and Pollution Control**. It is in no way a comprehensive "Design Manual" and it is to be read in conjunction with and as a supplement to referenced standards.

The Subdivision and Development Guidelines comprise the following:

Part 1 General Requirement
Part 2 Design of Roads
Part 3 Stormwater Drainage Design
Part 4 Water Reticulation Design
Part 5 Sewerage Reticulation Design
Part 6 Landscaping, and Measures for Erosion, Sedimentation and Pollution Control
Part 7 Testing

2. GENERAL

The object of these Guidelines is to:

- Encourage the implementation of environmental buffers and provide opportunities for repair and enhancement of natural systems especially for lands that were previously degraded
- Encourage developers to appreciate landscape design as a fundamental and critical element of a development proposal and to include landscape design considerations at an early stage in the planning process
- Protect the environment against soil erosion and soil loss from subdivision sites
- Improve Water Quality
- Prevent the degradation of drainage systems, waterways creeks and rivers, from the deposition of soil, polluting substances and other foreign material from subdivision sites
- To minimise disturbances and provide necessary control measures to prevent loss of soil

Relevant Acts and Guidelines include but are not limited to:

- Water Management Act 2000 (Part 3 management plans)
- Protection of the environment and operations Act 1997 (covers water, air, noise, pollution and waste)
- Local Land Services Act 2013
- Biodiversity Conservation Act 2016
- Fisheries Management Act 1994 (protects fisheries and habitat)
- Biosecurity Act 2015 (control of noxious weeds)
- The Local Government Act 1993
- Water Management Act 2000
- Environmental Planning and Assessment Act
- Soil conservation Act 1938
- State Environmental Planning Policy (Coastal Management) 2018

3. LANDSCAPING FOR SUBDIVISIONS

General:

Prior to development of a landscape concept it is recommended that you carry out preliminary discussions with the appropriate Council Officer regarding the existing landscape features and concepts that will reinforce the character of the area and preserve the local native habitat.

3.1. LANDSCAPE GUIDELINES

A landscape plan will be required. The level of detail will depend on the size, scale and location of the development site. At a minimum, detail to include:

- Existing trees and landscape elements accurately plotted to scale
- Species selection – including approximate height reached at maturity
- Purchasing criteria
- Planting schedule
- Planting methodology
- Maintenance schedule

At the initial stage of planning it is important that the trees to be retained on the development site are identified by a qualified arborist.

A tree protection plan is developed for the retained trees during the complete development phase. Refer to Table No 1 for design concepts that assist in the preservation of mature trees on a development site. An Australian Standard for Protection of trees on development sites is AS4970.

Council's nominal rate of street tree planting is one medium size tree every 15 metres or as directed. Tree purchase and planting is to be carried out as per Council's standards. These standards are available on request.

At the completion of the planting and development of all reserves and street trees a handover inspection is to occur with appropriate Council officer. Reserves to be dedicated to Council will only become Council's responsibility following the handover inspection and satisfactory completion. A letter stating the satisfactory completion of landscape works will be sent to the developer.

A maintenance period of a minimum of 12 months will apply unless otherwise nominated by Council. Following this period the release of the landscape bond will occur upon receipt of a written request.

Undesirable species for Council's are listed in Table No 2. These species are able to be removed without consent as exempt development.

3.2. CAR PARK LANDSCAPING

Ensure that car parking areas are landscaped to provide shade, define parking areas and improve the aesthetics of parking areas.

The development is to enhance the overall appearance of the streetscapes or streetscape elements including the street tree planting and other significant landscape elements.

4. NOXIOUS WEEDS

Under the Biosecurity Act 2015 Council is authorised to enforce the control of these plants. The NSW Department of Primary Industries makes regular updates the noxious weeds list for Council's Region. The vegetation management plan includes the listing of noxious weeds on the development site and the control methods in dealing with these weeds.

The Biosecurity Act 2015 requires that the growth and spread of all class 4 noxious weeds to be controlled according to the measures specified in Council's Class 4 Noxious Weed Management Plan.

5. GUIDELINES FOR CLEARING AND ESTABLISHMENT OF VEGETATION

5.1. CLEARING OF VEGETATION

- The recommended flow of information is as follows:
- Identify the type of activity
- List the applicable legislation and comply
- Prepare a planning document for each activity
- Type of activity whether exempt or complying
- Refer to the consent authority

Clearing of vegetation is to comply with the following:

- The removal of trees, shrubs and ground cover shall be minimised to protect the ground surface from erosion
- Removal of trees exceeding 300 mm in diameter and or 4.5 metres in height shall be
- undertaken only with Council consent under the Tree Preservation Order, or in accordance with Development or Building approvals. Any trees to be removed should be clearly identified on a drawing
- A drawing should accompany each Development Application showing clearly the genus location and health of all existing trees that exceed 300 mm in diameter and or 4.5 metres in height either on-site or on adjoining lands and within two metres of boundaries of the subject site. Removal of any trees will not be allowed before development approval unless written Council consent is obtained. In addition to Council requirements, approval may be required under the Native Vegetation Conservation Act
- Minimal clearing of vegetation, including trees less than 4.5 metres in height, may be undertaken without consent or in accordance with approved drawings for the following purposes:

xi. Survey or geotechnical investigations where clearing is limited to obtaining site lines or essential vehicle access;

xii. Reduction of the fire hazard in accordance with a notice under

- Section 13 of the Bush Fires Act
- A plan under Section 41 of the Act
- According to the needs of a fire radiation zone at the direction of Council, providing the material is removed in a way that does not disturb the ground surface

- In compliance with a notice for the destruction of noxious weeds or vegetation harbouring vermin
- Activities not requiring development consent, providing the material is removed in a way that does not disturb the ground surface, as in (ii) above, and/or the land is not within 20 metres of an urban stream (Section C) and/or the gradient is not steeper than 1(V):4(H) or not covered by the Native Vegetation Conservation Act

For subdivisional work clearing must be limited to 2 metres from the edge of any essential construction activity as shown on the Engineering Drawings.

All reasonable care must be taken to protect other vegetation from damage during construction. This will include the following:

- Clearly marking trees to remain
- Avoiding compaction of ground within the drip line of trees to remain
- Clearly delineating the area of disturbance and keeping all vehicles, building materials and refuse within that area. These areas are to be clearly marked exclusion zone
- Limiting the number of access points to the site
- Clearly restrict access to no go areas and provide exclusion fencing prior to the commencement of works on site

5.2. ESTABLISHMENT OF VEGETATION

- Promote revegetation of disturbed areas
- Conserve native vegetation
- Equal consideration should be given to native grasses, legumes, shrubs and trees
- Consider seasonal conditions to match the time of year to seedling germination and survival
- Replace or re-establish any damaged vegetation
- Perennial vegetation is preferable
- Revegetate 90% of the disturbed areas within eight months of the initial revegetation plantings
- Revegetation must comply with an approved Master Plan, the Master Plan must comply with any other relevant strategy policy plan or the like relevant to vegetation management

TABLE NO 1 - TREE MANAGEMENT ON A DEVELOPMENT SITE

IMPACT OF TREE	CONSTRUCTION ACTIVITY	METHODS TO MINIMISE TREE DAMAGE
Root Loss	Stripping site or organic surface soil during mass grading.	Restrict stripping of topsoil around trees. Any woody vegetation to be removed adjacent to trees should be cut at ground level and not pulled out by equipment, or root injury to
Root Loss	Lowering grade, scarifying, preparing subgrade for fills and structures.	Use retaining walls with discontinuous footings to maintain natural grade as far as possible from trees. Excavate to finish grade by hand and cut exposed roots with a saw to avoid root wrenching and shattering by equipment, or cut with root pruning equipment. Spoil behind cut face can be removed by equipment sitting outside the dripline of the tree.
Root Loss	Subgrade preparation for pavement.	Use paving materials requiring a minimum amount of excavation (eg reinforced concrete instead of asphalt). Design traffic patterns to avoid heaving loads adjacent to trees (heavy load bearing pavements require thicker base material and subgrade compaction). Specify minimum subgrade compaction under pavement within dripline (extra reinforcement in concrete or geotextile under asphalt may be needed).
Root Loss	Excavations for footings and wall foundations.	Design walls/structures with discontinuous footings, pier foundations. Excavate by hand. Avoid slab foundations, post and beam footings.
Root Loss	Trenching for utilities, drainage.	Co-ordinate utility trench locations with installation contractors. Consolidate utility trenches. Excavate trenches by hand in areas with roots larger than 25 mm in diameter. Tunnel under woody roots rather than cutting them.

IMPACT OF TREE	CONSTRUCTION ACTIVITY	METHODS TO MINIMISE TREE DAMAGE
Wounding top of tree	Injury from equipment.	Fence trees to enclose low branches and protect trunk. Report all damage promptly so arborist can treat appropriately.
Wounding top of tree	Pruning for vertical clearance for building, traffic and construction equipment.	Prune to minimum height required prior to construction. Consider minimum height requirements of construction equipment and emergency vehicles over roads. All pruning should be performed by an arborist, not by construction personnel.
Unfavourable conditions for root growth, chronic stress from reduced root systems.	Compacted soils.	Fence trees to keep traffic and storage out of root area. In areas of engineered fills, specify minimum compaction (usually 85%) if fill will not support a structure. Provide a storage yard and traffic areas for construction activity well away from trees. Protect soil surface from traffic compaction with thick mulch.
Unfavourable conditions for root growth, chronic stress from reduced root systems.	Spills, waste disposal (eg paint, oil, fuel).	Post notices on fences prohibiting dumping and disposal of waste around trees. Require immediate clean up of accidental spills.
Unfavourable conditions for root growth, chronic stress from reduced root systems.	Soil sterilants (herbicides).	Use herbicides safe for use around existing vegetation.

TABLE NO 2 - UNDESIRABLE PLANT SPECIES FOR

COMMON NAME	SCIENTIFIC NAME	QUALIFICATIONS
NOXIOUS WEEDS		
Castor Oil Plant	Ricinus communis	
Willows	Salix ssp.	
Tree of Heaven	Alilanthus altissima	
Rhus Tree	Toxicodendron succedaneum	

UNDESIRABLE SPECIES		
Bamboo		All species and cultivars.
Celtis ssp.		Specific species.
Cootamundra Wattle	Acacia baileyana	
Golden Wattle	Acacia salignus	
Desert Ash	Fraxinus oxycarpus	
Box Elder	Acer negundo	

PART 7
TESTING
APRIL 2018

PART 7
TESTING
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1. INTRODUCTION

This section of the Engineering Guidelines for Subdivisions and Developments outlines Council's recommended practice for testing roads, water reticulation and sewer reticulation. It is in no way a comprehensive "Testing Manual" and it is intended to be read in conjunction with relevant Standards that includes:

- Australian Standards;
- RMS NSW Standards;
- WSAA Standards for Water and Sewer; and
- State Government Authority Standards.

The other sections of the Subdivision and Development Guidelines comprise the following:

Part 1 General Requirement
Part 2 Design of Roads
Part 3 Stormwater Drainage Design
Part 4 Water Reticulation Design
Part 5 Sewerage Reticulation Design
Part 6 Landscaping, and Measures for Erosion, Sedimentation and Pollution Control
Part 7 Testing

The developer is required to pay for all tests. Forty-eight hours' notice is required.

2. ROADS

Test each layer of pavement material and obtain approval for each layer from Council prior to placing of subsequent pavement layers.

2.1. SUBGRADE

Test the Subgrade profile by template and make good irregularities by the addition or removal of material, followed by further rolling as in Table 1

TABLE 2.1 SUBGRADE TESTING

Subgrade compaction requirement as obtained in the standard compaction test	95% of maximum dry density
Test every 500 mm lift at	Maximum spacing of 100m
Minimum number of samples per road	2 samples
Compulsory Subgrade inspection	In accordance the quality control checklist

All fill material shall comply with the requirements of AS 3798, Guidelines on Earthworks for Commercial and Residential Developments by the submission of test certificates prior to the commencement of work. Samples must represent a particular batch; lot or consignment and test certificates shall be no older than three months.

Every 500 mm lift of Subgrade shall be proof rolled. The Subgrade shall be checked by proof rolling with a roller having an intensity loading of seven tonnes per metre width of roller. Any permanent deformation of the Subgrade under the roller shall be deemed a failure. The proof rolling shall be witnessed by the Council.

Upon completion of final boxing of Subgrade, the geotechnical testing Authority shall inspect the exposed Subgrade to ensure that the samples taken accurately represent the Subgrade condition and shall certify in writing, to Council that this is so prior to the placement of the first pavement layer. Where boxing is provided it must drain freely to subsoil drainage or the road pavement materials must be extended to a free draining surface.

2.2. SUB-BASE AND BASE

The sub-base and base shall be density tested at intervals along the road as directed by Council. The compaction test shall comply with the approved design. The minimum requirements are:

TABLE 2.2 SUB-BASE AND BASE TESTING

The sub-base and base shall be density tested at	100 metre
Minimum samples per road to be tested	Two
Sub-base course compaction	95% of the maximum dry density as per the modified compaction test.
Base course	100% of the maximum dry density as per the modified compaction test.
Compulsory sub-base and base inspection	In accordance the quality control checklist

2.3. DENSITY TESTING

All tests are to be undertaken and certified by an authorised representative of a laboratory registered by the National Association of Testing Authorities. The developer is to pay for all density testing with density test results supplied to Council for approval.

2.4. PAVEMENT DETAILS

Sub-base and base course material must be initially tested for suitability unless advised otherwise by Council.

The minimum thickness for base course is 100 mm.

No pavement material shall be placed without the prior approval of Council.

Pavement material shall be supplied in accordance with requirements of an approved pavement design that considers subgrade, subbase, and base course as an integral structure. Pavement design must be undertaken by a Council approved geotechnical consultant in accordance with the specific geotechnical site assessments. If work are on state authority road comply with road authority requirements.

All sub-base and base course gravel must comply with the following requirements:

2.5. ASPHALTIC CONCRETE

The supply and laying of asphaltic concrete when approved must comply with RMS test method T612

2.5.1. Stability of mixes

The stability of the job mix shall be between 16kN and 36kN, as determined by the modified "Hubbard – Field Method' i.e. RMS Test Methods T601 and T603.

Mixes with stability of less than 8kN below the limit or more than 12kN above the upper limit shall be removed from the site. For mixes having stability outside the specified ranges, but within the above-mentioned limit for rejection, consideration will be given to acceptance of the mix subject to deduction in accordance with RMS test method T612.

2.6. VOIDS IN COMPACTED MIXES

The design of job mixes shall be such that between 65% and 85% of the air voids in the total mineral aggregate will be filled by the binder when determined in accordance with RMS Test Methods T601, T605 and T606.

2.7. SPRAYED BITUMINOUS SURFACING

Spray seals shall be 14/7 double double and prime in one or two applications as specified on the drawings and shall conform with the RMS specification for the supply and spraying of bituminous material (RMS QA Specifications: R11, R107, R109, R112 and R113.

Aggregates shall conform to RMS NSW specification for cover of aggregates RMS DCM materials specification DCM 3151 with proof of compliance submitted prior to the commencement of work. Samples tested must represent a particular batch; lot or consignment and test certificates shall be no older than three months.

2.8. APPLICATION RATES

The designed application rates of binder and aggregates and average least dimension of aggregates is to be submitted for approval 48 hours prior to the commencement of works.

2.9. WORK RECORDS

Details of bitumen and aggregate applied are to be recorded immediately after each "run" and submitted for approval prior to acceptance "into maintenance.

2.10. DEFECTIVE WORK OR MATERIALS

Remove defective materials including replacement of binder that has been overheated, deteriorated or contaminated prior to application to the road. Where the Council considers that work is not in accordance with the specification whether caused by bad workmanship, defective materials or by materials made defective during construction these materials shall be removed at the cost of the developer and contractor.

Alternatively, the Council may consider accepting defective work subject to conditions.

2.11. FINAL ROAD PROFILE

2.11.1. Pavement Crossfalls

The final road profile shall satisfy the following requirements (if not otherwise stated in the drawings):

Mean Crossfall	=	3 ± 0.25%
Maximum Crossfall		3.5% (5% in extenuating circumstances)
Minimum Crossfall		>2.5%
Standard Deviation of Crossfalls		0.35%

The above requirements do not apply where the road is super elevated.

2.11.2. Vertical Alignment

The vertical alignment shall not deviate more than ± 0.25% from the value shown on the drawings.

2.12. CONCRETE

Comply with AS 1012 Methods of Testing Concrete.

2.13. SUBDIVISION EARTHWORKS

All earthworks associated with commercial and residential developments must comply with the requirements of AS 3798 "Guideline on Earthworks for Commercial and Residential Developments".

Drawings and specification for all earthworks are to be included with the Engineering Drawings and Construction Specification, for the Council's consideration.

Any material deemed to be unsuitable as described in the Australian Standard shall be disposed of from the site. The contractor must advise Council, in advance, where any material exported from the site is to be taken.

Any documentation for earthworks, including Works-As-Executed details and testing shall comply with Sections 3 and 7 of AS 3798. A copy of the documentation and test results shall be supplied to Council. The Approved Plan of Subdivision will not be released prior to the receipt and approval of all earthworks documentation.

3. WASTEWATER RETICULATION

3.1. GENERAL (REFER WSA 21.1)

This section relates to sewerage reticulation acceptance testing. The testing of sewerage reticulation shall generally be in accordance with the latest version of the Water Services Association of Australia (WSAA). However this part of the Council's "Engineering Guidelines" takes precedence over the WSAA Standards. The "Sewerage Code of Australia (WSA02) Part 3 Construction; Third Edition Version 3.1" has been cross-referenced.

All sewers and maintenance holes shall be subject to testing after construction (NATA accreditation is not mandatory). The tests shall be carried out before release of the "Approved Plan of Subdivision".

Should sewers or maintenance holes fail any test, defects shall be detected and repaired and the test repeated. The process of testing, detection and repair of defects and retesting shall continue until a satisfactory test is obtained.

All lines are to be clear and free from soil, slurry, liquids and other foreign substances at the notification of completion.

3.2. COMPACTION TESTING (REFER WSA 21.3)

All trenches are to be Flood Compacted or as determined by Council.

3.3. TEST OF GRAVITATION SEWERS

The testing of gravitation sewers shall be in accordance with the relevant requirements and method of testing specified in Sections 3.4 or 3.5.

Before the test is performed, all pipe laying on the section shall be completed and backfill compacted to the level of the centre of the pipe barrel, and the Developer shall have requested the Council to check the pipeline for line and grade.

The test may be carried out after risers and/or sidelines are constructed however Council will be reliant on the final test conducted immediately prior to acceptance into maintenance.

Any fault detected is to be rectified and a satisfactory test obtained before the remainder of backfill is placed.

3.4. AIR PRESSURE AND VACUUM TESTING OF GRAVITY SEWERS (REFER WSA 21.4)

3.4.1. Equipment

All necessary equipment is to be supplied by the Developer and kept in a condition acceptable to the Water Agency.

Pressure gauges are to be tested daily by static water column. At least one spare gauge per test rig is to be kept on the job at all times.

Compressed air is to be supplied by a compressor capable of supplying at least 1m^3/minute at 35 kPa. The air is to be fed through a pressure-reducing valve capable of reducing pressure from that supply to 28 kPa ± 4 kPa. The air is then to pass through an airtight line fitted with a 150 mm Bourdon type pressure gauge reading from 0 to 50 kPa, a pressure relief valve that may be set to blow off at 28 kPa ± 4 kPa and a gate valve to the pipeline to be tested.

3.4.2. Low pressure air testing (WSA 21.4.2.2)

The method of setting up and carrying out the test shall be in accordance with the requirements of WSA low-pressure air testing section WSA 21.4.2.2.

Pressure drop times, which are less than these, may indicate leakage or excessive air permeability through unsaturated pipe walls with some materials. Vitrified clay pipes, in particular, suffer from excessive air permeability under dry summer conditions. When this occurs, pipes must be thoroughly saturated with water before testing or a hydrostatic test applied.

In any case, where the allowable pressure drop time cannot be attained and there are no visible leaks, a hydrostatic test is to be applied at the request of the Council.

3.5. HYDROSTATIC TESTING

Where Council permits hydrostatic testing; the hydrostatic test shall be carried in accordance with the specific requirements of Council.

3.6. TESTING OF CONCRETE MAINTENANCE HOLES (REFER WSA 21.4.5)

Council may request the leakage testing of MH's at its discretion.

Where a test is required the test shall be carried out with the maintenance hole cover surround fitted with rendering of the channels and benches completed.

As an alternative to vacuum testing referred to in WSA *21.4.5* subject to the approval of Council water testing will be undertaken by plugging all pipe openings in the walls and by filling the maintenance hole with water to the lowest point on the top of the maintenance hole cover surround. The plugs shall be positioned in the pipes as near as practicable to the internal face of the maintenance hole.

After allowing 30 minutes for absorption, if not otherwise determined by Council, the maintenance hole shall be refilled and the loss of water during the following thirty minutes measured. The test on the maintenance hole will be considered satisfactory provided the water lost is less than 3 mm depth in the top section of the maintenance hole for each 1 metre depth of the maintenance hole. The depth of maintenance hole is to be taken from the bottom of the maintenance hole cover recess in the cover surround to the invert of the outlet from the maintenance hole. The plug of the outlet shall be fitted with a suitable release for emptying the maintenance hole on satisfactory completion of the test.

3.7. VISUAL INSPECTION AND MEASUREMENT FOR INFILTRATION (REFER WSA 21.5)

Whenever the pipeline is subjected to a significant head of groundwater (i.e. 1500 mm or more above the obvert of the sewer main) provided that groundwater is at least 150 mm above any sideline it shall be visually inspected for infiltration.

The Developer shall propose full details of the method by which the infiltration is to be measured and rectified.

The Developer at his own expense shall determine the head of groundwater by a method acceptable to Council.

3.8. TESTING OF SEWER RISING MAIN

Rising mains shall be pressure tested in order to detect any leakage and defects in the pipeline including joints, thrust and anchor blocks, if any.

Pipelines shall be tested in sections approved by Council as soon as practicable after each section has been laid, jointed and backfilled, provided that: -

- If so specified or if the Developer so desires, some or all of the pipe joints shall be left uncovered until the whole of the section has been successfully pressure tested to the satisfaction of Council
- The pressure testing shall not be commenced earlier than seven days after the last concrete thrust or anchor block in the section has been cast

For the purpose of this subclause, a section shall be defined as a length of pipeline, which can be effectively isolated for testing, e.g. by means of main stop valves. Unless otherwise approved by Council, pressure testing shall not be carried out during wet weather.

During pressure testing, all field joints, which have not been backfilled, shall be clean, dry and accessible for inspection. During the pressure testing of a pipeline each stop valve shall sustain at least once, the full test pressure on one side of the valve in closed position with no pressure on the other side for at least 15 minutes.

Before testing a pipeline section, it shall be cleaned to the satisfaction of the Water Agency and filled slowly with water, taking care that all air is expelled. Purging of air from rising mains shall be promoted by opening air valves. In order to achieve conditions as stable as possible for testing by allowing for absorption, movement of the pipeline and escape of entrapped air, the section shall be kept full of water for a period of not less than 24-hours prior to the commencement of the pressure testing.

The hydrostatic test pressure which shall be applied to each section of the pipeline shall be such that at each point of the section, the test head shall be equal to or greater than the design head specified or shown on the Drawings, but shall not exceed same by more than 20%.

The specified test pressure shall be maintained as long as required by Council, while he examines the whole of the section, and in any case not less than eight hours. For the purpose of determining the actual leakage losses, the quantity of water added in order to maintain the pressure during the period of testing shall be carefully measured and recorded.

The pressure testing of a section shall be considered to be satisfactory if:

a. There is no failure of any thrust block, anchor block, pipe, fitting, valve, joint or any other pipeline component

b. There is no visible leakage

c. The measured leakage rate does not exceed the permissible leakage rate as determined by the following formula:

$$Q1 = (0.000532 + C)\ D.L\ (H½)$$
$$1p$$

Where:
Q1 = permissible leakage rate (litres per hour)
C = a co-efficient as specified hereunder for the particular pipe material and type of joint
D = nominal diameter of pipe (mm)
L = length of section tested (km)
H = average test head (m)
1p = average pipe length (m)

If the measured leakage rate does not exceed that rate calculated by the simplified formula for the type of pipe tabulated hereunder, the determination of the permissible leakage rate on the basis of the formula specified in (c) above will not be necessary. The following simplified formulae are based on the co-efficient "C" and average pipe lengths contained in that tabulation.

TABLE 3.1 SIMPLIFIED APPROACH TO LEAKAGE RATES

Pipe Type	Simplified Formulae	Co-Efficient "C"	Nominal Pipe Length (M)
C.I. & D.I.	Q1 = 0.0105 DL (H)½	0.0548	5.5
uPVC	Q1 = 0.01 DL (H) ½	0.0568	6.0

Any failure, defect, visible leakage and/or excessive leakage rate, which is detected during the pressure testing of the pipeline or during the Maintenance Period shall be made good by the Developer at his expense.

3.9. INSPECTION PRIOR TO BACKFILLING

All sewerage lines shall be inspected and approved by Council after laying and jointing and prior to the placing of any backfilling.

3.10. CCTV INSPECTION (REFER WSA02-21.8)

At the conclusion of all construction activities and prior to lodgement of a survey certificate application, sewer/ stormwater pipelines within the subdivision development that are proposed to be handed over to Council, are to be inspected using closed circuit television (CCTV). The CCTV footage is to be presented to Council for assessment.

CCTV Inspections shall be completed in accordance with the requirements of WSA05–2013 and shall address both ovality (WSA02-21.6) and grade (WSA02-21.7) compliance with WSAA requirements unless other methods have already done so.

3.11. TOLERANCES ON AS-CONSTRUCTED-WORKS (REFER WSA02-22)

The testing of gravitation sewers shall be in accordance with the relevant requirements and method of testing specified in Section 22 of WSA02.

Before the test is performed, all pipe laying on the section shall be completed and backfill compacted to the level of the centre of the pipe barrel, and the developer shall have requested the Council to check the pipeline for line and grade.

The test may be carried out after risers and/or sidelines are constructed however Council will be reliant on the final test conducted immediately prior to acceptance into maintenance.

Any fault detected is to be rectified and a satisfactory test obtained before the remainder of backfill is placed.

3.12. TESTING OF SEWER PUMP STATIONS (REFER WSA04-36.0)

All testing shall be in accordance with WSA requirements, which are mentioned in the preceding test clauses.

Wet wells and emergency storages shall be pressure tested by either vacuum or hydrostatic test methods as previously defined in the Engineering Guidelines. Infiltration testing shall also be completed on wet wells and emergency structures.

Compaction testing shall be completed on fill surrounding pump stations in accordance with the requirements as detailed in WSA04-36.0 and in accordance with the requirements of this document.

4. WATER RETICULATION

4.1. GENERAL (REFER WSA 10.1)

This section relates to water reticulation acceptance testing. The testing of water reticulation shall generally be in accordance with the latest version of the Water Services Association of Australia (WSAA). However this part of the Council's "Engineering Guidelines" takes precedence over the WSAA Standards. The "Water Supply Code of Australia (WSA03) Part 3 Construction; Third Edition Version 3.1" has been cross-referenced.

All water reticulation shall be subject to testing after construction (NATA accreditation is not mandatory). The tests shall be carried out before release of the Approved Plan of Subdivision.

Should the water reticulation fail any test, defects shall be detected and repaired and the test repeated. The process of testing, detection and repair of defects and retesting shall continue until a satisfactory test is obtained.

4.2. ACCEPTANCE TESTING (REFER WSA 19)

4.2.1. Hydrostatic Pressure Testing (Refer WSA 19)

All pipelines including services shall be pressure tested to detect and repair leakage and defects in the pipeline including joints, thrust and anchor blocks, if any. The method of setting up and carrying out the test shall be in accordance with the requirements of WSA pressure testing section 19.4.

Pipelines shall be tested in sections approved by the Water Agency as soon as practicable after each section has been laid, jointed and backfilled provided that:

- If so specified or if the Developer so desires, some or all of the pipe joints shall be left uncovered until the whole of the section has been successfully pressure tested to the satisfaction of Council

- The pressure testing shall not be commenced earlier than seven days after last concrete thrust or anchor block in the section has been cast

For the purpose of this clause, a section shall be defined as a length of pipeline, which can be effectively isolated for testing, eg by means of main stop valves.

Unless otherwise approved by Council, pressure testing shall not be carried out during wet weather.

During pressure testing all field joints, which have not been backfilled, shall be clean, dry and accessible for inspection.

During pressure testing of a pipeline each stop valve shall sustain at least once the full test pressure on one side of the valve with no pressure on the other side for at least 15 minutes.

Before testing a pipeline section, it shall be cleaned to the satisfaction of the Water Agency and filled slowly with water, taking care that all air is expelled. Purging of air from reticulation shall be prompted by opening hydrants.

In order to achieve conditions as stable as possible for testing by allowing for absorption, movement of the pipeline and escape of entrapped air, the section shall be kept full of water for a period of not less than 24-hours prior to the commencement of the pressure testing.

The minimum hydrostatic test pressure, which shall be applied to each section of the pipeline, shall be 1.2 MPa.

Should the various works not be sufficiently completed to enable the supply to be thus provided when the pipeline is ready for testing, the time for testing shall be postponed until such is the case. Alternatively, the Developer may adopt other measures for supplying the water, but shall have no right to claim for any expenses that may be incurred thereby.

All expenses in connection with testing shall be borne by the Developer. The Developer shall have no claim for compensation or damages in respect of any postponement of the testing.

4.2.2. Disinfection (WSA 20)

All new or replacement water mains equal or greater than 100 mm diameter must be disinfected prior to being brought into service. Bacteriological testing and disinfection procedures shall be in accordance with WSA 19.7 and 20.

Disinfecting can only be carried out by appropriately authorised personal to the Council's Disinfection Procedures.